Level | Pressure | Flow | Temperature | Liquid Analysis | Registration | Systems Components | Services | Solutions

Temperature products and accessories

Quality instruments you can rely on

Endress+Hauser

People for Process Automation

Contents

Endress+Hauser – experts in temperature

With unprecedented experience and extensive manufacturing facilities the world over, Endress+Hauser is recognised as a specialist in temperature measurement technology. We specialise in the design and manufacture of industrial temperature sensors and bespoke engineered solutions tailored to our customers' needs across all industries. Drawing on considerable international experience and with accredited calibration laboratories (DKD, SIT), our global network of production facilities and logistics partners supports our customers in 86 countries.

Our production centres manufacture around 6,500 temperature assemblies and transmitters every week, to supply Endress+Hauser customers around the globe.

Endress+Hauser's quality management system is accredited to ISO 9001:2008 and the scope of supply covers the design and manufacture of thermowells and industrial temperature sensors. Recognising our customers' requirements for quality, we provide temperature measurement points with individual component parts subject to careful examination in our own test centres. The quality of materials, processes and instruments is fully certified and specific details can be traced back for years!

Our Sales Centre in Manchester houses our Centre of Competence for Engineered Temperature Solutions. With extensive temperature manufacturing and testing facilities, we handle bespoke single piece work through to large volume projects, offering expertise in the manufacture of tailor-made solutions for our customers. Key personnel with over 30 years experience are familiar with all aspects of temperature sensor design and manufacturing techniques to provide an accredited quality service across the UK.

Modular concept

Modular components, modular specification

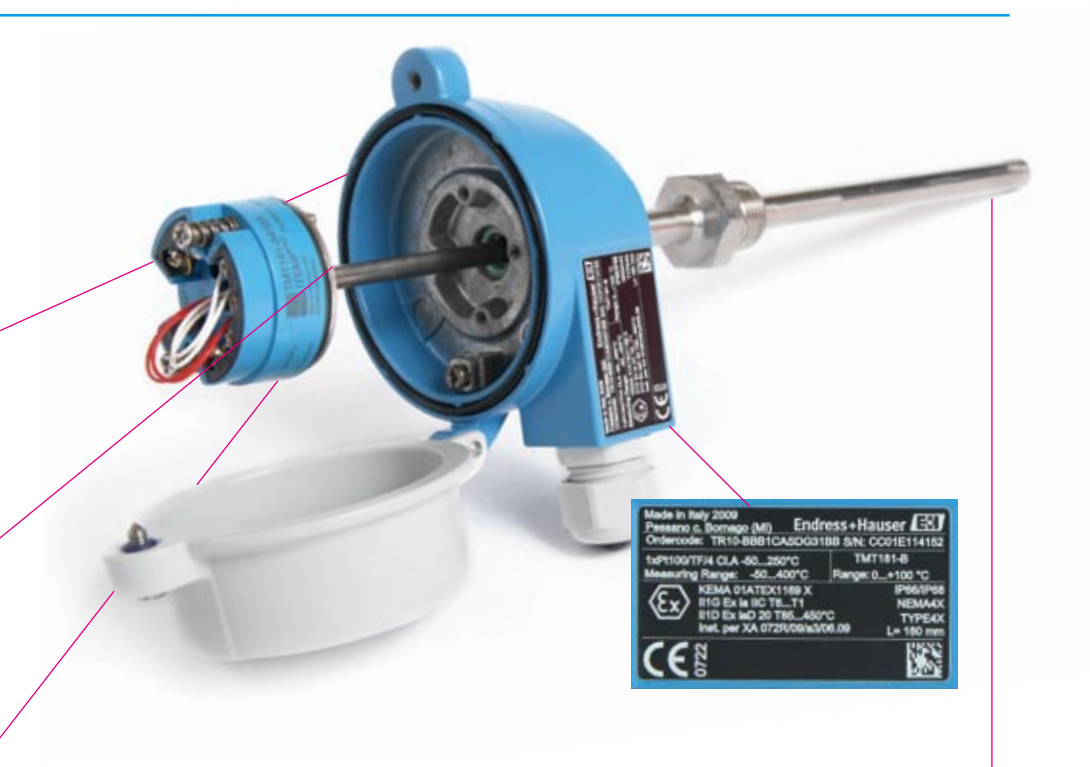
All of Endress+Hauser's temperature sensors are part numbered individually. This allows the customer to specify exact lengths, diameters, housings, terminations and many other attributes. Details of part number structures can be found via our product configurator or product datasheet, both of which can be found online (www.uk.endress.com). Furthermore each component of the modular thermometer can be supplied individually, as a spare part.

Ergonomically designed terminal head with clear labelling to identify spare parts and approvals, including serial number for complete traceability

High purity mineral insulated insert with serial number, temperature range and length clearly labelled

Termination into terminal block, flying leads or one of our range of electronic temperature transmitters which again carries its own serial number

Any testing carried out on the thermowell will be recorded against the assembly's serial number, which is clearly marked on the thermowell



Traceability

The Endress+Hauser modular thermometer is clearly labelled with its own individual serial number. This number is the link to all information regarding the product – simply enter the serial number into our online device viewer and with the click of a mouse you will have detailed information on the part structure along with a list of spare parts, and general documentation for the product. **www.uk.endress.com/device-viewer**

In addition to this, Endress+Hauser or customers who hold a W@M life-cycle management account can access the common equipment record and view more detailed information such as individual calibration certificates and test reports delivering total traceability.

Sensors without thermowell

Compact thermometers

- 316 stainless steel housing
- Fast response tip
- Integral electronics
- PC programmable

	Compact thermometer		Compact display / switch	
RTD	**TMR31**	**TMR35**	**TTR31**	**TTR35**
				
Features	Integral transmitter Pt100 or 4-20mA output 3A compliant (TMR35) M12 plug connection Selectable dimensions		Integral display 2 x PNP or 1 x PNP + 4-20mA output 3A compliant (TTR35) M12 plug connection Selectable dimensions	
Technical data ■ Temperature ■ Pressure ■ Response time ■ Connection ■ Sensing element ■ Supply voltage	-50 to 200°C with neck 30 bar (depending on connection) t_{90} ≤2.0 s TMR31 screwed / TMR35 hygienic Pt100, 4 wire, class A 10 to 35V DC		-50 to 200°C with neck 30 bar (depending on connection) t_{90} ≤2.0 s TTR31 screwed / TTR35 hygienic Pt100, 4 wire, class A 12 to 30V DC	
Typical applications	Food and beverage Energy monitoring Light chemical / pharmaceutical General process		Food and beverage Energy monitoring Light chemical / pharmaceutical General process	

General purpose thermometers

- Economic option
- Separate thermowell
- Thermocouple or RTD
- Configurable options

	Cable sensor	Sensor with housing	Tube thermowell
RTD	**TST310**	**TR24**	**TW251**
T/C	**TSC310**	**TEC420**	
			
Features	Cost effective Selectable dimensions Optional fitting Mineral insulated sheath	Cost effective Selectable dimensions Optional fitting Mineral insulated sheath	Cost effective Selectable dimensions St St or PTFE olive Straight, reduced or tapered
Technical data ■ Temperature ■ Pressure ■ Response time ■ Connection ■ Sensing element	 -200 to 600 / 1100°C Up to 40 bar t_{90} from ≤2.0s Optional, compression type RTD or thermocouple	 -200 to 600 / 1100°C Up to 50 bar t_{90} from ≤2.0s Optional, compression type RTD or thermocouple	 600°C Up to 50 bar / Screwed / weld in /
Typical applications	General light industrial For extra long lengths Where space is limited Thermal profiling	General light industrial When a thermowell is not needed	General light industrial

Modular thermometers

General purpose thermometers

- Insert inside thermowell
- ATEX Ex ia option
- Configurable dimensions
- For spare inserts see page 17

	With cooling neck	Without cooling neck	Separate fitting
RTD	TR10	TR11	TR12
T/C	TC10	/	TC12
			
Features	Integral thermowell Mineral insulated sensor Screw thread With lagging extension	Integral thermowell Mineral insulated sensor Screw thread Fitting under head	Integral thermowell Mineral insulated sensor Optional fittings Without cooling neck
Technical data ■ Temperature ■ Pressure ■ Response time ■ Connection ■ Spare insert	 -200 to 600°C / 1100°C Up to 50 bar t_{90} from ≤13.0s Thread ½" to 1" TPR100 / TPC100	 -200 to 600°C / 1100°C Up to 50 bar t_{90} from ≤13.0s Thread ½" to ¾" TPR100 / TPC100	 -200 to 600°C / 1100°C Up to 50 bar t_{90} from ≤13.0s Supplied separately TPR100 / TPC100
Typical applications	General process Chemical Hazardous areas	General process Chemical Hazardous areas	General process Chemical Hazardous areas

Flanged	DIN form 4 or 4F	Without thermowell
TR13 **TC13**	**TR15** **TC15**	**TR88** **TC88**
		
Integral thermowell Mineral insulated sensor Welded flange With cooling neck	Integral thermowell Mineral insulated sensor Flanged or weld-in With cooling neck	To fit into existing thermowell Mineral insulated sensor Screw thread With cooling neck
-200 to 600°C / 1100°C Up to 100 bar t_{90} from ≤13.0s Flange up to 2" TPR100 / TPC100	-200 to 600°C / 1100°C Up to 400 bar t_{90} from ≤18.0s Flange or weld-in TPR100 / TPC100	-200 to 600°C / 1100°C Dependent on thermowell Insert only, t_{90} from ≤2.0s Thread ½", M14, M18 TPR100 / TPC100
General process Chemical Hazardous areas	General process Chemical Hazardous areas	General process Chemical Hazardous areas

Modular thermometers

Approvals / certificates / tests

3A:	All thermometers fulfil the 3A Hygiene Standards for sensors, connections and fittings, No. 74-03.
EHEDG:	TR44 and TR45 have a number of EHEDG approvals.
FDA:	The materials used fulfil the FDA requirements.
ASME BPE 2007:	Option to fulfil the requirements in the ASME-BPE Standard 2007 for Bioprocessing Equipment.
EN 10204-3.1:	A material certificate to EN 10204-3.1 is available for all devices.

Hygienic thermometers

- Hygienic process connections
- 316 St St body, insert and terminal head
- Material/roughness certification available
- Numerous recognised approvals

	Without thermowell **TR44**	With thermowell **TR45**	Weld-in thermowell **TR47**
			
Features	Fixed insert Mineral insulated sensor Hygienic fitting Approved to 3A, EHEDG, FDA and ASME	Replaceable insert Mineral insulated sensor Hygienic fitting Approved to 3A, EHEDG, FDA and ASME	Replaceable insert Mineral insulated sensor Hygienic fitting Approved to 3A, EHEDG, FDA and ASME
Technical data ■ Temperature ■ Pressure ■ Response time ■ Fitting ■ Spare insert	 -50 to 250°C Up to 40 bar t_{90} from ≤7.0s Hygienic /	 -50 to 400°C Up to 40 bar t_{90} from ≤8.0s Hygienic TPR100	 -50 to 250°C Up to 170 bar t_{90} from ≤11.0s Weld-in TPR100
Typical applications	Food and beverage Pharmaceutical	Food and beverage Pharmaceutical	Food and beverage Pharmaceutical

Modular thermometers

Heavy duty thermometers

- ATEX Ex ia or Ex d options
- Optional 316 St St housing
- Configurable dimensions
- For spare insert see page 17

	Without thermowell	Tube thermowell Screwed or flanged	Solid drilled thermowell Screwed or flanged
RTD	TR62	TR63	TR66
T/C	TC62	TC63	TC66
			
Features	Replaceable insert Mineral insulated sensor Robust design To fit into existing thermowell	Replaceable insert Mineral insulated sensor Robust design Welded flange or screwed thread	Replaceable insert Mineral insulated sensor Robust design With bar stock thermowell
Technical data ■ Temperature ■ Pressure ■ Response time ■ Fitting ■ Spare insert	 -200 to 600°C / 1100°C Dependent on thermowell Insert only, t_{90} from ≤2.0s Screwed to suit thermowell TPR300 / TPC300	 -200 to 600°C / 1100°C Up to 100 bar Insert only, t_{90} from ≤2.0s Screwed or flanged TPR300 / TPC300	 -200 to 600°C / 1100°C Up to 500 bar Insert only, t_{90} from ≤2.0s Screwed or flanged TPR300 / TPC300
Typical applications	Oil and gas Petrochemical Heavy industry Hazardous areas	Oil and gas Petrochemical Heavy industry Hazardous areas	Oil and gas Petrochemical Heavy industry Hazardous areas

Heavy duty transmitters

- Insert and display only
- ATEX Ex ia or Ex d options
- See pages 14 and 15 for thermowells
- For spare insert see page 17

	Single chamber	Dual chamber
RTD	**TMT142R**	**TMT162R**
T/C	**TMT142C**	**TMT162C**
		
Features	Replaceable insert Mineral insulated sensor Robust design Transmitter with single chamber Optional display	Replaceable insert Mineral insulated sensor Robust design 316 St St housing option Transmitter with dual chamber display Optional display
Technical data ■ Temperature ■ Pressure ■ Response time ■ Fitting ■ Spare insert ■ Supply voltage	-200 to 600°C / 1100°C Dependent on thermowell Insert only from t_{90} ≤2.0s Screwed to suit thermowell TET300 / TEC300 11 to 40V DC	-200 to 600°C / 1100°C Dependent on thermowell Insert only from t_{90} ≤2.0s Screwed to suit thermowell TET300 / TEC300 11 to 40V DC
Typical applications	Oil and gas Petrochemical Heavy industry Hazardous areas	Oil and gas Petrochemical Heavy industry Hazardous areas

Modular thermometers

Thermowells

- Engineered solutions
- Available in exotic materials
- Wide range of process connections
- Non-destructive testing available

	Tubular up to 100 bar	**Bar stock up to 500 bar**
		
Features	Cost effective Reduced tip option for fast response Greater immersed lengths Quick turnaround	Drilled and machined from solid bar Partial or full penetration flange welds Can be straight, tapered or stepped Optional velocity collar
Technical data ■ Temperature ■ Pressure ■ Fitting ■ Flange style	 Up to 1100°C Up to 100 bar Screwed or flanged EN, ANSI	 Up to 1100°C Up to 500 bar Screwed or flanged EN, ANSI, API
Typical materials	Stainless steel Alloy C276, C22 Nickel alloys	Stainless steel Alloy C276, C22 Duplex, Super Duplex 6 moly Nickel alloys

Van stone up to 500 bar	Forged up to 700 bar	Hub up to 700 bar
		
Drilled and machined from solid bar Can be straight, tapered or stepped Optional velocity collar For use with backing flange	High pressure device Single piece forging Can be straight, tapered or stepped Optional velocity collar Integral flange	High pressure device Single piece forging Can be straight, tapered or stepped Optional velocity collar Hub and clamp connection DNV type approval
Up to 1100°C Up to 500 bar Backing flange type EN, ANSI	Up to 1100°C Up to 700 bar Flanged EN, ANSI, API	Up to 1100°C Up to 700 bar High pressure hub type Grayloc® or equivalent
Stainless steel Duplex, Super Duplex 6 moly Nickel alloys	Stainless steel Duplex, Super Duplex 6 moly High tensile carbon steel Nickel alloys	Stainless steel Duplex, Super Duplex 6 moly Nickel alloys

Modular thermometers

High temperature thermometers

- High resistance to arduous conditions
- Replaceable insert
- Configurable lengths and diameters
- Various sheath combinations

T/C	Refractory sheathed up to 1200°C **TAF11**	Refractory sheathed up to 1700°C **TAF12**	Metallic sheathed up to 1200°C **TAF16**
			
Features	Thermocouple types K or J Ceramic insulators Single sheath RA (Pythagoras) sheath	Thermocouple types R, S or B Ceramic insulators Single, double or triple sheath AP (Alsint) sheath	Thermocouple type K or J Ceramic or mineral insulated sheath Various metallic sheaths available Less fragile
Technical data ■ Temperature ■ Pressure ■ Fitting ■ Spare insert	Up to 1200°C defined by T/C type Up to 1 bar Optional adjustable flange 70mm Contact for details	Up to 1700°C defined by T/C type Up to 1 bar Optional adjustable flange 70mm Contact for details	Up to 1200°C Up to 50 bar Adjustable flange / compression fitting Contact for details
Typical applications	High temperature ovens Industrial furnaces	High temperature ovens Industrial furnaces High temperature kilns Incinerators	High temperature ovens Industrial furnaces Rotary kilns Incinerators

Sensor inserts

- Spare inserts for modular thermometers
- Thermocouple or RTD versions
- ATEX Ex ia option
- Supplied with block, transmitter or tails

	Standard Insert	Flame path collar	Spring loaded nipple
RTD	**TPR100**	**TPR300**	**TET300**
T/C	**TPC100**	**TPC300**	**TEC300**
			
Features	Standard replacement sensor ATEX Ex ia option Configurable dimensions With block, transmitter or leads	For ATEX Ex d units Integral flame path collar Configurable dimensions With block, transmitter or leads	Sprung replacement sensor ATEX Ex ia option Configurable dimensions With leads only
Technical data ■ Temperature ■ Pressure ■ Response time ■ Fitting ■ Sensing element	-200 to 600 / 1100°C Dependent on thermowell t_{90} from ≤2.0s DIN plate RTD or thermocouple	-200 to 600 / 1100°C Dependent on thermowell t_{90} from ≤2.0s DIN plate with flame path collar RTD or thermocouple	-200 to 600 / 1100°C Dependent on thermowell t_{90} from ≤2.0s Spring loaded nipple RTD or thermocouple
Replacement insert for	TR10, 11, 12, 13, 15, 88 TC10, 12, 13, 15, 88 TR45, 47	TR62, 63, 66 TC62, 63, 66	TMT142R, 142C TMT162R, 162C

Calibration and certification

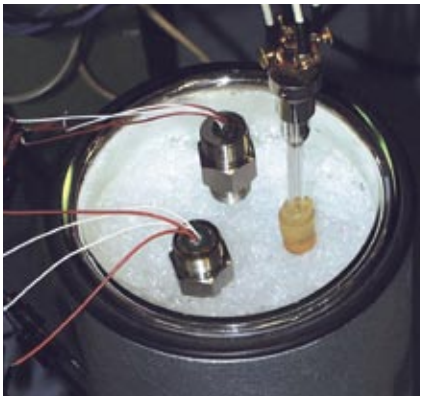
Certification and testing

Individual components of instruments are subject to careful examination at Endress+Hauser in our own test centres. The quality of the materials, processes and the important qualities of the thermometers are proved by reports and certificates and can be traced backwards for years.

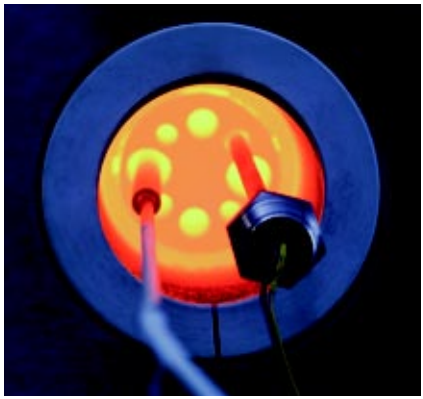
Calibrations can be performed in our primary laboratory or traceable to national standards to certify the accuracy of our thermometers.

Several methods of non-destructive testing can be performed to guarantee components are free from material joint problems such as cracks, pores and cavities.

TZC134 Traceable calibration	Calibrated using certified equipment traceable to ISO/IEC 17025, DKD and SIT guidelines for internationally recognised calibration certificates.
TXC33 Primary calibration	Calibrated in our own accredited laboratories to ISO/IEC 17025, DKD and SIT guidelines for internationally recognised calibration certificates.
TZC150 Evaluation report	Issued in lieu of calibration certificate if the immersion length of the sensor is too short for full calibration.
TZC130 Certificate of conformity	Issued by the Endress+Hauser quality department to certify that the goods supplied conform to the customer purchase order.
TZC131 Material certificate 3.1	The inspection certificate EN 10204 3.1 for wetted parts.
TZC138 Hydrostatic test	Using internal or external pressure test the strength and pressure rating of thermowells and process connections can be verified.
TZC125 Dye penetrant	Suitable for checking material surfaces and welded joints for surface breaking defects such as forging defects or cracks.
TZC161 PMI	Positive Material Identification. Non destructive X-ray fluorescence (XRF) to verify the chemical composition of the materials.
TZC127 Radiographic test	Hidden faults like inclusions, pores, tears, etc in the base material and/or in the weld are identified. Furthermore, the exact positioning of the welded components can be checked.
TZC140 Bore concentricity	Thermowell stems are checked for concentricity to guarantee wall thickness.



Ice bath zero point calibration



High temperature calibration

Electronics

Temperature transmitters

- DIN standard head mount
- DIN rail mount option available
- Optional displays
- Variety of interface methods

	Economical	Galvanic isolation	Hart protocol
	TMT180	**TMT181**	**TMT182**
			
Features	No ATEX rating PC programmable	ATEX Ex ia option PC programmable	ATEX Ex ia option SIL 2 compliant
Technical data ■ Input ■ Accuracy (Pt100) ■ Interface ■ Galvanic isolation ■ Power supply	RTD 0.1K / 0.08% of span PC / 10 to 35V DC	RTD, T/C, Ω, mV 0.2K / 0.08% of span PC 3.75kV AC 8 to 35V DC	RTD, T/C, Ω, mV 0.2K / 0.08% of span Hart 2kV AC 11 to 35V DC
Interface	ReadWin 2000 iTEMP PCP	ReadWin 2000 iTEMP PCP	HART COMMUNICATION FOUNDATION

Profibus PA	Foundation Fieldbus	Single chamber	Dual chamber
TMT84	**TMT85**	**TMT142**	**TMT162**
			
ATEX Ex ia option Display interface Dual input	ATEX Ex ia option Display interface Dual input	ATEX Ex ia or Ex d options Alloy housing Field or direct mount	ATEX Ex ia or Ex d options Stainless or alloy enclosure Field or direct mount Dual input
RTD, T/C, Ω, mV 0.1K Profibus 2kV AC 9 to 32V DC	RTD, T/C, Ω, mV 0.1K Foundation fieldbus 2kV AC 9 to 32V DC	RTD, T/C, Ω, mV 0.2K Hart 2kV AC 11 to 40V DC	RTD, T/C, Ω, mV 0.1K Hart, Profibus, Foundation fieldbus 2kV AC 11 to 40V DC

Transmitter accessories

- Variety of interface methods
- On site programming of instruments
- Compatible with a wide range of devices
- Easy to use

	Common Device Interface	Active / passive barrier	Plug on display	Field Xpert
	TXU10	**RN221/ RB223**	**TID10**	**SFX100**
				
Features	Communication device for Endress+Hauser transmitters and electronic modules USB port to standard Endress+Hauser service port connection Allows users to reconfigure existing devices or keep common stock and configure as needed	RN221 – Intrinsically safe power supply, galvanic isolation of loop HART status monitor with alarm relay, set-up using front mounted sockets RB223 – As above but does not require power supply, bidirectional HART transmission and applications up to SIL 3	Plug on interface unit with dot-matrix display 12 DIP switches on underside for configuration of TMT84 and TMT85 Process display when assembled with suitable terminal head	Handheld communication device for the configuration of HART protocol electronic modules Wireless communication via Bluetooth™ or WLAN based on an industrial PDA Device Xpert Configuration software package for field device commissioning, diagnosis and maintenance

Data managers

- Paperless recorders
- Large display of measured value
- Multiple inputs and outputs
- Integrated web server

	Ecograph **RSG30**	Memograph **RSG40**
		
Features	4.7" LC colour graphic display 320 x 240 pixels 2MB internal memory Compact flash memory expansion 24V auxiliary output voltage (250mA) Mechanically lockable interface panel	7" TFT colour graphic display 800 x 480 pixels 256MB internal memory SD slot & USB port for memory expansion 24V auxiliary output voltage (200mA) Person specific access authorisation and electronic signature
Technical data ■ Inputs ■ Outputs ■ Alarm setpoints ■ Mathematics ■ Power supply ■ Communication	 3 or 6 analogue, 3 digital 4 relay 14 2/5 mathematics channels 100-230V AC or 24V AC/DC, 50/60 Hz Ethernet, USB and serial RS232/485	 4/8/12/16 or 20 analogue, 6 or 14 digital 2 analogue, 6 or 12 relay 100 8 mathematics channels 115-230V AC or 24V AC/DC, 50/60 Hz Ethernet, USB and serial RS232/485
Typical applications	Utilities monitoring Temperature profiling Multichannel process display Consumption recording Process quality assurance	Utilities monitoring Temperature profiling Multichannel process display Consumption recording Process quality assurance Batching functions

Process indicators

- Loop powered process indicators
- Range of housing options
- Display any process variable
- ATEX Ex ia or Ex d options

	Panel indicator **RIA251**	Field indicator **RIA14 / RIA16**	Fieldbus indicator **RID14 / RID16**
			
Features	Panel mount display 5 digit LCD display ATEX Ex ia option	Field display 5 digit LCD display & bargraph Illuminated display ATEX Ex ia or Ex d options GRP, aluminium or 316 St St housing Wall or pipe mounting	8 Channel fieldbus indicator 5 digit LCD display & bargraph Illuminated display ATEX Ex ia or Ex d options GRP, aluminium or 316 St St housing Wall or pipe mounting
Technical data ■ Input ■ Output ■ Power supply ■ Interface ■ Housing ■ Protection	4-20mA / From 4-20mA loop Front buttons Panel 48 x 96mm IP65 front	4-20mA Digital limit switch From 4-20mA loop Fieldcare via plug Plastic (GRP), aluminium or 316 St St IP67	Foundation fieldbus Device blocks via fieldbus 9 to 32V DC via fieldbus Fieldcare via plug or fieldbus Plastic (GRP), aluminium or 316 St St IP67
Typical applications	Process display monitoring Control panels Plant and machine construction	Oil and gas / petrochemical Outdoor applications Process display monitoring Plant and machine construction	Oil and gas / petrochemical Outdoor applications 8 channel listener mode Plant and machine construction

Multifunction displays

- Multiple inputs and outputs
- Coloured, backlit LCD display
- Colour change to indicate alarm
- Intrinsically safe power supply

Field/panel meter	Din rail mounted meter	Bargraph panel meter
RIA45 / RIA46	**RMA42**	**RIA452**
		
Bargraph and segment display Panel or field housing LEDs for device and relay status Limit value and alarm output Mathematic functions Intrinsically safe loop power supply Min / max logging function Set up via PC 2 channel input	Bargraph and segment display DIN rail mounting LEDs for device and relay status Limit value and alarm output Mathematic functions Intrinsically safe loop power supply Min / max logging function Set up via PC 2 channel input	Bargraph and segment display Digital input for pump control Preset counter Pulse output Intrinsically safe loop power supply Open channel flow calculations Min / max logging function
4-20mA, V, Ω , TC or RTD 4-20mA, V, digital, optional relays 24-230V AC/DC Front buttons / Fieldcare via plug Panel - RIA45, Field – RIA46 IP65 front – RIA45, IP67 – RIA46	4-20mA, V, Ω , TC or RTD 2 x 4-20mA, V, digital, optional relays 24-230V AC/DC Front buttons / Fieldcare via plug Top hat DIN rail as per IEC 60715 IP20	4-20mA, V, Ω , TC, RTD or digital Up to 8 relays, mA, V, pulse 90-230V AC or 20-36V DC Jog wheel / Fieldcare via plug / RS232 Panel IP65 front
Process control Signal conditioning Process recording and supervision Process alarm	Process control, Signal conditioning Process recording and supervision Control rooms and cabinets Overfill protection, SIL2 compliant Process alarm	Process control Signal conditioning Process recording and supervision Pump control Tank linearisation

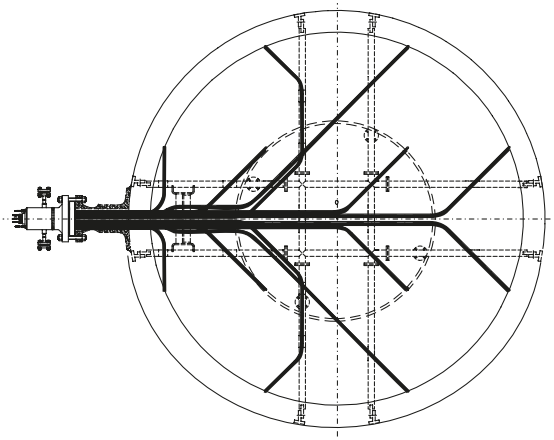
Engineered temperature

Flexible multipoint thermometers

These thermometers offer the possibility of distributing measurement points three-dimensionally within a reactor or vessel. Thermocouples enter the vessel via a common process connection and are routed to achieve the desired positions of the measurement points. This flexibility increases the number of measurements within a vessel from a single or limited number of process connections, thereby giving a better thermal profile of the process.

Connection box
(EEx d version) with transmitters
for multiple measurements.

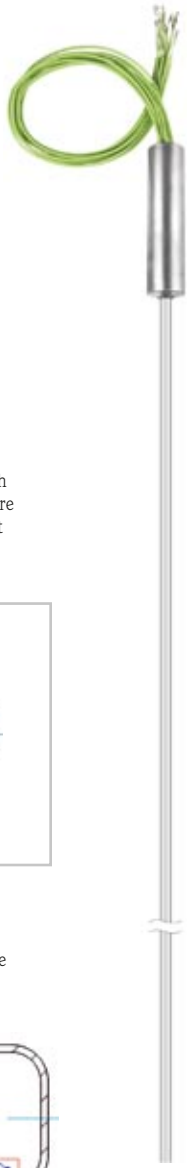
Gas tight interchangeable
thermocouples.



Measuring point positioning in a process reactor (top view)

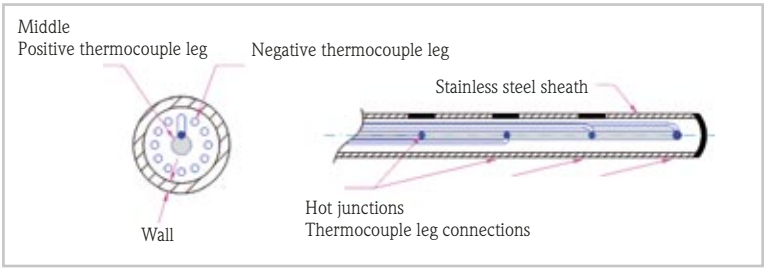
Detailed engineering design including material selection, drawing and planning, along with fault-free installation are key factors in the quality and longevity of the measuring system. This is why Endress+Hauser tailors its project solutions to meet our customers' needs, offering complete project management.

Rigid multipoint thermometers

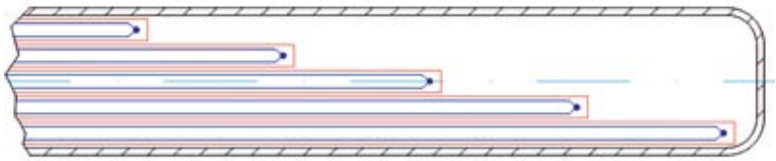


Rigid straight multipoint thermometers and thermowells are used for measuring temperature profiles. These multipoint thermometers consist of a thermowell with process connection, a number of sensors (mostly thermocouples) and a connection box. Various designs are available including individual interchangeable measurement elements, where each individual measurement point is in contact with the thermowell wall for faster response to the process temperature.
Terminals or transmitters can be fitted in the connection box which is either fitted directly onto the assembly or mounted remotely.

Version 1: Multi-point thermometer with common sheathing.
Optimised multipoint (OMP)
Constructed from a metallic sheath packed with high purified magnesium oxide powder with a number of conductors around a common central conductor. Thermocouple hot junctions are achieved by joining one of the negative outer conductors to the central positive conductor at different positions along the complete length of the sensor.

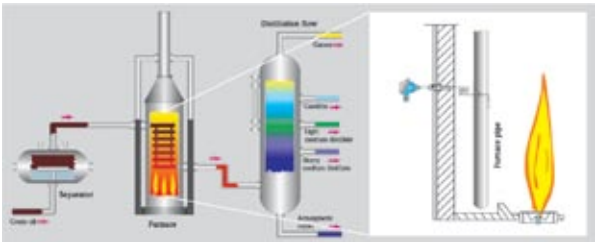


Version 2: Multi-point element with individual sheaths
Several mineral insulated thermocouples are placed into a metal tube, the generated multiple sensor is then drawn down in several steps to the required diameter.



Tube skin thermocouples

Tube skin thermocouples are designed for both the individual application and the furnace construction. The Endress+Hauser Hastelloy X pad thermocouple assembly set standards throughout industry and is now one of the most used tube skin surface mounted sensors. For very arduous environments we can supply heat protection and insulation shields.



Atmospheric distillation

Material
The choice of material is critical for the thermometer life span and therefore on the reliability of the temperature measurement. Among other things, the most suitable material is determined by the furnace temperature and the fuel used. By this, the effects due to radiation and open flames should be minimised. The use of Hastelloy® has proven itself in process furnaces. Versions in AISI 316 L, AISI 347, Inconel® and other materials are also possible.

Design
In the thermometer design the movements of the heat exchanger pipes and tip position are taken into account in the furnace. The pipe expansion is compensated for by expansion coils.

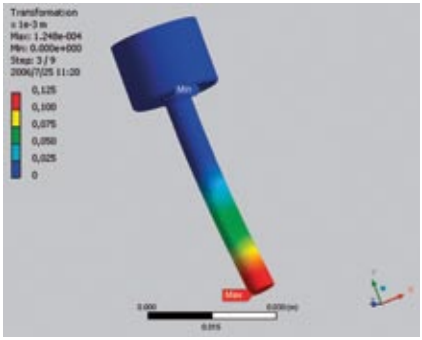
Connection to the pipe
The connection of the thermometer tip to the pipe surface has an influence on the measurement. The measurement result can be significantly influenced by radiated heat, flame impingement and corrosion.

Thermowell design

Thermowells can be divided into two categories:
- fabricated, constructed from welded tube
- solid drilled, machined from barstock material

In many cases thermometers cannot be placed directly into the medium and need protection from harsh process conditions. When process conditions do not allow for standard modular style assemblies, a thermowell must be designed to suit the process.

Endress+Hauser has a proven track record in the design and manufacture of high quality, specially designed thermowells using exotic materials and ingenious solutions to ensure we present our customers with a product which is optimised for the application.



The correct construction and design of a thermowell requires exact calculations to proven methods. An example of this is the wake frequency calculation which is performed to guarantee process conditions do not induce excessive vortices with the potential to cause the thermowell to fail/ shear. In such cases a velocity collar will be fitted to ensure that the thermowell is suited to the application.

Pipe dimensions in accordance with ANSI B36.10

Nominal Bore		Outside Diameter	Pipe schedule – inside diameter (all dimensions in mm)						
Inches	mm		5S	10S	10	20	30	40S	Std Wt
½	15	21.34	18.04	17.12				15.80	15.80
¾	20	26.67	23.37	22.45				20.93	20.93
1	25	33.40	30.10	27.86				26.64	26.64
1 ½	40	48.26	44.96	42.72				40.90	40.90
2	50	60.32	57.02	54.78				52.50	52.50
3	80	88.90	84.68	82.80				77.92	77.92
4	100	114.30	110.08	108.20				102.26	102.26
5	125	141.30	135.76	134.50				128.20	128.20
6	150	168.27	162.73	161.47				154.05	154.05
8	200	219.07	213.53	211.55		206.37	204.99	202.71	202.71
10	250	273.05	266.25	264.67		260.35	257.45	254.51	254.51
12	300	323.85	315.93	314.71		311.15	307.09	304.79	304.79
14	350	355.60	347.68	346.04	342.90	339.76	336.54		336.54
16	400	406.40	398.02	398.02	393.70	390.56	387.34		387.34
18	450	457.20	448.82	447.64	444.50	441.36	434.94		438.14
20	500	508.00	498.44	496.92	495.30	488.94	482.60		488.94
22	550	558.00	548.44	546.92	545.30	538.94	532.60		538.94
24	600	609.60	598.52	596.90	596.90	590.54	581.06		590.54
26	650	660.40			644.56	635.00			641.34
28	700	711.20			695.36	685.80	679.44		692.14
30	750	762.00	749.30	746.16	746.16	736.60	730.24		742.94
32	800	812.80			796.96	787.40	781.04		793.74
34	850	863.60			847.76	838.20	831.84		844.54
36	900	914.40			898.56	889.00	882.64		895.34

Pipe schedule – inside diameter (all dimensions in mm)									
40	60	80S	XS	80	100	120	140	160	XXS
15.80		13.88	13.88	13.88				11.78	6.40
20.93		18.85	18.85	18.85				15.55	11.03
26.64		24.30	24.30	24.30				20.70	15.22
40.90		38.10	38.10	38.10				33.98	27.96
52.50		49.24	49.24	49.24				42.84	38.18
77.92		73.66	73.66	73.66				66.64	58.42
102.26		97.18	97.18	97.18		92.06		87.32	80.06
128.20		122.24	122.24	122.24		115.90		109.54	103.20
154.05		146.33	146.33	146.33		139.73		131.75	124.37
202.71	198.45	193.67	193.67	193.67	188.89	182.55	177.83	173.05	174.61
254.51	247.65	247.65	247.65	242.87	236.53	230.17	222.25	215.89	222.25
303.23	295.31	298.45	298.45	288.89	280.97	273.05	266.69	257.21	273.05
333.34	325.42		330.20	317.50	307.94	300.02	292.10	284.18	
381.00	373.08		381.00	363.52	354.02	344.48	333.34	325.42	
428.66	419.10		431.80	409.54	398.48	387.34	377.86	366.72	
477.82	466.76		482.60	455.62	442.92	431.80	419.10	407.98	
	513.54		532.60	510.84	488.14	475.44	462.74	450.04	
574.64	560.38		584.20	547.68	531.82	517.56	504.86	490.52	
			635.00						
			685.80						
			736.60						
777.84			787.40						
828.64			838.20						
876.30			889.00						

Thermowell materials

Common materials used in the construction of thermowells – this information is to be used only as a guide.

Metal/alloy	Maximum operating temp °C	UNS number	DIN number	Application
Stainless steel AISI304	900	S30400	1.4301	Low cost, resistant to corrosive agents in industrial use
Stainless steel AISI316	900	S31600	1.4401	Best corrosion resistant austenitic stainless steel
Stainless steel AISI316Ti	900	S31635	1.4571	As above but Titanium stabilised
Stainless steel AISI316L	900	S31603	1.4404	As above but low carbon version
Stainless steel AISI310	1100	S31000	1.4841	Good for high temperature, cyclic heating, sulphur bearing atmospheres
Stainless steel AISI446	1150	S44600	1.4762 1.4749	High temperature, sulphurous atmospheres
Inconel® 600	1100	N06600	2.4816	High temperature, corrosion resistant
Inconel® 800	1100	N08800	1.4876	High temperature, oxidisation and carburisation resistant
Hastelloy® X	1200	N06002	2.4665	High temperature, resistant to oxidisation and reducing atmospheres
Hastelloy® C276	1200	N10276	2.4819	Corrosion resistance in many chemical environments
Monel®	538	N04400	2.4360	Excellent corrosion resistance to sea water and chlorinated solvents
Duplex	300	S31803	1.4462	Excellent corrosion resistance, high strength
Super duplex	300	S32750 S32760	1.4410 1.4501	Excellent corrosion resistance to sea water and high strength
6 Moly	600	S31254	1.4547	Excellent strength and corrosion resistance

Inconel, and Monel are trademarks of INCO Alloys International Inc.
Hastelloy is a trademark of Haynes International Inc.

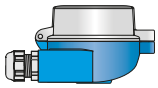
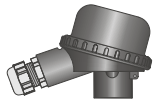
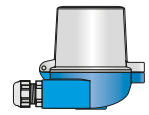
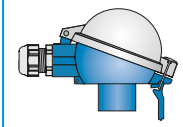
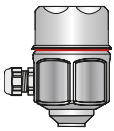
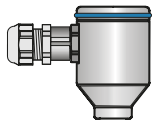
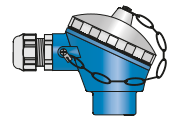
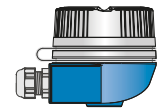
Hygienic connections

Fast and simple exchange of the complete thermometer as well as simple cleaning in the process have led to special hygienic process connections for the food and pharmaceutical industry.

Connection	Clamp to ISO 2852	DIN 11851	DIN 11864	SMS	Weld-in adaptor	Screw-in adaptor	Varivent	Ingold	Metallic sealing connection
Design									
Size	DN 8 / 18 DN 12 / 21.3 DN 25 / 38 DN 40 / 51 Tri-Clamp ½" / ¾"	DN 25 DN 32 DN 40 DN 50	DN 25 DN 40	DN 25	Cylindrical or spheric cylinder 30 x 40mm	G 1", as for Liquiphant M	DN 32 / 125, D = 68mm DN 25, D = 50mm DN 10 / 15, D = 31mm	25 x 50mm	G ½"

Terminal heads

The terminal heads, in which the terminal block or transmitter is installed, differ in shape and material depending on the application. Materials used are: plastic, varnished aluminium or 316 stainless steel. All terminal heads have an internal form according to DIN 43729 (form B) as well as a thermometer connection of M24x1.5. The cable glands supplied with the terminal heads are suitable for cables with a diameter of 5 to 9mm.

TA30A	IP	TA20B	IP	TA30D	IP	TA20W	IP
 Form B Standard (also with display)	66/67	 Form BUK	65	 Form BUZH	66	 Form BUS	66
TA 20J	**IP**	**TA20R**	**IP**	**TA21E**	**IP**	**TA30H**	**IP**
 (also with display)	66/67		66/67		65	 (also with display)	66/67

Technical reference

International colour codes for thermocouple cable insulation

T/C Type	Conductor +	Conductor –	Temp. Range °C	International EN 60584	Former British BS 4937	French to NFC 42-324	German to DIN 43714	Japanese to JIS C 1610-1981	American to ANSI MC 96.1
K	Ni-Cr	Ni-Al	-200 to +1200						
J	Fe	Cu-Ni Constantan	-40 to +750						
T	Cu	Cu-Ni Constantan	-200 to +350						
N	Ni-Cr-Si Nicrosil	Ni-Si-Mg Nisil	-200 to +1200						
E	Ni-Cr	Cu-Ni Constantan	-200 to +900						
B	Pt-30Rh	Pt-6Rh	600 to +1700						
R	Pt-13Rh	Pt	0 to +1600						
S	Pt-10Rh	Pt	0 to +1600						

Temperature range as defined in EN 60584 tolerance classes.

IEC tolerance class EN 60584-2

IEC code		Class 1	Class 2
J	Temp range Tolerance value Temp range Tolerance value	-40 to 375°C ±1.5°C 375 to 750°C ±0.4% reading	-40 to 333°C ±2.5°C 333 to 750°C ±0.75% reading
K/N	Temp range Tolerance value Temp range Tolerance value	-40 to 375°C ±1.5°C 375 to 1000°C ±0.4%	-40 to 333°C ±2.5°C 333 to 1200°C ±0.75% reading
T	Temp range Tolerance value Temp range Tolerance value	-40 to 125°C ±0.5°C 125 to 350°C ±0.4% reading	-40 to 133°C ±1°C 133 to 350°C ±0.75% reading
E	Temp range Tolerance value Temp range Tolerance value	-40 to 375°C ±1.5°C 375 to 800°C ±0.4% reading	-40 to 333°C ±2.5°C 333 to 900°C ±0.75% reading
R/S	Temp range Tolerance value Temp range Tolerance value	0 to 1100°C ±1°C 1100 to 1600°C ±[1 +0.3% x (Rdg-1100)]°C	0 to 600°C ±1.5°C 600 to 1600°C ±0.25% reading
B	Temp range Tolerance value Temp range Tolerance value	Not established	600 to 1700°C ±0.25% reading

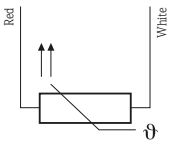
Tolerance classes for RTD thermometers as per IEC 60751 edition 2.0

Tolerance Class	Temperature range of validity (°C)		Tolerance values (°C)
	Wire wound element	Thin film element	
AA	-50 to +250	0 to +150	± (0.1 + 0.0017 [t])
A	-100 to +450	-30 to +300	± (0.15 + 0.002 [t])
B	-196 to +600	-50 to +500	± (0.3 + 0.005 [t])
C	-196 to +600	-50 to +600	± (0.6 + 0.01 [t])

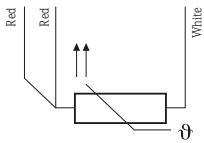
Temp°C	Resistance for Pt100 (Ω)	Approximate tolerance bands of resistance and temperature					
		Class C	Class B	Class A	Class AA	1/5 DIN	1/10 DIN
		± °C	± °C	± °C	± °C	± °C	± °C
-200.00	18.52	2.60	1.30	0.55	0.44	0.26	0.13
-150.00	39.72	2.10	1.05	0.45	0.36	0.21	0.11
-100.00	60.26	1.60	0.80	0.35	0.27	0.16	0.08
-50.00	80.31	1.10	0.55	0.25	0.19	0.11	0.06
0.00	100.00	0.60	0.30	0.15	0.10	0.06	0.03
50.00	119.40	1.10	0.55	0.25	0.19	0.11	0.06
100.00	138.51	1.60	0.80	0.35	0.27	0.16	0.08
150.00	157.33	2.10	1.05	0.45	0.36	0.21	0.11
200.00	175.86	2.60	1.30	0.55	0.44	0.26	0.13
250.00	194.10	3.10	1.55	0.65	0.53	0.31	-
300.00	212.05	3.60	1.80	0.75	0.61	0.36	-
350.00	229.72	4.10	2.05	0.85	0.70	-	-
400.00	247.09	4.60	2.30	0.95	-	-	-
450.00	264.18	5.10	2.55	1.05	-	-	-
500.00	280.98	5.60	2.80	-	-	-	-
550.00	297.49	6.10	3.05	-	-	-	-
600.00	313.71	6.60	3.30	-	-	-	-
650.00	329.64	7.10	3.55	-	-	-	-

Connection modes

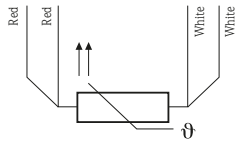
2-wire: Electrical connection of the Pt100 resistance
Features: Additional measurement error due to temperature dependent resistance changes in the cabling.



3-wire: Electrical connection of the Pt100 resistance
Features: Accurate measurement. In the main avoids additional measurement error due to temperature dependent resistance changes in the cabling.



4-wire: Electrical connection of the Pt100 resistance
Features: Highly accurate. No additional measurement error due to temperature dependent resistance changes in the cabling.



Conversion factors

Commonly used units of pressure							
Bar	Millibar	Pa	Kpa	PSI	in H_20	mm H_20	in Hg
1	1000	100,000	100	14.50	401.46	10197.16	29.53
0.001	1	100	0.1	0.0145	0.402	10.197	0.0295
0.00001	0.01	1	0.001	0.000145	0.00402	0.102	0.000295
0.01	10	1000	1	0.145	4.015	101.971	0.295
0.0689	68.948	6894.757	6.895	1	27.68	703.07	2.036
0.00249	2.491	249.0889	0.249	0.0361	1	25.4	0.0736
0.000098	0.0981	9.807	0.0098	0.00142	0.0393	1	0.0029
0.0339	33.863	3386.389	3.386	0.491	13.595	345.316	1

Thread dimensions		
Size (G = BSP)	Major Dia. (mm)	Pitch (mm)
G 1/8"	9.7	0.91
G 1/4"	13.2	1.34
G 3/8"	16.7	1.34
G 1/2"	21.0	1.81
G 5/8"	22.9	1.81
G 3/4"	26.4	1.81
G 1"	33.2	2.31
1/8" NPT	10.3	0.94
1/4" NPT	13.7	1.41
3/8" NPT	17.1	1.41
1/2" NPT	21.3	1.81
3/4" NPT	26.7	1.81
1" NPT	33.4	2.21

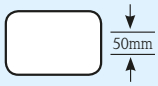
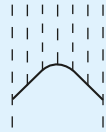
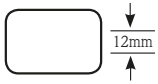
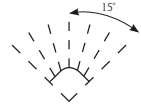
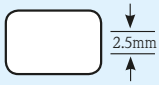
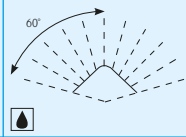
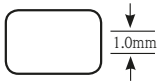
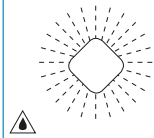
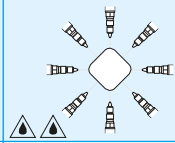
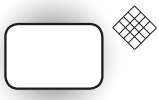
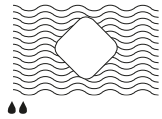
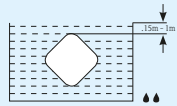
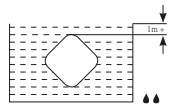
Length	Volume
1 in = 25.4 mm	1 in^3 = 16.39 cm^3
1 ft = 0.3048 m	1 ft^3 = 0.02832 m^3
1 yd = 0.914 m	1 gal (imp) = 4546.09 cm^3
1 mile = 1.609 km	1 litre = 1000 cm^3

Mass	Density & Flow
1 lb = 0.4536kg	1 lb/in^3 = 27.68 g/cm^3
1 ton = 1016 kg	1 lb/ft^3 = 16.018 kg/m^3
1 tonne = 1000 kg	1 ft^3/s = 0.02831 m^3/s

Abbreviation	Prefix	Factor	Value
k	kilo	10^3	1,000
h	hecto	10^2	100
da	deca	10	10
d	deci	10^{-1}	0.1
c	centi	10^{-2}	0.01
m	milli	10^{-3}	0.001
µ	micro	10^{-6}	0.000001

Temperature conversion
°C = °F x 9/5 + 32
°F = °C -32 x 5/9

The IP rating system as set out in BS EN 60529:1992

1st digit	Protection against solid objects	2nd digit	Protection against liquids
0	Not protected	0	Not protected
1	 Protected against solid objects over 50mm e.g. accidental touch by hands	1	 Protected against vertically falling drops of water
2	 Protected against solid objects over12mm e.g. fingers	2	 Protected against direct sprays of water up to 15° from the vertical
3	 Protected against solid objects over 2.5mm (tools and wires)	3	 Protected against sprays up to 60° from the vertical
4	 Protected against solid objects over 1mm (tools, wires and small wires)	4	 Protected against water sprayed from all directions – limited ingress permitted
5	 Protected against dust – limited ingress (no harmful deposit)	5	 Protected against low pressure jets of water from all directions – limited ingress permitted
6	 Totally protected against dust	6	 Protected against strong jets of water e.g. for use on ship decks – limited ingress protected
		7	 Protected against the effects of temporary immersion between 15cm and 1m. Duration of test 30 min
		8	 Protected against long periods of immersion under pressure

Division of hazardous areas into zones

Zone 0 Continuous hazard (> 1000 h/a)	**Zone 20** Continuous hazard (> 1000 h/a)
An area in which a hazardous explosive gas atmosphere is present **continuously** or **for long periods** or **frequently.**	An area in which a hazardous explosive atmosphere formed by a dust cloud in air is present **continuously** or **for long periods** or **frequently.**
Zone 1 Occasional hazard (10 to 1000 h/a)	**Zone 21** Occasional hazard (10 to 1000 h/a)
An area in which a hazardous explosive gas atmosphere is **likely to occur** in normal operation.	An area in which a hazardous explosive atmosphere formed by a dust cloud in air is **likely to occur** during normal operation.
Zone 2 Hazard only under abnormal operating conditions (> 10 h/a)	**Zone 22** Hazard only under abnormal operating conditions (> 10 h/a)
An area in which a hazardous explosive gas atmosphere is **not likely to occur** in normal operation, and if it does occur it will exist for a **short period** only.	An area in which a hazardous explosive atmosphere formed by a dust cloud in air is **not likely to occur** during normal operation, and if it does occur it will exist for a **short period** only.

Equipment groups and categories

Equipment group	Equipment category
Group I	**Category M1**
Electrical apparatus intended for use in mines liable to be endangered by firedamp and / or combustible dust.	Equipment remains energized and functional with an explosive atmosphere present.
Potentially explosive atmosphere: Firedamp and / or combustible dust.	**Category M2**
	Equipment to be de-energized in the event of an explosive atmosphere.
Group II	**Category 1**
Electrical apparatus intended for use in places other than mines liable to be endangered by explosive atmosphere.	Equipment must ensure the requisite level of protection, even in the event of rare incidents relating to equipment.
Potentially explosive atmosphere: Mixtures of air and gases, vapours or mists or air / dust mixtures.	Equipment suitable for zones 0, 1, 2 or 21, 22.
	Category 2
	Equipment must ensure the requisite level of protection, even in the event of frequently occurring disturbances or equipment faults.
	Equipment suitable for zones 1, 2 or 21, 22.
	Category 3
	Equipment must ensure the requisite level of protection during normal operation.
	Equipment suitable for zones 2 or 22.

Approval identification (Certificate number)

PTB	04	ATEX	1234	X
Notified body i.e PTB, KEMA, TÜV, etc.	**Year of issue**	**ATEX-directive**	**Consecutive number**	**Special conditions**

Equipment group

I = mining equipment

II = non-mining equipment

Categories

	Category 1		Category 2		Category 3	
G = Gas D = Dust	G	D	G	D	G	D
Used in	Zone 0	Zone 20	Zone 1	Zone 21	Zone 2	Zone 22

Specific marking of explosion protection

Certified according to harmonised European standards

Explosion protection

Electrical apparatus for potentially explosive atmosphere

Protection method		Standard
o	Oil immersion	EN 50015
p	Pressurised apparatus	EN 50016
q	Powder filling	EN 50017
d	Flameproof enclosure	EN 50018
e	Increased safety	EN 50019
n	Non-incendive	EN 50021
m	Encapsulation	EN 50028
i	Intrinsic safety	EN 50020
ia	Safe in normal operation or with one fault or with two independent faults	
ib	Safe in normal operation or with one fault	

Classification in gas /explosion group II

Gas group	Min. ignition energy	Test gas
IIA	180µJ	Propane
IIB	60µJ	Ethylene
IIC	20µJ	Hydrogen

Temperature Classification

Temperature Classification	Highest permissible surface temperature in °C	Ignition temperature of combustible materials in °C
T1	450	>450
T2	300	>300
T3	200	>200
T4	135	>135
T5	100	>100
T6	85	>85

Example of category marking

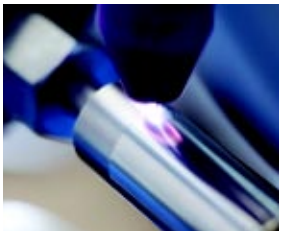
Category	Devices to be used in
1G	Zone 0
1/2G	Zone 0 (sensor element), Zone 1 (housing)
2G	Zone 1
3G	Zone 2
1D	Zone 20
1/2D	Zone 20 (sensor element), Zone 21 (housing)
1/3D	Zone 20 (sensor element), Zone 22 (housing)
2D	Zone 21
3D	Zone 22

CE conformity marking

CE XXXX

Identification code of notified body responsible for production

CE conformity sign according to directive 94/9/EC, Appendix X. Manufacturer declares conformity to relevant directives of the EC.



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CP001T/22/en/04.10