March 2025

CAN Newsletter

Hardware + Software + Tools + Engineering

Service robots

Embedded networking in modular service robots

European Robotics Forum

Robotic arms and end-of-arm tooling

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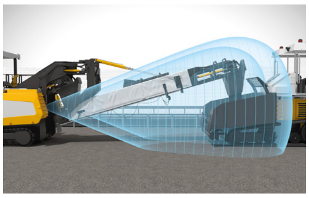

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CiA booth on Embedded World Nuremberg 2025 trade show

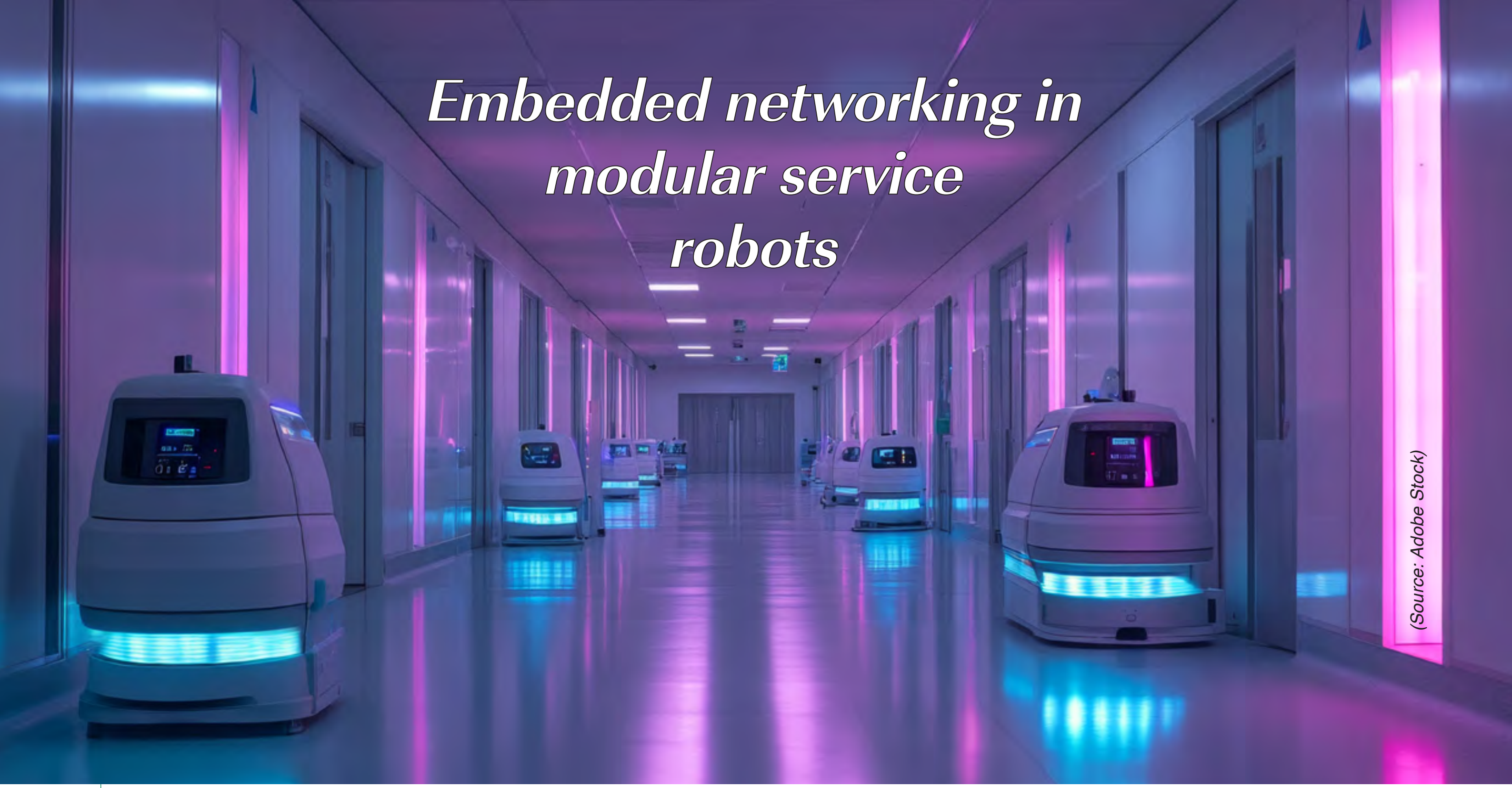
In hall 1 (stand 203), CiA shows three CAN FD light demonstrators by Bosch, STMicroelectronics, and Vector. Additionally, some CiA members exhibit devices by means of the CANopen product wall. The Embedded World trade show takes place in Nuremberg (Germany) from March 11 to 13.

CAN FD light is a commander/responder communication approach based on the CAN FD data link layer with up to 64-byte data field per data frame. It is internationally standardized in an annex of ISO 11898-1:2024. CAN FD responder nodes do not require costly external circuitry such as precise clocks. They are intended for applications, in which one commander node, a normal CAN FD protocol controller, manages the communication to multiple responder nodes. Bus arbitration is not necessary: The commander node has always the communication initiative. Bosch's demonstrator uses the company's CAN FD light IP cores implemented in FPGAs. The network by STMicroelectronics is based on their microcontrollers with on-chip CAN FD light responders. Vector demonstrates its CAN FD light design and diagnostic tools.

This CAN Newsletter issue contains some preliminary news and reports about CAN products presented on the Embedded World trade show.

Holger Zeltwanger

Embedded networking in modular service robots



(Source: Adobe Stock)

CAN is a preferred communication technology in service robots. CAN networks are used to communicate between several modules. Standardized CAN interfaces would be helpful to increase the market for provided modules, e.g., for navigation or for handling purposes.

Unfortunately, it is unclear, what belongs to the modular service robot market. Additionally, the markets of service robots are highly fragmented. This means, the production volumes are very low. Many of them are unique, meaning they are single units. But in total, it is a huge market, which is increasing. The nonprofit International Federation of Robotics (IFR), established in 1987, reported for 2023 a 30-percent increase for service robots, summing up to 205000 units. Nearly 80 percent (162284 units) of the service robots are developed in Far East: China, Japan, and Korea are in the lead. Europe follows with 33918 units.

"The service robotics industry is on the move: more and more robots are serving on factory floors, in shopping centers, or helping with deliveries on the street," said Marina Bill, the IFR president. In 2023, about half of the service robot market was installed for transportation and logistics.

In the U.S.A., medical service robots are booming. There are about 199 companies developing modules for applications in hospitals and other healthcare robots. Many of them are small and start-up companies. In China, there are some 107 service and medical robot manufacturers. The proportion of Chinese companies offering professional service robots is higher than in North America. In Germany, IFR counted 83 companies developing service robots or modules. These IFR figures seemed to be conservative compared with other market research. The Association for Advanced Automation (A3) reported an annual production of about 500000 logistics robots, for example. There is also the question: Are agriculture robots belonging to the service robot markets?

In general, service robots are different from industrial robots, which are used, for example, for welding and assembly purposes. Service robots are used in non-industrial environments for hospitality, healthcare, and home maintenance purposes or for logistics tasks. Agriculture robots have some similarities: Predictability is not always given, because of the changing environments. Professional cleaning robots have also some similarities with some service robots.

Common to all kinds of service robots is the navigation and the movement in not predictable environments. They need to avoid obstacles, to find an efficient path, and to perform tasks without permanent supervision. Therefore, service robots use advanced sensors to understand the surroundings. Increasingly, they are supported by AI (artificial intelligence).

Technical challenges for professional service robots

These challenges include navigation, dexterity of control, and cognition for human interaction. Improving vision software would help to navigate professional service robots. To automate non-factory tasks in a challenging environment is still in an early stage. Dexterity is a key issue, because unlike industrial robots, service robots are often not operated behind cages. Their actuation power should be limited, in order to avoid damage of human beings or handled objects (e.g., plants and animals in case of agriculture robots). This is the same as with robots

XML schema for inter-module communication

CiA is going to submit a proposal for an XML schema describing OSI (open systems interconnections) layers and sublayers. This is a generic approach for wired and wireless communication technologies. Of course, it is suitable for CAN-based networks, too.

Table 1 shows the OSI layers and sublayers, which defines the communication interfaces of service robot modules. Not all of them need to be defined. However, the more are defined the higher is the level of compatibility and interoperability.

The value definitions of the shown communication functions are defined in separate tables. As an example, the defined values for CAN-based PMA (physical medium attachment) sublayers are given in Table 2.

Using these definitions in an XML schema allows the service robot module supplier to describe all implemented communication interfaces. For the system designer, it is possible, to check the compatibility and interoperability of communication interfaces of a module with other modules. The higher the granularity of definitions, the more valuable is the statement of compatibility and interoperability.

In the case of the PCS (physical coding sublayer), the definition should provide information about the selectable bit rates as well as the sample points. To simplify this, existing documents such as CiA 301 (CANopen CC application layer and communication profile) or CiA 1301 (CANopen FD application layer and communication profile) should be referenced. The XML schema for communication interfaces also can reference optionally the related CANopen XML schema (CiA 311 respectively CiA 1311-1), in order to provide more detailed information.

Table 1: Definition of OSI layers/sublayers and communication functionality

Function	Data type	Entities	Reference
PMD	uint16	1	Table with value definitions
PMA	uint16	1	Table with value definitions
PCS	uint16	N	Table with value definitions
DLL	uint16	N	Table with value definitions
NL	uint16	N	Table with value definitions
TL	uint16	N	Table with value definitions
SL	uint16	N	Table with value definitions
PL	uint16	N	Table with value definitions
AL	uint16	N	Table with value definitions
SafetyProtocol	uint16	N	Table with value definitions
SecurityProtocol	uint16	N	Table with value definitions
NetworkRedundancy	uint16	1	Table with value definitions
Profile	uint16	N	Table with value definitions

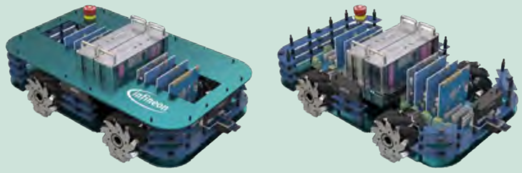
Table 2: Value definitions for the PMA sublayer

Value	Transceiver type	Remarks
0000_h	Reserved by document	
0001_h	CAN-HS transceiver (ISO 11898-2:2024)	No low-power and no selective wake-up capability
0002_h	CAN-FD transceiver (ISO 11898-2:2024)	No low-power and no selective wake-up capability
0003_h	CAN-SIC transceiver (ISO 11898-2:2024)	No low-power and no selective wake-up capability
0004_h	CAN-SIC-XL transceiver (ISO 11898-2:2024)	No low-power and no selective wake-up capability
0005_h to $FFFD_h$	Reserved for other PMA implementations	
$FFFE_h$	Proprietary	
$FFFF_h$	Not provided	

collaborating with humans on the factory floor. A better face-to-face interaction with humans requires an improved cognition. For all these improvements a reuse of modules would help to decrease development effort and to reduce production costs for a dedicated single service robot.

The core modules of service robots are sensors, actuators, and processing units. Advanced features such as collision avoidance or room modeling require built-in radars and other complex sensors. Smart navigation modules require sensor fusion, and smart handling ▷

Robotics development platform



Robot development platform with enclosure (left) and without enclosure (right) (Source: Infineon)

Infineon offers a development platform for mobile (service) robots. The one-stop shop approach consists of several modules equipped with semiconductors provided by the German chipmaker. Some modules feature CAN connectivity. For example, the central control and HMI (human machine interface) module (also known as motherboard) is based on the XMC microcontroller series featuring one on-chip CAN FD protocol controller and one CAN FD transceiver. Up to four motor control units, two battery management system modules, two power distribution modules, and one LED module are part of the platform. They also can communicate via on-module CAN FD ports. *hz*

modules are based on multiple electrical motors. The variety of modules is very high. Scalable modules are the demand.

Standardization of modules

It is hard to standardize service robot module interfaces for all small and niche markets. There are too many variants. Nevertheless, a kind of standardization is needed to find service robot modules originally developed for another kind of robot application. In the ISO/TC 299/WG 6, experts have developed a standardized description of service robot modules by means of an XML (extensible markup language) schema. The ISO 22166 document series standardizes also the electronic description of communication interfaces. This includes all seven OSI (open systems interconnection) layers. The intention is that the robot service developer can select appropriate modules with compatible and interoperable communication interfaces by means of these standardized descriptions.

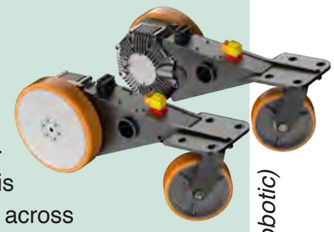
Unfortunately, the first edition of the ISO 22166 series does not specify sufficient details regarding the communication interface description. The second edition will improve this. It is intended to provide in a standardized way information about the used connector including pin-assignment. The description of the CAN physical medium attachment (i.e., transceiver) and the supported bit rates including sample-point location will be standardized, as well. For CAN-based interfaces, the data link layer variants (CAN CC, CAN FD, or CAN XL in the future) will be provided as well as the supported higher-layer protocols (i.e., CANopen CC or CANopen FD).

Of course, the interface description also may cover the application functionality by means of implemented device or application profiles. A typical example is CiA 402 for a simple robot wheel. A more complex wheel with a steering function would need a profile, which is not yet available. A navigation module profile specification is another example, which could be desired. Grippers and other handling modules are further examples for profile specifications to be developed. ◀

hz

Brief news: Service robot wheel drives

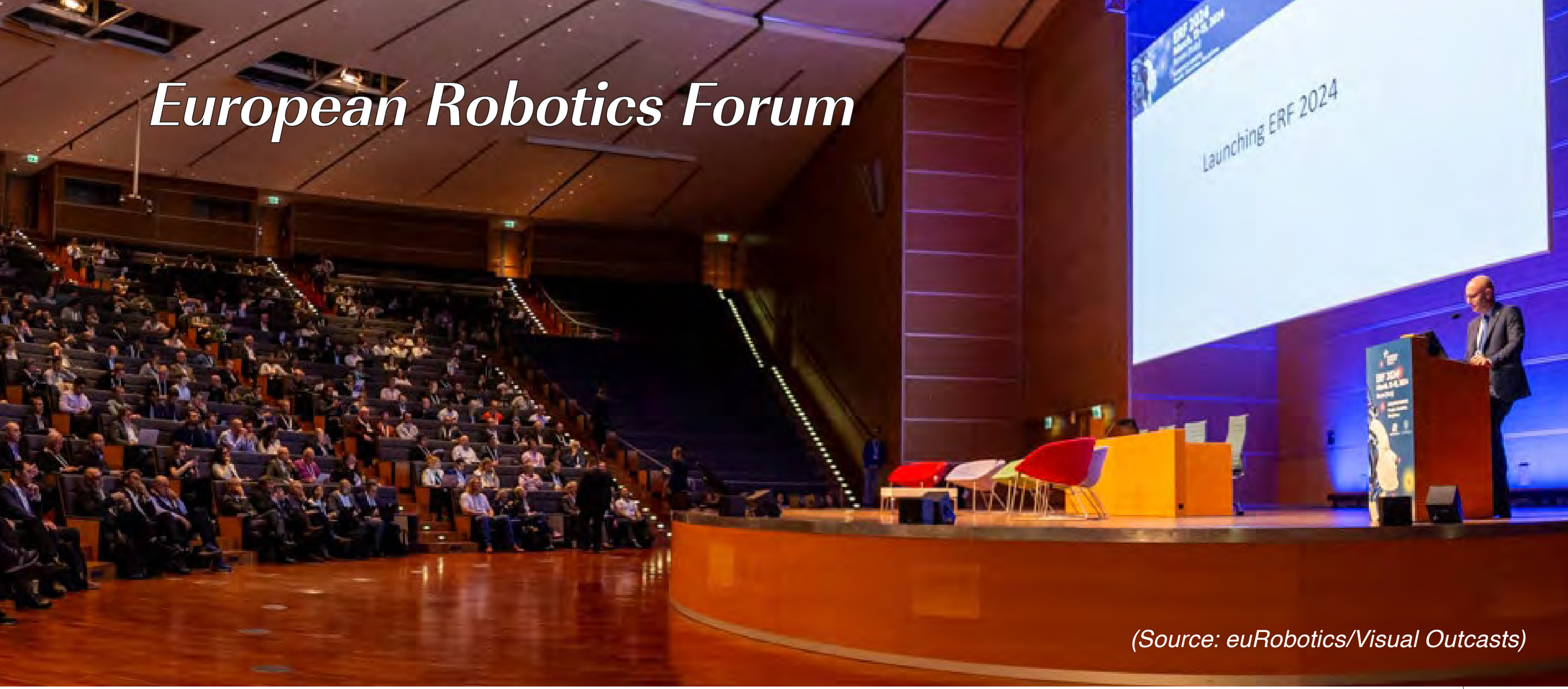
- ***Bluebotics:*** The Ant Lite+ CANopen host controller can control the Smartris CiA 402 compliant drives for service robots by Suitomo (Japan). The wheel drive units are available in different sizes. The host controller calculates the motion by means of x, y, and angle coordinates directly or via a PLC. There are more than 6000 Ant Lite+ units in operation. This includes also automated forklifts.
- ***Heidrive:*** The Heimotion servo motor units with reinforced planetary gears can be controlled by the company's CANopen-connectable controllers. They are available with an output power of up to 2300 W. A discrete safe encoder signal can be provided for a higher-level safety controller. The products are intended for AGVs (automated guided vehicles) and AMRs (autonomous mobile robots).
- ***Metronix:*** The Smartservo drives optionally equipped with a CANopen interface come in IP67-rated housings. They are suitable to be integrated into AMRs. The flagship is the BL 4840-M servo drive, which can be mounted on the motor. It measures 66 mm x 80 mm x 125 mm. The output power is 700 W.
- ***Mobotic:*** The Mobodrive DD drive systems are available with a CANopen interface. They are configurable and the motor controller is integrated. The products are used across various industries including intralogistics, agriculture, heavy load transportation, and healthcare.



(Source: Mobotic)

- ***Nanotec:*** The WD42 wheel drive with a length of 103 mm is designed for AGVs and service robots. They consist of a BLDC motor, a planetary gearbox, a magnetic encoder, and an exchangeable wheel. The products can be connected to the company's motion controllers providing CANopen connectivity. They feature a nominal speed of up to 2,2 m/s and a rated power of 183 W. Wheel diameters from 75 mm to 140 mm and four reduction ratios are available to meet individual requirements.
- ***Zhongling Technology:*** The ZLAC8030L wheel servo drive features a CANopen interface compliant with the CiA 402 profile. The default bit rate is 500 kbit/s. The products are used in AGVs as well as in cleaning and agriculture robots. Overvoltage and overcurrent protection is integrated. *hz*

European Robotics Forum



(Source: euRobotics/Visual Outcasts)

From March 25 to 27, the European Robotics Forum (ERF) 2025, takes place in Stuttgart, Germany. Over 1300 attendees are expected. Organizer is the European robotics association euRobotics in cooperation with the Fraunhofer-Gesellschaft with its institutes IPA and IAO, the University of Stuttgart, and Cyber Valley.

For the first time in its 15 years, ERF is coming to Germany. The European robotics community meets in the Liederhalle, located in the heart of Stuttgart. ERF is an event for robotics and artificial intelligence (AI) and this year's theme is "Boosting the synergies between robotics and AI for a stronger Europe". The aim is to bring together research and industry, presenting the current state of robotics and AI. In many robots, embedded CAN-based networks are used to communicate between robot modules. Especially, drives and motion controllers are networked via CAN. CAN-connectable sensors feed the AI-based controllers navigating the robot or controlling the manipulating equipment such as grippers, etc.

"The increasing integration of robotics with artificial intelligence, cognitive systems, and machine learning holds tremendous potential for our economy and society. It is crucial for Germany and Europe to not only use these technologies but also to develop them. This is the only way we can actively set standards and secure a leading position in international competition," said Prof. Holger Hanselka, President of the Fraunhofer-Gesellschaft. "The Fraunhofer-Gesellschaft is making an important contribution by advancing these technologies while also supporting companies and SMEs (small and mid-sized enterprises) in fully exploiting the potential of service and industrial robotics. I am delighted that we are supporting the European Robotics Forum as a research partner."

An exhibition and interactive opportunities bring robotic applications to life (Source: euRobotics/Jon Agirre Ibarbia)

ERF features a range of event formats, including keynotes, lectures, and workshops. There are more than 50 workshops with topics like application trends in industrial and service robotics, generative AI in robot programming and control, regulatory AI Act, or humanoid robots. In addition, individuals and companies can apply for several euRobotics awards, which will be presented during the event. Networking and professional exchange also play a role, which include two evening events and site visits to the regional robotic ecosystem.

Germany is the country with the highest number of euRobotics members and the highest robot density in Europe, with 429 robots per 10000 employees. This puts Germany in fourth place worldwide, with South Korea in first place with 1012 robots, according to an annual survey by the International Federation of Robotics. AI-based robotics is also a strategic cornerstone of German and European economic and science policy to tackle social challenges such as demographic change and labor shortages. An impetus for this will also come from the conference "AI-based Robotics 2025" (KIRO), which is integrated into ERF and is carried out by the German Federal Ministry of Economic Affairs (BMWK) and of Education and Research (BMBF). ◀

hz

Robotic arms and end-of-arm tooling

Some service robots are equipped with robotic arms and end-of-arm tools for different purposes. Some of them provide CAN connectivity.

Service robots are increasingly used to serve human beings and are applied in agriculture and in healthcare as well as in other application domains. Some of them have a robotic arm similar to robots suitable for factory automation. The same is true for the end-of-arm tools.

To control the robot arm movements, there are four types of applications, according to an Advantech whitepaper [1]:

- Single operation
- Vision integration
- Multi-tasking collaboration
- High-precision control

Normally, service robots do not require high-precision control and, in most cases, they are moving slowly, especially, if they interact with human beings. Single-operation tasks, repeating something, is also not done by service robots; they collaborate with human beings or distribute meals and medicine, for example. Vision integration is a need in dedicated applications.

Moving the robot arm is implemented in the robot control software. Standardized communication is more than helpful, to reduce programming effort. The CiA 402 profile for drives and motion control internationally standardized in the IEC 61800-7 series (Part 201/301) is a common approach used for controlling robot arm joints. CiA 402 software can be easily integrated into the open-source Robot Operating System (ROS) middleware.

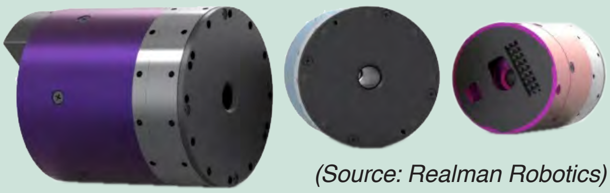
The latest version, ROS2, provides a set of frameworks for robot control. These frameworks cover a range of robot control applications, including:

- Positioning
- Low-level motion execution and interaction with other devices
- Perception via sensors and/or cameras

A data bus based on DDS (Dynamic Distribution Service), a middleware protocol, and an API (application programming interface) provide both modularity and flexibility. The ROS2 software typically sits on top of a real-time Linux environment. Appropriate software drivers and a CANopen protocol stack can control the robot arm peripherals that include motor controllers. If there is one drawback with ROS2, deploying it on hardware can prove ▷

Lightweight robot arm

Realman Robotics (China) has developed the ECO65 series of robotic arm joints designed for humanoid robots. The products feature CAN FD connectivity. The used higher-layer protocol is manufacturer-specific. It is called Tiny Mighty Dynamic Joint Actuator CANFD Communication Protocol. It is a simple commander/responder protocol. The commander message is structured as follows: The first byte contains the command type, the second byte provides the control table index, and the third and fourth byte are the command parameter. The read command has one byte of data representing the number of memory table registers to be read; and the write command consists of two data bytes, which are the contents to be written to the memory table, with the lower bits coming first.



(Source: Realman Robotics)

The response message has the same format as the command message. If the joint device receives a read command, the response message provides the data with the specified length.

If the joint device receives a write command, the response message indicates whether the operation was successful, with 01_h meaning successful, and 00_h meaning failed. When the transmitted command message does not meet the protocol requirements, the actuator returns a CMD_ERR response message. *hz* challenging. The advice here is to seek out a pre-integrated and pre-validated ROS2 bundle that also contains useful packages like MoveIt for motion planning. Advantech recommends to choose host controllers, which support for example Codesys, in order to reduce development effort. This enables the control of robot arms in real-time, regardless of the selected operating system (i.e., Linux, Ubuntu, or Windows). For future service robot application, AI (artificial intelligence) routines need to be integrated on top of the motion control software. Marc Segura, president of the ABB Robotics Division said, AI is enhancing robots' ability to grip, pick, and place. This is also true for service robots. Advantech offers ROS2 software suites supporting CANopen and CiA 402 for industrial robots, which can also be used for service robots.

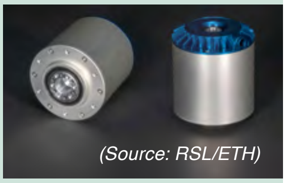
Communication between robot-arm controller and tools

Usually, at the robot arm's end is applied a tool. This can be a gripper or any kind of tool, including sprayers and dispensers. The tool has impacts on the arms kinematics. In case, the end user can change the tool, the kinematics need to be adapted automatically. As the robot moves, the physical forces at work around it affect the inertia, although often simultaneously creating undesired effects in the settling time and precision, and causing torque sensors to read problematic motion and faults on the motors. The tool always has some weight. When the arm swings, the motors must deliver more torque (and current) to accelerate to the given velocity and keep it constant. If too much current is required, this can be interpreted as a collision, and the robot shuts off power to the motor. This should be avoided. Therefore, the tool provider should provide the weight and the center of mass details to the robot, in order to calculate, how much current is required to move the joints. If the end user changes the tool, this information needs to be communicated by some means to the robot arm controller. CAN is an option. A CANopen profile for end-of-arm tools would enable interoperable communication with the arm controller. This would reduce integration effort.

Collaborative service robots require a functional-safe arm movement and also functional-safe end-of-arm tools. This can include used embedded communication networks. CANopen Safety as standardized in EN 50325-5 fulfills this requirement. ◀

hz

Elastic CANopen joints


(Source: RSL/ETH)

Already in 2016, Robotic Systems Lab of ETH Zuerich university developed the Anydrive joint applied to the four legs of the Anymal robot. The joint unit is built upon high-torque motors and harmonic drive gears in series with a rotational spring. Joint output position and spring deflection are measured using absolute position sensors providing a position accuracy of 0,025° and a torque resolution of 8 mNm. Due to integrated motor control electronics, joint torque, position, and impedance can be directly regulated without any additional components. The corresponding command values are sent over a CANopen network. The maximum bit rate is 1 Mbit/s. With a nominal 48-V voltage, the joint reaches a speed of 12 rad/s and a maximal torque of 40 Nm. The joint housing is IP66-rated. Integration into ROS (robot operating system) middleware is supported. *hz*

CANopen-based robot arm


(Source: Servosila)

Servosila located in Dubai (UAE) has developed a CANopen-connectable robot arm. It is designed for mobile service robots. The product is usually mounted on a chassis or a torso of a mobile robot and powered by the host robotic platform. The robotic arms can be used outdoors and indoors. They are water-tight, dust-proof, and function in rain and snow. They are controlled via a CANopen network. The robot host controller sends commands to the servo actuators of the robotic arm and receives execution reports from them. For convenience, an external USB-to-CAN adapter (dongle) is supplied with robotic arms.

The robot host controller runs either Linux or Windows or no operating system at all as long as it provides a CANopen interface. A software package for ROS, an open-source robotic operating system, is available online for those programmers or researchers, who prefer using ROS. The robotic arms come with a package of software tools for configuring, testing, health-checking, and fine-tuning the arms. The software shall normally be installed on a laptop computer or a PC that gets connected to the arm via a USB-to-CAN adapter, whenever the arm needs to be serviced.

The robot arm is equipped with either a rotating or a non-rotating gripper optimized for grabbing objects from the ground or from various heights. Opening doors by rotating the door handles is a key design use case. The grippers might have provisions for installing additional instruments such as dirt digging claws or drills.

The fingers of the gripper come with hardpoints for connecting external tools. The hardpoints on the fingers and on the chassis come handy when the robot needs to be adapted for a specific remote engineering operation. For example, special claws at the tips of the gripper fingers enable the robot to drag suspicious objects such as left bags, cut open holes, or gently open the bags. According to the supplier, the claws also enable the robot to dig dirt or pick objects hidden under piles of rubbish. The claws are optional and field-installable. *hz*

(Source: CSS Electronics)

Fleet electrification of Danish police cars

A recent case study by CSS Electronics shows how the Danish National Police uses the CANedge1 data logger with GPS/IMU (global positioning system/inertial measurement unit) in a vehicle electrification evaluation for patrol cars.

The Danish National Police is the highest authority within the Danish police. The Centre for Fleet and Equipment Management is responsible for managing the police vehicle fleet, amongst other responsibilities. The project was led by Carsten Noerregaard, Special Consultant at the Danish National Police.

As part of the green transition, the Danish National Police decided to conduct a pilot test of 10 electric uniformed patrol vehicles (VW ID.4 GTX) with the goal of evaluating their performance in daily operational situations. One key aspect was to determine if the EV-based range would impose any limitations on regular patrol duties.

To avoid purely anecdotal evidence, the police aimed to collect vehicle data from the 10 pilot EVs (electric vehicles) and compare it to a benchmark fleet of 100 fossil patrol vehicles. The data collection was to be conducted through all of 2023 across four police districts (due to geography being a significant factor).

Realized solution

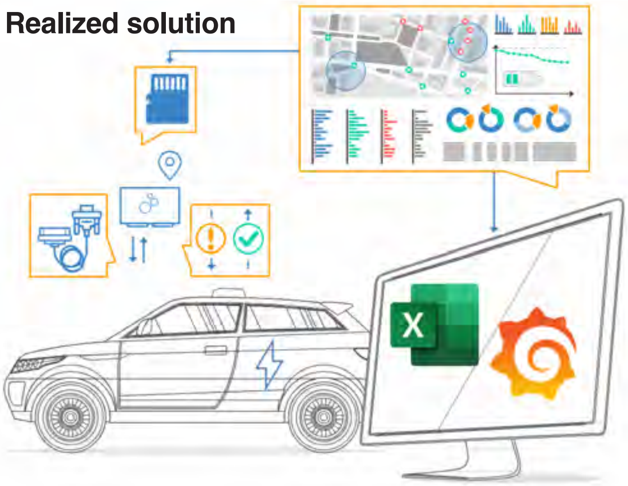


Figure 1: Case study setup (Source: CSS Electronics)

To solve this, the team used the CANedge1 including GPS/IMU from CSS Electronics to collect the vehicle data, as well as provide the GPS data required for the analyses. The data logger enabled the collection of various parameters of interest, including state of charge, speed, temperatures (battery, indoor, outdoor), position, trip distance, and more.

The device was configured to request data via the vehicle OBD2 (on-board diagnostics) connector. The specific CAN-based higher-layer protocols involved were OBD2 (from the ICE cars) and UDS (from the VW ID.4 EVs).

The data was collected from the device SD cards periodically and processed through a Python script in order to create decoded data for analysis. Importantly, the script also added custom geofence information, allowing the Danish National Police to e.g., evaluate the duration a vehicle would spend within a certain police station (i.e., an area with charging facilities) versus on-the-road.

The resulting dataset comprised several gigabytes and was analyzed through the use of Excel pivot tables and Grafana dashboard visualization. This allowed the team to produce reports that could be used as data-based supplements to the first-hand driver experiences. You can view a Grafana dashboard playground for the ID.4 electric car here.

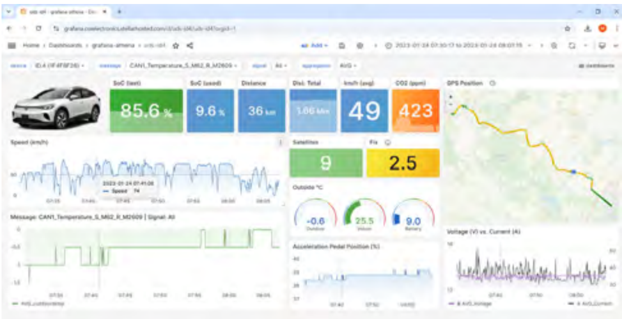
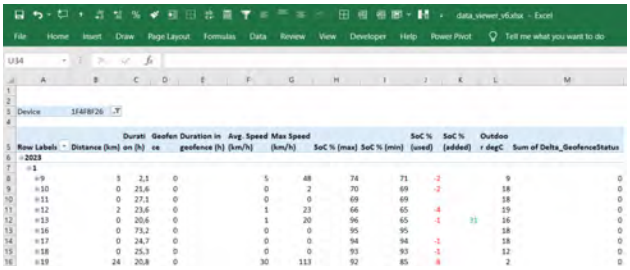


Figure 2: Grafana dashboards were used to provide ad hoc data visualization (Source: CSS Electronics)



Device: 1F4F8F26

Row Labels	Distance (km)	Duration (h)	Geofence	Duration in geofence (h)	Avg. Speed (km/h)	Max Speed (km/h)	SoC % (max)	SoC % (min)	SoC % (used)	SoC % (added)	Outdoor degC	Sum of Delta_GeofenceStatus
2023												
1												
9	5	2,1	0		5	48	74	71	-2		9	0
10	0	21,6	0		0	2	70	69	-2		18	0
11	0	27,1	0		0	0	69	69			18	0
12	2	23,6	0		1	23	66	65	-4		19	0
13	0	20,6	0		1	20	96	65	-1	31	16	0
16	0	73,2	0		0	0	95	95			18	0
17	0	24,7	0		0	0	94	94	-1		18	0
18	0	25,3	0		0	0	93	93	-1		12	0
19	24	20,8	0		30	113	92	85	-8		2	0

Figure 3: Excel pivot tables were used in analyzing the aggregated data (Source: CSS Electronics)

In terms of benefits, the collected data has provided extensive and solid knowledge of usage patterns for patrol cars assigned to different types of tasks. In that respect, the data has formed an important and necessary part of the foundation for the decision to phase in electric vehicles for operational tasks in the coming years.

Figure 4: Ten VW ID.4 GTX vehicles were used in the electrification project (Source: CSS Electronics)

Carsten Noerregaard stated: “The CANedge1 made it possible to investigate and document usage patterns for existing ICE-vehicles to evaluate the potential for deployment of EVs – and we received perfect support. We needed a data acquisition device that could reliably collect data through the extended period of time for our trial period. We did consider more classic telematics devices, but ended up deciding on the offline solution provided by the CANedge1, in part to secure sensitive data from exposure. Other key factors included the compactness of the device and the detailed support provided by CSS Electronics in both device configuration and post processing.”

Outlook

This collaboration has also helped inspire CSS Electronics to introduce new software/API (application programming interface) tools that ease the analysis of ‘big data’ resulting from CAN/LIN data logging. In particular, users are now able to deploy automated integrations that DBC-decode their data (using a data base CAN file) into Parquet data lakes for visualization/analysis in Grafana, Python, and Matlab. You can learn more about more than 100 other case studies from CSS. ◀

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FACTS & FIGURES

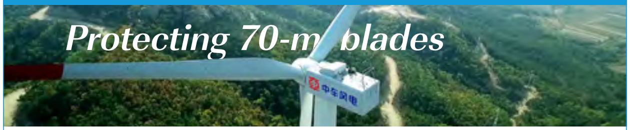
Lifting 40000 t and more

(Source: Mammoet)

Hycom, a Hydac daughter company, provides hydraulic systems. With the precision of millimeters, multiple hydraulic cylinders are controlled via CANopen. The Dutch company, established in 1974 and 2013 integrated into the Hydac Group, has developed for Mammoet the CANopen-based control system for the shown Mega Jack 5200 hydraulic lift system. The system is used to lift structures weighing over 40000 ton. It can lift more than 40 hydraulic cylinders with a tolerance of half a millimeter. The previous system consisted of a jack with four cylinders and was realized by two dual-axis controllers. If several jack towers were needed, system complexity increased enormously. For the current system Hycom developed a new control concept in less than three months. The company has already made positive experiences with Bachmann, an Austrian company. Hydac and Bachmann are CiA members.

Each tower uses a controller from Bachmann controlling the hydraulic cylinder and the associated diesel engine. Every tower is networked to the central host controller, allowing to move synchronized 40 cylinders and more. An MX207 processor, a PVA208 proportional valve amplifier, an AIO216 analog I/O module, and a DIO232 digital I/O module are applied for each sub-controller. The sub-systems communicate via CANopen with the CM202 host controller. By means of the Scada web interface, the user gets information about each individual cylinder including the exact status of the hydraulic valves. There is also a scope function, which helps to commissioning the jack towers and to troubleshoot them, if necessary. Every channel can be examined in details and analyze the results in Matlab Simulink. *hz*

Protecting 70-m blades



(Source: CRRC Shangdong)

CRRC Shangdong Wind Power (China) relies on the blade-load measurement system from CiA member Bachmann. In order to avoid damaging of rotor blades, the Austrian company has developed the CLS300 cantilever sensors. Two sensors are installed near the hub of each of the three blades and cabled to the control cabinet, where the signals are fed to the GIO212 module. The blade-load values are transmitted from the sensors to the wind turbine main controller via a CANopen network. The host controller evaluates in real-time the measurements with the manufacturer's design values. In case the limits are exceeded, the blade load is reduced by repositioning the rotor blades in relation to the wind (pitch control).

Unlike optical sensors, CLS300 sensors can be re-attached, which leads to lower follow-up costs. They are supplied pre-assembled on a mounting rail. The sensor unit, consisting of a cantilever clamped on one side and a proximity sensor on the opposite side, enables the conversion of a strain measurement into a distance measurement. Due to the inductive displacement measurement, the sensor is not subject to mechanical deformation. This guarantees a long-term stability. *hz*

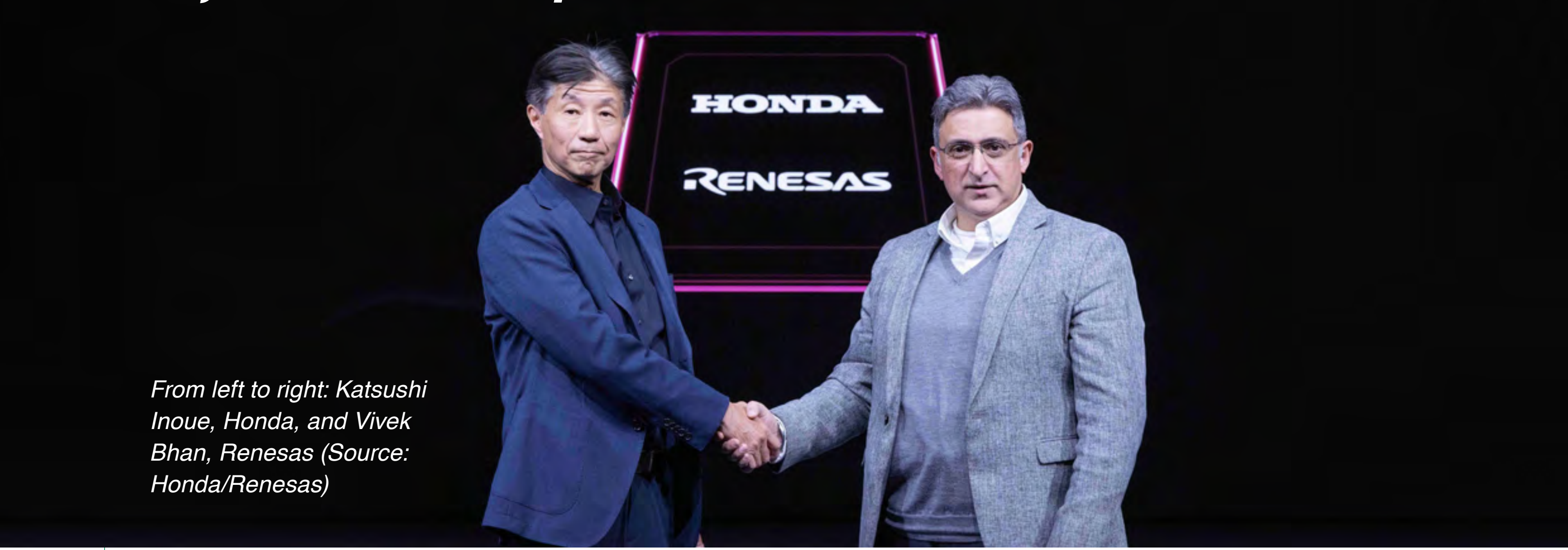
4 CAN interfaces

(Source: Bucher Municipal)

The Flexline 310 sewer cleaning vehicle by Bucher Municipal is based on a CR711S host controller by ifm, coming with four CAN ports. This control unit embeds two independent PLCs (programable logic controllers) and is suitable for safety-related control applications compliant with ISO 13849 (PL d) and IEC 62061 (SIL CL 2). The CAN interfaces can run CANopen Safety, CANopen, or J1939 protocol stacks. The embedded PLCs implement Codesys 3.5.

The vehicles also use the CR0451 display by ifm indicating the operator the necessary parameters. Via CANopen several CR2032 I/O modules are connected to the PLC. The 16 ports can be configured to provide different functionality, for example digital inputs or outputs for controlling proportional valves. The pre-filtering of data not only reduces the CANopen busload, but also simplifies the PLC programming. *hz*

System-on-chip for software-defined vehicles



From left to right: Katsushi Inoue, Honda, and Vivek Bhan, Renesas (Source: Honda/Renesas)

Renesas and Honda agreed to develop an SoC (system-on-chip) for SDVs (software-defined vehicles). It includes an AI (artificial intelligence) processor and a general-purpose microcontroller with multiple CAN FD ports.

Software-defined vehicles demand networked ECUs (electronic control units) with sufficient computing power. In order to reduce the footprint of ECUs, particular tailored SoCs need to be developed in a close cooperation with the carmaker or the Tier-1 supplier. At the CES 2025, Renesas and Honda signed an agreement in this regard. The SoC to be developed is intended for future models of the Honda 0 (Zero) electric vehicle (EV) series. It will be launched in the late 2020s.

The Honda 0 series will adopt a centralized E/E architecture that combines multiple legacy ECUs responsible for controlling vehicle functions into a single ECU. The core ECU, which serves as the heart of the SDV, manages essential vehicle functions such as advanced driver assistance systems (ADAS) and automated driving (AD), powertrain control, and comfort features, in a single ECU. Using TSMC's 3-nm automotive process technology, this SoC can achieve a significant reduction in power consumption. The chiplet is based on the fifth-generation (Gen 5) R-Car X5 SoC series with an accelerator optimized for AI software developed independently by Honda. The two Japanese companies have collaborated closely for many years. The R-Car X5 series can incorporate up to 32 Cortex-A720AE cores and six Cortex-R52 dual lockstep cores with ASIL D (automotive safety integrity level) capabilities without external microcontrollers.

The chiplet offers the UCIe (Universal Chiplet Interconnect Express) die-to-die interconnect and APIs (application programming interfaces), facilitating interoperability with other components in a multi-die system, even if they are non-Renesas chips. This design approach allows automakers such as Honda and Tier-1s to mix and match different functions and customize their systems including future upgrades across vehicle platforms.

Asif Anwar, Executive Director of Automotive Market Analysis, Techinsights, stated: "The path to the SDV will be underpinned by the digitalization of the cockpit, vehicle connectivity, and ADAS capabilities. The vehicle electric/electronic (E/E) architecture will be the core enabler as features and functions are integrated into zonal and centralized controllers that will provide the necessary compute capabilities. Techinsights forecasts the zonal controller and high-performance compute SoC processor market will grow at a CAGR (compound annual growth rate) of 17 % between 2028 and 2031."

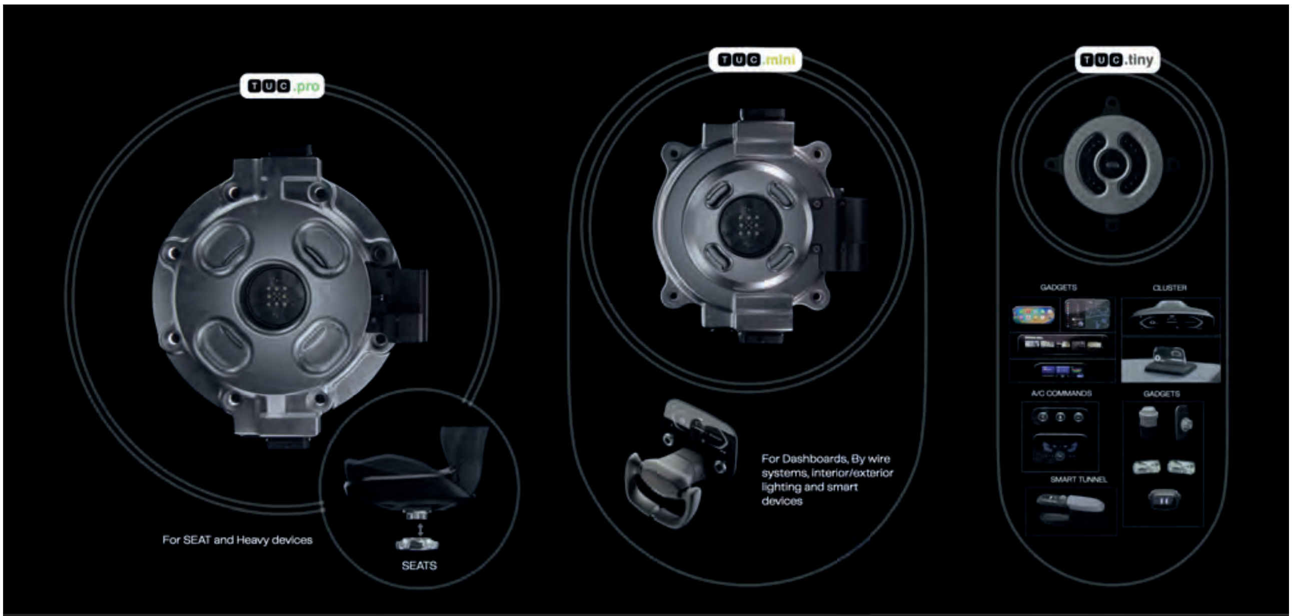
Anwar continued, "Renesas is a top-three supplier of automotive processors and is leveraging decades of experience with its fifth generation R-Car X5H SoC that will scale with the requirements of an SDV. By leveraging the 3-nm process, the R-Car X5H SoC allows the automotive industry to implement a multi-use solution set that can be used across the vehicle platform with optimized power budgets. Combining this with the RoX SDV platform, Renesas can offer a software-first, cross-domain approach that will shorten the time-to-market for the automotive industry."

Until the fourth generation, the R-Car SoCs were designed for specific use cases. The new SoC generation is scalable. On the top end, they are used in so-called zonal ECUs. They need to provide a lot of communication interfaces. The R-Car Gen 5 system-on-chips feature multiple CAN FD ports and several Ethernet interfaces.

Renesas' latest R-Car X5H and all future Gen 5 products are designed to accelerate SDV development by combining hardware and software into a comprehensive development platform. The recently launched R-Car Open Access (RoX) SDV platform integrates all essential hardware, operating systems (OS), software, and tools needed for automotive developers to rapidly develop next-generation vehicles with secure and continuous software updates. ◀

hz

Three types of automotive connectors



The shown connectors are suitable for different purposes (left to right): seats and heavy devices, dashboards and control units respectively infotainment displays, head-up displays and instrument clusters (Source: Tuc)

At the CES 2025 tradeshow, the Italian company Tuc exhibited its automotive connector family, which can be used to connect CAN-interfaced devices to wiring harnesses. There are available three variants. The products are mainly intended for vehicle-interior devices.

All three connector types share technical capabilities, including support for 9-V to 48-V electricity supply (like Tesla's Cybertruck), delivering up to 400 W of power to an attached device. Ethernet T1 is the default data interface, delivering up to 1 Gbit/s throughput. Additionally, the connector has some optional pins for CAN communication. The connectors provide common mechanical, electric, and communication interfaces. They can be pre-installed with the wiring harness.

A vehicle using these connectors can be upgraded with new devices. "Interfaces can be connected using a single cable to create the cabin of the future. The most important benefits are cost saving and customization," stated Ludovico Campana from Tuc. This comes from massive simplification of a car's wiring loom. "With traditional wiring, the same model can have 20 different cables, harness projects and typologies."

Campana also sees his company's technology streamlining and lowering the cost of developing new models, "We are telling automakers that they need to shift their ideas, especially in the mass market, because with this system, they can have a cheaper development process. Without different fragmented architectures and a single interface, they can smooth the chain of development. They can save around 20 % on their model development costs. Then they can open new component business on top of this."

Simplifying will be one benefit of connector standardization. "Another is enabling new business models like an App Store," said Campana. Just as you personalize your smartphone with different applications, having standard connectors could mean you can more easily change interior elements in your car, such as the seats, steering wheel, and infotainment interfaces. "We are like the second wave of the trend Tesla started," explained Campana. "But they are focused on screens. We are building the physical experience, not only a touch screen and interfaces. This is what makes it special because application functionalities and screen customization is cool but is not the complete answer for vehicles because they are objects that you need to live inside."

You can see where these developments are headed by looking towards the Chinese automotive market, which is increasingly focused on emerging technology rather than brand loyalty. When car buyers want the latest gadgets as quickly as possible like this, automakers need to be able to deliver with the shortest development cycle. "We can extend Tesla's vision because they have already made the car architecture simpler," says Campana. "We can help automakers do what Tesla is doing."

"We focused our technology on the cabin of the future, but it could also be applied to some exterior modularity, such as cameras and sensors," said Campana. "You could swap a conventional powered mirror for a camera-based ▷

90° cable entry


Source: Shenzhen Richlight Technologies

The Wellconn CAN-RCFM01 connector by Shenzhen Richlight Technologies (China) has been designed for CAN FD devices. It is suitable for bit rates up to 10 Mbit/s, coming in a galvanized metal housing. The termination resistor is integrated and can be enabled externally using a slide switch.

The connectors are suitable for CAN cables in accordance with CiA 303-1 and CiA 601-1. They feature an outside diameter of 5 mm to 8 mm. The products also can be connected to twisted cables without a shield. *hz*

system. The great potential of this technology is for mass markets. We spent six years making this happen. The lack of standardization is the problem, and we have the solution."

"We now collaborate with three of the top five automakers," reported Campana. "One we can mention is Hyundai Motor Group, which is looking at our open innovation platform. We are just a step before production and development." This still means vehicles beyond concepts are a few years away.

The concept is also suitable for other interior vehicle applications. This includes, especially, cabins of off-road and off-highway commercial vehicles. Those operator cabins are often application-specific. With the launched three connector types and a pre-installed wiring harness, the OEM (original equipment manufacturer) is able to support a high number of cabin variants. This could save costs caused by individual adaptations. Another application could be rail vehicles. ◀

hz

MCU increases performance of motor control systems

Figure 1: PSOC Control MCU family is dedicated for motor control and power conversion systems (Source: Infineon, Adobe Stock)

Infineon Technologies has launched the PSOC Control family of Arm Cortex-M33 based microcontroller units (MCUs) featuring CAN FD connectivity. With support of company's system design tools, the solution allows to create efficient and secured motor control and power conversion systems.

PSOC Control C3 features entry-line and main-line products offering a scalable and compatible range of performance, features, and memory options. Dedicated MCUs for motor control (C3M) and power conversion (C3P) address the needs of focus applications, such as home appliances, industrial drives, robots, light electric vehicles (LEVs), solar, and HVAC (heating, ventilation, and air-conditioning) systems.

"Next-generation industrial motors and power conversion applications require increasingly faster control loops, as these designs adopt wide band gap power devices to improve system efficiency," said Steve Tateosian, Senior Vice President for Industrial & IoT MCUs at Infineon. "We are committed to providing developers with best-in-class system solutions and design environments to take full advantage of the innovative analog and digital technologies of our new PSOC Control family."

The MCUs enable real-time control of systems that need to respond to real-time events with minimal delay and low utilization. The units utilizing the Arm Cortex-M33 processor operate at up to 180 MHz and are supported by a digital signal processor (DSP), a floating-point unit (FPU), and the coordinate rotation digital computer (Cordic). The latter is a hardware accelerator for mathematical functions to speed up control loop calculations. All MCUs feature a wide range of peripherals, on-chip memory, as well as various interfaces and pulse width modulation (PWM) architectures. For example, the C3M5 MCU provides two CAN FD interfaces supporting up to 8 Mbit/s in the data phase.

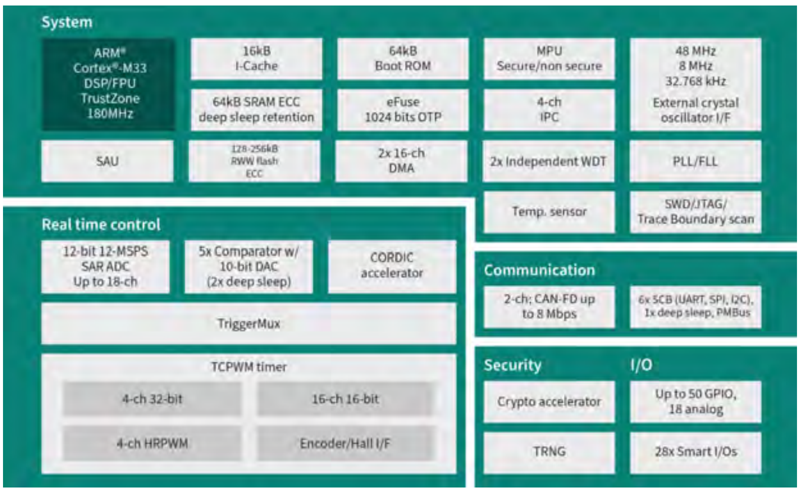


Figure 2: C3M5 main-line MCU block diagram (Source: Infineon Technologies)

The entry-line MCUs C3P2 and C3M2 use high-resolution and high-precision A/D converters and timers. The main-line MCUs C3P5 and C3M5 also offer high-resolution PWMs (HRPWMs), allowing high-performance systems to respond to real-time events with minimal delay. All four series support the execution of power and motor control loops, while the main-line components offer additional features for higher switching frequencies and support for power systems that utilize wide bandgap (WBG) switches.

PSOC Control C3 MCUs are equipped with safety features such as Class B and SIL 2 (safety integrity level) safety libraries as well as PSA Certified Level 2 / EPC2 security. The chips come with crypto accelerator, Trust-zone, and secured key storage, enabling IP protection and device firmware updates.

The MCU family is supported by Modustoolbox, a unified ecosystem platform with tools and software solutions. The toolbox offers dedicated ecosystems and software libraries, Motor Suite and Power Suite, for the focus applications of the MCUs. The suites provide a graphical user interface that streamlines evaluation and training, and provides real-time parameter monitoring for valuable insights into performance, efficiency, and reliability. Specialized application environments enable engineers to identify issues, optimize designs, and enhance overall functionality.

The PSOC Control C3 entry line and main line features 34 devices that are available since January 2025. Infineon will further expand these product lines and is developing a performance line that will sample later this year. Infineon showcases a demo of the launched PSOC Control MCUs at Embedded World Nuremberg 2025 in hall 4A, booth 138.

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Compact controllers in mobile automation

(Source: Adobe Stock)

B-Plus is a specialist in automation of mobile machinery. The company offers compact solutions for a variety of applications, particularly for the construction sector.

Compact controllers are indispensable in the world of mobile automation. The primary advantage of such controllers lies in their efficiency. They are streamlined for essential functions, eliminating unnecessary features that are not required for the specific application. For many applications, the functionalities provided by these controllers are sufficient, making the need for expensive and complex systems superfluous. The low programming effort and reduced hardware costs contribute to cost savings compared to conventional control elements. Compact design enables to use the controllers in environments with limited space or for applications that require discreet integration.

B-Plus provides expertise in areas such as industrial engines and truck applications using CAN technology supporting CANopen, J1939, and Isobus higher-layer protocols. The company offers engineering services ranging from the development of custom solutions to the integration of control systems. The flexible controllers are adaptable to the requirements of various applications.

Applications

B-Plus offers a range of compact controllers designed for use in harsh environments of mobile working applications. Housings with protection ratings of up to IP69K ensure safe outdoor use. The controllers can be used for simple automation tasks and are scalable to handle more complex processes. This adaptability makes them a valuable tool for manufacturers in the (special-)vehicle construction sectors. From small construction equipment such as vibrating plates to large truck-mounted concrete pumps, they control hydraulic systems and other functions. Municipal vehicle manufacturers use them to control hydraulic lifting and tipping mechanisms, while fire trucks rely on them to manage operations for booms, pumps, and more.

Programming and system integration

The integration of compact controllers into existing systems is straightforward, thanks to standardized interfaces and protocols such as CANopen, J1939, and Isobus for CAN-based communication.

The compact controllers are shipped with the included STM32CubeIDE development environment. The latter integrates a C-based development environment with a built-in compiler and debugger, along with debugging hardware such as ST-Link V2. The software API (application programming interface) with numerous programming examples allows also newcomers to C programming to navigate high-level programming.

The Mobile Automation Toolbox simplifies software flashing. It enables the identification of connected compact controllers and provides a flash tool for application download and upload. Additionally, CSV parameter files can be downloaded to FRAM, and both FRAM and Flash can be uploaded. The toolbox supports such USB-to-CAN adapters as PCAN-USB from Peak-System and CANfox from Sontheim.

As a service, B-Plus is guiding customers throughout the entire project. This includes consulting on selecting the right controller and providing expert support during implementation. Customized developments are possible as well. In addition to its own developments, B-Plus offers products from its partners ifm, Hydac, and Topcon. These partnerships enable to provide a versatile product range for specific customers' needs.

Actuators and displays

In addition to controllers, the company also provides a range of actuating elements including various CAN-connectable joysticks, keypads, and buttons. For example, the keypad modules are flexible input devices designed ▷

Compact controller series

B-CANCubeX series (Source: B-Plus)

The B-CANcubeX series includes five members. The IP54-protected B-CANcubeNano offers two digital I/Os (inputs/outputs) and a CAN interface. It measures 50 mm x 30 mm x 39 mm. For example, it can serve as a gateway device between EIA-232 (also known as RS-232) and CAN networks. The device is based on a 16-bit microcontroller.

Further devices implement a 32-bit microcontroller and increased I/O functionality. The B-CANcubeMicro (IP67) and B-CANcubeMini (IP54) provide respectively two CAN interfaces. B-CANcubeMini Sealed and CANcubeMini Sealed Plus are equipped with three CAN ports and are protected according to IP67/IP69k categories. The largest family members come with dimensions of 128 mm x 94 mm x 41 mm. The CANcubeMini Sealed Plus is equipped with 8/8 parametrizable analog I/Os, four digital outputs, two EIA-232 ports, and one EIA-485 interface. All named products have an operating temperature range of -40 °C to +85 °C.

for harsh environments. The proportional joystick B-Drive Cab Control enables flexibility and control with intuitive handling. Furthermore, the manufacturer offers a selection of displays from the companies Crosscontrol, Deep Sea Electronics, ifm, Topcon Opus, and TTControl/Hydac. These displays enable visualization of machine data in demanding environmental conditions allowing for monitoring and management of complex processes while machine's operation.

Conclusion

In an era of rapid digitalization and automation, compact and flexible control systems are becoming increasingly important. Their advantages are availability, robustness, reduced programming effort, and possibility for custom adaptations for simple and complex automation tasks. B-Plus continually invests in product development to adapt controllers to changing market requirements and enhance their performance and reliability. Available from stock, small controllers enable rapid integration into projects, which is important for time-critical applications.

B-Plus is exhibiting their products and solutions at this year's Bauma trade show in Munich, hall A3, stand 313. ◀

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CAN-connectable radar sensor

Pepperl+Fuchs has developed a radar sensor featuring CANopen and J1939 connectivity. The product is suitable for use in agricultural machinery and mobile equipment.

Figure 1: Radar sensors are suitable for distance and speed measurements between mobile equipment, i.e., road-construction machines (Source: Pepperl+Fuchs)

The device makes use of the fact that radar waves are reflected or partially penetrated by different materials to varying degrees. On this physical basis, the industrial radar sensors offer three different measurement modes:

- *"Closest distance"* detects the object nearest to the sensor, regardless of the material. For example, distance measurement reliably detects a wide variety of objects in the exit area of a vehicle.
- *"Best reflection"* detects the object with the highest reflection, whereas interfering objects are simply suppressed. For example, the sensor can measure the fill level of a tank through the plastic wall.
- *"Fastest velocity"* uses velocity measurement to detect the object that moves towards or away from the sensor the fastest. This operating mode is used, for example, to monitor the travel path of automated-guided vehicles (AGVs).

Methodological stability

Radar waves are resistant to interference such as rain, fog, wind, dust, and temperature fluctuations. Using the frequency-modulated continuous wave (FMCW) method, the industrial radar sensor generates stable signals for comprehensive detection within the detection range. The hardware is housed in a compact housing with an IP68/69 degree of protection. The rotatable and tiltable sensor head can be aligned to the target area in virtually all installations.

A key advantage of FMCW principle is that the detection of nearly all materials is not limited to specific objects. However, the possible detection range and the measuring range depend on the reflective properties of the target object, the so-called radar cross section (RCS). The larger the RCS, the better the electromagnetic waves are reflected back to the sensor. Depending on the material, the radar waves are reflected back to the radar sensor to different degrees and are therefore detected to a greater or lesser extent. This degree of reflection is also influenced by the thickness, size, and shape of the target object. A flat metal surface offers sufficient reflection and is therefore suitable as a target object.

Multiple corner reflectors are available as accessories. These consist of three orthogonal metal plates and create an effective reflective surface. If a corner reflector made of metal is attached to a weakly reflective object or an object that is not ideally aligned with the radar sensor, its effective reflection area increases considerably. This allows to stabilize measurements on the intended target object and therefore optimize the application.

CAN connectivity

The CAN interface is accessible by means of various connector variants such as M12, Deutsch, and AMP Superseal. Users can choose between variants with CANopen CC (classic) and J1939-21/71 protocol stacks transmitting the measured values and parameterization messages. This enables to integrate the devices into CAN-based networks running at a configurable bit rate, with a default of 250 kbit/s. The CANopen variant uses a proprietary profile with parameters in the object-dictionary address range from 2000_h to 5999_h and the J1939 variant is based on proprietary parameter groups (PGs) as specified in the SAE J1939DA digital annex. Parameters that can be transmitted are status register, distance, signal quality, velocity, and a cycle counter.

The measuring principle, hardware, and signal transmission are designed for robustness. This means that the radar sensor is optimized for use in vehicles and mobile machines both indoors and outdoors. With their long range of up to more than 25 m, they detect an extensive area within the ▷

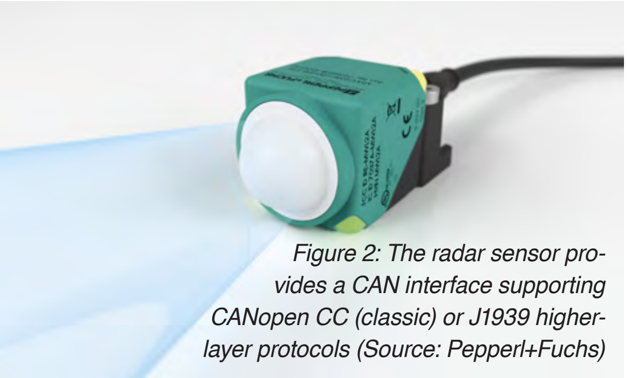

Figure 2: The radar sensor provides a CAN interface supporting CANopen CC (classic) or J1939 higher-layer protocols (Source: Pepperl+Fuchs)

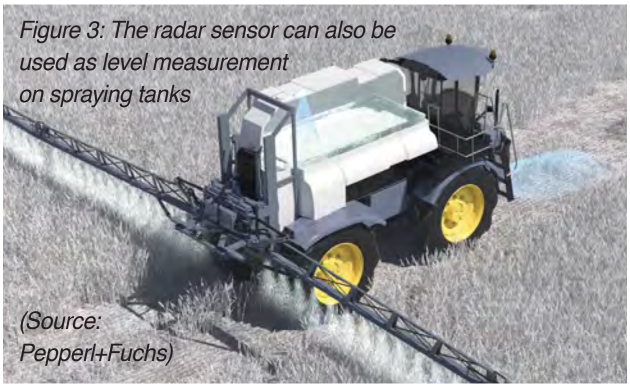

Figure 3: The radar sensor can also be used as level measurement on spraying tanks (Source: Pepperl+Fuchs)

radius of action of vehicles or their booms. To cover multiple areas, several devices can be mounted in close proximity to each other. They do not interfere with each other's function.

Application possibilities

The radar sensor can be used for velocity and environment monitoring in transport systems, crane booms, and construction machinery, among other things. When applied in outdoor machines such as for agriculture, it has to withstand harsh conditions. It can serve different purposes on agricultural machinery, such as speed measurement on seed drills, level measurement on field sprayers, or collision protection on harvesting machines.

The device can measure the actual movement of the vehicles relative to the ground (speed over ground). Bumpy ground is reliably detected and interfering objects such as plants are suppressed. In spray agent tanks, the device measures the fill level through the plastic tank wall and can also be retrofitted. The sensor therefore enables continuous monitoring of consumption to optimize the use of spraying agents. In intralogistics and merchandise management, the industrial radar sensor can perform similar control and safety tasks. It is used on vehicles and transport systems with and without drivers (forklifts, automated-guided vehicles, autonomous modular robots, etc.).

In road construction, a tandem of paver and feeder can be used for placing the pavement. The feeder continuously feeds the paver with material, such as asphalt, while the paver is on the move. It must be ensured that the distance and alignment to each other are correctly maintained at all times. The use of two radar sensors increases precision. Mounted on the feeder, they measure on two corner reflectors attached to the paver. Minimal distance or track deviations can therefore be registered and corrected.

Key features of the industrial radar sensor

- Distance measurement over more than 25 m
- Velocity measurement up to ±80 m/s
- Sampling rate of up to 200 Hz
- Integrated CAN interface supporting CANopen or J1939
- Ambient temperature range from -40 °C to +70 °C
- Working in rainy, foggy, windy, or dusty environments
- Interference-free measurement of the target object through objects with a lower reflection amplitude
- Safety level up to PL c

The radar sensor can be utilized in controlling crane booms. The lobe of a radar sensor mounted in the main boom is directed at a corner reflector positioned in the tip of the hydraulic telescopic element. If this telescopic element moves forward or backward when the boom is extended or retracted, the sensor registers this change in distance and transmits these values to the crane control system as the basis for further positioning operations. Contaminants such as hydraulic oil residues inside the crane arm do not impair the performance of the radar sensors.

Integrated into agricultural machinery, the radar sensor can measure the actual movement of the vehicle in relation to the ground even in rough surface environments. This enables a precise control of agricultural equipment such as field sprayers, harvesters, and seed drills. The efficiency of the process is increased, overlaps and gaps are minimized and the use of seeds, fertilizers, and pesticides can be optimized. The radar sensor can also play a role in level measurement on spraying tanks. It enables monitoring of the fill level through the plastic tank wall, depending on the thickness of the wall, without the need for physical intervention in the tank. This also makes retrofitting possible. In addition, this enables continuous monitoring of the fill level to ensure the correct amount of spray agent is used, maximizing the efficient use of resources, and avoiding overdosing and wastage, while early warning of low levels can optimize operations.

In general, a high speed is an advantage in outdoor logistics. However, forklifts, AGVs, and AMRs operated in factories and warehouses need to consider certain speed restrictions. To relieve personnel of this responsibility, a vertically aligned radar sensor that detects the hall ceiling or metallic cross bracing below can determine whether the vehicle has reached an indoor area. If this is the case, the maximum possible speed is automatically limited to a tolerable level and released again when the vehicle leaves the hall. Due to the reflectivity of the metal crossbars, the installation of a corner reflector is not necessary here.

The safe use of heavy-duty AGVs for liquid or gaseous media places special demands on sensor technology. The dimensions of the vehicles and the associated large monitoring area must be taken into account, as well as the weather influences in outdoor areas. Due to their long measuring range, it is also possible to monitor the flanks of long vehicles. Hereby, outdoor weather conditions do not affect the measurement accuracy. ◀

hz

J1939-connectable radar scanner

Figure 1: The radar scanner at the top of the stacker also records the height of the roller conveyor (Source: Turck)

The MR15-Q80 radar scanner by Turck provides 3-dimensional (3D) data. It is suitable for mobile machines, enabling object detection and collision avoidance.

Some radar sensors for collision avoidance are limited to detecting the distance and thus only output one dimension as a measured value. The MR15-Q80 radar scanner delivers genuine 3D data, improving the mapping of objects and spaces. Due to its robust design, which can withstand shocks of up to 100 g, the product is suitable for mobile machinery, in particular forklifts and automated-guided vehicles (AGV).

Radar technology is usually associated with speed measuring. But since the 2000s, the technology has also been used in road vehicles themselves. Active adaptive cruise control (ACC) systems use radars to determine the distance to cars in front and their speed. Radar sensors have also become popular in industrial automation in recent years. Especially in level and conventional distance measurement, advantages over ultrasonic, optical sensor or media-contacting technologies pay off in many applications.

The J1939 interface uses parameter groups (PG) for data transmission. The MR15 uses a special proprietary PGN (PG number) to transmit not just one, but all process data as well as the radii and signaling zone information. The bit rate is 250 kbit/s. The device does not comply with the ISO 11783 series (also known as Isobus); it does not support CANopen, yet.

Resistant against shock and vibration

In 2020, Turck had presented its first radar sensors for level measurement with the LRS series, followed by the DR-M30 radar sensors for distance measurement in 2021. Both device series operate in the 120-GHz range. Now, the company has launched the MR15-Q80 radar sensor as the third member of its radar portfolio. The shape of the housing alone shows that a new device type has been added to the product range. Unlike the cylindrical devices for distances and levels, the MR15-Q80 has a flat, cuboid design. The technology is also different: A 60 GHz multi-antenna radar chip operates inside the IP69K-rated housing. Compared to the 120-GHz single-antenna chip, this offers the advantage that the actual object position is analyzed and not just the distance value. In addition, the antenna pattern and the 4-GHz bandwidth led to further properties such as a larger and fully adjustable field of view. The radar scanner detects objects with an opening angle of 120 degrees horizontally and 100 degrees vertically. ▷

Figure 2: MR15-Q80 radar scanner is available with J1939 interface (Source: Turck)

The sensor achieves a range of up to 15 m, although this maximum value can also be reduced depending on the material, angle, and surface properties of the objects. However, users do not have to worry about a lack of range as the target applications are primarily object detection and collision avoidance. Foreign objects in the field can be detected better by radar than by alternative technologies. Lidar sensors, for example, require movable mirrors to direct the laser beams into every corner of the area to be scanned. This means, they cannot withstand shocks and impacts of up to 100 g. Additionally, radars are not sensitive to interference factors such as dust, fog, or light reflections. Besides its resistance to severe shocks, the radar scanner can also withstand supply voltages of 12 V or 24 V.

According to the supplier, the radar scanner is suitable for collision avoidance and object detection for non-safety related tasks. It detects objects in its surroundings and outputs measured values for three dimensions. A typical application is animal and object detection in harvesters and other mobile equipment applications. Due to the different reflective properties of animals or objects and grain stalks, the sensor can detect foreign objects that would either get damaged themselves or could damage the threshing unit.

In heavy-duty vehicle applications and on construction sites, mobile equipment requires to prevent collisions with other vehicles, buildings, animals, or objects. The MR15-Q80 provides distance and speed values for objects on all three spatial axes. This means that the surroundings and all the objects in them can be depicted. Mobile machines in particular with arms or booms at different heights receive valuable additional information about the surroundings. Due to the 3D information, the control system not only knows where an obstacle begins, but also where it ends and where the machine can operate with its arms. There are many other application areas where precise knowledge of the space in front of machines can be helpful, for example when recording topography and rocky outcrops in mining.

Another possible application on mobile equipment is blind-spot warning. Other application possibilities include intralogistics. Industrial trucks and AGVs could use the radar scanners to navigate and avoid collisions. Lidar scanners are normally used for safety-related environment monitoring. However, they are only suitable for the vertical monitoring of lift paths on autonomous forklift trucks to a limited extent, as they usually detect a small vertical opening angle. Special safety radars and scanners would also be oversized and therefore too expensive for the non-safety relevant function of height control. The 3D radar sensor can scan the height of obstacles and surroundings. This data can be used to control lifting movements, ensuring clearance heights and preventing damage to vehicles, goods, and plant elements. Camera systems are often used for these tasks, but they are more expensive and usually much more complex to set up.

Parametrization tool

The parameterization of radar scanners, which output more than just an analog signal or one or two switching signals, is often a challenge. The supplier supports customers with its TAS (Turck Automation Suite) configuration and IIoT (industrial Internet of things) software. The toolkit enables the optimization of setting signals and filters. The software visualizes raw data from the sensor in real-time in the web browser. Objects are displayed as points and point clouds on two graphs, one for the vertical data and one for the horizontal detection angles. ◀

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60-GHz radar sensor

D3 Embedded (U. S. A.) has developed the RS-6843AOPC radar sensor providing a CAN interface. It is equipped with an mmWave radar chip by Texas Instruments. The product comes in a 2,54-mm cube enclosure. The company offers development services to integrate the radar sensors into mobile machines and vehicles.

The radar sensor comes with an integrated CAN interface (Source: D3 Embedded)

Logimat 2025 preview: CAN in intralogistics

Figure 1: At Logimat, EK Robotics presents customized and standardized transport robots with customer-specific load handling devices (Source: EK Robotics)

The international Logimat trade show for intralogistics solutions and process management takes place in Stuttgart (Germany) from March 11 to 13. In 2024 it saw nearly 70000 visitors. This year, more than 1500 exhibitors, also for CAN-based solutions, are expected.

The Logimat trade show covers most of the intralogistics solutions focusing on automation, digitalization, and sustainability in logistics processes. This year, Logimat is once again filling over 120 000 m^2 square meters in all ten exhibit halls of the Messe Stuttgart convention center. Expected is the intralogistics community from over 80 countries with more than 1500 exhibitors, including 200 attending the trade show for the first time. The Logimat Exhibition Director Michael Ruchty reflects: “The key themes of artificial intelligence (AI), sustainability, and skilled labor shortages are creating various challenges as the dominant global trends. At Logimat, exhibitors representing all industry sectors will present solutions and their latest developments to confront these challenges effectively.” The Logimat organizers have established similar trade shows in China (Shenzhen), India (Mumbai), and Thailand (Bangkok).

In the CAN Newsletter magazine 2-2024 we reported about CAN-based products and solutions presented at the Logimat 2024 trade show. The companies Framo Morat, Gefeg-Neckar, EBM-Papst, Oceaneering, and Jungheinrich are presenting their solutions also at this years’ trade show.

AGVs, AMRs, and carrybots

In the intralogistics industry, industrial robots are considered a key factor in optimizing processes and helping to counteract the shortage of skilled labor. The latest developments in the field of picking robots can be viewed in the gallery in Hall 1. In addition to shuttle vehicles for shelf storage systems, several machinery and equipment manufacturers present service robots for untethered intra-logistical transports. These automated guided vehicles (AGVs), autonomous mobile robots (AMRs), and carrybots are concentrated in Hall 8. In addition, the Mobile Robotics User Forum returns in 2025 to the gallery level in Hall 6, where members of Forum AGV offer expert advice to AGV users and other parties interested in mobile robotics.

Many of these AGVs as well as forklifts use embedded CAN networks to interconnect sensors, actuators, and controllers. In forklifts, also the lift functions are often controlled via CAN. The next generation of AGVs, traditional industrial trucks, and assistance systems also sets the tone for forklift manufacturers, exhibiting in Halls 9 and 10. Regarding forklifts, all major international industry players are represented this year with their latest portfolio. Manufacturers announced introduction of three- and four-wheel forklifts, counterbalance forklift trucks for the up-to-two-ton segment, a new series of electric side forklifts, and the market launch of the world’s first automated cobot for pallet transport. Innovations in alternative powertrains, insights into the near and distant future of intralogistics using robots, drones, and autonomous vehicles are announced. In Halls 7 and 9, visitors can also find the latest innovations from suppliers of cranes, gates, loading technology, and fire protection systems and solutions.

AGVs with CANopen

EK Robotics, established in 1963, showcases in Stuttgart its practical automation solutions alongside a piece of history. Visitors of Hall 8, stand B05, can explore original automated guided vehicles (AGVs). On a 200-m² stand, the company showcases standardized vehicles with customized adaptations as well as bespoke transport robots for managing complex intralogistics tasks. According to the company, sensors and actuators in all vehicles are interconnected via CANopen.

Some of the displayed models are derived from real customer projects, highlighting the versatility of the used technologies – from simple transport tasks to complex automation solutions.

Electro-hydraulic lifting system

The hydraulics specialist Hawe Hydraulik presents the Logar system in Hall 10, stand A 45. Developed for lifting and lowering AGV and AMR platforms, the maintenance-free lifting system combines energy efficiency and a long service life with a compact design, states the CiA member company. The patented development ensures precise synchronization and self-synchronization due to the serial connection of the four differential cylinders. The solution is supplied ready for integration. Operators can implement it via plug-and-play functionality, informs the company. CANopen interconnection of devices inside the Logar is possible, as the implemented drive control system supports CANopen. Compared to electromechanical applications, Logar applies 100 % of the forces vertically from the start of the stroke. This avoids lateral forces and reduces wear. “Our customers benefit above all from 1000000 maintenance-free cycles. This is because Logar has a three-times longer service life compared to electromechanical solutions,” says Ahmed Wasel, Key Market Manager at Hawe Hydraulik.

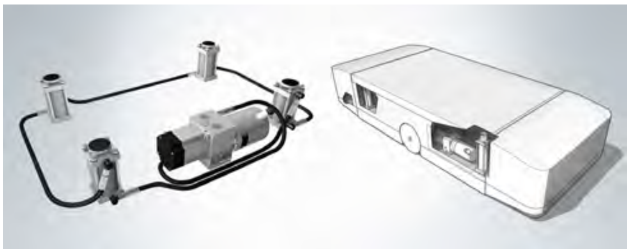


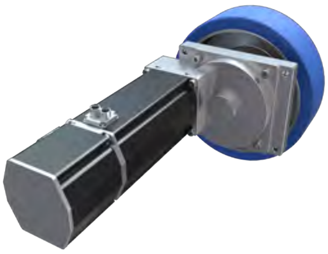
Figure 2: Logar lifting system provides compact and flexible design (Source: Hawe Hydraulik)

In addition, the efficiency of the integrated BLDC (brush-less) motor is higher than that of brushed motors, achieving 85 % to 90 % efficiency. Its pilot-controlled non-return valves hold loads of up to 1500 kg securely in position and prevent unwanted lowering. The lifting and lowering process can be switched quickly, directly and without loss, by the user changing the direction of rotation of the pump-motor unit. The system is also leak-free: the enclosed design prevents the ingress of impurities and the escape of oil, which further increases safety during operation.

With its compact design, Logar creates space for the installation of additional sub-systems in the vehicle. Thanks to a modular system, the solution can be customized according to requirements of the AGV and AMR platforms. "This means that our new development even exceeds some of the key requirements that are placed on AGV and AMR platforms," emphasizes Wasel.

Drives for driverless transport

Dunkermotoren, a brand of Ametek, is present in Hall 8, stand 8F09. Company's drive control solutions provide CANopen connectivity, supporting the CiA 402 profile for drives and motion control. For example, the CiA member shows the NG 1000 WO hub gearbox for driverless transport systems. In combination with the BG 95 Dpro drive, the overall solution is 95 mm high and, thanks to the axle offset, enables vehicles with a minimum width of 600 mm and a possible total weight of 4 t. Variants with reduced gear backlash also allow particularly precise positioning of the vehicle, informs Dunkermotoren. The availability of particularly low-noise versions means that mobile, self-propelled devices such as MRI (magnet resonance imaging) or X-ray machines can conquer the medical sector.



Firgure 3: NG 1000 WO hub gearbox for driverless transport systems (Source: Dunkermotoren)

The BG 42 brushless motor is already used in various applications. Its follower BG 42 Dgo is a four-quadrant integrated controller, which can be parameterized ex works and controlled via its inputs. By integrating the controller into the motor housing and optimizing the operating parameters, a particularly efficient drive can be configured that saves valuable energy, says the manufacturer. The drive can also be integrated into belt and roller applications. The exhibited BGE 8060 Dpro is a compact four-quadrant controller for brushless and brushed DC motors with a continuous output power of up to 1800 W. With a 72-A continuous current and 175-A peak current, it offers enough power for motors such as the BG 95 Dcore and BG 75 Dcore as well as for other applications requiring currents from 10 A to 72 A. The programmable (C language) controller is adaptable to different applications. It also integrates the safe torque off (STO) function and offers connection options for encoder and brake.

The CANopen-capable Nexolink is a basic module for IIoT (industrial Internet of things) integration of all drives from the manufacturer. This enables smart diagnostics and predictive maintenance of the drives. On its stand, the manufacturer also presents the Iw.hub autonomous mobile robot (AMR) from its partner Idealworks. The AMR integrates drives from Dunkermotoren.

CiA member Nord Drivesystems shows its product portfolio in Hall 3, stand 3C41. The company offers CANopen-connectable drive solutions as well. For instance, the Logidrive product family provides drive systems for post-and-parcel, airport, and warehouse sectors. The devices are characterized by their low weight and compact installation space. The Logidrive Basic variant consists of an IE3 asynchronous motor, the Nordac-On drive, and a gear unit. This solution mainly focuses on the acquisition costs and provides a large adjustment range, says the manufacturer. The Logidrive Advanced variant consists of the IE5+ synchronous motor, the Nordac-On+, and a gear unit. It was optimized in terms of energy efficiency. The high efficiency over a large speed and load range enables variant reduction for more streamlined processes and reduced administration and warehousing costs. This is of advantage for large systems with numerous drives and further reduces downtimes.

Figure 4: The Logidrive family is an industry solution suitable for intralogistics (Source: Nord Drivesystems)

The decentralized Nordac-On/On+ frequency inverters are characterized by their compact design, plug-and-play capability, and reliability, states the company. They also offer PLC functionality for drive-related functions (PLC onboard). The inverters are designed for power ranges from 0,37 kW to 3,7 kW.

The IE5+ synchronous motors with efficiencies of up to 95 % surpass the highest defined efficiency class and are characterized by their compact, hygienic design in a small installation space. Available versions are TENV smooth motor, TEFC motor with cooling fins and integrated Duodrive geared motor with a power range from 0,35 kW to 4 kW. The company also provides the Nord Eco service to analyze existing systems and reveal potential for saving energy. Additionally, Nord released the third version of its Windows parameterization software for setting up and monitoring drives. A customizable dashboard, a context-sensitive help function and a revised oscilloscope support application-specific control of the drive solutions. Nord develops and produces drive solutions for more than 100 industries. It supplies gear units for torques from 10 Nm up to over 282 kNm, electric motors in the power range of 0,12 kW to 1000 kW, and the required power electronics with frequency inverters of up to 160 kW. Inverter solutions are available for control cabinet installations as well as for decentralized, integrated drive units. ◀

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CAN SIC boards for system development and validation

(Source: Dspace)

For the modular and scalable Scalexio real-time platform by Dspace, there are interface boards with multiple CAN FD ports available. Now, they can be equipped with CAN SIC transceivers. The systems are suitable for hardware-in-the-loop (HIL) and rapid control prototyping (RCP) applications.

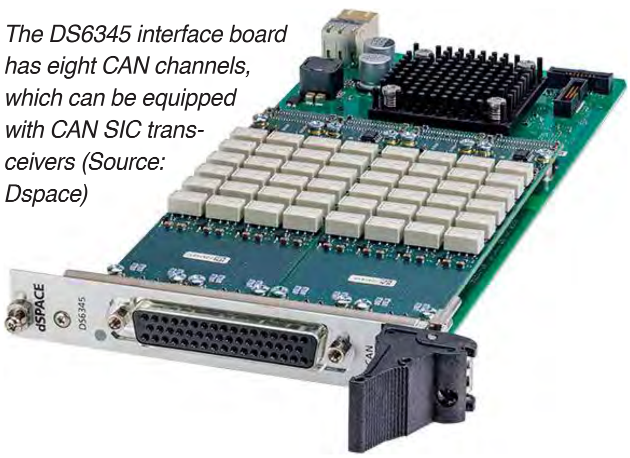
A Scalexio system consists of hardware and software. It comes in different sizes and can be used for laboratory as well as in-vehicle applications. During HIL tests, the system simulates the environment of the ECU (electronic control unit) whereas during RCP projects, the system replaces the ECU in a vehicle or controlled system, allowing the user to experience and test control functions in a real environment.

The German supplier provides several CAN interface modules. They can be equipped with different CAN transceivers. Besides legacy CAN FD transceiver (TJA1145T by NXP) supporting data-phase bit rates up to 2 Mbit/s, the CAN ports can be applied with a CAN SIC (signal improvement capability) transceivers (TJA1463AT by NXP) featuring bit rates up to 8 Mbit/s. Additionally, CAN transceivers with wake-up detection or partial networking are available. So-called fault-tolerant transceivers according to ISO 11898-3 can be selected.

The following CAN interface board variants are offered:

- DS6302 CAN/LIN board with four CAN and four LIN channels
- DS6344 CAN board with four CAN channels
- DS6345 CAN board with eight CAN channels

The CAN SIC physical layer option, called CAN 8 channel type, enables higher data-phase bit rates and meets the increasing demand of carmakers in using CAN SIC networks. All features and settings of these board can be configured with the supplier's Configuration-Desk software. The boards feature software-configurable 120-Ω termination resistors between the CAN-High and the CAN-Low pins. In case of fault-tolerant CAN transceivers, the termination resistor is software-configurable between 560 Ω and 5,6 kΩ.



The DS6345 interface board has eight CAN channels, which can be equipped with CAN SIC transceivers (Source: Dspace)

According to the supplier, the DS6345 interface board with eight CAN FD ports is ideal for compact test systems with a limited number of available slots, such as the Auto-Box or the eight-slot Lab-Box systems. Network management functions such as wake-up and sleep are also included as software-configurable functions. A CAN feed-through is also available. ◀

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SBC with integrated CAN FD transceiver

Figure 1: SBCs are suitable for different applications including drones, which use increasingly embedded CAN-FD networks (Source: Microchip)

System-base chips (SBC) comprise several electronic components in order to simplify device and electronic control unit (ECU) designs. Some of them feature a CAN-FD physical medium attachment (PMA) implementation.

A CAN-FD SBC is a semiconductor that integrates a CAN-FD transceiver with power-management elements, i.e., an LDO (low-dropout) regulator or a DC/DC (direct current/direct current) converter, or both. These products reduce the number of components and save space on the printed-circuit board (PCB). Usually, energy consumption is also lower. Some CAN-SBCs implement multiple CAN-FD transceivers and additionally LIN (local interconnect network) transceivers. There is also one SBC integrating a CAN-FD stand-alone controller, too.

According to Beatrice Fankem from Texas Instruments (TI) there are three main SBC categories:

- General-purpose SBCs include transceivers (CAN HS/FD and optionally LIN) and an LDO with an output voltage to power other components in the device. This type of SBC could also include a serial peripheral interface (SPI) or pin control for feature configuration from the host controller, a base watchdog timer, and a wake pin.
- Mid-range SBCs integrate enhanced features that further reduce the board footprint. These features include multiple power elements, high-side switches, multiple wake pins, a limp pin and a configurable watchdog timer. Some will have multiple LIN or CAN transceivers or offer the option to expand the bus interface, with support for channel expansion. The power elements could be DC/DC converters with less than 250 mA of output current or LDOs that support up to 250 mA.
- Advanced SBCs offer special functionalities, which vary based on the overall system's needs. For example, an integrated CAN controller and transceivers, also known as SPI-to-CAN FD controller SBCs, enable pairing with microcontrollers that do not have integrated CAN controllers or MCUs (microcontroller units) that need an additional CAN port.

CAN-FD transceivers feature an improved symmetry compared with legacy CAN-HS (high-speed) transceivers. They can achieve higher bit rates than 1 Mbit/s. Usually, CAN-FD transceivers are suitable for bit rates of 2 Mbit/s in multi-drop networks. In point-to-point you can run them up to 5 Mbit/s depending on the symmetry features and used physical-media components such as cables and connectors as well as the topology. If you want to go beyond these limits, you need to apply CAN-SIC (signal improvement capability) transceivers. They can suppress ringing by means of a dynamic impedance adjustment.

Some CAN-FD transceivers integrated in SBCs feature a low-power mode and a selective wake-up function for partial networking. They are used mainly in automotive applications. Some CAN-FD SBCs are suitable for automotive functional safety. They provide some dedicated monitoring functions and protection features.

SBCs are used in automotive applications since several years. However, they can also be applied in industrial battery-powered systems, especially in automated-guided vehicles (AGV) and autonomous mobile ▷

robots (AMR). Typical automotive applications include body control modules, gateways, closure modules (i.e., door, roof, tailgater, and trailer), seat control modules, gear shifts, fuel pumps, HVAC (heating, ventilation, air-conditioning), wireless in-cabin charger, transfer case, NOx sensors, exhaust modules, light control modules, and water pumps. Another application field for CAN-FD SBCs are drones.

Products by Elmos

The CAN-FD SBC by Elmos integrates a DC/DC buck converter or an LDO regulator with a 3,3-V or a 5-V output and load current up to 200 mA. In the LDO version an external NMOS transistor allows to share the power dissipation between external transistor and internal LDO. All supplies are monitored and can signalize a fail event by the SPI interface. System failure can activate a fail-safe output signal for limp home support. The products provide sleep, stop, active, and fail-safe modes. The CAN FD transceiver is qualified for bit rates up to 2 Mbit/s. The SBC is capable to detect local and remote wake-up events, which can be individually enabled via SPI.

Products by Infineon

Infineon's CAN-FD SBC family scales from the Lite SBC to the Multi-CAN Power+ SBC. They reduce the system cost through low-component count and small footprint. The Lite SBC (TLE9461 and TLE9471) measures 8,65 mm x 6 mm; the Mid-Range+ version comes in a 7 mm x 7 mm package. It comes with two (TLE926xB) or four (TLE927xQX) integrated LIN transceivers. The Multi-CAN Power+ (TLE9278B) features up to four CAN transceivers with a switch mode power supply (SMPS) buck regulator. The 5-V or 3,3-V output supplies up to 750 mA. The chip comes in a 7 mm x 7 mm package.

All these SBC products feature optionally a low-power mode with a wake-up functionality. They are specified for bit rates up to 5 Mbit/s. The achievable bit rate depends on other electromechanical components and the chosen network topology. The products enable design flexibility and reduce software design effort through shared state machine and SPI access.

Products by Microchip

Recently, Microchip has introduced the ATA650x family of CAN-FD SBCs, integrating a 5-V LDO regulator. The products come in 8-pin (2 mm x 3 mm), 10-pin (3 mm x 3 mm), or 14-pin (4,5 mm x 3 mm) packages. To further reduce power consumption, the SBCs can disable the microcontroller supply by switching off LDOs during sleep mode. The safety features include fail safe, protection, and diagnostic functions. Designed to withstand electrostatic discharge (ESD) and equipped with electromagnetic compatibility (EMC) performance, the SBCs are suitable to operate in harsh environments. The products are AEC-Q100 qualified with a Grade 0 rating and are designed to operate in temperatures ranging from -40 °C to +150 °C.

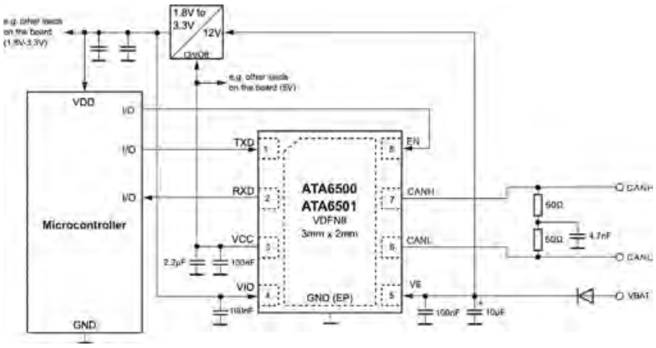

Figure 2: The shown ATA650x chip has a foot print of 3 mm x 2 mm (Source: Microchip)

"Our compact CAN-FD SBC is engineered for space-constrained applications, specifically addressing the critical need for resilience in demanding environments," said Rudy Jaramillo from Microchip. "This highly integrated solution can aid in system-level cost savings by minimizing board space requirements and helping reduce design complexities for our customers." They are available in production quantities.

Products by NXP

The FS6500 and FS4500 families integrate a CAN FD and optional LIN transceivers. The products implement safety features such as monitoring of critical analog parameters, a fail-safe state machine, and an advanced watchdog, reducing software complexity with dual-core lock-step MCUs. Additionally, the SBCs provide five configurable I/O (input/output) lines. The products support low-power functionality. There are multiple options implemented to wake up transceivers, I/O lines, and other functions. In low-power mode, a 3,3-V keep-alive memory supply is available. There is also a long duration timer, counting up to six months with a one-second resolution.

Products by Texas Instruments

The TCAN11623-Q1 general-purpose SBC integrates a CAN FD transceiver, a wake pin, and a 3-V, 70-mA LDO output, while the TCAN11625-Q1 supports a 5-V, 100-mA LDO output. The LDO powers external small loads, while an external component can use the wake pin to wake the node. The TCAN11623-Q1 family has a self-supply capability, thus removing the need for an extra voltage rail to power the SBCs.

The TCAN4550-Q1 advanced SBC combines both a CAN FD stand-alone controller and a CAN FD transceiver in a single package. It includes a local wake pin, a watchdog timer, and a 70-mA LDO output. This chip adds CAN communication to microcontrollers that don't have a CAN interface, and allows for an additional CAN channel. It also bridges the gap from CAN CC to CAN FD. This SBC is connected by means of SPI to the microcontroller. It provides additional features, including V_{IO} with 1,8-V, 3,3-V, and 5-V support, wake and inhibit functions, and a timeout watchdog that can enable processor functionality not normally available. ◀

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(Source: Adobe Stock)

CAN SIC XL transceiver comes in a HVSON8 package

(Source: Bosch)

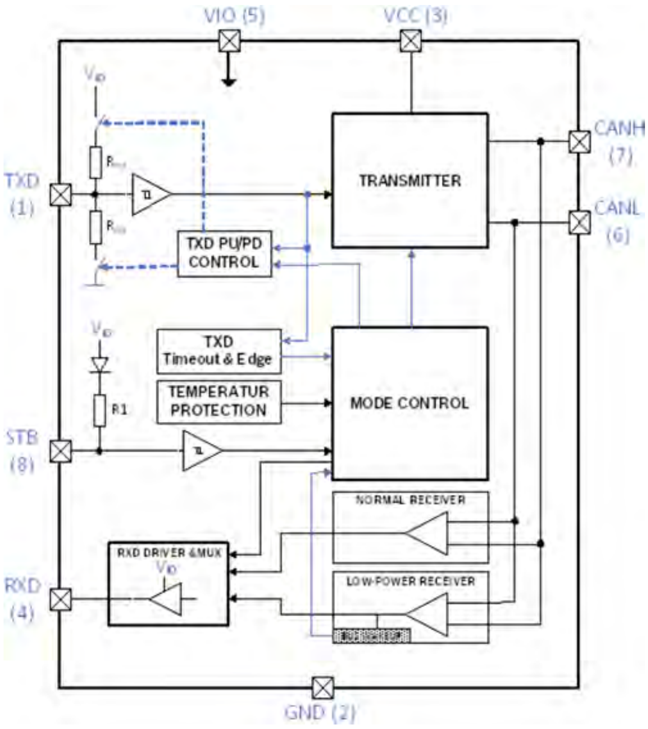
Bosch has launched the NT156 stand-alone transceiver compliant with ISO 11898-2:2024. It supports bit rates up to 20 Mbit/s. On the RxD pin, a wake-up is indicated.

The CAN SIC XL physical medium attachment (PMA) sublayer is internationally standardized in ISO 11898-2:2024. Originally, the requirements for CAN SIC XL transceivers were specified in CiA 601-4 (SIC) and in CiA 610-3 (FAST mode) documents, which have been submitted to ISO. Prototypes of the NT156 transceiver have been successfully tested on interoperability with CAN SIC XL transceivers from Infineon, NXP, and Texas Instruments during a CiA CAN XL plugfest in May 2024. The compatibility and the interoperability were also tested by C&S Group, an independent test house in Wolfenbuettel (Germany). Automotive EMC requirements (IEC 62228-3) have been proofed by IBEE in Zwickau (Germany).

Bosch has launched its CAN SIC XL transceiver at the Electronica tradeshow in Munich (Germany) end of last year. Samples will be available in the 2nd quarter of 2025. The chip is developed according to ISO 26262 (functional safety). According to a preliminary datasheet, the NT156 consumes in normal mode in recessive bus state 10 mA, and in dominant bus state 54 mA. In standby mode, the current consumption is 2 μA. The transition from standby mode to normal mode is specified with 50 μs.

The transceiver is intended to feature a junction temperature from -40 °C to +150 °C. Between +170 °C and +200 °C the chip shuts down, and releases the shutdown at +150 °C. The shutdown junction temperature hysteresis is 20 K. The minimum TXD dominant timeout is 0,8 ms. The chip features an undervoltage detection at V_{cc} and V_{IO} pins.

The CAN SIC XL transceiver featuring sleep-mode and wake-up capability supports in FAST mode bit rates up to 10 Mbit/s. In SIC mode, it can run up to 8 Mbit/s in the data phase depending on the chosen network topology and the selected electromechanical components such as cables and connectors. The transceiver differential impedance is typically 120 Ohm in SIC mode, and both single-ended impedances measured to ground are in FAST mode 66,5 Ohm. *hz*



Application example of the NT156 CAN SIC XL transceiver (Source: Bosch)

Microcontroller with CAN XL modules on chip

(Source: Infineon)

Infineon has launched the Aurix TC4Dx microcontroller family, manufactured using 28-nm technology. The MCUs (microcontroller units) support CAN XL connectivity. The German chipmaker is sampling the chip and plans mass production later on this year. Besides CAN XL modules, the MCUs provide Ethernet-based interfaces. The chips are intended for automotive ECUs (electronic control units). This includes applications such as vehicle motion control and ADAS (advanced driver assistance systems).

"Microcontrollers like our new Aurix TC4Dx are the backbone of software-defined vehicles. They are essential to further improve vehicle performance, safety and comfort," explained Thomas Boehm from Infineon. "It will contribute to secured processing performance and efficiency, and our customers will benefit from faster time-to-market and lower total system cost."

The products feature a six-core architecture with the 500-MHz Tricore, all with lock-steps for functional safety performance. With its PPU (parallel processing unit), the MCU provides a platform for developing embedded AI-based applications such as motor control, battery management systems, or vehicle motion control. The MCU is supported by a software ecosystem and includes networking accelerators to boost CAN and Ethernet communication, as well as the interfaces such as CAN XL, 5-Gbit/s Ethernet, PCIe, and 10Base-T1S. According to the chipmaker, this increased networking throughput and connectivity gives customers the performance and flexibility needed to implement E/E architectures. Its holistic approach to functional safety meets the functional safety requirements according to ISO 26262 (ASIL D). The MCUs also fulfill cyber security features according to ISO/SAE 21434 including post-quantum cryptography support.

One of the first customers is Marelli, an Italian Tier-1 supplier of automotive ECUs. The company is going to develop zone control units (ZCU). "Marelli and Infineon have a long history of working together and the joint development of our ZCUs is another significant step forward," said Ravi Tallapragada from Marelli. "With Infineon's contribution, Marelli is well positioned to strengthen its role as a partner to carmakers venturing into zonal architectures."

These ZCUs can be applied for software-defined vehicles (SDV). They can act as data-routing engine with low latencies, transferring data form CAN XL networks to an Ethernet-based backbone. Such ZCUs can also run lighting control software, paving the way for future MCU-less lamps. Of course, the ZCUs allow software updates, which are critical to maintaining the latest features without system downtime.

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Brief news: CAN SIC transceiver chips

The CAN SIC (signal improvement capability) transceivers were originally specified in the CiA 601-4 document. In the meantime, they are internationally standardized in ISO 11898-2:2024. Technically both documents are equivalent, however the wording has been improved. ISO is working on a new edition, in order to overcome some still misleading descriptions. As stated, this has no impact on the available products. There is also a conformance test plan under development (ISO 16845-2). The C&S Group (Germany) offers the Invio simulation test tool, which is suitable to test CAN SIC transceivers. A related evaluation board is available, too.

- ***Infineon:*** The TLE9371SJ and TLE9371VSJ stand-alone CAN SIC transceiver chips can support bit rates up to 8 Mbit/s. They come in DSO-8 packages and feature network wake-up functionality. They are pin-compatible with legacy CAN FD transceivers. The transceivers support a TXD-timeout function, in order to avoid that the network communication is blocked due to a permanent dominant signal is transmitted by this node.
- ***Novosense:*** The NCA1462-Q1 CAN SIC transceiver complies with ISO 11898-2:2024, featuring bit rates up to 8 Mbit/s even when using star topologies. The Chinese CiA member has a patent on the SIC circuitry implementation, which is optimized for high EMI (electromagnetic interference) performance tested in accordance with IEC 62228-3 (see CAN Newsletter 2/2024, page 17). The chips with an ESD (electrostatic discharge) performance of ±8 kV come in SOP8 and DFN8 packages.
- ***NXP:*** The TJA1463 is a CAN SIC transceiver with sleep-mode capability. It is intended as a replacement for TJA1043 CAN FD transceivers. The AEC-Q100 Grade 0 variant, the TJR1463 is suitable for temperature applications, supporting operation at +150 °C ambient temperature. They are specified for bit rates up to 8 Mbit/s. They are available in SO14 and leadless HVSON14 packages.
- ***Texas Instruments:*** The TCAN146x-Q1 partial networking CAN SIC transceivers are available in SOIC14, VSON14, and SOT23 packages. They are suitable for bit rates up to 8 Mbit/s. The transceivers provide an SPI (serial peripheral interface) for configuration purposes.

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Part I – CAN XL physical layer network design

With CAN XL protocol in combination with the CAN SIC XL transceiver bit rates up to 20 Mbit/s are possible. In two articles, the author presents testing results of this transmitter concept in different network topologies.

The new transmitter concept in the data phase was necessary to achieve bit rates above 8 Mbit/s. In a special physical layer plugfest in January 2023 in Nuremberg (Germany), this concept was tested in different network topologies.

Topology investigations

During the plugfest, the following topologies were verified, in order to evaluate the maximum possible bit rate:

- Point-to-point network with different distances between the nodes;
- Daisy-chain topology as used in 10BaseT1S networks with different distances between nodes;
- Linear topology with different stub lengths;
- Single-star topology;
- Multi-star topology.

In this article the testing results of the topologies as illustrated in Figure 1 to Figure 3 are presented:

In the second article (to be published in CAN Newsletter 2-2025) the testing results of the topologies as illustrated in Figure 4 to Figure 6 will be presented.

The verified pattern

The most critical scenarios in the CAN XL frame transmission are:

- The transition from SIC (signal improvement capability) mode to FAST mode;
- A burst of short bits;
- A short bit after a long level_0 phase or a long level_1 phase (maximum 11 bit due to the stuff bit rule) with the opposite level.

During the ADH (arbitration to data high) bit, the transmitter switches from dominant state to level_0 and afterwards to level_1 (see Figure 7). In parallel, all receiving nodes change the receiver thresholds. This is caused by PWM-coded (pulse-width modulation) symbols sent from the CAN XL protocol controller to the TXD pin of the transceivers. Before the PWM-coded symbol on the TXD pin is detected the receiving nodes transmit a short dominant pulse followed by a shortened SIC phase. The requirement is, that level_1 is stable before the SDT (service data unit type) field starts. Also, the length ▷

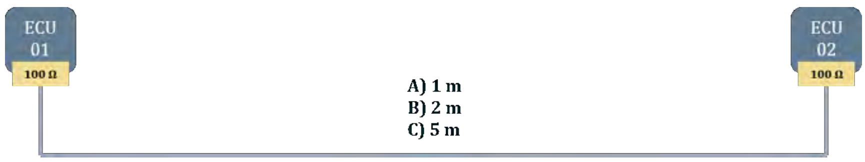

Figure 1: Point-to-point network (Source: Infineon)

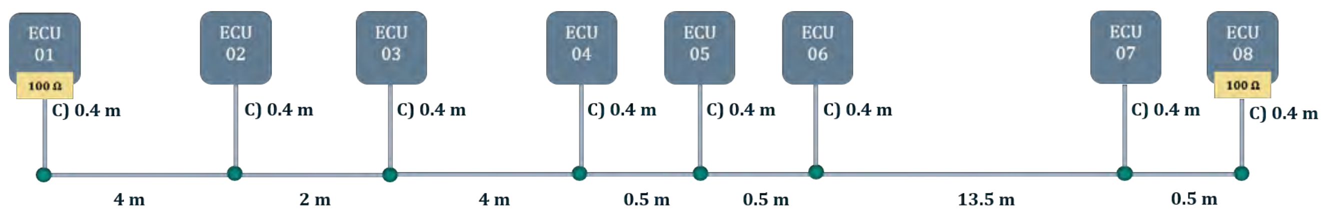

Figure 2: 10BaseT1S like daisy-chain topology (Source: Infineon)

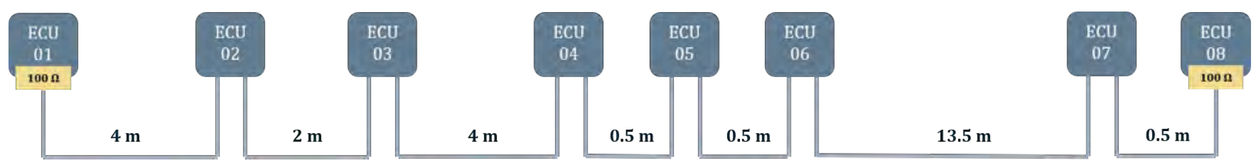

Figure 3: CAN typical linear topology with short stub lengths (Source: Infineon)

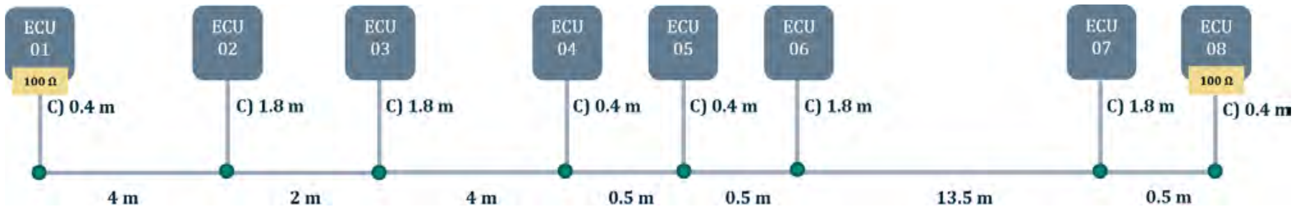

Figure 4: CAN typical linear topology with different stub lengths (Source: Infineon)

of the DL1 (data low) bit is of interest. The transition from DH2 (data high) to DL1 is used for resynchronization of the CAN XL protocol controller after the transition into the data phase. Also, level_0 should be achieved. In the SDT field a "0101" bit pattern was chosen to analyze the impact of short bits in case of high bit rates.

A long phase (four consecutive bits) followed by short bits (one, two, or three) with the opposite level (see Figure 8): The objective was to find out, how long it takes, until the bus signals are stable, especially at high bit rates. The bit lengths are measured after a longer level_0 or level_1 phase and the impact of the length on the following bits.

One bit after 11 consecutive level_1 or level_0 bits (highest possible number of consecutive bits) (see Figure 9): The objective was to find out, how the bit length and the level behave after the longest possible phase in the frame.

The test topology 1c (see Figure 11) is a point-to-point network. The distance between the two nodes is 5 m. The bit rate is 20 Mbit/s. There were observed no reflection or jitter during the full FAST phase (see Figure 12), which was short in this test. The values of level_0 and level_1 are independent of the bit length.

Figure 13 shows the critical ADS (arbitration to data sequence) phase, consisting of ADH bit (2000 ns), DH1 (data high; 50 ns), and DH2 bit (50 ns). At the beginning of the transition from dominant to level_0 a short SIC phase of the transmitting node can be seen, before the transceiver has the new PWM coding detected. The length and the voltage swing of this spike depends on the duty-cycle ratio of the PWM symbol. After the transition to level_1, the short spike is coming from the receiving node. On the receiving node, the PWM coding causes to set the transceiver into ▷

The test criteria

The bit-time lengths (see Figure 10) were measured at +100-mV and -100-mV thresholds. The bit time should be lose to the nominal bit time or multiples of them. For high bit rates the 0-V threshold was used. Glitches with a length of 20 ns were ignored.

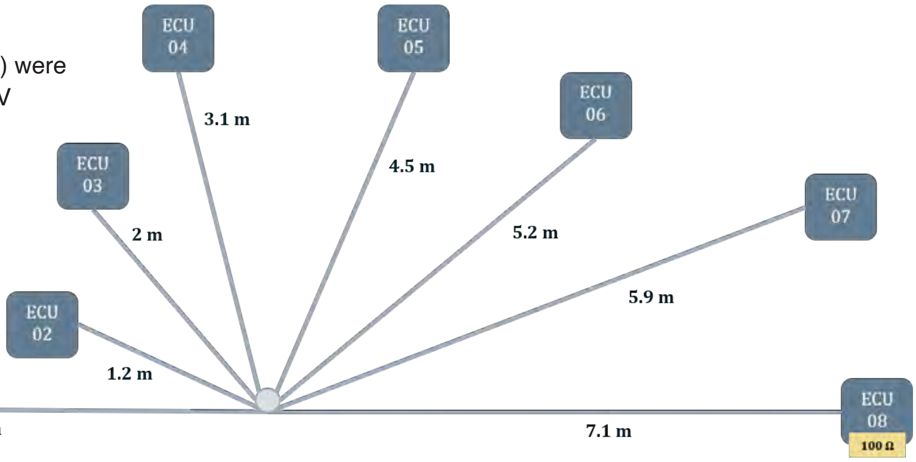

Figure 5: Single-star topology with stub lengths of 1 m, 2 m, and 4 m (Source: Infineon)

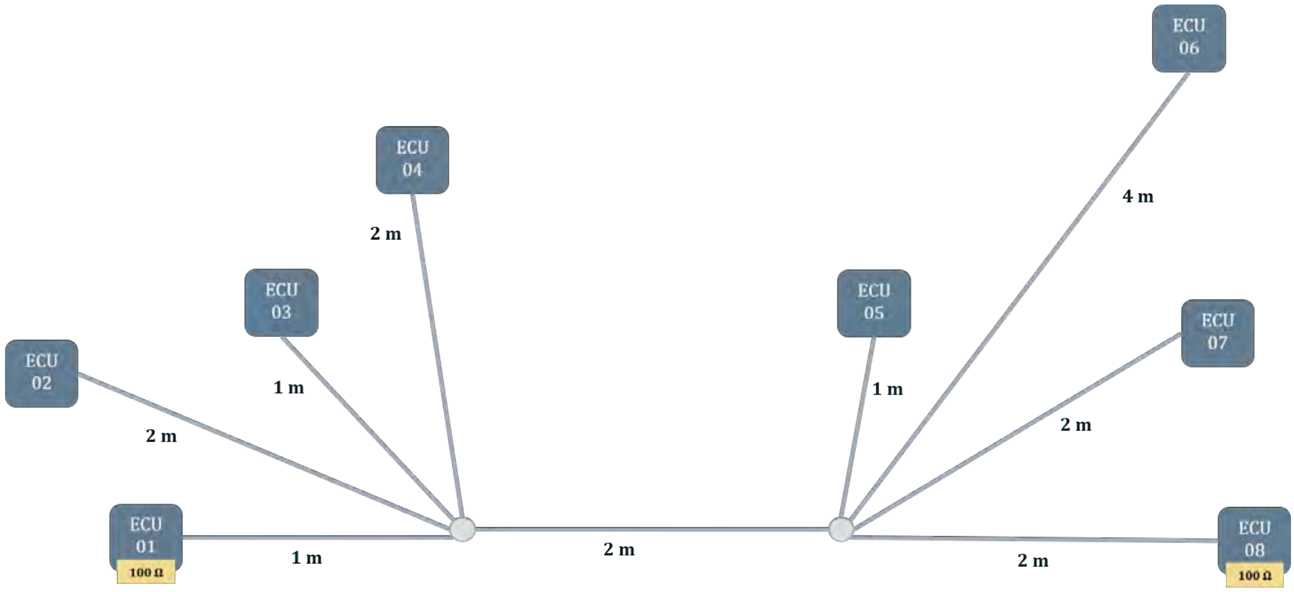

Figure 6: Multi-star topology (Source: Infineon)

Engineering

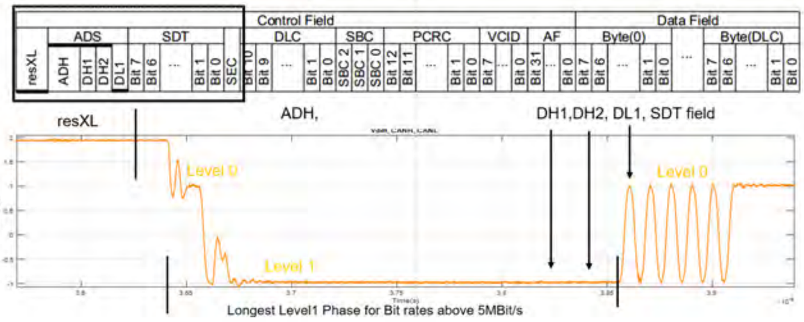

Figure 7: SIC-mode to FAST-mode transition during ADS field (Source: Infineon)

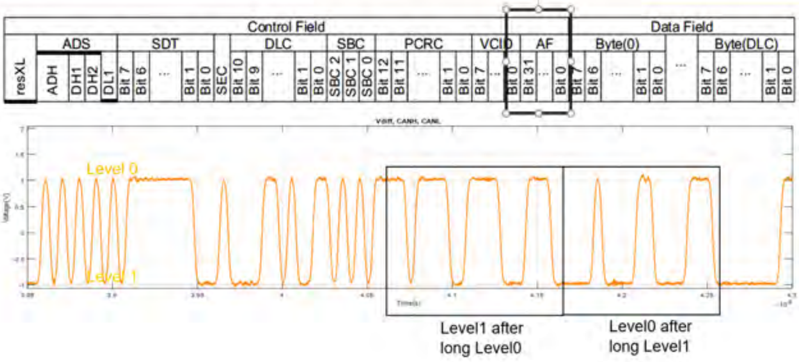

Figure 8: One, two, or three bits with opposite level after a long level_0 or a long level_1 sequence (Source: Infineon)

FAST mode. Before the transceiver is able to detect PWM coding on its TXD pin, a short dominant pulse followed by a shortened SIC phase is transmitted. The spikes during the transition from level_0 to level_1 are very short. The level_1, level_0 pattern in the SDT field are without any observations, too.

The maximum voltage values on single bits of level_0 or level_1 are achieved but they are short. In the transceiver prototype samples were used. The slew rates of non-prototype transceivers might be faster and the maximum-level phase during a single bit might be longer.

Using test topology 3 (see Figure 15), symbol levels in FAST mode and pulse (bit) lengths are symmetric. In scenario 1, node 7 transmitted with 20 Mbit/s (see Figure 16). Voltage level of short bits did not achieve the maximum voltage values of level_0 and level_1. There were just low (but acceptable) bit-time degradations observed. Temperature dependencies and wire-impedance variations were not considered and should be verified separately.

In scenario 2 of test topology 3 (see Figure 17), node 3 transmits frames and node 7 receives them. The maximum bit rate, which has been used successfully is 20 Mbit/s. In this test setup, the impact of the distance between transmitter and receiver is analyzed. The parasitic capacitance on the ECUs (electronic control unit), the number of star points, the high number of untwisted parts, and the 28-m distance between the transmitter and receiver were of interest. Node 3 transmits the pulse (bit) at first into the wire impedance of 100 Ω, with a delay the impact of the termination on node 1 (delay round about 40 ns (7 m x 5,5ns/m)) can be observed and with a delay of 120 ns (20 m x 5,5 ns/m) can be seen. The single-bit bursts are the most interesting situations during the frame transmission.

As seen in Figure 18, the longer distance between transmitting and receiving node caused lower voltage levels of short bits and didn't achieve the maximum voltage values of level_0 and level_1. The bit length is shorter but close to the minimum bit length. In the single-bit burst a "king of pumpkins" can be seen. The first bit level is lower than the second one and the third one, caused by the capacitive load. The capacitance on the ECUs should be as low as possible. The critical situation is the single bit after multiple bits with the same level. The level has an acceptable distance to 100 mV (maximum voltage value of the receiver threshold). There are impacts of temperature dependencies as well as wire-impedance variations due to production and mechanical stress. Also, the overall length of the untwisted parts has an impact on the maximum voltage values and the bit-length symmetry. These impacts are minor: The bit-time degradation is acceptable.

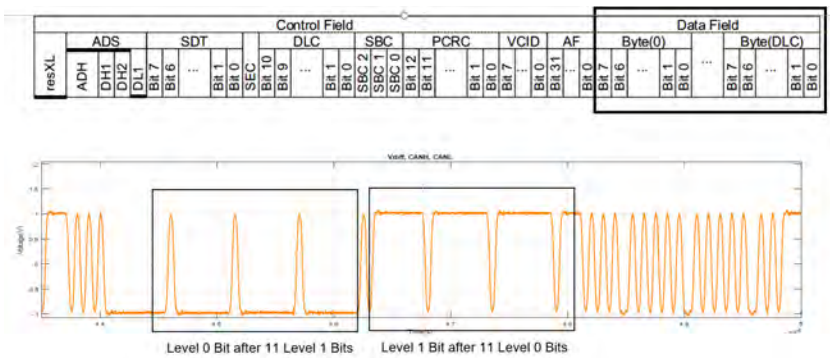

Figure 9: Level_1 or level_0 bit after a long phase (Source: Infineon)

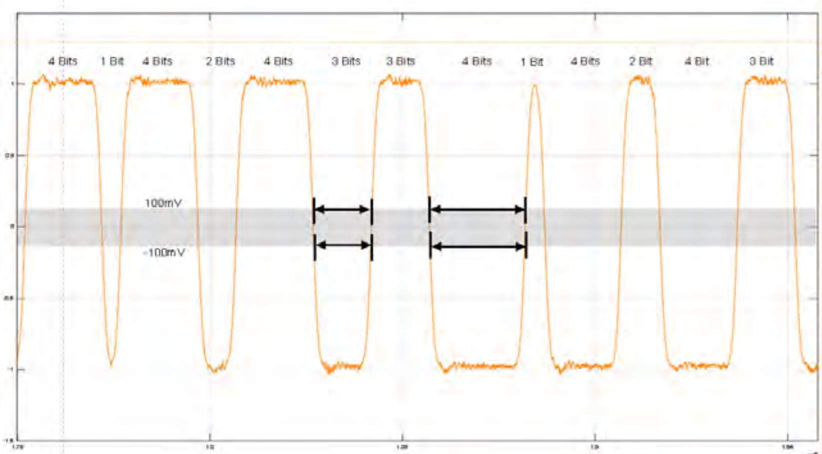

Figure 10: Test criteria timing (Source: Infineon)

In the scenario shown in Figure 19, the impact of terminated node was of interest. The impedance scenario of the transmitting node is different to the unterminated node. The transmitter is directly connected to the 100-Ohm termination resistor and in parallel with the 100-Ohm impedance of the wire. The impact of the second termination located in node 1 can be observed after 150 ns during the third bit. The waveforms on node 7 are more or less the same as on node 8 due to the short distance between both nodes. The voltage level of short bits doesn't achieve the maximum voltage values of level_0 and level_1. The low bit-time degradation is acceptable.

The long wire length, the number of nodes, the parasitic capacitances, and the untwisted parts caused that the voltage levels of short bits don't achieve the maximum values of level_0 and level_1. The bit lengths were shortened but close to the nominal bit time. In the test, the used prototype transceivers didn't fulfill all requirements, especially the slew-rate condition. With final silicon, the results might be better, the low bit-time degradation is acceptable. ▷

Figure 11: Test topology 1c (Source: Infineon)

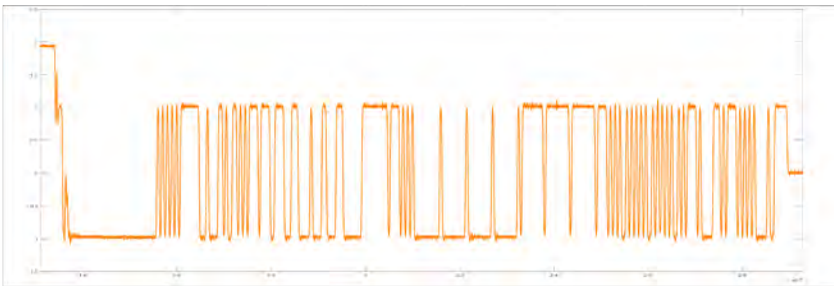

Figure 12: Full FAST phase result (differential network signal) for test topology 1c (Source: Infineon)

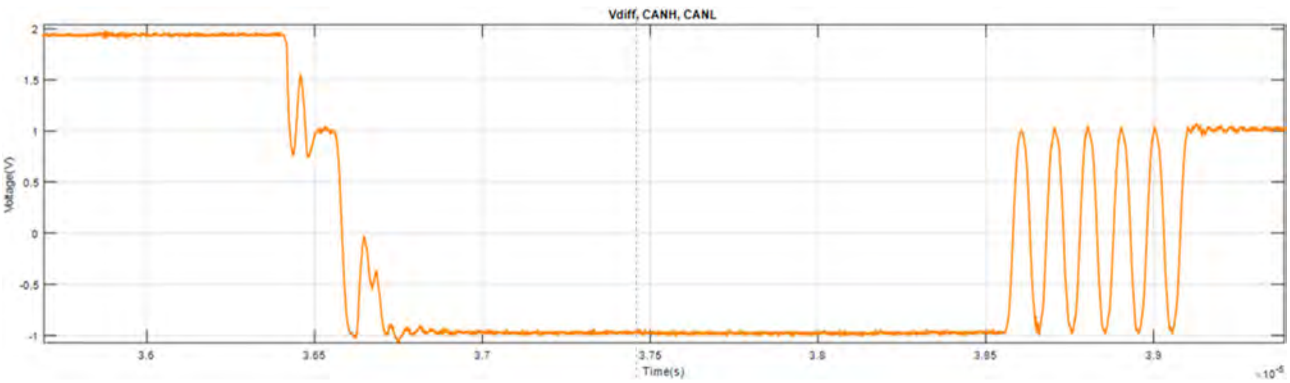

Figure 13: ADS phase and SDT phase results (Source: Infineon)

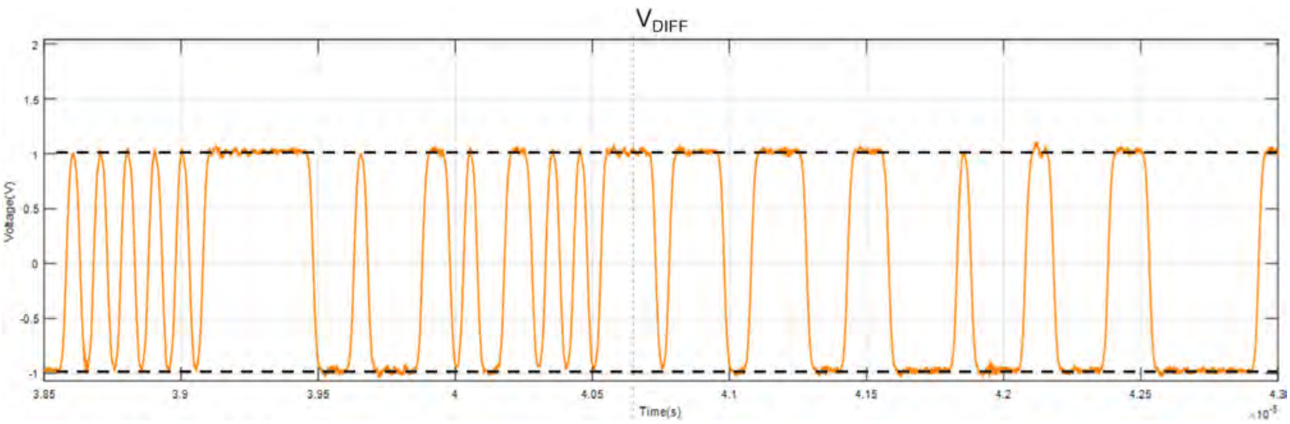

Figure 14: Different pattern in FAST mode (Source: Infineon)

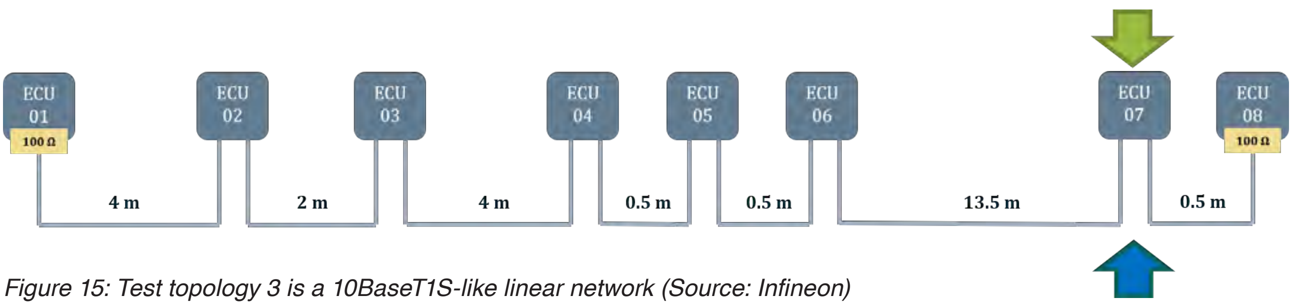

Figure 15: Test topology 3 is a 10BaseT1S-like linear network (Source: Infineon)

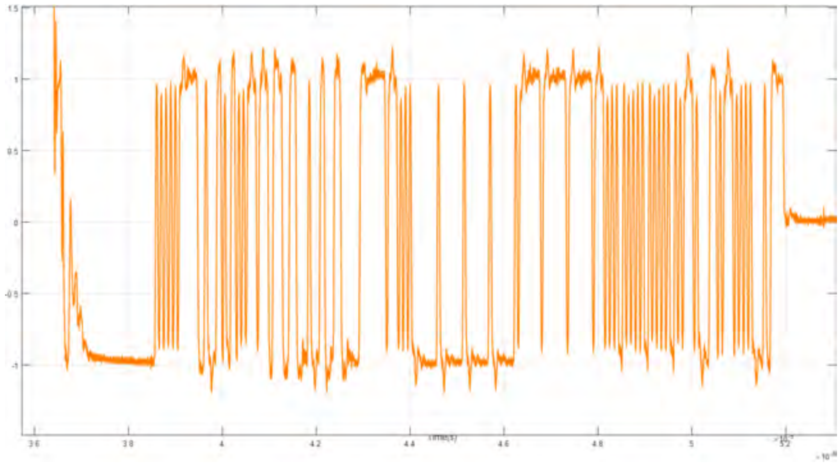

Figure 16: Full FAST phase on node 7 (Source: Infineon)

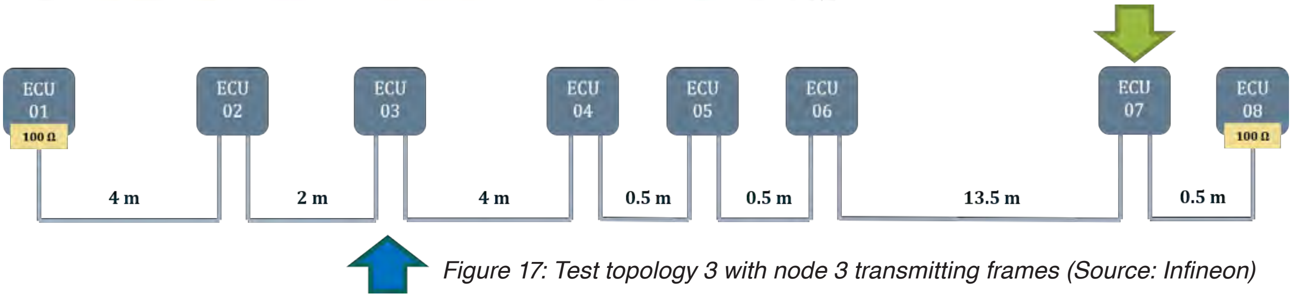

Figure 17: Test topology 3 with node 3 transmitting frames (Source: Infineon)

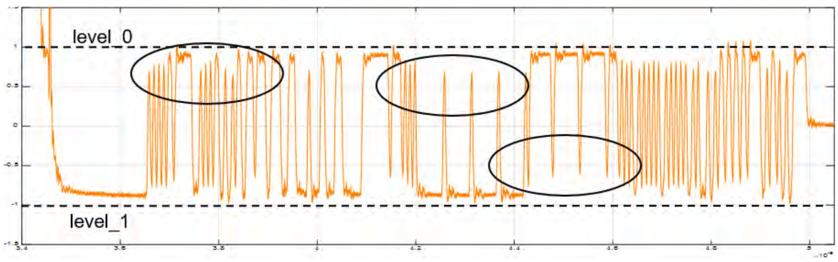

Figure 18: Full FAST phase of node 3 when transmitting (Source: Infineon)

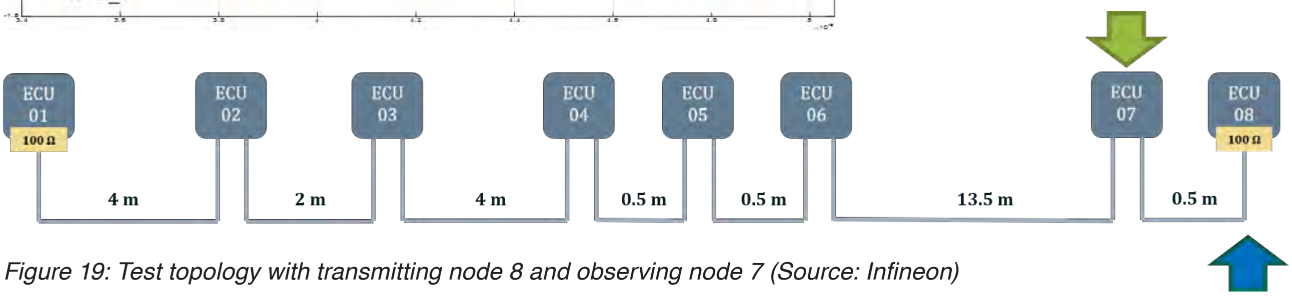

Figure 19: Test topology with transmitting node 8 and observing node 7 (Source: Infineon)

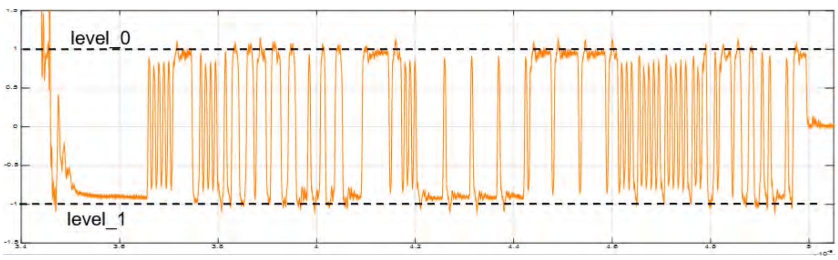

Figure 20: Full FAST phase of the transmitting node 8 (Source: Infineon)

Conclusion

In this first article, three tested CAN XL network topologies and according results have been presented. These topologies were the point-to-point network, the 10BaseT1S-like daisy-chain topology, and a CAN-typical linear topology with short stub lengths. In the second article (to be published in CAN Newsletter 2-2025) the testing results of three further topologies will be presented. These are the CAN-typical linear topology with different stub lengths, a single-star topology with different stub lengths, and a multi-star topology. ◀

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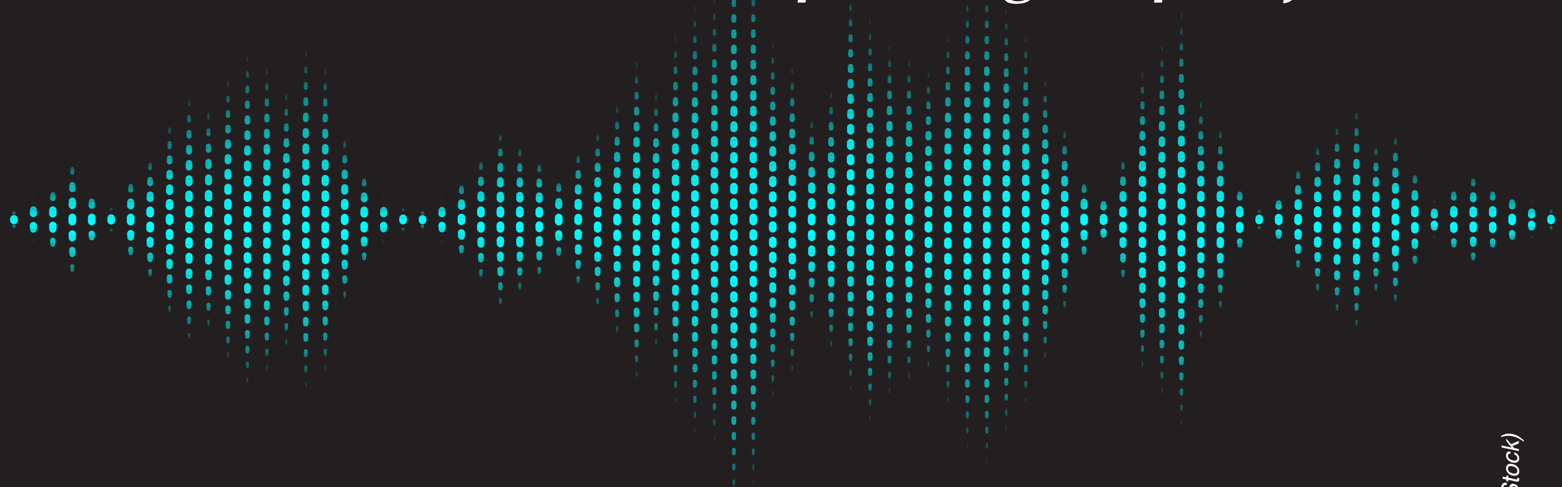
CAN SIC transceivers improve signal quality



The CAN serial communication system has been established for more than 30 years not only in the automotive industry but also in industrial automation. The increasing degree of automation in recent years has led to higher demands in terms of data throughput.

(Source: Adobe Stock)

New evolutions of CAN protocol – CAN FD and CAN XL – provide solutions to these requirements by allowing higher bit rates in the data phase. However, topologies with many branches, as commonly used in CAN applications so far, lead to problems at higher bit rates (see Figure 1). Large and unterminated branches cause reflections, especially when transiting from dominant to recessive signal level (see Figure 3).

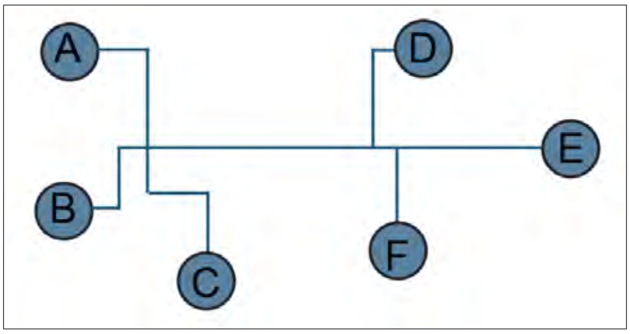


Figure 1: Multi-star topology (Source: esd electronics)

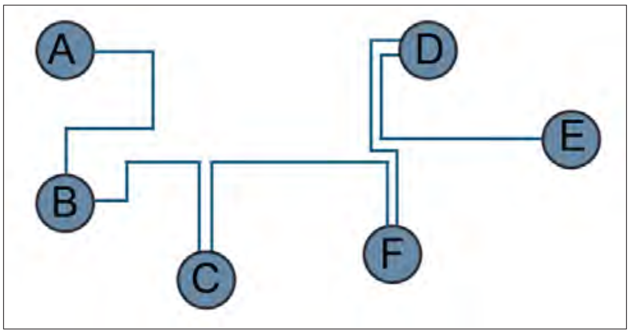


Figure 2: Line topology (Source: esd electronics)

One possible solution to this problem is the consistent implementation of a line topology, routing the bus cable from node to node, in order to avoid long branches with no termination (see Figure 2). However, this results in increased cabling effort and longer networks. Especially in the automotive industry, this is a ‘no go’.

Basics of loss-free arbitration

A key feature of CAN is the non-destructive bus arbitration. No nodes are addressed, instead, the data frames contain an ID (identifier), which implicitly features a priority, determining, which data frame is transmitted first, when multiple nodes start sending simultaneously. Data frames of lower priority are overwritten – the data frame with the highest priority gets the bus access without any delay. There is no interrupt and retry. This is one of the reasons for CAN's real-time capability.

This is achieved through recessive and dominant bits. Dominant bits are sent with a source impedance of about 50 Ω. For recessive bits, the impedance changes to about 60 kΩ. The bit signal level and the slope are then determined by the network terminations and the line capacity. The recessive bits are overwritten by dominant bits from other nodes. This mechanism is only relevant in the so-called arbitration phase of the CAN data frame. In the subsequent data phase, there is only one transmitting node in the network.

CAN SIC transceivers reduce reflections

The change of the source impedance to about 60 kΩ when sending recessive bits is a strong mismatch against the impedance of the CAN network of about 120 Ω and is thus one of the reasons for the strong reflections mentioned above. Depending on the network topology, the settling time can be much longer than the bit time of the higher CAN FD or CAN XL bit rates and can therefore lead to incorrect data reception. ▷

The CAN SIC (signal improvement capability) transceivers target precisely this mismatch. When transmitting a recessive bit, most reflections are eliminated by driving the signal with a 100-Ω source impedance for a set time period instead of immediately switching to a high-impedance state at the beginning of the transmission. Figure 3 and Figure 4 show the comparison between reflections with and without a CAN SIC transceiver.

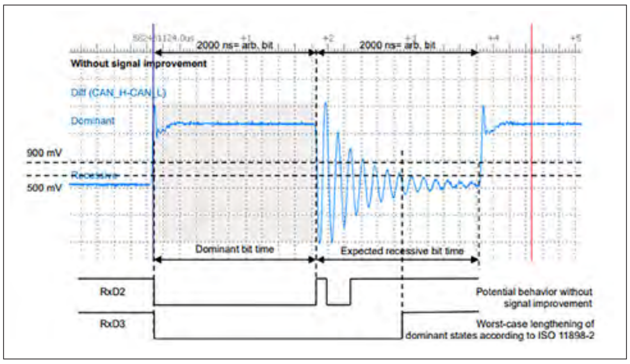


Figure 3: Reflections without CAN SIC transceivers (Source: CAN in Automation)

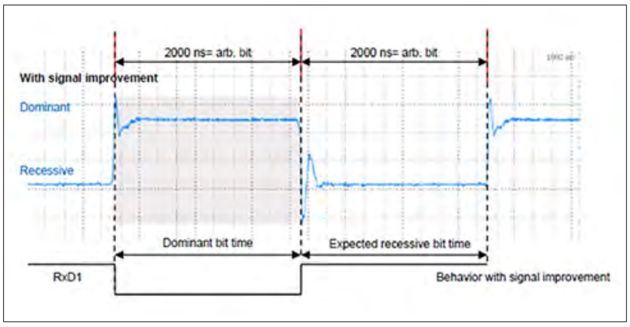


Figure 4: Reflections with CAN SIC transceivers (Source: CAN in Automation)

CAN SIC transceiver specification

The requirements for CAN SIC transceivers, originally specified in the CiA 601-4 document, are specified now in the ISO 11898-2:2024 standard. This standard specifies the maximum of the so-called "active recessive time" – meaning the active driving of the normally recessive level – as 530 ns. This time is longer than the bit time of the higher bit rates in CAN FD and CAN XL. With alternating levels in the data phase, the transceiver then switches from the active recessive state to the dominant state immediately. This means that high bit rates are transmitted almost entirely with a low impedance. In this context, the CAN SIC transceiver specification also deals with EMC issues, which, however, will not be discussed further in this article.

CAN SIC transceivers are another possible solution to achieve higher data rates, but without changing the topology. However, it should be remembered that the higher bit rates can only be reached in the data phase of the CAN data frames and that there are limitations in the arbitration phase.

Limitations of CAN SIC transceivers

Table 14 in ISO 11898-2:2024 specifies the maximum propagation delays, which limit the achievable bus lengths in the arbitration phase. According to the table, the maximum achievable bit rate in the arbitration phase for CAN SIC transceivers is limited to 727 kbit/s. The bus length that can be achieved with this bit rate is only 5 m, assuming a signal propagation delay of approximately 5 ns/m. For 500 kbit/s, the converted achievable bus length is 53 m. Compared to the previous CiA recommendations for CAN HS and CAN FD transceivers (100 m at 500 kbit/s), this represents a considerable reduction. An arbitration bit rate of 1 Mbit/s is no longer possible. The following sample calculation intends to show, where these restrictions come from and how they can be calculated.

1. A multi-star topology is assumed

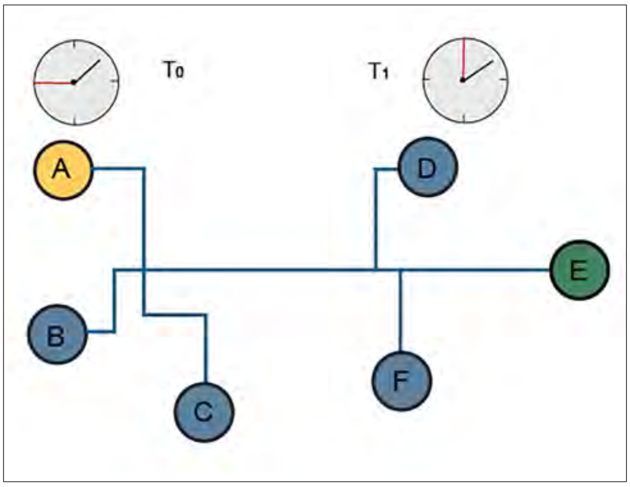


Figure 5: Example multi-star topology (Source: esd electronics)

2. According to the CAN specification, continuous synchronization of all nodes on a network takes place. For this purpose, the recessive to dominant transitions of the CAN frames are used. Node A has just successfully sent a CAN frame. Nodes D, E, and F have synchronized with the rising edges of the last CAN frame to the time T_1.
3. Time T_1 shows an offset compared to time T_0 at node A, which is due to the signal propagation delay.

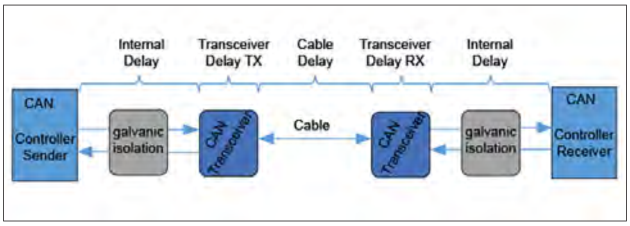


Figure 6: Signal propagation times on the CAN network (Source: esd electronics)

The offset compared to the time at node A is 2 x 45 ns (internal delays) + 80 ns (transmitter delay) + 110 ns (receiver delay) = 280 ns plus the runtime on the cable when assuming the maximum specifications for propagation delays (see Table 14 in ISO 11898-2:2024).

4. Within the next data frame, nodes A, D, and F want to send a recessive bit. Node E wants to send a dominant bit.

5. According to Table 18 in ISO 11898-2:2024, nodes A, D, and F send the recessive bit for a maximum time (signal improvement time TX-based $t_{SIC\_TX\_base}$) of 530 ns active recessive.
6. Common CAN transceivers (CAN high-speed transceivers) transmit the dominant level with a source impedance of 50 Ω. The active recessive level is sent with an impedance of 100 Ω. Assuming that there are other nodes besides nodes D and F that have synchronized on T_1 and that they are also driving the network active recessive, their impedances will connect in parallel. The dominant level then prevails after 530 ns at the earliest.
7. For a correctly functioning CAN network, the dominant level in the arbitration phase must also be seen by node A before its sample point. Node A is ahead of node E by 280 ns plus the cable propagation delay. Added to this is the signal propagation delay from the node E to A.
8. This leads to the following inequation, which can be used to calculate the values in Table 1.

Samplepoint at node A

"0" Time at node E

Active Rezessive Phase

Propagation delay back to node A

$$T_{0SP} > T_1 + t_{SIC\_TX\_base} + t_{Prop\_Delay} + t_{Cable}$$

$$T_0 + t_{Bit} \times P > (T_0 + t_{Prop\_Delay} + t_{Cable}) + t_{SIC\_TX\_base} + t_{Prop\_Delay} + t_{Cable}$$

$$\cancel{T_0} + t_{Bit} \times P > \cancel{T_0} + t_{SIC\_TX\_base} + 2 \times t_{Prop\_Delay} + 2 \times t_{Cable}$$

$$t_{Bit} \times P - t_{SIC\_TX\_base} - 2 \times t_{Prop\_Delay} > 2 \times t_{Cable}$$

$$\frac{t_{Bit} \times P - t_{SIC\_TX\_base} - 2 \times t_{Prop\_Delay}}{2} > t_{Cable}$$

$$\frac{2000\text{ns} \times 81\% - 530\text{ns} - 2 \times 280\text{ns}}{2} = 265\text{ns} > t_{Cable}$$

For better comparability, the sample points in Table 1 were set so that the values given in Table 14 in ISO 11898-2:2024 are exactly matched. A sample point of 99 % at 1 Mbit/s is unrealistic, but it shows that even with this, a meaningful solution is no longer possible.

Table 1: Cable propagation times per bit rate (Source: esd electronics)

Parameter	Abbreviation	Baudrate 1	Baudrate 2	Baudrate 3	Baudrate 4
Baudrate		500 kbit/s	667 kbit/s	727 kbit/s	1000 kbit/s
Bit time	t_{BIT}	2000 ns	1500 ns	1375 ns	1000 ns
Samplepoint [%]	P	81 %	82 %	82,9 %	99 %
Samplepoint [ns]	T_{0SP}	1620 ns	1230 ns	1140 ns	990 ns
Propagation delay (without cable)	t_{Prop_Delay}	280 ns	280 ns	280 ns	280 ns
Aktive Recessive Phase	$t_{SIC\_TX\_based}$	530 ns	530 ns	530 ns	530 ns
Cable Propagation delay	t_{Cable}	265 ns	70 ns	25 ns	-100 ns

As described above, these restrictions only apply to the arbitration phase. In the data phase, there is only one transmitter at a time. The correct signal level is therefore immediately present – without possible collision in the active recessive phase of 530 ns length – at the network.

The oscillator tolerances are not considered in the calculation, as they no longer play a significant role with today's standard oscillators. For the calculation of the possible topologies with individually adapted values, CiA offers a corresponding spreadsheet tool on request (currently under revision).

Conclusion

CAN SIC transceivers achieve a significant improvement in signal quality using non-optimal CAN topologies. However, this comes at the cost of reducing the maximum network lengths and limited bit rates in the arbitration phase. The previous backward compatibility of the CAN FD communication with the CAN CC (classic) communication regarding the arbitration bit rate is only maintained for bit rates below 727 kbit/s, when using CAN SIC transceivers. esd electronics offers special solutions for required applications also regarding the use of CAN SIC transceivers. ◀

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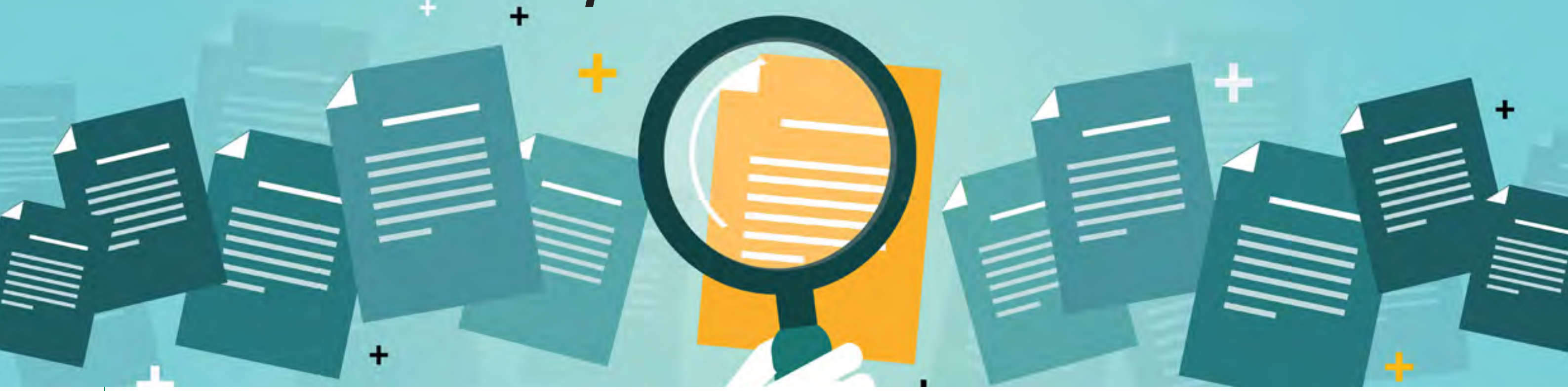
Standards and specifications



This regular column provides news from standardization bodies and nonprofit associations regarding CAN-related documents. Covered are also recommended practices, application notes, implementation guidelines, technical reports, and open-source projects.

Open-source telematics for commercial vehicles

Cummins has announced a collaboration with Bosch Global Software and KPIT to launch Eclipse CANought, an open-source project for commercial vehicle telematics. It is part of the Eclipse Software Defined Vehicle project.

"Cummins is partnering with two industry experts on this project, Bosch Global Software and KPIT, two companies that have extensive expertise in vehicle telematics and CAN communications," said Brad Sutton, working with Cummins. Eclipse CANought enables secure OTA (over-the-air) software updates to CAN-connected ECUs (electronic control units). It supports J1939, a higher-layer protocol for heavy-duty vehicles developed by SAE.

"This collaboration among industry leaders is just one more example of how the open-source model fuels innovation in the automotive sector, making advancements accessible industry-wide. CANought is particularly exciting as it merges open-source collaboration with established industry standards and architectures such as CAN and SAE J1939, accelerating the development of Software Defined Vehicle applications," stated Mike Milinkovich, executive director at the Eclipse Foundation. Eclipse CANought complements an existing project, Eclipse Kanto, which provides a hardware-agnostic solution for running containerized applications across a variety of telematics hardware.

"We believe that coordinated software updates are crucial for the commercial vehicle industry as more countries implement new regulations for cyber security. This new collaboration will enable customers to more effectively deploy software updates to all of the vehicle systems simultaneously," said Sven Kappel from ETAS, Bosch daughter company. "By establishing standard interfaces, our update systems can easily connect with OEM and Tier 1 ECU software update mechanisms."

Over the next few months, Cummins, Bosch BGSW, ETAS, and KPIT will continue to contribute to the Eclipse CANought project. These contributions will be analyzed and improved by the larger Eclipse SDV community as they are made production-ready.

"KPIT is proud to be a trusted software partner to Cummins for over two decades. We are delighted to bring the power of KPIT's remote diagnostics and OTA technology solutions to Cummins products deployed in commercial vehicles. This open-source, standardized solution, backed by Eclipse Foundation, will be a game changer in the experience for engineering and service professionals in the commercial vehicle space" said Anup Sable from KPIT. In spring 2025, Eclipse Kanto and Eclipse CANought are available for integration into projects. *hz*

DIN 14700 workshop

The online workshop was well participated by about 20 attendees. Speakers from CiA, DIN, Haensch, Rosenbauer, and Ziegler gave on overview about the DIN 14700 monolithic document, which is currently under publication. The German standard is written in English language and will substitute the legacy multi-part DIN 14700 standard written in German language. In order to internationalize this standard, DIN is willing to submit this document to ISO.

DIN 14700 specifies a fire-fighting truck host controller and dedicated fire-fighting equipment, so-called FFUs (fire-fighting units). This includes warning signal units, frequency inverter units, water cannon units, light mast units, and other units. The used CAN-based network complies with CANopen CC (classic) communication services and protocols as specified in CiA 301/EN 50325-4.

During the workshop, new functions – especially for telematics and for a second display unit for the body application – were discussed. In order to avoid extra protocol converters (gateway units), the option of in-vehicle gateway units (IGUs) based on a CANopen application layer were presented. IGUs are specified in DIN 4630 (also available in English language). This German standard has been already submitted to ISO and is currently under revision (ISO 25200). *hz*

ISO 16845 series in revision

The conformance test plans for the CAN data link layer and the physical coding sublayer (ISO 16845-1) and for the CAN physical medium attachment sublayer (ISO 16845-2) are under revision. They standardize test cases for ISO 11898-1 (CAN protocol controller) respectively ISO 11898-2 (CAN transceiver) implementations. Project leader (editor) is Christoph Wosnitza from the C&S Group test-house, Germany. The revision of these documents is a task of the ISO/TC 22/SC 31/WG 3 chaired by Holger Zeltwanger, the CiA Managing Director.

The ISO 16845-1 document covers all three CAN protocol variants: CAN CC (classic), the legacy CAN data link layer introduced beginning of the 90s, CAN FD (flexible data rate), launched mid of the 2010s, and CAN XL (extended data-field length), originally specified in CiA 610-1. Additionally, this standard provides test cases for CAN FD light responder implementations. The CiA task force "ISO 16845-1" supports the revision of the ISO conformance test plan by means of submitting joint comments discussed and prepared by CiA members and interested members of the ISO/TC 22/SC 31/WG 3 experts.

The ISO 16845-2 document is related to following CAN transceiver implementations: CAN HS (high-speed), CAN FD, CAN SIC (signal improvement capability), and CAN SIC XL. The CAN SIC XL approach features two modes: the SIC mode and the FAST mode. In FAST mode, bit rates up to 20 Mbit/s can be achieved, depending on the selected network topology and chosen electro-mechanical components such as cables and connectors. *hz*

Brief news

- ***CiA 702:*** CiA has released the CiA 702 document specifying the usage of LLS (layer setting services) FD services and protocols in CANopen CC (classic) networks. It specifies the mapping to CAN CC data frames, enabling a faster detection of unknown LSS addresses.
- ***CiA 910-1/2:*** The recently released CiA 910-1 (general terms and use cases) and CiA 910-2 (PMA simulation model requirements) documents specify a set of requirements for simulation models. This enables the development of simulation tools for networks based on CAN FD, CAN SIC, and CAN SIC XL transceivers, which provide comparable results. The simulation model for the PMD (physical-medium dependent) sublayer (CiA 910-3) is still under development.
- ***ISO 11992-1:*** On Semiconductor has qualified its NCV7390 transceiver, which complies with ISO 11992-1. Now, the product is available in production volume.
- ***ISO 11992 series:*** Part 2 (brake and running gear parameters) is under revision. Besides some missing J1939 parameter groups, there are some new feature requests in respect to e-trailer applications.
- ***ISO 11783-3:*** This document dedicated for control networks in agriculture machinery, has been revised. It specifies application, network, and transport layers and the mapping to CAN CC (classic) data frames in extended format. It will be submitted for DIS (Draft International Standard) ballot, soon.
- ***ISO 16844 series:*** The tachograph standard for commercial vehicles is going to be revised. There are some new feature requests and some pending comments. Part 7 specifies some J1939 parameters. ISO/TC 22/SC 31/WG 4 is responsible to update the documents.
- ***ISO 25200:*** ISO/TC 22/SC 31/WG 4 has started to develop a body application network based on the DIN 4630 standard. Project leader (editor) is Richard Moser (Palfinger). The standard under development addresses body builders as well as truck and trailer manufacturers. It is intended to provide a standardized interface to telematic systems, too.
- ***SAE J1939/13:*** The off-board diagnostic connector specification has been updated in 2024. The defined diagnostic connectors support connection to the twisted shielded pair media (SAE J1939/11), the unshielded twisted pair (SAE J1939/15), the twisted pair (SAE J1939/14), and the twisted unshielded quad media (ISO 11783-2).
- ***SAE J1939/16:*** The last year updated document specifies a process enabling devices to detect automatically the bit rate of a CAN CC network as specified in SAE J1939/11, SAE J1939/14, or SAE J1939/15. These networks support Classical Base Frame Format (CBFF) and Classical Extended Frame Format (CEFF), as standardized in ISO 11898-1. Automatic bit-rate detection in a CAN FD network is not in the scope, as SAE J1939-17 is currently the J1939 CAN FD physical layer option, which specifies only one bit rate combination (500 kbit/s and 2 Mbit/s). *hz*

Regular columns

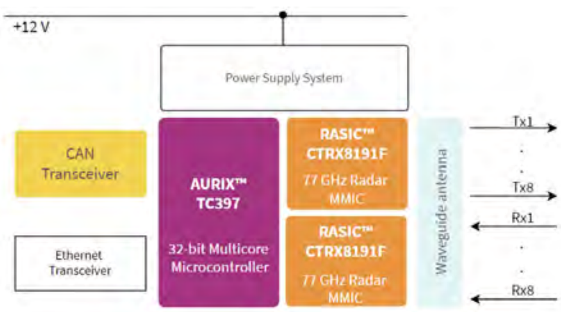
(Source: Adobe Stock)

News in this regular column came in, close to the editorial deadline. Nevertheless, they have been doublechecked on accuracy and correctness.

CES 2025: 77-GHz radar prototyping module

(Source: Infineon)

Infineon (Germany) presented in Las Vegas the Xensiv Carkit 2C3 module based on the company's CTRX8191F radar MMIC (monolithic microwave integrated circuit). The kit can be used for prototyping of front, corner, and rear radar ECUs (electronic control units) to be applied for adaptive cruise control (ACC) and automatic emergency brake (AEB) systems respectively for automated lane change assist (ALCA) applications. Via the on-chip CAN FD controller, the product can be connected to in-vehicle networks.



Block diagram of the Xensiv Carkit 2C3 module (Source: Infineon)

The CTRX8191F chip can detect objects in distances up to 380 m. It provides up to eight transmitters and up to eight receivers for four-dimensional (4D) front radar configurations, for example. The IC is cascadable. The integrated digital PLL (phase-locked loop) circuitry features a flyback time of less than 1 μs. The kit comes with software examples and graphical user interface (GUI), enabling rapid prototyping. *hz*

CES 2025: 79-GHz radar module with CAN FD port

(Source: Novelic)

Novelic (Serbia) has shown at the CES technology trade show in Las Vegas the Asper200 short-range radar module, featuring a 180° field of view (FOV). It is intended for use in passenger cars, commercial vehicles, motorcycles, transportation, and construction vehicles. The product can replace multiple ultrasonic sensors in park-assist applications. It detects and classifies objects up to 100 m. A radar-based park-assist sensor can be integrated seamlessly behind or above the bumper. A single hardware module outperforms ultrasonic sensors, with a minimum distance of less than 5 cm and detection of low-lying objects.

Using the same hardware, OEMs (original equipment manufacturers) can realize additional functionality such as power-door protection, tailgate protection, and gesture control. The implementation of edge computing allows an integration into in-vehicle networks or body application networks such as ISO 25200 (formerly DIN 4630), using a CAN FD interface. Other application options include rear-and-front collision warning, 360° surround awareness, urban blind spot detection (BSD), rear cross-traffic alert (RCTA), and rear automatic emergency braking (R-AEB). *hz*

PC-based oscilloscope solution


(Source: Rohde & Schwarz)

Rohde & Schwarz launched the R&S Scopestudio application that brings the functionality of the MXO oscilloscope series to a PC. This solution allows engineers to visualize, analyze, document, and share oscilloscope measurements away from the oscilloscope hardware. Users can import oscilloscope waveforms or entire sessions. The subsequent measurements and analysis capabilities mirror what a user would experience on their MXO oscilloscope.

Since users can view and analyze previously acquired data away from the instrument, it leaves the oscilloscope free for others to use. Engineers can use PC tools to more efficiently document designs, as well as improve the quality of images and annotations. Additionally, research and development teams can share measurement results with remote locations, partners, suppliers, and customers. Protocol decoding support for CAN CC, CAN FD, and CAN XL will be available soon. The PC application software for the R&S MXO 4, R&S MXO 5, and R&S MXO 5C oscilloscopes is now available from the company. *of*

+++ Elmos (DE) has launched the cascadable E522.96 OLED driver IC for exterior vehicle lighting, featuring CAN FD connectivity; it can control up to 48 OLED segments. +++ Microcontrol has published its CAN-related seminar schedule for 2025. +++ The MC 3602 B and MC 3606 B motion controllers by Faulhaber comply with the CiA 402 profile specification series, providing a CANopen interface. +++ Rafi has developed the configurable 3L joystick for Fendt tractors; it is IP5K4-rated and provides an Isobus interface. +++ New CiA member Macome (JP) offers linear encoders and inclinometers with CAN interfaces. +++ CiA member Ematic (IT) develops CANopen products for lift control systems; one reference application is the Olympic stadium in Rome. +++ NXP has started to sample its i.MX 94 system-on-chip (SoC) series featuring CAN FD interfaces; the chips are intended for programmable logic controllers (PLCs) and industrial gateway units. +++ Chipmaker Rohm and Denso automotive Tier-1 supplier have agreed to establish a strategic partnership, which also covers CAN-related products. +++ Miunske produces a CAN-connectable multi-sound module intended for vehicle applications; it can play back acoustic signals and voice messages by the vehicle operator (up to 50 messages). +++ New CiA members in 2025 are Altinay Robot Technologies (TR), Basicmicro (U.S.A.), Bever Car Products (NL), Copeland (U.S.A.), Emoco Labs (SE), Growy Group (NL), Hawe Hydraulic (DE), Hydrotechnik (DE), Jiangsu Fulling Motor Technology (CN), Macome (JP), Metron Automation (GR), MGB-Tech (BE), Micropower Group (SE), Naviq (CH), Optex (JP), Rolls-Royce Solutions (DE), Safetty Systems (UK), and Specialized Europe (CH). +++ The PE1102N, PE1101N, and PE1100N IoT-edge computer by Asus (TW) powered by Nvidia's AI (artificial intelligence) processors provide CAN interfaces accessible by a 9-pin Dsub connector. +++ *hz*

Embedded World ticker

+++ Forlinx Embedded launched the FET-MX95xx-C system-on-module featuring five independent CAN FD ports to be mounted on an evaluation board providing the CAN transceiver chips. +++ The miriac SBC-S32G274A single-board computer by Microsys powered by an NXP processor is equipped with 16 CAN CC (classic) and two CAN FD interfaces. +++ HMS exhibits the Ixxat CAN-IB500 and CAN IB600 interface boards in PCIe format, supporting one respectively two CAN FD channels. +++ Qiyang Technology presents the IAC-IMX8MP-Kit coming with two CAN FD channels and multiple other interfaces. +++ The owa5X wireless embedded computer by Owasys intended for off-road and rail vehicles provides four CAN FD interfaces with CAN SIC transceivers. +++ The EAC-50N3 box computer by Everfocus is powered by a Jetson Orin processor (Nvidia) and has one CAN FD interface. +++ Based on a Jetson Orin processor, the EAC-30N3 computer module exhibited by Acrosser offers one CAN FD port. +++ The IBOX-650P-M12X-IP66 fanless computer based on a Jetson Orin processor by Sintrones features two CAN FD ports for integration into in-vehicle networks. +++ Syslogic introduced the RSA4NA rugged computer based on the Jetson Orin processor, which comes with one CAN FD interface. +++ *hz*

Regular columns