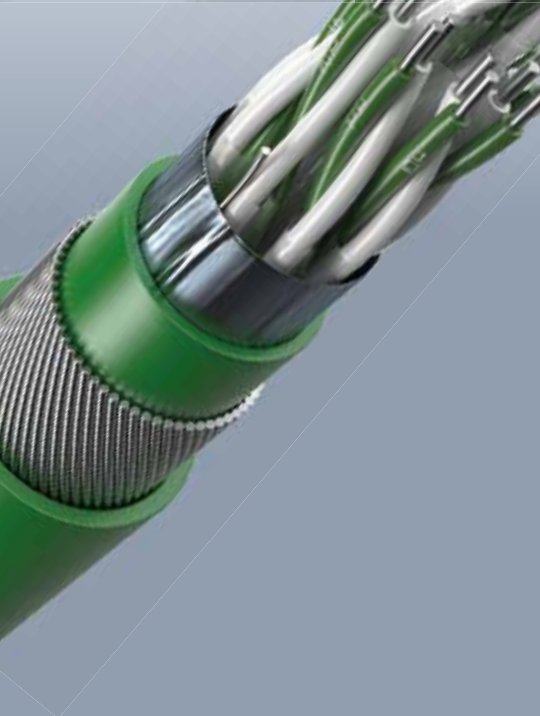
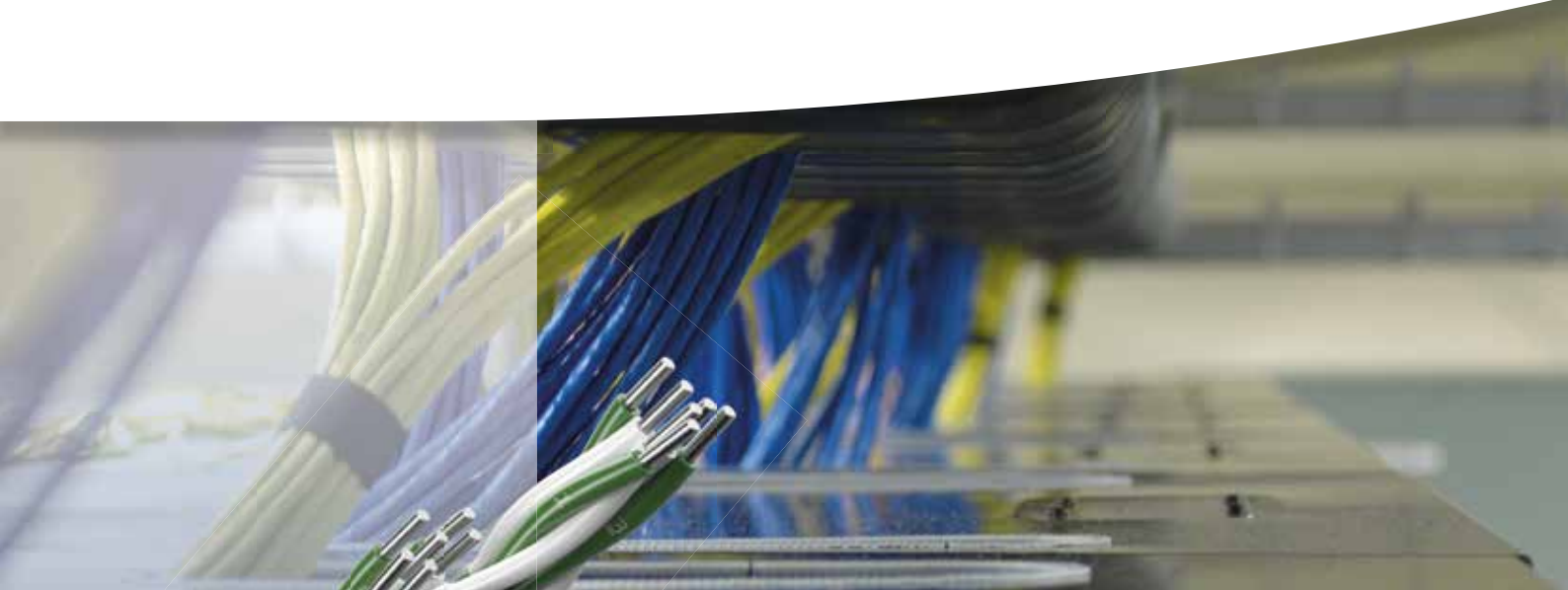


LEONI *technical report*

Industrial Projects technology 05/2016



Thermocouple extension & compensating cable

With conductor materials such as nickel or chromium, thermocouple & compensating cables are used for temperature sensing in industrial processes

- Conductor material according to the requirements of the HD 446.1 (IEC 60584-3) standard
- Design: solid, stranded or flexible
- Sizes: 0.5 mm² up to 1.5 mm²

Criteria for the choice of type, design or size of conductor are:

- the type of thermoelement used
- the E.M.F-tolerances
- the flexibility

Solid conductors are used in most cases.




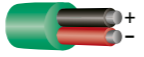
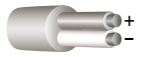
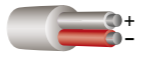

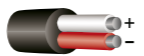

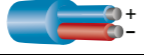

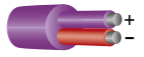
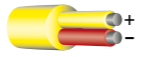

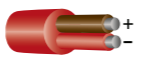

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Table 1: Temperature ranges and tolerances of conductors.

Color codes of insulations and outer sheaths.

Type	Thermocouple material	 IEC 60584 ^{1) 2)}	 ASTM E 230 ¹⁾
R	+ Platinum-13 % Rhodium - Platinum	RCA/SCA 0 °C up to +100 °C Copper/Copper-Nickel (Class 1:-----) (Class 2: ±30 µV/ ±2.5 °C)	RX 0 °C up to +200 °C Copper/Copper-Nickel (±5 °C)
		RCB/SCB 0 °C up to +200 °C Copper/Copper-Nickel (Class 1:-----) (Class 2: ±60 µV/ ±5 °C)	SX 0 °C up to +200 °C Copper/Copper-Nickel (±5 °C)
S	+ Platinum-10 % Rhodium - Platinum	 Cu CuNi	 Cu CuNi
B	+ Platinum-30 % Rhodium - Platinum-6 % Rhodium	BC 0 °C up to +100 °C Copper/Copper (± 40 µV/ ± 3.5 °C)	BX 0 °C up to +100 °C Copper-alloy/Copper (+0.0 µV/+0 °C) (-33 µV/-3.7 °C)
		 Cu Cu	 Cu-alloy (Cu) Cu (Cu)
J	+ Iron - Copper-Nickel	JX -25 °C up to +200 °C Iron/Copper-Nickel (Class 1: ±85 µV/ ±1.5 °C) (Class 2: ±140 µV/ ±2.5 °C)	JX 0 °C up to +200 °C Iron/Copper-Nickel (special: ±1.1 °C) (standard: ±2.2 °C)
		 Fe CuNi	 Fe CuNi
T	+ Copper - Copper-Nickel	TX -25 °C up to +100 °C Copper/Copper-Nickel (Class 1: ±30 µV/ ±0.5 °C) (Class 2: ±60 µV/ ±1.0 °C)	TX 0 °C up to +100 °C Copper/Copper-Nickel (special: ±0.5 °C) (standard: ±1.0 °C)
		 Cu CuNi	 Cu CuNi
E	+ Nickel-Chromium - Copper-Nickel	EX -25 °C up to +200 °C Nickel-Chromium/Copper-Nickel (Class 1: ±120 µV/ ±1.5 °C) (Class 2: ±200 µV/ ±2.5 °C)	EX Nickel 0 °C up to +200 °C (special: ±1.1 °C) (standard: ±1.7 °C)
		 NiCr CuNi	 NiCr CuNi
K	+ Nickel-Chromium - Nickel-Aluminum	KX -25 °C up to +200 °C Nickel-Chromium/Nickel-Aluminum (Class 1: ± 60 µV/ ±1.5 °C) (Class 2: ±100 µV/ ±2.5 °C)	KX 0 °C up to +200 °C Nickel-Chromium/ Nickel-Aluminum (special: ±1.1 °C) (standard: ±2.2 °C)
		KCB 0 °C up to +100 °C Copper/Copper-Nickel (Class 1:-----) (Class 2: ±100µV/ ±2.5 °C)	 NiCr NiAl
		KCA 0 °C up to +150 °C Iron/Copper-Nickel (Class 1:-----) (Class 2: ±100µV/ ±2.5 °C)	VX ISA RP 1.1 0 °C up to +100 °C Copper/Copper-Nickel (±2.2 °C)
		 NiCr NiAl KX Cu KCA CuNi Fe CuNi	 Cu CuNi
N	+ Nickel-Chromium-Silicon - Nickel-Silicon	NX -25 °C up to +200 °C Nickel-Chromium-Silicon/ Nickel-Silicon (Class 1: ± 60 µV/ ±1.5 °C) (Class 2: ± 100 µV/ ±2.5 °C)	NX 0 °C up to +200 °C Nickel-Chromium-Silicon/ Nickel-Silicon (special: ±1.1 °C) (standard: ±2.2 °C)
		NC 0 °C up to +150 °C Copper/Copper-Nickel (Class 1:-----) (Class 2: ±100 µV/ ±2.5 °C)	 NiCrSi NiSi NX Cu NC CuNi

1) In all standards the basic EMF values of the same thermocouple type are identical.

2) Following standards are corresponding with the IEC-Standard 60584 DIN 43722 and JIS C 1610 section 1.

Temperature ranges and tolerances to IEC 60584. Part 3, November 2007. Color coding for conductors and outer sheaths to IEC 60584. Part 3, November 2007.

Besides the identification letter of the thermocouple type, extension cables are identified by "X" compensating cables by "C".

The color coding of BC, NX and NC is according to DIN 43722.

The identification system of ASTM does not differ between extension and compensating cables; all materials are marked "X".

For BX the temperature range and tolerance have to be agreed upon between end-user and manufacturer. ISA RP 1.1 is withdrawn; VX material is still available.

Table 2: Electrical characteristics of conductors (approx. values)

Standard	Code		Resistivity mΩ x mm		Loop inductance mH/km
	(+) leg	(-) leg	(+) leg	(-) leg	
IEC	RPCA/SPCA	RNCA/SNCA	0.017	0.12	1
IEC	RPCB/SPCB	RNCA/SNCA	0.017	0.12	1
ANSI	SPX	SNX	0.017	0.12	1
IEC	BPC	BNC	0.017	0.017	1
ANSI	BPX	BNX	0.125	0.017	1
IEC	JPX	JNX	0.12	0.49	8
ANSI	JPX	JNX	0.12	0.49	8
IEC	TPC	TNC	0.017	0.49	1
ANSI	TPX	TNX	0.017	0.49	1
IEC	EPX	ENX	0.72	0.49	3
ANSI	EPX	ENX	0.72	0.49	3
IEC	KPX	KNX	0.72	0.27	3
IEC	KPCB	KNCB	0.017	0.49	1
IEC	KPCA	KNCA	0.12	0.51	8
ANSI	KPX	KNX	0.72	0.27	3
ISA	VPX	VNX	0.017	0.49	1
IEC	NPX	NNX	0.98	0.34	3
IEC	NPC	NNC	0.017	0.52	1
ANSI	NPX	NNX	0.98	0.34	3

Table 3: Loop resistance at 20 °C (nominal value in Ω/km)

Thermo-couple	Conductor material		Conductor size				
	IEC 60584	ANSI MC 96.1	0.5 mm ²	0.8 mm ²	1.0 mm ²	1.3 mm ²	1.5 mm ²
	solid		0.8 mm Ø	1.02 mm Ø	1.13 mm Ø	1.29 mm Ø	1.38 mm Ø
R/S	RC/SC	SX	282	173	141	109	94
B	...	BX	293	179	148	112	98
B	BC	...	70	43	35	27	23
J	JX	JX	1257	769	628	483	418
T	TX	TX	1044	639	522	402	348
E	EX	Ex	2493	155	1246	958	831
K	KX	KX	2039	1248	1020	785	680
K	KCB	VX*	1044	639	522	402	348
K	KCA	...	1298	794	649	499	433
N	NX	...	2719	1663	1359	1046	906
N	NC	...	1106	677	553	425	369

* VX according to ISA RP 1.1

Find out more:

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