MANGANIN®

ISABELLENHÜTTE

Brand Name	MANGANIN® 1)
Material Code	2.1362
Abbreviation	CuMn12Ni

Chemical Composition (mass components) in %
Average values of alloy components

Cu	Mn	Ni
Rem.	12	2

Form of Delivery

MANGANIN® is supplied in the form of round wires in the range 8.0 to 0.02 mm Ø in bare or enamelled condition, also with rayon or silk covering. The product line includes sheets, ribbons, flat wires, stranded wires, rods and tubes.

Properties and Application Notes

The precision resistance alloy MANGANIN®, developed by Isabellenhütte, is especially characterized by low temperature coefficient between 20 and 50 °C with a parabolic shape of the R(T) curve, high long-term stability of electrical resistance, extremely low thermal EMF versus copper and good working properties. Due to these features MANGANIN® is the standard material for precision, standard and shunt resistors. MANGANIN® is the basis for the production of ISA-PLAN® and ISA-WELD® components. The maximum working temperature in air is 140 °C. However, higher thermal loads in a non-oxidizing atmosphere are possible. When used for precision resistors with the highest requirements, the resistors should be carefully stabilised and the application temperature should not exceed 60 °C. Exceeding the maximum working temperature in air may result in a resistance drift generated by oxidizing processes. Thus, the long-term stability can be affected negatively. As a result, the resistivity as well as the temperature coefficient of the electric resistance may slightly change. It is also used as low cost replacement material for silver solder for hard metal mounting.

Electrical Resistance in Annealed Condition

Temperature coefficient of electrical resistance between	Electrical resistivity in: μΩ x cm (first line) and Ω / CMF (second line) Reference Values					
20 °C and 50 °C	20 °C	100 °C	200 °C	300 °C	400 °C	500 °C
10^{-6}/K	tolerance ±5 %					
-10 to +10	43	43	-	-	-	-
	259	259	-	-	-	-

Physical Characteristics (Reference Values)

Density at 20 °C		Melting Point	Specific heat at 20 °C	Thermal conductivity at 20 °C	Average linear thermal expansion coefficient between 20 °C and		Thermal EMF against copper at 20 °C
					100 °C	400 °C	
g/cm³	lb/cub in	°C	J/g K	W/m K	10^{-6}/K	10^{-6}/K	μV/K
8.4	0.30	960	0.41	22	18	19,5	Stand.: -1 Special: ± 0.2

Strength Properties at 20 °C in Annealed Condition[2)]

Tensile Strength[3)]		Elongation (L_0 = 100 mm) % at nominal diameter in mm				
MPa	psi	0.02 to 0.063	> 0.063 to 0.125	> 0.125 to 0,5	> 0.5 to 1	> 1
390	56550	≈ 12	≈ 18	≈ 20	≥ 20	≥ 25

1) MANGANIN® is a registered trademark of Isabellenhütte Heusler GmbH & Co. KG.
2) Other characteristic values are: Modulus of elasticity = 1.3 x 10^5 MPa, pressure coefficient of electrical resistance = 2.3 x 10^{-7} cm^2/N.
3) This value applies to wires of 2 mm diameter. For thinner wires the minimum values will substantially increase, depending on the dimensions.

Special Remarks on the Temperature Coefficient (TC)

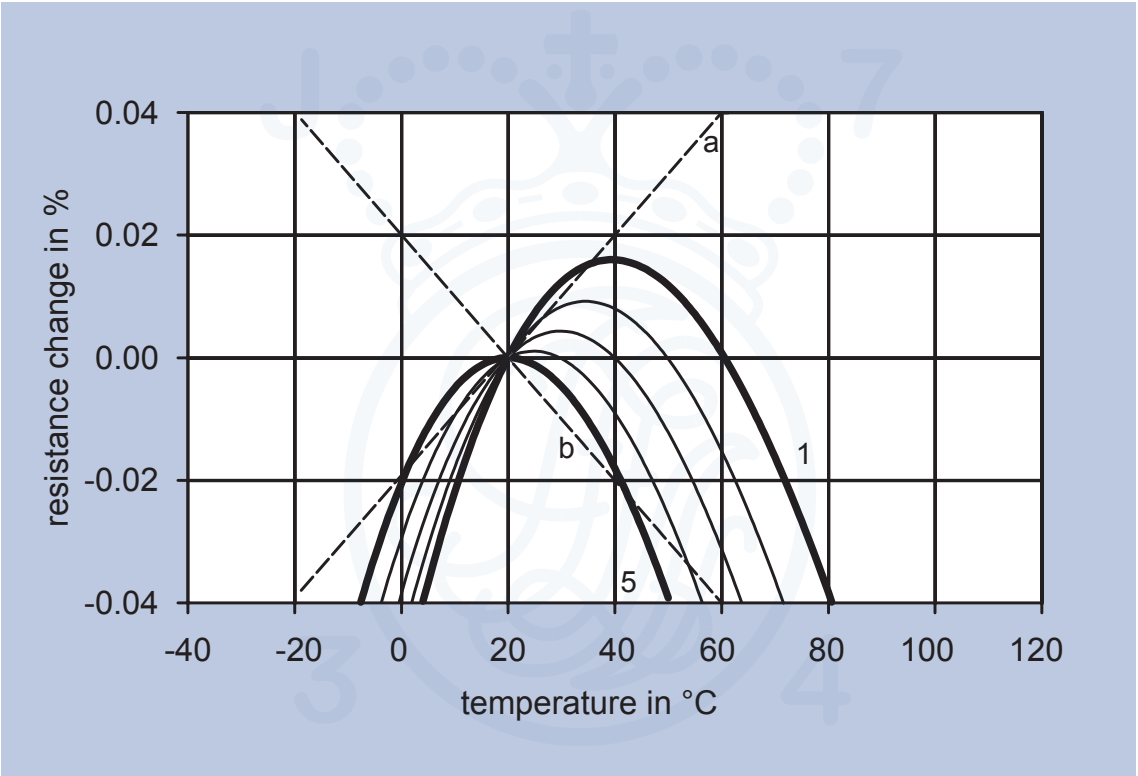
The following graphs show the variation of the electrical resistance vs. temperature for different temperature ranges. Because of the parabolic shape of the R(T)-curves in the room temperature range (graph 1) the TC data must be specified with the corresponding temperature range used. The typical curves 1-5 in graph 1 represent different supplied qualities which can be controlled by the alloy composition. A better and for MANGANIN® typical characterization of the R(T)-curve is therefore the second zero transition, which is the temperature where the resistance is equal to the 20 °C value. The dotted straight lines a and b apply to a TC = ±10 ppm/K.

Notes on Treatment

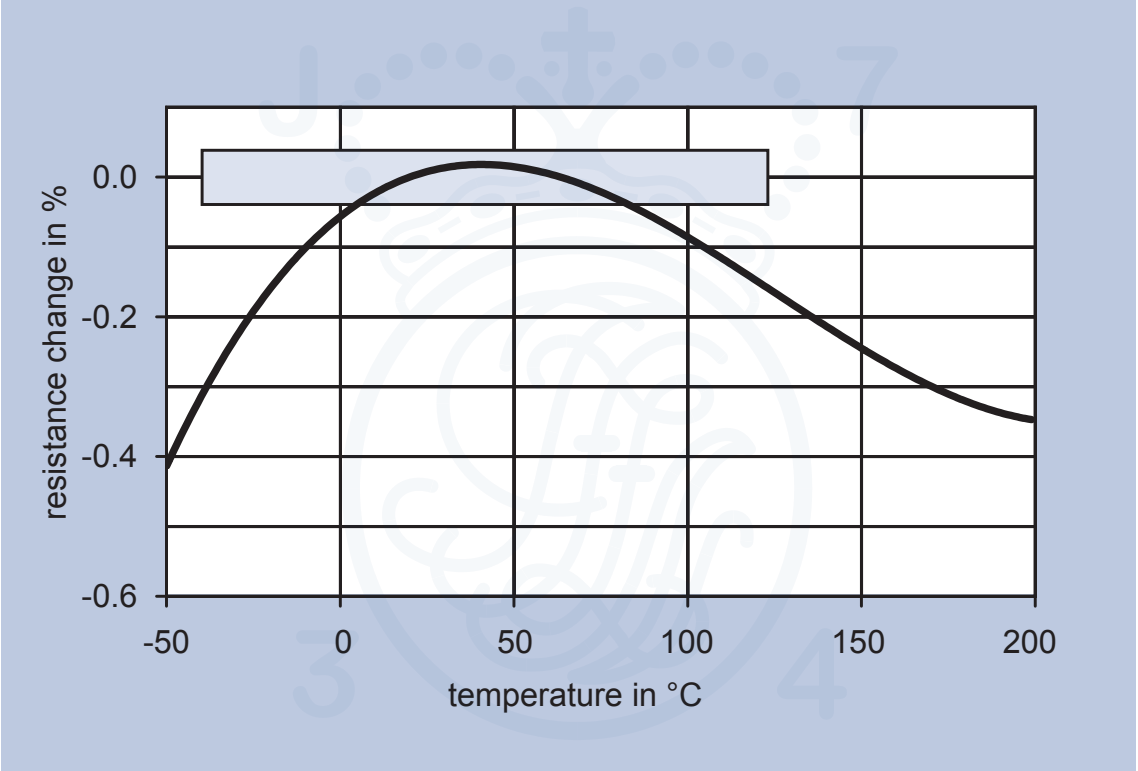
MANGANIN® can be worked easily. Though the alloy can be soldered, it develops in air a thin oxide film; this must be removed before working. With an appropriate flux MANGANIN® is also suitable for dip-tinning. Furthermore, MANGANIN® can be brazed and welded. Resistors made of MANGANIN® must be aged in order to remove mechanical stress. For further details see Technical Information.

Nominal Diameter d	Cross Section	Weight per 100 m	DC Resistance Referred to Length at 20 °C Ω / m			
mm	mm²	g	Nominal Value	Tolerance	Minimum Value	Maximum Value
0.02	0.0003142	0.264	1369	± 10 %	1232	1506
0.022	0.0003801	0.319	1131		1018	1244
0.025	0.0004909	0.412	876		788	964
0.028	0.0006158	0.517	698		629	768
0.03	0.0007069	0.594	608	± 8 %	560	657
0.032	0.0008042	0.676	535		492	577
0.036	0.001018	0.855	422		389	456
0.04	0.001257	1.06	342		315	370
0.045	0.001590	1.34	270		249	292
0.05	0.001963	1.65	219		202	237
0.056	0.002463	2.07	175		161	189
0.06	0.002827	2.38	152		140	164
0.063	0.003117	2.62	138		127	149
0.07	0.003848	3.23	112		103	121
0.071	0.003959	3.33	109		100	117
0.08	0.005027	4.22	85.5		78.7	92.4
0.09	0.006362	5.34	67.6		62.2	73.0
0.10	0.007854	6.60	54.7		50.4	59.1
0.11	0.009503	7.98	45.2	± 7 %	42.1	48.4
0.112	0.009852	8.28	43.6		40.6	46.7
0.12	0.01131	9.50	38.0		35.4	40.7
0.125	0.01227	10.3	35.0		32.6	37.5
0.13	0.01327	11.1	32.4		30.1	34.7
0.14	0.01539	12.9	27.9		26.0	29.9
0.15	0.01767	14.8	24.3		22.6	26.0
0.16	0.02011	16.9	21.4		19.9	22.9
0.18	0.02545	21.4	16.9		15.7	18.1
0.20	0.03142	26.4	13.7	± 6 %	12.9	14.5
0.22	0.03801	31.9	11.3		10.6	12.0
0.224	0.03941	33.1	10.9		10.3	11.6
0.25	0.04909	41.2	8.76		8.23	9.29
0.28	0.06158	51.7	6.98		6.56	7.40
0.30	0.07069	59.4	6.08		5.72	6.45
0.315	0.07793	65.5	5.52	± 5 %	5.24	5.79
0.35	0.09621	80.8	4.47		4.25	4.69
0.355	0.09898	83.1	4.34		4.13	4.56
0.40	0.1257	106	3.42		3.25	3.59
0.45	0.1590	134	2.70		2.57	2.84
0.50	0.1963	165	2.19		2.08	2.30
0.55	0.2376	200	1.81	± 4 %	1.74	1.88
0.56	0.2463	207	1.75		1.68	1.82
0.60	0.2827	238	1.52		1.46	1.58
0.63	0.3117	262	1.38		1.32	1.43
0.65	0.3318	279	1.30		1.24	1.35
0.70	0.3848	323	1.12		1.07	1.16
0.71	0.3959	333	1.09		1.04	1.13
0.80	0.5027	422	0.855		0.821	0.890
0.90	0.6362	534	0.676		0.649	0.703
1.0	0.7854	660	0.547		0.526	0.569
1.12	0.9852	828	0.436		0.419	0.454
1.2	1.131	950	0.380		0.365	0.395
1.25	1.227	1031	0.350		0.336	0.364
1.4	1.539	1293	0.279		0.268	0.291
1.5	1.767	1484	0.243		0.234	0.253
1.6	2.011	1689	0.214		0.205	0.222
1.8	2.545	2138	0.169		0.162	0.176
2.0	3.142	2639	0.137		0.131	0.142
2.2	3.801	3193	0.113		0.109	0.118
2.24	3.941	3310	0.109		0.105	0.113
2.5	4.909	4123	0.0876		0.0841	0.0911
2.8	6.158	5172	0.0698		0.0670	0.0726
3.0	7.069	5938	0.0608		0.0584	0.0633
3.15	7.793	6546	0.0552		0.0530	0.0574
3.2	8.042	6756	0.0535		0.0513	0.0556
3.5	9.621	8082	0.0447		0.0429	0.0465
3.55	9.898	8314	0.0434		0.0417	0.0452
4.0	12.57	10556	0.0342		0.0328	0.0356
4.5	15.90	13360	0.0270		0.0260	0.0281
5.0	19.63	16493	0.0219		0.0210	0.0228
5.5	23.76	19957	0.0181		0.0174	0.0188
5.6	24.63	20689	0.0175		0.0168	0.0182
6.0	28.27	23750	0.0152		0.0146	0.0158
6.3	31.17	26185	0.0138		0.0132	0.0143
8.0	50.27	42223	0.00855		0.00821	0.00890

Graph 1:
Electrical resistance vs. temperature



Graph 2
Electrical resistance vs. temperature



* 1 ppm = $1 \cdot 10^{-6}$ = 0.0001 %, 1000 ppm = $1 \cdot 10^{-3}$ = 0.1 %.

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