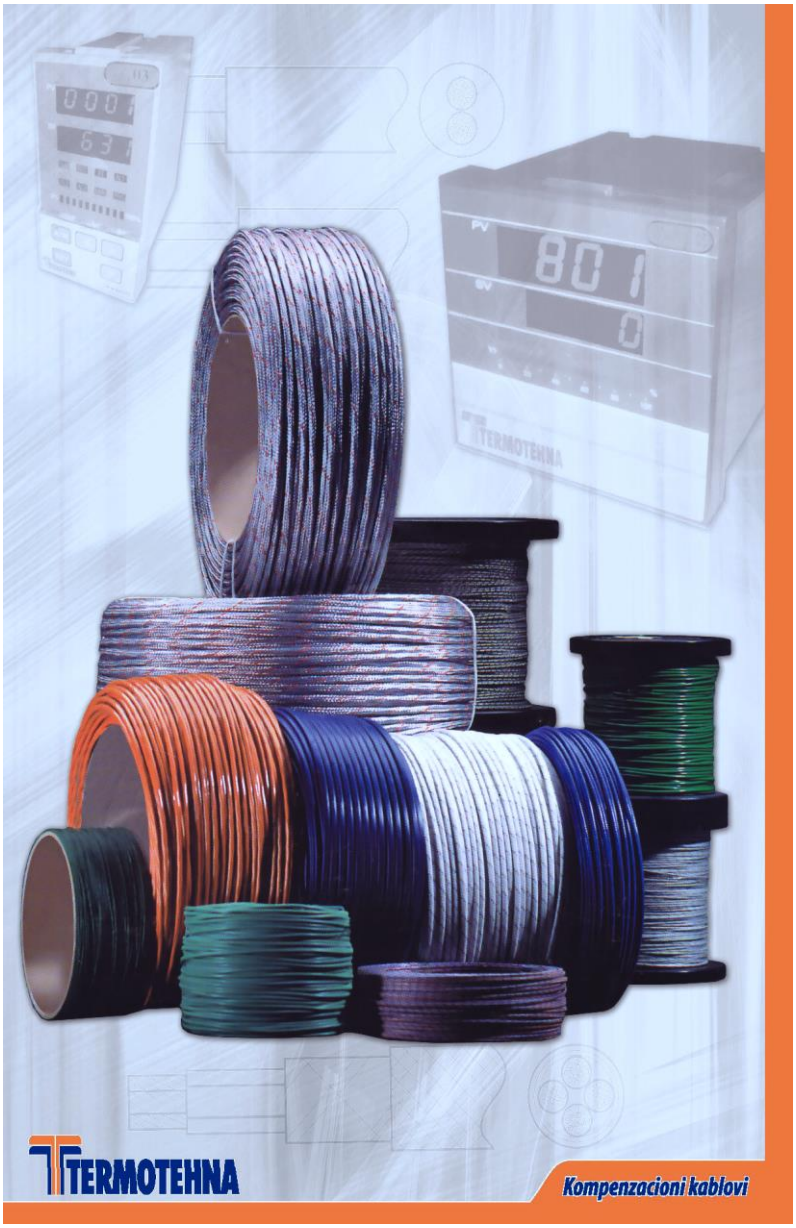


TERMOTEHNA

Compensating cables

COMPENSATING CABLES

COMPENSATING AND EXTENSION CABLES

Compensating and extension cables are used for the electrical connection between the open ends of the thermocouple and the reference junction in any installation where the conductors (thermoelectrodes) of the thermocouple are not directly connected to the reference junction.

For technical and economic reasons, thermocouples are not always directly connected to the reference junction. Open ends of the thermocouple are usually connected to a ceramic terminal block in the connection head.

Materials and colour labels (overview shown in Table 1)

Table 1: Materials and colour labels

Thermocouples				**Compensating and extension cables**			**Colour label**[1]			
Standard	**Type**	**Material**		**Type**[2]	**Material**		**+ pole**	**- pole**	**sheath**[3]	**Standard**
		+ pole	**- pole**		**+ pole**	**- pole**				
DIN EN 60584	**J**	Fe	CuNi	**JX**	Fe	CuNi	black	white	black	DIN 43 722
	T	Cu	CuNi	**TX**	Cu	CuNi	brown	white	brown	
	E	NiCr	CuNi	**EX**	NiCr	CuNi	purple	white	purple	
	K	NiCr	Ni	**KX**	NiCr	Ni	green	white	green	
				KCA	Fe	CuNi				
				KCB	Cu	CuNi				
	N	NiCrSi	NiSi	**NX**	NiCrSi	NiSi	pink	white	pink	
				NC	Cu	CuNi				
	R	Pt13%Rh	Pt	**RCA**	Cu	CuNi	orange	white	orange	
				RCB	Cu	CuNi				
	S	Pt10%Rh	Pt	**SCA**	Cu	CuNi	orange	white	orange	
				SCB	Cu	CuNi				
	B	Pt30%Rh	Pt6%Rh	**BC**	Cu	Cu	grey	white	grey	

[1] , CA, …CB: Compensating cables
, X: Extension cables for thermocouples
[2] See the page with the International Colour Codes applied to temperature measuring engineering in the catalogue.
[3] Sheaths with no colour (fiberglass) have one distinctive stripe, running the entire length of the cable.

DIN 43 710	**U**	Cu	CuNi	**UX**	Cu	CuNi	red	brown	brown	DIN 43 714
	L	Fe	CuNi	**LX**	Fe	CuNi	red	blue	blue	

COMPENSATING CABLES

Table 2 shows tolerances for compensating and extension cables for thermocouples, when used within the range indicated as Cable Temperature Range. This Table also includes - in brackets - the approximate equivalent error in degrees Celsius. Because the relationship between the electromotive force of the thermocouple and the temperature is not linear, the tolerance expressed in °C depends on the temperature of the measuring junction of the thermocouple. These temperatures are listed in the last column of the Table.

Table 2: Limit deviations (tolerances) and temperature ranges according to DIN 43 722

Type[4]	Limit deviations (1µV=0.001V)		Cable temperature range[5]	Measuring junction temperature
	Class 1	Class 2		
JX	±85µV(1.5°C)	±140µV(2.5°C)	-25°C to + 200°C	500°C
TX	±30µV(0.5°C)	±60µV(1.0°C)	-25°C to + 100°C	300°C
EX	±120µV(1.5°C)	±200µV(2.5°C)	-25°C to + 200°C	500°C
KX	±60µV(1.5°C)	±100µV(2.5°C)	-25°C to + 200°C	900°C
NX	±60µV(1.5°C)	±100µV(2.5°C)	-25°C to + 200°C	900°C
KCA	-	±100µV(2.5°C)	0°C to + 150°C	900°C
KCB	-	±100µV(2.5°C)	0°C to + 100°C	900°C
NC	-	±100µV(2.5°C)	0°C to + 150°C	900°C
RCA	-	±30µV(2.5°C)	0°C to + 100°C	1000°C
RCB	-	±60µV(5.0°C)	0°C to + 200°C	1000°C
SCA	-	±30µV(2.5°C)	0°C to + 100°C	1000°C
SCB	-	±60µV(5.0°C)	0°C to + 200°C	1000°C

Voltage drops

Modern electronic instruments have a high input resistance, so the resistance of the thermocouple compensating or extension cable is of secondary importance. Table 3 shows cable resistances and the most used cable cross-sections. Approximate values with a tolerance of ± +10% are specified for resistance.

[4] , CA, …CB: Compensating cables
, X: Extension cables for thermocouples

[5] Cable temperature range can be limited by lower temperature values, which depends on the insulation material of the cable

Table 3: Resistance drop of compensating and T/C extension cables at 20 °C (approximate values Ω/m)									
T/C thermocouple type	**Compensating and extension cables**			**Cable resistance in Ω/m for the cross-section**					
	Type	**Materials**		**0.22mm²**	**0.35mm²**	**0.50mm²**	**0.75mm²**	**1.00mm²**	**1.50mm²**
		+ pole	**- pole**						
J	JX	Fe	CuNi	2.77	1.74	1.22	0.81	0.61	0.41
T	TX	Cu	CuNi	2.30	1.45	1.01	0.68	0.51	0.34
E	EX	NiCr	CuNi	5.50	3.46	2.42	1.61	1.21	0.81
K	KX	NiCr	Ni	4.50	2.83	1.98	1.32	0.99	0.66
	KCA	Fe	CuNi	2.86	1.80	1.26	0.84	0.63	0.42
	KCB	Cu	CuNi	2.30	1.45	1.01	0.68	0.51	0.34
N	NX	NiCrSi	NiSi	6.00	3.77	2.64	1.76	1.32	0.88
	NC	Cu	CuNi	2.44	1.53	1.07	0.72	0.54	0.36
R/S	RC/SC	Cu	CuNi	0.62	0.39	0.27	0.18	0.14	0.09
B	BC	Cu	Cu	0.15	0.10	0.07	0.05	0.03	0.02
U	UX	Cu	CuNi	2.30	1.45	1.01	0.68	0.51	0.34
L	LX			2.77	1.74	1.22	0.81	0.61	0.41

COMPENSATING CABLES

Insulation materials of compensating and extension cables

The temperature stability of compensating and extension cables depends on the type of insulation material. In order to maintain the thermoelectric properties, the maximum operating temperature can be limited with the cable temperature range, even if the insulation material is designed for higher operating temperatures.

Table 4 shows approximate values related to general properties for the most important insulation materials.

Table 4: Approximate values for the general properties of the most important insulation materials

	Isolation material					
	PVC	**Silicone**	**Teflon FEP**	**Teflon PTFE**	**Fiberglass**	**Neoprene**
Temperature stability in °C	70	180	205	260	400	120
Specific resistance at 20 °C in Ω x cm	$>10^{12}$	$>10^{14}$	$>10^{18}$	$>10^{18}$	$>10^{12}$	$>10^{11}$
Tensile strength at 20°C in N/mm²	15	8	20	25	2400	15
Density at 20°C g/cm³	1.35	1.25	2.15	2.20	2.60	1.55
Absorption at 20°C	Moderate	Moderate	No	No	No	Moderate
Resistance to water vapor and atmospheric influences	Good	Moderate	Very good	Very good	Bad	Good
Combustibility	Self-extinguishing	Hardly combustible Self-extinguishing	Non-combustible	Non-combustible	Does not burn	Self-extinguishing
Chemical stability to:						
- **dilute acids**	+	o	+	+		+
- **alkaline solutions**	+	o	+	+		+
- **alcohol**	+	+	+	+		+
- **petrol**	+	-	+	+		-
- **benzene**	-	-	+	+		-
- **mineral oils**	+	o	+	+		+

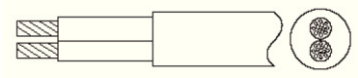
\+ stable
-limited stability
o unstable

INTERNATIONAL COLOR CODES FOR COMPENSATION AND EXTENSION CABLES

Thermo couple type	Extension cable	ANSI MC 96.1			DIN			BS			NFE			JISC		
		+	-	sheath	+	-	sheath	+	-	sheath	+	-	sheath	+	-	sheath
T	TX	blue	red	blue	red	brown	brown	white	blue	blue	yellow	blue	blue	red	white	brown
J	JX	white	red	black	red	blue	blue	yellow	blue	black	yellow	black	black	red	white	yellow
E	EX	pink	red	pink				brown	blue	brown				pink	red	pink
K	KX	yellow	red	yellow	red	green	green	brown	blue	red	yellow	pink	yellow	red	white	blue
K	WX				red	green	green				yellow	white	white			
K	VX				red	green	green	white	blue	red	yellow	brown	red			
R-S	SX	black	red	green	red	white	white	white	blue	green	yellow	green	green	red	white	black
B	BX	grey	red	grey												

COMPENSATING CABLES (Tables with types)

Strand PVC PVC

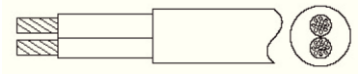


Cross section: 2 x 1.5 mm²
Outer diameter: ∅ 7.0 mm
Weight/m (approx.): 7.6 kg
Insulation resistant up to: 70°C

Straight strand lines, insulated with PVC insulation, strands in the lines twisted, external insulation from PVC

For thermocouple type[6]	Color[7]	Catalogue number
L (Fe-CuNi)	Blue	T17-507.1
J (Fe-CuNi)	Black	T17-507.2
K (NiCr-Ni)	Green	T17-508.1
N (NiCrSi-NiSi)	Pink	T17-508.2
S(R) (Pt10(13)%Rh-Pt)	Orange	T17-509.1
B (Pt30%Rh-Pt6%Rh)	Grey	T17-509.2

Strand PVC PVC

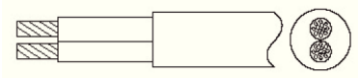


Cross section: 2 x 1.0 mm²
Outer diameter: ∅ 6.4 mm
Weight/m (approx.): 6.3 kg
Insulation resistant up to: 70°C

Straight strand lines, insulated with PVC insulation, strands in the lines twisted, external insulation from PVC

For thermocouple type	Color	Catalogue number
L (Fe-CuNi)	Blue	T17-517.1
J (Fe-CuNi)	Black	T17-517.2
K (NiCr-Ni)	Green	T17-518.1
N (NiCrSi-NiSi)	Pink	T17-518.2
S(R) (Pt10(13)%Rh-Pt)	Orange	T17-519.1
B (Pt30%Rh-Pt6%Rh)	Grey	T17-519.2

Strand Silicone Silicone



Cross section: 2 x 0.22 mm²
Outer diameter: ∅ 3.5 mm
Weight/m (approx.): 2.66 kg
Insulation resistant up to: 70°C

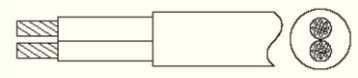
Straight strand lines, insulated with PVC insulation, strands in the lines twisted, external insulation from PVC

For thermocouple type	Color	Catalogue number
L (Fe-CuNi)	Blue	T17-1101.1
J (Fe-CuNi)	Black	T17-1101.2
K (NiCr-Ni)	Green	T17-1102.1
N (NiCrSi-NiSi)	Pink	T17-1102.2
S(R) (Pt10(13)%Rh-Pt)	Orange	T17-1103.1
B (Pt30%Rh-Pt6%Rh)	Grey	T17-1103.2

[6] Optionally, other types of cables (e.g. for thermocouple type T, E...) and cables for double thermocouples can be ordered.
[7] Color code is according to IEC 584, part 1 and 3 or DIN 43 722 (type L according to DIN 43 714), other colors may be available at the customer's request: see color codes on page .... of the catalog.

COMPENSATING CABLES (Tables with types)

Strand Silicone Silicone

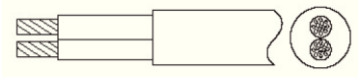


Cross section: 2 x 1.5 mm²
Outer diameter: ∅ 7.0 mm
Weight/m (approx.): 7.8 kg
Insulation resistant up to: 180°C

Straight strand lines, insulated with silicone, strands in the lines twisted, external insulation from silicone

For thermocouple type[8]	Color[9]	Catalogue number
L (Fe-CuNi)	Blue	T17-704.1
J (Fe-CuNi)	Black	T17-704.2
K (NiCr-Ni)	Green	T17-705.1
N (NiCrSi-NiSi)	Pink	T17-705.2
S(R) (Pt10(13)%Rh-Pt)	Orange	T17-706.1
B (Pt30%Rh-Pt6%Rh)	Grey	T17-706.2

Strand Silicone Silicone

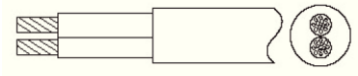


Cross section: 2 x 1.0 mm²
Outer diameter: ∅ 6.4 mm
Weight/m (approx.): 6.3 kg
Insulation resistant up to: 180°C

Straight strand lines, insulated with silicone, strands in the lines twisted, external insulation from silicone

For thermocouple type	Colour	Catalogue number
L (Fe-CuNi)	Blue	T17-714.1
J (Fe-CuNi)	Black	T17-714.2
K (NiCr-Ni)	Green	T17-715.1
N (NiCrSi-NiSi)	Pink	T17-715.2
S(R) (Pt10(13)%Rh-Pt)	Orange	T17-716.1
B (Pt30%Rh-Pt6%Rh)	Grey	T17-716.2

Strand Silicone Silicone



Cross section: 2 x 0.22 mm²
Outer diameter: ∅ 4.0 mm
Weight/m (approx.): 2.3 kg
Insulation resistant up to: 180°C

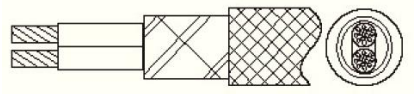
Straight strand lines, insulated with silicone, strands in the lines twisted, external insulation from silicone

For thermocouple type	Colour	Catalogue number
L (Fe-CuNi)	Blue	T17-1104.1
J (Fe-CuNi)	Black	T17-1104.2
K (NiCr-Ni)	Green	T17-1105.1
N (NiCrSi-NiSi)	Pink	T17-1105.2
S(R) (Pt10(13)%Rh-Pt)	Orange	T17-1106.1
B (Pt30%Rh-Pt6%Rh)	Grey	T17-1106.2

[8] Optionally, other types of cables (e.g. for thermocouple type T, E...) and cables for double thermocouples can be ordered.
[9] Color code is according to IEC 584, part 1 and 3 or DIN 43 722 (type L according to DIN 43 714), other colors may be available at the customer's request: see color codes on page .... of the catalog.

COMPENSATING CABLES (Tables with types)

Strand Silicone Fiberglass Steel reinforcement

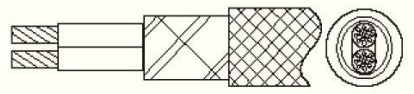


Cross section: 2 x 1.5 mm²
Outer diameter: ∅ 6.7 mm
Weight/m (approx.): 8.3 kg
Insulation resistant up to: 180°C

Straight strand lines, insulated with silicone, strands in the lines twisted, conductors, together, insulated with fiberglass, galvanized steel wire reinforcement with coloured tape

For thermocouple type[10]	Colour[11]	Catalogue number
L (Fe-CuNi)	Blue	T17-604.1
J (Fe-CuNi)	Black	T17-604.2
K (NiCr-Ni)	Green	T17-605.1
N (NiCrSi-NiSi)	Pink	T17-605.2
S(R) (Pt10(13)%Rh-Pt)	Orange	T17-606.1
B (Pt30%Rh-Pt6%Rh)	Grey	T17-606.2

Strand Silicone Fiberglass Steel reinforcement

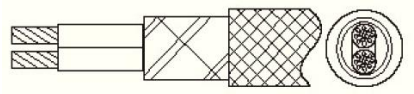


Cross section: 2 x 1.0 mm²
Outer diameter: ∅ 6.4 mm
Weight/m (approx.): 6.3 kg
Insulation resistant up to: 180°C

Straight strand lines, insulated with silicone, strands in the lines twisted, conductors, together, insulated with fiberglass, galvanized steel wire reinforcement with coloured tape

For thermocouple type	Colour	Catalogue number
L (Fe-CuNi)	Blue	T17-614.1
J (Fe-CuNi)	Black	T17-614.2
K (NiCr-Ni)	Green	T17-615.1
N (NiCrSi-NiSi)	Pink	T17-615.2
S(R) (Pt10(13)%Rh-Pt)	Orange	T17-616.1
B (Pt30%Rh-Pt6%Rh)	Grey	T17-616.2

Strand Silicone Fiberglass Steel reinforcement



Cross section: 2 x 0.5 mm²
Outer diameter: ∅ 5.2 mm
Weight/m (approx.): 6.3 kg
Insulation resistant up to: 180°C

Straight strand lines, insulated with silicone, strands in the lines twisted, conductors, together, insulated with fiberglass, galvanized steel wire reinforcement with coloured tape

For thermocouple type	Colour	Catalogue number
L (Fe-CuNi)	Blue	T17-624.1
J (Fe-CuNi)	Black	T17-624.2
K (NiCr-Ni)	Green	T17-625.1
N (NiCrSi-NiSi)	Pink	T17-625.2
S(R) (Pt10(13)%Rh-Pt)	Orange	T17-626.1

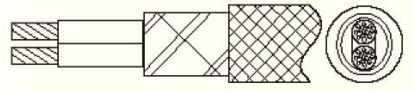
[10] Optionally, other types of cables (e.g. for thermocouple type T, E...) and cables for double thermocouples can be ordered.

[11] Colour code is according to IEC 584, part 1 and 3 or DIN 43 722 (type L according to DIN 43 714), other colours may be available at the customer's request: see colour codes on page .... of the catalogue.

	B (Pt30%Rh-Pt6%Rh)	Grey	T17-626.2

COMPENSATING CABLES (Tables with types)

Strand Silicone Fiberglass Steel reinforcement

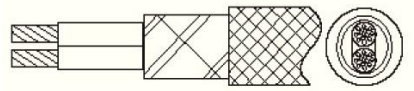


Cross section: 2 x 1.5 mm²
Outer diameter: 4.0 - 5.8 mm
Weight/m (approx.): 7.7 kg
Insulation resistant up to: 400°C

Straight strand lines, insulated with silicone, strands in the lines twisted, conductors, together, insulated with fiberglass, galvanized steel wire reinforcement with coloured tape

For thermocouple type[12]	Colour[13]	Catalogue number
L (Fe-CuNi)	Blue	T17-304.1
J (Fe-CuNi)	Black	T17-304.2
K (NiCr-Ni)	Green	T17-305.1
N (NiCrSi-NiSi)	Pink	T17-305.2
S(R) (Pt10(13)%Rh-Pt)	Orange	T17-306.1
B (Pt30%Rh-Pt6%Rh)	Grey	T17-306.2

Strand Silicone Fiberglass Steel reinforcement

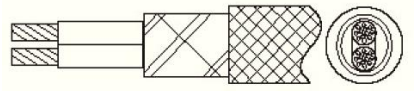


Cross section: 2 x 1.0 mm²
Outer diameter: 3.5 – 5.2 mm
Weight/m (approx.): 5.1 kg
Insulation resistant up to: 180°C

Straight strand lines, insulated with silicone, strands in the lines twisted, conductors, together, insulated with fiberglass, galvanized steel wire reinforcement with coloured tape

For thermocouple type	Colour	Catalogue number
L (Fe-CuNi)	Blue	T17-314.1
J (Fe-CuNi)	Black	T17-314.2
K (NiCr-Ni)	Green	T17-315.1
N (NiCrSi-NiSi)	Pink	T17-315.2
S(R) (Pt10(13)%Rh-Pt)	Orange	T17-316.1
B (Pt30%Rh-Pt6%Rh)	Grey	T17-316.2

Strand Silicone Fiberglass Steel reinforcement



Cross section: 2 x 0.8 mm²
Outer diameter: 3.4 - 5.0 mm
Weight/m (approx.): 4.8 kg
Insulation resistant up to: 400°C

Straight strand lines, insulated with silicone, strands in the lines twisted, conductors, together, insulated with fiberglass, galvanized steel wire reinforcement with coloured tape

For thermocouple type	Colour	Catalogue number
L (Fe-CuNi)	Blue	T17-324.1
J (Fe-CuNi)	Black	T17-324.2
K (NiCr-Ni)	Green	T17-325.1
N (NiCrSi-NiSi)	Pink	T17-325.2
S(R) (Pt10(13)%Rh-Pt)	Orange	T17-326.1
B (Pt30%Rh-Pt6%Rh)	Grey	T17-326.2

[12] Optionally, other types of cables (e.g. for thermocouple type T, E...) and cables for double thermocouples can be ordered.
[13] Color code is according to IEC 584, part 1 and 3 or DIN 43 722 (type L according to DIN 43 714), other colors may be available at the customer's request: see color codes on page .... of the catalog.

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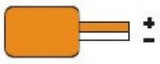
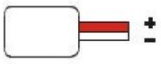
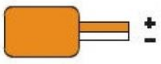
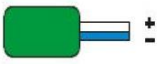
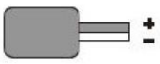
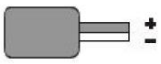
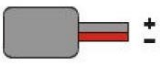
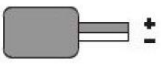
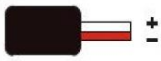
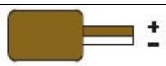
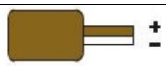
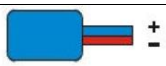
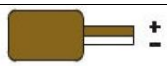
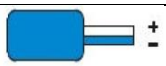
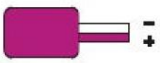
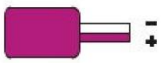
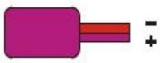
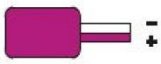
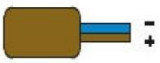
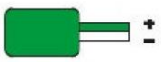
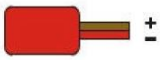
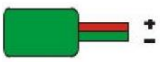
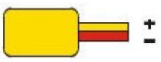
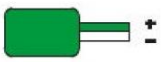
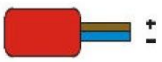
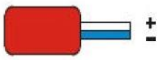
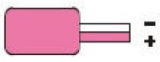
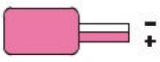
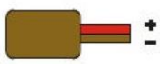
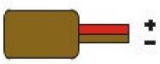
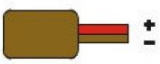
International Colour Codes applied to temperature engineering

Thermocouple type		Europe	Germany	USA	Serbia	Great Britain
		DIN43722(IEC 584-3)	DIN 43714	ANSI MC 96.1	IEC 584-3	BS 4937 / 1843
R **S**	⊕ Platinum-13% Rhodium ⊖ Platinum ⊕ Platinum-10% Rhodium ⊖ Platinum					
B	⊕ Platinum-30% Rhodium ⊖ Platinum-6% Rhodium					
J	⊕ Iron ⊖ Copper-Nickel					
T	⊕ Copper ⊖ Copper-Nickel					
E	⊕ Nickel- Chromium ⊖ Copper-Nickel					
K	⊕ Nickel- Chromium ⊖ Nickel	 				 
N	⊕ Nickel- Chromium-Silicon ⊖ Nickel- Silicon					
U	⊕ Copper ⊖ Copper-Nickel					
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