EXTID-199 - Subsystem Responsible: Franz Kufner

EXTID-200 - Subsystem engine cooling and lubrication (SECLU) is partitioned into two main parts: 1) Engine Temperature (ENTE) The main objective of the AGGR ENTE is control of the temperature of the combustion engine. This is handled by: - measurement of engine temperature (cooling water temperature) with sensors - control of water flow in cooling water circuits via pumps and valves - control of cooling of engine via fans and radiator shutters For each of the sensors/actuators diagnostics are provided. 2) Engine Lubrication (ENLU) The main objective of the AGGR ENLU is lubrication/cooling of the combustion engine and service interval calculation for engine oil. This is handled by: - measurement/modeling of oil temperature with sensor or by model - control of the oil pressure via oil pump - control of piston cooling via valve - calculation of time/distance until next oil change For each of the sensors/actuators diagnostics are provided.

EXTID-201 - In the engine cooling and lubrication control design specification, the architecture and the project specific configuration are illustrated. The architecture describes the used components and their interfaces, which are needed in order to respect the project specific design requirements and stakeholder requests. The correct function and the fulfillment of the engine cooling and lubrication control requirement specification can only be guaranteed when the following is fulfilled: - the configuration of the engine cooling and lubrication design specification is correctly applied - the component fulfills his requirement specification and - the correct function of all interfaces is verified

EXTID-202 - Project configuration: The project configuration defines the components of the subsystem element SECLU includes the application SW Components: ENTE = Engine Temperature (legacy naming - this is the ASW component for handling all powertrain temperature / thermal features independent of powertrain type combustion/hybrid/electric) abbreviationcomponentcomponent identifier C-Ssoftware consisting of ASWENTE BSWdifferent BSW firmware C-Eelectric componentCECU17 MC: micro controllerTC3xx ESC: electrical circuit for sensorsHW circuit C-SENSengine tempreatureLIN: cooler jalousie/ roller blind PWM: water pumps PWM: cooling fans LIN: Proportional mixing valve analog: Temperature sensors digital: switching valve (3/2 way valve) SENT: differential pressure sensors

EXTID-203 - Project configuration: The project configuration defines the components of the subsystem element

EXTID-204 - Project configuration: The project configuration defines the components of the subsystem element

EXTID-205 - Electrical interfaces and electrical diagnosis: The electrical interfaces define the nomenclature and the connection of the electrical circuits of the component electronic (ECU) with the electrical sensor respectively actuator components. In addition the requirements on the electrical connection (WH) are specified here. The resistances of the electrical interfaces shall not exceed the values below for a temperature of 20 °C. The measured values shall include the resistances of the connector pins of the component electronic (ECU) and the related connector pins of the sensors. Interface nameComponentSensor/Actuator typePin of control module e_ECF1_12VEngine Coolant Fan 1 - 12 Volt Analog e_ECF1_cgndEngine Coolant Fan 1 - Chassis Ground e_ECF2_12VEngine Coolant Fan 2 - 12 Volt Analog e_ECF2_cgndEngine Coolant Fan 2 - Chassis Ground e_ECP1_12VEngine Coolant Pump (electrical) 1 - 12 Volt Analog e_ECP1_actLoEngine Coolant Pump (electrical) 1 - Activation Low PWME43 e_ECP2_12VEngine Coolant Pump (electrical) 2 - 12 Volt Analog e_ECP2_actLoEngine Coolant Pump (electrical) 2 - Activation Low PWME48 e_ECP3_12VEngine Coolant Pump (electrical) 3 - 12 Volt Analog e_ECP3_actLoEngine Coolant Pump (electrical) 3 - Activation Low PWMB23D53 e_EOPT1_cgndEngine Oil Pressure Threshold Sensor 1 - Chassis Ground e_EOPT1_sigEngine Oil Pressure Threshold Sensor 1 - Signal DigitalC03 e_EOPT2_cgndEngine Oil Pressure Threshold Sensor 2 - Chassis Ground e_EOPT2_sigEngine Oil Pressure Threshold Sensor 2 - Signal DigitalC14 e_EOPT3_cgndEngine Oil Pressure Threshold Sensor 3 - Chassis Ground e_EOPT3_sigEngine Oil Pressure Threshold Sensor 3 - Signal DigitalC22 e_EOPV1_actHiEngine Oil Pressure Valve 1 - Activation High PWMC35 e_EOPV1_cgndEngine Oil Pressure Valve 1 - Chassis Ground e_EOPV2_actHiEngine Oil Pressure Valve 2 - Activation High DigitalC39 e_EOPV2_cgndEngine Oil Pressure Valve 2 - Chassis Ground e_LT-EOiT_12VLevel, Temperature Sensor - Engine Oil inside Tank - 12 Volt Analog e_LT-EOiT_cgndLevel, Temperature Sensor - Engine Oil inside Tank - Chassis Ground e_LT-EOiT_sigLevel, Temperature Sensor - Engine Oil inside Tank - Signal ComplexB10 e_RECV_5VRotary Engine Coolant Valve - 5 Volt AnalogA17 e_RECV_actHiRotary Engine Coolant Valve - Activation High PWMA50 e_RECV_actLoRotary Engine Coolant Valve - Activation Low PWMA49 e_RECV_gndRotary Engine Coolant Valve - Ground AnalogA09 e_RECV_sigRotary Engine Coolant Valve - Signal SENTA13 e_RS1_12VRadiator Shutter 1 - 12 Volt Analog e_RS1_cgndRadiator Shutter 1 - Chassis Ground e_T-ECdR1_gndTemperature Sensor - Engine Coolant downstream Radiator 1 - Ground AnalogD31 e_T-ECdR1_sigTemperature Sensor - Engine Coolant downstream Radiator 1 - Signal AnalogD25 e_T-ECiCH_gndTemperature Sensor - Engine Coolant inside Cylinder Head - Ground AnalogC28 e_T-ECiCH_sigTemperature Sensor - Engine Coolant inside Cylinder Head - Signal AnalogC27 e_T-ECuR2_gndTemperature Sensor - Engine Coolant upstream Radiator 2 - Ground AnalogD41 e_T-ECuR2_sigTemperature Sensor - Engine Coolant upstream Radiator 2 - Signal AnalogD35 e_TCV_actHiTransmission Coolant Valve - Activation High DigitalE52 e_TCV_cgndTransmission Coolant Valve - Chassis Ground Remark: The values are taken from general experience with sensor wiring. The signal quality is a part of the overall performance documented in the requirement specification. Thus, special attention must focus on avoiding signal interferences.

EXTID-206 - Electrical interfaces and electrical diagnosis: The electrical interfaces define the nomenclature and the connection of the electrical circuits of the component

electronic (ECU) with the electrical sensor respectively actuator components. In addition the requirements on the electrical connection (WH) are specified here. The resistances of the electrical interfaces shall not exceed the values below for a temperature of 20 °C. The measured values shall include the resistances of the connector pins of the component electronic (ECU) and the related connector pins of the sensors. Interface nameComponent abbreviationComponentSensor/Actuator typePin of control module e_ECF1_12VECF1Engine Coolant Fan 1 - 12 Volt Analog e_ECF1_actHiECF1Engine Coolant Fan 1 - Activation High PWME45 e_ECF1_cgndECF1Engine Coolant Fan 1 - Chassis Ground e_ECF2_12VECF2Engine Coolant Fan 2 - 12 Volt Analog e_ECF2_actHiECF2Engine Coolant Fan 2 - Activation High PWME46 e_ECF2_cgndECF2Engine Coolant Fan 2 - Chassis Ground e_ECP1_12VECP1Engine Coolant Pump (electrical) 1 - 12 Volt Analog e_ECP1_actLoECP1Engine Coolant Pump (electrical) 1 - Activation Low PWME43 e_ECP2_12VECP2Engine Coolant Pump (electrical) 2 - 12 Volt Analog e_ECP2_actLoECP2Engine Coolant Pump (electrical) 2 - Activation Low PWME48 e_ECP3_12VECP3Engine Coolant Pump (electrical) 3 - 12 Volt Analog e_ECP3_actLoECP3Engine Coolant Pump (electrical) 3 - Activation Low PWMB23D53 e_EOPT1_cgndEOPT1Engine Oil Pressure Threshold Sensor 1 - Chassis Ground e_EOPT1_sigEOPT1Engine Oil Pressure Threshold Sensor 1 - Signal DigitalC03 e_EOPT2_cgndEOPT2Engine Oil Pressure Threshold Sensor 2 - Chassis Ground e_EOPT2_sigEOPT2Engine Oil Pressure Threshold Sensor 2 - Signal DigitalC14 e_EOPT3_cgndEOPT3Engine Oil Pressure Threshold Sensor 3 - Chassis Ground e_EOPT3_sigEOPT3Engine Oil Pressure Threshold Sensor 3 - Signal DigitalC22 e_EOPV1_actHiEOPV1Engine Oil Pressure Valve 1 - Activation High PWMC35 e_EOPV1_cgndEOPV1Engine Oil Pressure Valve 1 - Chassis Ground e_EOPV2_actHiEOPV2Engine Oil Pressure Valve 2 - Activation High DigitalC39 e_EOPV2_cgndEOPV2Engine Oil Pressure Valve 2 - Chassis Ground e_LT-EOiT_12VLT-EOiTLevel, Temperature Sensor - Engine Oil inside Tank - 12 Volt Analog e_LT-EOiT_cgndLT-EOiTLevel, Temperature Sensor - Engine Oil inside Tank - Chassis Ground e_LT-EOiT_sigLT-EOiTLevel, Temperature Sensor - Engine Oil inside Tank - Signal ComplexB10 e_RECV_5VRECVRotary Engine Coolant Valve - 5 Volt AnalogA17 e_RECV_actHiRECVRotary Engine Coolant Valve - Activation High PWMA50 e_RECV_actLoRECVRotary Engine Coolant Valve - Activation Low PWMA49 e_RECV_gndRECVRotary Engine Coolant Valve - Ground AnalogA09 e_RECV_sigRECVRotary Engine Coolant Valve - Signal SENTA13 e_RS1_12VRS1Radiator Shutter 1 - 12 Volt Analog e_RS1_cgndRS1Radiator Shutter 1 - Chassis Ground e_T-ECdR1_gndT-ECdR1Temperature Sensor - Engine Coolant downstream Radiator 1 - Ground AnalogD31 e_T-ECdR1_sigT-ECdR1Temperature Sensor - Engine Coolant downstream Radiator 1 - Signal AnalogD25 e_T-ECdR2_gndT-ECdR2Temperature Sensor - Engine Coolant downstream Radiator 2 - Ground AnalogE05 e_T-ECdR2_sigT-ECdR2Temperature Sensor - Engine Coolant downstream Radiator 2 - Signal AnalogE01 e_T-ECdR3_gndT-ECdR3Temperature Sensor - Engine Coolant downstream Radiator 3 - Ground AnalogC21 e_T-ECdR3_sigT-ECdR3Temperature Sensor - Engine Coolant downstream Radiator 3 - Signal AnalogC17 e_T-ECiCH_gndT-ECiCHTemperature Sensor - Engine Coolant inside Cylinder Head - Ground AnalogC28 e_T-ECiCH_sigT-ECiCHTemperature Sensor - Engine Coolant inside Cylinder Head - Signal AnalogC27 e_T-ECiR2_cgndT-ECiR2Temperature Sensor - Engine Coolant inside Radiator 2 - Chassis Ground e_T-ECiR2_sigT-ECiR2Temperature Sensor - Engine Coolant inside Radiator 2 - Signal AnalogD24 e_T-ECuR2_gndT-

ECuR2Temperature Sensor - Engine Coolant upstream Radiator 2 - Ground AnalogD41 e_T-ECuR2_sigT-ECuR2Temperature Sensor - Engine Coolant upstream Radiator 2 - Signal AnalogD35 e_TCV_actHiTCVTransmission Coolant Valve - Activation High DigitalE52 e_TCV_cgndTCVTransmission Coolant Valve - Chassis Ground Remark: The values are taken from general experience with sensor wiring. The signal quality is a part of the overall performance documented in the requirement specification. Thus, special attention must focus on avoiding signal interferences.

EXTID-207 - Signal chain of engine cooling and lubrication: The pass criteria for the tests are listed in the table below. Interface nameSensor/Actuator typePin of control moduleASW label nameCorresponding aggregatePhysical unitPhysical minimumPhysical maximumSignal chain dynamic [ms]Integration test pass criteriaElectrical minimum[V]Electrical maximum[V]Numeric minimum [-]Numeric maximum [-]Duty cycle minimum [%]Duty cycle maximum [%]Frequency minimum [Hz]Frequency maximum [Hz] e_ECP1_actLoPWME43PWM_CWP[GB_COOL]ENTE%0100200.02nrnrnrnr01100500 e_ECP2_actLoPWME48PWM_CWP[INTER_HEAT]ENTE%0100200.02nrnrnrnr01100500 e_ECP3_actLoPWMB23D53PWM_CWP[ICO]ENTE%0100200.02nrnrnrnr01100500 e_EOPT1_sigDigitalC03LV_POIL_SWI_2_BASENLU-011000nrnr01nrnrnrnr e_EOPT2_sigDigitalC14LV_POIL_SWI_1_BASENLU-011000nrnr01nrnrnrnr e_EOPT3_sigDigitalC22RATIO_POIL_SWI_PIST_RAWENLU-011000nrnr01nrnrnrnr e_EOPV1_actHiPWMC35LV_ PUMP_OIL_EL _SPENLU-011000.02nrnrnrnr0100100500 e_EOPV2_actHiDigitalC39LV_OIL_2_PIST_OUTENLU-011000nrnr01nrnrnrnr e_LT-EOiT_sigComplexB10TOIL_SENSENLU°C-402151000.1 e_RECV_actHiPWMA50RVCPWMENTE%-110020.02nrnrnrnr-1110001500 e_RECV_actLoPWMA49RVCPWMENTE%-110020.02nrnrnrnr-1110001500 e_RECV_sigSENTA13RVC_AV°025522nrnr04095nrnrnrnr e_T-ECdR1_sigAnalogD25TLTS_MES[TCR]ENTE°C-402151000.105nrnrnrnrnrnr e_T-ECiCH_sigAnalogC27TLTS_MES[TCE]ENTE°C-402151000.105nrnrnrnrnrnr e_T-ECuR2_sigAnalogD35TLTS_MES[ICO1]ENTE°C-402151000.105nrnrnrnrnrnr e_TCV_actHiDigitalE52LV_COC_EPC[GB_HEAT]ENTE-011000nrnr01nrnrnrnr Remark: The interface between ASW and BSW (d_a/b) is described in the LIMAS aggregate infrastructure requirement specification (IRS), showing the link between the ASW variables and the infrastructure action. The interface between infrastructure actions and the related micro-controller PIN’s is described in the I/O configuration sheet of the BSW. The mapping of the micro-controller PIN’s to the connector PIN’s of the electric component is specified in the block diagram of the electric component.

EXTID-208 - Signal chain of engine cooling and lubrication: The pass criteria for the tests are listed in the table below. Interface nameSensor/Actuator typePin of control moduleASW label namePhysical unitPhysical minimumPhysical maximumSignal chain dynamic [ms]Integration test pass criteriaElectrical minimum[V]Electrical maximum[V]Numeric minimum [-]Numeric maximum [-]Duty cycle minimum [%]Duty cycle maximum [%]Frequency minimum [Hz]Frequency maximum [Hz] e_ECF1_actHiPWME45ECFPWM[1]%0100200.0201100500 e_ECF2_actHiPWME46ECFPWM[2]%0100200.0201100500 e_ECP1_actLoPWME43PWM_CWP[GB_COOL]%0100200.02nrnrnrnr01100500

e_ECP2_actLoPWME48PWM_CWP[INTER_HEAT]%0100200.02nrnrnrnr01100500
e_ECP3_actLoPWMB23D53PWM_CWP[ICO]%0100200.02nrnrnrnr01100500
e_EOPT1_sigDigitalC03LV_POIL_SWI_2_BAS-011000nrnr01nrnrnrnr
e_EOPT2_sigDigitalC14LV_POIL_SWI_1_BAS-011000nrnr01nrnrnrnr
e_EOPT3_sigDigitalC22RATIO_POIL_SWI_PIST_RAW-011000nrnr01nrnrnrnr
e_EOPV1_actHiPWMC35LV_ PUMP_OIL_EL _SP-011000.02nrnrnrnr0100100500
e_EOPV2_actHiDigitalC39LV_OIL_2_PIST_OUT-011000nrnr01nrnrnrnr
e_LT-EOiT_sigComplexB10TOIL_SENS°C-402151000.1
e_RECV_actHiPWMA50RVCPWM%-110020.02nrnrnrnr-1110001500
e_RECV_actLoPWMA49RVCPWM%-110020.02nrnrnrnr-1110001500
e_RECV_sigSENTA13RVC_AV°025522nrnr04095nrnrnrnr e_T-ECdR1_sigAnalogD25TLTS_MES[TCR]°C-402151000.105nrnrnrnrnrnr e_T-ECdR2_sigAnalogE01TLTS_MES[ICO_2]°C-402151000.105nrnrnrnrnrnr e_T-ECdR3_sigAnalogC17TLTS_MES[EGR]°C-402151000.105nrnrnrnrnrnr e_T-ECiCH_sigAnalogC27TLTS_MES[TCR]°C-402151000.105nrnrnrnrnrnr e_T-ECiR2_sigAnalogD24TLTS_MES[ICO_3]°C-402151000.105nrnrnrnrnrnr e_T-ECuR2_sigAnalogD35TLTS_MES[ICO]°C-402151000.105nrnrnrnrnrnr e_TCV_actHiDigitalE52LV_COC_EPC[GB_HEAT]-011000nrnr01nrnrnrnr Remark: The interface between ASW and BSW (d_a/b) is described in the LIMAS aggregate infrastructure requirement specification (IRS), showing the link between the ASW variables and the infrastructure action. The interface between infrastructure actions and the related micro-controller PIN’s is described in the I/O configuration sheet of the BSW. The mapping of the micro-controller PIN’s to the connector PIN’s of the electric component is specified in the block diagram of the electric component.

EXTID-209 - Mechanical interfaces: Below the mounting position of the engine cooling and lubrication sensors are listed.

EXTID-210 - Subsystem interfaces: The subsystem interfaces list all relevant performance requirements to other subsystems. See Attachment. The listed input parameters shall not violate the values within the related subsystem requirement specification. Producing work-packageSubsystem (element) interfaceRequirement ID SVHMT_CORELongitudinal acceleration14284673 SVHMT_CORETransversal acceleration14284757 SINFRSteps of activation Time for ICH from EXT13548015 SINFRRaw data of position of rotary coolant engine valve from SENT13703136 SINFRLogical variable for engine preheating13548015 SINFRLogical variable for hood open13548015 SINFRLogical variable for ICH active in last 30 minutes13548015 SINFRElectrical failure of electronically controlled water pump from EXT13548015 SINFRRequest from independent carheater via CAN to activate interior heating pump13548015 SINFRLogical variable for ICH function lamp on13548015 SINFRIndependent Car heater is on from EXT13548015 SINFRRaw data of position of position of rotary coolant engine valve from SENT valid13703136 SINFRIndependent car heater request for electrical fuel pump from EXT13548015 SINFRCooling fan is defective from EXT13548015 SINFRRadiator shutter is defective from EXT13548015 SINFRIntrerior heating request from EXT13548015 SGASX_FLOW_CTLAir mass flow at throttle11598601 11598450 SEPSDEngine speed6848089 SINFRRotation speed of cooling fan 1 from EXT13548015 SINFRRotation speed of cooling fan 2

from EXT13548015 SINFRCurrent raw position of controlled radiator shutter from EXT13548015 SINFRStatus of cooling fan 113548015 SINFRStatus of cooling fan 213548015 SINFRVariant of used cooling fan 1 from EXT13548015 SINFRVariant of used cooling fan 2 from EXT13548015 SINFRState of radiator 1 shutter from EXT13548015 SINFRState of radiator 2 shutter from EXT13548015 SINFRValve opening time of car heater from EXT13548015 SETQM_TQIndicated torque setpoint fast path11653855 SELPO_ECUBattery voltage12053625 SVHMT_COREVehicle speed12383873 SINFROil temperature of gearbox from EXT13548015 *. All other subsystem interfaces will be verified by project configuration check (correct resolutions,..)

EXTID-211 - Subsystem interfaces: The subsystem interfaces list all relevant performance requirements to other subsystems. See Attachment. The listed input parameters shall not violate the values within the related subsystem requirement specification. Producing work-packageSubsystem (element) interfaceRequirement ID SVHMT_CORELongitudinal acceleration14284673 SVHMT_CORETransversal acceleration14284757 SINFRSteps of activation Time for ICH from EXT13548015 SINFRRaw data of position of rotary coolant engine valve from SENT13703136 SINFRRaw data of position of position of rotary coolant engine valve from SENT valid13703136 SINFRIndependent car heater request for electrical fuel pump from EXT13548015 SGASX_FLOW_CTLAir mass flow at throttle11598601 11598450 SEPSDEngine speed6848089 SETQM_TQIndicated torque setpoint fast path11653855 SELPO_ECUBattery voltage12053625 SVHMT_COREVehicle speed12383873 SINFRRaw information of current direction of rotation of controlled radiator shutter13548015 SINFRCurrent raw position of controlled radiator shutter from EXT13548015 SINFRRaw information of response error from radiator shutter received13548015 SINFRRaw information of error 2 from radiator shutter received13548015 SINFRRaw information of error 1 from radiator shutter received13548015 SINFRRaw information of error 4 from radiator shutter received13548015 SINFRRaw information of error 3 from radiator shutter received13548015 SINFRRaw information of error 5 from radiator shutter received13548015 SINFRThermalstatus of heating13548015 SINFRFlag for oil change was set already in last DC13548015 SINFRIndependent car heater request for electrical fuel pump from EXT13548015 SINFRLogical variable for ICH function lamp on13548015 SINFRLogical variable for engine preheating13548015 SINFRRequest from independent carheater via CAN to activate interior heating pump13548015 SINFRLogical variable for ICH active in last 30 minutes13548015 *. All other subsystem interfaces will be verified by project configuration check (correct resolutions,..)

EXTID-212 - Subsystem interfaces: The subsystem interfaces list all relevant performance requirements to other subsystems. See Attachment. The listed input parameters shall not violate the values within the related subsystem requirement specification. Producing SubsystemSubsystem interfaceRequirement ID SELPOBattery voltage12053625 SVHMTVehicle speed3928275 CusfCoolant pump setpoint14247739 CusfCoolant fan setpoint14247739 CusfRadiator shutter/ roller blind setpoint14247739 GEOLTest radiator shutter7625509 SINFRThermomangement Valve13548015 SINFRRadiator shutter/ roller blind13548015

EXTID-213 - The combustion engine coolant system shall provide a suitable cooling in all operating modes.

EXTID-214 - The combustion engine cooling system shall provide the combustion engine coolant temperature.

EXTID-215 - Level 1 shall provide the measured as well as modeled coolant temperature value to the monitoring level 2. The accuracy of the measured coolant temperature shall be +- 5°C under all possible engine conditions (coasting, electrical driving, cylinder deactivation , ...).

EXTID-216 - In case of an error of the system coolant temperature sensor, there shall be a limp home value as close as possible to the real system temperature (e.g. using other temperature sensors or limp home model).

EXTID-217 - In case of existing external heater the system coolant temperature shall be adapted to the influence of the external heater, to provide the real engine temperature to the system to ensure a robust engine start.

EXTID-218 - In case of an unsuccessful engine start it is assumed that the temperature sensor could be defect. Therefore a substitute value (e.g. TAM, TIA, modeled temperature, ...) shall be used for the system coolant temperature.

EXTID-219 - The final SW value coolant temperature shall represent correct value of coolant temperature (after all diagnosis and plausibility checks).

EXTID-220 - The system shall take conditions into acount where the combustion engine is stopped and the vehicle is moving e.g. engine off coasting or electric driving. The respective temperature models must be adapted. The calculation of the coolant temperature should only take into account the combustion engine load. Any support by electric machine(s) shall not lead to an incorrect calculation of the coolant temperature. Note: Requirement is valid for water cooling circuit as well as engine oil circuit!

EXTID-221 - The software component shall provide signal for service PID $05 which consists of following information: Engine Coolant Temperature. Signal shall be provided according to SAE J1979-DA: \ \ptfs01p1.pt.de.int.vitesco.com\did01959\OBD\OBD-Comm\SAE\J1979\Documents \J1979_released_purchased_by_eStandards Implementation Guideline $01/02 must be considered (https://vitesco.sharepoint.com/:w:/r/teams/ext_10000886/

OBD_Legislation/_layouts/15/Doc.aspx?sourcedoc=%7B5D695E12-B6A3-4BEE-ACB0-0F103770D542%7D&file=Guideline_Signals_for_ScanTool.doc&action=default&mobileredirect=

EXTID-222 - The combustion engine cooling system shall control the combustion engine coolant temperature in a way that the engine is protected from overheating.

EXTID-223 - The Thermo management shall control the related components in a way to optimize fuel consumption and emissions.

EXTID-224 - The Thermo management shall ensure a fast heating and a better comfort of the passenger cockpit if requested by the driver.

EXTID-225 - The system shall support additional sources of heat / power dissipation between the radiator and the combustion engine. (Note: the outlet temperature of the radiator must not correspond to the inlet temperature for the combustion engine. E.g. by adding a starter generator or an electric machine additional heat can be transferred to the cooling water).

EXTID-226 - The OBD II system monitors thermostat and coolant temperature sensor; for detailed requirements see chapter below.

EXTID-227 - For all ENTE diagnostics the MIL activation and MIL deactivation over several driving cycles shall be tested For all ENTE diagnostics with IUPR-interface the correct incrementing of numerator and denominator in case of suitable conditions shall be checked. In case of service $06 is active for any ENTE diagnostic: the interface defined for service $06 shall be checked by reading out variables via tester; the received values shall show the expected behavior.

EXTID-228 - It shall be possible to acquire, store and filter the coolant temperature measured by a sensor with an accuracy of +-5 K. A limp-home value shall be provided in case of electrical fault on the acquired signal. The limp-home value shall be derived either from a temperature model or from another sensor.

EXTID-229 - There shall be a coolant temperature sensor signal diagnosis for short circuit to ground, open circuit and short circuit to VCC. The diagnosis shall detect if there is a SCP at the control pin of the coolant temperature sensor. a) BPU = (Best performing) unacceptable A short circuit to plus is applied. b) WPA = (Worst performing) acceptable No short circuit to plus is applied. c) P_code = P0118 (too high voltage), P2185 (engine block coolant temperature too high voltage). d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool The diagnosis

shall detect if there is a SCG at the control pin of the coolant temperature sensor. a) BPU = (Best performing) unacceptable A short circuit to ground is applied. b) WPA = (Worst performing) acceptable No short circuit to ground is applied. c) P_code = P0117 (engine coolant too low voltage), P2184 (engine block coolant too low voltage). d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool The diagnosis shall detect if there is an OC at the control pin of the coolant temperature sensor. a) BPU = (Best performing) unacceptable An open circuit is applied. b) WPA = (Worst performing) acceptable No open circuit is applied. c) P_code = P0117 or P0118 depending on the ECU HW input circuit. d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool

EXTID-230 - There shall be a control of the main water pump to ensure the heat transfer and avoid an overheating of the system. The control shall be done in a way to optimize the fuel consumption and emissions. The maximum and minimum allowed control signal shall be selectable.

EXTID-231 - There shall be a diagnosis of main water pump control output for detection of short circuit to ground, short circuit to battery and open circuit. The diagnosis shall detect if there is a SCP at the control pin of the main water pump control output. a) BPU = (Best performing) unacceptable A short circuit to plus is applied. b) WPA = (Worst performing) acceptable No short circuit to plus is applied. c) P_code = P1650. d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool The diagnosis shall detect if there is a SCG at the control pin of the main water pump control output. a) BPU = (Best performing) unacceptable A short circuit to ground is applied. b) WPA = (Worst performing) acceptable No short circuit to ground is applied. c) P_code = P1649. d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool The diagnosis shall detect if there is an OC at the control pin of the main water pump control output. a) BPU = (Best performing) unacceptable An open circuit is applied. b) WPA = (Worst performing) acceptable No open circuit is applied. c) P_code = P1647 d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool

EXTID-232 - There shall be a plausibility diagnosis of main water pump which checks if pump is running.

EXTID-233 - There shall be a control of the electronically controlled coolant pump to ensure the heat transfer and avoid an overheating of the powertrain system (whether combustion engine, electric machine or hybrid) under all conditions (for example combustion engine / mechanically driven coolant pump stopped). The control shall be done in a way to optimize the energy consumption. In case of problems with other components which can have influence on the heat transfer or can request a higher heat transfer, the electronically controlled water pump shall be set in an emergency mode to guarantee sufficient heat transfer.

EXTID-234 - There shall be a diagnosis of the electronically controlled coolant pump control output for detection of short circuit to ground, short circuit to battery and open circuit. The diagnosis shall detect if there is a SCP at the control pin of the electronically controlled water pump control output. a) BPU = (Best performing) unacceptable A short circuit to plus is applied. b) WPA = (Worst performing) acceptable No short circuit to plus is applied. c) P_code = P2603 d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool The diagnosis shall detect if there is a SCG at the control pin of the electronically controlled water pump control output. a) BPU = (Best performing) unacceptable A short circuit to ground is applied. b) WPA = (Worst performing) acceptable No short circuit to ground is applied. c) P_code = P2602 d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool The diagnosis shall detect if there is an OC at the control pin of the electronically controlled water pump control output. a) BPU = (Best performing) unacceptable An open circuit is applied. b) WPA = (Worst performing) acceptable No open circuit is applied. c) P_code = P2600 d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool

EXTID-235 - There shall be a plausibility diagnosis of electronically controlled water pump which checks if pump is running. a) BPU = (Best performing) unacceptable A faulty (stuck or running with degraded power) water pump causes that measured temperature difference before and after component which shall be cooled down via water pump activation is too high. b) WPA = (Worst performing) acceptable A regular (not stuck and running with normal power) water pump causes that measured temperature difference before and after component which shall be cooled down via water pump activation is not too high. c) P_code = P062A d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR relevant, diagnostic always active; report via scantool

EXTID-236 - For thermostat diagnostics refer to chapter "Engine Cooling System Monitoring".

EXTID-237 - The thermostat shall control the engine coolant temperature. It shall allow a fast warming-up of the engine for reduction of emissions and it shall prevent the engine from overheating by controling of engine cooling circuit.

EXTID-238 - The electronic thermostat shall control the engine coolant temperature. It shall allow a fast warming-up of the engine for reduction of emissions and it shall prevent the engine from overheating by controling of engine cooling circuit.

EXTID-239 - The electronic thermostat shall be controlled by external devices for test of component.

EXTID-240 - There shall be a diagnosis of electronically controlled thermostat output for detection of short circuit to ground, short circuit to battery and open circuit. The diagnosis shall detect if there is a SCP at the control pin of the electronically controlled thermostat output. a) BPU = (Best performing) unacceptable A short circuit to plus is applied. b) WPA = (Worst performing) acceptable No short circuit to plus is applied. c) P_code = P2683. d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool The diagnosis shall detect if there is a SCG at the control pin of the electronically controlled thermostat output. a) BPU = (Best performing) unacceptable A short circuit to ground is applied. b) WPA = (Worst performing) acceptable No short circuit to ground is applied. c) P_code = P2682. d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool The diagnosis shall detect if there is an OC at the control pin of the electronically controlled thermostat output. a) BPU = (Best performing) unacceptable An open circuit is applied. b) WPA = (Worst performing) acceptable No open circuit is applied. c) P_code = P2681 d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool

EXTID-241 - The RVC shall control the engine coolant temperature. It shall allow a fast warming-up of the engine for reduction of emissions and it shall prevent the engine from overheating by controling of engine cooling circuit. The RVC shall be controlled in way to provide the optimum coolant temperature for fuel consumption, emission and engine protection.

EXTID-242 - The current position of RVC shall be measured and shall be used for the RVC-control strategy.

EXTID-243 - There shall be a diagnosis of RVC output for detection of short circuit to ground, short circuit to battery and open circuit. The diagnosis shall detect if there is a SCP at the control pin of the electronically actuated thermostat (rotary coolant valve) output. a) BPU = (Best performing) unacceptable A short circuit to plus is applied. b) WPA = (Worst performing) acceptable No short circuit to plus is applied. c) P_code = P2683. d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool The diagnosis shall detect if there is a SCG at the control pin of the electronically actuated thermostat (rotary coolant valve) output. a) BPU = (Best performing) unacceptable A short circuit to ground is applied. b) WPA = (Worst performing) acceptable No short circuit to ground is applied. c) P_code = P2682. d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool The diagnosis shall detect if there is an OC at the control pin of the electronically actuated thermostat (rotary coolant valve) output. a) BPU = (Best performing) unacceptable An open circuit is applied. b) WPA = (Worst performing) acceptable No open circuit is applied. c) P_code = P2681 d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool

EXTID-244 - There shall be a diagnosis of RVC feedback signal for detection of short circuit to ground, short circuit to battery and open circuit. The diagnosis shall detect if there is a SCP at the control pin of the RVC feedback signal. a) BPU = (Best performing) unacceptable A short circuit to plus is applied. b) WPA = (Worst performing) acceptable No short circuit to plus is applied. c) P_code = P26A7 (PWM duty cycle too high). d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool The diagnosis shall detect if there is a SCG at the control pin of the RVC feedback signal. a) BPU = (Best performing) unacceptable A short circuit to ground is applied. b) WPA = (Worst performing) acceptable No short circuit to ground is applied. c) P_code = P26A6 (PWM duty cycle too low). d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool The diagnosis shall detect if there is an OC at the control pin of the RVC feedback signal. a) BPU = (Best performing) unacceptable An open circuit is applied. b) WPA = (Worst performing) acceptable No open circuit is applied. c) P_code = P26A6 or P26A7, depending on the ECU HW input circuit. d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool

EXTID-245 - There shall be an adaptation strategy for RVC to determine bottom/top limits of RVC-position. These limits shall be used for RVC-control.

EXTID-246 - Functional diagnosis jam monitoring: The monitoring of the RVC actuator shall detect an error if the difference between setpoint and actual value is above a certain threshold (e.g. 3°). When the jam monitoring detects a problem, it shall be tried to remove the problem by activation of a jerk function (fast change of RVC-setpoint) before setting of error. a) BPU = (Best performing) unacceptable A faulty (stuck) rotary valve causes that difference between requested rotary valve position and actual rotary valve position is too high for a longer time. b) WPA = (Worst performing) acceptable A regular (not stuck) rotary valve causes that difference between requested rotary valve position and actual rotary valve position is not too high for a longer time. c) P_code = P00B7 (Engine coolant flow low/performance) d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool

EXTID-247 - Functional diagnosis adaptation error: The adaptation process of the RVC shall be monitored. a) BPU = (Best performing) unacceptable A faulty rotary valve with a limited moving range causes that during adaptation process (moving of rotary valve to bottom/top limits of moving range) the pre-defined bottom/top position limits of rotary valve cannot be reached. b) WPA = (Worst performing) acceptable A regular rotary valve with no limited moving range causes that during adaptation process (moving of rotary valve to bottom/top limits of moving range) the pre-defined bottom/top position limits of rotary valve can be reached. c) P_code = P00B7 (Engine coolant flow low/performance) d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool

EXTID-248 - Functional diagnosis rough running monitoring: The monitoring of the adaptation time needed for requested position changes shall be performed.

EXTID-249 - The cooling and condenser fan should provide sufficient air flow in order to protect the powertrain system (whether combustion engine, electric machine or hybrid) from overheating . It shall support the thermal management strategy (e.g. best trade off between fan activation and radiator shutter activation). It shall support the air-conditioning system by providing air flow to the condenser. The cooling fan shall be deactivated, when the cooling is not necessary to reduce energy consumption.

EXTID-250 - The cooling and condenser fan shall provide sufficient air flow to protect the powertrain system (whether combustion engine, electric machine or hybrid) from overheating during operation and in the power-latch phase.

EXTID-251 - There shall be a diagnosis of the cooling fan, which detects defects and error free system. This information shall be provided to the diagnosis tool to allow an analysis in the garage. The diagnosis shall detect if there is a SCP at the control pin of the cooling fan output. a) BPU = (Best performing) unacceptable A short circuit to plus is applied. b) WPA = (Worst performing) acceptable No short circuit to plus is applied. c) P_code = P0692. d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool The diagnosis shall detect if there is a SCG at the control pin of the cooling fan output. a) BPU = (Best performing) unacceptable A short circuit to ground is applied. b) WPA = (Worst performing) acceptable No short circuit to ground is applied. c) P_code = P0691. d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool The diagnosis shall detect if there is an OC at the control pin of the cooling fan output. a) BPU = (Best performing) unacceptable An open circuit is applied. b) WPA = (Worst performing) acceptable No open circuit is applied. c) P_code = P0691 or P0692, depending on the ECU HW input circuit. d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool

EXTID-252 - The diagnosis of the cooling fan shall be deactivated according variant coding.

EXTID-253 - The rear spoiler shall be opened under certain conditions (e.g. sport mode, high temperatures...) to provide enough cooling air flow to protect the powertrain from overheating.

EXTID-254 - The engine compartment fan should provide sufficient air flow in order to protect the power train from overheating and support the thermo management strategy. The cooling fan shall be deactivated, when the cooling is not necessary to improve fuel consumtion.

EXTID-255 - There shall be a diagnosis of engine compartment fan output for detection of short circuit to ground, short circuit to battery and open circuit.

EXTID-256 - There shall be a plausibility diagnosis of engine compartment checking whether fans are working when requested.

EXTID-257 - The electropneumatic converters shall control the heat transfer to and from additional components (transmission, passenger compartment).

EXTID-258 - There shall be a diagnosis of electropneumatic converter output for detection of short circuit to ground, short circuit to battery and open circuit.

EXTID-259 - There shall be a plausibility diagnosis of electropneumatic converter between valve control signal and valve position feedback signal.

EXTID-260 - The electrical valves shall control the heat transfer to and from additional components (transmission, passenger compartment).

EXTID-261 - There shall be a diagnosis of electrical valve output for detection of short circuit to ground, short circuit to battery and open circuit.

EXTID-262 - The LIN-communication between ECU and component shall be tested.

EXTID-263 - The ECU shall provide the setpoint for the component and shall send it via LIN to the component..

EXTID-264 - The ECU shall provide diagnostics from the component: diagnostics of internal component states (received via LIN) diagnostics of control errors plus "tear away"-function

EXTID-265 - In case of engine cold start, the air flow would affect the engine heating curve by lowering its slope. By using an electronically controlled radiator shutter, it is possible to increase the slope of the engine heating curve and to reach the desired engine working point faster. In case of excessive warm engine, the optimal combination between air flow through radiator and air flow due to cooling fan activation can bring the engine to the desired working point by minimizing the energy required.

EXTID-266 - The electronically controlled radiator shutter shall control the airflow through the radiator to the engine compartment (combustion engine) or power electronics (electric machine) in a way to provide a fast heat up/cool down and consequently improve fuel consumption and emission (combustion engine) or minimize electrical energy consumption (electric machine).

EXTID-267 - In some special conditions (e.g. Limp home, fault reaction, extended power latch, intensive use of other devices that could increase their temperature to the limits, aerodynamic stability, ...) the radiator shutters shall be controlled to either open or close positions with high priority independently from other standard requests.

EXTID-268 - The electronically controlled radiator shutter shall be controlled by external devices for test of component.

EXTID-269 - There shall be a diagnosis of the radiator shutter for detection of short circuit to ground, short circuit to battery and open circuit as well as for mechanically defects (blocked icing, mechanically blocked, overcurrent, mechanically free). This information shall be provided to the diagnosis tool to allow an analysis in the garage.

EXTID-270 - There shall be inhibition flags for all Aggregates consuming signals from ENTE, which carry incorrect information in case of an error.

EXTID-271 - Inhibition flags carrying incorrect information in case of an error and provided by other Aggregates shall be taken into account by ENTE.

EXTID-272 - There shall be an activation of every component diagnosis possible via scan tool (see requirements for components).

EXTID-273 - The OBD II system shall monitor the thermostat on vehicles so-equipped for proper operation. a) BPU = (Best performing unacceptable) A faulty (stuck open) thermostat causes that warmed-up coolant temperature don't reach within 11 °K (20 degrees Fahrenheit) of the nominal thermostat regulating temperature. b) WPA = (Worst performing) acceptable A thermostat regulate warmed-up coolant temperature to reach within 11 °K (20 degrees Fahrenheit) of the nominal thermostat regulating temperature. c) P_code = P2181 (Detects a too slow engine warm-up by comparison of measured and modeled engine coolant temperature increase after cold start) d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR relevant, diagnostic always active; report via scantool

EXTID-274 - The OBD II system shall detect a thermostat malfunction before the end of emission test cycle (.e.g. CARB-FTP cycle), if the following condition occur:

the coolant temperature does not reach a warmed-up temperature within 11 °K (20 degrees Fahrenheit) of the nominal thermostat regulating temperature. a) BPU = (Best performing unacceptable) A faulty (stuck open) thermostat causes that warmed-up coolant temperature don't reach within 11 °K (20 degrees Fahrenheit) of the nominal thermostat regulating temperature. b) WPA = (Worst performing acceptable) A thermostat regulate warmed-up coolant temperature to reach within 11 °K (20 degrees Fahrenheit) of the nominal thermostat regulating temperature. c) P_code = P2181 (Detects a too slow engine warm-up by comparison of measured and modeled engine coolant temperature increase after cold start) d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR relevant, diagnostic always active; report via scantool

EXTID-275 - Approval of the time interval after engine start shall be granted upon determining that the data and/or engineering evaluation supports the specified times.

EXTID-276 - It shall be possible to use alternate malfunction criteria and/or monitoring conditions that are a function of temperature at engine start on vehicles that do not reach the temperatures specified in the malfunction criteria when the thermostat is functioning properly.

EXTID-277 - The OBD II system shall detect a thermostat fault, if after the coolant temperature has reached a pre-defined temperature, the coolant temperature drops below another pre-defined temperature. a) BPU = (Best performing unacceptable) A thermostat stucks open after highest minimum enable temperature was reached and engine is cooled down strong. b) WPA = (Worst performing) acceptable A thermostat will close when the engine is cooled down strong after the highest minimum enable temperature was reached. c) P_code = P2181 (Detects excessive decrease of engine coolant temperature after highest minimum enable temperature has been reached before) d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR relevant, diagnostic always active; report via scantool

EXTID-278 - Monitoring for malfunctions shall be conducted once per driving cycle on every driving cycle in which the ECT sensor indicates, at engine start, a temperature lower than the temperature established as the malfunction criteria. a) BPU = (Best performing unacceptable) A fault thermostat (open stuck) will be monitored once per driving cycle on every driving cycle in which the ECT sensor indicates, at engine start, a temperature lower than the temperature established as the malfunction criteria. b) WPA = (Worst performing acceptable) A normal working thermostat will be monitored once per driving cycle on every driving cycle in which the ECT sensor indicates, at engine start, a temperature lower than the temperature established as the malfunction criteria. c) P_code = P2181 (Detects excessive decrease of engine coolant temperature after highest minimum enable temperature has been reached before) d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR relevant, diagnostic always active; report via scantool

EXTID-279 - It shall be allowed to disable thermostat monitoring at ambient temperatures below -7°C (20 degrees Fahrenheit).

EXTID-280 - The OBD II system shall monitor the engine coolant temperature (ECT) sensor for circuit continuity, out-of-range values, and rationality faults.

EXTID-281 - Circuit Continuity: The OBD I system shall detect a malfunction when a lack of circuit continuity or out-of-range value occurs. The diagnosis shall detect if there is a SCP at the control pin of the coolant temperature sensor. a) BPU = (Best performing) unacceptable A short circuit to plus is applied. b) WPA = (Worst performing) acceptable No short circuit to plus is applied. c) P_code = P0118 (too high voltage) d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool The diagnosis shall detect if there is a SCG at the control pin of the coolant temperature sensor. a) BPU = (Best performing) unacceptable A short circuit to ground is applied. b) WPA = (Worst performing) acceptable No short circuit to ground is applied. c) P_code = P0117 (engine coolant too low voltage) d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool The diagnosis shall detect if there is an OC at the control pin of the coolant temperature sensor. a) BPU = (Best performing) unacceptable An open circuit is applied. b) WPA = (Worst performing) acceptable No open circuit is applied. c) P_code = P0117 or P0118 depending on the ECU HW input circuit. d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool

EXTID-282 - Time to Reach Closed-Loop Enable Temperature: (i) The OBD II system shall detect a malfunction if the ECT sensor does not achieve the stabilized minimum temperature which is needed for the fuel control system to begin closed-loop operation (closed-loop enable temperature) within an approved time interval after starting the engine. (ii) The time interval shall be a function of starting ECT and/or a function of intake air temperature and may not exceed two minutes for engine start temperatures up to 8°K (15 degreesFahrenheit) below the closed-loop enable temperature and five minutes for engine start temperatures between 8°K and 20°K (15 and 35 degrees Fahrenheit) below the closed-loop enable temperature. a) BPU = (Best performing unacceptable) A faulty (stuck low or high negative offset) sensor causes that coolant temperature doesn't reach within expected time after engine start the temperature needed for the fuel control system to begin closed-loop operation (closed-loop enable temperature). b) WPA = (Worst performing acceptable) A regular (not stuck low and no high negative offset) sensor causes that coolant temperature reaches within expected time after engine start the temperature needed for the fuel control system to begin closed-loop operation (closed-loop enable temperature). c) P_code = P0116 (Engine coolant temperature sensor range/ performance problem) d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR relevant, diagnostic always active; report via scantool

EXTID-283 - Stuck in Range Below the Highest Minimum Enable Temperature: When using all available information, the OBD II system shall detect a malfunction, if the ECT

sensor inappropriately indicates a temperature below the highest minimum enable temperature required by the OBD II system after a pre-defined time after engine start with engine speed above x rpm. The monitor must fulfil an IUMPR of 0.336. a) BPU = (Best performing unacceptable) A faulty (stuck low) sensor causes that coolant temperature doesn't reach the highest minimum enable temperature required by the OBD II system after a pre-defined time after engine start with engine speed above x rpm. b) WPA = (Worst performing acceptable) A regular (not stuck low) sensor causes that coolant temperature reaches the highest minimum enable temperature required by OBD II system after a pre-defined time after engine start with engine speed above x rpm. c) P_code = P0116 (Engine coolant temperature sensor range/performance problem) d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR relevant, diagnostic always active; report via scantool

EXTID-284 - Stuck in Range Above the Lowest Maximum Enable Temperature: When using all available information, the OBD II system shall detect a malfunction, if the ECT sensor inappropriately indicates a temperature above the lowest maximum enable temperature required by the OBD II at cold start of engine. The monitor must fulfil an IUMPR of 0.336. a) BPU = (Best performing unacceptable) A faulty (stuck high) sensor causes that no temperature sensor range fluctuations are recognized , when engine conditions are given, where a temperature increase (high engine speed/load conditions) resp. decrease (engine conditions with fuel cut-off) is expected. b) WPA = (Worst performing acceptable) A regular (not stuck high) sensor causes that temperature sensor range fluctuations are recognized , when engine conditions are given, where a temperature increase (high engine speed/load conditions) resp. decrease (engine conditions with fuel cut-off) is expected. c) P_code = P0116 (Engine coolant temperature sensor range/performance problem) d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR relevant, diagnostic always active; report via scantool

EXTID-285 - The plausibility check of the temperature sensors/model prior to the (cold) engine start shall be extended to cover different types of start. Note: start can be handled by classic starter, starter generators or by electric machine with clutch closing. It is also possible that after start release only the electric engine is starting (EV-drive); combustion engine start may happen any time during EV-driving, also with cold engine. a) BPU = (Best performing unacceptable) A faulty (stuck low/high) engine temperature sensor causes that cross-check of measured temperature sensor values with cold engine (engine-off time high) recognizes too high offset of the engine temperature sensor value in comparison with the other temperature sensor values. b) WPA = (Worst performing acceptable) A regular (not stuck low/high) engine temperature sensor causes that cross-check of measured temperature sensor values with cold engine (engine-off time high) recognizes no too high offset of the engine temperature sensor value in comparison with the other temperature sensor values. c) P_code = P0116 (Engine coolant temperature sensor range/performance problem) d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR relevant, diagnostic always active; report via scantool

EXTID-286 - OBD II diagnosis should detect a failure on coolant temperature sensor. The OBD system shall detect a defective coolant temperature sensor (i.e. after engine off time long enough to completely cool down all temperature sensors). A) BPU: The used temperature sensor delivers values that are outside of its range or accuracy mentioned in the sensor specification. The diagnosis shall detect an error while usage of such a temperature sensor. To provoke this error case either an aged component should be used or the sensor signal voltage to the ECU should be modified with a break out box and a potentiometer. In case the temperature value is delivered via INTC (i.e. CAN / FlexRay) the temperature value can be set accordingly by CANalyzer. B) WPA: The used temperature sensor delivers values that are within its range or accuracy mentioned in the sensor specification. The diagnosis shall not detect an error while usage of such a temperature sensor. C) P-code: P0116 (TCO) D) OBD-Demo: CN: 2x WLTC, EU: 3x WLTC, US: 2x FTP72 E) Operation frequency: IUMPR: 0,336, Mode 06 - not relevant.

EXTID-287 - There shall be a monitoring of the system temperature sensor, which takes the influence of the additional heaters into account.

EXTID-288 - Monitoring for stuck high/low shall be conducted once per driving cycle on every driving cycle in which the ECT sensor indicates a temperature lower than the closed loop enable temperature at engine start (i.e., all engine start temperatures greater than the ECT sensor out of range low temperature and less than the closed loop enable temperature).

EXTID-289 - It shall be allowed to suspend or delay the time to reach closed loop enable temperature diagnostic if the vehicle is subjected to conditions which could lead to false diagnosis (e.g., vehicle operation at idle for more than 50 to 75 percent of the warm-up time).

EXTID-290 - The OBD II system shall detect a malfunction, if the engine temperature sensor does not achieve the minimum temperature which is needed for the fuel control system to begin closed-loop operation (closed-loop enable temperature) within a defined time interval after starting the engine. a) BPU = (Best performing unacceptable) A malfunction will be diagnosed, if the engine temperature sensor does not achieve the minimum temperature which is needed for the fuel control system to begin closed-loop operation (closed-loop enable temperature) within a defined time interval after starting the engine. b) WPA = (Worst performing acceptable) Functioning will be diagnosed, if the engine temperature sensor achieves the minimum temperature which is needed for the fuel control system to begin closed-loop operation (closed-loop enable temperature) within a defined time interval after starting the engine. c) P_code = P0125 (Insufficient coolant temperature for closed loop fuel control) d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR relevant, diagnostic always active; report via scantool

EXTID-291 - Thermal cooling/heating systems for electric engines, inverters and batteries shall be supported.

EXTID-292 - There shall be an activation/control of every component/actuator possible via scan tool/ tester.

EXTID-293 - There shall be a calculation of the heat input of the low pressure EGR-cooler into the main water circuit depending on the EGR-temperature setpoint and also a measured and modeled coolant water temperature after EGR-cooler.

EXTID-294 - There shall be a reduction of the EGR-temperature setpoint, when measured/ modeled coolant water temperature after EGR-cooler is too high.

EXTID-295 - It shall be possible to acquire the coolant differential pressure measured by a sensor with an accuracy of +/- 0,4 kPa.

EXTID-296 - There shall be a differential coolant pressure diagnosis for value out of range, value erratic, and implausible value. The diagnosis shall detect if the coolant differential pressure value is too high: a) BPU = (Best performing) unacceptable: coolant differential pressure > threshold. b) WPA = (Worst performing) acceptable coolant differential pressure = threshold. c) P_code = TBC. d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool The diagnosis shall detect if the coolant differential pressure value is too low: a) BPU = (Best performing) unacceptable: coolant differential pressure < threshold. b) WPA = (Worst performing) acceptable coolant differential pressure = threshold. c) P_code = TBC. d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool The diagnosis shall detect if the coolant differential pressure value is erratic: a) BPU = (Best performing) unacceptable: rate of change of coolant differential pressure > threshold. b) WPA = (Worst performing) acceptable rate of change of coolant differential pressure = threshold. c) P_code = TBC. d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool The diagnosis shall detect if the coolant differential pressure value is implausibly high: a) BPU = (Best performing) unacceptable: coolant differential pressure > threshold while coolant pump is inactive. b) WPA = (Worst performing) acceptable: coolant differential pressure = threshold while coolant pump is inactive. c) P_code = TBC. d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool The diagnosis shall detect if the coolant differential pressure value is implausibly low: a) BPU = (Best performing) unacceptable: coolant differential pressure < threshold while coolant pump is active. b) WPA = (Worst performing) acceptable: coolant differential pressure = threshold while coolant pump is active. c) P_code = TBC. d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; report via scantool

EXTID-297 - In case of high engine speed/load oil shall be sprayed onto the pistons for additional cooling of the engine.

EXTID-298 - Electrical errors shall be recognized by the piston cooling actuator.

EXTID-299 - The activation of the piston cooling shall be checked via a plausibility diagnostic. Status of piston cooling actuator and oil pressure at piston cooling nozzle measured by a sensor must fit together.

EXTID-300 - When oil pressure at piston cooling nozzle is measured by an analogous sensor, an electrical diagnosis shall detect a short circuit to ground and a short circuit to battery and also a not plausible voltage value (voltage value neither within voltage range for low state nor within voltage range for high state).

EXTID-301 - The oil temperature model shall provide a modeled oil temperature in order to replace the oil temprature sensor.

EXTID-302 - The oil temperature model shall have the accuracy of +- 7 K and must be valid over the complete temperature range of -40°C to +160°C.

EXTID-303 - The oil temperature model shall be determined for all engine conditions (combustion engine on/off and/or electrical engine on/off). In case of cylinder deactivation, oil temperature model should consider less heating power from combustion chamber due to cylinder shut off.

EXTID-304 - The oil temperature model shall take into account influence of an external car heater on model initialization (car heater has influence on measured engine temperature which is used for oil temperature model) and shall make correction in case of car heater detection.

EXTID-305 - The measured oil temperature shall have an accuracy of +- 4 K and must be valid over the complete temperature range of -40°C to +160°C. The accuracy is depending on the sensor. The ECU has only a very low influence on the accuracy.

EXTID-306 - The sensor signal representing the measured oil temperature shall be diagnosed; signal levels out of the expected range shall be recognized and diagnosed as error.

EXTID-307 - Strong changes of the signal shall be detected by the gradient diagnosis.

EXTID-308 - Plausibility/electrical checks shall detect an implausible oil temperature from sensor at start of engine or after start of engine.

EXTID-309 - The component shall measure the oil level with an accuracy of +/- 5 mm.

EXTID-310 - The component shall diagnose the measured oil level; electrical check , range check and/or plausiblility check shall be performed depending on used sensor.

EXTID-311 - The physical oil level from sensor shall be determined. The raw sensor value shall acquired, transformed into a physical value and processed, e.g. filtered and limited. Diagnostic information shall be taken into account and a default value shall be delivered in case of error. For testing purposes only the sensor value might be calibrated.

EXTID-312 - Errors of the oil level and temperature sensor shall be detected. Errors may be electrical errors, communication errors and plausibility errors. Diagnostic information provided by the sensor shall be used and processed. The Diagnoses shall provide status information for all signals from oil level and temperatur sensor.

EXTID-313 - The oil pressure shall be controlled and observed to guarantee a sufficient lubrication of the engine and to prevent a damage of the engine. To ensure a low fuel consumption the pressure shall be as low as possible.

EXTID-314 - Oil Pressure switch: The oil pressure shall be measured by a switch to determine the current oil pressure status (above or below a level).

EXTID-315 - Oil Pressure sensor: The oil pressure shall be measured to determine the current oil pressure. The accuracy is depending on the sensor. The ECU has only a very low influence on the accuracy.

EXTID-316 - Oil Pressure two step pump: The Oil Pressure pump shall be controlled to ensure an engine operation without creating a damage using the engine speed, combustion mode and engine load as control parameters. To optimize the fuel consumption the low pressure state shall be active as long as possible in all engine conditions. Oscillating activation between the two pump states shall be avoided.

EXTID-317 - Oil Pressure controlled pump: The Oil Pressure pump shall be controlled to ensure an engine operation without creating a damage using the engine speed, combustion mode and engine load as control parameters. To optimize the fuel consumption the pressure shall be as low as possible in all engine conditions.

EXTID-318 - Oil Pressure controlled pump: In case of cylinder deactivation, different oil pressure levels should be possible.

EXTID-319 - Electrical errors shall be recognized by the oil pressure pump actuator. The diagnosis shall detect if the oil pressure pump actuator recognizes an electrical error SCP at the control pin . a) BPU = (Best performing) unacceptable A short circuit to plus is applied. b) WPA = (Worst performing) acceptable No short circuit to plus is applied. c) P_code = P06DC d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; no report via scantool The diagnosis shall detect if the oil pressure pump actuator recognizes an electrical error SCG at the control pin . a) BPU = (Best performing) unacceptable A short circuit to ground is applied. b) WPA = (Worst performing) acceptable No short circuit to ground is applied. c) P_code = P06DB d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; no report via scantool The diagnosis shall detect if the oil pressure pump actuator recognizes an electrical error OC at the control pin . a) BPU = (Best performing) unacceptable An open circuit is applied. b) WPA = (Worst performing) acceptable No open circuit is applied. c) P_code = P06DA d) OBD-demo: China6 ; EU: 3 x WLTC/NEDC e) Ratio: IUMPR not relevant, diagnostic always active; no report via scantool

EXTID-320 - A limp-home mode shall be activated, when oil pressure is diagnosed as too low for driving with high engine speed / high engine load.

EXTID-321 - The physical oil pressure from sensor shall be determined. The raw sensor value shall acquired, transformed into a physical value and processed, e.g. filtered and limited. Diagnostic information shall be taken into account and a default value shall be delivered in case of error. For testing purposes only the sensor value might be calibrated.

EXTID-322 - Errors of the oil pressure sensor shall be detected. Errors may be electrical errors, communication errors and plausibility errors. The Diagnoses shall provide status information for all signals from oil pressure sensor.

EXTID-323 - The oil pressure pump shall be controlled to ensure the required lubrication without the waste of energy. To ensure that this target is achieved in every engine condition the control shall use engine speed, combustion mode, engine load and oil temperature as control parameters. The oil pressure control shall be able to operate within series variations and achieve the necessary performance standards. Diagnostic information shall be taken into account and substitution reactions shall be delivered in

case of error. For testing purposes the oil pressure setpoint or oil pressure control output shall be adjustable. The oil pressure control shall be calibratable to operate different oil pumps.

EXTID-324 - Errors of the oil pressure pump shall be detected. Errors may be electrical errors, controller errors, too low or too high oil pressure and oscillating oil pressure. Diagnoses shall provide the mechanical status of the oil pressure pump. To ensure the adequate lubrication the hot idle shall be diagnose and idle speed should be raised. The Diagnoses shall provide status information about the oil pressure pump.

EXTID-325 - Oil Pressure switch plausibility diagnosis: There shall be a plausibility diagnosis for the oil pressure switches (using the different engine load conditions). The status of the oil pressure switches must fit to requested oil pressure. This shall ensure a correct pump operation.

EXTID-326 - There shall be a plausibility diagnosis for the oil pressure sensor (using the different engine load conditions). The measured oil pressure must fit to requested oil pressure. This shall ensure a correct pump operation.

EXTID-327 - The sensor signal representing the measured oil pressure shall be diagnosed; signal levels out of the expected range shall be recognized and diagnosed as error.

EXTID-328 - The service interval extension shall provide information to external controllers (dashboard) about next oil service.

EXTID-329 - The component shall estimate the wear of the engine oil (using engine speed and engine load).

EXTID-330 - The component shall estimate the oil dilution (fuel in oil).

EXTID-331 - The component shall determine warning flags for the driver indicating too high/low oil level and send oil level/temperature information for indication at dashboard.

EXTID-332 - The component shall estimate the amount of soot in oil for Diesel engines.

EXTID-333 - The component must be able to provide the oil temperature (measured or modeled).The measured oil temperature shall have an accuracy of +- 4 K valid over the

complete temperature range of -40°C to +160°C. The modeled oil temperature shall have an accuracy of +- 7 K valid over the complete temperature range of -40°C to +160°C.

EXTID-334 - The component must determine the information about next service interval (time / length of run).

EXTID-335 - There shall be an activation/control of every component/actuator possible via scan tool/ tester.

EXTID-336 - For all ENLU diagnostics the MIL activation and MIL deactivation over several driving cycles shall be tested For all ENLU diagnostics with IUPR-interface the correct incrementing of numerator and denominator in case of suitable conditions shall be checked. In case of service $06 is active for any ENLU diagnostic: the interface defined for service $06 shall be checked by reading out variables via tester; the received values shall show the expected behavior.

EXTID-337 - The LIN-communication between ECU and component shall be tested.

EXTID-338 - The ECU shall provide the setpoint for the component and shall send it via LIN to the component..

EXTID-339 - The ECU shall provide diagnostics from the component: diagnostics of internal component states (received via LIN) diagnostics of control errors

EXTID-340 - This chapter shall contain the definition of all variants with dedicated keywords relevant for this module.

EXTID-341 - This chapter shall contain the definition of all abbreviations, terms and expressions used in that module.