Active PLCD-Sensor

Standard Active Sensor PLCD 25
For Automotive Application

*Trademark
| Indicates change

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1. Introduction

Permanent-magnetic Linear Contactless Displacement (PLCD) sensor is a particularly robust and vehicle-compatible solution provided by Tyco Electronics for contactless position measuring.

A PLCD essentially comprises a special soft magnetic core, which is wound over its entire length by a primary coil as well as short secondary coils at each end.
A permanent Magnet brought close to the sensor results in a local magnetic saturation of the core. The magnetic flow, which induce corresponding voltages in the secondary coils. The position of this saturated area along the sensor axis can be determined very accurately through the secondary coil system. Since the difference in the secondary voltages is related via a linear function with respect to the position of the saturation zone, the position of the magnet is easily and accurately determined.

2. Sensor versions

Version	**Connector**	**Measurement Range [mm] Min/max**
PLCD 25G	GET/4 Pol (code A)	0 – 15 / 0 - 25
PLCD 25M	MQS/4 Pol (code A)	
Further versions will be available if demanded		

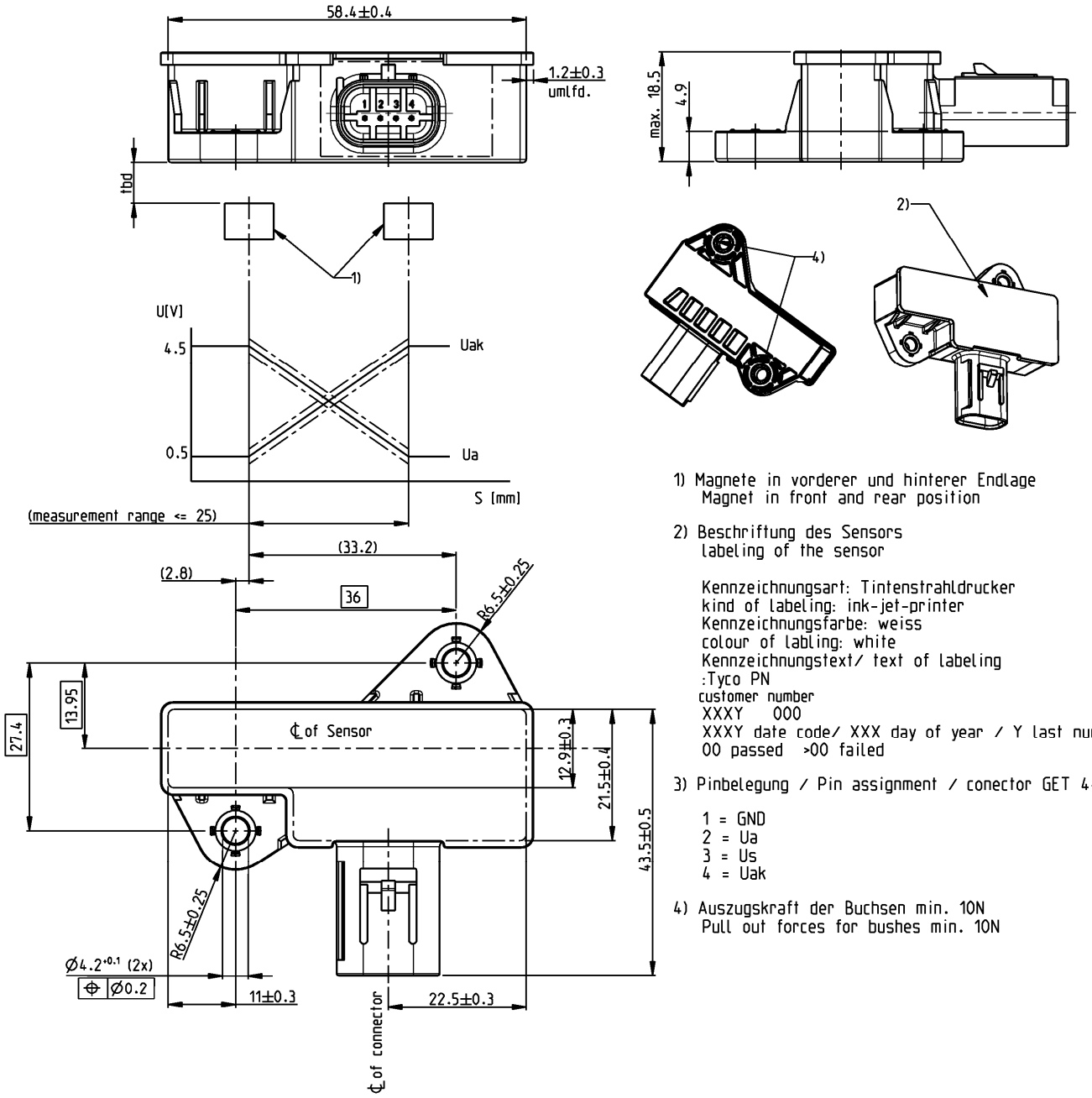
3. Magnetical Interface

The dimentions of the magnet depends on the Distance of the magnet from the sensor as well as on the application environment (e. g. iron devices near the magnet or Aluminum wall between the magnet and the sensor).
Some Magnets and the correspondent Distances for typical applications are listed below:

Magnet Dimentions [mm]	**Distance between Sensor and Magnet [mm]**
10X5X6 (LXWXH)	2,5 up to 3,5
20X5X5 (trapezoid magnet)	3,5 up to 4,5
Φ20XΦ10X4 (ring magnet)	4,5 up to 5,5

4. Drawings

4.1 PLCD 25G



1) Magnete in vorderer und hinterer Endlage
Magnet in front and rear position

2) Beschriftung des Sensors
labeling of the sensor

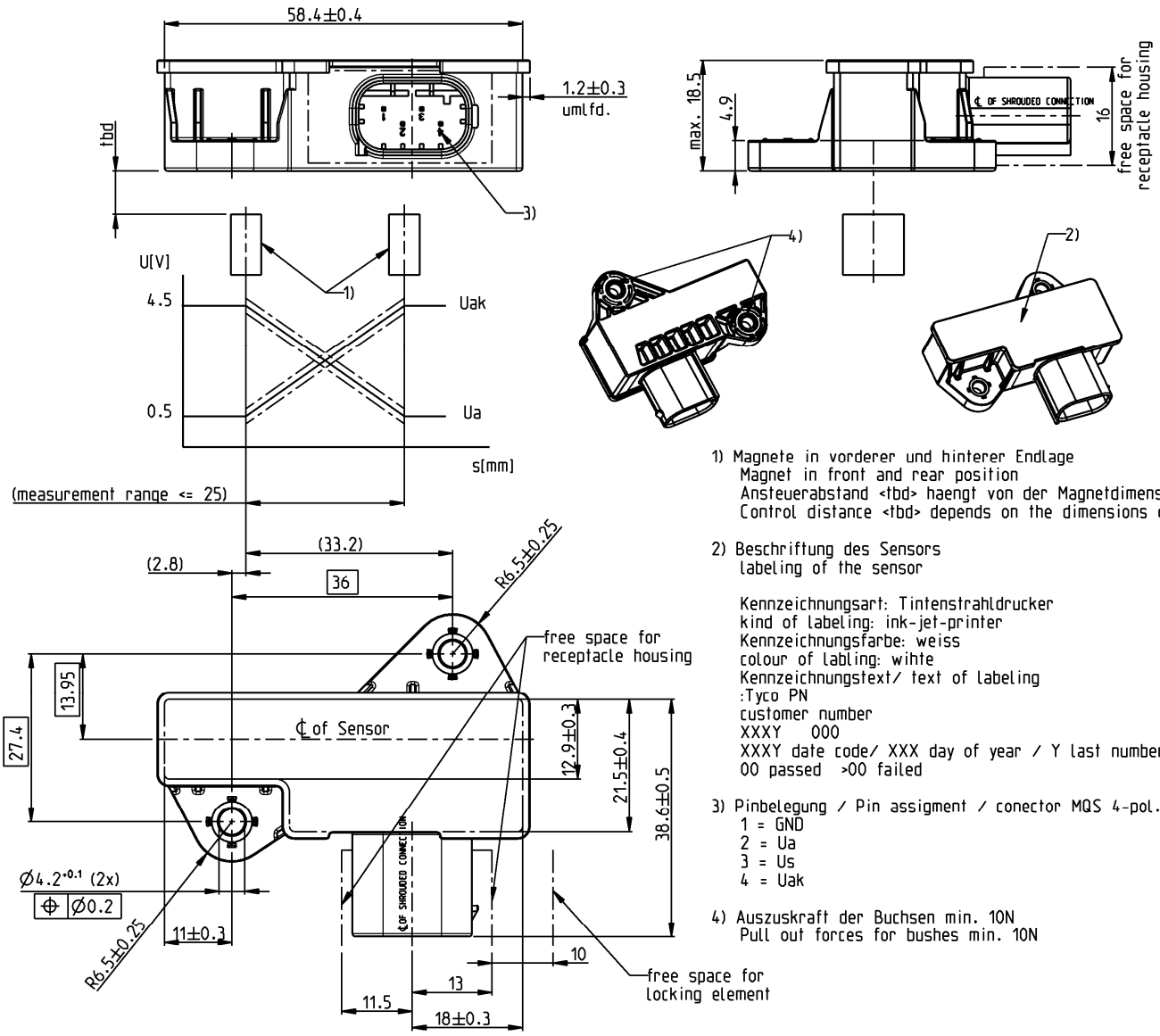
Kennzeichnungsart: Tintenstrahldrucker
kind of labeling: ink-jet-printer
Kennzeichnungsfarbe: weiss
colour of labling: white
Kennzeichnungstext/ text of labeling
:Tyco PN
customer number
XXXY 000
XXXY date code/ XXX day of year / Y last number of year
00 passed >00 failed

3) Pinbelegung / Pin assignment / conector GET 4-pol.:

1 = GND
2 = Ua
3 = Us
4 = Uak

4) Auszugskraft der Buchsen min. 10N
Pull out forces for bushes min. 10N

4.2 PLCD 25M



1) Magnete in vorderer und hinterer Endlage
Magnet in front and rear position
Ansteuerabstand <tbd> haengt von der Magnetdimension ab
Control distance <tbd> depends on the dimensions of the magnet

2) Beschriftung des Sensors
labeling of the sensor

Kennzeichnungsart: Tintenstrahldrucker
kind of labeling: ink-jet-printer
Kennzeichnungsfarbe: weiss
colour of labling: wihte
Kennzeichnungstext/ text of labeling
:Tyco PN
customer number
XXXY 000
XXXY date code/ XXX day of year / Y last number of year
00 passed >00 failed

3) Pinbelegung / Pin assigment / conector MQS 4-pol.
1 = GND
2 = Ua
3 = Us
4 = Uak

4) Auszuskraft der Buchsen min. 10N
Pull out forces for bushes min. 10N

5) Interface Signals

Pin no.	Name	Definition
1	GND	Ground Output
2	Ua	Output signal (Travel)
3	Us	DC Supply voltage
4	Uak	signal (complementary)

6) Absolute Maximum Ratings

Parameter	Conditions	Symbol	Min	Typ	Max	Unit
Max. Temperature		T max			150	°C
Reverse Polarity Voltage	T= 5min, Imax = 300mA	Urev			- 5,25	V
Overvoltage	Longtime	Us max			18	V
Lifetime	Constant reference temperature					
	T = 140 °C	T_{const}			3000	h
	T = 125 °C	T_{const}			8000	h

7) Operating Conditions

Parameter	Conditions	Symbol	Min	Typ	Max	Unit
Operating temperature range	Over lifetime	Ta	-40		140	°C
Driving Magnetic Field on Sensor Surface	Distance between sensor and ferromagnetic material > 10 * (air gap of driving field)	Hmag		20		mT
Air gap / driving distance	Depending on the strength of the magnet			2	20	mm

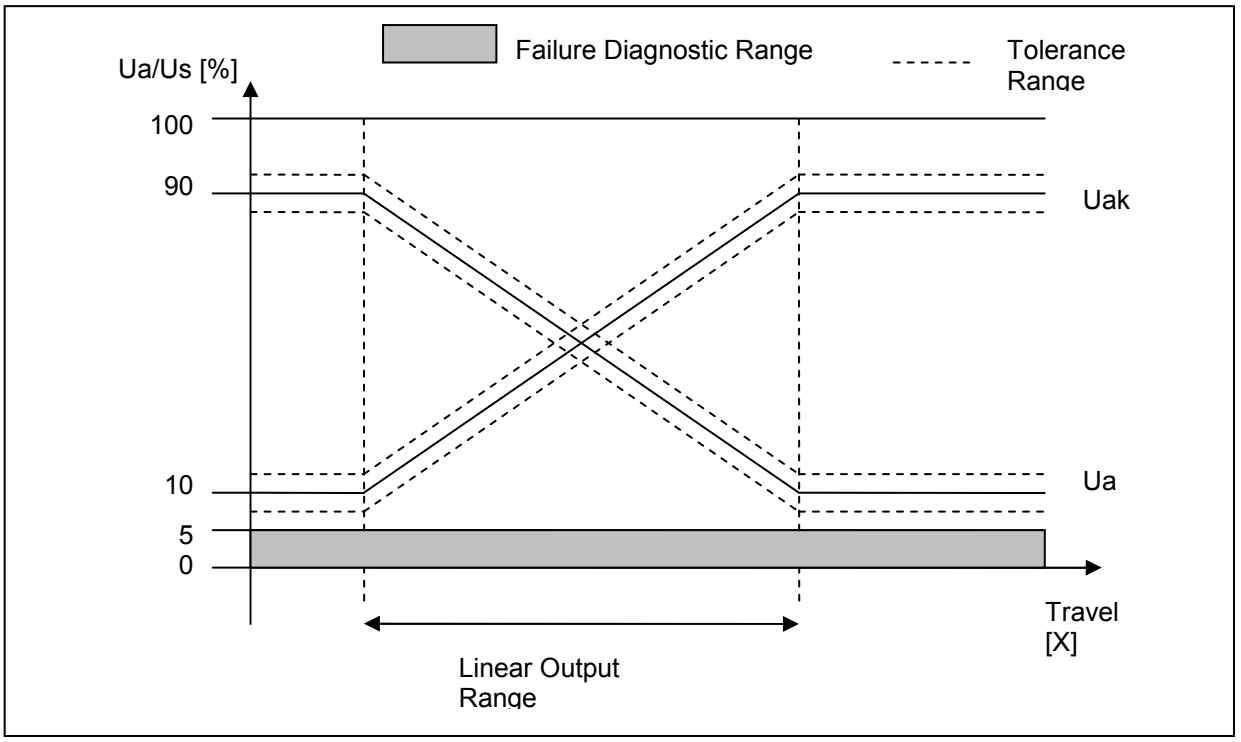
Supply Us

Parameter	Conditions	Symbol	Min	Typ	Max	Unit
Operating Voltage	DC to GND | GND = 0V Source impedance Z_US < 10 Ω	VDC_Us	4,5		5,5	V
Current Consumption	VDC_US = 5.25 V, (No Load)	IDC_ Us	14		18	mA
Ripple noise	Bandwith 20KHz at 5kΩ Load	VAC_Us			5	mVss

Output Ua Uak

Parameter	Conditions	Symbol	Min	Typ	Max	Unit
Linear output range	Function(travel)	LR_Ua	0,1 Us		0,9 Us	V
Failure Diagnostic Level	Internal failure diagnostic	FDL_Ua	0*Us		0,05*Us	V
Signal Resolution	10 Bit	Res_Ua			$^{1}/_{1024}$ Us	V
Continuous Load Current	C load < 39 nF R load > 2,2kΩ	I_Ua			2	mA
Shortcircuit Current Ua to GND Ua to Us	Us = 5,5V Isc = I_{Peak} Duration 50µs Repetition 2ms	Isc_Ua$_s$			 36 9	 mA mA
Signal refresh time	Ta = RT	T_Ua	1,5	1,75	2	ms
Power On Delay	Power-on or Reset	Tpo_Ua	3		10	ms
Undervoltage (supply us)	Range < 4,5 –4,0 reduction of accuracy possible	Ua (Uak)	ratiometric output			
	Range < 4 V – 2,5 V	Ua (Uak)	Threshold range			
	Range < 2,5 V	Ua (Uak)	error level or Us			
Output noise	Bandwidth 20 kHz at 5 kΩ Load	Ua_noise			5	mVeff
Output impedance	R load > 2,2 kΩ	Ri			11	Ω

Output Characteristic Ua Uak



Linear output range

Conditions	
Measurement Range	Max. 25 mm

Failure Diagnostic Functions

In the following section, relevant error conditions and their effects are listed.

Active error level An internal error in the sensor is signalled by an error-level, emitted by the internal ASIC.

Error level: Errors in connection with the sensor wiring will, in the ECU, cause an error level on at least one of the output signal lines. The error level is produced by the error itself.

Sensor connection				Error description	Error effect Remark
U_{Stab}	GND	U_a	U_{ak}		
				Internal Sensor Error conditions	
5V	0V	R_{L1}	R_{L2}	Internal sensor error, Distance sensor magnet to high	Active error level of the ASIC
5V	0V	R_{L1}	R_{L2}	Internal sensor error, broken or short cut of solenoid	Active error level of the ASIC
5V	0V	R_{L1}	R_{L2}	Internal sensor error, Gain Error of input channels	Active error level of the ASIC
5V	0V	R_{L1}	R_{L2}	Internal sensor error, Sum of Ua and Uak, internal short cuts	Active error level of the ASIC
5V	0V	R_{L1}	R_{L2}	Internal sensor error, Low voltage of internal regulator	Active error level of the ASIC
5V	0V	R_{L1}	R_{L2}	Internal sensor error, ADC under or over run	Active error level of the ASIC
5V	0V	R_{L1}	R_{L2}	Internal sensor error, Sum test of internal measurement channels against teached values	Active error level of the ASIC
5V	0V	R_{L1}	R_{L2}	Internal sensor error, Input signal of sensor coils are to low	Active error level of the ASIC
				Open circuit	
open	0V	R_{L1}	R_{L2}	Supply open circuit	Error level
5V	0V	Open	R_{L2}	Signal 1 open circuit	No error level on Uak
5V	0V	R_{L1}	open	Signal 2 open circuit	No error level on Ua
5V	Open	R_{L1}	R_{L2}	Ground open circuit	Is detected in the ECU by monitoring Ua+Uak
				Short circuit to ground	
0V	0V	R_{L1}	R_{L2}	Supply short circuit to ground	Error level
5V	0V	0V	R_{L2}	Signal 1 short circuit to ground	error level on Uak
5V	0V	R_{L1}	0V	Signal 2 short circuit to ground	error level on Ua
				Short circuit to sensor supply	
5V	0V	5V	R_{L2}	Signal 1 short circuit to sensor supply	Error level on Uak
5V	0V	R_{L1}	5V	Signal 2 short circuit to sensor supply	Error level on Ua

Sensor connection				Error description	Error effect Remark
U_{Stab}	GND	U_a	U_{ak}		
				Short circuit to U_{Batt} ≥ 12 V	
U_{Batt}	0V	R_{L1}	R_{L2}	Short circuit of supply to U_{Batt}	Is detected in the ECU by monitoring Ua+Uak
5V	0V	U_{Batt}	R_{L2}	Signal 1 short circuit to U_{Batt}	Error level
5V	0V	R_{L1}	U_{Batt}	Signal 2 short circuit to U_{Batt}	Error level
				Short circuit between Signal 1 and Signal 2	
5V	0V	R_{L1} R_{L2}	R_{L1} R_{L2}	Short circuit Signal 1 and Signal 2	Error has to be detected in the ECU
				Reversal	**only relevant for production and service**
5V	R_{L2}	0V	R_{L1}	Reversal Ground/Signal1/Signal2	*1)
5V	R_{L1}	R_{L2}	0V	Reversal Ground/Signal1/Signal2	*1)
5V	0V	R_{L2}	R_{L1}	Reversal Signal1/Signal2	*1) Is detected in the control unit
5V	R_{L1}	0V	R_{L2}	Reversal Ground/Signal1	*1)
5V	R_{L2}	R_{L1}	0V	Reversal Ground/Signal2	*1)
0V	5V	R_{L1}	R_{L2}	Reversal Supply/Ground	*1) I limit <300mA !
0V	R_{L2}	5V	R_{L1}	Reversal Supply/Ground/Signal1/Signal2	*1)
0V	R_{L1}	R_{L2}	5V	Reversal Supply/Ground/Signal1/Signal2	*1)
0V	5V	R_{L2}	R_{L1}	Reversal Supply/Ground/Signal1/Signal2	*1) I limit <300mA !
0V	R_{L1}	5V	R_{L2}	Reversal Supply/Ground/Signal1	*1)
0V	R_{L2}	R_{L1}	5V	Reversal Supply/Ground/Signal2	*1)
R_{L1}	5V	0V	R_{L2}	Reversal Supply/Ground/Signal1	*1)
R_{L1}	R_{L2}	5V	0V	Reversal Supply/Ground/Signal1/Signal2	*1)
R_{L1}	0V	R_{L2}	5V	Reversal Supply/Signal1/Signal2	*1)
R_{L1}	5V	R_{L2}	0V	Reversal Supply/Ground/Signal1/Signal2	*1)
R_{L1}	0V	5V	R_{L2}	Reversal Supply/Signal1	*1)
R_{L1}	R_{L2}	0V	5V	Reversal Supply/Ground/Signal1/Signal2	*1)
R_{L2}	5V	0V	R_{L1}	Reversal Supply/Ground/Signal1/Signal2	*1)
R_{L2}	R_{L1}	5V	0V	Reversal Supply/Ground/Signal1/Signal2	*1)
R_{L2}	0V	R_{L1}	5V	Reversal Supply/Signal2	*1)
R_{L2}	5V	R_{L1}	0V	Reversal Supply/Ground/Signal2	*1)
R_{L2}	0V	5V	R_{L1}	Reversal Supply/Signal1/Signal2	*1)
R_{L2}	R_{L1}	0V	5V	Reversal Supply/Ground/Signal1/Signal2	*1)

At latest 2 ms after the occurrence of a fault, the output signals must indicate the presence of the fault.
At latest 2 ms after the fault is no longer existing the sensor must be operating in A-level (no error level)
***1)** Firstly, the test of the error levels with reversed connections takes place in view of a safe and error free operation after removing the fault condition.
Secondly, by checking of Ua and Uak or Ua+Uak in the control unit, the presence of a fault must be recognised inside the control unit.

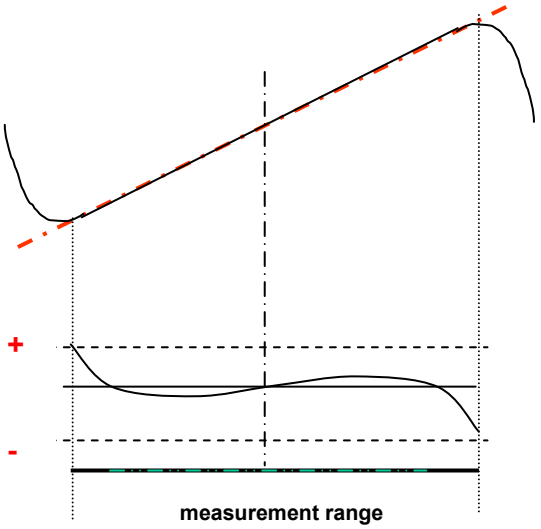
8) Measurement Performance

Parameter	Conditions within full measurement range	Symbol	Min	Typ	Max	Unit
Repeatability	Temp const	Rep			± 0,2	%
Hysteresis	Temp const Moderate speed				± 0,2	%
Linearity	application specific	LF		± 3		%
Sensivity drift	Temp > -20°C	Sdrift			± 1	%

Linearity

U1-U2
U1+U2

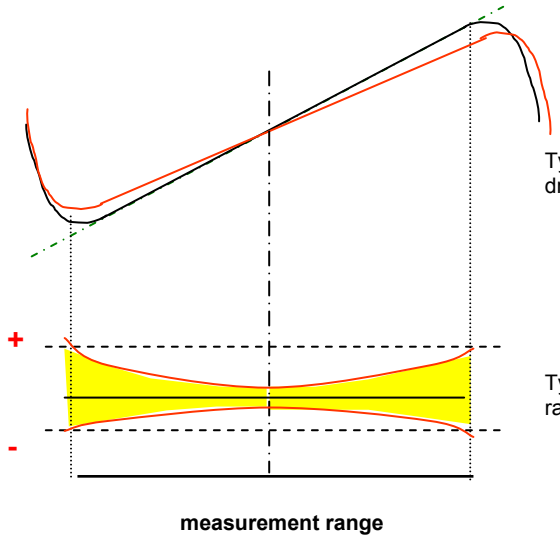
$$LF = \frac{\left| u^{fit}(x) - u^{mess}(x) \right|_{\max}}{\left| u^{fit}(x_{Ende}) - u^{fit}(x_{Anfang}) \right|} \times 100\ \%$$



typ. shape

Sensitivity

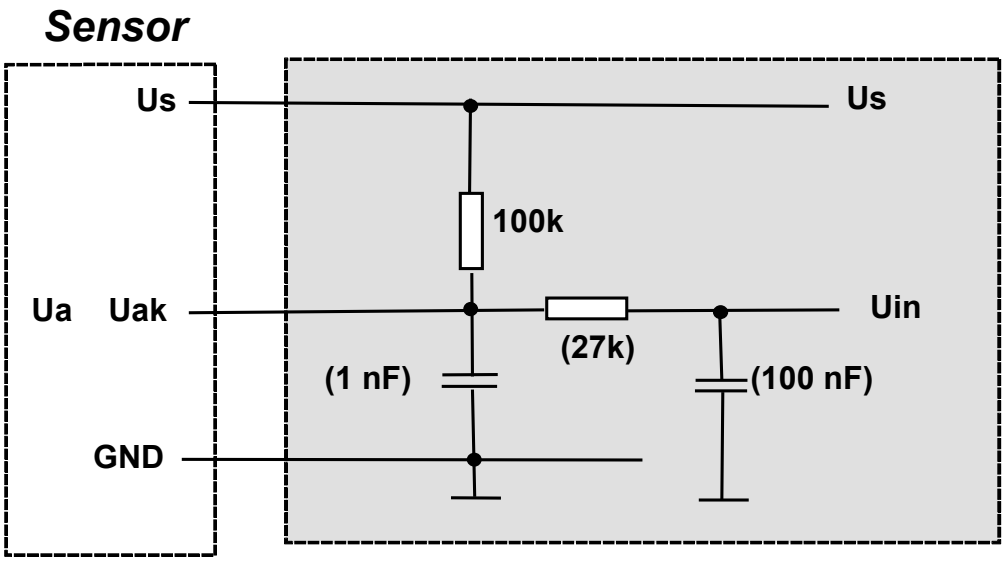
$$S = \frac{\left| u^{fit}(x_{Ende}) - u^{fit}(x_{Anfang}) \right|}{x}\ mV/mm$$

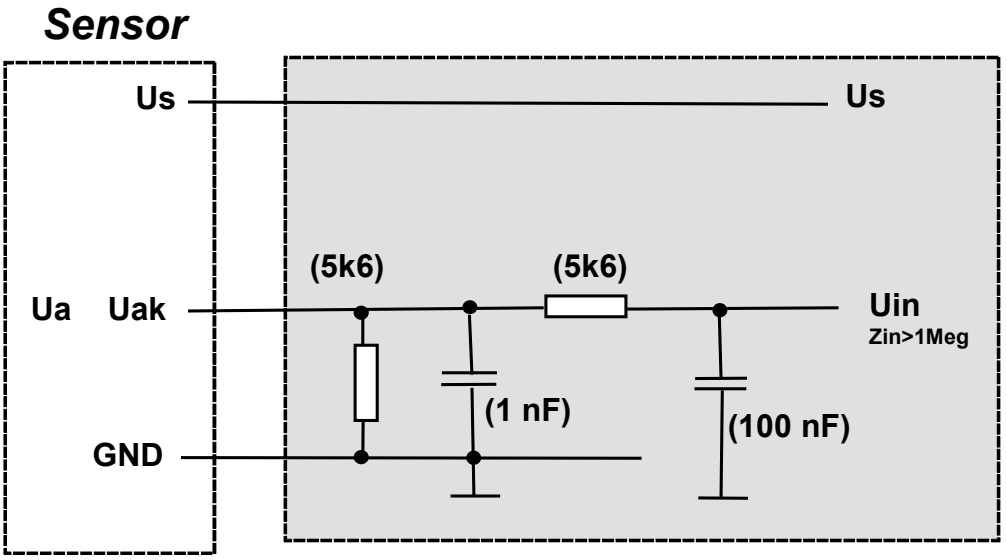


Typ. Temperature drift

Typ. Tolerance range

9) Application circuits (proposals)





10) Qualification level

Qualification adaptable to requirements of the customer. Dependend on the sensor design the following test levels have been proved:	
CHEMICAL RESISTANCE **TEST ACCORDING TO:** **DIN EN 68245, METHOD 2**	Test fluids: -Unleaded fuel acc. to DIN EN 228, unleaded Super fuel , superplus -Diesel fuel acc. to DIN EN 590 -Rape oil -Brake fluid DOT 4 -Hydraulic oil Pentosin CHF 11S, A001 989 24 03 -Motor oil (10W30) -Battery acid - Gear oil ATF
HIGH TEMPERATURE STORAGE **TEST ACCORDING TO:** **DIN EN 60068-2-2, IEC 68-2-2**	Test temperature Tp1: + 140°C ± 3°C Durability t1: 1000 h (tp1)
Rapid Temperature Change **Test according to:** **IEC 68 Teil 2-14, test group NA**	Test temperature TA: - 40 °C ± 3°C TB:+ 140°C ± 3° C Test temperature Durability t1: 1 h (Ta Tb) Change of climatic chamber t2: 3 min Cycles A – B: 200
Temperature Cycling with fixed rate of speed **Test according to: IEC 68 Teil 2–14 test group Nb**	Test temperature TA: - 40° C ± 3°C TB:+ 140 °C ± 3 °C Rate of temperature change k: 3K/ min Durability T1(-40 °C) = 60 min T2:(+140 °C) = 60 min Quantity of cycles: A – B: 100
Cyclic **corrosion reciprocal test**	Testing temperature T: - 40 °C up to 115 °C (± 3 °C) Relative humidity F.: 5 % up to 90 % (± 3 %) Cycle time: 24 h
SALT MIST ATMOSPHERE	DIN 50021-SS /1 cycle time 24 h Condensation water-due to changing climate conditions: KFW : DIN 50017 / 4 cycles 4 days Stocking in ambient temperature: 18 – 28 °C according to DIN50014 / 2 days
Vibration Test **with ambient temperature**	(50-200)Hz – 0,2 g (200-250)Hz – 30 g (250-500)Hz – 20 g (500-2000)Hz – 10 g
Stress Resistance **of connector interface (tyco interface)**	Axial tensile strength of plug connector: > 100N Radial stress of shearing force of connector: > 300N
MECHANICAL SHOCK **TEST ACCORDING. TO: DIN EN 60068-2-27**	Amplitude a: 30 g Shock durability: 18 ms Vibrational form: half sinusoidal Cycles: 3 in every space axis and polarity (overall 18)
DROP TEST **TEST ACCORDING TO: DIN EN 60068-2-32, IEC 68 PART 2-32**	Drop height: 1 m Drop targets: concrete Quantity of drops: 2 in every main axis

EMC-TESTING	

Disturbances to signal lines Test according to: ISO 7637-1	Testing pulse 1: U = - 30 V, T = 0,5s, tr = 1µs Testing pulse 2: U = + 30 V, T = 50µs, Tp = 0,5s, tr = 1µs Testing pulse 3a: U = 60 V, T=0,1us, tr=5ns, t1=100us Testing pulse 3b: U = 40 V, T = 0,1µs, tr = 5ns, t1 = 100µs
Strip line **Test according to: ISO 11452-5**	Frequency range: 1 - 200 MHz Field strength: 150 V/m, Modulation: 80%, AM, 1kHz
Anechoic chamber (antenna) **Test according to: ISO 11452-2**	Frequency range: 220 - 1000 MHz Field strength: 150V/m, Modulation: 80% AM, 1kHz
ESD in operating / non-operating mode of sensor **Test according to: ISO TR 10605**	Sharpeness of test: Contact discharge +/- 8kV Quantity of discharges: 5 times per discharge location and polarity RC artificial network: 2k□, 330 pF
Radiated emission **Test according to: CISPR 25**	Max. emission: 10dBµV Frequency range f: 1 - 400MHz
Isolation testing **(pins short cutted versus housing)**	Testing Voltage: Udc = 500 V Time: t = 2 s Leakage current: Imax < 1 mA