

THERMOCOUPLES AND INSULATORS

For many years, Berger S.A. has been specialized in the manufacturing and studying of thermocouples and their insulators.

They may be used in all industries where temperature must be measured and controlled.

A thermocouple is the suitable combination of elements (wires and insulators) selected according to the operating temperature and can work either alone or into a pyrometer and connected to an electric recorders.

STANDARD THERMOCOUPLE WIRES

General purposes

A thermocouple wire must meet the following conditions for suitable applications :

- Expand electromotive forces which are slightly different to those indicated in the published tables "temperature electromotive force" required for each kind of wire.
- To operate in the definite variations as far as possible.
- To be interchangeable, i.e. easily removed and replaced by a similar wire offering identical results without recalibration of recorders. In that respect, wires must provide the highest qualities of purity, homogeneity and non cold drawing.

Manufacturing :

Our thermocouples are manufactured with highest quality materials.

- Wire are selected and carefully checked according whatever the patterns may be.
- They may be used with any recorders whatever the patterns may be.
- These thermocouples are made up from standard components and materials selected to give the most appropriate physical and electric properties required.

Recalibration :

Recalibration can be made by using either thermostatic baths or stoves in comparing the results obtained from a gauge thermocouple or by a different system of stabilized smelting or boiling points.

How to choose an electric wire thermocouple

The most suitable thermocouple for any application must be selected depending on the maximum temperature to which it will be subjected and also the application and accuracy required.

In continuous operating service, we recommend the following wires :

MAXIMUM TEMPERATURE	ELEMENTS
- 200 + 300°C + 700°C +1100°C +1100°C +1500°C	Copper Constantan Iron Constantan Chromel Alumel Nickel chrome-Nickel Alloy Platinum 10% Platinum Rhodium

In alternative operating service, it appears possible to increase the maximum operating temperature up to 5 to 20%.

Identifications symbols and colors :

As per identification rules, our wires are identified according to symbols and colors shown underneath :

ELEMENTS	CODES	identification COLORS
Copper constantan	T	blue
Iron Constantan	J	black
Chromel Alumel	K	red
Nickel Chrome Nickel	N	red
Platinum 10% Rhodium Platinum	S	green

STANDARDISED TOLERANCES-BERGER TOLERANCE

ELEMENTS	NORME NF C 42322		STANDARD BERGER		
	<i>Temperature</i>	<i>Accuracy</i>	<i>Temperature</i>	<i>Standard</i>	<i>special Accuracy</i>
Copper/Constantan	-100°C -40°C -40°C +100°C +100°C +350°C	+/- 2 % +/- 0,8°C +/-0,75%	-180°C -40°C - 40°C +100°C +100°C +350°C	+/- 2 % +/- 0,8°C +/- 0,75%	+/- 1% +/- 0,40°C +/- 0,40%
Iron/Constantan	0°C +400°C +400°C +800°C	+/- 3°C +/-0,75%	0°C +400°C +400°C +800°C	+/- 3°C +/- 0,75%	+/- 2°C +/- 0,50%
Nickel-chrome/..... or Chromel Alumel	0°C + 400°C +400°C +1250°C	+/- 3°C +/- 0,40%	0°C +275°C +275°C +1250°C	+/-2,20°C +/- 0,75%	+/- 1,50°C +/- 0,50%
Platinum 10% Rhodium Platinum	0°C +600°C +600°C +1600°C	+/- 2,5°C +/- 0,40%	0°C +600°C +600°C +1600°C	+/- 2,50°C +/- 0,40%	+/- 2°C +/- 0,30%

Resistance to thermocouple wires chimic corrosion :

A thermocouple may be used either coated or not. In that case, the table herein gives some general information.

ELEMENT	PROPERTIES AND APPLICATIONS				OBSERVATION
	Oxydising	Reducing	Neutral	Empty	
Copper/Constantan	Average				Quite used in low temperature
Iron/Constantan	Average	Very good	Very good	Very good	General use, beware of oxidising conditions for not protected iron
Nickel-Chrome/..... or Chromel-Alumel	Very good	Average	Very good	Very good	General use, excepted in reducing atmosphere where it must be absolutely coated
Platinum 10% Rhodium Platinum	Very good	Feeble	Very good	Feeble	Use at high temperature

Thermoelectric characteristics applicable to standard FEM couples in millivolts according to centigrade temperature.
International scale 1948 - Reference junction in 0°C

Copper Constantan - T

° C	- 100*	-0*	+0	+100	+200	+300
0	3,349	0,000	0,000	4,277	9,288	14,864
10	3,624	0,380	0,389	4,749	9,823	15,447
20	3,887	0,751	0,787	5,227	10,363	16,035
30	4,138	1,112	1,194	5,712	10,909	16,626
40	4,377	1,463	1,610	6,204	11,459	17,222
50	4,603	1,804	2,035	6,703	12,015	17,821
60	4,817	2,135	2,467	7,208	12,575	18,425
70	5,018	2,455	2,908	7,719	13,140	19,032
80	5,205	2,764	3,357	8,236	13,710	19,642
90	5,379	3,062	3,813	8,759	14,285	20,257
100		3,349	4,277	9,288	14,864	

*The f.e.m. in the column are negativ

Platinum 10% Rhodium Platinum couple (s)

° C	0	100	200	300	400	500	600	700	800
0	0,000	0,643	1,436	2,316	3,251	4,221	5,224	6,260	7,329
10	0,056	0,717	1,521	2,408	3,347	4,319	5,326	6,365	7,438
20	0,113	0,792	1,607	2,499	3,442	4,419	5,429	6,471	7,547
30	0,173	0,869	1,693	2,592	3,539	4,518	5,532	6,577	7,656
40	0,235	0,946	1,780	2,685	3,635	4,618	5,635	6,683	7,766
50	0,299	1,025	1,868	2,778	3,732	4,718	5,738	6,790	7,876
60	0,364	1,106	1,956	2,872	3,829	4,818	5,842	6,897	7,987
70	0,431	1,187	2,045	2,966	3,926	4,919	5,946	7,005	8,098
80	0,500	1,269	2,135	3,061	4,024	5,020	6,050	7,112	8,209
90	0,571	1,352	2,225	3,156	4,122	5,122	6,155	7,220	8,320
100	0,643	1,436	2,316	3,251	4,221	5,224	6,260	7,329	8,432

Degrés Celsius	900	1000	1100	1200	1300	1400	1500	1600	1700
0	8,432	9,570	10,741	11,935	13,138	14,337	15,530	16,716	17,891
10	8,545	9,686	10,860	12,055	13,258	14,457	15,649	16,834	18,008
20	8,657	9,802	10,979	12,175	13,378	14,576	15,768	16,952	18,124
30	8,770	9,918	11,098	12,296	13,498	14,696	15,887	17,069	18,241
40	8,883	10,035	11,217	12,416	13,618	14,815	16,006	17,187	18,358
50	8,997	10,152	11,336	12,536	13,738	14,935	16,124	17,305	18,474
60	9,111	10,269	11,456	12,657	13,858	15,054	16,243	17,422	18,590
70	9,225	10,387	11,575	12,777	13,978	15,173	16,361	17,539	----
80	9,340	10,505	11,695	12,897	14,098	15,292	16,479	17,657	----
90	9,455	10,623	11,815	13,018	14,217	15,411	16,597	17,774	----
100	9,570	10,741	11,935	13,138	14,337	15,530	16,716	17,891	----

Iron Constantan couple - J

Degrés Celsius	0	100	200	300	400	500	600	700	800
0	0,00	5,27	10,78	16,33	21,85	27,39	33,11	39,15	45,53
10	0,50	5,81	11,34	16,88	22,40	27,95	33,70	39,78	46,18
20	1,02	6,36	11,89	17,43	22,95	28,52	34,29	40,41	46,82
30	1,54	6,90	12,45	17,98	23,50	29,08	34,88	41,05	47,46
40	2,06	7,45	13,01	18,54	24,06	29,65	35,48	41,68	48,09
50	2,58	8,00	13,56	19,09	24,61	30,22	36,08	42,32	48,73
60	3,11	8,56	14,12	19,64	25,16	30,80	36,69	42,96	49,36
70	3,65	9,11	14,67	20,20	25,72	31,37	37,30	43,60	49,98
80	4,19	9,67	15,22	20,75	26,27	31,95	37,91	44,25	----
90	4,73	10,22	15,77	21,30	16,83	32,53	38,53	44,89	----
100	5,27	10,78	16,33	21,85	27,39	33,11	39,15	45,53	----

Nickel Chrome Nickel Alloy (N), or Chromel Alumel (K)

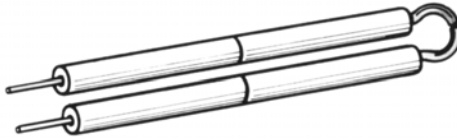
° C	-100*	-0*	+0	100	200	300	400	500
0	3,49	0,00	0,00	4,10	8,13	12,21	16,40	20,65
10	3,78	0,39	0,40	4,51	8,54	12,63	16,82	21,07
20	4,06	0,77	0,80	4,92	8,94	13,04	17,24	21,50
30	4,32	1,14	1,20	5,33	9,34	13,46	17,67	21,92
40	4,58	1,50	1,61	5,73	9,75	13,88	18,09	22,35
50	4,81	1,86	2,02	6,13	10,16	14,29	18,09	22,35
60	5,03	2,20	2,43	6,53	10,57	14,71	18,94	23,20
70	5,24	2,54	2,85	6,93	10,98	15,13	19,36	23,63
80	5,43	2,87	3,26	7,23	11,39	15,55	19,79	24,06
90	5,60	3,19	3,68	7,73	11,80	15,98	20,22	24,49
100	5,75	3,49	4,10	8,13	12,21	16,40	20,65	24,91

° C	600	700	800	900	1000	1100	1200	1300
0	24,91	29,14	33,30	37,36	41,31	45,16	48,89	52,46
10	25,34	29,56	33,71	37,76	41,70	45,54	49,25	52,81
20	25,76	29,97	34,12	38,16	42,09	45,92	49,62	53,16
30	26,19	30,39	34,53	38,56	42,48	46,29	49,98	53,51
40	26,61	30,81	34,93	38,95	42,87	46,67	50,34	53,85
50	27,03	31,23	35,34	39,95	43,25	47,04	50,69	54,20
60	27,45	31,65	35,75	39,75	43,63	47,41	51,05	54,54
70	27,87	32,06	36,15	40,14	44,02	47,78	51,41	54,88
80	28,29	32,48	36,55	40,53	44,40	48,15	51,76	----
90	28,72	32,89	36,96	40,92	44,78	48,52	52,11	----
100	29,14	33,30	37,36	41,31	45,16	48,89	52,46	----

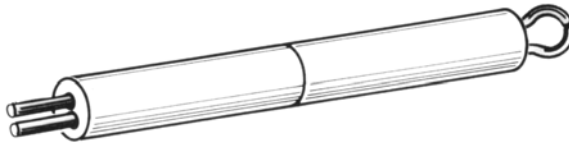
The f.e.m. in the column are negativ.

THERMOCOUPLES AND INSULATORS

Single wire,
refractory
insulators with
one hole



Single wire,
refractory
insulators with two
holes



Single wire, rod
refractory insulators

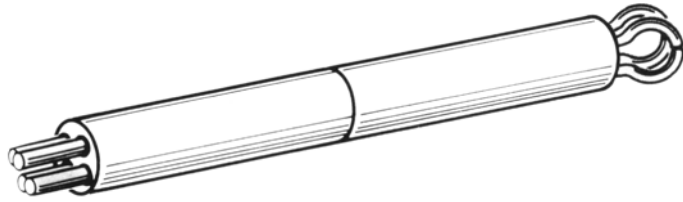


Standard length of wires

		Symbole	Diameters		Dead ligne of continuous working usin to in °C	
Positive +	Negative -		mm	BS gauge	Nu	With protected sheat
Copper	Constantan	T	0,10	38	150	200
			0,20	32	150	200
			0,51	24	200	250
			0,81	20	250	300
			1,02	18	250	300
			1,62	14	315	370
Iron	Constantan	J	0,10	38	200	250
			0,20	32	250	300
			0,51	24	450	500
			0,81	20	550	600
			1,02	18	550	600
			1,62	14	650	750
Nickel-Chrome or Chromel	Nickel or Alumel	N	0,10	38	650	750
			0,20	32	650	750
			0,51	24	800	900
		K	0,81	20	900	1000
			1,02	18	900	1000
			1,62	14	1000	1100
3,26	8	1100	1200			
Platinum- Rhodium 10%	Platinum	S	0,51	24	1300	1500

THERMOCOUPLES and ISOLATEURS

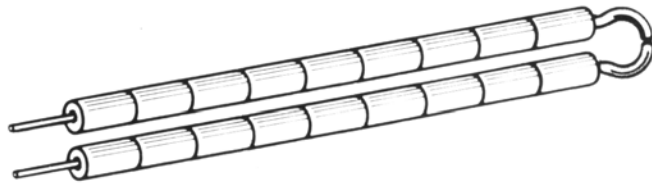
Duplex wire, refractory insulators with four holes



Duplex wire, rod refractory insulators



Single wire, knuckle refractory insulators



Insulator :

Two varieties of insulators are offered :

- Beads or isolated rods

They are made of special steatite up to 1100 / 1200°C.

Main properties :


Special steatite :

- High resistance to insulation
- Chemical inertness
- Good resistance to hot mechanic strength
- Used in continuous working operation up to 1100°C
- Used in discontinuous working operation up to 1200°C
- Water absorption - nil

For higher temperatures, we invite you to choose pythagoras insulators.

Section	Ø external (in mm)	Ø of the holes (in mm)	Length (in mm)
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two holes Isolators

	11	3,5	25 50
	7	1,8	25 50 100
	12,3x7	4	5 25 50 100

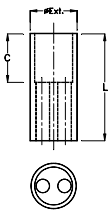
four holes Isolators

	12,5	3,4	25
	9	2,8	25 50 100

pipe insulators

	4	2	25
	6	4	25 50

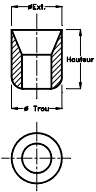
protector ends insulators

	11	3,5	L	C
			40	20
	7	2	30	12

These insulators are empty on a certain length in order to insert the thermocouple hot welding junction which becomes isolated from the thermowell.

Section	Ø external (in mm)	Ø of the holes (in mm)	Length (in mm)
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Knuckle beads

			Hauteur (en mm)
	3	1,2	3
	5	2,1	5
	8	4,5	8


Pythagoras

Highly recommended for temperatures exceeding 1200°C and up to 1750°C and specially for CRAL thermocouples upper 1100°C / 1200°C and for PT / PTRH thermocouples.

Insulators with two holes

	3	0,8	25 50
	6	1,8	25 50
	12	4	25 50

Insulators with four holes

	4	0,7	25 50
	6	1,5	25 50

Pythagoras may be used as protection well.

Main properties

- Gasproof up to 1750°C (in neutral atmosphere)
- Good resistance to thermal shocks
- Never affected by acids even when boiling, fluorhydric acid excepted
- Very high resistance to hot temperature when meet by salts or smelting metal (avoid thermal shocks)
- Out of soluble silica and does not affect nickel chrome alloy

Standard lengths

Type	Characteristics	Ø ext. (in mm)	Ø int. (in mm)	Standard length (in mm)
A	Pipe closed to one end	16	12	300, 400, 500, 600, 700, 800, 1000, 1200 , 1500, 1650 , 2000
B	Pipe closed to one end collar to the other end	26	20	

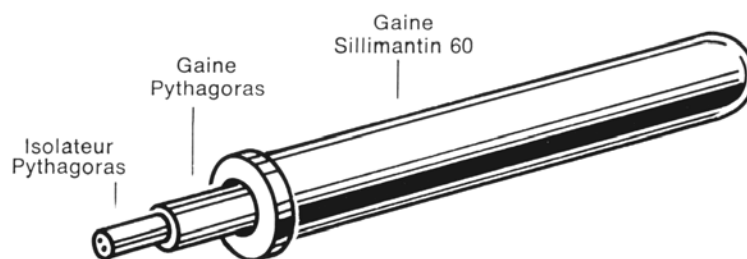
Sillimantin 60

Wells in Sillimantin 60 are used as double protection wherever pythagoras thermowells must be protected against thermal and mecanical shocks.

Main properties

- Not Gasproof thermowell
- Furnace resistace 1800°C
- Sillimantin 60 is never affected by acids, floyrhydric acid excepted
- Not affected by thermal shocks
- May be used up to 1700°C in oxidising atmosphere
- Out of soluble silica and does not affect nickel chrome alloy
- Highky recommended mounting in the following cases :

- Highly oxidising atmosphere
- Mecanical shocks
- Flame blasts
- Ash blast



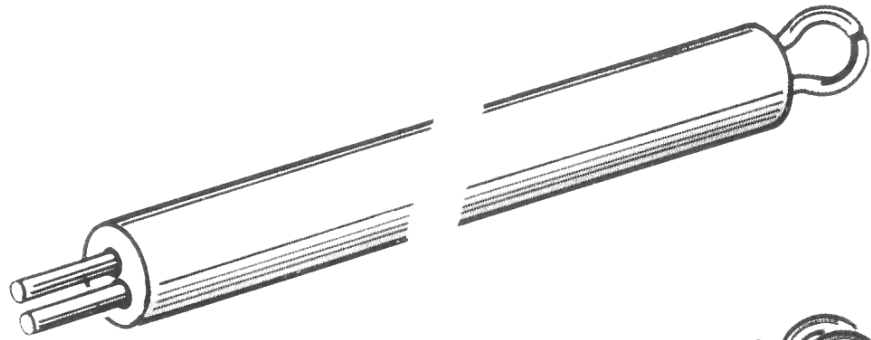
Type	Characteristics	Ø ext. (in mm)	Ø int. (in mm)	Standard length (in mm)
C	Pipe closed to one end	26	18	300, 400, 500, 600, 700, 800, 1000, 1200 , 1500, 1650 , 2000
D	Pipe closed to one end collar to the other end	26	18	

Nota : These wells are usually used for the external protection of pythagoras wells type A.

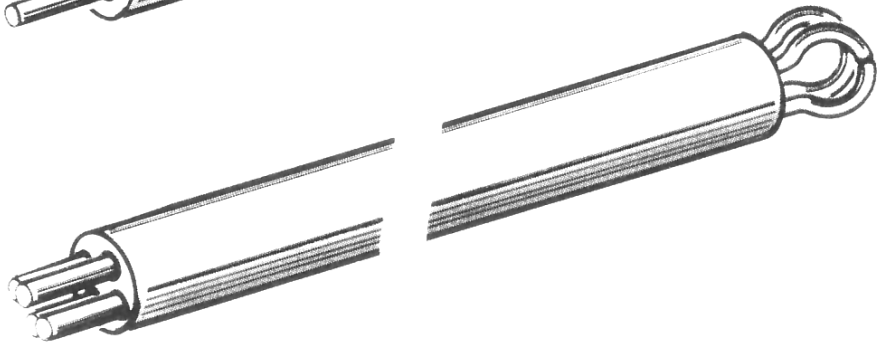
Pythagoras and Sillimantin 60 are "HANDELWANGER BERLIN" trade marks.

PACKED TYPE THERMOCOUPLE

Single wire



Duplex wire



Packed type thermocouples are made of wires inserted in a mineral insulator (magnesium oxide) highly compressed into a one piece metal sheath.

On the other hand, these thermocouples offer the following advantages :

- External diameter reduced which fit into openings that are too small for conventional size thermocouples.
- Quick response owing to a perfect conduction of mineral insulator.

They may be :

- In radius to meet the checking point
- Welded to a wall
- Dispatched in great lengths
- Directly fit into the liquid or through the operating atmosphere depending on the case

- Hot junction (isolated or not from the ground) is executed under plasma, metal sheath does not show an overthickness to its end

- A special end fitting either single or duplex guaranteed a perfect weatherproof is mounted on them.

This type of thermocouples save time considerably in mounting. An approximate time of 75% is evaluated comparatively with the conventional thermocouples.

STANDARD LENGTHS OF THERMOCOUPLES PACKED TYPE

T Y P E	T° max.to measure	Element	Ø of the core in mm	Ø ext. of the sheat in mm	Copper	Ref. and nature of the sheat				
						steel Inox. AISI 304 L	steel inox. AISI 316L	Refractory steel 310 AISI	Alloy 600	Alloy 800
S I N G L E	350° C	Copper/ Constan- tantan	0,20 0,30 0,46 0,70 1,03 1,38 1,84	1 1,5 2 3 4,5 6 8	3 TC 4,5 TC 6 TC 8 TC	1 TI 1,5 TI 2 TI 3 TI 4,5 TI 6 TI 8 TI				
		T								
	800° C	steel/ Constan- tantan	0,20 0,30 0,46 0,70 1,03 1,38 1,84	1 1,5 2 3 4,5 6 8		1 JI 1,5 JI 2 JI 3 JI 4,5 JI 6 JI 8 JI	1 JI 316L 1,5 JI 316L 2 JI 316L 3 JI 316L 4,5 JI 316L 6 JI 316L 8 JI 316L			
		J								
1.250° C	Chromel/A lumel	0,20 0,30 0,46 0,70 1,03 1,38 1,84	1 1,5 2 3 4,5 6 8		1 NI 1,5 NI 2 NI 3 NI 4,5 NI 6 NI 8 NI	1 NI 316L 1,5 NI 316L 2 NI 316 L 3 NI 316 L 4,5 NI 316L 6 NI 316 L 8 NI 316 L	1 NR 1,5 NR 2 NR 3 NR 4,5 NR 6 NR 8 NR	1 NINC 1,5 NINC 2 NINC 3 NINC 4,5 NINC 6 NINC 8 NINC	1 NY 1,5 NY 2 NY 3 NY 4,5 NY 6 NY 8 NY	
	K									
1.500° C	Platinum/ Platinum Rhodium S	0,30	1,5		Sheat in nickel or in platinum Manufacturing on request					
		0,50	3							
D U P L E X	350° C	Copper/ Constan- tantan	0,8 1,07 1,42	4,5 6 8	D 4,5 TC D 6 TC D 8 TC	D 4,5 TI D 6 TI D 8 TI				
		T								
	800° C	steel/ Constan- tantan	0,5 0,8 1,07 1,42	3 4,5 6 8		D 3 JI D 4,5 JI D 6 JI D 8 JI	D 3 JI 316L D 4,5 JI 316L D 6 JI 316L D 8 JI 316L			
J										
1.250° C	Chromel/A lumel	0,5 0,8 1,07 1,42	3 4,5 6 8		D 3 NI D 4,5 NI D 6 NI D 8 NI	D 3 NI 316L D 4,5 NI 316L D 6 NI 316L D 8 NI 316L	D 3 NR D 4,5 NR D 6 NR D 8 NR	D 3 NINC D 4,5 NINC D 6 NINC D 8 NINC	D 3 NY D 4,5 NY D 6 NY D 8 NY	
	K									

Any special manufacturing on request

