DEFINITION // ICONS


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HEAT GENERATION


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R & D


INDUSTRIAL


MEASUREMENT SYSTEMS


SMART GRID


AEROSPACE


IT TECHNOLOGY


RAIL ENGINEERING


RENEWABLE ENERGY


DRIVE TECHNOLOGY


MEDICAL ENGINEERING

GLOSSARY OF TERMS

THERMOCOUPLE

A thermocouple consists of two dissimilar electrical conductors that are connected in an electrical circuit. If their junctions are at different temperatures, a thermoelectric voltage will result (known as the "Seebeck effect"). This generated voltage is caused by the electron drift in the single legs resulting from the temperature difference over the length of the single conductors (legs) which form the thermocouple. Since the generated EMF of a single leg cannot be measured, two single leg materials with different electrical characteristics (number of electrons, binding energy, etc.) will be required to use the Seebeck effect for temperature measurement. The measured thermoelectric voltage is the difference of the generated single leg EMF. A thermocouple is an instrument (converter) by means of which heat energy is converted into electrical energy, i.e. a current or voltage generator. Thermoelectric voltage is used as a measuring signal. The voltage produced is solely dependent on the material and on the temperature difference to which the thermocouple is exposed. It is independent of the conductor's form or its dimensions. The thermoelectric power produced in a thermoelectric circuit is the product of thermoelectric current and the thermoelectric voltage. If the resulting voltage is measured with the lowest possible current (using temperature or DVM's with a very high internal resistance), it will be a direct measurement of the temperature difference to which the thermocouple is exposed. Due to the fact that only a temperature difference is measured, the temperature of the reference junction has to be well known.

Identification of the thermocouples in accordance with IEC 60584

Thermocouple	classification letter of the thermocouple type
Example	K for NiCr-Ni
Single leg	plus polarity identification ("**P**" or "**N**")

EXTENSION LEAD

Since it is difficult or impossible to directly connect the thermocouple to the transducer for reasons of cost or handling, an extension or compensating lead is frequently connected as an extension between the thermocouple and the transducer. The extension lead supplies the same thermoelectric voltage in a limited applicable temperature range and has the same nominal chemical composition as the thermocouple. The temperature range used is limited however. The total thermoelectric voltage supplied results from the thermoelectric voltage of the thermocouple in the temperature range between measuring point and the junction thermocouple/extension lead and thermoelectric voltage generated by the extension- or compensating lead between the junctions of thermocouple/extension lead and extension lead/transducer.

Identification of the extension lead in accordance with IEC 60584

Extension lead	classification letter of the corresponding thermocouple type plus letter "X" (extension)
Example	KX for NiCr-Ni thermocouple type K
Single leg As per IEC 60584	classification letter of the corresponding extension lead type plus polarity identification ("**P**" or "**N**") plus letter "X" (extension)
Example	KPX for NiCr-Ni positive leg of the extension lead type

COMPENSATING LEAD

A compensating lead is, by its function, an extension lead. A compensating lead however, shows a completely different chemical composition. The application range of temperatures is also limited here. Using compensating leads may result in a slightly higher increase of errors than with extension leads. Since the sum of thermoelectric voltages in a thermoelectric circuit is equal to the sum of all single thermocouples connected in series, such a measuring circuit can also be formed from a thermocouple and a compensating lead.

Identification of the compensating lead in accordance with IEC 60584

Compensating lead	classification letter of the corresponding thermocouple type plus letter "C" (Compensating)
Example	KC for NiCr-Ni, compensating lead type K
Single leg As per IEC 60584	classification letter of the corresponding thermocouple type plus polarity identification ("**P**" or "**N**") plus letter "C" (Compensating) plus letter "A" or "B" for different types of compensating leads
Example	KPCA for NiCr-Ni positive leg of compensating lead type K

For any further information regarding the physical principles, possible errors and the avoidance thereof, or to any of the keywords listed, please contact us at thermo@isabellenhuette.de or visit our homepage www.isabellenhuette.de

MATERIALS FOR THERMOCOUPLES

Standards for basic values of thermoelectric voltage

Standard	As per	Status	Thermocouple type						
			K	N	E	J	T	L	U
IEC 60584*	ITS 90	valid	✓	✓	✓	✓	✓		
ASTM E 230	ITS 90	valid	✓	✓	✓	✓	✓		
DIN 43710	IPTS 68	withdrawn						✓	✓
GOST P.8.585-2001	ITS 90	valid	✓	✓	✓	✓	✓		
NIST Monograph 175[1)]	ITS 90	valid	•	•	•	•	•		
NBS Monograph 125[1)]	IPTS 68	replaced by NIST Monograph 175	•	•	•	•	•		

We supply in accordance with the standards specified above. If you require special standards, older issues of the specified standards or your own customer's specifications, please contact us.

1) Basic values without assignment to tolerances.
✓ Applicable norm for indicated type.
• Indication of the related standards for the different thermocouple types.
* As well as the respective national translation of EN 60584. In this connection, the national standard designation will be added to EN 60584 (e.g. DIN EN 60584).

MATERIALS FOR THERMOCOUPLES
TOLERANCES ACCORDING TO THE INDICATED STANDARDS

Table 1 // IEC 60584

Standard symbol	Material	Temperature range class 1 in °C	Tolerance class 1	Temperature range class 2 in °C	Tolerance class 2	Temperature range class 3 in °C	Tolerance class 3	Permissible tolerance (not in standard)*
K	ISATHERM® PLUS ISATHERM® MINUS	–40 to +1,000	±1.5 °C or ±0.4 % (t90)	–40 to +1,200	±2.5 °C or ±0.75 % (t90)	–200 to +40	±2.5 °C or ±1.5 % (t90)	
N	NICROSIL NISIL	–40 to +1,000	±1.5 °C or ±0.4 % (t90)	–40 to +1,200	±2.5 °C or ±0.75 % (t90)	–200 to +40	±2.5 °C or ±1.5 % (t90)	
E	ISATHERM® PLUS ISOTAN®	–40 to +800	±1.5 °C or ±0.4 % (t90)	–40 to +900	±2.5 °C or ±0.75 % (t90)	–200 to +40	±2.5 °C or ±1.5 % (t90)	
J	IRON ISOTAN®	–40 to +750	±1.5 °C or ±0.4 % (t90)	–40 to +750	±2.5 °C or ±0.75 % (t90)			
T	E-COPPER ISOTAN®	–40 to +350	±0.5 °C or ±0.4 % (t90)	–40 to +350	±1.0 °C or ±0.75 % (t90)	–200 to +40	±1.0 °C or ±1.5 % (t90)	

Table 2 // ASTM E230

Standard symbol	Material	Temperature range in °C (t90)	Tolerances standard	Tolerances special	Permissible tolerance (not in standard)*
K	ISATHERM® PLUS ISATHERM® MINUS	0 to +1,260	±2.2 °C or ±0.75 % (t90)	±1.1 °C or ±0.4 % (t90)	±0.55 °C or ±0.2 %
N	NICROSIL NISIL	0 to +1,260	±2.2 °C or ±0.75 % (t90)	±1.1 °C or ±0.4 % (t90)	±0.55 °C or ±0.2 %
E	ISATHERM® PLUS ISOTAN®	0 to +870	±1.7 °C or ±0.5 % (t90)	±1.0 °C or ±0.4 % (t90)	±0.5 °C or ±0.2 %
J	IRON ISOTAN®	0 to +760	±2.2 °C or ±0.75 % (t90)	±1.1 °C or ±0.4 % (t90)	±0.55 °C or ±0.2 %
T	E-COPPER ISOTAN®	0 to +370	±1.0 °C or ±0.75 % (t90)	±0.5 °C or ±0.4 % (t90)	±0.25 °C or ±0.2 %

Table 3 // DIN 43710 (withdraw)

Standard symbol	Material	Temperature range in °C (t90)	Tolerances standard	Permissible tolerance (not in standard)*
L	IRON ISOTAN®	–200 to +900	±3.0 °C or ±0.75 % (t68)	±1.5 °C or ±0.375 %
U	E-COPPER ISOTAN®	–200 to +600	±3.0 °C or ±0.75 % (t68)	±1.5 °C or ±0.375 %

Table 4 // Measuring range ISA

Tolerance	Class 1/2 respectively Standard/Special and not standardised tolerance					Class 3
Range / Type	Upon request		Standard			–200/+40 °C
	–40 °C	0 to +1,200 °C	0 to +400 °C	0 to +700 °C	0 to +1,000 °C	
K	✓	✓			✓	✓
N	✓	✓			✓	✓
E	✓			✓		✓
J	✓			✓		
T	✓		✓			✓
L				✓		
U			✓			

* Please expect longer delivery times for these tolerances.
✓ Applicable norm for indicated type.

MATERIALS FOR EXTENSION LEADS

Standards for basic values of thermoelectric voltage

Standard	Status	Thermocouple type						
		KX	EX	JX	TX	NX	LX	UX
IEC 60584	valid	✓	✓	✓	✓	✓		
ASTM E 230	valid	✓	✓	✓	✓	✓		
GOST P.8.585-2001	valid	No compensating leads are specified in the GOST P.8.585-2001. Here the tolerances of the elements are assumed.						
DIN 43710	withdrawn						No compensating leads are specified in the DIN 43710. Here the tolerances of the elements are assumed.	

We supply in accordance with the standards specified above. If you require special standards, older issues of the specified standards or your own customer's specifications, please contact us.

✓ Applicable norm for indicated type.

MATERIALS FOR EXTENSION LEADS
TOLERANCES ACCORDING TO THE INDICATED STANDARDS

Table 1 // IEC 60584

Standard symbol	Material	Cable temperature range in °C (t90)	Tolerance class 1	Tolerance class 2	Permissible tolerance (not in standard)*	Measuring junction temperature in °C
KX	ISATHERM® PLUS ISATHERM® MINUS	–25 to +200	±60 µV (±1.5 °C)	±100 µV (±2.5 °C)	±30 µV	+900
NX	NICROSIL NISIL	–25 to +200	±60 µV (±1.5 °C)	±100 µV (±2.5 °C)	±30 µV	+900
EX	ISATHERM® PLUS ISOTAN®	–25 to +200	±120 µV (±1.5 °C)	±200 µV (±2.5 °C)	±60 µV	+500
JX	IRON ISOTAN®	–25 to +200	±85 µV (±1.5 °C)	±140 µV (±2.5 °C)	±50 µV	+500
TX	E-COPPER ISOTAN®	–25 to +100	±30 µV (±0.5 °C)	±60 µV (±1.0 °C)	±15 µV	+300

Table 2 // ASTM E230

Standard symbol	Material	Cable temperature range in °C (t90)	Tolerances standard	Tolerances special	Permissible tolerance (not in standard)*
KX	ISATHERM® PLUS ISATHERM® MINUS	0 to +200	±2.2 °C	±1.1 °C	±0.55 °C
NX	NICROSIL NISIL	0 to +200	±2.2 °C	±1.1 °C	±0.55 °C
EX	ISATHERM® PLUS ISOTAN®	0 to +200	±1.7 °C	±1.0 °C	±0.5 °C
JX	IRON ISOTAN®	0 to +200	±2.2 °C	±1.1 °C	±0.55 °C
TX	E-COPPER ISOTAN®	–60 to +100	±1.0 °C	±0.5 °C	±0.25 °C

Table 3 // Measuring range ISA

Range / Type	Upon request		Standard	
	–25 °C	–40 °C	+100 °C	+100/+200 °C
KX	✓			✓
NX	✓			✓
EX	✓			✓
JX	✓			✓
TX	✓	✓	✓	

* Please expect longer delivery times for these tolerances.
✓ Applicable norm for indicated type.

MATERIALS FOR COMPENSATING LEADS

Standards for basic values of thermoelectric voltage

Standard	Status	Compensating lead type							
		BC	SCA	SCB	RCA	RCB	KCA	KCB	NC
IEC 60584	valid	✓	✓	✓	✓	✓	✓	✓	✓
GOST P.8.585-2001	valid	No compensating leads are specified in the GOST P.8.585-2001. Here the tolerances of the elements are assumed.							

		BX	BC	SX	RX	CC	DC
ASTM E 230	valid	✓	✓	✓	✓		
ASTM E 988	valid					✓	✓

We supply in accordance with the standards specified above. If you require special standards, older issues of the specified standards or your own customer's specifications, please contact us.

✓ Applicable norm for indicated type.

MATERIALS FOR COMPENSATING LEADS
TOLERANCES ACCORDING TO THE INDICATED STANDARDS

Table 1 // IEC 60584

Standard symbol	Material	Cable temperature range in °C (t90)	Tolerance class 2	Measuring junction temperature in °C	Permissible tolerance (not in standard)*	
KCA	IRON ISA® MINUS	0 to +150	±100 µV (±2.5 °C)	+900	±60 µV	±30 µV
KCB	E-COPPER ISOTAN®	0 to +100	±100 µV (±2.5 °C)	+900	±50 µV	
NC	E-COPPER ISA®-SIL	0 to +150	±100 µV (±2.5 °C)	+900	±50 µV	
RCA/ SCA	E-COPPER A-COPPER 11	0 to +100	±30 µV (±2.5 °C)	+1,000	±22 µV	
RCB/ SCB	E-COPPER A-COPPER 11	0 to +200	±60 µV (±5.0 °C)	+1,000	±30 µV	
BC	E-COPPER E-COPPER	0 to +100	±40 µV (±3.5 °C)	+1,400		
BC	S-COPPER** E-COPPER	0 to +200		+1,400	±33 µV	

Table 2 // ASTM E230

Standard symbol	Material	Cable temperature range in °C (t68)	Tolerances standard	Permissible tolerance (not in standard)*
RX/SX	E-COPPER A-COPPER 11	0 to +200	±5.0 °C	±2.5 °C
BX	S-COPPER E-COPPER	0 to +200	±4.2 °C	
BC	E-COPPER E-COPPER	0 to +100	±3.7 °C	

Table 3 // ASTM E988

Standard symbol	Material	Cable temperature range in °C	Tolerances standard	Permissible tolerance ISA (not in standard)*
CC	ISA®-SIL ISOTAN®	0 to +200	±110 µV	±55 µV
DC	ISATHERM® PLUS IRON	0 to +200	±110 µV	±55 µV

Table 4 // Measuring range

Range / Type	+100 °C	+100/+200 °C
RCA/SCA/KCB/BC	✓	
Others		✓

* Please expect longer delivery times for these tolerances.
** Not mentioned in standard.
✓ Applicable norm for indicated type.