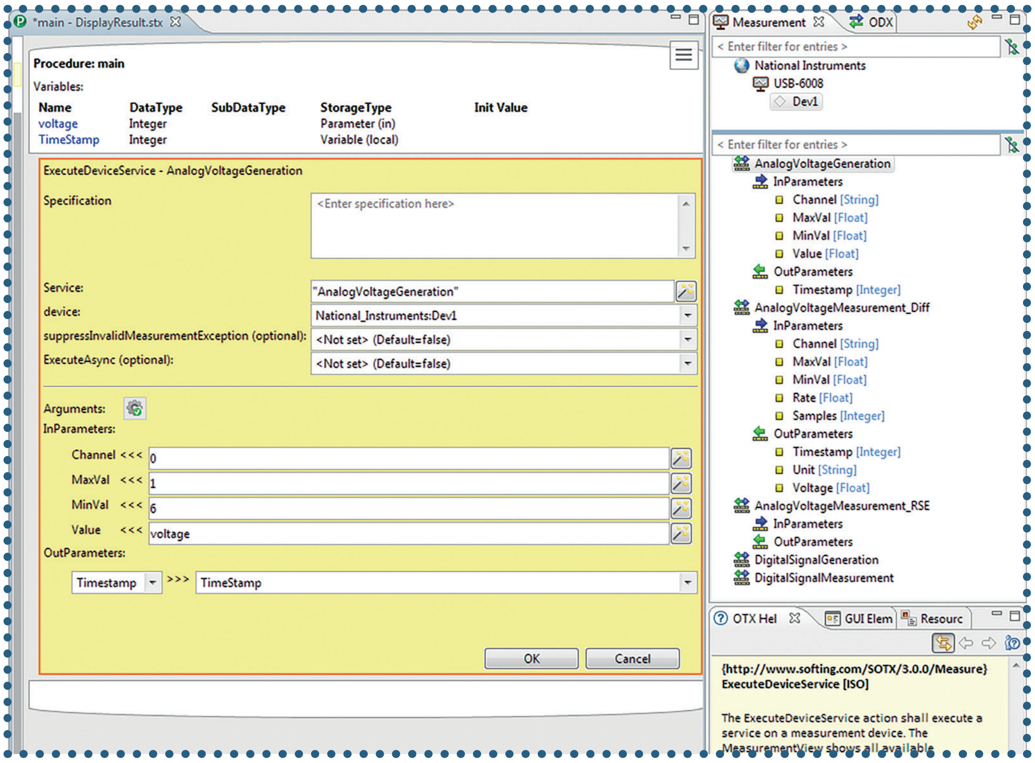

*main - DisplayResult.stx

Procedure: main

Variables:

Name	DataType	SubDataType	StorageType	Init Value
voltage	Integer		Parameter (in)	
TimeStamp	Integer		Variable (local)	

ExecuteDeviceService - AnalogVoltageGeneration

Specification	<Enter specification here>
Service:	"AnalogVoltageGeneration"
device:	National_Instruments:Dev1
suppressInvalidMeasurementException (optional):	<Not set> (Default=false)
ExecuteAsync (optional):	<Not set> (Default=false)

Arguments:

InParameters:

Channel	<<<	0
MaxVal	<<<	1
MinVal	<<<	6
Value	<<<	voltage

OutParameters:

Timestamp	>>>	TimeStamp

Measurement · ODX

< Enter filter for entries >

- National Instruments
  - USB-6008
    - Dev1

< Enter filter for entries >

- AnalogVoltageGeneration
  - InParameters
    - Channel [String]
    - MaxVal [Float]
    - MinVal [Float]
    - Value [Float]
  - OutParameters
    - Timestamp [Integer]
- AnalogVoltageMeasurement_Diff
  - InParameters
    - Channel [String]
    - MaxVal [Float]
    - MinVal [Float]
    - Rate [Float]
    - Samples [Integer]
  - OutParameters
    - Timestamp [Integer]
    - Unit [String]
    - Voltage [Float]
- AnalogVoltageMeasurement_RSE
  - InParameters
  - OutParameters
- DigitalSignalGeneration
- DigitalSignalMeasurement

OTX Hel · GUI Elem · Resourc

{http://www.softing.com/SOTX/3.0.0/Measure}
ExecuteDeviceService [ISO]

The ExecuteDeviceService action shall execute a service on a measurement device. The MeasurementView shows all available

Figure 1:
Incorporation of Measurement Functions in the OTX Sequence
(© Softing Automotive)

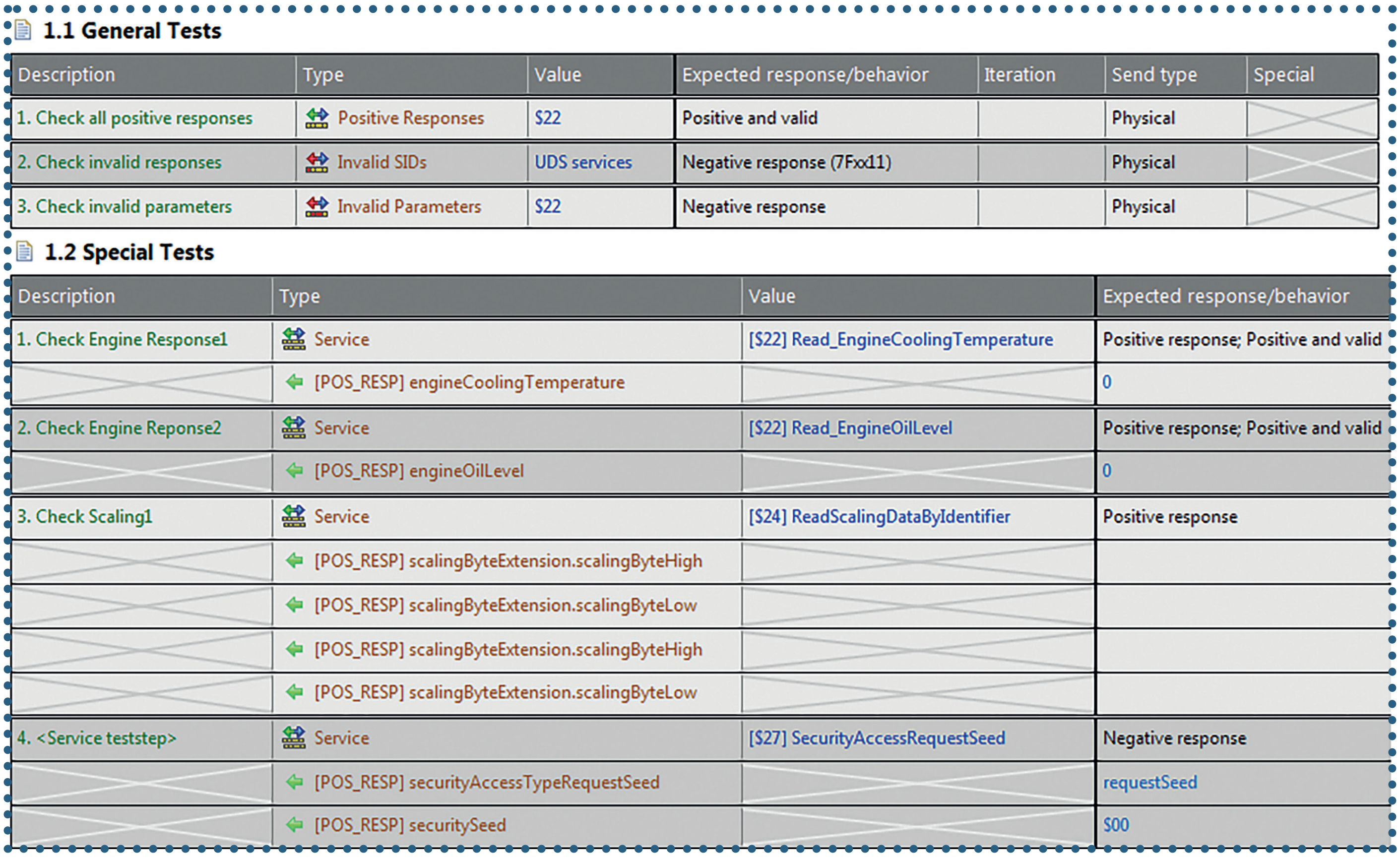
Implementation of OTX in Automated Diagnostic Environments for ECUs

The increasing complexity of ECU software is seeing a parallel rise in the scope of the diagnostic functionality it has to cover – all the more so since testing is no longer limited to valid diagnostic services and parameters. Rather it is also necessary for the response to invalid service and parameter queries to be included in diagnostics. Testing the temporal communication behavior also has to be covered. These additional requirements play a significant role particularly in access scenarios of remote diagnostics.

The OTX (Open Test sequence eXchange) standard ISO 13209 supports ECU diagnostics and testing. One of the central goals of this standard is that test cases should be able to be exchanged between different specialist departments and in different phases of a vehicle's life cycle. The "Measurement" language add-on is used to support test automation. This means the OTX standard provides library functions which are abstracted from the specific measurement hardware.
Open loop test systems of varying complexity can be realized thanks to the connection of the OTX commands for ECU diagnostics with the Measurement functions. For example, the exact voltage that corresponds to the measurement value of a physical variable (e.g. 22 degrees Celsius) can be applied at an ECU's sensor port with an OTX sequence and the "SetVoltage" function. A diagnostic service then reads out this measurement value from the ECU and compares it with the value expected allowing for an admissible tolerance. Actuator functions in the ECU are verified in a similar way: For example, a diagnostic service triggers a specific reaction at an actuator output which is then made available to the test routine via the "ReadVoltage" function. There is a temporal accuracy of 25 milliseconds for running the events and assessing the measurands.
This rough causal and temporal chain of effects is sufficient for many ECU tests and means an inexpensive test environment can be used in these cases. Here, meaningful test scenarios can be created on the basis of OTX commands and simple I/O systems. If, however, a "real-time-capable" simulation model is required linking virtual actuator actions with simulated sensor reactions resulting from these actions, it is imperative to deploy a suitable closed loop test system, such as a Hardware in the Loop (HiL) simulator. An example of an inexpensive test setup is OTX Studio from Softing Automotive which provides an engineering environment compliant with the OTX standard for creating, commissioning and debugging complex diagnostic sequences.

Support of NI Data Acquisition Devices in OTX Studio

Today, various data acquisition devices as well as measuring boards from National Instruments (NI) are used. These cover a large number of applications and are available in varying precision classes for a number of I/O types. They are often very suitable for ECU tests if no special hardware can be used. All I/O boards from National Instruments can be addressed using an identical driver DLL (NI-DAQ ™mx) thus greatly simplifying generic integration into automation systems.
OTX Studio features the Measurement add-on with NI device support . For every linked measurement hardware, OTX Studio determines the valid com-



1.1 General Tests

Description	Type	Value	Expected response/behavior	Iteration	Send type	Special
1. Check all positive responses	Positive Responses	$22	Positive and valid		Physical	
2. Check invalid responses	Invalid SIDs	UDS services	Negative response (7Fxx11)		Physical	
3. Check invalid parameters	Invalid Parameters	$22	Negative response		Physical	

1.2 Special Tests

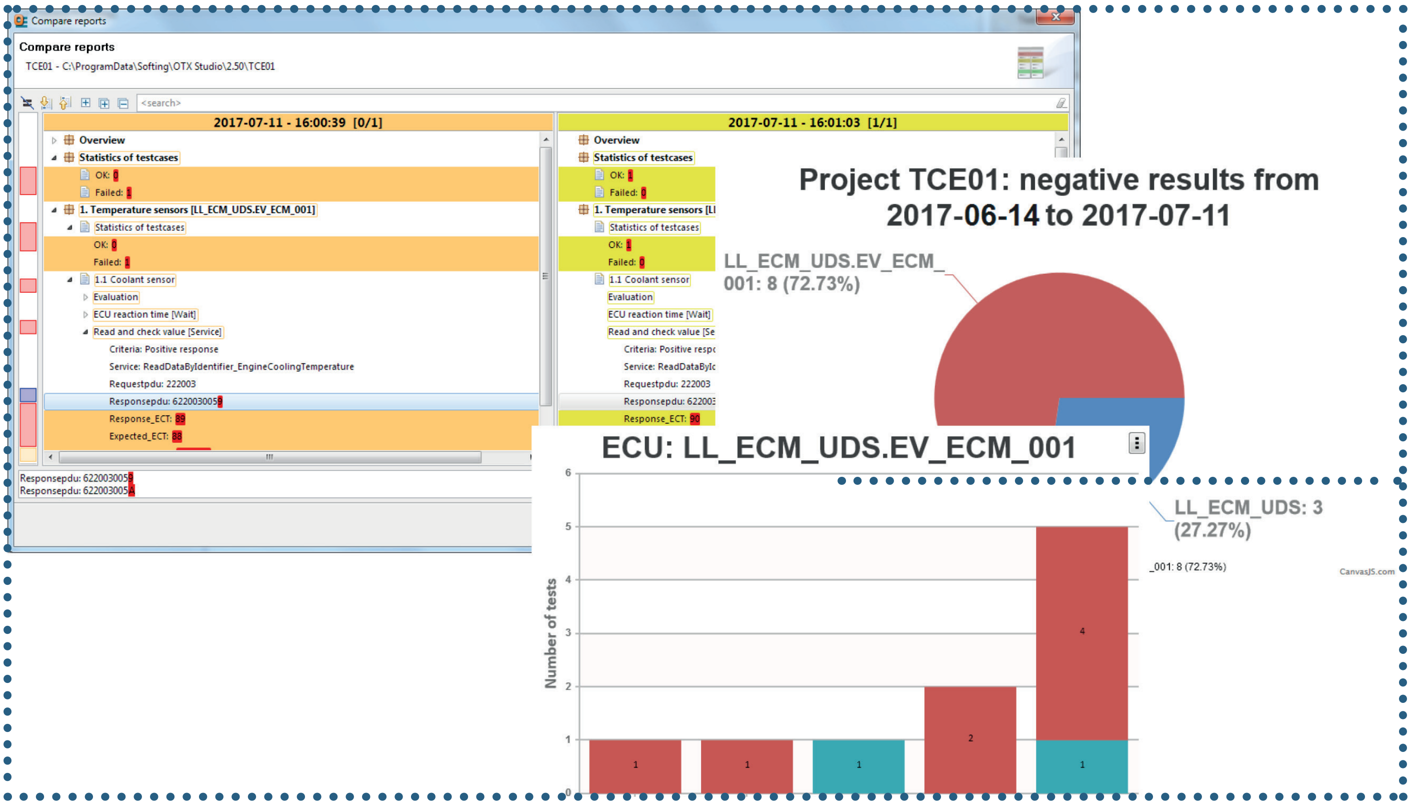
Description	Type	Value	Expected response/behavior
1. Check Engine Response1	Service	[$22] Read_EngineCoolingTemperature	Positive response; Positive and valid
	[POS_RESP] engineCoolingTemperature		0
2. Check Engine Reponse2	Service	[$22] Read_EngineOilLevel	Positive response; Positive and valid
	[POS_RESP] engineOilLevel		0
3. Check Scaling1	Service	[$24] ReadScalingDataByIdentifier	Positive response
	[POS_RESP] scalingByteExtension.scalingByteHigh		
	[POS_RESP] scalingByteExtension.scalingByteLow		
	[POS_RESP] scalingByteExtension.scalingByteHigh		
	[POS_RESP] scalingByteExtension.scalingByteLow		
4. <Service teststep>	Service	[$27] SecurityAccessRequestSeed	Negative response
	[POS_RESP] securityAccessTypeRequestSeed		requestSeed
	[POS_RESP] securitySeed		$00

Figure 2: Test Case Editor
(© Softing Automotive)

mand set, for example “ReadVoltage” or “SetVoltage”, and displays it in the “Measurement View”. This makes it easy for users to create test sequences for addressing and reading out measurement values. These commands are also easy to insert in the test sequence using Drag & Drop and the input assistant.

Simple Test Creation With the OTX Studio Test Case Editor

The OTX standard is a perfectly exchangeable, reusable and flexible way of creating tests for ECU diagnostics. A universal programming language is, however, used for this purpose. It requires a test engineer, on the one hand, to be proficient in programming techniques and, on the other, to understand the realization of standard tasks, such as troubleshooting and report creation. It is thus advantageous to use a suitable engineering environment which is tailored to the use case and which takes the pressure off the test engineer during test case creation. OTX Studio is all about “configuring instead of programming” and reduces the necessary tasks to the parameterization of individual steps in terms of their response. At the same time, this approach ensures an easy-to-understand representation of the test cases.
In OTX Studio, the Test Case Editor is used to create test cases. Many standard test cases are easy to describe simply by defining parameters. Simultaneously, the Test Case Editor also makes it possible to use the full capabilities of OTX for complex test cases. Precisely for this purpose, there is what is referred to as a customer test step with which the few special cases which require separate implementation can easily be integrated into the test sequence.
A code generator generates the OTX code from the test cases defined by the test engineer in the Test Case Editor. This code also covers troubleshooting and the creation of reports for example. This considerably reduces the effort involved in creating test cases; at the same time, errors in the implementation of test sequences are virtually excluded which also results in significantly lower overall test times. Furthermore the test cases created in OTX Studio can be reused virtually independently from the tools used.
The OTX code generated by the code generator can be used for the fast and convenient creation of complete validation sequences on an OTX basis. For this purpose the test engineer defines individual test steps and drags these to the test documentation template using drag & drop. These test sequences, which are typical for implementation, are then available. At the same time the template serves as a basis for the composition of the necessary validation test steps and for the creation of a requirements and/or testing document.
The generated OTX code can be run on a PC in the engineering environment of OTX Studio or in OTX Runtime, Softing’s runtime environment, as an inde-


Compare reports
TCE01 - C:\ProgramData\Softing\OTX Studio\2.50\TCE01

2017-07-11 - 16:00:39 [0/1]
Overview
Statistics of testcases
OK: 0
Failed: 1
1. Temperature sensors [LL_ECM_UDS.EV_ECM_001]
Statistics of testcases
OK: 0
Failed: 1
1.1 Coolant sensor
Evaluation
ECU reaction time [Wait]
Read and check value [Service]
Criteria: Positive response
Service: ReadDataByIdentifier_EngineCoolingTemperature
Requestpdu: 222003
Responsepdu: 6220030059
Response_ECT: 89
Expected_ECT: 88

2017-07-11 - 16:01:03 [1/1]
Overview
Statistics of testcases
OK: 1
Failed: 0
1. Temperature sensors [Ll
Statistics of testcases
OK: 1
Failed: 0
1.1 Coolant sensor
Evaluation
ECU reaction time [Wait]
Read and check value [Se
Criteria: Positive respo
Service: ReadDataById
Requestpdu: 222003
Responsepdu: 622003
Response_ECT: 90

Responsepdu: 6220030059
Responsepdu: 622003005A

<search>
Project TCE01: negative results from 2017-06-14 to 2017-07-11
LL_ECM_UDS.EV_ECM_001: 8 (72.73%)
LL_ECM_UDS: 3 (27.27%)
_001: 8 (72.73%)
CanvasJS.com
ECU: LL_ECM_UDS.EV_ECM_001
Number of tests
0
1
2
3
4
5
6
1
1
1
2
4
1

Figure 3: Test Progress, Statistics and Comparison Tool for Test Reports
(© Softing Automotive)

pendent diagnostic sequence on a PC, Android, iOS or Linux system.
The Test Case Editor offers a series of predefined standard test steps for a comprehensive test of the diagnostic services. The testing possibilities are not, however, only limited to the validation of individual diagnostic services. They can also be extended to the validation both of entire diagnostic groups and of the communication behavior. Within the tests the user can create further tests which test the positive and negative responses to the diagnostic services of an ECU. These are available for the validation of valid or invalid diagnostic services or the repetition of the test over the entire value ranges, for example for text tables or for complex and extended data types.
In the Test Case Editor, great store was set by a good test report available in XML and HTML format. Furthermore the test reports are stored in a timeline so that the progress of a test project can be followed at all times. This is made possible with an in-built comparison tool which shows test reports in a parallel view and highlights the differences. Various statistical values round out the display.
OTX offers the perfect solution for a comprehensive and systematic validation of all diagnostic services available on an ECU as well their valid and invalid parameter combinations.
With OTX Studio and the Test Case Editor, a test engineer can create very extensive diagnostic validation tests simply and efficiently, and run them on various test and operating systems. This means the created OTX sequences from different specialist departments as well as different phases of a vehicle's life cycle can be integrated into the diagnostic test system without any great effort. The integration of the National Instruments measurement technology library provides further flexibility when creating diagnostic test beds.

>> automotive.softing.com

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