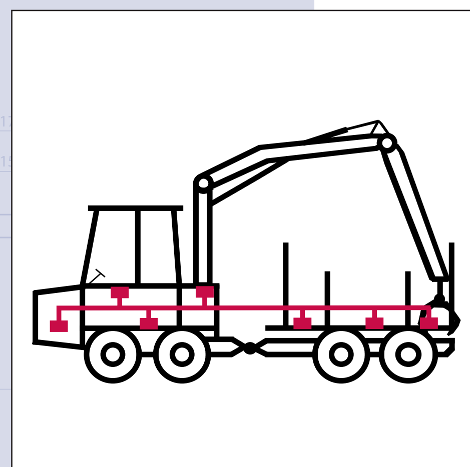
CAN
Controller
Area
Network

Technical Information



HISTORY

Forced by the increasing number of distributed control systems in cars and the increasing wiring costs of electronics, the availability of a powerful and reliable data communication system for the exchange of information between the different control units was becoming urgent.
This was the starting point for BOSCH, a main provider of electronic car equipment to develop the CAN protocol and standardize it as an international standard in ISO 11898. 1989 the first protocol controller chip was provided by INTEL.

WHAT IS CAN

CAN is a serial bus system which is especially suited for connecting devices within a system or sub-system. These devices (nodes) can be intelligent devices as well as sensors and actuators.
CAN is a serial bus system with multi-master capabilities, that means that all CAN nodes are able to transmit data and several CAN nodes can request access to the bus simultaneously. A transmitter sends a message to all CAN nodes (broadcasting).
A CAN message can transmit from 0 up to 8 bytes of user information. Each CAN Message starts with a so called identifier followed by the data bytes. This identifier can be 11 Bit or 29 Bit wide. If the identifier is 11 bit wide, than it is a message in „standard format" (CAN specification 2.0 Part A). Otherwise it is a message in the „extended format" (CAN specification 2.0 Part B). Please be aware that not all CAN controller supports the extended format.
Each node decides on the basis of the identifier received whether it should process the message or not. The identifier also determines the priority that the message have in competition for bus access.
One of the outstanding features of the CAN bus is its high transmission reliability. The CAN protocol controller detects a stations error and evaluates it statistically in order to take appropriate actions. These may extend to disconnecting the CAN node producing the errors.

BENEFITS

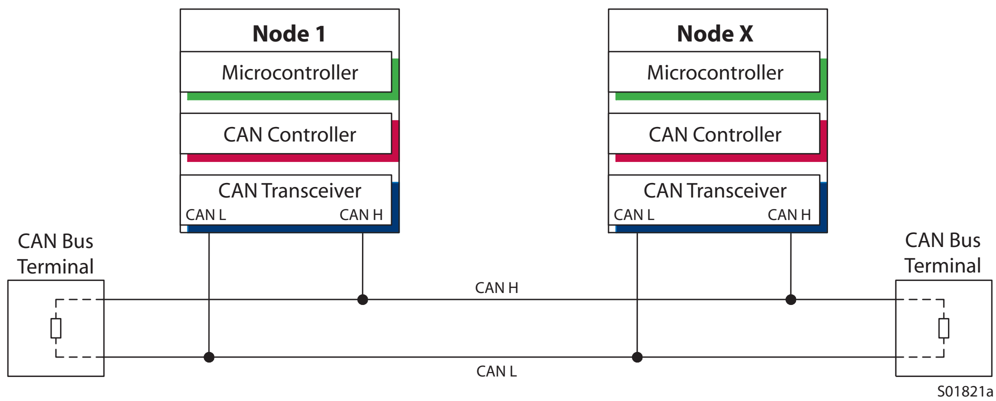
The use of a CAN system increases the flexibility of a system. One of the most obvious benefits is reduced wiring. A single two-wire bus is all that is needed to connect several CAN devices. This reduces costs, simplifies mechanical design, and makes it easier to insert additional devices into a system.
The key benefit of CAN, like any network, is that it makes it possible to share resources and information between devices. This means that one sensor can easily be shared between two or more controllers, or two controllers may share information about their respective subsystems. Instead of using point to point communications, any device on a CAN network can communicate with any other.
An additional benefit of this is that system diagnostics can be centralized and simplified. As a single device can access all of the devices on the CAN, it is possible to centralize diagnostic tools to a single access point.

BUS TOPOLOGY

According to ISO 11898 the CAN-Bus is realized by a cable with two lines. The bus cable is terminated at both ends by termination resistors (see figure 1).

Note: The stub cable, which is the cable from the bus cable to a node, is an unterminated cable and should be as short as possible.

Figure 1: CAN-Bus realization



BUS CABLES AND TERMINATION RESISTORS

The table below shows some standard values for CAN-networks according to ISO 11898 with less than 64 nodes and can be used as a kind of guideline. In addition, the cable should have following AC parameters:
- A 120 Ω impedance and a 5 ns/m specific line delay.

Bus length [m]	Bus cable: Length related resistance [mΩ/m]	Bus cable: Cross section [mm²]	Termination resistance [Ω]	Baud rate [Kbit/s]
0...40	70	0.25...0.34	120	1000 at 40 m
40...300	< 60	0.34...0.60	150 ... 300	> 500 at 100 m
300...600	< 40	0.50...0.60	150 ... 300	> 100 at 500 m
600...1000	< 26	0.75...0.80	150 ... 300	> 50 at 1 km

DATA EXCHANGE

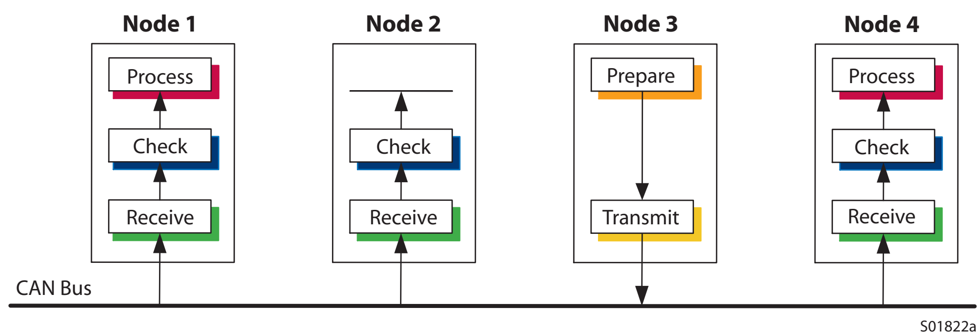
When data is transmitted through a CAN Network, no nodes are addressed, but instead, the content of the message (e.g. engine rpm or vehicle speed) is designated by an identifier that is unique throughout the network.

If the Microcontroller of a given node wishes to send a message to one or more nodes, it passes the data to be transmitted and their identifiers to the assigned CAN controller ("Prepare"). This is all the Microcontroller has to do: To initiate the data exchange. The message is constructed and transmitted by the CAN controller itself.

DATA EXCHANGE (continued)

As soon as the CAN controller receives bus access ("Transmit") all other nodes on the CAN network become receivers of this message ("Receive"). Each node in the CAN network, having received the message correctly, performs an acceptance test to determine whether the received data is relevant for that station ("Check"). If the data is of interest for the node it is processed ("Process"), otherwise ignored.

Figure 2: CAN network



HIGHER LEVEL PROTOCOLS

All the above mentioned specifications describes how data is physically transmitted through the CAN network but not what kind of data. This means that the CAN controller does not care with which identifier the engine RPM is transmitted.
This is the task of the system designer. He has to design what data is transmitted through the bus. Due to that application specific data exchange solutions have been implemented.

These so called „proprietary" protocols are mainly not compatible to each other because they are optimized for a specific application.

In this case optimized means:
- Bandwidth usage of the bus
- Memory allocation in the control unit
- Reaction time

For an open system approach several higher layer protocols have been envolved. Most popular protocols of that are:
- SAE J1939
- CANOpen
- CANKingdom

REFERENCES

- Robert Bosch GmbH:
  CAN specification 2.0 Part A+B (1991)

- CiA DS-102:
  CAN physical layer for industrial applications (1994)

- Konrad Etschberger (Hrsg.):
  Controller-Area-Network; Grundlagen, Protokolle, Bausteine, Anwendungen (2000)

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