NTC THERMISTORS

accuracy line

(extended accuracy line)

5078

Features

- Accurate over wide temperature range
- High stability
- Excellent price/performance ratio

TEMPERATURE SENSING AND CONTROL
TEMPERATURE COMPENSATION

QUICK REFERENCE DATA

Resistance value at 25 °C	2.2 kΩ to 470 kΩ
Tolerance on R_{25} value	± 2%, ± 3%, ± 5%, ± 10%
Tolerance on $B_{25/85}$ value	± 3% to ± 0.75%
Response time	1.2 s
Operating temperature range	
at zero power (continuously)	−40 to 125 °C
(for short periods) (note 1)	up to 150 °C
at maximum power (500 mW)	0 to 55 °C

APPLICATION

Temperature sensing and control.

DESCRIPTION

These thermistors have a negative temperature coefficient. The device consists of a chip with two tinned copper plated wires. It is grey lacquered and colour coded, but not insulated.

MECHANICAL DATA

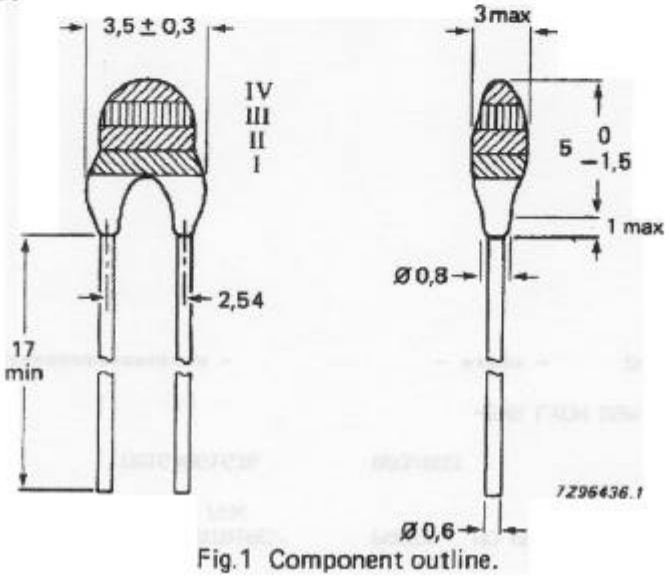


Fig.1 Component outline.

Note

1. For part of product range only; see Table 1 for details.

MECHANICAL DATA (continued)

Marking: The thermistors are marked with colour bands in accordance with Fig.1 and Table 3.

Mass: 0.22 g approx.

Mounting: in any position by soldering.

Robustness of terminations

Tensile strength	10 N
Bending (leads not allowed to break or become loose)	5 N

Soldering

Solderability	max. 240 °C, max. 4 s
Resistance to heat	max. 265 °C, max. 11 s

Resistance to solvents

Resistant to R113 at ambient temperatures in accordance with IEC Publication 68-2-45.

Impact

Free fall	1 m

Shock: 490 m/s, 11 ms, half sine-wave

Inflammability

The thermistors meet the requirements of IEC Publication 695-2-2 (1980, needle flame test)

PACKING

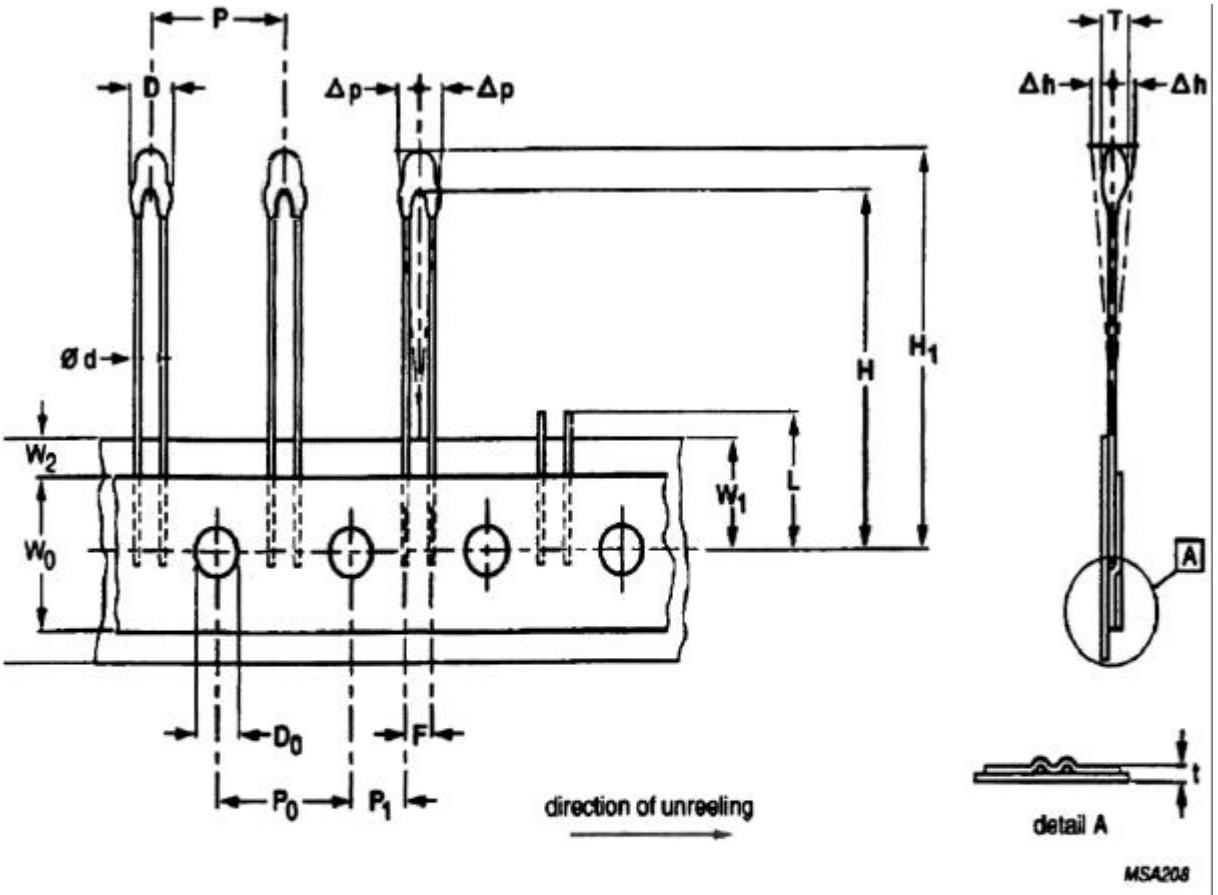
The thermistors are packed on cardboard boxes.
Products can be supplied on tape on special request:

Packing	bulk	tape and reel 1E pitch	tape and reel 2E pitch
Code number	640.6xxxx	640.4xxxx	640.3xxxx
Drawing	Fig.1	Fig.2	Fig.3
Quantity	500	1500 per reel 2 reels per box	1500 per reel 2 reels per box

Reel dimension, see Fig.4

Note

1. Max. 0.5% of the total number of the thermistors per reel may be missing, but no more than 3 consecutive positions may be vacant.

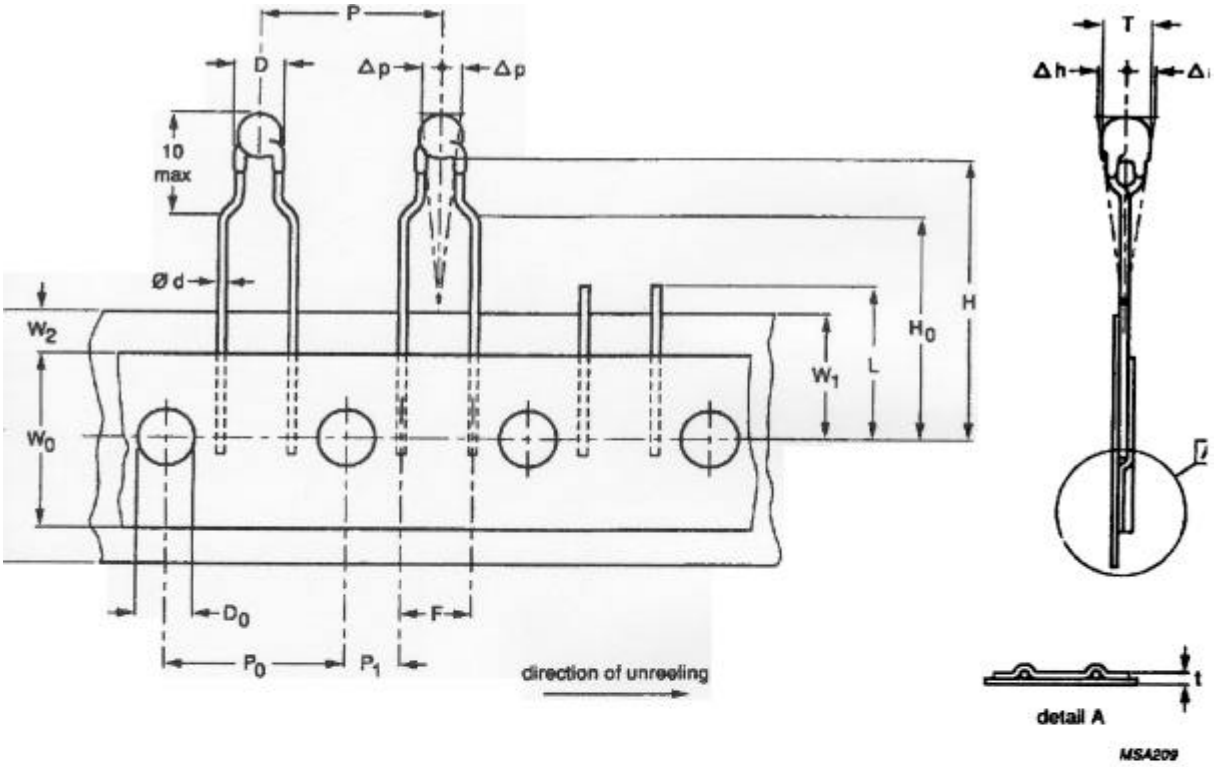


1E Pitch
640.4xxxx

Fig.2.

Table 1 Dimensional Data (refer to Fig.2)

details	symbol	dimensions nominal	tolerance	remarks
Body diameter	D	3.5	± 0.3	
Total thickness	T	3 max.		
Lead diameter	d	0.6	± 10%	
Pitch between thermistors	P	12.7	± 1	
Feed hole pitch	P_0	12.7	± 0.3	cumulative pitch error ± mm/20 p
Feed hole centre to lead centre	P_1	5.08	± 0.7	guaranteed between component/tape
Component alignment	Δp	0	± 1.3	
Lead to lead distance	F	2.54	± 0.3	guaranteed between component/tape
Component alignment	Δh	0	± 2	
Tape width	W	18	+ 1/–0.5	
Hold down tape width	W_0	12.5 min.		
Hole position	W_1	9	± 0.5	
Hold down tape position	W_2	3 max.		
Component height	H_1	32.2 max.		
Feed hole diameter	D_0	4	± 0.2	
Total tape thickness	t	0.9 max.		with cardboard tape 0.5 ± 0.1
Distance component to tape centre	H	22	–1	
Length of snipped lead	L	11 max.		
AQL: mechanical Level 11			1%	



2E Pitch
640.3xxxx
Fig.3.

Table 2 Dimensional Data (refer to Fig.3)

details	symbol	dimensions nominal	tolerance	remarks
Body diameter	D	3.5	± 0.3	
Total thickness	T	3.2 max.		
Lead diameter	d	0.6	± 10%	
Pitch between thermistors	P	12.7	± 1	
Feed hole pitch	P_0	12.7	± 0.3	cumulative pitch error ± mm/20 p
Feed hole centre to lead centre	P_1	3.85	± 0.7	guaranteed between component/tape
Component alignment	ΔP	0	± 1.3	
Lead to lead distance	F	5	+ 0.6 −0.1	guaranteed between component/tape
Component alignment	Δh	0	± 2	
Tape width	W	18	+ 1/−0.5	
Hold down tape width	W_0	12.5 min.		
Hole position	W_1	9	+0.75 −0.5	
Hold down tape position	W_2	3 max.		
Component to tape centre	H	20	+ 1	
Lead - wire clinch height	H_0	16	± 0.5	
Feed hole diameter	D_0	4	± 0.3	
Total tape thickness	t	0.7	± 0.2	with cardboarded tape 0.5 ± 0.1
Length of snipped lead	L	11 max.		
AQL: mechanical Level 11			1%	

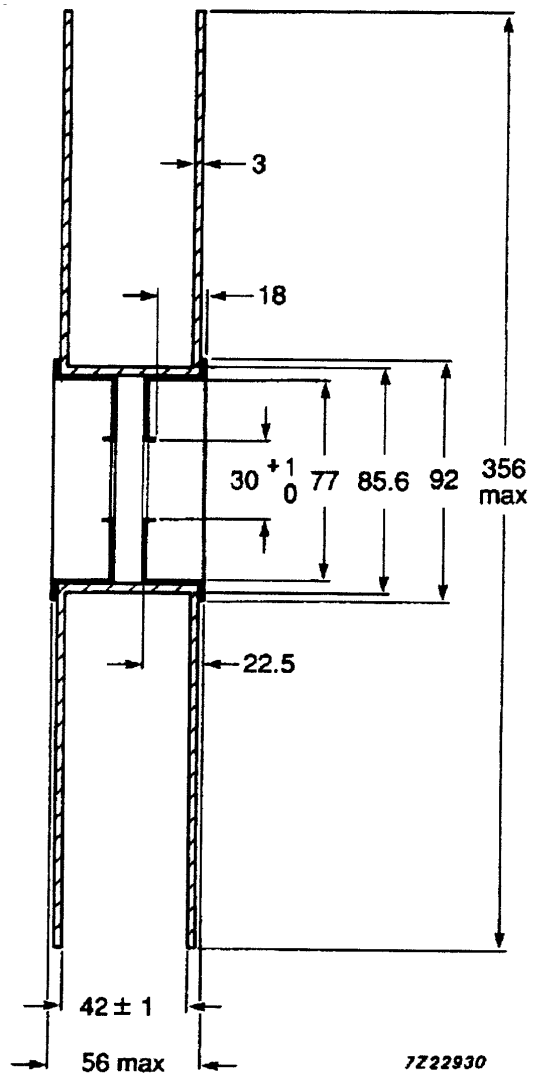


Fig.4 Dimensions of the reel.

Characteristics concerning taped thermistors

Minimum pull out force of the component	6 N
Minimum pull off force of adhesive tape	15 N
Minimum tearing force tape	
Maximum pull off force tape-reel	

Storage conditions

Storage temperature range	−25 to 40 °C
Maximum relative humidity	80 °C

ELECTRICAL DATA

Unless otherwise stated, the thermistors have been measured in accordance with IEC Publication 539 (see also Table 3).

Standard selection tolerance on R_{25}	± 2%, ± 3%, ± 5%, ± 10%
Stability	in accordance with CECC 43 000 and IEC; see Table 2
Climatic category	40/125/56
Rated dissipation	500 mW
Dissipation factor (for information only)	7 mW/K
Response time (for information only)	1.2 s (note 1)
Thermal time constant (for information only)	11 s
Operating temperature range	
at zero power (continuously)	−40 to 125 °C
(for short periods)	up to 150 °C (note 2)
at maximum power (500 mW)	0 to 55 °C

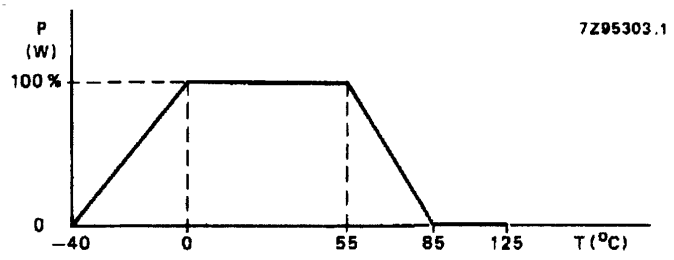


Fig.5 Derating curve.

Notes

1. Response time in silicone oil MS 200/50. This is the time needed for the sensor to reach 63.2% of the total temperature difference when subjected to a temperature change, in this case from 25 °C in air to 85 °C in oil.
2. Valid for part of product range only, see Table 3.

Table 3 Electrical data

R_{25} value kΩ	$B_{25/85}$ value	catalogue number 2322 640 6 .... R_{25} ± 2%	catalogue number 2322 640 6 .... R_{25} ± 3%	catalogue number 2322 640 6 .... R_{25} ± 5%	catalogue number 2322 640 6 .... R_{25} ± 10%	colour code band I (note 2)	colour code band II (note 2)	colour code band III (note 2)
2.2	3977 K ± 0.75%	.4222	.6222	.3222	.2222	red	red	red
2.7 (note 1)	3977 K ± 0.75%	.4272	.6272	.3272	.2272	red	violet	red
3.3 (note 1)	3977 K ± 0.75%	.4332	.6332	.3332	.2332	orange	orange	red
4.7 (note 1)	3977 K ± 0.75%	.4472	.6472	.3472	.2472	yellow	violet	red
6.8 (note 1)	3977 K ± 0.75%	.4682	.6682	.3682	.2682	blue	grey	red
10 (note 1)	3977 K ± 0.75%	.4103	.6103	.3101	.2103	brown	black	orange
12	3740 K ± 3%	.4123	.6123	.3123	.2123	brown	red	orange
15	3740 K ± 3%	.4153	.6153	.3153	.2153	brown	green	orange
22	3740 K ± 3%	.4223	.6223	.3223	.2223	red	red	orange
33 (note 1)	4090 K ± 1.5%	.4333	.6333	.3333	.2333	orange	orange	orange
47 (note 1)	4090 K ± 1.5%	.4473	.6473	.3473	.2473	yellow	violet	orange
68 (note 1)	4190 K ± 2%		.6683	.3683	.2683	blue	grey	orange
100 (note 1)	4190 K ± 2%		.6104	.3104	.2104	brown	black	yellow
150	4370 K ± 3%			.3154	.2154	brown	green	yellow
220	4370 K ± 3%			.3224	.2224	red	red	yellow
330	4570 K ± 3%			.3334	.2334	orange	orange	yellow
470	4570 K ± 3%			.3474	.2474	yellow	violet	yellow

Table 4 Stability data

CECC	IEC	test	procedure	drift (requirement)	drift (typical (note 1)
D3 4.20.1		endurance	25 °C, 1000 hours	$\Delta R/R < 1\%$	$\Delta R/R = 0.1\%$
	68-2-1	endurance	−40 °C, 1000 hours	$\Delta R/R < 1\%$	$\Delta R/R = 0.15\%$
	539-gen	endurance	500 mW, 55 °C, 1000 hours	$\Delta R/R < 3\%$ (note 2)	$\Delta R/R = 0.5\%$
	68-2-2	dry heat, steady state	125 °C, 1000 hours	$\Delta R/R < 3\%$	$\Delta R/R = 0.1\%$
D1 4.19	68-2-3	damp heat, steady state	56 days at 40 °C, 90-95% RH	$\Delta R/R < 3\%$	$\Delta R/R = -0.2\%$
C2 4.14	68-2-14	rapid change of temperature	−40 °C to 125 °C, 50 cycles	$\Delta R/R < 2\%$	$\Delta R/R = 0.1\%$

Notes to Table 3

1. Operating temperature range at zero power is 150 °C max.
2. Dependent upon R_{25} tolerance, the band IV is colour coded as follows:
   For R_{25} ± 2%, band IV is coloured red
   For R_{25} ± 3%, band IV is coloured orange
   For R_{25} ± 5%, band IV is coloured gold
   For R_{25} ± 10%, band IV is coloured silver

Note to Table 4

1. Typical drift is based on sample products with a $B_{25/85}$ value of 3977 K and a $B_{25/75}$ value of 3965 K.
2. For $R_{25} \geq 100$ kΩ the drift requirement is $\Delta R/R < 5\%$.

R_T values and tolerance on R_T values

These thermistors have a narrow tolerance on the B value, the result of which provides a very small tolerance on the nominal resistance value over a wide temperature range. For this reason, the usual graphs of R = f(T) are replaced by Table 5 together with a formula with which the characteristics can be calculated with high accuracy.

Formula to determine nominal resistance values

The resistance values at intermediate temperatures can be calculated using the 'Steinhart and Hart' equation:

$$R_T = (R_{25}/R_{ref}) \times e^{\left[\sqrt[3]{(\sqrt{E^2 + D} - E)} - \sqrt[3]{(\sqrt{E^2 + D} + E)}\right]}$$

Table 4 shows a list of different 'E', 'D', and 'R_{ref}' values for different B values. In the Table, the value of 'T' is the temperature in K.

Table 5 Values to be used with 'Steinhart and Hart' formula

B value (K)	E	D	R_{ref} (kΩ)
3977	$5766.8 - [5.0541 \times 10^6/T]$	4.7692×10^8	10
3740	$3498.5 - [4.1026 \times 10^6/T]$	2.7574×10^8	22
4090	$4194.7 - [4.5876 \times 10^6/T]$	2.8108×10^8	47
4190	$4169.4 - [5.0802 \times 10^6/T]$	3.4453×10^8	100
4370	$4185.0 - [5.2748 \times 10^6/T]$	3.1658×10^8	220
4570	$4404.9 - [5.6266 \times 10^6/T]$	3.1666×10^8	470

Determination of the resistance/temperature deviation from the nominal

The complete resistance deviation is obtained by combining the 'R_{25} tolerance' value with the 'resistance deviation due to B tolerance' value.

Let X = R_{25} tolerance
Y = resistance deviation due to B tolerance
Z = complete resistance deviation

$$Z = \{[1 + (X/100)] \times [1 + (Y/100)] - 1\} \times 100$$

or

$$Z = X + Y \text{ (approximation)}$$

TC = temperature coefficient
ΔT = temperature deviation

so

$$\Delta T = Z/TC$$

Example: (at 0 °C)

Let $X = 5\%$

$Y = 0.89\%$ (see Table 6)

$TC = 5.08\%/K$ (see Table 6)

Then

$$Z = \{ [1 + (5/100)] \times [1 + (0.89/100)] - 1 \} \times 100$$
$$= \{ [1 + 0.05] \times [1 + 0.0089] - 1 \} \times 100$$
$$= \{ [1.05 \times 1.0089] - 1 \} \times 100$$
$$= \{ 1.0593 - 1 \} \times 100$$
$$= 0.0593 \times 100$$
$$= 5.93\%$$

or, (by approximation)

$$Z = X + Y$$
$$= 5 + 0.89$$
$$= 5.89\%$$

$$\Delta T = Z/TC$$
$$= 5.93/5.08$$
$$= 1.167\ (1.17)$$

So, a NTC having a R_{25} value = 10 kΩ has a value of 32.51 kΩ between ± 1.17 °C.

Table 6 Resistance values at intermediate temperatures

temp.	ratio R_T/R_{25}	$\Delta R/B_{tol}$	temp. coeff.	resistance value (kΩ) for 2322 640 . . . . . (note 1)					
°C		%	%/K	6.222	6.272	6.332	6.472	6.682	6.103
−40	32.84	2.64	6.57	72.2400	88.67	108.4	154.3	223.3	328.4
−35	23.77	2.40	6.36	52.2800	64.18	78.44	111.7	161.6	237.7
−30	17.39	2.16	6.15	38.2500	46.95	57.39	81.72	118.3	173.9
−25	12.85	1.93	5.95	28.2700	34.70	42.41	60.40	87.38	128.5
−20	9.589	1.71	5.76	21.0900	25.89	31.64	45.07	65.21	95.89
−15	7.223	1.49	5.58	15.8900	19.50	23.84	33.95	49.12	72.23
−10	5.489	1.29	5.40	12.0700	14.82	18.11	25.80	37.33	54.89
−5	4.207	1.08	5.24	9.2540	11.36	13.88	19.77	28.61	42.07
0	3.251	0.89	5.08	7.1510	8.778	10.73	15.28	22.11	32.51
5	2.531	0.70	4.92	5.5690	6.834	8.352	11.90	17.21	25.31
10	1.986	0.52	4.78	4.3690	5.362	6.554	9.334	13.50	19.86
15	1.569	0.34	4.64	3.4520	4.236	5.178	7.374	10.67	15.69
20	1.249	0.17	4.50	2.7470	3.372	4.122	5.870	8.493	12.49
25	1.000	0.00	4.37	2.2000	2.700	3.300	4.700	6.800	10.00
30	0.8060	0.16	4.25	1.7730	2.176	2.660	3.788	5.481	8.060
35	0.6536	0.32	4.13	1.4380	1.765	2.157	3.072	4.444	6.536
40	0.5331	0.47	4.02	1.1730	1.439	1.759	2.506	3.625	5.331
45	0.4373	0.62	3.91	0.9619	1.181	1.443	2.055	2.973	4.373
50	0.3606	0.77	3.80	0.7933	0.9736	1.190	1.695	2.452	3.606
55	0.2989	0.91	3.70	0.6576	0.8070	0.9864	1.405	2.033	2.989
60	0.2490	1.05	3.60	0.5478	0.6723	0.8217	1.170	1.693	2.490
65	0.2085	1.18	3.51	0.4586	0.5630	0.6881	0.9800	1.418	2.085
70	0.1753	1.31	3.42	0.3857	0.4733	0.5785	0.8239	1.192	1.753
75	0.1481	1.44	3.33	0.3258	0.3999	0.4887	0.6961	1.007	1.481
80	0.1256	1.57	3.25	0.2764	0.3391	0.4145	0.5903	0.8541	1.256
85	0.1070	1.69	3.16	0.2355	0.2889	0.3531	0.5029	0.7276	1.070
90	0.09155	1.81	3.09	0.2014	0.2472	0.3021	0.4303	0.6225	0.9155
95	0.07861	1.93	3.01	0.1729	0.2122	0.2594	0.3695	0.5345	0.7861
100	0.06775	2.04	2.94	0.1490	0.1829	0.2236	0.3184	0.4607	0.6775
105	0.05860	2.15	2.87	0.1289	0.1582	0.1934	0.2754	0.3985	0.5860
110	0.05086	2.26	2.80	0.1119	0.1373	0.1678	0.2390	0.3458	0.5086
115	0.04429	2.37	2.73	0.0974	0.1196	0.1462	0.2082	0.3012	0.4429
120	0.03870	2.47	2.67	0.0851	0.1045	0.1277	0.1819	0.2632	0.3870
125	0.03392	2.57	2.61	0.0746	0.0916	0.1119	0.1594	0.2307	0.3392
130	0.02982	2.67	2.55	0.0655	0.0805	0.0984	0.1402	0.2028	0.2982
135	0.02629	2.77	2.49	0.0578	0.0710	0.0868	0.1236	0.1788	0.2629
140	0.02324	2.86	2.43	0.0511	0.0627	0.0767	0.1092	0.1580	0.2324
145	0.02061	2.95	2.38	0.0453	0.0556	0.0680	0.0969	0.1402	0.2061
150	0.01832	3.05	2.33	0.0403	0.0495	0.0605	0.0861	0.1246	0.1832

Note

1. Replace dot in catalogue number by one of the following, depending on tolerance on required R_{25} fo
   4 for tolerance of ± 2% (from 2.2 kΩ to 47 kΩ)
   6 for tolerance of ± 3% (from 2.2 kΩ to 100 kΩ)
   3 for tolerance of ± 5%
   2 for tolerance of ± 10%

Table 6 (continued)

temperature	ratio R_T/R_{25}	deviation in R value due to B tolerance	temperature coefficient	resistance value (kΩ) for 2322 640 . . . . . (note 1)		
°C		%	%/K	6.123	6.153	6.223
−40	25.80	10.24	6.09	309.5	386.9	567.5
−35	19.12	9.26	5.89	229.4	286.8	420.6
−30	14.31	8.31	5.70	171.7	214.6	314.8
−25	10.81	7.40	5.52	129.7	162.1	237.8
−20	8.235	6.53	5.35	98.82	123.5	181.2
−15	6.328	5.69	5.19	75.94	94.92	139.2
−10	4.902	4.88	5.03	58.82	73.52	107.8
−5	3.826	4.11	4.88	45.91	57.39	84.17
0	3.009	3.36	4.73	36.10	45.13	66.19
5	2.383	2.64	4.60	28.59	35.74	52.42
10	1.900	1.94	4.46	22.79	28.49	41.79
15	1.524	1.27	4.34	18.29	22.87	33.54
20	1.231	0.63	4.21	14.77	18.46	27.08
25	1.000	0.00	4.10	12.00	15.00	22.00
30	0.8171	0.61	3.98	9.805	12.26	17.98
35	0.6713	1.20	3.88	8.055	10.07	14.77
40	0.5545	1.79	3.77	6.653	8.317	12.20
45	0.4603	2.35	3.67	5.524	6.905	10.13
50	0.3840	2.91	3.57	4.609	5.761	8.449
55	0.3219	3.46	3.48	3.863	4.829	7.083
60	0.2711	3.99	3.39	3.253	4.067	5.964
65	0.2293	4.52	3.30	2.752	3.440	5.045
70	0.1948	5.03	3.22	2.337	2.922	4.285
75	0.1661	5.53	3.14	1.994	2.492	3.655
80	0.1423	6.02	3.06	1.707	2.134	3.130
85	0.1223	6.51	2.99	1.467	1.834	2.690
90	0.1055	6.98	2.92	1.266	1.582	2.321
95	0.09133	7.44	2.85	1.096	1.370	2.009
100	0.07935	7.90	2.78	0.9522	1.190	1.746
105	0.06917	8.34	2.71	0.8300	1.037	1.522
110	0.06048	8.78	2.65	0.7258	0.9072	1.331
115	0.05305	9.21	2.59	0.6366	0.7958	1.167
120	0.04668	9.63	2.53	0.5602	0.7002	1.027
125	0.04119	10.04	2.47	0.4943	0.6179	0.9061

Note

1. Replace dot in catalogue number by one of the following, depending on tolerance on required R_{25} valu
   - 4 for a tolerance of ± 2% (from 2.2 kΩ to 47 kΩ)
   - 6 for a tolerance of ± 3% (from 2.2 kΩ to 100 kΩ)
   - 3 for a tolerance of ± 5%
   - 2 for a tolerance of ± 10%

temperature	ratio R_T/R_{25}	deviation in R value due to B tolerance	temperature coefficient	resistance value (kΩ) for 2322 640 . . . . . (note 1)	
°C		%	%/K	6.333	6.473
−40	33.74	5.42	6.55	1114	1586
−35	24.44	4.91	6.34	806.7	1149
−30	17.89	4.42	6.15	590.3	840.7
−25	13.21	3.95	5.96	436.1	621
−20	9.852	3.49	5.78	325.1	463
−15	7.41	3.05	5.61	244.5	348.3
−10	5.620	2.62	5.45	185.5	264.1
−5	4.297	2.21	5.29	141.8	202
0	3.311	1.81	5.14	109.3	155.6
5	2.571	1.43	4.99	84.83	120.8
10	2.01	1.05	4.85	66.33	94.47
15	1.582	. 69	4.72	52.21	74.37
20	1.254	. 34	4.59	41.38	58.93
25	1	0	4.46	33.00	47
30	. 8024	. 33	4.34	26.48	37.71
35	. 6476	. 65	4.23	21.37	30.44
40	. 5256	. 97	4.12	17.35	24.70
45	. 4289	1.28	4.01	14.16	20.16
50	. 3519	1.58	3.91	11.61	16.54
55	. 2902	1.87	3.81	9.575	13.64
60	. 2404	2.16	3.71	7.934	11.3
65	. 2001	2.44	3.62	6.605	9.407
70	. 1674	2.72	3.53	5.524	7.867
75	. 1406	2.99	3.44	4.640	6.608
80	. 1186	3.25	3.36	3.913	5.574
85	. 10045	3.51	3.28	3.315	4.721
90	. 08541	3.76	3.2	2.819	4.014
95	. 07291	4.01	3.13	2.406	3.427
100	. 06246	4.25	3.06	2.061	2.936
105	. 05371	4.48	2.98	1.772	2.524
110	. 04634	4.72	2.92	1.529	2.178
115	. 04012	4.94	2.85	1.324	1.885
120	. 03484	5.16	2.79	1.150	1.637
125	. 03035	5.38	2.73	1.001	1.427
130	. 02653	5.6	2.67	. 8754	1.247
135	. 02325	5.8	2.61	. 7673	1.093
140	. 02044	6.01	2.55	. 6744	. 9605
145	. 01801	6.21	2.5	. 5944	. 8466
150	. 01592	6.41	2.44	. 5254	. 7482

Note

1. Replace dot in catalogue number by one of the following, depending on tolerance on required R_{25} va
   - 4 for a tolerance of ± 2% (from 2.2 kΩ to 47 kΩ)
   - 6 for a tolerance of ± 3% (from 2.2 kΩ to 100 kΩ)
   - 3 for a tolerance of ± 5%
   - 2 for a tolerance of ± 10%

Table 6 (continued)

temperature	ratio R_T/R_{25}	deviation in R value due to B tolerance	temperature coefficient	resistance value (kΩ) for 2322 640 . . . . . (note 1)	
°C		%	%/K	6.683	6.104
−40	36.65	7.47	6.70	2492	3665
−35	26.35	6.76	6.49	1792	2635
−30	19.14	6.08	6.29	1302	1914
−25	14.04	5.43	6.10	954.7	1404
−20	10.40	4.79	5.92	707.2	1040
−15	7.769	4.19	5.74	528.3	776.9
−10	5.855	3.60	5.57	398.1	585.5
−5	4.449	3.03	5.41	302.5	444.9
0	3.407	2.48	5.26	231.7	340.7
5	2.629	1.95	5.11	178.8	262.9
10	2.044	1.44	4.97	139.0	204.4
15	1.600	0.94	4.83	108.8	160.0
20	1.261	0.46	4.70	85.75	126.1
25	1.000	0.00	4.57	68.00	100.0
30	0.7982	0.45	4.45	54.28	79.82
35	0.6410	0.89	4.35	43.59	64.10
40	0.5176	1.33	4.22	35.20	51.76
45	0.4204	1.75	4.11	28.59	42.04
50	0.3432	2.16	4.00	23.34	34.32
55	0.2817	2.57	3.90	19.16	28.17
60	0.2323	2.96	3.80	15.80	23.23
65	0.1925	3.35	3.71	13.09	19.25
70	0.1603	3.73	3.62	10.90	16.03
75	0.1340	4.10	3.53	9.113	13.40
80	0.1126	4.46	3.45	7.654	11.26
85	0.09498	4.82	3.36	6.458	9.498
90	0.08043	5.17	3.28	5.469	8.043
95	0.06838	5.51	3.21	4.650	6.838
100	0.05836	5.85	3.13	3.969	5.836
105	0.04999	6.18	3.06	3.399	4.999
110	0.04297	6.50	2.99	2.922	4.297
115	0.03706	6.81	2.92	2.520	3.706
120	0.03207	7.12	2.86	2.181	3.207
125	0.02784	7.43	2.80	1.893	2.784

Note

1. Replace dot in catalogue number by one of the following, depending on tolerance on required R_{25} value
   - 4 for a tolerance of ± 2% (from 2.2 kΩ to 47 kΩ)
   - 6 for a tolerance of ± 3% (from 2.2 kΩ to 100 kΩ)
   - 3 for a tolerance of ± 5%
   - 2 for a tolerance of ± 10%

temperature	ratio R_T/R_{25}	deviation in R value due to B tolerance	temperature coefficient	resistance value (kΩ) for 2322 640 . . . . . (note 1)	
°C		- %	%/K	6.154	6.224
−40	41.38	11.82	6.89	6206	9103
−35	29.47	10.68	6.68	4420	6483
−30	21.20	9.60	6.48	3180	4664
−25	15.41	8.55	6.29	2311	3389
−20	11.30	7.55	6.11	1695	2486
−15	8.363	6.58	5.93	1254	1840
−10	6.243	5.65	5.76	936.5	1374
−5	4.700	4.75	5.60	704.9	1034
0	3.566	3.89	5.44	534.9	784.5
5	2.726	3.05	5.29	409.0	599.8
10	2.100	2.25	5.15	315.0	462.0
15	1.629	1.47	5.01	244.3	358.4
20	1.272	0.72	4.88	190.8	279.9
25	1.000	0.00	4.75	150.0	220.0
30	0.7911	0.71	4.62	118.7	174.0
35	0.6296	1.40	4.51	94.44	138.5
40	0.5040	2.08	4.39	75.60	110.9
45	0.4058	2.74	4.28	60.87	89.27
50	0.3285	3.40	4.17	49.27	72.26
55	0.2673	4.04	4.07	40.09	58.80
60	0.2186	4.67	3.97	32.79	48.09
65	0.1797	5.28	3.87	26.95	39.53
70	0.1484	5.89	3.78	22.25	32.64
75	0.1231	6.49	3.69	18.46	27.08
80	0.1026	7.07	3.60	15.38	22.56
85	0.08582	7.64	3.52	12.87	18.88
90	0.07211	8.21	3.44	10.82	15.86
95	0.06083	8.76	3.36	9.125	13.38
100	0.05152	9.31	3.28	7.728	11.33
105	0.04380	9.84	3.21	6.570	9.635
110	0.03737	10.36	3.14	5.605	8.221
115	0.03199	10.88	3.07	4.799	7.038
120	0.02749	11.39	3.00	4.124	6.048
125	0.02369	11.88	2.94	3.554	5.212

Note

1. Replace dot in catalogue number by one of the following, depending on tolerance on required R_{25}
   4 for a tolerance of ± 2% (from 2.2 kΩ to 47 kΩ)
   6 for a tolerance of ± 3% (from 2.2 kΩ to 100 kΩ)
   3 for a tolerance of ± 5%
   2 for a tolerance of ± 10%

Table 6 (continued)

temperature	ratio R_T/R_{25}	deviation in R value due to B tolerance	temperature coefficient	resistance value (kΩ) for 2322 640 . . . . . (note 1)	
°C		%	%/K	6.334	6.474
−40	47.68	12.29	7.13	15730	22410
−35	33.56	11.12	6.91	11080	15770
−30	23.87	9.99	6.71	7878	11220
−25	17.15	8.90	6.52	5659	8060
−20	12.44	7.86	6.33	4104	5846
−15	9.103	6.85	6.15	3004	4279
−10	6.721	5.88	5.98	2218	3159
−5	5.005	4.95	5.82	1651	2352
0	3.756	4.05	5.66	1240	1766
5	2.842	3.18	5.50	937.8	1336
10	2.166	2.35	5.36	714.7	1018
15	1.663	1.54	5.22	548.6	781.4
20	1.285	0.76	5.08	424.1	604.0
25	1.000	0.00	4.95	330.0	470.0
30	0.7832	0.74	4.82	258.4	368.1
35	0.6172	1.46	4.70	203.7	290.1
40	0.4893	2.17	4.59	161.5	229.9
45	0.3901	2.86	4.47	128.7	183.3
50	0.3128	3.55	4.36	103.2	147.0
55	0.2521	4.22	4.26	83.21	118.5
60	0.2043	4.88	4.15	67.42	96.03
65	0.1664	5.53	4.06	54.91	78.20
70	0.1362	6.16	3.96	44.93	64.00
75	0.1120	6.79	3.87	36.94	52.62
80	0.09247	7.40	3.78	30.51	43.46
85	0.07671	8.01	3.69	25.31	36.05
90	0.06391	8.60	3.61	21.09	30.04
95	0.05346	9.18	3.53	17.64	25.13
100	0.04490	9.76	3.45	14.82	21.10
105	0.03786	10.32	3.37	12.49	17.79
110	0.03204	10.87	3.30	10.57	15.06
115	0.02722	11.42	3.23	8.983	12.79
120	0.02320	11.95	3.16	7.656	10.90
125	0.01984	12.48	3.09	6.547	9.325

Note

1. Replace dot in catalogue number by one of the following, depending on tolerance on required R_{25} v
   4 for a tolerance of ± 2% (from 2.2 kΩ to 47 kΩ)
   6 for a tolerance of ± 3% (from 2.2 kΩ to 100 kΩ)
   3 for a tolerance of ± 5%
   2 for a tolerance of ± 10%

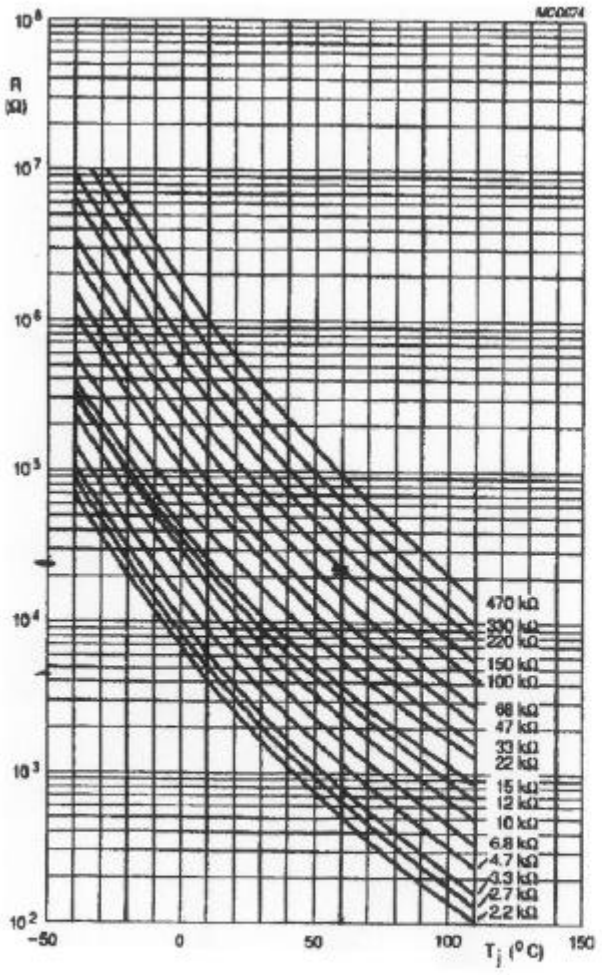


Fig.6 Typical resistance/temperature characteristics.

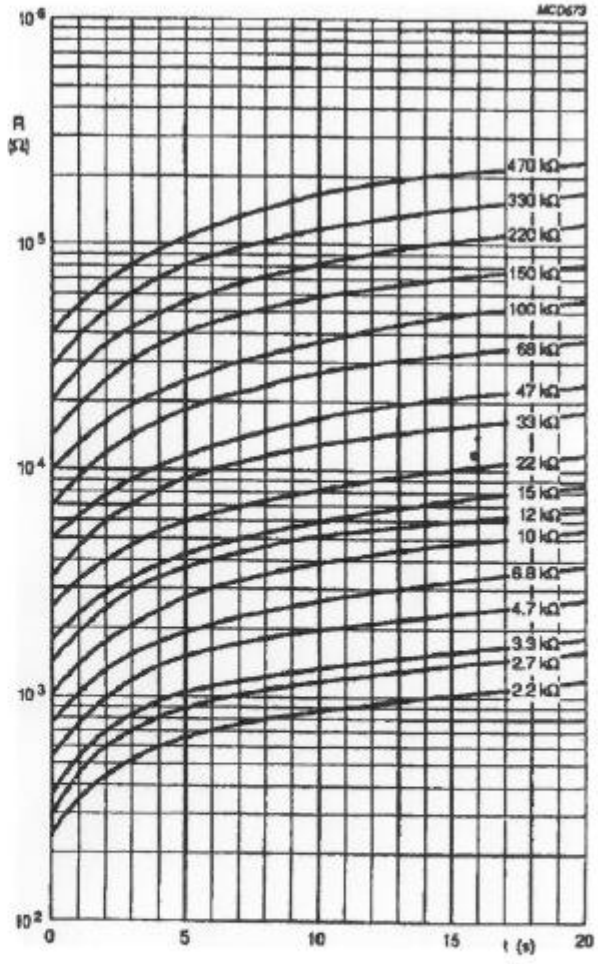
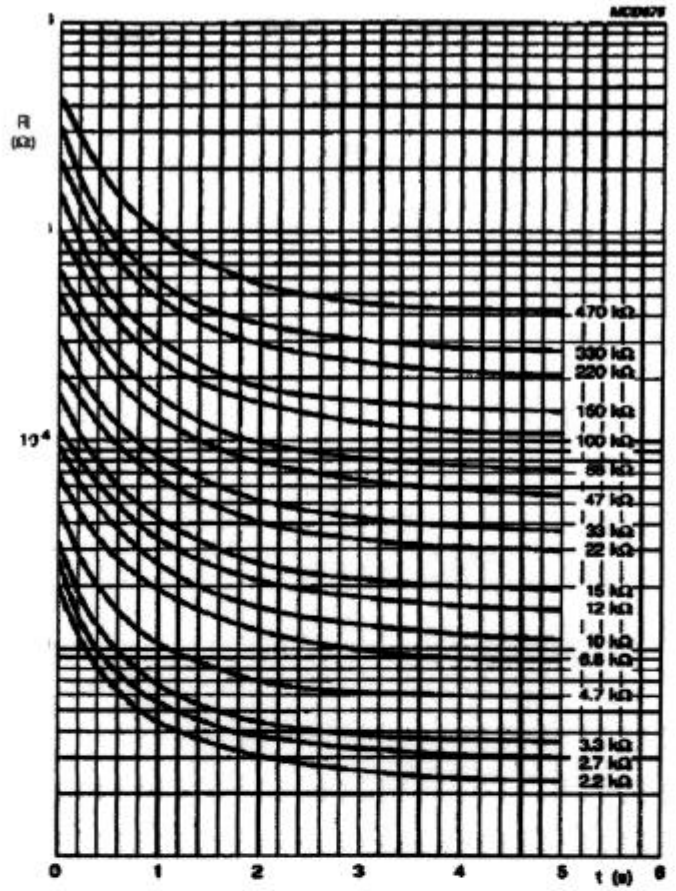


Fig.7 Typical resistance/cooling time characteristics. T_{amb} = + 25 °C, still air, T_{start} = + 85 °C.



ig.8 Typical resistance/heating time characteristics from ir of 25 °C to of 85 °C.

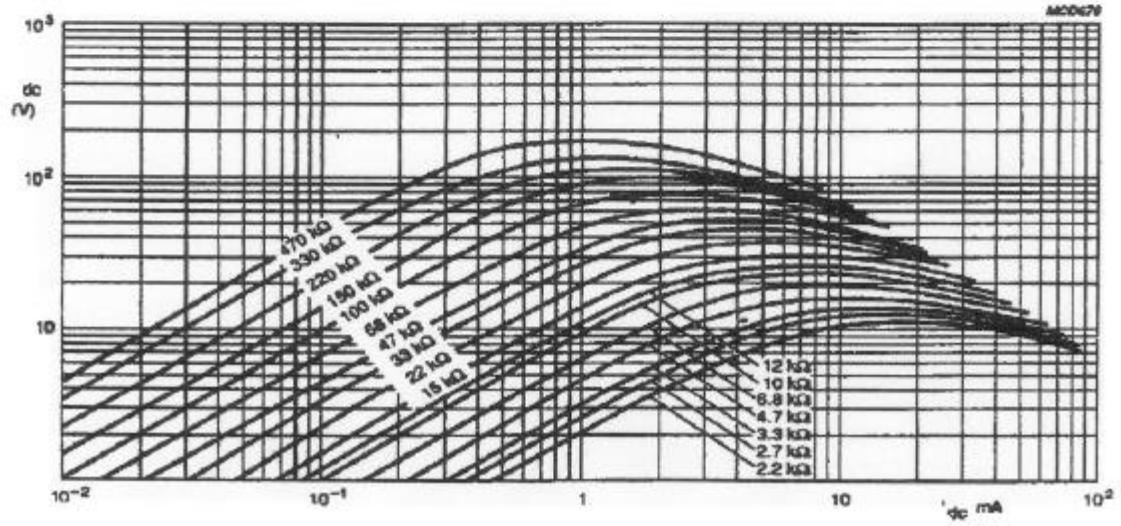


Fig.9 Typ cal voltage/current characteristics T_{amb} + 25 °C, still air

09 0344 600 97%