Flexible diagnosis for CAN FD

Going deep into a CAN FD network is possible with a handeld device. It can handle diagnosis on the data link layer and the physical layer.

In many cases, CAN diagnosis cannot be done in a laboratory environment where appropriate but stationary hardware is available. A handheld device which is specialized in CAN – and also the new CAN FD standard with its higher data bit-rates – helps to fulfill this task flexibly but still in a comprehensive manner.

The general CAN communication is based on the lower two layers of the OSI model (Open Systems Interconnection Model). The CAN FD protocol as defined in ISO 11898-1 refers to layer 2, the data link layer. This communication is managed by CAN controllers. If the CAN communication fails in new CAN FD environments with heterogeneous nodes and there is no way to get status outputs of the CAN controllers, it is time to take a look at the physical layer (layer 1) of the CAN network. The interesting thing to know is what actually happens on the CAN_H and CAN_L lines of the high-speed CAN (ISO 11898-2). The handheld device PCAN-Diag FD includes an oscilloscope function, specialized in the work with CAN FD communication.

The pure signal course of the two CAN lines already helps to detect basic cabling errors. For example, the assumed development environment is susceptible to mixed up CAN lines. This is reflected by the scope channels amplitudes pointing to wrong directions.

CAN frame decoding

More interesting is the analysis of the physical signal course for CAN and CAN FD frames. The scope function of the PCAN-Diag FD is able to decode a CAN frame from the signal on the lines and show information about the frame

Figure 2: Handheld device PCAN-Diag FD for diagnosis of a CAN FD network (Photo: Peak-System)

and its logical sections. This also works for broken CAN frames because the detection is independent of the CAN controller. Going into CAN FD peculiarities, there are two incompatible flavors of the protocol. The initial one and the one with improved CRC handling, which is now part of ISO 11898-1. If a non-ISO frame is decoded, but the CAN FD network should work only in ISO mode and other FD nodes already do, the situation is clear.

With higher bit-rates for the data part of the CAN FD frame and the resulting short bit times, timing issues are pushed to the foreground. The Report function shows the actual nominal bit-rate (for the arbitration) and data bit-rate. Both are calculated from the measured duration of the corresponding CAN frame parts. A CAN FD node may be configured with a wrong data bit-rate, e.g. 2,5 Mbit/s instead of 2,0 Mbit/s. As the CAN-ID of the faulty frame is also determined, the misconfigured CAN node is easily detected.

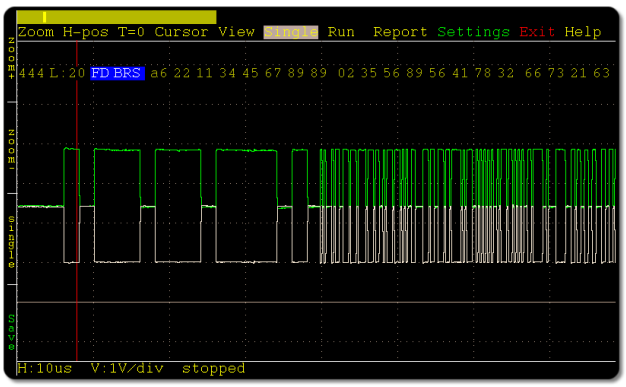

Figure 1: A CAN FD frame on the scope including frame information decoded from the CAN transceiver's data stream (Photo: Peak-System)

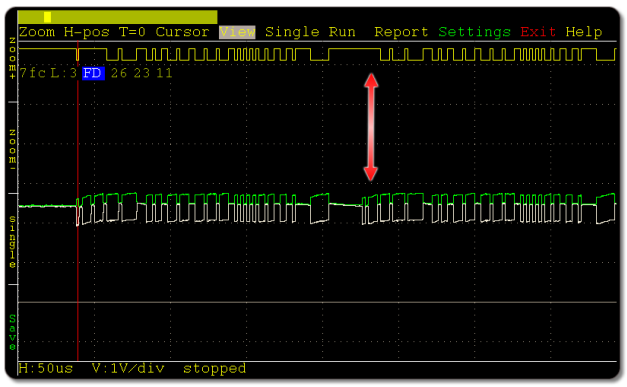

Figure 3: The upper curve displays the data stream from the CAN transceiver; the marked position exemplarily shows that the transceivers threshold is not reached by the analog signal (Photo: Peak-System)

Not only the analog signal course can be used to assess the signal quality. Important is what the CAN transceiver can pull out of a disturbed signal from the CAN network lines. As it uses the difference between CAN_H and CAN_L to interpret the signal course, it is good to take a look at this – on both sides of the CAN transceiver. The scope function has options to display the calculated differential signal and also the RxD channel as it is delivered by the CAN transceiver. The question is if all slopes on the physical lines are correctly converted into changes between 1 and 0.

This inspection should be done at different taps of the CAN network in order to see where state changes may not be detected properly anymore. This could happen if the amplitudes of the CAN signals are becoming low due to very long CAN lines or an improper termination with too many resistors or with wrong resistance values.

Layer-combined diagnosis

The PCAN-Diag FD acts as a regular CAN FD node. For example, it is able to initiate communication with other nodes that rely on specific CAN message sequences, e.g. control units. Transmit lists of CAN messages can be set up on the PCAN-Diag FD, even with defined pauses between single messages. As the trigger of the scope function can be set to a specific CAN-ID, the expected response can be observed on the scope. The dual-layer diagnosis is complemented by measuring functions for CAN termination and bus load during communication as well as tracing and playback of CAN traffic. Many aspects of the inspection can be handled by means of projects, i.e. CAN communication parameters, scope settings, and even a customized splash screen for a better distinction for the user. Projects are saved on the PCAN-Diag FD in order to handle different use cases without further need of configuring.

Author

Mark Gerber
Peak-System Technik GmbH
www.peak-sytem.com
info@peak-system.com

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