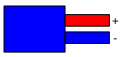
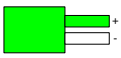
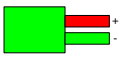
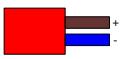
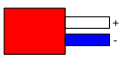
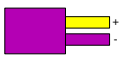
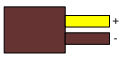
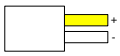
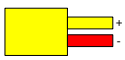
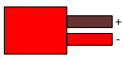
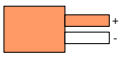
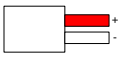
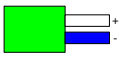
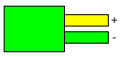
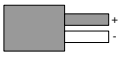
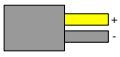
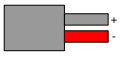
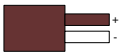
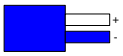
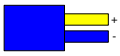
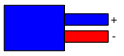
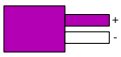
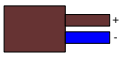
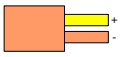
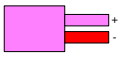
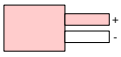
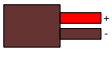
Internationale Kennfarben
International Colour Codes

Thermopaarart *thermocouple type*	DIN EN 60584	DIN 43710	BS 4937/1843	NF C 42-324	ANSI MC 96.1
J + Eisen - Kupfer-Nickel					
L + Eisen - Kupfer-Nickel					
K + Nickel-Chrom - Nickel			 	  	 
R + Platin- 13% Rhodium - Platin **S** + Platin- 10% Rhodium - Platin					
B + Platin- 30% Rhodium - Platin- 6% Rhodium					
T + Kupfer - Kupfer-Nickel					
E + Nickel-Chrom - Kupfer-Nickel					
N + Nickel-Chrom-Silizium - Nickel-Silizium					
U + Kupfer - Kupfer-Nickel					

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Grundwertreihen für Thermoelemente

Thermocouple reference tables

Eisen/ Kupfer-Nickel nach DIN 43710 Typ L

Iron/ Copper-Nickel acc. to DIN 43710

Bezugstemperatur 0°C. Temperaturen in °C

Reference temperature 0°C. Temperatures in degress celsius

Temp.	Millivolt									
°C	0	1	2	3	4	5	6	7	8	9
0	0,00	0,05	0,10	0,16	0,21	0,26	0,31	0,36	0,42	0,47
10	0,52	0,57	0,63	0,68	0,73	0,78	0,84	0,89	0,94	1,00
20	1,05	1,10	1,16	1,21	1,26	1,31	1,37	1,42	1,47	1,53
30	1,58	1,63	1,69	1,74	1,79	1,84	1,90	1,95	2,00	2,06
40	2,11	2,16	2,22	2,27	2,33	2,38	2,43	2,49	2,54	2,60
50	2,65	2,70	2,76	2,81	2,87	2,92	2,97	3,03	3,08	3,14
60	3,19	3,24	3,30	3,35	3,41	3,46	3,51	3,57	3,62	3,68
70	3,73	3,78	3,84	3,89	3,95	4,00	4,05	4,11	4,16	4,22
80	4,27	4,32	4,38	4,43	4,49	4,54	4,60	4,65	4,71	4,77
90	4,82	4,87	4,93	4,98	5,04	5,09	5,15	5,20	5,26	5,32
100	5,37	5,42	5,48	5,53	5,59	5,64	5,70	5,75	5,81	5,87
110	5,92	5,97	6,03	6,08	6,14	6,19	6,25	6,30	6,36	6,42
120	6,47	6,53	6,58	6,64	6,69	6,75	6,81	6,86	6,92	6,97
130	7,03	7,09	7,14	7,20	7,25	7,31	7,37	7,42	7,48	7,53
140	7,59	7,65	7,70	7,76	7,81	7,87	7,93	7,98	8,04	8,09
150	8,15	8,21	8,26	8,32	8,37	8,43	8,49	8,54	8,60	8,65
160	8,71	8,77	8,82	8,88	8,93	8,99	9,05	9,10	9,16	9,21
170	9,27	9,33	9,38	9,44	9,49	9,55	9,61	9,66	9,72	9,77
180	9,83	9,89	9,94	10,00	10,05	10,11	10,17	10,22	10,28	10,33
190	10,39	10,45	10,50	10,56	10,61	10,67	10,73	10,78	10,84	10,89
200	10,95	11,01	11,06	11,12	11,17	11,23	11,29	11,34	11,40	11,45
210	11,51	11,57	11,62	11,68	11,73	11,79	11,85	11,90	11,96	12,01
220	12,07	12,13	12,18	12,24	12,29	12,35	12,41	12,46	12,52	12,57
230	12,63	12,69	12,74	12,80	12,85	12,91	12,97	13,02	13,08	13,13
240	13,19	13,25	13,30	13,36	13,41	13,47	13,53	13,58	13,64	13,69
250	13,75	13,81	13,86	13,92	13,97	14,03	14,09	14,14	14,20	14,25
260	14,31	14,37	14,42	14,48	14,54	14,59	14,65	14,71	14,76	14,82
270	14,88	14,94	14,99	15,05	15,10	15,16	15,22	15,27	15,33	15,38
280	15,44	15,50	15,55	15,61	15,66	15,72	15,78	15,83	15,89	15,94
290	16,00	16,06	16,11	16,17	16,22	16,28	16,34	16,39	16,45	16,50

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Grundwertreihen für Thermoelemente

Thermocouple reference tables

Eisen/ Kupfer-Nickel nach DIN 43710 Typ L

Iron/ Copper-Nickel acc. to DIN 43710

Bezugstemperatur 0°C. Temperaturen in °C

Reference temperature 0°C. Temperatures in degress celsius

Temp.	Millivolt									
°C	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
300	16,56	16,62	16,67	16,73	16,78	16,84	16,90	16,95	17,01	17,06
310	17,12	17,18	17,23	17,29	17,34	17,40	17,46	17,51	17,57	17,62
320	17,68	17,47	17,79	17,85	17,90	17,06	18,02	18,07	18,13	18,18
330	18,24	18,30	18,35	18,41	18,46	18,52	18,58	18,63	18,69	18,74
340	18,80	18,86	18,91	18,97	19,02	19,08	19,14	19,19	19,25	19,30
350	19,36	19,42	19,47	19,53	19,58	19,64	19,70	19,75	19,81	19,85
360	19,92	19,98	20,03	20,09	20,14	20,20	20,26	20,31	20,37	20,42
370	20,48	20,54	20,59	20,65	20,70	20,76	20,82	20,87	20,93	20,98
380	21,04	21,10	21,15	21,21	21,26	21,32	21,38	21,43	21,49	21,54
390	21,60	21,66	21,71	21,77	21,82	21,88	21,94	21,99	22,05	22,10
400	22,16	22,22	22,27	22,33	22,38	22,44	22,50	22,55	22,61	22,66
410	22,72	22,78	22,83	22,89	22,95	23,00	23,06	23,12	23,18	23,23
420	23,29	23,35	23,40	23,46	23,52	23,57	23,63	23,69	23,74	23,80
430	23,86	23,92	23,97	24,03	24,09	24,14	24,20	24,26	24,32	24,37
440	24,43	24,49	24,54	24,60	24,66	24,71	24,77	24,83	24,89	24,94
450	25,00	25,06	25,11	25,17	25,23	25,28	25,34	25,40	25,46	25,51
460	25,57	25,63	25,68	25,74	25,80	25,85	25,91	25,97	26,03	26,08
470	26,14	26,20	26,25	26,31	26,37	26,42	26,48	26,54	26,60	26,65
480	26,71	26,77	26,82	26,88	26,94	26,99	27,05	27,11	27,17	27,22
490	27,28	27,34	27,39	27,45	27,51	27,56	27,62	27,68	27,74	27,79

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Grundwertreihen für Thermoelemente

Thermocouple reference tables

Eisen/ Kupfer-Nickel nach DIN EN 60584 Typ J

Iron/ Copper-Nickel acc. to DIN 60584

Bezugstemperatur 0°C. Temperaturen in °C (ITS-90)

Reference temperature 0°C. Temperatures in degress celsius (ITS-90)

Temp.	Mikrovolt									
°C	0	1	2	3	4	5	6	7	8	9
0	0	50	101	151	202	253	303	354	405	456
10	507	558	609	660	711	762	814	865	916	968
20	1019	1071	1122	1174	1226	1277	1329	1381	1433	1485
30	1537	1589	1641	1693	1745	1797	1849	1902	1954	2006
40	2059	2111	2164	2216	2269	2322	2374	2427	2480	2532
50	2585	2638	2691	2744	2797	2850	2903	2956	3009	3062
60	3116	3169	3222	3275	3329	3382	3436	3489	3543	3596
70	3650	3703	3757	3810	3864	3918	3971	4025	4079	4133
80	4187	4240	4294	4348	4402	4456	4510	4564	4618	4672
90	4726	4781	4835	4889	4943	4997	5052	5106	5160	5215
100	5269	5323	5378	5432	5487	5541	5595	5650	5705	5759
110	5814	5868	5923	5977	6032	6087	6141	6196	6251	6306
120	6360	6415	6470	6525	6579	6634	6689	6744	6799	6854
130	6909	6964	7019	7074	7129	7184	7239	7294	7349	7404
140	7459	7514	7569	7624	7679	7734	7789	7844	7900	7955
150	8010	8065	8120	8175	8231	8286	8341	8396	8452	8507
160	8562	8618	8673	8728	8783	8839	8894	8949	9005	9060
170	9115	9171	9226	9282	9337	9392	9448	9503	9559	9614
180	9669	9725	9780	9836	9891	9947	10002	10057	10113	10168
190	10224	10279	10335	10390	10446	10501	10557	10612	10668	10723
200	10779	10834	10890	10945	11001	11056	11112	11167	11223	11278
210	11334	11389	11445	11501	11556	11612	11667	11723	11778	11834
220	11889	11945	12000	12056	12111	12167	12222	12278	12334	12389
230	12445	12500	12556	12611	12667	12722	12778	12833	12889	12944
240	13000	13056	13111	13167	13222	13278	13333	13389	13444	13500
250	13555	13611	13666	13722	13777	13833	13888	13944	13999	14055
260	14110	14166	14221	14277	14332	14388	14443	14499	14554	14609
270	14665	14720	14776	14831	14887	14942	14998	15053	15109	15164
280	15219	15275	15330	15386	15441	15496	15552	15607	15663	15718
290	15773	15829	15884	15940	15995	16050	16106	16161	16216	16272

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Grundwertreihen für Thermoelemente

Thermocouple reference tables

Eisen/ Kupfer-Nickel nach DIN EN 60584 Typ J

Iron/ Copper-Nickel acc. to DIN EN 60584

Bezugstemperatur 0°C. Temperaturen in °C (ITS-90)

Reference temperature 0°C. Temperatures in degress celsius (ITS-90)

Temp.	Mikrovolt									
°C	0	1	2	3	4	5	6	7	8	9
300	16327	16383	16438	16493	16549	16604	16659	16715	16770	16825
310	16881	16936	16991	17046	17102	17157	17212	17268	17323	17378
320	17434	17489	17544	17599	17655	17710	17765	17820	17876	17931
330	17986	18041	18097	18152	18207	18262	18318	18373	18428	18483
340	18538	18594	18649	18704	18759	18814	18870	18925	18980	19035
350	19090	19146	19201	19256	19311	19366	19422	19477	19532	19587
360	19642	19697	19753	19808	19863	19918	19973	20028	20083	20139
370	20194	20249	20304	20359	20414	20469	20525	20580	20635	20690
380	20745	20800	20855	20911	20966	21021	21076	21131	21186	21241
390	21297	21352	21407	21462	21517	21572	21627	21683	21738	21793
400	21848	21903	21958	22014	22069	22124	22179	22234	22289	22345
410	22400	22455	22510	22565	22620	22676	22731	22786	22841	22896
420	22952	23007	23062	23117	23172	23228	23283	23338	23393	23449
430	23504	23559	23614	23670	23725	23780	23835	23891	23946	24001
440	24057	24112	24167	24223	24278	24333	24389	24444	24499	24555
450	24610	24665	24721	24776	24832	24887	24943	24998	25053	25109
460	25164	25220	25275	25331	25386	25442	25497	25553	25608	25664
470	25720	25775	25831	25886	25942	25998	26053	26109	26165	26220
480	26276	26332	26387	26443	26499	26555	26610	26666	26722	26778
490	26834	26889	26945	27001	27057	27113	27169	27225	27281	27337
500	27393	27449	27505	27561	27617	27673	27729	27785	27841	27897
510	27953	28010	28066	28122	28178	28234	28291	28347	28403	28460
520	28516	28572	28629	28685	28741	28798	28854	28911	28967	29024
530	29080	29137	29194	29250	29307	29363	29420	29477	29534	29590
540	29647	29704	29761	29818	29874	29931	29988	30045	30102	30159
550	30216	30273	30330	30387	30444	30502	30559	30616	30673	30730
560	30788	30845	30902	30960	31017	31074	31132	31189	31247	31304
570	31362	31419	31477	31535	31592	31650	31708	31766	31823	31881
580	31939	31997	32055	32113	32171	32229	32287	32345	32403	32461
590	32519	32577	32636	32694	32752	32810	32869	32927	32985	33044

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Thermocouple reference tables

Nickel-Chrom/ Nickel nach DIN EN 60584 Typ K

Nickel-Chromium/ Nickel acc. to DIN EN 60584

Bezugstemperatur 0°C. Temperaturen in °C (ITS-90)

Reference temperature 0°C. Temperatures in degress celsius (ITS-90)

Temp.	Mikrovolt									
°C	**0**	**-1**	**-2**	**-3**	**-4**	**-5**	**-6**	**-7**	**-8**	**-9**
-270	-6458									
-260	-6441	-6444	-6446	-6448	-6450	-6452	-6453	-6455	-6456	-6457
-250	-6404	-6408	-6413	-6417	-6421	-6425	-6429	-6432	-6435	-6438
-240	-6344	-6351	-6358	-6364	-6370	-6377	-6382	-6388	-6393	-6399
-230	-6262	-6271	-6280	-6289	-6297	-6306	-6314	-6322	-6329	-6337
-220	-6158	-6170	-6181	-6192	-6202	-6213	-6223	-6233	-6243	-6252
-210	-6035	-6048	-6061	-6074	-6087	-6099	-6111	-6123	-6135	-6147
-200	-5891	-5907	-5922	-5936	-5951	-5965	-5980	-5994	-6007	-6021
-190	-5730	-5747	-5763	-5780	-5797	-5813	-5829	-5845	-5861	-5876
-180	-5550	-5569	-5588	-5606	-5624	-5642	-5660	-5678	-5695	-5713
-170	-5354	-5374	-5395	-5415	-5435	-5454	-5474	-5493	-5512	-5531
-160	-5141	-5163	-5185	-5207	-5228	-5250	-5271	-5292	-5313	-5333
-150	-4913	-4936	-4960	-4983	-5006	-5029	-5052	-5074	-5097	-5119
-140	-4669	-4694	-4719	-4744	-4768	-4793	-4817	-4841	-4865	-4889
-130	-4411	-4437	-4463	-4490	-4516	-4542	-4567	-4593	-4618	-4644
-120	-4138	-4166	-4194	-4221	-4249	-4276	-4303	-4330	-4357	-4384
-110	-3852	-3882	-3911	-3939	-3968	-3997	-4025	-4054	-4082	-4110
-100	-3554	-3584	-3614	-3645	-3675	-3705	-3734	-3764	-3794	-3823
-90	-3243	-3274	-3306	-3337	-3368	-3400	-3431	--3462	-3492	-3523
-80	-2920	-2953	-2986	-3018	-3050	-3083	-3115	-3147	-3179	-3211
-70	-2587	-2620	-2654	-2688	-2721	-2755	-2788	-2821	-2854	-2887
-60	-2243	-2278	-2312	-2347	-2382	-2416	-2450	-2485	-2519	-2553
-50	-1889	-1925	-1961	-1996	-2032	-2067	-2103	-2138	-2173	-2208
-40	-1527	-1564	-1600	-1637	-1673	-1709	-1745	-1782	-1818	-1854
-30	-1156	-1194	-1231	-1268	-1305	-1343	-1380	-1417	-1453	-1490
-20	-778	-816	-854	-892	-930	-968	-1006	-1043	-1081	-1119
-10	-392	-431	-470	-508	-547	-586	-624	-663	-701	-739
0	0	-39	-79	-118	-157	-197	-236	-275	-314	-353

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Reference temperature 0°C. Temperatures in degress celsius (ITS-90)

Temp.	Mikrovolt									
°C	0	1	2	3	4	5	6	7	8	9
0	0	39	79	119	158	198	238	277	317	357
10	397	437	477	517	557	597	637	677	718	758
20	798	838	879	919	960	1000	1041	1081	1122	1163
30	1203	1244	1285	1326	1366	1407	1448	1489	1530	1571
40	1612	1653	1694	1735	1776	1817	1858	1899	1941	1982
50	2023	2064	2106	2147	2188	2230	2271	2312	2354	2395
60	2436	2478	2519	2561	2602	2644	2685	2727	2768	2810
70	2851	2893	2934	2976	3017	3059	3100	3142	3184	3225
80	3267	3308	3350	3391	3433	3474	3516	3557	3599	3640
90	3682	3723	3765	3806	3848	3889	3931	3972	4013	4055
100	4096	4138	4179	4220	4262	4303	4344	4385	4427	4468
110	4509	4550	4591	4633	4674	4715	4756	4797	4838	4879
120	4920	4961	5002	5043	5084	5124	5165	5206	5247	5288
130	5328	5369	5410	5450	5491	5532	5572	5613	5653	5694
140	5735	5775	5815	5856	5896	5937	5977	6017	6058	6098
150	6138	6179	6219	6259	6299	6339	6380	6420	6460	6500
160	6540	6580	6620	6660	6701	6741	6781	6821	6861	6901
170	6941	6981	7021	7060	7100	7140	7180	7220	7260	7300
180	7340	7380	7420	7460	7500	7540	7579	7619	7659	7699
190	7739	7779	7819	7859	7899	7939	7979	8019	8059	8099
200	8138	8178	8218	8258	8298	8338	8378	8418	8458	8499
210	8539	8579	8619	8659	8699	8739	8779	8819	8860	8900
220	8940	8980	9020	9061	9101	9141	9181	9222	9262	9302
230	9343	9383	9423	9464	9504	9545	9585	9626	9666	9707
240	9747	9788	9828	9869	9909	9950	9991	10031	10072	10113
250	10153	10194	10235	10276	10316	10357	10398	10439	10480	10520
260	10561	10602	10643	10684	10725	10766	10807	10848	10889	10930
270	10971	11012	11053	11094	11135	11176	11217	11259	11300	11341
280	11382	11423	11465	11506	11547	11588	11630	11671	11712	11753
290	11795	11836	11877	11919	11960	12001	12043	12084	12126	12167

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Temp.	Mikrovolt									
°C	0	1	2	3	4	5	6	7	8	9
300	12209	12250	12291	12333	12374	12416	12457	12499	12540	12582
310	12624	12665	12707	12748	12790	12831	12873	12915	12956	12998
320	13040	13081	13123	13165	13206	13248	13290	13331	13373	13415
330	13457	13498	13540	13582	13624	13665	13707	13749	13791	13833
340	13874	13916	13958	14000	14042	14084	14126	14167	14209	14251
350	14293	14335	14377	14419	14461	14503	14545	14587	14629	14671
360	14713	14755	14797	14839	14881	14923	14965	15007	15049	15091
370	15133	15175	15217	15259	15301	15343	15385	15427	15469	15511
380	15554	15596	15638	15680	15722	15764	15806	15849	15891	15933
390	15975	16017	16059	16102	16144	16186	16228	16270	16313	16355
400	16397	16439	16482	16524	16566	16608	16651	16693	16735	16778
410	16820	16862	16904	16947	16989	17031	17074	17116	17158	17201
420	17243	17285	17328	17370	17413	17455	17497	17540	17582	17624
430	17667	17709	17752	17794	17837	17879	17921	17964	18006	18049
440	18091	18134	18176	18218	18261	18303	18346	18388	18431	18473
450	18516	18558	18601	18643	18686	18728	18771	18813	18856	18898
460	18941	18983	19026	19068	19111	19154	19196	19239	19281	19324
470	19366	19409	19451	19494	19537	19579	19622	19664	19707	19750
480	19792	19835	19877	19920	19962	20005	20048	20090	20133	20175
490	20218	20261	20303	20346	20389	20431	20474	20516	20559	20602
500	20644	20687	20730	20772	20815	20857	20900	20943	20985	21028
510	21071	21113	21156	21199	21241	21284	21326	21369	21412	21454
520	21497	21540	21582	21625	21668	21710	21753	21796	21838	21881
530	21924	21966	22009	22052	22094	22137	22179	22222	22265	22307
540	22350	22393	22435	22478	22521	22563	22606	22649	22691	22734
550	22776	22819	22862	22904	22947	22990	23032	23075	23117	23160
560	23203	23245	23288	23331	23373	23416	23458	23501	23544	23586
570	23629	23671	23714	23757	23799	23842	23884	23927	23970	24012
580	24055	24097	24140	24182	24225	24267	24310	24353	24395	24438
590	24480	24523	24565	24608	24650	24693	24735	24778	24820	24863

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Reference temperature 0°C. Temperatures in degress celsius (ITS-90)

Temp.	Mikrovolt									
°C	0	1	2	3	4	5	6	7	8	9
600	24905	24948	24990	25033	25075	25118	25160	25203	25245	25288
610	25330	25373	25415	25458	25500	25543	25585	25627	25670	25712
620	25755	25797	25840	25882	25924	25967	26009	26052	26094	26136
630	26179	26221	26263	26306	26348	26390	26433	26475	26517	26560
640	26602	26644	26687	26729	26771	26814	26856	26898	26940	26983
650	27025	27067	27109	27152	27194	27236	27278	27320	27363	27405
660	27447	27489	27531	27574	27616	27658	27700	27742	27784	27826
670	27869	27911	27953	27995	28037	28079	28121	28163	28205	28247
680	28289	28332	28374	28416	28458	28500	28542	28584	28626	28668
690	28710	28752	28794	28835	28877	28919	28961	29003	29045	29087
700	29129	29171	29213	29255	29297	29338	29380	29422	29464	29506
710	29548	29589	29631	29673	29715	29757	29798	29840	29882	29924
720	29965	30007	30049	30090	30132	30174	30216	30257	30299	30341
730	30382	30424	30466	30507	30549	30590	30632	30674	30715	30757
740	30798	30840	30881	30923	30964	31006	31047	31089	31130	31172
750	31213	31255	31296	31338	31379	31421	31462	31504	31545	31586
760	31628	31669	31710	31752	31793	31834	31876	31917	31958	32000
770	32041	32082	32124	32165	32206	32247	32289	32330	32371	32412
780	32453	32495	32536	32577	32618	32659	32700	32742	32783	32824
790	32865	32906	32947	32988	33029	33070	33111	33152	33193	33234
800	33275	33316	33357	33398	33439	33480	33521	33562	33603	33644
810	33685	33726	33767	33808	33848	33889	33930	33971	34012	34053
820	34093	34134	34175	34216	34257	34297	34338	34379	34420	34460
830	34501	34542	34582	34623	34664	34704	34745	34786	34826	34867
840	34908	34948	34989	35029	35070	35110	35151	35192	35232	35273
850	35313	35354	35394	35435	35475	35516	35556	35596	35637	35677
860	35718	35758	35798	35839	35879	35920	35960	36000	36041	36081
870	36121	36162	36202	36242	36282	36323	36363	36403	36443	36484
880	36524	36564	36604	36644	36685	36725	36765	36805	36845	36885
890	36925	36965	37006	37046	37086	37126	37166	37206	37246	37286

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Reference temperature 0°C. Temperatures in degress celsius (ITS-90)

Temp.	Mikrovolt									
°C	0	1	2	3	4	5	6	7	8	9
900	37326	37366	37406	37446	37486	37526	37566	37606	37646	37686
910	37725	37765	37805	37845	37885	37925	37965	38005	38044	38084
920	38124	38164	38204	38243	38283	38323	38363	38402	38442	38482
930	38522	38561	38601	38641	38680	38720	38760	38799	38839	38878
940	38918	38958	38997	39037	39076	39116	39155	39195	39235	39274
950	39314	39353	39393	39432	39471	39511	39550	39590	39629	39669
960	39708	39747	39787	39826	39866	39905	39944	39984	40023	40062
970	40101	40141	40180	40219	40259	40298	40337	40376	40415	40455
980	40494	40533	40572	40611	40651	40690	40729	40768	40807	40846
990	40885	40924	40963	41002	41042	41081	41120	41159	41198	41237
1000	41276	41315	41354	41393	41431	41470	41509	41548	41587	41626
1010	41665	41704	41743	41781	41820	41859	41898	41937	41976	42014
1020	42053	42092	42131	42169	42208	42247	42286	42324	42363	42402
1030	42440	42479	42518	42556	42595	42633	42672	42711	42749	42788
1040	42826	42865	42903	42942	42980	43019	43057	43096	43134	43173
1050	43211	43250	43288	43327	43365	43403	43442	43480	43518	43557
1060	43595	43633	43672	43710	43748	43787	43825	43863	43901	43940
1070	43978	44016	44054	44092	44130	44169	44207	44245	44283	44321
1080	44359	44397	44435	44473	44512	44550	44588	44626	44664	44702
1090	44740	44778	44816	44853	44891	44929	44967	45005	45043	45081
1100	45119	45157	45194	45232	45270	45308	45346	45383	45421	45459
1110	45497	45534	45572	45610	45647	45685	45723	45760	45798	45836
1120	45873	45911	45948	45986	46024	46061	46099	46136	46174	46211
1130	46249	46286	46324	46361	46398	46436	46473	46511	46548	46585
1140	46623	46660	46697	46735	46772	46809	46847	46884	46921	46958
1150	46995	47033	47070	47107	47144	47181	47218	47256	47293	47330
1160	47367	47404	47441	47478	47515	47552	47589	47626	47663	47700
1170	47737	47774	47811	47848	47884	47921	47958	47995	48032	48069
1180	48105	48142	48179	48216	48252	48289	48326	48363	48399	48436
1190	48473	48509	48546	48582	48619	48656	48692	48729	48765	48802

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Reference temperature 0°C. Temperatures in degress celsius (ITS-90)

Temp.	Mikrovolt									
°C	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1200	48838	48875	48911	48948	48984	49021	49057	49093	49130	49166
1210	49202	49239	49275	49311	49348	49384	49420	49456	49493	49529
1220	49565	49601	49637	49674	49710	49746	49782	49818	49854	49890
1230	49926	49962	49998	50034	50070	50106	50142	50178	50214	50250
1240	50286	50322	50358	50393	50429	50465	50501	50537	50572	50608
1250	50644	50680	50715	50751	50787	50822	50858	50894	50929	50965
1260	51000	51036	51071	51107	51142	51178	51213	51249	51284	51320
1270	51355	51391	51426	51461	51497	51532	51567	51603	51638	51673
1280	51708	51744	51779	51814	51849	51885	51920	51955	51990	52025
1290	52060	52095	52130	52165	52200	52235	52270	52305	52340	5375
1300	52410	52445	52480	52515	52550	52585	52620	52654	52689	52724
1310	52759	52794	52828	52863	52898	52932	52967	53002	53037	53071
1320	53106	53140	53175	53210	53244	53279	53313	53348	53382	53417
1330	53451	53486	53520	53555	53589	53623	53658	53692	53727	53761
1340	53795	53830	53864	53898	53932	53967	54001	54035	54069	54104
1350	54138	54172	54206	54240	54274	54308	54343	54377	54411	54445
1360	54479	54513	54547	54581	54615	54649	54683	54717	54751	54785
1370	54819	54852	54886							

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Grundwertreihen in Ohm für Platin-Widerstandfühler Pt 100

Temperatursensor reference tables

Pt 100 Ohm nach DIN EN 60751

Platinum 100 Ohms acc. to DIN EN 60751

R(0) = 100,00 Ohm. Temperaturen in °C (ITS-90)

R(0) = 100,00 Ohm. Temperatures in degress celsius (ITS-90)

Temp.	Ohm									
°C	**0**	**-1**	**-2**	-3	**-4**	**-5**	**-6**	**-7**	**-8**	**-9**
-200	18,52									
-190	22,83	22,40	21,97	21,54	21,11	20,68	20,25	19,82	19,38	18,95
-180	27,10	26,67	26,24	25,82	25,39	24,97	24,54	24,11	23,68	23,25
-170	31,34	30,91	30,49	30,07	29,64	29,22	28,80	28,37	27,95	27,52
-160	35,34	35,12	34,70	34,28	33,86	33,44	33,02	32,60	32,18	31,76
-150	39,72	39,31	38,89	38,47	38,05	37,64	37,22	36,80	36,38	35,96
-140	43,88	43,46	43,05	42,63	42,22	41,80	41,39	40,97	40,56	40,14
-130	48,00	47,59	47,18	46,77	46,36	45,94	45,53	45,12	44,70	44,29
-120	52,11	51,70	51,29	50,88	50,47	50,06	49,65	49,24	48,83	48,42
-110	56,19	55,79	55,38	54,97	54,56	54,15	53,75	53,34	52,93	52,52
-100	60,26	59,85	59,44	59,04	58,63	58,23	57,82	57,41	57,01	56,60
-90	64,30	63,90	63,49	63,09	62,68	62,28	61,88	61,47	61,07	60,66
-80	68,33	67,92	67,52	67,12	66,72	66,31	65,91	65,51	65,11	64,70
-70	72,33	71,93	71,53	71,13	70,73	70,33	69,93	69,53	69,13	68,73
-60	76,33	75,93	75,53	75,13	74,73	74,33	73,93	73,53	73,13	72,73
-50	80,31	79,91	79,51	79,11	78,72	78,32	77,92	77,52	77,12	76,73
-40	84,27	83,87	83,48	83,08	82,69	82,29	81,89	81,50	81,10	80,70
-30	88,22	87,83	87,43	87,04	86,64	86,25	85,85	85,46	85,06	84,67
-20	92,16	91,77	91,37	90,98	90,59	90,19	89,80	89,40	89,01	88,62
-10	96,09	95,69	95,30	94,91	94,52	94,12	93,73	93,34	92,95	92,55
0	100,00	99,61	99,22	98,83	98,44	98,04	97,65	97,26	96,87	96,48

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Grundwertreihen in Ohm für Platin-Widerstandfühler Pt 100

Temperatursensor reference tables

Pt 100 Ohm nach DIN EN 60751

Platinum 100 Ohms acc. to DIN EN 60751

R(0) = 100,00 Ohm. Temperaturen in °C (ITS-90)

R(0) = 100,00 Ohm. Temperatures in degress celsius (ITS-90)

Temp.	Ohm									
°C	0	1	2	3	4	5	6	7	8	9
0	100,00	100,39	100,78	101,17	101,56	101,95	102,34	102,73	103,12	103,51
10	103,90	104,29	104,68	105,07	105,46	105,85	106,24	106,63	107,02	107,40
20	107,79	108,18	108,57	108,96	109,35	109,73	110,12	110,51	110,90	111,29
30	111,67	112,06	112,45	112,83	113,22	113,61	114,00	114,38	114,77	115,15
40	115,54	115,93	116,31	116,70	117,08	117,47	117,86	118,24	118,63	119,01
50	119,40	119,78	120,17	120,55	120,94	121,32	121,71	122,09	122,47	122,86
60	123,24	123,63	124,01	124,39	124,78	125,16	125,54	125,93	126,31	126,69
70	127,08	127,46	127,84	128,22	128,61	128,99	129,37	129,75	130,13	130,52
80	130,90	131,28	131,66	132,04	132,42	132,80	133,18	133,57	133,95	134,33
90	134,71	135,09	135,47	135,85	136,23	136,61	136,99	137,37	137,75	138,13
100	138,51	138,88	139,26	139,64	140,02	140,40	140,78	141,16	141,54	141,91
110	142,29	142,67	143,05	143,43	143,80	144,18	144,56	144,94	145,31	145,69
120	146,07	146,44	146,82	147,20	147,57	147,95	148,33	148,70	149,08	149,83
130	149,83	150,21	150,58	150,96	151,33	151,71	152,08	152,46	152,83	153,21
140	153,58	153,96	154,33	154,71	155,08	155,46	155,83	156,20	156,58	156,95
150	157,33	157,70	158,07	158,45	158,82	159,19	159,56	159,94	160,31	160,68
160	161,05	161,43	161,80	162,17	162,54	162,91	163,29	163,66	164,03	164,40
170	164,77	165,14	165,51	165,89	166,26	166,63	167,00	167,37	167,74	168,11
180	168,48	168,85	169,22	169,59	169,96	170,33	170,70	171,07	171,43	171,80
190	172,17	172,54	172,91	173,28	173,65	174,02	174,38	174,75	175,12	175,49
200	175,86	176,22	176,59	176,96	177,33	177,69	178,06	178,43	178,79	179,16
210	179,53	179,89	180,26	180,63	180,99	181,36	181,72	182,09	182,46	182,82
220	183,19	183,55	183,92	184,28	184,65	185,01	185,38	185,74	186,11	186,47
230	186,84	187,20	187,56	187,93	188,29	188,66	189,02	189,38	189,75	190,11
240	190,47	190,84	191,20	191,56	191,92	192,29	192,65	193,01	193,37	193,74
250	194,10	194,46	194,82	195,18	195,55	195,91	196,27	196,63	196,99	197,35
260	197,71	198,07	198,43	198,79	199,15	199,51	199,87	200,23	200,59	200,95
270	201,31	201,67	202,03	202,39	202,75	203,11	203,47	203,83	204,19	204,55
280	204,90	205,26	205,62	205,98	206,34	206,70	207,05	207,41	207,77	208,13
290	208,48	208,84	209,20	209,56	209,91	210,27	210,63	210,98	211,34	211,70

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Grundwertreihen in Ohm für Platin-Widerstandfühler Pt 100

Temperatursensor reference tables

Pt 100 Ohm nach DIN EN 60751

Platinum 100 Ohms acc. to DIN EN 60751

R(0) = 100,00 Ohm. Temperaturen in °C (ITS-90)

R(0) = 100,00 Ohm. Temperatures in degresse celsius (ITS-90)

Temp.	Ohm									
°C	0	1	2	3	4	5	6	7	8	9
300	212,05	212,41	212,76	213,12	213,48	213,83	214,19	214,54	214,90	215,25
310	215,61	215,96	216,32	216,67	217,03	217,38	217,74	218,09	218,44	218,80
320	219,15	219,51	219,86	220,21	220,57	220,92	221,27	221,63	221,98	222,33
330	222,68	223,04	223,39	223,74	224,09	224,45	224,80	225,15	225,50	225,85
340	226,21	226,56	226,91	227,26	227,61	227,96	228,31	228,66	229,02	229,37
350	229,72	230,07	230,42	230,77	231,12	231,47	231,82	232,17	232,52	232,87
360	233,21	233,56	233,91	234,26	234,61	234,96	235,31	235,66	236,00	236,35
370	236,70	237,05	237,40	237,74	238,09	238,44	238,79	239,13	239,48	239,83
380	240,18	240,52	240,87	241,22	241,56	241,91	242,26	242,60	242,95	243,29
390	243,64	243,99	244,33	244,68	245,02	245,37	245,71	246,06	246,40	246,75
400	247,09	247,44	247,78	248,13	248,47	248,81	249,16	249,50	249,85	250,19
410	250,53	250,88	251,22	251,66	251,91	252,25	252,59	252,93	253,28	253,62
420	253,96	254,30	254,65	254,99	255,33	255,67	256,01	256,35	256,70	257,04
430	257,38	257,72	258,06	258,40	258,74	259,08	259,42	259,76	260,10	260,44
440	260,78	261,12	261,46	261,80	262,14	262,48	262,82	263,16	263,50	263,84
450	264,18	264,52	264,86	265,20	265,53	265,87	266,21	266,55	266,89	267,22
460	267,56	267,90	268,24	268,57	268,91	269,25	269,59	269,92	270,26	270,60
470	270,93	271,27	271,61	271,94	272,28	272,61	272,95	273,29	273,62	273,96
480	274,29	274,63	274,96	275,30	275,63	275,97	276,30	276,64	276,97	277,31
490	277,64	277,98	278,31	278,64	278,98	279,31	279,64	279,98	280,31	280,64
500	280,98	281,31	281,64	281,98	282,31	282,64	282,97	283,31	283,64	283,97
510	284,30	284,63	284,97	285,30	285,63	285,96	286,29	286,62	286,95	287,29
520	287,62	287,95	288,28	288,61	288,94	289,27	289,60	289,93	290,26	290,59
530	290,92	291,25	291,58	291,91	292,24	292,56	292,89	293,22	293,55	293,88
540	294,21	294,54	294,86	295,19	295,52	295,85	296,18	296,50	296,83	297,16
550	297,49	297,81	298,14	298,47	298,80	299,12	299,45	299,78	300,10	300,43
560	300,75	301,08	301,41	301,73	302,06	302,38	302,71	303,03	303,36	303,69
570	304,01	304,34	304,66	304,98	305,31	305,63	305,96	306,28	306,61	306,93
580	307,25	307,58	307,90	308,23	308,55	308,87	309,20	309,52	309,84	310,16
590	310,49	310,81	311,13	311,45	311,78	312,10	312,42	312,74	313,06	313,39

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Grundwertreihen in Ohm für Platin-Widerstandfühler Pt 100

Temperatursensor reference tables

Pt 100 Ohm nach DIN EN 60751

Platinum 100 Ohms acc. to DIN EN 60751

R(0) = 100,00 Ohm. Temperaturen in °C (ITS-90)

R(0) = 100,00 Ohm. Temperatures in degresse celsius (ITS-90)

Temp.	Ohm									
°C	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
600	313,71	314,03	314,35	314,67	314,99	315,31	315,64	315,96	316,28	316,60
610	316,92	317,24	317,56	317,88	318,20	318,52	318,84	319,16	319,48	319,80
620	320,12	320,43	320,75	321,07	321,39	321,71	322,03	322,35	322,67	322,98
630	323,30	323,62	323,94	324,26	324,57	324,89	325,21	325,53	325,84	326,16
640	326,48	326,79	327,11	327,43	327,74	328,06	328,38	328,69	329,01	329,32
650	329,64	329,96	330,27	330,59	330,90	331,22	331,53	331,85	332,16	332,48
660	332,79	333,11	333,42	333,74	334,05	334,36	334,68	334,99	335,31	335,62
670	335,93	336,25	336,56	336,87	337,18	337,50	337,81	338,12	338,44	338,75
680	339,06	339,37	339,69	340,00	340,31	340,62	340,93	341,24	341,56	341,87
690	342,18	342,49	342,80	343,11	343,42	343,73	344,04	344,35	344,66	344,97
700	345,28	345,59	345,90	346,21	346,52	346,83	347,14	347,45	347,76	348,07
710	348,38	348,69	348,99	349,30	349,61	349,92	350,23	350,54	350,84	351,15
720	351,46	351,77	352,08	352,38	352,69	353,00	353,30	353,61	353,92	354,22
730	354,53	354,84	355,14	355,45	355,76	356,06	356,37	356,67	356,98	357,28
740	357,59	357,90	358,20	358,51	358,81	359,12	359,42	359,72	360,03	360,33
750	360,64	360,94	361,25	361,55	361,85	362,16	362,46	362,76	363,07	363,37
760	363,67	363,98	364,28	364,58	364,89	365,19	365,49	365,79	366,10	366,40
770	366,70	367,00	367,30	367,60	367,91	368,21	368,51	368,81	369,11	369,41
780	369,71	370,01	370,31	370,61	370,91	371,21	371,51	371,81	372,11	372,41
790	372,71	373,01	373,31	373,61	373,91	374,21	374,51	374,81	375,11	375,41
800	375,70	376,00	376,30	376,60	376,90	377,19	377,49	377,79	378,09	378,39
810	378,68	378,98	379,28	379,57	379,87	380,17	380,46	380,76	381,06	381,35
820	381,65	381,95	382,24	382,54	382,83	383,13	383,42	383,72	384,01	384,31
830	384,60	384,90	385,19	385,49	385,78	386,08	386,37	386,67	384,96	387,25
840	387,55	387,84	388,14	388,43	388,72	389,02	389,31	389,60	389,90	390,19
850	390,48									

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Grundwertreihen für Thermoelemente
Thermocouple reference tables

Eisen/ Kupfer-Nickel nach DIN 43710 Typ L
Iron/ Copper-Nickel acc. to DIN 43710

Bezugstemperatur 0°C. Temperaturen in °C
Reference temperature 0°C. Temperatures in degress celsius

Temp.	Millivolt									
°C	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
0	0,00	0,05	0,10	0,16	0,21	0,26	0,31	0,36	0,42	0,47
10	0,52	0,57	0,63	0,68	0,73	0,78	0,84	0,89	0,94	1,00
20	1,05	1,10	1,16	1,21	1,26	1,31	1,37	1,42	1,47	1,53
30	1,58	1,63	1,69	1,74	1,79	1,84	1,90	1,95	2,00	2,06
40	2,11	2,16	2,22	2,27	2,33	2,38	2,43	2,49	2,54	2,60
50	2,65	2,70	2,76	2,81	2,87	2,92	2,97	3,03	3,08	3,14
60	3,19	3,24	3,30	3,35	3,41	3,46	3,51	3,57	3,62	3,68
70	3,73	3,78	3,84	3,89	3,95	4,00	4,05	4,11	4,16	4,22
80	4,27	4,32	4,38	4,43	4,49	4,54	4,60	4,65	4,71	4,77
90	4,82	4,87	4,93	4,98	5,04	5,09	5,15	5,20	5,26	5,32
100	5,37	5,42	5,48	5,53	5,59	5,64	5,70	5,75	5,81	5,87
110	5,92	5,97	6,03	6,08	6,14	6,19	6,25	6,30	6,36	6,42
120	6,47	6,53	6,58	6,64	6,69	6,75	6,81	6,86	6,92	6,97
130	7,03	7,09	7,14	7,20	7,25	7,31	7,37	7,42	7,48	7,53
140	7,59	7,65	7,70	7,76	7,81	7,87	7,93	7,98	8,04	8,09
150	8,15	8,21	8,26	8,32	8,37	8,43	8,49	8,54	8,60	8,65
160	8,71	8,77	8,82	8,88	8,93	8,99	9,05	9,10	9,16	9,21
170	9,27	9,33	9,38	9,44	9,49	9,55	9,61	9,66	9,72	9,77
180	9,83	9,89	9,94	10,00	10,05	10,11	10,17	10,22	10,28	10,33
190	10,39	10,45	10,50	10,56	10,61	10,67	10,73	10,78	10,84	10,89
200	10,95	11,01	11,06	11,12	11,17	11,23	11,29	11,34	11,40	11,45
210	11,51	11,57	11,62	11,68	11,73	11,79	11,85	11,90	11,96	12,01
220	12,07	12,13	12,18	12,24	12,29	12,35	12,41	12,46	12,52	12,57
230	12,63	12,69	12,74	12,80	12,85	12,91	12,97	13,02	13,08	13,13
240	13,19	13,25	13,30	13,36	13,41	13,47	13,53	13,58	13,64	13,69
250	13,75	13,81	13,86	13,92	13,97	14,03	14,09	14,14	14,20	14,25
260	14,31	14,37	14,42	14,48	14,54	14,59	14,65	14,71	14,76	14,82
270	14,88	14,94	14,99	15,05	15,10	15,16	15,22	15,27	15,33	15,38
280	15,44	15,50	15,55	15,61	15,66	15,72	15,78	15,83	15,89	15,94
290	16,00	16,06	16,11	16,17	16,22	16,28	16,34	16,39	16,45	16,50

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Grundwertreihen für Thermoelemente

Thermocouple reference tables

Eisen/ Kupfer-Nickel nach DIN 43710 Typ L

Iron/ Copper-Nickel acc. to DIN 43710

Bezugstemperatur 0°C. Temperaturen in °C

Reference temperature 0°C. Temperatures in degress celsius

Temp.	Millivolt									
°C	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
300	16,56	16,62	16,67	16,73	16,78	16,84	16,90	16,95	17,01	17,06
310	17,12	17,18	17,23	17,29	17,34	17,40	17,46	17,51	17,57	17,62
320	17,68	17,47	17,79	17,85	17,90	17,06	18,02	18,07	18,13	18,18
330	18,24	18,30	18,35	18,41	18,46	18,52	18,58	18,63	18,69	18,74
340	18,80	18,86	18,91	18,97	19,02	19,08	19,14	19,19	19,25	19,30
350	19,36	19,42	19,47	19,53	19,58	19,64	19,70	19,75	19,81	19,85
360	19,92	19,98	20,03	20,09	20,14	20,20	20,26	20,31	20,37	20,42
370	20,48	20,54	20,59	20,65	20,70	20,76	20,82	20,87	20,93	20,98
380	21,04	21,10	21,15	21,21	21,26	21,32	21,38	21,43	21,49	21,54
390	21,60	21,66	21,71	21,77	21,82	21,88	21,94	21,99	22,05	22,10
400	22,16	22,22	22,27	22,33	22,38	22,44	22,50	22,55	22,61	22,66
410	22,72	22,78	22,83	22,89	22,95	23,00	23,06	23,12	23,18	23,23
420	23,29	23,35	23,40	23,46	23,52	23,57	23,63	23,69	23,74	23,80
430	23,86	23,92	23,97	24,03	24,09	24,14	24,20	24,26	24,32	24,37
440	24,43	24,49	24,54	24,60	24,66	24,71	24,77	24,83	24,89	24,94
450	25,00	25,06	25,11	25,17	25,23	25,28	25,34	25,40	25,46	25,51
460	25,57	25,63	25,68	25,74	25,80	25,85	25,91	25,97	26,03	26,08
470	26,14	26,20	26,25	26,31	26,37	26,42	26,48	26,54	26,60	26,65
480	26,71	26,77	26,82	26,88	26,94	26,99	27,05	27,11	27,17	27,22
490	27,28	27,34	27,39	27,45	27,51	27,56	27,62	27,68	27,74	27,79

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Grundwertreihen für Thermoelemente

Thermocouple reference tables

Eisen/ Kupfer-Nickel nach DIN EN 60584 Typ J

Iron/ Copper-Nickel acc. to DIN 60584

Bezugstemperatur 0°C. Temperaturen in °C (ITS-90)

Reference temperature 0°C. Temperatures in degress celsius (ITS-90)

Temp.	Mikrovolt									
°C	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
0	0	50	101	151	202	253	303	354	405	456
10	507	558	609	660	711	762	814	865	916	968
20	1019	1071	1122	1174	1226	1277	1329	1381	1433	1485
30	1537	1589	1641	1693	1745	1797	1849	1902	1954	2006
40	2059	2111	2164	2216	2269	2322	2374	2427	2480	2532
50	2585	2638	2691	2744	2797	2850	2903	2956	3009	3062
60	3116	3169	3222	3275	3329	3382	3436	3489	3543	3596
70	3650	3703	3757	3810	3864	3918	3971	4025	4079	4133
80	4187	4240	4294	4348	4402	4456	4510	4564	4618	4672
90	4726	4781	4835	4889	4943	4997	5052	5106	5160	5215
100	5269	5323	5378	5432	5487	5541	5595	5650	5705	5759
110	5814	5868	5923	5977	6032	6087	6141	6196	6251	6306
120	6360	6415	6470	6525	6579	6634	6689	6744	6799	6854
130	6909	6964	7019	7074	7129	7184	7239	7294	7349	7404
140	7459	7514	7569	7624	7679	7734	7789	7844	7900	7955
150	8010	8065	8120	8175	8231	8286	8341	8396	8452	8507
160	8562	8618	8673	8728	8783	8839	8894	8949	9005	9060
170	9115	9171	9226	9282	9337	9392	9448	9503	9559	9614
180	9669	9725	9780	9836	9891	9947	10002	10057	10113	10168
190	10224	10279	10335	10390	10446	10501	10557	10612	10668	10723
200	10779	10834	10890	10945	11001	11056	11112	11167	11223	11278
210	11334	11389	11445	11501	11556	11612	11667	11723	11778	11834
220	11889	11945	12000	12056	12111	12167	12222	12278	12334	12389
230	12445	12500	12556	12611	12667	12722	12778	12833	12889	12944
240	13000	13056	13111	13167	13222	13278	13333	13389	13444	13500
250	13555	13611	13666	13722	13777	13833	13888	13944	13999	14055
260	14110	14166	14221	14277	14332	14388	14443	14499	14554	14609
270	14665	14720	14776	14831	14887	14942	14998	15053	15109	15164
280	15219	15275	15330	15386	15441	15496	15552	15607	15663	15718
290	15773	15829	15884	15940	15995	16050	16106	16161	16216	16272

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Grundwertreihen für Thermoelemente

Thermocouple reference tables

Eisen/ Kupfer-Nickel nach DIN EN 60584 Typ J

Iron/ Copper-Nickel acc. to DIN EN 60584

Bezugstemperatur 0°C. Temperaturen in °C (ITS-90)

Reference temperature 0°C. Temperatures in degress celsius (ITS-90)

Temp.	Mikrovolt									
°C	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
300	16327	16383	16438	16493	16549	16604	16659	16715	16770	16825
310	16881	16936	16991	17046	17102	17157	17212	17268	17323	17378
320	17434	17489	17544	17599	17655	17710	17765	17820	17876	17931
330	17986	18041	18097	18152	18207	18262	18318	18373	18428	18483
340	18538	18594	18649	18704	18759	18814	18870	18925	18980	19035
350	19090	19146	19201	19256	19311	19366	19422	19477	19532	19587
360	19642	19697	19753	19808	19863	19918	19973	20028	20083	20139
370	20194	20249	20304	20359	20414	20469	20525	20580	20635	20690
380	20745	20800	20855	20911	20966	21021	21076	21131	21186	21241
390	21297	21352	21407	21462	21517	21572	21627	21683	21738	21793
400	21848	21903	21958	22014	22069	22124	22179	22234	22289	22345
410	22400	22455	22510	22565	22620	22676	22731	22786	22841	22896
420	22952	23007	23062	23117	23172	23228	23283	23338	23393	23449
430	23504	23559	23614	23670	23725	23780	23835	23891	23946	24001
440	24057	24112	24167	24223	24278	24333	24389	24444	24499	24555
450	24610	24665	24721	24776	24832	24887	24943	24998	25053	25109
460	25164	25220	25275	25331	25386	25442	25497	25553	25608	25664
470	25720	25775	25831	25886	25942	25998	26053	26109	26165	26220
480	26276	26332	26387	26443	26499	26555	26610	26666	26722	26778
490	26834	26889	26945	27001	27057	27113	27169	27225	27281	27337
500	27393	27449	27505	27561	27617	27673	27729	27785	27841	27897
510	27953	28010	28066	28122	28178	28234	28291	28347	28403	28460
520	28516	28572	28629	28685	28741	28798	28854	28911	28967	29024
530	29080	29137	29194	29250	29307	29363	29420	29477	29534	29590
540	29647	29704	29761	29818	29874	29931	29988	30045	30102	30159
550	30216	30273	30330	30387	30444	30502	30559	30616	30673	30730
560	30788	30845	30902	30960	31017	31074	31132	31189	31247	31304
570	31362	31419	31477	31535	31592	31650	31708	31766	31823	31881
580	31939	31997	32055	32113	32171	32229	32287	32345	32403	32461
590	32519	32577	32636	32694	32752	32810	32869	32927	32985	33044

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Grundwertreihen für Thermoelemente

Thermocouple reference tables

Nickel-Chrom/ Nickel nach DIN EN 60584 Typ K

Nickel-Chromium/ Nickel acc. to DIN EN 60584

Bezugstemperatur 0°C. Temperaturen in °C (ITS-90)

Reference temperature 0°C. Temperatures in degress celsius (ITS-90)

Temp.	Mikrovolt									
°C	**0**	**-1**	**-2**	**-3**	**-4**	**-5**	**-6**	**-7**	**-8**	**-9**
-270	-6458									
-260	-6441	-6444	-6446	-6448	-6450	-6452	-6453	-6455	-6456	-6457
-250	-6404	-6408	-6413	-6417	-6421	-6425	-6429	-6432	-6435	-6438
-240	-6344	-6351	-6358	-6364	-6370	-6377	-6382	-6388	-6393	-6399
-230	-6262	-6271	-6280	-6289	-6297	-6306	-6314	-6322	-6329	-6337
-220	-6158	-6170	-6181	-6192	-6202	-6213	-6223	-6233	-6243	-6252
-210	-6035	-6048	-6061	-6074	-6087	-6099	-6111	-6123	-6135	-6147
-200	-5891	-5907	-5922	-5936	-5951	-5965	-5980	-5994	-6007	-6021
-190	-5730	-5747	-5763	-5780	-5797	-5813	-5829	-5845	-5861	-5876
-180	-5550	-5569	-5588	-5606	-5624	-5642	-5660	-5678	-5695	-5713
-170	-5354	-5374	-5395	-5415	-5435	-5454	-5474	-5493	-5512	-5531
-160	-5141	-5163	-5185	-5207	-5228	-5250	-5271	-5292	-5313	-5333
-150	-4913	-4936	-4960	-4983	-5006	-5029	-5052	-5074	-5097	-5119
-140	-4669	-4694	-4719	-4744	-4768	-4793	-4817	-4841	-4865	-4889
-130	-4411	-4437	-4463	-4490	-4516	-4542	-4567	-4593	-4618	-4644
-120	-4138	-4166	-4194	-4221	-4249	-4276	-4303	-4330	-4357	-4384
-110	-3852	-3882	-3911	-3939	-3968	-3997	-4025	-4054	-4082	-4110
-100	-3554	-3584	-3614	-3645	-3675	-3705	-3734	-3764	-3794	-3823
-90	-3243	-3274	-3306	-3337	-3368	-3400	-3431	--3462	-3492	-3523
-80	-2920	-2953	-2986	-3018	-3050	-3083	-3115	-3147	-3179	-3211
-70	-2587	-2620	-2654	-2688	-2721	-2755	-2788	-2821	-2854	-2887
-60	-2243	-2278	-2312	-2347	-2382	-2416	-2450	-2485	-2519	-2553
-50	-1889	-1925	-1961	-1996	-2032	-2067	-2103	-2138	-2173	-2208
-40	-1527	-1564	-1600	-1637	-1673	-1709	-1745	-1782	-1818	-1854
-30	-1156	-1194	-1231	-1268	-1305	-1343	-1380	-1417	-1453	-1490
-20	-778	-816	-854	-892	-930	-968	-1006	-1043	-1081	-1119
-10	-392	-431	-470	-508	-547	-586	-624	-663	-701	-739
0	0	-39	-79	-118	-157	-197	-236	-275	-314	-353

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Grundwertreihen für Thermoelemente

Thermocouple reference tables

Nickel-Chrom/ Nickel nach DIN EN 60584 Typ K

Nickel-Chromium/ Nickel acc. to DIN EN 60584

Bezugstemperatur 0°C. Temperaturen in °C (ITS-90)

Reference temperature 0°C. Temperatures in degress celsius (ITS-90)

Temp.	Mikrovolt									
°C	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
0	0	39	79	119	158	198	238	277	317	357
10	397	437	477	517	557	597	637	677	718	758
20	798	838	879	919	960	1000	1041	1081	1122	1163
30	1203	1244	1285	1326	1366	1407	1448	1489	1530	1571
40	1612	1653	1694	1735	1776	1817	1858	1899	1941	1982
50	2023	2064	2106	2147	2188	2230	2271	2312	2354	2395
60	2436	2478	2519	2561	2602	2644	2685	2727	2768	2810
70	2851	2893	2934	2976	3017	3059	3100	3142	3184	3225
80	3267	3308	3350	3391	3433	3474	3516	3557	3599	3640
90	3682	3723	3765	3806	3848	3889	3931	3972	4013	4055
100	4096	4138	4179	4220	4262	4303	4344	4385	4427	4468
110	4509	4550	4591	4633	4674	4715	4756	4797	4838	4879
120	4920	4961	5002	5043	5084	5124	5165	5206	5247	5288
130	5328	5369	5410	5450	5491	5532	5572	5613	5653	5694
140	5735	5775	5815	5856	5896	5937	5977	6017	6058	6098
150	6138	6179	6219	6259	6299	6339	6380	6420	6460	6500
160	6540	6580	6620	6660	6701	6741	6781	6821	6861	6901
170	6941	6981	7021	7060	7100	7140	7180	7220	7260	7300
180	7340	7380	7420	7460	7500	7540	7579	7619	7659	7699
190	7739	7779	7819	7859	7899	7939	7979	8019	8059	8099
200	8138	8178	8218	8258	8298	8338	8378	8418	8458	8499
210	8539	8579	8619	8659	8699	8739	8779	8819	8860	8900
220	8940	8980	9020	9061	9101	9141	9181	9222	9262	9302
230	9343	9383	9423	9464	9504	9545	9585	9626	9666	9707
240	9747	9788	9828	9869	9909	9950	9991	10031	10072	10113
250	10153	10194	10235	10276	10316	10357	10398	10439	10480	10520
260	10561	10602	10643	10684	10725	10766	10807	10848	10889	10930
270	10971	11012	11053	11094	11135	11176	11217	11259	11300	11341
280	11382	11423	11465	11506	11547	11588	11630	11671	11712	11753
290	11795	11836	11877	11919	11960	12001	12043	12084	12126	12167

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Grundwertreihen für Thermoelemente

Thermocouple reference tables

Nickel-Chrom/ Nickel nach DIN EN 60584 Typ K

Nickel-Chromium/ Nickel acc. to DIN EN 60584

Bezugstemperatur 0°C. Temperaturen in °C (ITS-90)

Reference temperature 0°C. Temperatures in degress celsius (ITS-90)

Temp.	Mikrovolt									
°C	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
300	12209	12250	12291	12333	12374	12416	12457	12499	12540	12582
310	12624	12665	12707	12748	12790	12831	12873	12915	12956	12998
320	13040	13081	13123	13165	13206	13248	13290	13331	13373	13415
330	13457	13498	13540	13582	13624	13665	13707	13749	13791	13833
340	13874	13916	13958	14000	14042	14084	14126	14167	14209	14251
350	14293	14335	14377	14419	14461	14503	14545	14587	14629	14671
360	14713	14755	14797	14839	14881	14923	14965	15007	15049	15091
370	15133	15175	15217	15259	15301	15343	15385	15427	15469	15511
380	15554	15596	15638	15680	15722	15764	15806	15849	15891	15933
390	15975	16017	16059	16102	16144	16186	16228	16270	16313	16355
400	16397	16439	16482	16524	16566	16608	16651	16693	16735	16778
410	16820	16862	16904	16947	16989	17031	17074	17116	17158	17201
420	17243	17285	17328	17370	17413	17455	17497	17540	17582	17624
430	17667	17709	17752	17794	17837	17879	17921	17964	18006	18049
440	18091	18134	18176	18218	18261	18303	18346	18388	18431	18473
450	18516	18558	18601	18643	18686	18728	18771	18813	18856	18898
460	18941	18983	19026	19068	19111	19154	19196	19239	19281	19324
470	19366	19409	19451	19494	19537	19579	19622	19664	19707	19750
480	19792	19835	19877	19920	19962	20005	20048	20090	20133	20175
490	20218	20261	20303	20346	20389	20431	20474	20516	20559	20602
500	20644	20687	20730	20772	20815	20857	20900	20943	20985	21028
510	21071	21113	21156	21199	21241	21284	21326	21369	21412	21454
520	21497	21540	21582	21625	21668	21710	21753	21796	21838	21881
530	21924	21966	22009	22052	22094	22137	22179	22222	22265	22307
540	22350	22393	22435	22478	22521	22563	22606	22649	22691	22734
550	22776	22819	22862	22904	22947	22990	23032	23075	23117	23160
560	23203	23245	23288	23331	23373	23416	23458	23501	23544	23586
570	23629	23671	23714	23757	23799	23842	23884	23927	23970	24012
580	24055	24097	24140	24182	24225	24267	24310	24353	24395	24438
590	24480	24523	24565	24608	24650	24693	24735	24778	24820	24863

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Thermocouple reference tables

Nickel-Chrom/ Nickel nach DIN EN 60584 Typ K

Nickel-Chromium/ Nickel acc. to DIN EN 60584

Bezugstemperatur 0°C. Temperaturen in °C (ITS-90)

Reference temperature 0°C. Temperatures in degress celsius (ITS-90)

Temp.	Mikrovolt									
°C	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
600	24905	24948	24990	25033	25075	25118	25160	25203	25245	25288
610	25330	25373	25415	25458	25500	25543	25585	25627	25670	25712
620	25755	25797	25840	25882	25924	25967	26009	26052	26094	26136
630	26179	26221	26263	26306	26348	26390	26433	26475	26517	26560
640	26602	26644	26687	26729	26771	26814	26856	26898	26940	26983
650	27025	27067	27109	27152	27194	27236	27278	27320	27363	27405
660	27447	27489	27531	27574	27616	27658	27700	27742	27784	27826
670	27869	27911	27953	27995	28037	28079	28121	28163	28205	28247
680	28289	28332	28374	28416	28458	28500	28542	28584	28626	28668
690	28710	28752	28794	28835	28877	28919	28961	29003	29045	29087
700	29129	29171	29213	29255	29297	29338	29380	29422	29464	29506
710	29548	29589	29631	29673	29715	29757	29798	29840	29882	29924
720	29965	30007	30049	30090	30132	30174	30216	30257	30299	30341
730	30382	30424	30466	30507	30549	30590	30632	30674	30715	30757
740	30798	30840	30881	30923	30964	31006	31047	31089	31130	31172
750	31213	31255	31296	31338	31379	31421	31462	31504	31545	31586
760	31628	31669	31710	31752	31793	31834	31876	31917	31958	32000
770	32041	32082	32124	32165	32206	32247	32289	32330	32371	32412
780	32453	32495	32536	32577	32618	32659	32700	32742	32783	32824
790	32865	32906	32947	32988	33029	33070	33111	33152	33193	33234
800	33275	33316	33357	33398	33439	33480	33521	33562	33603	33644
810	33685	33726	33767	33808	33848	33889	33930	33971	34012	34053
820	34093	34134	34175	34216	34257	34297	34338	34379	34420	34460
830	34501	34542	34582	34623	34664	34704	34745	34786	34826	34867
840	34908	34948	34989	35029	35070	35110	35151	35192	35232	35273
850	35313	35354	35394	35435	35475	35516	35556	35596	35637	35677
860	35718	35758	35798	35839	35879	35920	35960	36000	36041	36081
870	36121	36162	36202	36242	36282	36323	36363	36403	36443	36484
880	36524	36564	36604	36644	36685	36725	36765	36805	36845	36885
890	36925	36965	37006	37046	37086	37126	37166	37206	37246	37286

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Grundwertreihen für Thermoelemente

Thermocouple reference tables

Nickel-Chrom/ Nickel nach DIN EN 60584 Typ K

Nickel-Chromium/ Nickel acc. to DIN EN 60584

Bezugstemperatur 0°C. Temperaturen in °C (ITS-90)

Reference temperature 0°C. Temperatures in degress celsius (ITS-90)

Temp.	Mikrovolt									
°C	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
900	37326	37366	37406	37446	37486	37526	37566	37606	37646	37686
910	37725	37765	37805	37845	37885	37925	37965	38005	38044	38084
920	38124	38164	38204	38243	38283	38323	38363	38402	38442	38482
930	38522	38561	38601	38641	38680	38720	38760	38799	38839	38878
940	38918	38958	38997	39037	39076	39116	39155	39195	39235	39274
950	39314	39353	39393	39432	39471	39511	39550	39590	39629	39669
960	39708	39747	39787	39826	39866	39905	39944	39984	40023	40062
970	40101	40141	40180	40219	40259	40298	40337	40376	40415	40455
980	40494	40533	40572	40611	40651	40690	40729	40768	40807	40846
990	40885	40924	40963	41002	41042	41081	41120	41159	41198	41237
1000	41276	41315	41354	41393	41431	41470	41509	41548	41587	41626
1010	41665	41704	41743	41781	41820	41859	41898	41937	41976	42014
1020	42053	42092	42131	42169	42208	42247	42286	42324	42363	42402
1030	42440	42479	42518	42556	42595	42633	42672	42711	42749	42788
1040	42826	42865	42903	42942	42980	43019	43057	43096	43134	43173
1050	43211	43250	43288	43327	43365	43403	43442	43480	43518	43557
1060	43595	43633	43672	43710	43748	43787	43825	43863	43901	43940
1070	43978	44016	44054	44092	44130	44169	44207	44245	44283	44321
1080	44359	44397	44435	44473	44512	44550	44588	44626	44664	44702
1090	44740	44778	44816	44853	44891	44929	44967	45005	45043	45081
1100	45119	45157	45194	45232	45270	45308	45346	45383	45421	45459
1110	45497	45534	45572	45610	45647	45685	45723	45760	45798	45836
1120	45873	45911	45948	45986	46024	46061	46099	46136	46174	46211
1130	46249	46286	46324	46361	46398	46436	46473	46511	46548	46585
1140	46623	46660	46697	46735	46772	46809	46847	46884	46921	46958
1150	46995	47033	47070	47107	47144	47181	47218	47256	47293	47330
1160	47367	47404	47441	47478	47515	47552	47589	47626	47663	47700
1170	47737	47774	47811	47848	47884	47921	47958	47995	48032	48069
1180	48105	48142	48179	48216	48252	48289	48326	48363	48399	48436
1190	48473	48509	48546	48582	48619	48656	48692	48729	48765	48802

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Grundwertreihen für Thermoelemente

Thermocouple reference tables

Nickel-Chrom/ Nickel nach DIN EN 60584 Typ K

Nickel-Chromium/ Nickel acc. to DIN EN 60584

Bezugstemperatur 0°C. Temperaturen in °C (ITS-90)

Reference temperature 0°C. Temperatures in degress celsius (ITS-90)

Temp.	Mikrovolt									
°C	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1200	48838	48875	48911	48948	48984	49021	49057	49093	49130	49166
1210	49202	49239	49275	49311	49348	49384	49420	49456	49493	49529
1220	49565	49601	49637	49674	49710	49746	49782	49818	49854	49890
1230	49926	49962	49998	50034	50070	50106	50142	50178	50214	50250
1240	50286	50322	50358	50393	50429	50465	50501	50537	50572	50608
1250	50644	50680	50715	50751	50787	50822	50858	50894	50929	50965
1260	51000	51036	51071	51107	51142	51178	51213	51249	51284	51320
1270	51355	51391	51426	51461	51497	51532	51567	51603	51638	51673
1280	51708	51744	51779	51814	51849	51885	51920	51955	51990	52025
1290	52060	52095	52130	52165	52200	52235	52270	52305	52340	5375
1300	52410	52445	52480	52515	52550	52585	52620	52654	52689	52724
1310	52759	52794	52828	52863	52898	52932	52967	53002	53037	53071
1320	53106	53140	53175	53210	53244	53279	53313	53348	53382	53417
1330	53451	53486	53520	53555	53589	53623	53658	53692	53727	53761
1340	53795	53830	53864	53898	53932	53967	54001	54035	54069	54104
1350	54138	54172	54206	54240	54274	54308	54343	54377	54411	54445
1360	54479	54513	54547	54581	54615	54649	54683	54717	54751	54785
1370	54819	54852	54886							

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Grundwertreihen in Ohm für Platin-Widerstandfühler Pt 100

Temperatursensor reference tables

Pt 100 Ohm nach DIN EN 60751

Platinum 100 Ohms acc. to DIN EN 60751

R(0) = 100,00 Ohm. Temperaturen in °C (ITS-90)

R(0) = 100,00 Ohm. Temperatures in degress celsius (ITS-90)

Temp.	Ohm									
°C	**0**	**-1**	**-2**	-3	**-4**	**-5**	**-6**	**-7**	**-8**	**-9**
-200	18,52									
-190	22,83	22,40	21,97	21,54	21,11	20,68	20,25	19,82	19,38	18,95
-180	27,10	26,67	26,24	25,82	25,39	24,97	24,54	24,11	23,68	23,25
-170	31,34	30,91	30,49	30,07	29,64	29,22	28,80	28,37	27,95	27,52
-160	35,34	35,12	34,70	34,28	33,86	33,44	33,02	32,60	32,18	31,76
-150	39,72	39,31	38,89	38,47	38,05	37,64	37,22	36,80	36,38	35,96
-140	43,88	43,46	43,05	42,63	42,22	41,80	41,39	40,97	40,56	40,14
-130	48,00	47,59	47,18	46,77	46,36	45,94	45,53	45,12	44,70	44,29
-120	52,11	51,70	51,29	50,88	50,47	50,06	49,65	49,24	48,83	48,42
-110	56,19	55,79	55,38	54,97	54,56	54,15	53,75	53,34	52,93	52,52
-100	60,26	59,85	59,44	59,04	58,63	58,23	57,82	57,41	57,01	56,60
-90	64,30	63,90	63,49	63,09	62,68	62,28	61,88	61,47	61,07	60,66
-80	68,33	67,92	67,52	67,12	66,72	66,31	65,91	65,51	65,11	64,70
-70	72,33	71,93	71,53	71,13	70,73	70,33	69,93	69,53	69,13	68,73
-60	76,33	75,93	75,53	75,13	74,73	74,33	73,93	73,53	73,13	72,73
-50	80,31	79,91	79,51	79,11	78,72	78,32	77,92	77,52	77,12	76,73
-40	84,27	83,87	83,48	83,08	82,69	82,29	81,89	81,50	81,10	80,70
-30	88,22	87,83	87,43	87,04	86,64	86,25	85,85	85,46	85,06	84,67
-20	92,16	91,77	91,37	90,98	90,59	90,19	89,80	89,40	89,01	88,62
-10	96,09	95,69	95,30	94,91	94,52	94,12	93,73	93,34	92,95	92,55
0	100,00	99,61	99,22	98,83	98,44	98,04	97,65	97,26	96,87	96,48

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Grundwertreihen in Ohm für Platin-Widerstandfühler Pt 100

Temperatursensor reference tables

Pt 100 Ohm nach DIN EN 60751

Platinum 100 Ohms acc. to DIN EN 60751

R(0) = 100,00 Ohm. Temperaturen in °C (ITS-90)

R(0) = 100,00 Ohm. Temperatures in degress celsius (ITS-90)

Temp.	Ohm									
°C	0	1	2	3	4	5	6	7	8	9
0	100,00	100,39	100,78	101,17	101,56	101,95	102,34	102,73	103,12	103,51
10	103,90	104,29	104,68	105,07	105,46	105,85	106,24	106,63	107,02	107,40
20	107,79	108,18	108,57	108,96	109,35	109,73	110,12	110,51	110,90	111,29
30	111,67	112,06	112,45	112,83	113,22	113,61	114,00	114,38	114,77	115,15
40	115,54	115,93	116,31	116,70	117,08	117,47	117,86	118,24	118,63	119,01
50	119,40	119,78	120,17	120,55	120,94	121,32	121,71	122,09	122,47	122,86
60	123,24	123,63	124,01	124,39	124,78	125,16	125,54	125,93	126,31	126,69
70	127,08	127,46	127,84	128,22	128,61	128,99	129,37	129,75	130,13	130,52
80	130,90	131,28	131,66	132,04	132,42	132,80	133,18	133,57	133,95	134,33
90	134,71	135,09	135,47	135,85	136,23	136,61	136,99	137,37	137,75	138,13
100	138,51	138,88	139,26	139,64	140,02	140,40	140,78	141,16	141,54	141,91
110	142,29	142,67	143,05	143,43	143,80	144,18	144,56	144,94	145,31	145,69
120	146,07	146,44	146,82	147,20	147,57	147,95	148,33	148,70	149,08	149,83
130	149,83	150,21	150,58	150,96	151,33	151,71	152,08	152,46	152,83	153,21
140	153,58	153,96	154,33	154,71	155,08	155,46	155,83	156,20	156,58	156,95
150	157,33	157,70	158,07	158,45	158,82	159,19	159,56	159,94	160,31	160,68
160	161,05	161,43	161,80	162,17	162,54	162,91	163,29	163,66	164,03	164,40
170	164,77	165,14	165,51	165,89	166,26	166,63	167,00	167,37	167,74	168,11
180	168,48	168,85	169,22	169,59	169,96	170,33	170,70	171,07	171,43	171,80
190	172,17	172,54	172,91	173,28	173,65	174,02	174,38	174,75	175,12	175,49
200	175,86	176,22	176,59	176,96	177,33	177,69	178,06	178,43	178,79	179,16
210	179,53	179,89	180,26	180,63	180,99	181,36	181,72	182,09	182,46	182,82
220	183,19	183,55	183,92	184,28	184,65	185,01	185,38	185,74	186,11	186,47
230	186,84	187,20	187,56	187,93	188,29	188,66	189,02	189,38	189,75	190,11
240	190,47	190,84	191,20	191,56	191,92	192,29	192,65	193,01	193,37	193,74
250	194,10	194,46	194,82	195,18	195,55	195,91	196,27	196,63	196,99	197,35
260	197,71	198,07	198,43	198,79	199,15	199,51	199,87	200,23	200,59	200,95
270	201,31	201,67	202,03	202,39	202,75	203,11	203,47	203,83	204,19	204,55
280	204,90	205,26	205,62	205,98	206,34	206,70	207,05	207,41	207,77	208,13
290	208,48	208,84	209,20	209,56	209,91	210,27	210,63	210,98	211,34	211,70

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Grundwertreihen in Ohm für Platin-Widerstandfühler Pt 100

Temperatursensor reference tables

Pt 100 Ohm nach DIN EN 60751

Platinum 100 Ohms acc. to DIN EN 60751

R(0) = 100,00 Ohm. Temperaturen in °C (ITS-90)

R(0) = 100,00 Ohm. Temperatures in degresse celsius (ITS-90)

Temp.	Ohm									
°C	0	1	2	3	4	5	6	7	8	9
300	212,05	212,41	212,76	213,12	213,48	213,83	214,19	214,54	214,90	215,25
310	215,61	215,96	216,32	216,67	217,03	217,38	217,74	218,09	218,44	218,80
320	219,15	219,51	219,86	220,21	220,57	220,92	221,27	221,63	221,98	222,33
330	222,68	223,04	223,39	223,74	224,09	224,45	224,80	225,15	225,50	225,85
340	226,21	226,56	226,91	227,26	227,61	227,96	228,31	228,66	229,02	229,37
350	229,72	230,07	230,42	230,77	231,12	231,47	231,82	232,17	232,52	232,87
360	233,21	233,56	233,91	234,26	234,61	234,96	235,31	235,66	236,00	236,35
370	236,70	237,05	237,40	237,74	238,09	238,44	238,79	239,13	239,48	239,83
380	240,18	240,52	240,87	241,22	241,56	241,91	242,26	242,60	242,95	243,29
390	243,64	243,99	244,33	244,68	245,02	245,37	245,71	246,06	246,40	246,75
400	247,09	247,44	247,78	248,13	248,47	248,81	249,16	249,50	249,85	250,19
410	250,53	250,88	251,22	251,66	251,91	252,25	252,59	252,93	253,28	253,62
420	253,96	254,30	254,65	254,99	255,33	255,67	256,01	256,35	256,70	257,04
430	257,38	257,72	258,06	258,40	258,74	259,08	259,42	259,76	260,10	260,44
440	260,78	261,12	261,46	261,80	262,14	262,48	262,82	263,16	263,50	263,84
450	264,18	264,52	264,86	265,20	265,53	265,87	266,21	266,55	266,89	267,22
460	267,56	267,90	268,24	268,57	268,91	269,25	269,59	269,92	270,26	270,60
470	270,93	271,27	271,61	271,94	272,28	272,61	272,95	273,29	273,62	273,96
480	274,29	274,63	274,96	275,30	275,63	275,97	276,30	276,64	276,97	277,31
490	277,64	277,98	278,31	278,64	278,98	279,31	279,64	279,98	280,31	280,64
500	280,98	281,31	281,64	281,98	282,31	282,64	282,97	283,31	283,64	283,97
510	284,30	284,63	284,97	285,30	285,63	285,96	286,29	286,62	286,95	287,29
520	287,62	287,95	288,28	288,61	288,94	289,27	289,60	289,93	290,26	290,59
530	290,92	291,25	291,58	291,91	292,24	292,56	292,89	293,22	293,55	293,88
540	294,21	294,54	294,86	295,19	295,52	295,85	296,18	296,50	296,83	297,16
550	297,49	297,81	298,14	298,47	298,80	299,12	299,45	299,78	300,10	300,43
560	300,75	301,08	301,41	301,73	302,06	302,38	302,71	303,03	303,36	303,69
570	304,01	304,34	304,66	304,98	305,31	305,63	305,96	306,28	306,61	306,93
580	307,25	307,58	307,90	308,23	308,55	308,87	309,20	309,52	309,84	310,16
590	310,49	310,81	311,13	311,45	311,78	312,10	312,42	312,74	313,06	313,39

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Grundwertreihen in Ohm für Platin-Widerstandfühler Pt 100

Temperatursensor reference tables

Pt 100 Ohm nach DIN EN 60751

Platinum 100 Ohms acc. to DIN EN 60751

R(0) = 100,00 Ohm. Temperaturen in °C (ITS-90)

R(0) = 100,00 Ohm. Temperatures in degresse celsius (ITS-90)

Temp.	Ohm									
°C	0	1	2	3	4	5	6	7	8	9
600	313,71	314,03	314,35	314,67	314,99	315,31	315,64	315,96	316,28	316,60
610	316,92	317,24	317,56	317,88	318,20	318,52	318,84	319,16	319,48	319,80
620	320,12	320,43	320,75	321,07	321,39	321,71	322,03	322,35	322,67	322,98
630	323,30	323,62	323,94	324,26	324,57	324,89	325,21	325,53	325,84	326,16
640	326,48	326,79	327,11	327,43	327,74	328,06	328,38	328,69	329,01	329,32
650	329,64	329,96	330,27	330,59	330,90	331,22	331,53	331,85	332,16	332,48
660	332,79	333,11	333,42	333,74	334,05	334,36	334,68	334,99	335,31	335,62
670	335,93	336,25	336,56	336,87	337,18	337,50	337,81	338,12	338,44	338,75
680	339,06	339,37	339,69	340,00	340,31	340,62	340,93	341,24	341,56	341,87
690	342,18	342,49	342,80	343,11	343,42	343,73	344,04	344,35	344,66	344,97
700	345,28	345,59	345,90	346,21	346,52	346,83	347,14	347,45	347,76	348,07
710	348,38	348,69	348,99	349,30	349,61	349,92	350,23	350,54	350,84	351,15
720	351,46	351,77	352,08	352,38	352,69	353,00	353,30	353,61	353,92	354,22
730	354,53	354,84	355,14	355,45	355,76	356,06	356,37	356,67	356,98	357,28
740	357,59	357,90	358,20	358,51	358,81	359,12	359,42	359,72	360,03	360,33
750	360,64	360,94	361,25	361,55	361,85	362,16	362,46	362,76	363,07	363,37
760	363,67	363,98	364,28	364,58	364,89	365,19	365,49	365,79	366,10	366,40
770	366,70	367,00	367,30	367,60	367,91	368,21	368,51	368,81	369,11	369,41
780	369,71	370,01	370,31	370,61	370,91	371,21	371,51	371,81	372,11	372,41
790	372,71	373,01	373,31	373,61	373,91	374,21	374,51	374,81	375,11	375,41
800	375,70	376,00	376,30	376,60	376,90	377,19	377,49	377,79	378,09	378,39
810	378,68	378,98	379,28	379,57	379,87	380,17	380,46	380,76	381,06	381,35
820	381,65	381,95	382,24	382,54	382,83	383,13	383,42	383,72	384,01	384,31
830	384,60	384,90	385,19	385,49	385,78	386,08	386,37	386,67	384,96	387,25
840	387,55	387,84	388,14	388,43	388,72	389,02	389,31	389,60	389,90	390,19
850	390,48									

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Methods and Regulations for Installation, Attachment and Operation of small Temperature Sensing Devices for the Plastics Industry

Methods and Regulations for Installation, Attachment and Operation of small Temperature Sensing Devices for the Plastics Industry

1. Introduction

Since there is a great variety of thermoelements and resistance sensors, we can only consider their most important characteristics in the instructions for installation and attachment. If necessary, refer to our technical consultants. For obtaining a general view, please, consider our “Description of Application and Use” (form no.124)”.

Please note that for the material and construction used, this type of temperature sensing device is sensitive and subject to close physical and mechanical limits of wear and tear. The working temperature, humidity, the aggressiveness of media etc. have to be taken into account. In addition, the thermal circuit must be properly unwound to avoid knots or damage to the cable.This is the reason why these sensors should only be used by trained personnel.
Moreover, we would like to point out that any cut of leads or thermoconductions may evoke mechanical or measuring problems. Thus, you are advised to give us the required measurements of length in any case of order.

2. Bayonet temperature sensing device

2.1 Sensor point / Material

For agressive media you should consider to take an adequate resistant material.

2.2 Sensor drilling

The sensor drilling has to be bigger than the outside diameter of the sensor by approx. 0.2 mm. The front-view sensor drilling should be adapted to the sensor point (plane or pointed, drilling angle of 118° or hemispherical). With temperatures of more than 200°C, we recommend to use a special paste for the sensor to provide a better accumulation of heat. This paste can be delivered by us.

2.3 Screwed nipple

The screwed nipples have been developed for the metrical thread 6H, with thread “G” for tolerance class A. By drum-nickel-plating and a respective preliminary treatment, the cleanliness of threads may suffer slightly. During installation, the lateral screwed nipple pins must not be damaged. Loosening the pins would cause the same negative effects as being described under the topics “Bayonet joint” and “Spring pressure”. During the installation of screwed nipples you have to remove the screwed nipple transport protection first (if available). Then you should compare the screwed nipple thread with the thread drilling in the tool or machine. You must not start installation if both are not compatible. The nipple has to be screwed in with a torque given in the following table.

Thread	Torque up to a max. of [Nm]
M4	1,0
M6	3,0
M8 x 1	4,0
M8 x 0,75	4,0
M10	4,5
M10 x 1	5,0
M12	6,5
M12 x 1	7,0
M14	15,0
M14 x 1,5	15,0
M16	16,0
G 1/4”	14,0
G 3/8”	20,0
G1/2”	20,0

2.4 Bayonet joint

The screwed nipple being used has to correspond to the bayonet cap installed at the temperature sensing device. If this condition has not been observed, both elements may unlock and the required sensor pressure cannot be garanteed. As a result, the measured values may be falsified as descibed under the topic “Spring pressure”.

2.5 Spring pressure

A minimum of spring pressure has to be kept. At the same time, the depth of immersion and the length of the self-contained lead should be observed. The most favorable way of installation is vertically from above. Since a change of temperature may reduce the spring rate, the pressure force of the bayonet cap of the sensor should constantly be checked.

If spring pressure is too low, the sensor point may be withdrawn from the hot-junction by which the measured value may be falsified as already mentioned before.

2.6 Thermoconduction / Equalizer connection / Leads

Thermoconductions resp. equalizer leads of thermoelements and the leads of resistance sensors will be resistant to temperature according to the following table:

Insulating material	**Temperature up to a max. of [°C]**
Teflon (PTFE)	230
Silicon	200
Fibreglass	400
Fibreglass/Fe plaiting	400
Fibreglass/VA plaiting	400
Spec. fibreglass “E”/VA plaiting	550

These conductions should not be layed next to the mains since this may cause interfering impulses

You are advised to give us the working temperature of the sensor. Humidity or aggressive media have to be considered when choosing the appropriate leads.

2.7 Duration and degree of accuracy

Thermoconductions correspond to the maximum working temperatures quoted in the manuals which have to be referred to. If the maximum temperature limit has not been exceeded constantly or for a prolonged period, ageing which will influence the physical properties of thermoalloys – and in this context the thermal electromotive force - will practically not occur.
In any case, it may be garanteed that a change of thermal electromotive force by ageing will be limited to a maximum of 2 µV even at a working temperature of 200 °C if no other conditions occur like e.g. mechanical overstrain, a rather intensive exposure to radioactivity or chemical corrosion.
If the latter is the case, you can determine any possible change by calibration.

2.8 Calibration

Regular calibrating of sensors in use is recommended only if the value new of the sensor is proportionate to the cost of calibration.
If ageing has been caused by higher temperatures (see 2.7), an exchange of sensors within particularly defined and regular intervals may be a less expensive alternative.

2.9 Sensor break

As of the current measurement and control techniques, the temperature reading speeds to infinity after sensor break and the relay is automatically disconnected. In the latest type of equipment, the display indicates any sensor break.

2.10 Failure

Failures may only occur very suddenly, e.g. by interruption of one out of the two bunched conductors (thermo-paired). Interruption may be caused by mechanical damage.

3. Screwed sensor

3.1 Sensor point / Material

For agressive media you should consider to take an adequate resistant material.

3.2 Sensor drilling

The sensor drilling has to be bigger than the outside diameter of the sensor by approx. 0.2 mm. The front-view sensor drilling should be adapted to the sensor point (plane or pointed, drilling angle of 118° or hemispherical). With temperatures of more than 200°C, we recommend to use a special paste for the sensor to provide a better accumulation of heat. This paste can be delivered by us.

3.3 Depth of immersion / Point of measurement

When immersing the temperature sensing device (into a liquid medium, air etc.), the depth of immersion is to be known at the date of order. The point of measurement has to be in the correct place.

3.4 Screwed nipple

The screwed nipples have been developed for the metrical thread 6H, with thread “G” for tolerance class A. By drum-nickel-plating and a respective preliminary treatment, the cleanliness of threads may suffer slightly. During installation, the lateral screwed nipple pins must not be damaged. Loosening the pins would cause the same negative effects as being described under the topics “Bayonet joint” and “Spring pressure”. During the installation of screwed nipples you have to remove the screwed nipple transport protection first (if available). Then you should compare the screwed nipple thread with the thread drilling in the tool or machine. You must not start installation if both are not compatible. The nipple has to be screwed in with a torque given in the following table.

Thread	**Torque up to a max. of [Nm]**
M8 x 1	4,0
M10 x 1	5,0
M12	6,5
G 1/4”	14,0
G 3/8”	20,0
G1/2”	20,0

During installation of a temperature sensing . device into a vessel including liquids, you should care for an appropriate sealing

3.5 Terminal point

When connecting the lead you should pay attention to the type of polarity:
Adequate equalizer connection and thermoconduction at thermoelements
Cupric leads with the largest diameter possible

Ambient temperature at the terminal point must not exceed 200 °C. Ambient temperature at the terminal point including transmitter must not exceed 90 °C.

Fasten the terminal point tap and seal it against moisture etc. if necessary.

3.6 Thermoconduction/Equalizer connection/Leads

Thermoconductions resp. Equalizer leads of thermoelements and the leads of resistance
sensors will be resistant to temperature according to followin table :

Insulating material	**Temperaturs up to a max. of [°C]**
Tefllon(PTFE)	230
Silicon	200
Fibreglass	400
Fibreglass/Fe plaiting	400
Fibreglass/VA plaiting	400
Spec. Fibreglass “E”/VA plaiting	550

these conductions should ot be layed next to the mains since this may cause interfering impulses

You are advised to give us the working temperature of the sensor. Humidity or aggressive media have to be considered when choosing the appropriate leads.

3.7 Duration and degree of accuracy

Thermoconductions correspond to the maximum working temperatures quoted in the manuals which have to be referred to. If the maximum temperature limit has not been exceeded constantly or for a prolonged period, ageing which will influence the physical properties of thermoalloys – and in this context the thermal electromotive force - will practically not occur.
In any case, it may be garanteed that a change of thermal electromotive force by ageing will be limited to a maximum of 2 µV even at a working temperature of 200 °C if no other conditions occur like e.g. mechanical overstrain, a rather intensive exposure to radioactivity or chemical corrosion.
If the latter is the case, you can determine any possible change by calibration.

3.8 Calibration

Regular calibrating of sensors in use is recommended only if the value new of the sensor is proportionate to the cost of calibration.
If ageing has been caused by higher temperatures (see 2.7), an exchange of sensors within particularly defined and regular intervals may be a less expensive alternative.

3.9 Sensor break

As of the current measurement and control techniques, the temperature reading speeds to infinity after sensor break and the relay is automatically disconnected. In the latest type of equipment, the display indicates any sensor break.

3.10 Failure

Failures may only occur very suddenly, e.g. by interruption of one out of the two bunched conductors (thermo-paired). Interruption may be caused by mechanical damage.

4. Mass temperature sensing device

4.1 Screwed thread

When installing the temperature sensing device, you have to compare first the screwed thread to the threaded drilling and the sealing surfaces of the drillings to each other. The installation can only be made when they correspond exactly. The thread should be screwed in with the torques given in the following table:

Thread	Torque up to a max. of [Nm]
M18 x 1,5	50
1/2” 20 UNF	40,0

4.2 Sensor point / Material

For agressive media you should consider to take an adequate resistant material.

During the installation of the temperature sensing device into a drilling, you are advised to take into account that the drilling will not exceed the outside diameter of the sensor by more than 0.05 mm.

The knife-edge of a swordshaped temperature sensing device has to point at the forward direction. Please note the identification mark SW 14. Before installation you are advised to check whether the identification mark SW 14 corresponds to the knife-edge.

After installation the closeness of the temperature sensing device has to be checked.

4.3 Depth of immersion / Point of measurement

When immersing the temperature sensing device (into a liquid medium, air etc.), the depth of immersion is to be known at the date of order. The point of measurement has to be in the correct place.

4.4 Thermoconduction/Equalizer connection/Leads

Thermoconductions resp. Equalizer leads of thermoelements and the leads of resistance
sensors will be resistant to temperature according to followin table :

Insulating material	**Temperaturs up to a max. of [°C]**
Tefllon(PTFE)	230
Silicon	200
Fibreglass	400
Fibreglass/Fe plaiting	400
Fibreglass/VA plaiting	400
Spec. Fibreglass “E”/VA plaiting	550

these conductions should ot be layed next to the mains since this may cause interfering impulses

You are advised to give us the working temperature of the sensor. Humidity or aggressive media have to be considered when choosing the appropriate leads.

4.5 Duration and degree of accuracy

Thermoconductions correspond to the maximum working temperatures quoted in the manuals which have to be referred to. If the maximum temperature limit has not been exceeded constantly or for a prolonged period, ageing which will influence the physical properties of thermoalloys – and in this context the thermal electromotive force - will practically not occur.
In any case, it may be garanteed that a change of thermal electromotive force by ageing will be limited to a maximum of 2 µV even at a working temperature of 200 °C if no other conditions occur like e.g. mechanical overstrain, a rather intensive exposure to radioactivity or chemical corrosion.
If the latter is the case, you can determine any possible change by calibration.

4.6 Calibration

Regular calibrating of sensors in use is recommended only if the value new of the sensor is proportionate to the cost of calibration.
If ageing has been caused by higher temperatures (see 2.7), an exchange of sensors within particularly defined and regular intervals may be a less expensive alternative.

4.7 Sensor break

As of the current measurement and control techniques, the temperature reading speeds to infinity after sensor break and the relay is automatically disconnected. In the latest type of equipment, the display indicates any sensor break.

4.8 Failure

Failures may only occur very suddenly, e.g. by interruption of one out of the two bunched conductors (thermo-paired). Interruption may be caused by mechanical damage.

5. Clamping temperature sensing device

5.1 Clamping sheet

Clamping temperature sensing devices have a clamping sheet. This sheet should mould to the strip heater from below. Keep the strip heater (mostly nozzle strip heater) tight to the point to be measured and any existing air gap as narrow as possible. Provide for the best heat transfer possible.

Clamping temperature sensing devices containing a clamping sheet which is formed like an MS ring do not have to have an air gap larger than 3 mm.

Using this type of temperature sensing devices you should provide for an additional heat insulation if possible, since the measuring result may be influenced by external conditions.

5.2 Thermoconduction/Equalizer connection/Leads

Thermoconductions resp. Equalizer leads of thermoelements and the leads of resistance sensors will be resistant to temperature according to followin table :

Insulating material	**Temperaturs up to a max. of [°C]**
Tefllon(PTFE)	230
Silicon	200
Fibreglass	400
Fibreglass/Fe plaiting	400
Fibreglass/VA plaiting	400
Spec. Fibreglass “E”/VA plaiting	550

these conductions should ot be layed next to the mains since this may cause interfering impulses

You are advised to give us the working temperature of the sensor. Humidity or aggressive media have to be considered when choosing the appropriate leads.

5.3 Duration and degree of accuracy

Thermoconductions correspond to the maximum working temperatures quoted in the manuals which have to be referred to. If the maximum temperature limit has not been exceeded constantly or for a prolonged period, ageing which will influence the physical properties of thermoalloys – and in this context the thermal electromotive force - will practically not occur.
In any case, it may be garanteed that a change of thermal electromotive force by ageing will be limited to a maximum of 2 µV even at a working temperature of 200 °C if no other conditions occur like e.g. mechanical overstrain, a rather intensive exposure to radioactivity or chemical corrosion.
If the latter is the case, you can determine any possible change by calibration.

5.4 Calibration

Regular calibrating of sensors in use is recommended only if the value new of the sensor is proportionate to the cost of calibration.
If ageing has been caused by higher temperatures (see 2.7), an exchange of sensors within particularly defined and regular intervals may be a less expensive alternative.

5.5 Sensor break

As of the current measurement and control techniques, the temperature reading speeds to infinity after sensor break and the relay is automatically disconnected. In the latest type of equipment, the display indicates any sensor break.

5.6 Failure

Failures may only occur very suddenly, e.g. by interruption of one out of the two bunched conductors (thermo-paired). Interruption may be caused by mechanical damage.

6. Pipe clamp temperature sensing device

6.1 Pipe clamp

The pipe clamp temperature sensing devices delivered by DR. MENNICKEN GMBH have been provided with a pipe clamp containing a strap retainer usually made of special steel 1.4301. The screw is made of nickel-plated steel.

During the first installation, the pipe clamps have to be tightened with a maximum of 1.5 Nm. Since contact pressure may give off, the seat of the pipe clamp has to be checked regularly.

Using this type of temperature sensing devices, you should provide for an additional heat insulation if possible, since the measuring result may be influenced by heat abstraction or other external conditions.

6.2 Thermoconduction/Equalizer connection/Leads

Thermoconductions resp. Equalizer leads of thermoelements and the leads of resistance

sensors will be resistant to temperature according to followin table :

Insulating material	**Temperaturs up to a max. of [°C]**
Tefllon(PTFE)	230
Silicon	200
Fibreglass	400
Fibreglass/Fe plaiting	400
Fibreglass/VA plaiting	400
Spec. Fibreglass "E"/VA plaiting	550

these conductions should ot be layed next to the mains since this may cause interfering impulses

You are advised to give us the working temperature of the sensor. Humidity or aggressive media have to be considered when choosing the appropriate leads.

6.3 Duration and degree of accuracy

Thermoconductions correspond to the maximum working temperatures quoted in the manuals which have to be referred to. If the maximum temperature limit has not been exceeded constantly or for a prolonged period, ageing which will influence the physical properties of thermoalloys – and in this context the thermal electromotive force - will practically not occur.
In any case, it may be garanteed that a change of thermal electromotive force by ageing will be limited to a maximum of 2 µV even at a working temperature of 200 °C if no other conditions occur like e.g. mechanical overstrain, a rather intensive exposure to radioactivity or chemical corrosion.
If the latter is the case, you can determine any possible change by calibration.

6.4 Calibration

Regular calibrating of sensors in use is recommended only if the value new of the sensor is proportionate to the cost of calibration.
If ageing has been caused by higher temperatures (see 2.7), an exchange of sensors within particularly defined and regular intervals may be a less expensive alternative.

6.5 Sensor break

As of the current measurement and control techniques, the temperature reading speeds to infinity after sensor break and the relay is automatically disconnected. In the latest type of equipment, the display indicates any sensor break.

6.6 Failure

Failures may only occur very suddenly, e.g. by interruption of one out of the two bunched conductors (thermo-paired). Interruption may be caused by mechanical damage.

7. Sheathed temperature sensing device

7.1 Depth of immersion / Point of measurement

When immersing the temperature sensing device (into a liquid medium, air etc.), the depth of immersion is to be known at the date of order. The point of measurement has to be in the correct place.

7.2 Sensor point / Material

For agressive media you should consider to take an adequate resistant material.

During the installation of the temperature sensing device into a drilling, you are advised to take into account that the drilling will not exceed the outside diameter of the sensor by more than 0.2 mm. With temperatures up to 200 °C we recommend to use a special paste for the sensor to provide a better accumulation of heat. This paste can be delivered by us.

The sheathed temperature sensing device can be installed even in air channels without any problem by means of a spring ring screw fitting .

For the sheathed thermoelement with an outside diameter of 1.5 mm, the screw fitting M 8 x 1 item no. 028.114, which includes an aluminium spring ring, may be delivered. Screwed torque M 8 x 1 up to a maximum of 4 Nm. Torque for aluminium spring ring 1.6 Nm.

If the sheathing material has to be bent or plied, the bending radius “5 x sheathing diameter” has to be observed. The sensor point of sheathed resistance sensors must not be bent within the range of the multiplier.

The sheathing material has been developed for the following temperatures (according to the current standard):

Thermo pairings	**Material Sensor point**	**Temperature up to**
Fe-CuNi DIN (L) or IEC (J)	1.4541, V4A	800 °C
NiCr-Ni IEC (K)	1.4541, V4A	800 °C
NiCr-Ni IEC (K)	2.4816, Inconel	1100 °C

The transition piece has been developed for temperatures up to 200 °C.

For testing voltages please refer to the DR. MENNICKEN GMBH type list or the current standards.

7.3 Thermoconduction/Equalizer connection/Leads

Thermoconductions resp. Equalizer leads of thermoelements and the leads of resistance sensors will be resistant to temperature according to followin table :

Insulating material	**Temperaturs up to a max. of [°C]**
Tefllon(PTFE)	230
Silicon	200
Fibreglass	400
Fibreglass/Fe plaiting	400
Fibreglass/VA plaiting	400
Spec. Fibreglass "E"/VA plaiting	550

these conductions should ot be layed next to the mains since this may cause interfering impulses

You are advised to give us the working temperature of the sensor. Humidity or aggressive media have to be considered when choosing the appropriate leads.

7.4 Duration and degree of accuracy

Thermoconductions correspond to the maximum working temperatures quoted in the manuals which have to be referred to. If the maximum temperature limit has not been exceeded constantly or for a prolonged period, ageing which will influence the physical properties of thermoalloys – and in this context the thermal electromotive force - will practically not occur.
In any case, it may be garanteed that a change of thermal electromotive force by ageing will be limited to a maximum of 2 µV even at a working temperature of 200 °C if no other conditions occur like e.g. mechanical overstrain, a rather intensive exposure to radioactivity or chemical corrosion.
If the latter is the case, you can determine any possible change by calibration.

7.5 Calibration

Regular calibrating of sensors in use is recommended only if the value new of the sensor is proportionate to the cost of calibration.
If ageing has been caused by higher temperatures (see 2.7), an exchange of sensors within particularly defined and regular intervals may be a less expensive alternative.

7.6 Sensor break

As of the current measurement and control techniques, the temperature reading speeds to infinity after sensor break and the relay is automatically disconnected. In the latest type of equipment, the display indicates any sensor break.

7.7 Failure

Failures may only occur very suddenly, e.g. by interruption of one out of the two bunched conductors (thermo-paired). Interruption may be caused by mechanical damage.

8. Plug-type temperature sensing device

8.1 Depth of immersion / Point of measurement

When immersing the temperature sensing device (into a liquid medium, air etc.), the depth of immersion is to be known at the date of order. The point of measurement has to be in the correct place.

8.2 Sensor point / Material

For agressive media you should consider to take an adequate resistant material.

During the installation of the temperature sensing device into a drilling, you are advised to take into account that the drilling will not exceed the outside diameter of the sensor by more than 0.2 mm. With temperatures up to 200 °C we recommend to use a special paste for the sensor to provide a better accumulation of heat. This paste can be delivered by us.

The sheathed temperature sensing device can be installed even in air channels without any problem by means of a spring ring screw fitting .

For the sheathed thermoelement with an outside diameter of 1.5 mm, the screw fitting M 8 x 1 item no. 028.114, which includes an aluminium spring ring, may be delivered. Screwed torque M 8 x 1 up to a maximum of 4 Nm. Torque for aluminium spring ring 1.6 Nm.

If the sheathing material has to be bent or plied, the bending radius “5 x sheathing diameter” has to be observed. The sensor point of sheathed resistance sensors must not be bent within the range of the multiplier.

The sheathing material has been developed for the following temperatures (according to the current standard):

Thermo pairings	**Material Sensor point**	**Temperature up to**
Fe-CuNi DIN (L) or IEC (J)	1.4541, V4A	800 °C

NiCr-Ni IEC (K)	1.4541, V4A	800 °C
NiCr-Ni IEC (K)	2.4816, Inconel	1100 °C

The transition piece has been developed for temperatures up to 200 °C.

For testing voltages please refer to the DR. MENNICKEN GMBH type list or the current standards.

8.3 Thermoconduction/Equalizer connection/Leads

Thermoconductions resp. Equalizer leads of thermoelements and the leads of resistance sensors will be resistant to temperature according to followin table :

Insulating material	**Temperaturs up to a max. of [°C]**
Tefllon(PTFE)	230
Silicon	200
Fibreglass	400
Fibreglass/Fe plaiting	400
Fibreglass/VA plaiting	400
Spec. Fibreglass “E”/VA plaiting	550

these conductions should ot be layed next to the mains since this may cause interfering impulses

You are advised to give us the working temperature of the sensor. Humidity or aggressive media have to be considered when choosing the appropriate leads.

8.4 Duration and degree of accuracy

Thermoconductions correspond to the maximum working temperatures quoted in the manuals which have to be referred to. If the maximum temperature limit has not been exceeded constantly or for a prolonged period, ageing which will influence the physical properties of thermoalloys – and in this context the thermal electromotive force - will practically not occur.
In any case, it may be garanteed that a change of thermal electromotive force by ageing will be limited to a maximum of 2 µV even at a working temperature of 200 °C if no other conditions occur like e.g. mechanical overstrain, a rather intensive exposure to radioactivity or chemical corrosion.
If the latter is the case, you can determine any possible change by calibration.

8.5 Calibration

Regular calibrating of sensors in use is recommended only if the value new of the sensor is proportionate to the cost of calibration.

If ageing has been caused by higher temperatures (see 2.7), an exchange of sensors within particularly defined and regular intervals may be a less expensive alternative.

8.6 Sensor break

As of the current measurement and control techniques, the temperature reading speeds to infinity after sensor break and the relay is automatically disconnected. In the latest type of equipment, the display indicates any sensor break.

8.7 Failure

Failures may only occur very suddenly, e.g. by interruption of one out of the two bunched conductors (thermo-paired). Interruption may be caused by mechanical damage.

The technical data has been established according to our potential and procedings. Any characteristics can only be garanteed in this context.

The preconditions for application cannot be monitored by us and therefore have to be clarified by the client or user. We refuse any claims of warrenty which may refer to this context.

cartridge heater (Mounting-/ Demounting advices)

Mounting-/ Demounting advices

Type HLP, VP, NP

The durability of a cartridge heater depends on the follwing points, therefore attention should be paid to them:

1) *tolerance and condition of the bore high–density cartridge heater type HLP*

surface load:	over 12 W/cm²
diameter–tolerance of the cartridge heater:	- 0,01 ...- 0,05 mm
diameter–tolerance of the bore according to:	ISA H 7
compacted heating cartridge Type VP	
surface load:	max. 12 W/cm²
diameter–tolerance of the cartridge heater:	± 0,1 mm
diameter–tolerance of the bore:	+ 0,2 mm
heating cartridge Type NP	
surface load:	max. 6 W/cm²
diameter–tolerance of the cartridge heater:	± 0,1 mm
diameter–tolerance of the bore:	+ 0,2 mm

For surface loads of more then 20 W/cm² it is recommendable to accieve a press–fit by using a two–part-tool. The good condition and low roughness of the bore is important. Insufficient heat–conducting due to enclosed air leads to higher cartridge temperature and lowers the durability of the heating cartridge.

For the use of a high–density cartridge heater type HLP we recommend to operate with a reamer in order to obtain a good condition of the bore.

2) *mounting-aids*
Assembly spray or assembly paste prevent from heat seizure of the cartridge in the bore even over a long period of time. In case of demounting of the cartridge the bore will be saved in order to have good characteristics for mounting of the new cartridge.
CAUTION!: Assembly spray or assembly paste should never get in contact with the cartridge leads. Danger of short-circuit!!

3) *demounting–aids*
It is recommendable to weld a hexagon ring at the lead–end of the cartridge. The cartridge can easily be removed by turning it with a wrench.

welded–on–hexagon–ring
screwed nipple (reusable) with welded collar

In order to reduce periods of disuse for changing the cartridge heaters it is useful to supply them with a welded collar and a reusable screwed nipple. In case of demounting the cartridge is pulled out by turning the nipple with a wrench.
Nevertheless the demounting of the cartridge is eased by using a through–bore in the tool.

4) *protection of the leads*
The leads–end of the heating cartridge has to be protected from contact with liquids (like plastics, oil, assembly spray...) . Danger of short-circuit!!

cartridge heater (Mounting-/ Demounting advices)

side 2

5) *position of the cartridge heaters in the tool*
This distance between the cartridge heaters should not be below 1,5 ∅, the distance from the cartridge heater to the end of the tool should be more than 1 ∅.

6) *placement of the leads*
The leads should be place so that chafe and pressure marks are avoided. Moving leads (e. g. by the movement of the tool) have to be placed so that the junction is not affected.

7) *temperatur control*
The right chosement of the temperatur control is an important condition for the function and durability of the cartridge heaters. It is recommendable to use temperatur controllers with soft start in order to dry the cartridge heater after a period of storement.

[] Inquiry [] Order

Small temperature sensor's

Dr. Mennicken GmbH

Industrie-Elektronik

Company:

Officer :_____

Department :_____

telephone/fax :_____

Amount :_____ piece

Of use / placement :_____

Comes the temperature sensor or the cable in contact with aggressive media?
If yes, which? _____

Thermocouples:
[] 1 x Fe-CuNi DIN EN (J) [] 2 x Fe-CuNi DIN EN (J)
[] 1 x Fe-CuNi DIN (L) [] 2 x Fe-CuNi DIN (L)
[] 1 x NiCr-Ni DIN EN (K) [] 2 x NiCr-Ni DIN EN (K)

[] non-isolated
[] potential free

RTD's :
[] 1 x Pt 100 Ohm DIN IEC [] 2 x Pt 100 Ohm DIN IEC
[] 1 x Pt 50 Ohm DIN IEC [] 2 x Pt 50 Ohm DIN IEC

[] 2- [] 3- [] 4-wire connection

(If this information is not available, please click on the regulator to read, or at least color Specify the characteristic thread or line and the color of the connection ends):

_____

Probe tip: [] straight [] angeled version

Sketch see back, sensor type:_____

Dimensions: D=_____mm, Length of the immersion depth *(ET)*:_____mm

[] plan [] 118° drill angle
[] pointed-plan [] hemispherical

Material:
[] Ms 58 (brass) [] V4A (1.4541, 1.4571)
[] V2A (1.4301, 1.4305) [] others:_____

bayonet connector: [] yes
[] no

[] bayonet cap „m“ ID=10,5 mm
[] bayonet cap „k“ ID=12,8 mm
[] bayonet cap „n“ ID=14,8 mm
[] bayonet cap „g“ ID=16,8 mm
[] bayonet cap „gs“ID=15,5 mm,
(with pins, pin spacing 13,2 mm)

Screw-in: *thread*:_____, *overall length*:_____mm

[] slotted
[] with cross hole

[] with wrench width, SW_____

kink protection: [] yes
[] no

[] mainspring [] compression spring

Dimensions: AD=_____mm x _____mm long

Therm- or. connection- line : length:_____m

Isolation of cable
[] glasses cloth
[] R- glasses cloth (max. 550°C)
[] Teflon
[] Silikon
[] PVC

outer sheath:
[] Fe-jacket, tinned
[] stainless steel jacket
[] Teflon
[] Silikon
[] PVC
[] glasses jacket

cross-section:_____x_____qmm AD:_____mm

Ambient temperature during the thermal or connecting cable:_____°C

Terminal side of the thermocouple or lead with:
[] free ends tinnedden (verzinnt)
[] cable shoes (K)
[] Pin Terminal (SK)
[] plug (Please indicate connector design and pin assignment)

Working temperature:_____°C

---

sketch:

Date:_____ Signature:_____

Dr. Mennicken GmbH – Duisbergstr. 2 – 58339 Breckerfeld – Tel. 02338-9186-0 – Fax: 02338-9186-40
eMail: domeg@mennicken.de **– Internet:** http://www.mennicken.de

Fax reply to

Formular-Nr. 121/3 Stand 09/00

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Fax-No. 02338/ 9186-40

We are interested in the following products:

- O VMS reference measurement system
- O Thermocouples and RTDs
- O heating Elements
- O emperature controllers, recorders, Timers, measuring instruments
- O REPAIR SERVICE

  - O and solicit contact our / our Mrs / Mr _____
  - O and ask about your free quote:

_____

_____

_____

_____

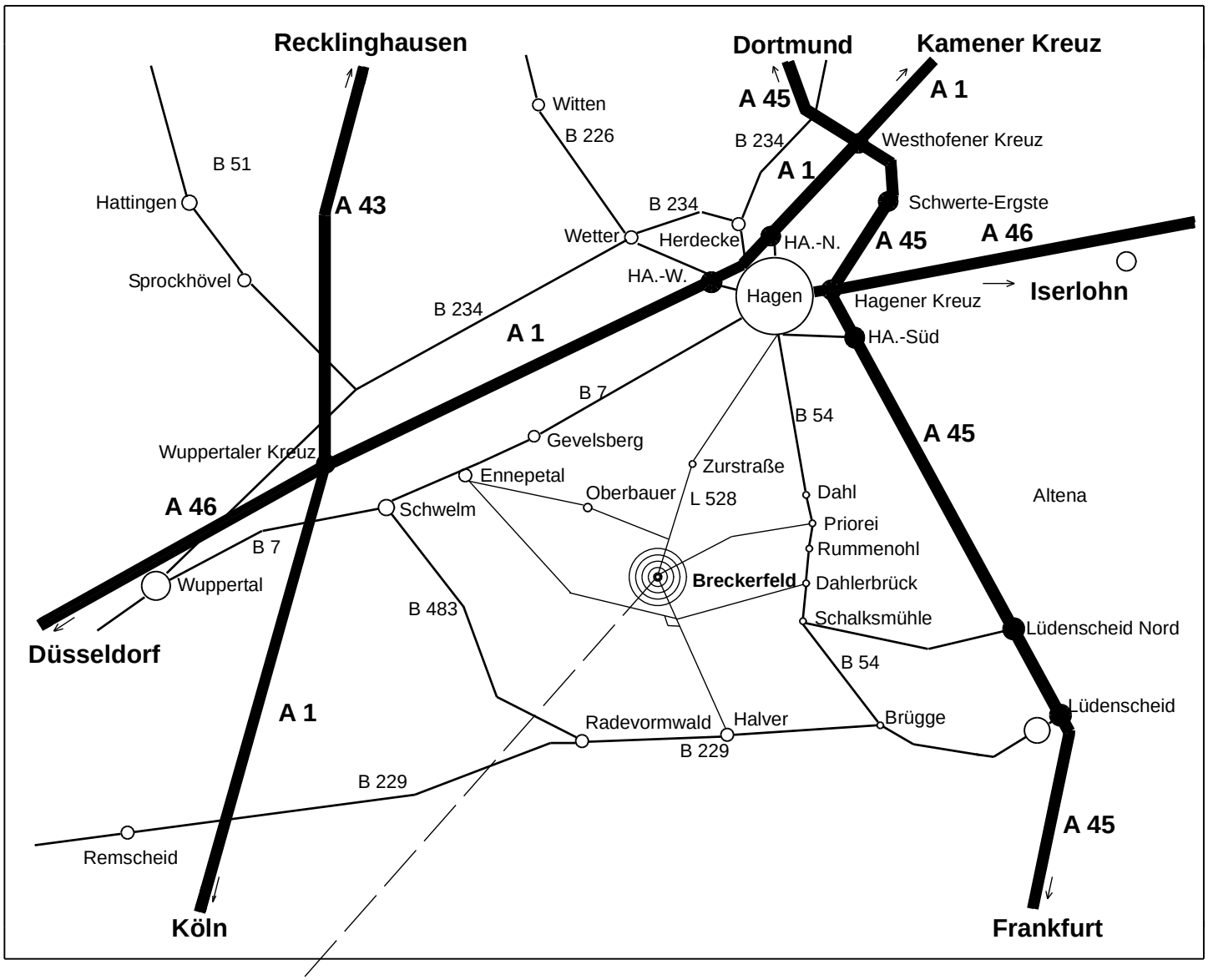
_____

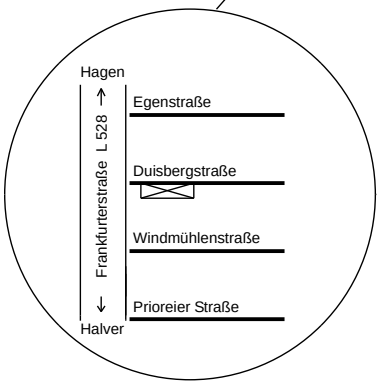
company:	Mrs/ Mr department

Many roads lead to Breckerfeld, but no way around us!

OUR LOCATION:

F.Nr. 120/2





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Temperature sensing devices (General Description of Application)

Contents

Temperature sensing devices (General Description of Application)

1. Introduction

Measurement and control of temperatures

Measuring and controlling is very important for all sectors. The values to be covered will be measured by the respective transducer i.e. thermometer, and further processed in the measuring or control device. The topic to be discussed will be confined to the field of temperature coverage and control. However, since this topic cannot be covered completely either, we are going to point out the temperature coverage and control in the plastics industry (mechanical engineering and further processing).

Temperatures can be measured by means of various methods. We merely distinguish between 2 major sectors which are most important for us:

-
- Thermoelements
- Resistance sensors

2. Coverage of temperature by means of thermoelements

Thermoelements produce a millivolt potential, also called thermovoltage, which is caused by a solid conducting combination of two conducting metals. This effect has first been discovered by Seebeck in 1821. In order to obtain a certain voltage defined within the standards, there is always a combination of identical materials.

The most important combinations being used in the plastics industry are Fe-CuNi (ferrous copper nickel), formerly called Fe-Const (ferrous constantan), and NiCr-Ni (nickel chromium nickel). Fe-CuNi can be used for temperatures up to 600°C, NiCr-Ni for up to 900°C.

2.1 Standards for thermoelements

In Germany, the millivolt potentials produced by heat including their tolerances were defined in DIN 43710 (which has been withdrawn and not been replaced by a new standard). At the prospect of a common Europe 92, DIN EN 60 584 will be used in this business. The potential values of the thermoelement combination NiCr-Ni are the same in both standards. With regard to the thermoelement Fe-CuNi, the values differ slightly from one another. I.e. e.g. DIN 43710 (which has been withdrawn and not been replaced by a new standard) defines the value of 21.11 mV for a temperature of 400°C within an ambient temperature of 20°C whereas DIN EN defines the value of 20.827 mV. This results in a deviation of approx. 6°C at this temperature.

The Fe-CuNi thermoelement according to DIN 43710 (which has been withdrawn and not been replaced by a new standard) has also been named Type “L”, whereas the new DIN EN 60584-1 (the former DIN IEC 584 was withdrawn in October 1996) calls it Type “J”. For the combination NiCr-Ni, the element has been given the distinguishing mark “K” in DIN 43710 (which has been withdrawn and not been replaced by a new standard) and in the new standard DIN EN 60584-1 (the former DIN IEC 584 was withdrawn in October 1996).

2.3

Tolerances for thermoelements

The tolerances have been defined according to the standard as follows:

Thermopairing	Distinguishing mark	Temperature	Tolerances
Fe-CuNi	(L)	up to 400 °C	± 3 °C
Fe-CuNi	(J)	-40 °C to 333 °C	± 2.5 °C
NiCr-Ni	(K)	-40 °C to 333 °C	± 2.5 °C
Fe-CuNi	(L)	400 °C to 600 °C	± 0.75 %
Fe-CuNi	(J)	333 °C to 600 °C	± 0.0075 x (t) / (t= °C)
NiCr-Ni	(K)	333 °C to 900 °C	± 0.0075 x (t) / (t= °C)

2.4 Colour coding for thermoelements

We may distinguish the thermoelement combinations by colour coding of the sheathing of the equalizer connection or thermoconduction resp. of the insulation of lead:

	Colour coding		
Thermopairing	**Sheathing**	**Insulation of lead**	
		+ plus	**- minus**
Fe-CuNi DIN (L)	blue	red	blue
Fe-CuNi IEC (J)	black	black	white
NiCr-Ni IEC (K)	green	green	white
NiCr-Ni DIN (K)	green	red	green

2.5.1 Extension of thermoelements

Connect the thermoelements and the designated thermoregulator in any case by means of the particular equalizer connections or thermoconductions corresponding to the respective element. Then you can choose a small cross section for the lead of electronic control devices. Even these leads can be extended by several meters since the control devices have a high resistive input. If the source resistance is ≤ 1000 x resistance of the low-potential circuit including the lead-in, the leads should be aligned. If the extension has been carried out by means of a usual copper conductor, new thermoelements will be produced at the conductive solid joinings. They will have an influence on the final results and falsify them if the ambient temperature increases.

2.5.2 Moreover, it should be mentioned that cutting leads or thermoconductions may cause mechanical or measuring problems. This is the reason why we ask you to give us the exact length in case of order.

2.6 Thermoelements free from and depending on potential

It is important whether the thermoleads have been connected to the test prod or not. If they have been connected to the test prod (mass), the thermoelement will be called *dependent on potential*. This construction usually has the advantage of a quicker response to heat. This effect may be enhanced by using highly argentiferous solder (increases conducting capacity of heat) at the test prod for temperatures up to approx. 400°C. If the thermoleads have not been connected to the test prod, the thermoelement will be called *free from potential*. The sensors may be required for the use of CNC controls in order to avoid the transfer of perturbations via mass into the control system.

The advantages of the small-type thermoelement depending on potential is the rapid and concentrated reception of heat at the test prod. Better resistance to vibration also plays a major role. The leads of these sensors free from potential are additionally resistant to tensile strength (strain relief). Measuring with thermoelements free from potential is slower because of the insulated internal construction of the test prod.

2.7 Further thermoelement pairings

There are further combinations in addition to the thermoelements quoted (see the table below). These combinations, however, are not used in the plastics industry.

Apart from the DIN and the IEC standards we have not mentioned the US American ANSI standard and the French NF standard yet, which will not further be explained in this context.

This is a general view of further thermoelement pairings including the respective colour coding:

Colour coding	**Sheathing**	**Insulation of lead**	
		+ plus	**- minus**
Cu-CuNi DIN (U)	brown	red	brown
Cu-CuNi IEC (T)	brown	brown	white
NiCr-CuNi DIN IEC 584	purple	purple	white
Pt13/10Rh-Pt IEC 584 R/S	orange	orange	white
Cu-CuNi ANSI (T)	blue	blue	red
Fe-CuNi ANSI (J) = BS	black	white	red
NiCr-CuNi ANSI (E)	yellow	yellow	red
Pt 13/10 Rh-Pt ANSI (R/S)	green	black	red
Pt30Rh-Pt ANSI (B)	grey	grey	red
Cu-CuNi NF (T)	blue	yellow	blue

NiCr-CuNi NF (E)	orange	yellow	orange
Fe-CuNi NF (J)	black	yellow	black
NiCr-Ni NF (K)	purple	yellow	purple
Or other aggl.	brown	yellow	brown
Or other aggl.	white	yellow	white
Pt13/10 Rh-Pt NF (R/S)	green	yellow	green
Pt30Rh-Pt NF (B)	grey	yellow	grey

3. Coverage of temperature by means of resistance sensors

Resistance sensors are based on a completely different measuring system. Heat changes the value of resistance of metals. We differentiate between NTC or PTC resistances. The plastics industry mainly uses PTC resistances. The value of resistance will increase if temperature rises. The resistance-temperature coefficient is in fact positive. The term PTC resistance can be derived from the term *positive temperature coefficient*.

The plastics industry uses the metal platinium (Pt). In most of the cases, a multiplier will be used which has a resistance of 100 Ohm at 0 °C (Pt 100).

3.1 Standards for resistance sensors

The Ohm values, which are changed when temperature changes, and their tolerances have been defined in DIN 43760 for platinium multipliers. Today, DIN EN 60751, which corresponds to the former one, is replacing this standard. We differentiate between quality A (± 1.5 °C up to 200 °C) and quality B (± 3.0 °C up to 200 °C).

Glass multipliers are used. They consist of a body made of glass which has been wrapped by a platinium wire and then casted into glass again. For economic reasons thin-film multipliers are used, which are qualitatively equivalent. These thermometers contain a tile which has been vacuum-metallized by a platinium film. This procedure may garantee the production of smaller and faster responding multipliers.

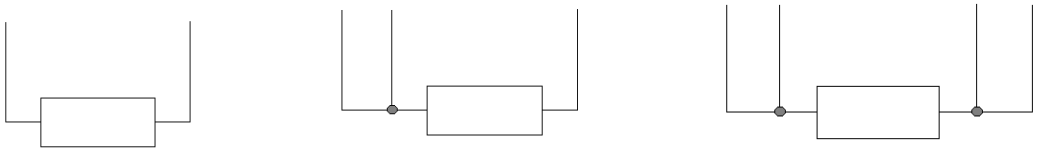
Platinium multipliers are used within a range of – 200 °C and 850 °C.

3.2 Colour coding for resistance sensors

The final ends are marked red and white, the leads do not have a particular colour. The three-conductor circuit has two red and one white ends; the four-conductor circuit has two red and white ends each.

red white red red white red red white white

Pt 100/2 Pt 100/3 Pt 100/4



3.3 Extension of resistance sensors

The resistance sensors do not need a special lead for extending the thermometer. An extension can be conducted by commercial copper leads. You are advised to choose a cross section big enough in order to avoid different values of resistivity. (For repairing this failure see 3.4).

3.4 3- or 4-wire circuit

In order to avoid measuring faults, the thermometers are equipped with 3- or 4-wire circuits. One or both leads of the multiplier are directed to the respective measuring instrument twice. The error will be compensated in the respective device.

3.5 Further resistance sensors

There are more types of multipliers which are different to those mentioned before e.g. multipliers including a resistance of 50 Ohm at 0 °C (Pt 50) or multipliers which do not have a platinium wrapping or film but nickel, copper, aluminium, silver or tungsten for determining the temperature.

The second big sector we have mentioned before is the NTC resistance. The more temperature increases the more these multipliers reduce their resistance. The resistance-temperature coefficient is negative. The term NTC resistance can be derived from the term *negative temperature coefficient*. The characteristic curve of these multipliers has not been determined by a definite standard. However, they are adapted to the respective circumstances each time. By exact adaption of the multipliers to the circumstances, an extremely precise measurement of temperature can be conducted. This type of sensors is often used in heating control systems (measurement of the flow temperature, outside temperature etc.).

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