Brand Name	MANGANIN®
Material Code	2.1362
Abbreviation	CuMn12Ni

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

Cu	Mn	Ni
Rem.	12	2

Properties and Application Notes

The precision resistance alloy MANGANIN®, developed by us, is especially characterized by low temperature coefficient between 20 and 50°C with parabolic shape of the R/T curve, high stability of electrical resistance, low thermo EMF against copper and good working properties. Due to these features MANGANIN® is the standard material for precision, standard and shunt resistors.

The maximum working temperature in air is 140°C. When used for precision resistors, however, the temperature should not exceed 60°C.

Electrical Resistance in Annealed Condition

Temperature coefficient [1]) of electrical resistance between 20°C and 50°C	Electrical resistivity in Ω mm²/m at 20°C		100°C	200°C	300°C	400°C	500°C
10^{-6}/K	Nom. value	Perm. Dev.%	Reference values				
− 10 to + 10	0,43	± 5	0,43	–	–	–	–

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 100°C	Average linear thermal expansion coefficient between 20°C and 400°C	Thermo EMF against copper at 20°C
g/cm³	°C	J/g K	W/m K	10^{-6}/K	10^{-6}/K	μ V/K
8,4	960	0,41	22	18	19,5	− 0,6

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

Tensile Strength [3]) N/mm²	Elongation (L_o = 100 mm) % at nominal diameter in mm				
min.	from 0,02 to 0,063 ≅	over 0,063 to 0,125 ≅	over 0,125 to 0,5 ≅	over 0,5 to 1 min.	over 1 min.
390	12	18	20	20	25

[1]) This value applies to temperatures between 20 and 50 °C. Upon request it can be adjusted to a certain degree.

[2]) Other characteristic values are: Modulus of elasticity = $1{,}3 \cdot 10^5$ N/mm², pressure coefficient of electrical resistance = $2{,}3 \cdot 10^{-7}$ cm²/N.

[3]) This value applies to wires of 2 mm diameter. For thinner wires the minimum values will substantially increase, depending on the dimensions.

Form of Delivery

MANGANIN® is supplied in the form of round wires in the range 8,0 to 0,02 mm diam. in bare or enamelled condition, also with rayon or silk covering. The product line includes sheets, ribbons, flat wires, rods and tubes.

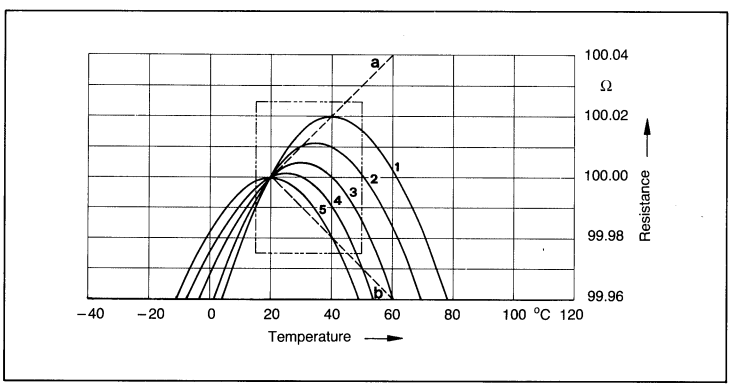
Notes on Treatment

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. MANGANIN® is not suitable for dip-tinning. MANGANIN® can, however, be brazed and welded.

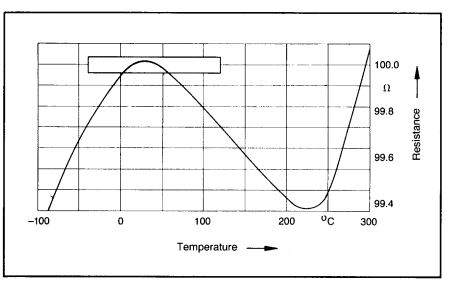
Resistors made of MANGANIN® must be aged in order to remove mechanical stress. For further details see Part 2, „Instructions for Treatment".

Special Remarks on the Temperature Coefficient (see also the Notes in Part 2)

The variation of the electrical resistance vs. temperature in the range between –10 and +80°C, referred to 20°C, is shown in Graph 1. Because of the parabolic shape of the curves of resistance vs. temperature, one cannot speak of an ideal curve; instead five possible curves are shown. The resistance variations of the alloy supplied by us normally lie between curves 1 and 5. The cut-out in the temperature range from 15 to 50°C corresponds with the generally known values of Graph 1255. The dotted straight lines a and b apply to a temperature coefficient α = ± 10 ppm in the temperature range between 20 and 80°C. Between 20 and 105°C the temperature coefficient increases to ± 50 ppm. The possible resistance variations in the range from −100 to +300°C are presented in another scale in Graph 2. Graph 1 is an enlarged view of the cut-out.



Graph 1: Electrical Resistance vs. Temperature



Graph 2

* 1 ppm = $1 \cdot 10^{-6}$ = 0,0001%, 1000 ppm = $1 \cdot 10^{-3}$ = 0,1%.

Nominal-Diameter d mm	Cross-Section mm²	Weight per 100 m g	DC Resistance Referred to Length at 20°C Ω/m			
			Nominal value	Perm. dev.	Minimum value	Maximum value
0,02	0,0003142	0,264	1370	± 10%	1230	1510
0,022	0,0003801	0,319	1130		1020	1240
0,025	0,0004909	0,412	876		788	964
0,028	0,0006158	0,517	698		628	768
(0,03)	0,0007069	0,594	608	± 8%	559	657
0,032	0,0008042	0,676	535		492	578
0,036	0,001018	0,855	422		388	456
0,04	0,001257	1,06	342		315	369
0,045	0,001590	1,34	270		248	292
0,05	0,001964	1,65	219		201	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	118
0,08	0,005027	4,22	85,5		78,7	92,3
0,09	0,006362	5,34	67,6		62,2	73,0
0,1	0,007854	6,60	54,7		50,3	59,1
(0,11)	0,009503	7,98	45,2	± 7%	42,0	48,4
0,112	0,009852	8,28	43,6		40,5	46,7
(0,12)	0,01131	9,50	38,0		35,3	40,7
0,125	0,01227	10,3	35,0		32,5	37,5
(0,13)	0,01327	11,1	32,4		30,1	34,7
0,14	0,01539	12,9	27,9		25,9	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
0,2	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		10,2	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
(0,3)	0,07069	59,4	6,08		5,72	6,44
0,315	0,07793	65,5	5,52	± 5%	5,24	5,80
(0,35)	0,09621	80,8	4,47		4,25	4,69
0,355	0,09898	83,1	4,34		4,12	4,56
0,4	0,1257	106	3,42		3,25	3,59
0,45	0,1590	134	2,70		2,56	2,84
0,5	0,1964	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
(0,6)	0,2827	238	1,52		1,46	1,58
0,63	0,3117	262	1,38		1,32	1,44
(0,65)	0,3318	279	1,30		1,25	1,35
(0,7)	0,3848	323	1,12		1,08	1,16
0,71	0,3959	333	1,09		1,05	1,13
0,8	0,5027	422	0,855	± 4%	0,821	0,889
0,9	0,6362	534	0,676		0,649	0,703
1	0,7854	660	0,547		0,525	0,569
1,12	0,9852	828	0,436		0,419	0,453
(1,2)	1,131	950	0,380		0,365	0,395
1,25	1,227	1030	0,350		0,336	0,364
1,4	1,539	1290	0,279	± 4%	0,268	0,290
1,5	1,767	1480	0,243		0,233	0,253
1,6	2,011	1690	0,214		0,205	0,223
1,8	2,545	2140	0,169		0,162	0,176
2	3,142	2640	0,137		0,132	0,142
(2,2)	3,801	3190	0,113		0,108	0,118
2,24	3,941	3310	0,109		0,105	0,113
2,5	4,909	4120	0,0876	± 4%	0,0841	0,0911
2,8	6,158	5170	0,0698		0,0670	0,0726
3	7,069	5940	0,0608		0,0584	0,0632
3,15	7,793	6550	0,0552		0,0530	0,0574
(3,2)	8,042	6760	0,0535		0,0514	0,0556
(3,5)	9,621	8080	0,0447		0,0429	0,0465
3,55	9,898	8310	0,0434		0,0417	0,0451
4	12,57	10600	0,0342	± 4%	0,0328	0,0356
4,5	15,90	13400	0,0270		0,0259	0,0281
5	19,64	16500	0,0219		0,0210	0,0228
(5,5)	23,76	20000	0,0181		0,0174	0,0188
5,6	24,63	20700	0,0175		0,0168	0,0182
6	28,27	23800	0,0152		0,0146	0,0158
6,3	31,17	26200	0,0138		0,0132	0,0144
8	50,27	42000	0,00855		0,00821	0,00889