

M01

Pressure sensors

KEY FEATURES

- Compact and robust design for use in harsh environments, suitable for safety machinery applications
- Designed for mobile hydraulics and industrial sectors
- Maximum flexibility through modular design, customization and individualization possible
- High media compatibility (with welded stainless steel measurement cell)
- Integrated into STW's openSYDE software platform
- Designed for OEM needs
- With ECE type approval
- UL Recognized

TECHNICAL DATA

- Nominal pressure from 0.1 to 7 bar (relative and absolute), silicon measurement cell, incl. vacuum
- Nominal pressure from 5 to 2000 bar (relative), welded stainless steel measurement cell, incl. vacuum
- Overload pressure at least twice the nominal pressure
- Media temperatures up to 150 °C / 302 °F
- Protection class IP67 and IPX9K
- Performance Level PL b acc. to ISO 13849
- CAN enabled: CANopen, SAE J1939, STW proprietary
- SENT variant: SAE J2716 APR2016 (Rev. 4) supported
- All common analog output signals available

ACCESSORIES

- Software package for CAN interface setting parameters

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

Available standard pressure ranges (other ranges available) and sensor parameters

Component	Description/value													
Pressure reference	Relative R (gauge G) / absolute A ¹⁾							Relative R (gauge G)						
Standard pressure range	0.3 bar	1 bar	3.4 bar	7 bar	5 bar ²⁾	10 bar	20 bar	50 bar	100 bar	250 bar	400 bar	800 bar	1200 bar	2000 bar ³⁾
Overload pressure (per DIN EN 60770-1)	0.6 bar	1.9 bar	6.9 bar	13.8 bar	20 bar	40 bar	40 bar	100 bar	200 bar	500 bar	800 bar	1000 bar	1600 bar	2200 bar
Bursting pressure (per DIN EN 60770-1)	0.7 bar	2 bar	7 bar	14 bar	70 bar	70 bar	70 bar	500 bar	1000 bar	2500 bar	4000 bar	> 4000 bar	> 4000 bar	> 4000 bar
Media temperature	-40 ... +85 °C / -40 ... +185 °F							-40 ... +150 °C / -40 ... +302 °F						
Operating and storage temperature	-40 ... +85 °C / -40 ... +185 °F							-40 ... +125 °C / -40 ... +257 °F at cable output: -25 ... +85 °C / -13 ... +185 °F						
Material with medium contact	Stainless Steel AISI 316 Ti (EN 1.4571), Silicone Elastomer and NBR seal (For applications with non-aggressive gases and fluids or substances which do not react with above mentioned materials)							Stainless Steel AISI 630 (EN 1.4542), AISI 316 L (EN 1.4435) on request						
Overall accuracy at operating temperature	≤ 1.0 %FS (0 ... +85 °C) / (32 ... +185 °F) ≤ 2.5 %FS (-40 ... 0 °C) / (-40 ... +32 °F)							≤ 0.5 %FS (0 ... +105 °C) / (32 ... +221 °F) ≤ 1.5 %FS (-40 ... 0 °C and +105 ... +125 °C) / (-40 ... +32 °F and +221 ... +257 °F)						
Thereof linearity, pressure hysteresis and repeatability (Linearization with limit point setting)	< 0.25 %FS							< 0.25 %FS						
Long-term stability	< 0.2 %FS p.a.							< 0.2 %FS p.a.						

¹⁾ Not applicable for the M01-SENT and M01-CAN2 variant.

²⁾ Only applicable for the M01-SENT variant.

³⁾ For common-rail applications.

TECHNICAL DATA

Available outputs

Type	Component	Description/value
CAN	Output protocol	STW-CAN (M01-CAN), CANopen, SAE J1939 The technical variant M01-CAN2 provides a state-of-the-art CAN protocol stack and openSYDE support. M01-CAN is no longer recommended for new designs (NRND).
	Sampling Rate	1000 Samples/s (max.)
	Digital Filter	Averaging adjustable
	Electrical connection	M12 connector (plastic or stainless steel), DIN Bayonet (per DIN 72585), DT04-4P, cable output Other connectors on request
SENT	Output protocol	SENT according to SAE J2716 APR2016 (Rev. 4) https://www.sae.org/standards/content/j2716_201604
	Protocol configuration	Fast Channel Frame Format: H.4 with sensor type P/S/t (Pressure/Secure Sensor/Temperature in supplementary channel) Slow Channel Messages: "Enhanced Serial Format" with Diagnostic Error Codes, identification and supplementary information
	Electrical connection	5 V version: M12 connector (plastic), DIN bayonet (per DIN 72585), DT04-4P, DT04-3P, AMP-Superseal 1.5, cable output 8 ... 36 V version: DT04-3P, AMP Superseal 1.5 Other connectors on request
Analog	Output signal	4 ... 20 mA (2-wire technique), 0 ... 20 mA (3-wire technique), 4 ... 20 mA (3-wire technique), 0 ... 10 V, 0 ... 5 V, 1 ... 6 V, 10 ... 90 %VCC (ratiometric output) Other output signals on request
	Electrical connection	M12 connector (plastic or stainless steel), DIN bayonet (per DIN 72585); DT04-4P, DT04-3P, AMP Superseal 1.5, cable output Other connectors on request

TECHNICAL DATA

Mechanical data

Component	Description/value
Pressure connection	G 1/4", G 1/4" with manometer pin, 1/4" NPT, SAE04 (7/16-20UNF), SAE06 (9/16-18UNF), selected metrical pressure connectors, e.g. M14 x 1.5 and other pressure connectors on request, possible limitations of the pressure range. Pressure connections are available with a reduced diameter of the pressure channel to dampen pressure peaks.
Material housing	Stainless steel, AISI 304 (EN 1.4301)
Material connector	Glass-fiber reinforced plastic (PBT) or AISI 304 (EN 1.4301)
Installation torque	Max. 35 Nm
Protection class	IP67 and IPX9K (depends on the electrical connection)

Power supply, cable connection

Parameter	Description
Voltage supply (DC)	U_{VCC} : 9 ... 36 V (for transmitter with 0...20 mA or 4 ... 20 mA current output or voltage output \leq 6 V or M01-CAN variant) U_{VCC} : 14 ... 36 V (for transmitter with 0 ... 10 V voltage output) U_{VCC} : 5 V \pm 10 % (for transmitter with ratiometric output) U_{VCC} : 4.75 ... 5.25 V (for transmitter with SENT interface, version for 5 V sensor supply) U_{VCC} : 8 ... 36 V (for transmitter with SENT interface, version with integrated voltage regulator or M01-CAN2 variant)
Electrical protection	Short circuit protected, signal on GND/VCC and inverse polarity protection (not at ratiometric output)
Maximum cable length	For CE conformity (EMC), the maximum overall cable length must not exceed 30 m

TECHNICAL DATA

Functional safety

Standard

EN ISO 13849-1:2015

Description

PL b / Category B
MTTF₀ = 949.9 years (high) for M01 4 ... 20 mA (2-wire technique)
MTTF₀ = 724.6 years (high) for M01-CAN
MTTF₀ = 760.2 years (high) for M01-CAN2
MTTF₀ = 1507.1 years (high) for M01-SENT

SN 29500

MTTF = 475.0 years for M01 4 ... 20 mA (2-wire technique)
MTTF = 362.3 years for M01-CAN
MTTF = 380.1 years for M01-CAN2
MTTF = 753.6 years for M01-SENT

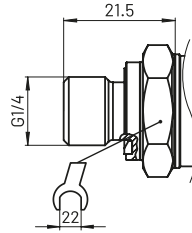
TECHNICAL DRAWINGS AND PIN ASSIGNMENTS

Available Standard Pressure Connections

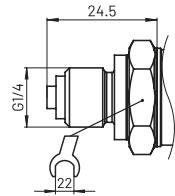
Connection

Drawing

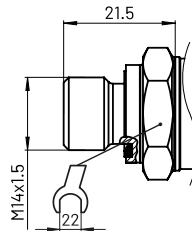
G1/4", DIN EN ISO 1179-2:2014-03 (formerly DIN 3869:1994-05)



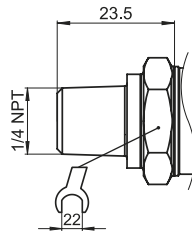
G1/4" according to DIN EN 837-1:1997-02 (formerly DIN 16288)



M14 x 1.5, DIN EN ISO 9974-2:2000-09



1/4" NPT per „Nominal width for US-standard bevelled pipe thread NPT“

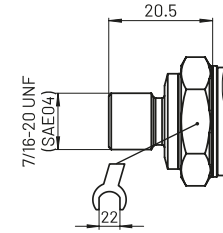


Available Standard Pressure Connections

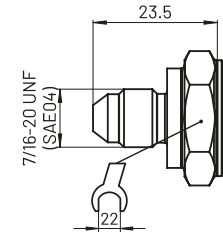
Connection

Drawing

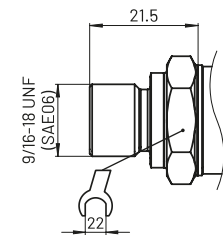
SAE04 (7/16-20UNF) - O-Ring



SAE04 (7/16-20UNF) - Cone



SAE06 (9/16-18UNF) - O-Ring



TECHNICAL DRAWINGS AND PIN ASSIGNMENTS

Available Electrical Connections, Protection Class

Connection Circular plug-in connector M12x1, 5-pole, IP67 applicable for CAN, SENT and analog Version

Drawing

PBT-GF30
L = 30.8
L = 24.4 ratiometric and SENT

Pins

Pin	2-wire technique	3-wire technique	CAN
1	VCC	VCC	PE, housing
2	-	-	VCC
3	SIG	GND	GND
4	-	SIG	CAN_H
5	-	-	CAN_L

Do not connect the pins marked with „-“!

Connection Circular plug-in connector M12x1, 5-pole, IP67 applicable for CAN and analog Version

Drawing

stainless steel

Pins

Pin	2-wire technique	3-wire technique	CAN
1	VCC	VCC	PE, housing
2	-	-	VCC
3	SIG	GND	GND
4	-	SIG	CAN_H
5	-	-	CAN_L

Do not connect the pins marked with „-“!

Connection Bayonet connector DIN 72585, 4-pole, IP67 applicable for CAN, SENT and analog Version

Drawing

L = 35.6
L = 29.2 ratiometric and SENT

Pins

Pin	2-wire technique	3-wire technique	CAN
1	VCC	VCC	VCC
2	SIG	GND	GND
3	-	SIG	CAN_H
4	-	-	CAN_L

Do not connect the pins marked with „-“!

Connection Connector DT04-4P, 4-pole, IP67 applicable for CAN, SENT and analog Version

Drawing

L = 43.7
L = 37.3 ratiometric and SENT

Pins

Pin	2-wire technique	3-wire technique	CAN
1	VCC	VCC	CAN_L
2	SIG	GND	VCC
3	-	SIG	GND
4	-	-	CAN_H

Do not connect the pins marked with „-“!

Available Electrical Connections, Protection Class

Connection Cable output IP67/IPX9K (Oil-resistant cable on request) applicable for CAN, SENT and analog Version

Drawing

L = 55.5
L = 49.1 ratiometric and SENT

Pins

Litz wire	2-wire technique	3-wire technique	CAN
brown	VCC	VCC	PE, housing
white	-	-	VCC
blue	SIG	GND	GND
black	-	SIG	CAN_H
grey	-	-	CAN_L

Do not connect the litz wires marked with „-“!

Connection Connector for AMP Superseal 1,5 3-pole, IP67 applicable for SENT and analog

Drawing

L = 38.2
L = 31.8 ratiometric and SENT

Pins

Pin	2-wire technique	3-wire technique
1	SIG	GND
2	-	SIG
3	VCC	VCC

Do not connect the pins marked with „-“!

Connection Connector DT04-3P 3-pole, IP67 applicable for SENT and analog

Drawing

L = 42.7
L = 36.3 ratiometric and SENT

Pins

Pin	2-wire technique	3-wire technique
A	VCC	VCC
B	-	SIG
C	SIG	GND

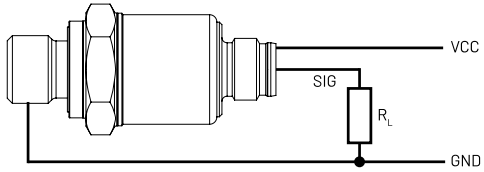
Do not connect the pins marked with „-“!

STW standard pin assignments are shown, other pin assignments on request. The actual pin assignment is shown on the product label.
Pin assignments for 3-wire technique are also applicable for versions with SENT interface.

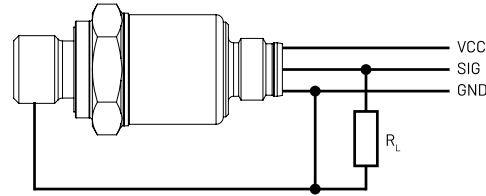
TERMINAL LAYOUTS

Recommended terminal layout

2-wire technique



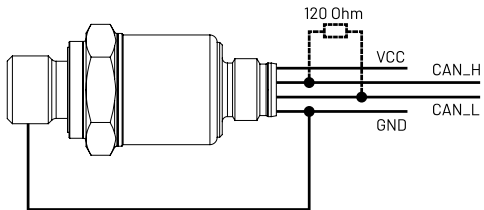
3-wire technique



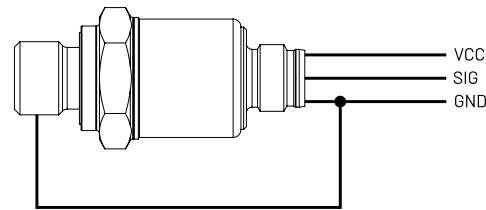
Current output load $R_L \leq (U_{VCC} - 9\text{ V}) / 0.02\text{ A}$ for $U_{VCC} \geq 24\text{ V}$
 additionally $R_L \geq (U_{VCC} - 24\text{ V}) / 0.048\text{ A}$

Voltage output load: $R_L \geq 10\text{ k}\Omega$

CAN



SENT



QUALIFICATION

Compliance Information

Standard

ISO/IEC 17050-1



Description

Conformity

UL recognized



UL File Number E317934

KBA (Kraftfahrt-Bundesamt)



Certification

According UN ECE Regulation No. 10

DETAILED QUALIFICATION

EMC industrial (CE)

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND}	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
DIN EN 61000-6-3:2007 + A1:2011 DIN EN 55011:2007 + A2:2007	Emissions - Residential, commercial and light-industrial environments	Conducted emission 150 kHz to 30 MHz; Radiated emission 30 MHz to 1000 MHz, 10 m	Yes	Yes	Yes	—	—	—	—
DIN EN 61000-6-4:2007 DIN EN 55011:2007 + A2:2007	Emissions - Residential, commercial and light-industrial environments	Conducted emission 150 kHz to 30 MHz; Radiated emission 30 MHz to 1000 MHz, 10 m	—	—	—	Yes	—	—	—
DIN EN 61326-1:2013-07 DIN EN 61326-2-3:2013-07 DIN EN 55016-2-1:2014 + A1:2017	Emissions - Electrical equipment for measurement, control and laboratory use ^{TMC)}	150 kHz to 30 MHz conducted emission	—	—	—	—	—	Yes	Yes
DIN EN 61326-1:2013-07 DIN EN 61326-2-3:2013-07 DIN EN 55016-2-3:2017	Emissions - Electrical equipment for measurement, control and laboratory use ^{TMC)}	30 MHz to 1000 MHz radiated emission, 10 m	—	—	—	—	—	Yes	Yes
DIN EN 61326-1:2013-07 DIN EN 61326-2-3:2013-07 DIN EN 55011:2017-03	Emissions - Electrical equipment for measurement, control and laboratory use	Conducted emission 150 kHz to 30 MHz; Radiated emission 30 MHz to 1000 MHz, 3 m	—	—	—	—	Yes	—	—
DIN EN 61000-6-2:2005 DIN EN 61000-4-2:1998 + A2:2001	Immunity - Industrial environments - Electrostatic discharge immunity test	330 Ω / 150 pF Contact discharge ±2, ±4 kV Air discharge ±2, ±4, ±8 kV	Yes	Yes	Yes	Yes	—	—	—
DIN EN 61326-1:2013-07 DIN EN 61326-2-3:2013-07 DIN EN 61000-4-2:2009	Immunity - Electrical equipment for measurement, control and laboratory use - Electrostatic discharge immunity test ^{TMC)}	330 Ω / 150 pF Contact discharge ±4 kV Air discharge ±8 kV	—	—	—	—	Yes	Yes	Yes

DETAILED QUALIFICATION

EMC industrial (CE)

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND}	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
DIN EN 61326-1:2013-07 DIN EN 61326-2-3:2013-07 DIN EN 61000-4-3:2006 + A1:2008 + A2:2010	Immunity - Electrical equipment for measurement, control and laboratory use - Radiated, radio-frequency, electromag- netic field immunity test ^{TMC}	80 MHz to 1.0 GHz → 10 V/m 1.4 GHz to 2 GHz → 3 V/m 2 GHz to 2.7 GHz → 1 V/m 3 m, horizontal and vertical AM 80 %, 1 kHz	–	–	–	–	–	Yes	Yes
DIN EN 61000-6-2:2005 DIN EN 61000-4-3:1998 + A2:2001	Immunity - Industrial environments - Radiated, radio-frequency, electromag- netic field immunity test	80 MHz to 2.7 GHz → 10 V/m 3 m, horizontal and vertical AM 80 %, 1 kHz	Yes	Yes	Yes	Yes	–	–	–
DIN EN 61326-1:2013-07 DIN EN 61326-2-3:2013-07 DIN EN 61000-4-3: 2011-04	Immunity - Electrical equipment for measurement, control and laboratory use - Radiated, radio-frequency, electromag- netic field immunity test	80 MHz to 2.7 GHz → 10 V/m 2.7 GHz to 6 GHz → 3 V/m 3 m, horizontal and vertical AM 80 %, 1 kHz	–	–	–	–	Yes	–	–
DIN EN 61000-6-2:2005 DIN EN 61000-4-4:2001 + A2:2001	Immunity - Industrial environments - Elec- trical fast transient / burst immunity test	Supply lines ±2 kV data lines ±1 kV waveform: 5/50 ns tr/th repetition frequency 5 kHz	Yes	Yes	Yes	Yes	–	–	–
DIN EN 61326-1:2013-07 DIN EN 61326-2-3:2013-07 DIN EN 61000-4-4:2012	Immunity - Electrical equipment for measurement, control and laboratory use - Electrical fast transient / burst immunity test	Supply lines ±2 kV data lines ±1 kV waveform: 5/50 ns tr/th repetition frequency 5 kHz	–	–	–	–	–	Yes	Yes
DIN EN 61326-1:2013-07 DIN EN 61326-2-3:2013-07 DIN EN 61000-4-4:2013-04	Immunity - Electrical equipment for measurement, control and laboratory use - Electrical fast transient / burst immunity test	Supply lines ±2 kV data lines ±1 kV waveform: 5/50 ns tr/th repetition frequency 100 kHz	–	–	–	–	Yes	–	–
DIN EN 61000-6-2:2005 DIN EN 61000-4-5:2001	Immunity - Industrial environments - Surge immunity test	Supply lines (symmetrical) ±0.5 kV	Yes	Yes	–	Yes	–	–	–

DETAILED QUALIFICATION

EMC industrial (CE)

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND})	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
		Supply lines (asymmetrical) ±0.5 kV							
DIN EN 61326-1:2013-07 DIN EN 61326-2-3:2013-07 DIN EN 61000-4-5:2014 + A1:2017	Immunity - Electrical equipment for measurement, control and laboratory use - Surge immunity test	Supply lines (symmetrical) ±0.5, ±1 kV Supply lines (asymmetrical) ±0.5, ±1, ±2 kV	-	-	-	-	-	Yes	-
DIN EN 61000-6-2:2005 DIN EN 61000-4-6:2001	Immunity - Industrial environments - Immunity to conducted disturbances, induced by radio-frequency fields	150 kHz to 80 MHz, 10 V 80 % AM, sine at 1 kHz	Yes	Yes	Yes	Yes	-	-	-
DIN EN 61326-1:2013-07 DIN EN 61326-2-3:2013-07 DIN EN 61000-4-6: 2012-11	Immunity - Electrical equipment for measurement, control and laboratory use - Immunity to conducted disturbances, induced by radio-frequency fields	150 kHz to 80 MHz, 3 V 80 % AM, sine at 1 kHz	-	-	-	-	-	Yes	Yes
DIN EN 61326-1:2013-07 DIN EN 61326-2-3:2013-07 DIN EN 61000-4-6: 2014-08	Immunity - Electrical equipment for measurement, control and laboratory use - Immunity to conducted disturbances, induced by radio-frequency fields	150 kHz to 80 MHz, 10 V 80 % AM, sine at 1 kHz	-	-	-	-	-	-	-
DIN EN 61326-1:2013-07 DIN EN 61326-2-3:2013-07 DIN EN 61000-4-6: 2014-08	Immunity - Electrical equipment for measurement, control and laboratory use - Immunity to conducted disturbances, induced by radio-frequency fields	150 kHz to 80 MHz, 3 V 80 % AM, sine at 1 kHz	-	-	-	-	Yes	-	-

TMC) applicable only for Thin-film based Measurement Cell.

NRND) not recommended for new design.

DETAILED QUALIFICATION

FCC, 47 CFR Part15, Subpart B

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND}	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
FCC 47 CFR Part15 Subpart B: 2007, Class A	Emissions - Conducted emission from power port	Frequency: 150 kHz to 30 MHz	–	–	–	Yes	–	–	–
FCC 47 CFR Part15 Subpart B: 2007, Class A	Emissions - Radiated emission	Frequency: 30 MHz to 1 GHz	–	–	–	Yes	–	–	–
FCC 47 CFR Part15 Subpart B: Class B	Emissions - Conducted emission from power port	Frequency: 150 kHz to 30 MHz	Yes	Yes	Yes	–	–	–	–
FCC 47 CFR Part15 Subpart B: Class B	Emissions - Radiated emission	Frequency: 30 MHz to 1 GHz	Yes	Yes	Yes	–	–	–	–
FCC Part15 class B: 2017 ANSI C63.4: 2014	Emissions - Conducted emission from power port	Frequency: 150 kHz to 30 MHz	–	–	–	–	Yes	Yes	Yes
FCC Part15 class B: 2017 ANSI C63.4: 2014	Emissions - Radiated emission	Frequency: 30 MHz to 1 GHz, 10 m	–	–	–	–	Yes	Yes	Yes

NRND) not recommended for new design.

DETAILED QUALIFICATION

EMC automotive

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND}	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
UN ECE R10 DIN EN 55025:2003-11, IEC/CISPR 25:2002	Emissions - Radiated emissions from components - ALSE method	150 kHz to 3 GHz, 1 m	Yes	Yes	Yes	Yes	–	–	–
UN ECE R10 DIN EN 55025:2003-11, IEC/CISPR 25:2002	Emissions - Radiated emissions from components - ALSE method	30 MHz to 1 GHz	–	–	–	–	–	Yes	Yes
UN ECE R10 DIN EN 55025:2018-03, IEC/CISPR 25:2016-10	Emissions - Radiated emissions from components - ALSE method	150 kHz to 3 GHz, CISPR Class 4	–	–	–	–	Yes	–	–
IEC/CISPR 25:2002, DIN EN 55025:2003-11	Emissions - Conducted emission - voltage probe method	150 kHz to 108 MHz	Yes	Yes	Yes	Yes	–	–	–
IEC/CISPR 25:2002, DIN EN 55025:2003-11	Emissions - Conducted emission - current probe method	150 kHz to 108 MHz	Yes	Yes	Yes	Yes	–	–	–
IEC/CISPR 25:2016-10, DIN EN 55025:2018-03	Emissions - Conducted emission - current probe method	150 kHz to 108 MHz, CISPR Class 4	–	–	–	–	Yes	–	–
UN ECE R10 ISO 11452-2:2004, ISO 11452-5:2002-04	Immunity - For components to electro- magnetic Energy	ALSE - 400 MHz to 2000 MHz, 200 V/m Stripline - 0.01 MHz to 400 MHz, 200 V/m	–	–	–	Yes	–	–	–
UN ECE R10 ISO 11452-2:2004, ISO 11452-5:2002-04	Immunity - For components to electro- magnetic Energy	ALSE - 400 MHz to 2000 MHz, 100 V/m Stripline - 0.01 MHz to 400 MHz, 200 V/m	–	–	Yes	–	–	–	–
UN ECE R10 ISO 11452-2:2004, ISO 11452-5:2002-04	Immunity - For components to electro- magnetic Energy	ALSE - 400 MHz to 2000 MHz, 50 V/m	Yes	Yes	–	–	–	–	–

DETAILED QUALIFICATION

EMC automotive

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND}	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
		Stripline - 150 kHz to 400 MHz, 200 V/m							
UN ECE R10 ISO 11452-2:2004, ISO 11452-5:2002-04	Immunity - For components to electro- magnetic Energy	ALSE - 1 GHz to 2 GHz, 30 V/m Stripline - 20 MHz to 1 GHz, 60 V/m	–	–	–	–	–	Yes	Yes
ISO 11452-2:2004, ISO 11452-4:2011-12, ISO 11452-5:2002-04	Immunity - For components to electro- magnetic Energy	ALSE - 200 MHz to 3200 MHz, 200 V/m BCI - 1 MHz to 400 MHz, 200 mA Stripline - 20 MHz to 1000 MHz, 60 V/m	–	–	–	–	Yes	–	–
ISO 7637-2:2004	Emissions - Voltage transient emissions	12 V: +75/-100 V	–	–	–	–	Yes	Yes	–
ISO 7637-2:2004	Emissions - Voltage transient emissions	24 V: +150/-450 V	Yes	Yes	Yes	Yes	Yes	Yes	–
UN ECE R10 ISO 7637-2:2004-09	Immunity - Electrical transient conduction along supply lines only (12 V and 24 V System) - Level 4	Pulse 1(24 V) -600 V, 5000 pulses Pulse 1(12 V) -100 V, 5000 pulses Pulse 2a (24 V) +50 V, 5000 pulses Pulse 2b (24 V), +20 V, 10 pulses Pulse 3a (24 V), -200 V, 1 h Pulse 3b (24 V), +200 V, 1 h Pulse 4 (24 V), -16 V, 2 pulses	–	–	–	Yes	–	–	–
UN ECE R10 ISO 7637-2:2004-09	Immunity - Electrical transient conduction along supply lines only (24 V System) - Level 4	Pulse 1(24 V) -600 V, 5000 pulses Pulse 2a (24 V) +50 V, 5000 pulses	Yes	Yes	–	–	–	–	–

DETAILED QUALIFICATION

EMC automotive

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND}	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
		Pulse 2b (24 V), +20 V, 10 pulses Pulse 3a (24 V), -200 V, 1 h Pulse 3b (24 V), +200 V, 1 h Pulse 4 (24 V), -16 V, 2 pulses							
UN ECE R10 ISO 7637-2:2004-09	Immunity - Electrical transient conduction along supply lines only (12 V and 24 V System) - Level 3	Pulse 1 (24 V) -450 V, 5000 pulses Pulse 2a (24 V) +37 V, 5000 pulses Pulse 2a (12 V) +37 V, 5000 pulses Pulse 2b (24 V), +20 V, 10 pulses Pulse 2b (12 V), +10 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 Pulse 4 (12 V), -6 V, 1 pulse	-	-	-	-	-	Yes	-
ISO 7637-2:2011-03	Immunity - Electrical transient conduction along supply lines only (12 V and 24 V System) - Level 4	12 V: Pulse 1 (12 V) -200 V, 500 pulses Pulse 2a (12 V) +112 V, 500 pulses Pulse 2b (12 V), +10 V, 10 pulses Pulse 3a (12 V), -450 V, 1 h Pulse 3b (12 V), +200 V, 1 h 24 V: Pulse 1 (24 V) -600 V, 500 pulses	-	-	-	-	Yes	-	-

DETAILED QUALIFICATION

EMC automotive

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND}	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
		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 16750-2:2012-11	Immunity - Environmental conditions and testing for electrical and electronic equipment – Part 2: Electrical loads	Load Dump - Test B 48 V, 100 ms, 8 Ω, 5 pulses	–	–	–	Yes	–	–	–
ISO 7637-3:1999	Immunity - Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines (24 V System) - Level 4	CCC Pulse 3a: -200 V, 1 h Pulse 3b: +200 V, 1 h	Yes	Yes	–	–	–	–	–
ISO 7637-3:1999	Immunity - Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines (24 V System) - Level 4	CCC Pulse 3a: -80 V, 1 h Pulse 3b: +80 V, 1 h	–	–	Yes	Yes	–	–	–
ISO 7637-3:2016-07	Immunity - Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines (12 V and 24 V System) - Level 4	12 V: CCC Pulse 3a: -110 V, 10 min. Pulse 3b: +75 V, 10 min. ICC Pulse Slow-: -6 V, 5 min. Pulse Slow+: +6 V, 5 min. 24 V: CCC Pulse 3a: -150 V, 10 min. Pulse 3b: +150 V, 10 min.	–	–	–	–	Yes	–	–

DETAILED QUALIFICATION

EMC automotive

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND}	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
		ICC Pulse Slow-: -10 V, 5 min. Pulse Slow+: +10 V, 5 min.							
ISO 10605:2001-12	Immunity - ESD component test method - Powered-up test	2 kΩ/150 pF Contact discharge: ±8 kV Air discharge: ±15 kV	Yes	Yes	Yes	Yes	—	—	—
ISO 10605:2001-12	Immunity - ESD component test method - Powered-up test	2 kΩ/330 pF Contact discharge: ±8 kV Air discharge: ±15 kV	—	—	Yes	Yes	—	—	—
ISO 10605:2008-07	Immunity - ESD component test method - Powered-up test	330 Ω/330 pF, 330 Ω/150 pF Contact discharge: ±2, ±4, ±6, ±8 kV Air discharge: ±4, ±8, ±15 kV Indirect contact discharge: ±2, ±4, ±6, ±8 kV	—	—	—	—	Yes	—	—
ISO 10605:2001-12	Immunity - ESD component test method - Packaging and Handling test (unpowered test)	2 kΩ/330 pF Contact discharge: ±6, ±8 kV	Yes	Yes	Yes	Yes	—	—	—
ISO 10605:2001-12	Immunity - ESD component test method - Packaging and Handling test (unpowered test)	2 kΩ/150 pF Contact discharge: ±8 kV	—	—	Yes	Yes	—	—	—
ISO 10605:2008-07 + 1 AMD:2014-04	Immunity - ESD component test method - Packaging and Handling test (unpowered test)	2 kΩ/150 pF Contact discharge on pins and contacts: ±2, ±4, ±6, ±8 kV	—	—	—	—	Yes	—	—

DETAILED QUALIFICATION

EMC automotive

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND}	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
		Air discharge on surfaces: ± 2 , ± 4 , ± 8 , ± 15 kV							

NRND) not recommended for new design.

DETAILED QUALIFICATION

Climatic and mechanical tests

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND}	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
ISO 16750-4:2010-04	Tests at constant temperature: Low temperature - storage	-40 °C for 24 h	–	–	–	–	Yes	–	–
ISO 16750-4:2010-04	Tests at constant temperature: High temperature - storage	+125 °C for 48 h	–	–	–	–	Yes	–	–
ISO 16750-4:2010-04	Tests at constant temperature: Low temperature - operation	-40 °C for 24 h	–	–	–	–	–	Yes	Yes
DIN EN 60068-2-1:1995-03	Tests at constant temperature: Low temperature - operation	-40 °C for 96 h	Yes	Yes	Yes	Yes	–	–	–
ISO 16750-4:2010-04	Tests at constant temperature: Low temperature - operation	-40 °C for 96 h	–	–	–	–	Yes	–	–
DIN EN 60068-2-2/A2:1995-01	Tests at constant temperature: High temperature - operation	+125 °C for 96 h	Yes	Yes	Yes	Yes	–	–	–
ISO 16750-4:2010-04	Tests at constant temperature: High temperature - operation	+125 °C for 96 h	–	–	–	–	Yes	Yes	Yes
DIN EN 60068-2-2/A2:1995-01	Tests at constant temperature: High Temperature endurance test	+70 °C for 500 h	Yes	Yes	Yes	–	–	–	–
DIN EN 60068-2-2:2007-07	Tests at constant temperature: High Temperature endurance test	+125 °C for 500 h	–	–	–	–	Yes	–	–
DIN EN 60068-2-14:2000-08	Temperature cycling test - Rapid change of Temperature	10 cycles, -40 °C to +125 °C Transfer time < 30 s Dwell time: 60 min. In operation	Yes	Yes	Yes	Yes	–	–	–
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 +125 °C	–	–	–	–	Yes	–	–

DETAILED QUALIFICATION

Climatic and mechanical tests

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND})	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
		Transfer time ≤ 10 s Dwell time: 30 min. Not in operation							
DIN EN 60068-2-14:2000-08	Temperature cycling test - specified change rate of Temperature	10 cycles, -40 °C to 125 °C Temp. Change rate: 3 K/min. Dwell time: 60 min. In operation	Yes	Yes	Yes	Yes	–	Yes	Yes
ISO 16750-4:2010-10 DIN EN 60068-2-14:2010-04	Temperature cycling test - specified change rate of Temperature	Test Nb 100 cycles, -40 °C to 125 °C Temp. Change rate: > 1 K/ min. Dwell time: 60 min. In operation, 10 and 2 restarts at the end of T _{min} and T _{max} cycles respectively.	–	–	–	–	Yes	–	–
ISO 16750-4:2010-04	Ice water shock test - Submersion test	number of cycles: 10 h holding time (th) at T _{max} +125 °C: 1 h water temperature: 0 °C to +4 °C immersion time: 5 min. In operation	Yes	Yes	Yes	Yes	Yes	Yes	Yes
DIN EN 60068-2-52:2000-02	Salt spray test - cyclic	5 % NaCl, 4 cycles á 24 h, +35 °C	Yes	Yes	Yes	Yes	Yes	Yes	Yes
DIN EN ISO 9227:2017-07	Salt spray test - Corrosion test	Test NSS 5 % NaCl, 4 cycles á 24 h, +35 °C Not in operation	Yes	Yes	Yes	Yes	Yes	Yes	Yes

DETAILED QUALIFICATION

Climatic and mechanical tests

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND}	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
DIN EN 60068-2-30:2000-02, DIN EN 50016:1962-12	Humid heat - Damp heat cyclic test	+25 °C to +55 °C and 96 % relative humidity 6 cycles á 24 h	Yes	Yes	Yes	Yes	–	Yes	Yes
DIN EN 60068-2-30:2005	Humid heat - Damp heat cyclic test	+25 °C to +55 °C and 96 % relative humidity 6 cycles á 24 h	–	–	–	–	Yes	–	–
DIN EN 60068-2-78:2002-09	Damp heat, steady-state test	+40 °C and 96 % relative humidity Not in operation for 20 days 23 h In operation for the last hour Duration: 21 days	Yes	Yes	Yes	Yes	–	–	–
ISO 16750-4:2010-04 IEC 60068-2-60	Corrosion test with flow of mixed gas	Test Ke, Method 4 Duration: 10 days SO ₂ , H ₂ S, NO ₂ , Cl ₂	Yes	Yes	Yes	Yes	Yes	Yes	Yes
DIN EN ISO 6270-2:2005	Condensation water atmospheres	4 cycles, 96 h	Yes	Yes	Yes	Yes	–	–	–
DIN EN 60068-2-14 Na:2000-08	Life-time Temperature cycling test - Rapid change of Temperature (Weibull)	Test duration: 9 days Min. temperature: -50 °C Max. temperature: +125 °C Holding time: 30 min. Cycles: 216	Yes	Yes	Yes	Yes	–	–	–
DIN EN 60068-2-6: 2008-10	Vibration (sinusoidal)	10 to 2000 to 10 Hz, 1 oct/ min., 5 g 10 cycles, bidirectional	–	–	–	–	–	Yes	Yes

DETAILED QUALIFICATION

Climatic and mechanical tests

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND}	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
DIN EN 60068-2-6:1996-05 V	ibration (sinusoidal)	5 to 2000 to 5 Hz, 1 oct/min., 20 g 5 h /axis, 3 axes	–	–	–	Yes	–	–	–
DIN EN 60068-2-6:2008 DIN EN 60068-2-14:2009	Vibration (sinusoidal) with temperature superimposition	5 to 2000 to 5 Hz, 1 oct/min., 20 g 5 h/axis, 3 axes Test Nb, Temperature super- imposition: -40 °C to +125 °C, 3 K/min. Duration time = 15 min., Change = 60 min. 2 Temp. cycles/axis	–	–	–	–	–	Yes	Yes
ISO 16750-3:2012 Test VI DIN EN 60068-2-6:2008 DIN EN 60068-2-14:2010	Vibration (sinusoidal) with temperature superimposition	20 to 520 Hz, 0.5 oct/min., 100 to 60 m/s ² 32 h/axis, 3 axes Test Nb, Temperature super- imposition: -40 °C to +110 °C In operation	–	–	–	–	Yes	–	–
ISO 16750-3:2012 Test VI IEC 60068-2-80	Vibration (sinusoidal & random) with temperature superimposition	94 h/axis, 3 axes, mixed mode vibration (sine and random) Temperature superimpo- sition: -40 °C to +125 °C	Yes	Yes	–	Yes	–	–	–
ISO 16750-3:2012 Test VII IEC 60068-2-64:2008-04 DIN EN 60068-2-14:2010	Vibration (random) with temperature superimposition	10 to 2000 Hz, 57.9 m/s ² , 32 h/ axis, 3 axes, random vibration Temperature superimpo- sition:	–	–	–	–	Yes	–	–

DETAILED QUALIFICATION

Climatic and mechanical tests

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND}	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
		-40 °C to +110 °C, 4 cycles/ axis In operation							
DIN EN 60068-2-27:1995-03	Mechanical shock	Acceleration: 50 g, half sine Time: 11 ms 3 Shocks/direction, 6 direc- tions	Yes	Yes	–	Yes	–	–	–
DIN EN 60068-2-27:2009	Mechanical shock	Acceleration: 50 g, half sine Time: 11 ms 3 Shocks/direction, 6 direc- tions	–	–	–	–	–	Yes	Yes
DIN EN 60068-2-27:1995-03	Mechanical shock	Acceleration: 500 g, half sine Time: 1 - 2 ms 3 Shocks/direction, 6 direc- tions	Yes	Yes	–	Yes	–	–	–
DIN EN 60068-2-27:2009	Mechanical shock	Acceleration: 50 g, half sine Time: 11 ms 10 Shocks/direction, 6 direc- tions	–	–	–	–	Yes	–	–
DIN EN 60068-2-29:1995-03	Bump	Acceleration: 30 g, half sine Time: 6 ms 500 Shocks/direction, 6 directions	Yes	Yes	–	Yes	–	–	–
DIN EN 60068-2-27:2009	Bump	Acceleration: 30 g, half sine Time: 6 ms 500 Shocks/direction, 6 directions	–	–	–	–	–	Yes	Yes

DETAILED QUALIFICATION

Climatic and mechanical tests

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND}	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
ISO 16750-3: 2012 DIN EN 60068-2-31:2009-04	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	–	–	–	–	–	Yes	Yes
DIN EN 60068-2-32:1995-03	Free fall	1 device, 6 falls each side of the housing drop height: 1 m on iron plate	Yes	Yes	–	Yes	–	–	–
DIN EN 60068-2-31:2009-04	Free fall	1 device, 6 falls each side of the housing drop height: 1 m on iron plate	–	–	–	–	Yes	–	–
DIN EN ISO 4892-3:2016-10	Solar Radiation Test (UV Test)	Exterior Method A Test Cycle - Nr. 3 No. Of Cycles = 100 Test duration = 600 h	–	–	–	–	Yes	–	–
SAE J 1211 part 4.4:1978-11	Immersion and splash	Agents: gasoline, diesel, degreaser, anti-freezing agent After test: drying at +125 °C, 48 h	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ISO 16750-5:2010-04	Chemical resistance	Agents: diesel, motor oil, hydraulic oil, gear oil, bio-diesel, E10, urea "Caelo" After test: drying at +70 °C, 48 h	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ISO 16750-5:2010-04	Chemical resistance	Agents: AA(Diesel fuel), AB (bio-Diesel), Vegetable oil, BA (Engine oil), BB (Differ-	–	–	–	–	Yes	–	–

DETAILED QUALIFICATION

Climatic and mechanical tests

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND}	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
		ential oil), BC (Transmission fluid), BD (Hydraulic fluid), CC (Coolant additive), CD (Urea), DA (Windscreen washer fluid) - drying at T _{max} (+125 °C) Agents: AC (Petrol/Gasoline), AE (Methanol), BE (Greases), BF (Silicone oil), DB (Vehicle washing chemicals), DH (Cleaning solvent), EA (Contact spray), ED (Refreshment containing caffeine and sugar), YY1 (Vehical washing chemicals e.g. Metasil), YY2 (Liquid Fertilizer), YY3 (Dry Fertilizer) - drying at Room Temperature							
DIN EN 60529:1991	IP Protection grade	IP67 (depending on connector type)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
DIN 40050-9:1993-05 (Now ISO 20653:2006)	IP Protection grade	IPX9K (depending on connector type)	Yes	Yes	Yes	Yes	Yes	Yes	Yes

NRND) not recommended for new design.

DETAILED QUALIFICATION

UL Certification

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND}	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
UL 61010-1:2012-04-17, 3rd Edition CAN/CSA-C22.2 NO. 61010-1:2012-04, 3rd Edition	UL RECOGNIZED COMPONENT File No. E317934		Yes	Yes	Yes	Yes	Yes	—	—

NRND) not recommended for new design.

DETAILED QUALIFICATION

Electrical Safety Requirements

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND}	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
STW Company Standard (Art.Nr. 26688)	Direct current supply voltage	U _{min} = 8 V U _{max} = 36 V Test duration for each voltage level: 60 min.	–	–	–	–	Yes	Yes	–
STW Company Standard (Art.Nr. 26688)	Direct current supply voltage	U _{min} = 4.75 V U _{max} = 5.25 V Test duration for each voltage level: 60 min.	–	–	–	–	–	–	Yes
STW Company Standard (Art.Nr. 26688)	Direct current supply voltage	U _{min} = 9 V U _{max} = 36 V Test duration for each voltage level: 60 min.	–	–	–	Yes	–	–	–
STW Company Standard (Art.Nr. 26688)	Direct current supply voltage	U _{min} = 4.5 V U _{max} = 5.5 V Test duration for each voltage level: 60 min.	–	–	Yes	–	–	–	–
STW Company Standard (Art.Nr. 26688)	Direct current supply voltage	U _{min} = 14 V U _{max} = 36 V Test duration for each voltage level: 60 min.	Yes	–	–	–	–	–	–
ISO 16750-2:2012-11	Overvoltage	U _{max} (36 V) + 3 % = 37.08 V, 5 mins Room Temperature (23 °C)	–	–	–	Yes	Yes	Yes	–
ISO 16750-2:2012-11	Superimposed alternating voltage (12 V and 24 V System)	12 V System Peak to peak voltage, U _{pp} = 2 V, Severity Level 4 24 V System	–	–	–	–	Yes	–	–

DETAILED QUALIFICATION

Electrical Safety Requirements

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND}	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
		Peak to peak voltage, $U_{pp} = 10$ V, Severity Level 3 Sweep duration = 120 s, Nr. of sweeps = 5, Freq. Range = 50 Hz to 25 kHz, Internal resistance = 50 m Ω to 100 m Ω							
ISO 16750-2:2012-11	Slow decrease and increase of supply voltage	Decrease the supply voltage from $U_S = 12$ V to $U_S = 0$ V Increase the supply voltage from $U_S = 0$ V to $U_S = 12$ V Change rate: 0.5 ± 0.1 V/min linear	–	–	–	–	Yes	–	–
STW Company Standard (Art.Nr. 26688)	Undervoltage / Switch-on hysteresis	Decrease supply voltage from $U_{min}(8$ 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 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 U_{min} . Duration: 5 minutes	–	–	–	–	Yes	Yes	–
STW Company Standard (Art.Nr. 26688)	Undervoltage / Switch-on hysteresis	Decrease supply voltage from $U_{min}(4.75$ V) in steps	–	–	–	–	–	–	Yes

DETAILED QUALIFICATION

Electrical Safety Requirements

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND})	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
		<p>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 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 U_{min}. Duration: 5 minutes</p>							
ISO 16750-2:2012-11	Discontinuities in supply voltage - Momentary drop in supply voltage (12 V and 24 V System)	<p>12 V System Test Voltage = 4.5 V, ≤ 10 ms 24 V System Test Voltage = 9 V, ≤ 10 ms</p>	–	–	–	–	Yes	–	–
ISO 16750-2:2012-11	Discontinuities in supply voltage - Reset behaviour at voltage drop	<p>Decrease supply voltage from $U(100\%) = +14\text{ V}$ in 5 % steps Drop of test voltage $U = 14\text{ V}$ to 7 V → Criterion "A" Drop of test voltage $U = 7\text{ V}$ to 0 V → Criterion "C"</p>	–	–	–	–	Yes	–	–
ISO 16750-2:2012-11	Discontinuities in supply voltage - Starting profile (12 V and 24 V System)	<p>12 V System Voltage cranking; Level 4 $U_B = 12\text{ V}$, $U_{S6} = 6\text{ V}$, $U_S = 6.5\text{ V}$</p>	–	–	–	–	Yes	–	–

DETAILED QUALIFICATION

Electrical Safety Requirements

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND}	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
		10 pulses, FC B 24 V System Voltage cranking; Level 3 $U_B = 24\text{ V}$, $U_{S6} = 6\text{ V}$, $U_S = 10\text{ V}$ 10 pulses, FC B							
ISO 16750-2:2012-11	Discontinuities in supply voltage - Load Dump (12 V and 24 V System)	Test B - with centralized load dump suppression 12 V System $U_A = 14\text{ V}$, $U_S = 80\text{ V}$, $U_S^* = 35\text{ V}$ 5 pulses Time interval = 1 min. 24 V System $U_A = 28\text{ V}$, $U_S = 200\text{ V}$, $U_S^* = 58\text{ V}$ 5 pulses Time interval = 1 min.	–	–	–	–	Yes	–	–
ISO 16750-2:2012-11	Reversed voltage (12 V and 24 V System)	12 V System Test voltage = -16 V, Duration = 60 s 24 V System Test voltage = -36 V (U_{max}), Duration = 60 s	–	–	–	–	Yes	–	–
ISO 16750-2:2012-11	Short circuit protection (12 V and 24 V System)	Test case 1: Connected supply voltage and ground terminals Test case 2: Disconnected supply voltage terminals, Duration = 60 s, Test performed with both test cases	–	–	–	–	Yes	–	–

DETAILED QUALIFICATION

Electrical Safety Requirements

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND})	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
		12 V System Short circuit strength test of all inputs and outputs against 16 V and to ground 24 V System Short circuit strength test of all inputs and outputs against 32 V(U _{smax}) and to ground							
ISO 16750-2:2012-11	Short circuit protection	Test case 1: Connected supply voltage and ground terminals Test case 2: Disconnected supply voltage terminals Short circuit strength test of all inputs and outputs against 5.25 V and to ground Duration = 60 s, Test performed with both test cases	–	–	–	–	–	–	Yes
ISO 16750-2:2012-11	Short circuit protection (24 V System)	Test case 1: Connected supply voltage and ground terminals Test case 2: Disconnected supply voltage terminals Short circuit strength test of all inputs and outputs against 36 V and to ground Duration = 60 s, Test performed with both test cases.	–	–	–	–	–	Yes	–

DETAILED QUALIFICATION

Electrical Safety Requirements

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND}	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
		Note: SENT pin is only short-circuit protected up to 20 V.							
STW Company Standard (Art.Nr. 26688)	Short circuit strength of signal and communication lines	Short circuit test of each type of Input and Output (CIN, VIN, DIN, FIN, PWM, DOUT...) against GND and U_B at U_{max} and U_{min} for a duration of 1 minute.	Yes	Yes	–	Yes	–	–	–
ISO 16750-2:2012-11	Insulation resistance	Apply test voltage of 500 V dc, Duration = 60 s Insulation resistance measured > 550 MΩ	–	–	–	–	–	Yes	Yes
STW Company Standard (Art.Nr. 26688)	Cable breakage supply lines	Disconnect each single supply line (UB, UE, Digital GND, Analog GND and Housing GND) at U_{min} (4.75 V) and U_{max} (5.25 V) for a duration of 1 minute	–	–	–	–	–	–	Yes
STW Company Standard (Art.Nr. 26688)	Cable breakage supply lines	Disconnect each single supply line (UB, UE, Digital GND, Analog GND and Housing GND) at U_{min} (8 V) and U_{max} (36 V) for a duration of 1 minute	–	–	–	–	–	Yes	–
STW Company Standard (Art.Nr. 26688)	Polarity protection	Test case 1: Supply lines are disconnected, GND is connected.	–	–	–	–	–	–	Yes

DETAILED QUALIFICATION

Electrical Safety Requirements

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND}	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
		Then connect one input and if available one low-side output to $U_B(5.25\text{ V})$ Duration: 5 Minutes. Test case 2: Changed battery terminals $U_B(5.25\text{ V})$ Duration: 5 Minutes.							
STW Company Standard (Art.Nr. 26688)	Polarity protection	Test case 1: Supply lines are disconnected, GND is connected. Then connect one input and if available one low-side output to $U_B(28\text{ V})$ Duration: 5 Minutes. Test case 2: Changed battery terminals $U_B(28\text{ V})$ Duration: 5 Minutes.	Yes	—	—	Yes	—	Yes	—
STW Company Standard (Art.Nr. 26688)	Load Test	48 hrs. at $T_{min}(-40\text{ °C})$: 12 hrs. OM 3.1 - from the 13th hour OM 3.2 at $U_{min}(4.75\text{ V})$. 48 hrs. at $T_{max}(+85\text{ °C})$: OM 3.2 at $U_{max}(5.25\text{ V})$ Duration: 4 days	—	—	—	—	—	—	Yes
STW Company Standard (Art.Nr. 26688)	Load Test	48 hrs. at $T_{min}(-40\text{ °C})$: 12 hrs. OM 3.1 - from the 13th hour OM 3.2 at $U_{min}(8\text{ V})$. 48 hrs. at $T_{max}(+85\text{ °C})$: OM 3.2 at $U_{max}(36\text{ V})$ Duration: 4 days	—	—	—	—	—	Yes	—

DETAILED QUALIFICATION

Electrical Safety Requirements

Standard	Test Description	Test Parameter	M01 (analog voltage)	M01 (analog current)	M01 (analog ratio- metric)	M01- CAN ^{NRND}	M01- CAN2	M01- SENT (8 ... 36 V)	M01- SENT (5 V)
STW Company Standard (Art.Nr. 26688)	Current consumption	The current consumption of DUT is measured at $U_{max}(5.25\text{ V})$ and $U_{min}(4.75\text{ V})$	–	–	–	–	–	–	Yes
STW Company Standard (Art.Nr. 26688)	Current consumption	The current consumption of DUT is measured at $U_{max}(36\text{ V})$ and $U_{min}(8\text{ V})$	–	–	–	–	–	Yes	–
STW Company Standard (Art.Nr. 26688)	Current consumption	The current consumption of DUT is measured at $U_{max}(36\text{ V})$	Yes	Yes	–	–	–	–	–
STW Company Standard (Art.Nr. 26688)	Current consumption	The current consumption of DUT is measured at $U_{max}(5.5\text{ V})$	–	–	Yes	–	–	–	–
STW Company Standard (Art.Nr. 26688)	Current consumption	The current consumption of DUT is measured at $U_{max}(36\text{ V})$, $U_{min}(8\text{ V})$ and $U_{nom}(14\text{ V})$	–	–	–	–	Yes	–	–

NRND) not recommended for new design.

