

# NTC Thermistors

## SMD

### NTCG series

Type:            NTCG06(0603)  
                  NTCG10(1005)  
                  NTCG16(1608)  
                  NTCG20(2012)

Issue date:     May 2009

- All specifications are subject to change without notice.
- Conformity to RoHS Directive: This means that, in conformity with EU Directive 2002/95/EC, lead, cadmium, mercury, hexavalent chromium, and specific bromine-based flame retardants, PBB and PBDE, have not been used, except for exempted applications.

# NTC Thermistors

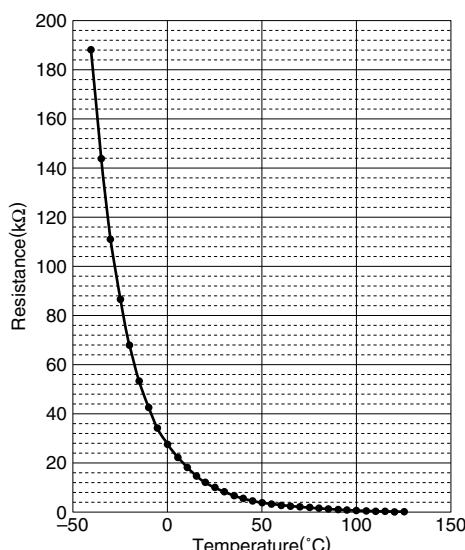
Conformity to RoHS Directive

## NTCG Series(SMD, Pb Free) NTCG06/10/16/20 Types

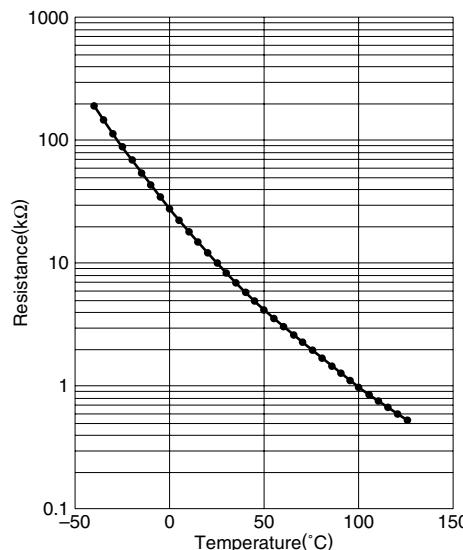
NTC(Negative Temperature Coefficient) Thermistors are manufactured from sintered metal oxides. Each thermistor consists of a combination of two to four of the following materials: Manganese, Nickel, Cobalt and Copper. NTC thermistors are semiconductor resistors that exhibit decreasing resistance characteristics with increasing temperature. TDK thermistors have low thermal time constants which result in extremely high rates of resistance change to accurately track the temperature.

### CHARACTERISTICS OF THE NTC THERMISTOR

Y-axis: Linear



Y-axis: Log.



### FEATURES

- Small sized 0603 type (L0.6×W0.3×T0.3mm) series are available.
- Lead (Pb) free product.  
By using lead-less terminal electrodes and electroplating (Ni-Sn), this product realized excellent solderability and soldering heat resistance, comparing with the conventional eutectic mixture solder and lead-free solder (Sn/Ag/Cu, etc.).
- Product Conforming to RoHS Directive  
Conformity to RoHS Directive: This means that, in conformity with EU Directive 2002/95/EC, lead, cadmium, mercury, hexavalent chromium, and specific bromine-based flame retardants, PBB and PBDE, have not been used, except for exempted applications.
- Good solderability.
- Layered internal electrode structure.
- Product series provides a wide range of resistances and B constants.
- Good stability of resistance value after soldering.
- The 0603, 1608 and 1005 types provide 3 different shapes with identical resistance-temperature characteristics.
- Attains less than low floating capacitance (using TCXO) in the high frequency region.
- Conformity to RoHS Directive: This means that, in conformity with EU Directive 2002/95/EC, lead, cadmium, mercury, hexavalent chromium, and specific bromine-based flame retardants, PBB and PBDE, have not been used, except for exempted applications.

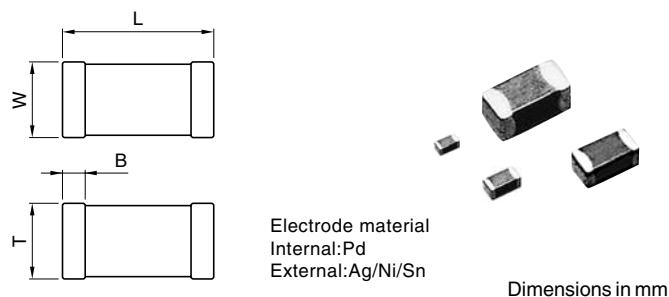
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### APPLICATIONS

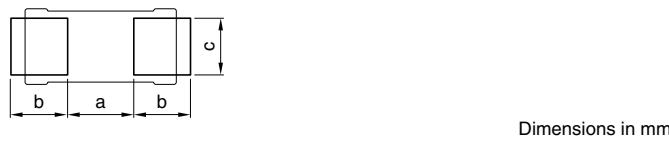
- Temperature sensor
- Temperature compensation

### USED SET

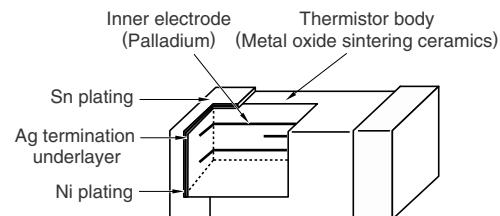
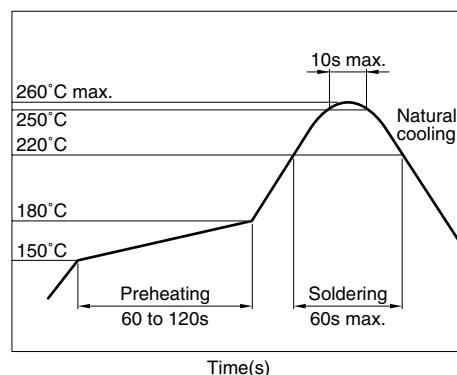
- Equipment related to mobile communication  
TCXOs (temperature compensated type quartz oscillator), RF circuits (power amp circuits, temperature monitoring circuits), LCD panel temperature compensation circuits, battery pack temperature compensation circuits
- Computer related equipment  
CPU periphery temperature monitoring circuits, temperature compensation circuit of optical pickup for DVD writing, temperature compensated circuit in HDD
- DVC/DSC devices  
Auto-focus circuits, plunger peripheral circuits, battery pack temperature control circuits
- Equipment related to car audio  
Various types of pickup temperature compensation circuits, temperature compensation for various types of circuits
- Optical communication related equipment  
Laser transmission circuit temperature compensation

**SHAPES AND DIMENSIONS**


Type	L	W	T	B
0603	0.6±0.03	0.3±0.03	0.3±0.03	0.1 min.
1005	1±0.05	0.5±0.05	0.5±0.05	0.1 min.
1608	1.6±0.1	0.8±0.1	0.8±0.1	0.2 min.
2012	2±0.2	1.25±0.2	0.7±0.2	0.2 min.

**RECOMMENDED PC BOARD PATTERN**


Type	a	b	c
0603	0.25 to 0.35	0.2 to 0.3	0.25 to 0.35
1005	0.3 to 0.5	0.35 to 0.45	0.4 to 0.6
1608	0.6 to 0.8	0.6 to 0.8	0.6 to 0.8
2012	0.9 to 1.2	0.7 to 0.9	0.9 to 1.2

**STRUCTURAL DIAGRAM**

**RECOMMENDED REFLOW SOLDERING CONDITIONS**


**RESISTANCE VALUE RANGE**

Resistance Type \n	10Ω	100Ω	1kΩ	10kΩ	100kΩ	1MΩ
0603	30Ω	100Ω	1kΩ	10kΩ	100kΩ	1MΩ
1005	30Ω	100Ω	1kΩ	10kΩ	100kΩ	1MΩ
1608	30Ω	100Ω	1kΩ	10kΩ	100kΩ	1MΩ
2012		470Ω			150kΩ	

**TYPICAL USED SET AND TDK PRODUCT NAMES**

Used set	Applied circuit	Resistance (R25)	B constant (B25/85)	TDK recommended part number
Mobile communication devices	TCXO(Temperature compensated crystal oscillator)	Low-temperature area compensated circuit	30Ω to 100Ω	3250K(2800K) NTCG103EH400H
		High-temperature area compensated circuit	1.0kΩ to 3.0kΩ	4100K to 4500K NTCG104BH102H
	Power amplifier module	Power amplifier temperature compensated circuit	30Ω to 10kΩ	3250K to 4500K NTCG104KH202J
	LCD	LCD temperature compensated circuit	22kΩ to 1MΩ	4550K to 4750K NTCG104LH473J
	Temperature monitor	Various-circuit temperature compensated circuit	10kΩ to 470kΩ	4100K to 4750K NTCG104BH103J
Computer devices	Battery pack	Battery temperature monitor and charging control circuit	10kΩ to 100kΩ	3435K to 4550K NTCG103JF103F
	CPU	CPU temperature monitor	10kΩ to 1MΩ	3435K to 4550K NTCG103JF103F
	LCD	LCD temperature compensated circuit	22kΩ to 1MΩ	4550K to 4750K NTCG104LH473J
	HDD	Pickup temperature compensated circuit	10kΩ to 100kΩ	3435K to 4550K NTCG103JF103F
	ODD	CD or DVD write current compensated circuit	10kΩ to 100kΩ	3435K to 4550K NTCG103JF103F
DVC, DSC	Battery pack	Battery temperature monitor and charging control circuit	10kΩ to 100kΩ	3435K to 4550K NTCG103JF103F
	Auto focus	Driving circuit temperature compensated circuit	1.0kΩ to 15kΩ	3435K to 4100K NTCG104BH103J
	Iris stop	Hole element temperature compensated circuit	10kΩ to 100kΩ	3435K to 4550K NTCG104LH473J
Car audio unit	Battery pack	Battery temperature monitor and charging control circuit	10kΩ to 100kΩ	3435K to 4550K NTCG103JF103F
	Car audio unit	Car CD or MD	22kΩ to 150kΩ	4550K NTCG104LH473J
	Optical transmission system	Laser transmitter or receiver temperature compensated circuit	1.0kΩ to 150kΩ	4100K to 4550K NTCG104LH154J
Printer		Ink viscosity controller	10kΩ to 47kΩ	3435K to 4550K NTCG104LH473H

**LIST OF SERIES BY TYPE**

Type	B constant(K)	Nominal resistance(Ω) [at 25°C]					
		10Ω	100Ω	1kΩ	10kΩ	100kΩ	1MΩ
0603	2800K		100Ω				
	3250K	30Ω	150Ω				
	3435K				10kΩ		
	3650K	220Ω	680Ω				
	1005			1.0kΩ	3.0kΩ		
	4100K					115kΩ	
	1608			3.3kΩ			
	4550K						150kΩ
	4750K					220kΩ	1MΩ
2012	4500K			2.0kΩ	3.0kΩ		
	3250K		470Ω	680Ω			
	3100K			1.0kΩ	1.5kΩ		
	3300K				2.2kΩ	3.3kΩ	
	3450K				4.7kΩ	6.8kΩ	
	3650K					10kΩ	15kΩ
	3850K					22kΩ	33kΩ
	4000K					47kΩ	68kΩ
	4150K					100kΩ	150kΩ

\* B constant is calculated from the resistance at 25°C and 85°C

The B constant indicates the magnitude of a change in a zero-load resistance value to a temperature, and is obtained based on arbitrary two temperatures in resistance-to-temperature characteristics.

**B constant calculation formula**

$$B = \frac{\ln R_1 - \ln R_2}{(1/T_1) - (1/T_2)}$$

B: B Constant (K)  
T1: Arbitrary temperature (K)  
T2: Arbitrary temperature different from T1 (K)

R1: Zero-load resistance value at temperature T1(Ω)

R2: Zero-load resistance value at temperature T2(Ω)

Each temperature is measured in absolute temperature. 0°C=273.15K

**PRODUCT IDENTIFICATION**

NTC	G		3E	H	101		T	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

(1) NTC thermistor

(2) Structural classification

G	Multilayer internal electroded chip type NTC thermistor(Pb free type)
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(3) Shapes and dimensions code

06	0603
10	1005
16	1608
20	2012

(4) B constant

This code indicates the value of B constant using a combination of one numeric character and one alphabetic character.

Example

Code	B constant(K)
3E	3201 to 3250
3N	3601 to 3650
4L	4501 to 4550
4Q	4701 to 4750

Code	B constant(K)
2	2000
3	3000
4	4000

(5) B constant tolerance

Code	Tolerance(%)
H	$\pm 3$

(6) Nominal resistance

The resistance is expressed in three digit codes and in units of  $\Omega$ .  
The first and second digits: Effective number  
The third digit: Number of 0 which following the effective number.

300	30 $\Omega$
101	100 $\Omega$
102	1000 $\Omega$ (1k $\Omega$ )
103	10000 $\Omega$ (10k $\Omega$ )

(7) Nominal resistance tolerance

Code	Tolerance(%)
H	$\pm 3^*$
J	$\pm 5$

\* Resistance tolerance H( $\pm 3\%$ ) products: 2012 Types are excluded.  
For more details, please contact us separately.

(8) Packaging style

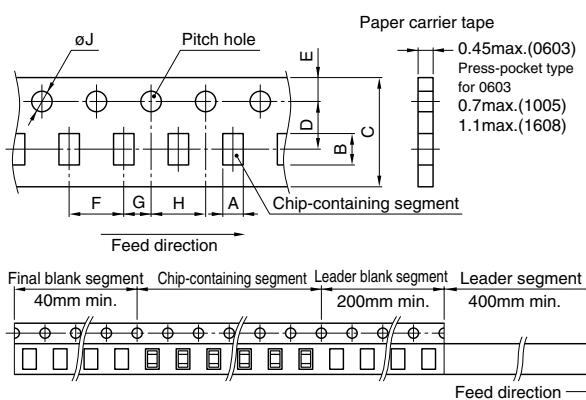
T	Tape and reel
B	Bulk

(9) TDK internal code: Taping specifications

1	Standard
B	0603type standard

**PACKAGING STYLE AND QUANTITIES**

**TAPING SPECIFICATIONS  
0603, 1005, 1608 TYPES**



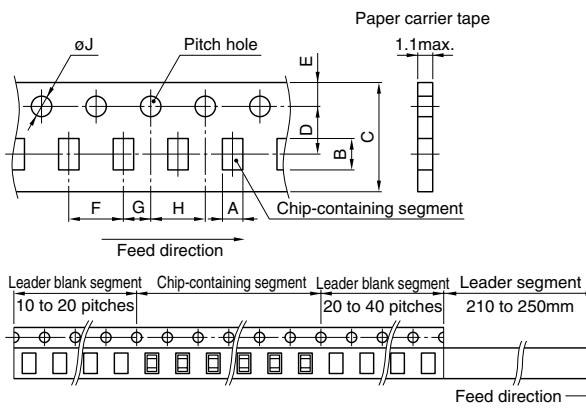
- Cumulative pitch hole shift is within  $\pm 0.3\text{mm}$  over a 10-pitch interval.

Dimensions in mm

Type	0603	1005	1608
A	$0.38 \pm 0.05$	$0.65 \pm 0.05, -0.1$	$1.1 \pm 0.2$
B	$0.68 \pm 0.05$	$1.15 \pm 0.05, -0.1$	$1.9 \pm 0.2$
C	$8 \pm 0.3$	$8 \pm 0.3$	$8 \pm 0.3$
D	$3.5 \pm 0.05$	$3.5 \pm 0.05$	$3.5 \pm 0.05$
E	$1.75 \pm 0.1$	$1.75 \pm 0.1$	$1.75 \pm 0.1$
F	$2 \pm 0.05$	$2 \pm 0.05$	$4 \pm 0.1$
G	$2 \pm 0.05$	$2 \pm 0.05$	$2 \pm 0.05$
H	$4 \pm 0.05$	$4 \pm 0.05$	$4 \pm 0.1$
J	$1.5 \pm 0.1, -0$	$1.5 \pm 0.1, -0$	$1.5 \pm 0.1, -0$

- Packaging quantities  
15000 pieces/reel(0603 type), 10000 pieces/reel(1005 type), 4000 pieces/reel(1608 type)

**2012 TYPE**



- Cumulative pitch hole shift is within  $\pm 0.3\text{mm}$  over a 10-pitch interval.

Dimensions in mm

Type	2012
A	$1.5 \pm 0.2$
B	$2.3 \pm 0.2$
C	$8 \pm 0.3$
D	$3.5 \pm 0.05$
E	$1.75 \pm 0.1$
F	$4 \pm 0.1$
G	$2 \pm 0.05$
H	$4 \pm 0.1$
J	$1.5 \pm 0.1, -0$

- Packaging quantities  
2000 pieces/reel



**1005 TYPE****ELECTRICAL CHARACTERISTICS**

Resistance-temperature group	Part No.	Nominal resistance value [25°C]	B constant [25/85°C] [25/50°C]	Operating temperature range
A	NTCG103EH300□	30Ω	3250K±3% (3244K)	−40 to +125°C
	NTCG103EH400□	40Ω	3250K±3% (3244K)	
	NTCG103EH101□	100Ω	3250K±3% (3244K)	
C	NTCG104BH102□	1.0kΩ	4100K±3% (4096K)	−40 to +125°C
	NTCG104BH152□	1.5kΩ	4100K±3% (4096K)	
	NTCG104BH222□	2.2kΩ	4100K±3% (4096K)	
E	NTCG104BH472□	4.7kΩ	4100K±3% (4067K)	−40 to +125°C
	NTCG104BH682□	6.8kΩ	4100K±3% (4067K)	
	NTCG104BH103□	10kΩ	4100K±3% (4067K)	
F	NTCG104LH223□	22kΩ	4550K±3% (4485K)	−40 to +125°C
	NTCG104LH333□	33kΩ	4550K±3% (4485K)	
	NTCG104LH473□	47kΩ	4550K±3% (4485K)	
	NTCG104LH683□	68kΩ	4550K±3% (4485K)	
	NTCG104LH104□	100kΩ	4550K±3% (4485K)	
G	NTCG104LH154□	150kΩ	4550K±3% (4485K)	−40 to +125°C
	NTCG104QH224□	220kΩ	4750K±3% (4661K)	
	NTCG104QH334□	330kΩ	4750K±3% (4661K)	
	NTCG104QH474□	470kΩ	4750K±3% (4661K)	
H	NTCG104QH105□	1.0MΩ	4750K±3% (4661K)	−40 to +125°C
	NTCG103JH103□	10kΩ	3435K±3% (3380K)	
J	NTCG104BF473□	47kΩ	(4150K) 4085K±1%	−40 to +125°C
K	NTCG104BF683□	68kΩ	(4150K) 4085K±1%	−40 to +125°C
U	NTCG104EH104□	100kΩ	(4308K) 4250K±3%	−40 to +125°C
	NTCG103UH103J	10kΩ	3950K±3% (3900K)	−40 to +125°C

- Resistance-temperature group A, C: Capacitance 3pF max.[25°C, 10 to 40MHz, 0.1Vrms]

## 1005 TYPE

## RESISTANCE vs. TEMPERATURE CHARACTERISTICS TABLE (CONVERSION TABLE)

Temp.(°C)	Resistance-temperature group							
	A		C		E		F	
	RT/R25	B(25/T)	RT/R25	B(25/T)	RT/R25	B(25/T)	RT/R25	B(25/T)
-40	19.59	3182	41.78	3991	38.44	3903	50.89	4203
-35	14.79	3188	29.45	4003	27.34	3915	35.49	4224
-30	11.28	3193	21.01	4014	19.68	3928	25.03	4245
-25	8.685	3199	15.17	4024	14.33	3939	17.85	4264
-20	6.753	3204	11.07	4033	10.54	3951	12.86	4284
-15	5.298	3208	8.168	4041	7.837	3962	9.353	4302
-10	4.192	3213	6.087	4049	5.883	3972	6.869	4320
-5	3.343	3217	4.581	4056	4.456	3982	5.090	4337
0	2.687	3220	3.480	4062	3.406	3992	3.805	4353
5	2.176	3224	2.667	4068	2.625	4001	2.868	4369
10	1.774	3227	2.062	4073	2.039	4010	2.179	4384
15	1.456	3230	1.607	4077	1.596	4018	1.669	4399
20	1.203	3233	1.263	4081	1.259	4026	1.287	4412
25	1.000 <sup>1</sup>	3235	1.000	4084	1.000 <sup>2</sup>	4034	1.000	4426
30	0.8360	3237	0.7976	4088	0.7997	4041	0.7823	4439
35	0.7029	3239	0.6407	4090	0.6437	4048	0.6160	4451
40	0.5941	3241	0.5182	4092	0.5213	4055	0.4882	4463
45	0.5047	3243	0.4218	4094	0.4248	4061	0.3893	4474
50	0.4309	3244	0.3455	4096	0.3481	4067	0.3123	4485
55	0.3697	3246	0.2847	4097	0.2869	4072	0.2520	4496
60	0.3185	3247	0.2360	4098	0.2377	4078	0.2044	4506
65	0.2757	3248	0.1967	4099	0.1979	4083	0.1667	4515
70	0.2396	3248	0.1648	4099	0.1657	4087	0.1367	4524
75	0.2091	3249	0.1388	4100	0.1393	4092	0.1126	4533
80	0.1832	3250	0.1175	4100	0.1177	4096	0.09325	4542
85	0.1610 <sup>1</sup>	3250	0.0999	4100	0.09989 <sup>2</sup>	4100	0.07757	4550
90	0.1421	3250	0.0853	4100	0.08513	4104	0.06482	4558
95	0.1258	3251	0.0732	4100	0.07286	4107	0.05440	4565
100	0.1118	3251	0.0630	4100	0.06260	4110	0.04584	4573
105	0.09960	3251	0.05451	4100	0.05400	4114	0.03879	4580
110	0.08903	3251	0.04731	4100	0.04675	4116	0.03295	4586
115	0.07981	3251	0.04121	4101	0.04063	4119	0.02810	4593
120	0.07175	3251	0.03602	4101	0.03543	4122	0.02405	4599
125	0.06468	3251	0.03159	4101	0.03099	4124	0.02066	4606

## Examples

<sup>1</sup>R25=R25/R25(1.000)×30=30Ω<sup>2</sup>R25=R25/R25(1.000)×10=10kΩ

R85=R85/R25(0.1610)×R25(30Ω)=4.83Ω

R85=R85/R25(0.09989)×R25(10kΩ)=0.999kΩ

## 1005 TYPE

## RESISTANCE vs. TEMPERATURE CHARACTERISTICS TABLE (CONVERSION TABLE)

Temp.(°C)	Resistance-temperature group									
	G		H		J		K		U	
	RT/R25	B(25/T)	RT/R25	B(25/T)	RT/R25	B(25/T)	RT/R25	B(25/T)	RT/R25	B(25/T)
-40			18.850	3140	35.340	3813	42.510	4010	31.059	3675
-35			14.429	3159	25.280	3822	30.049	4027	22.561	3688
-30			11.133	3176	18.330	3834	21.489	4043	16.573	3701
-25			8.656	3194	13.470	3848	15.538	4059	12.304	3714
-20	13.55	4371	6.779	3210	10.010	3864	11.353	4075	9.226	3727
-15	9.833	4398	5.346	3226	7.520	3882	8.378	4090	6.983	3740
-10	7.197	4424	4.245	3241	5.697	3900	6.241	4105	5.333	3752
-5	5.309	4449	3.393	3256	4.352	3919	4.691	4119	4.107	3765
0	3.947	4473	2.728	3270	3.349	3937	3.556	4133	3.188	3777
5	2.957	4496	2.207	3283	2.596	3956	2.718	4147	2.494	3789
10	2.232	4518	1.796	3296	2.026	3974	2.094	4160	1.965	3801
15	1.696	4539	1.470	3308	1.591	3989	1.625	4172	1.559	3813
20	1.298	4559	1.209	3320	1.258	4012	1.270	4185	1.245	3824
25	1.000	4577	1.000	3332	1.000	4024	1.000	4196	1.000	3835
30	0.7755	4596	0.831	3343	0.800	4036	0.792	4208	0.808	3847
35	0.6052	4614	0.694	3353	0.644	4049	0.632	4219	0.657	3857
40	0.4753	4630	0.583	3363	0.521	4062	0.507	4230	0.537	3868
45	0.3754	4646	0.491	3373	0.424	4074	0.409	4240	0.441	3878
50	0.2983	4661	0.416	3382 <sup>*1</sup> (3346 to 3414)	0.347	4085 <sup>*2</sup> (3928 to 4171)	0.332	4250	0.365	3888 <sup>*3</sup> (3783 to 4017)
55	0.2384	4676	0.354	3390	0.285	4096	0.271	4259	0.303	3898
60	0.1916	4690	0.302	3399	0.235	4106	0.222	4269	0.252	3907
65	0.1548	4703	0.259	3407	0.195	4115	0.183	4277	0.211	3917
70	0.1257	4716	0.223	3414	0.163	4126	0.152	4286	0.178	3925
75	0.1026	4728	0.192	3422	0.137	4134	0.126	4293	0.150	3934
80	0.08412	4739	0.167	3428	0.115	4142	0.106	4301	0.128	3942
85	0.06933	4750	0.145	3435	0.0971	4150	0.0889	4308	0.109	3950
90	0.05740	4760	0.127	3441	0.0824	4158	0.0750	4315	0.0929	3958
95	0.04773	4770	0.111	3447	0.0702	4165	0.0636	4321	0.0798	3965
100	0.03987	4780	0.0975	3453	0.0601	4172	0.0541	4327	0.0687	3972
105	0.03344	4789	0.0860	3458	0.0515	4179	0.0462	4332	0.0594	3978
110	0.02817	4797	0.0760	3463	0.0444	4186	0.0397	4338	0.0516	3985
115	0.02382	4806	0.0674	3468	0.0384	4193	0.0342	4342	0.0449	3990
120	0.02022	4813	0.0599	3473	0.0333	4199	0.0295	4347	0.0392	3996
125	0.01723	4821	0.0534	3478	0.0289	4206	0.0256	4351	0.0344	4001

<sup>\*1</sup> B25/50: 3380±1%<sup>\*2</sup> B25/50: 4050±3%<sup>\*3</sup> B25/50: 3900±3%



**1608 TYPE****RESISTANCE vs. TEMPERATURE CHARACTERISTICS TABLE (CONVERSION TABLE)**

Temp.(°C)	Resistance-temperature group				
	G RT/R25	H B(25/T)	J RT/R25	B(25/T)	
-40		18.850	3140	35.340	3813
-35		14.429	3159	25.280	3822
-30		11.133	3176	18.330	3834
-25		8.656	3194	13.470	3848
-20	13.55	4371	3210	10.010	3864
-15	9.833	4398	3226	7.520	3882
-10	7.197	4424	3241	5.697	3900
-5	5.309	4449	3256	4.352	3919
0	3.947	4473	3270	3.349	3937
5	2.957	4496	3283	2.596	3956
10	2.232	4518	3296	2.026	3974
15	1.696	4539	3308	1.591	3989
20	1.298	4559	3320	1.258	4012
25	1.000	4577	3332	1.000	4024
30	0.7755	4596	3343	0.800	4036
35	0.6052	4614	3353	0.644	4049
40	0.4753	4630	3363	0.521	4062
45	0.3754	4646	3373	0.424	4074
50	0.2983	4661	3382 <sup>*1</sup> (3346 to 3414)	0.347	4085 <sup>*2</sup> (3928 to 4171)
55	0.2384	4676	3390	0.285	4096
60	0.1916	4690	3399	0.235	4106
65	0.1548	4703	3407	0.195	4115
70	0.1257	4716	3414	0.163	4126
75	0.1026	4728	3422	0.137	4134
80	0.08412	4739	3428	0.115	4142
85	0.06933	4750	3435	0.0971	4150
90	0.05740	4760	3441	0.0824	4158
95	0.04773	4770	3447	0.0702	4165
100	0.03987	4780	3453	0.0601	4172
105	0.03344	4789	3458	0.0515	4179
110	0.02817	4797	3463	0.0444	4186
115	0.02382	4806	3468	0.0384	4193
120	0.02022	4813	3473	0.0333	4199
125	0.01723	4821	3478	0.0289	4206

<sup>\*1</sup> B25/50: 3380±1%<sup>\*2</sup> B25/50: 4050±3%

**1005 AND 1608 NARROW TOLERANCE TYPES**

Resistance-temperature group	Part No.	Nominal resistance value [25°C]	B constant [25/85°C]	B constant [25/50°C]	Operating temperature range
H	NTCG163JF103□*	10kΩ±□*%	3435K±1%	(3380K)	
	NTCG103JF103□	10kΩ±□%	3435K±1%	(3380K)	-40 to +125°C
	NTCG063JF103□	10kΩ±□%	3435K±1%	(3380K)	
J	NTCG104BF473□	47kΩ±□%	(4150K)	4085K±1%	-40 to +125°C
K	NTCG104EF104□	100kΩ±□%	(4308K)	4250K±1%	-40 to +125°C

\* □: Tolerance, Narrow tolerance F: ±1%, G: ±2%, H: ±3% supported.

**RESISTANCE vs. TEMPERATURE CHARACTERISTICS TABLE (CONVERSION TABLE)**

Temp.(°C)	Resistance-temperature group				
	H	J	K	RT/R25	B(25/T)
-40	18.850	3140	35.340	3813	42.510
-35	14.429	3159	25.280	3822	30.049
-30	11.133	3176	18.330	3834	21.489
-25	8.656	3194	13.470	3848	15.538
-20	6.779	3210	10.010	3864	11.353
-15	5.346	3226	7.520	3882	8.378
-10	4.245	3241	5.697	3900	6.241
-5	3.393	3256	4.352	3919	4.691
0	2.728	3270	3.349	3937	3.556
5	2.207	3283	2.596	3956	2.718
10	1.796	3296	2.026	3974	2.094
15	1.470	3308	1.591	3989	1.625
20	1.209	3320	1.258	4012	1.270
25	1.000	3332	1.000	4024	1.000
30	0.831	3343	0.800	4036	0.792
35	0.694	3353	0.644	4049	0.632
40	0.583	3363	0.521	4062	0.507
45	0.491	3373	0.424	4074	0.409
50	0.416	3382*	0.347	4085* <sup>2</sup>	0.332
		(3346 to 3414)		(3928 to 4171)	4250
55	0.354	3390	0.285	4096	0.271
60	0.302	3399	0.235	4106	0.222
65	0.259	3407	0.195	4115	0.183
70	0.223	3414	0.163	4126	0.152
75	0.192	3422	0.137	4134	0.126
80	0.167	3428	0.115	4142	0.106
85	0.145	3435	0.0971	4150	0.0889
90	0.127	3441	0.0824	4158	0.0750
95	0.111	3447	0.0702	4165	0.0636
100	0.0975	3453	0.0601	4172	0.0541
105	0.0860	3458	0.0515	4179	0.0462
110	0.0760	3463	0.0444	4186	0.0397
115	0.0674	3468	0.0384	4193	0.0342
120	0.0599	3473	0.0333	4199	0.0295
125	0.0534	3478	0.0289	4206	0.0256

\*<sup>1</sup> B25/50: 3380±1%

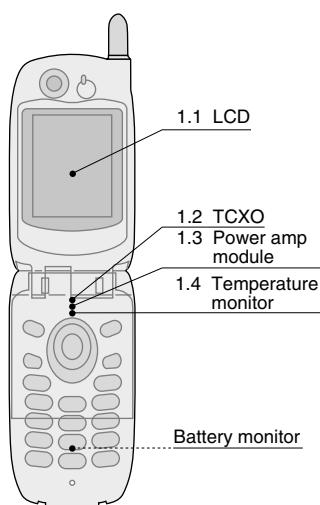
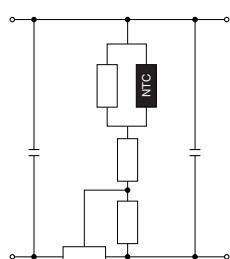
\*<sup>2</sup> B25/50: 4050±3%



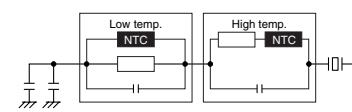
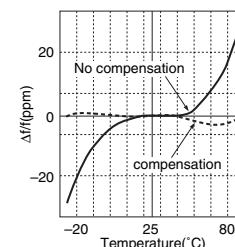
## CIRCUIT EXAMPLES

### 1. CELLULAR PHONE

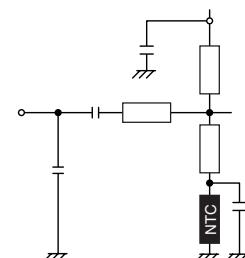
#### 1.1 LCD, Adjustment of contrast



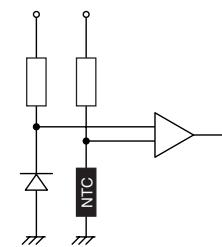
#### 1.2 TCXO, Frequency compensation of crystal



#### 1.3 Power amp. module, Control of voltage



#### 1.4 Temperature monitor

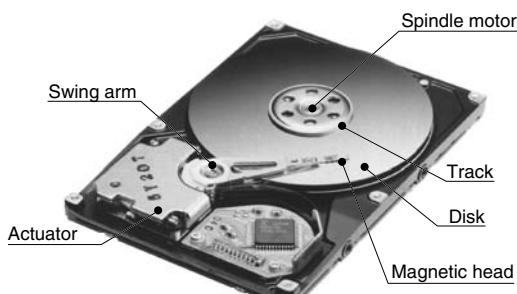


### 2. HARD DISK DRIVE

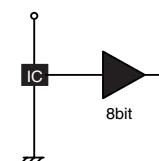
Chip NTC thermistor

NTCG1005, 1608 types

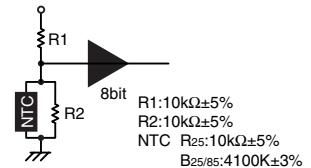
Resistance tolerance:  $\pm 3$  to  $\pm 5\%$ /B constant tolerance:  $\pm 2$  to  $\pm 3\%$



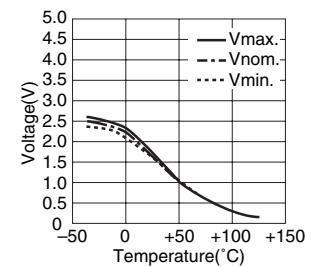
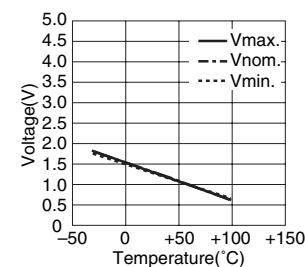
#### Temperature sensor IC



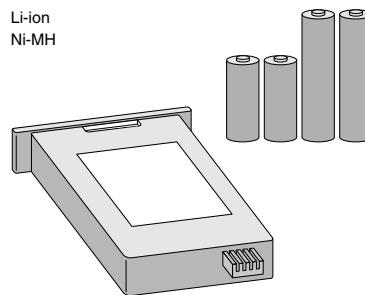
**NTC thermistor**  
(Cost: about 50% down)



#### Voltage vs. temperature characteristics



### 3. BATTERY PACK



#### Control circuit for quick charge battery

