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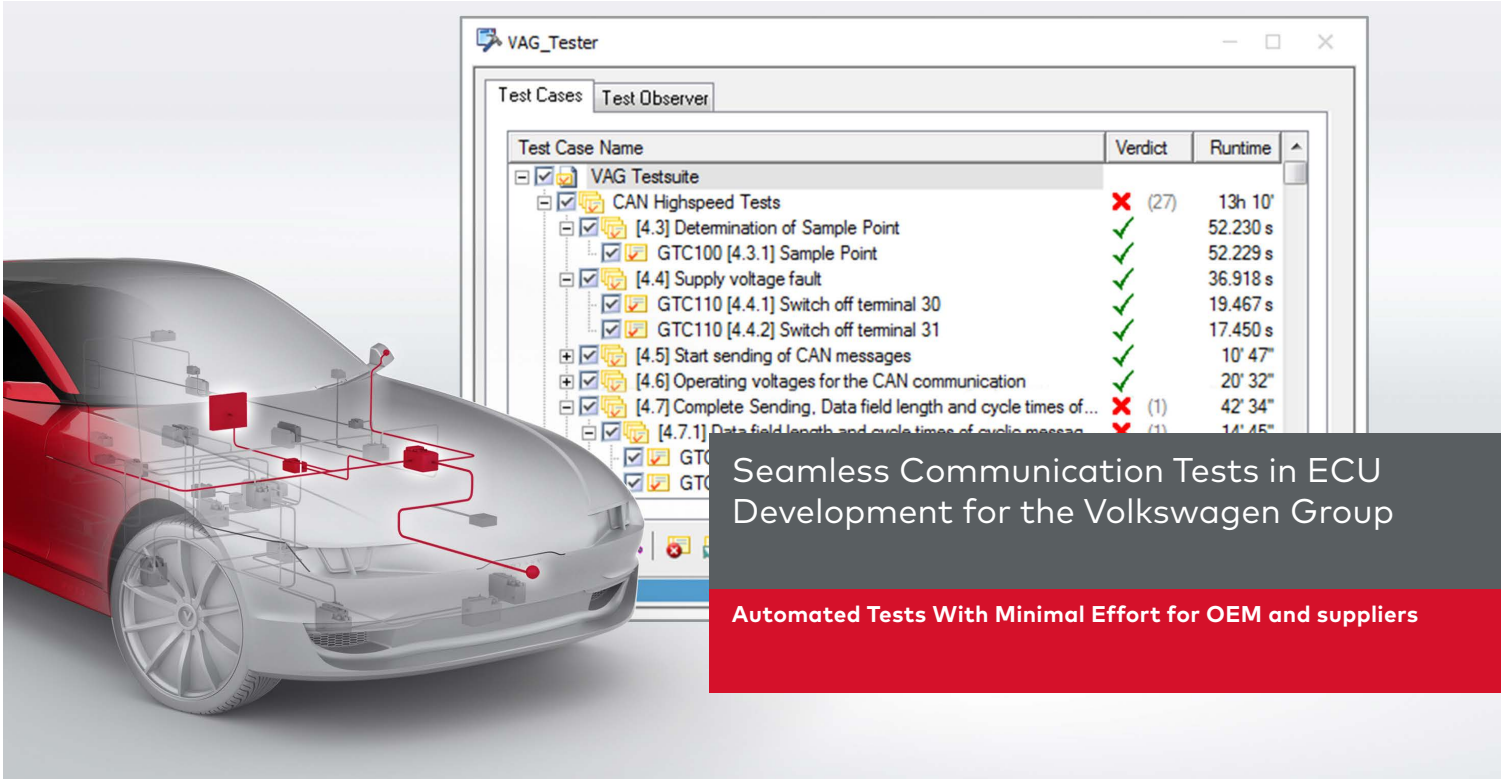

Seamless Communication Tests in ECU Development for the Volkswagen Group

Automated Tests With Minimal Effort for OEM and suppliers

In ECU development, the specific test implementations play a special role for suppliers of Volkswagen AG (VAG): they check for network conformity, assure smooth interplay of the numerous ECUs and are a key criterion for final acceptance by the automotive manufacturer. Using VAG-specific test software, developers and suppliers conduct automated tests according to VAG specifications DUM.857.BE.1 and DUM.000.AC.A for High-Speed CAN and Network Management High which ultimately saves a lot of time and expense.

Not only do ECUs have to fulfill their required functionalities in a narrower sense, they must also be integrated seamlessly into the ECU environment – under consideration of individual OEM-specific aspects. Therefore, in addition to functional tests, intensive communications tests are also necessary. The latter are used to examine ECU behavior – not only under normal conditions, but also, and especially, in various error situations. These situations include not receiving messages, protocol violations in transmitting, faulty voltage supply including voltage drops, faults in bus voltage potential due to short circuits, and many more.

Testing at the Supplier and at VAG

The supplier assumes primary responsibility for proper and defined behavior of the Device Under Test under all of these test constraints. However, from the OEM's perspective, it is more than sensible to validate conformant ECU behavior by conducting its own tests. These tests at the OEM are usually conducted in a late phase of ECU development. Since it is well-known that the costs of correcting an error are higher the later it is discovered, the supplier has an interest in detecting errors as early as possible and not for the first time in tests at the OEM.

However, creating and maintaining the test applications needed for this requires an in-depth understanding of requirements and is also time intensive: not only due to the number of tests to be run, but also due to their complexity. Even small modifications to an ECU can require extensive adaptations in tests. Therefore, in-house implementation of tests is associated with considerable costs. An alternative is to hire a testing company. Due to the costs associated with a test run at a testing company, it is typically not possible to conduct tests continually over the course of development.

Another problematic aspect of this approach is that the test implementations of all parties – whether supplier, testing company or OEM – can diverge more or less in their details. If tests return different results when testing to the current test specifications, time-consuming troubleshoot-

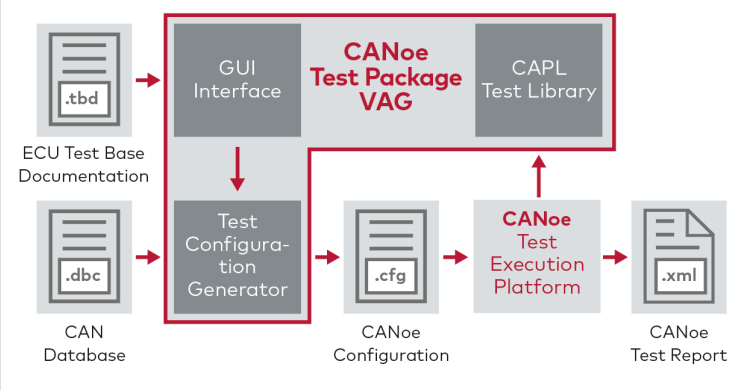

Figure 1: At the push of a button, the CANoe Test Package VAG creates a complete test configuration, starts test execution and generates a report.

ing is unavoidable. The cause of the problem does not necessarily reside in the ECU, so the unpleasant question must be clarified as to which party is responsible for the error. A test could, after all, be based on false assumptions or simply have been implemented with errors. Gaps in the test specifications are also a possibility.

Testing at the Push of a Button

Cost reduction and increased quality in ECU tests do not have to contradict one another. However, as shown by an extension of the CANoe test and simulation system from Vector that was specially designed for the Volkswagen Group. Use of the CANoe Test Package VAG enables ECU developers and testers at suppliers, test companies and, of course, in-house departments of the Group to achieve their goals with incomparable speed. Test configurations for automated conformity tests for High-Speed CAN and Network Management (NM) High can be generated at the push of a button and without further preparation effort. Version 4.0 of the test package implements tests from the latest specifications DUM.857.BE.1 and DUM.000.AC.A, and it has a test coverage that has been coordinated with Volkswagen. High-quality implementation of the conformity test according to Volkswagen requirements has been the result of many years of close cooperation with the OEM in developing the test system, and feedback from a broad user base.

In particular, the CANoe Test Package VAG includes test libraries for conformity tests and for diagnostic queries via Unified Diagnostic Services (UDS). These libraries are written in the CANoe-specific programming language CAPL (Communication Access Programming Language). If necessary, this enables to comprehend the exact test flow. Also included with the product is a generator that creates a test configuration with the relevant linked test libraries and a remaining bus simulation that has been specially adapted for this purpose **(Figure 1)**. This step is performed by the CANoe AddOn VAG Multibus Package that is supplied free-of-charge with the product. It has a simulation generator, an interaction layer and network management.

The test system achieves full test automation with the following Vector hardware: VH1150 for voltage supply of the ECU and VH6501 as the CAN (FD) network interface as well as the stress module **(Figure 2)**.

Hardware for Full Test Automation

The test system simulates different supply situations for the Device Under Test with the help of the VH1150 controllable voltage supply. The VH1150 has relays for independently switching terminals for power, ground and ignition, and it enables precise measurement of current consumption of the ECU under test. Various voltage responses and faults can be simulated via USB remote control. These elicit reactions from the Device Under Test to overvoltages, undervoltages and voltage drops.

On the other hand, the VH6501 USB hardware module is

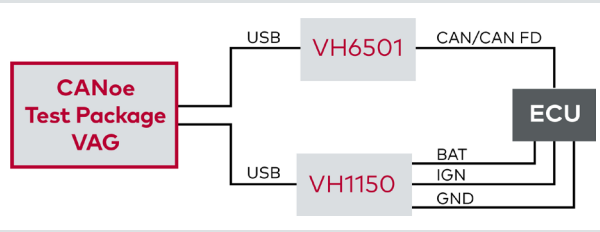

Figure 2: Schematic test setup of the CANoe Test Package VAG

used to simulate digital and analog disturbances on the CAN (FD) network. At the same time, it serves as a normal CAN (FD) network interface. It reproducibly alters the physical properties and the logical levels. Flexible trigger and disturbance logic enables specific corruption of CAN (FD) messages at any bit positions.

VAG Supplies Test Basis to Suppliers

The most important prerequisites for successful configuration of the test environment include consistent communication description of the ECU in the form of test basis coordination documentation (TBAD) and the CAN network database (DBC). Both files are created by the OEM and transferred to the supplier. While OEM-specific information about the network and the remaining bus simulation are stored in the DBC, the TBAD contains detailed information about the ECU. It must be re-created for each ECU, and it offers information in XML format about Tx and Rx messages, diagnostic parameters, diagnostic trouble codes (DTCs), time settings, specification versions and much

more. That is, the TBAD supplies the necessary specific information about correct configuration of the conformity tests. This file can also be edited by the supplier – with the help of an editor provided by the Volkswagen Group – and it might be supplemented by DTCs, for example. The test configuration generator reads the TBAD and DBC, and from them it generates the CANoe test configuration **(Figure 1)**, which consists of the remaining bus simulation and an XML test flow module.

Well-Organized HTML Test Reports

Depending on the number of Tx and Rx messages, several hundred test cases may be generated **(Figure 3)**. Each test case provides a detailed HTML test report **(Figure 4)** and log files in ASCII format. The test reports are organized with section numbers, which correspond to numbers in the test specification. Color highlighting of errors gives the user a quick overview of the success or failure of the test cases that were run.

Summary and Outlook

The CANoe Test Package VAG, together with Vector VH1150 test hardware and the VH6501 form a cost-effective test environment based on standard CAN tools. The described solution gives ECU developers and testers the ability to execute the same tests as Volkswagen AG with minimal effort. Full automation of the test execution allows conformity tests to be repeated at any time, also with minimal effort. This makes it possible for suppliers to conduct extensive tests throughout the development process and thereby enables early error detection. This saves time, reduces development costs and leads to quick improvements in product quality.

The CANoe Test Package VAG has been tested and released by Volkswagen. The OEM recommends explicitly that suppliers use it for tests of High-Speed CAN and NM-

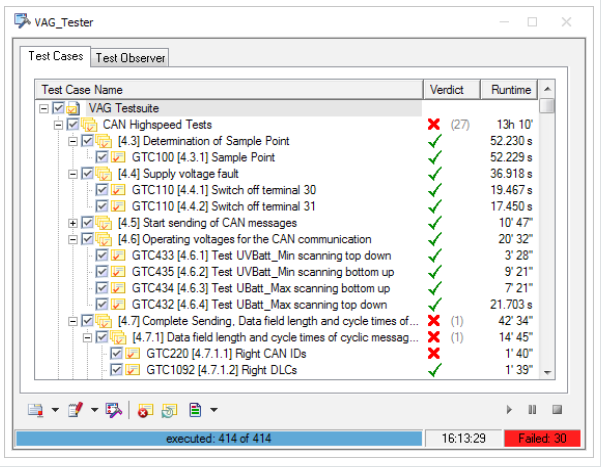

Figure 3: Flow control of the conformity tests

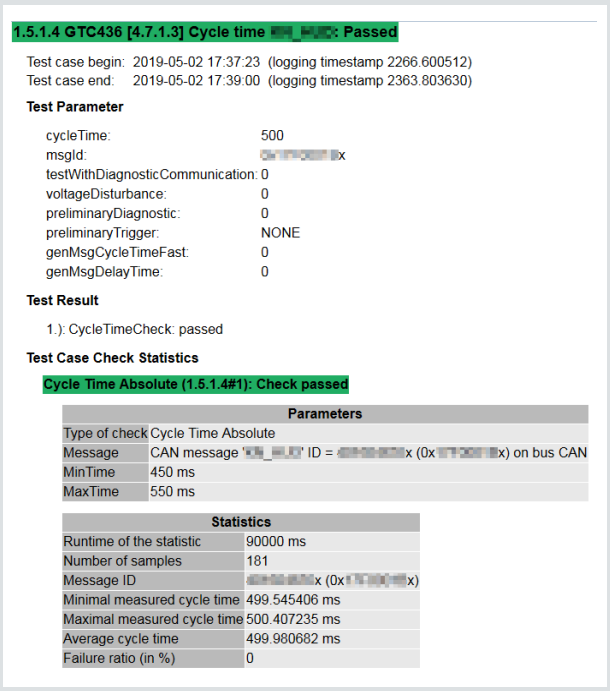

Figure 4: Detailed report of a successfully run test case

High. This makes the positioning of this test system unique in the market.

Modifications to the CANoe Test Package VAG to meet future requirements are already in planning. One example is the need for Secure On-Board Communication (SOK).

Author
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