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Electronic Engineering

Testing of Automotive Systems (Part I)

Module 6 – HW/SW Tests and Test benches

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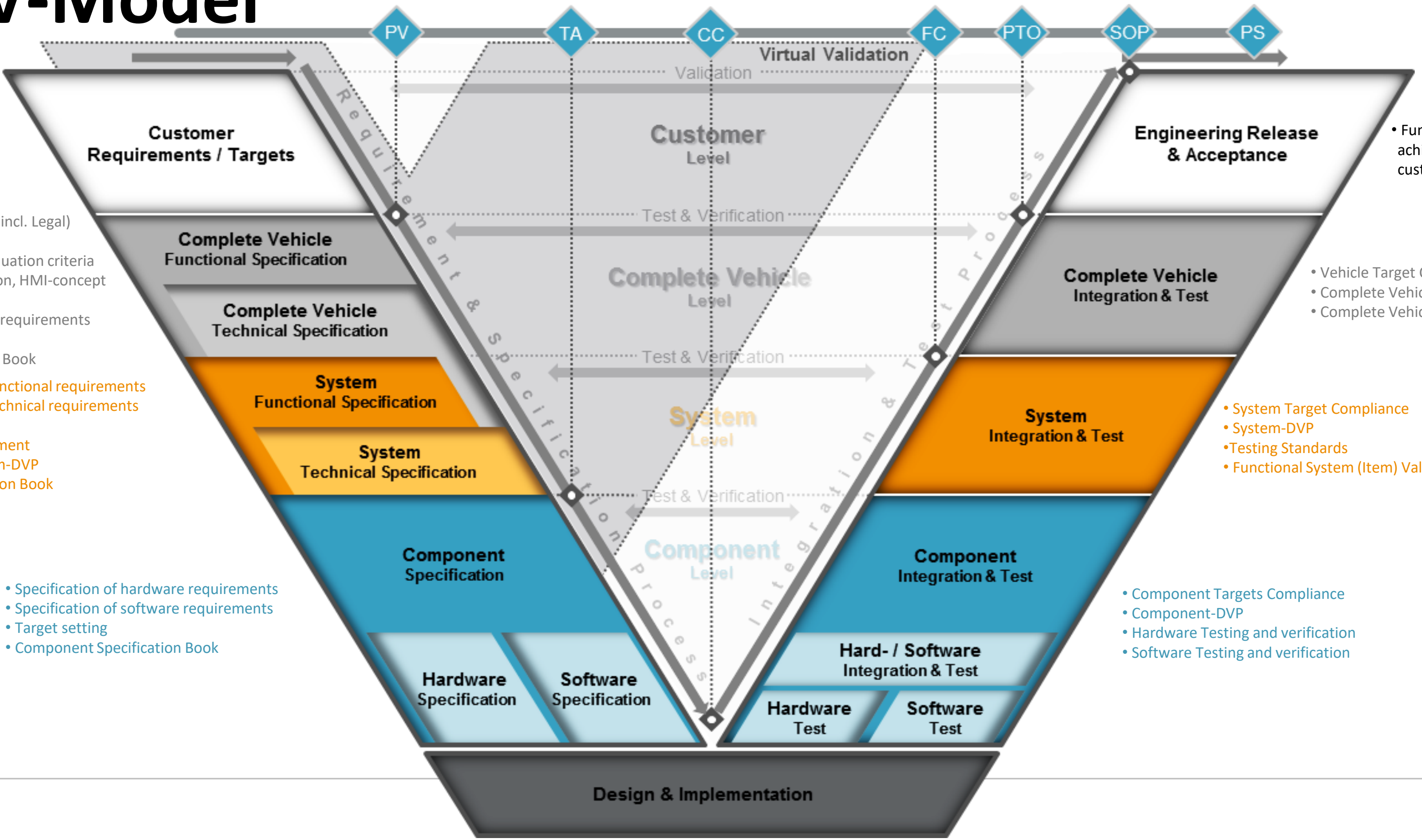
The V-Model

- Customer Market Profile
- Sales Markets
- Configuration List
- Feature und Function List
- Benchmarks
- Vehicle Profile Description

- Definition of CV requirements (incl. Legal)
- Target setting
- Derivation of measureable evaluation criteria
- Product & Functional description, HMI-concept
- Creation of CV-DVP
- Definition of Items and system requirements
- Item List
- Complete Vehicle Specification Book

- Specification of functional requirements
- Specification of technical requirements
- Target Setting
- Functional assessment
- Creation of System-DVP
- System Specification Book
- Drawings
- Serial BOM

- Specification of hardware requirements
- Specification of software requirements
- Target setting
- Component Specification Book



- Functional target achievement confirmed on customer-ready vehicles

- Vehicle Target Compliance
- Complete Vehicle-Test Program
- Complete Vehicle Function Validation

- System Target Compliance
- System-DVP
- Testing Standards
- Functional System (Item) Validation

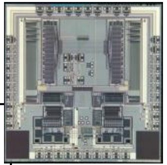
- Component Targets Compliance
- Component-DVP
- Hardware Testing and verification
- Software Testing and verification

ECU Testing

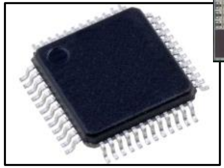
Hardware

HW Standards : Different level definitions in development with focus hardware

Tier 2



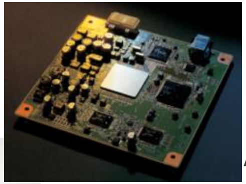
Chip level



Hardware part level

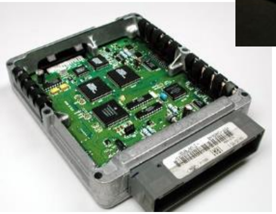
Main qualification Spec: AEC-Q

Tier 1



Assembly level

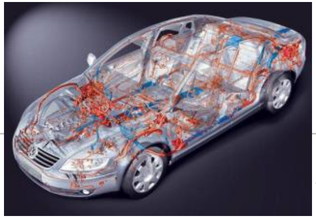
Main qualification Spec: Set of IPC



Component level

Main qualification Spec: ISO-16750 or OEM equivalent

OEM



Vehicle/system level

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Definition of A/B/C/D/E - Samples

A-Sample (Engineering Sample)

Main purpose is to show basic communication and some base functionality is already implemented. It could be either a development board or a design intent housing already

B-Sample (DV-Sample)

All functionality shall be implemented already. All required environmental and EMC tests shall be done.

C-Sample (Off-tool Sample)

100% Off-tool parts – all functionality implemented as well as all **Design Verification (DV) t**asks shall be finished.

D-Sample (PV-Sample)

100% Off-tool and Off-process parts - used to deliver the parts for **Product Validation (PV)** and **Production Part Approval Process (PPAP)**

E-Samples (Series Parts)

Serial production parts with continuous conformity testing (CC)

Sample Description

Sample-Category	Use / Purpose	Quality	Software	Manufacturing	Conditions for approval	Testing
A	First build up of the concept in hardware for the representation of the customer related functions. Object for FMEA.	Customer related functions confirmed. Deviations to specification / functional restrictions are stated in the test report.	Restrictions of functions according specification. Deviations are stated in release notes which are added to the test report.	Hand- work, special manufacturing, modified processes. Partly alternative materials. Rapid prototyping parts. Tacking according internat. standards.	100% testing of characteristics defined in the prototype control plan	Start of testing at MAGNA in special environment with qualified staff. Hardware is not shipped to the customer.
B	Final hardware. Used for DV testing in an extent that the release of the series tools manufacturing can take place.	Functions confirmed. DV test finalized with positive results. Reliability and lifetime confirmed with defined confidence. Surface not finalized in tools. Deviations to specification / functional restrictions are stated in the test report.	All functions confirmed, which are necessary for the DV testing of the hardware and the operation of the vehicle. All important safety functions confirmed primarily. Deviations are stated in release notes which are added to the test report.	Series related PT building, auxiliary tools (e.g. aluminum or unhardened steel) and auxiliary devices / fixtures. Target: 100% final material.	100% testing of characteristics defined in the prototype control plan. Prototype process flow chart and control plan supplied	Design verification Testing in vehicles. Defined restrictions for operating
C	Confirmation of final design with parts off tools. Samples for building up the assembly line. Internal release of production process at supplier	Same as B. All functions of the hardware according specification confirmed. Can be flashed in serial production process	Same as B, but all specifications confirmed. All safety functions confirmed.	100% off tool (not hardened) 100% final material Start-up of series process in series production site	100% testing of characteristics defined in the series control plan. Series process flow chart and control plan supplied	Testing with parts off serial tools. Testing in vehicles. Defined restrictions for operating
D	PV testing PPAP parts Run at rate Release / approval	Same as C Reliability and lifetime confirmed Short-term process capability confirmed. Parts marked like parts from serial production.	Same as D. Documentation finalized.	100% final process at 100% cycle time 100% final tools 100% final material 100% series staff 100% series packing MSA done; IMDS done Parts from / after run@rate	Documentation for process and product approval completed	Product validation Assembly in pre-series vehicles
Series P	Serial production Continuous Conformity Testing	Same as D confirmation of long term process capability	Same as D	Same as D	Same as D confirmation of long term process capability	Assembly in serial vehicles for the customer

Test Item	Test against	Target Summary	Main Characteristics	Test Bench
Hardware Unit and Integration Testing (HWIT)	Hardware Detailed Design	Verify HW design decisions, functionality	White-box, low level, Hardware	Basic measurement tools, normal working place
	Hardware Architecture Spec	Interfaces between HW Units / Components	White-box, Hardware Component level	Basic measurement tools, normal working place
Hardware Tests (HWT)	HW Requirement Spec	Verify requirements	Mainly black-box	Normal working place HiL Special Lab (climatic, mechanical, chemical chambers
Qualification of HW Comp.	Integrated HW components	Suitability for usage	Testing (functional, climatic…) Analysis (simulation, extrapolation…)	Special Lab (climatic, mechanical, chemical chambers Computer workplace

HW Development: Hardware Unit and Integration Testing (HWIT)

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Verification of:

Hardware Architecture and Detailed Design Specification

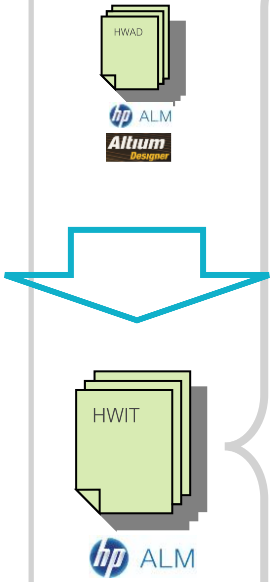
Hardware Construction

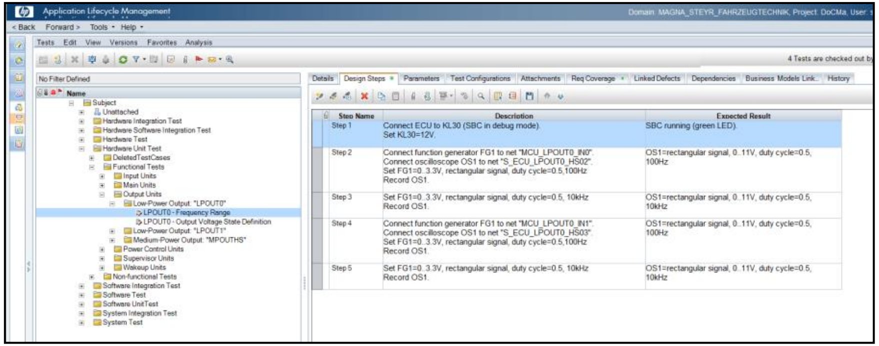
Tasks:

- White Box Testing
- Datasheet Limit/Worst Case Conditions
- Design Decision Limits/Worst Case Conditions
- Electrical Testing
- Error Guessing
- Fault Injection Testing
- Unit Tests
  - HW Functional Testing
  - HW Expanded Function Testing
- Integration Tests
  - Internal and external Interfaces Functional Testing
  - Expanded Interfaces Functional Testing

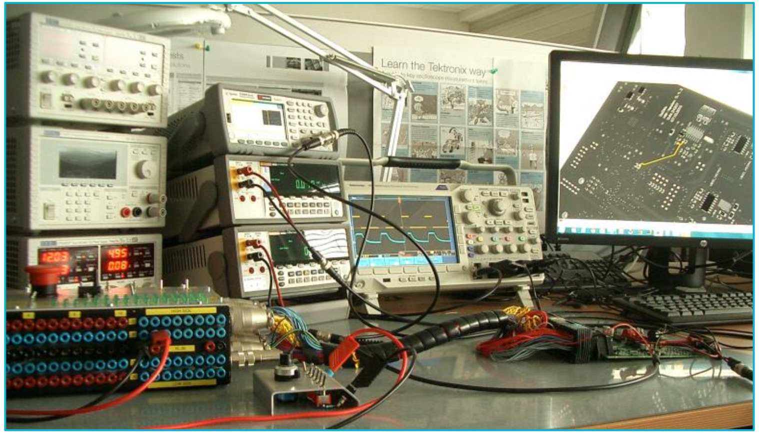
Examples:

- HP ALM Test Specification and Test Steps
- HP ALM Test Results





HP ALM: Hardware Unit Test Specification for Low-Power Output "LPOUT0". Extract with 1 test case and its steps.



HW Unit Test: Measurement setup for frequency range upper limits of medium power output driver.

HW Development: Hardware Testing (HWT)

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Verification of:

Hardware Requirement Specification (result of Hardware Requirement Analysis)

HWRA

ALM

Tasks:

- Test Plan and Test Specification
- Black Box Testing
- Electrical Testing according to OEM/internal standards
- Environmental Testing according to OEM/internal standards

Examples:

- Hardware Qualification Test Plan Overview XGW
- Hardware PV/DV Test Report XGW
- DIAdem Relay Test Issue Report XGW

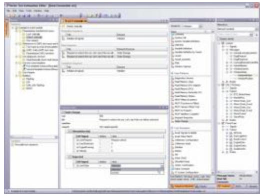
HWT

vector VT System

NATIONAL INSTRUMENTS DIAdem

ALM Under construction

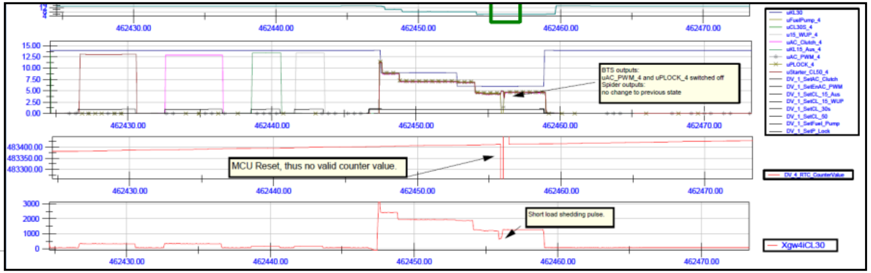

HiL Testing: Test Bench for electrical Tests


HiL Testing: Test Automation Editor


PV/DV Test s: Climate Chamber

PV/DV Tests: Simulation Boards


PV/DV Tests: Devices under Test



PV/DV Test Results Verification: NI DIAdem Report Extract

HW Development: Hardware Testing (HWT) – Test plan

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Verification of:

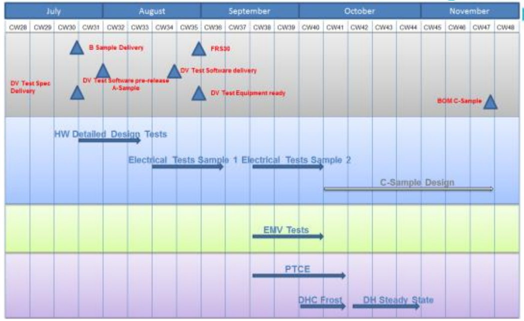
Hardware Requirement Specification (result of Hardware Requirement Analysis)

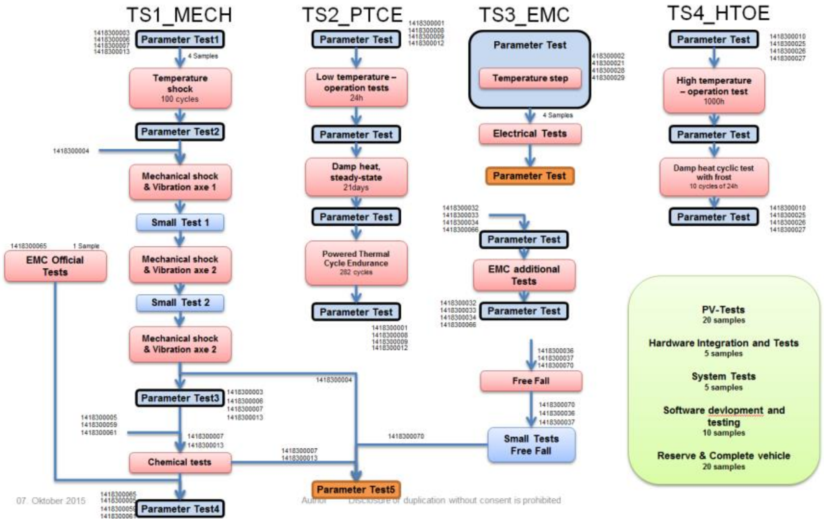
Tasks:

- Specify list of tests to be executed on each sample
- Arrange test samples
- Schedule tests according to development schedule
- Plan and supervise testing budget with PM
- Coordinate testing with external test labs

Examples:

- Hardware Qualification Test Plan Overview XGW





ECU Testing

Hardware in the loop - HiL

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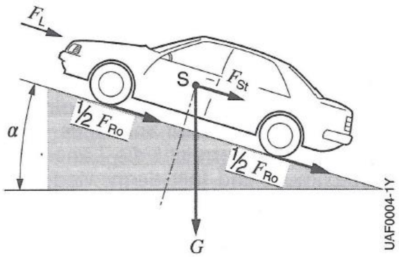
EE Testing – Concepts

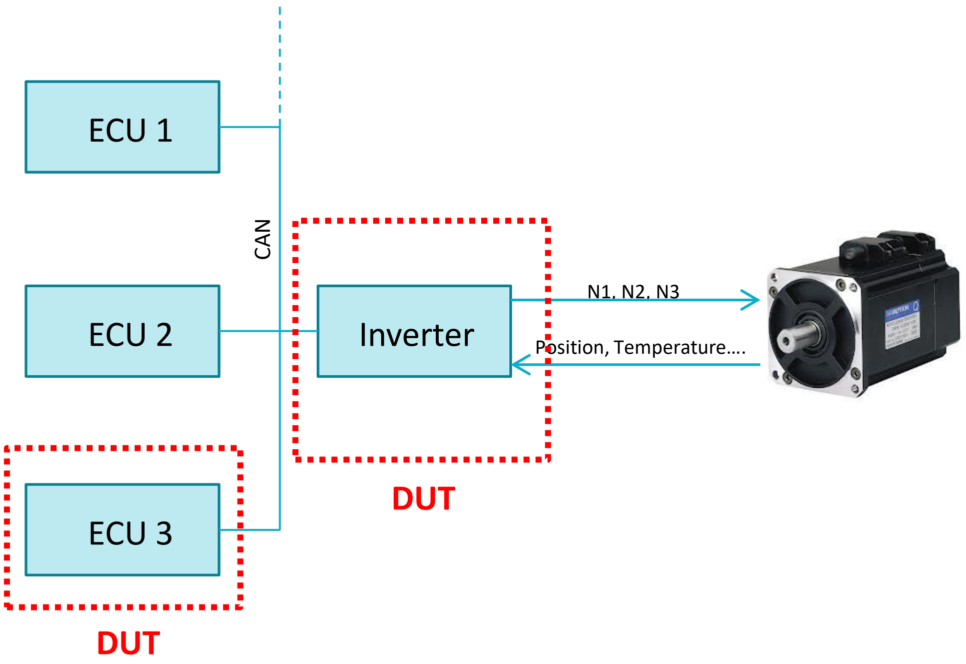
- Hardware in the Loop and Simulation-based testing
  - testing of electrical functions in an early project phase
  - reproducible testing, automated testing
  - testing is possible long before vehicle prototype is available
  - fault injection made easy



- HiL benefits:
  - “Virtual Test Drives”, ECUs connected to a “mathematical model”
  - environmental conditions change on a click (temperature/slope/friction)

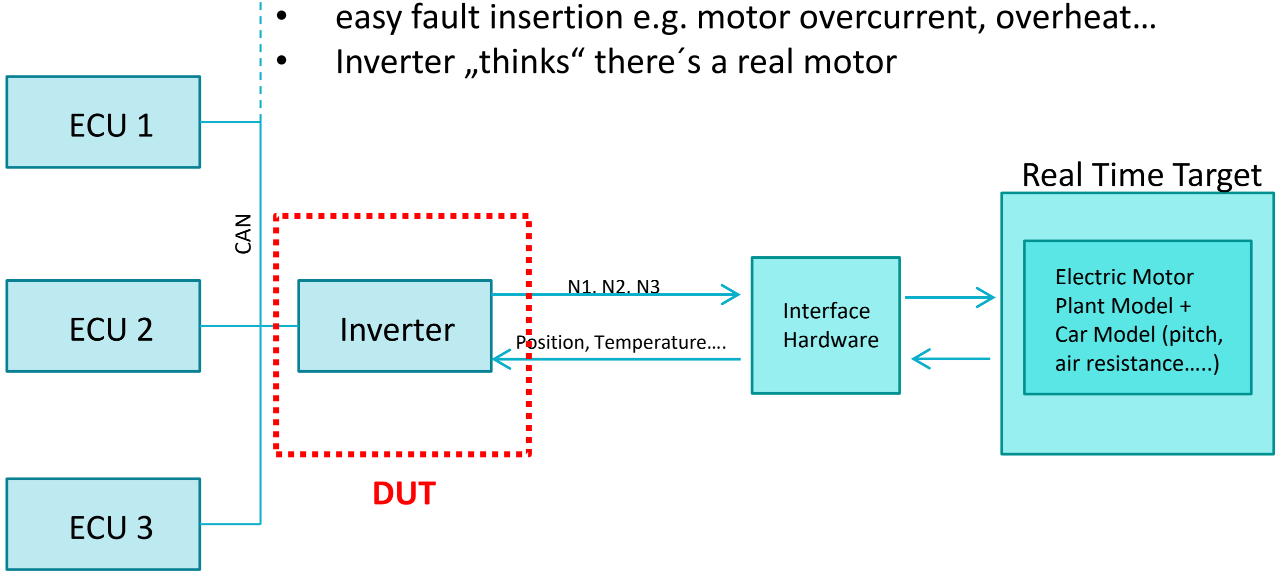
- Simulation benefits:
  - no complex mathematical models needed
  - easy to extend

System example - real configuration

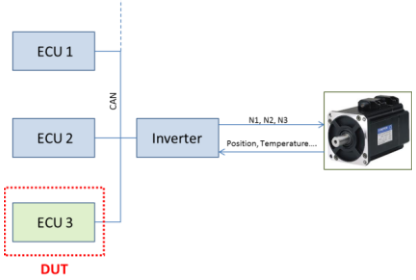


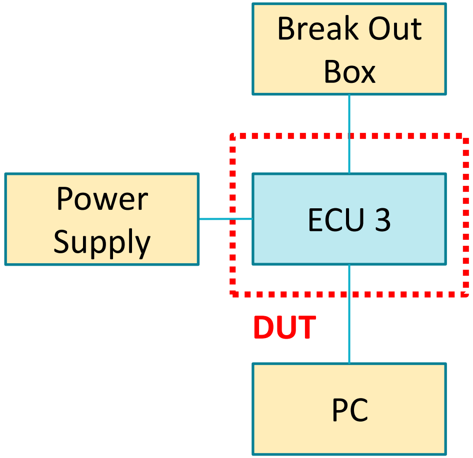
Hardware In the Loop - configuration

- **Complete electrical system of the car available**
- Mathematical Model of simulated hardware part
- Test bench testing without real electric motor (no moving parts)
- easy fault insertion e.g. motor overcurrent, overheat…
- Inverter „thinks“ there´s a real motor

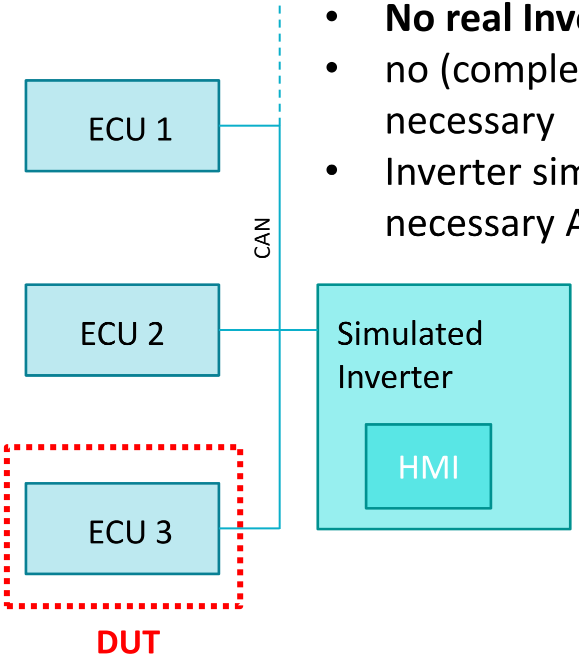


HiL configuration on ECU level





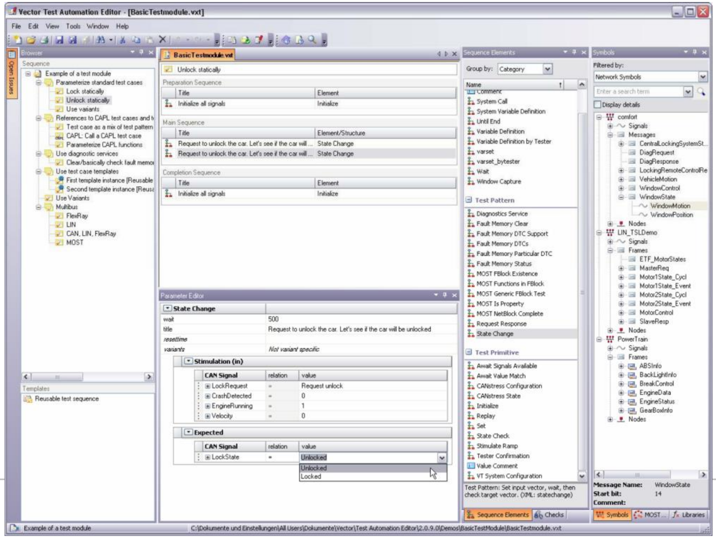
Hardware In the Loop – simulation configuration



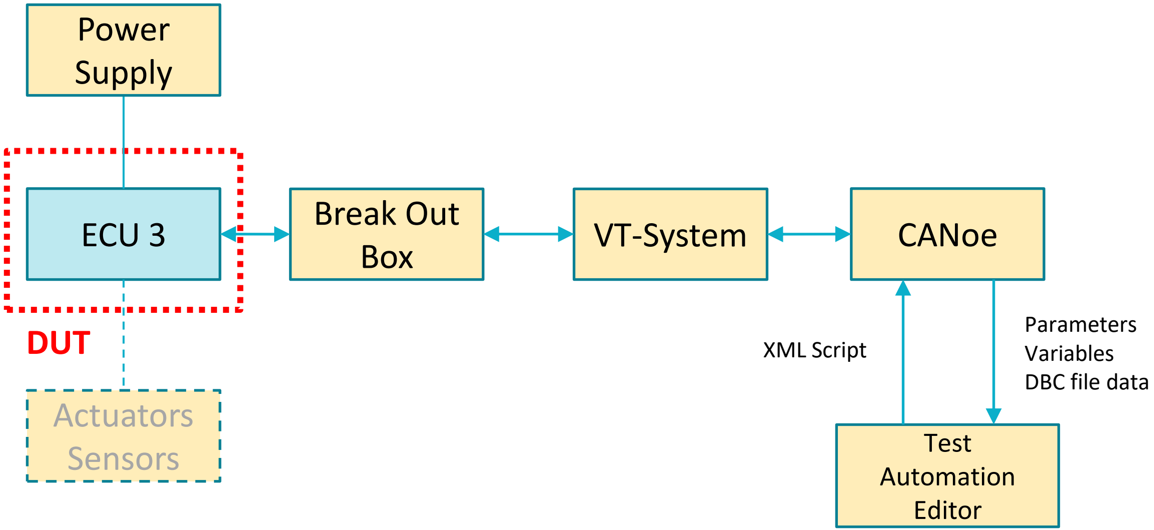
- **No real Inverter**
- no (complex) mathematical models necessary
- Inverter simulated on bus level, only necessary A/D signals generated

Hardware In the Loop - Tools used

- **Test Automation Editor** - development environment for creating automated ECU tests
- **CANoe** - software tool for development, test, and analysis of entire ECU networks and individual ECUs (LINK)
- **VT System** - Modular Test Hardware comprising bus interfaces, measurement modules, stimulation modules, relay modules…



HiL configuration on ECU level



Input documents and work products

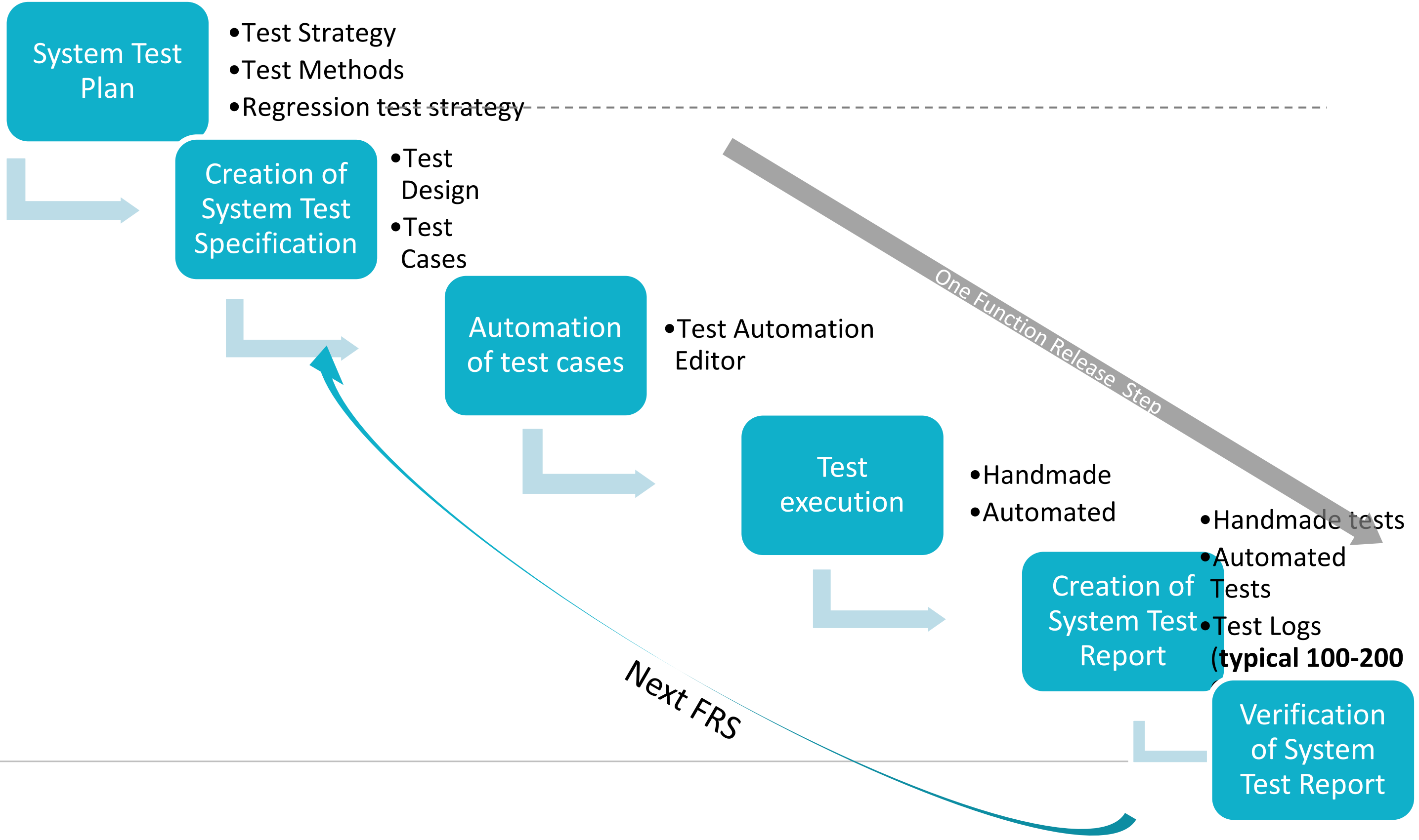
» Input Documents

- **System Requirement Specification**- defined and refined customer requirements/functions on system level
- **Standards (IEEE, ISO ….)** – standardized communication protocols or standardized diagnostic communication in automotive

» Work products

- **System Test Plan**- defined Test strategy including test methods, test design technics and regression test strategy
- **System Test Specification**- including test case specification, test design specification and test environment specification
- **System Test Report-** Results of all accomplished tests (automated and hand made)
- **Traceability Record-** All tests have to be traceable to the input document and the next work product

Hardware In the Loop - example



System Test Plan

4 System Test

4.1 Test Goal

The purpose of the Systems testing process is to ensure that the implementation of each system requirement is tested for compliance and that the system is ready for delivery.

4.2 Test Strategy

4.2.1 Planning and Organization

The test schedule for A-, B-, C-, D-Sample releases can be found in the XGW work product status document APStatus [37].

The project roles for performing the tests can be found in the project role matrix document [38].

Initially, the system requirements specification must be analyzed. The requirements must be prioritized for the impact of these requirements on the operational state of the complete J11 system. Additionally, the requirements must be categorized in safety and non safety relevant requirements and in functional parts of the system.

For each system requirements a sufficient number of test cases will be defined and documented in the system test specification. The test cases must be developed to demonstrate compliance with the system
Requirements, including the interfaces between system elements. The order of the sequence of the defined test cases shall be derived from priorities and categorization the system requirements in order to find errors earlier in the system development life cycle.

The consistency and bilateral traceability between system requirements and the system test specification including test cases are established by the tool REqTracer. Consistency check is done by review.

The test cases in the test specification includes input test vectors as well as expected results, i.e. output vectors.

4.2.2 Testing Methods

The System test will be done in Black-Box- Testing Method.

System Test Specification

» Document examples

No.	Test case name	[SYSTS0094]
	Test case outline	Function test Clamp_50 emergency start
Prio.	Expected test result outline	Clamp_50 activate with emergency start conditions
	Time involved (time effort)	
Traceability		
SYSR0159		
Detailed description		
Clamp_50_IK (active high HW input) **Clamp_15_1** (active high HW input) **RPM_ENG** (PT-CAN, Torque_3) **ST_ENG_RUN** (PT-CAN, ENGINE_1)		

Test steps:	Test step result
1. **Clamp_15_1** (Analog in) < 3 V and **Clamp_50_IK** = 0	Clamp_50=0
2. **Clamp_15_1** (Analog in) > 7,5 V and **Clamp_50_IK** = 0	Clamp_50 = 0
3. **Clamp_15_1** (Analog in) > 7,5 V and **Clamp_50_IK** = 1 (min. 300ms) and vehicle speed of is > 10 km/h (**V_VEH** > 10) and Engine is not running (**ST_ENG_RUN** ~= ST_ENGINE_RUN)	Clamp_50 = 1 for a defined time (max. 21 sec) than Clamp_50 = 0

System Test Report

No.	SYSTR5418	**Test Case Name:**	SYSTS0094
Test type	A	**Test Case Outline:**	Function test Clamp_50 emergency start
Result:	OK	**Tester:**	Stefan Pfingstl
OIL References			
Annotations and comments			
Test log			
Starter_Test_Report_1418300024.html			

No.	SYSTR5419	**Test Case Name:**	SYSTS0794
Test type	M	**Test Case Outline:**	Reset during engine start
Result:	OK	**Tester:**	Stefan Pfingstl
OIL References			
Annotations and comments			
Test log			
SYSTR5419.blf			

No.	SYSTR5420	**Test Case Name:**	SYSTS0795
Test type	A	**Test Case Outline:**	During engine start defined outputs shall not be activated:
Result:	OK	**Tester:**	Stefan Pfingstl
OIL References			
Annotations and comments			
Test log			
Starter_Test_Report_1418300024.html			

Test Log (automated test)

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7.12 SYSTS0094: Passed

Test case begin: 2014-08-05 13:16:05 (logging timestamp 7085.140305)
Test case end: 2014-08-05 13:16:19 (logging timestamp 7099.640305)

Preparation of Test Case

Timestamp	Test Step	Description	Result
1. MC_ABAG_1 and other MCs = 15 (due to MC and Checksum Skript): Passed			
7085.140305		Set specified value. CAN signal 'MC_ABAG_1' on bus Chassis-CAN: 15	-
7085.140305		Set specified value. CAN signal 'ALIV_COU_DME' on bus PT-CAN: 15 (Signal ungültig)	-
7085.140305		Set specified value. CAN signal 'ALIV_V' on bus PT-CAN: 15 (Signal invalid)	-
7085.140305		Set specified value. CAN signal 'ALIV_GRB' on bus PT-CAN: 15 (Signal invalid)	-
7085.140305		Set specified value. CAN signal 'ALIV_COU_DSC' on bus PT-CAN: 15 (Signal invalid)	-
7085.140305		Set specified value. CAN signal 'ALIV_TORQ_1_DME' on bus PT-CAN: 15 (Signal invalid)	-
7085.140305		Set specified value. CAN signal 'ALIV_TORQ_3_DME' on bus PT-CAN: 15 (Signal invalid)	-
7085.140305	1	Stimulation of the input parameters	pass
7085.140305		Emergency start	-
2. Start conditions: Passed			
7085.140305		Set specified value. CAN signal 'St_crashOut' on bus Chassis-CAN: 0 (No crash)	-
7085.140305		Set specified value. CAN signal 'ST_ENG_RUN' on bus PT-CAN: 0 (Engine off)	-
7085.140305		Set specified value. CAN signal 'V_VEH' on bus PT-CAN: 20	-
7085.140305		Set specified value. CAN signal 'ST_ILK_STRT' on bus PT-CAN: 0 (Kein Motorstart)	-
7085.140305		Set specified value. CAN signal 'ST_CT_BRPD_DME' on bus PT-CAN: 0 (Brake not pressed)	-
7085.140305		Set specified value.	-

Test file for test automation

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Tests_FRSD1.vxt - Editor

Datei Bearbeiten Format Ansicht ?


```xml
<?xml version="1.0" encoding="iso-8859-1"?>
<!--Vector Test Automation Editor 2.1.28.0-->
<testmodule title="Tests FRS D1" version="1.0" xmlns="http://www.vector-informatik.de/CANoe/TestModule/1.26">
  <testgroup title="Routing">
    <preparation>
      <set title="Key pos. 1">
        <sysvar name="RelayVBatt" namespace="VTS::M12_Ch16_CL_R">1</sysvar>
        <sysvar name="RelayVBatt" namespace="VTS::M12_Ch14_CL_15_1">0</sysvar>
        <sysvar name="RelayVBatt" namespace="VTS::M12_Ch13_CL_50_IK">0</sysvar>
      </set>
      <wait title="Wait" time="500" />
      <set title="Key pos. 2">
        <sysvar name="RelayVBatt" namespace="VTS::M12_Ch16_CL_R">1</sysvar>
        <sysvar name="RelayVBatt" namespace="VTS::M12_Ch14_CL_15_1">1</sysvar>
        <sysvar name="RelayVBatt" namespace="VTS::M12_Ch13_CL_50_IK">0</sysvar>
      </set>
      <wait title="Wait" time="500" />
    </preparation>
    <testcase title="SYSTS0109" ident="">
      <preparation>
        <vardef name="Cycle" type="int" default="0">1</vardef>
        <set title="MC_IPC_2 = 15">
          <cansignal name="MC_IPC_2">15</cansignal>
        </set>
      </preparation>
      <for_loop title="Cycle" loopvar="Cycle" stopvalue="3" startvalue="0" increment="1">
        <set title="N_TempEx = -40">
          <cansignal name="N_TempEx">-40</cansignal>
        </set>
        <wait title="Wait" time="1s" />
      </for_loop>
      <statechange title="N_TempEx - TEMP_EX = -40" wait="1s">
        <in>
          <cansignal name="N_TempEx">-40</cansignal>
        </in>
        <expected>
          <cansignal name="TEMP_EX">-40</cansignal>
        </expected>
      </statechange>
```

System Testbenches

Network testbench

- Easy accessible ECUs
- All ECUs are connected with supply and bus communication wires to the test bench
- E/E system tests can be done before vehicle building starts
- Automated tests for diagnostic, bus errors, buslogic, network management, gateway
- Fast hardware replacement
- No influence from wiring harness

Network testbench – test content

- Flash verification
- check of the raw data
- check of logistic data for/after flash
- check the bus behavior by ECU flash
- switch off bus at ECU flash

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Subsystem (domain) testbench

- Automated validation of the complete function-network
- Automation of the validation steps incl. automated test report generating, by plugging and switching via Robot for all customer-, long-term-, voltage-, diagnosis- and coding tests.
- Automation with 4 engineering tools:
  - TestStand
  - LabView
  - CANoe
  - Katana 4D (Robot)

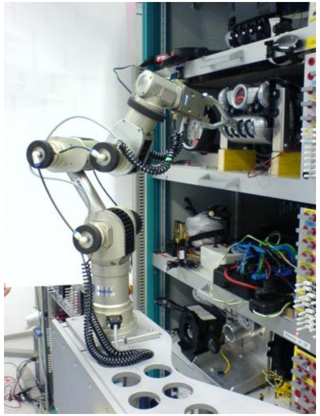
Breakout Rack

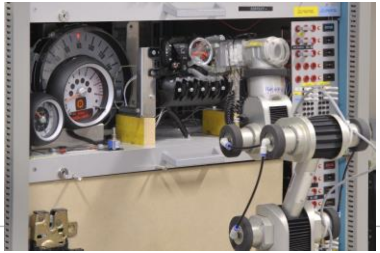
Load Rack
ECU´s, operating elements

Periphery Rack
sensors / actuators

Subsystem (domain) testbench – test content

- System functions (partly automated):
  - Pinning / wiring (pinning, coding)
  - Bus verification (CAN, LIN, Ethernet, etc.)
    - Bus-Physic (Error Frames, ramp up/down time, voltage level, load resistor, error simulation)
    - Bus-logic (message errors, service messages)
    - Bus load (stress impact, power up/down, rest bus simulation stress load)
  - Hardware-Signals 1:n connections
  - Voltage tests (under voltage, cranking profile, etc.)
  - Failure simulation (signal failure, cable failure, ECU malfunction, invalid signals)
  - Misuse tests (reverse polarisation, short cut, etc.)
  - Flash, diagnostics
  - Gateway tests

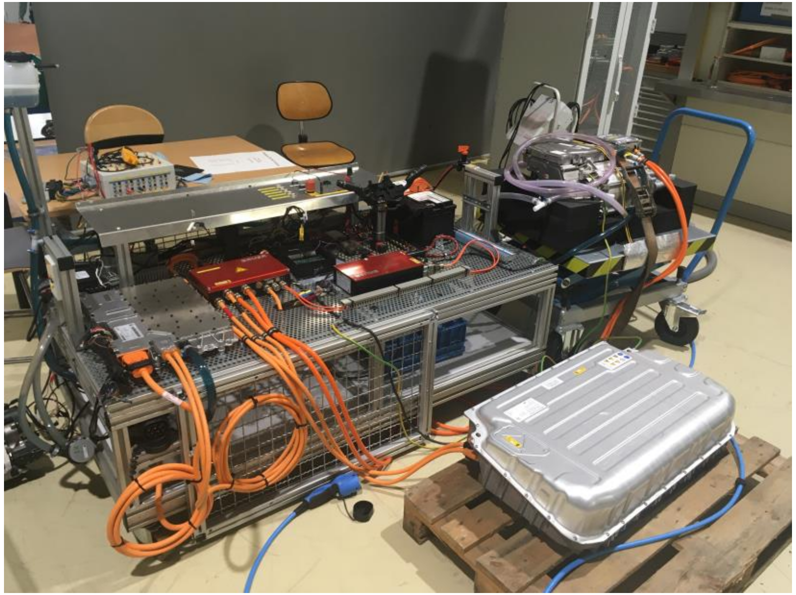




Powertrain Sub System Test Bench

Test content:

- **Verification of local buses** (CAN-High, CAN-Low, LIN, etc.)
- **Bus-Physic** (Error Frames, ramp up/down time, voltage level, load resistor, error simulation)
- **Energy-Management** (quiescent current, power up/down)
- **Bus-logic** (message errors, service messages)
- **Failure simulation** (signal failure, cable failure, ECU malfunction, invalid signals)
- **Bus load** (stress impact, power up/down, rest bus simulation stress load)
- **Misuse tests**
- **Flash, diagnosis, gateway**
- **customer function tests** (checklist)
- **HV function validation with all HV components**
- **HW/SW development platform**



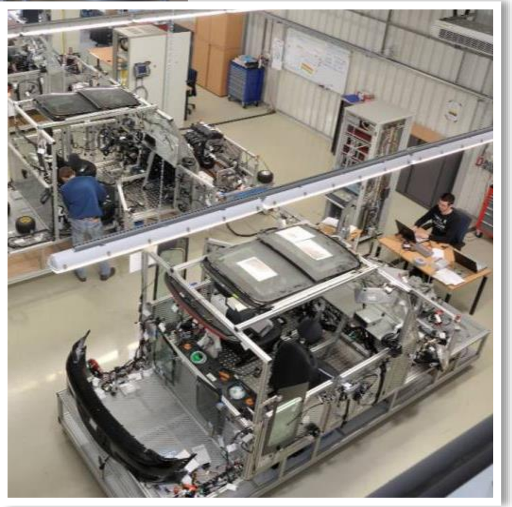
ADAS Sub System Test Bench

Test content:

- Base customer function testing (with original Components)
- Static maneuver testing (Ideal virtual world)
- Failure/Manipulation/Stress testing (Wiring/ECU/Sensor/Actuator failures)
- HMI Validation (functionally)
- EE maturity monitoring
- Vehicle Configuration and Vehicle variant testing
- Safety robustness validation
- Automated testing, Repetitive testing, Long-time testing and Variation testing
- Free and stochastic testing and error analysis

Laboratory Vehicle (Labcar) - Overview

- Aluminium frame
- Easy accessible ECUs and harness
- Fast hardware replacement without disassembling the complete vehicle
- Original vehicle wiring harness and all ECU´s, sensors and actuators are integrated into the test platform.
- Complete system tests can be done before vehicle building starts
- Automated test sequences (LabVIEW, CANoe, C#)
- HIL-Simulation (NI, dSPACE)
- Residual bus simulation for missing ECU´s



Laboratory Vehicle (Labcar) – test content

- E/E system function tests
  - wiring harness validation
  - flashing/coding verification
  - physical/logical bus layer tests (CAN,LIN, Ethernet)
  - clamp control tests
  - network management tests (Autosar)
  - hardwired signal measurements
  - voltage tests according specification (ISO 16750-2, LV124,…)
  - quiescent current measurements
  - power management functions
  - diagnostic function tests
  - gateway tests
- Customer function tests

Vehicle Intensive Test (VIT)

- Assembling and Configuration of special measurement equipment
- Assembling of data logging equipment for AnalysisVehicle upgrades incl. flashing of the control units and error analysis
- Mechanical and electrical Vehicleupgrades
- Commissioning of complete vehicles at the customer and at the PT Shop incl. Flashing, Coding and Functioncheck.

Vehicle Intensive Test (VIT) – test content

- Validation of system and customer function tests incl. stochastic tests during off-duty testdrives
- “Free testing”
  - Reproduce typical consumer behavior
  - Reproduce misuse
- Summer/wintertestdrives and special component trails on different countries. (e.g. head unit, navigation)
- Support of product demonstrations on trade shows
- Vehicle build up support on the in-plant production line

Tools: Data Loggers

EMC compliant?	yes	no
Placement close to ECU's?	yes	not always
Interfaces for all bus technologies?	yes	no
Testing without manual?	yes	no
Invisible for the driver?	yes	no
Temperature range (-40° to 60°C)?	yes	no
Shock resistant?	yes	no
Autonomous logging?	yes	no
Second driver needed?	no	sometimes

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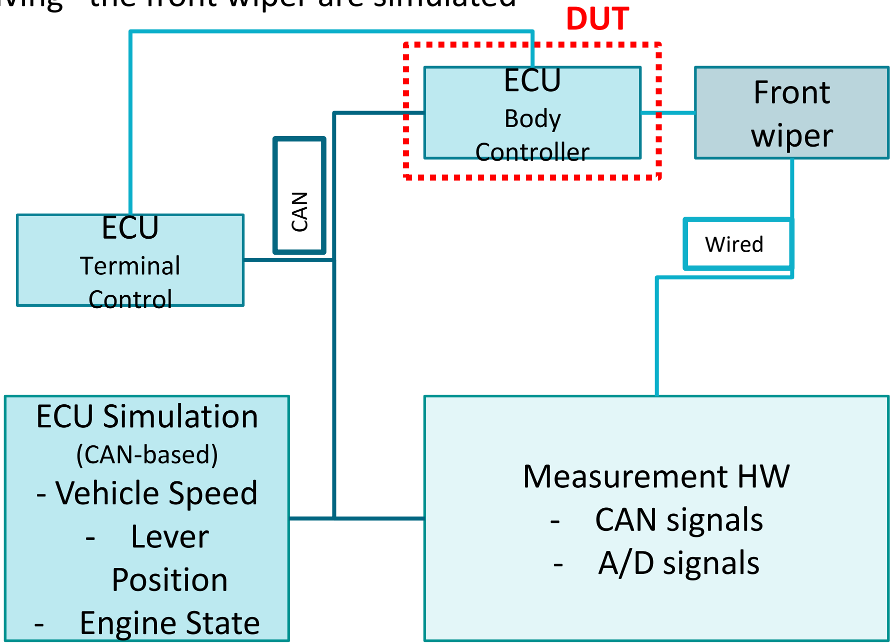
System Testing

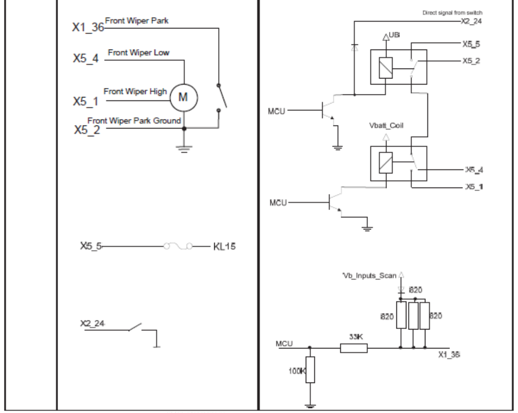
Front Wiper Example

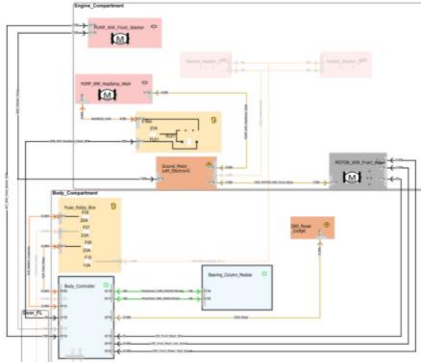
Hardware In the Loop - example

- ECUs which are operating the front wiper assembly are physically available
- ECUs which are not “driving” the front wiper are simulated



No	External Interface	Internal Interface (inside AFC)
X5_5	Vbatt Front Wiper	Power_Front_Wiper
X5_1	Front Wiper High	HO_Front_Wiper_High_Speed
X5_4	Front Wiper Low	HO_Front_Wiper_Low_Speed
X5_2	Front Wiper Park Ground	Front_Wiper_Park_Ground
X1_36	Front Wiper Park Switch	DI_Front_Wiper_Park
X2_24	Front Wiper Switch High Speed	DI_Front_Wiper_High_SW





Front wiper testing – ECU Simulation

- Engine management system (EMS) simulation for Engine State
- Electronic stability control (ESC) simulation for Vehicle Speed
- Steering column modules (SCM) simulation for Lever Position

From specification

5.3.2 Interface Requirements

5.3.2.2 CAN Signal Inputs

Signal Logical Name	Description
C_FrontWiper_LowSpeed_SW_ST	Front wiper low speed switch input on CAN **- SCM**
C_FrontWiper_HighSpeed_SW_ST	Front wiper high speed switch input on CAN **- SCM**
C_FrontWiper_IntermSpeed_SW_ST	Front wiper intermittent speed switch input on CAN **- SCM**
C_FrontWiper_MistMode_SW_ST	Front wiper mist mode switch input on CAN - **SCM**
C_FrontWiper_Interval_SW_ST	Front wiper interval switch input on CAN **- SCM**
C_FrontWasher_SW_ST	Front washer switch input on CAN **- SCM**
C_VehicleSpeed_ESC	Speed information from ESC ECU- **ESC**
C_EngineState_EMS_ST	Engine state status from EMS ECU **- EMS**

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Front wiper testing – Measurement

- A/D signals to monitor
- CAN signals

From specification

5.3.2.2 Digital Inputs

Signal Logical Name	Description
HW_Ignition_ST	KL15 power supply input
HW_FrontWiper_Park_SW_ST	Front wiper park switch status

5.3.2.3 Digital Outputs

Signal Logical Name	Description
HW_FrontWiper_OnOff_CMD	Front wiper power enable relay output
HW_FrontWiper_HighLow_CMD	Front wiper high/low speed relay output
HW_FrontWasher_CMD	Front washer output
HW_HeadlampWasher_CMD	Headlamp washer output

Front wiper testing – Speed Mode Test

From specification

5.3.5 Function Requirements

5.3.5.4 Front Wiper Intermittent Mode

Dwell Time of Front Wiper Intermittent Speed Class Mode

ID: FRS_AFC_FWP_018:

There are 5 speed class variations available with 4 dwell times in each class. The dwell time should only be changed from one vehicle speed class to another vehicle speed class when the wiper motor is in park position.

Interval Adjust switch position	Vehicle speed class (kph)				
	V0 (<5)	V1 (32)	V2 (<64)	V3 (<96)	V4 (>=96)
Interval 1, dwell time in s	24	16	12	10	8
Interval 2, dwell time in s	15	10	8	6	4
Interval 3, dwell time in s	8	5	4	3	2
Interval 4, dwell time in s	3	2	2	1	1
Default, dwell time in s	8	5	4	3	2

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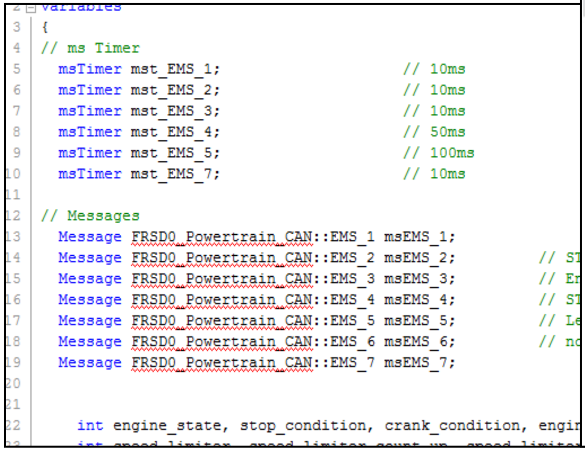
Wiper Speed Mode Testing – Test sequence

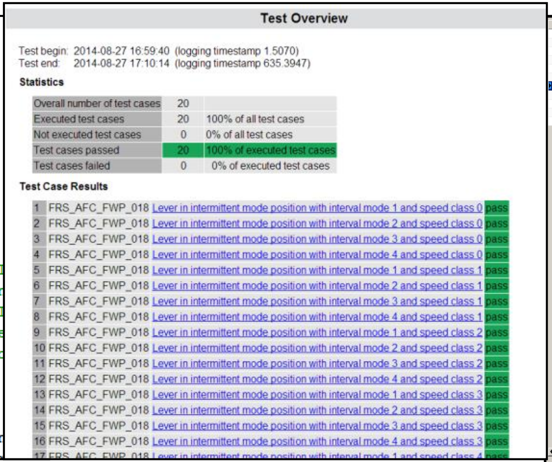
- Prepare test environment (supply voltage, parameter sets, simulated ECUs…)
- Prepare test modules
- Start testing
- Test report generation



```
{
// ms Timer
  msTimer mst_EMS_1;                    // 10ms
  msTimer mst_EMS_2;                    // 10ms
  msTimer mst_EMS_3;                    // 10ms
  msTimer mst_EMS_4;                    // 50ms
  msTimer mst_EMS_5;                    // 100ms
  msTimer mst_EMS_7;                    // 10ms

// Messages
  Message FRSD0_Powertrain_CAN::EMS_1 msEMS_1;
  Message FRSD0_Powertrain_CAN::EMS_2 msEMS_2;          // ST
  Message FRSD0_Powertrain_CAN::EMS_3 msEMS_3;          // Er
  Message FRSD0_Powertrain_CAN::EMS_4 msEMS_4;          // ST
  Message FRSD0_Powertrain_CAN::EMS_5 msEMS_5;          // Le
  Message FRSD0_Powertrain_CAN::EMS_6 msEMS_6;          // no
  Message FRSD0_Powertrain_CAN::EMS_7 msEMS_7;


    int engine_state, stop_condition, crank_condition, engir
```



Test Overview

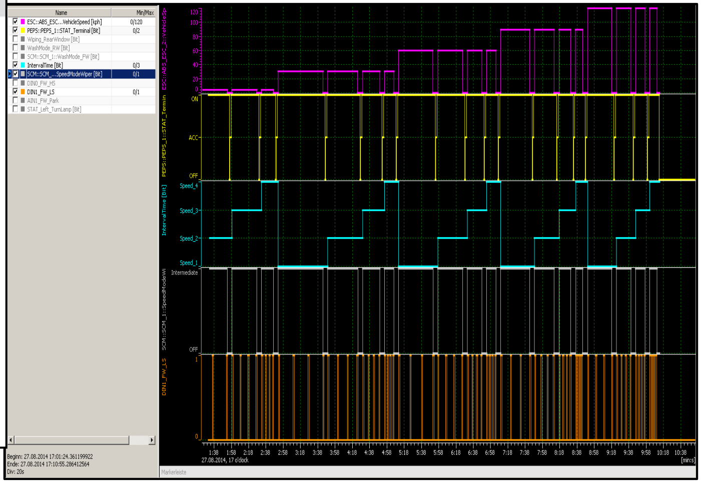
Test begin: 2014-08-27 16:59:40 (logging timestamp 1.5070)
Test end: 2014-08-27 17:10:14 (logging timestamp 635.3947)

Statistics

Overall number of test cases	20	
Executed test cases	20	100% of all test cases
Not executed test cases	0	0% of all test cases
Test cases passed	20	100% of executed test cases
Test cases failed	0	0% of executed test cases

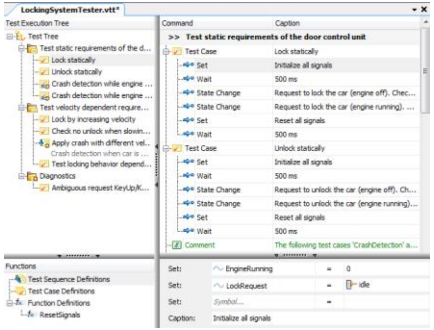
Test Case Results

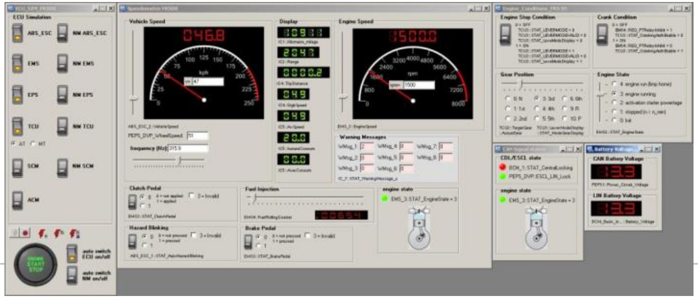
1	FRS_AFC_FWP_018	Lever in intermittent mode position with interval mode 1 and speed class 0	pass
2	FRS_AFC_FWP_018	Lever in intermittent mode position with interval mode 2 and speed class 0	pass
3	FRS_AFC_FWP_018	Lever in intermittent mode position with interval mode 3 and speed class 0	pass
4	FRS_AFC_FWP_018	Lever in intermittent mode position with interval mode 4 and speed class 0	pass
5	FRS_AFC_FWP_018	Lever in intermittent mode position with interval mode 1 and speed class 1	pass
6	FRS_AFC_FWP_018	Lever in intermittent mode position with interval mode 2 and speed class 1	pass
7	FRS_AFC_FWP_018	Lever in intermittent mode position with interval mode 3 and speed class 1	pass
8	FRS_AFC_FWP_018	Lever in intermittent mode position with interval mode 4 and speed class 1	pass
9	FRS_AFC_FWP_018	Lever in intermittent mode position with interval mode 1 and speed class 2	pass
10	FRS_AFC_FWP_018	Lever in intermittent mode position with interval mode 2 and speed class 2	pass
11	FRS_AFC_FWP_018	Lever in intermittent mode position with interval mode 3 and speed class 2	pass
12	FRS_AFC_FWP_018	Lever in intermittent mode position with interval mode 4 and speed class 2	pass
13	FRS_AFC_FWP_018	Lever in intermittent mode position with interval mode 1 and speed class 3	pass
14	FRS_AFC_FWP_018	Lever in intermittent mode position with interval mode 2 and speed class 3	pass
15	FRS_AFC_FWP_018	Lever in intermittent mode position with interval mode 3 and speed class 3	pass
16	FRS_AFC_FWP_018	Lever in intermittent mode position with interval mode 4 and speed class 3	pass



Hardware In the Loop - Tools used

- **vTESTstudio** - development environment for creating automated ECU tests
- **CANoe** - software tool for development, test, and analysis of entire ECU networks and individual ECUs (LINK)
- **VT System** - Modular Test Hardware comprising bus interfaces, measurement modules, stimulation modules, relay modules…





Laboratory exercise 28/10/22

Preparation

Lab Exercise overview

- Meet 28/10 at Magna Steyr Main Entry Liebenauer Hauptstr.317 at 11.30
  - Be on time, access takes a while!
- Lab time 12.00h-16.00h (approx.)
- Contents: 4 exercise parts
- Tools used: CANoe, Measurement equipment (all onsite)
- Please bring your own laptop and USB stick for notes, save CAN-Traces etc.

MAGNA

Magna Steyr

Confidential

Graz

This form is assigned to AAE00038 „Berichte im Engineering".

Test Report

Project:	Report No.:	Serial No.: –	Index Code: /	Pages:	Date (dd.mm.yyyy):
R&D Center:	Order No.:	Test Object:	Report: is complete	Test target accomplished: yes	
Execution Unit: Please Choose			Comments:		
Special Subject: 0000-9999 Complete Vehicle					
Reference:			(*) Relevant for strength ☐ Relevant for Homologation ☐		
Chief Engineer	Head of Department	FTE resp. ITL:		(*)	
Copy:					
Distribute 2 hardcopies to the EM office ☐ for the customer					

Task

Summary, assessment

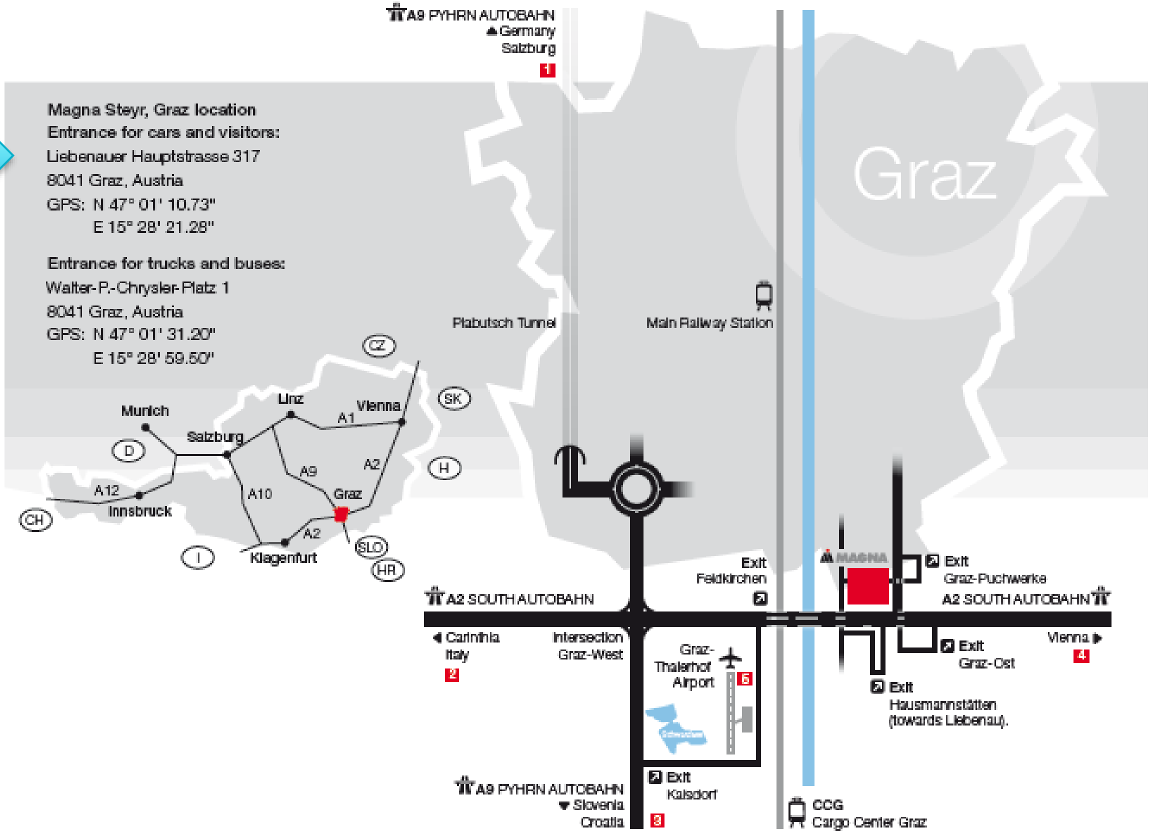
Proposals, further procedures

The exercises must be documented in a test report

<u>Due date test reports 04/11 (will be part of grading)</u>

Template provided via moodle

Directions

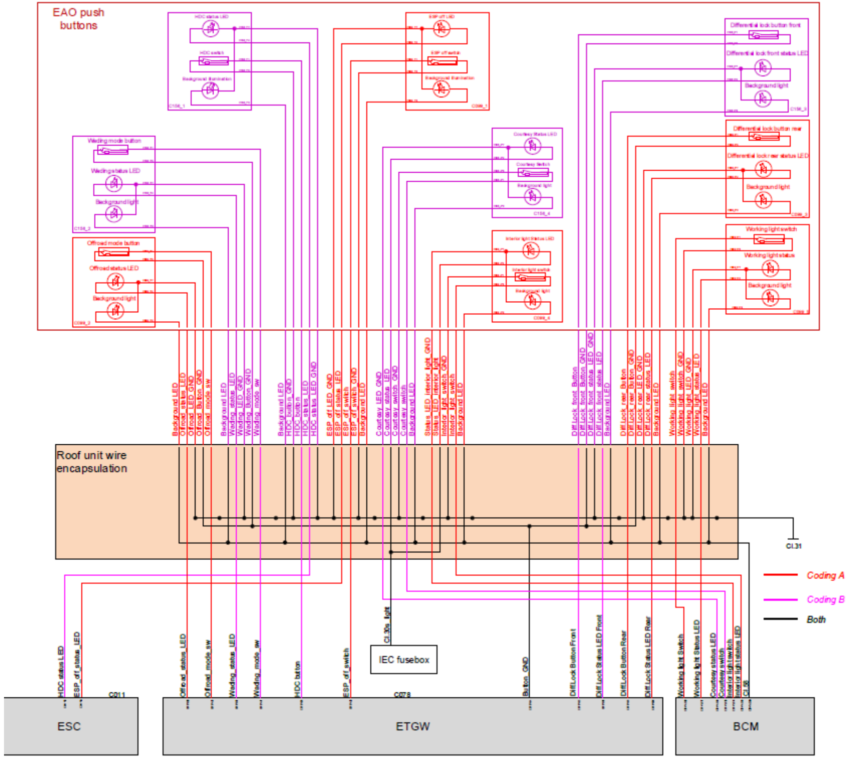


Magna Steyr, Graz location
Entrance for cars and visitors:
Liebenauer Hauptstrasse 317
8041 Graz, Austria
GPS: N 47° 01' 10.73"
E 15° 28' 21.28"
Entrance for trucks and buses:
Walter-P.-Chrysler-Platz 1
8041 Graz, Austria
GPS: N 47° 01' 31.20"
E 15° 28' 59.50"
A9 PYHRN AUTOBAHN
Germany
Salzburg
1
Graz
Plabutsch Tunnel
Main Railway Station
CZ
SK
H
D
CH
I
SLO
HR
Munich
Salzburg
Linz
Vienna
A1
A9
A2
A10
A12
Innsbruck
Graz
Klagenfurt
Exit
Feldkirchen
MAGNA
Exit
Graz-Puchwerke
A2 SOUTH AUTOBAHN
A2 SOUTH AUTOBAHN
Carinthia
Italy
2
Intersection
Graz-West
Graz-
Thalerhof
Airport
5
Exit
Graz-Ost
Vienna
4
Exit
Hausmannstätten
(towards Liebenau).
A9 PYHRN AUTOBAHN
Slovenia
Croatia
3
Exit
Kalsdorf
CCG
Cargo Center Graz

Roof Console

SYSTEM-SCHEMATICS of Roof Console

Task 1: Connect all the buttons on the Roof Console to the wiring harness and check the correct pinning according the system schematics



Find this document on USB drive :

RoofPannelPinning.pdf

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Check the functionality of the Roof-panel switches on CHASSY-CAN:

→ For following switches there is no CAN signal available, therefore it is only possible to check the correct pinning or the functionality itself : ESP-,HDC-,Curtesy-,Iterior light- Button

1551.944691 197 ETGW_CH	ETGW_ST_OFFROAD	CHCAN
CRC_ETGW_ST_OFFROAD	229	DataID=136dez.
ALIVE_ETGW_ST_OFFROAD	3	Alive counter roll
ST_RANGE	Low Range	Status LowGear
QU_RANGE	No fault	Qualifier LowGea
DRV_MOD	Onroad Mode	Status Driving M
ST_4L_Sens	Open	Status LowGear :
ST_4H_Sens	Open	Status HighGear
ST_CENTERDIFFLOCK_Sens	Open	Status CenterDif
STAT_DIFFLOCK_R_Relay_ETGW	OFF	Status Difflock R
ST_DIFFLOCK_CD	Signal invalid	Status Center Di
QU_ST_DIFFLOCK_CD	Undefined CD. Position unknown due to…	Qualifier Center I
STAT_DIFFLOCK_F_Button_ETGW	Not pressed	Status Difflockbu
STAT_DIFFLOCK_R_Button	Not pressed	Status Difflockbu
STAT_DIFFLOCK_R	RD engaged	Status of Rear D
QU_ST_DIFFLOCK_R	No fault	Qualifier Rear Di
STAT_DIFFLOCK_F	FD engaged	Status of Front D
QU_ST_DIFFLOCK_F	No fault	Qualifier Front Di
REQ_DIFFLOCK_F_Relay	Open Difflock Relay Front	Request to close
QU_REQ_DIFFLOCK_F_Relay	Request is invalid	Qualitifier for Rel
STAT_DIFFLOCK_F_EnergCurr	FD Coil not energized	Energizing Curre
STAT_DIFFLOCK_R_EnergCurr	RD Coil not energized	Energizing Curre
STAT_OFFROAD_Button	Offroad mode button not pressed	Signal about Off
STAT_WADING_Button	Wading mode button not pressed	Signal about Wa

2028.906537 109 BCM_CH	BCM_SWITCH_STATUS
CHKSM_BCM_SWITCH_STATUS	172
ALIV_BCM_SWITCH_STATUS	12
STAT_HazardWarn	Not active
STAT_BrakeLightSwitchBCM	Brakel Light Switch not pressed
STAT_ClutchPedalBCM	Not applied
STAT_Horn	not active
STAT_ESS_Deactivation	Not active
STAT_WorkingLight_Button	Not Pressed
STAT_FuelPumpCutOFF	Not active
STAT_DIFFLOCK_F_Relay_BCM	OFF
STAT_DIFFLOCK_F_Button_BCM	OFF
STAT_BLTS_BCM_Mon	No failure

CAN-Communication

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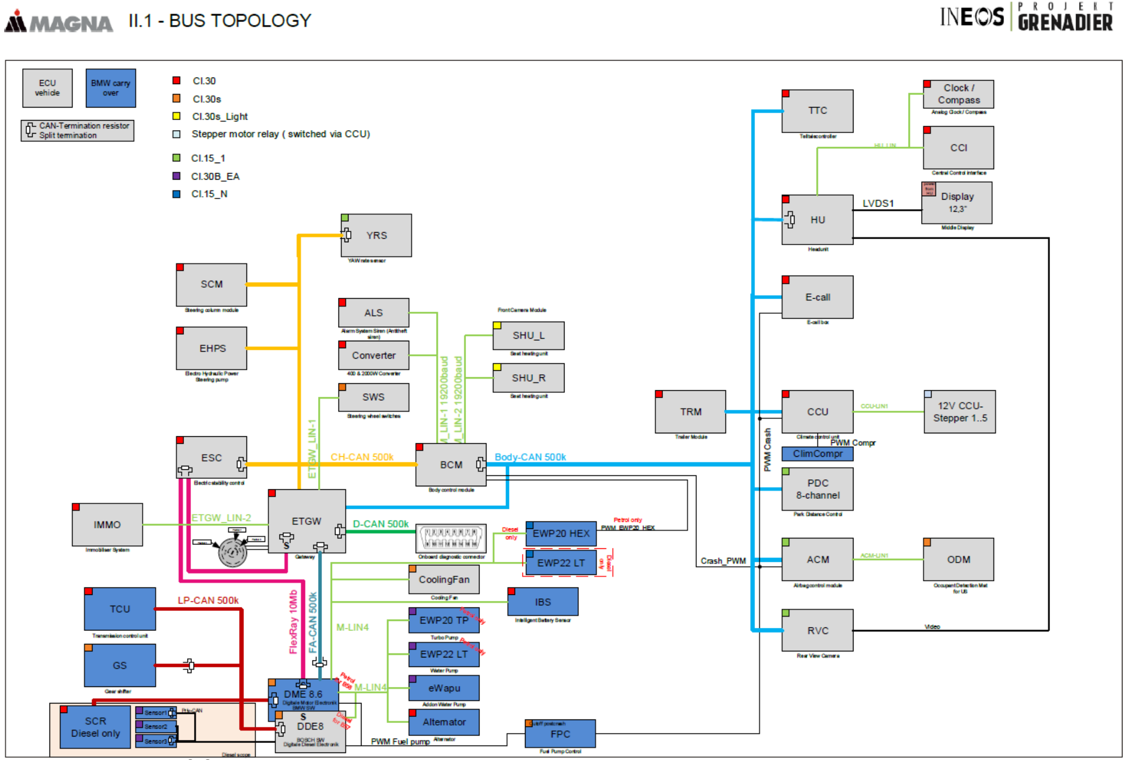
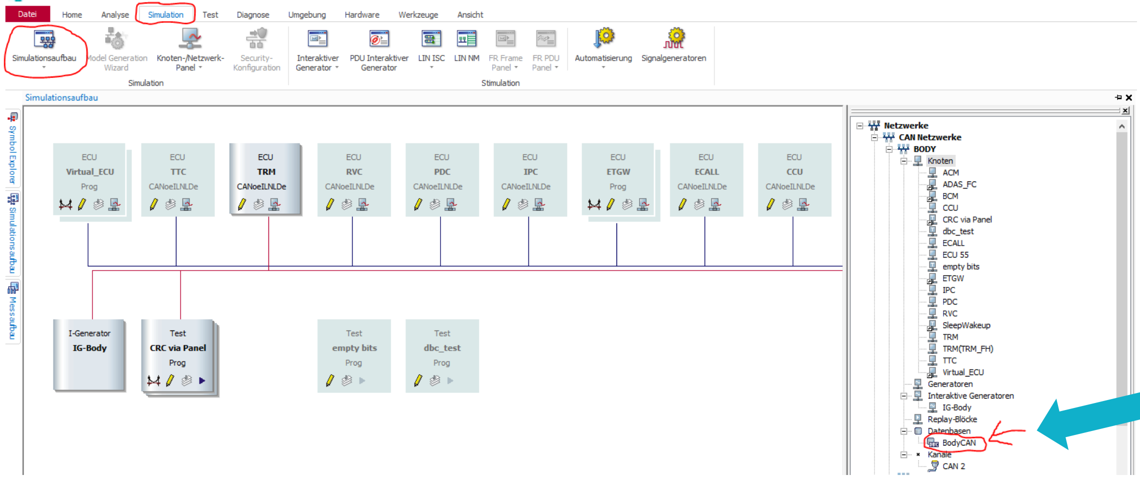
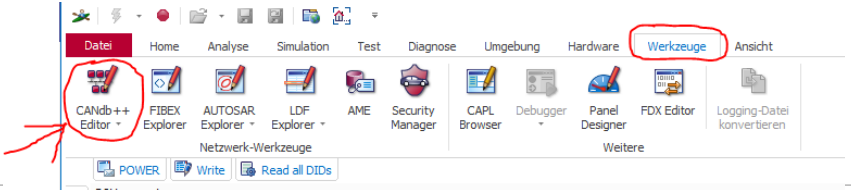
Overview Complete Architecture





Including the .dbc file

How to find the CAN database:



CAN-Database/Matrix → .dbc

Task 2: Check the CAN-communication according the .dbc file for the BODY- and CHASSY-CAN network:

[BODY-CAN:]

1.) Check the CAN for error-messages(are shown in red color in CANoe) (why?)

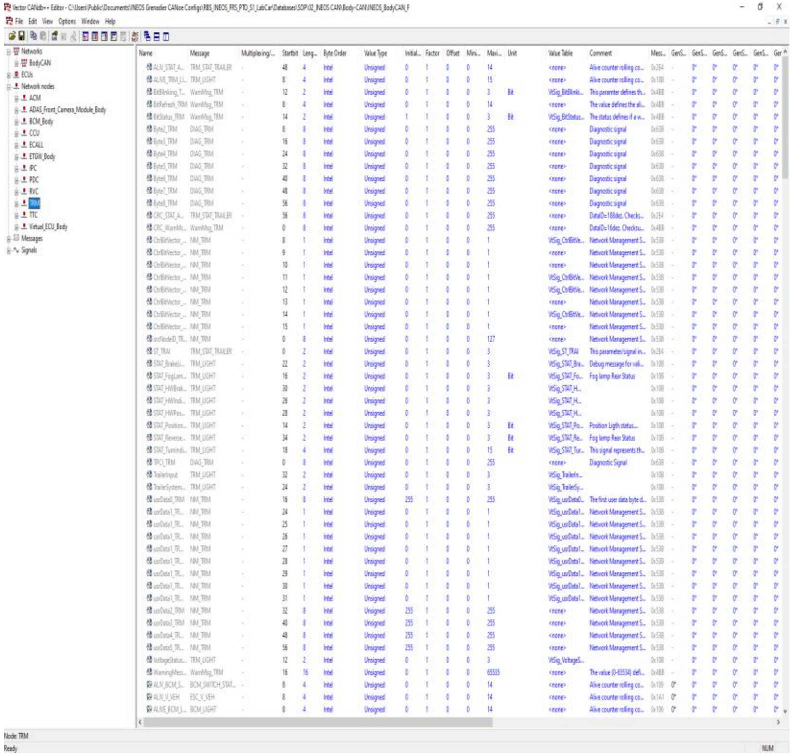
2.) Check if all nodes are sending on CAN network

(If not why?)

3.) Search for CAN ID: 3FA on the active Bus network(Body-CAN) → (Is it sending correctly?)

[CHASSY-CAN]

4.) Check the cycle times of all messages transmitted from BCM



All .dbc files also provided on USB drive

SIMULATION

Simulation of a disconnected ECU

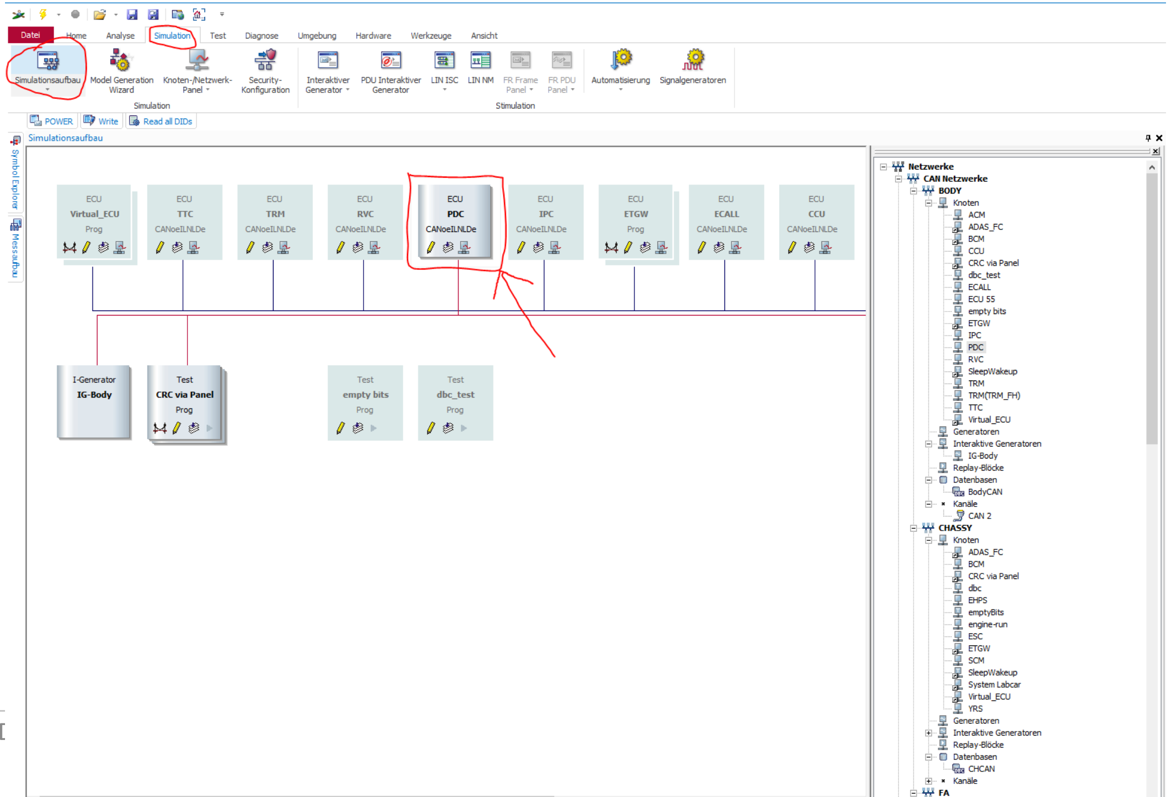
Task 3:

1.)

Disconnect the PDC(**P**ark**D**istance**C**ontrol) unit from wiring harness.

2.)

Activate the PDC simulation node and start the measurement



Check if the Simulation works correctly

BODY-CAN

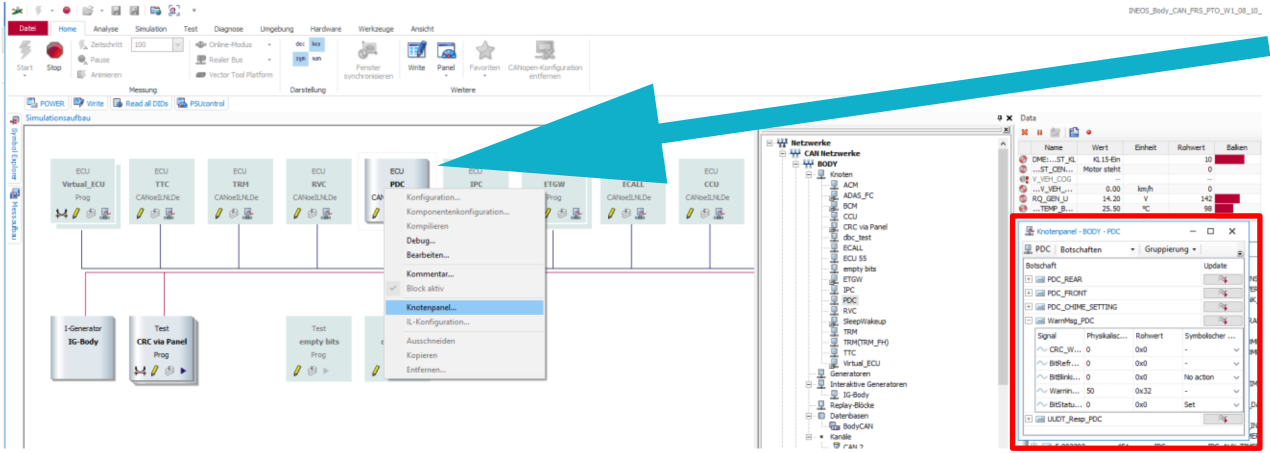
<Suche> Initial

Time	ID	Sender ...	Name	Database	Chn	Dir	Data	DLC
0.099421	389	IPC	IC_PHOTOSENSOR	BodyCAN	CAN 2	Rx	00	1
0.099591	3B4	IPC	IPC_ST_POWER	BodyCAN	CAN 2	Rx	FF FF FF FF FF FF FF FF	8
0.200011	3EE	IPC	IC_RAW_TANK_DATA	BodyCAN	CAN 2	Rx	E2 03	2
0.640004	503	IPC	NM_IC	BodyCAN	CAN 2	Rx	03 00 FF 24 00 00 00 00	8
1.000905	2C9	IPC	IPC_TEMP_TRANSFER_CASE	BodyCAN	CAN 2	Rx	FF	1
0.999827	329	IPC	IC_ODO	BodyCAN	CAN 2	Rx	52 FC A6 11 F0	5
0.499541	3F3	IPC	IC_BORD_COMP_TRIP_A	BodyCAN	CAN 2	Rx	FF FF FF FF 00 00 FE	7
0.499533	3F4	IPC	IC_BORD_COMP_TRIP_B	BodyCAN	CAN 2	Rx	FF FF FF FF 00 00 FE	7
1.000001	411	IPC	IPC_DISP	BodyCAN	CAN 2	Rx	12 0E 04	3
1.000001	483	IPC	WarnMsg_IC	BodyCAN	CAN 2	Rx	FD 40 DC 02	4
0.999998	328	IPC	IC_RELATIVTIME	BodyCAN	CAN 2	Rx	76 07 8D 00 6A 00	[illegible]
5.001825	285	IPC	IC_UNIT	BodyCAN	CAN 2	Rx	01 00 80	3
5.000752	2F8	IPC	IC_UHRZEIT_DATUM	BodyCAN	CAN 2	Rx	09 17 23 05 17 E4 07 F0	8
5.000326	390	IPC	IC_DIMMING	BodyCAN	CAN 2	Rx	46 FF FF FF	4
5.000326	3EF	IPC	IC_SERVICE_INTERV	BodyCAN	CAN 2	Rx	7C 3A A[illegible] FF	8
5.000326	450	IPC	IPC_AUX_TIMER_1_2	BodyCAN	CAN 2	Rx	EB 0[illegible] 00 00	8
5.000318	451	IPC	IPC_AUX_TIMER_3_4	BodyCAN	CAN 2	Rx	D[illegible] 00 00	8
10.002277	330	IPC	IC_MILEAGE	BodyCAN	CAN 2	Rx	[illegible] 02 00 00 FD FF	8
10.001006	5E0	IPC	IC_SVC_Kombi	BodyCAN	CAN 2	Rx	01 00 00 FF FF FF FF FF	8
0.049961	290	PDC	PDC_REAR	BodyCAN	CAN 2	Tx	02 00 00	3
0.049807	291	PDC	PDC_FRONT	BodyCAN	CAN 2	Tx	02 00 00	3
0.050113	293	PDC	PDC_CHIME_SETTING	BodyCAN	CAN 2	Tx	02 00 00	3
1.000261	486	PDC	WarnMsg_PDC	BodyCAN	CAN 2	Tx	8E 4D 00 00	4
1.000183	490	TTC	WarnMsg_TTC	BodyCAN	CAN 2	Rx	4F 05 FA 02	4
0.200233	3D4	TTC	TTC_STATUS_A_B	BodyCAN	CAN 2	Rx	93 43 84 00 7C 44 15 F0	8
0.200235	3D5	TTC	TTC_STATUS_C	BodyCAN	CAN 2	Rx	7F 03 85 01 FE	5
0.640018	510	TTC	NM_TTC	BodyCAN	CAN 2	Rx	10 40 FF 00 FF FF FF FF	8
0.500162	3D0	TTC	TTC_STAT_SOUND	BodyCAN	CAN 2	Rx	08 0A 00 00 FC	5
0.499980	2F1	TTC	TTC_STAT_ABAG	BodyCAN	CAN 2	Rx	A6 1A F8	3

3.)

Tx→ means that those messages are transmitted by our simulation

Simulation of a Warning which should be shown to the driver



4.)

Do a ‚right click' on the actual simulated PDC node and open the node-panel (Knotenpanel)

5.)

Simulate the warning ID:50 and send it with „SET" to activate and „RESET" to deactivate the warning message

Check if the warning gets displayed correctly to the driver

1.)
The warning must be added to the list (Active warning message menu)

2.)
On IPC(Instrument Panel Cluster) part, all the warnings from the list must get displayed intermittened

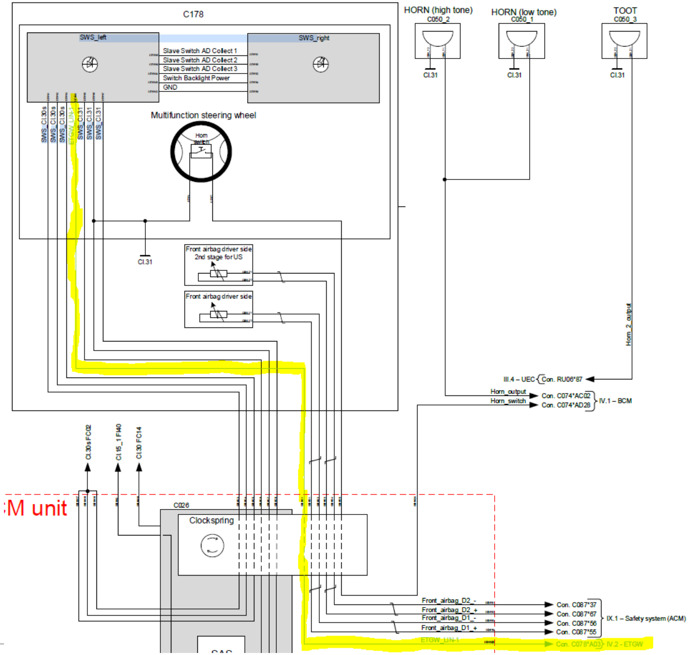
Settings → Vehicle Functions→ Vehicle Information→Active warning and Status Messages

Problem finding

Component Data Sheet CDS

Task 4: After an Gateway software update, the functionality of the Steering wheel switches is not given anymore. The SWS (**S**teering **W**heel **S**witches) worked correctly before the SW update.

Gateway ECU (ETGW)



Schematics of the SWS circuit provided on USB drive

Discuss together:

1.) What could lead to the problem?
2.) What can be done to find out the root cause?

ENGINEERING

Component Data Sheet CDS

Current implementation:

Socket Number	Pin Number	I/O Type	Clamp Definition	Signal Definition	Drive Definition - High/LowSide/PWM - int. Relay	wire size mm^2	Crimp Conntact
	1	BUS	LIN1	Steering wheel switches	20kBd Masternode wakeup	0.5	MQS (0.5-0.75mm2)
	2	BUS	LIN2	Immobilizer	20kBd Masternode wakeup	0.5	MQS (0.5-0.75mm2)
	3						
	4	BUS	LIN3		20kBd Masternode wakeup	0.5	MQS (0.5-0.75mm2)
	5	BUS	LIN4		20kBd Masternode wakeup	0.5	MQS (0.5-0.75mm2)
	6						
	7	I/O_IN	Hall1PWMK	4H/L hall PWMK	Lowside 5V PWM	0.35	MQS (0.25-0.35mm2)
	8	I/O_IN	Hall1PWW	4H/L hall PWM	Lowside 5V PWM	0.35	MQS (0.25-0.35mm2)
	9	I/O_IN	Hall2PWMK	center diff.lock hall PWMK	Lowside 5V PWM	0.35	MQS (0.25-0.35mm2)
	10	I/O_IN	Hall2PWM	center diff.lock hall PWM	Lowside 5V PWM	0.35	MQS (0.25-0.35mm2)
	11	I/O_IN	Hall3PWMK		Lowside 5V PWM	0.35	MQS (0.25-0.35mm2)
	12	I/O_IN	Hall3PWM		Lowside 5V PWM	0.35	MQS (0.25-0.35mm2)
	13						
	14	ANALOG_GND	AGND1	analog GND buttons		0.35	MQS (0.25-0.35mm2)
	15	I/O_IN	AIM1	front diff.lock button	Lowside 5V ADC	0.35	MQS (0.25-0.35mm2)
	16	I/O_IN	AIM2	rear diff.lock button	Lowside 5V ADC	0.35	MQS (0.25-0.35mm2)
	17	I/O_IN	AIM3	wading mode button	Lowside 5V ADC	0.35	MQS (0.25-0.35mm2)
	18	I/O_IN	AIM4	offroad mode button	Lowside 5V ADC	0.35	MQS (0.25-0.35mm2)
	19						
	20						
	21						
	22						
	23	DIGITAL_GND	DGND1	digital GND 4H/L hall		0.35	MQS (0.25-0.35mm2)
	24	I/O_OUT	Hall1+	supply 4H/L hall	Highside CV 5V	0.35	MQS (0.25-0.35mm2)
	25	DIGITAL_GND	DGND2	digital GND center diff.lock hall		0.35	MQS (0.25-0.35mm2)
	26	I/O_OUT	Hall2+	supply center diff.lock hall	Highside CV 5V	0.35	MQS (0.25-0.35mm2)
A	27	I/O_OUT	Hall3+		Highside CV 5V	0.35	MQS (0.25-0.35mm2)
	28						
	29	I/O_IN	AIPM1	coolant level sensor 1	High/Lowside GND/30BL/5V ADC/PWM	0.35	MQS (0.25-0.35mm2)
	30	I/O_IN	AIPM2	coolant level sensor 2	High/Lowside GND/30BL/5V ADC/PWM	0.35	MQS (0.25-0.35mm2)
	31	I/O_IN	AIPM3		High/Lowside GND/30BL/5V ADC/PWM	0.35	MQS (0.25-0.35mm2)
	32	I/O_IN	AIPM4		High/Lowside GND/30BL/5V ADC/PWM	0.35	MQS (0.25-0.35mm2)
	33	ANALOG_GND	AGND2			0.35	MQS (0.25-0.35mm2)
	34	I/O_IN	AIM7		Lowside 5V ADC	0.35	MQS (0.25-0.35mm2)
	35	I/O_IN	AIM6	ESP button	Lowside 5V ADC	0.35	MQS (0.25-0.35mm2)
	36	I/O_IN	AIM5	HDC button	Lowside 5V ADC	0.35	MQS (0.25-0.35mm2)
	37						
	38						
	39	I/O_IN	DIM5	handbrake switch NC	Lowside CC 30BL wakeup	0.35	MQS (0.25-0.35mm2)

Implementation with new Gateway Software

Socket Number	Pin Number	I/O Type	Clamp Definition	Signal Definition	Drive Definition - High/LowSide/PWM - int. Relay	wire size mm^2	Crimp Conntact
	1	BUS	LIN1	reserved, not needed	20kBd Masternode wakeup	0.5	MQS (0.5-0.75mm2)
	2	BUS	LIN2	Immobilizer	20kBd Masternode wakeup	0.5	MQS (0.5-0.75mm2)
	3	BUS	LIN5	Steering wheel switches	20kBd Masternode wakeup	0.5	MQS (0.5-0.75mm2)
	4	BUS	LIN3	reserved, not needed	20kBd Masternode wakeup	0.5	MQS (0.5-0.75mm2)
	5	BUS	LIN4	reserved, not needed	20kBd Masternode wakeup	0.5	MQS (0.5-0.75mm2)
	6						
	7	I/O_IN	Hall1PWMK	4H/L hall PWMK	Lowside 5V PWM	0.35	MQS (0.25-0.35mm2)
	8	I/O_IN	Hall1PMW	4H/L hall PWM	Lowside 5V PWM	0.35	MQS (0.25-0.35mm2)
	9	I/O_IN	Hall2PWMK	center diff.lock hall PWMK	Lowside 5V PWM	0.35	MQS (0.25-0.35mm2)
	10	I/O_IN	Hall2PWM	center diff.lock hall PWM	Lowside 5V PWM	0.35	MQS (0.25-0.35mm2)
	11	I/O_IN	Hall3PWMK	reserved, not needed	Lowside 5V PWM	0.35	MQS (0.25-0.35mm2)
	12	I/O_IN	Hall3PWM	reserved, not needed	Lowside 5V PWM	0.35	MQS (0.25-0.35mm2)
	13						
	14	ANALOG_GND	AGND1	analog GND buttons		0.35	MQS (0.25-0.35mm2)
	15	I/O_IN	AIM1	front diff.lock button	Lowside 5V ADC	0.35	MQS (0.25-0.35mm2)
	16	I/O_IN	AIM2	rear diff.lock button	Lowside 5V ADC	0.35	MQS (0.25-0.35mm2)
	17	I/O_IN	AIM3	wading mode button	Lowside 5V ADC	0.35	MQS (0.25-0.35mm2)
	18	I/O_IN	AIM4	offroad mode button	Lowside 5V ADC	0.35	MQS (0.25-0.35mm2)
	19	BUS	CAN6P	Station Wagon -> reserved Pickup GSR -> HMI-CAN high	2Mbit/s 120R-Termination wakeup	0.35	MQS (0.25-0.35mm2)
	20						
	21	BUS	LIN6	reserved, not needed	20kBd Masternode wakeup	0.5	MQS (0.5-0.75mm2)
	22	BUS	LIN7	reserved, not needed	20kBd Masternode wakeup	0.5	MQS (0.5-0.75mm2)
	23	DIGITAL_GND	DGND1	digital GND 4H/L hall		0.35	MQS (0.25-0.35mm2)
	24	I/O_OUT	Hall1+	supply 4H/L hall	Highside CV 5V	0.35	MQS (0.25-0.35mm2)
	25	DIGITAL_GND	DGND2	digital GND center diff.lock hall		0.35	MQS (0.25-0.35mm2)
	26	I/O_OUT	Hall2+	supply center diff.lock hall	Highside CV 5V	0.35	MQS (0.25-0.35mm2)
A	27	I/O_OUT	Hall3+	reserved, not needed	Highside CV 5V	0.35	MQS (0.25-0.35mm2)
	28						
	29	I/O_IN	AIPM1	coolant level sensor 1	High/Lowside GND/30BL/5V ADC/PWM	0.35	MQS (0.25-0.35mm2)
	30	I/O_IN	AIPM2	coolant level sensor 2	High/Lowside GND/30BL/5V ADC/PWM	0.35	MQS (0.25-0.35mm2)
	31	I/O_IN	AIPM3	reserved, not needed	High/Lowside GND/30BL/5V ADC/PWM	0.35	MQS (0.25-0.35mm2)
	32	I/O_IN	AIPM4	reserved, not needed	High/Lowside GND/30BL/5V ADC/PWM	0.35	MQS (0.25-0.35mm2)
	33	ANALOG_GND	AGND2	reserved, not needed		0.35	MQS (0.25-0.35mm2)
	34	I/O_IN	AIM7	reserved, not needed	Lowside 5V ADC	0.35	MQS (0.25-0.35mm2)
	35	I/O_IN	AIM6	ESP button	Lowside 5V ADC	0.35	MQS (0.25-0.35mm2)
	36	I/O_IN	AIM5	HDC button	Lowside 5V ADC	0.35	MQS (0.25-0.35mm2)
	37	BUS	CAN6N	Station Wagon -> reserved Pickup GSR -> HMI-CAN low	2Mbit/s 120R-Termination wakeup	0.35	MQS (0.25-0.35mm2)
	38						
	39	I/O_IN	DIM5	handbrake switch NC	Lowside CC 30BL wakeup	0.35	MQS (0.25-0.35mm2)