Reliable Diagnostics of a MOST System

MOST is a proven standard of infotainment systems. A MOST network has high demands regarding performance and stability. Developers of these infotainment systems are aware that in case of a critical failure – ring break in a system where it cannot be diagnosed by the "switch to power" method via MOST, for example – there must be a powerful method for analyzing the network. Ruetz System Solutions, as part of the MOST Compliance Technical Group (MCTG), has developed an efficient test system for the Electrical Control Line. It ensures a constant high quality, so that in case of an error the diagnosis works correctly.

By Dr. Terezia Toth

If failures are not found and not resolved quickly, the car is held up at the car workshop and that means the consumer loses confidence in the quality of the car as a product. To avoid this and fulfill important diagnostic purposes, the MOST Cooperation has introduced the Electrical Control Line (ECL) as a new optional feature for MOST150. ECL is the key element to increase diagnostic capability in a MOST system. It is the way to detect and allocate errors in the MOST system via an additional wire line. This wire line can also be used to generate an electrical wake-up signal.

The ECL protocol provides a variety of functions which can be divided into two separate groups:

- ➜ Triggering a system test
- ➜ Waking up the system by an electrical wake-up signal.

A device connected to the ECL can act in the role of an initiator and/or in the role of a participant. Because of the two separate functions there are two roles for each:

- ➜ System test initiator triggers the test and collects the test results,
- ➜ System test participant report the test results.
- ➜ Electrical wake-up initiator creates the electrical wake-up signal,
- ➜ Electrical wake-up participant is woken up by this signal.

There is exactly one system test initiator, but eventually more than one electrical wake-up initiator in a MOST system.

A system test message has three sequences: start sequence, parameter sequence and result sequence. Each message is initiated by the initiator and starts with the system test start impulse and optional retries, followed by the parameter sequence. The initiator generates five parameter values, which together define one of the four kinds of system test:

- ➜ Ring break diagnosis (00000)
- ➜ Alive (10000)
- ➜ Coding error / threshold (01000)
- ➜ Sudden signal off / critical unlock (11000)

Electrical control line in a MOST network

ECL is limited to MOST systems with a maximum of 20 devices. Each device gets a unique node class in the system. Each node class has a result slot in the test result sequence. Each result slot has two parameters: "En" and "On", where n is the node class. En=1 indicates that the device is not alive or the test is not supported. "On" is the MOST signal result.

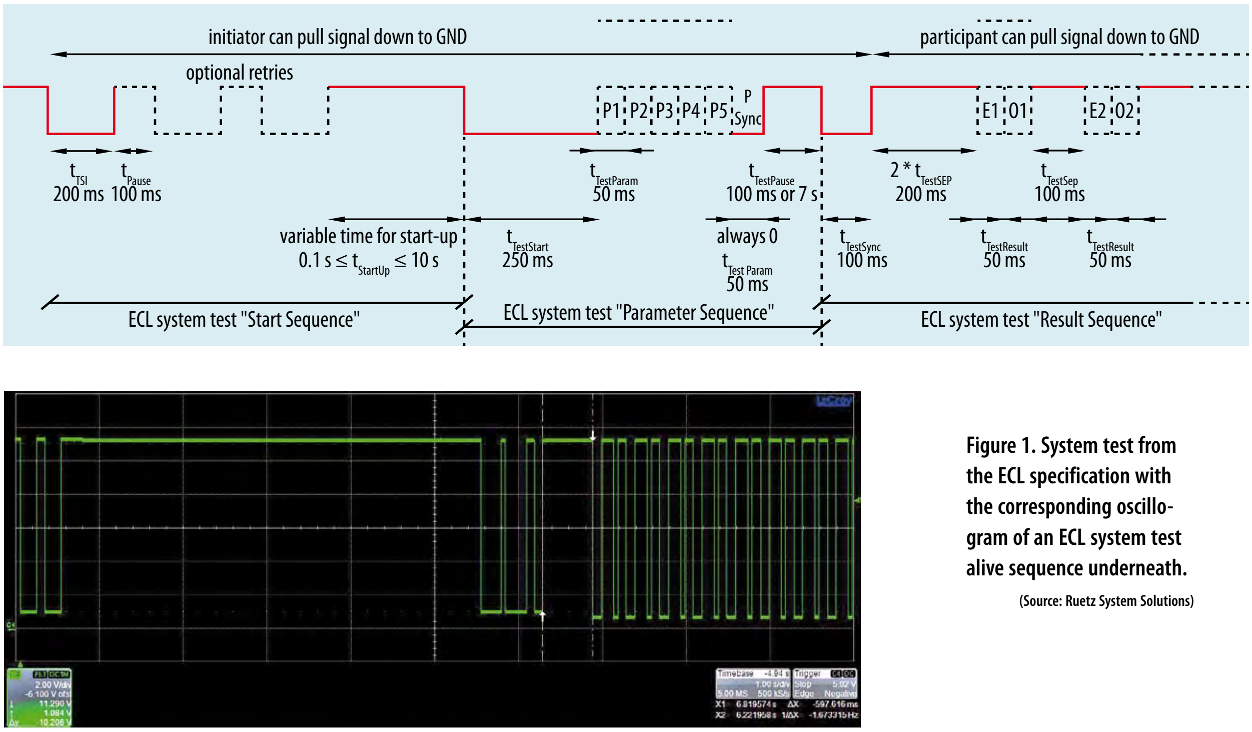

Figure 1. System test from the ECL specification with the corresponding oscillogram of an ECL system test alive sequence underneath.
(Source: Ruetz System Solutions)

An electrical wake-up impulse (EWU) defines the start of an electrical wake-up without a system test. With a single EWU, the wake-up has to be triggered by the falling edge of the first impulse. Electrical wake-up repetitions are called a multiple EWU.

If implemented, the optional ECL feature must be compliant with the ECL Specification [1] of the MOST Cooperation. Compliance with the specifications is one major element for the success of MOST technology. To ensure it, the MOST Cooperation released the “MOST Extended Core Compliance Test Specification: Electrical Control Line” in July 2012 [2]. Depending on the functionality of the device under test (DUT), the corresponding features have to be tested while the other roles have to be simulated. On the one hand the tester has to simulate the ECL sequences of the initiator or the participant, depending on the DUT. On the other hand the tester has to evaluate the received sequences.

The testing process shall be flexible enough to handle this diversity of options and requirements. The challenge is to test not only the good case but also the bad cases with fault injection.

On the one hand the tests have to be reliable, without oversights, mistakes, or other chances of human error. The test specification has to be easily readable and understandable. The execution shall be independent of the area where the test takes place, at a MOST Compliance Test House (MCTH) or at a supplier’s in-house test lab. Global consistency regarding test results has to be ensured. On the other hand

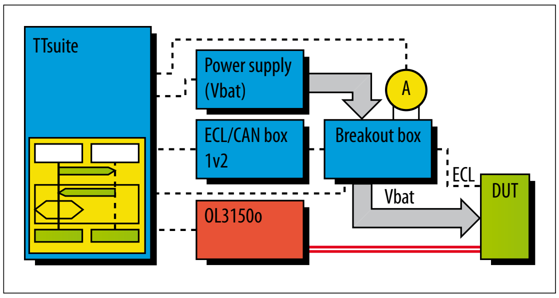

Figure 2. Test setup ECL test automation. (Source: Ruetz System Solutions)

the effort has to be limited. The test process shall not be costly and time-consuming but provide results fast.

Qualified testing through automation

Automation is generally a significant saving of time and effort compared with manual testing. In this case it is also a strong argument for automation that some of the tests cannot be performed manually because a very short reaction time is needed. Ruetz System Solutions, as a MCTH, has developed an automated ECL compliance test suite. Its fully automated test systems have their own history and evolution. A giant leap forward was the TTsuite. The TTsuite provides users with an easy to use TTCN-3 based platform that allows them to carry out tests and simulations of varying complexity. With TTsuite it is easy to describe and carry out new test scenarios such as the ECL test suite.

The test cases in the “MOST Extended Core Compliance Test Specification: Electrical Control Line” introduced by the MOST Cooperation are written as executable test specifications in the Graphical Format of TTCN-3 (GFT). The ECL test suite is generated from these GFTs by TTsuite. This kind of test development process provides a reliable test specification and eliminates the chance of misinterpretation from the very beginning.

TTsuite is able to handle very different communication protocols via adapters. ECL is similar to the LIN bus, therefore TTsuite has an adapter that translates the ECL pulses into data for testing purposes and codes the data into pulses for the simulation. Tests regarding the reaction of the DUT to ECL protocol violations by changing the pulse width can reliably be performed with TTsuite [3]. Information is transferred via pulse state and pulse width on the ECL as a bidirectional bus line. It has two states: high, logical 1 (supply voltage) and low, logical 0 (ground). The default state is high.

The ECL sequence chart (see **Figure 1**) shows the results of a system test from the ECL specification; below that is a corresponding oscillogram of an ECL system test alive-sequence. It begins with the start sequence with 7 s start up time, followed by the parameter sequence 10000 and the result sequence with results from node classes 4 to 19. An oscilloscope is used only for display purposes, not for the measurements.

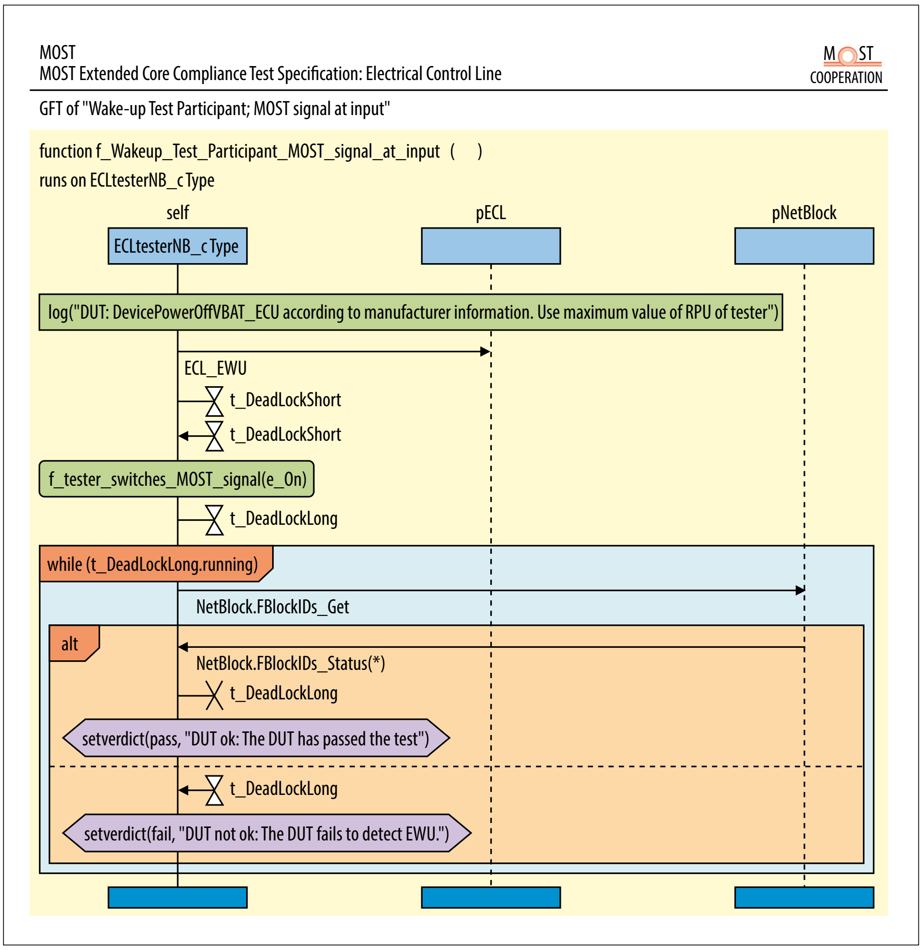

Figure 3. Excerpt from the test case specification, a GFT. (Source: MOST Cooperation)

Efficient test environment for reliable networks

TTsuite is able to control any additional tools needed for the test setup. In this case, TTsuite controls Ruetz System Solutions' ECL/CAN Box and Breakout Box, with OptoLyzer and a power supply (see **Figure 2**). The MOST bus of the test setup is set via the OptoLyzer module. The ECL bus is formed by the ECL/CAN Box. The Breakout Box is a device for configuring the test setup. This hardware interface serves as an expansion of the TTsuite test bench in order to automatically execute the test setup described in the test specification. It is connected to the power supply of the DUT, and to the ECL line of the DUT. The ECL/CAN Box is a device for sending wake-up and test sequences of the ECL and for receiving subsequent replies from the DUT and forwarding them to the TTsuite via the interface. Apart from this, connected control devices can be woken up by CAN messages from the ECL Box.

The documentation of the test results is fundamental in the compliance verification process. It shall include detailed information about the behaviour of the DUT and recommendations for improvement if necessary. TTsuite provides a test report with a chart about the test result, including a statistical overview. The tool also provides a graphical test protocol, which has the same structure and look as the test specification from the MOST Cooperation. So it is very easy to analyze and understand the test protocol and to compare it to the test specification (see **Figure 3**).

This new, fully automated ECL test system ensures global consistency regarding test results. The benefits of using this test system are apparent. Executable test specifications, detailed documentation of test results, easy to analyze test protocols provide transparency and allow unambiguous, clear communication between tester and developer regardless whether the tester sits in a MCTH or in-house with the developer. The devices can be validated using this test system from the beginning of the development via in-house tests. *eck*

References

[1] Electrical Control Line Specification Rev 1.0 10/2008, Rev 1.0.1 06/2009, Rev 1.1 11/2010, Rev. 1.1 Errata Sheet Rev. 1.0 07/2011, Rev 1.1.1 11/2011
[2] MOST Extended Core Compliance Test Specification: Electrical Control Line Rev 1.0 07/2012
[3] TTsuite Test Development Kit: making test projects effective and unambiguous, Ruetz System Solutions, MOST Interconnectivity Asia, 2011

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