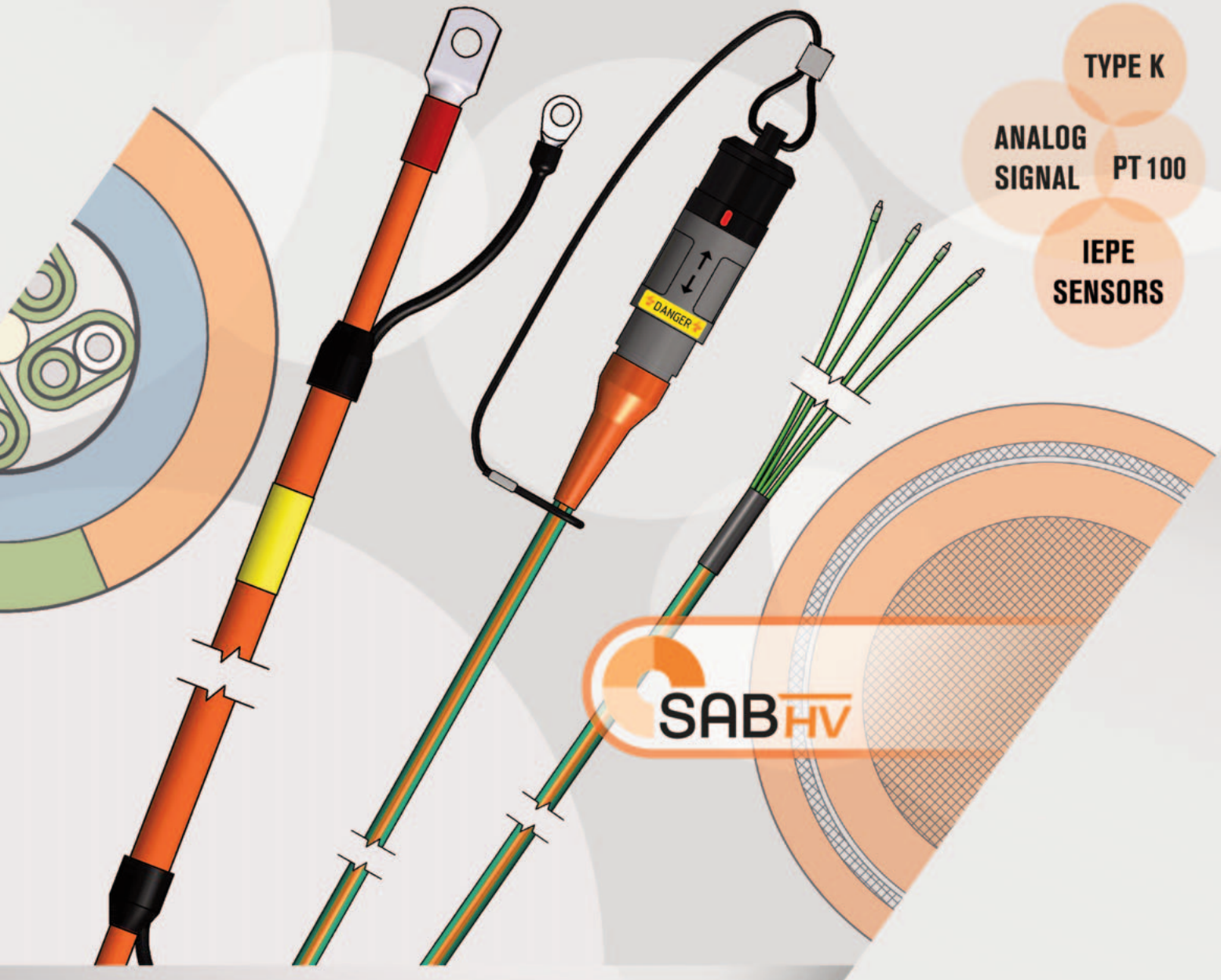
# E-MOBILITY

## HIGH VOLTAGE MEASUREMENT TECHNOLOGY




www.sab-cable.com

SPECIAL CABLES
SAB BRÖCKSKES

# Family business in the third generation

75 years of experience in cable and wire manufacturing as well as in temperature measurement technology turned a one-man business into a company with more than 550 employees. We prove our strength every year with more than 1500 special products according to customers' requirements. Each product is a new challenge for our creative technical team. We at SAB see ourselves as a manufacturer and a service provider – in the sense of true partnership and the greatest possible customer orientation.

Today, the quality of our products is known and appreciated in more than 100 countries around the world. In all product ranges, we are certified according to DIN EN ISO 9001. Furthermore, we have implemented an environmental management system for our company according to DIN EN ISO 14001, an occupational health and safety management system according to NLF/ILO-OSH and DIN ISO 45001, and an energy management system according to DIN EN ISO 50001.

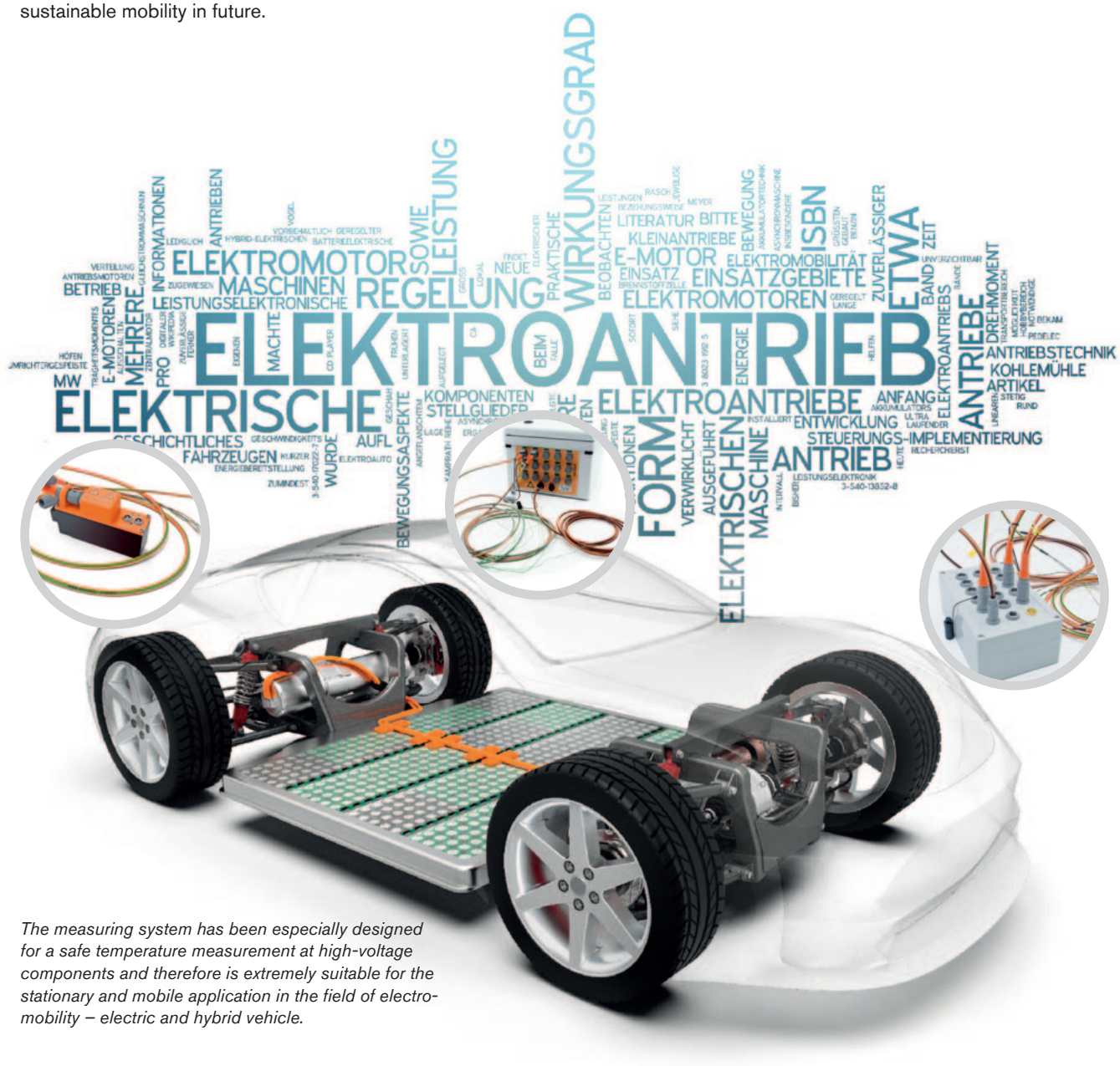
And also for the future, our slogan is: "WE GO FORWARD!"

| | |
|---|---|
| FOUNDED: | 1947 by Peter Bröckskes sen.<br>an independent, medium-sized company. |
| CEO: | Peter Bröckskes and Sabine Bröckskes-Wetten |
| PLANT/LOCATION: | In Viersen (Lower Rhine) 110.000 m² company site.<br>Own manufacturing from copper conductor to outer sheath.<br>VDE approved burnchamber and laboratory within the company. |
| EMPLOYEES/WORKERS: | Approx. 430 at the plant in Viersen, 550 worldwide |
| YEARLY SALES: | Approx. 134 Mio. € worldwide |
| PRODUCTS: | Special Cables<br>Measurement Technology<br>Cable Harnessing |
| CERTIFICATES AND APPROVALS: | Quality management system acc. to DIN EN ISO 9001 for every manufacturing field<br>Environmental management system acc. to DIN EN ISO 14001<br>Occupational health and safety management acc. to NLF/ILO-OSH and DIN ISO 45001<br>Energy management system acc. to DIN EN ISO 50001 |

# Content

# Reliable temperature measurement at HV components

For more than 10 years SAB Bröckskes as a worldwide leading cable manufacturer is confronted with the challenges of development and optimization of high-voltage cables as well as high-voltage measurement technology for components in electro-mobility. As a leading manufacturer we optimize our products with regard to the steadily changing requirements and develop continuously new products in the range of temperature measurement technology and wiring for a better and sustainable mobility in future.




*The measuring system has been especially designed for a safe temperature measurement at high-voltage components and therefore is extremely suitable for the stationary and mobile application in the field of electro-mobility – electric and hybrid vehicle.*

***The transport sector is the third biggest polluter with greenhouse gases after the energy sector and industry with approximately 20 percent CO2-emission (2019). The biggest part of transport pollution (94 percent) is caused by traffic. Fuel and diesel powered cars are responsible for 59 percent thereof".***

(German government)

This is the reason why the development of electric drives are of greatest importance for the transport sector. E-mobility has become much more than a niche market.



Fotos: Thomas Söllner - stock.adobe.com / XtravaganT - stock.adobe.com

# Safe and efficient measurement with CSM measurement technology

A safe and precise collection of temperatures (thermocouples and PT sensors) and analogue measuring signals can be realized by CSM HV measuring modules in HV environments. CSM HV measuring modules offer tested safety acc. to DIN EN 61010 and due to the multi-level safety concept a measuring chain is set up between sensor and data collection by special sensor cables and HV measuring modules. Furthermore, also standard sensors of LV environments can be used for HV applications.

The measuring modules are appropriate for use in road tests or for test benches as 19 “ insert module.

CSM

For more information, plese see
**www.csm.de**


**T141 / T151**
**page 8-14**

**HV TH4 evo / HV TH8 evo**
temperature measurement with thermocouples: NiCr-Ni temperature input (type K)


**T641** **page 15**

**HV PT2 / HV PT8**
temperature measurement with PT100- and PT1000 resistance thermometers

**T642**
**page 17**

**HV IEPE3 FL100**
safe measurement of acceleration, power and pressure with IEPE sensors

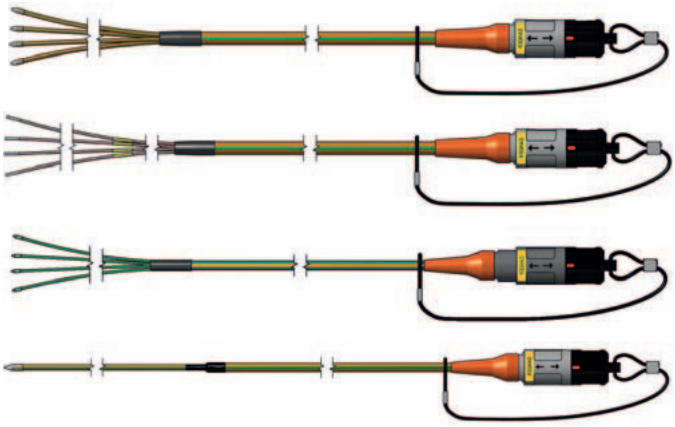
**T644** **page 18**

**HV STG4 pro BS20**
for measurements with strain gauges

**T641/T645** **page 19-21**

**HV CAN and ECAT AD measuring modules**
for direct voltage measurement and standard sensors (analogue measurements)

# Product presentation

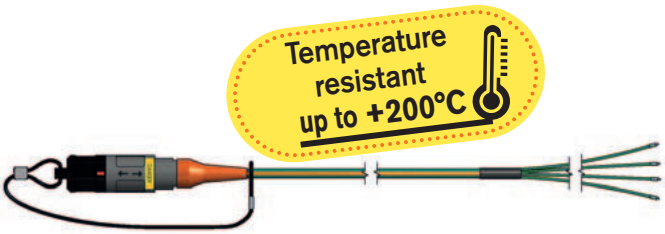


## HV SENSORS TYPE K

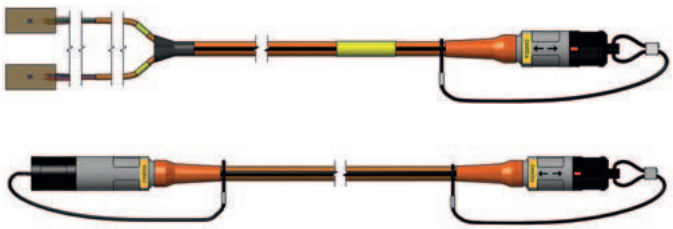
The use of HV type K sensors in HV environments is wide-ranging in vehicle technology and guarantees a safe measurement especially wherever a robust sensor and an exact temperature collection is needed. The sensors are used in HV components as for example inverters, electric motors, HV batteries and power electronics. The HV sensors are appropriate for the stationary as well as for mobile test drives.

## HV SENSORS TYPE K HT

HV type K sensors with high temperature design can be used in HV environments of vehicle technology as well as the standard HV sensors especially whenever high process temperatures are expected in the whole environment. This can be for example a thermal hardening process of insulating materials in E-units or other HV components.



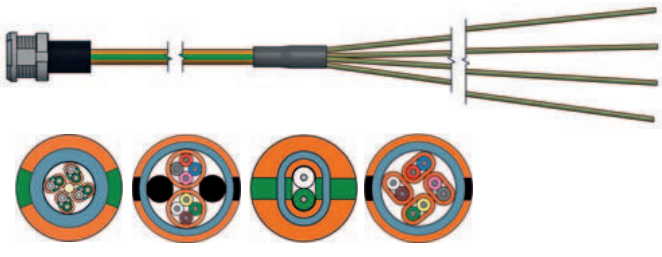

## HV SENSORS PT100/1000



The use of HV PT sensors in HV environments is wide ranging in vehicle technology especially whenever a small thermal mass, short response times by full-surface contact as well as a thin construction combined with an exact measurement are required. The application includes among others the temperature collection between the individual cells of a HV battery.

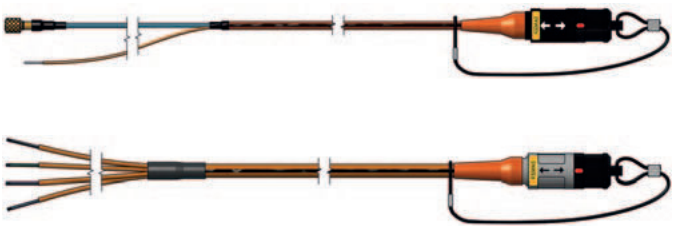
## HV TEST ADAPTER

HV test adapters are used for the adaptation of HV sensors in fixed installation and are available for all sensor types in high voltage environments. The test adapter is among others appropriate to test installed sensors for potential equalisation measurements or the fixed mounting in empty housings.



# Product presentation

## HV SENSOR CABLE ACCELERATION & STRAIN GAUGES

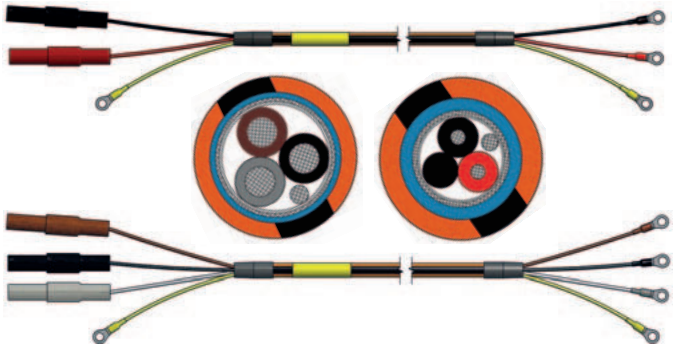


In order to measure acceleration and mechanical tension (strain gauge), HV sensor cables are needed. By the use of these special sensor cables for example tri-axial IEPE acceleration sensors and strain gauges in full and half bridge of the standard low voltage ranges can be used. In combination with the CSM measuring modules HV IEPE3 FL100 and HV STG4 pro BS20 reliable measurements in stationary as well as mobile application for example at test benches can be realised.

## HV ANALOGUE MEASURING CABLE AND VOLTAGE MEASURING CABLE

The analogue and voltage measuring cable are especially appropriate for the creation of safe HV measuring chains for example between sensors with analogue voltage output and the CSM measuring modules of series HV AD. By the use of these HV measuring cables combined with the suitable measuring module a voltage up to 90 V and a high voltage up to 1000 V in the stationary test field or mobile road test can be measured.

## HV VOLTAGE MEASUREMENT



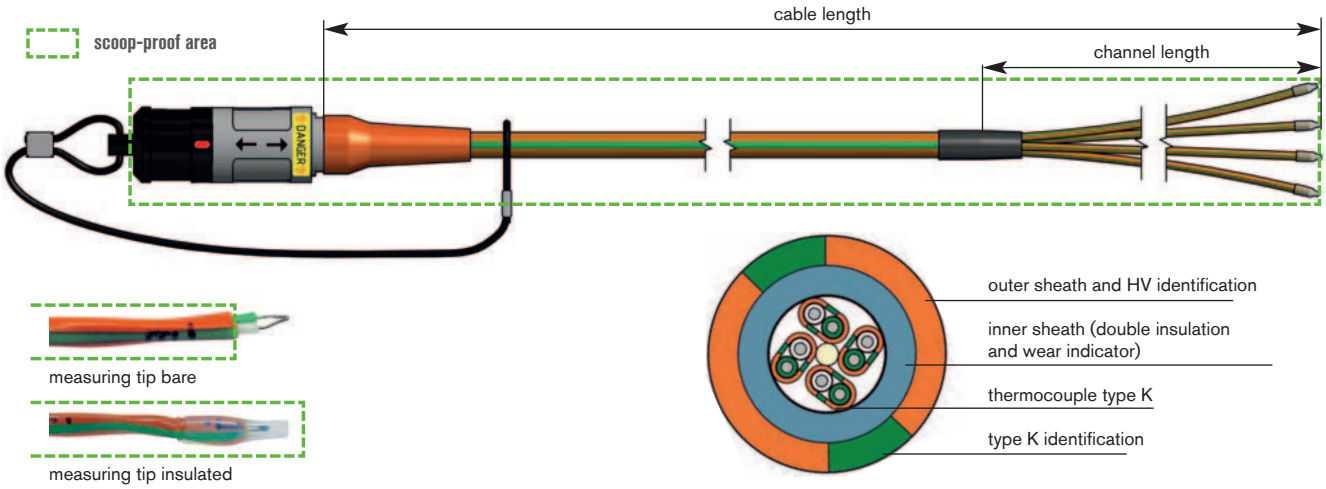
By the use of HV measuring cables (two of three core types) reliable measurements of DC and AC voltage in HV environments can be made. The measuring cables are designed for an operating voltage of up to 1800 V. Furthermore, the cores are colour coded acc. to the voltage type - red and black for plus and minus pole as well as brown, black and grey for the phases L1, L2 and L3.

## HIGHLY FLEXIBLE HV CABLES

Our highly flexible HV single cores and sensor cables are especially appropriate for the laying at HV test benches. The HV single cores are an optimal feed line for electric motors or battery systems. By the use of silicone as insulating material combined with a fine stranding, the cables can be installed easily. The screened HV single core offers a 100% EMC protection by a double screening of braid and aluminium foil.

# HV temperature sensor type K

**HV 4-channel thermocouple with FEP insulated thermo channels**




## Application range:

**Safe HV temperature measurement in HV environments**

## Connector:

Lemo Redel male connector with orange kink protection sleeve and black protecting cap, 8-pin, B-coded
1000 V AC voltage-stable – IP 67 when connected

## Sensor:

| | |
|---|---|
| **Thermocouple:** | 4 x type K |
| **Limit deviation:** | class 1 |
| **Measuring point:** | bare or electrically insulated (1000 V) |
| **Temperature range single channel:** | -40°C / +180°C |
| **Response time:** | on request |

## Cable data:

| | |
|---|---|
| **Connection cable:** | HV thermo cable type K |
| **Insulation:** | FEP – green and white |
| **Pair sheath:** | FEP – orange with green vertical stripes |
| **Inner sheath:** | FEP – blue acc. to RAL 5024 |
| **Outer sheath:** | PUR |
| **Sheath colour:** | orange with green vertical stripes |
| **Stranding:** | paired construction (for EMC) |
| **Outer diameter:** | approx. 6,1 mm |
| **Dielectric strength:** | 1000 V AC over single channel |
| **Temperature range** fixed laying: flexible application: | -50°C / +150°C -40°C / +150°C |
| **Special characteristics:** | contact protection of individual channels ✓ mechanically rugged ✓ |

## Tests:

**▶ Cable test**
over single channel in water bath –
5000 V AC – 5 min – with reference to EN 50264-2-1

**▶ Sensor test**
routine test of harnessed connector with reference to standard 61010-1 for measuring devices as well as VDE indications in our in-house ball bath (released by VDE). Control of contact protection towards outside – 3000 V/1 min AC

***Issue of HV test certificate with reference to batch number due to optimum traceability***

***Optional: Test and repair of already used sensors on request***



CONFIGURATION EXAMPLES

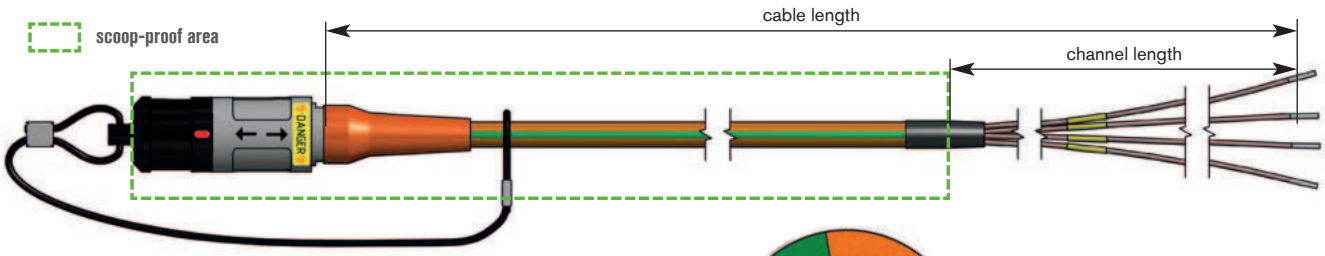
| item no. | connection cable length [mm] | single channel length [mm] | | | | type of measuring tip |
|---|---|---|---|---|---|---|
| | | channel 1 | channel 2 | channel 3 | channel 4 | measuring tip |
| T141-056-330 | 2400 | 400 | 400 | 400 | 400 | insulated |
| T141-051-650 | 2400 | 400 | 400 | 400 | 400 | bare |
| T141-061-909 | 3000 | 580 | 560 | 575 | 355 | insulated |

**Total cable and channel lengths can be realised on customer's request.**

**SAB identification:**
item number, batch number

# HV temperature sensor type K

**HV 4-channel thermocouple with PI (polyimide) insulated thermo channels**

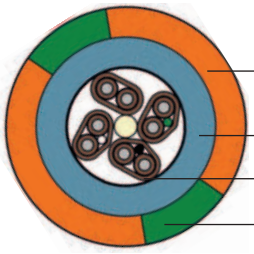




measuring tip bare


measuring tip insulated
(open shrinkable sleeve)/channel oil resistant


measuring tip bare/channel oil resistant




## Application range:

**Safe HV temperature measurement in HV environments**

## Connector:

Lemo Redel male connector with orange kink protection sleeve and black protecting cap, 8-pin, B-coded
1000 V AC voltage-stable – IP 67 when connected

## Sensor:

| | |
|---|---|
| **Thermocouple:** | 4 x type K |
| **Limit deviation:** | class 1 |
| **Measuring point:** | bare or electrically insulated (1000 V) |
| **Temperature range single channel:** | -40°C / +250°C |
| **Response time:** | on request |

## Cable data:

| | |
|---|---|
| **Connection cable:** | HV thermo cable type K |
| **Insulation:** | PI foil |
| **Pair sheath:** | PI foil |
| **Inner sheath:** | FEP – blue acc. to RAL 5024 |
| **Outer sheath:** | PUR |
| **Sheath colour:** | orange with green vertical stripes |
| **Stranding:** | optimised in layers |
| **Outer diameter:** | approx. 4,5 mm |
| **Dielectric strength:** | 1000 V AC over inner sheath |
| **Temperature range** | |
| fixed laying: | -50°C / +150°C |
| flexible application: | -40°C / +150°C |
| **Special characteristics:** | small cable diameter for narrow spaces ✓ |

## Tests:

**▶ Cable test**
over inner sheath in water bath –
5000 V AC – 5 min – with reference to EN 50264-2-1

**▶ Sensor test**
routine test of harnessed connector
with reference to standard 61010-1 for measuring devices as well as VDE indications in our in-house ball bath (released by VDE). Control of contact protection towards outside – 3000 V/1 min AC

***Issue of HV test certificate with reference to batch number due to optimum traceability***

***Optional: Test and repair of already used sensors on request***

CONFIGURATION EXAMPLES

| item no. | connection cable length [mm] | single channel length [mm] | | | | type of measuring tip |
|---|---|---|---|---|---|---|
| | | channel 1 | channel 2 | channel 3 | channel 4 | measuring tip |
| T141-058-907 | 2400 | 400 | 400 | 400 | 400 | bare / channel oil resistant |
| T141-051-415 | 2400 | 400 | 400 | 400 | 400 | bare |
| T141-060-960 | 3000 | 570 | 620 | 560 | 385 | insulated |

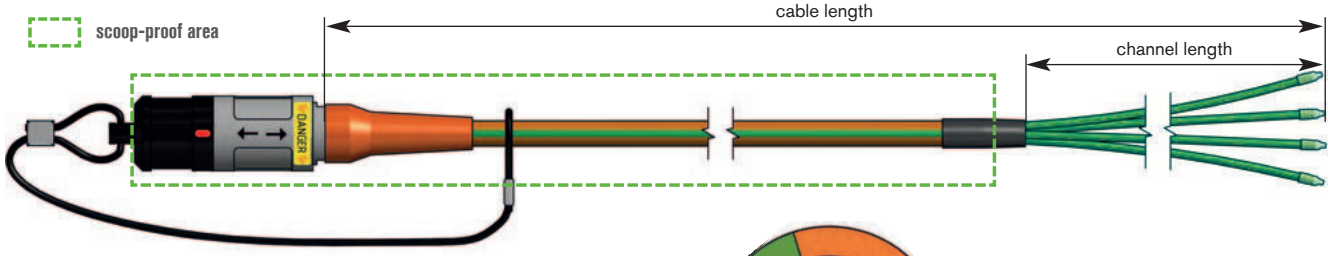
**Total cable and channel lengths can be realised on customer's request.**

**SAB identification:**
item number, batch number

# HV temperature sensor type K

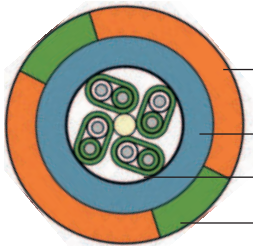
**HV 4-channel thermocouple with PFA insulated thermo channels**

NEW




measuring tip bare

measuring tip insulated




## Application range:

**Safe HV temperature measurement in HV environments**

## Connector:

Lemo Redel male connector with orange kink protection sleeve and black protecting cap, 8-pin, B-coded
1000 V AC voltage-stable – IP 67 when connected

## Sensor:

| | |
|---|---|
| **Thermocouple:** | 4 x type K |
| **Limit deviation:** | class 1 |
| **Measuring point:** | bare or electrically insulated (1000 V) |
| **Temperature range single channel:** | -40°C / +250°C |
| **Response time:** | on request |

## Cable data:

| | |
|---|---|
| **Connection cable:** | HV thermo cable type K |
| **Insulation:** | PFA – green and white |
| **Pair sheath:** | PFA – green acc. to RAL 6018 |
| **Inner sheath:** | FEP – blue acc. to RAL 5024 |
| **Outer sheath:** | PUR |
| **Sheath colour:** | orange with green vertical stripes |
| **Stranding:** | paired construction (for EMC) |
| **Outer diameter:** | approx. 4,4 mm |
| **Dielectric strength:** | 1000 V AC over inner sheath |
| **Temperature range** fixed laying: flexible application: | -50°C / +150°C -40°C / +150°C |
| **Special characteristics:** | small cable diameter for narrow spaces ✓ |

## Tests:

**▶ Cable test**
over single channel in water bath –
5000 V AC – 5 min – with reference to EN 50264-2-1

**▶ Sensor test**
routine test of harnessed connector with reference to standard 61010-1 for measuring devices as well as VDE indications in our in-house ball bath (released by VDE). Control of contact protection towards outside – 3000 V/1 min AC

***Issue of HV test certificate with reference to batch number due to optimum traceability***

***Optional: Test and repair of already used sensors on request***

CONFIGURATION EXAMPLES

| item no. | connection cable length [mm] | single channel length [mm] | | | | type of measuring tip |
|---|---|---|---|---|---|---|
| | | channel 1 | channel 2 | channel 3 | channel 4 | measuring tip |
| T141-063-016 | 2400 | 400 | 400 | 400 | 400 | bare |
| T141-063-018 | 3000 | 500 | 500 | 500 | 500 | bare |
| T141-063-019 | 2400 | 400 | 400 | 400 | 400 | insulated |
| T141-063-020 | 3000 | 500 | 500 | 500 | 500 | insulated |

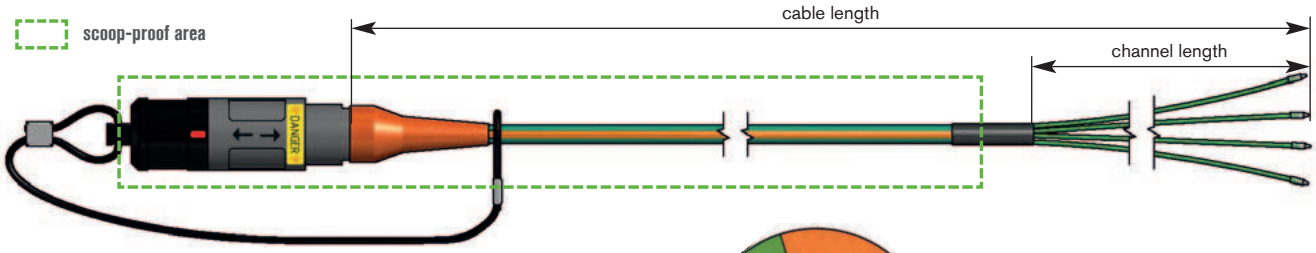
**Total cable and channel lengths can be realised on customer's request.**

**SAB identification:**
item number, batch number

# HV temperature sensor type K

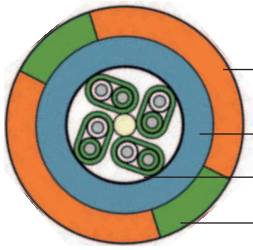
**HV 4-channel thermocouple as high temperature version**

Temperature resistant up to +200°C




measuring tip bare

measuring tip insulated




## Application range:

**Safe HV temperature measurement with ambient temperatures up to + 200°C (for example in hardening processes of impregnated motor windings)**

## Connector:

Lemo Redel male connector with orange kink protection sleeve and black protecting cap, 8-pin, B-coded
1000 V AC voltage-stable – IP 67 when connected

## Sensor:

| | |
|---|---|
| **Thermocouple:** | 4 x type K |
| **Limit deviation:** | class 1 |
| **Measuring point:** | bare or electrically insulated (1000 V) |
| **Temperature range single channel:** | -40°C / +250°C |
| **Response time:** | on request |

## Cable data:

| | |
|---|---|
| **Connection cable:** | HV thermo cable type K HT |
| **Insulation:** | PFA – green and white |
| **Pair sheath:** | PFA – green acc. to RAL 6018 |
| **Inner sheath:** | FEP – blue acc. to RAL 5024 |
| **Outer sheath:** | Besilen® |
| **Sheath colour:** | orange with green vertical stripes |
| **Stranding:** | paired construction (for EMC) |
| **Outer diameter:** | approx. 4,4 mm |
| **Dielectric strength:** | 1000 V AC over inner sheath |
| **Temperature range** fixed laying: flexible application: | -40°C / +220°C -25°C / +220°C |
| **Special characteristics:** | high temperature resistant ✓ highly flexible ✓ small cable diameter for narrow spaces ✓ |

## Tests:

**▶ Cable test**
over blue inner sheath in water bath –
5000 V AC – 5 min – with reference to EN 50264-2-1

**▶ Sensor test**
routine test of harnessed connector with reference to standard 61010-1 for measuring devices as well as VDE indications in our in-house ball bath (released by VDE). Control of contact protection towards outside – 3000 V/1 min AC

***Issue of HV test certificate with reference to batch number due to optimum traceability***

***Optional: Test and repair of already used sensors on request***



CONFIGURATION EXAMPLES

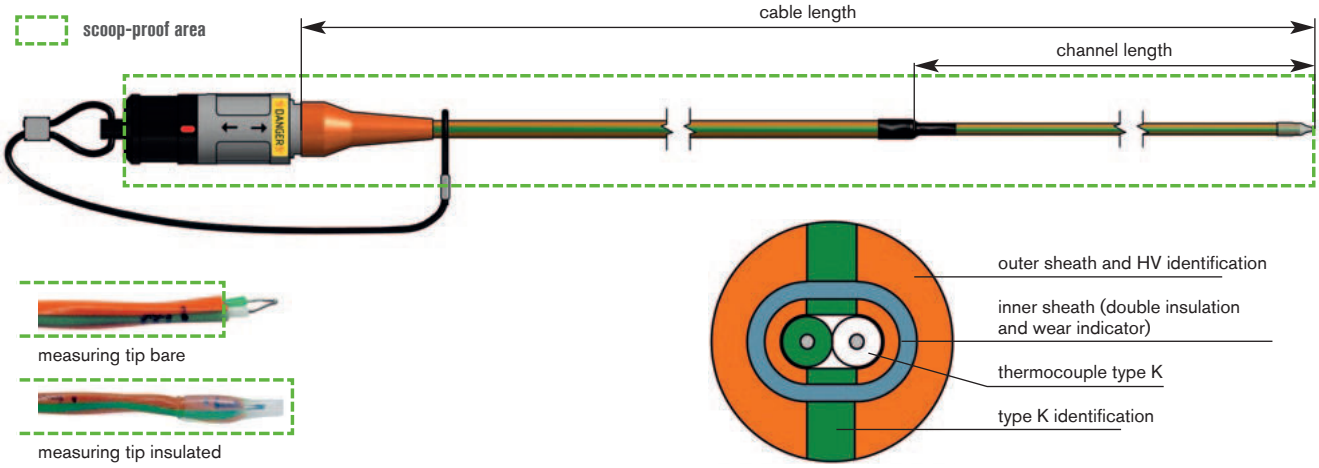
| item no. | connection cable length [mm] | single channel length [mm] | | | | type of measuring tip |
|---|---|---|---|---|---|---|
| | | channel 1 | channel 2 | channel 3 | channel 4 | measuring tip |
| T151-061-737 | 3000 | 500 | 500 | 500 | 500 | insulated |
| T151-061-736 | 3000 | 500 | 500 | 500 | 500 | bare |

**Total cable and channel lengths can be realised on customer's request.**

**SAB identification:**
item number, batch number

# HV temperature sensor type K

**HV 1-channel thermocouple**




## Application range:

**Safe HV temperature measurement in HV environments**

## Connector:

Lemo Redel male connector with orange kink protection sleeve and black protecting cap, 2-pin, C-coded
1000 V AC voltage-stable – IP 67 when connected

## Sensor:

| | |
|---|---|
| **Thermocouple:** | 1 x type K |
| **Limit deviation:** | class 1 |
| **Measuring point:** | bare or electrically insulated (1000 V) |
| **Temperature range single channel:** | -40°C / +180°C |
| **Response time:** | on request |

## Cable data:

| | |
|---|---|
| **Connection cable:** | HV thermo cable type K |
| **Insulation:** | FEP – green and white |
| **Pair sheath:** | FEP – orange with green vertical stripes |
| **Inner sheath:** | FEP – blue acc. to RAL 5024 |
| **Outer sheath:** | PUR |
| **Sheath colour:** | orange with green vertical stripes |
| **Stranding:** | paired construction (for EMC) |
| **Outer diameter:** | approx. 3,4 mm |
| **Dielectric strength:** | 1000 V AC over single channel |
| **Temperature range**<br>fixed laying:<br>flexible application: | <br>-50°C / +150°C<br>-40°C / +150°C |
| **Special characteristics:** | contact protection over single channel ✓ |

## Tests:

**▶ Cable test**
over pair sheath in water bath –
5000 V AC – 5 min – with reference to EN 50264-2-1

**▶ Sensor test**
routine test of harnessed connector with reference to standard 61010-1 for measuring devices as well as VDE indications in our in-house ball bath (released by VDE). Control of contact protection towards outside – 3000 V/1 min AC

***Issue of HV test certificate with reference to batch number due to optimum traceability***

***Optional: Test and repair of already used sensors on request***

CONFIGURATION EXAMPLES

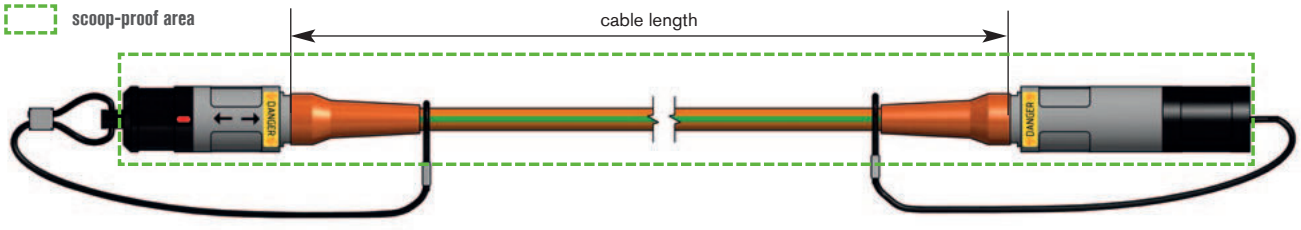
| item no. | connection cable length [mm] | single channel length [mm] | type of measuring tip |
|---|---|---|---|
| | | channel 1 | measuring tip |
| T141-059-052 | 2400 | 400 | insulated |
| T141-058-124 | 3000 | 400 | bare |

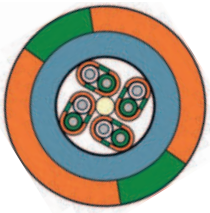
**Total cable and channel lengths can be realised on customer's request.**

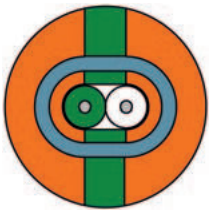
**SAB identification:**
item number, batch number

# HV extension cable type K

**HV 4- and 1-channel extension cable with FEP insulated thermo channels**





## Application range:

**Extension of 4- or 1-channel high voltage sensors type K**

## Connectors:

Lemo Redel connector -
male and female,
with orange kink protection sleeve and black protecting cap
4-channel:
8-pin, B-coded
1000 V AC voltage-stable -
IP 67 when connected

2-channel:
2-pin, C-coded
1000 V AC voltage-stable -
IP 67 when connected

## Cable data:

| | 4-channel | 1-channel |
|---|---|---|
| **Connection cable:** | HV thermo cable type K | HV thermo cable type K |
| **Insulation:** | FEP – green and white | FEP – green and white |
| **Pair sheath:** | FEP – orange with green vertical stripes | FEP – orange with green vertical stripes |
| **Inner sheath:** | FEP – blue acc. to RAL 5024 | FEP – blue acc. to RAL 5024 |
| **Outer sheath:** | PUR | PUR |
| **Sheath colour:** | orange with green vertical stripes | orange with green vertical stripes |
| **Stranding:** | paired construction (for EMC) | paired construction (for EMC) |
| **Outer diameter:** | approx. 6,1 mm | approx. 3,4 mm |
| **Dielectric strength:** | 1000 V AC | 1000 V AC over single channel |
| **Temperature range**<br>fixed laying:<br>flexible application: | <br>-50°C / +150°C<br>-40°C / +150°C | <br>-50°C / +150°C<br>-40°C / +150°C |
| **Special characteristics:** | contact protection over all components ✓ | contact protection over all components ✓ |

## Tests:

**▶ Cable test**
over pair sheath in water bath –
5000 V AC – 5 min – with reference to EN 50264-2-1

**▶ Product test**
routine test of harnessed connector
with reference to standard 61010-1 for measuring devices as well as VDE indications in our in-house ball bath (released by VDE). Control of contact protection towards outside – 3000 V/1 min AC

***Issue of HV test certificate with reference to batch number due to optimum traceability***

***Optional: Test and repair of already used sensors on request***



CONFIGURATION EXAMPLES

| item no. | connection cable length [mm] | channels |
|---|---|---|
| T141-054-030 | 1000 | 4 |
| T141-054-143 | 2000 | 4 |
| T141-058-575 | 3000 | 4 |
| T141-058-576 | 5000 | 4 |

**Total lengths can be realised on customer's request.**

CONFIGURATION EXAMPLES

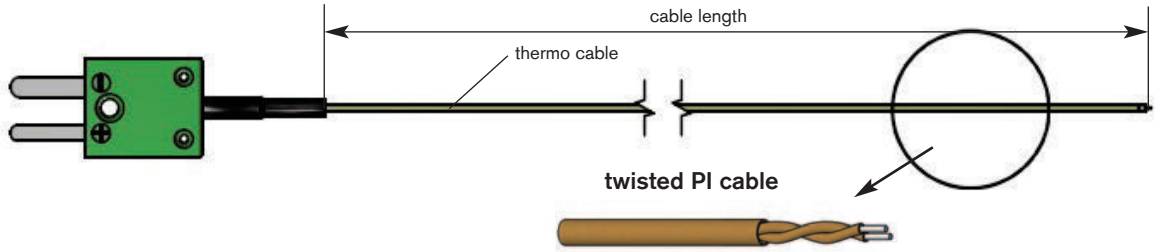
| item no. | connection cable length [mm] | channels |
|---|---|---|
| T141-062-840 | 1000 | 1 |
| T141-062-843 | 3000 | 1 |
| T141-062-844 | 5000 | 1 |

**Total lengths can be realised on customer's request.**

**SAB identification:**
item number, batch number, length

# Special thermocouple type K

**surface thermocouple made of twisted thermo cable**




## Application range:

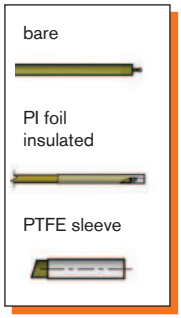
**for example for temperature collection at Hairpin windings in the stator of E-drives. The scattering effect of electromagnetic radiation from the surrounding copper windings shall not distort the measuring result.**

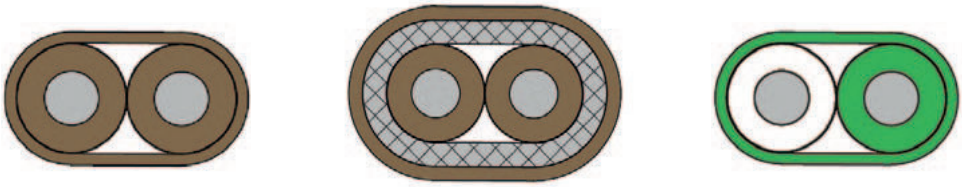
## Connector:

e.g. miniature thermo plug type K (as shown in the figures)

## Sensor:

| | |
|---|---|
| **Thermocouple:** | 1 x type K |
| **Limit deviation:** | class 1 |
| **Measuring point:** | see Illustration of measuring tips |
| **Temperature range single channel:** | -40°C / +250°C |
| **Response time:** | on request |



## Cable data:

| | PI (polyimide) | PI (polyimide) | PFA |
|---|---|---|---|
| **Designation:** | twisted PI thermo cable | screened and twisted PI thermo cable | twisted PFA thermo cable |
| **Insulation:** | PI foil insulation | PI foil insulation | PFA |
| **Outer sheath:** | PI foil insulation | PI foil insulation | PFA |
| **Stranding:** | paired construction (for EMC) | paired construction (for EMC) | paired construction (for EMC) |
| **Outer diameter:** | approx. 0,85 mm | approx. 1,05 mm | approx. 0,80 mm |
| **Temperature range**<br>fixed laying:<br>flexible application: | <br>-40°C / +250°C<br>-40°C / +250°C | <br>-40°C / +250°C<br>-40°C / +250°C | <br>-40°C / +250°C<br>-40°C / +250°C |



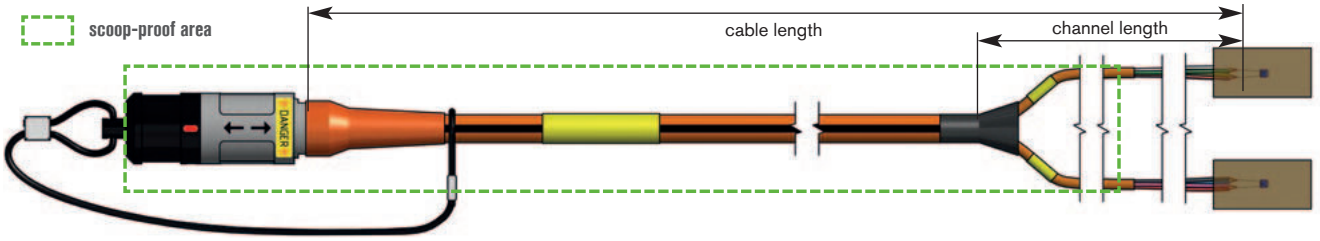
### CONFIGURATION EXAMPLES

| item no. | type | measuring tip | cable | cable length m | connection end |
|---|---|---|---|---|---|
| T100-061-046 | K | PTFE sleeve | 2 x 0,20 mm PI twisted | 1.5 | miniature thermoplug |
| T100-061-998 | K | PI foil | 2 x 0,20 mm PI twisted | 2.0 | bare |
| T100-060-628 | K | bare | 2 x 0,20 mm PI twisted | 2.0 | miniature thermoplug |
| T100-060-629 | K | bare | 2 x 0,20 mm PI twisted | 3.0 | miniature thermoplug |
| T100-061-276 | K | bare | 2 x 0,20 mm PI twisted | 1.0 | bare |

**SAB identification:**
item number, batch number

# HV temperature sensor PT100/PT1000

**HV 2 x PT100/PT1000 resistance thermometer**




## Application range:

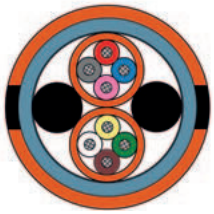
**Safe HV temperature measurement in HV environments**

## Connector:

Lemo Redel male connector with orange kink protection sleeve and black protecting cap, 8-pin, C-coded
1000 V AC voltage-stable – IP 67 when connected

## Sensor:

| | |
|---|---|
| **Type of sensor:** | 2 x PT100 |
| **Limit deviation:** | class A |
| **Wire circuit:** | 4-wire |
| **Measuring point:** | embedded in PI foil adhesive pad |
| **Dimension of sensor:** | for example 2,3 mm x 2,0 mm x 0,47 mm (appropriate for pouch cells) or 3,0 mm x 0,80 mm x 0,60 mm |
| **Temperature range single channel:** | -30°C / +180°C |



## Cable data:

| | FEP | FEP |
|---|---|---|
| **Designation:** | HV measuring cable – 1 x 8 cores | HV measuring cable – 4 x 2 cores |
| **Insulation:** | FEP – acc. to DIN 47100 1-8 (core-Ø 0,45 mm) | FEP – acc. to DIN 47100 1-8 |
| **Outer sheath:** | PUR | PUR |
| **Stranding:** | optimised in layers | optimised in layers |
| **Outer diameter:** | approx. 4,6 mm | approx. 7,3 mm |
| **Dielectric strength:** | 1000 V AC over orange inner sheath | 1000 V AC over orange bundle sheath |
| **Temperature range** fixed laying: flexible application: | -40°C / +150°C -40°C / +150°C | -40°C / +150°C -40°C / +150°C |

## Tests:

▶ **Cable test**
core/core – 2500 V AC - 5 min
over orange bundle sheath –
5000 V AC – 5 min – with reference to EN 50264-2-1

▶ **Sensor test**
routine test of harnessed connector
with reference to standard 61010-1 for measuring devices as well as VDE indications in our in-house ball bath (released by VDE). Control of contact protection towards outside – 3000 V/1 min AC

***Issue of HV test certificate with reference to batch number due to optimum traceability***

***Optional: Test and repair of already used sensors on request***



**CONFIGURATION EXAMPLES**

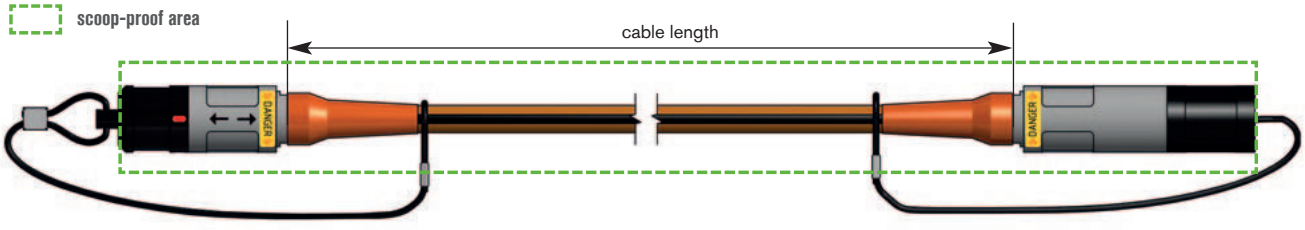
| item no. | connection cable length [mm] | single channel length [mm] | |
|---|---|---|---|
| | | channel 1 | channel 2 |
| T641-060-817 | 2000 | 70 | 70 |
| T641-060-870 | 5000 | 700 | 700 |

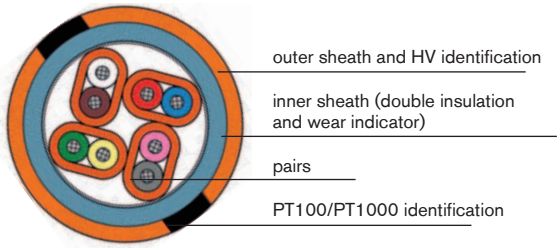
**Total cable and channel lengths can be realised on customer's request.**

**SAB identification:**
item number, batch number

# HV extension cable PT100/PT1000

**HV 2 x PT100/PT1000 extension cable**




## Application range:

**Extension of HV 2 x Pt 100 sensors**

## Connectors:

Lemo Redel male connector -
male/female connector with orange kink protection sleeve and black protecting cap, 8-pin, C-coded
1000 V AC voltage-stable – IP 67 when connected

### CONFIGURATION EXAMPLES

| item no. | connection cable length [mm] |
|---|---|
| T641-056-497 | 1000 |
| T641-058-117 | 3000 |
| T641-058-574 | 5000 |

**Total cable and channel lengths can be realised on customer's request.**

## Cable data:

| | |
|---|---|
| **Connection cable:** | HV measuring cable |
| **Insulation:** | FEP – acc. to DIN 47100 1-8 |
| **Pair sheath:** | FEP – orange acc. to RAL 2004 |
| **Inner sheath:** | PUR – blue acc. to RAL 5024 |
| **Outer sheath:** | PUR |
| **Sheath colour:** | orange with green vertical stripes |
| **Stranding:** | optimised in layers |
| **Outer diameter:** | approx. 7,4 mm |
| **Dielectric strength:** | 1000 V AC over pair sheath |
| **Temperature range**<br>fixed laying:<br>flexible application: | <br>-40°C / +150°C<br>-40°C / +150°C |
| **Special characteristics:** | contact protection over all components ✓ |



## Tests:

▶ **Cable test**
core/core – 2500 V AC - 5 min
over pair sheath –
5000 V AC – 5 min – with reference to EN 50264-2-1

▶ **Product test**
routine test of harnessed connector
with reference to standard 61010-1 for measuring devices as well as VDE indications in our in-house ball bath (released by VDE). Control of contact protection towards outside – 3000 V/1 min AC

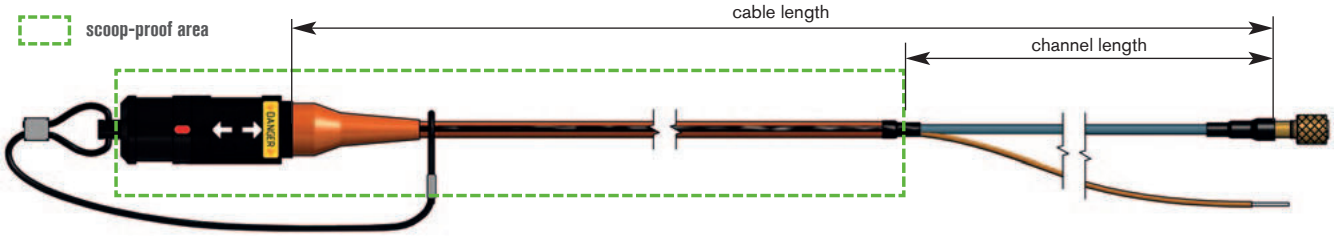
***Issue of HV test certificate with reference to batch number due to optimum traceability***

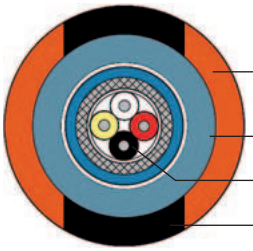
***Optional: Test and repair of already used sensors on request***

**SAB identification:**
item number, batch number, length

# HV connecting cable

**for acceleration sensors (IEPE)**




## Application range:

**Safe HV acceleration measurement for example with CSM HV IEPE3 FL 100 measuring module**

## Connector:

Lemo Redel male connector with orange kink protection sleeve and black protecting cap, 8-pin, C-coded
1000 V AC voltage-stable – IP 67 when connected

## Sensor connection side:

| | |
|---|---|
| **Connector:** | 4-pin ¼-28 UNF socket for the connection of a triaxial IEPE acceleration sensor (also with 4-pin 8-36 UNF and 4-pin M4,5) |
| **Screen:** | led out in bundle and insulated with shrinkable sleeve |
| **Temperature range bundle channel:** | -55°C / +250°C |

## Cable data:

| | |
|---|---|
| **Connection cable:** | HV IEPE sensor cable |
| **Core insulation:** | PFA – red, white, black, yellow |
| **Bundle sheath:** | PFA – blue acc. to RAL 5015 |
| **Inner sheath:** | PUR – blue acc. to RAL 5024 |
| **Outer sheath:** | PUR |
| **Sheath colour:** | orange with black vertical stripes |
| **Stranding:** | optimised in layers |
| **Outer diameter:** | approx. 4,3 mm |
| **Dielectric strength:** | 1000 V AC over second inner sheath |
| **Temperature range**<br>fixed laying:<br>flexible application: | <br>-50°C / +150°C<br>-40°C / +150°C |
| **Special characteristics:** | contact protection<br>see presentation ✓ |

## Tests:

▶ **Cable test**
core/core – 600 V AC - 1 min - acc. to IEC 60584-1
over second inner sheath in water bath –
5000 V AC – 5 min – with reference to EN 50264-2-1

▶ **Product test**
routine test of harnessed connector
with reference to standard 61010-1 for measuring devices as well as VDE indications in our in-house ball bath (released by VDE). Control of contact protection towards outside – 3000 V/1 min AC

***Issue of HV test certificate with reference to batch number due to optimum traceability***

***Optional: Test and repair of already used sensors on request***



CONFIGURATION EXAMPLES

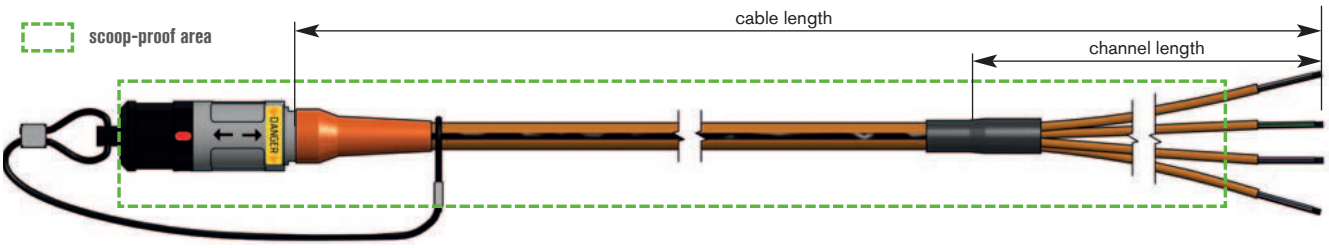
| item no. | connection cable length [mm] | single channel length [mm] | | male connector |
|---|---|---|---|---|
| | | channel 1 | grounding | |
| T642-062-666 | 3000 | 100 | 200 | 4-Pin ¼ -28 UNF |
| T642-062-794 | 6000 | 100 | 200 | 4-Pin ¼ -28 UNF |
| T642-062-635 | 3000 | 100 | 200 | 4-Pin 8-36 UNF |

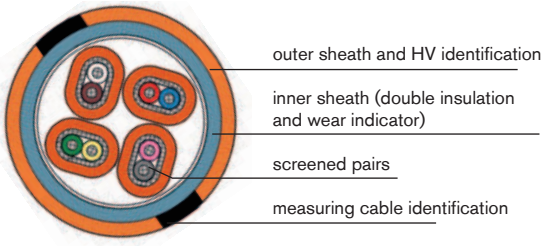
**Total cable and channel lengths can be realised on customer's request.**

**SAB identification:**
item number, batch number

# HV connecting cable

**for strain gauges**




## Application range:

**Safe HV strain gauge measurement (full / half bridge) for example with CSM HV STG4 pro BS20 measuring module**

## Connector:

Lemo Redel male connector with orange kink protection sleeve and black protecting cap, 8-pin, E-coded
1000 V AC voltage-stable – IP 67 when connected

## Connection end:

| | |
|---|---|
| **Outer sheath:** | 122 mm stripped |
| **Pair sheath:** | 22 mm |
| **Open end:** | 2 mm |
| **Connection:** | tinned |
| **Screen:** | small cable diameter for narrow spaces |
| **Temperature range single channel:** | -55°C / +180°C |

## Cable data:

| | |
|---|---|
| **Connection cable:** | HV strain gauge sensor cable |
| **Core insulation:** | FEP – acc. to DIN 47100 1-8 (core-Ø 0,55 mm) |
| **Screen:** | tinned copper braiding incl. drain wire |
| **Pair sheath:** | FEP – orange acc. to RAL 2004 |
| **Inner sheath:** | PUR – blue acc. to RAL 5024 |
| **Outer sheath:** | PUR |
| **Sheath colour:** | orange with black vertical stripes |
| **Stranding:** | paired construction (for EMC) |
| **Outer diameter:** | approx. 7,4 mm |
| **Dielectric strength:** | 1000 V AC over pair sheath |
| **Temperature range** | |
| fixed laying: | -50°C / +150°C |
| flexible application: | -40°C / +150°C |

## Tests:

**▶ Cable test**
core/core – 600 V AC - 1 min - acc. to IEC 60584-1
over pair sheath in water bath –
5000 V AC – 5 min – with reference to EN 50264-2-1

**▶ Product test**
routine test of harnessed connector
with reference to standard 61010-1 for measuring devices as well as VDE indications in our in-house ball bath (released by VDE). Control of contact protection towards outside – 3000 V/1 min AC

***Issue of HV test certificate with reference to batch number due to optimum traceability***

***Optional: Test and repair of already used sensors on request***

CONFIGURATION EXAMPLES

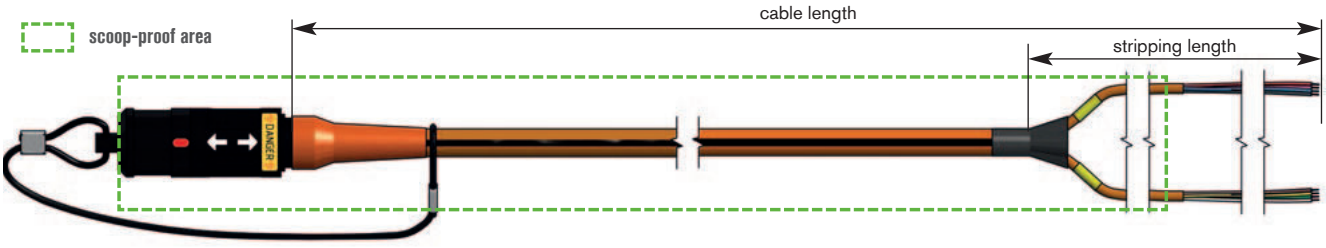
| item no. | connection cable length [mm] | single channel Length [mm] | | | connection type |
|---|---|---|---|---|---|
| | | Length sheath | Length pair | Length core | connection |
| T644-061-009 | 2000 | 122 | 22 | 2 | tinned |
| T644-061-014 | 3000 | 122 | 22 | 2 | tinned |

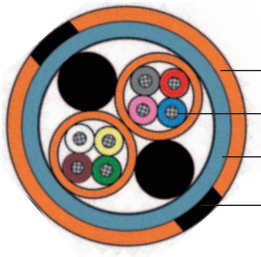
**Total cable and channel lengths can be realised on customer's request.**

**SAB identification:**
item number, batch number

# HV analogue measuring cable

**HV 2-channel analogue measuring cable for CSM measurement technology (90 V)**




## Application range:

**Safe HV analogue measurements with standard sensors combined with CSM measuring modules HV AD2 IF20, HV AD4 IF20 & HV AD4 IF1000**

## Connector:

Lemo Redel male connector with orange kink protection sleeve and black protecting cap, 8-pin, C-coded
1000 V AC voltage-stable – IP 67 when connected

## Connection end:

*(stripping lengths)*

| | |
|---|---|
| **Outer sheath:** | 100 mm |
| **Pair sheath:** | 10 mm |
| **Open end:** | 2 mm |
| **Connection:** | tinned |

## Cable data:

| | |
|---|---|
| **Connection cable:** | HV measuring cable |
| **Core insulation:** | FEP – acc. to DIN 47100 1-8 |
| **Pair sheath:** | FEP – orange acc. to RAL 2004 |
| **Inner sheath:** | PUR – blue acc. to RAL 5024 |
| **Outer sheath:** | PUR |
| **Sheath colour:** | orange with black vertical stripes |
| **Stranding:** | optimised in layers |
| **Outer diameter:** | approx. 7,3 mm |
| **Dielectric strength:** | 1000 V AC over orange bundle sheath |
| **Temperature range** | |
| fixed laying: | -50°C / +150°C |
| flexible application: | -40°C / +150°C |

## Tests:

▶ **Cable test**
core/core – 600 V AC - 1 min - acc. to IEC 60584-1
over orange bundle sheath –
5000 V AC – 5 min – with reference to EN 50264-2-1

▶ **Product test**
routine test of harnessed connector
with reference to standard 61010-1 for measuring devices as well as VDE indications in our in-house ball bath (released by VDE). Control of contact protection towards outside – 3000 V/1 min AC

***Issue of HV test certificate with reference to batch number due to optimum traceability***

***Optional: Test and repair of already used sensors on request***

CONFIGURATION EXAMPLES

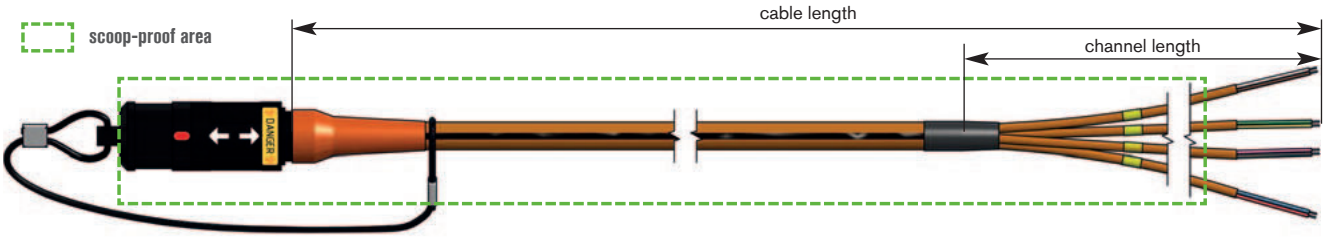
| item no. | connection cable length [mm] | single channel length [mm] | | |
|---|---|---|---|---|
| | | sheath | pair | core |
| T641-056-710 | 2000 | 100 | 10 | 2 |
| T641-056-711 | 3000 | 100 | 10 | 2 |

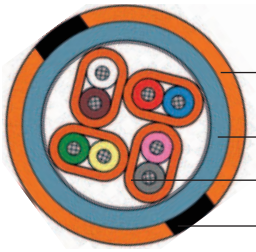
**Total cable and channel lengths can be realised on customer's request.**

**SAB identification:**
item number, batch number

# HV voltage measuring cable (90 V)

**HV 4-channel voltage measuring cable for CSM measurement technology (90 V)**




## Application range:

**Safe HV measurements of analogue voltage combined with CSM measuring modules HV AD4 OW20, HV AD8 OW20 & HV AD4 OW1000***

*test bench & road test

## Connector:

Lemo Redel male connector with orange kink protection sleeve and black protecting cap, 8-pin, B-coded
1000 V AC voltage-stable – IP 67 when connected

## Connection end:

| | *(stripping lengths)* |
|---|---|
| **Outer sheath:** | 122 mm stripped |
| **Pair sheath:** | 22 mm |
| **Open end:** | 2 mm |
| **Connection:** | tinned |
| **Temperature range single channel:** | -55°C / +180°C |

## Cable data:

| | |
|---|---|
| **Connection cable:** | HV measuring cable |
| **Core insulation:** | FEP – acc. to DIN 47100 1-8 |
| **Pair sheath:** | FEP – orange acc. to RAL 2004 |
| **Inner sheath:** | PUR – blue acc. to RAL 5024 |
| **Outer sheath:** | PUR |
| **Sheath colour:** | orange with black vertical stripes |
| **Stranding:** | paired construction (for EMC) |
| **Outer diameter:** | approx. 7,4 mm |
| **Dielectric strength:** | 1000 V AC over pair sheath |
| **Temperature range** | |
| fixed laying: | -50°C / +150°C |
| flexible application: | -40°C / +150°C |
| **Special characteristics:** | contact protection also over individual channels ✓ |

## Tests:

▶ **Cable test**
core/core – 2500 V AC - 5 min
over pair sheath –
5000 V AC – 5 min – with reference to EN 50264-2-1

▶ **Product test**
routine test of harnessed connector
with reference to standard 61010-1 for measuring devices as well as VDE indications in our in-house ball bath (released by VDE). Control of contact protection towards outside – 3000 V/1 min AC

***Issue of HV test certificate with reference to batch number due to optimum traceability***

***Optional: Test and repair of already used sensors on request***

CONFIGURATION EXAMPLE

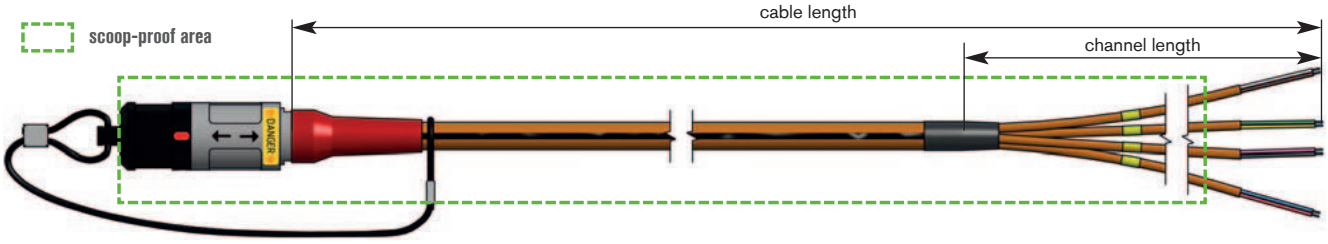
| item no. | connection cable length [mm] | single channel length [mm] | | | connection type |
|---|---|---|---|---|---|
| | | sheath | pair | core | connection |
| T645-062-738 | 2000 | 122 | 22 | 2 | tinned |

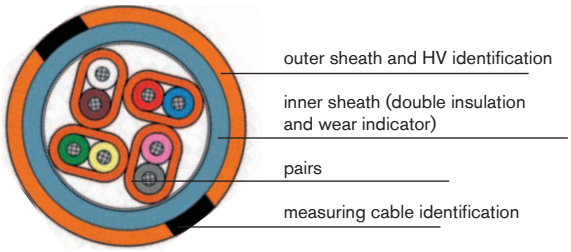
**Total cable and channel lengths can be realised on customer's request.**

**SAB identification:**
item number, batch number

# HV voltage measuring cable (1000 V)

**HV 4-channel voltage measuring cable for CSM measurement technology (1000 V)**




## Application range:

**Safe HV measurements of high voltage combined with CSM measuring modules HV AD4 XW1000* & HV AD4 XW20**

*test bench & road test

## Connector:

Lemo Redel male connector with red kink protection sleeve and black protecting cap, 8-pin, D-coded
1000 V AC voltage-stable – IP 67 when connected

## Connection end:

| | *(stripping lengths)* |
|---|---|
| **Outer sheath:** | 122 mm stripped |
| **Pair sheath:** | 22 mm |
| **Open end:** | 2 mm |
| **Connection:** | tinned |
| **Temperature range single channel:** | -55°C / +180°C |

## Cable data:

| | |
|---|---|
| **Connection cable:** | HV measuring cable |
| **Core insulation:** | FEP – acc. to DIN 47100 1-8 |
| **Pair sheath:** | FEP – orange acc. to RAL 2004 |
| **Inner sheath:** | PUR – blue acc. to RAL 5024 |
| **Outer sheath:** | PUR |
| **Sheath colour:** | orange with black vertical stripes |
| **Stranding:** | paired construction (for EMC) |
| **Outer diameter:** | approx. 7,4 mm |
| **Dielectric strength:** | 1000 V AC over pair sheath |
| **Temperature range** | |
| fixed laying: | -50°C / +150°C |
| flexible application: | -40°C / +150°C |
| **Special characteristics:** | contact protection also over individual channels ✓ |

## Tests:

▶ **Cable test**
core/core – 2500 V AC - 5 min
over pair sheath –
5000 V AC – 5 min – with reference to EN 50264-2-1

▶ **Product test**
routine test of harnessed connector with reference to standard 61010-1 for measuring devices as well as VDE indications in our in-house ball bath (released by VDE). Control of contact protection towards outside – 3000 V/1 min AC

***Issue of HV test certificate with reference to batch number due to optimum traceability***

***Optional: Test and repair of already used sensors on request***

CONFIGURATION EXAMPLE

| item no. | connection cable length [mm] | single channel length [mm] | | | connection type |
|---|---|---|---|---|---|
| | | sheath | pair | core | connection |
| T645-062-695 | 2000 | 122 | 22 | 2 | tinned |
| T645-063-151 | 3000 | 122 | 22 | 2 | tinned |

**Total cable and channel lengths can be realised on customer's request.**

**SAB identification:**
item number, batch number

# HV measuring cable (DC)

**for DC voltage measurement**


Marking for HV connecting cable 38339800:
SAB BRÖCKSKES · D-VIERSEN · HV-Messleitung (2x0,25mm²)

**Application range:** The high voltage measuring cable is used in the development of electric vehicles where scoop-proof testing and measuring of up to 1800 V DC operating voltage and application in the HV environment of electromobility take place. Examples of applications are HV power electronics, HV batteries, electric motors, inverters, etc. High voltage measuring cables are used on the test benches and in test vehicles.

## Construction:

| | |
|---|---|
| **Conductor:** | tinned copper strands, extra fine wires |
| **Core insulation:** | FEP |
| **Colour code:** | red and black |
| **Stranding:** | together<br>with tinned copper drain wire, AWG 24 |
| **Screen:** | alu foil and tinned copper braiding |
| **Inner sheath:** | FEP - blue acc. to RAL 5024 |
| **Outer sheath:** | PUR |
| **Sheath colour:** | orange with black vertical stripes |

## Outstanding features:

- **temperature resistance up to +150 °C (up to 3000 hours)**
- **high flexibility**
- **high abrasion resistance**
- **easy harnessing**

## Technical data:

| | |
|---|---|
| **Scoop-proof:** | 1000 V DC<br>over blue inner sheath |
| **Testing voltage:** | 5000 V AC<br>over blue inner sheath |
| **Operating voltage:** | Uo 1000 V DC |
| **Operating voltage:** | U 1800 V DC |
| **Testing voltage:** | core/core 5000 V AC<br>core/screen 5000 V AC |
| **Min. bending radius**<br>fixed laying:<br>flexible application: | <br>5 x d<br>10 x d |
| **Temperature range**<br>fixed laying:<br>flexible application:<br>short time use: | <br>-50/+125 °C<br>-40/+125 °C<br>+150 °C (up to 3000 h) |
| **Absence of harmful substances:** | acc. to RoHS directive of the European Union |

| item no. | no. of cores x cross section n x mm² | outer-ø approx. mm | copper figure kg/km | cable weight ≈ kg/km | ohmic resistance max. Ω/km |
|---|---|---|---|---|---|
| 3833-9800 | 2 x 0,25 | 6,5 | 21,3 | 58 | 80,0 |
| 3833-9819 | 2 x 0,34 | 6,7 | 24,9 | 63 | 58,8 |
| 3833-9801 | 2 x 0,50 | 7,1 | 28,1 | 70 | 40,1 |
| 3833-9802 | 2 x 1,00 | 7,8 | 42,5 | 90 | 20,0 |
| 3833-9803 | 2 x 1,50 | 8,4 | 55,8 | 108 | 13,7 |

Other dimensions and colours are possible on request.

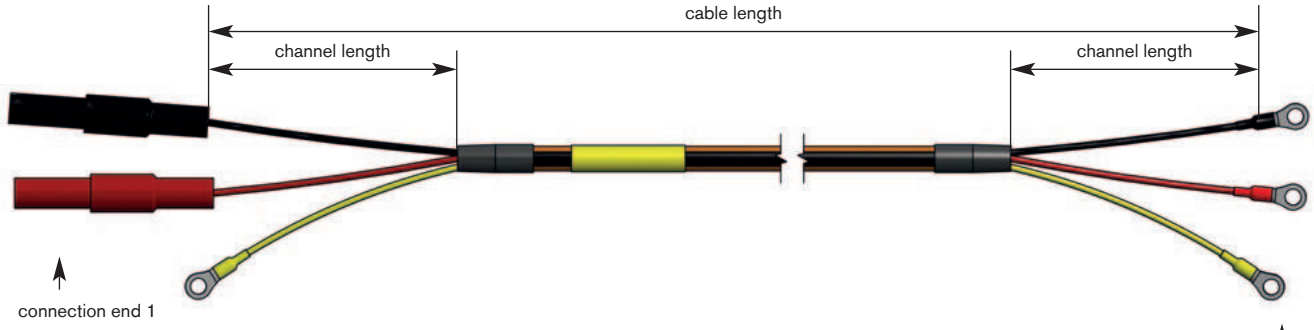
## Possible on request:

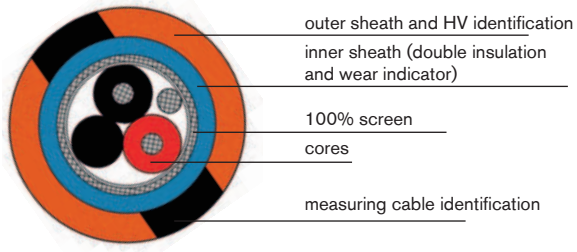
**As harnessed measuring cable with connected lab plugs to collect the voltage at HV components**

**- see next page -**

# HV measuring cable (DC)

**for DC voltage measurement (as cable harness)**




## Application range:

**Safe HV measurement of DC voltages**

## Connectors:

Safety lab plugs 1000 V, CAT III,
red and black, 4 mm cable lug M4

## Connection end:

| | |
|---|---|
| **Stripping length:** | 250 mm |
| **Screen:** | led out with filler and insulated with shrinkable sleeve |
| **Temperature range of single core:** | -55°C / +180°C |

## Cable data:

| | |
|---|---|
| **Connection cable:** | HV measuring cable |
| **Core insulation:** | FEP – red and black |
| **Stranding:** | together with tinned copper drain wire, AWG 24 |
| **Screen:** | 100% screen with alu foil and braiding |
| **Inner sheath:** | PUR – blue acc. to RAL 5024 |
| **Outer sheath:** | PUR |
| **Sheath colour:** | orange with black vertical stripes |
| **Outer diameter:** | see table on page 22 |
| **Scoop-proof:** | 1000 V DC over blue inner sheath |
| **Operating voltage:** | 1800 V DC |
| **Temperature range** | |
| fixed laying: | -50°C / +125°C |
| flexible application: | -40°C / +125°C |
| short time use: | +150°C (up to 3000 h) |

CONFIGURATION EXAMPLE

| item no. | connection cable length [mm] | single channel length [mm] | | |
|---|---|---|---|---|
| | | channel 1 | channel 2 | safety lab plugs + M4 cable lugs |
| T645-062-912 | 6500 | 250 | 250 | |

**Total cable and channel lengths can be realised on customer's request.**

**SAB identification:**
item number, batch number

# HV measuring cable (AC)

**for AC voltage measurement**


Marking for HV connecting cable 38339813:
SAB BRÖCKSKES · D-VIERSEN · HV-Messleitung (3x1,50mm²)

**Application range:** The high voltage measuring cable is used in the development of electric vehicles where scoop-proof testing and measuring of up to 1800 V DC operating voltage and application in the HV environment of electromobility take place. Examples of applications are HV power electronics, HV batteries, electric motors, inverters, etc. High voltage measuring cables are used on the test benches and in test vehicles.

## Construction:

| | |
|---|---|
| **Conductor:** | tinned copper strands, extra fine wires |
| **Core insulation:** | FEP |
| **Colour code:** | brown, black, grey |
| **Stranding:** | together<br>with tinned copper drain wire, AWG 24 |
| **Screen:** | alu foil and tinned copper braiding |
| **Inner sheath:** | FEP - blue acc. to RAL 5024 |
| **Outer sheath:** | PUR |
| **Sheath colour:** | orange with black vertical stripes |

## Outstanding features:

- **temperature resistance up to +150 °C (up to 3000 hours)**
- **high flexibility**
- **high abrasion resistance**
- **easy harnessing**

## Technical data:

| | |
|---|---|
| **Scoop-proof:** | 1000 V DC<br>over blue inner sheath |
| **Testing voltage:** | 5000 V AC<br>over blue inner sheath |
| **Operating voltage:** | core/core 1800 V DC<br>core/core 1000 V AC |
| **Testing voltage:** | core/core 5000 V AC<br>core/screen 5000 V AC |
| **Min. bending radius**<br>fixed laying:<br>flexible application: | <br>5 x d<br>10 x d |
| **Temperature range**<br>fixed laying:<br>flexible application:<br>short time use: | <br>-50/+125 °C<br>-40/+125 °C<br>+150 °C (up to 3000 h) |
| **Temperature range of cores:** | up to +180 °C (short time use up to +205 °C) |
| **Oil resistance:** | very good - TMPU<br>acc. to EN 50363-10-2 + VDE 0207-363-10-2 |
| **Absence of harmful substances:** | acc. to RoHS directive of the European Union |

| item no. | no. of cores x cross section n x mm² | outer-ø approx. mm | copper figure kg/km | cable weight ≈ kg/km | ohmic resistance max. Ω/km |
|---|---|---|---|---|---|
| 38339820 | 3 x 0,25 | 6,8 | 25,5 | 66 | 80,0 |
| 38339816 | 3 x 0,34 | 7,0 | 28,3 | 71 | 58,8 |
| 38339815 | 3 x 0,50 | 7,4 | 34,5 | 81 | 40,1 |
| 38339814 | 3 x 1,00 | 8,1 | 53,3 | 106 | 20,0 |
| 38339813 | 3 x 1,50 | 8,8 | 71,7 | 130 | 13,7 |

Other dimensions and colours are possible on request.

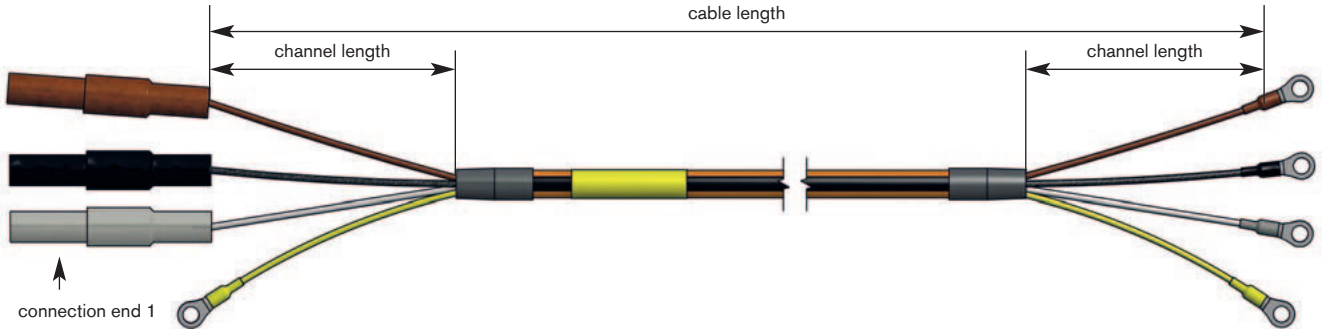
## Possible on request:

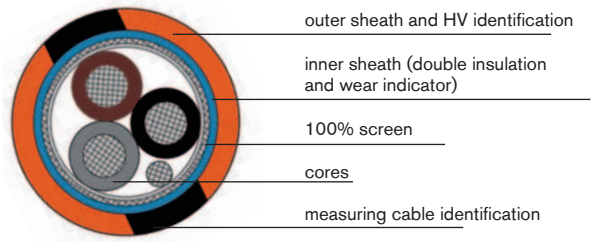
**As harnessed measuring cable with connected lab plugs to collect the voltage at HV components**

**- see next page -**

# HV measuring cable (AC)

**for AC voltage measurement (as cable harness)**




## Application range:

**Safe HV measurement of AC voltages**

## Connectors:

Safety lab plugs 1000 V, CAT III,
brown, grey and black, 4 mm cable lug M4

## Connection end:

| | |
|---|---|
| **Stripping length:** | 250 mm |
| **Screen:** | led out with filler and insulated with shrinkable sleeve |
| **Temperature range of single core:** | -55°C / +180°C |

## Cable data:

| | |
|---|---|
| **Connection cable:** | HV measuring cable |
| **Core insulation:** | FEP – brown, black and grey |
| **Stranding:** | together with tinned copper drain wire, AWG 24 |
| **Screen:** | 100% screen with alu foil and braiding |
| **Inner sheath:** | PUR – blue acc. to RAL 5024 |
| **Outer sheath:** | PUR |
| **Sheath colour:** | orange with black vertical stripes |
| **Outer diameter:** | see table on page 24 |
| **Scoop-proof:** | 1000 V DC over blue inner sheath |
| **Operating voltage:** | 1800 V DC |
| **Temperature range** | |
| fixed laying: | -50°C / +125°C |
| flexible application: | -40°C / +125°C |
| short time use: | +150°C (up to 3000 h) |

CONFIGURATION EXAMPLE

| item no. | connection cable length [mm] | stripping length [mm] | | |
|---|---|---|---|---|
| | | connection 1 | connection 2 | safety lab plugs + M4 cable lugs |
| T645-062-913 | 6500 | 250 | 250 | |

**Total cable and channel lengths can be realised on customer's request.**

**SAB identification:**
item number, batch number

Nominal voltage up to
**Uo/U 1.8/3 kV AC**

# B 110 C

**highly flexible Besilen® HV single core, shielded, cULus recognized**


c UL us RoHS

Marking for B 110 C 01109507:
SAB BRÖCKSKES · D-VIERSEN · B 110 C Uo/U 1,8/3 kV 95,0mm² c UL us AWM Style 30123 AWM I/II A/B 150°C 3000V FT1 FT2

**Application range:** The connection cable is for example appropriate to connect converters to electric-mobility test benches. Due to the high voltage rating, the cable can be used for various components and power electronics. The extremely flexible cable design enables an easy laying.

## Construction:

| | |
|---|---|
| **Conductor:** | bare copper strands, extra fine wires |
| **Core insulation:** | Besilen® EI2<br>acc. to EN 50363-1 + VDE 0207-363-1,<br>orange |
| **Screen:** | alu foil and tinned copper braiding |
| **Sheath material:** | Besilen® EM9<br>acc. to EN 50363-2-1 + VDE 0207-363-2-1 |
| **Sheath colour:** | orange (similar RAL 2004) |

## Outstanding features:

- **extremely flexible**
- **good EMC characteristics**
- **halogen-free**
- **heat resistant**
- **flexible at low temperatures**
- **flame retardant and self-extinguishing**
- **weather resistant**
- **cULus recognized**

## Technical data:

| | |
|---|---|
| **Nominal voltage:** | Uo/U 1,8/3,0 kV AC<br>Uo/U 2,7/5,4 kV DC |
| **Voltage cULus:** | 3000 V |
| **Testing voltage:** | 6500 V |
| **Current-carrying capacity:** | acc. to VDE 0298-4 |
| **Min. bending radius**<br>fixed laying:<br>flexible application: | <br>3 x d<br>6 x d |
| **Temperature range**<br>fixed laying:<br>flexible application:<br>short time use: | **DIN VDE** **cULus:** up to +150 °C<br>-40/+180 °C<br>-25/+180 °C<br>+250 °C |
| **Halogen-free:** | acc. to IEC 60754-1 + VDE 0482-754-1 |
| **Fire performance:** | flame retardant and self-extinguishing<br>acc. to IEC 60332-1-2 + VDE 0482-332-1-2,<br>cULus FT1, FT2 |
| **Corrosiveness of conflagration gases:** | IEC 60754-2 + VDE 0482-754-2<br>- no development of corrosive conflagration gases |
| **Weather resistance:** | very good |
| **Absence of harmful substances:** | acc. to RoHS directive of the European Union |

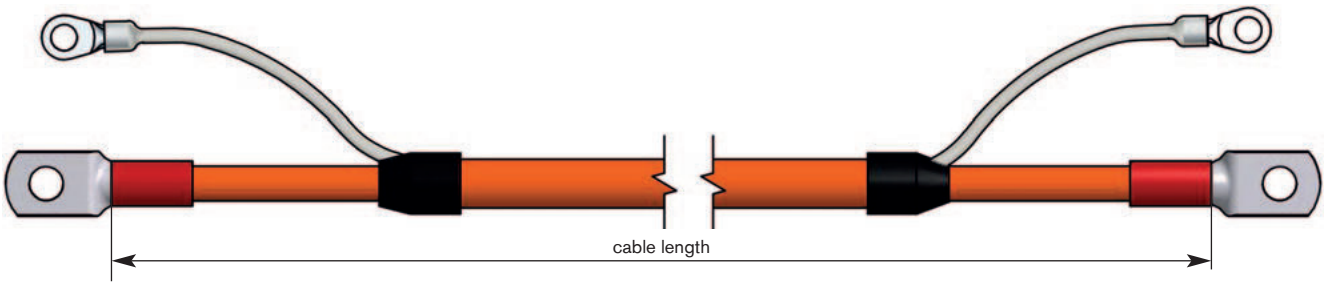
| item no. | nominal cross section mm² | largest single wire ø mm | ø over inner sheath approx. mm | outer-ø approx. mm | copper figure kg/km | cable weight ≈ kg/km |
|---|---|---|---|---|---|---|
| 01100107 | 1,00 | 0,07 | 4,3 | 7,6 | 27,2 | 70 |
| 01100157 | 1,50 | 0,07 | 4,7 | 8,0 | 34,4 | 81 |
| 01100257 | 2,50 | 0,07 | 5,2 | 8,5 | 44,6 | 96 |
| 01100407 | 4,00 | 0,07 | 5,9 | 9,2 | 61,3 | 118 |
| 01100607 | 6,00 | 0,07 | 6,3 | 9,6 | 83,8 | 143 |
| 01101007 | 10,00 | 0,07 | 8,2 | 11,7 | 147,7 | 222 |
| 01101607 | 16,00 | 0,07 | 8,5 | 12,0 | 205,7 | 273 |
| 01102507 | 25,00 | 0,10 | 10,9 | 14,7 | 307,4 | 416 |
| 01103507 | 35,00 | 0,10 | 12,6 | 16,3 | 432,6 | 548 |
| 01105007 | 50,00 | 0,10 | 14,5 | 18,2 | 593,6 | 725 |
| 01107007 | 70,00 | 0,10 | 16,5 | 20,4 | 804,4 | 954 |
| 01109507 | 95,00 | 0,10 | 18,4 | 22,3 | 1064,5 | 1244 |
| 01101207 | 120,00 | 0,10 | 20,1 | 24,2 | 1311,0 | 1514 |
| 01101507 | 150,00 | 0,10 | 23,3 | 27,4 | 1627,6 | 1873 |
| 01101857 | 185,00 | 0,15 | 24,9 | 29,2 | 1970,9 | 2231 |
| 01102407 | 240,00 | 0,15 | 27,5 | 32,0 | 2511,2 | 2841 |
| 01103007 | 300,00 | 0,15 | 30,0 | 34,7 | 3108,6 | 3354 |

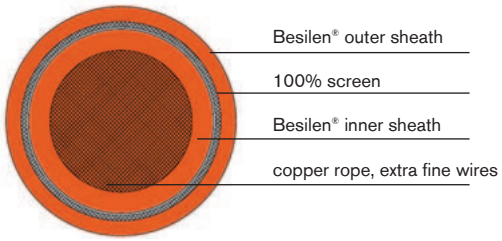
Other dimensions and colours are possible on request.

Nominal voltage up to **Uo/U 1.8/3 kV AC**

# B 110 C

**highly flexible Besilen® HV single core, shielded, cULus recognized (as cable harness)**




c UL us RoHS

## Application range:

**for example at HV test benches**
**for the transmission of high current load**

## Connection end:

| | |
|---|---|
| **Outer sheath:** | 50 mm stripped |
| **Connection end 1+2:** | tube cable lug (single core) and ring cable lug (screen) |
| **Screen:** | led out, twisted and insulated with shrinkable sleeve |

## Cable data:

| | |
|---|---|
| **Connection cable:** | highly flexible HV single core, screened |
| **Core insulation:** | Besilen® |
| **Screen:** | 100% screen with alu foil and braiding |
| **Outer sheath:** | Besilen® |
| **Sheath colour:** | orange |
| **Outer diameter:** | see table on page 26 |
| **Nominal voltage:** | Uo/U 1,8/3,0 kV AC<br>Uo/U 2,7/5,4 kV DC |
| **Voltage cULus:** | 3000 V |
| **Temperature range**<br>fixed laying:<br>flexible application:<br>short time use: | **DIN VDE**<br>-40/+180 °C<br>-25/+180 °C<br>+250 °C |
| | **cULus:** up to +150 °C |

CONFIGURATION EXAMPLE

| item no. | connection cable length [mm] | stripping lengths + conductor cross section | | |
|---|---|---|---|---|
| | | side 1 | side 2 | cross section |
| S0110-1006-00075 | 750 | 50 mm | 50 mm | 16 mm² |

**Total cable and channel lengths can be realised on customer's request.**

**SAB identification:**
item number, batch number

Nominal voltage up to
Uo/U 1.8/3 kV AC

# B 107

**highly flexible Besilen® HV single core, unshielded, cULus recognized**


Marking for B 107 01079507:
SAB BRÖCKSKES · D-VIERSEN · B 107 Uo/U 1,8/3 kV 95,0mm² cULus AWM Style 30122 AWM I A 150°C 3000V FT2

**Application range:** The highly flexible single core is particularly appropriate for the application on electric test benches. Due to the fine stranding and the resulting flexibility, the cable can be installed easily. The high voltage single core is designed for a voltage range up to 1,8/3 kV. In this way it fulfils the increasing demands within the voltage class.

## Construction:

| | |
|---|---|
| **Conductor:** | bare copper strands, extra fine wires |
| **Core insulation:** | Besilen® EI2<br>acc. to EN 50363-1 + VDE 0207-363-1 |
| **Sheath colour:** | orange (similar RAL 2004) |

## Outstanding features:

- **extremely flexible**
- **halogen-free**
- **heat resistant**
- **flexible at low temperatures**
- **flame retardant and self-extinguishing**
- **weather resistant**
- **cULus recognized**

## Technical data:

| | |
|---|---|
| **Nominal voltage:** | Uo/U 1,8/3,0 kV AC<br>Uo/U 2,7/5,4 kV DC |
| **Voltage cULus:** | 3000 V |
| **Testing voltage:** | 6500 V |
| **Current-carrying capacity:** | acc. to VDE 0298-4 |
| **Min. bending radius**<br>*fixed laying:*<br>*flexible application:* | <br>2 x d<br>4 x d |
| **Temperature range**<br>fixed laying:<br>flexible application:<br>short time use: | **DIN VDE** **cULus:** up to +150 °C<br>-40/+180 °C<br>-25/+180 °C<br>+250 °C |
| **Halogen-free:** | acc. to IEC 60754-1 + VDE 0482-754-1 |
| **Fire performance:** | flame retardant and self-extinguishing<br>acc. to IEC 60332-1-2 + VDE 0482-332-1-2,<br>cULus FT2 |
| **Corrosiveness of conflagration gases:** | IEC 60754-2 + VDE 0482-754-2<br>- no development of corrosive conflagration gases |
| **Weather resistance:** | very good |
| **Absence of harmful substances:** | acc. to RoHS directive of the European Union |

| item no. | nominal cross section mm² | largest single wire ø mm | outer-ø approx. mm | copper figure kg/km | cable weight ≈ kg/km |
|---|---|---|---|---|---|
| 01070107 | 1,00 | 0,07 | 4,3 | 9,6 | 25 |
| 01070157 | 1,50 | 0,07 | 4,7 | 14,4 | 31 |
| 01070257 | 2,50 | 0,07 | 5,2 | 24,0 | 43 |
| 01070407 | 4,00 | 0,07 | 6,3 | 38,4 | 60 |
| 01070607 | 6,00 | 0,07 | 6,3 | 57,6 | 73 |
| 01071007 | 10,00 | 0,07 | 9,0 | 96,0 | 144 |
| 01071607 | 16,00 | 0,07 | 9,3 | 153,6 | 194 |
| 01072507 | 25,00 | 0,10 | 12,0 | 240,0 | 316 |
| 01073507 | 35,00 | 0,10 | 13,8 | 336,0 | 431 |
| 01075007 | 50,00 | 0,10 | 15,7 | 480,0 | 591 |
| 01075007 | 70,00 | 0,10 | 17,7 | 672,0 | 777 |
| 01079507 | 95,00 | 0,10 | 18,8 | 912,0 | 1033 |
| 01071207 | 120,00 | 0,10 | 20,5 | 1152,0 | 1280 |
| 01071507 | 150,00 | 0,10 | 23,7 | 1440,0 | 1602 |
| 01071857 | 185,00 | 0,15 | 25,3 | 1776,0 | 1936 |
| 01072407 | 240,00 | 0,15 | 27,9 | 2304,0 | 2509 |
| 01073007 | 300,00 | 0,15 | 30,8 | 2880,0 | 3003 |

Other dimensions and colours are possible on request.

**for E-Mobility**
**HV test benches**

Nominal voltage up to
**Uo/U 1.8/3 kV AC**

# B 110 C Sense Cable

**halogen-free Besilen® Sense cable, shielded, cULus recognized**


Marking for B 110 C Sense Cable:
SAB BRÖCKSKES · D-VIERSEN · B 110 C Sense Cable 2x1,0mm² 0110-9001 c us AWM Style 4659 AWM I/II A/B 150°C 3000V FT1 FT2

## Construction:

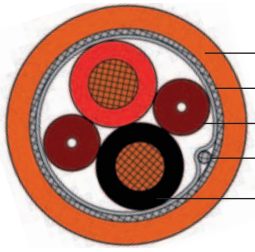
| | |
|---|---|
| **Conductor:** | bare copper strands, extra fine wires |
| **Core insulation:** | Besilen® EI2<br>acc. to EN 50363-1 + VDE 0207-363-1 |
| **Colour code:** | black and red |
| **Stranding:** | together<br>with , AWG 26 |
| **Screen:** | alu foil, tinned copper drain wire and<br>tinned copper braiding |
| **Sheath material:** | Besilen® EM9<br>acc. to EN 50363-2-1 + VDE 0207-363-2-1 |
| **Sheath colour:** | orange (similar RAL 2004) |

## Outstanding features:

- **extremely flexible**
- **good EMC characteristics**
- **halogen-free**
- **heat resistant**
- **flexible at low temperatures**
- **flame retardant and self-extinguishing**
- **weather resistant**
- **cULus recognized**

## Technical data:

| | |
|---|---|
| **Nominal voltage:** | Uo/U 1,8/3,0 kV AC<br>Uo/U 2,7/5,4 kV DC |
| **Voltage cULus:** | 3000 V |
| **Testing voltage:** | 4000 V |
| **Current-carrying capacity:** | acc. to VDE 0298-4 |
| **Min. bending radius**<br>fixed laying:<br>flexible application: | <br>6 x d<br>10 x d |
| **Temperature range**<br>fixed laying:<br>flexible application:<br>short time use: | **DIN VDE** **cULus:** up to +150 °C<br>-40/+180 °C<br>-25/+180 °C<br>+250 °C |
| **Halogen-free:** | acc. to IEC 60754-1 + VDE 0482-754-1 |
| **Fire performance:** | flame retardant and self-extinguishing<br>acc. to IEC 60332-1-2 + VDE 0482-332-1-2,<br>cULus FT1, FT2 |
| **Corrosiveness of conflagration gases:** | IEC 60754-2 + VDE 0482-754-2<br>- no development of corrosive conflagration gases |
| **Weather resistance:** | very good |
| **Absence of harmful substances:** | acc. to RoHS directive of the European Union |




| item no. | no. of cores x cross section n x mm² | core-ø max. mm | outer-ø approx. mm | outer-ø max. mm | copper figure kg/km | cable weight ≈ kg/km | ohmic resistance at 20 °C max. Ω/km |
|---|---|---|---|---|---|---|---|
| 01109006 | 2 x 0,25 | 3,50 | 10,2 | 10,7 | 32,8 | 112 | 80,0 |
| 01109007 | 2 x 0,34 | 3,60 | 10,6 | 11,1 | 53,5 | 130 | 58,8 |
| 01109008 | 2 x 0,50 | 3,80 | 11,1 | 11,7 | 57,3 | 142 | 39,0 |
| 01109001 | 2 x 1,00 | 4,35 | 12,1 | 12,7 | 72,7 | 170 | 20,0 |
| 01109002 | 2 x 1,50 | 4,75 | 12,9 | 13,5 | 90,1 | 198 | 13,3 |
| 01109003 | 2 x 2,50 | 5,25 | 13,9 | 14,6 | 111,0 | 238 | 7,98 |
| 01109004 | 2 x 4,00 | 5,95 | 15,3 | 16,1 | 146,5 | 297 | 4,95 |
| 01109005 | 2 x 6,00 | 6,35 | 16,3 | 17,1 | 216,3 | 365 | 3,3 |

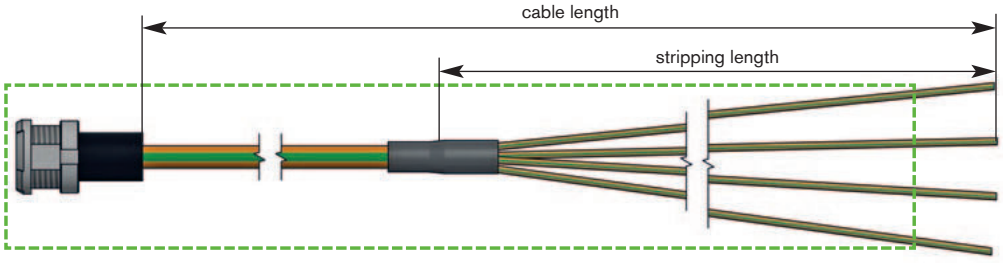
Other dimensions and colours are possible on request.

## Possible on request:

**As harnessed cable**
**acc. to customer's specification**

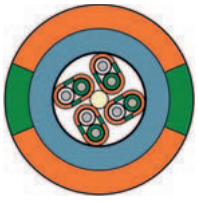
# HV test adapter

scoop-proof area

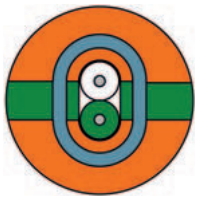



**For all sensor types available!**
**e.g. HV test adapter for HV 4-channel type K sensors**

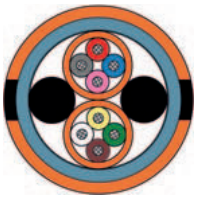
4-channel type K



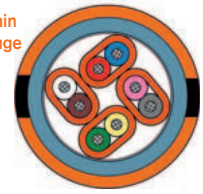
1-channel type K



2-channel PT100



strain gauge



**Application range:** The HV test adapter is used for the adaptation of HV sensors in fixed installation and are available for all sensor types in high voltage environments. The connection to test installed sensors for potential compensating measurements or the fixed installation in empty housings are only some of the application fields for which a test adapter can be used.

## Application range:

**for example to test installed HV sensors**

## Connector:

Lemo Redel 2P apparatus socket with black potting sleeve, 8-pole, coding acc. to sensor type

1000 V AC voltage-proof
– only suitable for fixed installation.

## Connection end:

stripping length acc. to customer`s request /
open end: 2 mm

dimensions for mounting cut-out on request

## Cable data:

| | |
|---|---|
| **Description:** | high voltage cable acc. to sensor type |
| **Core insulation:** | FEP |
| **Inner sheath:** | PUR – blue acc. to RAL 5024 |
| **Outer sheath:** | PUR |
| **Sheath colour:** | orange with vertical stripes (black or green) |
| **Stranding:** | paired construction (for EMC) |
| **Outer diameter:** | depending on the used cable |
| **Dielectric strength:** | 1000 V AC – depending on the used cable |
| **Temperature range**<br>fixed laying:<br>flexible application: | <br>-50°C / +150°C<br>-40°C / +150°C |

## Tests:

▶ **Cable test**
core/core – 600 V AC - 1 min - acc. to IEC 60584-1
over pair sheath/inner sheath in water bath –
5000 V AC – 5 min – with reference to EN 50264-2-1

▶ **Product test**
routine test of harnessed connector
with reference to standard 61010-1 for measuring devices as well as VDE indications in our in-house ball bath (released by VDE). Control of contact protection towards outside – 3000 V/1 min AC

***Issue of HV test certificate with reference to batch number due to optimum traceability***

***Optional: Test and repair of already used sensors on request***

CONFIGURATION EXAMPLES

| item no. | connection cable length | single channel length | type |
|---|---|---|---|
| T141-056-583 | 115 mm | 100 mm | 4 x type K |
| T141-055-568 | 200 mm | 50 mm | 1 x type K |
| T641-057-773 | 150 mm | 100 / 50 mm | 2 x PT100/PT1000 analogue (90V) |
| T644-062-235 | 115 mm | 100 mm | strain gauge |
| T645-xxx-xxx | 115 mm | 100 mm | voltage (90V) |
| T645-xxx-xxx | 155 mm | 100 mm | voltage (1000V) |

**SAB identification:**
item number, batch number

**Total cable and channel lengths can be realised on customer's request.**

# Accessories

## Application range: HV cap

HV cap black,
universally coded with fixing cord
for HV connector.

CONFIGURATION EXAMPLES

| item no. | configuration |
|---|---|
| T021-061-745 | plug |
| T021-062-719 | socket |

## Application range: dual shrinkable sleeve

Dual shrinkable sleeve natural, PTFE/FEP, Ø before shrinking 1,65 mm - Ø after shrinking 0,00 mm
-190°C up to +200°C (for example for the later insulation of measuring tips)

CONFIGURATION EXAMPLE

| item no. | configuration |
|---|---|
| T020-024-319 | 1000 mm |

## Application range: spare pads

Replacement of adhesive pads
to apply the measuring tip on surfaces.

CONFIGURATION EXAMPLES

| item no. | configuration |
|---|---|
| T095-044-258 | glass cloth 25 x 25 |
| T095-056-403 | PI foil 12,5 x 25 |

## Application range: automatic hinged cover

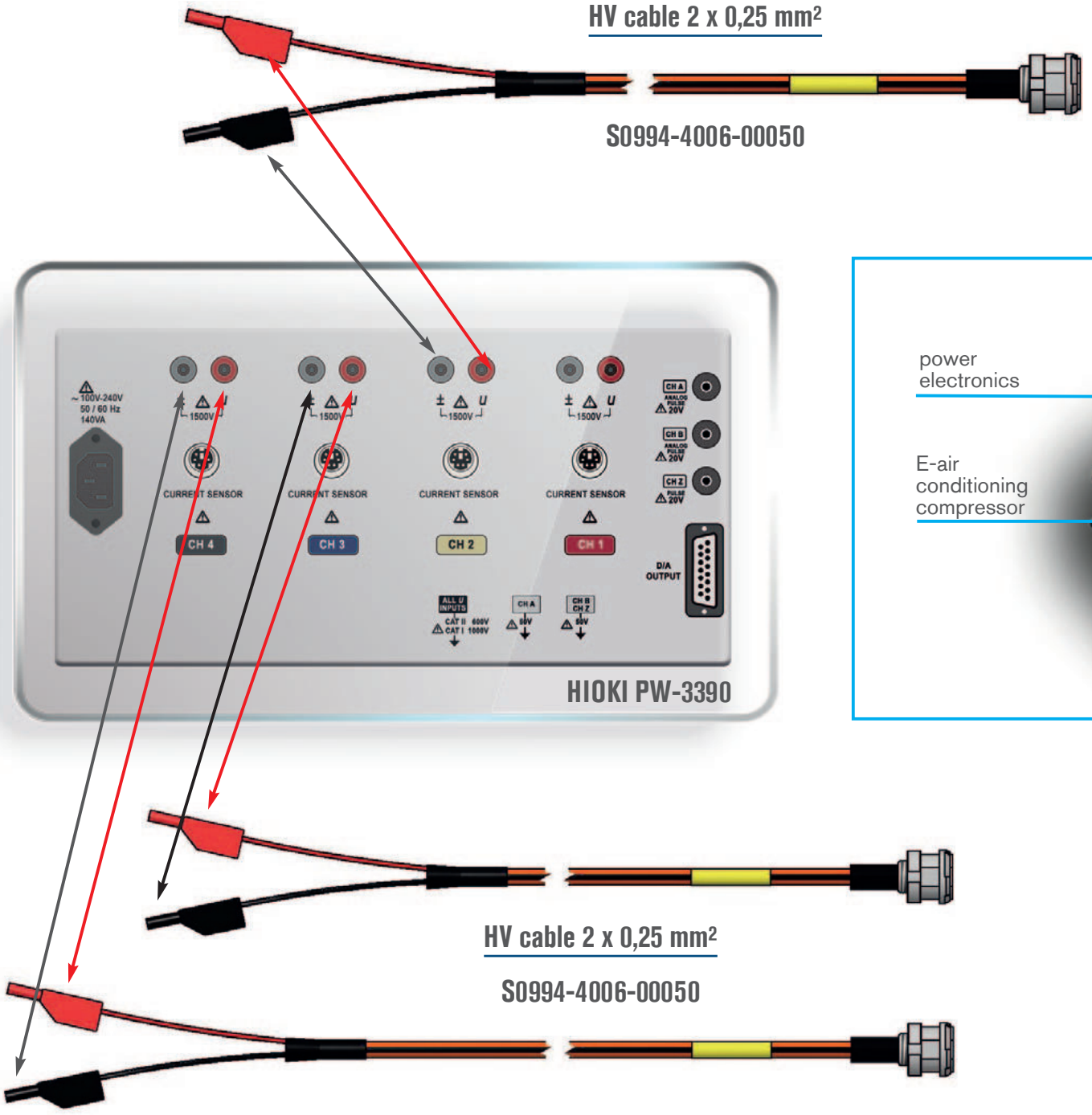
Conversion kit to automatic hinged cover
for Redel socket / size 2P
to protect the socket from dust,
dirt and moisture

CONFIGURATION EXAMPLE

| item no. | configuration |
|---|---|
| T021-060-467 | conversion kit |

# Application example

**for high voltage measuring cables**



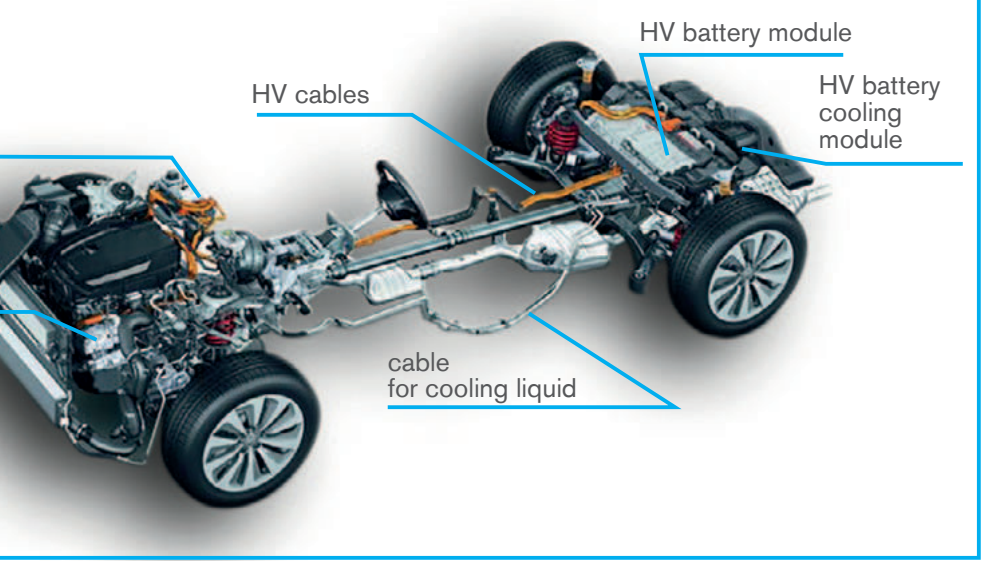
**LV cable 2 x 0,5 mm² screened**

S3833-4555-00700

**LV connection**

**(e.g. 12V vehicle battery)**

## ELECTRIC VEHICLE

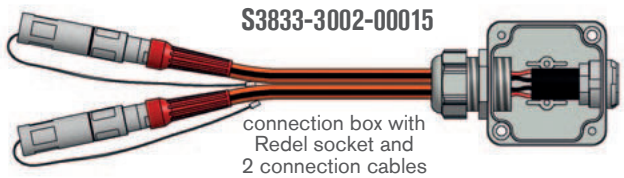



**HV adapter with clamping points**

**(vehicle specific)**

**HV cable 2 x 0,25 mm² screened**

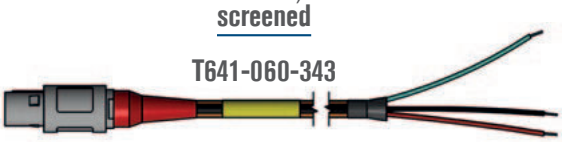
S3833-3002-00015



connection box with Redel socket and 2 connection cables with Redel plug

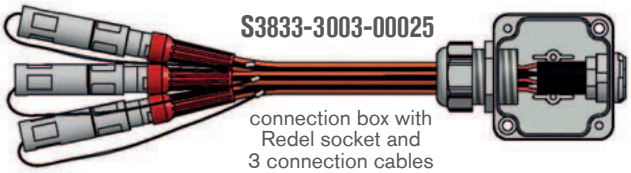
**HV cable 2 x 0,25 mm² screened**

T641-060-343



**extension**

S3833-3003-00025



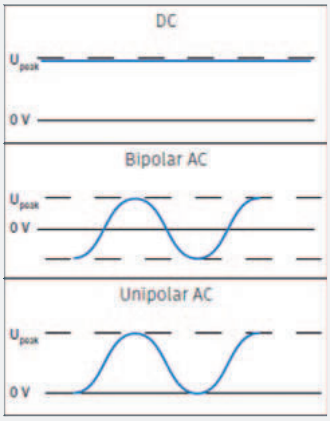
connection box with Redel socket and 3 connection cables with Redel plug

T641-061-127

# Glossary

### AC voltage
Alternating current (AC) refers to a type of electric current that changes its direction periodically and in constant repetition. Alternating current is often used for electrical energy supply. It flows through high-voltage lines and reaches ordinary households via socket.

### Bipolar (unipolar)
In connection with SAB HV sensors unipolar is the voltage that in contrast to real direct voltage – does not change sign but has got an alternating value. In fact it is a mixture out of direct and alternating voltage. In contrast to unipolar, bipolar means that the sign of voltage can change.




### Breakdown voltage
The breakdown voltage is the voltage required to allow current to flow through an insulator. This results in an electrical voltage breakdown. In a statistical series of breakdown voltage tests, this is the upper limit of the measured values.

### DC voltage
Direct current (DC) refers to electrical current whose strength and direction do not change over time. Batteries and solar cells, for example, supply direct current.

### Dielectric strength
The dielectric strength (usually specified in kV/mm) of an insulator is the maximum electric field strength that may prevail in the material without a voltage breakdown (arc or spark) occurring. In a statistical series of breakdown voltage tests, this is the lower limit of the measured values.

### High voltage
An electrical voltage above 1000V AC or 1500V DC is generally referred to as high voltage. In the VDE regulations, standardised voltages up to 1kV are referred to as low voltage and over 1kV as high voltage. In electrical power engineering, further conceptual subdivisions of high voltage into the sub-terms „medium voltage“, „high voltage“ and „extra-high voltage” are common, although the limits are not standardised. In the context of this glossary, „high voltage“ refers to the 60 kV and 110 kV range for supplying smaller towns, overland supply and the connection of smaller power stations.

Within the range of electrical technology in vehicles we also talk abour high voltage. When the term „high voltage“ (HV for short) is used, it clearly refers to a voltage in motor vehicles that is higher than 25V (AC) or higher than 60V (DC). The reason for this is that the term „high voltage“ clearly indicates the potential danger.

### HV identification
The term HV identification refers to the labelling of the cables and connection components of the HV sensors. The connection component is labelled with an orange bend protection sleeve and a „Danger“ label, the measuring cable with a corresponding identification strip in orange. This signal colour warns of the new sources of danger in hybrid and electric vehicles. The use or marking with the colour orange (known as „high-voltage orange“) can be found in the ISO 6469-3 and ECE-R 100 standards.

### Insulated measuring tip
With the „insulated measuring tip”, the bare measuring tip is hermetically sealed. The insulation at the bare point (measuring tip) is stronger than the basic insulation, but weaker than the reinforced insulation. However, it fulfils the criteria for a dielectric strength of 1000V AC and is considered as scoop-proof.

With the „mechanically insulated measuring tip”, the bare measuring tip is provided with additional basic insulation, but this is open on the side of the measuring tip. It offers no protection against accidental contact, but fulfils the criteria for 1000V AC. If the insulation fails, there is no additional protection in the area of the measuring tip.

### Insulation
**Basic insulation:**
Insulation of dangerously active parts that ensures basic protection.

**Additional insulation:**
Independent insulation applied in addition to the basic insulation to ensure protection against electric shock in the event of failure of the basic insulation.

**Double insulation:**
Insulation consisting of the basic insulation and the additional insulation.

**Reinforced insulation:**
Insulation that provides protection against electric shock that is not less than the protection provided by the double insulation.

# Glossary

### Leakage distance (acc. to IEC 61010-031)
The leakage distance is the shortest distance along the surface of a solid insulating material between two conductive parts. The leakage distance for measuring accessories means the shortest distance along the surface of an insulating material between a part that is dangerous to touch and a part of the user's body.

### Nominal voltage
The nominal voltage is the basis of assessment for out items. Certain operational characteristics refer to this nominal voltage.

### Operating voltage (in accordance with EN 61010-031)
Highest effective value of the direct or alternating voltage that can be permanently applied to an insulation during normal operation.

### Protection against contact
Constructive precautions at electric operating equipment that protect against hazardous contact with energized components (for example insulation). The term „contact protection“ is related to voltage rating that indicates the upper limit of electric voltage with which measuring equipment can be operated safely. This upper limit (nominal voltage) depends on the operational environment of the measuring accessories.

### Recognised rules of technology
The (generally) recognised rules of technology are technical rules or guidelines for the design and execution of structural or technical objects. These are rules that are recognised as theoretically correct and established in science, as well as being known in practice by technicians trained in accordance with the latest state of knowledge and have proven themselves on the basis of continuous practical experience. The generally recognised rules of technology are not identical to standards.

### Routine test
Conformity tests on each individual unit during or after production.

### Scoop-proof
The indication „scoop-proof” means in connexion with our SAB HV sensors the following:

The item has been designed and tested in a way that there is no risk of an electric shock for the user if he touches the cable under condition that the measuring tip is conductively connected with a component that does not exceed the indicated nominal voltage. Herewith, it is always indicated until which point or layer safety is guaranteed. Some items have for example a coloured inner sheath that indicates when mechanical wear threatens the safety described before. Other multi pair cables have partial elements. Here the pairwise insulation already fulfils the safety requirements.

Due to the risk to mix it up with the normative term „tangible”, the term „voltage-proof” is preferred for this characteristic as it is not used in standards.

### Sparking distance in air (acc. to IEC 61010-031)
The sparking distance in air is defined as the shortest distance in air between two conductive parts.

### Standard test finger
The purpose of the test finger is to simulate the non-touchability of active parts by the human finger. The dimensions are specified in EN 61010-031. A distinction is made between rigid test fingers and articulated ones.

### Tangible (with regard to one part) (acc. to EN 61010-031) (please see also „scoop-proof” and „voltage-proof”)
Conditioned in a way that it can be touched by a standardized test pin. This term could be confused with the term „scoop-proof”.

### Testing voltage
Testing voltage is the voltage that a test specimen (connector, cable, other components) can withstand without breakdown or flashover when handled as specified. This voltage is significantly higher than the specified nominal voltage.

Common scales are $2xU_{nenn}$ + 1000V.

### VDE
The VDE, originally Verband Deutscher Elektrotechniker (Association of German Electrical Engineers), since 1998 the Association for Electrical Engineering, Electronics and Information Technology is committed to the sciences in these fields and the technologies based on them. The VDE's work focuses on safety in electrical engineering, the development of recognised rules of technology as national and international standards and the testing and certification of devices and systems.

SPECIAL CABLES

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