CAN FD simulation in real-time systems

Migration from Classical CAN to CAN FD affects both the hardware and the application software. Real-time simulations must support the steps necessary for migration.

Figure 1: FPGA-based CAN FD module for use in RCP and HiL systems

Over the next few years, many ECU networks will migrate from Classical CAN to CAN FD. This new type of network increases the payload length and offers a higher bandwidth, while still providing the advantages of CAN, namely flexibility and affordability. The basic mechanisms of arbitration, message acknowledgement, and frame setup remain unchanged. It is therefore possible to further develop existing topologies, and developers can continue to use their working methods and accumulated know-how. Nevertheless, changing the network also poses a challenge because it affects both the hardware and the application software. The real-time simulation must support the steps necessary for migration, so the complete ECU can be validated.

Migrating from Classical CAN to CAN FD

The hardware changes required for the migration from Classical CAN to CAN FD are straightforward. The only prerequisite is that the ECU's CAN controllers are prepared for use with CAN FD. One way of migrating is to use CAN FD passive parts that ignore certain CAN FD messages instead of destroying them via the error frame. This change is mainly a hardware change and barely affects the real-time software, but it makes it possible to build mixed networks with both CAN and CAN FD, in which some network nodes use the new CAN FD frames, while the others exchange Classical CAN frames.

It is also possible to create networks, e.g. private networks, that contain only CAN FD nodes. These extended networks let developers exchange more data between the distributed control algorithms without performing major changes in the topology. The application software can then be migrated to CAN FD. The new capabilities offered by CAN FD depend widely on the application programming interface (COM interfaces or PDU routing). To validate the application with its algorithms and to test the ECU, the CAN communication has to be validated in real time.

Simulating CAN FD in real time

Restbus simulation has established itself as a way of validating the communication behavior and the related functions of one or more ECUs. In restbus simulations, only part of a networked communication system is actually present. Communication with the missing bus nodes is emulated by a test system. The test system must therefore be able to simulate CAN and CAN FD communication, including all network properties.

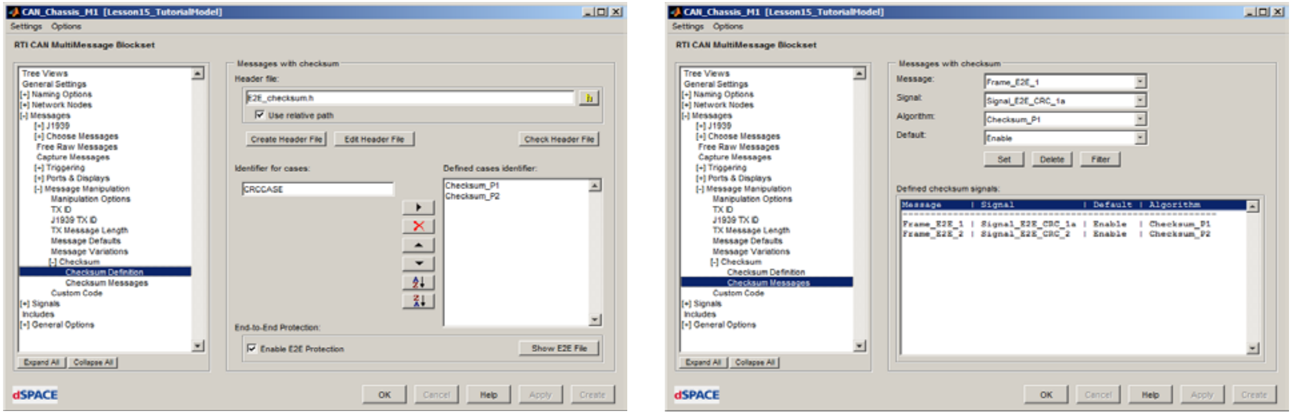

Figure 2: Pre configuration of CRC algorithms with the RTI CAN Multi Message Blockset

Dspace has expanded its product range with new software functions and hardware to include and simulate CAN FD systems. Existing systems are easy to integrate into the new FPGA-based DS4342 CAN FD Interface Module. With this module, CAN FD can be used in the known rapid control prototyping (RCP) systems, such as Micro Auto Box II, and the modular hardware systems for Hardware-in-the-Loop (HiL) simulators. To configure the restbus simulation, the customer can still rely on the tried and tested RTI CAN Multi Message Blockset, which supports both CAN FD hardware and existing Classical CAN hardware. Porting existing configurations to the new CAN FD module is possible. New configurations are based on read-in communication databases, such as Autosar System Templates, Fibex files, or DBC files. The user can configure restbus simulations via a graphical user interface, without manual programming.

The implementation software has functionalities especially for testing communication. Here, users can test not only 'good behavior', such as the functionality with correct input data. They can also test 'bad behavior' by inserting failures into the communication. The data to be sent can be created statically or synthetically by using existing algorithms, or it can come from the real-time model through a connection to Matlab/Simulink.

The RTI CAN Multi Message Blockset's functions are subdivided into message-level and signal-level functions. At message level, the test functions control the transmission of messages and other actions, including the targeted failure of single messages or even whole ECUs. The tool also covers tests at signal level. There is the mandatory option for transmitting fixed static values, plus an option for transmitting signals from the real-time model. In addition, the user has access to the typical functions for defining contents and manipulating signals. These include functions for the implementation of specific checksums and CRC algorithms, for instance for validating end-to-end protection (E2E).

The RTI CAN Multi Message Blockset lets users define abstract CRC algorithms that can by parameterized with E2E protection data from the communication database. These CRC algorithms are then assigned to the different CAN messages. In this way, developers can reuse CRC algorithms for a large number of different CAN messages or even build a library for CRC algorithms.

Configurations created in this manner also provide dynamic entry points for testing and automating the communication later on. This is done via the central tool Control Desk Next Generation and its Bus Navigator. The Bus Navigator's tree view is the central access point for handling. It contains the model's CAN communication that was configured with the RTI CAN Multi Message Blockset. In the tree view, layouts that mirror the send and receive configuration of the messages and signals from the real-time model can be generated as needed. These layouts contain, for example, options for the transmission control of the messages, such as an edit field to set the cycle time or a button to send messages sporadically.

To analyze the communication behavior comprehensively, there are functions for communication logging or monitoring with different views, filters, and sorting options.

The extended tool chain proves that CAN FD functionality can be used without causing operating or compatibility problems, because all existing CAN configurations can be used as they are and no additional software license is needed.

CAN FD was created with only a few changes to the well-known mechanisms of Classical CAN. A variable transmission speed and longer payload length ensure flexibility for many applications. Only few changes are necessary to extend existing CAN networks for mixed use. This also applies to the simulation tools whose new hardware and extended software let customers switch from Classcial CAN to CAN FD swiftly. ◀


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