

Mineral Insulated Cables



- Thermocouple MI Cables
- RTD Extension MI Cables
- Heater MI Cables
- Mineral Insulated Power Cable

ABOUT THE COMPANY



Tempsens Instruments (I) Pvt. Ltd. is a part of Pyrotech Group which was established by four technocrats in 1976 at Udaipur, with their first product as Thermocouples and RTDs.

Today Tempsens is one of the largest manufacturers of Temperature Sensors in India.

We are ISO 9001:2008 certified company with NABL accredited Lab. Tempsens Instruments (I) Pvt. Ltd. U # II was started in 2009 to produce quality cables with high

standard of manufacturing process conforming to national & international specifications.

We manufacturer wide range of cables for Temperature sensors and Instrumentation in various insulations as PTFE, Kapton, Silicon, Fiber Glass, Ceramic Fiber, Refrasil/Nextel, PVC etc. in variety of configurations. These cables are available in temperature range -60°C to 1200°C.

All our products are manufactured under strict ISO-9001 quality control system. We also provide Calibration Certificates with all cables. We stock most types of cables which enable us for fast delivery of goods. Our engineering staffs are capable of custom design a solution for any application for customer. We are dedicated to provide the highest quality products that meet our customer's specifications for various applications. We continuously focus on improving our manufacturing processes and Competitiveness in the industry.

We introduce our latest addition in the cable line which is the mineral – insulated, metal sheathed cable products. The applications of MI Cable are many such as blast furnace, atomic research, nuclear reactors, Kilns and many more. Our product catalogue will help you in understanding and selecting MI cables for your application requirements. We provide our customers from standard as well as custom made products according to the needs of the customer, our lines are flexible and ready to meet the demand.

We manufacture cables in four distinct product lines:

- Thermocouple cables for measuring temperature.

- RTD extension cables for use with resistance temperature devices.

- Micro – Heater cables for unique industrial heating applications.

- Mineral Insulated Power Cable

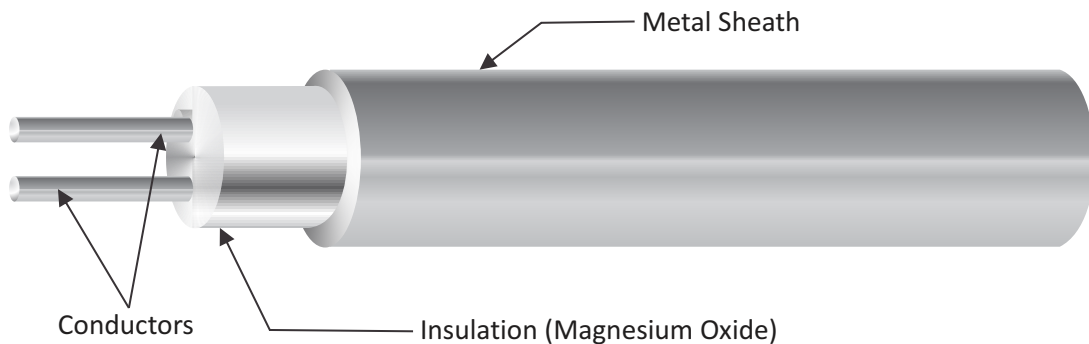
- Any Special Cable which requires high temperature and rugged insulation.

BASICS OF MI CABLES

GENERAL INFORMATION

One or more wire like conductors (cores) are embedded in a high insulation quality MGO and pressed into a metal tube (sheath) made of oxidation and corrosion resistant material. The entire combination is then processed using suitable forming steps to obtain the final dimensions.

In other words Mineral Insulated Cable, comprising a metal sheath in which the conductors are embedded in highly compressed magnesium oxide insulation.



Mineral insulated cables are designed for high-temperature applications and used wherever there are particularly strict requirements with regard to mechanical, chemical and electrical stability.

On account of their good flexibility, the use of mineral insulated cables are preferred in areas where mounting is difficult and where a high degree of flexibility is required (for example, laboratories or pilot manufacturing plants). The minimum bending radius is 2 times the outer diameter of the mineral insulated cable.

Innovations in technology and manufacturing have made it possible for these cables to be used increasingly frequently as a material in the manufacture of standardized thermocouples and RTDs, in particular in industrial measuring and control technology and in automotive sensor technology.

Mineral Insulated Cables

- 1) Mineral Insulated Thermocouple Cable.
- 2) Mineral Insulated RTD Cable.
- 3) Mineral Insulated Heater Cable.
- 4) Mineral Insulated Power Cable/Mineral Insulated Copper Cable
- 5) Coaxial/Triaxial Cable
- 6) Self Powered Neutron Detectors (SPNDs)

Thermocouple cables are manufactured to meet the requirements specified in ASTM E585/E585M & ASTM E 839 & IEC1515, Internationally recognized standards which specify the base metal thermocouple types.

Emf outputs comply with ASTM E230/E230M & IEC 584-2/ANSI MC 96.1

RTD extension cables adhere to very high quality standards which ensure best performance of finished IPRT (RTD) sensors which are required to comply with ASTM E1137/E1137M.

FEATURES

Long Life : The construction of the cable guarantees a long conductor life because the sheath and the insulating material protect the conductors (wire) against environmental conditions such as corrosion and scaling . This ensures accurate calibration throughout the life of the cable.

Long Lengths : Our unique manufacturing process results in lengths previously unheard of for mineral insulated cables.

Rapid Response : The small mass and high thermal conductivity promotes rapid heat transfer from the heat source to measuring junction.

Mechanical Strength : The Compact construction with densely packed MgO and the robust metal sheath ensure the position of the conductors in the compound and thus the function of the cable, even when exposed to mechanical stresses such as bending, twisting or flattening.

Corrosion and scaling Resistance : The vast array of materials included in our standard inventory and the possibility of manufacturing to specification has put us in a position to supply suitable sheath materials, even for unfavorable environmental conditions in a corrosive atmosphere and at high temperatures.

Radiation Resistance : The Correct choice of components ensures radiation resistance making possible the use of these cables in primary circuits as well as in the incore area, i.e. inside the actual reactor core.

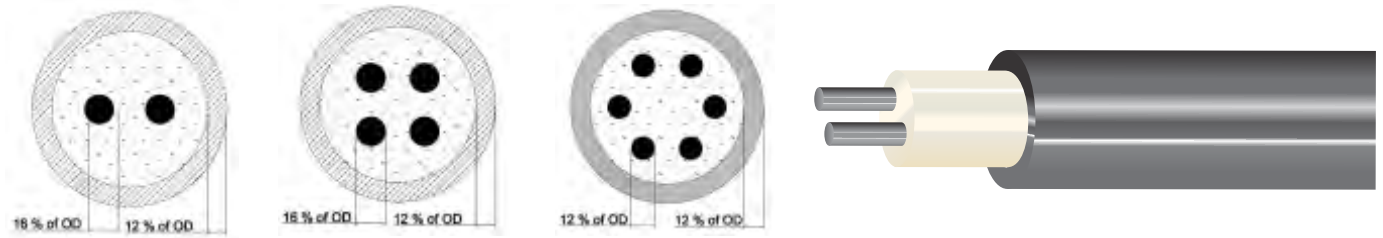
Moisture/Pressure : The Homogeneous metal sheaths are impervious to most liquids and gases and will withstand high external pressures. Unless otherwise specified our sheaths are seamless.

Safety : Since the only materials in manufacture are MgO and metals, the cables are fire-proof and can thus be exposed to considerably higher temperatures than cables with synthetic sheaths.



MI THERMOCOUPLE CABLE

Mineral insulated thermocouple cables have inner conductors of Thermocouple base material as per standard ASTM E 585/585M and ASTM E 839.



Number of Pair	Sheath Diameter (mm)	Nominal Wall Thickness (mm)	Element Diameter (mm)	Insulation Thickness (mm)	Insulation Resistance (MΩ)	Sheath Material	Conductor Type	Insulation	Calibration Accuracy
Simplex	1.50	≥ 0.15	≥ 0.23	≥ 0.11	≥ 100 MΩ	SS316L SS321 SS310 SS446 SS304 Inconel 600 Inconel 601 and others	K Type J Type E Type N Type R Type S Type	MgO (Standard Purity ≥ 97%) MgO (High Purity ≥ 99.4%)	Class 1/Class 2 Accuracy as per IEC 584-2/ANSI MC 96.1/ASTM E 230
	2.00	≥ 0.20	≥ 0.30	≥ 0.14					
	2.50	≥ 0.25	≥ 0.38	≥ 0.18					
	3.00	≥ 0.30	≥ 0.45	≥ 0.21					
	4.50	≥ 0.45	≥ 0.68	≥ 0.32					
	6.00	≥ 0.60	≥ 0.90	≥ 0.42					
	6.40	≥ 0.64	≥ 0.96	≥ 0.45					
	8.00	≥ 0.80	≥ 1.20	≥ 0.56					
	9.50	≥ 0.95	≥ 1.43	≥ 0.67					
	10.00	≥ 1.00	≥ 1.50	≥ 0.70					
Duplex	1.50	≥ 0.15	≥ 0.18	≥ 0.08	≥ 100 MΩ	SS316L SS321 SS310 SS446 SS304 Inconel 600 Inconel 601 and others	K Type J Type E Type N Type R Type S Type	MgO (Standard Purity ≥ 97%) MgO (High Purity ≥ 99.4%)	Class 1/Class 2 Accuracy as per IEC 584-2/ANSI MC 96.1/ASTM E 230
	2.00	≥ 0.20	≥ 0.24	≥ 0.11					
	2.50	≥ 0.25	≥ 0.30	≥ 0.14					
	3.00	≥ 0.30	≥ 0.36	≥ 0.17					
	4.50	≥ 0.45	≥ 0.54	≥ 0.25					
	6.00	≥ 0.60	≥ 0.72	≥ 0.33					
	6.40	≥ 0.64	≥ 0.77	≥ 0.35					
	8.00	≥ 0.80	≥ 0.96	≥ 0.44					
	9.50	≥ 0.95	≥ 1.14	≥ 0.52					
	10.00	≥ 1.00	≥ 1.20	≥ 0.55					
Triplex	3.00	≥ 0.30	≥ 0.27	≥ 0.12	≥ 100 MΩ	SS316L SS321 SS310 SS446 SS304 Inconel 600 Inconel 601 and others	K Type J Type E Type N Type R Type S Type	MgO (Standard Purity ≥ 97%) MgO (High Purity ≥ 99.4%)	Class 1/Class 2 Accuracy as per IEC 584-2/ANSI MC 96.1/ASTM E 230
	4.50	≥ 0.45	≥ 0.41	≥ 0.18					
	6.00	≥ 0.60	≥ 0.54	≥ 0.24					
	6.40	≥ 0.64	≥ 0.58	≥ 0.26					
	8.00	≥ 0.80	≥ 0.72	≥ 0.32					
	9.50	≥ 0.95	≥ 0.86	≥ 0.38					
	10.00	≥ 1.00	≥ 0.90	≥ 0.40					
	12.70	≥ 1.27	≥ 1.14	≥ 0.51					

Ordering Example

60K600 : 6.0 mm OD, K Type, Simplex, Inconel 600 Sheath with high purity of MgO Insulation and accuracy class 1 as per specification IEC 584

64NN316 : 6.4 mm OD, N Type, Duplex, SS316L Sheath with high purity of MgO Insulation and accuracy class 1 as per specification IEC 584

MI THERMOCOUPLE CABLE

Standard Deviation of Mineral Insulated Thermocouple Cable as per IEC 584-2

Type	Temperature Range	Tolerance for Class 1 Accuracy	Tolerance for Class 2 Accuracy
K/N	-40°C to +1100°C	+/- 1.5°C or +/-0.004(t)	+/- 2.5°C or +/-0.0075(t)
J	-40°C to +750°C	+/- 1.5°C or +/-0.004(t)	+/- 2.5°C or +/-0.0075(t)
T	-40°C to +350°C	+/- 0.5°C or +/-0.004(t)	+/- 1.0°C or +/-0.0075(t)
E	-40°C to +800°C	+/- 1.5°C or +/-0.004(t)	+/- 2.5°C or +/-0.0075(t)
R/S	0°C to +1600°C	+/-1°C or +/-[1+0.003(t-1100)]	+/- 1.5°C or +/-0.0025(t)

Mineral Insulated Thermocouple Cables with Precious Thermocouple:

Precious metal thermocouples are exceptionally suited for high-temperature applications under oxidizing conditions. They are used in chemical plants when absolute resistance to all kinds of acids is required.

Resistance of Precious Metal Mineral Insulated Thermocouples in different Atmosphere								
Sheath Material	Thermocouple	Max. Operating Temperature	Oxygen	Nitrogen	Hydrogen	Carbon	Chlorine	Sulphur
Inconel 600 2.4816	S Type	1100°C	Good	Good	Good	Good	Good	Conditional
	R Type	1100°C	Good	Good	Good	Good	Good	Conditional
	B Type	1100°C	Good	Good	Good	Good	Good	Conditional
pt10%Rh	S Type	1300°C	Good	Good	Conditional	Conditional	Conditional	Conditional
	R Type	1300°C	Good	Good	Conditional	Conditional	Conditional	Conditional
	B Type	1300°C	Good	Good	Conditional	Conditional	Conditional	Conditional

MINERAL INSULATED COMPENSATING CABLE

Mineral insulated compensating Cables have inner conductors of R/S Type (Cu- CuNi) and B Type (Cu-Cu) Compensating conductor with copper sheath.

Conductor	No. of Pair	Sheath Material	Operating Temperature	Testing
R/S Type Compensating Wire (Cu-CuNi)	1	Copper Sheath	200°C	(0.645 +/- 0.057) mV as per ANSI MC 96.1
R/S Type Compensating Wire (Cu-CuNi)	2		200°C	(0.645 +/- 0.057) mV as per ANSI MC 96.1

Ordering Example

60 R SC : 6.0 mm OD, R Type compensating Conductor, Simplex, and Copper Sheath

60 SS SC : 6.0 mm OD, S Type compensating Conductor, Duplex, and Copper Sheath

MINERAL INSULATED HEATER CABLE

Tempsens Mineral Insulated Heating Cable is an electrical metal sheath heating cable with high economic efficiency (specific heating capacity up to 300 W/m). It is the most rugged and durable type of heating cable. Mineral Insulated Heating Cable is applicable for operation in high temperatures and explosion-proof areas. It can have a very high watt output and is used for process heating applications at temperatures where plastics insulated heating cables are not suitable. When properly installed, it has a very high lifetime.

Mineral Insulated Heaters are applicable in the Machinery, power generating industry, chemical and petrochemical industry as well as research and development.

Heating Element	Sheath Material	Operating Temperature up to
NiCr Alloy	Inconel 600 (2.4816) and SS316L (1.4404)	800°C
CuNi Alloy	SS321/AISI 321 (1.4541)	500°C

Technical Data

Conductors NiCr Alloy, applicable for temperature up to 800°C				
Outer Diameter (mm)	Resistance at 20°C (Ω/m)	Conductor Diameter (mm)	Wall Thickness(mm)	Maximum Voltage Rating
3.2	10	0.38	≥ 0.32	800 V
3.2	6.3	0.48	≥ 0.32	
3.2	4	0.61	≥ 0.32	
3.6	2.5	0.77	≥ 0.36	
3.8	1.6	0.96	≥ 0.38	
4.1	1	1.21	≥ 0.41	
4.5	0.63	1.52	≥ 0.45	
5	0.4	1.91	≥ 0.50	
5.6	0.25	2.42	≥ 0.56	
6.5	0.16	3.03	≥ 0.65	
Conductors CuNi, applicable for temperature up to 500°C				
6.5	0.16	3.03	≥ 0.65	up to 300V /500V
6.5	0.16	3.03	≥ 0.65	
6.5	0.16	3.03	≥ 0.65	
6.5	0.16	3.03	≥ 0.65	
6.5	0.16	3.03	≥ 0.65	
6.5	0.16	3.03	≥ 0.65	

Tolerance for the resistance per Mtr: ± 10%

Tolerance for the outer diameter: according to DIN EN 61515

Example : 45-NiCr316 Heater MI Cable : 4.5 mm OD, 1 Core, NiCrAlloy Conductor, SS316L Sheath

MINERAL INSULATED RTD CABLE

Mineral insulated cables for RTDs have inner conductors of copper, copper-nickel alloys, nickel, nickel-chromium or nickel-plated copper.

Sheath Diameter (mm)	Number of Core	Nominal Wall Thickness (mm)	Element Diameter (mm)	Insulation Resistance (MΩ)	Sheath Material	Conductor Type	Insulation
2.00	2 Core & 3 Core	≥ 0.20	≥ 0.30	≥ 100 MΩ	SS316L SS321 SS304 Inconel 600 and others	Copper Nickel Nickel-Copper Alloy and others	MgO (Standard Purity ≥97%) MgO (High Purity ≥ 99.4%)
2.50		≥ 0.25	≥ 0.38				
3.00		≥ 0.30	≥ 0.45				
4.50		≥ 0.45	≥ 0.68				
6.00		≥ 0.60	≥ 0.90				
6.40		≥ 0.64	≥ 0.96				
8.00		≥ 0.80	≥ 1.20				
9.50		≥ 0.95	≥ 1.43				
10.00		≥ 1.00	≥ 1.50				
2.00	4 Core	≥ 0.20	≥ 0.24	≥ 100 MΩ	SS316L SS321 SS304 Inconel 600 and others	Copper Nickel Nickel-Copper Alloy and others	MgO (Standard Purity ≥97%) MgO (High Purity ≥ 99.4%)
2.50		≥ 0.25	≥ 0.30				
3.00		≥ 0.30	≥ 0.36				
4.50		≥ 0.45	≥ 0.54				
6.00		≥ 0.60	≥ 0.72				
6.40		≥ 0.64	≥ 0.77				
8.00		≥ 0.80	≥ 0.96				
9.50		≥ 0.95	≥ 1.14				
10.00		≥ 1.00	≥ 1.20				
3.00	6 Core	≥ 0.30	≥ 0.30	≥ 100 MΩ	SS316L SS321 SS304 Inconel 600 and others	Copper Nickel Nickel-Copper Alloy and others	MgO (Standard Purity ≥97%) MgO (High Purity ≥ 99.4%)
4.50		≥ 0.45	≥ 0.45				
6.00		≥ 0.60	≥ 0.60				
6.40		≥ 0.64	≥ 0.64				
8.00		≥ 0.80	≥ 0.80				
9.50		≥ 0.95	≥ 0.95				
10.00		≥ 1.00	≥ 1.00				
6.00	8 Core	≥ 0.60	≥ 0.60	≥ 100 MΩ	SS316L SS321 SS304 Inconel 600 and others	Copper Nickel Nickel-Copper Alloy and others	MgO (Standard Purity ≥97%) MgO (High Purity ≥ 99.4%)
6.40		≥ 0.64	≥ 0.64				
8.00		≥ 0.80	≥ 0.80				
9.50		≥ 0.95	≥ 0.95				
10.00		≥ 1.00	≥ 1.00				

Ordering Example

80-4Cu316 RTD MI Cable : 8.0 mm OD, 4 Cores, Copper Conductor, SS316L Sheath

60-6NiCu600 RTD MI Cable : 8.0 mm OD, 4 Cores, Nickel-Copper Alloy Conductor (Constantan), Inconel 600 Sheath

MINERAL INSULATED POWER CABLE

Mineral Insulated Copper cable belongs to electric cable class.

Outer Sheath : Copper Sheath with melting point of 1083°C

Insulation : Magnesium oxide insulator, hardly compressed, with melting point of 2800°C.

Conductor: Annealed conductor of 99.9% of purity electrolytic copper wire, with melting point of 1083°C

Applicable Standard : IEC/EN 60702 Part 1

- Maximum Continuous Temperature of Conductor is 250°C.
- Heavy Duty Grade Cable : Voltage Grade 750V

Details	Standard Follow	Description
MI Power Cable	IEC/EN 60702 Part 1	Mineral Insulated Copper sheathed Cable with Copper Conductor
Copper Conductor	IEC 60228 for Class 1	Copper (>99.9 %)
Insulation	IEC/EN 60702 Part 1	MgO (>99.4 % Pure)
Metallic Sheath	ASTM B75 Specification	Seamless Copper Tube (99.9%)
Insulation Resistance	IEC/EN 60702 Part 1	>1000 MΩ for above 100 Mtr coil
TESTING		
A) Routine Test	IEC/EN 60702 Part 1	Conductor Resistance, Insulation Resistance, Sheath And Insulation Integrity, Diameter & ovality
B) Type Test	IEC/EN 60702 Part 1	Voltage Test , Resistance of Copper Sheath, Insulation Thickness, Sheath Thickness, Bending test, Flattening test, Fire Resistance,

How to Order - MI Power Cable

Type of Cable	No. of Core X Core Size (MM ²)	Nominal Outer Copper Sheath Diameter (MM)	Mean Copper Sheath thickness (MM)	Nominal Core diameter (MM)	Maximum Core resistance (Ω/Km)	Nominal Insulation thickness (MM)	Maximum Resistance of Copper Sheath (Ω/Km)
Suitable for (450/750 v); Single Core							
1 C 1.5	1 X 1.5	4.9	0.41	1.38	12.1	1.3	4.13
1 C 2.5	1 X 2.5	5.3	0.42	1.78	7.41	1.3	3.71
1 C 4	1 X 4	5.9	0.45	2.26	4.61	1.3	3.09
1 C 6	1 X 6	6.4	0.48	2.76	3.08	1.3	2.67
Suitable for (450/750 v); Multi Core							
2 C 1.5	2 X 1.5	7.9	0.54	1.38	12.1	1.3	1.9
2 C 2.5	2 X 2.5	8.7	0.57	1.78	7.41	1.3	1.63
2 C 4	2 X 4	9.8	0.61	2.26	4.61	1.3	1.35
2 C 6	2 X 6	10.9	0.65	2.76	3.08	1.3	1.13
3 C 1.5	3 X 1.5	8.3	0.56	1.38	12.1	1.3	1.75
3 C 2.5	3 X 2.5	9.3	0.59	1.78	7.41	1.3	1.47
3 C 4	3 X 4	10.4	0.63	2.26	4.61	1.3	1.23

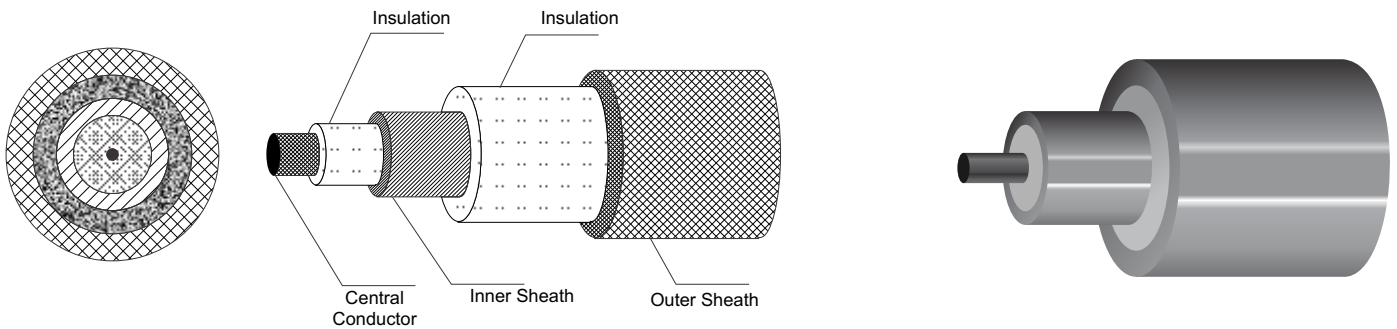
Mineral Insulated Copper Cables are Useful:

- Doesn't deteriorate with age.
- Its high current carrying capacity.
- Over come the overload and short circuit.
- Resist to flame.
- Working under fire condition also.
- Such places where it is not allowed to break the walls to embed the conduit this is the ideal solution.

OTHER SPECIAL TYPE OF MI CABLE

Coaxial Cables/Triaxial Cable

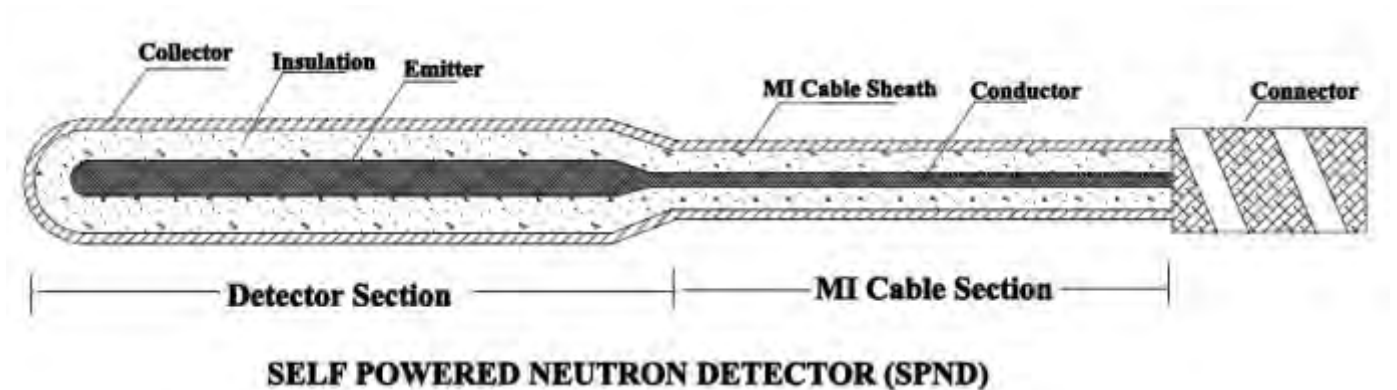
Triaxial cable is a type of electrical cable similar to coaxial cable, but with the addition of an extra layer of insulation and a second conducting sheath. It provides greater bandwidth and rejection of interference than coax, but is more expensive.



Triaxial Mineral Insulated Cables

SPND

Self-Powered Neutron Detectors have been used effectively as in-core flux monitors for over twenty-five years in nuclear power reactors world-wide. The typical SPND is a coaxial cable consisting of an inner electrode (the emitter), surrounded by insulation and an outer electrode (the collector).



Various type of SPND emitters are used in power reactor application.

1. Inconel 600
2. Rhodium (Rh^{103})
3. Vanadium (V^{51})
4. Platinum (Pt^{195})



General Characteristics

Need no power supply. simple and robust structure. Relatively small mechanical "size" desired for in-core installation. Good stability under temperature & pressure conditions.

RAW MATERIAL FOR MINERAL INSULATED CABLE

(i) Sheath Material

Sheath Material	Maximum Operating temperature	Specification	Material Properties	Applications
SS304 AISI 304 1.4301	800°C	ASTM A 269 or ASTM A 213	Resistance to intercrystalline corrosion. Good resistance to organic acids at moderate temperatures, saline solutions, such as sulphates, sulphides and sulphites, and alkaline solutions at moderate temperatures. Good welding properties.	Used in chemical, petrochemical and fertilizer industries, and as equipment in dairy, food processing, pharmaceutical industries, in hospitals, households as kitchenware, cryogenic vessels and as heat exchanger in air conditioning refrigeration, for machinery in paper, pulp and textile beverage sectors.
SS316 AISI 316 1.4401	800°C	ASTM A 269 or ASTM A 213	An austenitic stainless steel with 2.0 to 3% Mo. which improves corrosion resistance and imparts hot strength characteristics. Used for applications requiring resistance to pitting corrosion. and in halogen atmospheres. Good welding properties	Architectural trims, marine exteriors, chemical processing equipment, food processing equipment, petroleum refining equipment, pharmaceutical equipment, photographic equipment, pulp and paper processing equipment, textile finishing equipment, etc.
SS321 AISI 321 1.4541	800 °C	ASTM A 269 or ASTM A 213	Good resistance to intercrystalline corrosion, also after welding. Good resistance to heavy oil products, steam and exhaust gases. Good oxidation resistance. Can be used continuously up to approximately 800°C. Good welding properties in all standard welding processes without the need for welding retreatment. Good ductility.	Nuclear power and reactor construction, chemical apparatus engineering, annealing furnaces, heat exchangers, paper and textile industry, petrochemical and crude oil industry, grease and soap industry, food processing industry. used for aircraft exhaust stacks and manifolds, pressure vessels, large mufflers for diesel engines, carburetors, expansions belows, stack liners, fire walls etc.
SS446 AISI 446 1.4749	1150 °C	ASTM A 268	Extremely good resistance to reducing, sulphurous atmospheres. Very good resistance to oxidation and air. Good resistance to corrosion caused by incinerator slag and copper, lead and tin smelts. Good welding properties in arc welding and WIG welding. Preheating to 200 - 400°C is recommended. Retreatment is not necessary.	Petrochemical industry, metallurgy, power technology, recuperators, heat treatment kilns, vortex firing installations, waste incinerators.
SS310/310 S AISI 310/310S 1.4845	1100 °C	ASTM A 213	Grade 310S is a low carbon version of grade 310. 310S is less prone to embrittlement and sensitization in service. Good resistance to oxidation and sulphidisation. Due to the high content of chromium, the material is resistant to oxidizing hydrous solutions and has good resistance to chlorine-induced tension crack corrosion. Good resistance in cyanide smelts and neutral salt melts at high temperatures. Not susceptible to green mould. Good welding properties. It is recommended to weld with low heat impact. Apply solution annealing after welding to avoid the danger of intercrystalline corrosion.	Boilers and blast furnaces, cement and brick kilns, glass production, crude oil and petrochemical industries, furnace construction and power stations. Kilns, Heat Exchangers, Radiant Tubes, Muffles, retorts, annealing covers, Tube hangers for petroleum refining and steam boilers, Coal gasifier internal components, Saggars, Furnace parts, conveyor belts, rollers, oven linings, fans, Food processing equipment, Cryogenic structures.
Inconel 600 2.4816	1100 °C	ASTM B 167	Good general resistance to corrosion, resistant to tension crack corrosion. Excellent resistance to oxidation. Not recommended with gases containing CO ₂ and sulphur above 550°C and sodium above 750°C. In air, resistant up to 1100°C. Good welding properties for all types of welding processes. Excellent ductility even after long-term use.	PWR, nuclear power, furnace construction, plastics industry, heat treatment, paper and food processing industries, boilers, aircraft engines.

RAW MATERIAL FOR MINERAL INSULATED CABLE

Sheath Material	Maximum Operating temperature	Specification	Material Properties	Applications
Inconel 800 1.4876	1100 °C in air	ASTM B 163	This material provides superior thermal stability due to the addition of titanium and aluminum. Suitable for applications requiring maximum stability under load in addition to scaling resistance. Excellent resistance to carburization and nitrogenisation. The material has good welding properties in arc and WIG welding processes. Heat treatment is not necessary after welding.	Power stations, crude oil and petrochemical industries, furnace construction.
Nimonic 75 2.4951	1100 °C	-	Excellent high-temperature stability and resistance to oxidation and carburization. Due to the combination of nickel and chromium, the material has very good resistance to hot, gaseous media. Resistance to thermal fatigue and thermal shock. Good welding properties for all types of welding processes. Excellent ductility even after long-term use.	Space travel, aircraft construction, nuclear reactors, mechanical engineering, metal working, thermal materials processing.
Pt 10 % Rh	1300 °C		High-temperature resistance up to 1300°C under oxidizing conditions. High heat resistance up to 1200°C in the presence of oxygen, sulphur and silicon. Especially resistant to halogens, ethanolic acids, NaHCl solutions etc. Can become brittle through the absorption of silicon from armoring ceramics. Sulphur eutectics possible at temperatures over 1000°C. Sensitive to phosphorus.	Glass, electrochemical and catalytic technology, chemical industry, laboratories, melting and annealing furnaces and other furnaces, final storage of nuclear power products.
Copper Tube	250°C	ASTM B 75	Good Corrosion resistance, Antibacterial, Non Magnetic, Good Mechanical Strength	Air Conditioning & Refrigeration, Medical Gas and Vacuum, Fire Sprinklers, Fuel Gas (Natural Gas L.P. Gas) Distribution, Direct Exchange Geothermal Heating/Cooling,

Other sheathed material are available on request

(ii) Insulation (Magnesium Oxide)

Tempens supplies MgO as the standard insulator with standard purity of $\geq 97\%$ as well as MgO with a high purity of $\geq 99.4\%$ as per specification ASTM E 1652

PURITY	HIGH PURITY ($\geq 99.4\%$ PURE)	STANDARD PURITY ($\geq 97\%$ PURE)
COMPOSITION	CONCENTRATION (MASS) %	CONCENTRATION (MASS) %
MgO	99.4 % (min)	97 % (min)
CaO	0.35 % (max)	0.80 % (max)
Al ₂ O ₃	0.15 % (max)	1.00 % (max)
Fe ₂ O ₃	0.04 % (max)	0.08 % (max)
SiO ₂	0.13 % (max)	1.20 % (max)
C	0.02 % (max)	0.02 % (max)
S	0.005 % (max)	0.005 % (max)
B	0.0035 % (max)	0.0025 % (max)
Cd	0.001 % (max)	0.001 % (max)
B+Cd	0.004 % (max)	0.003 % (max)
Fe	-	0.02 % (max)

Values obtained from specification ASTM E 1652

(iii) Conductors

1. Thermocouple Conductors (K, J, E, N, R, S, B, T Type)
2. Pure Nickel wire, Pure Copper Wire, Copper Nickel Alloy wire for RTD Extension Cable
3. Nichrome 80-20 wire, Nichrome 60-40 wire etc. for Heater MI cable
4. Pure copper Wire for MI copper Cable
5. Inconel 600, SS316L etc. for Coaxial and other special cables

PROCESSING OF MINERAL INSULATED CABLES

Sintering Of MgO



Raw MgO is hygroscopic, so it is to be sintered to remove the moisture contents from MgO. Then MgO is put inside the furnace at a temperature of 1280°C for around 5 hours.

Drawing Of Sheath with Raw Materials

Bar Drawing Machine



Reduce the diameter of MI cable step by step. Employing special equipments.

Horizontal Drawing Machine (Below 8m)

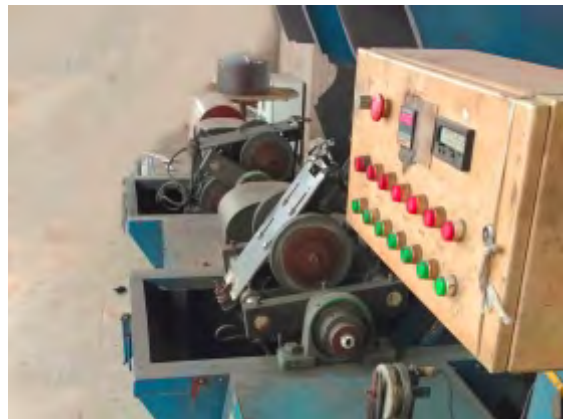


Annealing Of Cable



Annealing of MI cable in a furnace having five zones at different temperatures depending on material types & properties.

Polishing of MI Cable



Polishing has to be performed for better finish of surface and free from any foreign material.



TESTING OF MINERAL INSULATED CABLE

Auto Calibration

Tempsens has facility of auto calibration at three temperature points.

Calibration has to be performed on 100 percent Thermocouple MI Cable.



S. No.	Name Of Test	Descriptions	Standard	Test
1	Dimensions test	a) Sheath Outer Diameter	ASTM E585/E585M-09	Routine Test
		b) Sheath Wall Thickness	ASTM E585/E585M-09	Routine Test
		c) Insulation thickness	ASTM E585/E585M-09	Type Test
		d) Conductor Diameter	ASTM E585/E585M-09	Routine Test
2	Insulation Resistance Test	a) At ambient Temperature	ASTM E 839-03	Routine Test
		b) At elevated Temperature	ASTM E 839-03	Type Test
3	Insulation Compaction Density	a) By Tension test	ASTM E 839-03	Type Test
		b) By Calculation	ASTM E 839-03	Type Test
4	Continuity Test	By Measuring	ASTM E 839-03	Routine Test
5	Loop Resistance Test	By Measuring	ASTM E 839-03	Routine Test
6	Sheath Integrity Test	a) Water test	ASTM E 839-03	Routine Test
		b) Helium leak test	ASTM E 839-03	Routine Test
		c) Dye Penetrate Test	ASTM E 839-03	Type Test
		d) Bend Test	ASTM E 839-03/ IEC 60702-1/IEEE 515	Type Test
		e) Tension Test	ASTM E 839-03	Type Test
7	Calibration Test	As per standard Temperature	ANSI MC 96.1 IEC 584-2	Routine Test for MI Thermocouple cable
8	Thermal Cycle Test	At 325°C for 5 Cycle minimum	ASTM E 839-03	Type Test
9	Fire Resistance Test	At 750°C	IEC 60702 Part 1	Type Test for MI Power Cable
10	Flattening Test	At 750°C	According to Cable OD	Type Test for MI Power Cable

All tests perform in house and as per standard.

TESTING OF MINERAL INSULATED CABLE

Packaging and Storage

Storing in dry & dust free atmosphere with proper tagging. The magnesium oxide insulation is hygroscopic. To prevent moisture penetration, both ends are sealed. Under extreme conditions some moisture absorption could take place in spite of the sealing, so a dry place is desirable for storage.


When pieces are cut from stock lengths, the exposed ends to be sealed at once. If at all Moisture has entered, this will lower the insulation resistance and may prove troublesome in welding. Moisture Penetration can be corrected by heating the sheath.



Tagging

Each coil is fitted with a temporary seal to prevent moisture ingress during storage and shipping. Each coil is tagged to uniquely identify it for traceability purposes.

A-190, Road No.5, M.I.A., Udaipur-313003
(Rajasthan) INDIA
info@tempens.com



Type : _____ Length : _____
Serial No. : _____ Core : _____
Sheath : _____ OD : _____

Deviation

--	--	--	--	--	--

Date : _____ Final Inspection : _____

Dispatch and Test Certificate



TEMPENS INSTRUMENTS PVT. LTD. (INDIA)
1006, MIDC Area, B. Market Industrial Area,
Gandhinagar, PO. No. 313001,
Udaipur, RAJ. 313001, INDIA. TEL: 0294 242424, 242424
E-MAIL: info@tempens.com

TEST CERTIFICATE

Certificate No. : 1617/12/TC-062 Date : 06/01/2018

Customer Name : _____


P.O. Name : AS 495 HAS	P.O. Code : 0114-04-01	Lot No. : 06
J.O. Name : 71071820-2418	J.O. Code : 0114-02-01	Test Quantity : 27.20 Mtr.
Type : 600018	Description : A11 non-GE, A Type, 600018, 5218 Sheath	

MATERIAL CERTIFICATE

Tube Test Report	Conductor Chemical Analysis	Troubleshooting
Sheath : 60118	T.C. No. : LCH0018018	T.C. No. : 801800018
T.C. No. : 04-0017296	T.A. No. : 200712-02	T.R. No. : 245701
T.R. No. : 042018	Chemical Analysis	Chemical Analysis
	AS	EN
	Chemical Analysis	Chemical Analysis
C : 0.028 %	O : 0.30 %	Si : 0.03 %
Cr : 0.000 %	W : 0.000 %	Al : 0.000 %
Mn : 0.018 %	Others : 0.00 %	Si : 0.01 %
W : 0.000 %		Cr : 0.000 %
P : 0.014 %		Co : 0.001 %
S : 0.017 %		P : 0.001 %
Se : 0.000 %		Mn : 0.001 %
		Si : 0.000 %



DR. J. S. BHARGAVA (MPTC) MEMBER
1001/001/1/2008 Certified
1001/001/1/2008 Certified
1001/001/1/2008 Certified



TEMPENS INSTRUMENTS PVT. LTD. (INDIA)
1006, MIDC Area, B. Market Industrial Area,
Gandhinagar, PO. No. 313001,
Udaipur, RAJ. 313001, INDIA. TEL: 0294 242424, 242424
E-MAIL: info@tempens.com


EMF CHARACTERISTICS AND ADDITIONAL MEASUREMENT

Serial No.	EMF @ 25°C			MARK	INSULATION RESISTANCE (MΩ)	EMF @ 100°C (mV)	WALL THICKNESS (mm)	LENGTH (mm)	WEIGHT (kg)
	220°C	250°C	300°C						
30106	0.85	-1.85	-1.77	08011	1112000	0.50	0.7894	1020018	1.30
	-0.85	-1.15	-1.85	08011	1112000	0.50	0.7894		
30114	-0.85	-1.25	-1.40	08011	1112000	0.50	0.7894	4430018	1.80
	-0.87	-1.38	-1.40	08011	1112000	0.50	0.7894		
30118	-0.58	-1.40	-0.50	08011	1112000	0.50	0.7894	1020018	1.80
	-0.60	-0.70	-0.50	08011	1112000	0.50	0.7894		

Through Our Presence, Customers of M I Tanks every year. Contact : 0294 242424

SUBMITTED BY : _____ APPROVED BY : _____

ENGINEER Q.C. : _____ MANAGER Q.C. : _____



DR. J. S. BHARGAVA (MPTC) MEMBER
1001/001/1/2008 Certified
1001/001/1/2008 Certified
1001/001/1/2008 Certified

Test Certificate

CERTIFICATES



THERMAL ENGINEERING SOLUTIONS



www.tempsens.com

www.thermowellworld.com | www.temperaturecalibration.in | www.glassthermocouples.com | www.compensatingcables.net | www.marathonheater.in

INDIA

Tempsens Instruments (I) Pvt. Ltd. U# I
 B-188A, Road No.5, M.I.A.,
 Udaipur-313003 (Rajsthan) INDIA
 Ph.:+91-294-3057700 to 800
 Fax.:+91-294-3057750
 Email: info@tempsens.com

Tempsens Instruments (I) Pvt. Ltd. U# II
 A-190, Road No.5, M.I.A.,
 Udaipur-313003 (Rajsthan) INDIA
 Ph.:+91-294-3052900
 Fax.:+91-294-3052950
 Email: info@tempsens.com

GERMANY

Tempsens Instruments GmbH
 Loehestrasse 37,
 53773 Hennef, GERMANY
 Ph.:+49-2242-8703-22
 Fax.:+49-2242-8703-20
 Email: hmueller@tempsens.de

