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CLEVELAND ELECTRIC LABORATORIES

Thermocouples & Sensing Solutions since 1920

WARRANTY

Cleveland Electric Laboratories backs its products against defects and will repair or replace defective products returned to us freight prepaid. Excluded from this Warranty is equipment deterioration resulting from normal use, defects due to negligence, misuse, improper installation, accident or unauthorized alteration or repair by the purchaser. Full or partial credits for defective materials will be issued only after our inspection and evaluation.

THE CLEVELAND ELECTRIC LABORATORIES
1776 Enterprise Parkway • Twinsburg, Ohio 44087
Office: 330-425-4747 • Fax: 330-425-7209
E-mail: info@thermocouple.cc • Web Site: www.clevelandelectriclabs.com
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CLEVELAND ELECTRIC LABORATORIES
Thermocouples & Sensing Solutions since 1920

Thermocouple Codes: Conductor Combinations and Characteristics

ANSI CODE	CONDUCTOR COMBINATIONS		TEMP. RANGE	LIMITS OF ERROR		APPLICATION INFORMATION
	POSITIVE + LEG	NEGATIVE – LEG		STANDARD	SPECIAL	
TYPE **J**	IRON (magnetic) WHITE +	CONSTANTAN RED –	32 to 1400°F (0 to 760°C)	±4°F or ±0.75% whichever is greater	±2°F or ±0.4% whichever is greater	Suitable for vacuum, reducing, or inert atmospheres. Reduced life in oxidizing atmosphere. Iron oxidizes rapidly above 1000°F (538°C) so only heavy gauge wire is recommended for high temperature. Bare elements should not be exposed to sulfurous atmospheres above 1000°F (538°C).
TYPE **K**	CHROMEL YELLOW +	ALUMEL (magnetic) RED –	32 to 2300°F (0 to 1260°C)	±4°F or ±0.75% whichever is greater	±2°F or ±0.4% whichever is greater	Recommended for continuous oxidizing or neutral atmospheres. Mostly used above 1000°F (530°C). Subject to failure if exposed to sulfur. Preferential oxidation of chromium in positive leg at certain low oxygen concentrations causes "green rot" and large negative calibration drifts most serious in the1500-1900°F range.
TYPE **T**	COPPER BLUE +	CONSTANTAN RED –	32°F to 700°F (0 to+370°C)	±2°F or ±0.75% whichever is greater	±1°F or ±0.4% whichever is greater	Useable in oxidizing, reducing, or inert atmospheres, as well as vacuum. Not subject to corrosion in moist atmospheres.
TYPE **E**	CHROMEL PURPLE +	CONSTANTAN RED –	32 to 1600°F (0 to 871°C)	±3°F or ±0.5% whichever is greater	±2°F or ±0.4% whichever is greater	Recommended for continuously oxidizing or inert atmospheres. Highest thermoelectric output of common calibration.
TYPE **S** TYPE **R**	PLATINUM-10% Rhodium BLACK PLATINUM-13% Rhodium +	PLATINUM RED PLATINUM –	32 to 2700°F (0 to 1480°C)	±2.7°F or ±0.25% whichever is greater	±1°F or ±0.1% whichever is greater	Recommended for high temperature. Must be protected with non-metallic protection tube and ceramic insulators. Continued high temperature usage causes grain growth which can lead to mechanical failure. Negative calibration drift caused by rhodium diffusion to pure leg as well as from rhodium volatilization.
TYPE **B**	PLATINUM-30% Rhodium GREY +	PLATINUM 6% Rhodium RED –	1600 to 3100°F (871 to 1705°C)	±0.5%	±0.25%	Same as S & R but output is lower. Also less susceptible to grain growth and drift.
TYPE **N**	NICROSIL ORANGE +	NISIL (magnetic) RED –	32 to 2300°F (0 to 1260°C)	±4°F or ±0.75% whichever is greater	±2°F or ±0.4% whichever is greater	Nicrosil/Nisil nickel-based thermocouple alloy used primarily at high temperature (up to 2300°F). While not a direct replacement for Type K, Type N provides better resistance to oxidation at high temperature and longer life in applications where sulfur is present.
TYPE **C**	TUNGSTEN 5% Rhenium GREEN +	TUNGSTEN 26% Rhenium RED –	32 to 4200°F (0 to 2330°C)	±8°F or ±1.0% whichever is greater	Not Available	This refractory metal thermocouple may be used at temperatures up to 4200°F (2315°C). As it has no oxidation resistance its use is restricted to vacuum, hydrogen or inert atmospheres.

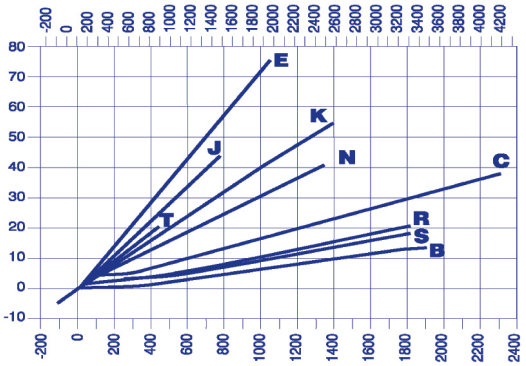
** Special tolerances for temperatures below 32°f are difficult to validate due to limited available information. The following values for **Types E and T** thermocouples are suggested as a guideline for discussion between the customer and Cleveland Electric Labs.

Tolerance values for **Type J** thermocouples at temperatures below 32°f and special tolerances for Type K thermocouples below 32°F are not given due to the nature of the material.

Type E -320 to 32°F ± 2°F or ±0.5% (whichever is greater)
Type T -320 to 32°F ± 1°F or ±0.8% (whichever is greater)

Temperature in °F

THERMOCOUPLE TEMPERATURE EMF GRAPH



Temperature in °C

ANSI SYMBOL

T Copper vs. Constantan
E Chromel vs. Constantan
J Iron vs. Constantan
K Chromel vs. Alumel
S Platinum 10% Rhodium vs.Platinum
R Platinum 13% Rhodium vs.Platinum
B Platinum 30% Rhodium vs. Platinum 6% Rhodium
N Nicrosil vs. Nisil
C Tungsten 5% Rhenium vs. Tungsten 26% Rhenium

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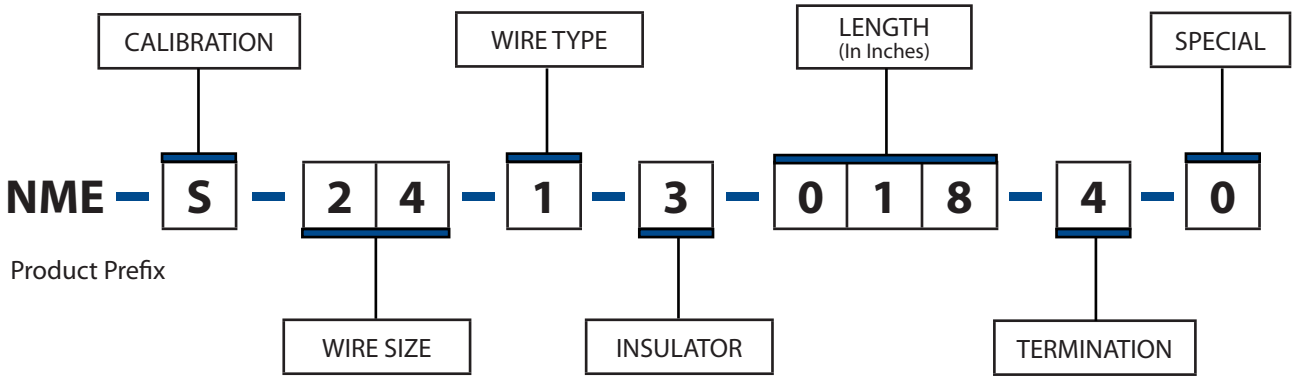
How to use the Cleveland Electric Laboratories Ordering Number System

Each product section in this catalog contains a table that lists the specifications for each component of the featured product. Every specification has a code that is used in a "box" format to create an Ordering Number. To order, fill in each Ordering Number box with the appropriate specification code. This series of numbers and letters will form the final Ordering Number.

Typical Ordering Number

A typical Ordering Number for a Noble Metal Element (NME) Thermocouple is shown below as an example.



The above Ordering Number specifies a Noble Metal Element (NME):

Plt.-Plt. 10% Rh. Type "S" Noble Element, .020": diameter wire size, Standard Grade Thermocouple wire type, in a 0.125" diameter Alumina insulator, 18" long, with fish spine beads and copper tips, no special requirements.

S	=	Plt.-Plt. 10% Rh. Calibration Type
24	=	.020" Diameter Wire Size (24GA)
1	=	Standard Grade Thermocouple Wire Type
3	=	0.125" OD Alumina Insulator
018	=	18" Length
4	=	Fish Spine Beads/Copper Tip Termination
0	=	No Special Requirements

How to order using a system other than ours

This catalog is designed to assist you in ordering the appropriate thermocouple, thermocouple components or accessories to meet your exact needs. However, if you are more comfortable with another vendor's ordering number system or with using a generic description, contact us with that information and we will help you identify your product requirements.

Noble Metal Thermocouples

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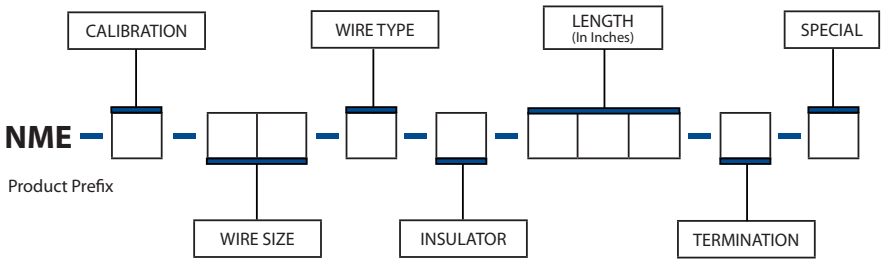
Noble Metal Thermocouples are available in a wide variety of configurations. Once a specific application is identified, the thermocouple can be built to order for peak performance. Available in single or multi-point assemblies, this series of products will perform well in applications of extreme temperatures, as high as 4200ºF. For information on material selection parameters for Protection Tubes and other components, please refer to the appropriate pages.

Noble Metal Elements (NME)

- Temperatures up to 4200°F
- Platinum / Rhodium elements in Standard, Reference, and Certified materials
- Type **S** and **R** used for short periods up to 3100°F, continuously up to 2700°F
- Type **B** for temperature up to 3100°F
- Type **C** and Tungsten/Rhenium elements up to 4200°F
- Platinel II is used up to 2300°F



Use Specification Codes below to assemble a complete Ordering Number.

Specifications/Codes

CALIBRATION	WIRE SIZE	WIRE TYPE	INSULATOR	LENGTH	TERMINATION	SPECIAL
S - Plt-Plt 10% Rh R - Plt-Plt 13% Rh B - Plt 6% Rh-Plt 30% Rh C - W 5% Re-W 26% Re F - Platinel G - Gold L - Silver	30 - .010 28 - .013 27 - .014 26 - .016 24 - .020 23 - .023 22 - .025 21 - .028 20 - .032 18 - .040 15 - .060 14 - .064 XX - Other	1 - Standard 2 - Reference Grade 3 - Stabilized	1 - Bare 2 - .125 OD Mullite 4 - .187 OD Mullite A - .187 OD Mullite w/Collar E - .200 OD Mullite G - .200 OD Mullite w/Collar 6 - .250 OD Mullite C - .250 OD Mullite w/Collar 3 - .125 OD Alumina 5 - .187 OD Alumina B - .187 OD Alumina w/Collar F - .200 OD Alumina H - .200 OD Alumina w/Collar 7 - .250 OD Alumina D - .250 OD Alumina w/Collar S - 1/16" OD Spaghetti 9 - 1/16" OD Alumina Ins. 8 - .150 OD x 1" Alumina M - .156 Alumina w/Collar T - Ceramic Braid-Twist U - Special Insulator	Specify from 000" to 999"	1 - Copper Tips 2 - Knife Clips/Glass Sleeving 3 - Fish Spine Beads Only 4 - Fish Spine Beads/CU Tips 5 - Fiber Glass Sleeve Only 6 - Bare Ends Only 7 - Mini Plug w/Tube Adapter 8 - Mini Plug w/Cable Clamps A - SHX Alumina Plug B - NHX Alumina Plug H - Hi-Temp. Mini Plug P - Hi-Temp. Plug w/Tube Adapter G - Male Plug (400 deg) Tube Adaptor J - HiTemp Jack/Tube Adaptor	0 - None C - Lot Certification D - Dual Element E - Individual Certification X - Special (Consult Factory) 2 - Dual Element Lot Certified

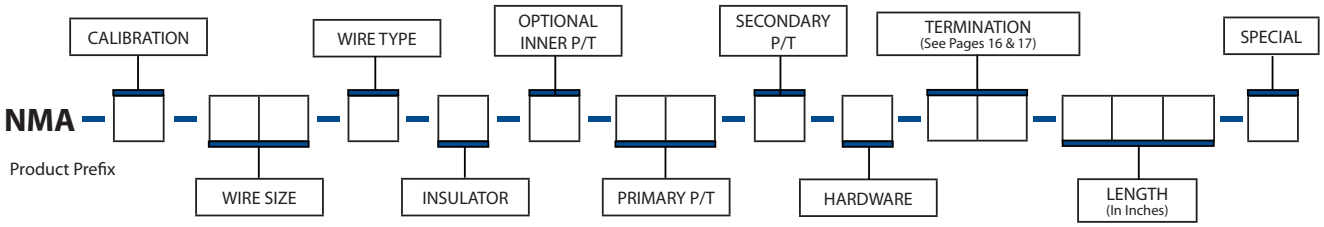
Type S
.020" dia. wire size
standard grade thermocouple wire type
in a 3/16" mullite insulator with collar
fish spine beads with copper tips, 18" length

NME – S – 24 – 1 – A – 018 – 4 – 0

Example Ordering Number

Noble Metal Assemblies (NMA)

- Numerous configurations for rigorous applications, temperatures up to 4200°F
- Careful component, wire, and gauge specifications will optimize every assembly
- Specifications and product code tables enable CEL users to make effective design decisions



Specifications/Codes

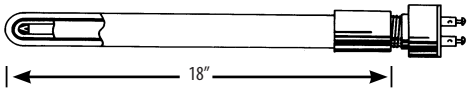
CALIBRATION	WIRE SIZE (Dia. In inches)	WIRE TYPE	INSULATOR	OPTIONAL INNER P/T	PRIMARY P/T	
S - Plt-Plt 10% Rh	30 - .010	1 - Standard	2 - .125 OD Mullite	0 - No Inner Tube	M9 - 1/8" x 3/16" OD Mullite	A8 - 1/4" x 3/8" OD Alumina
R - Plt-Plt 13% Rh	28 - .013	2 - Reference Grade	4 - .187 OD Mullite	3 - 5mm x 7mm Mullite	M2 - 3/16" x 1/4" OD Mullite	AA - 5/16" x 7/16" Alumna
B - Plt 6% Rh-Plt 30% Rh	27 - .014	3 - Stabilized	A - .187 OD Mullite w/Collar	1 - 1/4" x 3/8" Mullite	M5 - 5mm x 7mm Alumina	A3 - 3/8" x 1/2" OD Alumina
C - W 5% Re-W 26% Re	26 - .016		6 - .250 OD Mullite	4 - 5mm x 7mm Alumina	M8 - 1/4" x 3/8" OD Mullite	A6 - 7/16" x 11/16" OD Alumina
F - Platinel	24 - .020		C - .250 OD Mullite w/Collar	2 - 1/4" x 3/8" Alumina	M3 - 3/8" x 1/2" OD Mullite	AF - 11/16" Alumina. 3/4 Hex 3/4 SS
G - Gold	23 - .023		3 - .125 OD Alumina	5 - 5mm x 8mm Alumina	M6 - 7/16" x 11/16" OD Mullite	AH - 11/16" Alumina. w/1/2 x 3/4 Ftg.
L - Silver	22 - .025		5 - .187 OD Alumina	6 - 3/16 X 1/4" Alumina	MF - 11/16" Mullite 3/4 Hex 3/4 SS	AN - 11/16" Alumina w/3/4 Nipple (Close)
	21 - .028		B - .187 OD Alumina w/Collar		MH - 11/16" Mullite w/1/2 x 3/4 Ftg.	AS - 11/16" Alumina w/356 Slv.
	20 - .032		7 - .250 OD Alumina		MN - 11/16" Mullite w/3/4 Nipple (Close)	A4 - 1/2" x 3/4" OD Alumina
	18 - .040		D - .250 OD Alumina w/Collar		MS - 11/16" Mullite w/356 Slv.	A1 - 3/4" x 1" OD Alumina
	15 - .060		E - 1/16" OD Spaghetti		M4 - 1/2" x 3/4" OD Mullite	A7 - 1" x 1-1/4" Alumina
	14 - .064		U - Special Insulator		M1 - 3/4" x 1" OD Mullite	I4 - 1/4" OD Inconel Tubing
	XX - Other		M - .156 Alumina w/Collar		M7 - 1" x 1-1/4" Mullite	I5 - 3/16" OD Inconel Tubing
			N - .200 Alumina		A9 - 1/8" x 3/16" Alumina	H3 - Hexaloy
					A2 - 3/16" x 1/4" OD Alumina	HM - 3/8" x 11/16" Halsic "R"
					A0 - 3/16" x 5/16" OD Alumina	HL - 5/16" x 5/8" Halsic "R"
					A5 - 5mm x 7mm Alumina	

SECONDARY P/T		HARDWARE		LENGTH (In inches)	SPECIAL
0 - No Secondary	E - 3/4" x 1" Alumina	0 - No Hardware	A - Alloy Sleeve	Specify from 000" to 999"	0 - None
2 - Silicon Carbide w/o Collar	F - 1" x 1-1/4" Alumina	1 - Support Casting Assembly	B - 1/2" X Close Nipple		C - Lot Certification (Std.)
3 - 1/2" NPT Inconel	G - LT-1 Metal Ceramic	2 - Weatherproof Cover	C - Close Nipple		D - Dual Element
4 - 3/4" NPT Inconel	H - 1/4" NPT Inconel	3 - 1" Coupling	E - Hex Bushing, 3/4" NPT		E - Individual Certification
5 - 1" NPT Inconel	J - 1/2" NPT 446SS	4 - Adjustable Flange	F - W/P Cover w/Flange		F - Evacuate & Backfill
6 - 1/4" x 3/8" Mullite	K - 3/4" NPT 309	6 - St. Hex Bush/Alloy Sleeve	H - 1/2" Hex 1/2" Fitting		H - Effective Length
7 - 7/16" x 11/16" Mullite	L - 3/4" NPT 446SS	7 - Hex Bushing 1" NPT	P - 3/4" x 1-1/4" Hex Bushing		X - Special (Consult Factory)
8 - 1/2" x 3/4" Mullite	M - 3/4" NPT 310SS	8 - 3/4" Hex 3/4" Fitting	Q - 1" x 1-1/2" Hex Busing		5 - Split Flange
9 - 3/4" x 1" Mullite	S - Silicon Carbide w/Collar	9 - 3/4" x 1" St. Hex Fitting	R - 1/2" x 3/4" St. Hex Fitting		2 - Dual Element Lot Certified
A - 1" x 1-1/4" Mullite	T - 3/4" NPT 253 Alloy		T - Tapered Plug		
B - 1/4" x 3/8" Alumina	U - 3/8" NPT Inconel		W - 1-1/2" Hex Bushing		
C - 7/16" x 11/16" Alumina	W - 1/2" NPT 253 Alloy		X - 1/2" NPT Hex Bushing		
D - 1/2" x 3/4" Alumina	X - 3/4" NPT 304				

Example Ordering Numbers

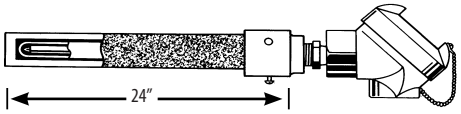
Platinum thermocouple assemblies with generic description and ordering

NME S-2 4-1-2-0-A S-0-0-B 1-0 1 8-0



Type S, .020" dia. assembly 7/16"x11/16" Alumina tube, 356 brass sleeve, open terminal head, 18" long.

NME S-2 4-1-3-0-A H-2-2-C 2-0 2 4-0



Type R, .020" dia. assembly 7/16"x11/16" Alumina primary tube, with 1/2" x 3/4" steel fitting inside a silicon carbide tube with a weatherproof cover and cast iron head, 24" long

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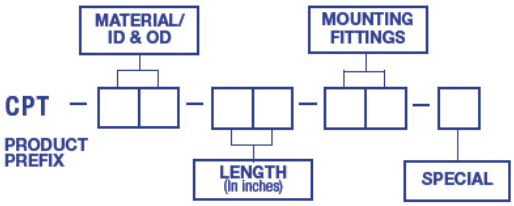
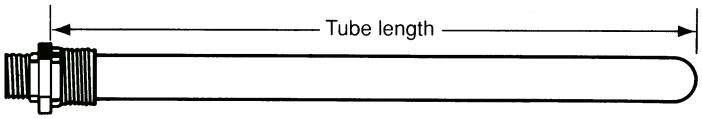
Ceramic Protection Tubes (CPT)

- High temperature to protect platinum or base metal thermocouples



Mullite Protection Tubes

- Maximum temperature range 2800°F
- Impervious to gasses at high temperature
- Good shock and chemical resistance

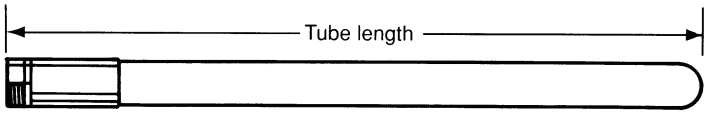


7/16" x 11/16" Mullite Protection Tube with 1/2" x 3/4" NPT Hex Fitting (1/2" fitting for use with connecting head), 16" long.

Example Ordering Number **CPT – M 6 – 1 6 – 2 4 – 0**

Alumina Protection Tubes

- Maximum temperature range 3200°F
- Fair shock resistance, preheating recommended
- Resists chemicals, will not contaminate platinum
- Impervious to gasses at high temperature



7/16" x 11/16" Alumina Protection T ube with Brass Ferrule (threaded for use with open terminal head only). Similar ferrule available for 1/4" x 3/8" protection tube, 36" long.

Example Ordering Number **CPT – A 6 – 3 6 – B 3 – 0**

MATERIAL ID & OD		LENGTH (In Inches)	MOUNTING FITTINGS	SPECIAL
Mullite	Alumina			
M5 - 5mm X 7mm Mullite	A5 - 5mm X 7mm Alumina	Specify from 00" to 99"	00 - No Fitting	0 - None
M8 - 1/4" X 3/8" Mullite	A8 - 1/4" X 3/8" Alumina		B3 - Brass Sleeve	B - Open Both Ends
M3 - 3/8" X 1/2" Mullite	A2 - 5/16" X 1/2" Alumina		B4 - 3/4" X 1" Brass Hex Ftg	E - Effective Length
M6 - 7/16" X 11/16" Mullite	A3 - 3/8" X 1/2" Alumina		24 - 1/2" X 3/4" Hex Ftg	X - Special
M4 - 1/2" X 3/4" Mullite	A6 - 7/16" X 11/16" Alumina		05 - Pipe Nipple	(Consult Factory)
G0 - 1/2" X 3/4" Mullite G-0	A4 - 1/2" X 3/4" Alumina		06 - Ceramic Collar	
G2 - 1/2" X 3/4" Mullite G-2	A1 - 3/4" X 1" Alumina		D2 - 1/2"-Hex-1/2" Ftg	
M1 - 3/4" X 1" Mullite	A7 - 1" X 1-1/4" Alumina		D3 - 3/4"-Hex-3/4" Ftg	
M7 - 1" X 1-1/4" Mullite	A9 - 1-1/4" X 1-1/2" Alumina		D1 - 1"-Hex-1" Ftg	
M9 - 1-1/4" X 1-1/2" Mullite	A0 - 5mm X 8mm Alumina		H2 - Hex-1/2" Ftg	
12 - 1-5/8" X 1-7/8" Mullite	11 - 5/8" X 7/8" Alumina		H3 - Hex-3/4" Ftg	
13 - 1" X 2" Mullite	15 - 3/16" X 1/4" Alumina		C1 - 1-1/4" Coupling	
14 - 3/4" X 1-1/4" Mullite	18 - 1-5/8" X 1-7/8" Alumina		C2 - 1" Coupling	
16 - 5/16" X 7/16" Mullite	19 - 3/16" X 5/16" Alumina		C3 - 1-1/2" Coupling	
17 - 5/8" X 7/8" Mullite	20 - 15mm X 10mm Alumina		H1 - Hex-1" Ftg	
21 - 15mm X 11mm Mullite	22 - 1/8" X 3/16" Alumina		31 - 3/4" X 1" Hex Ftg	
M2 - 3/16" X 1/4" Mullite	26 - 9/16" X 3/4" Alumina		32 - 3/4" X 1-1/4" Hex Ftg	
23 - 9/16" X 3/4" Mullite	H3 - Hexoly		25 - 1" X 1-1/4" Hex Ftg	
	HM - 3/8" x 11/16" Halsic®		AS - Alloy Sleeve	
	HL - 5/16" x 5/8" Halsic®		21 - 1/2" X 1" Hex ftg	

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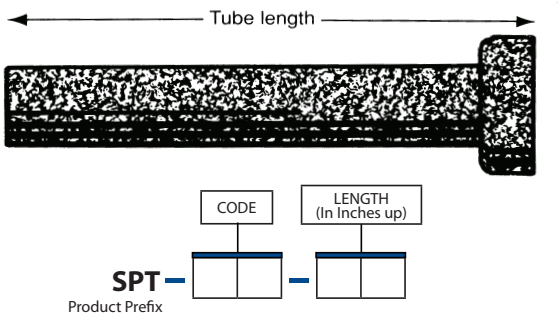
Silicon Carbide Protection Tube (SPT)

Silicon Carbide Protection Tubes

- Excellent thermal conductivity, responds quickly to temperature change
- Alternative to cast iron tubes, eliminating iron contamination
- Special surface treatment assures maximum resistance to metal penetration into the contained thermocouple
- Available with or without collar
- Lengths from 12" to 48" in 6" increments

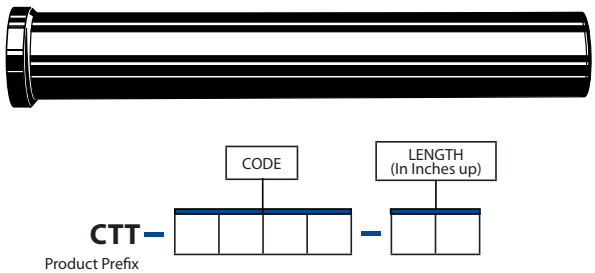


SILICON CARBIDE PROTECTION TUBES		
CODE	**ID x OD**	**LENGTH** (In inches)
WC	1" x 1-3/4" with Collar 3" Diameter	12 - 12" 18 - 18" 24 - 24" 30 - 30" 36 - 36" 42 - 42" 48 - 48"
WO	1" x 1-3/4" without Collar	

Silicon Carbide Target Tube (CTT)

Silicon Carbide Protection Tubes

- Excellent thermal conductivity, responds quickly to temperature change
- Available with or without collar
- Lengths from 12" to 48" in 6" increments



SILICON CARBIDE PROTECTION TUBES		
CODE	**ID x OD**	**LENGTH** (In inches)
1008	1-1/4" x 2", Collar 3-1/4" Dia.	112, 18
1009	1-3/4" x 2-1/2", Collar 3-3/4" Dia.	12, 18, 24
1010	2" x 3", Collar 4-1/4" Dia.	18, 24, 30, 36
1011	2-1/2" x 3-1/2", Collar 4-3/4" Dia.	24, 30, 36-42
1071	1-3/8" x 2-1/8", Collar 3-1/2" Dia.	12
1072	1-1/2" x 2-1/4", Collar 3-1/2" Dia.	18
1073	1-5/8" x 2-3/8", Collar 3-1/2" Dia.	24
1074	1-7/8" x 2-3/4", Collar 3-1/2" Dia.	30
1075	2-1/4" x 3-3/8", Collar 4-3/8" Dia.	36
1076	2-1/2" x 3-5/8", Collar 4-3/8" Dia.	42

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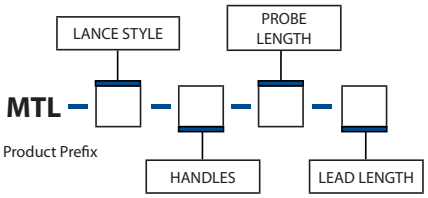
Immersion Tips and Lance (MTL)

- Immersion tips for intermittent temperature sensing below 2300°F
- Used in molten brass, copper, aluminum, lead, other non-ferrous metals
- 446SS sheath, ½" OD protects a 16 gauge, ANSI Type K thermocouple
- Tip lengths from 8" to 30"



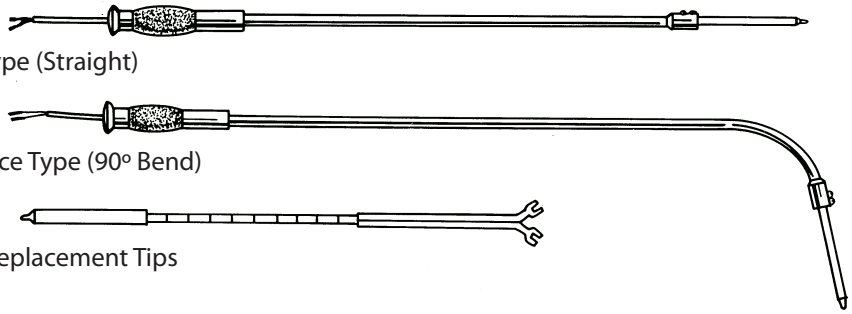
To order, use Specification Codes to assemble a complete Ordering Number.

Example Ordering Number

MTL – 3 – 1 – 2 – 2

Immersion Tip Thermocouple with 12" tip, 43" straight lance, and plastic grip.

SPECIFICATIONS/CODES			
Lance Style	Handles	Probe Length	Lead Length
0 - None 1 - 31" Straight Lance 2 - 43" 90° Bend Lance 3 - 43" Straight Lance	0 - None 1 - Plastic Grip 2 - Aluminum Grip	0 - None 1 - 8" 2 - 12" 3 - 15" 4 - 18" 5 - 20" 6 - 24" 7 - 30"	0 - None 1 - 31" 2 - 43"



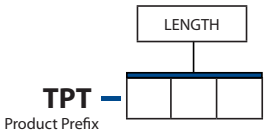
Ladle Type (Straight)

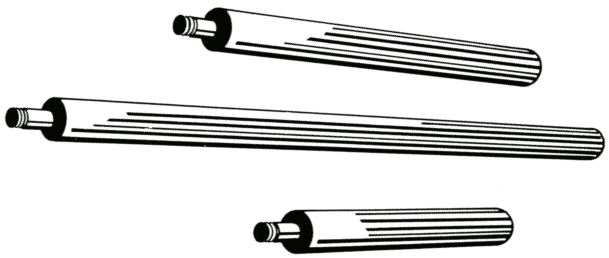
Furnace Type (90° Bend)

Replacement Tips

Tercod Pyrometer Tubes (TPT)

- For monitoring, melting, holding high temperatures of aluminum, other non-ferrous metals up to 2300°F
- Carbon bonded silicon carbide, isostatically formed around threaded pipe for attachment ease
- Available in ½", ¾" NPT pipe, lengths 12" to 48, 6" increments





Example Ordering Number

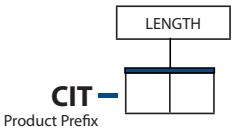
TPT – 2 3 0

This is Tercod Protection Tube with ½" NPT pipe, 30" long.

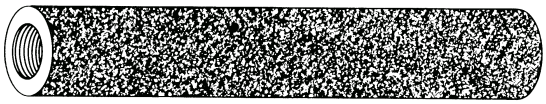
SPECIFICATIONS/CODES	
212	1/2" NPT Pipe, 12" Long
218	1/2" NPT Pipe, 18" Long
224	1/2" NPT Pipe, 24" Long
230	1/2" NPT Pipe, 30" Long
236	1/2" NPT Pipe, 36" Long
248	1/2" NPT Pipe, 48" Long
312	3/4" NPT Pipe, 12" Long
318	3/4" NPT Pipe, 18" Long
324	3/4" NPT Pipe, 24" Long
330	3/4" NPT Pipe, 30" Long
336	3/4" NPT Pipe, 36" Long
348	3/4" NPT Pipe, 48" Long

Cast Iron Protection Tubes (CIT)

- Used in reducing atmospheres to 1600 F non-oxidizing atmospheres to 2000°F
- Tubes 7/8" ID, 1 5/8" OD with ¾" NPT internal thread
- Lengths 12" to 48", in 6" increments



CAST IRON PROTECTION TUBES	
LENGTH (In inches)	
12	12" Long
18	18" Long
24	24" Long
30	30" Long
36	36" Long
48	48" Long



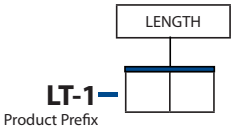
Example Ordering Number

CIT – 1 8

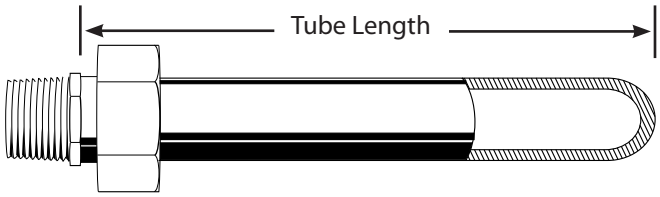
This is an 18" Cast Iron Protection Tube, with ¾" FNPT Standard.

Metal Ceramic Protection Tube (LT-1)

- Excellent resistance in oxidizing atmospheres over 2200°F
- Resists wetting from metals, alloys, and furnace slags
- Superior to ceramics in thermal shock and mechanical shock
- Less resistant to shock and impact than metal alloys
- LT-1 tubes standard with 3/4" conduit connector
- Available lengths 12" to 48" in 6" increments

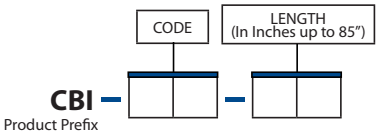


METAL CERAMIC PROTECTION TUBES	
LENGTH (In inches)	
12	12"
18	18"
24	24"
30	30"
36	36"
42	42"
48	48"



Ceramic Insulator (CBI)

- Thermocouple insulators withstand elevated temperatures and thermal shock
- Mullite max temp. 2800°F (Good Thermal Shock)
- Alumina max temp. 3400°F (Fair Thermal Shock)
- CEL stocks Mullite and Alumina insulators in many diameters, bore sizes and lengths



CERAMIC INSULATORS			
ALUMINA		**MULLITE**	
CODE	**TYPE**	**CODE**	**TYPE**
A1	1/8" OD .040" (2-bore)	**M1**	1/8" OD .040" (2-bore)
A2	3/16" OD .062" (2-bore)	**M2**	3/16" OD .062" (2-bore)
A3	1/4" OD .062" (2-bore)	**M3**	1/4" OD .062" (2-bore)
A4	3/16" OD .040" (4-bore)	**M4**	3/16" OD .040" (4-bore)
A5	1/4" OD .062" (4-bore)	**M5**	1/4" OD .062" (4-bore)
A6	.200" OD .040" (2-bore)	**M6**	.200" OD .040" (2-bore)

CLEVELAND ELECTRIC LABORATORIES
Thermocouples & Sensing Solutions since 1920

Base Metal Elements (BME)

- Industrial base metal elements and assemblies designed for the most severe environments
- Styles selected by temperature range, ambient atmosphere, and media conditions
- Select sizes and configurations based upon application requirements
- Select by the need for accuracy and speed of response

Type K – Due to its reliability and accuracy, Type K is used extensively at temperatures of up to 2300ºF. It is good practice to always protect this type of thermocouple with a suitable metal or ceramic protection tube, especially in reducing atmospheres. In oxidizing atmospheres and when other conditions are suitable, tube protection is not always necessary; however, protection is recommended for cleanliness and general mechanical protection. Recommended temperature range is 32ºF to 2300ºF.

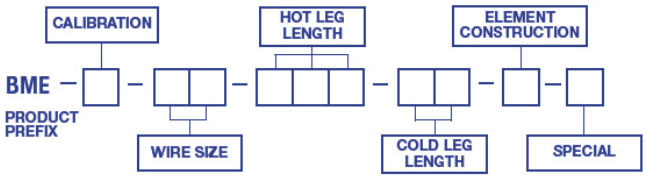
Type J – This element may be used, protected or unprotected, where there is a deficiency of free oxygen. To maintain cleanliness and generally longer life, a protection tube is recommended. Because Type J wire will oxidize rapidly at temperatures over 1000ºF, it is recommended that larger gauge wire be used to compensate. Recommended temperature range is 32ºF to 1400ºF.

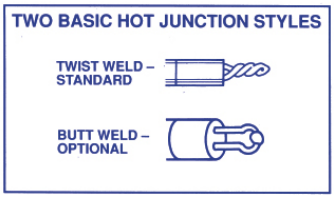
Type T – Useable in oxidizing, reducing or inert atmospheres, as well as vacuum applications. Not subject to corrosion in moist atmospheres. Recommended temperature range is -328ºF to 700ºF, but can be used to -454ºF.

Type E – This thermocouple is suitable for use in temperatures up to 1652ºF in a vacuum, inert, mildly oxidizing or reducing atmosphere. Recommended temperature range is 32ºF to 1600ºF.

Type N – This thermocouple is used primarily at high temperatures of up to 2300ºF.

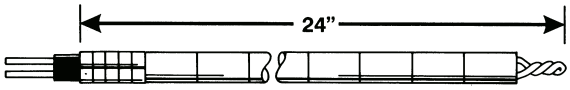
To order an element, use Specification Codes below to assemble a complete Ordering Number.





CALIBRATION	WIRE SIZE	HOT LEG LENGTH	COLD LEG LENGTH	ELEMENT CONSTRUCTION	SPECIAL
K - Chromel-Alumel J - Iron-Constantan T - Copper-Constantan E - Chromel-Constantan N - Nicrosil-Nisil M - Ni-Ni Moly	08 - 8 AWG 11 - 11 AWG 14 - 14 AWG 16 - 16 AWG 18 - 18 AWG 20 - 20 AWG 22 - 22 AWG 24 - 24 AWG 30 - 30 AWG	Specify from 000″ to 999″	Specify from 00″ to 99″	A - Straight SGL Element Insul. C - 90º Angle Element w/Insul. D - Bare Wire Element F - Straight Dual Element w/Insul. G - Angle Dual Element w/Insul. H - SGL One-Hole Ins Per Wire S - E-808-1 Ins	0 - None B - Butt Weld C - Lot Certification D - Dual Element E - Individual Certification 2 - Dual / Lot Certified 3 - Butt Weld / Lot Certified 4 - Dual Butt Weld / Lot Certified X - Special (Consult Factory)

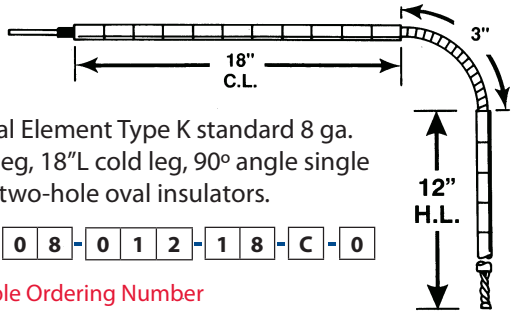
ELEMENT EXAMPLES WITH GENERIC DESCRIPTION AND ORDERING NUMBER



Base Metal Element Type K standard 8 ga. 24″L straight, single element, two-hole oval insulators.

BME K-08-02 4-00-A-0

Example Ordering Number



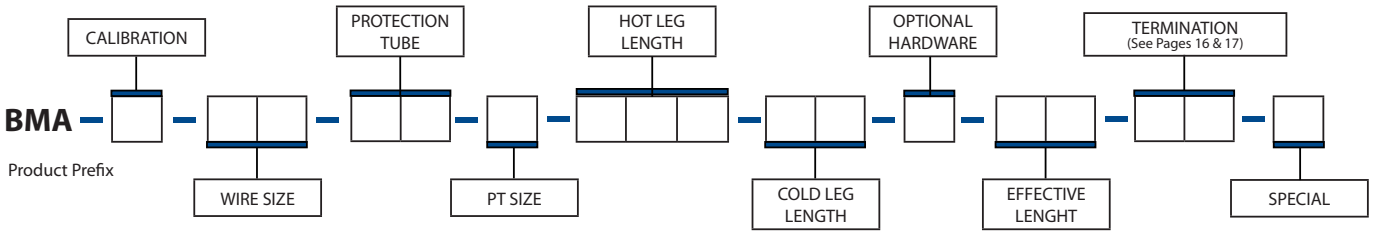
Base Metal Element Type K standard 8 ga. 12″L hot leg, 18″L cold leg, 90º angle single element, two-hole oval insulators.

BME K-08-012-18-C-0

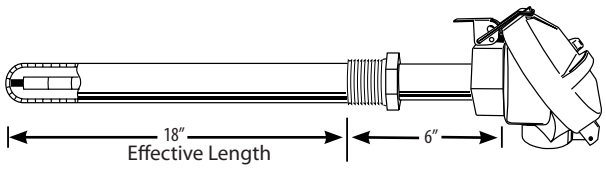
Example Ordering Number

Base Metal Assemblies (BMA)

- Industrial base metal elements and assemblies designed for the most severe environments
- Styles selected by temperature range, ambient atmosphere, and media conditions
- Select sizes and configurations based upon application requirements
- Select by the need for accuracy and speed of response



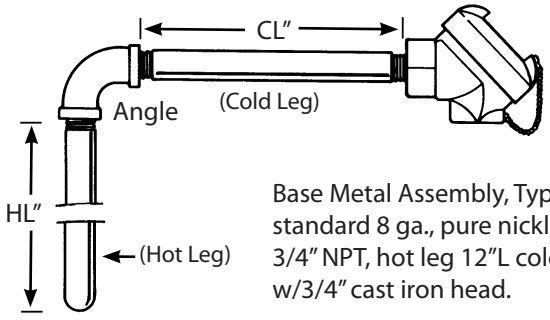
CALIBRATION	WIRE SIZE	PROTECTION TUBE	P/T SIZE	HOT LEG LENGTH	COLD LEG LENGTH	OPTIONAL HARDWARE	EFFECTIVE LENGTH	SPECIAL
J-Iron-Constantan K-Chromel-Alumel T-Copper-Constantan E-Chromel-Constantan N-Nicrosil-Nisil M-Ni-Ni Moly**	08- 8 AWG 11-11 AWG 14-14 AWG 16-16 AWG 20-20 AWG	15-446 SS 16-Pure Nickel 17-Inconel 18-304 SS 19-310 SS 20-316 SS 21-Silicon Carbide 22-Mullite 23-Alumina 24-Metal Ceramic 25-Carbon Steel 26-Tercod 27-Cast Alloy 28-Cast-Iron w/Tap 29-330 SS 30-Hexaloy 31-Cast-T 32-Refractory Coated 33-Incoloy 800 34-Hastelloy C 276	A-1/4" NPT B-1/2" NPT C-3/4" NPT D-1" NPT E-1-3/4" OD F-3/8" OD G-11/16" OD H-3/4" OD I-7/8" OD J-1" OD K-1/8" NPT L-3/8" NPT M-1/2" OD N-7mm P-1/4" OD	Specify from 00" to 999"	Specify from 00" to 99"	O-None A-Adjustable Flange B-1/4" NPT Fix Hex St.Mt.Bush C-1/2" NPT Fix Hex St.Mt.Bush D-3/4" NPT Fix Hex St.Mt.Bush E-1" NPT Fix Hex St.Mt.Bush F-1-1/4" NPT Fix Hex St.Mt.Bush G-1-1/2" NPT Fix Hex St.Mt.Bush H-1/4" NPT Fix Hex St.St. J-1/2" NPT Fix Hex St.St. K-3/4" NPT Fix Hex St.St. L-1" NPT Fix Hex St.St. M-1-1/4" NPT Fix Hex St.St. N-1-1/2" NPT Fix Hex St.St. P-Hot Junction Cup Q-Tapered Plug R-1/2 x 3/4" St. Hex Fitting S-3/4 x 1" St. Hex Fitting T-6" Alloy Sleeve U-6" Carbon Steel Sleeve W-1/2"-Hex-1/2" Y-3/4"-Hex-3/4" Z-3/4" x 1-1/4" Hex Fitting 3-3/4" X 1-1/2" Hex Fitting 2-3/4 x Close Nipple	Specify from 00" to 99"	O-None A-Ajax Bend * See drawing in appendix B-Open Both Ends C-Lot Certification D-Dual Element E-Individual Cert. H-SCH 80 2-Dual/Lot Certified 3-Butt Weld/Lot Certified 4-Dual Butt Weld/Lot Certified X-Special (Consult Factory)



Base Metal Assembly, Type K standard 8 ga., Inconel PT 3/4" NPT, 24" L w/1" NPT bushing for 18" effective, 3/4" snap cover head.

Example Ordering Number

BMA K-08-17-C-024-00-E-18-S4-0



Base Metal Assembly, Type K standard 8 ga., pure nickle tube, 3/4" NPT, hot leg 12"L cold leg 24"L w/3/4" cast iron head.

Example Ordering Number

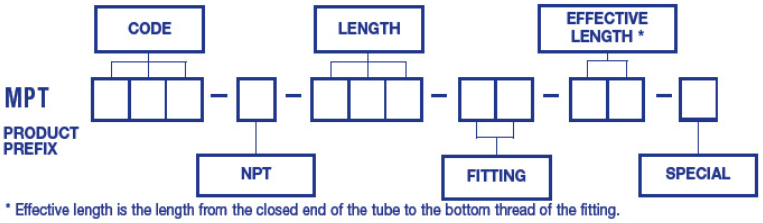
BMA K-08-16-C-012-24-O-00-C4-0

CLEVELAND ELECTRIC LABORATORIES

Thermocouples & Sensing Solutions since 1920

Metal Protection Tubes (MPT)

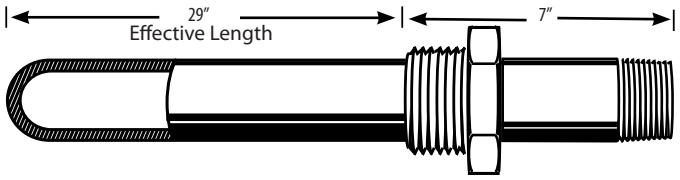
- Protects thermocouples from corrosion, physical damage, contamination
- Available in most widely used alloys and pipe sizes



* Effective length is the length from the closed end of the tube to the bottom thread of the fitting.

MATERIAL	OPERATING TEMP.	REMARKS	NPT	LENGTH	FITTING	EFFECTIVE LENGTH	SPECIAL
600-600 Inconel 601-601 Inconel	2220ºF	Generally used for high temperature. Good corrosion-resistance.	A-1/4" NPT B-1/2" NPT C-3/4" NPT D-1" NPT E-3/4" NPT Tap F-1/8" NPT H-3/8" NPT J-3-1/2" NPT X-1¼" NPT	Specify from 000" to 999"	00-None AF-Adjustable Flange C3-3/8" Steel Hex Bushing C2-1/2" Steel Hex Bushing C4-3/4" Steel Hex Bushing C1-1" Steel Hex Bushing C5-1-1/4" Steel Hex Bushing C6-1-1/2" Steel Hex Bushing S3-3/8" St.St. Hex Bushing S2-1/2" St.St. Hex Bushing S4-3/4" St.St. Hex Bushing S1-1" St.St. Hex Bushing S5-1-1/4" St.St. Hex Bushing S6-1-1/2" St.St. Hex Bushing TP-Tapered Plug RF-Raised Face Flange S7-2" NPT SS Bushing C7-2" NPT Steel Bushing FF-Flat Face Flange	Specify from 00" to 99"	0-None B-Open Both Ends H-SCH 80 X-Special (Consult Factory) T-No Threads
304-304 Stainless Steel 309-309 Stainless Steel	1800ºF	Good corrosion-resistance. Embrittles in the 900ºF to 1450ºF range.					
310-310 Stainless Steel	2100ºF	High mechanical and creep strength at elevated temperature. Very good corrosion resistance.					
316-316 Stainless Steel	1700ºF	Higher corrosion resistance than 304SS. Resists pitting in sulfuric, phosphoric acids.					
330-330 Stainless Steel	2200ºF	Good in oxidizing or reducing atmosphere.					
446-446 Stainless Steel	2000ºF	Highly resistant to sulfur attack. General purpose alloy.					
200-Pure Nickel	2000ºF	Do not use in the presence of sulfur or reducing atmosphere.					
CIT-Cast Iron	1400ºF	Withstands sulfuric and caustic solutions. Good mechanical strength.					
LT1-Metal Ceramic	2600ºF	Good resistance to mechanical and thermal shock.					
CSP-Carbon Steel Pipe	1000ºF	Non-corrosive gases and liquids. Scales quickly at higher temperatures.					

All pipe available in schedule 80. Consult factory for additional information.



Example Ordering Number

MPT – 6 0 1 – B – 0 3 6 – C 5 – 2 9 – 0

1/2" NPT x 36" Inconel 601 Protection Tube with 1¼" steel bushing for 29" effective

PROTECTION TUBE CODE	TYPICAL APPLICATIONS	TUBE DESCRIPTION	COMPOSITION OR FORM	MAX. TEMP.	GENERAL COMMENTS
304	Food Preparation Petroleum Industry Chemical Processes Mixed Acids Lactic Acid Dyeing Tanks	304 Stainless Steel	Controlled amounts of Nickel, Chromium, Carbon, Manganese, Silicon, traces of Phosphorous & Sulfur, balance Iron	1600°F Oxidizing, 2300°F Non-Oxidizing	Good resistance to corrosion. For wet process applications such as steam, oil, and many chemical solutions.
316	Petroleum Industry Chemical Processes	316 Stainless Steel	12% Nickel, 17% Chromium, 2 1/2% Molybdenum, 2% Manganese max., 0.08% Carbon max., 1% Silicon max., traces of Phosphorous & Sulfur, balance Iron	1600°F Oxidizing	Good resistance to corrosion. Resists pitting corrosion. More resistant to acids than 304 SS.
446	High Temperature Hardening Nitriding Salt Baths Vitreous Enameling Non-ferrous Metals such as Tin, Lead, Zinc or Babbit Metal Smelting Low Temperature Blast Furnaces	446 Stainless Steel	27% Chromium, 0.25% Nitrogen max., 0.20% Carbon max., 1.50% Manganese max., 1.00% Silicon max., traces of Phosphorous & Sulfur, balance Iron	2000°F Oxidizing, 2300°F Non-Oxidizing	Good resistance to corrosion at high temperatures. Impervious to sulfurous atmospheres, salt bath or low temperature molten metals.
601	High Temperature Heat Treating Carburizing Nitriding Salt Baths Blast Furnace Operations Gas Generators Ceramic Kilns	Inconel 601	61% Nickel, 23% Chromium, 14% Iron, 1.35% Aluminum	2200°F Oxidizing	Excellent resistance to corrosion and oxidation at high temperature. Good mechanical strength. More resistant to sulfur than Inconel 600. Hydrogen causes embrittlement.
200	Potassium Cyanide Salt Baths 2000°F Caustics and Brines High Temperature Chemical Applications 1200°F	Pure Nickel	Drawn or Drilled, 99.5% Nickel	2200°F Oxidizing, 1000°F Reducing, 2400°F Neutral	For high temperature applications. Will withstand many chemical actions, but must not be placed in the presence of sulfur. Frequently placed in caustic and molten salt baths. Drilled tube recommended for hydrogen atmospheres.
CSP	Annealing Drawing Tempering Glass Lehrs Power Plant Preheaters Food Baking Ovens Asphalt Mixers	Low Carbon Black Steel Pipe	Controlled amounts of Carbon Manganese, Silicon and Copper, traces of Phosphorous & Sulfur, balance Iron	1250°F	For non-corrosive atmospheres and in low temperature molten metals.
CIT	Chemical Industry: • Molten Aluminum • Die Cast Metals	Cast Iron	Cast	1300°F Oxidizing, 2000°F Non-Oxidizing	To 1600°F in reducing atmospheres. Will withstand sulfuric acid and caustic solutions. For extra long life, process coated tubes are available. Cast iron tubes should be painted daily with whiting when measuring aluminum or die cast metal temperatures.
LT-1	High Temperature Heat Treating: • Molten Copper Base Alloys to 2100°F • Blast Furnace and Stack Gases to 2400°F • Sulfur Burners to 2000°F • Cement Kilns to 2200°F • Chemical Process Reactors to 2500°F	Metal-Ceramic Tubes	(Slip cast composite of Chromium and Aluminum Oxide) 77% Chromium 23% Aluminum Oxide	2500°F	Superior oxidation resistance to 2500°F. Thermal conductivity equal to that of stainless steel. Good resistance to most molten metals to 2100°F. Not usable in molten aluminum. With noble metal element, a ceramic primary tube is required.
CPT	Ceramics Industry: • Bright Annealing • Forging Furnaces • Glass Making • High Speed Salt Baths	Mullite	Al2O3 63.5% SiO2 34.2% Fe2O3 0.6% TiO2 0.6% CaO 0.1% MgO 0.4% Na2O 0.6%	2800°F	Impervious to gases at high temperature. Possesses good thermal shock but poor mechanical shock. Often necessary to provide secondary tube protection. Should be mounted vertically. Usable in Barium Chloride salt baths to 2350°F.
CPT	Induction Melting up to 3200°F Applications for metal and ceramic industry requiring extreme temperatures	Alumina	SiO2 0.1% MgO 0.1% Na2O 0.1%	3400°F	Fair resistance to thermal and mechanical shock. For very high temperature processes. Impervious to gases up to 3200°F.
SPT	Brick and Ceramic Kilns Steel Soaking Pits Applications requiring resistance to cutting action of flames and gases	Silicon Carbide	90% Silicon Carbide, 9% Silicon Dioxide, balance Aluminum Oxide & Ferric Oxide	3000°F	For molten non-ferrous metals. Also is a secondary protection tube for resistance to thermal shock.

CLEVELAND ELECTRIC LABORATORIES
Thermocouples & Sensing Solutions since 1920

Magnesium Oxide (MgO) Insulated Thermocouples

- MgO thermocouples are versatile sensors for use in process temperatures up to 2400°F and are also recommended in high moisture, liquid, high pressure, and corrosive environments
- Attributes are high dielectric strength, durability, malleability and quick response to temperature fluctuations
- The uniform thickness of wires and magnesium oxide insulation provides mechanical strength, plus corrosion and moisture resistance
- Densely- packed, high- purity MgO insulation is used in all calibrations and sheath materials
- Minimum Bend Diameter is equal to two times the outside diameter

Sheath Ratings

Continuous maximum temperature ratings of sheath in oxidizing atmospheres

304SS:	Up to1650°F	good corrosion characteristics and resistance to oxidation, generally regarded as a standard sheath material.
Inconel 600:	Up to 2100°F	good high temperature resistance to corrosion, not suitable for use in presence of sulfur above 1000°F.
316SS:	Up to1700°F	has excellent acid corrosion resistance; highly resistant to pitting type corrosion.
310SS:	Up to 2100°F	good resistance to oxidation and corrosion at high temperatures.

Time Constants

The time required for a thermocouple to indicate 63.2% of a step change in temperature in a surrounding media is The time constant. Several factors influence the measured time constant, such as the degree of insulation compaction, sheath wall thickness and distance of junction from the welded cap on the ungrounded style. These factors, as well as the velocity of liquid or mass past the thermocouple probe, affect the time constant.

TIME CONSTANTS/SECOND

SHEATH DIAMETER (In inches)	GROUNDED JUNCTION	UNGROUNDED JUNCTION	EXPOSED JUNCTION
0.040	0.2	0.7	0.1
0.063	0.3	0.8	0.2
0.125	0.5	1.3	0.3
0.188	1.0	2.5	0.5
0.250	2.3	4.3	0.6

Junction Construction

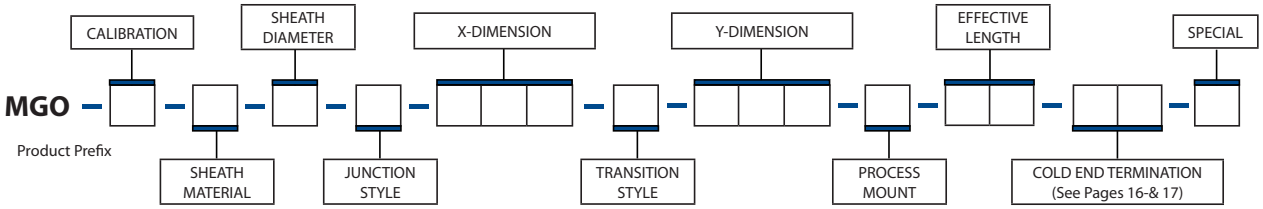
Grounded • Thermocouple welded to the sheath. Fast response with thermocouple protected.

Ungrounded (Isolated) • Thermocouple insulated from sheath with magnesium oxide. Stray EMF's are prevented from affecting the reading. Response from rapid or frequent temperature cycling is slower than grounded style.

Exposed • Thermocouple junction is not protected by welded cap. Used for quick response, but is susceptible to early corrosive failure.

Dual Element Common • Two thermocouples with junctions welded together.

Dual Element Isolated (Standard) • Two thermocouples electrically separate in the same sheath, provides isolation where instrumentation necessitates.

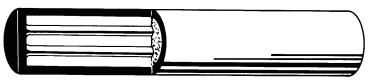


• X-Dimension is the measurement from the tip of the thermocouple to beginning of termination (length of metal sheath).
•• Y-Dimension is the measurement from the beginning of the transition fitting to the end of the wire (transition style only).

CALIBRATION	SHEATH MATERIAL	SHEATH DIAMETER	JUNCTION CONSTRUCTION	X-DIMENSION (IN.)	TRANSITION STYLE
J - Iron-Constantan **K** - Chromel-Alumel **E** - Chromel-Constantan **T** - Copper-Constantan **N** - Nicrosil-Nisil **S** - Plt - Plt 10% Rh **R** - Plt - Plt 13% Rh **B** - Plt 6% Rh - Plt 30% Rh **C** - W 5% Re - W 26% Re **D** - W 3% Re - W 25% Re **P** - Plt 40% Rh- Plt 20% Rh **W** - W-W/26% re **M** - NI/NI Moly	**1** - 304SS **2** - Inconel 600 **3** - 316SS **4** - 310SS **5** - 446SS **6** - Tantalum **7** - Molybdenum **8** - Inconel 601 **9** - Pyrosil **C** - 276 **X** - Hastalloy X **P** - Plt 10% Rh **T** - Plt 20% Rh **G** - 347SS **Q** - Pure Platinum **E** - Super O-C	**1** - .032 **2** - .040 **3** - .063 (1/16") **4** - .125 (1/8") **5** - .188 (3/16") **6** - .250 (1/4") **7** - .315 (5/16") **8** - .375 (3/8") **9** - .500 (1/2") **M** - .090 **F** - .020 **E** - .010 **L** - .750 (3/4") **C** - .013 **H** - .025	**G** - Grounded Junction **U** - Ungrounded Junction **E** - Exposed Junction **H** - Spcl Half Exposed Junction **S** - Squared Tip-Grounded Junction **A** - 45 Deg Angle Tip-Grounded Junction	Specify from 000" to 999"	**0** - No Trans Flex Lead Wire **1** - Fiberglass Covered Std Temp Trans (400 deg F) **2** - Fiberglass w/Flex ArmCov Std Temp Trans (400 deg F) **3** - Fiberglass w/SS Ovrbrd Std Temp Trans (400 deg F) **4** - Polyvinyl Plastic Std Temp Trans (400 deg F) **5** - Teflon Insulation Std Temp Trans (400 deg F) **6** - Teflon w/SS Ovrbrd Std Temp Trans (400 deg F) **7** - Hitemp Glass w/SS Ovrbrd Std Temp Trans (400 deg F) **8** - Teflon Insul/No Trans Body **9** - Teflon w/Flex Armor Std Temp Trans (400 deg F) **M** - Hitemp Glass insulation Std Temp Trans (400 deg F) **C** - PVC Coil Cord Std Temp Trans (400 deg F) **F** - PVC Insulation w/Flex Armor Std Temp Trans (400degF) **K** - Kapton Insulation Std Temp Trans (400 deg F) **A** - Fibre-Glass Insulation Hi Temp Trans (1000 F) **B** - Fibre-Glass w/Flex Armor Hi Temp Trans (1000F) **D** - Fibre-Glass w/SSOB Hi Temp Trans (1000 F) **E** - Hi Temp Glass w/SSOB Hi Temp Trans (1000F) **G** - HI Temp Glass w/Flex Armor Hi Temp Trans (1000F) **H** - Butt-welded Leads-Varflex-No Trans Ftg. **L** - Hi Temp Glass-Hi Temp Trans (1000 F)

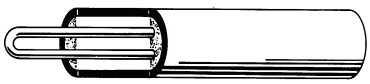
Y-DIMENSION (IN.)	PROCESS MOUNTING DEVICE			EFFECTIVE LENGTH (IN.)	SPECIAL
Specify from 000" to 999"	**0** - None **1** - SS 1/2-Hex-1/2" NPT Bushing **2** - SS 3/4-Hex-3/4" NPT Bushing **3** - CS 1/2-Hex-1/2" NPT Bushing **4** - CS 3/4-Hex-3/4"NPT Bushing **5** - Hex Proc Mtg Ftg-1/8" NPT **6** - Hex Proc Mtg Ftg-1/4" NPT **7** - Hex Proc Mtg Ftg-3/8" NPT **8** - Hex Proc Mtg Ftg-1/2" NPT **9** - Hex Proc Mtg Ftg-3/4" NPT **A** - BR Adj Comp Ftg-1/8" NPT **B** - BR Adj Comp Ftg-1/4" NPT **C** - BR Adj Comp Ftg-3/8" NPT **D** - BR Adj Comp Ftg-1/2" NPT	**E** - SS Adj Comp Ftg-1/8" NPT **F** - SS Adj Comp Ftg-1/4" NPT **G** - SS Adj Comp Ftg-3/8" NPT **H** - SS Adj Comp Ftg-1/2" NPT **I** - CS Adj Comp Ftg-1/8" NPT **J** - CS Adj Comp Ftg-1/4" NPT **K** - CS Adj Comp Ftg-3/8" NPT **L** - CS Adj Comp Ftg-1/2" NPT **M** - BR Re-Adj Comp Ftg-1/8" NPT **N** - BR Re-Adj Comp Ftg-1/4" NPT **P** - BR Re-Adj Comp Ftg-3/8" NPT **Q** - BR Re-Adj Comp Ftg-1/2" NPT **R** - SS Re-Adj Comp Ftg-1/8" NPT	**S** - SS Re-Adj Comp Ftg-1/4" NPT **T** - SS Re-Adj Comp Ftg-3/8" NPT **U** - SS Re-Adj Comp Ftg-1/2" NPT **V** - CS Re-Adj Comp Ftg-1/8" NPT **W** - CS Re-Adj Comp Ftg-1/4" NPT **X** - Re-Adj Comp Ftg-3/8" NPT **Y** - CS Re-Adj Comp Ftg-1/2" NPT **Z** - 1/2-Hex-1/2 S.L. Bushing **BR** - Brass **CS** - Carbon Steel **SS** - Stainless Steel Comp - Compression Fitting Mtg - Fixed Mounting Fitting	Specify from 000" to 999"	**0** - None **C** - Lot Certification **D** - Dual Element **E** - Individual Cert **F** - Evac & Backfill **L** - Low Drift / Lot Certified **W** - Weld Pad **X** - Special (Consult Factory) **2** - Dual Element Lot Certified

(G) Grounded Junction
Welded to form a completely sealed integral junction, the G junction component is recommended in presence of liquids, moisture, gas, or high pressure.



(U) Ungrounded Junction
Fully insulated from the welded sheath end, this junction is excellent for applications where stray EMF's would affect the reading and for rapid or frequent temperature cycling.

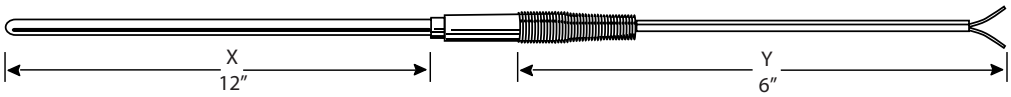
E) Exposed Junction
Exposed Junction thermocouple wires are butt welded with insulation sealed against liquid or gas penetration. This component provides the fastest response time, but is unprotected against corrosive or mechanical damage.



Example Ordering Numbers

MGO – K – 2 – 4 – U – 0 2 4 – 0 – 0 0 0 – 0 – 0 0 – 0 4 – 0

This is a Type K Inconel sheath, 1/8" diameter, unground junction, 24" long, with tube adapter and plug.



MGO – K – 3 – 5 – U – 0 1 2 – 1 – 0 0 6 – 0 – 0 0 – 1 S – 0

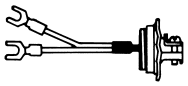
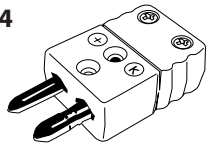
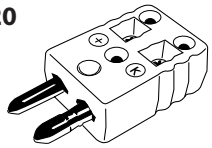
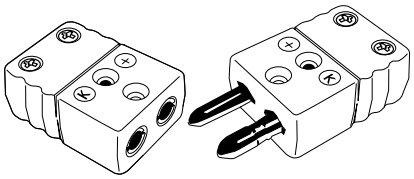
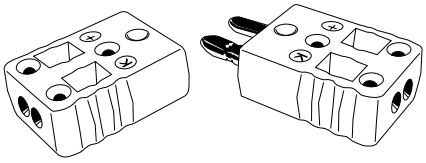
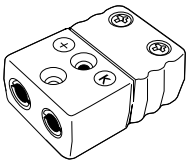
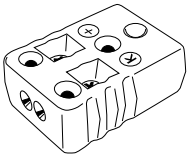
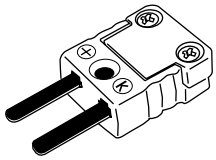
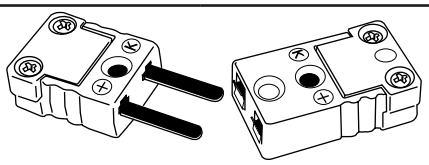
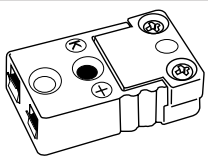
This is a Type K 316 stainless steel sheath, 3/16" diameter, ungrounded junction, 12" long/transition fitting to 6" glass/glass extension wire-1" strip.

Thermocouple Terminations

CLEVELAND ELECTRIC LABORATORIES

Thermocouples & Sensing Solutions since 1920

The Termination Specifications listed may be used in assembly Ordering Numbers for Noble, Base and MgO Thermocouples. Most may be ordered separately. Listed are the most common types. Consult the factory for other requirements you may have.

__S 	**Strip*** CODE: ___"S" (Insert desired length in inches)
02 	**2-1/2" Strip with Spade Lugs*** CODE: 02
03 	**2-1/2" Strip with Spade Lugs* BX Connect and Locknut** CODE: 03
04  20 	**Male Plug (400°F)** CODE: 04 Standard Connect CODE: 20 Jab-in Style
05 	**Male Plug and Female Jack (400°F)** CODE: 05 Standard Connect
21 	**Male Plug and Female Jack (400°F)** CODE: 21 Jab-in Style
06  22 	**Female Jack (400°F)** CODE: 06 Standard Connect CODE: 22 Jab-in Style
10 	**Male Mini Plug (400°F)** CODE: 10
11 	**Male Mini Plug and Female Mini Jack (400°F)** CODE: 11
12 	Female Mini Jack (400°F) CODE: 12

High Temperature Male Plug (800°F)
CODE: 07 Standard Connect
CODE: 23 Jab-in Style

High Temperature Male Plug and High Temperature Female Jack (800°F)
CODE: 08 Standard Connect
CODE: 24 Jab-in Style

High Temperature Female Jack (800°F)
CODE: 09 Standard Connect
CODE: 25 Jab-in Style

High Temperature Male Mini Plug (800°F)
CODE: HM

Male Plug with Crimp Fitting (400°F)*
CODE: CP

High Temperature Male Plug with Crimp Fitting (800°F)*
CODE: CH

Solid Pin Male Plug (400°F)
CODE: SP

3-Pin Male Plug (400°F)
CODE: 3P

Alumina Male Plug (1200°F)
CODE: 18

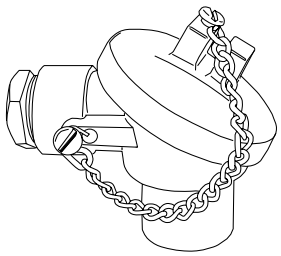
Alumina Female Jack (1200°F)
CODE: 19

No Termination*
CODE: 00

* Not available as separate item.

Screw Cover Heads with Terminal Block

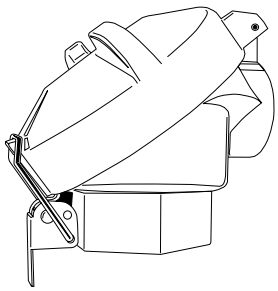
CODE	DESCRIPTION
A1	1″ NPT Aluminum
A2	½″ NPT Aluminum
A4	¾″ NPT Aluminum
C1	1″ NPT Cast Iron
C2	½″ NPT Cast Iron
C4	¾″ NPT Cast Iron
E2	½″ NPT Epoxy Coated Aluminum
SA	Mini Aluminum (Single)
SD	Mini Aluminum (Double)
E1	1″ NPT Stainless Steel
E5	½″ NPT Stainless Steel
E4	¾″ NPT Stainless Steel



SA
SD

Snap Cover Heads with Terminal Block

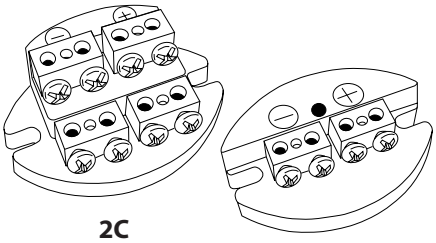
CODE	DESCRIPTION
S1	1″ NPT Aluminum
S2	½″ NPT Aluminum
S4	¾″ NPT Aluminum



S1
S2
S4

Terminal Blocks

CODE	DESCRIPTION
1C	Universal Screw Cover – Single
2C	Universal Screw Cover – Dual
1S	Snap Cover – Single
2S	Snap Cover – Dual

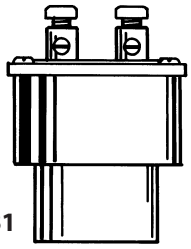


2C
2S

1C
1S

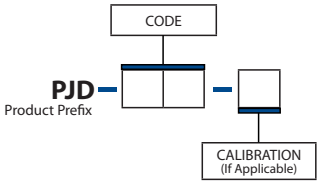
Open Terminal Heads

CODE	DESCRIPTION
B1	Open Terminal Head (Noble Metal Only) Specify Calibration
B2	External Thread Head (Noble Metal Only) Specify Calibration
B3	Open Terminal Head (Base Metal Only)



B1

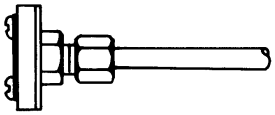
To order a thermocouple termination as a separate item, Follow the ordering information below.



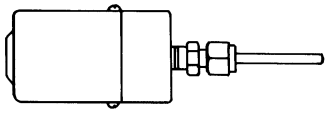
Example Ordering Number

PJD – 0 7 – K
Product Prefix

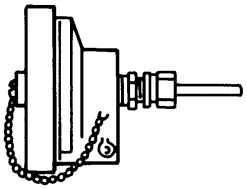
This is a High Temperature Male Plug (800°F) Termination, Type K.



Wafer Type Open Head
Code: 13

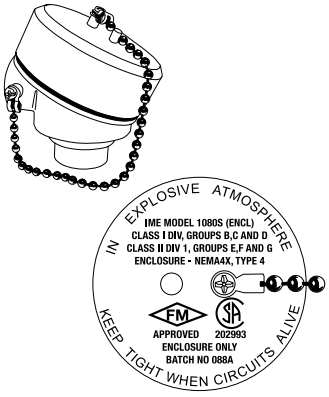


Cannister Head
CODE: 14



Plastic Weatherproof Head (400ºF)
CODE: 15

High Temperature Plastic Weatherproof Head (800ºF)
CODE: 16



Explosion-Proof Head
CODE: 17

1/2″ Polypropylene Head
CODE: P2

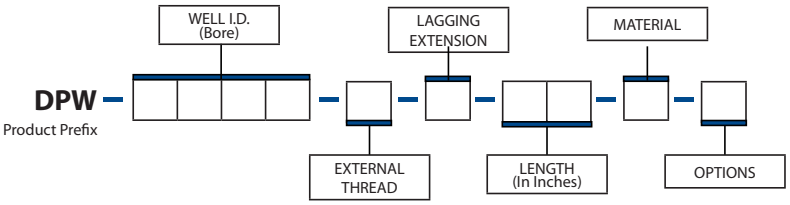
CLEVELAND ELECTRIC LABORATORIES
Thermocouples & Sensing Solutions since 1920

Drilled Protection Wells (DPW)

Alloy wells are generally categorized as metal protection tubes. But unlike the tubes we fabricate from standard schedule 40 or 80 pipe, alloy wells are drilled bar stock, precision machined, highly polished and designed for high pressure applications.

Thermocouple assemblies with alloy wells are recommended for used in high-pressure environments or where there is severe vibration. Typical applications include measuring temperatures in water, steam, and air lines in power plants or in chemical and petrochemical applications.

To order, use Specification Codes below to assemble a complete Ordering Number.

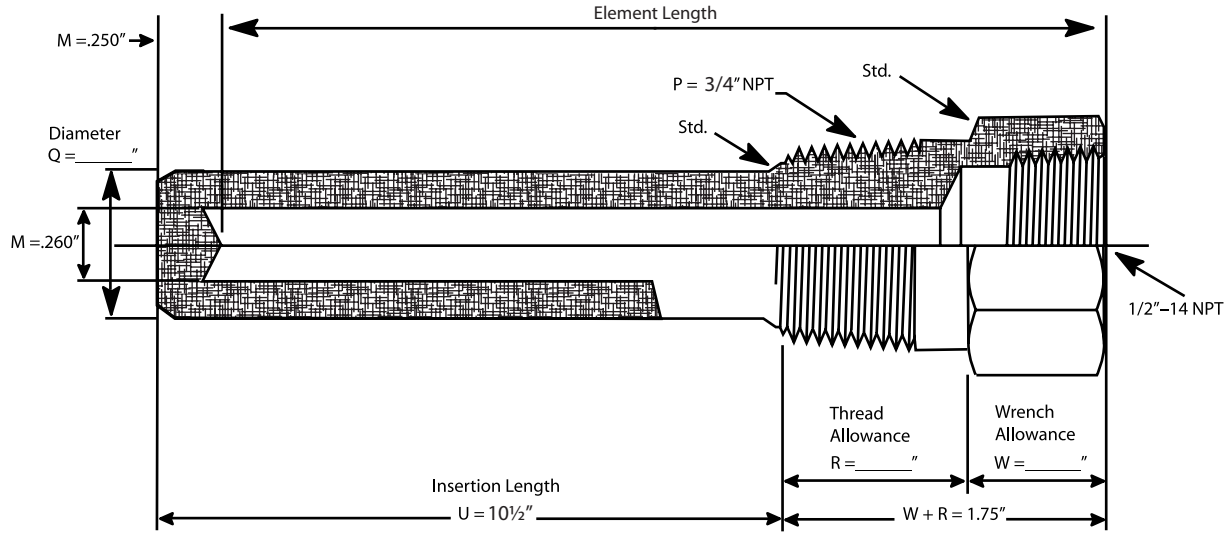


WELL I.D. (BORE)	EXTERNAL	LAGGING EXTENSION	LENGTH (In inches)		MATERIAL	OPTIONS
			"0"	"L"		
260S - Straight 1/4" Dia. Elements 260R - Reduced Tip 1/4" Dia. Elements 260H - Tapered 1/4" Dia. Elements 385S - Straight 3/8" Dia. Elements 385R - Reduced Tip 3/8" Dia. Elements 385H - Tapered 3/8" Dia. Elements 260W - Weldin 1/4" Dia Element 385W - Weldin 3/8" Dia Element	A - 1/2" NPT B - 3/4" NPT C - 1" NPT	0 - None L - Lagging Extension	04 - U=2-1/2, T=0 06 - U=4-1/2", T=0; 09 - U=7-1/2, T=0; 12 - U=10-1/2, T=0; 15 - U=13-1/2, T=0; 18 - U=16-1/2, T=0; 24 - U=22-1/2, T=0; XX - Other Than Above (Consult Factory) T - Lagging Dimension	U=2-1/2, T=2 U=4-1/2, T=3 U=7-1/2, T=3 U=10-1/2, T=3 U=13-1/2, T=3 U=19-1/2, T=3	1 - Brass (ASTM B-16) 2 - Carbon Steel (C-1018) 3 - 304 Stainless Steel 4 - 316 Stainless Steel 5 - Monel 6 - Other Than Above (Consult Factory) T - Inconel	0 - None B - For Brass Cap & Chain S - For SS Cap & Chain

No. 260S and No. 385S, Standard Duty Straight ½" Well For ¼" Diameter Elements

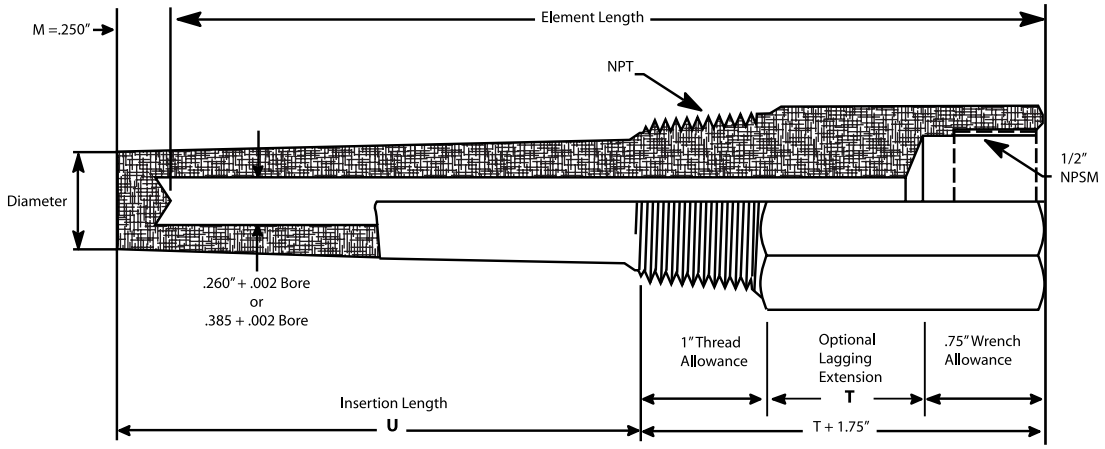
This is a heavy-duty threaded thermowell for ¼" dia. elements, ¾" NPT process thread, 10½" insertion, 304SS material.

Example Ordering Number **DPW – 2 6 0 S – B – 0 – 1 2 – 3 – 0**

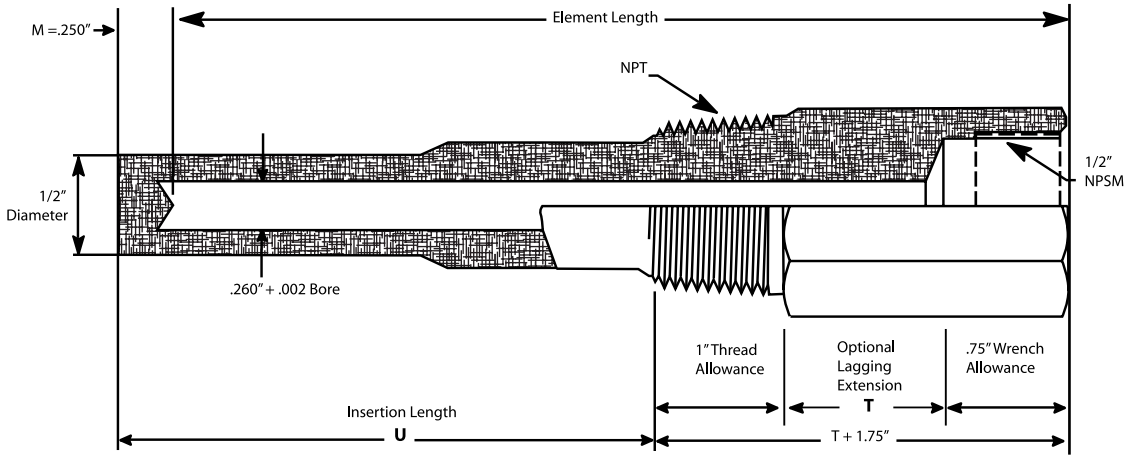


Drilled Protection Wells (DPW)

No. 260H & 385H Std. & Heavy-duty Tapered 1/4" Well for 3/8" Dia. Elements



No. 260R & 385R Standard Duty Reduced Tip 1/2" Well for 1/4" Dia. Elements

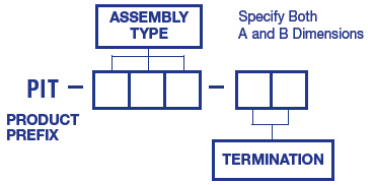


For Flanged Thermowell, please consult factory.

CLEVELAND ELECTRIC LABORATORIES
Thermocouples & Sensing Solutions since 1920

Plastics Industry Thermocouples (PIT)

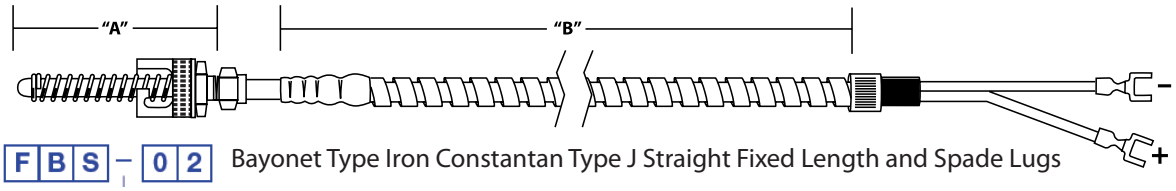
- Three Styles Available
- Bayonet
- Variable depth
- Melt bolt (Consult Factory) does not apply to cold end terminations.



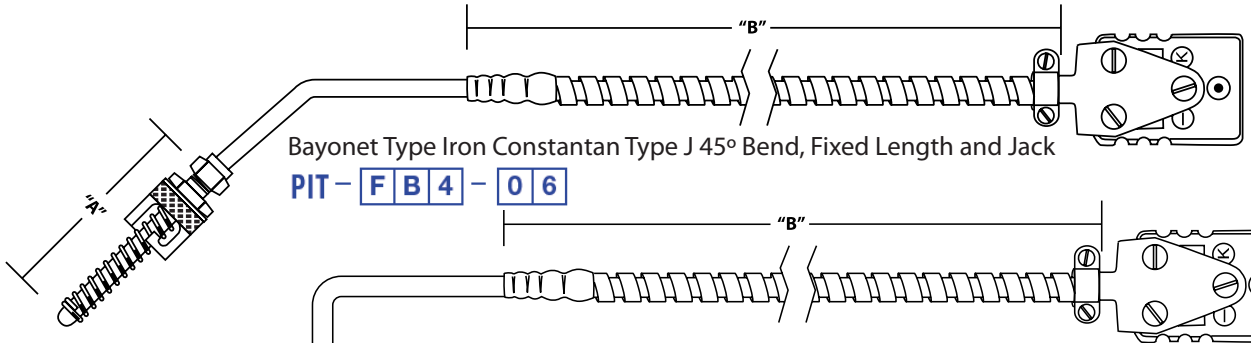
ASSEMBLY TYPE	TERMINATION
FBS - Straight w/Fixed Length	**02** - Spade Lugs
FB9 - 90º Bend w/Fixed Length	**04** - Plug
FB4 - 45º Bend w/Fixed Length	**06** - Jack
ABS - Spring Type w/Adj Length	
ABF - Flex Armor Type w/Adj Length	

Example Ordering Numbers

PIT – F B S – 0 4 Straight with fixed length Bayonet Thermocouple with plug termination. Specify A and B dimensions in inches.

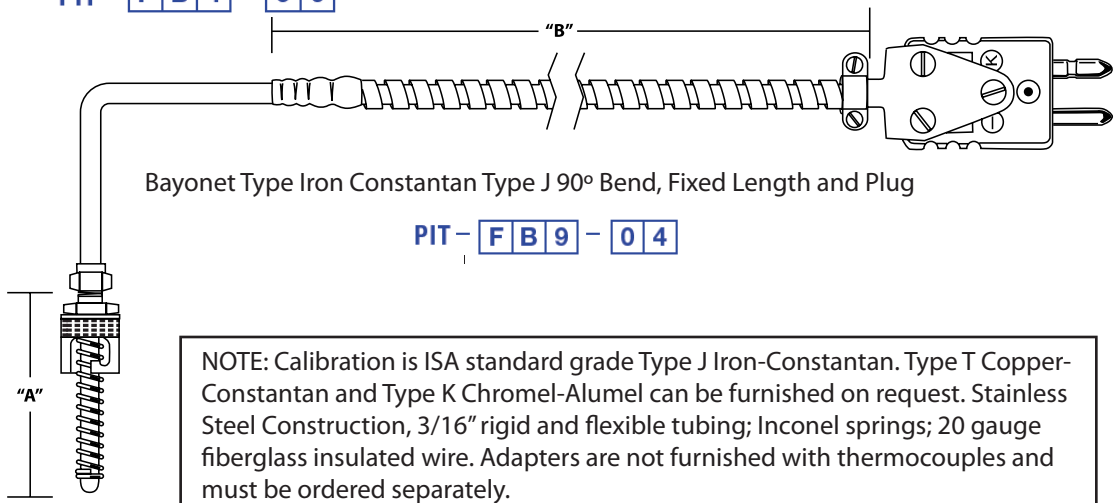


PIT – F B S – 0 2 Bayonet Type Iron Constantan Type J Straight Fixed Length and Spade Lugs



Bayonet Type Iron Constantan Type J 45º Bend, Fixed Length and Jack

PIT – F B 4 – 0 6

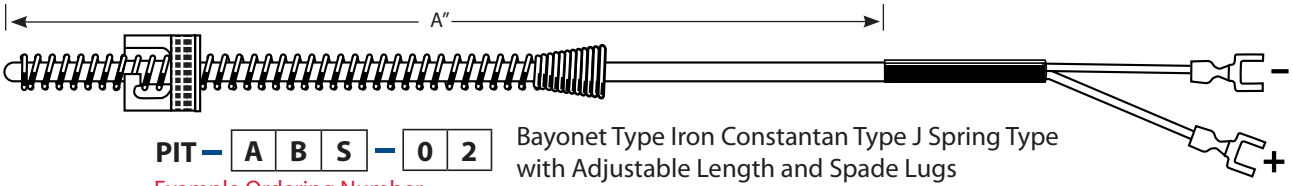


Bayonet Type Iron Constantan Type J 90º Bend, Fixed Length and Plug

PIT – F B 9 – 0 4

NOTE: Calibration is ISA standard grade Type J Iron-Constantan. Type T Copper-Constantan and Type K Chromel-Alumel can be furnished on request. Stainless Steel Construction, 3/16" rigid and flexible tubing; Inconel springs; 20 gauge fiberglass insulated wire. Adapters are not furnished with thermocouples and must be ordered separately.

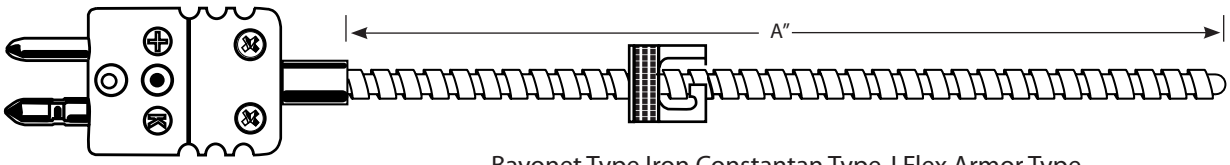
Bayonet Type for Use to 800ºF



PIT – A B S – 0 2

Example Ordering Number

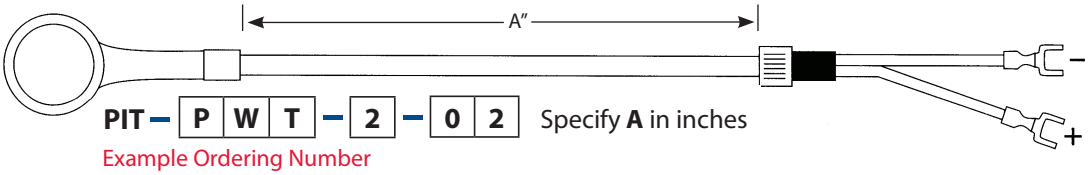
Bayonet Type Iron Constantan Type J Spring Type
with Adjustable Length and Spade Lugs
Specify **A** in inches



PIT – A B F – 0 4

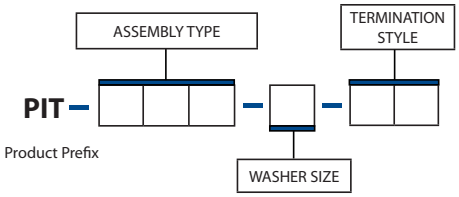
Example Ordering Number

Bayonet Type Iron Constantan Type J Flex Armor Type
with Adjustable Length and Plug
Specify **A** in inches



PIT – P W T – 2 – 0 2 Specify **A** in inches

Example Ordering Number



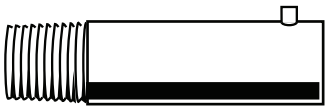
SURFACE THERMOCOUPLE FOR USE TO 800ºF
(Stranded wire with stainless steel overbraid)

WASHER SIZE		TERMINATION STYLE	
CODE	TYPE	CODE	TYPE
1	15/32" Dia	02	Spade Lugs
2	7/32" for #10 Screw	04	Plug
		06	Jack

NOTE: Calibration is ISA standard grade Type J Iron-Constantan. Type T Copper-Constantan and Type K Chromel-Alumel can be furnished on request. Stainless Steel Construction, 3/16" rigid and flexible tubing; Inconel springs; 20 gauge fiberglass insulated wire. Adapters are not furnished with thermocouples and must be ordered separately.

Plastics Bayonet Adapter (PBA)

PBA –



CODE	LENGTH (In Inches)	THREAD
1	7/8"	1/8"-27 NPT
2	7/8"	3/8"-24
3	1 3/8"	1/8"-27 NPT
4	1 3/8"	3/8"-24
5	2 1/2"	1/8"-27 NPT
6	2 1/2"	3/8"-24
7	2 3/8"	14 x 1.5mm
8	2 1/2"	10 x 1.5mm

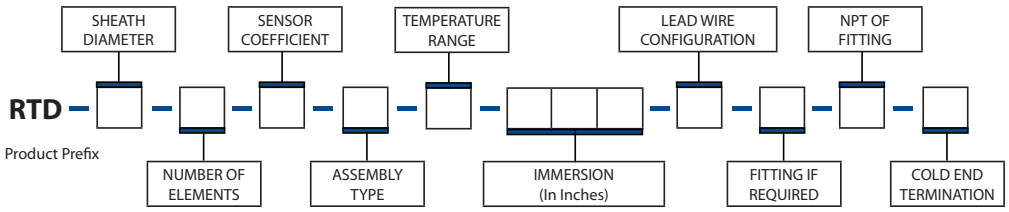
CLEVELAND ELECTRIC LABORATORIES

Thermocouples & Sensing Solutions since 1920

Resistance Temperature Detectors (RTD)

- Sensing elements in platinum, copper, nickel, nickel wire
- Custom RTDs-Consult Factory

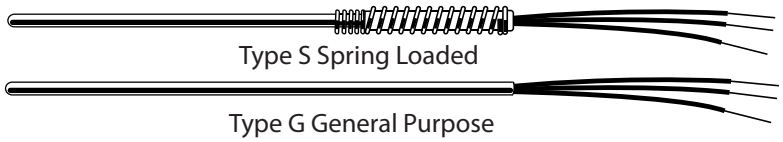
SHEATH DIAMETER (OD)	NUMBER OF ELEMENTS	SENSOR COEFFICIENT	ASSEMBLY TYPE	TEMPERATURE RANGE
1 - .125″ 2 - .188″ 3 - .250″ 4 - .313″ 5 - .375	D - Dual S - Single	D - .00385 OHMS/OHM/Deg C A - .00392 OHMS/OHM/Deg C B - .00385 Degussa	G - General Purpose Stem Sensitive S - Spring Loaded Head X - Exposed Tip Dry Air/Gas	S – 350 to +500°F H – 320 to +1700°F
IMMERSION (In Inches)	**LEAD WIRE CONFIGURATION**	**FITTING IF REQUIRED**	**NPT OF FITTING**	**COLD END TERMINATION**
(In inches)	2 - 2 Wire 3 - 3 Wire 4 - 4 Wire 6 - 6 Dual 3 Wire 8 - 8 Dual 4 Wire	0 - None 1 - Hex Nipple 2 - Hex Bushing (Proc Connect) 3 - Hex Bushing (Head Connect) 4 - Adj Stainless 5 - Hex Nipple Oil Seal (Spring Loaded) 6 - Hex Nipple Spring Loaded 7 - Bayonet Spring Loaded 8 - With Spring Loaded Block 9 - 1/2″ x 5″ Galvanized Nipple	0 - None A - 1/8″ B - 1/4″ C - 1/2″ D - 3/4″ E - 1/4″ x 1/2″ F - 3/4″ x 1/2″ G - 1″ x 1/2″	0 - 6″ Leads w/Strip A - Std Cast Iron Head B - Std Cast Aluminum Head C - Explosion Proof Head D - Miniature Polypropylene E - Assy. w/Flex Armor Lead F - Assy. w/SS Overbraid Leads G - 3 Pin Plug H - Epoxy Coated Aluminum X - Special P - Std Polypropylene Head



Example Ordering Number

RTD – 2 – S – A – S – H – 024 – 3 – 6 – C – 0

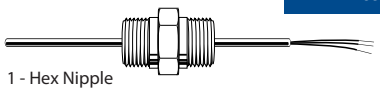
3/16″ OD x 24″ length 100 ohm Plt RTD sensor, .00392 ohms/ohm deg. C. Coefficient, ½″ NPT hex spring loaded nipple, 6″ leads.



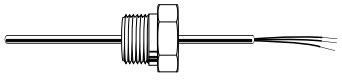
Type S Spring Loaded

Type G General Purpose

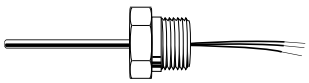
Fittings



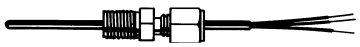
1 - Hex Nipple



2 - Hex Bushing (Process Connection)

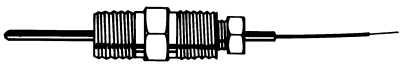


3 - Hex Bushing (Head Connection)

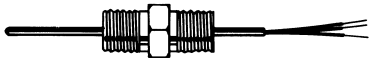


4 - Adjustable Stainless

7 - Bayonet Spring Loaded



5 - Hex Nipple with Oil Seal (Spring Loaded)

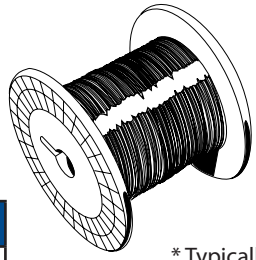


6 - Hex Nipple (Spring Loaded)

CLEVELAND ELECTRIC LABORATORIES

Thermocouples & Sensing Solutions since 1920

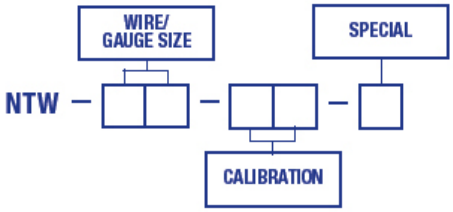
- CEL offers Noble Metal Thermocouple wire in bulk form
- Available in Standard and Reference Grade
- Consult factory for special requirements



* Typically sold in inch Quantities

Noble Thermocouple Wire (NTW)

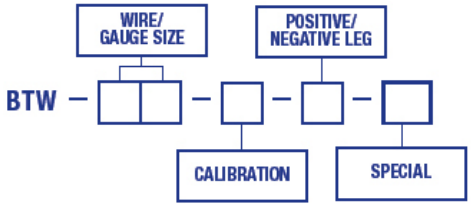
WIRE/GAUGE SIZE		CALIBRATION	SPECIAL
32 - 32 AWG (.008)	22 - 22 AWG (.025)	OP - Pure Platinum Wire	0 - None
30 - 30 AWG (.010)	21 - 21 AWG (.028)	06 - Platinum-6% Rhodium Wire	F - Stabilized
28 - 28 AWG (.013)	20 - 20 AWG (.032)	10 - Platinum-10% Rhodium Wire	S - Special Limits
27 - 27 AWG (.014)	18 - 18 AWG (.040)	13 - Platinum-13% Rhodium Wire	C - Certified
26 - 26 AWG (.016)	17 - 17 AWG (.045)	30 - Platinum-30% Rhodium Wire	
24 - 24 AWG (.020)	15 - 15 AWG (.060)		
23 - 23 AWG (.023)	08 - 8 AWG (.125)		



Bare Thermocouple Wire (BTW)

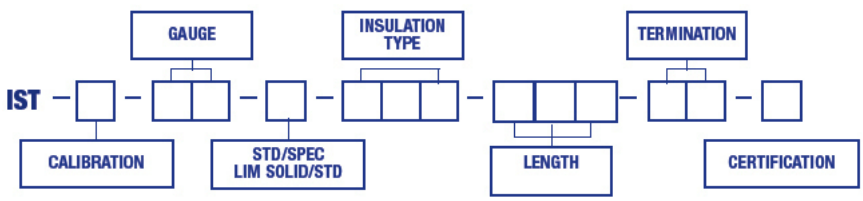
WIRE/GAUGE SIZE		CALIBRATION	POSITIVE/ NEGATIVE LEG	SPECIAL
32 - 32 AWG	18 - 18 AWG	N - Nicrosi-Nisil	P -Positive Leg	0 -None
30 - 30 AWG	17 - 17 AWG	J - Iron-Constantan	N -Negative Leg	S -Special Limits
28 - 28 AWG	16 - 16 AWG	K - Chromel-Alumel		C -Certified
27 - 27 AWG	14 - 14 AWG	T - Copper-Constantan		
26 - 26 AWG	11 - 11 AWG	E - Chromel-Constantan		
24 - 24 AWG	09 - 9 AWG	C - 5% Re-W 26% Re		
23 - 23 AWG	08 - 8 AWG	M** - Ni/Ni Moly		
22 - 22 AWG	02 - 2 AWG			
20 - 20 AWG				

* Typically sold in pound Quantities
** CEL identification only - None Established.
Nickel 0.8% Cobalt/Nickel 18% Moly



Insulated Survey Thermocouple (IST)

CALIBRATION	GAUGE	STD/SPEC LIM SOLID/STD	INSULATION TYPE	LENGTH	TERMINATION	CERTIFICATION
J - Iron-Constantan	14 - 14 AWG	1 - Solid STD Limits	232 - HiTemp GL BR/HiTemp GL BR	000 - 999	01 - 1" Strip	0 - None
K - Chromel-Alumel	16 - 16 AWG	2 - Solid Special Limits	301 - VIT SIL FIB/VIT SIL FIB		02 - Std. Male Plug	C - Std. Points
N - Nicrosil-Nisil	20 - 20 AWG		304 - Glass Braid/Glass Braid		03 - Hi-Temp Male Plug	X - Special Points
T - Copper-Constantan	24 - 24 AWG		332 - HiTemp GL BR/HiTemp GL BRD		04 - Mini Plug	
	28 - 28 AWG		350 - Ceramic Fibr/Ceramic Fibr		05 - Std. Jack	
	30 - 30 AWG		507 - FEP Extruded/FEP Extruded		06 - Hi-Temp Jack	
					XX - Special	



CLEVELAND ELECTRIC LABORATORIES
Thermocouples & Sensing Solutions since 1920

How to read the catalog number chart

Cleveland Electric Laboratories offers a complete line of insulated thermocouple and extension grade wires in single, duplex and multipair constructions. Ordering with another manufacturer's part number is an acceptable option, or construct a Cleveland Electric Laboratories part number using the box format explained below. By filling in the boxes in the natural order of progression, construction of a part number for a thermocouple or extension grade wire is a simple seven-step process.

Step 1: Insert the "ITW" Insulated Thermocouple Wire or "IEW" Insulated Extension Wire prefix into the designated space.

Step 2: Insert the desired calibration K, J, T etc. into the corresponding box.

Step 3: Insert desired wire gauge.

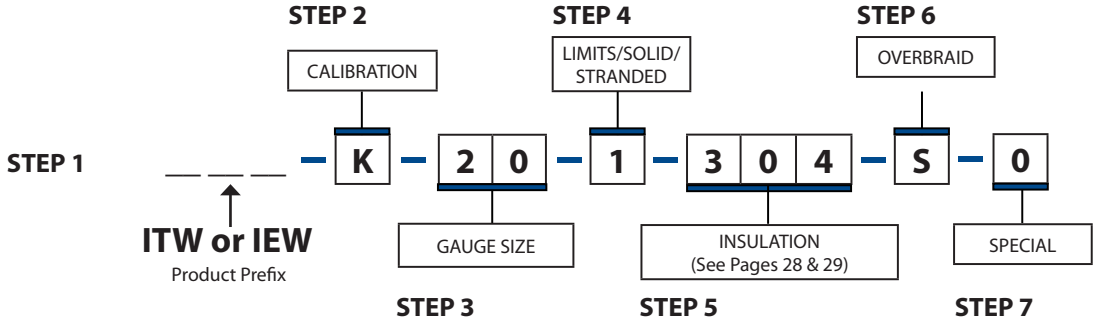
Step 4: The "limits/solid/stranded" box consists of a single digit. The #1 indicates solid conductors standard limits of error, while the #3 indicates stranded conductors standard limits of error for thermocouple grade wire. When constructing an extension cable, insert the #5 for solid conductors standard limits of error or the #7 for stranded conductors standard limits of error. NOTE: When special limits of error material is required, these digits must be changed to the next higher even digit, i.e., from ITW-K-20-1-304-0-0 to special limits ITW-K-20-2-304-0-0.

Step 5: Select desired insulation type.

Step 6: Select overbraid material. If none, insert "0".

Step 7: This box is reserved for certified and custom constructions. If certified (see below) or a custom built wire is required, please consult factory for further instructions. If none, please insert "0" in this box.

CERTIFICATION: **ISO/IEC 17025**
Cleveland Electric Laboratories is an approved source to certify bulk thermocouple wire or individual elements traceable to N.I.S.T. Each thermocouple element, coil or spool of wire is tagged with the individual temperature departure from the corresponding calibration curve. Please consult factory for additional information.



ANSI TOLERANCES:
Unless specified, our thermocouple and extension wires are supplied to meet Standard Tolerances of ANSI circular MC96.1-1982. Special Tolerances are also available per ANSI MC96.1. Tolerances for thermocouple and extension wires are given in the accompanying tables. Where tolerances are given in percent, the percentage applies to the temperature being measured.

Initial Calibration Tolerances for Thermocouples

THERMOCOUPLE TYPE	TEMPERATURE RANGE		TOLERANCES †	
	°C	°F	STANDARD	SPECIAL
T	0 to 370	32 to700	±1.0°C or ±0.75%	±0.5°C or 0.4%
J	0 to 760	32 to 1400	±2.2°C or ±0.75%	±1.1°C or 0.4%
E	0 to 870	32 to 1600	±1.7°C or ±0.5%	±1.0°C or ±0.4%
K or N	0 to 1260	32 to 2300	±2.2°C or ±0.75%	±1.1°C or ±0.4%
R or S	0 to 1480	32 to 2700	±1.5°C or ±0.25%	±0.6°C or ±0.1%
B	870 to 1700	1600 to 3100	±0.5°C%	±0.25%
C	0 to 2315	32 to 4200	±4.4°C or ±1%	
E*[A]	-200 to 0	-328 to 32	±1.7°C or ±1%	*B
K*[A]	-200 to 0	-328 to 32	±2.2°C or ±2%	*B
T*[A]	-200 to 0	-328 to 32	±1.0°C or ±1.5%	* B

* [A] Thermocouples and thermocouple materials are normally supplied to meet the tolerances specified in the table for the temperature above 0°C. The same materials, however, may not fall within the tolerances given for temperatures below °C in the second section of the table. If materials are required to meet the tolerances stated for temperatures below 0°C, the purchase order must so state. Selection of materials will be required.

* [B] Special tolerances for temperatures below 0°C are difficult to justify due to limited available information. However, the following values for types E and T thermocouples are suggested as a guide between purchaser and supplier:

Type **E** -200 to 0°C ±1.0°C or ±0.5% (whichever is greater)
Type **T** -200 to 0°C ±0.5°C or ±0.8% (whichever is greater)

Initial values of tolerance for Type J thermocouples at temperatures below 0°C and special tolerances for Type K thermocouples below 0°C are not given due to the characteristics of the materials.

Initial Calibration Tolerances for Thermocouple Extension Wires

Reference Junction 0°C (32°F)

THERMOCOUPLE TYPE	TEMPERATURE RANGE		TOLERANCES †			
	°C	°F	STANDARD		SPECIAL	
			°C	°F	°C	°F
TX	-60 to 100	-75 to 200	±1.0	±1.8	±0.5	±0.9
JX	0 to 200	32 to 400	±2.2	±4.0	±1.1	±2.0
EX	0 to 200	32 to 400	±1.7	±3.0	±1.0	±1.8
KX	0 to 200	32 to 400	±2.2	±4.0	±1.1	±2.0
NX	0 to 200	32 to 400	±2.2	±4.0	±1.1	±2.0

† Tolerances represent the maximum error contribution allowable from new and essentially homogeneous thermocouple extension wire when exposed to the full temperature range given in the table above. Extension grade materials are not intended for use outside the temperature range shown.

Note: Thermocouple extension wire makes a contribution to the total thermoelectric signal that is dependent upon the temperature difference between the extreme ends of the extension wire length. The actual magnitude of any error introduced into a measuring circuit by homogeneous and correctly connected extension wires is equal to the algebraic difference of the deviations at its two end temperatures, as determined for that extension wire pair.

Initial Calibration Tolerances for Thermocouple Extension Wires

Reference Junction 0°C (32°F)

THERMOCOUPLE TYPE	TEMPERATURE RANGE		TOLERANCES †		
	°C	°F	STANDARD		SPECIAL
			°C	°F	
SX	0 to 200	32 to 400	±5	±9	*A*
RX	0 to 200	32 to 400	±5	±9	*A*
BX[B]	0 to 200	32 to 400	±4.2	±7.6	*A*
BX[C]	0 to 100	32 to 200	±3.7	±6.7	---
CX	0 to 200	32 to 400	±2.2	Initial Calibration Tolerances ±0.110 mV	

† Tolerances apply to new and essentially homogeneous thermocouple compensating extension wire when at temperatures within the range given in the table above.

Note: Thermocouple compensating extension wire makes a contribution to the total thermoelectric signal that is dependent upon the temperature difference between the extreme ends of the compensating extension wire length.

[A] Special tolerance grade compensating extension wires are not available.
[B] Proprietary alloy compensating extension wire is available for use over a wide temperature range.
[C] Special compensating extension wires are not necessary with Type B over the limited temperature range 0 to 50 °C (32 to 125 °F), where the use of non-compensated (copper/copper) conductors introduces no significant error. For a somewhat larger temperature gradient of 0 to 100 °C (32 to 210 °F) across the extension portion of the circuit, the use of non-compensated (copper/copper) extension wire may result in small errors, the magnitude of which will not exceed the tolerance values given in the table above for measurements above 1000 °C (1800 °F).

Ansi Letter Designations

Thermocouple and extension wires are now generally ordered and specified by ANSI letter designations for wire type. Positive and negative legs are identified by the appropriate letter suffixes P and N, respectively.

ANSI LETTER	DESCRIPTION	POPULAR GENERIC & TRADE NAMES*
T	TP	Copper
	TN	Constantan, Cupron, Advance
J	JP	Iron
	JN	Constantan, Cupron, Advance
E	EP	Chromel, Tophel, T1
	EN	Constantan, Cupron, Advance
N	NP	Nicrosil
	NN	Nisil (Magnetic)
K	KP	Chromel, Tophel, T1
	KN	Alumel, Nial, T2
S	SP	Platinum 10% Rhodium
	SN	Pure Platinum
R	RP	Platinum 13% Rhodium
	RN	Pure Platinum
B	BP	Platinum 30% Rhodium
	BN	Platinum 6% Rhodium
C	CP	Tungsten 5% Rhenium
	CN	Tungsten 26% Rhenium

Color Coding

Standard ANSI color coding is used on all insulated thermocouple wire and extension wire when the type of insulation permits. In color coding, the right is reserved to include a tracer to identify the ANSI type.

ANSI Type		Magnetic		Single	ANSI Color Code	
T/C	Single	Yes	No		Overall Extension Wire	Overall T/C Wire
T	TP		•	Blue	Blue	Brown
	TN		•	Red		
J	JP	•		White	Black	Brown
	JN		•	Red		
E	EP		•	Purple	Purple	Brown
	EN		•	Red		
K	KP		•	Yellow	Yellow	Brown
	KN	•		Red		
S, R	RP, SP		•	Black	Green	
	RN, SN		•	Red		
B	BP		•	Grey	Grey	
	BN		•	Red		
N	NP			Orange	Orange	Brown
	NN	•		Red		
C	CP		•	Green	Red	
	CN		•	Red		

Solid and Stranded Conductors

Thermocouple and extension wires are usually solid conductors, but both are available in stranded construction if greater flexibility is required.

Conductor		Stranding	
Gauge	ANSI Type	No. of Strands	Gauge
14	All	7	22
16	All	7	24
18	All	7	26
20	All	7	28
22	Al	7	30
24	All	7	32

Thermocouple Wire, Insulation, Construction and Characteristics

Insulation Code	Single Conductor		Duplex Conductors		Temperature Rating**		ANSI Color Coded	Physical Properties		Notes
	Insulation	Impregnation	Insulation	Impregnation	Continuous	Single Reading		Abrasion Resistance	Moisture Resistance	
200	High Temp. Glass Braid	High Temp. Varnish	None Twisted	—	704°C	871°C	Yes	Good	Good	Impregnation retained to 204°C (400°F)
					1300°F	1600°F				
232	High Temp. Glass Braid	High Temp. Varnish	High Temp. Glass Braid	High Temp. Varnish	704°C	871°C	Yes	Good	Good	
					1300°F	1600°F				
301	Vitreous	None	Vitreous Silica	None	871°C	1092°C	N0	Fair	Fair	—
	Silica Fiber	—	Fiber	—	1600°F	2000°F				Impregnation retained to 204°C (400°F)
304	Glass Braid	Silicone Modified Resin	Glass Braid	Silicone Modified Resin	482°C	538°C	Yes	Fair	Good	
					900°F	1000°F				
305	Double Glass Wrap	High Temp. Varnish	Glass Braid	Silicone Modified Resin	482°C	538°C	Yes	Fair	Good	
					900°F	1000°F				Teflon good to 260°C (500°F)
307	TFE Tape (not fused)	—	TFE Coated	—	482°C	538°C	Yes	Good	Excellent	
	TFE Coated Glass	—	Glass Braid	—	900°F	1000°F				
350	Ceramic Fiber	—	Ceramic Fiber	—	1204°C	1427°C		Good	Fair	—
					2200°F	2600°F	No			
505	Polyvinyl	—	Ripcord	—	-29 to +150°C			Good	Excellent	—
					-20 to +221°F		Yes			
507	FEP Extr.	—	FEP Extr.	—	204°C	316°C		Very Good	Excellent	—
					400°F	600°F	Yes			
508	TFE Tape Fused	—	TFE Tape Fused	—	260°C	316°C		Good	Excellent	—
					500°F	600°F	Yes			
509	FEP Extr.	—	FEP Extr. Twisted	—	204°C	316°C		Very Good	Excellent	Aluminum/ Mylar® shield with drain wire
					400°F	600°F	Yes			
513	Fused Kapton	—	Fused Kapton	—	316°C	427°C				FEP binder melts at approx. 260°C (500°F)
	Tape Polymide		Tape		600°F	800°F	Yes	Excellent	Excellent	
514	Tefzel®	—	Tefzel	—	150°C	200°C				
					302°F	392°F	Yes	Excellent	Excellent	—

*Trade names of E I duPont de Nemours & Co.
**Thermocouple extension grade wire is only calibrated up to 204°C (400°F).

Extension Wire, Insulation, Construction and Characteristics

Insulation Code	Single Conductor		Duplex Conductors		Temperature Rating**		ANSI Color Coded	Physical Properties		Notes
	Insulation	Impregnation	Insulation	Impregnation	Continuous	Single Reading		Abrasion Resistance	Moisture Resistance	
155	Glass Braid	Silicone Modified Resin	ServTex Braid	Moisture Resistant	288°C 550°F	343°C 650°F	Yes	Good	Fair	Impregnation retained to 204°C (400°F)
157	TFE Tape (not fused) Glass Braid	Silicone Modified Resin	ServTex Braid	Compound	288°C 550°F	343°C 650°F	Yes	Good	Good	Impregnation retained to 204°C (400°F) Teflon good to 260°C (500°F)
232	High Temp. Glass Braid	High Temp. Varnish	High Temp. Glass Braid	Moisture Resistant Compound	704°C 1300°F	871°C 1600°F	NO	Good	Fair	Impregnation retained to 204°C (400°F)
304	Glass Braid	Silicone Modified Resin	Glass Braid	High Temp. Varnish	482°C 900°F	538°C 1000°F	Yes	Fair	Good	
502	Polyvinyl	—	Polyvinyl	—	-29 to +150°C -20 to +221°F		Yes	Good	Excellent	—
507	FEP Extr.	—	FEP Extr.	—	204°C 400°F	316°C 600°F	Yes	Very Good	Excellent	—
509	FEP Extr.	—	FEP Extr.	—	204°C 400°F	316°C 600°F	Yes	Very Good	Excellent	Aluminum/ Mylar® shield with drain wire
510	Polyvinyl	—	Polyvinyl Twisted	—	-29 to +150°C -20 to +221°F		Yes	Good	Excellent	
514	Tefzel	—	Tefzel	—	150°C 302°F	200°C 392°F	Yes	Excellent	Excellent	

*Trade names of E I duPont de Nemours & Co.
**Thermocouple extension grade wire is only calibrated up to 204°C (400°F).

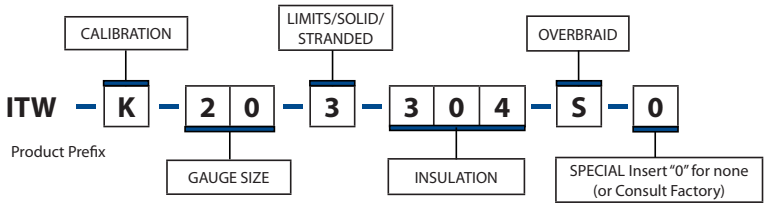
Note: ServTex synthetic fibers are organic compounds. Good ventilation is recommended in areas where this product may be subjected to elevated temperatures.

Insulated Thermocouple Wire Ordering

CLEVELAND ELECTRIC LABORATORIES

Thermocouples & Sensing Solutions since 1920

How to order: Insulated Thermocouple Wire (ITW)



The box format above illustrates the following:
Type K, 20 ga., standard limits-stranded conductors, glass braid insulation, stainless steel overbraid.

OVERBRAID SELECTION CODE	
Stainless Steel Wire Braid	S
Tinned Copper Wire Braid	C
Flat Stainless Steel Ribbon Braid	F
Flat Stainless Steel Spiral Wrap	W
Half Oval Galvanized Steel Spiral Wrap	G
Inconel	I

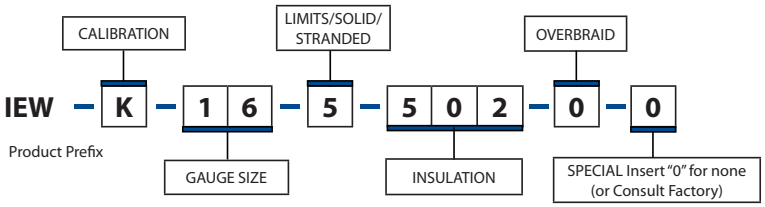
To order standard catalog material with overbraid do so by catalog number as follows.
Desired: ITW-J-20-1-305 with stainless steel wire braid.
Specify: Catalog Number ITW-J-20-1-305-S-0.

Insulation

AVAILABLE TYPES	CALIBRATION	B & S GAUGE SIZE	CONDUCTOR CODE	INSULATION CODE	EACH CONDUCTOR	OVERALL
J, K		14	*1, 2*	232	High Temperature Glass Braid	High Temperature Glass Braid
K		16	*1, 2*	350	Ceramic Fiber	Ceramic Fiber
J, K		16	*1, 2*	232	High Temperature Glass Braid	High Temperature Glass Braid
K		20	*2*	301	Vitreous Silica Fiber	Vitreous Silica Fiber
J, K, T, E		20	*1, 2, 3*	304	Glass Braid	Glass Braid
J, K, T		20	*1, 2*	305	Double Glass Wrap	Double Glass Wrap
J, K		20	*2*	232	High Temperature Glass Braid	High Temperature Glass Braid
K		20	*2*	350	Ceramic Fiber	Ceramic Fiber
J, K, T		20	*1, 2*	507	FEP Extruded	FEP Extruded
J, K, T		20	*1, 2*	508	Fused TFE Tape	Fused TFE Tape
J, K, T		20	*1, 2, 3*	509	FEP Extruded	FEP Extruded
J, K, T		20	*1, 2*	513	Fused Kapton Tape	Fused Kapton Tape
J		20	*1, 2*	307	TFE Tape/TFE Imp Glass	TFE Tape/TFE Imp Glass
J		20	*9*	P04	JP Single Conductor	JP Single Conductor
J		20	*9*	N04	JN Single Conductor	JN Single Conductor
J, K, T		20	*1, 2*	304	Glass Braid	Glass Braid
J, K, T		24	*1, 2*	305	Glass Wrap	Glass Wrap
J,K		24	*1, 2*	232	High Temperature Glass Braid	High Temperature Glass Braid
J, K, T		24	*1, 2*	508	Fused TFE Tape	Fused TFE Tape
J, K, T		24	*1, 2*	505	Polyvinyl	Polyvinyl
J, K, T		24	*1, 2*	513	Fused Kapton Tape	Fused Kapton Tape
T		24	*1, 2*	514	Tefzel	Tefzel
K		26	*1, 2*	305	Glass Wrap	Glass Wrap
J,K		26	*1, 2*	305	Glass Wrap	Glass Wrap
K,T		30	*1, 2*	305	Glass Wrap	Glass Wrap
K,T		30	*1, 2*	507	FEP Extruded	FEP Extruded
J,K,T		30	*1, 2*	513	Fused Kapton Tape	Fused Kapton Tape

*Multi Pair Thermocouple Wire Available. Consult Factory.

How to order: Insulated Extension Wire (IEW)



The box format above illustrates the following:
Type K, 16 ga., standard limits-solid conductors, polyvinyl insulation.

OVERBRAID SELECTION CODE	
Stainless Steel Wire Braid	S
Tinned Copper Wire Braid	C
Flat Stainless Steel Ribbon Braid	F
Flat Stainless Steel Spiral Wrap	W
Half Oval Galvanized Steel Spiral Wrap	G
Inconel	I

To order standard catalog material with overbraid do so by catalog number as follows.
Desired: IEW-K-20-5-502 with stainless steel wire braid.
Specify: Catalog Number IEW-K-20-5-502-S-0.

Insulation

AVAILABLE TYPES	CALIBRATION	B & S GAUGE SIZE	CONDUCTOR CODE	INSULATION CODE	EACH CONDUCTOR	OVERALL
J, K		14	5	155	Felted ServTex	ServTex Braid
J, K		14	5	502	Polyvinyl	Polyvinyl
J, K		14	5	304	Glass Braid	Glass Braid
J, K		14	5	232	High Temperature Glass Braid	High Temperature Glass Braid
J, K		14	5	507	FEP Extruded	FEP Extruded
J, K, S		16	5, 7	155	Felted ServTex	ServTex Braid
J, K, S		16	5, 7	157	TFE/Felted ServTex	ServTex Braid
J, K, S		16	5	304	Glass Braid	Glass Braid
J, K		16	5	232	High Temperature Glass Braid	High Temperature Glass Braid
J, K, E, T, S		16	5, 7	502	Polyvinyl	Polyvinyl
J, K, E, T, S		16	5, 7	510	Polyvinyl	Twisted Aluminum Mylar/PVC
J, K, E, T,		16	5	515	Tefzel	Tefzel Twisted
J, K, S		16	5, 7	507	FEP Extruded	FEP Extruded
J, K, S		16	5, 7	509	FEP Extruded	Twisted Aluminum Mylar/FEP
J, K, E, T, S		20	5	502	Polyvinyl	Polyvinyl
J, K, S		20	5, 7	232	High Temperature Glass Braid	High Temperature Glass Braid
J, K, E, T, S		20	5, 7	510	Polyvinyl	Twisted Aluminum Mylar/PVC
J, K, E, T		20	5	514	Tefzel	Tefzel
J, K, S		20	5	507	FEP Extruded	FEP Extruded
J, K, S		20	5, 7	509	FEP Extruded	Twisted Aluminum Mylar/FEP
S		20	5	304	Glass Braid	Glass Braid
S		24	5	304	Glass Braid	Glass Braid

AVAILABLE TYPES	CALIBRATION	B & S GAUGE SIZE	CONDUCTOR CODE	INSULATION CODE	EACH CONDUCTOR	OVERALL
R		22	3	701	PVC	PVC (3-wire) Stranded
R		22	4	701	PVC	PVC (3-wire) Stranded
R		24	3	705	Glass Braid	Glass Braid (3-wire) Stranded
R		24	4	705	Glass Braid	Glass Braid (3-wire) Stranded

CLEVELAND ELECTRIC LABORATORIES
Thermocouples & Sensing Solutions since 1920

Multipair Thermocouple Extension Cable

Special Orders – Thermocouple extension wire can be made to your specific order as multipair cable with individual and over-all insulations to suit installation conditions. Such cables greatly reduce cost of installation compared to pulling separate pairs of wires through conduit. Minimum quantity of any cable manufactured to order is 1000 feet. Complete specifications must accompany request for quotation.
Standard Multipair

Standard Multipair
Extension Cable – The more common extension wire types are made up into standard multipair cables which are usually available for immediate delivery.

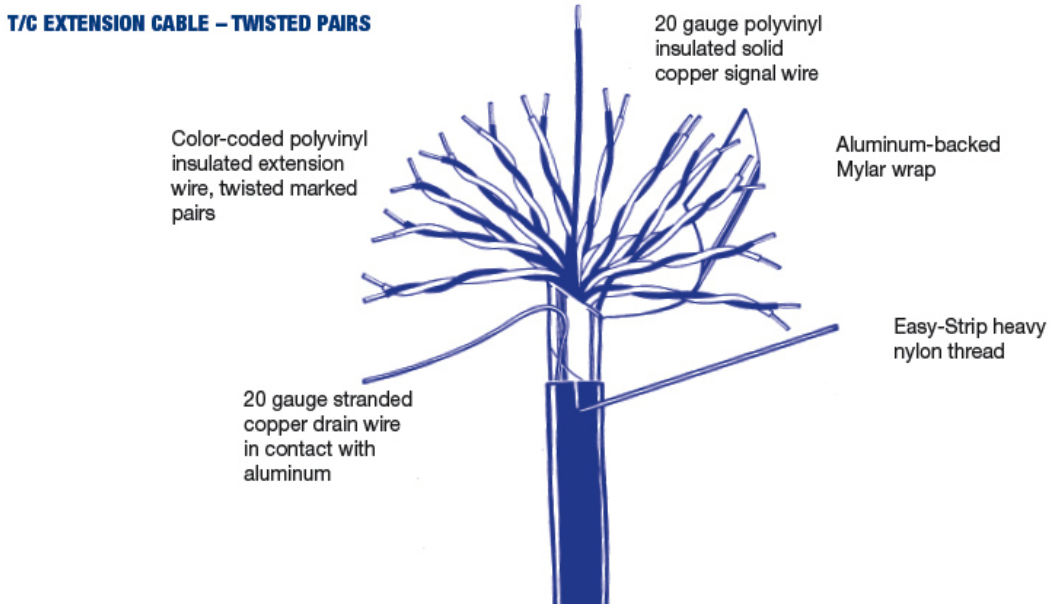
Twisted Pair Cable – Each conductor is covered with polyvinyl, nominal .015 inch thick, with each pair twisted to reduce magnetic interference. The twisted pairs are cabled and then shielded with a .0015 inch thick aluminum backed Mylar tape and a 20 gauge stranded copper drain wire. The drain wire, in contact with the aluminum, provides a simple mechanical connection for the shield, thus minimizing the effects of electromagnetic interference. The cable is then covered with an outer layer of polyvinyl, nominal .045 inch thick. A heavy Easy-Strip nylon thread is included. This cable is particularly adapted to those installations demanding maximum reduction in magnetic and electrostatic interference.

Signal Wire and Coding – As an added convenience, each standard cable contains an extra polyvinyl-clad 20-gauge solid copper wire for use as a signal connection for completing a communications of signal circuit. These standard cables are color coded on the individual conductors and over-all. The positive leg only on Series 900 is marked 1, 2, etc. Primary insulation will withstand ambient temperatures up to 105°C (221°F) and resists atmosphere and moisture.

Wire Overbraid – Any of the standard cables listed in the accompanying tables can be supplied with a braid of stainless steel wire.

MULTIPAIR EXTENSION CABLE

AVAILABLE TYPES	CALIBRATION	B & S GAUGE SIZE	CONDUCTOR CODE	INSULATION CODE	Number of Pairs	EACH CONDUCTOR	OVERALL
J, K, T		20	5	904	4 Pairs Twisted	Polyvinyl Twisted	Twisted Aluminum Mylar/PVC
J, K, T		20	5	908	8 Pairs Twisted	Polyvinyl Twisted	Twisted Aluminum Mylar/PVC
J, K, T		20	5	912	12 Pairs Twisted	Polyvinyl Twisted	Twisted Aluminum Mylar/PVC
J, K		20	5	916	16 Pairs Twisted	Polyvinyl Twisted	Twisted Aluminum Mylar/PVC
J, K		20	5	920	20 Pairs Twisted	Polyvinyl Twisted	Twisted Aluminum Mylar/PVC
J, K, T		20	5	924	24 Pairs Twisted	Polyvinyl Twisted	Twisted Aluminum Mylar/PVC



Ajax Bend