# **Thermo-Sensor**

#### **Connection head**



Head mounted temperature Head mounted temperature Field mounted temperature **Rüeger type** transmitter S95.3Ux2/... transmitter, two entries S95.3Wxx | transmitter, two entries S95.4Wxx Pt100/0°C Pt100/0°C Pt100/0°C Thermocouples Thermocouples Thermocouples Input signal Resistances ohm Resistances ohm Resistances ohm Voltages mV Voltages mV Voltages mV 2, 3, 4 wires and 2x2, 2x3 wires 2, 3 & 4 wires 2, 3, 4 wires and 2x2, 2x3 wires Sensor connection type 4...20 mA HART 4. 20 mA HART 4 20 mA HART Profibus PA, Profile 3.01 Profibus PA, Profile 3.01 Output signal FF H1, IMC Version 5.1 FF H1, IMC Version 5.1 11... 42 VDC 11... 42 VDC 11... 42 VDC (protected against wrong polarity) (protected against wrong polarity) (protected against wrong polarity) Power supply Ëxi 11 ... 30 VDC Exi 11 ... 30 VDC Ëxi 11 ... 30 VDC -40 + 85°C -40 + 85°C -40 + 85°C Ambient temperature 0.1 °K 0.1 °K 0.1 °K Measuring error Low : 3.5 mA Low : 3.5 mA Low : 3.5 mA Error current signal High: 22 mA High: 22 mA High: 22 mA Dia. 44.4 mm / h= 24.7 mm Dia. 44.4 mm / h= 24.7 mm Head size Dia. 90 mm / h= 129.2 mm configurable configurable configurable Range Housing display Aluminium / with or without display 2" pipe mounting bracket 2x M20x1.5 Cable entry 2x 1/2"NPT -50+85°C -50+85°C -50+85°C ATEX, IECEx EX, Zone 0 ATEX, IECEx EX, Zone 0 ATEX, IECEx EX, Zone 0 FM / CSA / GOST FM / CSA / GOST Options FM / CSA / GOST SIL2 SIL2 SIL2 Clips for DIN RAIL (35 mm) Clips for DIN RAIL (35 mm) Housing stainless steel

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# **Thermo-Sensor Manufacturing range** MR TS 02.2014



### A wide range of reliable Thermo-Sensor executions

### RTD

- Mineral insulated execution
- Single or double element
- Electrical circuit: 2, 3 or 4 wires
- Temperature range: -200 ... + 850°C

### Thermocouples

- Ceramic or mineral insulated execution
- Single or double element
- Type: E, J, K, N, T, S, R, B (others on request)
- Temperature range: -200 ... + 1'800°C

### **Ex certifications**





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(3b

(10)



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# Other head types on request. **Thermo-Sensor Transmitters**



# Applications

- Oil & gas
- Chemical
- Powergen
- Machine
- HVAC
- Food and beverage
- Etc...

# Services

- Works calibration of sensors (3 and 5 points)
- Certificate of compliance EN 10204/2.1
- Test report EN 10204/2.2
- Inspection certificate EN 10204/3.1
- Thermowell Karman stress calculation ANSI PTC 19.3
- Hydrostatic and dye penetrant tests
- X-ray examination
- PMI examination
- Helium test



#### **Thermo-Sensor Basics of Thermocouples and RTD's**

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(1) execution: thermoresistance (RTD) or thermocouple (TC) in standard/special executions for hazardous areas. Without thermowell see data sheets \$10, \$50.

(2) inset diameter "d": TC inset diameters 0.5 to 8mm; 3.0 to 12.7mm for surface temperature measurement (S70). RTD inset diameters 3 to 8mm.

(3) sensing element: choice of sensing element relative to temperature and environmental conditions. Standard thermocouple types J, K, T, E, N or RTD Pt100.

(4) precision class: choice of precision class according to international standards: Cl. A, B according to IEC 60751 for Pt100 and class 1,2,3 according to IEC 60584-2 for TC. Other precision classes on request.

(5) sensing element: this is the most commonly TC or platinum RTD element. The element is the actual sensor of the measured temperature. Different executions according to customer needs.

(6) electrical circuit: with RTD's, the standard lead arrangement is the 3-wires form. Optional with 2 & 4 wires per circuit.

(7) **sheathed inset**: the sensing element (RTD/TC) within the inset is embedded in a compacted MgO powder, protected by a metal sheath. This sheath is free of pores and can be bent to a limited curvature.

(8) head type: materials vary to suit your needs from lightweight plastic or aluminium to stainless steel. Explosion proof executions are available.

(9) head mounting: standard threads are M24x1.5 or 1/2 NPT.

(10) cable entry: choice of different threads with/without cable gland. Standard is M20x1,5; 1/2 "NPT, 3/4" NPT or other on request.

(11) nominal length "LN": this is the total length from the bottom of the head to the tip of the inset, when installed. The length Li of the replacement inset S01 depends on the dimensions of the instrument.

(12) insertion length "U": this is the length for the thermowell to be inserted into the process.

Any special design or length can be executed once all the needed dimensions are given.

\* tip thickness t: if not indicated by customer: t = 5mm for barstock t = 3mm for built-up thermowells



(13) lag extension "N": the standard is "nipple-union-nipple" configuration with standard length N = 120 mm. This design permits installation of the assembly into the process and allows easy rotation of the connection head to facilitate the wiring and the removal of the inset S01, if necessary. A telescopic lag extension (see fig.4) is recommended when inset length is not exactly known or to reduce the stock of replacement insets.

(14) thermowell dimensions D1/D2: root (D1) and tip (D2) diameter of the thermowell, according to customer needs. Standard values according to ISA or DIN 43772. Other dimensions available on request. In standard execution with inset dia "d" = 6mm, the thermowell is drilled 7 mm diameter (inside diameter = "d" + 1mm). LT = total length of the thermowell.

(15) thermowell: thermowell can be manufactured in built-up, bar stock, or forged execution. A large range of materials can be chosen.

(16), (17) process connection: process connection depends on thermowell type. It can be flanged, welded or threaded.

(18), (19), (20) transmitter: choice of transmitters according to specified application. From a fixed range, programmable, programmable HART™, PROFIBUS PA<sup>™</sup> and Foundation FIELDBUS<sup>™</sup> transmitter, a wide range is available.

#### **Thermo-Sensor** Thermowells

### **Material Selections**

The following table provides an overview of the many materials used for thermowells as informative character.

Max. Temp. in°C	Material no	Material properties	Application range
Unalloy	ed, Heat and Hi	gh Heat Resistant Steel	
400	1.0305 (ASTM 105)	Unalloyed steel	Welded and threaded thermowells in steam pipelines
500	1.5415 (AISI A204 Gr.A)	Low alloy heat resistant with Molybdenum additive	Welded and threaded thermowells
540	1.7335 (AISI A182 F11)	Low alloy heat resistant steel with Chromium & Molybde- num additives	Welded and threaded thermowells
570	1.7380 (AISI A182 F22)	Low alloy heat resistant steel with Chromium & Molybde- num additives	Welded and threaded thermowells
Rust and	d Acid Resistand	ce Steel	
550	1.4301 (AISI 304)	Good resistance against organic acids at moderate tempera- tures, salt solutions, e.g. sulfates, sulfides, alkaline solutions at moderate temperatures	Food and beverage industry, medical system engineering
550	1.4404 (AISI 316L)	Through the addition of Molybdenum higher corrosion resistance in non-oxidizing acids, such as acetic acid, tartaric acid, phosphoric acid, sulphuric acid and others. Increased resistance against intercrystalline and pitting corrosion due to reduced Carbon content	Chemical and paper industries, nuclear technology, tex- tile, dye, fatty acid, soap and pharmaceutical industries as well as dairies and breweries
550	1.4435 (AISI 316L)	Higher corrosion resistance than 1.4404, lower Delta-ferrite content	Pharmaceutical industry
550	1.4541 (AISI 321)	Good intercrystalline corrosion resistance. Good resistance against heavy oil products, steam and combustion gases. Good oxidation resistance	Chemical, nuclear power plants, textile, dye, fatty acid and soap industries
550	1.4571 (AISI 316 Ti)	Increased corrosion resistance against certain acids due to addition of Titanium Resistant to pitting, salt water and aggressive industrial influences	Pharmaceutical industry and dairies and breweries
Refracto	ory steel		
1200	1.4762 (AISI 446)	High resistance to Sulphur containing gases due to high Chromium content (Minimum resistance to Nitrogen contai- ning gases)	Use in flue and combustion gases, industrial furnaces
1150	1.4841 (AISI 314)	High resistance to Nitrogen containing and Oxygen poor gases. Continuous use not between 700°C and 900°C due to embrittlement	Poser plant construction, petroleum and petrochemical, industrial furnaces
1100	2.4816 (Inconel 600)	Good general corrosion resistance, resistant to stress crack corrosion. Exceptional Oxidation resistance. Not recom- mended for CO2 and Sulphur containing gases above 550°C and Sodium above 750°C.	Pressurized water reactor, nuclear power, industrial furnaces, steam boilers, turbines
1100	1.4876 (Incoloy 800)	Due to addition of Titanium and Aluminum the material has especially good heat resistance. Suitable for applications, where in addition to scale resistance, highest toughness is required. Exceptional resistance to carburizing and nitration	Pressurized water reactor, nuclear power construction, petroleum and petrochemical, industrial furnaces

#### Thermowells classified according to DIN 43772



#### Thermowells classified according to ISA

				-	
	Form 3G	Form 4	Form 4F	ISA 115, 117	ISA 131, 133
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	TW10	TW10	TW10	TW50	TW50

insets		low pressure (with TW)			heav	heavy duty (with TW)			high temperature surface temp		. special executions				
S01	S10	S50	S80	S81	S10 + TW10 S10 + TW10	S10 + TW10	S10 + TW10 S10 + TW10 .	. S50 + TW50	S50 + TW50	S50 + TW50	S40	S41	\$70	S10 Food	SD
					for more infor	mation, kind	ly refer to www.ruege	com or www.ins	strugate.com	ı					









\* for sensor with transmitter please consult table "Thermo Sensor Transmitters"

TR:	•	•	•		•	•	•	•	•	•	•	•	•				•	•	•	•		•	TR:
TC:	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•		•		•	•	•	TC:
type:	Pt100 / K,N,J,T,E	Pt100/K,N,J,T,E	Pt100/K,N,J,T,E	K,N,J,T,E	Pt100/Pt1000	Pt100/K,N,J,T,E	Pt100/K,N,J,T,E	Pt100/K,N,J,T,E	Pt100/K,N,J,T,E	Pt100/K,N,J,T,E	Pt100/K,N,J,T,E	Pt100/K,N,J,T,E	Pt100/K,N,J,T,E	K,J,N,E,T	R,S,B	К		K; Pt100	Pt100 + bimetal / gas	Pt100/TC "K" + gas	K; Pt100 + gas	Pt100/K,N,R,S	type:
*Ex-protection:	Ex ia IIC T6	Ex ia IIC T6	Ex ia IIC T6	Ex ia IIC T6	Ex ia IIC T6	Ex ia IIC T6	Ex ia IIC T6	Ex ia IIC T6	Ex ia IIC T6	Ex ia IIC T6	Ex ia IIC T6	Ex ia IIC T6	Ex ia IIC T6			Ex ia IIC T6	on request	Ex ia IIC T6	on request	on request	on request	on request	*Ex-protection:
	Ex d IIC T6	Ex e IIC T6	Ex d IIC T6	Ex e IIC T6	Ex e IIC T6	Ex d IIC T6	Ex d IIC T6	Ex d IIC T6	Ex d IIC T6	Ex d IIC T6	Ex d IIC T6	Ex d IIC T6	Ex d IIC T6			Ex d IIC T6							
Maria ta una sua ta una una una sua sua sua sua sua sua sua sua sua su	Ex e IIC T6		Ex e IIC T6			Ex e IIC 16	Ex e IIC 16	Ex e IIC T6	Ex e IIC T6	Ex e IIC T6	Ex e IIC T6	Ex e IIC 16	Ex e IIC 16		10 10 1	Ex e IIC T6				1 11	P		
low: -200°C to 300°C Medium: 300°C to 1100°C High:1100°C to1600°C	low medium	low medium	low medium	medium	low medium	low medium	low medium	low medium	low medium	low medium	low medium	low medium	low medium	medium high	medium very high	medium high	low	medium	low medium	low medium	medium	medium	Max temperature range: low: -200°C to 300°C Medium: 300°C to 1100°C High:1100°C to1600°C
max pressure range:	see thermowell	see thermowell	see thermowell	low medium	low medium	medium	medium	medium	high	high	high	high	high	low	low	medium	medium	medium	see thermowell	see thermowell	see thermowell	medium high	max pressure range:
vibration resistance:	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	medium	low	low	medium	medium	very high	medium	high	very high	low	vibration resistance:
inset insulation:	MgO	MgO	MgO	MgO	MgO	MgO	MgO	MgO	MgO	MgO	MgO	MgO	MgO	ceramic	ceramic	MgO	MgO	MgO/ceramic/composite	plastic / ceramic	fiber glass / ceramic	MgO	MgO	inset insulation:
diameter :	3 8	3 8	3 8	0.5 9.5	3 8	3 8	3 6	3	3 8	3 8	3 8	3 8	3 8	8.5 / 14	5.5 / 8.5	3 12.7	3 8	6 / 9.5	6 13	8 13	13	0,56.35mm	diameter :
sheath material:	316 L	AISI 316 AISI 316 / Inconel 600	AISI 316 AISI 316 / Inconel 600	AISI 316 / Inconel 600	AISI 316	AISI 316 / Inconel 600	AISI 316 / Inconel 600	AISI 316 / Inconel 600	AISI 316 / Inconel 600	AISI 316 / Inconel 600	AISI 316 Inconel	AISI 316 Inconel	AISI 316 Inconel	w/o	w/o	AISI 446 / Inconel 600	AISI 316 AISI 316Ti	AISI 316 Inconel 600	AISI 304 AISI 316	AISI 316	AISI 316	AISI 316, AISI 321 Inconel 600	sheath material:
termination:	terminal block DIN B	head see list	see head list	cable	cable	head see list	head see list	head see list	head see list	head see list	head see list	head see list	head see list	head DIN A	head DIN A	see head list	see head list	see head list	Head DIN B	Head DIN B	wire	head	termination:
protection IP:	IP00	IP54/IP66	IP54/IP66	IPOO	IPOO	IP54 IP66	IP54 IP66	IP54 IP66	IP54 IP66	IP54 IP66	IP54 IP66	IP54 IP66	IP54 IP66	IP53	IP53	IP54 IP66	IP54 IP56	IIP54 IP56	IP65	IP65	IP65	min. IP54	protection IP:
terminal material:	ceramic	AL alloy	AL alloy	plastic mat.	plastic mat.	Al alloy	Al alloy	Al alloy	Al alloy	Al alloy	Al alloy	Al alloy	Al alloy	Al alloy	Al alloy	Al alloy	Al alloy	Al alloy	Al alloy	Al alloy	PTFE	Al alloy	terminal material:
		PA plastic / nylon	stainless steel	fiberglass	fiberglass	PA plastic / nylon	PA plastic / nylon	PA plastic / nylon	PA plastic / nylon	PA plastic / nylon	stainless steel	stainless steel	stainless steel				PA plastic	stainless steel				PA plastic	
	,		lag	composite	,	stainiess steel	stainless steel	stainless steel	stainless steel	stainless steel							stainless steel			le e		stainless steel	
extension:	W/O		nipple/nipp_up_nipp	W/0	W/O	lag	lag	lag	lag	lag	lag	lag	lag	ріре	pipe	lag	lag	lag	lag	lag	lag	lag	extension:
туре:		telescopic	telescopic			telescopic	acc. DIN 43772, telescopic	acc. DIN 43772, telescopic	acc. DIN 43772 telescopic	acc. DIN 43772, telescopic	nipple/nippunion-nipp., telesopic	nippie/nippunion-nipp. telesopic	telesopic			nipple/nippunion-nipp., telescopic	tube	tube, DIN 43772	tupe	tube		nippie/nippunion-nipp. telescopic	туре:
material:		stainless steel	stainless/carbon steel			stainless steel	stainless steel	stainless steel	stainless steel	stainless steel	stainless/carbon steel	stainless/carbon steel	stainless/carbon steel	stainless/carbon steel	stainless/carbon steel	stainless steel	stainless steel	stainless steel	stainless steel	stainless steel	stainless steel	stainless steel	material:
connection to well:		metric threads	tapered threading			M24x1.5	M24x1.5	M24x1.5	cylindrical M14, M18 G1/2	cylindrical M14, M20, G1/2	tapered threading	tapered threading	tapered threading	cyl. dia 21.3 mm	cyl. dia 21.3, 32 mm	w/o	M24x1.5	M24x1.5	thread	thread	thread	tapered threading 1/2" NPT	connection to well:
thermowell:	w/o	w/o	w/o	w/o	w/o	cyl	conical	stepped	conical	cyl.	cyl./conical	cyl./conical	cyl./conical	cyl.	cyl.	w/o	w, w/o	w, w/o	W	W	W	W	thermowell:
type:						welded built-up	welded built-up	welded built-up	bar stock	bar stock	bar stock	bar stock	bar stock	welded built-up and/or ceramic	straight ceramic	w/o	welded built-up	w/o, built-up, bar stock	w/o, built-up, bar stock	w/o, built-up, bar stock	w/o, built-up, bar stock	acc. to customer specifications	type:
form:						DIN 43772	DIN 43772		DIN 43772	DIN 43772	ISA dS 49	ISA dS 49	ISA dS 49	DIN 43733	DIN 43733	w/o	DIN 43772 form 2	cylindric / conical,	acc. to customer	acc. to customer	acc. to customer	acc. to customer	form:
						form 2	form 3		form 4	form 6	form 115 + 117	form 125 + 127	form 131 + 133	AM,AMK,AK	AK,AKK			DIN 43772 form 2, cust. specifications	specifications	specifications	specifications	specifications	
connection to process:	n/a	see thermowell	see thermowell	ATX	ATX	flanges or threadings	flanges or threadings	flanges or threadings	pipe welding	flanges	tapered threading	tapered threading	flanges acc. ASME,	flanges acc.	flanges acc.	welding on process	aseptic flanges or	see thermowell	threadings	threadings	threadings	flanges or threadings	connection to process:
		or G1/2	or 1/2 NPT	Compression fitting	Compression fitting	acc. DIN, EN, ISO	acc. DIN, EN, ISO	acc. DIN, EN, ISO	or flanged	or threadings	NPT	NPT	ANSI	DIN 43734	DIN 43734	pipe	welded in process	"G" / "M" threading	AMX compression fittings	AMX compression fittings	AMX compression fittings		
material:		ATX see accessories	ATX see accessories	Stainless steel	Stainless steel	Stainless steel / Nickel	AISI 316Ti / 1.4571	AISI 316L / 1.4404	carbon steel / Mo steel,	carbon steel / Mo steel,	carbon steel / Mo steel,	carbon steel / Mo steel,	carbon steel / Mo steel,	high temperature steel,	ceramics	welding pad	AISI 316Ti / 1.4571	AISI 303	AISI 303	AISI 303	AISI 303	carbon steel / Mo steel,	material:
						steel / other			austenitic steel,	nickel allows	austenitic steel,	austenitic steel,	nickel allov	Cerdinics			AISI 316L / 1.4435	AISI 304 AISI 316	AISI 316	AISI 510	AISI 510 AISI 446	nickel allov	
						material on request.			There alloys	meker anoys	metter anoy	THICKET ANOY	meker unoy			inconel 600		AISI 446			7.131 1 10	meker unoy	
options:	transmitters	transmitters,	transmitters,	weld pad for	weld pad for	transmitters, claddings,	transmitters, claddings,	transmitters, claddings,	transmitters, claddings,	transmitters, claddings,	transmitters, claddings,	transmitters claddings	transmitters, claddings,	transmitters	transmitters	transmitters	transmitters,	transmitters	transmitters	transmitters		acc. to customer	options:
	densmitters	weld pad for	weld pad for	, pipings	pipings	coatings, stress	coatings, stress	coatings, stress	coatings, stress	coatings, stress	coatings, stress	coatings, stress	coatings, stress				electropolishing,		dansmitters			specifications	
		pipings	pipings			calculation, material	calculation, material	calculation, material	calculation, material	calculation, material	calculation, material	calculation, material	calculation, material				material certificates					- transmitters	
						certificates	certificates	certificates	certificates, exhaust "gas" measurement	certificates	certificates	certificates	certificates									- indicators	
applications:	spare parts for sensors	spare parts for wells	spare parts for wells	machines, laboratories,	machines, laboratories,	direct mounting	direct mounting	direct mounting	direct mounting	direct mounting	direct mounting	direct mounting	direct mounting	incineration ovens,	incinerators,	fired heaters,	pharma and food	cooling systems, turbo	reactors, vessels	diesel engines,	diesel engines, exhaust	reactors	applications:
	with DIN heads or	acc. DIN 43772	acc. ISA	gas turbines, cooling	gas turbines, cooling	on vessels,	on vessels,	on vessels,	on pipes	on pipes	on pipes and vessels	on pipes and vessels	on pipes and vessels	exhaust gases,	metal baths,	reformers	processes	charger & exhaust gas		reactors, vessels	gas lines,		
	similar			sytems, heating plates	sytems, heating plates	cooling systems	cooling systems	cooling systems						metal baths	glass baths			tor diesel engines			reactors, vessels		







### **Thermo-Sensor** Accessories



# **Thermo-Sensor** Choice of thermocouples (TC'S) =

# Thermocouples industrial grades E, J, K, N, T

J-type	K-type	T-type	E-type	N-type				
iron/constantan Fe – CuNi low cost	chromel/alumel NiCr-Ni mostly used, std. sensor	copper/constantan Cu – CuNi high resistance to corrosion	chromel/constantan NiCr – CuNi highest EMF	nicrosil/nisil NiCrSi – NiSi best registing to				
High EMF (lower than "E")	less expensive than E, J, T	high precision & good stability	low thermal conductivity	higher EMF than K-type				
good linearity	low resistance to reducing (low oxygen) environment	sensitive & inexpensive used in oxidizing & reducing environment,	excell. corrosion resistance can be used in oxidizing environment, high signal	longer life-time & better performance than K-Type very good stability				
higher lead thickness 8 AWG		good linearity below 0°C, good for cryogenic meas.	output					
range : 0 °C+750°C	range : 0 °C+1200°C	range : -100°C+350°C	range : 0 °C+900°C	range : 0 °C+1200°C				
Precision according to IEC 60 584-2								

J-type	K-type	T-type	E-type	N-type
class 1: -40°C+750°C	class 1: -40°C+1000°C	class 1: -40°C+350°C	class 1: -40°C+800°C	class 1: -40°C+1000°C
± 1,5°C or ± 0,004•ltl <sup>(1)</sup>	± 1,5°C or ± 0,004• tl <sup>(1)</sup>	± 0,5°C or ± 0,004•ltl <sup>(1)</sup>	± 1,5°C or ± 0,004•ltl <sup>(1)</sup>	± 1,5°C or ± 0,004•ltl <sup>(1)</sup>
class 2: -40°C+750°C	class 2: -40 °C+1200°C	class 2: -40°C+350°C	class 2: -40°C+900°C	class 2: -40°C+1200°C
± 2,5°C or ± 0,0075•ltl <sup>(1)</sup>	± 2,5°C or ± 0,0075•ltl <sup>(1)</sup>	± 1°C or ± 0,0075•ltl <sup>(1)</sup>	± 2,5°C or ± 0,0075•ltl <sup>(1)</sup>	± 2,5°C or ± 0,0075•ltl <sup>(1)</sup>
class 3: –	class 3: -200 °C+40°C	class 3: -200°C+40 °C	class 3: -200°C+40°C	class 3: -200°C+40°C
	± 2.5°C or ± 0,015•ltl <sup>(1)</sup>	± 1°C or ± 0,015•ltl <sup>(1)</sup>	± 2.5°C or ± 0,015•ltl <sup>(1)</sup>	± 2.5°C or ± 0,015•ltl <sup>(1)</sup>

# Thermocouples (TC'S) noble metal = B, R, S

PtRh 90/10 + PtPtRh 70chemically inert at high temp. inless driftoxidizing environnementconditionnot to use below + 18 °Chighestmax. temp. +1500 °C cont. ormax. temp. +1760 °C	D/30 + PtRh 94/6 ft when operating under same ons as S- and R-type price mp. 1820 °C cont.

# Precision according to IEC 60 584-2

S-type	B-type
<b>class 1</b> S: 0 + 1600 [°C] ±1°C or ±[1+0.003x(t-1100)]°C (1)	<b>class 1</b> B: n/a
class 2 S: -40 + 1600 [°C] ±1,5°C or ± 0.0025• t °C (1)	class 2 B: +600 + 1700 [°C] ±1,5°C or ± 0.0025● t °C (1)
class 3 S: n/a	<b>class 3</b> B: +600 + 1700 [°C] ±4°C or 0.005● t °C (1)

Precision	according to ANSI MC 96.1	Standar	d grade	Special grade			
Туре	Range (°C)	Tolerance (°C)	Tolerance %	Tolerance (°C)	Tolerance %		
J	0 — 750	2,2	0,75	1,1	0,4		
К	0 — 1250	2,2	0,75	1,1	0,4		
Т	0 - 350	1	0,75	0,5	0,4		
E	0 - 900	1,7	0,5	1	0,4		
Ν	0 — 1250	2,2	0,75	1,1	0,4		
S/R	0 — 1450	1,5	0,25	0,6,5	0,1		
В	870 – 1700	-	0,5	-	-		

ltl = absolute	value of measuring temperature
<sup>(1)</sup> = highest	of the two values applicable

50°C 40°C housing temperature rise above ambient (°C) 30°C 20°C 250°C process tr 10°C ambient 0°C 75 100 125 150 175 200 230

minimum lag extension in mm

Figure 3. Connection head temperature due to process temperature



Figure 4. Telescopic lag extension features

### Lag extension

Aside from ambient temperature variations, heat from the process, in a direct mounting configuration, is transferred from the thermowell to the connecting head and transmitter, when located in head. If the expected process temperature is near or beyond the transmitter specification limits, consider the use of additional thermowell lagging, an extension nipple, or a remote mounting configuration to isolate the connection head and the transmitter from these excessive temperatures.

**Figure 3** provides an example of the relationship between connecting head temperature rise and extension length.

**Example**: The rated ambient temperature specification for the transmitter is 85°C. If the maximum ambient temperature is 40°C and the temperature to be measured is 540°C, the maximum allowable housing temperature rise is the rated temperature specification limit minus the existing ambient temperature (85-40), or 45 °C.

As shown in Figure 3 with a process temperature of 540°C, a lag extension "N" of 90 mm will result in a housing temperature rise of 22 °C. An "N" dimension of 100 mm would therefore be the minimum recommended length, and would provide a safety margin of about 25 °C. A longer "N" dimension, such as 120 mm, would be desirable in order to reduce errors caused by transmitter temperature effect, although in that case the transmitter may require extra support.

### Fixed lag extension

The fixed lag extension may be achieved by nipples, nipple-unions or nipple-union-nipple (N-U-N) as well as extension tubes, depending on the type of the thermosensor. Material of the lag extension is in general AISI 316 stainless steel, but may be also galvanized steel (nipples & unions).

# Telescopic lag extension

The Rüeger patented lag extension will provide for a standard and **Ex(d) executions** a variable lag extension in order to use for each length of a thermowell an inset of normalized length LN. This results in a dramatic reduction of spare insets.

**Example**: the total thermowell length LT of 135 mm through 210 mm will only require one normalized inset of LN = 330 mm

# **Compression fittings**

RUEGER compression fittings provide a leak-proof, torquefree seal at all tubing connections and eliminate costly, hazardous leaks in instrumentation and processing tubing.

RUEGER compression fittings are easily installed with no special tool required. When mounted for the first time, the compression ferrule is compressed onto the tube by tightening the nut. A metal sealing is the result. The union can be disassembled by loosening the nut. However, the compression ferrule remains on the tube.



#### R-type

PtRh 87/13 + Pt slightly better than S-type

higher price than S-type max. temp. + 1500 °C cont. or +1760 °C intermittent

#### R-type

**class 1** R: 0 ... + 1600 [°C] ±1°C or ±[1+0.003x(t-1100)]°C (1)

class 2 R: -40 ... + 1600 [°C] ±1,5°C or ± 0.0025•|t|°C (1)

**class 3** R: n/a

**Thermo-Sensor** Basics of Thermocouples and RTD's



Definitions

Electric sensors measure changes of electrical properties, which correspond to changes in temperature. The instruments in the RUEGER Thermo-Sensor program use two types of electrical sensing elements:

**RTD** is a resistance temperature detector. Temperature measurement is given by the electrical resistance variation of a metal wire, in general of platinium

**Thermocouple** consists of two different metals joined to form an electrical circuit. One junction is exposed to the temperature to be measured, the other is at room temperature. A voltage is generated and varies with changes of the temperature difference between the two junctions.

The measuring criteria of the application determines the sensor type. The electrical values are transformed by a transmitter into a standardised output signal.

#### Explosion protection

For hazardous areas with the risk of explosions, executions conform with international standards must be used.

#### **Comparisons chart of sensors**

Criteria	тс	Platinum RTD
interchangeability	good	excellent
repeatability	poor to fair	excellent
accuracy	medium ± 1,55°C	high ± 0,1 1,5°C
stability (typical)	0,5°C error / year	< 0,1°C error / 5 years
sensitivity	10 100 μV/°C low	~0,4 $\Omega$ /°C for Pt100 moderate
response time	medium to very fast	medium fast
self heating	N/A	very low low
min. insertion length of sensing element	dimension: ~ ø sheath 0,5 mm to 12 mm	15-30 mm
linearity	poor	very good
temperature range	-190 + 1820°C	-200 + 600°C
min. diameter for sheathed execution	0,5 mm	3 mm



Identification of measurement circuits on terminal block and/or marking plate:

RTD: (with color identification marking, according to IEC 751)



Remark: "yellow" and "black" are used for double element.

#### Sheath and thermowell materials

AISI 316L (1.4404) stainless steel, lower carbon content than 316, often used for RTD's sheaths for continuous operation at temperatures up to 850°C. Corrosion resistant in salty and chemical media. Thermocouples J and T use also this material.

AISI 316Ti (1.4571) stainless steel, contain titanium, inhibiting carbon precipitation.

**INCONEL 600<sup>®</sup>** nickel alloy. Used for sheaths of insets for temperatures up to 1100°C in oxidizing environments, notably for type K and type N thermocouples.

**C610/KER 610** ceramic (Pythagoras). Composed of 60% AL<sub>2</sub>O<sub>3</sub>. 37% SiO<sub>2</sub> and 3% alkali. Used for non-precious metal thermocouples up to 1500°C.

**C799/KER 710** ceramic (Pure Alumina). At least 99.7% Al<sub>2</sub>O<sub>3</sub>, suitable for temperatures up to 1600°C or higher according to medium. Excellent high-temperature stability, superior to all other sheath materials for precious metal thermocouples, relatively expensive.

AISI 321 (1.4541) Good oxydation resistance. For temperatures up to 550°C.

#### RTD's and TC advantages

Thermocouple	Platinum RTD
- lower price (non-noble metal)	- high accuracy
- suits high temperature	- best stability & repeatability
- fast response time	- good corrosion resistance
- small dimensions	- good linearity
- self powered	
- rugged	

# **Precision classes: RTD** according to IEC 751

G00 lead

No wire

Only

Use to co

class A +/- (0.15 + 0.002 Itl)class B +/- (0.3 + 0.005 ltl) class AA +/-(0.1 + 0.0017 Itl)

ires probe	3-wires probe	4-wires probe
l accuracy for limited length	Very good accuracy for any lead length	Excellent accuracy for any lead length
ompensation of lead resistance	Simplified compensation of lead wire resistance	Complete compensation of lead wire resistance
for small wire length of adjustable transmitter	No compensation of unhomo- geneous effects & tolerances of lead wires	Use of small wire diameters possible AWG 22 instead of AWG 14 18
mpensate mismatches omic execution	mostly used	Only used when highest accuracy required

# Tolerances according to IEC 60 751 as function of temperature for Pt 100 RTD



Temperature [°C]