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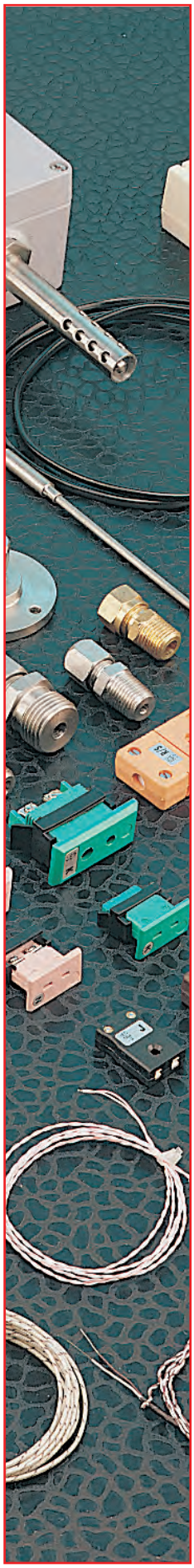
THERMOCOUPLES, CONNECTORS, PLATINUM RESISTANCE THERMOMETERS, PROBE FITTINGS & CABLES

Contents



Thermocouples and Resistance Thermometers

Rigid general purpose & plastics machinery thermocouples for up to 350°C

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Mineral Insulated Thermocouples

Flexible, rugged mineral insulated industrial thermocouples for up to 1200°C

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General purpose and industrial platinum resistance thermometers for high accuracy up to 450°C

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All technical information published in this catalogue is for guidance and not necessarily definitive. All thermocouple assemblies comply with BS EN60584-3 (= IEC 584-3) colour codes and cable tolerances unless otherwise stated. All thermoelements comply with BS EN60584-2 Class 1 or Class 2 tolerance depending on type. All dimensions stated are nominal. Product specifications may change as a result of product development.

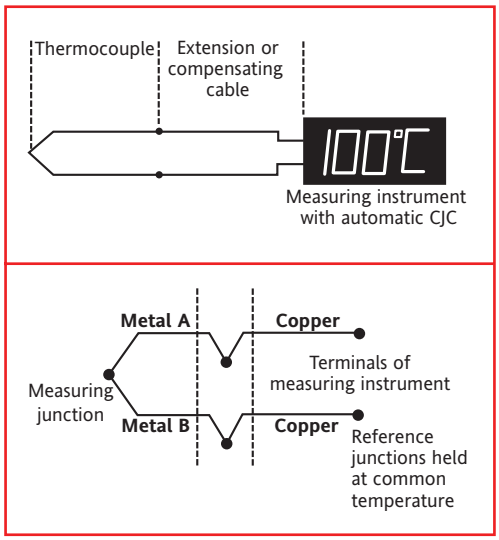
Our range provides two alternative types of temperature sensor – thermocouple or platinum resistance thermometer (PRT).

General guidance for choosing between the two:

Thermocouples are less expensive than PRT sensors, more versatile, less accurate, more rugged, more sensitive, have a wider operating range, are tip sensitive and can be smaller. Extension cabling is more expensive. Various calibrations are available for different applications.

PRT assemblies are much more accurate and stable, permit greater resolution of measurement but over a more limited range, are stem sensitive, larger and more expensive. Extension cabling is by inexpensive copper wire.

Remember the type of sensor chosen must suit the associated instrumentation.



Comparison of sensor types

	Platinum Resistance Thermometer	Thermocouple
Sensor	Platinum-wire wound or flat-film resistor	Thermoelement, two dissimilar metals/alloys
Accuracy (typical values)	0.1 to 1.0°C	0.5 to 5.0°C
Long term stability	Excellent	Variable, Prone to ageing
Temperature range	-200 to 650°C	-200 to1750°C
Thermal response	Wirewound – slow Film – faster 1-50 secs typical	Sheathed – slow Exposed tip – fast 0.1 to 10 secs typical
Excitation	Constant current required	None
Characteristic	PTC resistance	Thermovoltage
Linearity	Fairly linear	Most types
Lead resistance effect	3 & 4 wire – min 2 wire – errors result	Short cable runs satisfactory (e.g. 25m)
Electrical "pick-up"	Rarely susceptible	Susceptible
Interface	Bridge 2, 3 or 4 wire	Potentiometric input. Cold junction compensation required
Vibration effects/ shock	Wirewound – not suitable Film – good	Mineral insulated types suitable
Output/ characteristic	Approx. 0.4 W/°C	From 10mV/°C to 40mV/°C depending on type
Extension Leads	Copper	Compensating cable
Cost	Wirewound – more	Relatively

Comments and values shown in this chart are generalised and nominal. They are not intended to be definitive but are stated for general guidance. The information given shows average application experience, but some of the considerations can be modified by special design or selection.

Thermocouples

For practical purposes, thermocouples are divided into two categories; base metal types such as Nickel Chromium v Nickel Aluminium and Iron v Copper Nickel (Constantan) and rare metal types (usually Platinum v Platinum Rhodium). Measuring junctions are formed by a spot weld of the two dissimilar wires usually located inside a protecting sheath.

A thermocouple does not measure the temperature at the "hot" (measuring) junction but is a differential measurement between the "hot" junction and the "cold" (reference) junction. For accurate temperature measurement, the reference junction must be held at a fixed, known temperature; alternatively, accurate compensation must be made for any temperature variations of the reference junction.

In the majority of industrial applications, instruments configured for thermocouple inputs incorporate some form of automatic cold junction compensation (C.J.C) The temperature of the input termination is sensed and a corrective signal is applied to the measuring circuit of the instrument. High accuracy automatic CJC is incorporated in all Eurotherm instruments. For purposes of calibration of a thermocouple or the associated instrument, reference is made to standard tables which indicate thermocouple output versus "hot" junction temperature with the "cold junction" at 0°C. Where it is impractical to maintain a 0°C cold junction temperature it is necessary to accurately measure the "cold Junction" temperature, say at 20°C and to add the value of thermocouple output at that temperature (obtained from the table) to the observed output from the thermocouple to arrive at an absolute figure.

To determine the temperature of the "hot" junction we must know:-

i) The calibration data for the thermocouple
ii) The measured output voltage
iii) The temperature of the reference (cold) junction.

General Purpose Thermocouple Style FA

for use up to 350°C

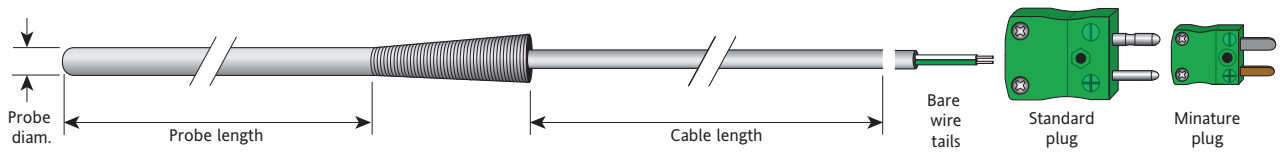
HINTS & TIPS

The general purpose thermocouple with a grounded junction combines good physical strength and high thermal sensitivity. Its rigid probe makes it a good choice for immersion in a wide variety of media.

Thermocouple element sheathed in a 316 grade stainless steel tube with welded, closed rounded end, connecting cable.

These low cost, versatile sensors are suitable for a wide range of medium temperature applications including the plastics industry. Our range of fittings and adaptors allow for quick and simple installation.

A range of standard sensors is available. Alternatively we can offer a custom-made service using the part-numbering system shown.



Ordering standard versions – available from stock

Stainless steel thermocouples, type J, K or T with 2 metres of stainless steel braided flexible cable Thermocouple junction grounded to the sheath. Temperature rating — with braided cable 350°C. Colour BS EN60584.

TC type	Probe diameter	Probe length	Cable type	Order code
J	4.5mm	100mm	Braided	311-001
J	4.5mm	200mm	Braided	311-003
J	4.5mm	300mm	Braided	311-004
J	6.0mm	100mm	Braided	311-005
J	6.0mm	200mm	Braided	311-007
J	6.0mm	300mm	Braided	311-008
K	4.5mm	100mm	Braided	311-017
K	4.5mm	200mm	Braided	311-019
K	4.5mm	300mm	Braided	311-020

TC type	Probe diameter	Probe length	Cable type	Order code
K	6.0mm	100mm	Braided	311-021
K	6.0mm	200mm	Braided	311-023
K	6.0mm	300mm	Braided	311-024
T	4.5mm	100mm	Braided	311-047
T	4.5mm	200mm	Braided	311-048
T	4.5mm	300mm	Braided	311-049
T	6.0mm	100mm	Braided	311-050
T	6.0mm	200mm	Braided	311-051
T	6.0mm	300mm	Braided	311-052

These general purpose thermocouples have a grounded (earthed) measuring junction. This arrangement, which is usual in the industry, means that the probe and extension cables are electrically common. Such probes used individually with their associated controller or indicator. They also have good thermal sensitivity.

Ordering custom-made versions – available on short delivery time

Style	Tip form	Thermocouple junction	Thermocouple type	Probe diameter	Probe length	Cable length	Cable type	Termination	Colour code
FA	A Rounded	GS Single grounded	K	3.00 mm	Specify in mm.	Specify in m. (to one d.p.)	C2 PTFE	T Tails	I BS EN60584
		GD Duplex grounded	J	4.50 mm			C3 Fibreglass	MP Mini plug	
		IS Single insulated	T	6.00 mm			C4 Braided	SP Std. plug	
		ID Duplex insulated		6.35 mm			AC3 Armoured	DP Duplex plug	
Notes				For duplex sensors specify 4.50 or above			For duplex sensors specify C4 or AC3 only		

e.g. FAA-GSK-3.00-150-2.0-C4-T-I General purpose thermocouple, rounded tip, single grounded junction, type K, 3.00mm diameter probe, 150mm long probe, 2.0 metres of braided cable and tails. BS EN60584 colour code.

Temperature rating of probes: With cables C3, C4 or AC3 – 350°C, C2 – 250°C.

Flexicouple Style FS

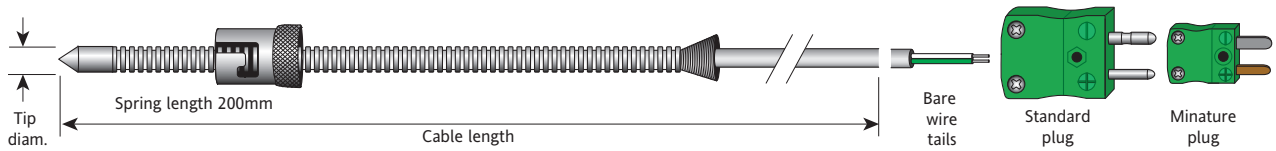
widely used in the plastics industry for use up to 350°C

HINTS & TIPS

The insertion length of this thermocouple can be varied by screwing the bayonet cap along the flexible spring to suit individual machines. Bayonet fitting makes for easy installation and removal but does not provide a pressure tight seal.

Flexible thermocouple assembly with an adjustable bayonet cap to give spring loaded contact for insertion depths up to 200mm. This versatility permits use in many applications, minimising spares holding. Adaptors are available to suit the bayonet cap.

A choice of type J or K standard flexicouples is available. Alternatively we can offer a custom-made service using the part-numbering system shown.



Ordering standard versions – available from stock

Flexicouples with 2 metres of stainless steel braided cable and tails. Stainless steel tip diameter 4.5mm. Thermocouple junction grounded to tip. Temperature rating 350°C. Colour coded to BS EN60584.

TC type	Probe		Cable type	Order code
	diameter	length		
J	4.5mm	100mm	Braided	311-033
K	4.5mm	100mm	Braided	311-034

Ordering custom-made versions – available on short delivery time

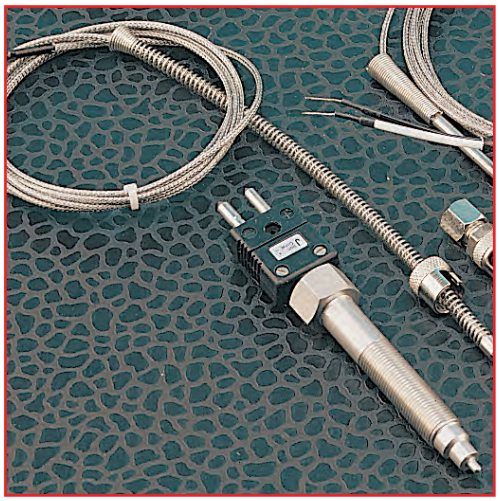
Style	Thermocouple		Tip	Cable		Termination	Colour
	junction	type	diameter	length	type		code
FS	GS Single	K	4.5 mm	Specify in m. (to one d.p.)	C4 Braided	T Tails	I BS EN60584
	GD Duplex	J	6.0 mm		AC3 Armoured	MP Mini plug	
		T	8.0 mm			SP Std. plug	
						DP Duplex plug	
Notes			4.5 and 6.0 preferred				

e.g. FS-GSI-6.0-2.0-C4-T-I Flexicouple thermocouple, single junction, type J, 6.0mm diameter tip, with 2 metres of braided cable and tails. BS EN60584 colour code.

Temperature rating of probes: 350°C.

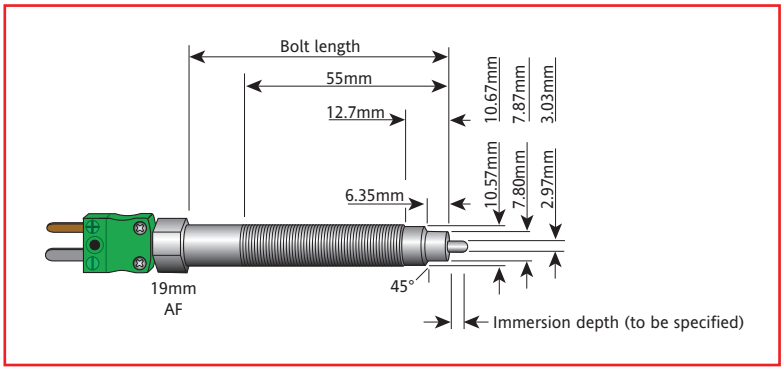
HINTS & TIPS

Reliability is enhanced but sensitivity reduced if a flush face tip is specified. Conversely, long immersion depth versions can be prone to tip damage by product movement.



Designed to withstand the very high melt pressures within plastics extruders and injection moulding machines, enabling direct measurement of the melt temperature.

Available with 76mm and 152mm bolt lengths and terminated in a standard round-pin thermocouple plug, the thermocouple junction is insulated from the stainless steel body. Specify immersion depth required.



Ordering custom-made versions – available on short delivery time

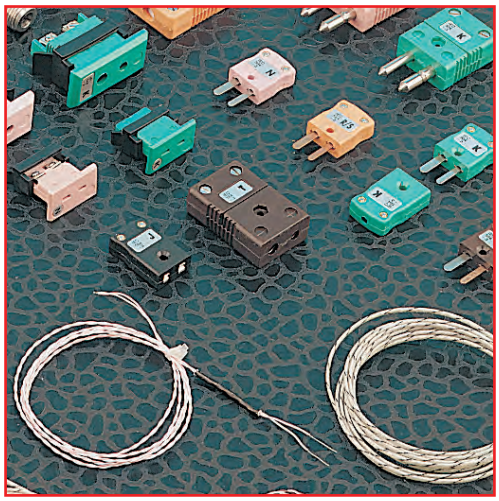
Style	Thermocouple type	Thread type	Bolt length	Immersion depth	Colour code
FM	K	U 1/2" UNF 20	76 mm	0	I BS EN60584
	J		152 mm	5	
Notes		Other threads available Special order		Other depths available to special order. 0mm = Flush face. 5mm is preferred immersion depth.	

e.g. FM-J-U-152-5-I Melt thermocouple, type J, 1/2" UNF 20 thread, 152mm bolt length (below hex) with 5mm immersion depth. BS EN60584 colour code.

Alternative bolt lengths available to special order.

Nozzle Thermocouple Style FN

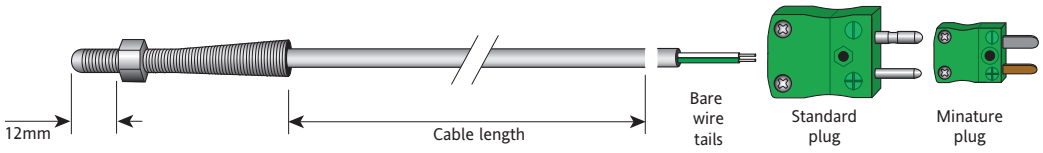
for use up to 350°C



HINTS & TIPS

Ideal for nozzle temperature measurement of plastics injection moulding machines. The wires do not rotate when threading in and tightening the nozzle. Terminate the cable after fitting.

Nozzle thermocouple with choice of 6 x 1.0 metric or 1/4" BSF threaded bolt designed to screw directly into workpiece. The grounded thermocouple junction is brazed into a nipple at the end of the bolt, allowing the bolt to be screwed in without rotating the flexible stainless steel braided cable.



Ordering custom-made versions – available on short delivery time

Style	Thermocouple type	Thread type	Cable length	Termination	Colour code
FN	K	M 6 x 1.0 metric	Specify in m. (to one d.p.)	T Tails	I BS EN60584
	J	B 1/4" BSF		MP Mini plug	
	T			SP Standard plug	

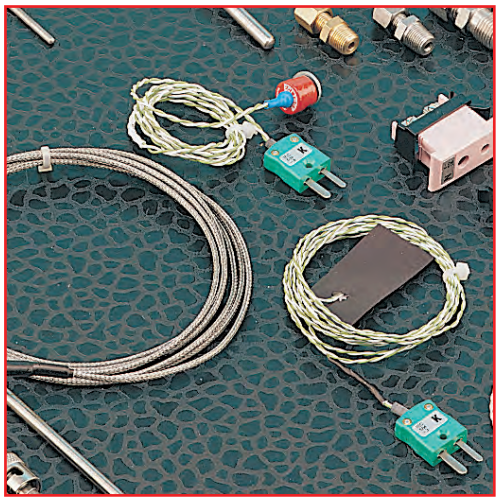
e.g. FN-J-M-2.0-T-I Nozzle thermocouple, type J, 6 x 1.0 metric thread, with 2 metres of braided cable and tails. BS EN60584 colour code.

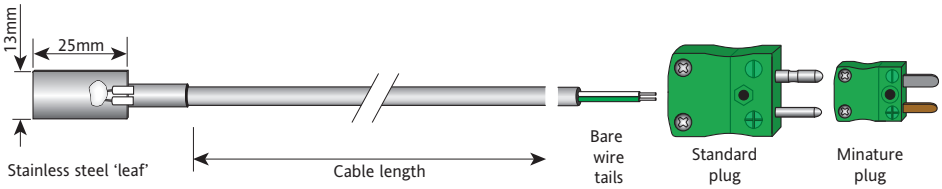
Leaf Thermocouple Style FL
for use up to 350°C

HINTS & TIPS

A quick and simple way to sense temperature without special drilling or fixing. For best results, try to sandwich the entire shim. Ensure that the thermocouple cable is not subject to strain.

Fast response thermocouple mounted on to stainless steel shim, ideal for fitting under band or nozzle heaters.





Ordering custom-made versions – available on short delivery time

Style	Thermocouple type	Cable		Termination	Colour code
		length	type		
FL	K	Specify in m. (to one d.p.)	C4 Braided	T Tails	I BS EN60584
	J		C3 Fibreglass	MP Mini plug	
	T			SP Standard plug	

e.g. FL-J-M-2.0-C4-T-I Leaf thermocouple, type J, with 2 metres of braided cable and tails. BS EN60584 colour code.

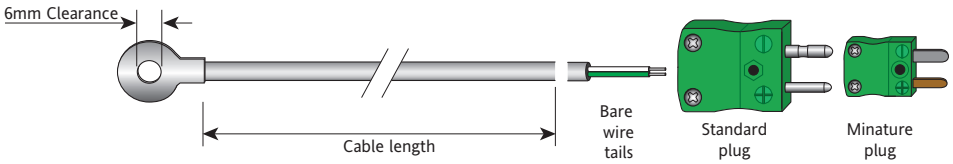
Washer Thermocouple Style FW

for use up to 350°C

HINTS & TIPS

This thermocouple is easy to fit to various equipment without intrusion; it is an ideal way to measure surface temperatures. Try to place lagging over the sensor for better results.

A convenient and easy method of measuring surface temperatures. The thermocouple junction is located on a washer with a 6mm clearance hole bolting to the surface.



Ordering custom-made versions – available on short delivery time

Style	Thermocouple type	Cable length	Cable type	Termination	Colour code
FW	K	Specify in m. (to one d.p.)	C4 Braided	T Tails	I BS EN60584
	J		C3 Fibreglass	MP Mini plug	
	T		C2 PTFE	SP Standard plug	

e.g. FW-J-2.0-C3-T-I Washer thermocouple, type J, with 2 metres of braided cable and tails. BS EN60584 colour code.

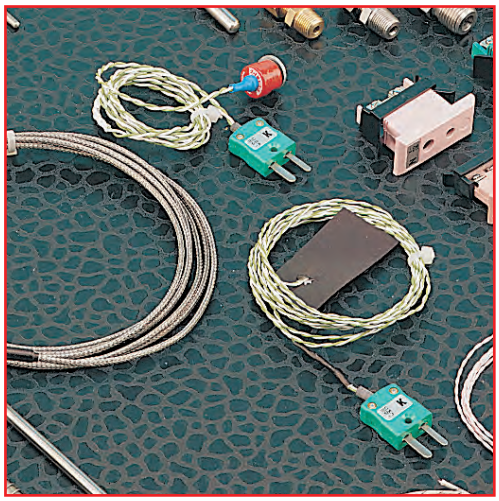
Temperature rating with C2 cable 250°C, C3 or C4 cable 350°C.
Other washer sizes available to special order.

Exposed Junction and Magnetic Thermocouples

HINTS & TIPS

Exposed junction thermocouples can be welded directly on to metal surfaces for accurate and reliable sensing. For ferrous metals, magnet thermocouples are ideal permitting instant attachment and re-attachment.

- **Fast response exposed junction thermocouples**
- **Magnetic thermocouples for ferrous metals**
- **For surface and air temperature measurement**



Fast response exposed junction thermocouples

- 0.2mm wire with PTFE or 0.315mm with glassfibre insulation
- Welded bead
- 1 metre long
- Maximum 250°C (PTFE), 350°C (glassfibre)
- Type K,J or T

Ordering – available from stock

TC type	Cable type	Order code
K	PTFE	356-001
K	GLASSFIBRE	356-004
J	PTFE	356-002
J	GLASSFIBRE	356-005
T	PTFE	356-003

Magnetic patch thermocouple

- Flexible magnetic patch thermocouple for ferrous metals
- 1 metre twin twisted PTFE insulated cable
- Fast response
- Maximum 120°C
- Insulated measuring junction
- Type K

Ordering – available from stock

	Order code
	319-001

"Button" magnet thermocouple

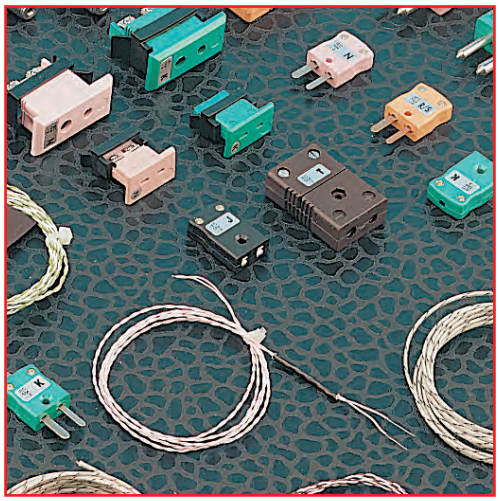
- Powerful magnet disc thermocouple for ferrous metals
- Grounded hot junction
- Maximum 250°C
- 1m PTFE insulated twin twisted cable
- Type K

Ordering – available from stock

	Order code
	319-002

Pipe Surface Thermocouple Style FP

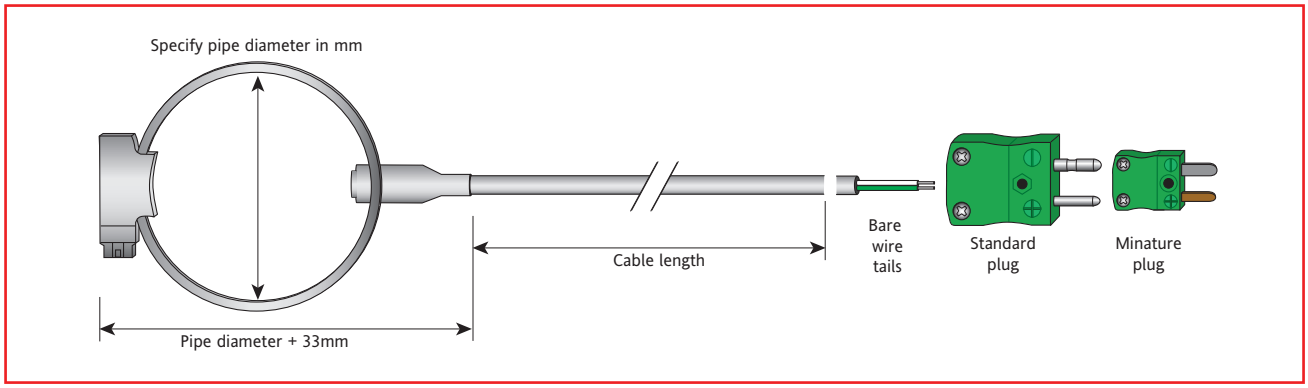
for use up to 350°C



HINTS & TIPS

A pipe surface sensor is ideal for any pipework – there is no need to disturb the installation. However, try to lag the pipe in the region of the sensor for accurate readings.

Thermocouple junction located on the inside face of a stainless steel clip which can be tightened ensuring good thermal contact. Range of clip sizes available to suit alternative pipe diameters. Fitted with stainless steel braided cable.



Ordering custom-made versions – available on short delivery time

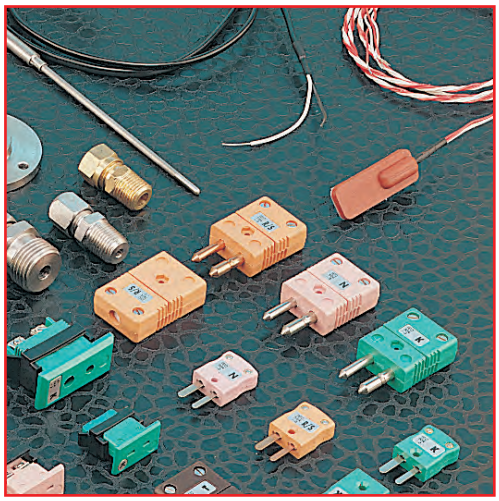
Style	Thermocouple type	Pipe diameter	Cable length	Termination	Colour code
FP	K	Specify in mm	Specify in metres (to one d.p.)	T Tails	I BS EN60584
	J			MP Mini plug	
	T			SP Standard plug	
Notes		Min. 25mm Max.120mm			

e.g. FP-K-50-2.0-T-I Pipe surface thermocouple, type K for 50mm diameter pipe, with 2 metres of braided cable and tails. BS EN60584 colour code.

Temperature rating 350°C.

General

The mineral insulated thermocouple offers an extremely versatile thermocouple system capable of working under extreme conditions. The units comprise a seamless metal sheath in which the thermocouple elements are embedded in highly compressed mineral powder. Mineral insulated thermocouples are therefore self armoured and usually require no extra protection and yet have exceptionally low thermal mass and good flexibility.



Advantages –

Stability: The conductors are protected from oxidisation and corrosive environmental conditions so the emf characteristics remain very stable.

Strength: The MI cable can be bent and formed without adversely affecting the performance. The MI probe can therefore be installed in difficult locations.

Rapid response: Its size and the good thermal conductivity of the compressed powder give a rapid response to temperature changes.

Pressure tight: The seamless metal sheaths are impervious to liquids and gases and can withstand extremely high external pressures.

Application guide

Thermoelement type	Max. temp. rating	Sheath material	Typical applications	Notes
Copper-Constantan (T)	400°C	18/8 Stainless steel to BS 3605-832	Food processing, plastics mouldings Sub zero temps Condensers	The 18/8 S/S sheath gives good corrosion resistance in a wide range of industrial applications while retaining good ductility.
Iron-Constantan (J)	750°C	18/8 Stainless steel to BS 3605-832	Re-heat and annealing furnaces. Paper and pulp mills Plastics.	The 18/8 S/S sheath gives good corrosion resistance in a wide range of industrial applications while retaining good ductility.
Chromel-Alumel (K)	1100°C	25/20 Stainless steel to BS3605-805 Salt baths	Engine exhaust. Glass manufacture. Furnace gases. Annealing furnaces.	The 25/20 S/S sheath has good oxidisation properties at elevated temperatures but should not be subsequently manipulated. Satisfactory in sulphur bearing atmospheres.
Nicrosil-Nisil (N)	1200°C	Nicrobell B*	Extends typical 25/20 stainless steel applications up to 1200°C plus minimised thermocouple element contamination.	*Nicrobell B is a trademark. Offers superior stability at elevated temperatures and longer element life. and longer element life.

Sheath material used for any given thermocouple may be subject to change due to continuous product development

Thermocouple Response Times

The response time for a thermocouple is usually defined as the time taken for the thermal voltage (output) to reach 63% of maximum for the step change temperature in question. It is dependent on several parameters including the thermocouple dimensions, construction, tip configuration and the nature of the medium in which the sensor is located. If the thermocouple is plunged into a medium with a high thermal capacity and heat transfer is rapid, the effective response time will be practically the same as for the thermocouple itself (the intrinsic response time). However, if the thermal properties of the medium are poor (e.g. still air) the response time can be 100 times greater.

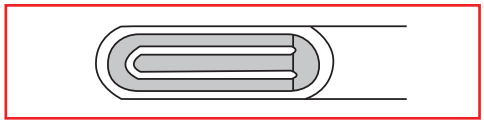
Sheath outside diameter	Types of measuring junction	Response Time - Seconds Tip Temperature °C					
		100	250	350	430	700	850
6.0mm	Insulated	3.2	4.0	4.7	5.0	6.4	16.0
6.0mm	Earthed	1.6	2.0	2.3	2.5	3.15	8.0
3.0mm	Insulated	1.0	1.1	1.25	1.4	1.6	4.5
3.0mm	Earthed	0.4	0.46	0.5	0.56	0.65	1.8
1.5mm	Insulated	0.25	0.37	0.43	0.50	0.72	1.0
1.5mm	Earthed	0.14	0.17	0.185	0.195	0.22	0.8
1.0mm	Insulated	0.16	0.18	0.19	0.21	0.24	0.73
1.0mm	Earthed	0.07	0.09	0.11	0.12	0.16	0.6

Values shown are for a closed end sheath.
Immersion in mineral oil
For exposed measuring junctions, divide the values shown by 10

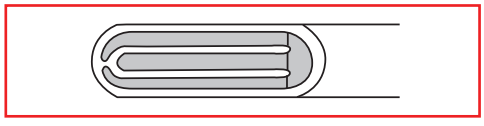
Types of junction

Insulated or earthed hot junction units are available.

Insulated hot junction
The conductors are welded together and insulated from the sheath and cap closure. This allows the insulation resistance of the probe to be checked.

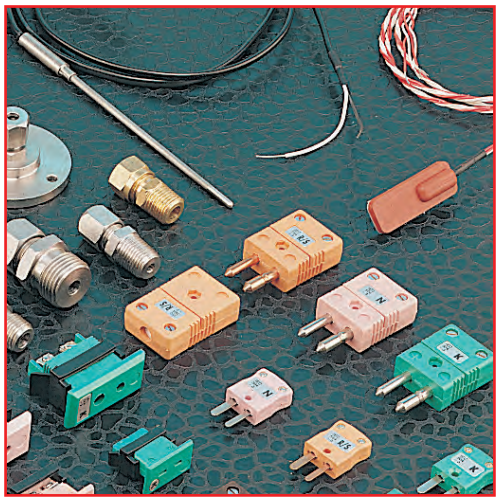


Earthed hot junction
The conductors and sheath are welded together with the junction at the extreme tip of the probe. Intimate contact is achieved for accurate surface temperature measurement.



Mineral Insulated Thermocouples Style MA

for use up to 1200°C



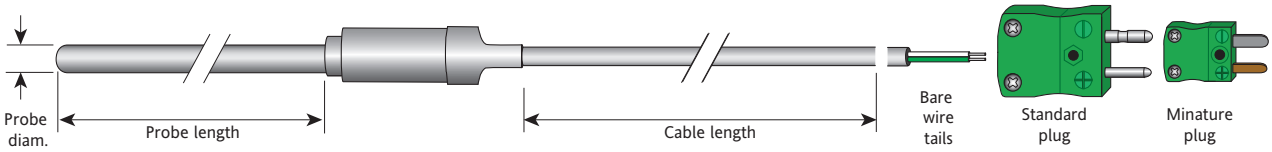
HINTS & TIPS

Mineral insulated sheaths can be formed into bends and loops Use long sheath length mineral insulated probes to route the tip into a remote hot zone and keeping the "cold end" seal outside the process.

With flexible connecting cable

Rugged mineral insulated thermocouples from 0.5 to 6.0mm diameter in types K, J, T and N terminating in a flexible connecting cable. The thermocouple junction is insulated from the sheath as standard, but can be grounded as an option.

A popular range of standard thermocouples is available in types K and J. Alternatively we offer a custom-made service using the part-numbering system shown.



Ordering standard versions – available from stock

Stainless steel sheath mineral insulated thermocouples with 2 metres of stainless steel braided flexible cable and tails. Thermocouple junction insulated from sheath. Temperature rating of probe – type K 1100°C, type J 750°C. The cold end plain pot seal is rated to 200°C. Colour coded to BS EN60584.

Mineral insulated thermocouples have an insulated measuring junction as standard; this arrangement, usual in the industry, means that the stainless steel sheath and extension cables are electrically insulated from each other.

TC type	Probe diameter	Probe length	Cable type	Order code
J	1.5mm	100mm	Braided	312-011
J	1.5mm	200mm	Braided	312-012
J	3.0mm	300mm	Braided	312-001
J	3.0mm	100mm	Braided	312-002
J	4.5mm	200mm	Braided	312-003
J	4.5mm	300mm	Braided	312-008

TC type	Probe diameter	Probe length	Cable type	Order code
K	1.5mm	250mm	Braided	312-013
K	1.5mm	500mm	Braided	312-014
K	3.0mm	250mm	Braided	312-005
K	3.0mm	500mm	Braided	312-006
K	4.5mm	250mm	Braided	312-007
K	4.5mm	500mm	Braided	312-008

Ordering custom-made versions – available on short delivery time

Style	Thermocouple junction	Thermocouple type	Probe diameter	Probe length	Pot seal	Cable length	Cable type	Termination	Colour code
MA	**GS** Single grounded	**K**	**0.50** mm (K only)	Specify in mm.	**P1** Plain	Specify in m. (to one d.p.)	**C1** PVC	**T** Tails	**I** BS EN60584
	GD Duplex grounded	**J**	**1.00** mm (K only)		**P5** 8mm threaded		**C2** PTFE	**MP** Mini plug	
	IS Single insulated	**T**	**1.50** mm				**C4** Braided	**SP** Std. plug	
	ID Duplex insulated	**N**	**3.00** mm				**AC3** Armoured	**DP** Duplex plug	
			4.50 mm (not T)						
			6.00 mm						
Notes		N not available in duplex	For duplex specify 3.00, 4.50 or 6.00 only				For duplex specify C4 or AC3 only		

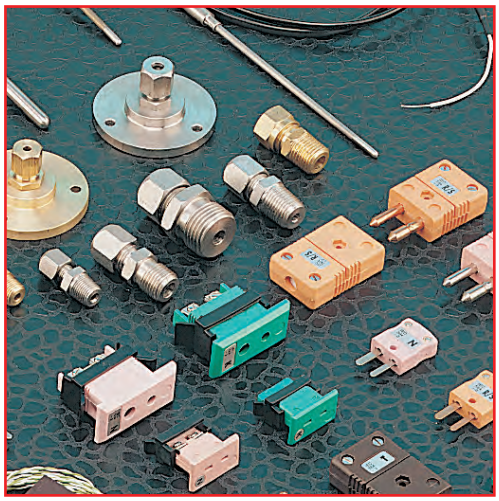
e.g. MA-ISK-3.00-500-P1-2.0-C1-MP-I Mineral insulated thermocouple, insulated single junction, type K, 3.00mm diameter probe, 500mm long, plain pot seal, 2.0 metres of PVC cable and mini plug termination. BS EN60584 colour code.

Temperature rating of probes: Type K – 1100°C, Type J – 750°C, Type T – 400°C, Type N – 1200°C.
Cold end pot seal rated to 200°C.
Type "K" Inconel sheathed thermocouples available to special order.

Mineral Insulated Thermocouples Style MD
for use up to 1200°C

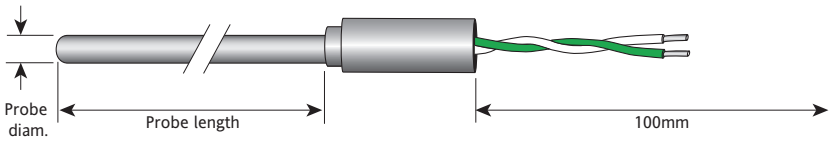
HINTS & TIPS

Thermocouples, however good, do not last forever. Use a connector termination to allow rapid sensor change over. Similarly, tails make life simple – with cabling back to the instrumentation left in place.



With flexible tails

Rugged mineral insulated thermocouples in types K,J,T and N terminating in 100mm long insulated tails. The thermocouple junction is insulated from the sheath as standard, but can be grounded as an option.



Ordering custom-made versions – available on short delivery time

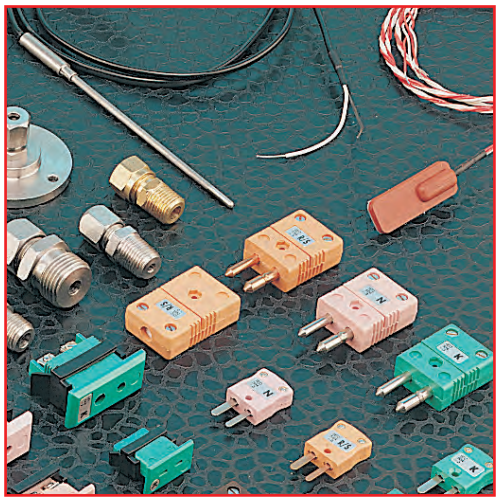
Style	Thermocouple		Probe		Pot seal	Colour code
	junction	type	diameter	length		
MD	**GS** Single grounded	**K**	**0.50** mm (K only)	Specify in mm.	**P1** Plain	**I** BS EN60584
	GD Duplex grounded	**J**	**1.00** mm (K only)		**P5** 8mm threaded	
	IS Single insulated	**T**	**1.50** mm			
	ID Duplex insulated	**N**	**3.00** mm			
			4.50 mm (not T)			
			6.00 mm			
Notes		N not available in duplex	For duplex specify 3.00, 4.50 or 6.00 only			

e.g. MD-ISK-1.50-250-P1-I Mineral insulated thermocouple, insulated single junction, type K, 1.50mm diameter probe, 250mm long, plain pot seal. BS EN60584 colour code.

Temperature rating of probes: Type K – 1100°C, Type J – 750°C, Type T – 400°C, Type N – 1200°C.
Type "K" Inconel sheathed thermocouples available to special order.

Mineral Insulated Thermocouples Style MB

for use up to 1200°C

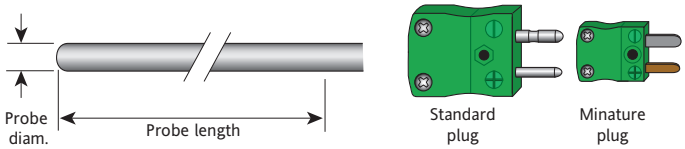


HINTS & TIPS

Thermocouples, however good, do not last forever. Use a connector termination to allow rapid sensor change over. Similarly, tails make life simple – with cabling back to the instrumentation left in place.

With thermocouple connector

Rugged mineral insulated thermocouples in types K, J, T and N terminating in a miniature (flat pin) or standard (round pin) thermocouple plug. The thermocouple junction is insulated from the sheath as standard, but can be grounded as an option.



Ordering custom-made versions – available on short delivery time

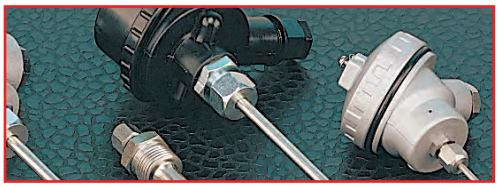
Style	Thermocouple		Probe		Termination	Colour code
	junction	type	diameter	length		
MB	GS Single grounded	K	0.50 mm (K only)	Specify in mm.	MP Mini plug	I BS EN60584
	GD Duplex grounded	J	1.00 mm (K only)		SP Standard plug	
	IS Single insulated	T	1.50 mm		DP Duplex plug	
	ID Duplex insulated	N	3.00 mm			
			4.50 mm (not T)			
			6.00 mm			
Notes		N not available in duplex	For duplex specify 3.00, 4.50 or 6.00 only			

e.g. MB-ISK-3.00-500-MP-I Mineral insulated thermocouple, insulated single junction, type K, 3.00mm diameter probe, 500mm long, mini plug termination. BS EN60584 colour code.

Temperature rating of probes: Type K – 1100°C, Type J – 750°C, Type T – 400°C, Type N – 1200°C.
Type "K" Inconel sheathed thermocouples available to special order.

HINTS & TIPS

If using a thermowell , the probe should be 50mm longer than the immersion length of the well to allow for the compression coupling. Alternatively, if a 1/8" BSP thread below head is chosen, the sensor and thermowell must be ordered together. Selection of the KNE/SUS head means that you can have an all stainless steel assembly.

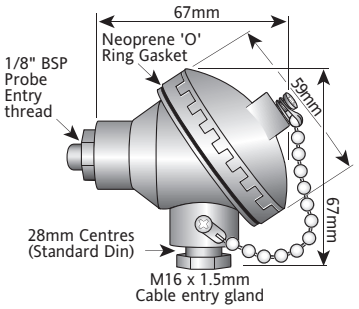


With connecting head

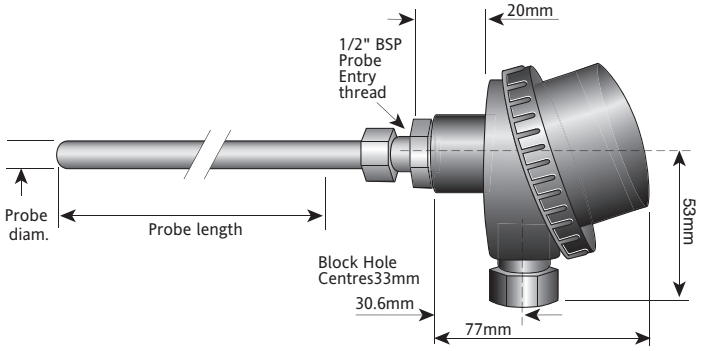
Rugged mineral insulated thermocouples from 3.0mm to 6.0mm diameter in types K, J, T, and N terminating in a connecting head. Choose from die-cast aluminium (standard or miniature), nylon or stainless steel terminal heads.

The thermocouple junction is insulated from the sheath as standard, but can be grounded as an option. A popular range of standard thermocouples is available in types K and J. Alternatively, we offer a custom-made service using the part numbering system shown.

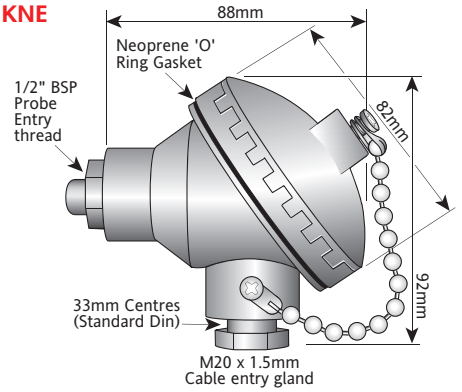
KNS



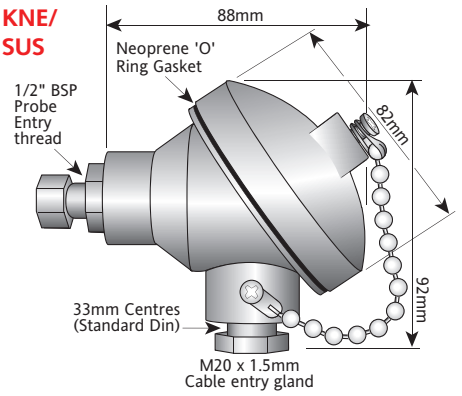
N



KNE



KNE/ SUS



Ordering standard versions – available from stock

Stainless steel sheathed mineral insulated thermocouples terminating in model KNS miniature die-cast aluminium connecting head. Thermocouple junction insulated from the sheath. Temperature rating of probe – K 1100°C, J 750°C. Connecting head rated to 100°C.

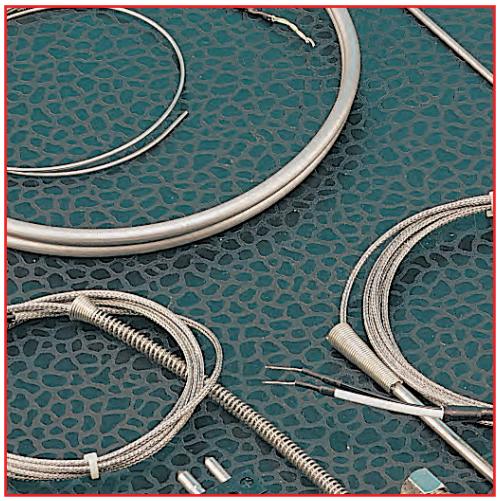
TC type	Probe diameter	Probe length	Order code
J	6.0mm	100mm	313-010
J	6.0mm	200mm	313-012
J	6.0mm	300mm	313-013
K	4.5mm	100mm	313-014
K	4.5mm	200mm	313-015
K	4.5mm	300mm	313-016

Ordering custom-made versions – available on short delivery time

Style	Thermocouple junction	Thermocouple type	Probe diameter	Probe length	Termination head below head	Process Thread	Colour code
MC	**GS** Single grounded	**K**	**3.00** mm	Specify in mm.	**KNE** Standard aluminium	Omit from code if not required	**I** BS EN60584
	GD Duplex grounded	**J**	**4.50** mm*		**KNS** Small aluminium		
	IS Single insulated	**T**	**6.00** mm		**N** Nylon	**PRI** 1/2" BSP	
	ID Duplex insulated	**N**			**KNE/SUS** Stainless steel	**PR5** 1/8" BSP	
Notes		N not available in duplex	* Not T			Other sizes to special order	

e.g. MC-ISK-6.00-250-KNE-I Mineral insulated thermocouple, insulated single junction, type K, 6.00mm diameter probe, 250mm long probe with KNE aluminium head. BS EN60584 colour code

Temperature ratings of probes: Type K – 1100°C, Type J – 750°C, Type T – 400°C, Type N – 1200°C
Probes with KNE, KNE/SUS and N heads can be supplied with in-head 4-20mA transmitters to special order.
Type "K" Inconel sheathed thermocouples available to special order.



Resistance thermometers

The resistance of a conductor varies according to its temperature and this principle is employed in resistance thermometry. By specifying a conductor material which displays a stable and approximately linear temperature coefficient of resistance over the required range, a reliable thermometer can be made.

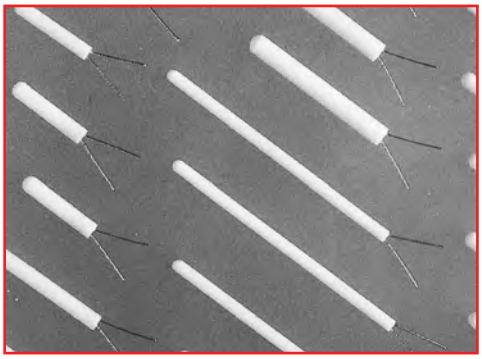
Since Platinum is chosen for the world standard resistance thermometer material, the PRT assembly is the predominant choice for both laboratory and industry.

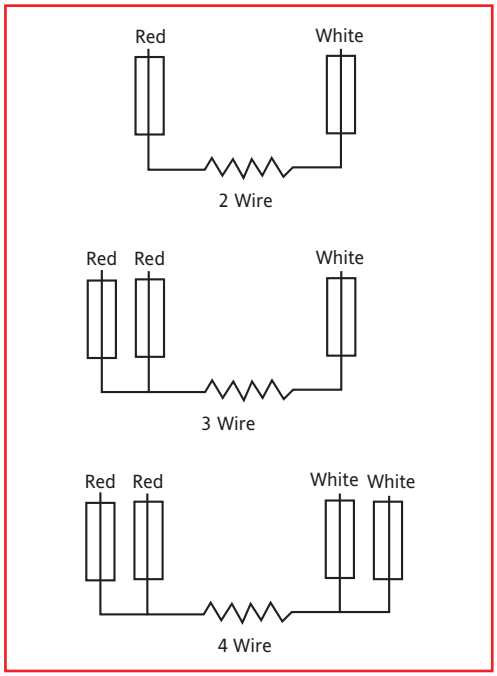
As a sensing element, Platinum has many virtues. In a pure form it will resist contamination and is stable both mechanically and electrically. The relationship between temperature and resistance is nearly linear which allows production of accurately interchangeable detectors.

Materials other than platinum are sometimes used but only to a limited extent; only PRT assemblies are therefore offered.

The use of the PRT is in practice much simpler than that of the thermocouple; copper wires are used between sensor and instrument and since the calibration is absolute, no reference or CJC correction techniques are required.

Standard PRT detectors have a resistance of 100 Ohms at 0°C and have a resistance / temperature characteristic which conforms to IEC 751, class A or B. The resistance change over the range 0°C to 100°C is 38.5 Ohms and is referred to as the Fundamental Interval.





Platinum resistance thermometer practice

The PRT detector is available in many different types of construction but most commonly as a miniature ceramic assembly. The platinum wire is wound in a small spiral and located in axial holes in a high purity alumina rod. Glass adhesive is used to seal the lead exit points, fired to form a permanent bond. Many shapes and sizes of detector are employed but the majority are 25mm long by 3mm diameter. During construction, the element resistance at 0°C is trimmed to 100 Ohms with a very close tolerance.

This detector arrangement, when located in a suitable protecting sheath results in a stem sensing assembly (sensing occurs along the entire detector body length) as opposed to the tip sensing thermocouple.
Alternative arrangements include the widely used flat film construction which is very compact and has a low thermal mass.

Lead Configuration – The accuracy of PRT temperature measurement is largely determined by the number of leads used between the probe and the instrument. Two leads are often acceptable in the case of short cable runs, three or four leads compensating for lead resistance variations give the greatest precision. The choice of 2,3 or 4 wires must be made in context with the measuring instrument input arrangement; Eurotherm instruments use the industry standard 3-wire arrangement.

General Purpose & Air Duct Resistance Thermometer Style RA

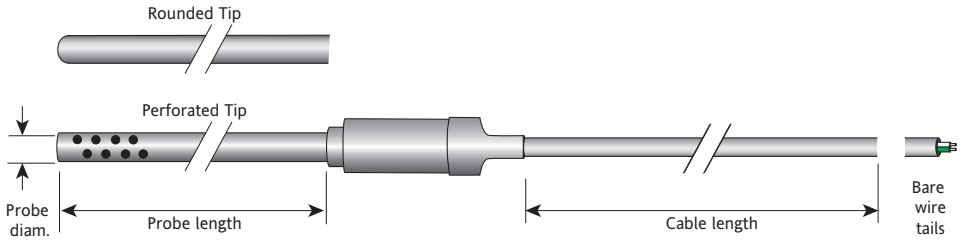
range –100 to +250°C

HINTS & TIPS

Unlike thermocouples which are usually tip sensing, resistance thermometer probes need some stem immersion to give accurate results. The resistance sensor lengths vary from a few mm to 25mm – a good rule is to double this value. Aim for at least 50mm where possible.

Pt100 sensor protected by a 316 grade stainless steel tube with a welded closed end for general purpose applications. Also available with perforated probe tip for air and gas temperature measurement. Available in various probe diameters and extension cable types.

A popular range of standard probes is available. Alternatively, we offer a custom-made service using the part numbering system shown.



Ordering standard versions – available from stock

Single Pt100 sensor, grade B tolerance, 3 wire, stainless steel probe with 2 metres flexible cable. Temperature rating of probe 250°C.

Probe		Cable type	Tip form	Order code
diameter	length			
3.0	100mm	PTFE	Closed	314-020
3.0	200mm	PTFE	Closed	314-021
4.5	100mm	PTFE	Closed	314-007
4.5	200mm	PTFE	Closed	314-009
6.0	100mm	PTFE	Closed	314-010
6.0	200mm	PTFE	Closed	314-012

Probe		Cable type	Tip form	Order code
diameter	length			
3.0	100mm	Braided	Closed	314-025
3.0	200mm	Braided	Closed	314-026
4.5	100mm	Braided	Closed	314-013
4.5	200mm	Braided	Closed	314-015
6.0	100mm	Braided	Closed	314-016
6.0	200mm	Braided	Closed	314-018
6.0	200mm	Braided	Perforated	316-001

Ordering custom-made versions – available on short delivery time

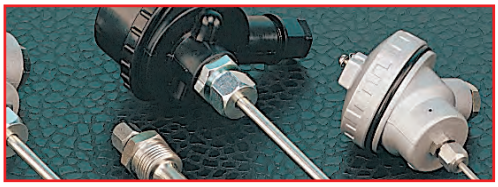
Style	Tip form	Thermocouple		Probe		Cable		Termination	Colour code
		junction	type	diameter	length	length	type		
FA	A Rounded	GS Single grounded	K	3.00 mm	Specify in mm.	Specify in m. (to one d.p.)	C2 PTFE	T Tails	I BS EN60584
		GD Duplex grounded	J	4.50 mm			C3 Fibreglass	MP Mini plug	
		IS Single insulated	T	6.00 mm			C4 Braided	SP Std. plug	
		ID Duplex insulated		6.35 mm			AC3 Armoured	DP Duplex plug	
Notes				For duplex sensors specify 4.50 or above			For duplex sensors specify C4 or AC3 only		

e.g. FAA-GSK-3.00-150-2.0-C4-T-I General purpose thermocouple, rounded tip, single grounded junction, type K, 3.00mm diameter probe, 150mm long probe, 2.0 metres of braided cable and tails. BS EN60584 colour code.

Temperature rating of probes: With cables C3, C4 or AC3 – 350°C, C2 – 250°C.

Heavy Duty Resistance Thermometers Style RC

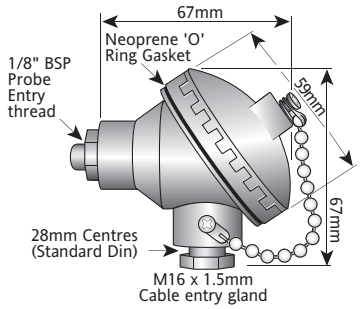
range –50 to +450°C



HINTS & TIPS

RC assemblies combine rugged construction with good accuracy for use in any process. A thermowell provides extra protection for the sheath but impairs thermal response to some extent. If using a thermowell, allow 50mm extra probe length over and above the thermowell immersion length for the compression coupling. Alternatively, if a 1/8"BSP thread below head is chosen, the sensor and thermowell must be ordered together. Selection of the KNE/SUS head means that you can have an all stainless steel assembly.

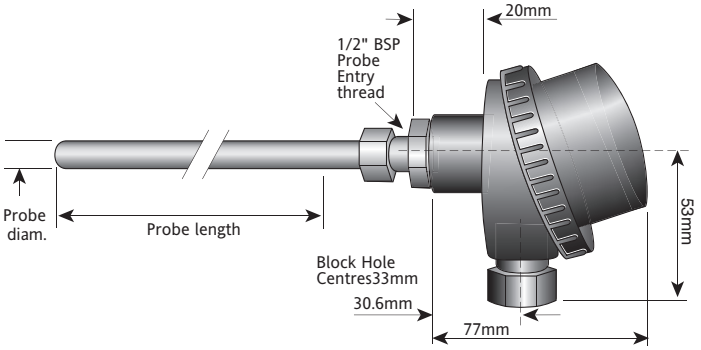
KNS



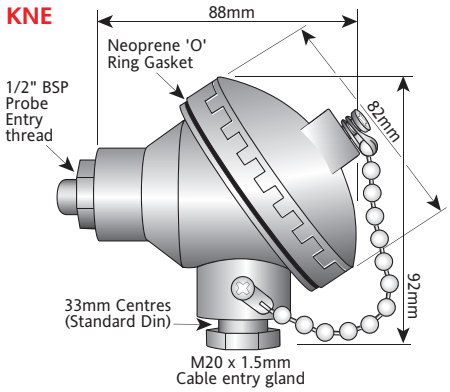
Pt100 sensor protected by a 316 grade stainless steel tube with a welded closed end for use up to 450°C. The probes are terminated in a connecting head. Choose from die-cast aluminium (standard or miniature), nylon or stainless steel terminal heads.

A popular range of standard probes is available fitted with the KNS miniature aluminium head. Alternatively we can offer a custom-made service using the part numbering system shown.

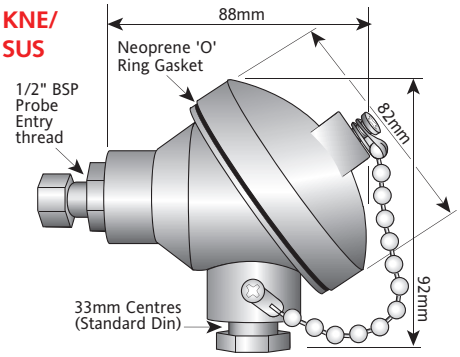
N



KNE



KNE/ SUS



Ordering standard versions – available from stock

Single Pt100 sensor, grade B tolerance, 3 wire stainless steel probe terminating in model KNS miniature aluminium head.

Temperature rating of probe 450°C.

Probe		Order code
diameter	length	
6.0mm	100mm	315-005
6.0mm	150mm	315-006
6.0mm	200mm	315-007
6.0mm	300mm	315-008

Ordering custom-made versions – available on short delivery time

Style	Tip form	Single /duplex	No of wires /element	Tolerance class	Probe		Terminal head below head		Thread
					diameter	length			
RC	A Rounded	S Single	2	B	6.00 mm	Specify in mm.	KNE	Standard aluminium	Omit from code if not required
		D Duplex	3	A	6.35 mm		KNS	Small aluminium	
			4				N	Nylon	PRI 1/2" BSP
							KNE/SUS	Stainless steel	PR5 1/8" BSP
Notes			4 not available in duplex						Other sizes to special order

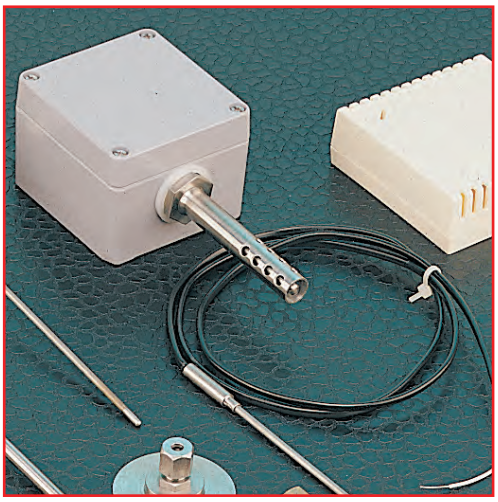
e.g. RCA-S3B-6.00-250-KNE Heavy duty resistance thermosensor single element PRT, 3 wire, class B, Probe 6.00mm diameter, 250mm long with KNE aluminium head.

Probes with KNE, KNE/SUS and N heads can be supplied with in-head 4-20mA transmitters to special order.

HINTS & TIPS

Exposed junction thermocouples can be welded directly on to metal surfaces for accurate and reliable sensing. For ferrous metals, magnet thermocouples are ideal permitting instant attachment and re-attachment.

- **Self adhesive patch Pt100 sensor**
- **Wall mounting air temperature sensors**
- **All 4 wire sensors allowing connection to any Pt100 instrument, 2,3, or 4 wire**
- **Pt100 sensors to IEC 751 class B. 100 ohms at 0°C**
- **Available from stock**



Self-adhesive patch Pt100 sensor

- Silicone rubber patch with self adhesive foil backing
- Good resistance to oils and chemicals
- Range -60 to +250°C
- 1 metre PTFE insulated cable

Ordering – available from stock

Order code
320-001

Dimensions Patch: 35mm long x 13mm wide x 2mm

Magnetic patch thermocouple

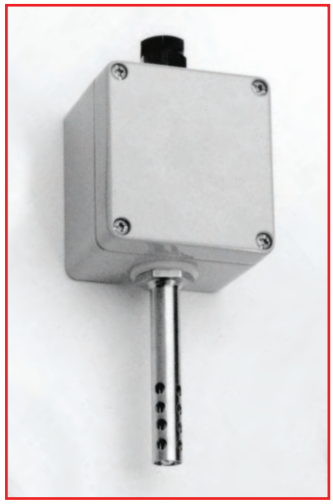
- Wall mounting moulded case
- Maximum 75°C
- Mounts on standard electrical conduit

Ordering – available from stock

Order code
316-002

Dimensions Case: 85mm x 85mm x 30mm

"Button" magnet thermocouple



- Wall mounting
- Rugged stainless steel probe with waterproof connection box
- Recommended for outdoor use, cold stores, etc.
- Range -50 to +150°C
- Perforated sheath acts as radiated heat shield and mechanical protection

Ordering – available from stock

Order code
316-003

Dimensions Case: 80mm x 74mm x 54mm high
Probe: 75mm long x 12.5mm o/d

Sensor Installation Fittings

HINTS & TIPS

Properly installed compression couplings provide pressure tight fitting especially when a taper thread is used. Bayonet fittings provide quick and easy probe insertion and removal but do not provide pressure tight coupling.

The Eurotherm range of bayonet fittings and adaptors allow simple and rapid installation of probes with spring loading to ensure good contact with the measured surface. They are particularly suitable for use in plastics machinery.

Adjustable bayonet fittings and adapters

Ordering – available from stock

Adjustable bayonet fittings	Order code
3.0mm Grub screw	184-058
3.0mm Compression	184-055
4.5mm Grub screw	184-050
4.5mm Compression	184-051
6.0mm Grub screw (suits 184-034)	184-052
Bayonet adapters, 1/8" BSP	
22mm	184-030
35mm	184-031
48mm	184-033
64mm	184-032
22mm 2 pin (suits 184-052)	184-034

Eurotherm flange plates

The Eurotherm flange plates enable the mounting of probes with compression fittings. Available in stainless steel and brass, flange plates are particularly recommended for mounting probes in process ovens, kilns, heating and ventilation ducts.

Diameter: 50mm
Thread: 1/8" BSPP female
Mounting holes: 3mm x 4mm diam. on 40mm pcd

Ordering – available from stock

Flange type	Order code
Stainless steel flange	184-076
Brass flange	184-077

Adjustable mounting fittings (compression couplings)

The Eurotherm range of adjustable mounting fittings (compression couplings) allow the positioning of probes to achieve the desired immersion depth in the process. They are also used to couple the probe with a thermowell or thermopocket. Brass and stainless steel versions are offered.

Ordering – available from stock

Brass	Order code
1/8" BSPT x 1.5mm	351-003
1/8" BSPT x 3.0mm	184-039
1/8" BSPT x 4.5mm	184-040
1/8" BSPT x 6.0mm	184-041
1/4" BSPT x 6.0mm	351-005
1/4" BSPT x 1/4"	351-007
1/2" BSPT x 6.0mm	351-001
1/2" BSPT x 1/4"	351-009

Stainless steel	Order code
1/8" BSPT x 1.5mm	351-004
1/8" BSPT x 3.0mm	184-042
1/8" BSPT x 4.5mm	184-043
1/8" BSPT x 6.0mm	184-044
1/4" BSPT x 6.0mm	351-006
1/4" BSPT x 1/4"	351-008

Note. All adjustable mounting fitting threads are tapered.

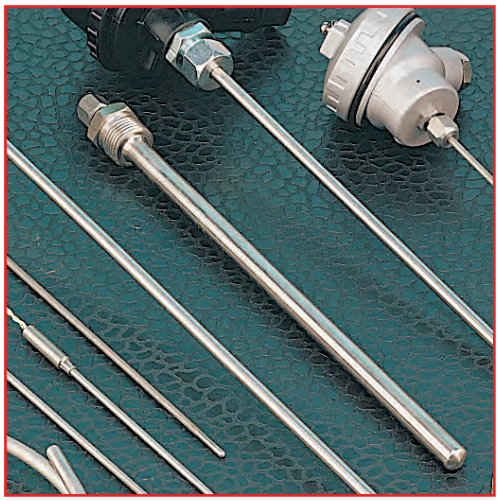
Metric to BSP converter – brass

Ordering – available from stock

Converter	Order code
M12 x 1 to 1/8" BSP female	184-036

HINTS & TIPS

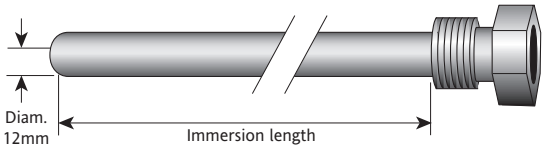
When specifying thermowells or pockets, ensure that the associated probe has an overall length 50mm greater than the well/pocket immersion length to allow for the compression fitting. Not the case if 1/8"BSP thread below head. Remember that a thermowell / pocket will introduce some additional thermal inertia resulting in an increase in thermal response time.



A range of thermowells machined from solid stainless steel stock and thermopockets fabricated from stainless steel tube and welded closed. All with 1/8" BSPP female thread in rear for probe fitting.

The thermowells and thermopockets have a 1/2" BSPP parallel process thread. 1/8" BSP compression fittings should be used to fit the sensors in the well or pocket.

Thermowells and pockets allow removal of probes from the process without the need for shutdown or system draining. They also provide protection for the probe in the case of aggressive media.



Ordering – available from stock

Thermowell type	Order code
50mm	181-237
100mm	181-238
150mm	181-239
250mm	181-240

Other sizes are available to special order

Thermocouple Connectors & Panels

HINTS & TIPS

Connectors and cable in BS EN60584 colours will match in colour. However, connectors in the "old" ANSI C96.1 colours will not match the colours of BS1843 cables. Refer to inside back cover for colour codes. Ensure that you use the correct connector / cable combination for the correct thermocouple compatibility.

A range of miniature (flat-pin) and standard (round-pin) thermocouple connectors.

- **Miniature and standard connectors in BS EN60584 colours available from stock**
- **Special colours to order – short delivery**
- **Miniature and standard connectors, in-line and panel mounting**
- **Compensated connections ensure high accuracy**
- **Types J, K, T, N, E, R and S or Copper-Copper**
- **Compatibility with all other makes of equivalent connectors**
- **Polarised connector pins guarantee correct polarity**
- **Withstand high temperature, 220°C continuous**
- **Rugged construction with solid pins**
- **Single and multi-way panels available to order**

Ordering standard items – available from stock

Standard connectors

Type	Order code		
	Plug	In-line socket	Panel socket
J	354-001	354-002	354-003
K	354-004	354-005	354-006
T	354-007	354-008	354-009
R/S	354-010	354-011	354-012
Copper	354-013	354-014	354-015

Miniature connectors

Type	Order code		
	Plug	In-line socket	Panel socket
J	354-016	354-017	354-018
K	354-019	354-020	354-021
T	354-022	354-023	354-024
N	354-025	354-026	354-027
R/S	354-028	354-029	354-030
Copper	354-031	354-032	354-033

Cable clamps

Type	Order code
Standard – external	355-002
Miniature – external	355-001

Technical specification

Sizes (body)	Length	Width	depth
Minimum line plug:	21mm	17mm	8mm
Minimum line socket:	24mm	17mm	8mm
Minimum panel socket:	25mm	17mm	8mm
Standard line plug:	30mm	25mm	13mm
Standard line socket	38mm	25mm	13mm
Standard panel socket:	32mm	25mm	13mm

Panel cut outs

Minimum. panel socket: 8.5mm x 17mm
Standard panel socket: 13mm x 26mm

Temperature range: -40° to +220°C
(of the connector NOT the measuring range of the thermocouple)

Note. The maximum continuous operating temperature for the panel mounted socket retaining clip is 100°C.

Maximum wire size: 0.5mm²
Body material: glass-filled polyester
Body colours: BS EN60584-3

Types K – Green, N – Pink, E – Violet, T – Brown, J – Black, R/S – Orange, Copper – White

Ordering other connectors (including ANSI MC96.1 colours)

Style		T/C type	Connector type	
IM	Miniature size (BS colour code)	J	M	Plug
FMTC	Miniature size (ANSI MC96.1 colour code)	K	F	In-line socket
IS	Standard size (BS colour code)	T	FF	Panel socket with fascia
FSTC	Standard size (ANSI MC96.1 colour code)	N		
		E	PF	Panel socket lugs (mini only)
		R/S		
		Copper		

e.g. FMTC-T-M Miniature plug, type T. ANSI colour code.

Panels (1 to 25 way) are available for use with fascia sockets (standard and miniature).
Other connectors, including duplex available.

Thermocouple Extensions & Compensating Cables & PRT Cables

HINTS & TIPS

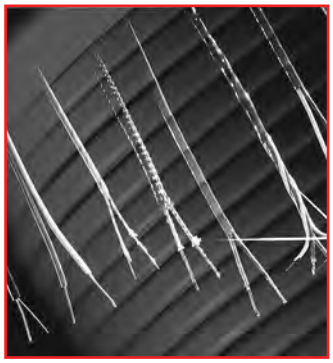
1. If you intend to use thermocouple cable to make a bead weld thermocouple, ensure that true thermoelement wire (extension cable) is used and not compensating cable. The latter works only over a limited temperature range.
2. Glassfibre insulation is not waterproof and should not be used in damp environments. PVC does provide waterproofing in non-freezing conditions but has a limited temperature range.

A range of thermocouple cable in BS EN60584 colour code is available from stock. In addition we can supply other cable constructions, sizes and colour codes.

- **Wide range of high quality insulated cables**
- **Types J, K, T, N, U and Vx**
- **Extension and compensating**
- **Various insulations and configurations**
- **Available in 50 and 100 metre lengths**

Ordering standard versions – available from stock

Thermocouple cable



PVC, flat twin 7/0.2mm – Extension and compensating cable for use up to 105°C

Type	Order code	
	50m	100m
J	353-002	353-003
K	353-023	353-024
T	353-008	353-009
N	353-011	353-012
K(Vx)*	353-005	353-006
R/S(U)*	353-014	353-015

*Compensating cable. Vx is a compensating cable for type K thermocouples for ambient temperatures up to 80°C and type U is a compensating cable for type R and S thermocouples for ambient temperatures up to 50°C.

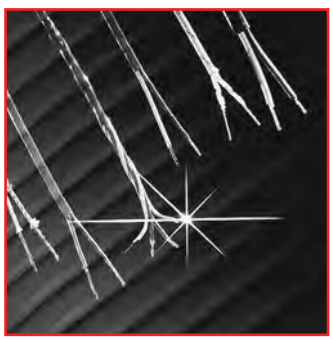
Glassfibre, flat twin 7/0.2mm – Extension cable for use up to 350°C.

Type	Order code	
	50m	100m
J	353-026	353-027
K	353-029	353-030

Glassfibre, with stainless steel overbraid, flat twin 7/0.2mm – Extension cable for use up to 350°C.

Type	Order code	
	50m	100m
J	353-017	353-018
K	353-020	353-021

PRT extension cable



PVC, 4 cores 7/0.2 copper with screen.

Order code	
50m	100m
353-084	353-085

Note. Use 3 of the 4 cores for your 3 wire connection between PRT and the Eurotherm instrument.

Thermocouple cable colour codes are shown inside the back cover.
Refer to the technical data section of this catalogue for more information about the cables.

Special Requirements

Use the suffix -99 on part numbers for custom-made sensors to indicate special requirement. Common special requirements include:

Bends in probes

Mineral insulated thermocouples can be readily bent to shape by the user. General purpose thermocouples and resistance thermometers can be ordered with a bend. Specify the angle of bend and length (mm) from the probe tip. e.g. 99 = Bend 90°/100mm.

Alternative probe terminations

Flexible cables on probes can be terminated as standard in plain tails, miniature or standard plugs.

We can also offer the following terminations:

Termination:	**specify:**
3/16” ring washer	code TB
2BA spade	code TC
4BA spade	code TE
1/4” faston	code TF
3mm blade	code TD

Other terminations can be supplied to special order

Use of thermowells

If a thermowell is specified, the probe length must be around 50mm greater than the specified thermowell immersion length. This allows room for the required compression coupling. Alternatively, if a thread below head is chosen, the sensor and thermowell must be ordered together.

4 to 20mA transmitters

Thermocouples and Pt100 probes with connecting heads can be fitted with integral 4-20mA transmitters. Insulated measuring junctions are required. Please call Technical Services on 01903 695777 for more information.

Tagging of probes

We can supply probes with rugged identification tags if required.

Certificate of calibration

We offer a temperature calibration service in the range -30 to +1200°C with traceability to national standards. We can also organise NAMAS certification.

Note.
BS EN60584-3 is precisely equivalent to IEC 584-3 in defining colour codes for thermocouple cables and their thermal emf tolerance values. All dimensions stated in this publication are nominal.

A practical guide to the selection of thermocouple wire & cable

Which insulation?

Material	Usable temperature range	Application notes
PVC	-10°C to 105°C	Good general purpose insulation for "light" environments. Waterproof and very flexible.
PTFE	-75°C to 250/300°C	Resistant to oils, acids, other adverse agents and fluids. Good mechanical strength and flexibility.
Glassfibre (varnished)	-60°C to 350/400°C	Good temperature range but will not prevent ingress of fluids. Fairly flexible but does not provide good mechanical protection.

Installation notes

a) Always observe colour codes and polarity of connections for each type of thermocouple. If the correct cable is used but crossed at both ends, the associated instrument will show an error equal to twice the temperature difference between the thermocouple termination and the instrument ambient temperature.

b) Avoid introducing "different" metals into the cabling, preferably use compensating colour coded connectors for the greatest accuracy, reliability and convenience of installation.

c) Avoid subjecting compensating cable to high temperatures to avoid inaccuracies. Extension cable is superior in this respect.

d) Do not form thermo-junctions using compensating cable; only extension cable is valid for this purpose.

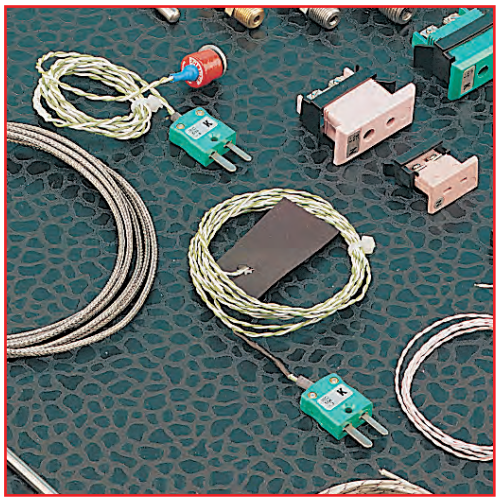
e) Use screened or braided cable connected to ground in any installation where ac pick-up or relay contact interference is likely. "Twisted pair" construction is useful in such situations.

f) For very long cable runs, ensure that cable resistance can be tolerated by the instrumentation without resulting in measurement errors. Modern electronic instruments usually accept up to 100 Ohms or so; they will usually tolerate higher lead resistance but some error will result. Refer to relevant instrument specifications for full details.

g) Cabling is usually available with many different types of insulation material and outer covering to suit different applications. Choose carefully in consideration of ambient temperature, the presence of moisture or water and the need for abrasion resistance.

h) If errors or indicator anomalies occur, be sure to check the thermocouple, the cable, interconnections and the instrument. Most problems of this nature can be due to incorrect wiring but instrument calibration error or faults can occur.

Interchangeability is facilitated by the use of plug and socket interconnections. Special connectors are available from Eurotherm for this purpose and thermocouple alloys or compensating materials are used for the pins and receptacles to avoid spurious thermal voltages. The connectors are colour coded to indicate the relevant thermocouple type and are available as "standard" size with round pins or "miniature" size with flat pins.



Connection of thermocouples to measuring and control instruments

Ordinary copper wires should never be used, as the resultant error will be equal to the difference in temperature between the connecting point of the thermocouple and the instrument (or external reference junction).

Extension or compensating wire or cable must be employed, and it is essential that the same polarity is maintained. If the polarity is reversed, the error is equal to twice the temperature difference between the connecting point of the thermocouple and the instrument (or external reference junction).

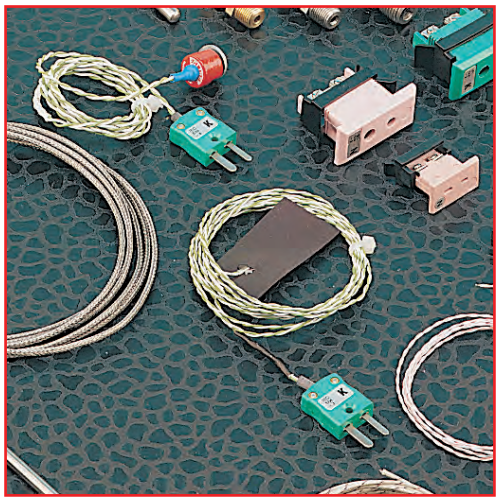
Compensating cable resembles the thermoelectric characteristic of the relevant thermocouple over a limited ambient temperature range, 0° to 80°C typically. Since these cables are made from low cost materials, cost savings can be achieved on plant installations compared with running true thermocouple extension cable.

Extension cable (true thermocouple material) should be used for maximum accuracy.

Loop Resistance, Ohms per combined metre approximate

Type	1/0.2	1/0.315	1/0.508	7/0.2	13/0.2	14/0.2	23/0.2
E	38.1mm	15.4mm	5.9mm	5.3mm	2.9mm	2.7mm	1.6mm
J	19.3mm	7.8mm	3.0mm	2.7mm	1.5mm	1.4mm	0.8mm
K	31.8mm	12.8mm	4.9mm	4.5mm	2.4mm	2.2mm	1.4mm
N	44.2mm	17.7mm	6.8mm	6.2mm	3.4mm	3.2mm	1.9mm
T	16.2mm	6.5mm	2.5mm	2.3mm	1.2mm	1.1mm	0.7mm
U	1.4mm	0.6mm	0.2mm	0.2mm	0.1mm	0.1mm	0.1mm
VX	16.2mm	6.5mm	2.5mm	2.3mm	1.2mm	1.1mm	0.7mm

Using Thermocouples



Thermocouple accuracies

Tolerance classes for thermocouples to BS EN60584-2

Fe-Con (J)		
Class 1		
-40 +750°C:	+0.004 . t	or ±1.5°C
Class 2		
-40 +750°C:	+0.0075 . t	or ±2.5°C
Class 3		
—	—	—
Cu-Con (T)		
Class 1		
-40 +350°C:	+0.004 . t	or ±0.5°C
Class 2		
-40 +350°C:	+0.0075 . t	or ±1.0°C
Class 3		
-200 +40°C:	+0.015 . t	or ±1.0°C
NiCr-Ni (K) & NiCrs-NiSi (N)		
Class 1		
-40 +1000°C:	+0.004 . t	or ±1.5°C
Class 2		
-40 +1200°C:	+0.0075 .t	or ±2.5°C
Class 3		
-200 +40°C:	+0.015 . t	or ±2.5°C
NiCr-Con (E)		
Class 1		
- 40 +800°C:	+0.004 . t	or ±1.5°C
Class 2		
- 40 +900°C:	+0.0075 . t	or ±2.5°C
Class 3		
-200 +40°C:	+0.015 . t	or ±2.5°C
Pt10Rh-Pt (S) & Pt13Rh-Pt (R)		
Class 1		
0 +1600°C:	+[1 + (t-1000).0.003]	or ±1.0°C
Class 2		
-40 +1600°C:	+0.0025 . t	or ±1.5°C
Class 3		
—	—	—
Pt30Rh-Pt6Rh (B)		
Class 1		
—	—	—
Class 2		
+600 +1700°C:	+0.0025. t	or ±1.5°C
Class 3		
+600 +1700°C:	+0.005 . t	or ±4.0°C

Note.
t = actual temperature
Use the larger of the two deviation values

Performance considerations when connecting thermocouples

a) Length of cable runs and loop resistance

The resistivity of extension and compensating cables varies according to the different conductor metals; the limit to cable lengths which can be accommodated by measuring instruments therefore depends on both the thermocouple type and instrument specifications. A general rule for electronic instruments is that up to 100 Ohms loop cable resistance (i.e. total of both legs) will not result in measurement errors.

The table of loop resistances gives values for the popular types of thermocouple. One example is that for Type K extension cable which has a combined per metre loop resistance of 4.5 Ohms with 7/0.2mm conductors; in this case, 20 to 25 (100÷4.5) metres is the maximum permissible cable run. The use of larger gauge wires will permit greater lengths of course.

b) Interference and Isolation

With long runs, the cables may need to be screened and earthed at one end (at the instrument) to minimise noise pick-up (interference) on the measuring circuit.

Alternative types of screened cable construction are available to special order and these include the use of copper or mylar screening. Twisted pair configurations are offered and these can incorporate screening as required.

With mineral insulated cables the use of the sheath for screening may raise problems. In certain forms the measuring point is welded to the sheath in order to reduce the response time; the screen is then connected directly to the sensor input of the instrument and is therefore ineffective. In thermocouples where the measuring point is welded to the protection tube it may be necessary to take special precautions against interference since the sheath tube can in this case act as an aerial.

Even if the measuring point is not welded to the protection tube it is inadvisable to use the sheath of a mineral-insulated thermocouple as a screen. Since it consists of non-insulated material there is a possibility with electrically heated furnaces that it can carry currents between the furnace material and the earthing point. These may result in measurement errors.

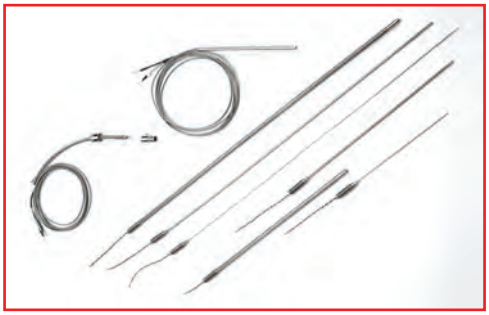
Generally, thermocouples in electrical contact with the protection tube can easily suffer interference from external voltages through voltage pick-up. In addition, two such inputs form a current loop through which the two inputs are connected together. Since such current loops have a large effective cross-sectional area they form a preferred path for the introduction of interference.

Thermocouples should under these conditions always be isolated from each other, i.e. the amplifier circuits must have no electrical connection to the remaining electronics. This is already provided on most instruments intended for connection to thermocouples.

Ceramic materials used for insulating the thermocouples inside the protection tube suffer a definite loss of insulation resistance above 800 to 1000°C. The effects described can therefore appear at high temperatures even in thermocouples where the measuring junction is not welded to the protection tube. Here again full isolation is strongly recommended.

With electrically heated furnaces in the high-temperature range it is also necessary to consider that the increased conductivity of the ceramic insulating materials may cause the supply voltage to leak into the thermocouple. Here again full isolation against supply and earth potential with an insulating voltage exceeding the peak voltage of the supply (heater voltage) is essential.

The isolation of the inputs becomes specially important when electrically heated furnaces are fitted with several thermocouples which are linked to one or several instruments.



Tolerances for Pt100 thermometers to IEC 751

Temp.	Resistance	Tolerance			
		Class A		Class B	
(°C)	(Ω)	(±°C)	(±Ω)	(±°C)	(±Ω)
-200	18.52	0.55	0.24	1.3	0.56
-100	60.26	0.35	0.14	0.8	0.32
0	100.00	0.15	0.06	0.3	0.12
100	138.51	0.35	0.13	0.8	0.30
200	175.86	0.55	0.20	1.3	0.48
300	212.05	0.75	0.27	1.8	0.64
400	247.09	0.95	0.33	2.3	0.79
500	280.98	1.15	0.38	2.8	0.93
600	313.71	1.35	0.43	3.3	1.06
650	329.64	1.45	0.46	3.6	1.13
700	345.28	—	—	3.8	1.17
800	375.70	—	—	4.3	1.28
850	390.48	—	—	4.6	1.34

Terminating the resistance thermometer

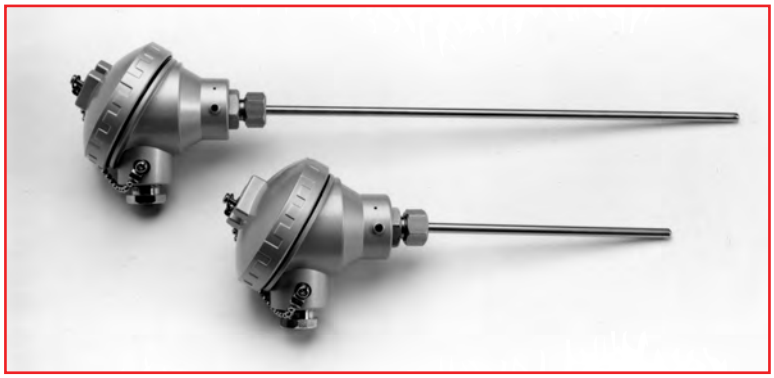
Fundamentally, every sensing resistor is a two wire device. When terminating the resistor with extension wires, a decision must be made as to whether a 2,3 or 4 wire arrangement is required for measurement purposes.

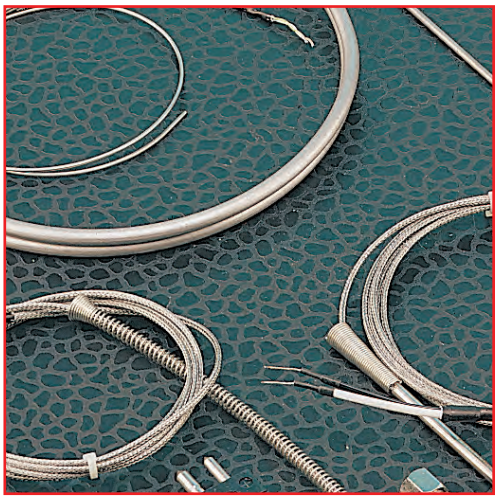
A 3 wire system is most commonly utilised in industry and is adopted universally for all Eurotherm instruments.

In the sensing resistor, the electrical resistance varies with temperature. Temperature is measured indirectly by reading the voltage drop across the sensing resistor in the presence of a constant current flowing through it using Ohm's Law: V = R.I

The measuring current should be as small as possible to minimise sensor heating; a maximum of around 1mA is regarded as acceptable for practical purposes. This would produce a 0.1V drop in a Pt100 sensing resistor at 0°C; the voltage dropped which varies with temperature is then measured by the associated circuitry. The interconnection between the Pt100 and the associated input circuit must be compatible with both and the use of 2, 3 or 4 wires must be specified accordingly. It is essential that in any resistance thermometer the resistance value of the external leadwires be taken into account, and if this value affects the required accuracy of the thermometer, its effect should be minimised.

This is usually accomplished by connecting the leadwires into the modified WHEATSTONE BRIDGE circuit in the measuring instrumentation. The leadwires can be 2, 3 or 4 in number, often dependant upon the requirements of the instrumentation and/or the overall accuracy required. Two leads are adequate for some industrial applications, three leads compensating for lead resistance improves accuracy, and for the highest accuracy requirements four leads are required, in a current/voltage measuring mode.



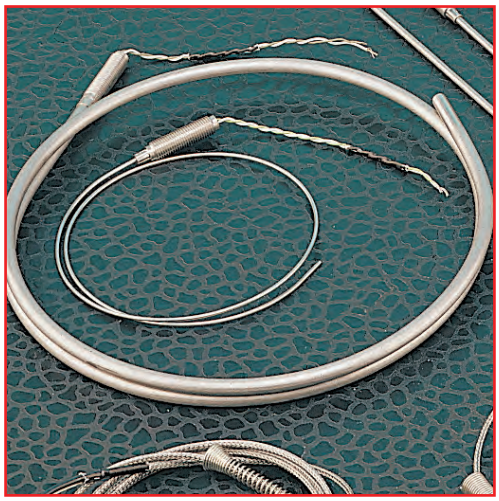


Connecting resistance thermometers to instruments

The connection between the thermometer assembly and the instrumentation is made with standard cable with copper conductors in 2, 3 or 4 core construction. The cabling introduces electrical resistance which is placed in series with the resistance thermometer. The two resistances are therefore cumulative and could be interpreted as an increased temperature if the lead resistance is not allowed for. The longer and/or the smaller the diameter of the cable, the greater the lead resistance will be and the measurement errors could be appreciable. In the case of a 2 wire connection, little can be done about this problem and some measurement error will result according to the cabling and input circuit arrangement.

The heavier the gauge of the conductors, the less the impact is on errors due to lead resistance effects as described. Typically 7/0.2mm or 14/0.2mm conductors are specified with insulation chosen to suit a particular application.

Using Platinum Resistance Thermometers



Termination colour codes IEC 751: 1983

Installation notes:

a) Always observe colour codes and terminal designations; the wiring configuration of the thermometer must match that of the instrument input arrangement.

b) Avoid introducing "different" metals into the cabling; preferably use copper connecting blocks or colour coded (or other dedicated) connectors for greater accuracy, reliability and convenience of installation. Alternative conductor materials could have "Ohmic" effects which may result in different resistance values in lead wires.

c) Use screened or braided cable connected to ground in any installation where ac pick-up or relay contact interference is likely.

d) For very long cable runs, ensure that cable resistance can be tolerated by the instrumentation without resulting in measurement errors. Eurotherm instruments typically accept up to 22Ohms resistance in each of the 3 leads. Refer to the relevant instrument specifications for full details.

e) Cabling is usually available with many different types of insulation material and outer covering to suit different applications. Choose carefully in consideration of ambient temperature, the presence of moisture or water and the need for abrasion resistance.

f) If errors occur, be sure to check the sensor, the cable, interconnections and the instrument. Many such problems are due to incorrect wiring or instrument calibration error rather than the sensor.

Interchangeability is facilitated by the use of plug and socket interconnections. Various connectors are available for this purpose.

Performance considerations when using resistance thermometers

There are various considerations appropriate to achieving good performance from resistance thermometer sensors:

a) Length of cable runs and loop resistance - Refer to Installation Notes

b) Interference and Isolation

With long cable runs, the cables may need to be screened and earthed at one end (at the instrument) to minimise noise pick-up (interference) on the measuring circuit.

Poor insulation is manifested as a reduction in the indicated temperature, often as a result of moisture ingress into the probe or wiring.

c) Self-heating

In order to measure the voltage dropped across the sensing resistor, a current must be passed through it. The measuring current produces dissipation which generates heat in the sensor. This results in an increased temperature indication. There are many aspects to the effects of self-heating but generally it is necessary to minimise the current flow as much as possible; 1mA or less is usually acceptable. The choice of current value must take into account the Ro value of the sensing resistor since dissipation = I^2R.

Eurotherm instruments use small values of excitation current such that self-heating effects are minimal.

d) Stem conduction

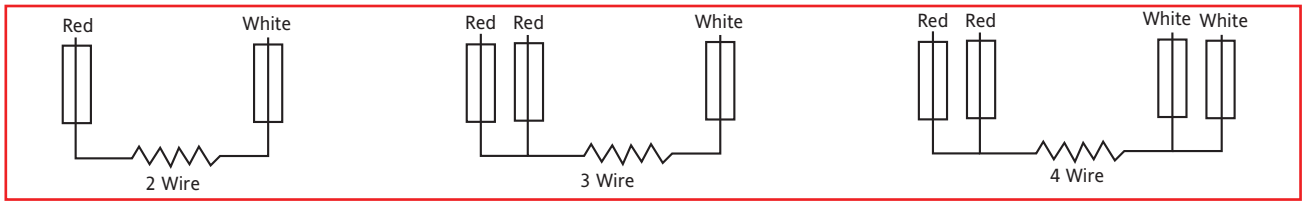
This is the mechanism by which heat is conducted from or to the process medium by the probe itself; an apparent reduction or increase respectively in measured temperature results. The immersion depth (the length of that part of the probe which is directly in contact with the medium) must be such as to ensure that the "sensing" length is exceeded (double the sensing length is recommended). Small immersion depths result in a large temperature gradient between the sensor and the surroundings which results in a large heat flow.

The ideal immersion depth can be achieved in practice by moving the probe into or out of the process medium incrementally; with each adjustment, note any apparent change in indicated temperature. The correct depth will result in no change in indicated temperature.

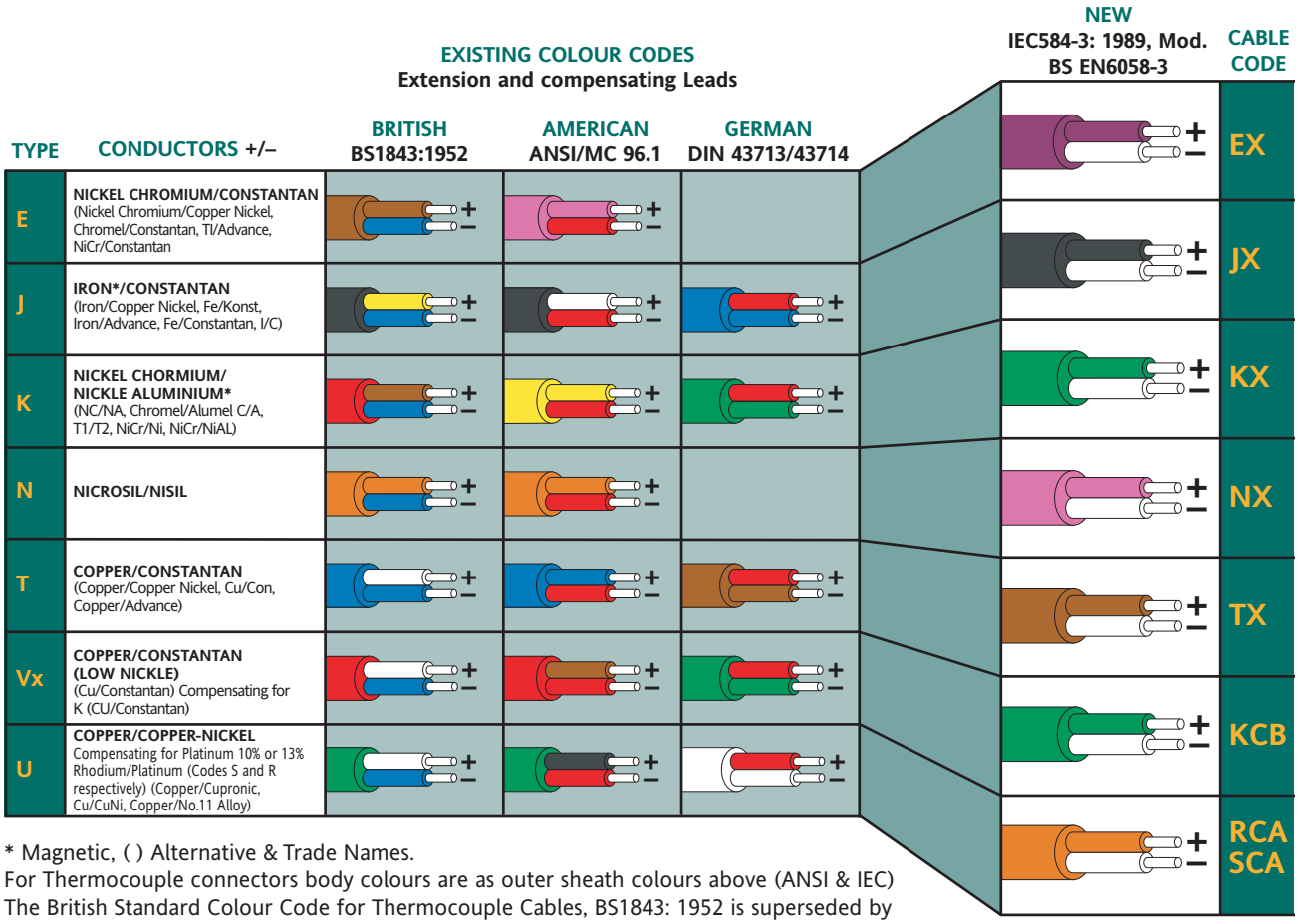
For calibration purposes 150 to 300mm immersion is required depending on the probe construction.

The use of thermowells increases the thermal resistance to the actual sensor; heat also flows to the outside through the thermowell material. Direct measurements are preferable for good response and accuracy but may be mechanically undesirable.

Low flow rates or stationary media result in reduced heat transfer to the thermometer; maximum flow rate locations are necessary for more accurate measurement.



Colour Codes Thermocouple Connectors, Extension and Compensating Wires and Cables



* Magnetic, ( ) Alternative & Trade Names.
For Thermocouple connectors body colours are as outer sheath colours above (ANSI & IEC)
The British Standard Colour Code for Thermocouple Cables, BS1843: 1952 is superseded by BS EN60584-3 (=IEC 584-3 1989 modified)
Additional identification as to whether a thermocouple cable type is extension or compensating is indicated in the example which follows; however, please note that a letter A or B after the C for Compensating refers to the Cable Temperature Range in accordance with the Table of Tolerance Values set out with this standard.

K X 1 = K EXTENSION CLASS 1
K CA 2 = K COMPENSATING CLASS 2 0 TO 150°C

For further information refer to the publication BS EN60584-3

Thermocouple wire tolerances

The figures shown in the tables are those appropriate to the measuring junction temperatures in the final column.

Tolerance classes to BS EN60584-3

Type	Tolerance Class 1	Tolerance Class 2	Cable temp range	Measuring junction temperature
JX	±85µV(±1.5°C)	±140µV(±2.5°C)	-25° to + 200°C	500°C
TX	±30µV(±0.5°C)	±60µV(±1.0°C)	-25° to + 100°C	300°C
EX	±120µV(±1.5°C)	±200µV(±2.5°C)	-25° to + 200°C	500°C
KX	±60µV(±1.5°C)	±100µV(±2.5°C)	-25° to + 200°C	900°C
NX	±60µV(±1.5°C)	±100µV(±2.5°C)	-25° to + 200°C	900°C
KCA	—	±100µV(±2.5°C)	0° to + 150°C	900°C
KCB	—	±100µV(±2.5°C)	0° to + 100°C	900°C
NC	—	±100µV(±2.5°C)	0° to + 150°C	900°C
RCA	—	±30µV(±2.5°C)	0° to + 100°C	1000°C
RCB	—	±60µV(±5.0°C)	0° to + 200°C	1000°C
SCA	—	±30µV(±2.5°C)	0° to + 100°C	1000°C
SCB	—	±60µV(±5.0°C)	0° to + 200°C	1000°C

Notes.

1. Cable temperature range may be restricted to figures lower than those shown in the table because of temperature limitations imposed by the insulant.
2. A cable comprising two copper conductors may be used with type B thermocouples. The expected maximum additional deviation within the cable temperature range 0°C to + 100°C is 40µV. The equivalent in temperature is 3.5°C when the measuring junction of the thermocouple is at 1400°C.

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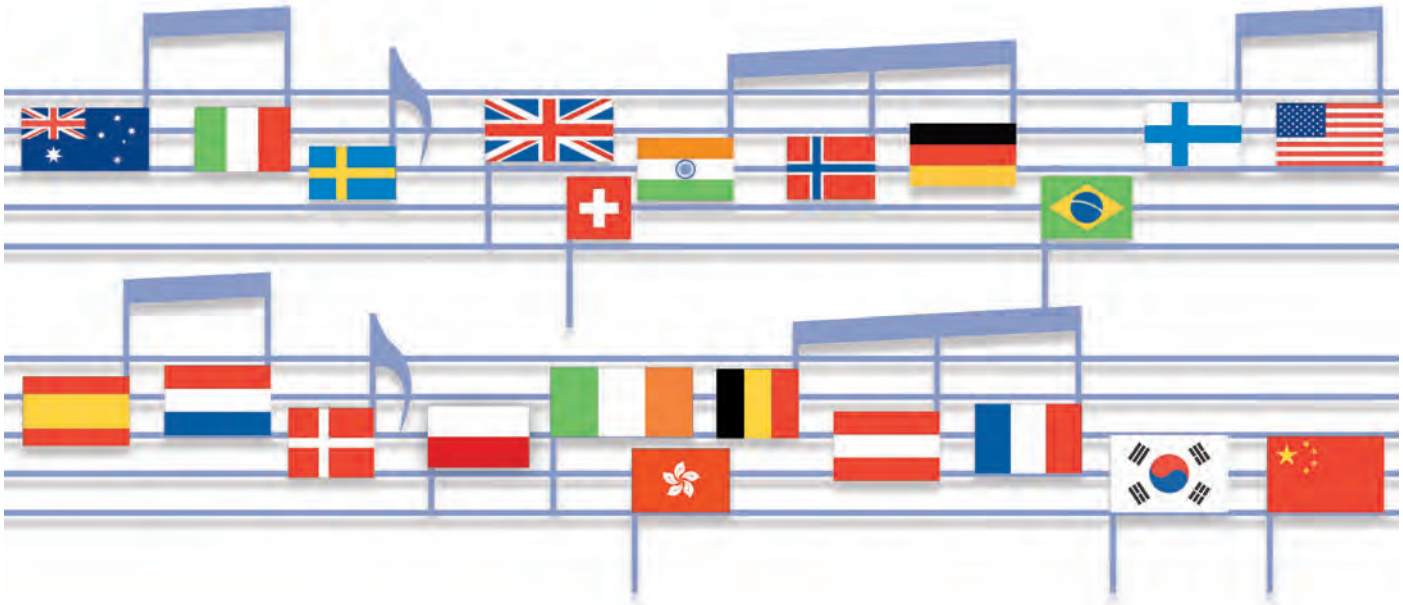

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Part No. HA013208 Issue 6