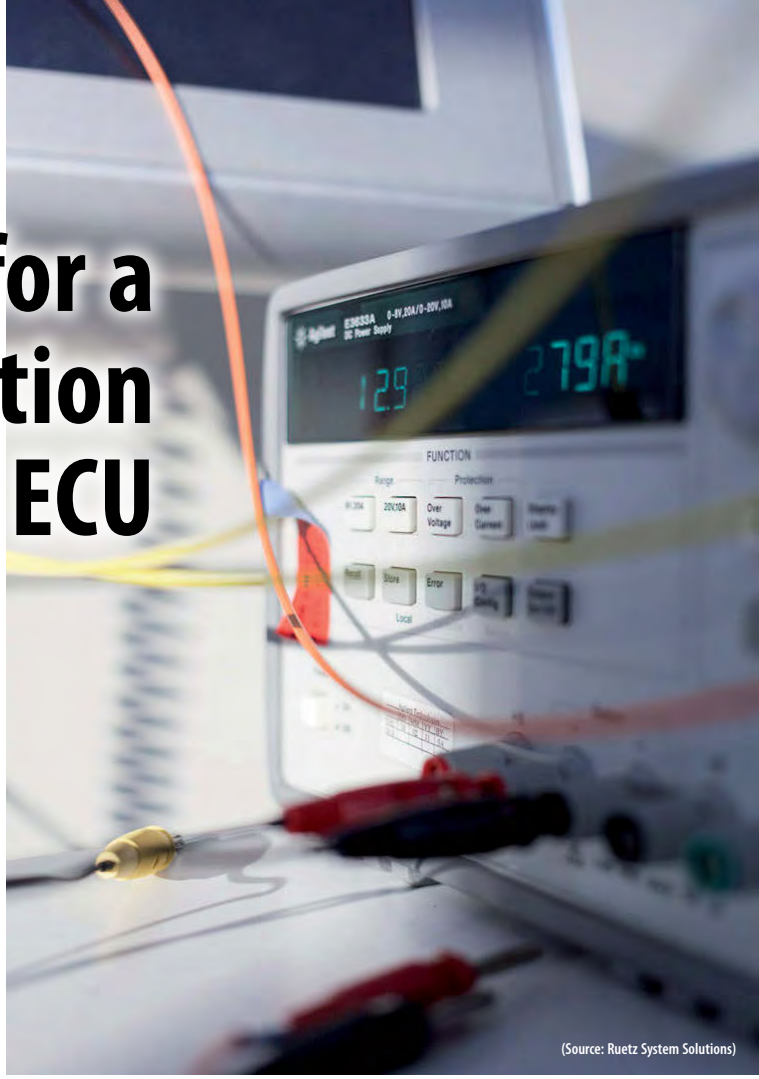
Building Blocks for a Successful Verification Process of a Tier-1 ECU



(Source: Ruetz System Solutions)

More than 150 vehicle models are equipped with the MOST technology. Due to this success there are new suppliers in the community. A Tier-1 supplier has integrated MOST150 technology into its portfolio and has recently developed a head unit including a CAN-MOST gateway. Ruetz System Solutions GmbH provided a complete infrastructure to enable all tests concerning MOST technology. So, 100 per cent of the OEM requirements can be verified with test suites.

By Terezia Toth

Starting up within a new technological area is always a challenge for the development and system integration departments. The first step is to develop comprehensive know-how, in-depth understanding, and knowledge of this new area. The second step is to understand and implement the OEM requirements according to the standards. A wide variety of standards has to be considered in order to be able to implement all of the features required in the electronic control unit (ECU); for example

- Data transport
- Network management
- Power management
- Diagnosis
- CAN-MOST routers
- MHP
- ECL
- ISO-TP
- UDS

These functions should not be handled completely independently, as they affect and influence each other. The tight time schedule of automotive projects does not allow for experiments. However, as yet there is no internal reference project to benchmark the development status and quality of the product.

A Tier-1 supplier needs infrastructure for regression testing to be able to determine if the ECU meets the specified requirements. Regression tests are needed for each integration step of new or fixed software in order to ensure that the ECU works correctly. Additionally, the Tier-1 supplier needs tests that focus on robustness, availability and error handling – not just on correct behavior under normal circumstances.

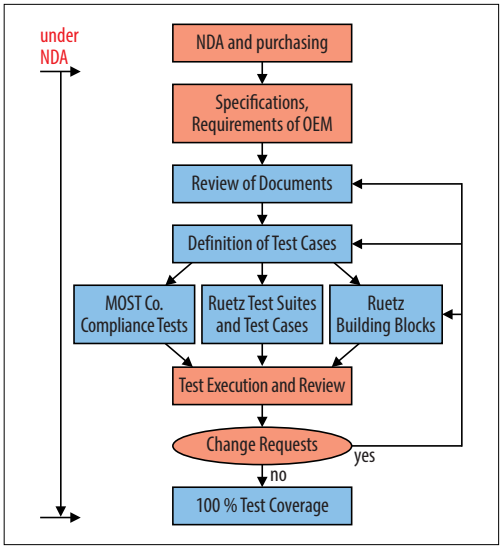


Figure 1. Process steps for test and quality assurance of ECUs.
(Source: Ruetz System Solutions)

Requirements analysis

In such a situation, the support of an expert as well as a ready-to-go test infrastructure are well appreciated. Ruetz System Solutions supports carmakers and Tier-1 suppliers with "Test House as a Service". With this service fully equipped test laboratory solutions in its own facilities are provided to support companies in the control unit development (**Figure 1**).

The support includes static testing, review and verification of all relevant specifications according to the Tier-1 supplier's requirements. Challenges may arise such as unrecognized requirements or gaps in them. It is a fact that the earlier an error is found, the cheaper it is to fix it. If a problem in the requirements is found after the release, it costs 10 to 100 times more to fix it compared to identifying it an early stage.

During the review, one task is the requirement analysis for test case definition

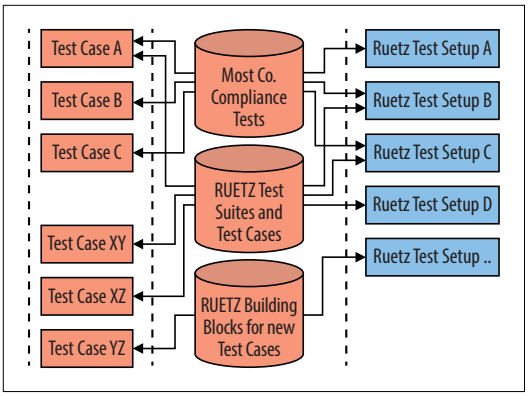


Figure 2. Tailored test suites. (Source: Ruetz System Solutions)

of black box testing. On the one hand, it has to determine how each requirement will be tested. That means, you have to review the textual specifications in consideration of function catalogs and sequence catalogs, if available, and to select the requirements chapter by chapter. In addition, the definition of test cases for unexpected behavior is based on know-how and best practice.

On the other hand, the minimum number of tests needed to achieve 100 per cent coverage of the requirements has to be identified. Test automation should be used rationally, but it can be very useful for regression testing. A well-developed suite of test cases is necessary in order to be truly useful. The Tier-1 supplier needs complete test cases which can be provided to the tester. For a given input or trigger, the tester can simply verify if the behavior of the ECU is the same as the expected value specified in the test case.

Definition of test cases

Many test cases are available and can be used, such as

- The MOSTCO compliance tests developed with and for the MOST Cooperation members.
- The Ruetz System Solutions test suites and test cases, which include manual and automated tests as well [1].

Fully-automated test systems by Ruetz System Solutions have their own history and evolution. An important development has been the test lab solution TTsuite [2]. The TTsuite provides users with an easy-to-use platform that allows them to carry out tests and simulations of varying complexity. This tool is based on the standardized test description language TTCN-3 and uses the Graphical Presentation Format of TTCN-3 (GFT) for defining, visualizing and documenting the tests. TTsuite generates the various test suites from these GFTs. This kind of test development process provides a reliable test specification and eliminates the chance of misinterpretation from the very beginning.

Many test cases have to be defined. In particular, OEM-specific content needs specific handling. The existing building blocks of Ruetz System Solutions help to develop them, as depicted in **Figure 2**. Ruetz System Solutions has defined several test setups, which can be driven by the TTsuite Test Development Kit. TTsuite is able to handle different communication protocols via adapters. Therefore it is easy to describe and carry out new test scenarios with this tool. TTsuite is able to control additional tools needed for each test setup.

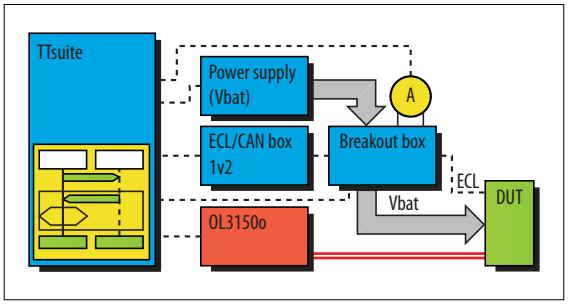


Figure 3. ECL test setup. (Source: Ruetz System Solutions)

Test execution

For this example, the test setup ECL [3] is used. The test tool controls the ECL/CAN Box and Breakout Box as well as the OptoLyzer and a power supply (**Figure 3**). The MOST bus of the test setup is set by 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 is used as an extension of the 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 ECL wake-up and test sequences as well as for receiving subsequent replies from the DUT and forwarding them to the test tool via the interface. Apart from this, connected control devices can be woken up by CAN messages of the ECL Box.

The test of diagnosis functions is a good example of the many standards which have to be considered for testing the features required in the ECU. For the diagnosis test setup an adapter for the OEM-specific on-board diagnosis tool has been developed (**Figure 4**). To be

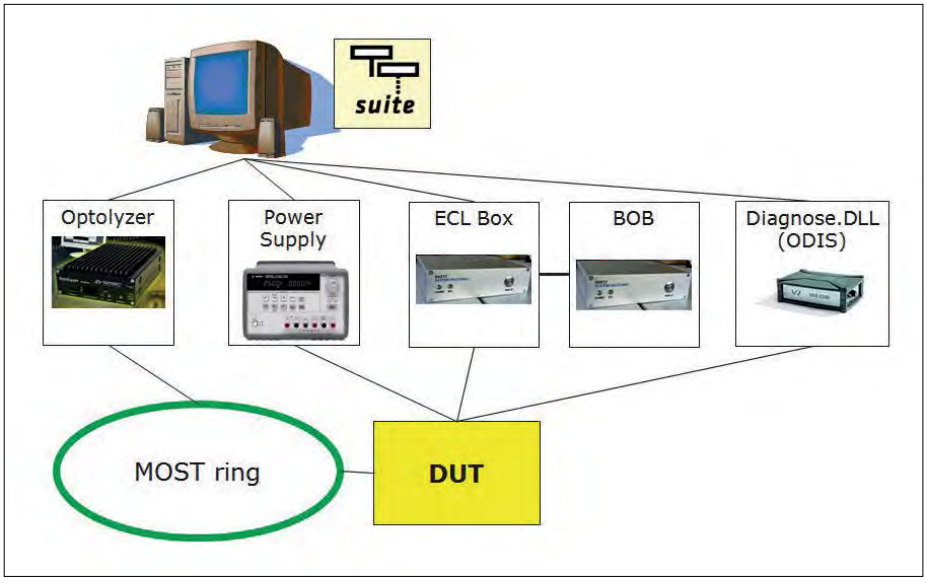


Figure 4. Diagnosis test setup. (Source: Ruetz System Solutions)

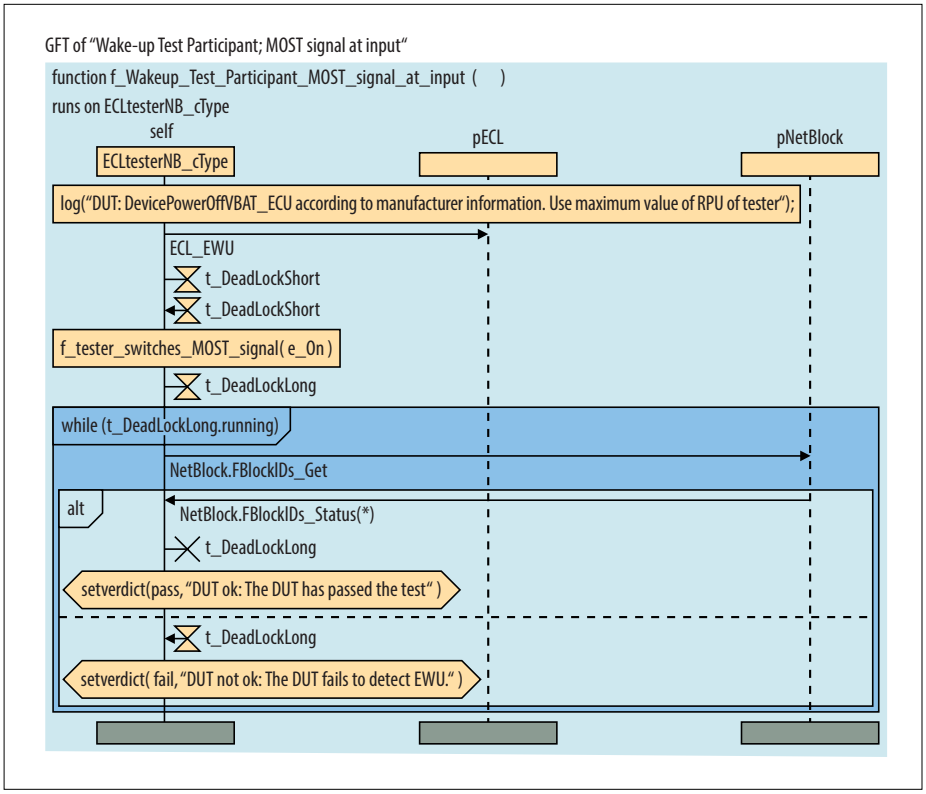


Figure 5. MOST Extended Core Compliance Test Specification: ECL. (Source: Ruetz System Solutions)

able to communicate via this on-board diagnosis tool with the ECU a chain of communication protocols is implemented.

- A codec for the Unified Diagnostic Services (UDS, ISO 14229).
- The transport of the UDS messages is realized by ISO TP (ISO 15765-2), the transport protocol which CAN uses.
- Using the MOST High Protocol (MHP), the simulation of diagnosis functions is possible.

This way test functions can be combined in a powerful way to enable the required configuration and execution flexibility which is needed to succeed in a sufficient test depth.

The Ruetz building blocks ensure consistency regarding test results. The benefits of using this infrastructure 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. It does not matter if the tester is located in an independent test house or in-house with the developer.

Ruetz System Solutions Cooperates with HiRain Technologies

Ruetz System Solutions cooperates with HiRain Technologies as distributor and technology partner in China. The company located in Munich has transferred Chinese distribution rights to HiRain Technologies for the standardized test setup portfolio for MOST compliance testing. Included are the test setups for MOST Core Compliance Testing, MOST Extended Core Compliance Testing, MOST Optical Limited Physical Layer Testing, and the Full MOST Electrical Physical Layer Compliance Test. HiRain will also distribute TTsuite, the framework for System Integration Testing. In addition to these products, consulting and engineering services are part of the agreement. In response to the needs of the Chinese market, Ruetz System Solutions and HiRain Technologies will develop solutions for components, devices and systems based on MOST technology.

"This partnership is our response to the growing demands of carmakers and automotive suppliers in China," stated Wolfgang Malek, General Manager and co-founder of Ruetz System Solutions. "Together, we will provide support in automotive data communications for a smooth and on-time start of production. In HiRain Technologies we have found a partner to meet these requirements."

The documentation of the test results is fundamental for ECU development. It shall include detailed information about the behavior of the ECU. TTsuite provides a test report with a chart showing the test results to get a statistical overview. It also provides a graphical test protocol. So it is very easy to analyze and understand the test protocol and to compare it to the test specification, as you can see in **Figure 5**.

Clear communication between the Tier-1 supplier and Ruetz System Solutions Test House is assured by documentation of the test automation. It summarizes the state of the project at any given time: the considered OEM requirements, mapping between requirements and test cases, if a test case is manual or automated, test setup of the test case, and the current state of the test such as work in progress, released or delivered.

The Tier-1 supplier can always request changes if requirements are changed, or add further OEM requirements according to its needs.

The objective of the Ruetz System Solutions "Test House as a Service" is to provide confidence that the developed ECU meets the requirements of OEM- and MOSTCO-standardized test methods and test setups. The Ruetz building blocks used guarantee transparency and flexibility. Due to configuration and parameterisation of the test process, testing of DUT variants is possible without any delay. So the system integration has been improved significantly. *eck*

References

[1] **Automation speeds up MOST testing, Wolfgang Malek in an interview with Automotive Industries Standards for System Integration of Automotive Infotainment Systems, p. 78, Automotive Industries Vol. 189, Issue 2, Aug. 2010**

[2] ***Janker, Georg*: TTsuite Test Development Kit: making test projects effective and unambiguous, 12th MOST Interconnectivity Conference Asia 2011, Tokyo, Japan**

[3] ***Toth, Terezia*: ECL – Reliable Diagnostics of a MOST System, MOST Forum 2013, Stuttgart/Esslingen, Germany**

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