

DATA SHEET

2322 640 6....

NTC thermistors, accuracy line

Product specification
Supersedes data of April 1995
File under BCcomponents, BC02

1998 Sep 04

NTC thermistors, accuracy line

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FEATURES

- Accuracy over a wide temperature range
- High stability over a long life
- Excellent price/performance ratio.

APPLICATION

- Temperature sensing and control.

DESCRIPTION

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

MARKING

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

MOUNTING

By soldering in any position.

QUICK REFERENCE DATA

PARAMETER	VALUE
Resistance value at 25 °C	3.3 Ω to 470 kΩ
Tolerance on R ₂₅ -value	±2%; ±3%; ±5%; ±10%
Tolerance on B _{25/85} -value	±0.5% to ±3%
Maximum dissipation	500 mW
Response time	1.2 s
Operating temperature range:	
at zero dissipation; continuously	−40 to +125 °C
at zero dissipation; for short periods	≤150 °C
at maximum dissipation (500 mW)	0 to 55 °C
Climatic category	40/125/56
Mass	≈0.22 g

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MECHANICAL DATA

Outline

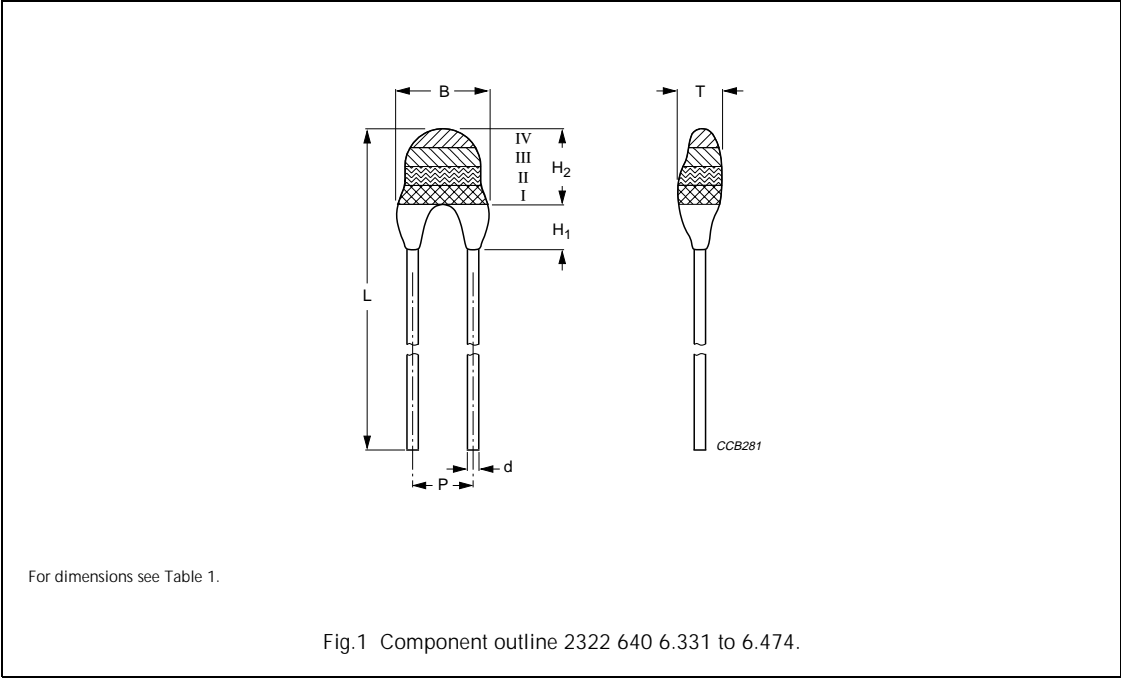


Table 1 Physical dimensions for relevant type; see Fig.1

CODE NUMBER 2322 640	B _{max} (mm)	d (mm)	H ₁ (mm)		H _{2 max} (mm)	L (mm)	P (mm)	T _{max} (mm)
			MIN.	MAX.				
6.331 to 6.474	3.3 ±0.5	0.6 ±0.06	—	2.0 ±1.0	6.0	24 ±1.5	2.54	3.0
6.338 to 6.221	5.0	0.6 ±0.06	1.0	4.0	6.0	24 ±1.5	2.54	4.0

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ORDERING INFORMATION

Table 2 Code numbers and relevant packaging quantities

PARAMETER	BULK	TAPE AND REEL ⁽¹⁾ 1e pitch	TAPE AND REEL ⁽¹⁾ 2e pitch
	2322 640 6....	2322 640 4....	2322 640 3....
Quantity	500	1 500 per reel, 2 reels per box	1 500 per reel, 2 reels per box

Note

- The maximum number of empty places per reel shall not exceed 0.5% of the total number of components per reel. No more than three consecutive positions may be vacant.

Table 3 R₂₅-values, catalogue numbers and coding

R ₂₅ (Ω)	B _{25/85} -VALUE	CATALOGUE NUMBER 2322 640 6....				COLOUR CODE (see Fig.1 and note 1)		
		R ₂₅ ±2%	R ₂₅ ±3%	R ₂₅ ±5%	R ₂₅ ±10%	I	II	III
3.3	2880 K ±3%	4338	6338	3338	2338	orange	orange	gold
4.7	2880 K ±3%	4478	6478	3478	2478	yellow	violet	gold
6.8	2880 K ±3%	4688	6688	3688	2688	blue	grey	gold
10	2990 K ±3%	4109	6109	3109	2109	brown	black	black
15	3041 K ±3%	4159	6159	3159	2159	brown	green	black
22	3136 K ±3%	4229	6229	3229	2229	red	red	black
33	3390 K ±3%	4339	6339	3339	2339	orange	orange	black
47	3390 K ±3%	4479	6479	3479	2479	yellow	violet	black
68	3390 K ±3%	4689	6689	3689	2689	blue	grey	black
100	3560 K ±0.75%	4101	6101	3101	2101	brown	black	brown
150	3560 K ±0.75%	4151	6151	3151	2151	brown	green	brown
220	3560 K ±0.75%	4221	6221	3221	2221	red	red	brown
330	3560 K ±0.75%	4331	6331	3331	2331	orange	orange	brown
470	3560 K ±0.5%	4471	6471	3471	2471	yellow	violet	brown
680	3560 K ±0.5%	4681	6681	3681	2681	blue	grey	brown
1 000	3528 K ±0.5%	4102	6102	3102	2102	brown	black	red
1 500	3528 K ±0.5%	4152	6152	3152	2152	brown	green	red
2 000	3528 K ±0.5%	4202	6202	3202	2202	red	black	red
2 200	3 977 K ±0.75%	4222	6222	3222	2222	red	red	red

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R_{25} (Ω)	$B_{25/85}$ -VALUE	CATALOGUE NUMBER 2322 640 6....				COLOUR CODE (see Fig.1 and note 1)		
		$R_{25} \pm 2\%$	$R_{25} \pm 3\%$	$R_{25} \pm 5\%$	$R_{25} \pm 10\%$	I	II	III
2700	3977 K $\pm 0.75\%$	4272	6272	3272	2272	red	violet	red
3300	3977 K $\pm 0.75\%$	4332	6332	3332	2332	orange	orange	red
4700	3977 K $\pm 0.75\%$	4472	6472	3472	2472	yellow	violet	red
6800	3977 K $\pm 0.75\%$	4682	6682	3682	2682	blue	grey	red
10000	3977 K $\pm 0.75\%$	4103	6103	3103	2103	brown	black	orange
12000	3740 K $\pm 2\%$	4123	6123	3123	2123	brown	red	orange
15000	3740 K $\pm 2\%$	4153	6153	3153	2153	brown	green	orange
22000	3740 K $\pm 2\%$	4223	6223	3223	2223	red	red	orange
33000	4090 K $\pm 1.5\%$	4333	6333	3333	2333	orange	orange	orange
47000	4090 K $\pm 1.5\%$	4473	6473	3473	2473	yellow	violet	orange
68000	4190 K $\pm 1.5\%$	4683	6683	3683	2683	blue	grey	orange
100000	4190 K $\pm 1.5\%$	4104	6104	3104	2104	brown	black	yellow
150000	4370 K $\pm 2.5\%$	4154	6154	3154	2154	brown	green	yellow
220000	4370 K $\pm 2.5\%$	4224	6224	3224	2224	red	red	yellow
330000	4570 K $\pm 1.5\%$	4334	6334	3334	2334	orange	orange	yellow
470000	4570 K $\pm 1.5\%$	4474	6474	3474	2474	yellow	violet	yellow

Note

1. Dependent upon R_{25} -tolerance, the band IV is coloured as follows:

- for $R_{25} \pm 2\%$, band IV is coloured red
- for $R_{25} \pm 3\%$, band IV is coloured orange
- for $R_{25} \pm 5\%$, band IV is coloured gold
- for $R_{25} \pm 10\%$, band IV is coloured silver.

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R_T value and tolerance

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 Tables 5 through 17, together with a formula to calculate the characteristics with a high precision.

Formulae to determine nominal resistance values⁽¹⁾

The resistance values at intermediate temperatures, or the operating temperature values, can be calculated using the following interpolation laws (extended "Steinhart and Hart"):

$$R(T) = R_{\text{ref}} \times e^{A + B/T + C/T^2 + D/T^3} \quad (1)$$

$$T(R) = \left(A_1 + B_1 \ln \frac{R}{R_{\text{ref}}} + C_1 \ln^2 \frac{R}{R_{\text{ref}}} + D_1 \ln^3 \frac{R}{R_{\text{ref}}} \right)^{-1} \quad (2)$$

where:

A, B, C, D, A₁, B₁, C₁ and D₁ are constant values depending on the material concerned; see Table 4.

R_{ref} is the resistance value at a reference temperature (in this event 25 °C).

T is the temperature in K.

(1) Formulae numbered (1) and (2) are interchangeable with an error of max. 0.005 °C in the range 25 °C to 125 °C and max. 0.015 °C in the range -40 °C to +25 °C.

Determination of the resistance/temperature deviation from nominal value

The total resistance deviation is obtained by combining the 'R₂₅-tolerance' and the 'resistance deviation due to B-tolerance'.

When:

X = R₂₅-tolerance

Y = resistance deviation due to B-tolerance

Z = complete resistance deviation,

$$\text{then: } Z = \left[\left(1 + \frac{X}{100} \right) \times \left(1 + \frac{Y}{100} \right) - 1 \right] \times 100\%$$

or $Z \approx X + Y$.

When:

TC = temperature coefficient

ΔT = temperature deviation,

$$\text{then: } \Delta T = \frac{Z}{TC}$$

The temperature tolerances are plotted in Figs 3, 4, 5, 6, 7 and 8.

Example: at 0 °C, assume X = 5%, Y = 0.89% and TC = 5.08%/K (see Table 12), then:

$$Z = \left\{ \left[1 + \frac{5}{100} \right] \times \left[1 + \frac{0.89}{100} \right] - 1 \right\} \times 100\%$$

$$= \{ 1.05 \times 1.0089 - 1 \} \times 100\% = 5.9345\% (\approx 5.93\%)$$

$$\Delta T = \frac{Z}{TC} = \frac{5.93}{5.08} = 1.167 \text{ °C } (\approx 1.17 \text{ °C})$$

A NTC with a R₂₅-value of 10 kΩ has a value of 32.56 kΩ between -1.17 and +1.17 °C.

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Table 4 Parameters for determining nominal resistance values

B _{25/85} -VALUE (K)	A	B (K)	C (10 ⁵ K ²)	D (10 ⁶ K ³)	A ₁ (10 ⁻³)	B ₁ (10 ⁻⁴ K ⁻¹)	C ₁ (10 ⁻⁶ K ⁻²)	D ₁ (10 ⁻⁷ K ⁻³)
2880	-9.094	2251.74	229098	-27.4482	3.354016	3.495020	2.095959	4.260615
2990	-10.2296	2887.62	132336	-25.0251	3.354016	3.415560	4.955455	4.364236
3041	-11.1334	3658.73	-102895	0.516652	3.354016	3.349290	3.683843	7.050455
3136	-12.4493	4702.74	-402687	31.96830	3.354016	3.243880	2.658012	-2.70156
3390	-12.6814	4391.97	-232807	15.09643	3.354016	2.993410	2.135133	-8.05672
3528	-12.060	3.688	-0.076	-5.915	3.354016	2.909670	1.632136	0.719220
3528	-21.095	11.930	-25.139	248.120	3.354016	2.933908	3.494314	-7.71269
3560	-13.072	4.191	-0.472	-11.993	3.354016	2.884193	4.118032	1.786790
3740	-13.897	4.558	-0.983	-7.522	3.354016	2.744032	3.666944	1.375492
3977	-14.634	4.792	-1.153	-3.731	3.354016	2.569355	2.626311	0.675278
4090	-15.532	5.230	-1.605	-5.414	3.354016	2.519107	3.510939	1.105179
4190	-16.035	5.459	-1.911	-3.328	3.354016	2.460382	3.405377	1.034240
4370	-16.872	5.759	-1.943	-6.869	3.354016	2.367720	3.585140	1.255349
4570	-17.644	6.023	-2.032	-7.184	3.354016	2.264097	3.278184	1.097628

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Table 12 Resistance values at intermediate temperatures

T _{oper} (°C)	R _T /R ₂₅	ΔR DUE TO B-TOLERANCE (%)	TC (%/K)	R ₂₅ (kΩ)					
				2322 640; see Table 17, note 1					
				6.222	6.272	6.332	6.472	6.682	6.103
−40	33.21	2.66	6.57	73.06	89.67	109.6	156.1	225.8	332.1
−35	23.99	2.41	6.36	52.78	64.77	79.17	112.8	163.1	240.0
−30	17.52	2.17	6.15	38.55	47.31	57.82	82.35	119.1	175.2
−25	12.93	1.94	5.95	28.44	34.91	42.67	60.77	87.92	129.3
−20	9.636	1.71	5.76	21.20	26.02	31.80	45.30	65.53	96.36
−15	7.250	1.50	5.58	15.95	19.58	23.93	34.08	49.30	72.50
−10	5.505	1.29	5.40	12.11	14.86	18.16	25.87	37.43	55.05
−5	4.216	1.08	5.24	9.275	11.38	13.91	19.81	28.67	42.16
0	3.255	0.89	5.08	7.162	8.790	10.74	15.30	22.14	32.56
5	2.534	0.70	4.92	5.575	6.842	8.362	11.91	17.23	25.34
10	1.987	0.52	4.78	4.372	5.366	6.558	9.340	13.51	19.87
15	1.570	0.34	4.64	3.454	4.239	5.181	7.378	10.67	15.70
20	1.249	0.17	4.50	2.747	3.372	4.121	5.869	8.492	12.49
25	1.000	0.00	4.37	2.200	2.700	3.300	4.700	6.800	10.00
30	0.8059	0.16	4.25	1.773	2.176	2.660	3.788	5.480	8.059
35	0.6535	0.32	4.13	1.438	1.764	2.156	3.072	4.444	6.535
40	0.5330	0.47	4.02	1.173	1.439	1.759	2.505	3.624	5.330
45	0.4372	0.62	3.91	0.9618	1.180	1.443	2.055	2.972	4.372
50	0.3605	0.77	3.80	0.7932	0.973	1.190	1.694	2.451	3.606
55	0.2989	0.91	3.70	0.6575	0.807	0.9863	1.405	2.032	2.989
60	0.2490	1.05	3.60	0.5478	0.672	0.8217	1.170	1.693	2.490
65	0.2084	1.18	3.51	0.4586	0.562	0.6879	0.9797	1.417	2.084
70	0.1753	1.31	3.42	0.3857	0.473	0.5785	0.8239	1.192	1.753
75	0.1481	1.44	3.33	0.3258	0.399	0.4887	0.6960	1.007	1.481
80	0.1256	1.57	3.25	0.2764	0.339	0.4146	0.5905	0.8544	1.256
85	0.1070	1.69	3.16	0.2355	0.289	0.3532	0.5031	0.7278	1.070
90	0.09154	1.81	3.09	0.2014	0.247	0.3021	0.4303	0.6225	0.9154
95	0.07860	1.93	3.01	0.1729	0.212	0.2594	0.3694	0.5345	0.7860
100	0.06773	2.04	2.94	0.1490	0.182	0.2235	0.3183	0.4607	0.6773
105	0.05858	2.15	2.87	0.1289	0.158	0.1933	0.2753	0.3983	0.5858
110	0.05083	2.26	2.80	0.1118	0.137	0.1677	0.2389	0.3457	0.5083
115	0.04426	2.37	2.73	0.0974	0.1195	0.1461	0.2080	0.3010	0.4426
120	0.03866	2.47	2.67	0.0851	0.1044	0.1276	0.1817	0.2629	0.3866
125	0.03387	2.57	2.61	0.0745	0.0915	0.1118	0.1592	0.2303	0.3387
130	0.02977	2.67	2.55	0.0655	0.0804	0.0982	0.1399	0.2024	0.2977
135	0.02624	2.77	2.49	0.0577	0.0709	0.0866	0.1233	0.1784	0.2624
140	0.02319	2.86	2.43	0.0510	0.0626	0.0765	0.1090	0.1577	0.2319
145	0.02055	2.96	2.38	0.0452	0.0555	0.0678	0.0966	0.1398	0.2055
150	0.01826	3.05	2.33	0.0402	0.0493	0.0603	0.0858	0.1242	0.1826

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ELECTRICAL CHARACTERISTICS

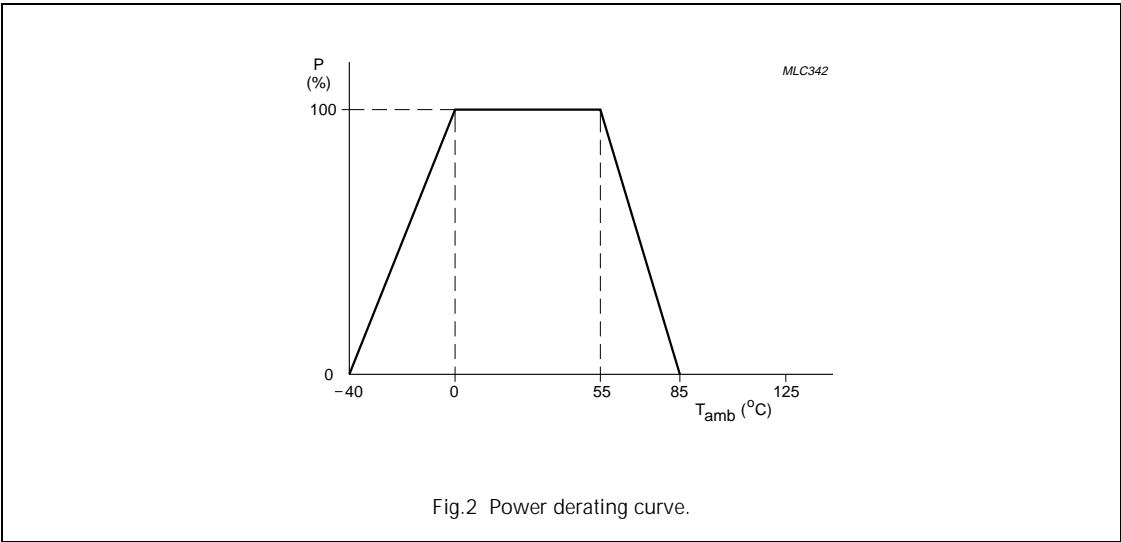
Unless otherwise stated, measurements are in accordance with “IEC publication 60539”, see also Table 3.
Stability is in accordance with “CECC 43 000” and “IEC 60068-2”, see Table 18.

PARAMETER	VALUE
Standard selection tolerance on R ₂₅	±2%; ±3%; ±5% and ±10%
Climatic category	40/125/56
Maximum dissipation	500 mW
Dissipation factor δ (for information only)	7 mW/K
Response time (for information only); note 1	1.2 s
Thermal time constant τ (for information only)	11 s
Operating temperature range: at zero dissipation; continuously at zero dissipation at maximum dissipation	−40 to +125 °C ≤150 °C 0 to +55 °C

Note

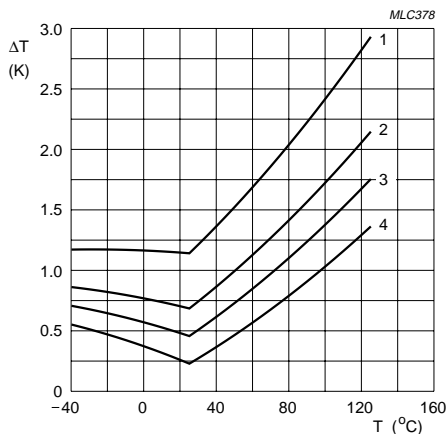
1. Response time in silicone oil MS200/50. This is the time needed for the sensor to reach 63.2% of the total temperature difference when subjected to a temperature change from 25 °C in air to 85 °C in oil.

Derating



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Curves valid for 2.2 to 10 k Ω .

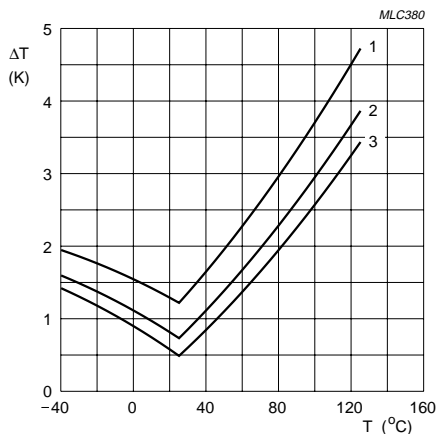
Curve 1: $\Delta R_{25}/R_{25} = 5\%$.

Curve 2: $\Delta R_{25}/R_{25} = 3\%$.

Curve 3: $\Delta R_{25}/R_{25} = 2\%$.

Curve 4: $\Delta R_{25}/R_{25} = 1\%$ (for 2322 640 5.... series only).

Fig.3 Temperature deviation as a function of the ambient temperature.



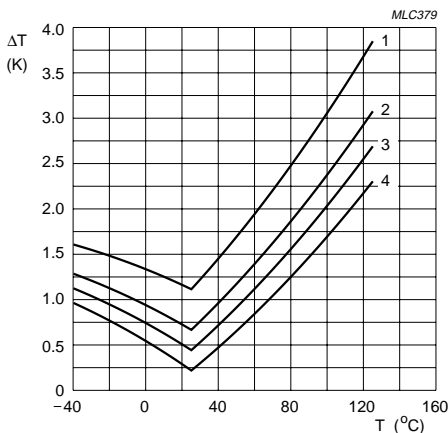
Curves valid for 12 to 22 k Ω .

Curve 1: $\Delta R_{25}/R_{25} = 5\%$.

Curve 2: $\Delta R_{25}/R_{25} = 3\%$.

Curve 3: $\Delta R_{25}/R_{25} = 2\%$.

Fig.4 Temperature deviation as a function of the ambient temperature.



Curves valid for 33 to 47 k Ω .

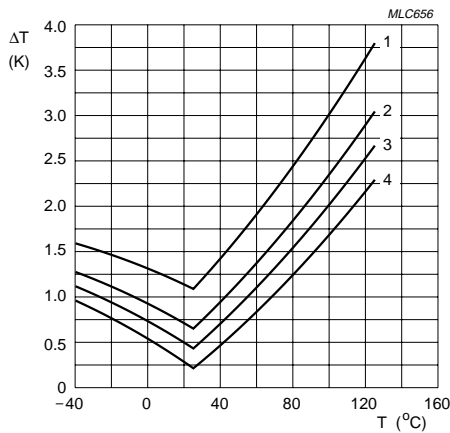
Curve 1: $\Delta R_{25}/R_{25} = 5\%$.

Curve 2: $\Delta R_{25}/R_{25} = 3\%$.

Curve 3: $\Delta R_{25}/R_{25} = 2\%$.

Curve 4: $\Delta R_{25}/R_{25} = 1\%$ (for 2322 640 5.... series only).

Fig.5 Temperature deviation as a function of the ambient temperature.



Curves valid for 68 to 100 k Ω .

Curve 1: $\Delta R_{25}/R_{25} = 5\%$.

Curve 2: $\Delta R_{25}/R_{25} = 3\%$.

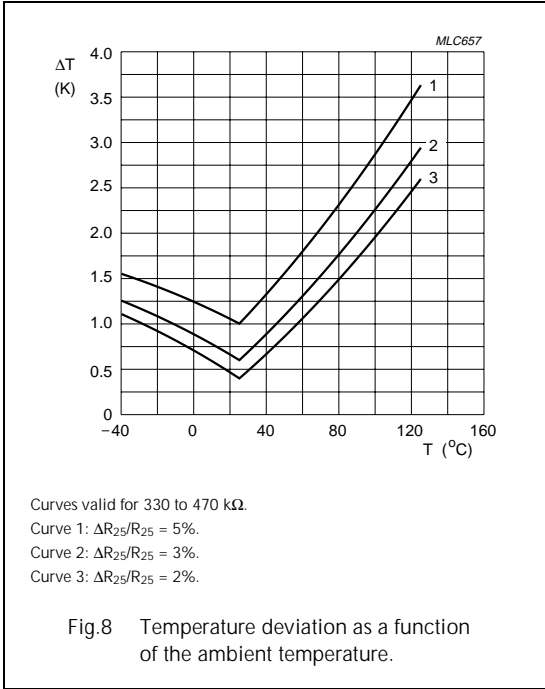
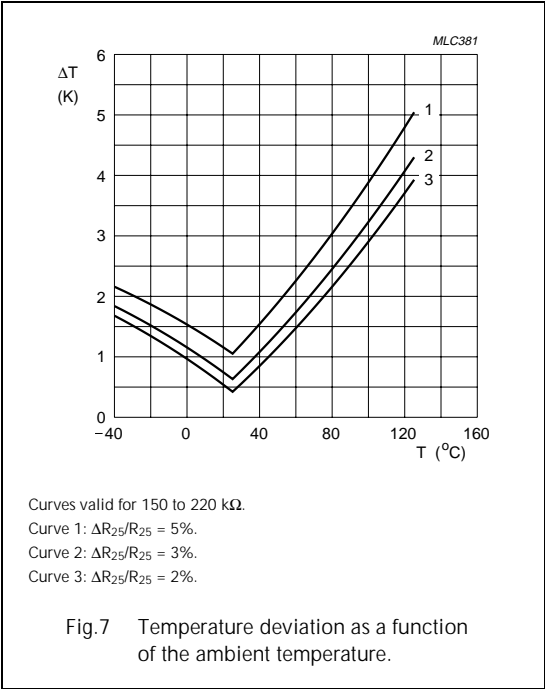
Curve 3: $\Delta R_{25}/R_{25} = 2\%$.

Curve 4: $\Delta R_{25}/R_{25} = 1\%$ (for 2322 640 5.... series only).

Fig.6 Temperature deviation as a function of the ambient temperature.

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TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with "IEC publication 60068-2; Environmental testing", except where indicated.

Table 18 Stability tests

CECC 32 100 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
D3; 4.20.1		endurance	25 °C; 1000 hours	$\Delta R/R < 1\%$
	1	endurance	-40 °C; 1000 hours	$\Delta R/R < 1\%$
	539	endurance	500 mW; 55 °C; 1000 hours	$\Delta R/R < 3\%$ (note 1)
	2	dry heat, (steady state)	125 °C; 1000 hours	$\Delta R/R < 3\%$
D1; 4.19	3	damp heat (steady state)	56 days at 40 °C; 90 to 95% RH	$\Delta R/R < 3\%$
C2; 4.14	14	rapid change of temperature	-40 °C to +125 °C; 50 cycles	$\Delta R/R < 2\%$
Other applicable tests				
	21	robustness of leads: tensile strength bending	loading force 10 N loading force 5 N	$\Delta R/R \leq 1\%$
	58	soldering: solderability resistance to heat	240 °C max.; duration 4 s max. 265 °C max.; duration 5 s max.	$\Delta R/R \leq 1\%$ (note 2)
	27	impact	free fall; 1 m	$\Delta R/R \leq 1\%$
	29	shock	490 m/s; half sinewave	$\Delta R/R \leq 1\%$
	45	resistance to solvent (isopropanol)	ambient temp for 5 min; 5 N with hydrophylic cotton wool	no traces of lacquer on cotton wool
	6	vibration	1.5 mm peak to peak: 10 to 58 Hz 10 gp: 50 to 500 Hz 1 octave/min. 2 hours in each direction in three orthogonal directions	no visible damage $\Delta R/R < 1\%$
	2	inflammability	1980, needle flame test	non-flammable

Notes

- For $R_{25} \geq 100 \text{ k}\Omega$ the drift requirement is $\Delta R/R < 5\%$.
- For R_{25} from 2.2 k Ω to 10 k Ω , requirement is $\pm 2\%$ max.