NCP/NXFT/NXRT Series

NTC Thermistor

NCP/NXFT/NXRT Series

Features

NCP Series / NXFT Series / NXRT Series

- High accuracy in resistance and B-Constant
- Recognized by UL/cUL. (UL1434, File No.E137188)

NCP Series

- Excellent solderability and high stability in the application's environment
- Same B-constant in the same resistance in the three sizes (0805 size/0603 size/0402 size) Downsize is easy for design

NXFT Series

- This small and highly accurate NTC Thermistor provides extremely precise temperature sensing.
- The small sensing head and thin lead wire deliver temperature sensing in a narrow space.
- Flexibility and a wide variety of lengths (25mm to 150mm) enable the design of flexible temperature sensing architectures.

NXRT Series

- Strong lead intensity with original lead mounting technique, it is bent at the time of use and can withstand processing, etc., readily.

Applications

NCP Series

- Temperature compensation for transistors, ICs, and crystal oscillators in mobile communications
- Temperature sensor for rechargeable batteries
- Temperature compensation of LCD
- Temperature compensation in general use of electric circuits

NXFT Series / NXRT Series

- For temperature detection of a rechargeable battery pack, charge circuit, a printer head, DC fan motor, home electronics

Overview

NCP Series

The NCP series offers chip type temperature sensors ideal for temperature sensing and compensation.
Available in sizes from 0603 to 2012 mm, NCP sensors are widely used in mobile phones, PCs, and LED lighting equipment.

NXF Series

The Murata NXF series of lead NTC thermistors offers temperature sensors featuring one of the industry's smallest sensor heads, allowing for compact size and fast response. The flexible leads are available in lengths from 25 to 150 mm.
Murata's outstanding ceramic technology enables these NTC thermistors to meet various customer requirements for characteristics.

NXR Series

The Murata NXR series of self-standing lead NTC thermistors feature high lead strength. Designed for use in room-temperature sensors, these thermistors based on NTC chips can detect temperatures with high sensitivity and precision.
Murata's unique technology for attaching lead wires achieves high lead strength in the NXR thermistors, allowing the customer to bend them for production of equipment. NXR series products can be supplied in taped formats.

TABLE OF CONTENT

1. Electrical Handling

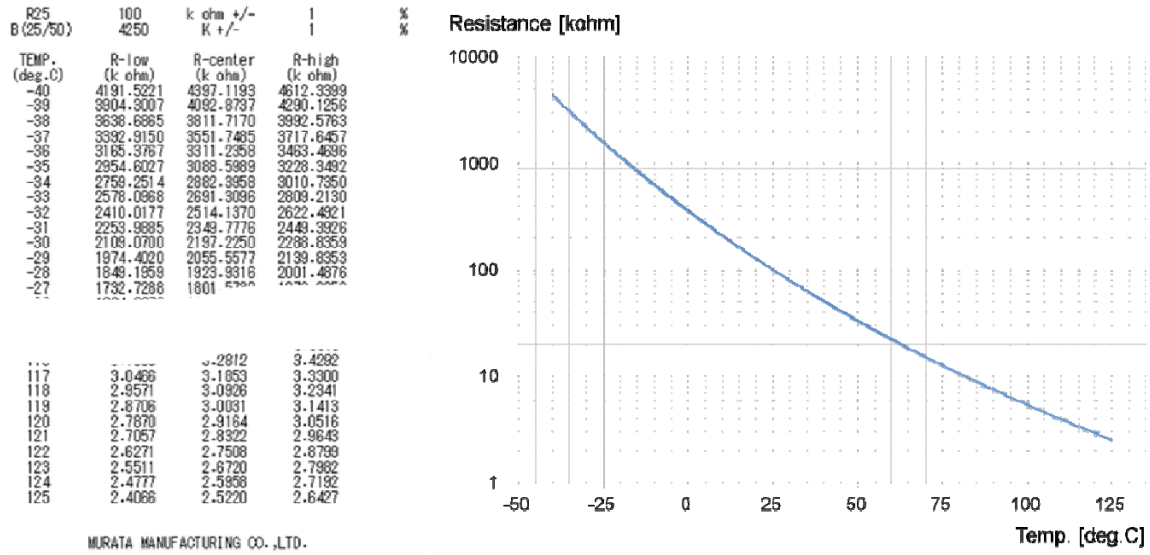
1.1 Resistance -Temperature Characteristic

The resistance-temperature (R-T) characteristics of all NTC thermistor products have been posted as the R-T table in Murata web site. In the case of NXFT15WF104FA1B, for example, the R-T table is below shown in the left side of Figure 1.

URL: http://www.murata.com/en-global/products/productdata/8796839346206/NTHCG143.txt?1437969927000

Resistance values at each one degree Celsius steps are listed. The “R-center” is the typical resistance at each temperature. The “R-low” and “R-high” are the lower and upper limit of resistance, respectively.

The right side of Figure 1 shows the chart of this R-T table. The resistance value changes exponentially versus the temperature.



R25	100	k ohm +/-	1	%
B(25/50)	4250	K +/-	1	%

TEMP. (deg.C)	R-low (k ohm)	R-center (k ohm)	R-high (k ohm)
-40	4191.5221	4397.1193	4612.3399
-39	3904.9007	4092.8737	4290.1256
-38	3638.6865	3811.7170	3992.5763
-37	3392.9150	3551.7485	3717.6457
-36	3165.3767	3311.2358	3463.4696
-35	2954.6027	3088.5989	3228.3492
-34	2759.2514	2882.3958	3010.7350
-33	2578.0968	2691.3096	2809.2130
-32	2410.0177	2514.1370	2622.4821
-31	2253.9885	2349.7776	2449.3926
-30	2109.0700	2197.2250	2288.8359
-29	1974.4020	2055.5577	2139.8353
-28	1849.1959	1923.9316	2001.4876
-27	1732.7288	1801	

117	3.0466	3.1853	3.3300
118	2.9571	3.0926	3.2341
119	2.8706	3.0031	3.1413
120	2.7870	2.9164	3.0516
121	2.7057	2.8322	2.9643
122	2.6271	2.7508	2.8799
123	2.5511	2.6720	2.7982
124	2.4777	2.5958	2.7192
125	2.4066	2.5220	2.6427

MURATA MANUFACTURING CO.,LTD.

Figure 1. Resistance-temperature characteristic, the table and chart

1.2 Constant Voltage Drive

The most popular temperature sensing circuit is shown Figure 2. A thermistor and a resistor are connected in series, and a constant voltage (Vin) is applied. This is called as the constant voltage drive.

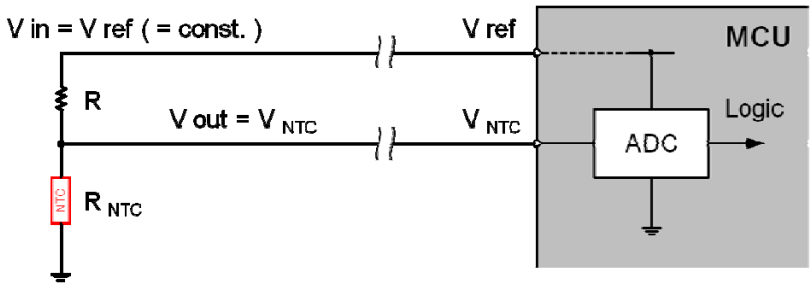


Figure 2. A popular temperature sensing circuit

At this time, the relationship between the divided voltage (Vout) and the temperature of the thermistor is plotted as shown in Figure 3. Vout is able to calculate by the following formula.

$$Vout = Vin \times R_{NTC} / (R_{NTC} + R)$$

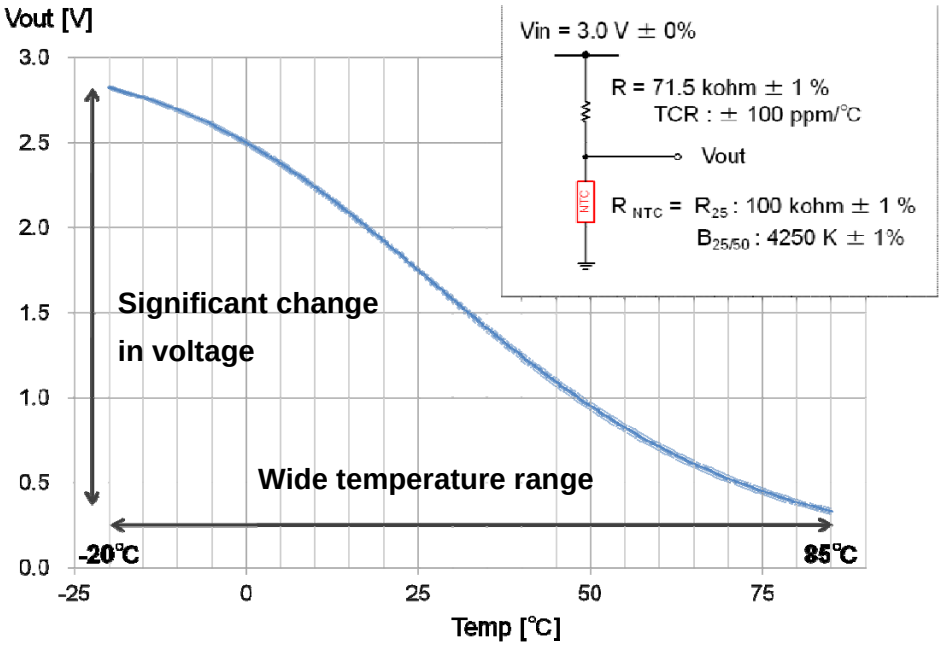


Figure 3. Voltage-temperature curves (Vout)

In a wide temperature range, a significant voltage change is obtained.

This voltage change can be treated as temperature information. Specifically, directly connecting the thermistor to the analog-to-digital (A/D) port on a microcontroller unit (MCU) to carry out A/D conversion allows the A/D-converted value to be treated by the logic of the MCU as temperature information.

For example, in order to show a warning at a certain temperature, what is needed is to program the MCU to issue a warning when detecting the A/D-converted value equivalent to the temperature.

1.3 Voltage Gain and Resolution of A/D Converter

Figure 4 shows the voltage change (gain) versus temperature. A gain of more than 10mV/°C can be obtained even at the lower and upper limits of the temperature range (-20 to +85°C), where the gain becomes the smallest.

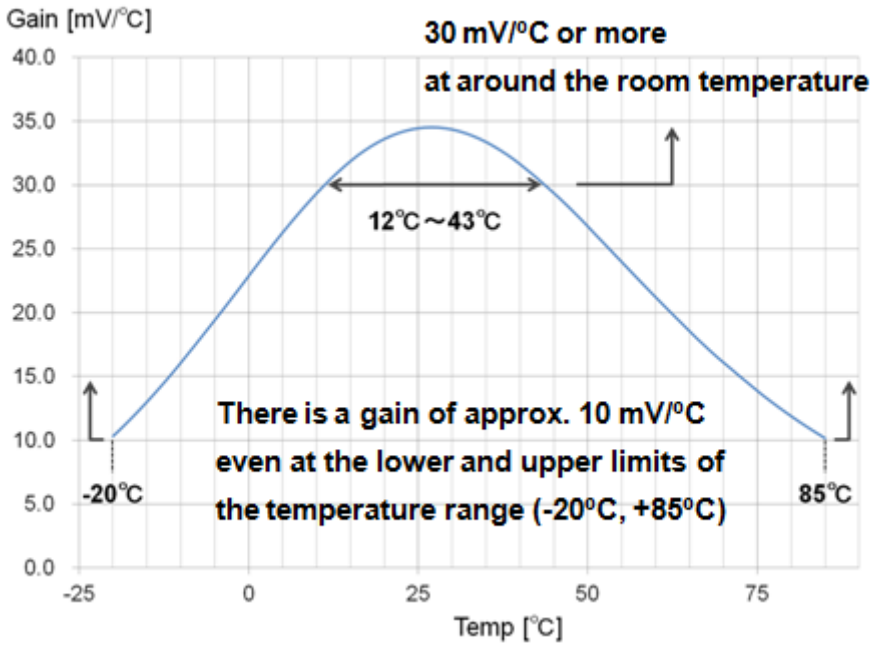


Figure 4. Voltage gain

Supposed that:

1) the voltage applied to the thermistor is the same as the voltage supplied to the ADC in MCU.

   Vin = Vref = 3V

2) the input voltage range to the ADC is from 0V to 3V.

3) the resolution of the ADC is 10bits, which is a normal resolution of such ADC in MCU.

The quantization unit (LSB: Least Significant Bit) is approx. 2.9mV.

$$1\ \text{LSB} = (3\text{V} - 0\text{V}) / (2^{10} - 1) \times 10^{3} = 2.9\text{mV}$$

At this time, 1 LSB is equivalent to approx. 0.3°C.

$$0.3°\text{C} = 2.9\text{mV} / 10\text{mV/°C}$$

Even the 10-bit ADC incorporated in the MCU is expected to achieve a temperature resolution of approx. 0.3°C. At around room temperature (+12 to +43°C), 1LSB is 0.1°C or less because the gain is 30mV/°C or more.

1.4 Estimated Error by Tolerance of Thermistor and Resistor

Figure 3 shows voltage-temperature characteristics obtained when a thermistor and a resistor that has a resistance tolerance of ±1% are used. The bold line indicates the typical value of the voltage, and the thin line indicates the lower and upper limits of the voltage calculated from the maximum tolerances of the components. In the case of thermistor, the resistance tolerances at each temperature have adapted the values of R-T table in Figure 1.

As there is little difference, a chart of the lower and upper limits calculated as temperature when the central value is zero (0) is shown in Figure 5.

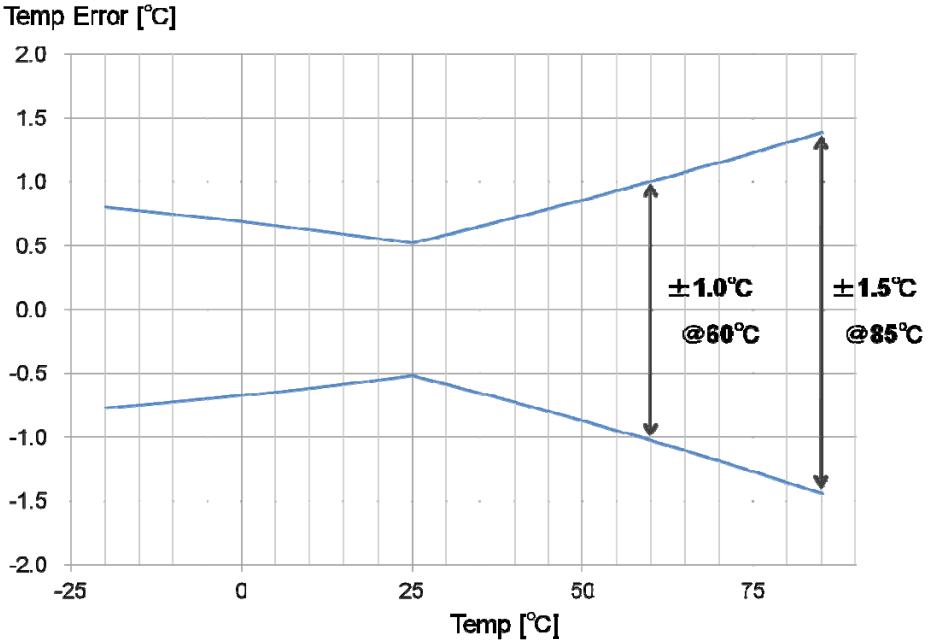


Figure 5. Estimated temperature error in Figure 3

It can be observed approx. ±1.0°C temperature error at +60°C and approx. ±1.5°C at +85°C.

The accuracy may not be so excellent but it can be described as passably reliable enough to monitor temperatures in electronic devices. Using a normal tolerance of thermistor and of resister, this simple circuit can offer very high cost performance.

1.5 Applied Voltage to Thermistor and to ADC

Take a look again at Figure 2. The applied voltage to the thermistor (Vin) and the voltage to the ADC in MCU (Vref) are coming from the same voltage souse. The input voltage to the ADC (V_{NTC}) will change in accordance with the Vin (=Vref). The voltage variation is canceled theoretically.

The voltage source shall be regulated but it still has a certain error or fluctuation. This error has a direct negative impact to the temperature sensing accuracy. Therefore, such differential voltage detection will be strongly recommended. See below Figure 6.

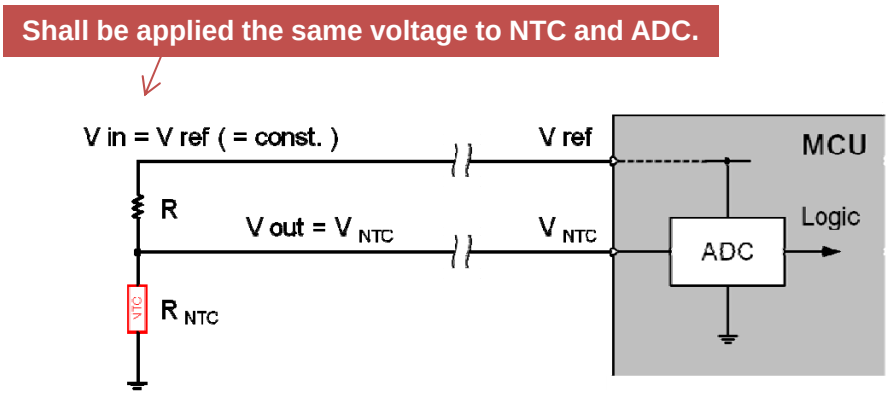


Figure 6. Differential voltage detection

1.6 A Capacitor to Cancel The Low-Frequency Noise

As shown in Figure 7, a capacitor in parallel with the thermistor or with resistor is also highly recommended. Due to the sampling period of ADC and/or the influence of surrounding parts in the circuit, it is the case that low-frequency noise at VNTC will be observed. Such noise can be removed using the parallel capacitor.

The capacitance of capacitor is popularly used from 0.01uF to 1uF. In the selection of capacitance, please refer to the datasheets and/or application notes of the ADC and/or the MPU.

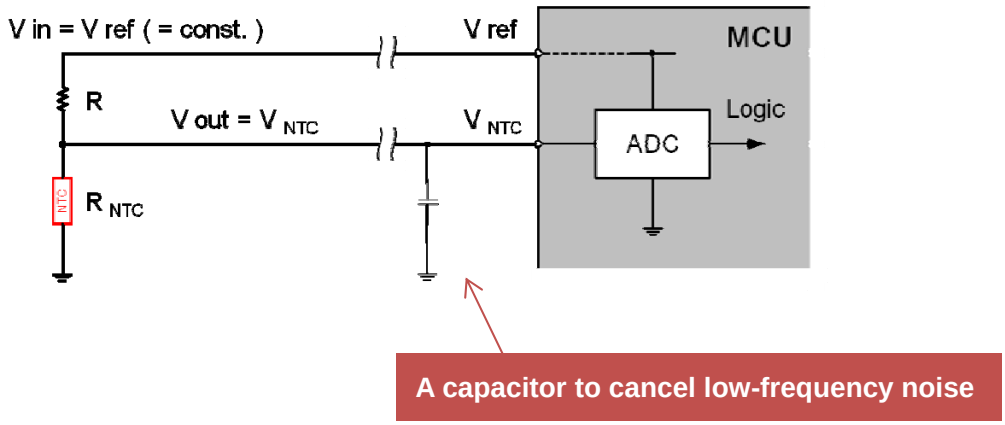


Figure 7. A capacitor in parallel with the thermistor or with resistor

2. Mechanical Handling – Leaded NTC Thermistors: NXFT/NXRT Series

2.1 Bonding Sensor Head

Leaded NTC thermistors are characterized by a small sensor head, they are designed to be placed without processing to the sensor head in the vicinity of the sensing target. When you bond and/or resin coat the sensor head, be performed under room temperature. Avoid processing of high temperature and high pressure, such as heat-shrink tubing, plastic mold processing.

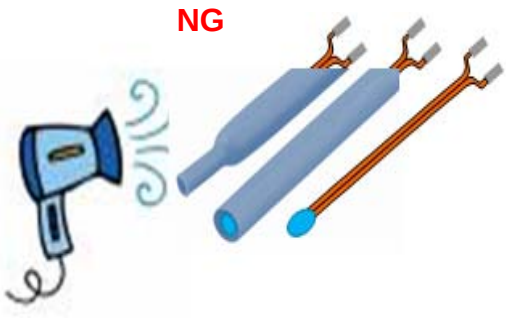


Figure 7. Do NOT use heat-shrink tubing, plastic mold processing

Solder is used for between thermistor element and lead wires connection in the sensor head. It will melt or move when high temperature and high pressure or only high temperature are applied. That may bring electric short or electric open in the circuit.

In addition, the expansion and contraction of heating and cooling, due to bias and temperature changes in the amount of coating and thickness of adhesive or mold resin or coating resin, there is a possibility that excessive stress is applied to the product. In processing or during use by these stresses, there is a risk of causing crack of the resin and the thermistor element or deterioration of the characteristics of the element.

2.2 Mechanical Stress to Sensor Head

Applying a strong force to the sensor head causes destruction of the sensor head itself and/or the internal joint between thermistor element and lead wires. Do NOT apply more pressure (at room temperature) 30N at the time of assembling. At the term of use, avoid use of in a state where it is pressurized.

And also, avoid point load showing right side of Figure 8.

2.3 Handling Lead Wire

Because of the ceramic body of thermistor element, the resin and the solder might crack then there might be the possibility of characteristic deterioration, do NOT split the lead wire exceeding the range that you can divide into two.

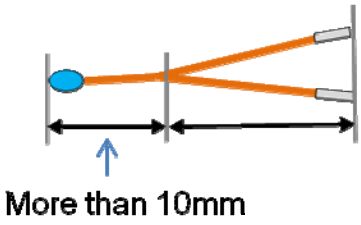


Figure 9. The range that you can divide into two

If you are bending the lead wire, please bending in 1mm or more of R.

Number of times bending the lead wire, keep it up to 10 times.

The lead wire is bent on the edge of 90degree and returned back to the initial position.

To repeat 10 times about this bending cycle.

2.4 Lead Wire Soldering to Substrate

If the product is soldered in total length 25 mm or more, please be soldered within 10 seconds at 260 deg.C, or 350 deg.C in less than 3.5 seconds. Do NOT cut the product overall length to 25mm or less.

3. Mechanical Handling – Chip NTC Thermistors: NCP Series

3.1 Chip Size and Soldering Processes

There are 4 sizes of chip NTC thermistors; 0201, 0401, 0603 and 0805 inch size.

The recommend soldering process is the 'Flow Soldering' for 0603 inch and 0805 inch size, the 'Reflow Soldering' for all sizes.

3.2 Flow Soldering

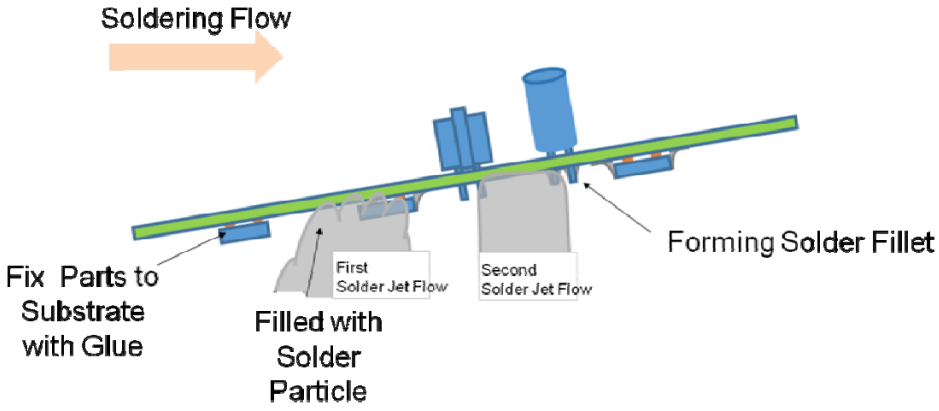


Figure 9. Flow soldering process

Solder Paste

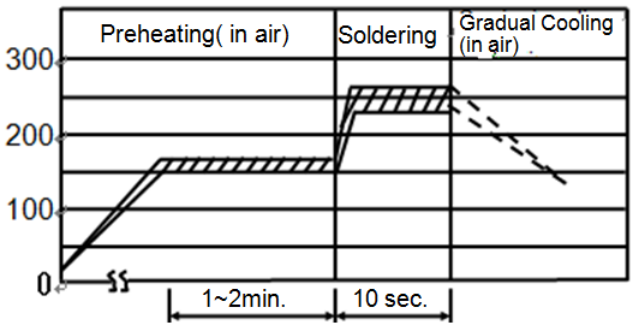
MURATA is using the following solder paste for any internal tests of this product.

- Sn:Pb = 63wt%:37wt%
- Sn:Ag:Cu = 96.5wt%:3.0wt%:0.5wt%

Soldering Temperature Profile

Insufficient preheating may cause a crack on ceramic body. The deference between preheating temperature and soldering temperature shall be less than 100°C.

Rapid cooling by dipping in solvent or by other means is NOT recommended.



Preheating: 160 +/- 10 °C
1min. to 2 min.
Soldering: 230~260°C
10sec.

Figure 10. Flow soldering temperature profile

Recommendable Land Size

Too big land size gives too much solder paste on the land. It may cause destruction of this product, because of the mechanical stress especially in the case of board bending.

	Size	a	b	c
Flow Soldering	2012 (0805inch)	1.0 - 1.1	0.9 - 1.0	1.0 - 1.2
	1608 (0603inch)	0.6 - 1.0	0.8 - 0.9	0.6 - 0.8

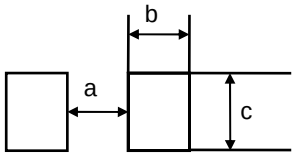


Table 1. Recommendable land size for flow soldering

3.3 Flow Soldering

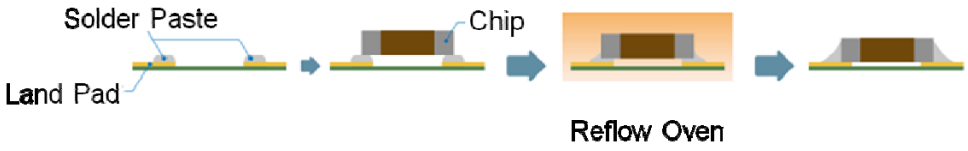


Figure 11. Reflow soldering process

Solder Paste

Shall be used RA/RMA type or equivalent type of solder paste.

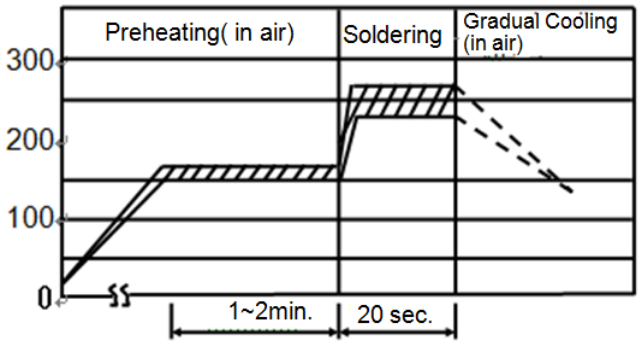
MURATA is using the solder paste below for any internal tests of this product.

- RMA9086 90-4-M20 (Sn:Pb = 63wt%:37wt%)
  Manufactured by Alpha Metals Japan Ltd.
- M705-221BM5-42-11 (Sn:Ag:Cu = 96.5wt%:3.0wt%:0.5wt%)
  Manufactured by Senju Metals Industry Co., Ltd.

Soldering Temperature Profile

Insufficient preheating may cause a crack on ceramic body. The deference between preheating temperature and soldering temperature shall be less than 100°C.

Rapid cooling by dipping in solvent or by other means is NOT recommended.



Preheating: 160 +/- 10 °C
1min. to 2 min.
Soldering: 230~270°C
20sec.

Figure 12. Reflow soldering temperature profile

Recommendable Land Size

Too big land size gives too much solder paste on the land. It may cause destruction of this product, because of the mechanical stress especially in the case of board bending.

	Size	a	b	c
Reflow Soldering	2012 (0805inch)	1.0 - 1.1	0.6 - 0.7	1.0 - 1.2
	1608 (0603inch)	0.6 - 0.8	0.6 - 0.7	0.6 - 0.8
	1005 (0402inch)	0.4	0.4 - 0.5	0.5
	0603 (0201inch)	0.25	0.3	0.3

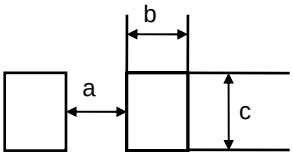


Table 2. Recommendable land size table for reflow soldering

Printing Conditions of Solder Paste

Recommendable thickness of solder paste printing is shown as follows.

Size	Solder Paste Thickness
2012 (0805inch)	200
1608 (0603inch)	200
1005 (0402inch)	150
0603 (0201inch)	100

Table 3. Solder paste thickness

3.4 Adhesive Application and Curing

If insufficient adhesive is applied, or if the adhesive is not sufficiently hardened, this product may have a loose contact with the land, during flow soldering. Too low viscosity of adhesive causes this product to slip on broad, after mounting.

3. FAQ

4.1 FAQ URL of NTC Thermistor

・Please click here to check the FAQ.

http://www.murata.com/en-global/support/faqs/products/thermistor

4.2 WEB URL of NCP/NXFT/NXRT Series

・Please visit our the website

<NCP Series>

http://www.murata.com/en-global/products/thermistor/ntc/ncp

<NXFT Series>

http://www.murata.com/en-global/products/thermistor/ntc/nxf

<NXRT Series>

http://www.murata.com/en-global/products/thermistor/ntc/nxr