APPROVAL SHEET

MULTILAYER CERAMIC CAPACITORS

Open-Mode Series (50V to 630V)

0805 to 1812 Sizes

X7R Dielectric

Halogen Free & RoHS Compliance

*Contents in this sheet are subject to change without prior notice.

1. INTRODUCTION

WTC open-mode series MLCC is designed by a special internal electrode pattern, which can reduce voltage concentrations by distributing voltage gradients throughout the entire capacitor. This special design also affords open-mode pattern to prevent circuit leakage when focused to failure in a board flex situation.

2. FEATURES

a. High voltage in a given case size.
b. Circuit open during product cracking.
c. High stability and reliability.

3. APPLICATIONS

a. High current applications.
b. Power supply and related industries
c. The other mechanical stress concerned products.

4. HOW TO ORDER

OP	31	B	102	K	201	C	T
Series	**Size**	**Dielectric**	**Capacitance**	**Tolerance**	**Rated voltage**	**Termination**	**Packaging**
OP=Open-mode	**21**=0805 (2012) **31**=1206 (3216) **32**=1210 (3225) **43**=1812 (4532)	**B**=X7R	Two significant digits followed by no. of zeros. And R is in place of decimal point. eg.: $102=10x10^2$ =1000pF	**K**=±10% **M**=±20%	Two significant digits followed by no. of zeros. And R is in place of decimal point. **500**=50 VDC **101**=100 VDC **201**=200 VDC **251**=250 VDC **501**=500 VDC **631**=630 VDC	**C**=Cu/Ni/Sn	**T**=7" reeled **G**=13" reeled

5. EXTERNAL DIMENSIONS

Size Inch (mm)	L (mm)	W (mm)	T (mm)/Symbol		Remark	M_B (mm)
0805 (2012)	2.00±0.15	1.25±0.10	0.80±0.10	B		0.40±0.20
			1.25±0.10	D	#	
1206 (3216)	3.20±0.15	1.60±0.15	0.80±0.10	B		0.50±0.20
			0.95±0.10	C		
			1.25±0.10	D	#	
	3.20±0.20	1.60±0.20	1.60±0.20	G	#	
1210 (3225)	3.20±0.30	2.50±0.20	0.95±0.10	C	#	0.50±0.25
			1.25±0.10	D	#	
	3.20±0.40	2.50±0.30	1.60±0.20	G	#	
			2.50±0.30	M	#	
1812 (4532)	4.50+0.5/-0.3	3.20±0.30	1.25±0.10	D	#	0.60±0.25
			2.00±0.20	K	#	

Reflow soldering only is recommended.

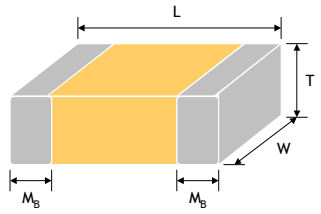


Fig. 1 The outline of MLCC

6. GENERAL ELECTRICAL DATA

Dielectric	X7R
Size	0805, 1206, 1210, 1812
Capacitance*	100pF to 1μF
Capacitance tolerance**	K (±10%), M (±20%)
Rated voltage (WVDC)	50V, 100V, 200V, 250V, 500V, 630V
Dielectric strength	50V,100V: ≥2.5 x WVDC 200V and 250V: ≥2 x WVDC 500V,630V: ≥1.5 x WVDC
Operating temperature	-55 to +125℃
Capacitance characteristic	±15%
Termination	Ni/Sn (lead-free termination)

* Measured at 25℃ ambient temperature and 30~70% r elated humidity. Apply 1.0±0.2Vrms, 1.0kHz±10%.

** Preconditioning for Class II MLCC: Perform a heat treatment at 150±10℃ for 1 hour, then leave in a mbient condition for 24±2 hours before measurement.

7. CAPACITANCE RANGE

DIELECTRIC		X7R																				
SIZE		0805					1206						1210					1812				
RATED VOLTAGE		100	200	250	500	630	50	100	200	250	500	630	100	200	250	500	630	100	200	250	500	630
Capacitance	100pF (101)	B	B	B	B	B																
	120pF (121)	B	B	B	B	B																
	150pF (151)	B	B	B	B	B	B	B	D	D	D	D										
	180pF (181)	B	B	B	B	B	B	B	D	D	D	D										
	220pF (221)	B	B	B	B	B	B	B	D	D	D	D										
	270pF (271)	B	B	B	B	B	B	B	D	D	D	D										
	330pF (331)	B	B	B	B	B	B	B	D	D	D	D										
	390pF (391)	B	B	B	B	B	B	B	D	D	D	D										
	470pF (471)	B	B	B	B	B	B	B	D	D	D	D										
	560pF (561)	B	B	B	B	B	B	B	D	D	D	D										
	680pF (681)	B	B	B	B	B	B	B	D	D	D	D										
	820pF (821)	B	B	B	B	B	B	B	D	D	D	D										
	1,000pF (102)	B	B	B	B	B	B	B	D	D	D	D	C	C	C	D	D	D	D	D	D	D
	1,200pF (122)	B	B	B	B	B	B	B	D	D	D	D	C	C	C	D	D	D	D	D	D	D
	1,500pF (152)	B	B	B	B	B	B	B	D	D	D	D	C	C	C	D	D	D	D	D	D	D
	1,800pF (182)	B	B	B	B	B	B	B	D	D	D	D	C	C	C	D	D	D	D	D	D	D
	2,200pF (222)	B	B	B	B	B	B	B	D	D	D	D	C	C	C	D	D	D	D	D	D	D
	2,700pF (272)	B	B	B	B	B	B	B	D	D	D	D	C	C	C	D	D	D	D	D	D	D
	3,300pF (332)	B	B	B	B	B	B	B	D	D	D	D	C	C	C	D	D	D	D	D	D	D
	3,900pF (392)	B	B	B			B	B	D	D	D	D	C	C	C	D	D	D	D	D	D	D
	4,700pF (472)	B	B	B			B	B	D	D	D	D	C	C	C	D	D	D	D	D	D	D
	5,600pF (562)	B	D	D			B	B	D	D	D	D	C	C	C	D	D	D	D	D	D	D
	6,800pF (682)	B	D	D			B	B	D	D	D	D	C	C	C	D	D	D	D	D	D	D
	8,200pF (822)	B	D	D			B	B	D	D	D	D	C	C	C	D	D	D	D	D	D	D
	0.010μF (103)	B	D	D			B	B	D	D	D	D	C	C	C	D	D	D	D	D	D	D
	0.012μF (123)	B	D	D			B	B	D	D	D	D	C	C	C	D	D	D	D	D	D	D
	0.015μF (153)	B	D	D			B	B	D	D	D	D	C	C	C	D	D	D	D	D	D	D
	0.018μF (183)	B	D	D			B	B	D	D	D	D	C	C	C	D	D	D	D	D	D	D
	0.022μF (223)	B	D	D			B	B	D	D	G	G	C	C	C	D	D	D	D	D	D	D
	0.027μF (273)	D					B	B	D	D	G	G	C	C	C	D	D	D	D	D	D	D
	0.033μF (333)	D					B	B	G	G	G	G	C	C	C	G	G	D	D	D	D	D
	0.039μF (393)	D					B	B	G	G			C	C	C	G	G	D	D	D	D	D
	0.047μF (473)	D					B	B	G	G			C	D	D	G	G	D	D	D	D	D
	0.056μF (563)						B	B	G	G			C	D	D	G	G	D	D	D	K	K
	0.068μF (683)						B	B	G	G			C	G	G	G	G	D	D	D	K	K
	0.082μF (823)						D	D	G	G			C	G	G			D	D	D	K	K
	0.10μF (104)						D	D	G	G			C	G	G			D	D	D	K	K
	0.12μF (124)						D	D					C	G	G			D	D	D		
	0.15μF (154)						D	G					D	M	M			D	K	K		
	0.18μF (184)						D	G					D	M	M			D	K	K		
	0.22μF (224)						D	G					D	M	M			D	K	K		
	0.27μF (274)						D						G					D	K	K		
	0.33μF (334)						D						G					D	K	K		
	0.39μF (394)						D						M					D	K	K		
	0.47μF (474)						D						M					K	K	K		
	0.56μF (564)												M					K				
	0.68μF (684)																	K				
	0.82μF (824)																	K				
	1.0μF (105)																	K				

The letter in cell is expressed the symbol of product thickness.

8. PACKAGING DIMENSION AND QUANTITY

Size	Thickness (mm)/Symbol		Paper tape		Plastic tape	
			7" reel	13" reel	7" reel	13" reel
0805	0.80±0.10	B	4k	15k	-	-
	1.25±0.10	D	-	-	3k	10k
1206	0.80±0.10	B	4k	15k	-	-
	0.95±0.10	C	-	-	3k	10k
	1.25±0.10	D	-	-	3k	10k
	1.60±0.20	G	-	-	2k	10k
1210	0.95±0.10	C	-	-	3k	10k
	1.25±0.10	D	-	-	3k	10k
	1.60±0.20	G	-	-	2k	-
	2.50±0.30	M	-	-	1k	6k
1812	1.25±0.10	D	-	-	1k	5k
	2.00±0.20	K	-	-	1k	-

Unit: pieces

9. INNER CONSTRUCTION OF OPEN-MODE DESIGN

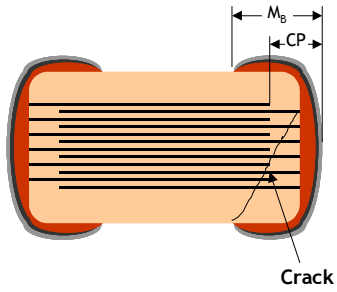


Fig. 2 Normal design (CP<M_B) – circuit leakage during cracking.

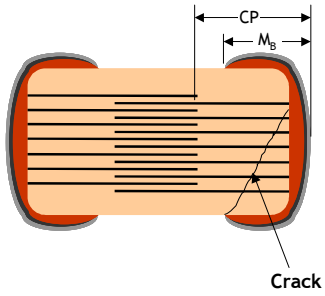


Fig. 3 Open-mode design (CP>M_B) – circuit open during cracking.

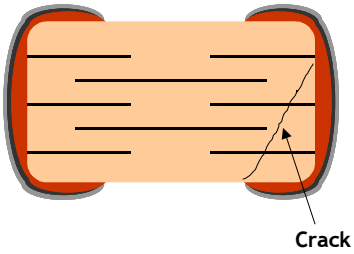


Fig. 4 Floating design (one kind of open-mode design)– circuit open during cracking.

10. RELIABILITY TEST CONDITIONS AND REQUIREMENTS

No.	Item	Test Condition	Requirements
1.	Visual and Mechanical	---	* No remarkable defect. * Dimensions to conform to individual specification sheet.
2.	Capacitance	1.0±0.2Vrms, 1kHz±10%	* Shall not exceed the limits given in the detailed spec.
3.	Q/ D.F. (Dissipation Factor)	*Before initial measurement (Class II only): To apply de-aging at 150℃ for 1hr then set for 24±2 hrs at room temp .	* D.F. ≤2.5% * D.F. ≤3% : 50V / 1206≧0.47μF
4.	Dielectric Strength	* To apply voltage: 50V, 100V ≥2.5 times VDC 200V~300V ≥2 times VDC 500V~630V ≥1.5 times VDC * Duration: 1 to 5 sec. * Charge & discharge current less than 50mA.	* No evidence of damage or flash over during test.
5.	Insulation Resistance	50V, 100V, To apply rated voltage for max. 120 sec. ≥200V, To apply rated voltage for 60 sec.	≥10GΩ or RxC≥100Ω-F whichever is smaller. X7R=100V: RxC≥100Ω-F
6.	Temperature Coefficient	With no electrical load. Operating temperature: -55~125℃ at 25℃ *Before initial measurement (Class II only): To apply de-aging at 150℃ for 1hr then set for 24±2 hrs at room temp .	Within ±15%.
7.	Adhesive Strength of Termination	* Pressurizing force： 5N (≤0603) and 10N (>0603) * Test time: 10±1 sec.	* No remarkable damage or removal of the terminations.
8.	Vibration Resistance	* Vibration frequency: 10~55 Hz/min. * Total amplitude: 1.5mm * Test time: 6 hrs. (Two hrs each in three mutually perpendicular directions.) *Before initial measurement (Class II only): To apply de-aging at 150℃ for 1hr then set for 24±2 hrs at room temp . *Cap./DF(Q) Measurement to be made after de-aging at 150℃ for 1hr then set for 24±2 hrs at room temp.	* No remarkable damage. * Cap change and Q/D.F.: To meet initial spec.
9.	Solderability	* Solder temperature: 235±5℃ * Dipping time: 2±0.5 sec.	95% min. coverage of all metalized area.
10.	Bending Test	* The middle part of substrate shall be pressurized by means of the pressurizing rod at a rate of about 1 mm per second until the deflection becomes 1 mm and then the pressure shall be maintained for 5±1 sec. *Before initial measurement (Class II only): To apply de-aging at 150℃ for 1hr then set for 24±2 hrs at room temp . * Measurement to be made after keeping at room temp. for 24±2 hrs.	* No remarkable damage. * Cap change: X7R: within ±12.5% (This capacitance change means the change of capacitance under specified flexure of substrate from the capacitance measured before the test.)
11.	Resistance to Soldering Heat	* Solder temperature: 260±5℃ * Dipping time: 10±1 sec * Preheating: 120 to 150℃ for 1 minute before imme rse the capacitor in a eutectic solder. *Before initial measurement (Class II only): To apply de-aging at 150℃ for 1hr then set for 24±2 hrs at room temp . *Cap. / DF(Q) / I.R. Measurement to be made after de-aging at 150℃ for 1hr then set for 24±2 hrs at room temp.	* No remarkable damage. * Cap change: X7R: within ±7.5% * Q/D.F., I.R. and dielectric strength: To meet initial requirements. * 25% max. leaching on each edge.

<table>
<tr><th>No.</th><th>Item</th><th>Test Condition</th><th>Requirements</th></tr>
<tr><td>12.</td><td>Temperature Cycle</td><td>* Conduct the five cycles according to the temperatures and time.
<table><tr><th>Step</th><th>Temp. (℃)</th><th>Time (min.)</th></tr><tr><td>1</td><td>Min. operating temp. +0/-3</td><td>30±3</td></tr><tr><td>2</td><td>Room temp.</td><td>2~3</td></tr><tr><td>3</td><td>Max. operating temp. +3/-0</td><td>30±3</td></tr><tr><td>4</td><td>Room temp.</td><td>2~3</td></tr></table>*Before initial measurement (Class II only): To apply de-aging at 150℃ for 1hr then set for 24±2 hrs at room temp .
* Cap. / DF(Q) / I.R. Measurement to be made after de-aging at 150℃ for 1hr then set for 24±2 hrs at room temp .</td><td>* No remarkable damage.
* Cap change：within ±7.5%
* Q/D.F., I.R. and dielectric strength: To meet initial requirements.</td></tr>
<tr><td>13.</td><td>Humidity (Damp Heat) Steady State</td><td>* Test temp.: 40±2℃
* Humidity: 90~95% RH
* Test time: 500+24/-0hrs.
*Before initial measurement (Class II only): To apply de-aging at 150℃ for 1hr then set for 24±2 hrs at room temp .
* Cap. / DF(Q) / I.R. Measurement to be made after de-aging at 150℃ for 1hr then set for 24±2 hrs at room temp .</td><td>* No remarkable damage.
* Cap change: within ±12.5%
* Q/D.F. value:
D.F. ≤3.0%
D.F. ≤6% : 50V / 1206≧0.47μF
* I.R.: ≥1GΩ or RxC≥50Ω-F whichever is smaller.
X7R=100V: RxC≥10Ω-F</td></tr>
<tr><td>14.</td><td>Humidity (Damp Heat) Load</td><td>* Test temp.: 40±2℃
* Humidity: 90~95%RH
* Test time: 500+24/-0 hrs.
* To apply voltage：rated voltage (Max. 500V)
*Before initial measurement (Class II only): To apply de-aging at 150℃ for 1hr then set for 24±2 hrs at room temp .
* Cap. / DF(Q) / I.R. Measurement to be made after de-aging at 150℃ for 1hr then set for 24±2 hrs at room temp .</td><td>* No remarkable damage.
* Cap change: within ±12.5%
* Q/D.F. value:
D.F. ≤3.0%
D.F. ≤6% : 50V / 1206≧0.47μF
* I.R.: ≥500MΩ or RxC≥25Ω-F whichever is smaller.
X7R=100V: RxC≥5Ω-F</td></tr>
<tr><td>15.</td><td>High Temperature Load (Endurance)</td><td>* Test temp.: X7R: 125±3℃
* To apply voltage:
(1) V<500V: 200% of rated voltage.
(2) 500V~630V: 150% of rated voltage.
* Test time: 1000+24/-0 hrs.
*Before initial measurement (Class II only): To apply de-aging at 150℃ for 1hr then set for 24±2 hrs at room temp .
* Cap. / DF(Q) / I.R. Measurement to be made after de-aging at 150℃ for 1hr then set for 24±2 hrs at room temp .</td><td>* No remarkable damage.
* Cap change: within ±12.5%
* Q/D.F. value:
D.F. ≤3.0%
D.F. ≤6% : 50V / 1206≧0.47μF
* I.R.: ≥1GΩ or RxC≥50Ω-F whichever is smaller.
X7R=100V: RxC≥10Ω-F</td></tr>
</table>

APPENDIXES

◙ Tape & reel dimensions

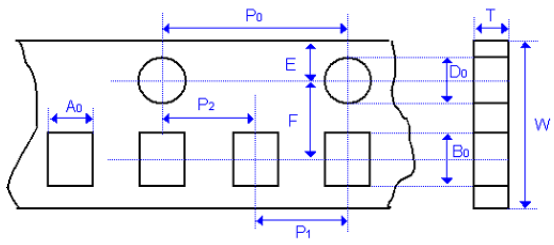


Fig. 5 The dimension of paper tape

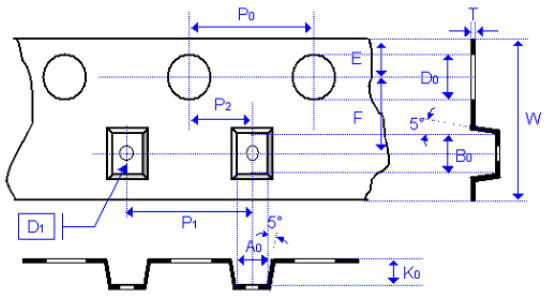


Fig. 6 The dimension of plastic tape

Size	0805		1206			1210		1812
Thickness	B	C, D, I	B	C, D	G	C, D	G	D, K, M
A_0	1.50 +/-0.20	< 1.80	1.90 +/-0.50	< 2.00	<2.30	< 3.05	< 3.05	< 3.20
B_0	2.30 +/-0.20	< 2.70	3.50 +/-0.50	< 3.70	< 4.00	< 3.80	< 3.80	<4.00
T	≦1.20	0.23 +/-0.1	≦1.20	0.23 +/-0.1	0.23 +/-0.1	0.23 +/-0.1	0.23 +/-0.1	0.23 +/-0.1
K_0	-	< 2.50	-	< 2.50	< 2.50	< 1.50	< 2.50	< 3.20
W	8.00 +/-0.30	8.00 +/-0.30	8.00 +/-0.30	8.00 +/-0.30	8.00 +/-0.30	8.00 +/-0.30	8.00 +/-0.30	8.00 +/-0.30
P_0	4.00 +/-0.10	4.00 +/-0.10	4.00 +/-0.10	4.00 +/-0.10	4.00 +/-0.10	4.00 +/-0.10	4.00 +/-0.10	4.00 +/-0.10
$10xP_0$	40.00 +/-0.20	40.00 +/-0.20	40.00 +/-0.20	40.00 +/-0.20	40.00 +/-0.20	40.00 +/-0.20	40.00 +/-0.20	40.00 +/-0.20
P_1	4.00 +/-0.10	4.00 +/-0.10	4.00 +/-0.10	4.00 +/-0.10	4.00 +/-0.10	4.00 +/-0.10	4.00 +/-0.10	4.00 +/-0.10
P_2	2.00 +/-0.05	2.00 +/-0.05	2.00 +/-0.05	2.00 +/-0.05	2.00 +/-0.05	2.00 +/-0.05	2.00 +/-0.05	2.00 +/-0.05
D_0	1.50 +0.1/-0	1.50 +0.1/-0	1.50 +0.1/-0	1.50 +0.1/-0	1.50 +0.1/-0	1.50 +0.1/-0	1.50 +0.1/-0	1.50 +0.1/-0
D_1	-	1.00 +/-0.10	-	1.00 +/-0.10	1.00 +/-0.10	1.00 +/-0.10	1.00 +/-0.10	1.00 +/-0.10
E	1.75 +/-0.10	1.75 +/-0.10	1.75 +/-0.10	1.75 +/-0.10	1.75 +/-0.10	1.75 +/-0.10	1.75 +/-0.10	1.75 +/-0.10
F	3.50 +/-0.05	3.50 +/-0.05	3.50 +/-0.05	3.50 +/-0.05	3.50 +/-0.05	3.50 +/-0.05	3.50 +/-0.05	3.50 +/-0.05

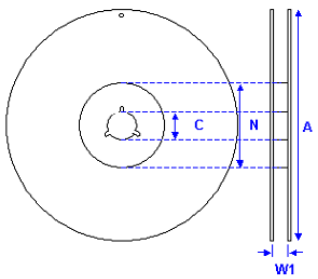
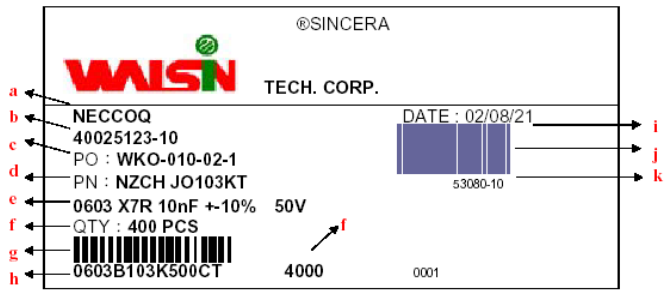


Fig. 7 The dimension of reel

Size	0603, 0805, 1206, 1210			1808, 1812
Reel size	7”	10”	13”	7”
C	13.0+0.5/-0.2	13.0+0.5/-0.2	13.0+0.5/-0.2	13.0+0.5/-0.2
W_1	8.4+1.5/-0	8.4+1.5/-0	8.4+1.5/-0	12.4+2.0/-0
A	178.0±1.0	250.0±1.0	330.0±1.0	178.0±1.0
N	60.0+1.0/-0	100.0±1.0	100±1.0	60.0+1.0/-0

Example of customer label



*Customized label is available upon request

a. Customer name
b. WTC order series and item number
c. Customer P/O
d. Customer P/N
e. Description of product
f. Quantity
g. Bar code including quantity & WTC P/N or customer
h. WTC P/N
i. Shipping date
j. Order bar code including series and item numbers
k. Serial number of label

Constructions

No.	Name		X7R
①	Ceramic material		$BaTiO_3$ based
②	Inner electrode		Ni
③	Termination	Inner layer	Cu
④		Middle layer	Ni
⑤		Outer layer	Sn (Matt)

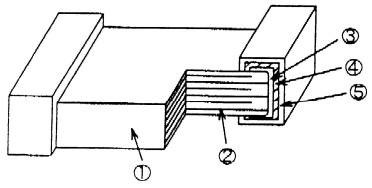


Fig. 8 The construction of MLCC

Storage and handling conditions

(1) To store products at 5 to 40°C ambient temperature and 20 to 70%. related humidity conditions.
(2) The product is recommended to be used within one year after shipment. Check solderability in case of shelf life extension is needed.

Cautions:

a. The corrosive gas reacts on the terminal electrodes of capacitors, and results in the poor solderability. Do not store the capacitors in the ambience of corrosive gas (e.g., hydrogen sulfide, sulfur dioxide, chlorine, ammonia gas etc.)
b. In corrosive atmosphere, solderability might be degraded, and silver migration might occur to cause low reliability.
c. Due to the dewing by rapid humidity change, or the photochemical change of the terminal electrode by direct sunlight,the solderability and electrical performance may deteriorate. Do not store capacitors under direct sunlight or dewing condition. To store products on the shelf and avoid exposure to moisture.

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◙ Recommended soldering conditions

The lead-free termination MLCCs are not only to be used on SMT against lead-free solder paste, but also suitable against lead-containing solder paste. If the optimized solder joint is requested, increasing soldering time, temperature and concentration of N_2 within oven are recommended.

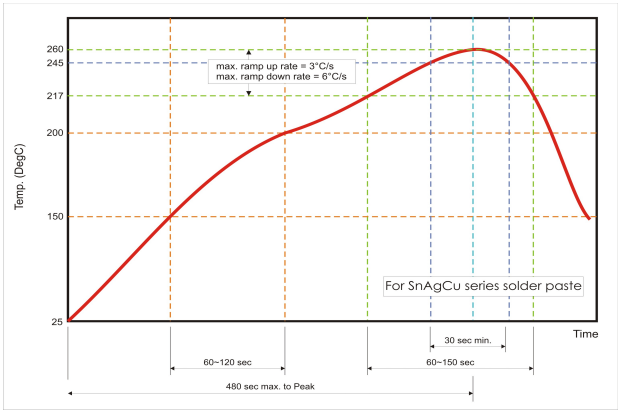

Fig. 9 Recommended reflow soldering profile for SMT process with SnAgCu series solder paste.

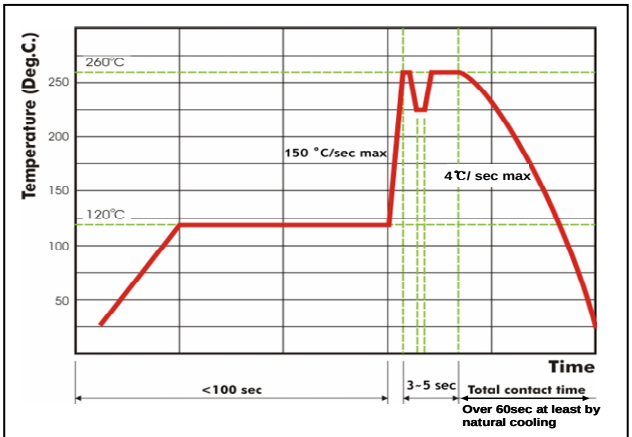

Fig. 10 Recommended wave soldering profile for SMT process with SnAgCu series solder.