

ESX.3ios

ESX I/O modules

KEY FEATURES

- Control specially designed for use in harsh mobile applications
- Suitable for safety related applications up to:
 - SIL2 according to IEC 61508-1:2010, IEC 61508-2:2010 and IEC 61508-3:2010
 - SIL CL 2 according to IEC 62061:2005 + A1:2012 + A2:2015
 - PL d according to EN ISO 13849-1:2015
- Flexible I/O module for programming via CANopen. Other protocols (CANopen safety, ESX CAN efficient safety (ECeS), J1939) on request

TECHNICAL DATA

- TriCore TC 1798 32 bit, 300 MHz
- CAN 1 with wake up function
- 18 inputs (SENT support)
- 17 outputs

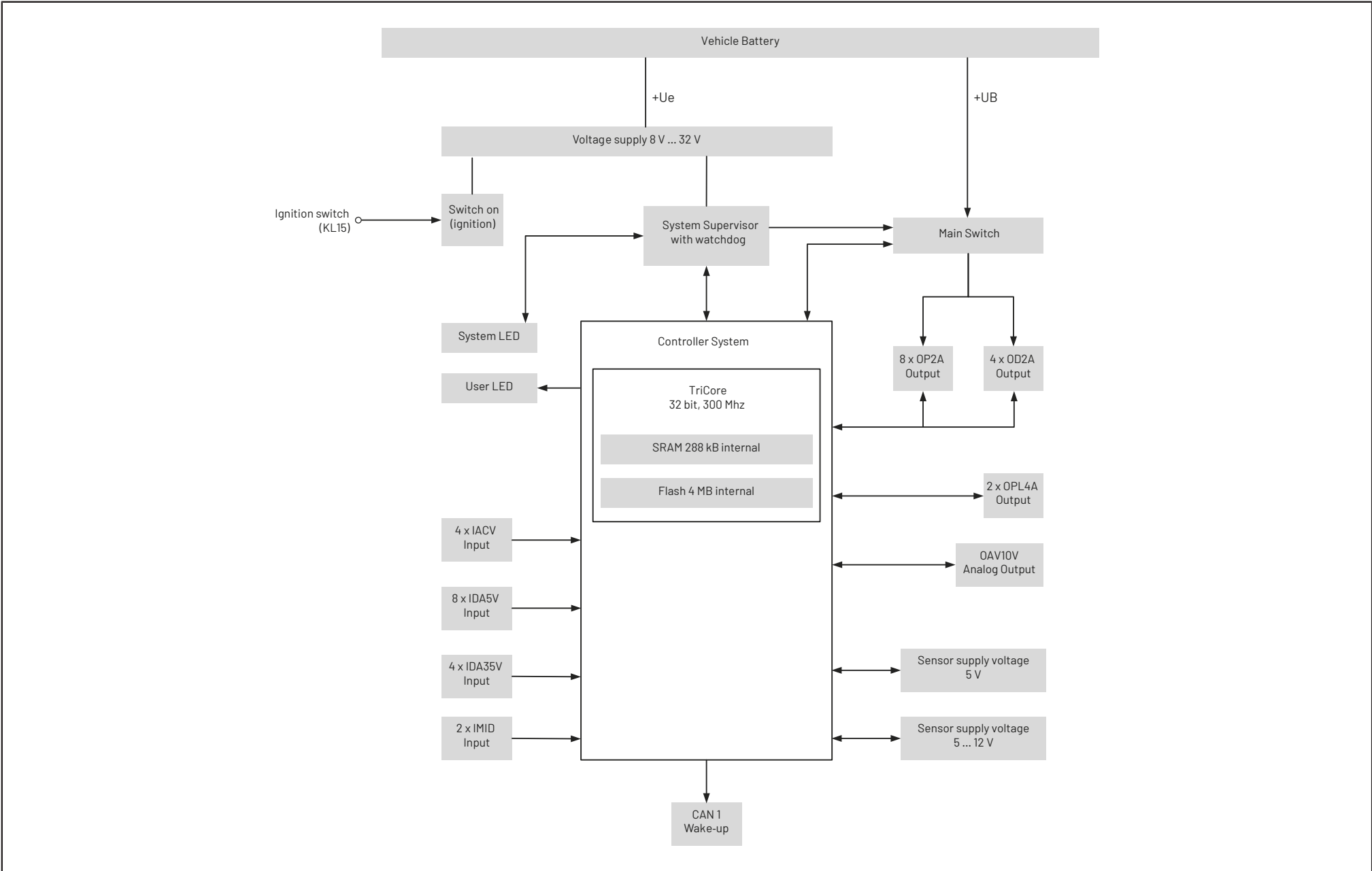
ACCESSORIES

- Mating plug
- Integrated in STW Software Toolchain openSYDE

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BLOCK DIAGRAM



TECHNICAL DATA

Processor and memory

Type	Properties	Comment
TriCore TC1798	32 bit, 300 MHz	<ul style="list-style-type: none"> External system supervisor with programmable watchdog 12 bit A/D converter for analog signal processing
SRAM	288 kB internal	On-chip RAM of the TriCore.
Flash	4 MB	Internal Flash

Communication interfaces

Type	Maximal available counts	Configuration
CAN	1	CAN 2.0 B, high-speed and low-speed, baud rate from 100 kbit/s to 1 Mbit/s CAN bus 1 with ECU wake-up feature

Inputs

Type	Maximal available counts	Possible configuration	Measurement
Multi functional input IDA35V	4	Analog voltage	0 ... 35 V
		Programmable pull-up resistor to +8.5 V	1.1 kΩ
		Programmable pull-down resistor to GND	1 kΩ
		NAMUR sensor compatible	-
		Digital	Low active
			High active
		Frequency	0.6 Hz ... 20 kHz
Analog input IACV	4	Incremental encoder interface	Change of position or angular change
		Analog voltage	0 ... 12 V
		Analog current	0 ... 24 mA
		Digital (voltage mode)	Low active
			High active

TECHNICAL DATA

Inputs

Type	Maximal available counts	Possible configuration	Measurement
Multi functional input IDA5V	8	Analog voltage	0 ... 5 V
		Programmable pull-up resistor to +5 V	6.8 kΩ
		Digital	Low active
			High active
Identification input IMID	2	Frequency	0.6 Hz ... 20 kHz
		Externally connected resistors	Open, short to GND and up to 6 different resistor values

Outputs (All Outputs are Short Circuit Protected)

Type	Max. Quantity	Possible Configuration	Range	Characteristics	Feature	Group
Digital-/PWM- output OP2A	8	Digital		ON/OFF	<ul style="list-style-type: none"> • High side switch • Precise current measurement, accuracy is $\pm 2\% \pm 20$ mA • Supports current control mode • Digital feedback, open load detection in OFF state • Automated shutdown on overcurrent > 4.6 A ± 0.9 A • Combine several outputs for parallel operation up to 12 A 	Power supply via main switch and +UB: 8 outputs
		PWM	0 ... 2.5 A	0 ... 100 % duty cycle resolution $< 0.1\%$ PWM frequency 20 ... 1000 Hz		
Digital output OD2A	4	Digital		ON/OFF	<ul style="list-style-type: none"> • High side switch • Optimized for digital operation mode (ON/OFF) • Raw current measurement, accuracy is $\pm 25\% \pm 100$ mA • Output voltage feedback • Automated shutdown on overcurrent > 3.6 A $\pm 20\%$ • Combine several outputs for parallel operation up to 12 A 	Power supply via main switch and +UB: 4 outputs
		PWM	0 ... 2.5 A	0 ... 100 % duty cycle resolution $< 0.1\%$ PWM frequency 20 ... 1000 Hz		

TECHNICAL DATA

Outputs (All Outputs are Short Circuit Protected)

Type	Max. Quantity	Possible Configuration	Range	Characteristics	Feature	Group
Digital-/PWM- output OPL4A	2	Digital PWM	0 ... 4 A	ON/OFF 0 ... 100 % duty cycle resolution < 0.1 % PWM frequency 20 ... 1000 Hz	<ul style="list-style-type: none"> • Low side switch • Supports current control mode • Precise current measurement, accuracy is $\pm 3\% \pm 100\text{ mA}$ • Output voltage feedback, accuracy is $\pm 3.5\% \pm 150\text{ mV}$ • Digital feedback, open load detection in OFF state • Automated shutdown on overcurrent > 7.5 A $\pm 1.2\text{ A}$ 	Supplied from external load over +UB, or can be combined with a high side switch
Analog voltage output OAV10V	1	Analog voltage signal	0 ... 10 V	0 ... 10 V 10 bit resolution $\pm 1\%$ $\pm 100\text{ mV}$	<ul style="list-style-type: none"> • Voltage feedback, accuracy is $\pm 3\% \pm 100\text{ mV}$ • Resistive load: $\geq 500\text{ Ohm}$ • Capacitive load: $\leq 500\text{ nF}$ • Actuating time $\leq 5\text{ ms}$ at capacitive load of 500 nF 	Supplied from ECU power pin +UE
Sensor supply Uext	2	Programmable voltage Fixed voltage	5 ... 12 V $\pm 2.5\%$ 5 V $\pm 1\%$	Maximal output current $I_{\text{MAX}} = 250\text{ mA}$ programmable output needs derating for output voltages $U_{\text{EXT}} < 10\text{ V}$: $I_{\text{MAX}} = 0.9 / (13.6 - U_{\text{EXT}})\text{ A}$ Maximal output current $I_{\text{MAX}} = 250\text{ mA}$	<ul style="list-style-type: none"> • The Uext output voltage is stable also when the +UE input voltage is below the Uext output voltage. E.g. it is possible to use $U_{\text{ext}} = 12\text{ V}$ when +UE is at the min voltage $+U_{\text{E,MIN}} = 8\text{ V}$ • Voltage feedback accuracy is $\pm 3\% \pm 100\text{ mV}$ • Voltage feedback accuracy is $\pm 3\% \pm 100\text{ mV}$ 	Supplied from ECU power pin +UE

TECHNICAL DATA

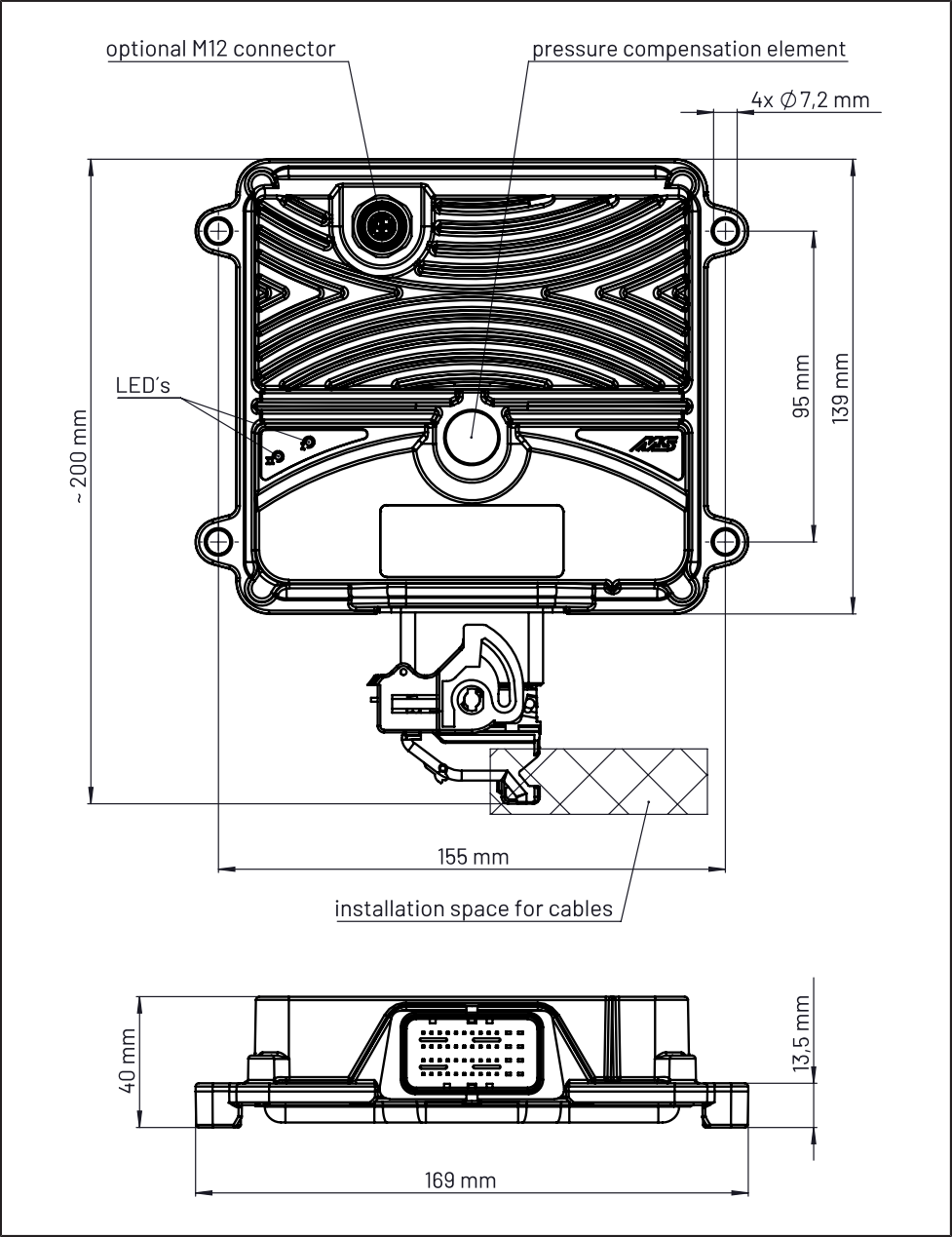
Mechanical Data

Component	Description	Value
Connector	XS1	Automotive 48 pins, matching plug: Molex 64320-1311 and 64320-3311
Indicators	2 LED, dual color (red/green or mixed colors)	1 for the state of the system, 1 freely programmable
Housing	Die-cast aluminum	GORE-TEX®-breathing filter for pressure equalization
Weight	-	about 0.565 kg / about 1.25 lb
Degree of Protection	Variant without Ethernet connector	IP6k7 and IP6k9k
	Variant with Ethernet connector	IP6k7
Dimensions	-	169 mm x 139 mm x 40 mm
Operating temperature, chassis temperature	-	-40 .. +85°C (-40 .. +185°F)

Power Supply

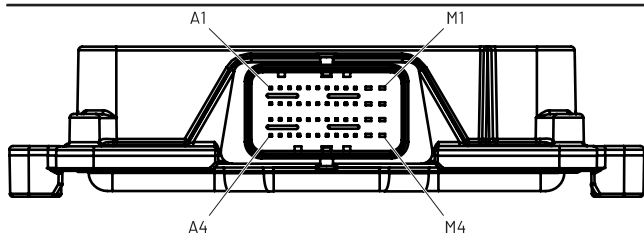
Component	Description	Range	
		Minimum Value	Maximum Value
DC voltage supply	Voltage at +UE ECU supply and +UB power supply	8 V DC	32 V DC
Current consumption (Load)	12 A power pin fully loaded, including low side outputs, short-term		20 A
Current consumption (Stand-by)	Sum of input currents at +UE and +UB ($U_{KL15} = 0$ V, ignition off)		< 1 mA
Current consumption (ECU active)	+UE supply current ($U_{KL15} > U_{KL15HIGH}$, no external load, without sensor supply U_{ext})		< 800mA at +UE = 12 V < 400mA at +UE = 24 V

TECHNICAL DRAWING



PIN ASSIGNMENT

Pin assignment 81 pin connector:



Pin No	Functional signal name	BIOS defines	Description
A1	CAN1_L	X_CAN_BUS_01	CAN bus 1(low)
B1	CAN1_H	X_CAN_BUS_01	CAN bus 1(high)
C1	-	-	-
D1	-	-	-
E1	IDA5V3	X_IN_11	Input digital, pull-up, frequency analog input voltage 0 ... 5 V
F1	IDA5V2	X_IN_10	Input digital, pull-up, frequency analog input voltage 0 ... 5 V
G1	IDA35V2	X_IN_02	Input digital, pull-up and pull-down, NAMUR, frequency, incremental 1-B analog input voltage 0 ... 35 V
H1	OD2A2	X_OUT_12	Output high-side digital/PWM 2.5 A
J1	OP2A4	X_OUT_04	Output high-side PWM/digital 2.5A
K1	OP2A3	X_OUT_03	Output high-side PWM/digital 2.5A
L1	OAV10V	X_OUT_15	Output analog voltage 10V
M1	UB	X_SYS_RELAY_01 supply for output channel X_OUT_01..08 and 11..14	Power supply for the outputs of type OP2A and OD2A
A2	CAN1_L	X_CAN_BUS_01	2nd pin for CAN bus 1(low)

Pin assignment 81 pin connector:

Pin No	Functional signal name	BIOS defines	Description
B2	CAN1_H	X_CAN_BUS_01	2nd pin for CAN bus 1(high)
C2	IACV3	X_IN_07	Analog input current 0 ... 25 mA / voltage 0 ... 12 V, digital functionality with limited bandwidth
D2	IACV2	X_IN_06	Analog input current 0 ... 25 mA / voltage 0 ... 12 V, digital functionality with limited bandwidth
E2	IDA5V6	X_IN_14	Input digital, pull-up, frequency analog input voltage 0 ... 5 V
F2	IDA5V4	X_IN_12	Input digital, pull-up, frequency analog input voltage 0 ... 5 V
G2	IDA35V3	X_IN_03	Input digital, pull-up and pull-down, NAMUR, frequency, incremental 2-A analog input voltage 0 ... 35 V
H2	OD2A3	X_OUT_13	Output high-side digital/PWM 2.5 A
J2	OP2A6	X_OUT_06	Output high-side PWM/digital 2.5A
K2	OP2A5	X_OUT_05	Output high-side PWM/digital 2.5A
L2	OPL4A2	X_OUT_10	Output low-side PWM 4 A
M2	OPL4A1	X_OUT_09	Output low-side PWM 4 A
A3	IMID2	-	Identification input
B3	IMID1	-	Identification input
C3	5Vext	X_SYS_SENSOR_SUPPLY_02	Sensor supply voltage 5 V
D3	5-12Vext	X_SYS_SENSOR_SUPPLY_01	Programmable sensor supply voltage 5 ... 12 V

PIN ASSIGNMENT

Pin assignment 81 pin connector:


Pin No	Functional signal name	BIOS defines	Description
E3	IDA5V7	X_IN_15	Input digital, pull-up, frequency analog input voltage 0 ... 5 V
F3	IDA5V5	X_IN_13	Input digital, pull-up, frequency analog input voltage 0 ... 5 V
G3	IDA35V4	X_IN_04	Input digital, pull-up and pull-down, NAMUR, frequency, incremental 2-B analog input voltage 0 ... 35 V
H3	OD2A4	X_OUT_14	Output high-side digital/PWM 2.5 A
J3	OP2A8	X_OUT_08	Output high-side PWM/digital 2.5A
K3	OP2A7	X_OUT_07	Output high-side PWM/digital 2.5A
L3	OP2A2	X_OUT_02	Output high-side PWM/digital 2.5A
M3	OP2A1	X_OUT_01	Output high-side PWM/digital 2.5A
A4	AGND	-	Analog ground for sensory supplies, IMID inputs and OAV10V output
B4	AGND	-	Analog ground for sensory supplies, IMID inputs and OAV10V output
C4	AGND	-	Analog ground for sensory supplies, IMID inputs and OAV10V output
D4	IACV4	X_IN_08	Analog input current 0 ... 25 mA / voltage 0 ... 12 V, digital functionality with limited bandwidth
E4	IACV1	X_IN_05	Analog input current 0 ... 25 mA / voltage 0 ... 12 V, digital functionality with limited bandwidth

Pin assignment 81 pin connector:

Pin No	Functional signal name	BIOS defines	Description
F4	IDA5V8	X_IN_16	Input digital, pull-up, frequency analog input voltage 0 ... 5 V
G4	IDA5V1	X_IN_09	Input digital, pull-up, frequency analog input voltage 0 ... 5 V
H4	IDA35V1	X_IN_01	Input digital, pull-up and pull-down, NAMUR, frequency, incremental 1-A analog input voltage 0 ... 35 V
J4	OD2A1	X_OUT_11	Output high-side digital/PWM 2.5 A
K4	KL15	-	Ignition (KL15)
L4	GND	-	Ground of the ECU
M4	+UE	-	Power supply of the ECU

QUALIFICATION

Compliance Information

Standard/Directive	Description	Parameter
ISO/IEC 17050-1	 Conformity	See Declaration of Conformity
ISO 13849-1:2015	Safety of machinery	PL d, Cat 2
IEC 61508-1:2010 (SIL 2)	Functional safety	SIL 2
IEC 61508-2:2010 (SIL 2)	Functional safety	SIL 2
IEC 61508-3:2010 (SIL 2)	Functional safety	SIL 2
IEC 62061:2005 + A1:2012 + A2:2015	Safety of machinery	SIL CL 2
2011/65/EU 2015/863/EU	RoHS Restriction of Hazardous Substances	
2006/42/EG	Machinery Directive	
2014/30/EU	Electromagnetic Compatibility Directive	

DETAILED QUALIFICATION

Electrical Safety

Standard	Test Description	Test Parameter
ISO 16750-2: 2012-11	Overvoltage	12 V: 60 min, Voltage supply = 18 V, T = 65 °C, 1 Cycle
		24 V: 60 min, Voltage supply = 18 V, T = 65 °C, 1 Cycle
	Superimposed alternating voltage	12 V: Severity 2: Upp = 4V 24 V: Severity 2: Upp = 4 V
	Slow decrease and increase of supply voltage	Decrease and increase supply voltage with 0.5 V / min
	Momentary drop in supply voltage	12 V: Singel voltage drop to 4.5 V
	Reset behavior at voltage drop	12 V: Voltage drops in 5 % steps until 0 V, drop duration 10 s
		24 V: Voltage drops in 5 % steps until 0 V, drop duration 10 s
	Starting profile switch-on hysteresis	12 V: Testlevel 4
		24 V: Testlevel 3
	Load Dump	12 V Impulse b: Us* = 70 V, Us = 101 V, 5 Pulses
24 V Impulse b (with LowSide - output): Us* = 58 V, Us = 202 V, 5 Pulses 24 V Impulse b (without LowSide - output): Us* = 70 V, Us = 202 V, 5 Pulses		

DETAILED QUALIFICATION

Electrical Safety

Standard	Test Description	Test Parameter
	Reversed voltage	Test case 2
	Ground reference and supply offset	Max. offset (1 ± 0.1) V
	Open circuit test - Single line interruption	Interruption 10 s ± 1 s
	Open circuit test - Multiple line interruption	Interruption 10 s ± 1 s
	Short circuits - signal lines	Connect every In- and Output to Usmax and GND for 1 min
	Short circuits - load lines	To load circuits duration: 5 min

Electromagnetic Compatibility (CE)

Standard	Test Description	Test Parameter
EN 61000-6-3	Emission	Conducted Emission: 0.15 MHz to 30 MHz Radiated Emission: 30 MHz to 5000 MHz
DIN EN 61000-4-2: 2009-12	Electrostatic Discharge (ESD) direct	330 Ohm / 150 pF contact: ±2 kV / ±4 kV / ±6 kV air: ±2 kV / ±4 kV / ±8 kV / ±15 kV
	Electrostatic Discharge (ESD) indirect HCP	330 Ohm / 150 pF contact: ±2 kV / ±4 kV / ±6 kV
	Electrostatic Discharge (ESD) indirect VCP	330 Ohm / 150 pF contact: ±2 kV / ±4 kV / ±6 kV

Electromagnetic Compatibility (CE)

Standard	Test Description	Test Parameter
DIN EN 61000-6-2: 2006-03	Limits and methods of measurement of radio disturbance; characteristics for the protection of receivers used on board vehicles	80 MHz to 2700 MHz, 10 V/m, 20 V/m
DIN EN 61000-4-4: 2013-04	Burst	1 kV & 2 kV (pos/neg)
DIN EN 61000-4-5: 2007-06	Surge	symmetric: ±0.5 kV dissymmetric: ±1 kV
DIN EN 61000-4-6: 2014	Immunity	10 V (0.15 MHz to 80 MHz) AM: 80 % / sinusoidal: 1000 Hz

Environmental Qualification

Standard	Test Description	Test Parameter
DIN EN 50102:1997-09	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code).	IK7 Impact energy (joules): 2
ISO 4892-2:2013-06	Exposure from Xenon-arc lamps	Method A - Testing with filters for global radiation - Cycle no. 1, table 3
DIN EN 60068-2-64:2009-04 ISO 16750-3:2012-12	Resonance search	5 Hz - 2000 Hz, 1 g, 1 oct/min
DIN EN 60068-2-27:2010-02 ISO 16750-3:2012-12	Shock	50 g / 6 ms, halfsine wave, 10 shocks / axis

DETAILED QUALIFICATION

Environmental Qualification

Standard	Test Description	Test Parameter
	Shock	Pulse shape: half-sine Control strategy: single channel Number of shocks: 3 positive, 3 negative per axis Acceleration: 50 g Number of tested axes: 3 Pulse duration: 11 ms
DIN EN 60068-2-31:2009-04 ISO 16750-3:2012-12	Free fall	Drop height: 1 m
DIN EN 60068-2-6:2008-10 ISO 16750-3:2012-12	Vibration (sinusoidal)	Frequency range: 10 Hz - 2000 Hz Acceleration: 5 g Sweep rate: 1 oct/min
DIN EN 60068-2-27:2010-02	Bump	Pulse shape: half-sine Control strategy: single channel Acceleration: 30 g Pulse duration: 6 ms Number of tested axes: 3 Number of shocks: 1000 positive, 1000 negative per axis
DIN EN 60068-2-1:2008-01 ISO 16750-4:2010-04	Low temperature, storage	Tmin: -40 °C Duration: 24 h
DIN EN 60068-2-2:2008-05 ISO 16750-4:2010-04	High temperature, storage	Tmax.: +105 °C Duration: 48 h
ISO 16750-4:2010-04	Temperature step test	Tmax.: +85 °C Tmin: - 40 °C Dwell time at each step: 1 hour (38 steps) Duration: 2 days

Environmental Qualification

Standard	Test Description	Test Parameter
DIN EN 60068-2-14:2010-04 ISO 16750-4:2010-04	Rapid change of temperature	Tmin: -40 °C Tmax: +85 °C Dwell time at Tmin/Tmax: 60 min Number of cycles: 100
DIN EN 60068-2-14:2010-04 ISO 16750-4:2010-04	Temperature cycle with specified change rate	Tmin: -40 °C Tmax: +85 °C Duration: 30 cycles a 480 min
ISO 16750-4:2010	Ice water shock test - Splash water test	Heat the DUT at Tmax for the specified holding time th, then splash it with ice water (0 °C to +4 °C) for 3 sec.; (th = 1 h or until temp. Stabilization is reached) 100 cycles each 66 Min.
	Salt spray test - Corrosion test	acc. to IEC60068-2-52, Test Kb Severity: Severity 4 Cycle duration: 7 days Number of cycles: 2 cycles
	Salt spray test - Leakage and function	acc. to IEC60068-2-11, Test Ka Cycle duration: 24 h (8 h salt spray - 16 h without spray) Number of cycles: 6 cycles
	Corrosion test with flow of mixed gas	acc. To IEC60068-2-60, Test Ke, Method 4 Test cycle: 21 days in pollutant gas atmosphere (SO2, H2S, NO2, Cl2)
	Dust test	Test performed as specified in ISO 20653 Cycle duration: 20 min. Number of cycles: 20 cycles

DETAILED QUALIFICATION

Environmental Qualification

Standard	Test Description	Test Parameter
ISO 20653: 2013-02	IP Protection	IP6k6k, IPx7, IPx9k
EN 60068-2-38:2010-06	Damp heat, steady state	Tmax: +65 °C Tmin: -10 °C Duration: 240 h (10 cycles a 24 h)
DIN EN 60068-2-78:2014-02 ISO 16750-4:2010-04	Damp heat, steady state	Tmax: +40 °C Relative humidity: 85 % RH
DIN EN 60068-2-30:2006-06 ISO 16750-4:2010-04	Dewing test	Upper test temperature: +80 °C Lower test temperature: +25 °C Relative humidity: 98 % RH max / 55 % RH min Number of test cycles: 5, 5.5 h per cycle Total test duration: 27.5 h
ISO 16750-5:2010	Chemical resistance	Exposure time 24 h, Exposure condition 20 °C, 85 % relative humidity, Gasoline, Methanol, Battery acid, Protective lacquer, Windshield washer fluid, Vehicle washing chemicals, Cold cleaning agent, Cleaning solvent, Denatured alcohol, Runway de-icer, Aceton Exposure time 24 h Exposure condition 125 °C, 85 % relative humidity Diesel fuel, Diesel fuel "Bio", Engine oil, Transmission fluid, Automatic transmission oil, Hydraulic oil, Greasees, Silicone oil, Brake fluid, Antifreeze fluid, Urea, Protective lacquer remover, Contact spray

Environmental Qualification

Standard	Test Description	Test Parameter
DIN EN 60068-2-14:2010-04	Life test (Weibull)	-40 °C to +125 °C, dwell time: 1 h, cycle time: 2 h, cycles: 290, test time: 580 h (ca 24 days)