Semiconductor Based Temperature Sensors

- Motor Protection Thermistors (PTC)
- Thermistors (NTC)
- Silicon Sensors (KTY)
1 Notes to the use of the Catalogue

Products included in this catalogue represent a general overview of the principally deliverable types of construction and confectioning variations of PTC-, NTC- und KTY- Sensors of EPHY-MESS. At first the individual basic types of construction of the sensors, as well as the technical benchmark figures are presented. An overview of the default deliverable possibilities of confectioning follows. Finally some release devices for the different types of sensors are discussed. The different variations and modifications for one product are separated by the sign "|". Please note that the variations cannot be combined always freely, because, for example, a small collet diameter only allows a specific hose pipe or a special sensor. The confectioning variations shown in the catalogue are standard types of construction. However, any customer specific solutions are practicable. The specification sheets are kept general and normally specify only the benchmark figures. Due to the countless number of possibilities which could result, it is unfortunately not possible to display all variations. In the case of special requirements or desires, please contact our sales department. We would gladly develop with you a temperature sensor according your special requirements. A confectioning of sensors, as set by you, is also possible.

2 Introduction

For the thermal control of electrical machines motor protection (PTC, NTC) thermistors, as well as (NTC) silicon sensors (KTY of the production series 83-1xx and 84-1xx), have stood the test at best. Motor protection PTC thermistors qualify very good for control of a limit temperature. By use of these PTC thermistors and a suitable switching device a reliable overheating protection system can be realised. By means of silicon sensors and NTC in many cases a well-priced temperature measurement can be realised. All sensors are mainly confectioned by EPHY-MESS for the placement inside the winding or slot of electrical machines. But they are also suitable for other tasks of temperature measurement and control.
3 Motor Protection Thermists (PTC)

3.1 General
A Positive Temperature Coefficient thermistor (PTC) is a semiconductor of endowed, polycrystalline barium titanate ceramic, whose electrical resistance rapidly increases when a certain temperature is exceeded. PTC thermistors deliverable by EPHY-MESS are mainly motor protection thermistors according to DIN 44081 – 82, which are set in the winding of electrical motors, generators and transformers. The typical resistance / temperature characteristic of motor protection thermistors is displayed in the following diagram.

At combination of a motor protection PTC thermistor with a switching device one receives an effective, well-priced and quickly reacting solution for the protection of electrical machines from overheating.

As visible in fig. 1, the resistance value of the PTC thermistor increases steeply after reaching of its reference temperature. For the classification of the sensor one fixes a point in the steep zone of the response curve, the so called nominal response temperature (NAT). It signifies the temperature value, at which the downstream connected release device reacts inside the tolerance range. At the selection of the used PTC, its NAT incl. tolerance has to be chosen so, that it corresponds to the maximum acceptable operation temperature of the motor. The PTC’s are also to be connected in series with different NAT inside a measurement circuit. Thereby different ranges of temperature of a machine can be controlled with only one measurement circuit. As soon as at one PTC the by its NAT defined maximum temperature is exceeded, the connected downstream switching device switches the machine off. Furthermore the usage of 2 different NAT is possible, if for example, one wants to realise at a single motor a combination of forewarn and shutoff. However in this case two measurement circuits are necessary.
3.2 Classical Motor Protection Thermistor Type (EPTC / DPTC-SH-xxx)

**Designation**
EPTC / DPTC-SH-xxx
- **EPTC** = single PTC thermistor
- **DPTC** = triplet PTC thermistor
- **SH** = shrinkage tube coat
- **xxx** = (NAT) nominal response temperature [°C]

**Construction**
- **EPTC-SH-xxx**
  - PTC thermistor pill according to DIN 44081 varnish and shrinkage tube insulated with fix connected single strands
- **DPTC-SH-xxx**
  - 3 PTC thermistor pills according to DIN 44082 varnish and shrinkage tube insulated with fix connected single strands boarded in series

**UL-approval**
- UL 1434 (UL file-Nummer E69802)
  - optional incl. NAT 180°C

**Measuring element EPTC**
- **type**
  - single PTC thermistor
- **material**
  - Bariumtitanat (BaTiO₃)
- **connection**
  - 2-wire circuit
- **resistance value**
  - $R < 100 \Omega$ at metering voltage ≤ 2.5V
  - ±5K acc. DIN 44081 (up to/ incl. NAT 160°C)
  - ±7K acc. DIN 44081 (starting at NAT 170°C)

**Measuring element DPTC**
- **type**
  - triple PTC thermistor
- **material**
  - Bariumtitanat (BaTiO₃)
- **connection**
  - 2-wire circuit
- **resistance value**
  - $R < 300 \Omega$ at metering voltage ≤ 2.5V (bis incl. NAT 180°C)
  - $R < 350 \Omega$ at metering voltage ≤ 2.5V (from NAT 190°C)
  - ±5K acc. DIN 44082 (up to/ incl. NAT 160°C)
  - ±7K acc. DIN 44082 (from NAT 170°C)
Electric values EPTC
nominal switching temperature NAT °C (see above)
max. operating voltage 30VDC valid in the range from 0°C … +40°C
max. measuring voltage 7,5VDC in the range from -25°C up to TNAT +23K
dielectric strength 2,5 kV / AC 50 Hz / 1 min.

Electric values DPTC
nominal switching temperature NAT °C (see above)
max. operating voltage 30 V DC valid in the range from 0°C … +40°C
max. measuring voltage 7,5 V DC in the range from -25°C up to TNAT +23K
dielectric strength 2,5 kV / AC 50 Hz / 1 min.

Temperature range
operating temperature -25°C … +200°C; above +200°C a possible self-heating caused by the measuring voltage has to be considered.

Pill size (insulated)
Old, former standard pill ø<4mm | Up-to-date mini pill ø < 3mm

Pill insulation
T < 160°C => Kynar® shrinkage tube
T ≥ 160°C => PTFE shrinkage tube

Nominal response temperature
60°C … +190°C

Colour codes

<table>
<thead>
<tr>
<th>TNAT [°C]</th>
<th>Colour code</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>WH / GY</td>
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<tr>
<td>70</td>
<td>WH / BN</td>
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<tr>
<td>80</td>
<td>WH / WH</td>
</tr>
<tr>
<td>90</td>
<td>GN / GN</td>
</tr>
<tr>
<td>100</td>
<td>RD / RD</td>
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<tr>
<td>110</td>
<td>BN / BN</td>
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<td>120</td>
<td>GY / GY</td>
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<td>130</td>
<td>BU / BU</td>
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<td>140</td>
<td>WH / BU</td>
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<td>145</td>
<td>WH / BK</td>
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<tr>
<td>150</td>
<td>BK / BK</td>
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<td>155</td>
<td>BU / BK</td>
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<tr>
<td>160</td>
<td>BU / RD</td>
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<td>170</td>
<td>WH / GN</td>
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<tr>
<td>180</td>
<td>WH / RD</td>
</tr>
<tr>
<td>190</td>
<td>BK / GY</td>
</tr>
</tbody>
</table>

Tab. 1: Colour code of motor protection PTC thermistors according to DIN 40080

Connection line
Single strands AWG 26/7

Insulation
PTFE

Standard cable length

- EPTC  500mm | 2000mm
- DPTC  500/180/180/500mm | 2000/300/300/2000mm

1 Other cable length on request
4 Thermistor (NTC)

4.1 General
A NTC thermistor is according to DIN 44070 resp. IEC 60593 a temperature dependant semiconductor resistor whose value of resistance decreases with growing temperature. The Negative Temperature Coeffizient (NTC) lies at approx. -2...-6%/K and is therewith approx. ten times bigger as for metals. Therefore thermistors are well suitable for the measurement of temperatures. They consist of manganese, iron, cobalt, nickel, copper and zinc oxide; those are admixed with other oxides for chemical stabilisation. These are prepared to a powdery compound and after addition of a plastic binding agent sintered at temperatures of approx. 1000 - 1400°C. Afterwards the polycrystalline semiconductors are pinned and by means of special ageing methods aged for the stabilisation of the resistant values aged. The change of the resistance in operation can be caused by a change in the temperature of the environment, as well as by self-heating as a result of electrical loading. While using PTC thermistors the response temperature of the protection equipment is defined by the NAT of the PTC, one can adjust the switching point of a NTC at the corresponding switching device.

4.2 Thermistors for Temperature Control Type (K227)

**Fig. 3:** Motor protection PTC thermistor type K227, 1,8kΩ

**Specification**  
NTC-SH, type K227 B57227 K333A, 1,8kΩ

**Special construction**  
10 kΩ, technical dates on request  
**ATTENTION:** all here mentioned dates refer to the type 1.8 kΩ

**Construction**  
Thermistor disk with Kynar shrinkage tube insulation and fix connected single strands

**Pill dimensions (insulated)**  
$\varnothing_{\text{max}} = 5 \text{ mm x 14 mm}$

**Application**  
For the thermal control of electrical machines and the temperature measurement inside electrical motors and transformers

**Temperature range**  
-55...155°C

**Max. power**  
200mW at $T=25°C$
Resistance tolerance \( \Delta R/R_N = \pm 10\% \)

Nominal resistance (RN) \[ 1.8 \text{ k}\Omega \mid 10 \text{ k}\Omega \quad \text{special construction} \]

Nominal temperature 100°C

Resistance R25°C 32.762 kΩ

Heat conductance value 5 mW/K (in static air)

Therm. cooling period constant 30 s (in static air)

Heat capacity 150 mJ/K

Insulation resistance (U=100V) >100 MΩhm

Dielectric strength 2.5 kV / AC 50Hz / 1min.

B-value (B25/B100) 4300 K

B-value tolerance ±1.5%

Pill insulation Kynar® shrinkage tube

Connection line PTFE single strands
Cable section AWG26
Colour code Red / Grey
Cable length (standard) 380mm \mid 2000mm
Characteristic curve

Fig. 4: Characteristic curve NTC K227, 1.8kOhm

Confectioning variations

ESH/DSH | SGH | KH | AK/ZS | MH
5 Silicon Sensors

5.1 General

Silicon sensors of the KTY production series are like diodes built semiconductors. Their operation temperature range extends from \(-55^\circ\text{C}...+175^\circ\text{C}\) (KTY 83 series), resp. from \(40^\circ\text{C}...+300^\circ\text{C}\) (KTY84 series), what is sufficient for the most industrial measuring purposes. They have, just as PTC thermistors, a positive temperature coefficient but in contrary to them they show an approximate linear characteristic line. Their resistance response is comparable with this of a precision resistor with a big temperature coefficient. The range of application is the measuring of temperatures and control of limit values. The range of tolerance at reference temperature lies according to the construction between 3 and 5\%, what is compared with a Pt100 relatively inexact. But for many applications, as e.g. motor protection, this is completely sufficient, because in this case the sensors operate mostly relatively close to their nominal temperature (for KTY84-1xx) and at this applications a degree more or less is not important. For this reason, in industry they are a very common and a low priced alternative for the classical Pt100. By EPHY-MESS confectioned sensors base on the KTY production series 83-1xx and 84-1xx. On customers request, other KTY types are available.
5.2 Sensor Production Series 83-1xx and 84-1xx

5.2.1 KTY-Sensor Production Series 83-1xx

Fig. 5: Silicon KTY 83-1xx sensor

**Designation**

Silicon KTY83-1xx

\[ xx = \text{tolerance range (see Tab. 2:)} \]

**Construction**

Silicon sensor in DO-34 housing with axial connection rods

**Type labelling**

Printed type number on DO-34 housing (see Tab. 2:)

**Connection labelling**

Black cathode ring

Remark: The side of the cathode is marked with a black colour ring. This side has to be connected due to the polarity dependence of the sensor with the negative potential of the measuring appliance.

**Measuring range**

\(-55^\circ C...175^\circ C\)

**Nominal resistance**

1000 \( \Omega \)

**Nominal temperature**

25°C

**Measuring current**

1mA

**Max. acceptable constant current**

\[ I_{d_{\text{max}}} \text{ in air (25°C)} = 10 \text{ mA} \]

\[ I_{d_{\text{max}}} \text{ in air (175°C)} = 2 \text{ mA} \]

\[ ^1 \text{ Dimensions see Fig 5} \]
Tolerance range

<table>
<thead>
<tr>
<th>Type</th>
<th>Type labelling</th>
<th>Tolerance</th>
<th>Tolerance range</th>
</tr>
</thead>
<tbody>
<tr>
<td>KTY83-110</td>
<td>KTY83A</td>
<td>±1%</td>
<td>990... 1010 Ω</td>
</tr>
<tr>
<td>KTY83-120</td>
<td>KTY83C</td>
<td>±2%</td>
<td>980... 1020 Ω</td>
</tr>
<tr>
<td>KTY83-121</td>
<td>KTY83D</td>
<td>-2%</td>
<td>980... 1000 Ω</td>
</tr>
<tr>
<td>KTY83-122</td>
<td>KTY83E</td>
<td>+2%</td>
<td>1000... 1020 Ω</td>
</tr>
<tr>
<td>KTY83-150</td>
<td>KTY83H</td>
<td>±5%</td>
<td>950... 1050 Ω</td>
</tr>
<tr>
<td>KTY83-151</td>
<td>KTY83K</td>
<td>-5%</td>
<td>950... 1000 Ω</td>
</tr>
<tr>
<td>KTY83-152</td>
<td>KTY83N</td>
<td>+5%</td>
<td>1000... 1050 Ω</td>
</tr>
</tbody>
</table>

Tab. 2: Tolerances of KTY 83-1xx

Temperature coefficient $\alpha_{25}$: 0.76%/K

Resistance ratio
- $R_{100} / R_{25} = 1.67 \pm 0.02$
- $R_{55} / R_{25} = 0.50 \pm 0.01$

Thermal time constant $T$
- Inside static air: 20 s
- Inside resting water: 1 s
- Inside flowing water: 0.5 s

Housing / dimensions: Diode glass housing DO-34 (compare Fig. 5: )

Confectioning variations: ESH/DSH | KH | MH | SGH | AK/ZS

Characteristic curve
- $R_T = R_N [1 + A (\Theta - \Theta_N) + B (\Theta - \Theta_N)^2]$
- $R_N$ = nominal resistance
- $\Theta_N$ = nominal temperature (25°C)
- $\Theta$ = temperature [°C]
- A, B = constants
  - $A = 7.635 \times 10^{-3}$
  - $B = 1.731 \times 10^{-5}$
Fig. 6: R(T) characteristic curve of KTY 83-1xx

Fig. 7: Resistance deviation dependent of the measuring current

Fig. 8: Max. current in dependence of the temperature

Fig. 9: Max. measuring error in dependence of the temperature
5.2.2 KTY Sensor Production Series 84-1xx

![Diagram of KTY Sensor Production Series 84-1xx](image)

**Fig. 10:** Silicon KTY production series 84-1xx

- **Designation:** Silicon KTY84-1xx
  - xx = tolerance range (see Tab. 3: )

- **Construction:** Silicon sensor in DO-34 housing with axial connection rods

- **Type labelling:** Printed type number on DO-34 housing (see Tab. 3: )

- **Connection labelling:** Black cathode ring
  - Remark: The side of the cathode is marked with a black colour ring. This side has to be connected due to the polarity dependence of the sensor with the negative potential of the measuring appliance.

- **Colour code¹:** (+) = yellow  (-) = green

- **Measuring range:** -40°C ... +300°C

- **Nominal resistance:** 1000 Ω

- **Nominal temperature:** 100°C

- **Measuring current:** 2 mA

- **Max. acceptable constant current:**
  - $I_{D_{max}}$ inside air (25°C) 10 mA
  - $I_{D_{max}}$ inside air (300°C) 2 mA

¹ At confectioning variations of Ephy-Mess
Tolerance range

<table>
<thead>
<tr>
<th>Type</th>
<th>Type labelling</th>
<th>Tolerance</th>
<th>Tolerance range</th>
</tr>
</thead>
<tbody>
<tr>
<td>KTY84-130</td>
<td>KTY84L</td>
<td>±3%</td>
<td>970...1030 Ω</td>
</tr>
<tr>
<td>KTY84-150</td>
<td>KTY84M</td>
<td>±5%</td>
<td>950...1050 Ω</td>
</tr>
<tr>
<td>KTY84-151</td>
<td>KTY84O</td>
<td>+5%</td>
<td>950...1000 Ω</td>
</tr>
<tr>
<td>KTY84-152</td>
<td>KTY84P</td>
<td>+5%</td>
<td>1000...1050 Ω</td>
</tr>
</tbody>
</table>

Tab. 3: Tolerances of KTY 84-1xx

Temperature coefficient $\alpha_{25} = 0.61\%/K$

Resistance ratio

<table>
<thead>
<tr>
<th>Resistance ratio</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>R250/R100</td>
<td>2.166±0.055</td>
</tr>
<tr>
<td>R25/R100</td>
<td>0.603±0.08</td>
</tr>
</tbody>
</table>

Thermal time constant $T$

- Inside static air: 20 s
- Inside resting water: 1 s
- Inside flowing water: 0.5 s

Housing / dimensions

Diode glass housing DO-34 (compare Fig. 10: )

Confectioning variations

ESH/DSH | KH | MH | SGH | AK/ZS

Characteristic curve

$R_T = R_N [1+A (\vartheta-\vartheta_N) + B (\vartheta-\vartheta_N)^2]$

$R_N$ = nominal resistance

$\vartheta_N$ = nominal temperature (100°C)

$\vartheta$ = temperature [°C]

$A, B$ = constants

A = 6.229 10-3

B = 1.159 10-5
**Fig. 11:** $R(T)$ characteristic curve of KTY 84-1xx

**Fig. 12:** Resistance deviation dependent of the measuring current

**Fig. 13:** Max. current in dependence of the temperature

**Fig. 14:** Max. measuring error in dependence of the temperature
6 Confectioning variations

The following table gives a general view over the different confectioning variations of the single basic sensors.

<table>
<thead>
<tr>
<th>Designation</th>
<th>Construction</th>
<th>PTC</th>
<th>DPTC</th>
<th>NTC</th>
<th>KTY</th>
</tr>
</thead>
<tbody>
<tr>
<td>XXX-ESH</td>
<td>XXX-Sensor with a single layer of shrinkable tube and a fix connected supply line</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
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<tr>
<td>XXX-DSH</td>
<td>XXX-Sensor with a double layer of shrinkable tube and a fix connected supply line</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
</tr>
<tr>
<td>XXX-MH</td>
<td>XXX-Sensor built into a metall sleeve with fix connected supply line</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
</tr>
<tr>
<td>XXX-KH</td>
<td>XXX-Sensor sealed into a ceramic sleeve with fix connected supply line</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
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<tr>
<td>XXX-SGH</td>
<td>XXX-Sensor built into a screw housing with fix connected supply line</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
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<tr>
<td>XXX-AK</td>
<td>XXX-Sensor built in a HGW intake body (AK). Closed with cover disk and additional insulated with PTFE shrinkage tube. Fix connected supply line.</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
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<tr>
<td>XXX-ZS</td>
<td>XXX-Sensor built into a ZS housing</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
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Tab. 4: Confectioning variations of basic sensors

6.1 Confectioning variations with Ex certification according to ATEX

<table>
<thead>
<tr>
<th>Typ</th>
<th>Bauform</th>
<th>Sensor</th>
<th>IEC Ex</th>
<th>ATEX</th>
<th>TR</th>
</tr>
</thead>
<tbody>
<tr>
<td>PR-SPA-EX-WKF</td>
<td>XXX - ESH</td>
<td>PTC*</td>
<td>KTY83/84</td>
<td>Ex eb IIC Ex ta IIC</td>
<td>II 2G Ex e IIC Gb Ex ia IIC Gb</td>
</tr>
<tr>
<td></td>
<td>XXX - DSH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>XXX – MH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>XXX - KH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>XXX - SGH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PR-SPA-EX-NWT</td>
<td>XXX – AK</td>
<td>PTC*</td>
<td>KTY83/84</td>
<td>Ex ia IIC Gb</td>
<td>II 2G Ex ia IIC Gb Ex 2D Ex ia IIC Db</td>
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<tr>
<td></td>
<td>XXX - ZS</td>
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</tbody>
</table>

*acc. DIN 44081-82

Tab. 5: Confectioning variations with Ex certification according to IECEx, ATEX and TR certification
6.2 Confectioned Shrinkage Tube Insulated Sensors Type (XXX-XSH)

IECEx:  Ex eb IIC, Ex ta IIIC, Ex ia IIC Gb, Ex ia IIIC Gb
ATEX:   II 2G Ex e IIC Gb, II 2D Ex ta IIIC Da, II 2G Ex ia IIC Gb, II 2D Ex ia IIIC Db
TR:     Ex e II U, Ex tb IIIC Db U, Ex ia IIC U, Ex ia IIIC Db U

Fig. 15: KTY-ESH with Teflon single litz wires

Specification
XXX/XSH
XXX = PTC | NTC | KTY, (see basic sensors)
X =E = single shrinkage tube insulated
X =D = double shrinkage tube insulated

Construction
Measuring sensor, single or double layer insulated by means of shrinkage tube with fix connected connection line

Temperature sensor
EPTC/ DPTC | NTC | KTY (also as Pt100 available)

Measuring range
Dependent on the used sensor

Max. operation temperature*
175°C | 190°C | 260°C *) Dependent on the used sensor

Sensor insulation
1) ESH single-layer insulated
2) DSH double-layer insulated

Dimensions*
From approx. ø3mm x length from approx. 10mm
*) dependent on the used sensor and wire

Material
Kynar | Kynarflex | PTFE shrinkage tube

Connection line
Shrinkage tube | teflon flat cable shrinkage tube
Screened shrinkage tube | PTFE single strands

Insulation
Silicon | teflon | spun glass

Cable section*
AWG 20 | 22 | 24 | 26 | 28 | 30
*) section at SL /FSL dependent on type

Cable length
Upon customers request

Cable ends
Partly stripped | cable collets | blank | solder plated

Colour code
At PTC according to Tab. 1: | on customer’s request

Dielectric strength*
Without | \( R_{iso} \geq 500V \leq 200M\Omega \) | 1.5 kV / AC 50 Hz / 1 min. |
2.5 kV / AC 50 Hz / 1 min. *) Only at DSH

Special constructions
Waterproofed construction (IP 66)
Screened construction (XXX-DSH-A)
Dielectric strength up to 8 kV
Optional with IECEx, ATEX or TR-certification*
*) not available for NTC
6.3 Confectioned Sensors in Ceramic Collet Type (XXX-KH)

**IECEx:** Ex eb IIC, Ex ta IIIC, Ex ia IIC Gb, Ex ia IIIC Gb

**ATEX:** II 2G Ex e IIC Gb, II 2D Ex ta IIIC Da, II 2G Ex ia IIC Gb, II 2D Ex ia IIIC Db

**TR:** Ex e II U, Ex tb IIIC Db U, Ex ia IIC U, Ex ia IIIC Db U

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**Fig. 16:** XXX-KH, top: 4.9x30mm / below: 3x15mm

### Specification

XXX-KH

<table>
<thead>
<tr>
<th>Type</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>XXX= EPTC/DPTC</td>
<td>NTC</td>
</tr>
<tr>
<td>KH = ceramic collet</td>
<td></td>
</tr>
</tbody>
</table>

### Construction

Basic sensor with fix connected connection line shed in ceramic collet/s

### Sensors

EPTC/DPTC | NTC | KTY

### Protection collet

Ceramic protection collet

### Material

Al2O3 ceramic

### Dimensions

<table>
<thead>
<tr>
<th>Type</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>HÜ-KH-EFG*</td>
<td>ø3 x 15 mm</td>
</tr>
<tr>
<td>HÜ-KH-EFG</td>
<td>ø4 x 25 mm</td>
</tr>
<tr>
<td>HÜ-KH-ERG**</td>
<td>ø4.9 x 16 mm</td>
</tr>
<tr>
<td>HÜ-KH-ERG</td>
<td>ø4.9 x 30 mm</td>
</tr>
</tbody>
</table>

*) EFG = single sided flat closed

**) ERG = single sided round closed

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### Connection line

Shrinkage tube | screened shrinkage tube | PTFE single strands

**Insulation**

Teflon | silicone | spun glass

**Cable section**

AWG 20 / 22 / 24 / 26 / 28 / 30

*) For SL dependent on type

**Cable length**

On customer’s request

**Cable ends**

Partly stripped | cable collets | blank | solder plated

**Colour code**

For PTC according to Tab. 1: | on customer’s request

**Dielectric strength**

$R_{(iso)} \geq 500V \geq 200M\Omega$ | up to 5 kV / AC 50 Hz / 1 min.

**Special construction**

With varnish glass filament tube (LGLS) as nick protection
6.4 Confectioned Sensors in Metal Collet Type (XXX-MH)

IECEx: Ex eb IIIC, Ex ta IIIC, Ex ia IIIC Gb, Ex ia IIIC Gb
ATEX: II 2G Ex e IIC Gb, II 2D Ex ta IIC Da, II 2G Ex ia IIC Gb, II 2D Ex ia IIC Db
TR: Ex e II U, Ex tb IIIC Db U, Ex ia IIC U, Ex ia IIIC Db U

Fig. 17: XXX-MH with mounting hole and fix connected supply line

Specification

XXX-MH
XXX = EPTC | NTC | KTY
MH = metal collet

Construction

Basic sensor built in metal collet, with fix connected connection line

Sensors

EPTC | NTC | KTY

Protection collet

Metallic protection collet

Material

V2A | brass

Cable connection* Beaded | rolled | shed
*) Dependent on cable type

Dimensions*

ø min 3 x length min 20mm
*) dependent on connection line and used sensor

Connection line

Shrinkage tube | screened shrinkage tube | PTFE single strands

Insulation

Silicone | Teflon | spun glass

Cable section* AWG 20 / 22 / 24 / 26 / 28 / 30
*) for SL dependent on type

Cable length On customer’s request

Cable ends Partly stripped | cable collets | blank | solder plated

Colour code For PTC according to Tab. 1: on customer’s request

Dielectric strength

Without | $R_{\text{iso}} 500V \geq 200\Omega$ | 2kV / AC 50Hz / 1min.

Special construction

Screened construction
With mounting hole M4
6.5  Thermometer for Screwing In Type (XXX-SGH)

**IECEx:** Ex eb IIC, Ex ta IIC, Ex ia IIC Gb, Ex ia IIIC Gb  
**ATEX:** ll 2G Ex e IIC Gb, ll 2D Ex ta IIC Da, ll 2G Ex ia IIC Gb, ll 2D Ex ia IIIC Db  
**TR:** Ex e ll U, Ex tb IIIC Db U, Ex ia IIC U, Ex ia IIIC Db U

**Fig. 18:** Left: XXX-SGH construction A with PTFE single strands)  
Middle: XXX-SGH construction A with fix shed connector  
Right: XXX-SGH construction B with silicone insulated hose liner

**Designation**  
Thermometer for screwing in, screw housing XXX-SGH  
XXX = PTC | NTC | KTY  
SGH = screw housing

**Construction**  
**Construction (A):** Basic sensor shed in brass or aluminium screw housing, with fix connected connection line  
**Construction (B):** Basic sensor in VA collet with fix or shiftable screwing

**Measuring range**  
Dependent on used sensor

**Max. operation temperature**  
180°C | 260°C  
*Dependent on used sensor

**Sensors**  
PTC | NTC | KTY
Screw housing construction A

<table>
<thead>
<tr>
<th>Material</th>
<th>Thread x mounting length1</th>
<th>SW x height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brass</td>
<td>M4 x 7,5mm</td>
<td>SW 7x10mm</td>
</tr>
<tr>
<td>Brass</td>
<td>M4 x 6mm</td>
<td>SW 7x10mm</td>
</tr>
<tr>
<td>Brass</td>
<td>M5 x 7,5mm</td>
<td>SW8x10mm</td>
</tr>
<tr>
<td>Brass</td>
<td>M6 x 7,5mm</td>
<td>SW10x10mm</td>
</tr>
<tr>
<td>Brass</td>
<td>M6 x 7,5mm</td>
<td>SW 8x15mm</td>
</tr>
<tr>
<td>Brass</td>
<td>M8 x 8mm</td>
<td>SW19x24mm²</td>
</tr>
<tr>
<td>Brass</td>
<td>M8 x 7,5mm</td>
<td>SW13x10mm</td>
</tr>
<tr>
<td>Aluminium</td>
<td>M4 x 6mm</td>
<td>SW8x8mm</td>
</tr>
<tr>
<td>Aluminium</td>
<td>M5 x 6mm</td>
<td>SW8x12mm</td>
</tr>
</tbody>
</table>

Tab. 7: Dimensions of standard screw housings

Screwings construction B

<table>
<thead>
<tr>
<th>Ø-VA collet [mm]</th>
<th>mounting length [mm]</th>
<th>VA-VSB</th>
</tr>
</thead>
<tbody>
<tr>
<td>4mm</td>
<td>from 20</td>
<td>M10x1</td>
</tr>
<tr>
<td>5mm</td>
<td></td>
<td>G1/4&quot;</td>
</tr>
<tr>
<td>6mm (standard)</td>
<td></td>
<td>G3/8&quot;</td>
</tr>
<tr>
<td>8mm</td>
<td></td>
<td>G1/2&quot;</td>
</tr>
</tbody>
</table>

Tab. 8: Collets ø and screwings

Connection line
- Shrinkage tube | PTFE single strands

Insulation
- Silicone | Teflon | spun glass

Cable length
- On customer’s request

Cable ends
- Partly stripped | cable collets | blank | solder plated

Colour code
- For PTC according to Tab. 1: | on customer’s request

Dielectric strength
- Without | $R_{iso}$ 500V ≥ 200MΩ | 2kV / AC / 50Hz 1min.

1 For all diameters ≥ 6mm, the sensor is placed inside the screw base for a better thermal linking

2 with shed connector (4-pole) see 0
6.6 Slot Resistance Thermometer Type (ZS; AK; E-NTS-ZS; KTY-ZS)

**IECEx:** Ex eb IIC, Ex ta IIIC, Ex ia IIC Gb, Ex ia IIIC Gb  
**ATEX:** II 2G Ex e IIC Gb, II 2D Ex ta IIIC Da, II 2G Ex ia IIC Gb, II 2D Ex ia IIIC Db  
**TR:** Ex e II U, Ex tb IIIC Db U, Ex ia IIC U, Ex ia IIIC Db U

**Fig. 19:** Above: XXX-ZS with flat cable shrinkage tube  
Below: XXX-AK with PTFE single strands

**Designation**
- XXX-ZS slot resistance thermometer  
- XXX-AK slot resistance thermometer  
  (E-NTS-ZS) Ex e version (only PTC)  
  (KTY-ZS) Ex e version (only KTY)  
  ZS = intermediate slide  
  AK = intake body  
  XXX = PTC | NTC | KTY

**Construction**
- (ZS) Basic sensor with fix connected connection line, fixed by means of bridge and directly shed in epoxy resin intermediate slide housing  
- (AK) Basic sensor built in and shed in HGW intake body of silicon. Closed with cover disk and additional insulated with PTFE shrinkage tube. Fix connected connection line.

**Measuring range**
Dependent on used sensor

**Max. operation temperature**¹
180°C | 200°C

**Sensors**
- PTC | NTC | KTY  
  (also as Pt100 available)

**Intake body (ZS)**
- Epoxy resin intermediate slide, rigid

**Material**
- Epoxy resin

**Dimensions**²
D(min.)=3±0,3 mm x B(min.) =4±0,3 mm x L(min.) =20±3 mm

¹ Dependent on used sensor  
² Dependent on used sensor and cable
Intake body (AK)  HGW intake body, flexible
Material  Silicon glass fabric-base laminate
Dimensions$^1$  D(min.) = 3 ± 0.3 B(min.) = 5 ± 0.3 mm L(min.) = 20 ± 3 mm
  *) depends on the used sensor
Insulation  PTFE shrinkage tube single or double layer
Connection line  Shrinkage tube  |  Teflon flat cable shrinkage tube  |  PTFE single strands
Insulation  Teflon  |  silicone
Colour code  For PTC according to Tab. 1:  |  on customer’s request
Section$^2$  AWG 20  |  24  |  26  |  28  |  customers request
  *) When hose line cross-section depending of the type
Cable length  On customer’s request
Cable ends  Partly stripped  |  cable collets  |  blank  |  solder plated
Dielectric strength  Without  |  up to 5kV / AC 50Hz / 1 min.  |  on customer’s request
Special construction  Ex e certificated versions according to IEC EX and ATEX$^{*)}$
  *) not for NTC
  **) only E-NTS-ZS | KTY-ZS | XXX-AK-ESH

---

$^1$ Dependent on used sensor
$^2$ At shrinkage tube section dependent of type
7 Switching Devices for PTC Thermistors and KTY Sensors

7.1 General
The by PTC thermistors or temperature measuring sensors controlled switching devices ensure primarily the thermal overload protection of electrical machines. The switching point of the protection appliance is defined for PTC thermistors by whose nominal response temperature (NAT). For KTY sensors it is adjustable on the device.

By EPHY-MESS supplied PTC thermistor switching devices can be used together with all motor protection PTC thermistors according to DIN 44081/82. The KTY switching device is compatible with all sensors of the production series KTY84-1xx.

7.2 Operating and Application Fields of PTC Thermistor Switching Devices
After mounting of the PTC thermistor sensors into the winding heads of the to get protected motors, the connection with the switching device takes place. The number of the to get connected PTC thermistors is only limited by the total resistance R25 of the switching device. If in one of the to get controlled parts or areas the temperature increases over the nominal response temperature of the respective PTC sensor e.g. by

- blocking rotor
- aggravated starting
- counter current operation
- low-voltage or phases deficit

so the PTC sensor becomes high-resistive and the release device shuts off the motor contactor over a relay. According to the type of the release device, a switch-back occurs after cooling of approx. 2-5K. For particular cases of an application, an independent restart is not suggested or not acceptable. For such cases, there are release devices with restart blocking (locking, manual reset) available. For this construction, a manual unlocking has to occur for the restart of the machine after a thermal shut off e.g. after a mains voltage failure of the output relay without locking switches on again. The relay output of the EPHY-MESS release devices is constructed as a potential-free change-over contact. All devices operate by the holding-current principle, what ensures a shutoff of the machine at mains voltage failure, sensor or cable breaking.

Temperature control systems based on PTC thermistor and release devices are not only well suited for the classical motor protection, but also for any kind of temperature controls at which an action has to be ensured after exceeding a temperature threshold value.
7.3 PTC Thermistor Release Devices

7.3.1 Release Device Type (INT69)

![PTC thermistor release device INT69](image)

**Fig. 20:** PTC thermistor release device INT69

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Designation</strong></td>
<td>PTC thermistor release device INT69 / 69V</td>
</tr>
<tr>
<td></td>
<td>( V = \text{locking} )</td>
</tr>
<tr>
<td><strong>Construction</strong></td>
<td>Release device in standard or miniature construction with an alteration relay. Optional with or without locking</td>
</tr>
<tr>
<td><strong>Supply voltage</strong></td>
<td>220V AC 50Hz</td>
</tr>
<tr>
<td><strong>Special constructions</strong></td>
<td>From 12 – 60VDC, to 24 – 380VAC</td>
</tr>
<tr>
<td><strong>Ambient temperature</strong></td>
<td>-30°C ... +70°C</td>
</tr>
<tr>
<td><strong>Sensors</strong></td>
<td>Motor protection PTC thermistor DIN 44081/82</td>
</tr>
<tr>
<td><strong>Quantity</strong></td>
<td>1 to 9 PTC thermistors in series (R25ges &lt; 1800Ohm)</td>
</tr>
<tr>
<td><strong>Measuring circuits</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Relay</strong></td>
<td>1 potential-free alteration contact</td>
</tr>
<tr>
<td><strong>Switching capacity</strong></td>
<td>250 VAC max. 6A, 300 VA ind.</td>
</tr>
<tr>
<td><strong>Installation</strong></td>
<td>Top hat rail</td>
</tr>
<tr>
<td><strong>Dimensions</strong></td>
<td>Standard: 68 x 33 x 80mm</td>
</tr>
<tr>
<td></td>
<td>Mini: 68 x 33 x 50mm</td>
</tr>
<tr>
<td><strong>IP-Protection class</strong></td>
<td>IP20, clamps IP00</td>
</tr>
<tr>
<td><strong>Locking</strong></td>
<td>With (INT69V)</td>
</tr>
</tbody>
</table>

\(^{1}\) Identical or different NAT
Circuit diagram

Clamps allocation

Power supply\(^1\): L / N

Sensor clamps: 1 / 2
  polarity doesn’t matter

Relay clamps: 12 / 14 / 11
  11 / 12 closed if:
    sensor temperature > adjusted switching temperature
    sensor or cable breaking
    breakdown of the supply voltage

  11 / 12 opened if:
    sensor temperature < adjusted switching temperature &
    supply voltage applied

  11 / 14 closed if:
    sensor temperature < switching temperature & supply
    voltage applied

  11 / 14 opened if:
    sensor temperature > adjusted switching temperature
    sensor or cable breaking
    breakdown of the supply voltage

---

\(^1\) See available supply voltage
7.3.2 Release Device Type (TÜS100)

![PTC thermistor release device TÜS100R](image)

**Fig. 22:** PTC thermistor release device TÜS100R

- **Designation:** TÜS 100 ZEM xxx, TÜS 100R ZEM xxx  
  R = with manual reset  
  xxx = supply voltage

- **Construction:** PTC thermistor release device with potential-free switch contact, optional with or without locking for connection of motor protection PTC thermistor

- **Supply voltage:** 220V AC | 110V DC | 24V DC

- **Ambient temperature:** -30....70°C

- **Sensors:** PTC thermistor according to DIN 44081/82

- **Measuring circuits:** 1

- **Quantity:** 1 to 6 PTC thermistor in series (R25ges < 1500Ohm)

- **Relay:** 1 alteration contact

- **Switching capacity:** 250V AC | max. 6 A | 300VA ind.

- **Locking:** With (TÜS100R) | without (TÜS100)

- **Installation:** Top hat rail and screw mounting

- **Dimensions:** 68 x 33 x 50mm

- **IP-Protection class:** IP20, clamps IP00

- **Weight:** Approximate 105g

---

1 Identical or different NAT
Circuit diagram

Fig. 23: Circuit diagram TÜS-100

Clamps allocation

Power supply\(^1\): L / N

Sensor clamps: 1 / 2
polarity doesn’t matter

Relais clamps: 14 / 12 / 11
11 / 12 closed if:
sensor temperature > adjusted switching temperature
sensor or cable breaking
breakdown of the supply voltage

11 / 12 opened if:
sensor temperature < adjusted switching temperature &
 supply voltage applied

11 / 14 closed if:
sensor temperature < switching temperature & supply
voltage applied

11 / 14 opened if:
sensor temperature > adjusted switching temperature
sensor or cable breaking
breakdown of the supply voltage

\(^1\) See available supply voltages
### 7.3.3 PTC Release Device with ATEX Approval Type MS(R)

Fig. 24: PTC switch device MSR 220KA

<table>
<thead>
<tr>
<th>Description</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Designation</strong></td>
<td>MS(R) 220 KA</td>
</tr>
<tr>
<td><strong>Construction</strong></td>
<td>ATEX approved PTC release device with switch relais, electively with or without manual reset. Suitable for PTC acc. to DIN</td>
</tr>
<tr>
<td><strong>Protection</strong></td>
<td>II (2 GD)</td>
</tr>
<tr>
<td><strong>Supply voltage</strong></td>
<td>220V AC</td>
</tr>
<tr>
<td><strong>Ambient temperature</strong></td>
<td>-20°C ... +55°C</td>
</tr>
<tr>
<td><strong>Sensors</strong></td>
<td>PTC acc. to DIN 44081/82</td>
</tr>
<tr>
<td><strong>Measurement circuits</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Quantity</strong></td>
<td>1 up to 6 PTC(^1) in serial, (switch value &lt;4000Ω)</td>
</tr>
<tr>
<td><strong>Relais</strong></td>
<td>1 or 2 alternation contacts</td>
</tr>
<tr>
<td><strong>Reset</strong></td>
<td>With for type MSR</td>
</tr>
<tr>
<td><strong>Mounting</strong></td>
<td>35mm DIN-rail</td>
</tr>
<tr>
<td><strong>Dimension (HxWxT)</strong></td>
<td>75 x 22.5 x 110mm</td>
</tr>
<tr>
<td><strong>IP-Protection class</strong></td>
<td>Housing IP30, clamps IP20</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>Approximate 150g</td>
</tr>
</tbody>
</table>

\(^1\) Same or different NAT
7.4 KTY Release Device Type (KTY 04.01-R)

**Fig. 25:** KTY –release device KTY 04.01-R

- **Designation**: Release device KTY 04.01-R
- **Construction**: KTY- release device with mains and faults display, self control regarding sensor breaking and voltage breakdown (based on the holding-current principle). Adjustable switchoff temperature. A potential-free relay alteration contact
- **Supply voltage**: 230V AC 50Hz (±10%).
- **Ambient temperature**: -20°C ... +60°C
- **Sensors**
  - **Type**: KTY 84-130 / -150 / -151 / -152
  - **Quantity**: 1
  - **Measuring circuits**: 1
- **Relais**: 1 potential-free alteration contact
- **Switching capacity**: 250V AC max. 6A, 300VA ind.
- **Adjustable switching range**: 60°C ...+260°C
- **Switch-back**: 10K ±2.5K below switchoff temperature
- **Installation**: top hat rail and screw mounting
- **Dimensions**: 75 x 45 x 107.5mm
- **IP-Protection class**: Housing IP40, connection clamps IP00
- **Weight**: Approximate 195g
Circuit diagram

Clamps allocation

Sensor clamps: 1 / 2
Polarity $^1$ 1 = (+) colour code: yellow
2 = (-) colour code: green

Relay clamps: 4 / 5 / 6

4 / 5 closed if:
- sensor temperature > adjusted switching temperature
- sensor or cable breaking
- breakdown of the supply voltage

4 / 5 opened if:
- sensor temperature < adjusted switching temperature &
  supply voltage applied

4 / 6 closed if:
- sensor temperature < switching temperature & supply
  voltage applied

4 / 6 opened if:
- sensor temperature > adjusted switching temperature
- sensor or cable breaking
- breakdown of the supply voltage

Power supply: 7 / 8
230VAC / 50-60 Hz

$^1$ Colour code of EPHY-MESS KTY84-1xx sensors