PETRO DAVVAR ENERGY

Thermocouple

Rev E
2021/09/05

If there is a will, there is a way...

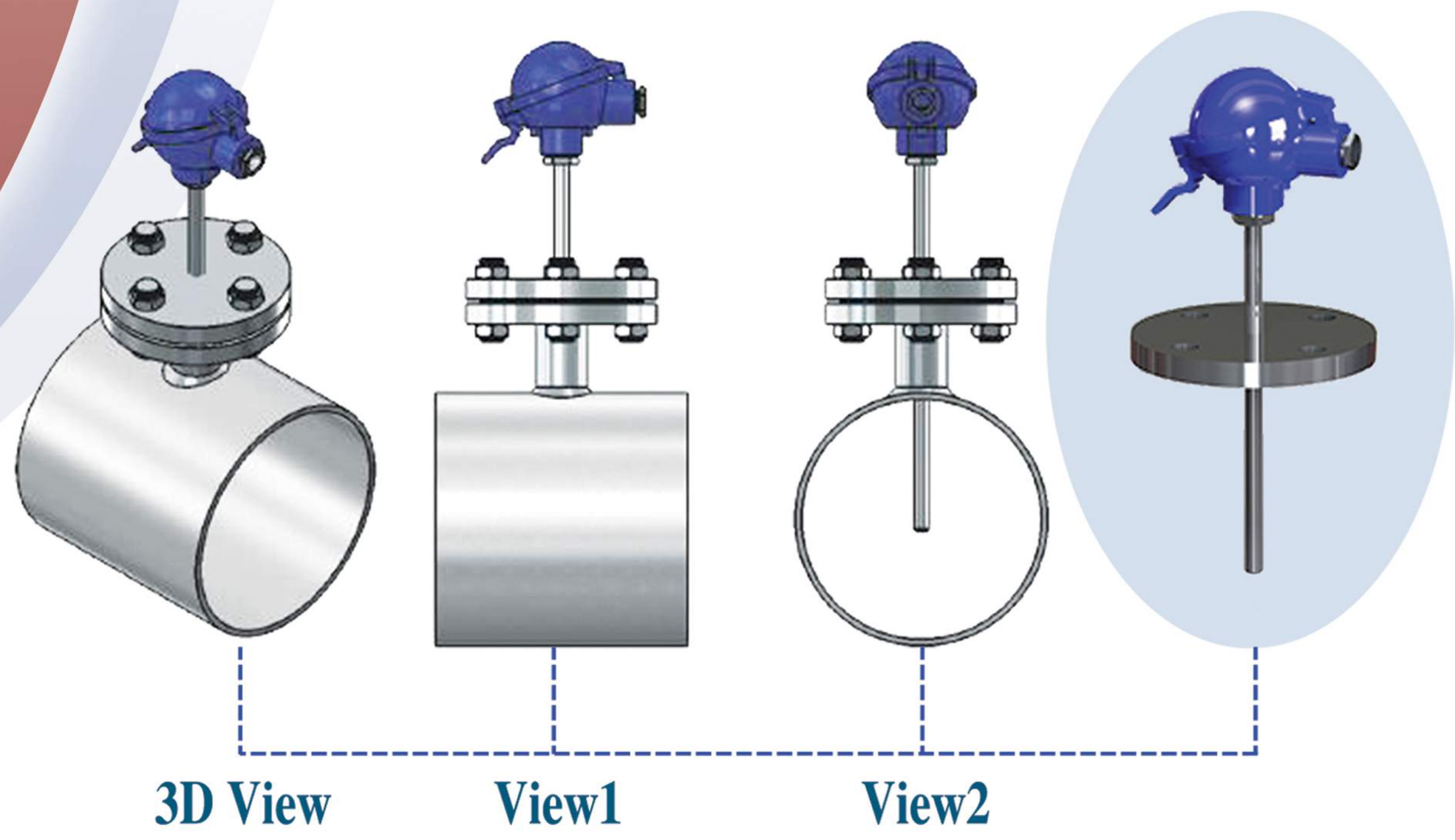
Thermocouple

Introduction To Thermocouple

Temperature is one of the most measured of the physical quantities, so measuring it correctly is important.If there is temperature gradient in an electrical conductor, the energy (heat) flow is associated with an electron flow along the conductor, and an electromotive force (emf) is then generated in that region. Both the size and direction of the emf are dependent on the size and direction of the temperature gradient itself – and on the material forming the conductor. The voltage is a function of the temperature difference along the conduc--tor length. For the historians among you, this effect was discovered by TJ seebeck in 1822.The output voltage of a single conductor, as shown, is not, however, normally measurable since the sum of the inte--rnal emfs around a completed circuit in any temperature situation is zero. So, in a practical thermoco--uple temperature sensor, the trick is to join two materials having different thermoelectric emf/ tem--perature characteristics in order to produce a usable net electron flow and a detectable net output voltage. Thus, two connected dissimilar conductors, a and b, are exposed to the same temperature gradients. basically, there is a net electron flow across the junction caused by the different thermo--electric emfs, in turn resulting from the interaction of the gradient with the two different conductors.

Thermocouple Types

Many combinations of materials have been used to produce acceptable thermocouples, each with its own particular application spectrum. However, the value of interchangeability and the econo--mics of mass production have led to standardisation, with a few specific types now being easily available, and covering by far the majority of the temperature and environmental applications.



Style T1
Ceramic Insulated Thermocouple Element

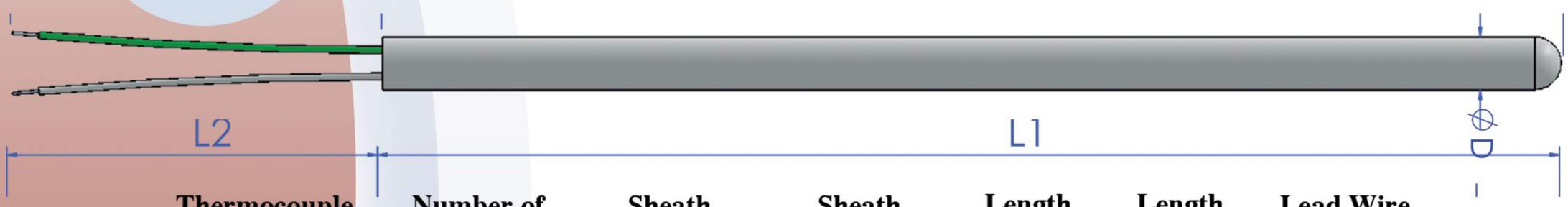
These are suitable for general use and as replacement elements for industrial and hightemperature thermocouples. Type 1 assemblies are available for thermocouple conductor combination codes K, T, J, N with insulators in Alumina. The length of insulators is 25mm,50 mm or 100mm depending on the application and availability. Insulators with 4 bores are available for duplex applications, please consult us for further details.

Style No	Thermocouple Type (Table 1)	Number of wire (Table 2)	Sheath Material (Table3)	Sheath Diameter (mm)	Length (mm)	Junction (Table 6)
T1						

How to Order

Sample: T1 -K-2Wires-304-6mm-500mm-UG

Style T2
Thermocouple without End Seal



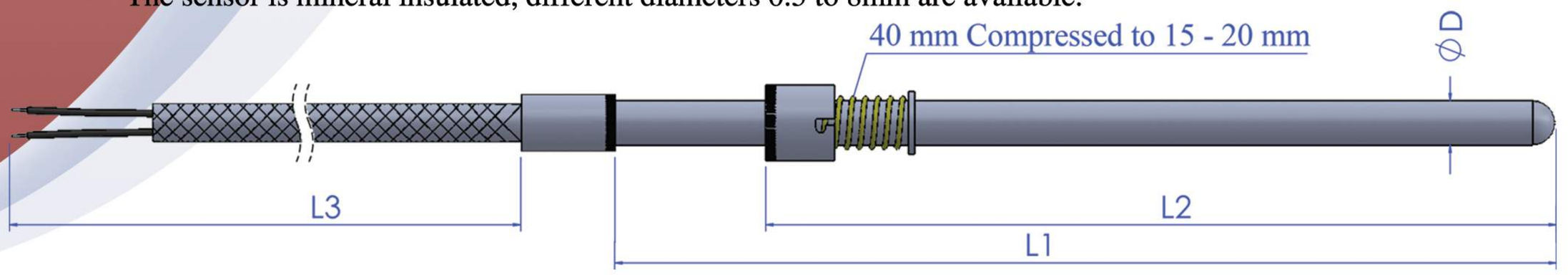
Style No	Thermocouple Type (Table 1)	Number of wire (Table 2)	Sheath Material (Table3)	Sheath Diameter (mm)	Length L1 (mm)	Length L2 (mm)	Lead Wire (Table5)	Junction (Table 6)
T2								

How to Order

Sample: T2 -E-2Wires-304-6mm-500mm-300mm-02-UG

Style T3
Bayonet Thermocouple

Suitable for different industries, these assemblies are available in thermocouple conductor combination codes K, T, J , N with an industry standard one slot adjustable bayonet cap fitting. The fitting can be fined tuned for positioning o n site and is suitable where several applications in your plant require individual positioning of the assembly. The sensor is mineral insulated, different diameters 0.5 to 8mm are available.



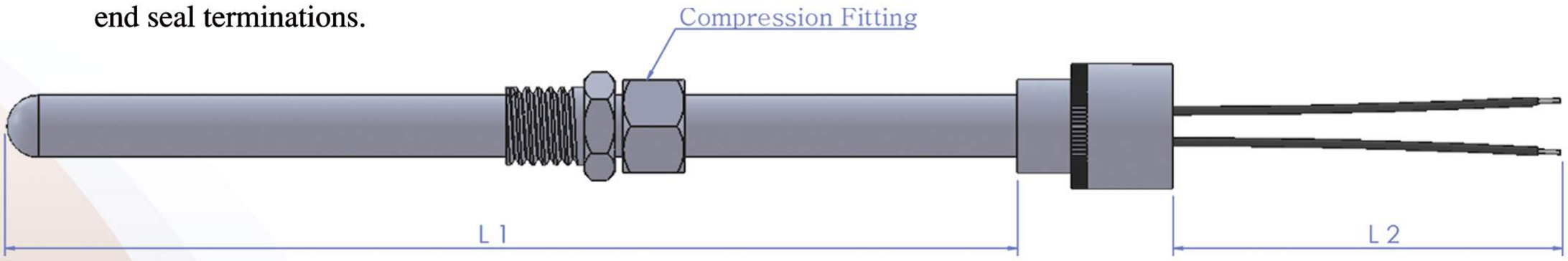
Style No	Thermocouple Type (Table 1)	Number of wire (Table 2)	Sheath Material (Table3)	Sheath Diameter D (mm)	Length L1 (mm)	Length L2 (mm)	Length L3 (mm)	Lead Wire (Table 5)	Junction (Table 6)
T3									

How to Order

Sample: T3 -K-4Wires-304-8mm-400mm-300mm-1200mm-06-UG

Style T4
Mineral Insulated Metal Sheathed Thermocouple

The most popular type of available thermocouples, they have a wide temperature operating range, can be bent, twist ed or flattened without impairing performance and are available in a wide variety of sheath materials, diameters and end seal terminations.



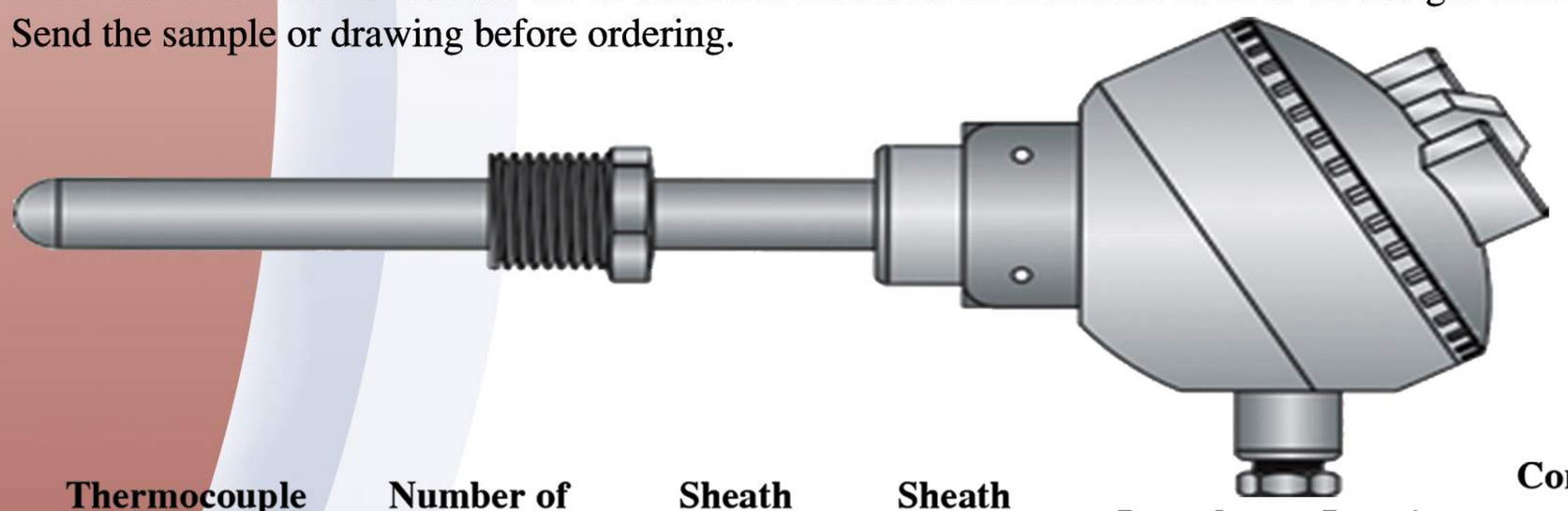
Style No	Thermocouple Type (Table 1)	Number of wire (Table 2)	Sheath Material (Table3)	Sheath Diameter (mm)	Length L1 (mm)	Length L2 (mm)	Lead Wire (Table5)	Junction (Table6)
T4								

How to Order

Sample: T4 -K-4Wires-304-8mm-400mm-300mm-05-UG

Style T5
Heavy Duty Metal Sheathed Thermocouple

These assemblies are suited for use in differernt industrial environment such as oil and gas industries and furnaces. Send the sample or drawing before ordering.



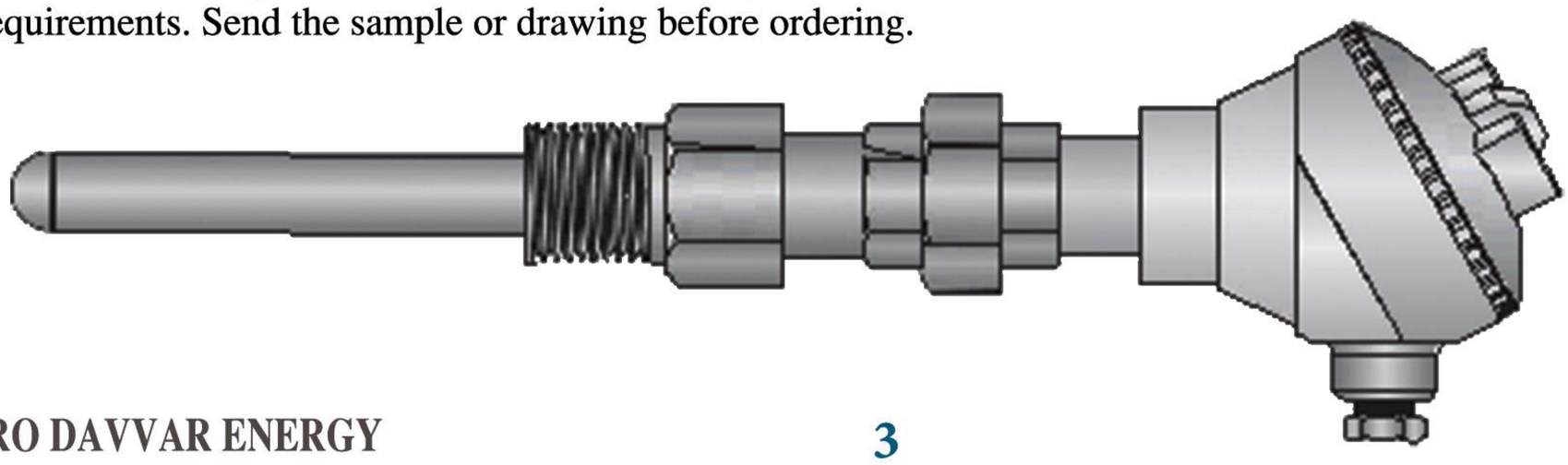
Style No	Thermocouple Type (Table 1)	Number of wire (Table 2)	Sheath Material (Table3)	Sheath Diameter (mm)	Length (mm)	Junction (Table 6)	Compression Fitting or Nut Nipple Size (Table 7)
T5							

How to Order

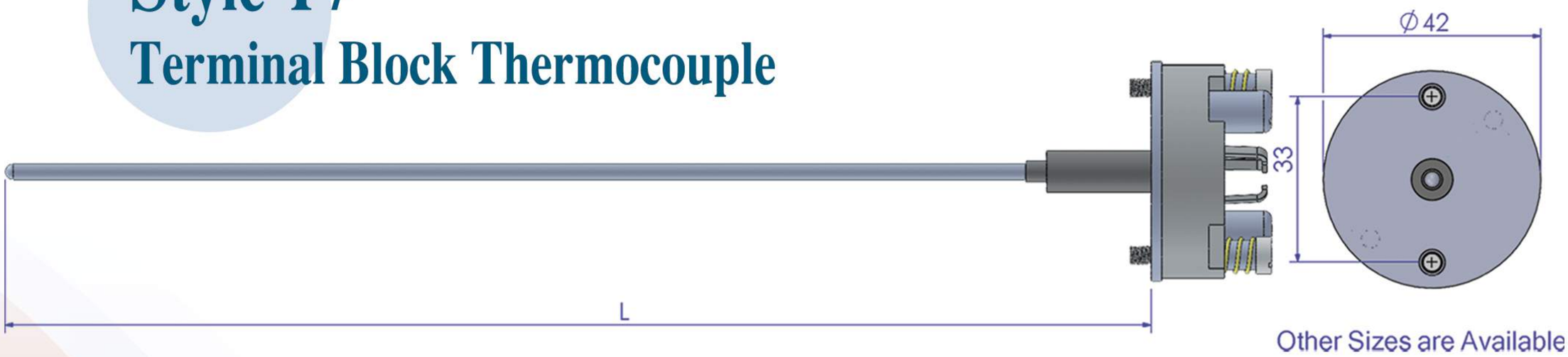
Sample: T5 -J-4Wires-304-8mm-300mm-UG-M8

Style T6
Thermocouple, Thermowell, Extension Piece & Terminal Head Assemblies

These thermocouples are available in a wide range of dimensions and materials, custom assembled to your exact requirements. Send the sample or drawing before ordering.



Style T7
Terminal Block Thermocouple



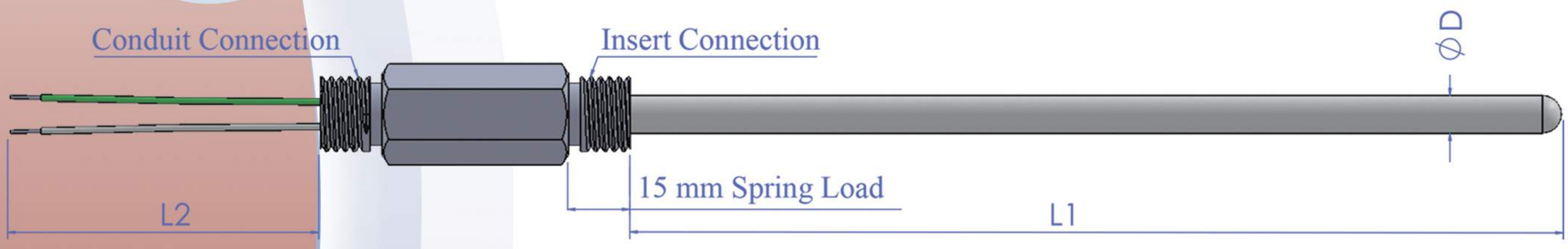
Other Sizes are Available

Style No	Thermocouple Type (Table 1)	Number of wire (Table 2)	Sheath Material (Table3)	Sheath Diamete (mm)	Length L (mm)	Junction (Table 6)
T7						

How to Order

Sample: T7 -K-4Wires-304-5mm-110mm-UG

Style T8
Spring Load Thermocouple

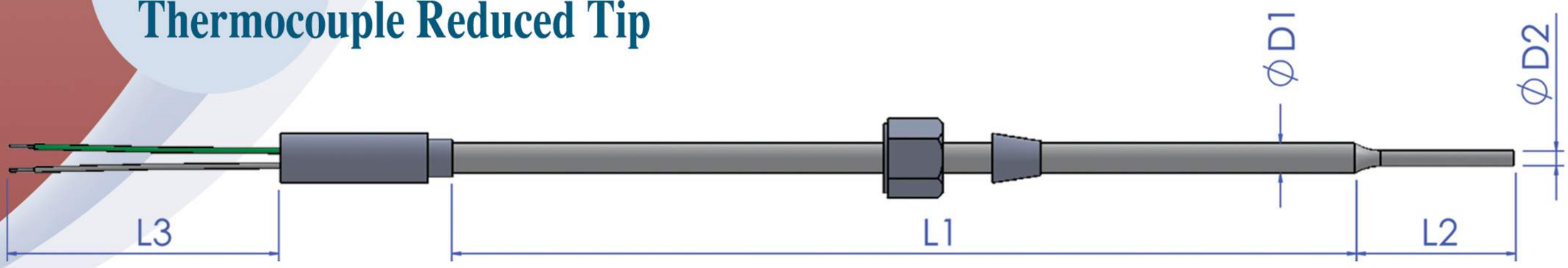


Style NO	Thermocouple Type (Table 1)	Number of wire (Table 2)	Sheath Material (Table3)	Sheath Diameter (mm)	L_1 (mm)	L_2 (mm)	Conduit Connectio Thread	Insert Connection Thread	Lead Wire (Table5)	Junctio (Table 6)
T8										

How to Order

Sample: T8 -K-4Wires-304-8mm-400mm-150mm-M20 x 1.5-1/2" NPT-04-UG

Style T9
Thermocouple Reduced Tip

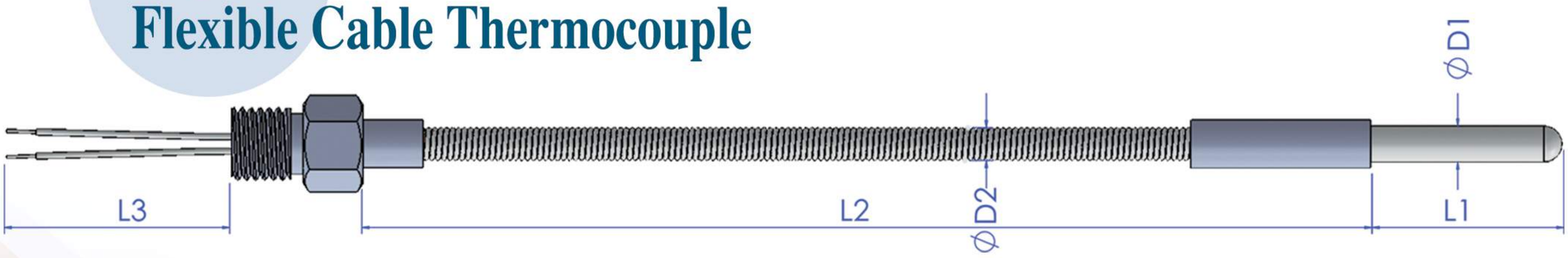


Style No	Thermocouple Type (Table 1)	Number of wire (Table 2)	Sheath Material (Table3)	Sheath Diameter D1	Sheath Diameter D2	L1 (mm)	L2 (mm)	End Seal	Wire Length L3 (mm)	Lead Wire (Table5)	Junction (Table6)	Cmpression Fitting or Nut Nipple (Table7)
T9												

How to Order

Sample: T9 -K-2Wires-304-6mm-3mm-120mm-25mm-P2 -50mm-04-UG-02

Style T10
Flexible Cable Thermocouple

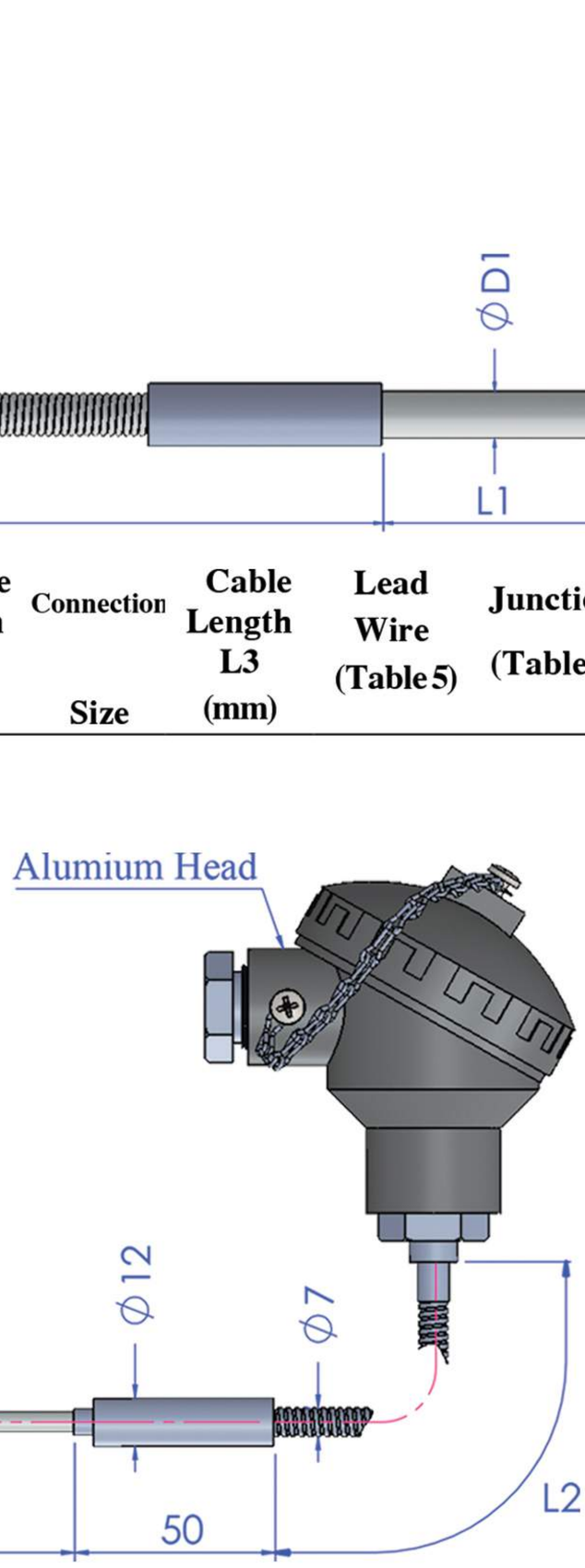


Style No	Thermocouple Type (Table 1)	Number of wire (Table 2)	Sheath Material (Table3)	Sheath Diameter D1 (mm)	Probe Length L1 (mm)	Flexible Diameter (mm)	Flexible Length L2 (mm)	Connection Size	Cable Length L3 (mm)	Lead Wire (Table 5)	Junction (Table 6)
T10											

How to Order

Sample: T10 -K-2Wires-304-8mm-35mm-6mm-1100mm-1/2" BSPP-150mm-UG

Style T11
Skin Thermocouple



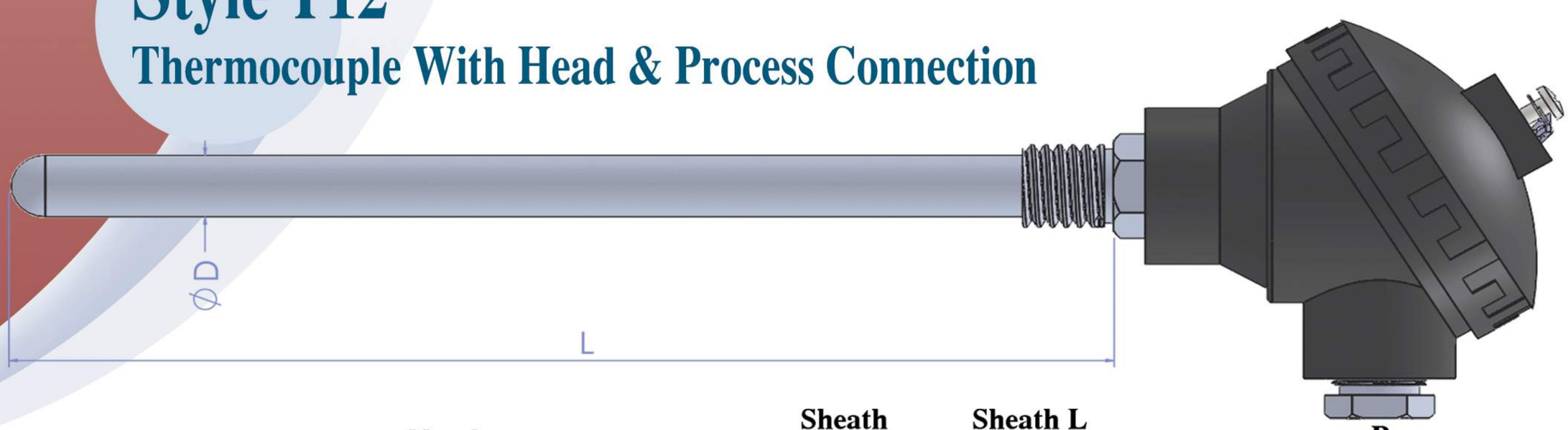
Style No	Thermocouple Type (Table 1)	Number of Cable (Table 2)	Sheath Material (Table3)	Sheath Diameter D (mm)	Probe Length L1 (mm)	Flexible Length L2 (mm)	Plate Size (mm) (A x B x T*)	Junction (Table 6)
T11								

How to Order

Sample: T11 -K-2Wires-304-8mm-1000mm-2000mm-1100mm-25 x 25 x 3 -UG

Note *: T isthe Thickness of the Plate

Style T12
Thermocouple With Head & Process Connection

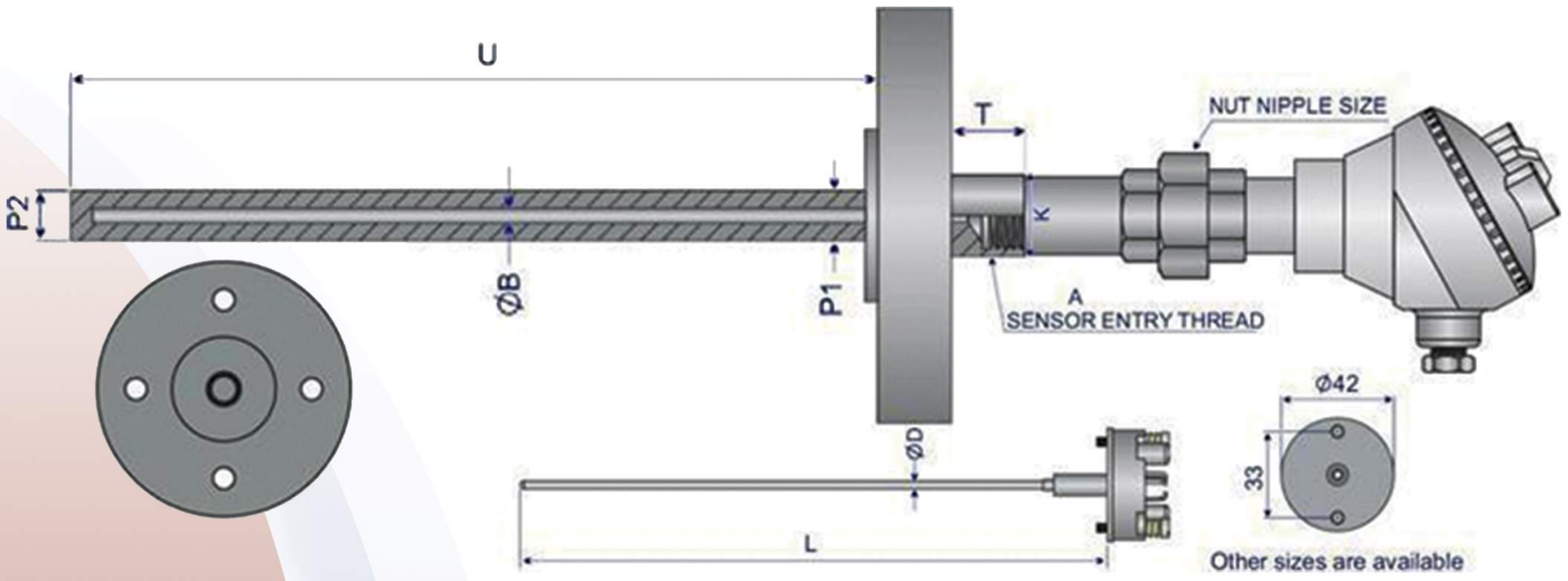


Style No	Thermocouple Type (Table 1)	Number of Wire (Table 2)	Sheath Material (Table3)	Sheath Diameter D (mm)	Sheath L engtth L (mm)	Junction (Table 6)	Process Connection (Table 7)
T12							

How to Order?

Sample: T12 -K-2Wires-304-6mm-1100mm-UG-1/2 NPT

Style T13
Thermocouple With Flanged Thermowell



Style No	Thermocouple Type (Table 1)	Number of wire (Table 2)	Sheath Material (Table 3)	Sheath Diameter D (mm)	Sheath Length L (mm)	Junction (Table6)	Compression Fitting or Nut Nipple (Table 7)
T_{13}							

Thermowell Cap	Flange size &class	Shea Material (Table3)	Sensor Entry Thread (A)	Insertion Length (U)	Thermowell Bore di ameter (B)	Hex Lenght (T)	Hex diameter (K)	Root diameter (P1)	Tip diameter (P2)
.....									

How to Order?

Sample: T13 -K-2Wires-316-6mm-900mm-UG-1/2 NPT

S-2"#150 RF-321-1/2 NPT-500mm-6mm-22mm-32mm-25mm-19mm

Thermocouple Wires

These thermocouples are made to conform to an emf/ temperature relationship specied in the form of tabulated values of emfs resolved normally to 1 ìv against temperature in 1°C intervals, and vice versa. Internationally, these reference tables are published as IEC 60584.1 (BS EN 60584.1). it is worth noting here, however, that the standards do not address the construction, or insulation of the cables themselves or other performance criteria. With the diversity to be found, manufacturers own standards must be relied upon in this respect.As a brief summary, thermocouple temperature ranges and material combinations are given in table 1.

Thermocouple grade wire is used in construction of a thermocouple temperature sensor.

Thermocouple extension wire is used to carry the signal from the thermocouple sensor to the readout device while maintaining a high degree of accuracy. The extension wire material must match the material used in the positive and negative leg of the thermocouple type (e.g. type K) being used in the application.

If a transmitter is installed within the thermocouple sensor assembly, copper wire is typically used in place of thermocouple extension wire to send the scalable (4 to 20) mA signal back to the process control equipment.

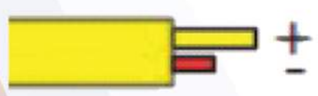
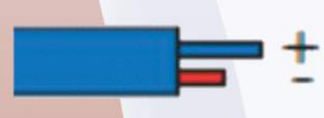
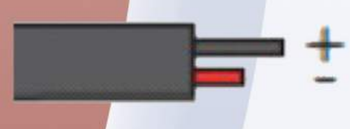
THERMO-COUPLE TYPE	U.S. & CANADIAN (ANSI/MC96.1,ANSI/ASTM E230)			International	Czech British	Netherlands German	Working Temperature	Tolerance for Class1
	ALLOY COMBINATION	THERMOCOUPLE GRADE	EXTENSION GRADE	IEC 584-3	BS 1843	DIN 43710	CONTINUOUS °C	
T	Copper / Constantan (Copper-Nickel)	Brown, Blue, Red, + -	Blue, Blue, Red, + -	Brown, Brown, White, + -	Blue, White, Blue, + -	Brown, Red, Brown, + -	-185 to +300	-40ºC to +125ºC ±0.5ºC 125ºC to 350ºC ±0.004 ·|t|
J	Iron (magnetic) / Constantan (Copper-Nickel)	Brown, White, Red, + -	White, Black, Red, + -	Black, Black, White, + -	Black, Yellow, Blue, + -	Blue, Red, Blue, + -	+20 to +700	-40ºC to +375ºC ±1.5ºC 375ºC to 750ºC ±0.004 ·|t|
E	Nickel - Chromium / Constantan (Copper-Nickel)	Brown, Purple, Red, + -	Purple, Purple, Red, + -	Purple, Purple, White, + -	Brown, Brown, Blue, + -	Black, Red, Black, + -	0 to +800	-40ºC to +375ºC ±1.5ºC 375ºC to 800ºC ±0.004 ·|t|
K	Nickel - Chromium / Nickel - Aluminium (magnetic)	Brown, Yellow, Red, + -	Yellow, Yellow, Red, + -	Green, Green, White, + -	Red, Brown, Blue, + -	Green, Red, Green, + -	0 to +1100	-40ºC to +375ºC ±1.5ºC 375ºC to 1000ºC ±0.004 ·|t|
N	Nicrosil (Nickel-Chrominium-Silicon) / Nisil (Nickel-Silicon-Magnesium)	Brown, Orange, Red, + -	Orange, Orange, Red, + -	Pink, Pink, White, + -	Orange, Orange, Blue, + -	No Standard (Use American Color Codes)	0 to +1150	-40ºC to +375ºC ±1.5ºC 375ºC to 1000ºC ±0.004 ·|t|
S	Platinum Rhodium - 10% / Platinum	None Established	Black, Green, Red, + -	Orange, Orange, White, + -	Green, White, Blue, + -	White, Red, White, + -	0 to +1550	0ºC to +1100ºC ±1.0ºC 1100ºC to 1600ºC ±(1+0.003(t·1100)ºC
R	Platinum Rhodium - 13% / Platinum	None Established	Black, Green, Red, + -	Orange, Orange, White, + -	Green, White, Blue, + -	White, Red, White, + -	0 to +1600	0ºC to +1100ºC ±1.0ºC 1100ºC to 1600ºC ±(1+0.003(t·1100)ºC

Table 1: Guide To Thermocouple

2 Wires	4 Wires	6 Wires
Single	Duplex	Triplex

Table 2: Number of Thermocouple Wire

Thermocouple Wires

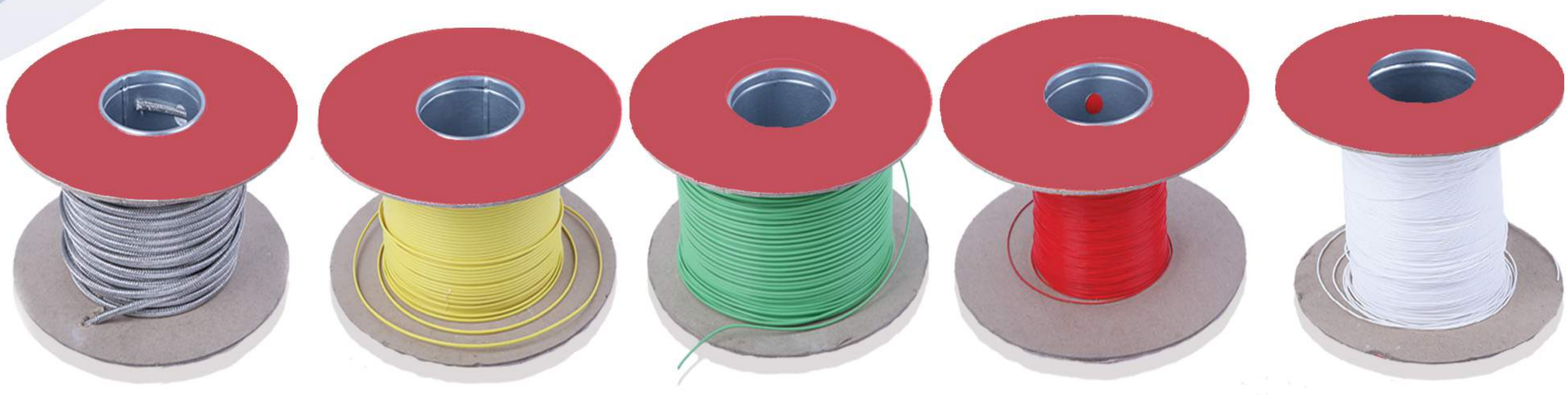
ANSI Code	ANSI Color Code	Positive (+) Leads	Negative (-) Leads	Temperature Range	Initial Calibration Tolerances	
					Standard	Special
JX		Iron	Constantan (45% Nickel, 55 % Cupper)	0~200°C	±2.2°C	±1.1°C
KX		Chromel (90%Nickel, 10%Chromium)	Alumel (95% Nickel, 2% Aluminum, 2% Manganese, 1% Silicone)	0~200°C	±2.2°C	±1.1°C
EX		Chromel (90%Nickel, 10%Chromium)	Constantan (45% Nickel, 55 % Cupper)	0~200°C	±1.7°C	±1.1°C
TX		Copper	Constantan (45% Nickel, 55 % Cupper)	0~100°C	±1.0°C	±0.5°C
NX		Nicrosil (84.6% Nickel, 4% Chromium, 1.4% Silicone)	Nisil (95.6% Nickel, 4.4% Silicone)	0~200°C	±2.2°C	±1.1°C
RX		Copper	Copper Alloy	0~200°C	±5.0°C	N/A
SX		Copper	Copper Alloy	0~200°C	±5.0°C	N/A
BXt		Copper	Copper	0~100°C	±3.7°C	N/A

How to Order

Sample: THEC-KX-2 Wire-, 2 Wire, PTFE/PTFE Cable

Table1.1: Type of Thermocouple Cable

THEC	Type of Thermocouple Cable (Table 1 &1.1)	Number of Wire (Table 2)	Lead Wire Material (Table 3)



Thermocouple Wires

01	PVC/PVC Cable		PVC Sheathed Wire With PVC Jacket ratedto 105 °C
02	PTFE/PTFE Cable		PTFE Sheathed Cable With PTFE Jacket rated to 250 °C
03	PTFE/Armor PTFE Cable		PTFE Sheathed Cable With Armor PTFE Jacket rated to 250 °C
04	PTFE/Armor Fiberglass Cable		PTFE Sheathed Wire With Overall Fiber Armor Jacket rated to 250 °C
05	Fiberglass/Fiber glass Cable		Fiberglass Sheathed Wire With Overall Fiber Jacket rated to 480 °C
06	Fiberglass/Ar mor Fiberglass Cable		Fiberglass Sheathed Wire With Overall Fiber Armor Jacket rated to 480 °C
07	Kapton/ KaptonCable		Kapton Sheathed Wire With Overall Kapton Jacket rated to 300 °C
08	Silicone Sheathed		Silicone Rubber Insulated up to 200 °C

Note 1: Standard AWG Size for Thermocouple Wire: AWG20 (2×7/0.3) (IF Not Please Specify)
Note 2: for Type of Thermocouple, type of Cable we have are KX, TX, JX, NX, EX.

Table 5 : Thermocouple Wires

Thermocouple Sheath Material

Code	Material Specifications	Operational Properties	Max. Temp.
304	**Grade 304 Stainless Steel** WN : 1.4304	Good Corrosion Resistance about Water	**700 °C**
321	**Grade 321 Stainless Steel** WN : 1.4321	Heat Resisting	**900 °C**
316 L	**Grade 316LStainless Steel** WN : 1.4404	Very good corrosion resistance high ductility.	**800 °C**
310	**Grade 310 Stainless Steel** WN : 1.4845	Good high temperature corrosion resistance and suitable for use in Sulphur bearing atmospheres. High oxidation resistance.	**1100 °C**
600	**Inconel 600** WN : 2.4816	Used in severely corrosive atmospheres to elevated temperatures. Good resistance to oxidation.	**1100 °C**
800	**Incoloy 800** Iron/Nickel/Chromiumalloy WN: 1.4876	Used in severely corrosive atmospheres to elevated temperatures. Good resistanceto oxidation and carburisation. Resistant to Sulphur bearing atmospheres.	**1100 °C**
825	**Incoloy 825** WN: 2.4858	Highly resistant to corrosion and oxidising conditions. useful when used In acidic environments.	**1250 °C**
900	**Ceramic Alumina 99% (ker 710)**	Highly resistant to high temperature	**1400°C**
950	**Silicon Carbide**	Good resistant to temperatures and higher chemical corrosion resistance than ceramic	**1600°C**

Standard

Table3 : Sheath Materials Description

Types of Thermocouple End Seal Configuration

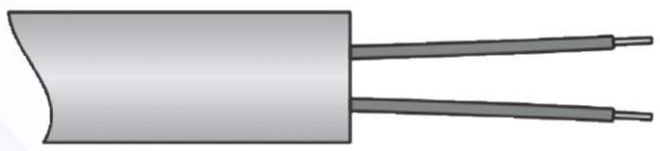
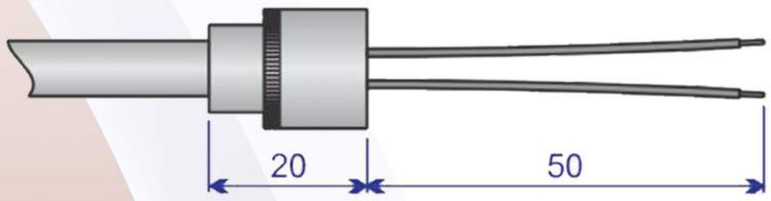
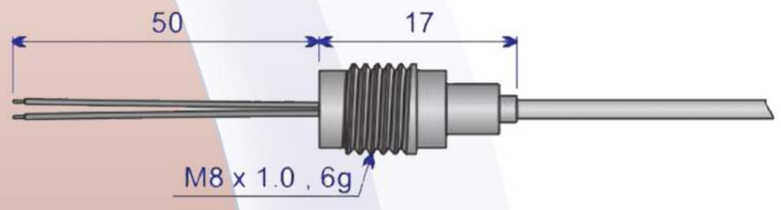
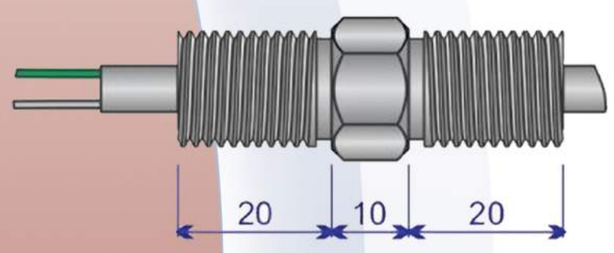
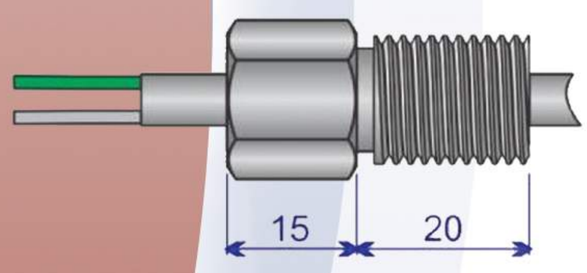
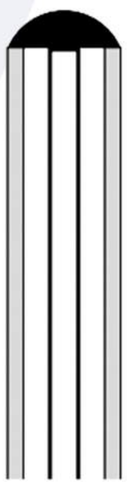
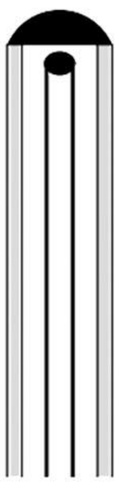
Code	Photo	Description
P1		Supplied as standard with bare conductors as long as customer needs. Plain internal epoxy resin seal.
P2		Crimp on stainless steel pot seal with PTFE sleeved solid tails 50 mmlong. Potted with resin.
P3		Crimp on stainless steel pot seal (M8 x 1mm) with PTFE sleeved solid tails 50 mm long. Potted with resin.
P4		Stainless SteelDouble Connection Welded Pot seal With Screw(½ × ½ Standard size With 50mm PTFE Cable)
P5		Stainless Steel Compression Gland Pot seal (Standard size ½ Inch With 50 mm PTFE Cable)

Table4: Types of End Seal Configuration

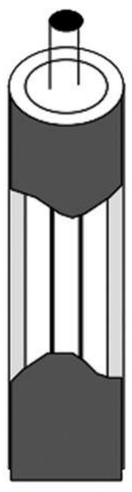
Thermocouple Junction



Grounded Thermocouple Junction



Ungrounded Thermocouple Junction



Exposed Thermocouple Junction

Code	Compression fitting or nut & nipple
01	M8
02	M10
03	M12
04	M16
05	1/2 NPT

Table7: Compression Fitting

Calibration Report

PETRO DAVVAR ENERGY	**Thermocouple Calibration Report**	Date: 1400/04/16 Report No: 211041-C Page: 1

Part Name: Thermocouple Type K 4wire	**Client:** RAMINPOWE
Project No: PD-MF211041	**Serial No:** 191752
OEM P/N: ----	**Order No.:** 99/202

Calibration Range: 150 to 450 (ºC)

Ambient Temperature: 21 (ºC)

Measurement Standard Used: To IEC60584

Humidity: 10% RH

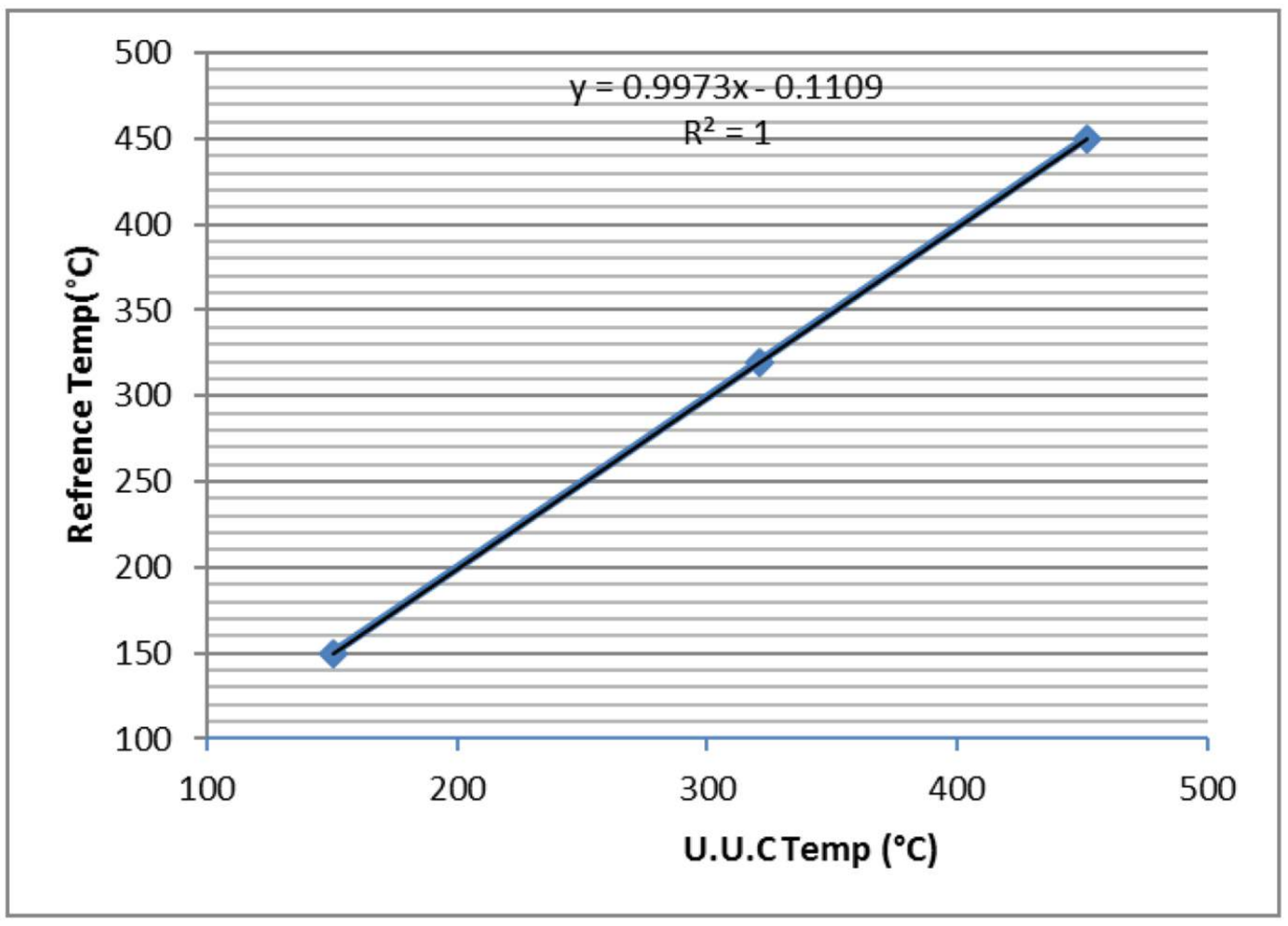
Calibration Device: Dry Block Calibrator BX-150 & Thermocouple Calibrator (UT 713) & INSTEC GOM 801H

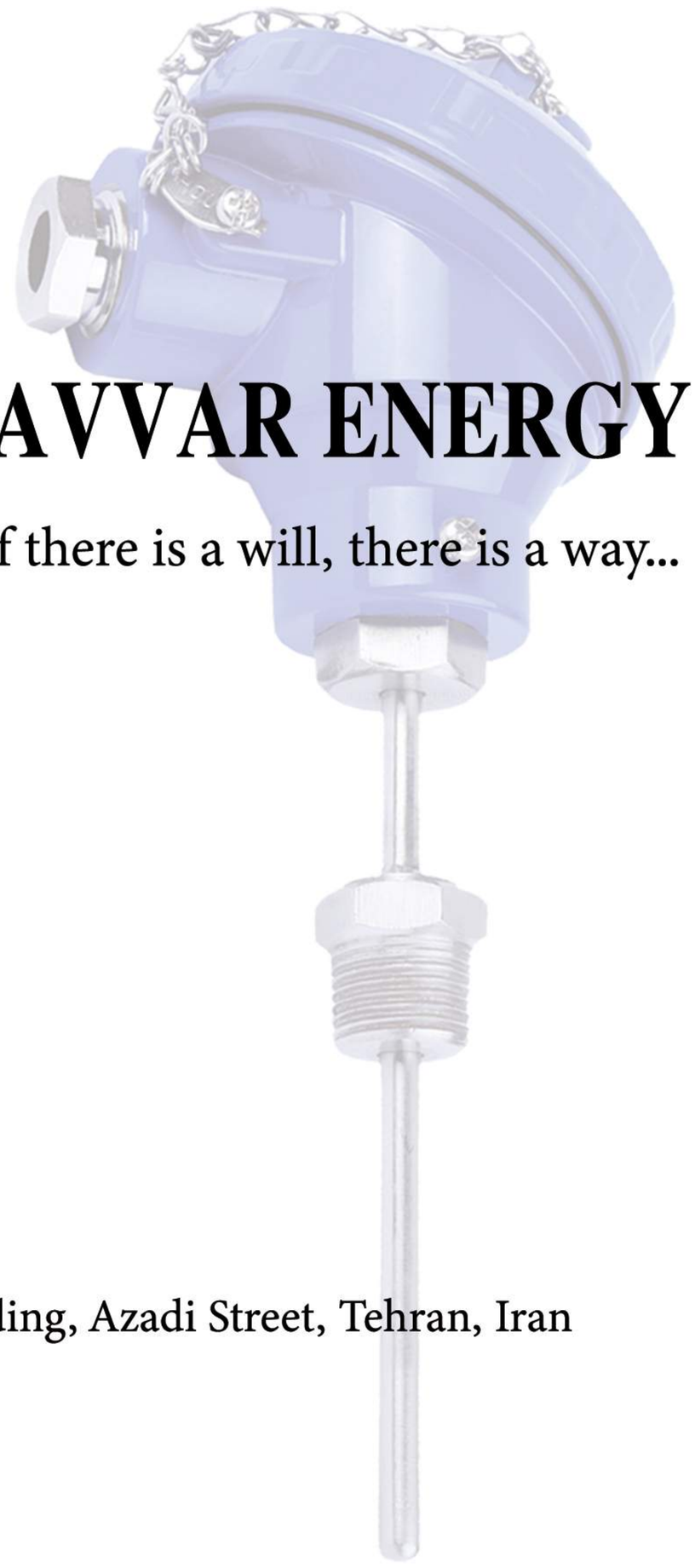
Measurement Uncertainty: Measurement uncertainty is estimated according to EA-4/02

Traceability: To IEC60584.1:1995/BS EN 60584.1 Part 4: 1996 (ITS-90)

The International Temperature Scale of 1990 (ITS-90)

Set Point (°C)	Reference (°C)	U.U.C. (°C)	Error (°C)
150	**150.1**	**150.6**	**0.5**
320	**320.0**	**320.9**	**0.9**
450	**450.1**	**451.4**	**1.3**





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