Construction machines

Embedded CAN-based control networks

From Classical CAN via CAN FD to CAN XL

We shape the future!

Classical CAN

Since more than 20 years, Classical CAN is used in construction machinery

This dominating network technology is standardized in ISO 11898-1 (data link layer and physical signaling) and ISO 11898-2 (physical media attachment sub-layer). In the beginning, several original equipment manufacturers (OEM) used proprietary higher-layer protocols. In the meantime, many machine builders have migrated to standardized higher-layer protocols, especially CANopen (EN 50325-4) and SAE J1939.

Suppliers of CANopen devices often apply CiA profile specifications

This includes generic device profiles such as CiA 401 (input/output modules including joysticks), CiA 404 (e.g. pressure, temperature, or force sensors), CiA 406 (rotary and linear encoders), CiA 408 (hydraulic actuators), and CiA 410 (inclinometers). This supports standardized access to machine internal data.

CiA supports the integration of construction machine data into clouds

There are several approaches under development to process machine-internal data by means of big-data processing. This includes the CiA 309-5 specification (Internet of Things) as well as DIN 4630 (CAN-based network for body applications).

CANopen and J1939 comprises functional safety protocol extensions

CANopen Safety is already standardized in EN 50325-5. It complies with IEC 61805 (SIL 3). Several suppliers offer IEC 61131-3 programmable host controllers featuring CANopen Safety. There are also many sensors available, which support CANopen Safety. Recently, SAE released the J1939-76 functional safety protocol extension. Compliant functional safe products are under development.

Robust and reliable CAN hardware is available for reasonable prices

The CAN protocol controller often integrated in micro-controllers and the CAN transceivers comply with extended temperature ranges (-40 °C to +125 °C). Several suppliers provide higher-layer protocol stacks for CANopen and J1939. Engineering and diagnostic tools are available for several companies.

SAE J1939 is mainly used in powertrain control systems

The J1939 Digital Annex provides standardized Parameter Groups (PG) dedicated for joysticks and other devices. They are similar to PDOs in CiA profile specifications. This enables a high degree of off-the-shelf plug-and-play capability and partial interchangeability.

Sophisticated construction machinery automates functionality increasingly

This requires more throughput and more data per frame. This includes resources for functional safety and cybersecurity protocol extensions. CAN FD provides this capability with the same bus latency as provided by Classical CAN.

The CANopen FD application layer specified in CiA 1301 is based on CAN FD

It does not just feature higher bandwidth, but it provides also more design flexibility compared to classic CANopen. In particular, the USDO (universal service data object) service enables confirmed broadcast and multicast communication. New CANopen FD functions improve diagnostics and pre-emptive maintenance.

The J1939-22 application layer supports CAN FD, too

It introduces an Autosar-compliant multi-PDU (protocol data unit) approach originally specified in CiA 602-2. Additionally, SAE develops the J1939-17 physical layer specification. It supports 500 kbit/s in the arbitration phase and 2 Mbit/s in the data phase.

CANopen FD and J1939-22 are prepared to support functional safety and cybersecurity

The extended payload of up to 64 byte per data frame provides sufficient space for related protocol extensions. However, such extensions are not yet standardized, but are under development.

The next step

CiA develops already the next CAN protocol generation

With the introduction of Ethernet backbone networks, there is a need to tunnel TCP/IP via CAN-based networks. This would require even larger data frames as CAN FD provides. Therefore, the nonprofit CiA association is developing in cooperation with automakers and chipmakers the CAN XL data link layer featuring payloads of up to 2048 byte. Additionally, a new PMA standard is under development, which supports data phase bit-rates of in minimum 10 Mbit/s.

CiA members shape the future of CAN technology

Regarding applications in construction machinery, the CiA Interest Groups "Profiles" and "J1939" are going to develop appropriate solutions. The CiA Interest Group "Safety and Security" specifies application layer independent extensions for functional safety and cybersecurity.

Interoperability of devices is important for the construction machine industry

This reduces system design effort. It is achieved by means of standardized device and application profiles. CiA adapts its broad range of construction machine relevant profile specifications to CANopen FD and future application layer approaches. On demand of the construction machine industry additional profiles are specified.