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User Manual for Resistance Thermometers and Thermocouples

1. General

We supply complete thermometer assemblies ready for immediate use. These thermocouples or resistance thermometers are sensitive devices which contain either glass or ceramic parts. They must therefore be handled with due care. On receiving the thermometer assembly, carefully unpack all supplied articles, including those that may be delivered in dismantled form. Long thermometers must be supported at various points, and Lifted up or transported in an appropriate manner. The same care must be taken during the actual installation of the device. Prior to installation, please check the thermometers (see 7.1) to ensure that the device has suffered no transportation damages.

2. Thermocouples

Thermocouple assemblies are delivered with 1, 2, or sometimes 3 thermocouple elements. The measuring point is usually insulated but can still be connected to the protecting tube. The connection of the thermocouple to the measuring instrument is established with a compensation lead (CL). Only use the specified type of compensation lead and the appropriate polarity for connection of thermocouple. The leads should be at least 0.5 m away from the power cables, preferably laid in their own cable trays. Twisted and shielded cables suppress magnetic and electrical parasitical interferences.

3. Resistance Thermometers

Resistance thermometers are supplied with 1, 2, or sometimes with 3 measuring resistors. The measuring point is isolated. The connection between resistance thermometer and measuring instrument is mostly a 2-wire type (the sum and compensation of line resistance become part of the measurement). To obtain accurate measurements, 3-wire technique is used. If highly accurate measurements are desired, the 4-wire technique with constant current and high-resistance voltage pick up are used. Conventional copper cables usually found on the market, preferably with 1.5 mm^2 cross section should be laid, if possible at about 0.5 m away from the power cables, preferably on their own cabletrays. Twisted and shielded cables suppress magnetic and electrical parasitical interferences. Depending on the type, care must be taken not to exceed the measuring currents of 0.1 to 10mA, recommended by the manufacturer (errors may result from inherent heating).

4. Thermometer with Head Mounted Transmitter

The afore mentioned problems which could eventually be caused by transfer resistances in the cable and EMC can be prevented by installing a 2-wire transmitter (output signal 4-20 mA) in the sensor head. Only a 2-core copper cable is required. Multiple wire circuits for resistance thermometers and compensation cables for thermocouples are not necessary. When using the transmitter, please take notice of the following:

- The contents of these instructions or the operating manual provided with the transmitter
- The relevant rules involving the installation and operation of electrical systems, in some cases the regulations and directives for explosion protection.

5. Mounting and Operation

5.1 Installation

The thermometer (thermocouple, resistance thermometer) must be brought into contact with the medium to be measured in the best possible manner. To avoid thermal conduction errors, the immersion depth should be:

6-8 times greater in fluids
10-15 times greater in gases

than the protective tube diameter. The temperature sensitive length should be 1 to 1,5 times greater than the resistance elements or 30-50 mm by an o.d. of 6 mm. If only very short installation lengths are possible, the temperature-sensitive length of a resistance element or 30-50 mm may not be undershot by 1 to 1.5 times when applying either thermocouples or resistance thermometers. It is often helpful to install a pipe bend, whereby the protective tube must be positioned against the flow of the medium.

5.2 Connecting wires

For all connecting wires it is important to ensure that proper contact has been established and that corrosion, humidity, pollution, electrical parasitic interferences of power cables etc. are avoided. The cables should be insulated to counter the ambient influences (dry, humid, chemicals, aggressive influences, heat), whereby the ambient temperature of both the cable and the connection head may not exceed 100°C. Please pay attention to the valid standards and regulations when selecting the types of cables to be used. If possible, all measuring systems should be operated in ungrounded conditions, or only grounded at one point. When using thermocouples connected to protective tubes, these should be the only ground/mass connection.

5.3 Protection Tubes

Thermometers can be installed in any mounting position, preferably hanging vertically, up to temperatures reaching apprx. 500°C. Ceramic protection tubes must be protected from mechanical stress (bumps, bends) including temperature shocks e.g. through direct flame contact. If they are applied to hot processes (e.g. when changing the thermocouple), they must be either prewarmed or inserted very slowly (1-2 cm/min at 1600°C, 10-20 cm/min at 1200°C). This also applies when removing the hot protecting tube. Care must be taken to avoid suspending lengths > 500 mm for temperatures > 1200°C.

5.4 Instructions for explosion proof components

Maintenance work (repairs) may be conducted only under the following conditions and must follow legal guidelines or regulations:

1. Repair work may only be carried out using original components of the original manu facturer, otherwise the standards stipulated in the Certificate of Conformity shall not be fulfilled.
2. When ordering spare parts, exact information on previous delivery such as type of protection (Exd, Exi), Certificate of Conformity number, serial and item No.'s must be supplied.
3. Ex-protected thermometers only fulfil the required safety requirements as a unit component, as determined by the Certificate of Conformity. Measuring insets or connecting heads alone do not satisfy the explosion protection requirements.
4. If SCHRAMM supplies thermometers destined for operation in hazardous areas ordered without protecting tubes, it is the responsibility of the buyer to ensure

4.1 that these thermometers are deployed only in zones which are permissible in accordance with the Certificate of Conformity or with the manufacturer's declaration (e.g. Zones 1 or 2).

4.2 ...a protecting tube is provided in the event of an obligatory zone seperation (e.g. from Zone 0 from Zone 1). Such a tube must correspond fully to the "special conditions" spelled out in the respective Certificate of Conformity.

5. SCHRAMM shall advise the plant manager regarding “4.1 and 4.2” as maintained above.

6. Maintenance

The thermometer and the entire temperature measuring circuit must be checked at regular intervals for

- wear and tear of protecting tube or chemical activity
- drifts of the measuring element caused by aging
- reduction of insulation resistance through humidity and pollution
- improper contact of the wire connections
- mechanical and chemical damage of the thermometer and wires. Resistance themometer circuits can be checked by replacing the measuring element with a known defined resistance, thereby simulating a specific temperature. Thermoelement measuring circuits can be checked by connecting a mV voltage of a known v

ariable to the measuring circuits, instead of the thermocouple. In both cases, substantial deviations from the set point can be determined, and also if the thermometer or the instrumentation is the cause of functional errors. The insulation resistance of the entire ungrounded measuring circuit (wires and thermometer) against ground should be > 1 MOhm (measured with 100V DC).

7. Troubleshooting

7.1 Quick Check

of thermocouples and resistance thermometers, including their associated measuring circuits in dismantled form. Required instruments: mV meter, Ohm-meter or resistance bridge, insulation meter with 60-100 V voltage; all measurements at room temperature

- in the case of room temperature the throughput and insulation are checked by "knocking" to see if any wire breaks have occured.
- a thermocouple is regarded as being in order if R < 20 Ohm (wire > 0.5 mm Ø); the value depends on the wire cross-section and the length. Risol 100 MOhm (for insulated thermocouples)
- a resistance thermometer is considered to be in order if R is about 100 Ohm (for Pt 100), Risol > 100MOhm.

A heating up of the thermocouples or resistance thermometers to between 200 and 400°C (without temperature control) gives further clues to interruptions, polarity errors (for thermocouples), and low insulation resistance etc. The accuracy of thermometers acc. to ISO 9000 can only be checked by a reference element. Therefore in most cases the thermometers have to be removed and checked by a heating device.

7.2 Error Table for Thermocouples and Resistance Thermometers

The entire temperature measuring circuit should be routinely checked. The following table contains an illustration of the most important errors and provides suggestions towards their solution.

Fault	Probable or possible cause	Remedy
Errors in the measuring signal	a) electrical/magnetic pick-up	- at least 0.5 m spacing between the measuring cable and power cables supply lines if laid parallel - electrostatic shielding caused by a metal foil/braiding grounded at one point - twist the core wires (in pairs) to combat magnetic pick-up - right-angled crossing of electrode with interfering power cables
	b) Grounded loops	- only one grounding point in circuit or "floating" measuring system (ungrounded)
	c) Drop in insulation resistance	- humidity has eventually penetrated the thermometer/insert; in this case dry and rescale - replace insert - check to see if thermometer is thermally overloaded

Fault	Probable or possible cause	Remedy
Response times too long, incorrect readouts	a) wrong location for installation - there is a heat source within the flow path	- change the point of installation so that the medium can transmit its temperature to the thermometer without interface
	b) wrong installation: - insufficient installation depth - excessive loss of warmth	- immersion depth approx. TSL) + 6 x (fluids) up to 10 x (gases) d (d= external protecting tube Ø) - ensure for thermal contacts, especially on the surface measurements are established with matching contact surfaces and/or heat conducting materials
	c) protecting tube too thick, drilled hole for protecting tube too big	- select the smallest possible protecting tube for this process; response time at first exposure should be proportional to the cross-section or the volume of the thermometer, depending on the tentative thermal figures and air gaps within the assembly. - fill any such gaps with contact agent (oil, grease) if possible
	d) Deposits on the protecting tube	- remove during inspections - if possible, select another protecting tube, another installation point
Thermometer interruptions	Vibrations	- reienforced springs on insert - shorten insert insertion length - change the measuring point (if poss.) - special construction of inset and protecting tube
Highly corroded protecting tube	- composition of the medium is not as assumed, or has changed - unsuitable material chosen for protecting tube	- check the medium, eventually analyze the defective protecting tube and select a more suitable material, while providing additional surface protection - in certain circumstances the protecting tube must be replaced from time to time, since it is subject to wear

TSL = Temperature Sensitive Length

Typical Thermocouple faults

Fault	Probable or possible cause	Remedy
Fluctuating temperature readout even though thermocouple circuit is faultless	Reference junction temperature or voltage is not constant	- temperature or supply voltage must be kept constant at < 0.1%; check instruments - for non-precious metal thermocouples use the full value for measurement; use only about half the value for thermocouples made of precious metals
Temperature display highly deviates from the table values for thermocouples	improper material combinations, bad electrical contacts, parasitic voltages (thermostatic voltages, galvanic voltage), wrong compensation cable	check thermocouples and wires for - correct pairing - correct compensation lead - correct pinup - permitted ambient temperature at connection head

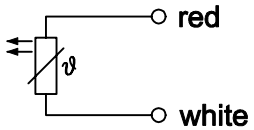
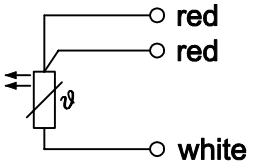
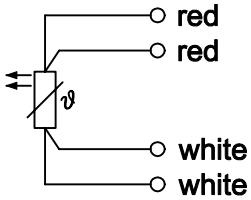
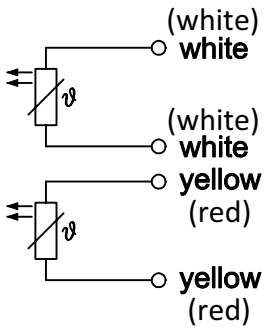
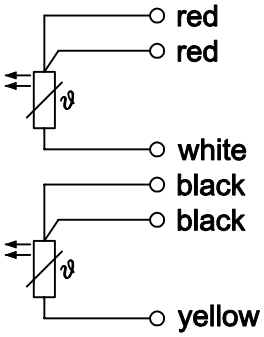
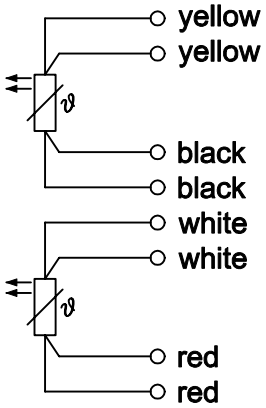
Typical Resistance thermometer faults

Fault	Probable or possible cause	Remedy
Too high or fluctuating temperature readout despite known cross-section, accurate sensor of the resistance thermometer	- wire resistance too high, uncompensated - supply lead resistance altered by high temperature	if still possible: - select 2-wire leads with bigger cross-sections eventually move to a more accessible point and - shorten wire - lead adjustment - change 3- or 4-wire system - use the head transmitter
Fluctuating temperature readout even though measuring circuit of the resistance thermometer	Voltage or power supply is not constant	- must be kept constant at < 0,1%. Fully affects the measurement when tuned off bridge and current/voltage measurements (4-wire)

THERMOCOUPLE - COLOR CODE

Thermopair	Typ	DIN IEC 584	DIN 43710	ANSI MC96.1
Fe-CuNi	J	+ black - white	+ red - blue	+ white - red
NiCr-Ni	K	+ green - white	+ red - green	+ yellow - red
NiCrSi-NiSi	N	+ pink - white	———	———
Pt10Rh-Pt	S	+ orange - white	+ red - white	+ black - red
Pt13Rh-Pt	R	+ orange - white	+ red - white	+ black - red
Pt30Rh-Pt6Rh	B	+ grey - white	———	+ grey - red

RESISTANCE TEMPERATURE DETECTOR - COLOR CODE

	2 - wire	3 - wire	4 - wire
1 x Pt100			
2 x Pt100 *			

* Colour in brackets for Type MW08 and MW08-Ex