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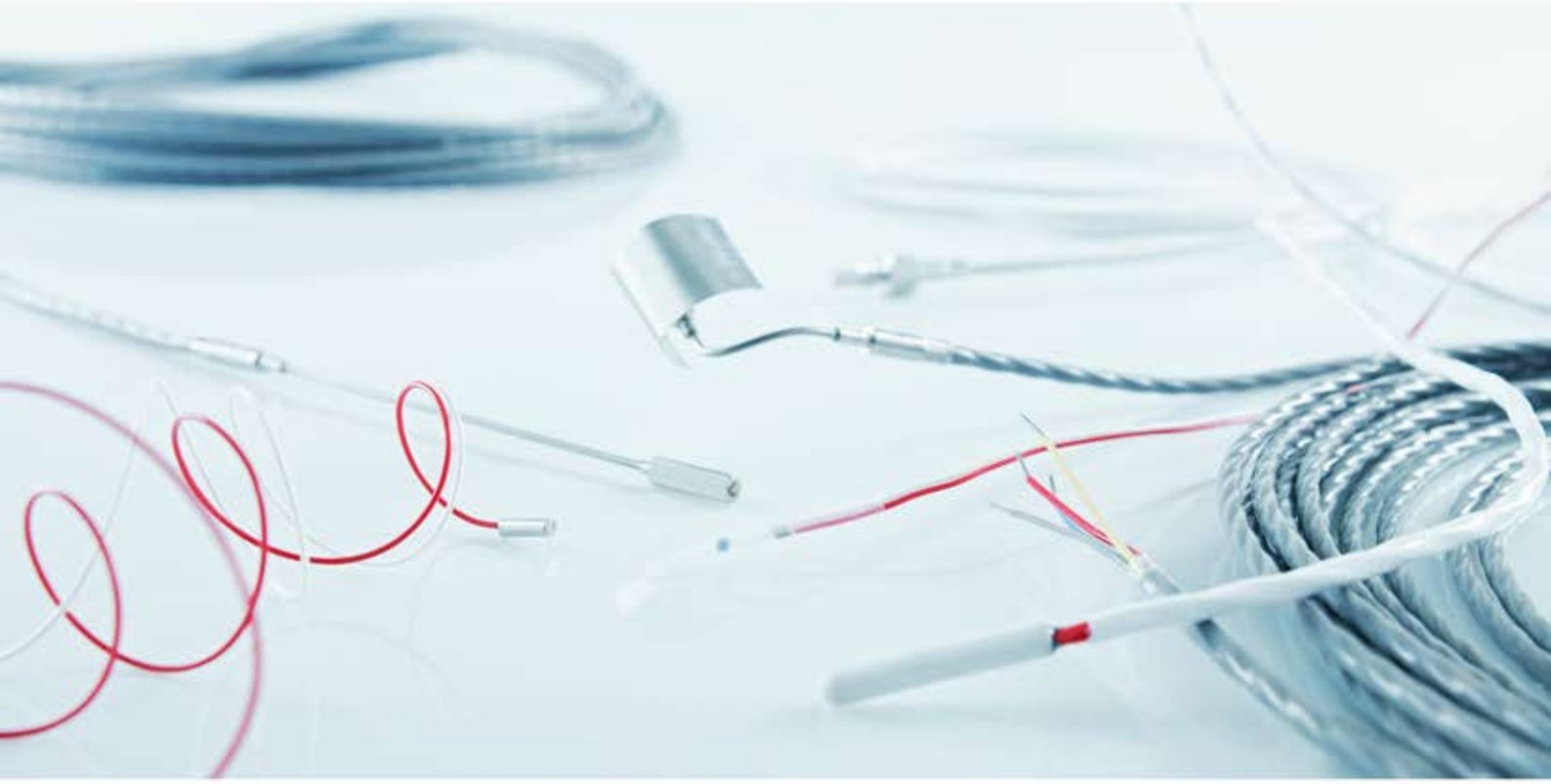

Manual

Temperature sensor PR-SPA-EX-MH

www.ephy-mess.de

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Manual
Temperature sensor PR-SPA-EX-MH

1. Manufacturer and distributor

EPHY-MESS GmbH
Berta-Cramer-Ring 1
65205 Wiesbaden
Germany

phone: +49 6122 9228-0
fax: +49 6122 9228-99
email: info@ephy-mess.de

2. Applied standards

- DIN EN 60079-0:2012 + A11:2013 (IEC 60079-0:2017)
- DIN EN 60079-7:2015 (IEC 60079-7:2015)
- DIN EN 60079-11:2012 (IEC 60079-11:2011 + Cor.:2012)
- DIN EN 60079-31:2014 (IEC 60079-31:2013)

3. Labeling

3.1 Equipment protection by increased safety

EPHY-MESS GmbH	AB-No.-Pos. No.	CE 0637	IBExU JJ ATEX xxxx X, IECEx IBE JJ.00xx X	mm/yy
Berta-Cramer-Ring 1		Ex	II 2G Ex eb IIC T6...T3 Gb	
65205 Wiesbaden			II 2D Ex tb IIIC T80°C T95°C T130°C T185°C Db	Sn.-No. xxxx
Germany			T_{min} [°C] ≤ TA ≤ T_{max} [°C] U_I ≤ s.point 4.5 manual	I_I ≤ s.point 4.5 manual

Labeling according to manual
**not for bimetallic switches*

3.2 Equipment protection by intrinsic safety

EPHY-MESS GmbH	AB-No.-Pos. No.	CE 0637	IBExU JJ ATEX xxxx X, IECEx IBE JJ.00xx X	mm/yy
Berta-Cramer-Ring 1		Ex	II 2G Ex ia IIC T6...T3 Gb	
65205 Wiesbaden			II 2D Ex ia IIIC T80°C T95°C T130°C T185°C Db	Sn.-No. xxxx
Germany			T_{min} [°C] ≤ TA ≤ T_{max} [°C] U_I ≤ s.point 4.5 manual	I_I ≤ s.point 4.5 manual

Labeling according to manual

4. Assembly

4.1 Installation in the slot of an electrical machine

- Temperature sensors of type PR-SPA-EX-MH are specially designed for the assembly into blind hole drillings in electric motors (generators) or other electrical machinery.
- The assembly / the installation can be done with a specific moveable fitting with Teflon, brass or steel clamp ring, aligned to the protection pipe diameter, or with a bayonet cap system.
- If moveable fittings are used the nominal length can be matched to the requirements on-site.
- The protection pipe of the thermometer must be mounted protected along its full length (e.g. in a blind hole- or through bore-hole).
- Bending loads (flexing) as well as mechanical loads on the temperature sensor (protection pipe and cable exit) during installation and operation must be avoided.
- During installation one has to pay attention that no damage occurs to cable and insulation.
- The supply lines (connecting wires) have to be installed strain-relieved.
- The sensor may be operated only in according to regulations and in undamaged, clean state.
- The temperature sensors must be connected to the local potential equalization.

- The thermometers don't need to be grounded in the case of a completely insulated protection pipe. If a clamp fitting is used, the clamp ring must be made of Teflon.
- During mounting and installations at and with the sensor, as well as during the on-site installation, the national and international safety- and accident prevention regulation must be observed.
- For long supply lines the specific length dependent capacities and inductances have to be observed.
- The special conditions of the type examination certificate have to be observed.
- The user of the sensor must specify and documented the used type of protection.

4.2 Usage outside the winding of an electrical machine

At this type of use, wherein the sensor is in direct contact with the explosive atmosphere are the self-heating and the resultant increase of the surface temperature be observed.

Temperature class	Maximum surface temperature of the equipment	Ignition temperature of the flammable materials
T1	450°C	> 450°C
T2	300°C	> 300°C < 450°C
T3	200°C	> 200°C < 300°C
T4	135°C	> 135°C < 200°C
T5	100°C	> 100°C < 135°C
T6	85°C	> 85°C < 100°C

4.3 Self-heating

When measuring the electrical resistance value, the current flows through the temperature sensor. Depending on the external influences, this causes power dissipation and thus a self-heating of the temperature sensor. Since a measuring current of 1 mA is generally not exceeded, the power dissipation of a Pt100 is in the range of a few tenths of a milliwatt and normally does not produce any significant measuring error. Otherwise, the self-heating must be observed so that the permissible maximum temperature is not exceeded and measurement errors are avoided.

Sample calculation for the self-heating, which the end user has to consider in his application:

Ohm's law:

1] $U = R \times I \rightarrow I = \frac{U}{R}$

[2] $P = U \times I$

[3] $P = R \times I^2$

P = electrical power / W
R = sensor resistance / Ω
I = measuring current / A
U = voltage / V

[4] $R(t) = R_0 \times (1 + A \times t + B \times t^2)$

R(t) = resistance at temperature t / Ω
T = temperature / °C
R_0 = nominal resistance at 0 °C / Ω
A = $3.90802E^{-3}$ x°C^{-1}
B = $-5.802E^{-7}$ x °C^{-2}

[5] $\Delta T = E \times P = E \times \frac{U^2}{R} = E \times R \times I^2$

E = self-heating coefficient, $K/mW^{-1} = 0.4\ KmW^{-1}$ *
ΔT = self-heating
T = permissible surface or ambient temperature

$R\ (180°C) = 100\ \Omega \times (1 + 3.90802E^{-3} \times °C^{-1} \times 180°C + (-5.802E^{-7} \times °C^{-2} \times (180°C)^2) = 168.48\ \Omega$

$P\ (180°C) = 168.48\ \Omega \times (0.001\ A)^2$ ** $= 0.00016848\ W \rightarrow 0.16848\ mW$

$\Delta T = 0.4\ K/mW \times 0.16848\ mW = 0.067392\ K$

$T = 180°C - 0.067392°C = 179.932608°C$

* This calculation is applicable to one measuring circuit. If several (n) measuring circuits are included in a sensor, k must be replaced by n x k in the formulae.
** As an example we take 1 mA, because generally a measuring current of 1 mA is not exceeded.

4.4 Self-heating coefficients

Sensor/Variant	**Self-heating coefficients**
Pt/Ni/Cuxxxxx	0.4 K/mW
TE	0 K/mW
KTYxx	0.4 K/mW
PTC-NATxxx	Not relevant because of characteristic curve
BIS	Not applicable*

**only under observation of max. switching currents, see technical data, p. 6*

4.5 Electrical data

Characteristic values		Gas / Dust	
		Ex e	Ex i
Max. voltage U_I	*Chip, Class A*	DC 17 V	DC 17 V
	Chip, Class B	DC 25 V	DC 25 V
Max. current I_I	*Chip, Class A*	55 mA	55 mA
	Chip, Class B	80 mA	80 mA
Max. power P_I	*Chip, Class A*	1 W	1 W
	Chip, Class B	2 W	2 W
Permissible surface/ ambient temperature		T_{max} – self-heating	T_{max} - self-heating
Capacity C_I		*negligible*	*negligible*
Inductivity L_I		*negligible*	*negligible*

For the error analysis acc. to DIN EN 60079-ff. the permissible electrical values must be considered carefully. The maximum permissible ambient temperatures must be calculated and ensured under consideration of the self-heating.
The equipment operators must ensure that these values will not be exceeded.

5. Connection

- The connecting wires of the PR-SPA-EX-MH sensors are color coded according color code and mode of circuit of the used resistance sensors / thermocouples (see 9.1 and 9.2 circuit and labeling of connecting wires).
- The connector ends have to be attached to suitable clamps only.
- The sensor supply lines (connecting wires) may only be connected to power supply units suitable and approved for passive resistance / thermocouple sensors according to the standards belonging to that special sensor.
- If the sensor is intended to be used in an explosive-area, the connection may occur only in a connection area which is approved according the valid standards or outside the explosive-area.
- The power supply must have a connection adequate to the thermometer's type of circuit (2-, 3- or 4-wire-circuit).
- The electrical performance data have to be observed (see 6. technical data).
- The sensor signal for the resistance sensor version and the thermistor version has no polarity.
- The sensor signal for the thermocouple version and KTY-sensor version has polarity. For the thermocouples the plus- and minus pole are color coded according the valid standard. The KTY is color coded.
- The potential equalization occurs for example via assembly fitting.
- The thermometers don't need to be grounded in the case of a completely insulated protection pipe and an installation with a clamp fitting with Teflon clamp ring.
- The connecting cables must be laid straight and without loops.
- It is not allowed to connect, install or apply the PR-SPA-EX-MH sensor in another way than described under item 4 and 5.
- Only mechanically protected sensors can be mounted.
- The cable of a sensor with a bimetallic switch as a measuring element must not be laid overlappingly and touchingly.
- Constructions with plugs are generally available with Ex i ignition protection. The operating temperatures and the electrical values of the each plug must be considered.

6. Technical data

Description	Temperature sensor PR-SPA-EX-MH, acc. to drawings: 666211016906002	
Construction	insulated measuring resistance with fix connected supply lines, shockproof mounted in metallic protection pipe.	
Approval	IBExU JJ ATEX xxxx X IECEx IBE JJ.00xx X	
Type of protection	II 2G Ex ia IIC T6...T3 Gb II 2D Ex ia IIIC T80°C T95°C T130°C T185°C Db II 2G Ex eb IIC T6...T3 Gb* II 2D Ex tb IIIC T80°C T95°C T130°C T185°C Db* **Not for bimetallic switches*	
Sensor insulation	insulation hose and metallic protection pipe	
Dimensions (∅xL)	∅ mm x L mm	
Ambient temperature	Resistance sensor (Pt/Ni/Cuxxxxx):	-60°C … +180°C
	Thermocouples (TE):	-60°C … +180°C
	Silicon-sensor (KTY83):	-55°C … +175°C
	Silicon-sensor (KTY84):	-40°C … +180°C
	Thermistor (PTC-NATxxx):	-45°C ... +ROT[1)] + 23 K
	Bimetallic switches (BIS):	-25°C … +180°C
Resistance sensor (Pt/Ni/Cuxxxxx)	Material:	Platinum (Pt) / Nickel (Ni) / Copper (Cu)
	Nominal value:	5 … 2000 Ω at [0°C]
	Tolerance class:	according to respective standard
	Measuring circuits:	1 or 2
	Mode of connection:	2-, 3- or 4-wire circuit
	Measuring current:	0.3 ... 1 mA
	Self-heating:	0.4 K/mW at 0°C
	Operating temperature:	-60°C … +180°C
Thermocouples (TE)	Measuring circuits:	1 or 2
	Max. voltage:	1.5 V
	Max. current:	100 mA
	Max. power:	25 mW
	Self-heating:	-
	Operating temperature:	-60°C … +180°C

Silicon-sensor (KTY)	Model series:	KTY83	KTY84
	Measuring circuits:	1 or 2	1 or 2
	Nominal value:	1000 Ω at 25°C	1000 Ω at 100°C
	Measuring current:	1 mA	2 mA
	Max. voltage:	5 V	5 V
	Max. power:	6.3 mW	6.3 mW
	Self-heating:	0.4 K/mW at 0°C	0.4 K/mW at 0°C
	Operating temperature:	-55°C … +175°C	-40°C … +180°C
Motor protection thermistor (PTC)	Measuring circuits:	1 or 2	
	Reference temperature:	60°C … 180°C	
	Max. current:	2 mA	
	Max. voltage:	2.5 V	
	Power:	4.7 mW	
	Self-heating:	not relevant because of characteristic curve	
	Operating temperature:	-45°C … +180°C	
Bimetallic switches (BIS)	Type series:		
	Opener	S.01 / C.01 / L.01	S.06 / C.06 / L.06
	Closer	S.02 / C.02 / L.02	S.08 / C.08 / L.08
	Nominal switching temperature:	60°C ... 200°C	70°C ... 200°C
	Operational voltage range AC/DC up until:	500 V AC / 14 V DC*	500 V AC / 28 DC*
	Rated voltage AC:	250 V	250 V
	Rated voltage DC:	12 V*	24 V*
	Max. switching current AC:		
	cos φ = 1,0 / cycles	6.3 A / 3000	25.0 A / 2000
	cos φ = 0,4 / cycles	7.2 A / 1000	
	Max. switching current DC:	40.0 A / 5000*	40.0 A / 8000*
	Rated current AC:		
	cos φ = 1,0 / cycles	2.5 A / 10000	10.0 A / 10000
	cos φ = 0,6 / cycles	1.6 A / 10000	6.3 A / 10000
	cos φ = 0,4 / cycles	1.8 A / 10000	
	High voltage resistance:	2.0 kV	2.0 kV
	*just Opener		
Dielectric strength	sensor:	0.5 kV / 50Hz, 1min.	
	supply line:	0.5 kV / 50Hz, 1min.	
Supply line	construction	single litz, hose line or flat cable	
	insulation:	teflon or silicone	
	color code:	acc. to DIN resp. customers request	
	cross section	≥ AWG 30	
	cable capacitance (Ci)	negligible	
	cable inductance (Li)	negligible	

1) *ROT= rated operation temperature*

General hints:

When mounting one has to pay attention that no damage will occur to the supply line and the insulation of the sensor. The supply line must be installed strain-relieved. Extreme bending load as well as punctual, mechanical stress to the sensor should be avoided.

The special security hints for the mounting regarding the ATEX approval are fixed in the above-named ATEX-approval which is available at EPHY-MESS or at www.ephy-mess.de.

7. Type identification

PR-SPA-EX-MH + variant identification (see point 8)

PR	SPA	EX	Design	Version
				see point 8
			MH	
		EX-certification		
	Sensor, passive			
Product				

8. Variant identification

Version	Customer standards (optional)	Measu-ring circuits	Sensor	Nominal value	Tolerance	Wire circuit	Dimensions in mm	Supply line	Sensor version (optional)	Addition[1)]
									Screened =abg Number of isolations	
								Information about cable		
							ø= diameter l= length			
						2- ,3- or 4-wire circuit for RTD for TE, KTY, PTC, BIS (always 2-wire circuit)				
					Tolerance class according to DIN - for example: Class A; B for RTD Class 1; 2; 3 for TE In % for KTY, PTC-sensors					
				100, 500 or 1000 for RTD-nominal value in [Ω] J, K … etc. for thermocouple type 83 or 84 for KTY-sensor type 60, 70, 80 … etc. for NAT in [°C] 60, 70, 80 ... etc. NST in [°C] for BIS						
			Pt, Cu or Ni for RTD TE for thermocouple KTY for KTY-sensor EPTC,ZPTC,DPTC for thermistors BIS for bimetallic switches "Kombi" for combination of several sensor types							
		Number of measuring circuits / sensors								
	Titel of customer standards									

MH = Metall sleeve

E.g.: MH,1Pt100A3,ø3x20,E1x24/7,1200RD/WH

MH	1	Pt	100	A	3	ø3x20	E1x24/7RD/WH

RTD = Resistance thermometer
NAT = Rated operation temperature
NST = Nominal Switsching Temperature
Pt = Platinum
Cu = Copper
Ni = Nickel

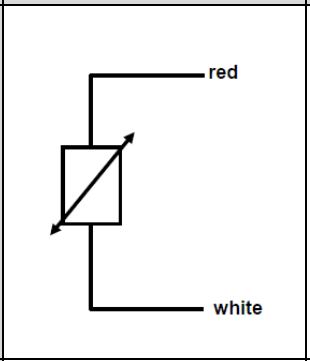
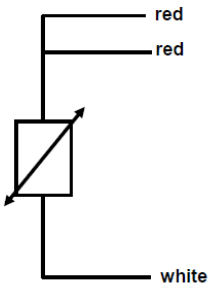
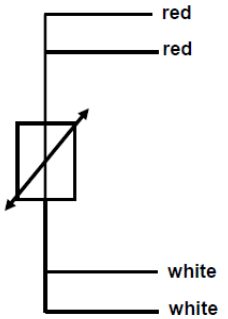
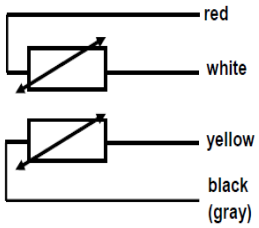
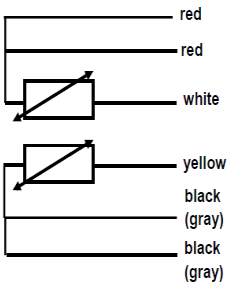
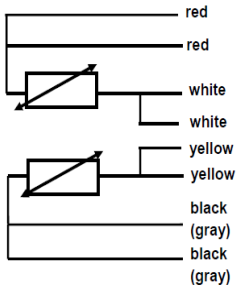
1) Addition: e. g.: In KTY also be asked to specify color code and polarity of the line e. g.: YE (+) / GN (-)

9. Nominal values / characteristics

Nominal values and characteristics for the individual sensors are specified in the following standards:

- Platinum resistance thermometer DIN EN 60751
- Nickel resistance thermometer not standardized
- Copper resistance thermometer not standardized
- Thermocouples (TE) DIN EN 60584
- Thermistors (PTC) DIN VDE V 0898-1-401
- Silicon sensors (KTY) not standardized
- Bimetallic switches (BIS) not standardized

9.1 Circuit and labeling of connecting wires of Pt100 sensors acc. to EN 60751

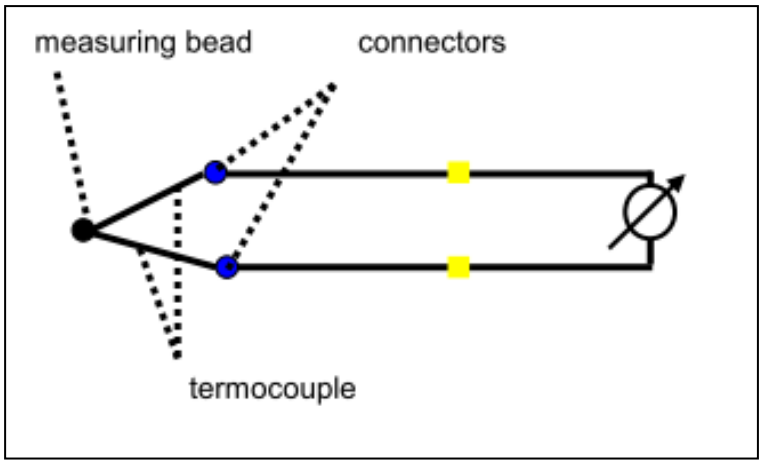
	2- conductor connection	3- conductor connection	4- conductor connection
1 x Pt100 measuring resistor			
2 x Pt100 measuring resistors			

9.2 Circuit and labeling of connecting wires of thermocouples acc. standard (excerpt)

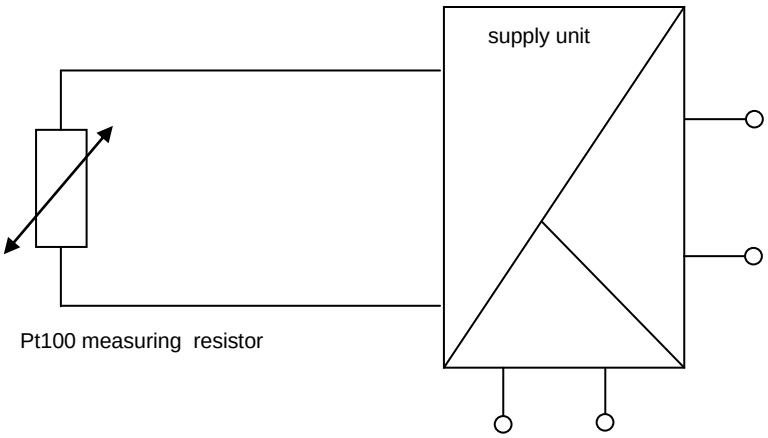
Type	Color	Standard
T	BN(BN$^{(+)}$ / WH$^{(-)}$)	EN 60584
J	BK(BK$^{(+)}$ / WH$^{(-)}$)	EN 60584
K	GN(GN$^{(+)}$ / WH$^{(-)}$)	EN 60584
S	OR(OR$^{(+)}$ / WH$^{(-)}$)	EN 60584

9.3 Connection diagram

9.3.1 Connection diagram equipment protection by increased safety (Principle sketch of thermocouples)



9.3.2 Connection diagram equipment protection by intrinsic safety (Use of a suitable operating equipment)



Wiesbaden, 29th March 2017