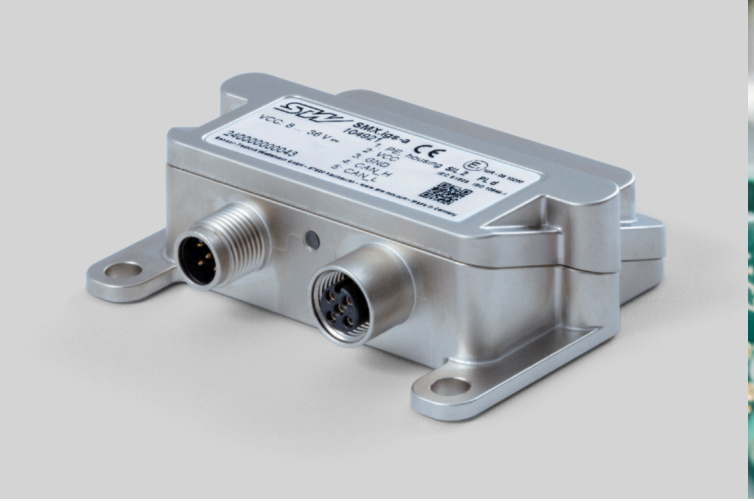
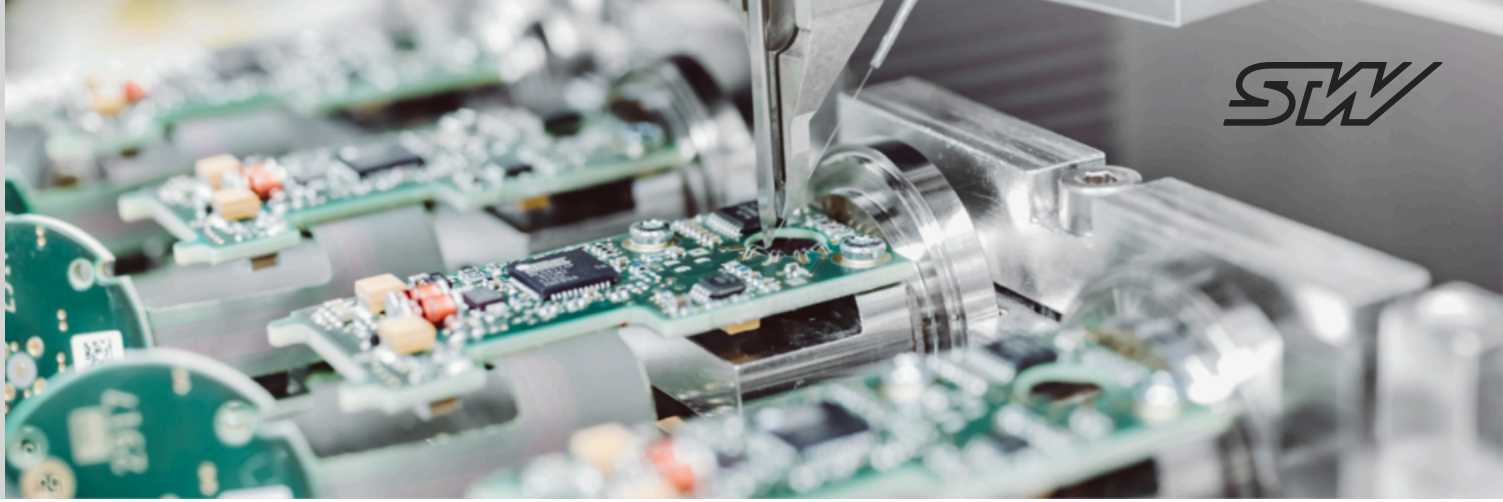




SMX.igs-a (SIL 2 / PL d variant)

Inclination and Gyro Sensors

KEY FEATURES

- Inertial measurement unit (IMU)
- Functional safe measurement of acceleration in 3 axes
- Functional safe measurement of angular velocity in 3 axes
- Functional safe measurement of the inclination of up to 3 axes
- Internal adjustable digital signal filters
- Active temperature compensation available
- Looped-through CAN bus
- Compact and robust design for use in harsh environments
- Integrated into STW's openSYDE software platform
- With ECE type approval

TECHNICAL DATA

- Acceleration measurement range ±3 g
- Gyroscope measurement range ±125°/s ... ±4000°/s
- Configurable inclination measurement range
- Temperature range -40 °C to +85 °C
- CAN protocol: CANopen safety
- Status LED
- Protection class IP6K5/IPX7

Sensor-Technik Wiedemann GmbH

Am Bärenwald 6
87600 Kaufbeuren
Germany
+49 8341 9505-0
info.stw@wiedemann-group.com
www.stw-mm.com

TECHNICAL DATA

Sensor

Characteristics	Parameter	SMX.igs-a (SIL 2 / PL d variant)
Accelerometer	Measuring range	±3 g
	Resolution	0.25 mg
	Offset error @ T_A=25 °C	±5 mg
	Offset error @ T_H [4]	±10 mg
	Offset error @ -40 °C ... +85 °C	±20 mg
	Gain error @ T_A=25 °C	±0.4 %
	Gain error @ T_H [4]	±0.5 %
	Gain error @ -40 °C ... +85 °C	±0.7 %
Gyroscope	Measuring range	±125°/s ... ±4000°/s
	Resolution	0.004375°/s ... 0.140°/s [1]
	Offset error @ T_A=25 °C	±2°/s
	Offset error @ T_H [4]	±3°/s
	Offset error @ -40 °C ... +85 °C	±5°/s
	Gain error @ T_A=25 °C	±2 %
	Gain error @ T_H [4]	±3 %
	Gain error @ -40 °C ... +85 °C	±5 %
	Bias Instability @ T_A=25 °C	typ. 3 °/h
	Angle Random Walk @ T_A=25 °C	typ. 0.2 °/√h

Sensor

Characteristics	Parameter	SMX.igs-a (SIL 2 / PL d variant)	
Angle	Measuring range	max. 360°	
	Resolution	0.01°	
	Accuracy @ T_A=25 °C	static ±0.3°	dynamic ±0.62° [2]
	Accuracy @ T_H [4]	static ±0.5°	dynamic ±1.0° [2]
	Accuracy @ -40 °C ... +85 °C	static ±0.8°	dynamic ±1.6° [2]
	Filter options (configurable) [3]	IIR Butterworth filter 8th order IIR Critical damped filter 8th order	

1) The resolution depends on the measuring range

2) Valid for Kalman parameters R=10.0, Q=0.01

3) The IIR filter algorithms act on the acceleration values, from which the angles are calculated.

4) Valid if target temperature of heater is reached (HNIR=0)

TECHNICAL DATA

CAN Interface

Feature	Properties
Output signal	CAN, bit rate 100 ... 1000 kBit/s
Protocol	CANopen safety
Electrical protection	Short circuit protected (signal on GND/VCC)
Two-Colour-Status LED	Green / Red

Power Supply

Feature	Properties
Voltage supply (power supply pin VCC)	9 ... 36 V DC
	Supply lines inverse-polarity protected
Current Consumption (without active heating)	25 mA @ 12 V DC
Current Consumption (with active heating)	350 mA @ 12 V DC

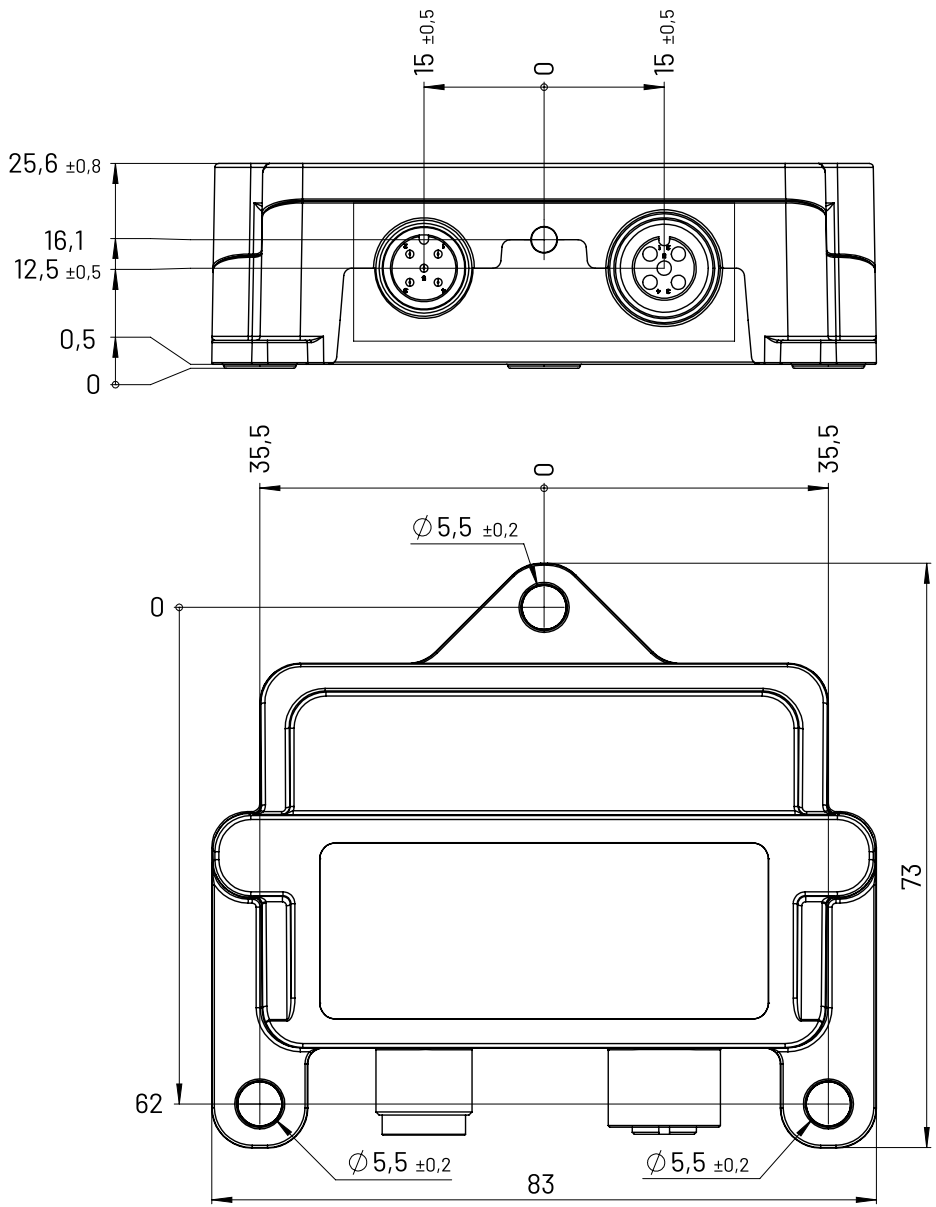
Housing

Feature	Properties
Housing material	Zinc die cast
Dimensions (L x W x H)	83 x 73 x 26 mm
Weight	250 g
Degree of protection	IP6K5/IPX7
Electrical connection	5 pole M12 plug, A coded
	5 pole M12 socket, A coded
Operating temperature	-40 °C ... +85 °C / -40 °F ... +185 °F
Storage temperature	-40 °C ... +85 °C / -40 °F ... +185 °F

Functional Safety

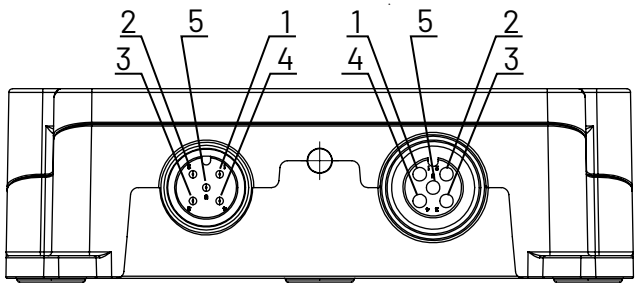
Standard	Description	Parameter
SN 29500	Mean Time To Failure (MTTF)	MTTF = 203 years
IEC 61508:2010	Safety Integrity Level (SIL)	SIL 2
	Operation Mode	High demand mode / continuous mode
	Architecture	1oo1 (single channel)
	Hardware Fault Tolerance (HFT)	HFT = 0
	Safety-related subsystem	Type B
	Safe Failure Fraction (SFF)	SFF ≥ 90 % (incl. Soft-errors)
	Average frequency of dangerous failure per hour (PFH)	PFH ≤ 65 * 10^{-9} failure/hour (incl. Soft-errors)
EN ISO 13849-1:2023	Performance Level (PL)	PL d
	Category (Cat.)	Category 2
	Diagnostic Coverage (DC_{avg})	DC_{avg} = medium
	Mean Time To dangerous Failure ($MTTF_D$)	$MTTF_D$ ≥ 75 years (high; incl. Soft-errors)

TECHNICAL DRAWING



PIN ASSIGNMENT

Pin Assignment 5 Pin M12 Connector (plug or socket)



Pin	Name	Description
1	CAN_SHLD	Shield
2	VCC	Power supply, 9 ... 36 V DC
3	GND	Common Ground
4	CAN_H	CAN High
5	CAN_L	CAN Low

QUALIFICATION

Compliance Information

Standard		Description	Parameter
ISO/IEC 17050-1	CE	Conformity	See Declaration of Conformity
KBA (Kraft-fahrt-Bundesamt)	E1	Certification	According UN ECE Regulation No. 10

DETAILED QUALIFICATION

Electrical Safety

Standard	Test Description	Test Parameter
ISO 16750-1:2018-11	Direct current supply voltage	U_{min} = 9 V U_{max} = 36 V Test duration for each voltage level: 60 min.
ISO 16750-2:2012-11	Overvoltage	36 V for 60 min. at 20 °C below Tmax
ISO 16750-2:2012-11	Superimposed alternating voltage (12 V and 24 V System)	12 V System U_{smax} = 16 V (for UN = 12 V) Sweep duration: 120 seconds Number of sweeps: 5 Severity 1, 2, 4 24 V System U_{smax} = 32 V (for UN = 24 V) Sweep duration: 120 seconds Number of sweeps: 5 Severity 1, 2, 3
ISO 16750-2:2012-11	Slow decrease and increase of supply voltage	Decrease supply voltage from Usmin to 0 V and increase it from 0 V to Usmin. Applying a change rate of (0.5 ±0.1)V per minute
STW Company Standard (Art.Nr. 26688)	Overvoltage / Undervoltage / Switch-on hysteresis	1st: Decrease supply voltage from Umin (9 V) in steps of 0.1 V until all outputs turned off. The determined voltage is called switch-off voltage. Increase supply voltage in steps of 0.1 V. The voltage where the device is

Electrical Safety

Standard	Test Description	Test Parameter
		running again in normal operating mode is the determined switch-on voltage. The difference between switch-off voltage and switch-on voltage is the hysteresis. Operate the device below Umin. Duration: 5 minutes. 2nd: Over-voltage: Operate the device with maximum 3 % above Umax (36 V). Duration: 5 minutes
STW Company Standard (Art.Nr. 26688)	Start test	Supply lines are disconnected, GND is connected. Then connect one input and if available one low-side output to UB Duration: 5 min.
ISO 16750-2:2012-11	Discontinuities in supply voltage - Reset behaviour at voltage drop	Decrease supply voltage from Usmin =9 V in 5 % steps
ISO 16750-2:2012-11	Discontinuities in supply voltage - Starting profile (12 V and 24 V System)	12 V System Voltage cranking; Level 4 24 V System Voltage cranking; Level 3
ISO 16750-2:2012-11	Discontinuities in supply voltage - Load Dump (12 V and 24 V System)	with centralized load dump suppression 5 Pulses

DETAILED QUALIFICATION

Electrical Safety

Standard	Test Description	Test Parameter
ISO 16750-2:2012-11	Reversed voltage - Case 2 - 24 V Systems	Unom. = 24 V -> Case 2 - Test Voltage = 28 V reversed polarity Duration: 60 s
ISO 16750-2:2012-11	Short circuit protection - signal circuits	Connect every In- and Output to maximum supply voltage (U_{smax}) and Ground for 1 minute various modes necessary
ISO 16750-2:2012-11	Short circuit protection - load circuits (supply lines)	to load circuits
ISO 16750-2:2012-11	Open circuit tests - Single line interruption - 24 V Systems	Interruption of each single Output for (10 ±1) s.
ISO 16750-2:2012-11	Open circuit tests - Multiple line interruption - 24 V Systems	Disconnect the DUT for (10 ±1) s.

Electromagnetic and Electrical Tests - EMC (CE)

Standard	Test Description	Test Parameter
DIN EN 61326-1:2013 DIN EN 61000-4-3	Immunity - For electrical equipment for measurement, control and laboratory use - Radiated, radio-frequency, electromagnetic field immunity test	80 MHz to 1 GHz →10 V/m; 1.4 GHz to 6.0 GHz →3 V/m; horizontal and vertical
EN 61326-1:2013 (and 2021) EN IEC 61000-6-2:2019 DIN EN 61000-4-6	Immunity to conducted disturbances, induced by radio-frequency fields - supply and data lines	150 kHz to 80 MHz, 10 V 150 kHz to 80 MHz, 3 V
EN 61326-1:2013 (and 2021)	CISPR11	150 kHz to 30 MHz 30 MHz to 1 GHz (18 GHz)
EN 61326-1:2013 (and 2021) DIN EN 61000-4-8	Immunity - Electrical equipment for measurement, control and laboratory use - magnetic field	Frequency: 50 Hz, 60 Hz Duration: 3 s Field strength: 30 A/m

DETAILED QUALIFICATION

Electromagnetic and Electrical Tests - EMC (automotive)

Standard	Test Description	Test Parameter
UN ECE R10 Add. 9, Rev. 6 Annex 7 CISPR25:2004	Radiated broadband emissions from ESAs	30 MHz to 1000 MHz
UN ECE R10 Add. 9, Rev. 6 Annex 8 CISPR25:2004	Radiated narrowband emissions from ESAs	30 MHz to 1000 MHz
UN ECE R10 Add. 9, Rev. 6 Annex 9 STW Company Standard (Art.Nr. 26688) DIN EN ISO 13766-2:2018	Immunity of ESAs to electromagnetic radiation General: ISO 11452-1:2015 ALSE: ISO 11452-2:2019 BCI: ISO 11452-4:2020 (Stripline and TEM alternative test methods)	General 20 MHz ... 2000 MHz 20 MHz ... 800 MHz: AM 800 MHz ... 3200 MHz: PM BCI: 1 MHz ... 400 MHz, 60 mA (substitution (150 mm, 450 mm, 750 mm) or closed loop (900 mm) method allowed) Antenne, ALS E (vert): 200 MHz ... 800 MHz, 30 V/m, CW, AM 800 MHz ... 3200 MHz, 30 V/m, CW, PM
UN ECE R10 Add. 9, Rev. 6 Annex 9 ISO 7637-2:2004	Emissions - Voltage transient emissions	12 V: +75/-100 V 24 V: +150/-450 V
ISO 7637-2: 2011	Conducted transient emission from ESAs on supply lines, Level 3	12 V slow+: +37 V slow-: -75 V fast+: +75 V fast-: -112 V 24 V slow+: +37 V slow-: -150 V fast+: +150 V fast-: -150 V
UN ECE R10 Add. 9, Rev. 6 Annex 10 ISO 7637-2:2004	Immunity -Electrical transient conduction along supply lines 12 V System, Level 3	Pulse 1 (12 V) -75 V, 5000 pulses Pulse 2a (12 V) +37 V, 5000 pulses Pulse 2b (12 V), +10 V, 10 pulses Pulse 3a (12 V), -112 V, 1 h Pulse 3b (12 V), +75 V, 1 h Pulse 4 (12 V), -6 V, 1 pulse

Electromagnetic and Electrical Tests - EMC (automotive)

Standard	Test Description	Test Parameter
UN ECE R10 Add. 9, Rev. 6 Annex 10 ISO 7637-2:2004	Immunity -Electrical transient conduction along supply lines 24 V System, Level 3	Pulse 1 (24 V) -450 V, 5000 pulses Pulse 2a (24 V) +37 V, 5000 pulses Pulse 2b (24 V), +20 V, 10 pulses Pulse 3a (24 V), -150 V, 1 h Pulse 3b (24 V), +150 V, 1 h Pulse 4 (24 V), -12 V, 1 pulse
ISO 7637-2:2011	Immunity -Electrical transient conduction along supply lines 24 V System, Level 4	Pulse 1 (24 V) -600 V, 500 pulses Pulse 2a (24 V) +112 V, 500 pulses Pulse 2b (24 V), +20 V, 10 pulses Pulse 3a (24 V), -300 V, 1 h Pulse 3b (24 V), +300 V, 1 h
ISO 10605:2008	Immunity - ESD component test method -Powered-up test	330 Ω /330 pF, 330 Ω /150 pF, Contact discharge: ±2, ±4, ±8 kV Air discharge: ±8, ±15 kV

DETAILED QUALIFICATION

Electromagnetic and Electrical Tests - EMC (automotive)

Standard	Test Description	Test Parameter
		Indirect contact discharge: ±2, ±4, ±8 kV
ISO 10605:2008-07	Immunity - ESD component test method - Packaging and Handling test (unpowered test)	2 kΩ /150 pF Contact discharge : ±2, ±4 kV, ±8 kV Air discharge on surfaces: ±4, ±8 kV, ±15 kV
DIN EN ISO 13766-2:2018	Immunity - ESD component test method - Packaging and Handling test (unpowered test) - direct discharges	2 kΩ /300 pF Contact discharge: ±2, ±4 kV, ±8 kV Air discharge: ±4, ±8 kV, ±15 kV
DIN EN ISO 13766-2:2018	Immunity - ESD component test method - Packaging and Handling test (unpowered test) - indirect discharges	2 kΩ /300 pF Contact discharge: ±2, ±4 kV, ±8 kV
DIN EN ISO 13766-2:2018	Electrical transient conduction along supply lines - 12 V and 24 V System, Level 3	12 V /24 V: Pulse 1, 2a, 2b, 3a, 3b, starting profile, load dump with centralized load dump suppression
DIN EN ISO 13766-2:2018 ISO 7637-3:2016	Faults on data lines; 12 V an 24 V system, Level 4	12 V: Slow +: ICC, +6 V, 5 min, t1 = 0,2 s to 5 s Slow -: ICC, -6 V, 5 min, t1 = 0,2 s to 5 s Pulse 3a: CCC, -110 V, 10 min Pulse 3b: CCC, +75 V, 10 min 24 V: Slow +: ICC, +6 V, 5 min, t1 = 0,2 s

Electromagnetic and Electrical Tests - EMC (automotive)

Standard	Test Description	Test Parameter
		to 5 s Slow -: ICC, -6 V, 5 min, t1 = 0,2 s to 5 s Pulse 3a: CCC, -110 V, 10 min Pulse 3b: CCC, +75 V, 10 min

DETAILED QUALIFICATION

Environmental Qualification

Standard	Test Description	Test Parameter
ISO 16750-4:2010-04	Tests at constant temperature: Low temperature - storage	-40 °C for 24 h
ISO 16750-4:2010-04	Tests at constant temperature: High temperature - storage	+85 °C for 48 h
ISO 16750-4:2010-04	Tests at constant temperature: Low temperature - operation	-40 °C for 24 h
ISO 16750-4:2010-04	Tests at constant temperature: High temperature - operation	+85 °C for 96 h
ISO 16750-4:2010-04	Temperature step test	+20 °C to T_{min} to T_{max}, 5 °C steps Duration: 16 h (-40 °C to +85 °C) Perform functional tests when DUT has reached the new temperature
ISO 16750-4:2010-10 DIN EN 60068-2-14:2010-04	Temperature cycling test - Rapid change of Temperature	Test Na 100 cycles, -40 °C to +85 °C Transfer time ≤ 30 s Dwell time: 60 min.
ISO 16750-4:2010-04 DIN EN 60068-2-14	Temperature cycling test - specified change rate of Temperature	Test Nb 30 cycles á 480 min , Tmin to Tmax Duration: 10 days
ISO 16750-4:2010-04	Ice water shock test - Splash water test	Test Fluid: de-ionized water Chamber Temperature: +85 °C Water Temperature: 0 to +4 °C Water Flow: (3 to 4 l)/3 sec (splash

Environmental Qualification

Standard	Test Description	Test Parameter
		duration) Cycle Duration: 66 min Number of cycles: 100 Total Duration 110 h In operation during splash
ISO 16750-4:2010-04 and CLAAS - CN 05 0215-1:2017-01-01 IEC 60068-2-11	Salt spray test - Leakage and function	Test Ka 8 h salt spray and 16 h without spray minimum 6 cycles á 24 h In operation between fourth and fifth hour of each cycle
ISO 16750-4:2010-04 DIN EN 60068-2-52: 2018-08	Salt spray test - Corrosion test	Severity 4 Duration: 14 days
ISO 16750-4:2010 IEC 60068-2-38	Humid heat - Test 2: Composite temperature / humidity cyclic test	Test Z/AD 10 cycles, upper temperature +65 °C 93 % relative humidity, 5 cycles with frost phase (-10 °C) Duration: 11 days In operation when the maximum cycle temperature is reached
ISO 16750-4: 2010-04 IEC 60068-2-30: 2005	Humid heat - Test 3: Dewing test	Test Db Lower temperature: +25 °C Upper temperature: +80 °C 5 cycles and 98 % relative humidity In operation

DETAILED QUALIFICATION

Environmental Qualification

Standard	Test Description	Test Parameter
ISO 16750-4: 2010-04 DIN EN 60068-2-78:2014-02	Damp heat, steady-state test	Severity: (40 ±2) °C and (85 ±3) % relative humidity Not in operation for 20 days 23 h In operation for the last hour Duration: 21 days
ISO 16750-4:2010-04 IEC 60068-2-60	Corrosion test with flow of mixed gas	acc to IEC60068-2-60, Test Ke, method 4; (SO2, H2S, NO2, CL2) 10 days (mounting passenger or luggage/ load compartment) 21 days (other mounting locations)
ISO 16750-1:2018 Annex B	Life-time Temperature cycling test - Rapid change of Temperature (Weibull)	
ISO 16750-3:2012 Test VII	Vibration (random) with temperature superimposition	Vibration noise with temperature superimposition in case of natural frequencies of DUT upper 30 Hz: random vibration acc IEC60068-2-64 from 10 Hz to 2000 Hz for 32 hrs each axis, Temperature cycle 8 h from Tmin to Tmax

Environmental Qualification

Standard	Test Description	Test Parameter
ISO 16750-3: 2012-12 DIN EN 60068-2-27	Mechanical Shock - Test for devices on rigid points on the body and on the frame	Acceleration: 50 g , half sine Time: 6 ms room temperature 10 shocks / direction
ISO 16750-3: 2012-12 DIN EN 60068-2-27: 2010-02	Bump	Acceleration: 30 g, sine Time: 6 ms 500 Shocks/direction, 6 directions
ISO 16750-3:2012 EN 60068-2-32 : 1993	Free fall	3 devices, 2 falls every device on the opposite side of the housing drop height: 1 m to concrete ground or steel plate
ISO 16750-3:2012	Resonance search	10 Hz - 2000 Hz, 1 g, 0,5 oct/min
ISO 16750-4:2010	Solar radiation	Confirmation of housing- and plug manufacturer about UV and OZON durability or test e.g. ISO 75220 or DIN EN 60068-2-5
ISO 16750-4:2010 ISO 20653:2013	IP Protection grade	IP6K5/IPX7

DETAILED QUALIFICATION

EMC (Functional Safety)

Standard	Test Description	Test Parameter
EN 61326-1:2013 (and 2021) DIN EN 61000-4-2	Electrostatic discharge immunity test - direct discharges	330 Ω / 150 pF, Contact discharge ±4 kV Air discharge ±8 kV
DIN EN 61326-3-1:2018 DIN EN 61000-4-2	Functional safety-Electrostatic discharge immunity test - direct discharges	330 Ω / 150 pF, Contact discharge ±6 kV Air discharge ±8 kV
EN 61326-1:2013 (and 2021) DIN EN 61000-4-2	Electrostatic discharge immunity test - indirect discharges (HCP, VCP)	330 Ω / 150 pF, Contact discharge ±4 kV
DIN EN 61326-3-1:2018 DIN EN 61000-4-2	Functional safety-Electrostatic discharge immunity test - indirect discharges	330 Ω / 150 pF, Contact discharge ±6 kV
DIN EN 61326-3-1:2018 DIN EN 61000-4-3	Functional safety- Radiated, radio-frequency, electromagnetic field immunity test	80 MHz to 1.0 GHz →20 V/m 1.4 GHz to 2 GHz →10 V/m 2 GHz to 2.7 GHz →3 V/m 3 m, horizontal and vertical
EN 61326-1:2013 (and 2021) DIN EN 61000-4-4	Immunity - Electrical equipment for measurement, control and laboratory use -Electrical fast transient / burst immunity test	data lines ±1 kV waveform: 5/50 ns tr/th repetition frequency 5 kHz
DIN EN 61326-3-1:2018 DIN EN 61000-4-4	Functional safety- Electrical fast transient / burst immunity test	Supply lines ±3 kV data lines ±2 kV waveform: 5/50 ns tr/th repetition frequency 5 kHz

EMC (Functional Safety)

Standard	Test Description	Test Parameter
DIN EN 61326-3-1:2018 DIN EN 61000-4-6	Functional safety- Immunity to conducted disturbances, induced by radio-frequency fields	Supply lines, data lines 150 kHz to 80 MHz, 10 V