

Scalability of CANopen

When price matters, scalability is an important feature for embedded and deeply embedded networks. Although CANopen FD is not completely compatible with classic CANopen, scalability is provided.



(Source: Adobe Stock)

The complete article is published in the [March issue](#) of the CAN Newsletter magazine 2020. This is just an excerpt.

Classic CANopen embedded networks are used in a very broad range of application fields: Just have a look into previous issues of the [CAN Newsletter magazine](#) and the CAN Newsletter Online. You will find reports about CANopen in satellites, in subsea, any kind of vehicle, and many motion-control applications. Additionally, CANopen has migrated into deeply embedded networks such as backbone networks, in industrial I/O devices, and in smart devices with multiple sub-modules. CANopen introduced already in 1994 offered from the beginning scalability not only regarding communication functionality.

Some people still think that CANopen is complex. No, it is not. It provides just a few mandatory features (NMT, Heartbeat, and expedited SDO functionality), and a lot of optional add-on communication functions (PDO, normal SDO, SYNC, TIME, and EMCY as well as "Flying" NMT master functionality), if needed. This is like in a restaurant: the menu lists more dishes than you can eat.

Regarding the bit-rate, CANopen allows eight standardized bit-rates; from 10 kbit/s to 1 Mbit/s. Other communication technologies do not support those much different bit-rates. But consider: The higher the speed, the more challenging is the physical network design. This means the costs for cabling, connectors, and energy consumption increase with the higher bit-rates.

On the other hand, data throughput requirements are increasing permanently with new control functions. Of course, you can spend some effort to communicate smartly, not wasting the available bandwidth. For example, do not talk, if you have no new data. But at some point you need more throughput. The limit for classic CANopen is 1 Mbit/s, when your network is not longer than 25 m and only very short not terminated stubs are installed.

CANopen FD for higher bit-rates

CANopen FD is based on the CAN FD data link layer. Depending on the bus-line topology you can achieve 2 Mbit/s in the data-phase. If you need more, you should implement the so-called SIC (signal improvement circuit) transceiver as specified in CiA 601-4 version 2.0.0. Up to 8 Mbit/s is possible, when the topology is as close as possible a bus-line and the impedance of the installed

Bit-rate [kbit/s]	Max. network length [m]	Sample-point [%]
1000	25	75 to 90
800	50	
500	100	85 to 90
250	250	
125	500	
50	1000	
20	2500	
10	5000	

Table 1: Classical CAN bit-rates, which also can apply for the arbitration bit-rate in CANopen FD, but the sample-point shall be set to 80 %

components matches 120 Ohm. For more details on SIC transceiver, see [this article](#). In some applications, the busload is not the restriction. It's the 8-byte payload limit, which matters. CANopen FD features because of the used CAN FD data link layer a maximum data frame length of 64 byte. Unfortunately, the length is not byte-wise increasable.

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