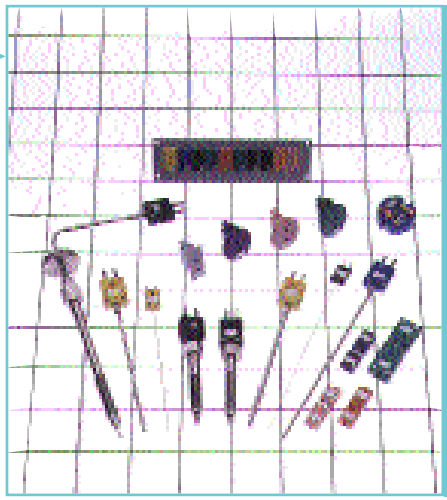
Temperature Sensors – Thermocouples



We offer a range of Standard Mineral Insulated Assembly, Mineral Insulated Assembly with Extension Lead, Exposed Loop Assembly, Heavy Duty Thermocouple Assembly, Standard Thermocouple Assemblies, Flexicouples, Nozzle Thermocouples, Standard Melt Thermocouple, Adjustable Melt Thermocouple, Twist Melt Thermocouple, Leaf Thermocouple, Roller Surface Thermocouple, Washer Thermocouple, Pipe Surface Thermocouple, Bead Weld Thermocouple, Magnet Surface Thermocouple, Self Adhesive 'Patch' Thermocouple, Heavy Duty Fabricated Thermocouple and Rare Metal Thermocouple.

THERMOCOUPLES

In 1821 T J Seeback observed that a small electric current flows in a closed circuit of dissimilar metals if one of the junctions is heated with respect to the other. Reversing the heating polarity produces an opposite direction of current flow. The magnitude of the voltage generated, called the thermal electromotive force (e.m.f.) is a function of temperature difference of the two junctions.

Although many combinations of metals and alloys display thermocouple behaviour, in practice only a small number meet the general requirements of industrial and laboratory applications. The small thermal e.m.f. (thermocouple signal) produced must be of sufficient magnitude, linearity and repeatability for use by conventional instrumentation as a measured quantity. For practical purposes, thermocouples are divided into two categories: rare metal types (usually Platinum V Platinum Rhodium) and base metal types such as Nickel Chromium V Nickel Aluminium and Iron V Copper Nickel (Constantan). Measuring junctions are formed by 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. In order to ascertain the temperature of the 'hot' junction we must know the: 1) calibration data for the thermocouple, 2) measured output voltage, and 3) temperature of the reference (cold junction).

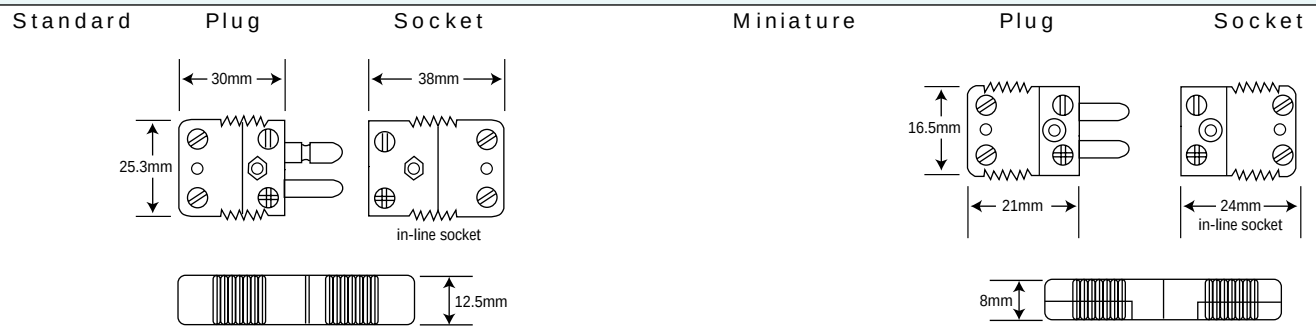
Connection of Thermocouples to Measuring Instruments

Ordinary copper wires should never be used, as the 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).

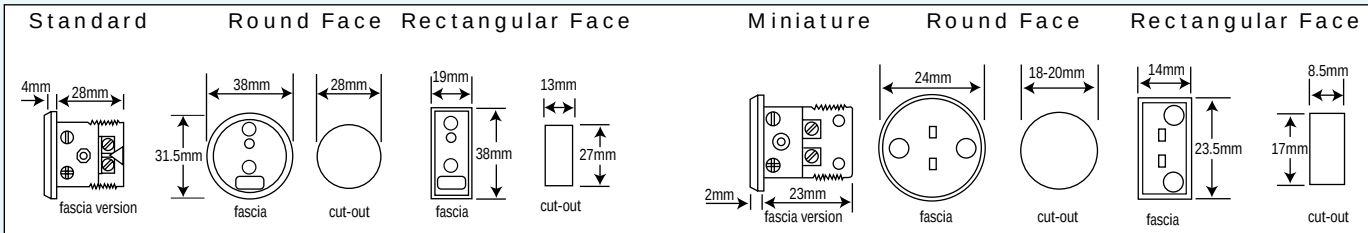
Due to their location in often adverse environments such as hot working zones of furnaces and machinery, temperature sensors are liable to corrosion and mechanical damage. The need for occasional replacement is inevitable and the use of suitable connectors permits error free fast, positive and reliable interchange with no risk of dangerous cross connection. These thermocouple plugs and sockets have a technical and practical advantage over other types when terminating thermocouple wires or compensating cables in a wide variety of sizes. The wires are sandwiched between plates of thermocouple compatible material with a clamping screw, accommodating from very fine wires to standard cables (0.5mm^2). The connectors are colour coded and polarised and will mate with other makes of plugs and sockets. They can be mounted directly on to sheaths of up to 3mm diameter in the case of the miniature version or $^1/_4$" (6.25mm) with the standard version by means of mounting adaptors. The sockets can be supplied as in-line or panel mounting versions with rectangular or circular fascias. The connectors are ruggedly made of glass filled thermoplastic for reliable operation up to 220ºC sustained temperature (optional special version available for 275ºC). The colour coded connector bodies ensure clear identity of the thermocouple in use.

Selecting a thermocouple sensor – we list here things to be considered:

*In-Line Connectors – Plug and Sockets



*Panel Mounting Connectors – Sockets



*Thermocouple cables: A guide to the selection of wire and cable – insulation – single or multistand

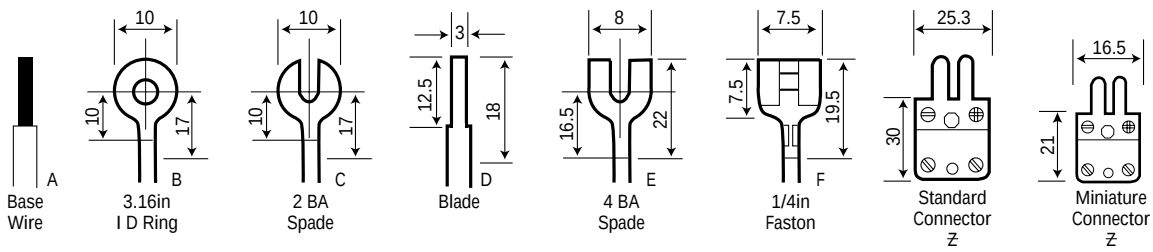
Extension or Compensating Cable? Extension cable uses the same material as the thermocouple whereas Compensating cable uses material with a similar emf/temperature characteristic over a limited temperature range. For maximum accuracy extension cables should be used and terminals and connectors should be of the thermocouple materials to maintain continuity. For details of the international thermocouple connectors, extension and compensating wires and cables colour codes see page 9.8.

Insulation Thermocouple extension cable can come with a variety of insulation as follows:

Material	Useable Temperature Range	Application Notes
PVC	–10ºC to +105ºC	Good general purpose insulation for 'light' environments. Waterproof and very flexible.
PTFE	–75ºC to +250/300ºC	Resistant to oils, acids, other adverse agents and fluids. Good mechanical strength and flexibility.
Glass Fibre (Varnished)	–60ºC to +350/400ºC	Good temperature range but will not prevent the ingress of fluids. Fairly flexible but does not provide good mechanical protection.
High Temp. Glass Fibre	–60ºC to +700ºC	Will withstand high temperature up to 700ºC. Will not protect against fluids and physical disturbance.
Ceramic Fibre	0 to +1000ºC	Will withstand high temperatures up to 1000ºC. Will not protect against fluids and physical disturbance.
Glass Fibre (Varnished) Stainless Steel Overbraid	–60ºC to +350/400ºC	Good resistance to physical disturbance and high temperature. Will not prevent the ingress of fluids.

Single or Multistrand? The choice is mainly determined by the application (e.g. termination considerations and internal diameter of associated sheath). Generally, single strand wires are used for hot junctions, and multistrand for extensions of the thermocouples as being more flexible. The greater the effective conductor diameter, the lower the value of thermocouple loop resistance; an important consideration with long cable runs.

Both PRTs and Thermocouples, with or without extension cables fitted, can have a variety of terminations fitted as follows:



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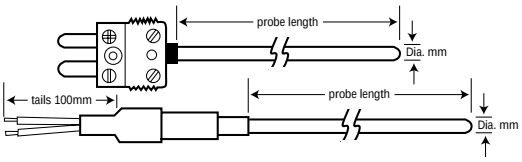
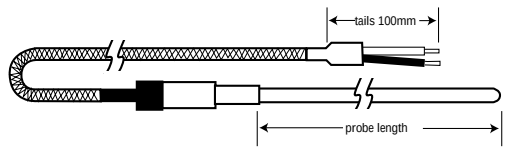


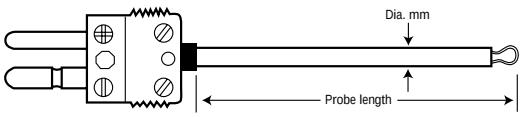
Standard Mineral Insulated Assembly Type: MI (Insulated) ME (Earthed) –100ºC to +1200ºC Max cold end (pot seal) +100ºC

Available in any combination of thermocouple calibrations (J, K, T, E and N), sheath length or sheath diameter, (0.5, 1.0, 1.5, 2.0, 3.0, 4.5, 6.0 and 8.0mm). Complete with plain pot seal, (or threaded option), and 100mm tails or thermocouple connector terminations.



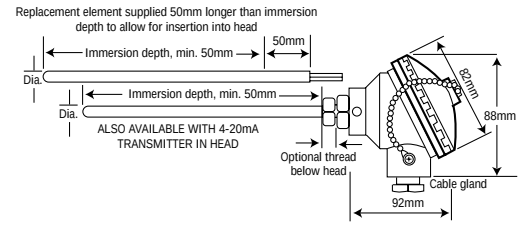
Mineral Insulated Assembly with Extension Lead Type: MI (Insulated) ME (Earthed) –100ºC to +1200ºC Max cold end (pot seal) +100ºC

The sensor specification is identical to the standard mineral insulated assembly. However, these units have an additional flexible lead out to suit the application. Note: J, K, T and E sheath is stainless steel as standard. Specify if Inconel is required for type K. Type N is supplied with nicrobell B sheath. A plain stainless steel pot is fitted as standard. Specify if 1/8" BSP or 8mm ISO pot is required. Locknuts are also available.



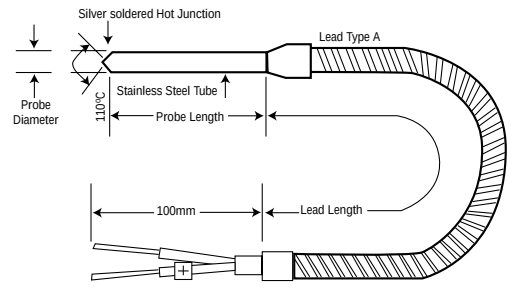
Exposed Loop Assembly Type: EX –100ºC to +800ºC Max cold end +100ºC

Available in thermocouple calibrations (J, K, T and N), and sheath diameter, (1.0, 1.5, 2.0, 3.0, 4.5, and 6.0mm) this mineral insulated thermocouple employs an exposed hot junction to achieve the fastest possible thermal response and sensitivity. As standard the EX is fitted with a standard size male compensating connector (option miniature). Note: When exposed to temperatures in excess of 450ºC the sensors seal integrity is compromised.



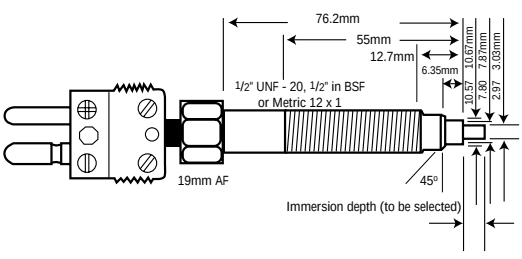
Heavy Duty Thermocouple Type: HD –100ºC to +1200ºC

This assembly comprises a mineral insulated thermocouple probe terminating in a weather-proof head and provides for long life even under rigorous conditions of vibration, abrasion, corrosion and wide temperature range. A cable gland is fitted in each case. Replacement elements are available which consist of a probe and bare element tails. Single or dual element versions are available as standard. Flameproof assemblies and alternative head types are also available.



Standard Thermocouples Type: LS –60ºC to +350ºC

The thermocouple element is protected by a 316 stainless steel tube with a silver soldered tip as standard or welded as an option. The hot junction is grounded as standard or optionally insulated. Single or dual element versions are available and the probes can be straight or formed (bent) as required during manufacture. An economical and versatile range which is popular for a wide variety of medium temperature applications, particularly in the plastics industry. Note: Maximum sensor working temperature is determined by the lead type selected.



Standard Melt Thermocouple Type: PU, PM or PF 0ºC to +500ºC

Designed to withstand the very high pressures experienced within the nozzles of plastic extruders and injection moulders, these thermocouples enable direct measurement of the molten plastic temperature. The probe element is thermally insulated from the bolt to allow more accurate measurement. The immersion depth (probe extension beyond the bolt) must be specified. The probe is terminated in a standard compensating plug as standard.

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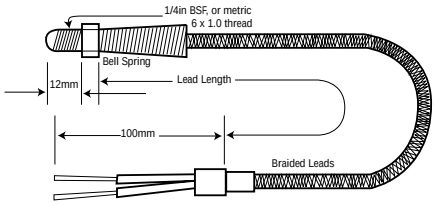
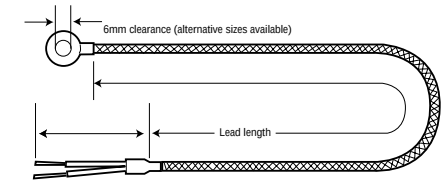


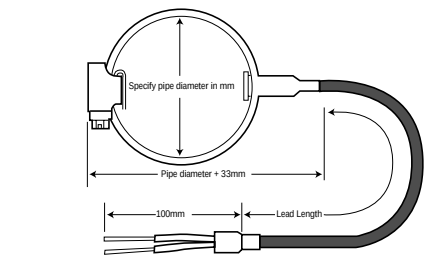
Nozzle Thermocouple Type: NF or NM –60ºC to +350ºC

The thermocouple element is housed in a stainless steel imperial or metric bolt for threading directly into the process. The grounded element is brazed into the nozzle tip allowing it to be threaded in without the leads being turned. Stainless steel braided leads are fitted as standard.



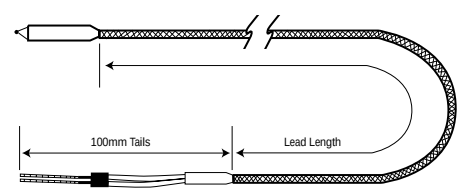
Washer Thermocouple Type: WR –60ºC to +350ºC

The thermocouple hot junction is located in a washer which has a 6.0mm clearance hole for bolting to the surface to be monitored. Available in type T, N, J and K thermocouple versions with various choices of lead out (7/0.2mm).



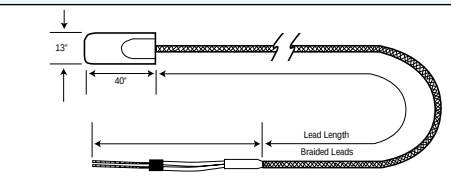
Pipe Surface Thermocouple Type: PC –60ºC to +350ºC

The thermocouple hot junction is located on the inside face of the stainless steel clip; tightening of the clip directly around the pipe thus ensures good thermal contact between the pipe surface and the sensor. Combinations of different calibration type and clip diameter make this thermocouple suitable for a wide range of applications.



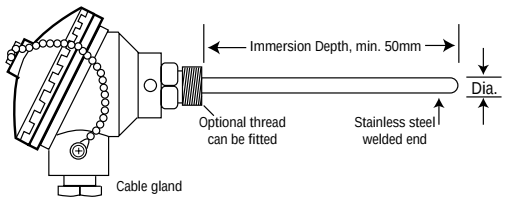
Bead Weld Thermocouple Type: BW –60ºC to +350ºC

This sensor is the most simple type of thermocouple and is therefore inexpensive. The thermocouple junction is formed directly on the end of a length of thermocouple extension cable. The exposed junction has a small thermal mass and therefore will respond quickly to temperature change. It can be attached to a surface using self adhesive pads (supplied separately) used for gas temperatures or in the case of the PVC or PTFE version immersed in fluids.



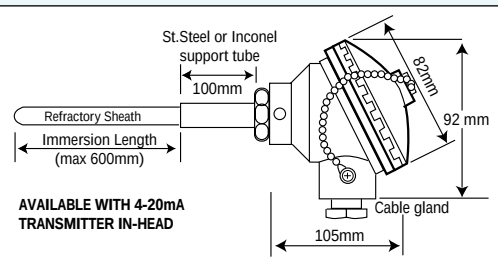
Self Adhesive 'Patch' Thermocouple Type: PATCH –50ºC to +150ºC

A thermocouple junction is housed in a flexible silicon rubber 'patch'. The proximity of the element to the self adhesive face of the patch ensures good surface temperature sensing. Available with an extensive choice of leadouts.



Heavy Duty Fabricated Thermocouple Type: LM –100ºC to +500ºC

The assembly comprises a 316 stainless steel sheath and a die cast aluminium weatherproof head. This low cost assembly combines high sensitivity and fast response with rugged construction and utilizes components rated for sustained high temperature operation. Supplied with an insulated hot junction as standard. A range of optional male brass threads can be fitted below the head for process mounting.



Rare Metal Thermocouple Type: PRV 0ºC to +2000ºC

Platinum v Platinum Rhodium thermocouples housed in a refractory aluminium oxide sheath with a weatherproof connecting head and stainless steel or inconel support tube. A choice of type R (PtvPt13%Rh) and type S (PtvPt10%Rh) thermocouples are available. The standard refractory sheath (60% Aluminium Oxide) provides good protection in a wide range of applications and permits continuous operation at 1400ºC.

Details of other types mentioned in the header section can be obtained by application to our internal sales department.

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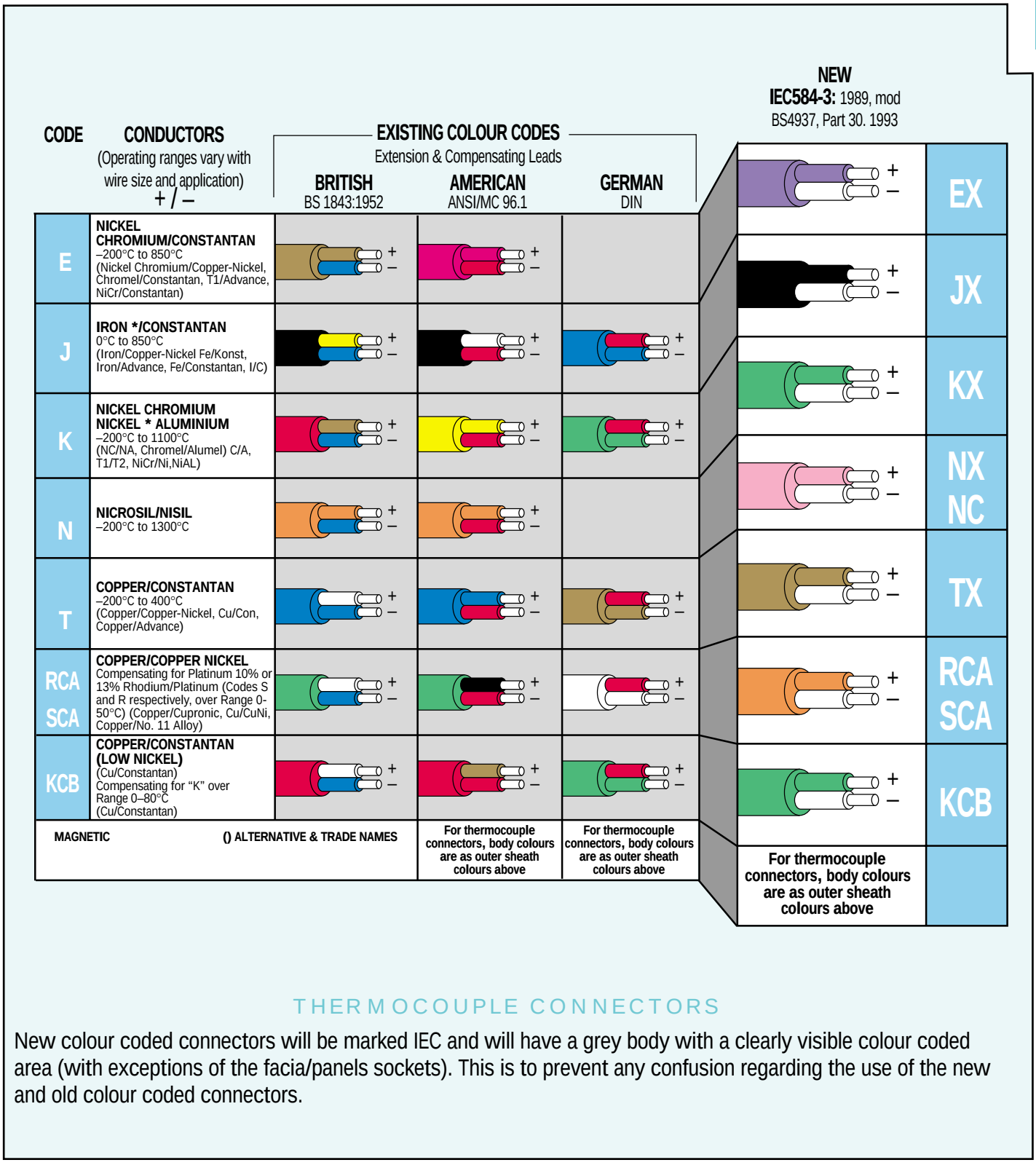
THERMOCOUPLE CONNECTORS, EXTENSION AND COMPENSATING WIRES AND CABLES

INTERNATIONAL COLOUR CODES

The British standard colour code for thermocouple cables BS1843:1952 has been replaced by BS4937 part 30:1993 (IEC584-3:1989 modified). This change came into effect in January 1994 and BS1843 will be phased out by December 1998. Lee-Dickens will also phase in the use of the new standard. Cables and connectors are available in the new colours now.



THERMOCOUPLE CONNECTORS

New colour coded connectors will be marked IEC and will have a grey body with a clearly visible colour coded area (with exceptions of the facia/panels sockets). This is to prevent any confusion regarding the use of the new and old colour coded connectors.

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