TO. : Reference Sheet **NO. : A250201**

APPROVAL SHEET

MULTILAYER CERAMIC CAPACITOR

Commercial Grade

(Thin Layer Large-Capacitance Type)

SAMWHA CAPACITOR .CO., LTD.

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*** Notice**
This sheet is for reference only and is subject to change or be discontinued without notice.
Please contact our sales representatives for detailed information.

< SPECIFICATION SUMMARY >			
SAMWHA Part no.	**CS1608X6S226M6R3NRB**		
Type	**General / Thin Layer Large-Capacitance**		
Items	**Specification**	**Unit**	**Test Conditions**
Capacitance	22.0	μF	Testing Frequency : 120 ± 24Hz Testing Voltage : 0.5 ± 0.1Vrms Should be measured at 25°C
Capacitance Tolerance	± 20	%	
Dissipation Factor	Max. 12.5	%	
Insulation Resistance	More than 2.27	MΩ	Should be measured with a DC voltage not exceeding rated voltage at 25℃ for 2 minutes of charging.
Chip Size	1.60 ± 0.20	L (㎜)	Capacitance Tolerance Code ---------- page 4/14 Chip size ---------- page 5/14 Characteristics & Test Method ---------- page 6/14~8/14
	0.80 ± 0.20	W (㎜)	
	0.80 ± 0.20	T (㎜)	

Record of Revision

PART NO.		SAMWHA SPEC.	CS1608X6S226M6R3NRB

NO	REASON	CONTENTS	DATE OF APPROVAL	CHECKED	REMARKS
1	Initial written	full document	96. 03. 27		
2	Re-revision of approval document	full document	25. 02. 01		

General Description

1. General Article

Application Range

These specifications refer to the "Multilayer Ceramic Capacitors" mainly

used in various every products such as home appliances, audio/visual equipment, communication devices, and Etc.

*Caution : Industrial equipment / For the high reliability equipment / LED equipment / Etc.

Please contact sales representatives or product engineers before using the products.

(For details, please referenece "Note" page)

2. General Code

(1) Type Designation

CS	1608	X6S	226	M	6R3	N	R	B
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

1) Multilayer Ceramic Capacitor (Commercial Grade)

2) Size Code : This is expressed in tens of a millimeter.

The first two digits are the length, The last two digits are width.

Classification	Code	Temperature Range	Capacitance Tolerance
Class Ⅱ	X6S	-55 to +105℃	± 22 %

4) Capacitance Tolerance Code

The nominal Capacitance Value in pF is expressed by three digit numbers.

The first two digits represents significant figures and the last digit denotes the number of zero

ex) 104 = 100000 pF / R denotes decimal / 8R2 = 8.2 pF

5) Capacitance Tolerance Code

Code	Tolerance
B	± 0.1 pF
C	± 0.25 pF
D	± 0.5 pF
F	± 1.0 %

Code	Code
G	± 2.0 %
J	± 5 %
K	± 10 %
M	± 20 %

6) Voltage Code

Code	2R5	040	6R3	100	160	250	350	500	101	201	251	501	631	102	202	302
Rate Voltage	DC 2.5V	DC 4V	DC 6.3V	DC 10V	DC 16V	DC 25V	DC 35V	DC 50V	DC 100V	DC 200V	DC 250V	DC 500V	DC 630V	DC 1KV	DC 2KV	DC 3KV

7) Termination Code

N : Nickel-Tin Plate

A : Nickel-Tin Plate → Soft Termination Type

8) Packing Code

R : 7“ Reel Type, L : 13“ Reel Type, B : Bulk Type

General Description

9) Thickness option

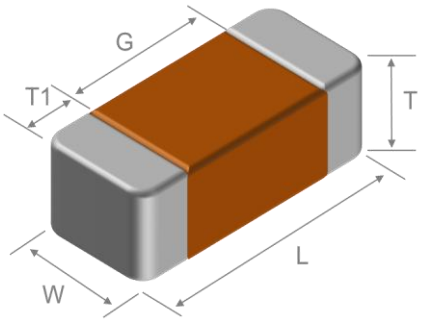
Thickness (mm)		Code
t	Tolerance (±)	
0.80	0.20	B

3. Temperature Characteristics

See Page 8 (Specifications and Test Methods : No.13)

4. Constructions and Dimensions

1) Dimensions

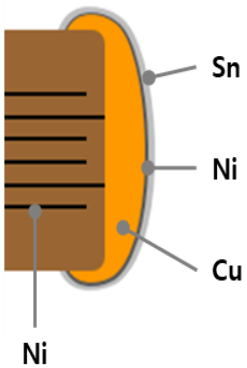


(Unit : ㎜)

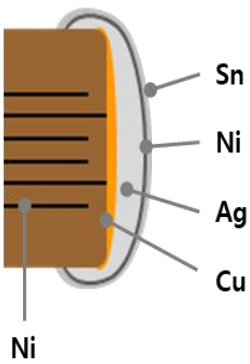
Size Code	EIA Code	Dimension							
		Length		Width		Thickness		T1(min.)	G(min.)
		L	Tol(±)	W	Tol(±)	T	Tol(±)		
1608	0603	1.60	0.20	0.80	0.20	0.80	0.20	0.50	0.50

(2) Construction of Termination

- Ni Termination



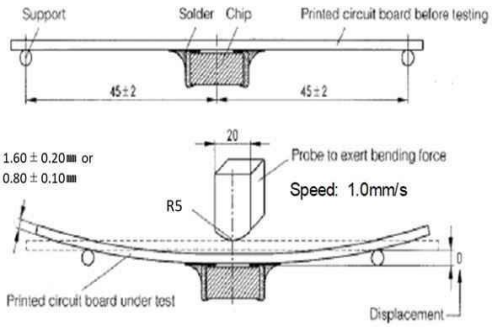
- Soft termination



Specifications and Test Methods (Thin Layer Large-Capacitance Type) (IEC-60384 Qualified)

<table>
<tr><th>No.</th><th colspan="2">Test Item</th><th>Specification</th><th>Test Methods and Conditions</th></tr>
<tr><td>1</td><td colspan="2">Operating Temperature Range</td><td>X7R, X7S, X7T : -55 to +125℃
X6S : -55 to +105℃
X5R : -55 to +85℃
Y5V : -30 to +85℃</td><td></td></tr>
<tr><td>2</td><td colspan="2">Insulation Resistance</td><td>50Ω.F min</td><td>Applied Voltage — Rated voltage
Charging Time — 2min.
Charge/Discharge Current — 50mA max.</td></tr>
<tr><td>3</td><td colspan="2">Voltage proof</td><td>No defects or abnormalities</td><td>Applied Voltage — x 250%
Applied Time — 1 to 5sec.
Charge/Discharge Current — 50mA max.</td></tr>
<tr><td>4</td><td colspan="2">Capacitance</td><td>within the specified tolerance</td><td>Measurement Temperature — 25℃
Applied Voltage — Shown in the table</td></tr>
<tr><td>5</td><td colspan="2">Dissipation Factor</td><td>12.5% max
*3216 Size 100μF : 15% max
Y5V : 20% max</td><td>Capacitance | Frequency | Voltage
C≦10μF | 1 ± 0.1kHz | 0.5~1.0Vrms
C>10μF | 120 ± 24Hz | 0.5 ± 0.1Vrms
Initial Measurement — Perform the initial measurement according to Note1 for Class II
Measurement after test — Take it out and set it for 24±2 hours (Class II) then measure</td></tr>
<tr><td>6</td><td colspan="2">Solderability</td><td>95% of the terminations is to be soldered evenly and continuously.</td><td>Solder — 96.5Sn-3Ag-0.5Cu
Solder temperature — 245±5°C
Immersion time — 3 ± 0.1sec.
Pre-Heating — 80~120°C for 10~30sec.</td></tr>
<tr><td rowspan="4">7</td><td rowspan="4">Resistance to Soldering Heat</td><td>Appearance</td><td>No defects which may affect performance</td><td rowspan="4">Preheat Temperature — 120 to 150°C
Preheat Time (3225,4520,4532 Size) — 1min.
Preheat Temperature — 100 to 120°C (Step1) / 170 to 200°C (Step2)
Preheat Time — 1min.
Soldering Temp — 260±5°C
Immersion Time — 10±0.5 sec.
Initial Measurement — Perform the initial measurement according to Note1 for Class II
Measurement after test — Let sit at room temperature for 24±2 hours, then measure</td></tr>
<tr><td>Capacitance Change</td><td>Within ±7.5%
Y5V : ≦ ±20%</td></tr>
<tr><td>Dissipation Factor</td><td>12.5%max
*3216 Size 100μF : 15% max
Y5V : 20% max</td></tr>
<tr><td>I.R</td><td>50Ω.F min</td></tr>
<tr><td rowspan="4">8</td><td rowspan="4">Rapid change of temperature</td><td>Appearance</td><td>No defects which may affect performance</td><td rowspan="4">Heat treatments — Shown in the table
Cycles — 5cycles
Step | 1 | 2 | 3 | 4
Temp (℃) | Min. Operating temp. +0, -3 | Room Temp | Max. Operating temp. +3, -0 | Room Temp
Time (min) | 30 ± 3 | 2 to 3 | 30 ± 3 | 2 to 3
Initial measurement — Perform the initial measurement according to Note1 for Class II
Measurement after test — Perform the final measurement according to Note2</td></tr>
<tr><td>Capacitance Change</td><td>Within ±7.5%
Y5V : Within ±20%</td></tr>
<tr><td>Dissipation Factor</td><td>12.5%max
*3216 Size 100μF : 15% max
Y5V : 20% max</td></tr>
<tr><td>I.R</td><td>50Ω.F min</td></tr>
</table>

Specifications and Test Methods (Thin Layer Large-Capacitance Type) (IEC-60384 Qualified)

No.	Test Item		Specification	Test Methods and Conditions
9	Endurance	Appearance	No defects which may affect performance	Testing Time: 1000+48/-0 hrs Applied Voltage: Rated Voltage x150% Temperature (C0G,X7R): 125±3℃ Temperature (X5R, Y5V): 85±3℃ Charge/discharge current: 50mA max. Initial measurement: Perform the initial measurement according to Note1 for Class II Measurement after test: Perform the final measurement according to Note2
		Capacitance Change	Within ±15.0%	
		Dissipation Factor	20%max *3216 Size 100μF : 30% max Y5V : 40% max	
		I.R	12.5Ω.F min	
10	Substrate bending test		 No cracking or marking defects shall occur	Substrate material: Glass Epoxy Board Thickness: 1.6mm 0.8mm (0603/1005size) Bending limit: 1mm Pressurizing speed: 1mm/sec. Holding time: 5±1sec.
		Capacitance Change	Within ±10% Y5V : Within ±30% Within +30/-40% (cap≥10μF)	
11	Vibration	Appearance	No defects which may affect performance	After soldering and then let sit for 24±2hr at room temperature Type of Vibration: From 10Hz to 55Hz then 10Hz again Vibration Time: 1min. Total Amplitude: 1.5mm Vibration directions and time: This motion shall be applied for a period of 2 hours in each 3 mutually perpendicular directions (total is 6hours)
		Capacitance Change	Whin the specified tolerance	
		Dissipation Factor	12.5%max *3216 Size 100μF : 15% max Y5V : 20% max	
12	Accelerated damp heat, steady state	Appearance	No defects which may affect performance	Applied Voltage: Rated voltage Temperature: 40±2°C Humidity: 90 to 95%RH Time: 500+24/-0 hrs Charge/Discharge Current: 50mA max. Initial measurement: Perform the initial measurement according to Note1 for Class II Measurement after test: Perform the final measurement according to Note2
		Capacitance Change	Within ±12.5% Y5V : Within ±30%	
		Dissipation Factor	20%max *3216 Size 100μF : 30% max Y5V : 40% max	
		I.R	12.5Ω.F min	

Specifications and Test Methods (Thin Layer Large-Capacitance Type) (IEC-60384 Qualified)

<table>
<tr><th>No.</th><th>Test Item</th><th>Specification</th><th>Test Methods and Conditions</th></tr>
<tr><td>13</td><td>Temperature characteristic of capacitance</td><td>
<table>
<tr><th>Char.</th><th>Temp. Range</th><th>Reference Temp.</th><th>Cap. Change</th></tr>
<tr><td>X5R</td><td>-55 to +85°C</td><td>25℃</td><td>Within ±15%</td></tr>
<tr><td>X6S</td><td>-55 to +105°C</td><td>25℃</td><td>Within ±22%</td></tr>
<tr><td>X7R</td><td>-55 to +125°C</td><td>25℃</td><td>Within ±15%</td></tr>
<tr><td>X7S</td><td>-55 to +125°C</td><td>25℃</td><td>Within ±22%</td></tr>
<tr><td>X7T</td><td>-55 to +125°C</td><td>25℃</td><td>Within +22/-33%</td></tr>
<tr><td>Y5V</td><td>-30 to +85°C</td><td>25℃</td><td>Within +22/-82%</td></tr>
<tr><td>X8R</td><td>-55 to +150°C</td><td>25℃</td><td>Within ±15%</td></tr>
<tr><td>X8L</td><td>-55 to +150°C</td><td>25℃</td><td>Within +15/-40%</td></tr>
</table>
</td><td>The capacitance change should be measured after 5 min at each specified temperature stage.
The ranges of capacitance change compared with the 25℃ value over the temperature ranges shown in the table should be within the specified ranges.</td></tr>
</table>

*Note1. Initial Measurement for Class II
Perform a heat treatment at 150+0,-10°C for one hour and then let sit for 24±2 hours at room temperature,then measure

*Note2. Measurement after test Class II
Perform a heat treatment at 150+0,-10°C for one hour and then let sit for 24±2 hours at room temperature,then measure.

"Following the International standards, the title of each test item is subject to change."

Packing

(1) Bulk Packing

① 1000 pcs per polybag

② 5 polybags per inner box

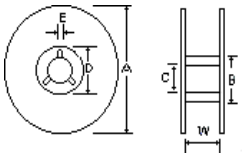
③ 10 inner boxes per out box

(2) Reel Packing

① 8~10 Reels per inner box

② 6 inner boxes per out box

(3) Reel Dimensions



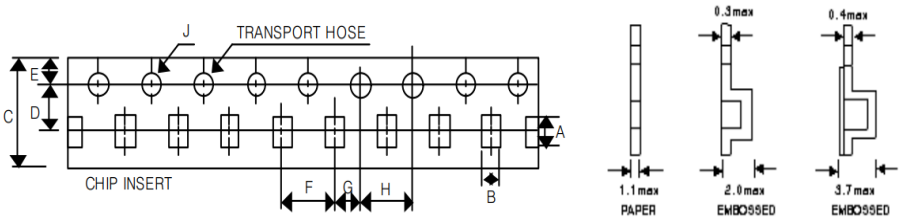
(Unit : mm)

Mark	Size Code	EIA Code	A	B	C	D	E	W
7 ″ Reel	0603~3225	0201~1210	Φ178±2	Φ50Min	Φ13±0.5	Φ21±0.8	2±0.5	10±1.5
	4520~4532	1808~1812	Φ180+0,-3	Φ60-0,+1	Φ13±0.2	Φ57-0+1	3±0.2	13±0.5
13 ″ Reel	1005~3225	0402~1210	Φ330±2	Φ70Min	Φ13±0.5	Φ21±0.8	2±0.5	10±1.5

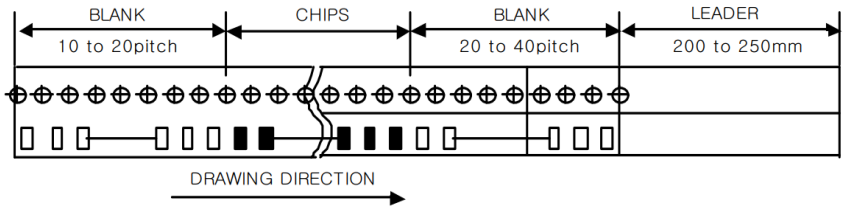
Size Code	EIA Code	7"	13"
		Quantity (pcs) / Reel	Quantity (pcs) / Reel
CS0603	CC0201	15,000	-
CS1005	CC0402	10,000	50,000
CS1608	CC0603	4,000	15,000
CS2012	CC0805	3,000 ~ 4,000	8,000 ~ 15,000
CS3216	CC1206	2,000 ~ 4,000	6,000 ~ 10,000
CS3225	CC1210	1,000 ~ 3,000	4,000 ~ 10,000
CS4520	CC1808	1,500 ~ 3,000	-
CS4532	CC1812	500 ~ 1,000	1,500 ~ 5,000

Packing

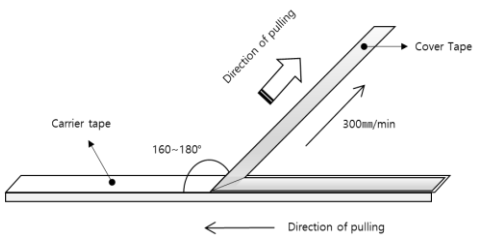
(5) Tape Dimensions



Size Code	EIA Code	Size	Thickness	A	B	C	D	E	F	G	H	J
CS0603	CC0201	0603	all	0.7±0.02	0.4±0.02	8±0.1	3.5±0.05	1.75±0.05	2±0.05	2±0.05	4±0.1	1.55±0.03
CS1005	CC0402	1005	all	1.12±0.03	0.62±0.03	8±0.1	3.5±0.05	1.75±0.05	2±0.05	2±0.05	4±0.1	1.55±0.03
CS1005	CC0402	1005	all	1.12±0.03	0.58±0.03	8±0.1	3.5±0.05	1.75±0.05	2±0.05	2±0.05	4±0.1	1.55±0.03
CS1005	CC0402	1005	all	1.16±0.03	0.66±0.03	8±0.05	3.5±0.05	1.75±0.05	2±0.05	2±0.05	4±0.1	1.55±0.03
CS1608	CC0603	1608	A, B	1.8±0.05	0.95±0.05	8±0.1	3.5±0.05	1.75±0.05	2±0.05	2±0.05	4±0.1	1.55±0.03
CS1608	CC0603	1608	A, B	1.78±0.05	0.92±0.05	8±0.1	3.5±0.05	1.75±0.05	2±0.05	2±0.05	4±0.1	1.55±0.03
CS1608	CC0603	1608	B	1.9±0.05	1.1±0.05	8±0.2	3.5±0.05	1.75±0.1	4±0.1	2±0.05	4±0.1	1.5+0.1
CS1608	CC0603	1608	B	1.9±0.05	1.1±0.05	8±0.1	3.5±0.05	1.75±0.05	4±0.1	2±0.05	4±0.1	1.55±0.03
CS2012	CC0805	2012	E	2.25±0.1	1.35±0.1	8±0.1	3.5±0.05	1.75±0.1	4±0.1	2±0.05	4±0.05	1.5±0.1
CS2012	CC0805	2012	E	2.4±0.1	1.6±0.1	8±0.1	3.5±0.05	1.75±0.1	4±0.1	2±0.05	4±0.05	1.5±0.1
CS2012	CC0805	2012	E	2.25±0.1	1.35±0.1	8±0.1	3.5±0.05	1.75±0.1	4±0.1	2±0.05	4±0.1	1.5+0.1
CS2012	CC0805	2012	E	2.25±0.05	1.53±0.08	8±0.1	3.5±0.05	1.75±0.1	4±0.1	2±0.05	4±0.1	1.5+0.1
CS2012	CC0805	2012	A	2.3±0.05	1.55±0.05	8±0.1	3.5±0.05	1.75±0.05	4±0.1	2±0.05	4±0.1	1.55±0.03
CS2012	CC0805	2012	B	2.3±0.05	1.55±0.05	8±0.1	3.5±0.05	1.75±0.05	4±0.1	2±0.05	4±0.1	1.55±0.03
CS3216	CC1206	3216	E	3.5±0.1	1.88±0.1	8±0.1	3.5±0.05	1.75±0.1	4±0.1	2±0.05	4±0.05	1.5±0.1
CS3216	CC1206	3216	I	3.45±0.1	1.75±0.1	8±0.1	3.5±0.05	1.75±0.1	4±0.1	2±0.05	4±0.05	1.5±0.1
CS3216	CC1206	3216	I	3.7±0.1	1.85±0.1	8±0.1	3.5±0.05	1.75±0.1	4±0.1	2±0.05	4±0.05	1.5±0.1
CS3225	CC1210	3225	L	3.58±0.1	2.75±0.1	8±0.1	3.5±0.05	1.75±0.1	4±0.1	2±0.05	4±0.05	1.5±0.1
CS3225	CC1210	3225	J	3.58±0.1	2.85±0.1	8±0.1	3.5±0.05	1.75±0.1	4±0.1	2±0.05	4±0.05	1.5±0.1
CS3225	CC1210	3225	L	3.5±0.1	2.7±0.1	8±0.1	3.5±0.05	1.75±0.1	4±0.1	2±0.05	4±0.05	1.5±0.1
CS4532	CC1812	4532	M	4.9±0.1	3.6±0.1	12±0.1	5.5±0.05	1.75±0.1	8±0.1	2±0.05	4±0.05	1.5±0.1



2. Measurement Method

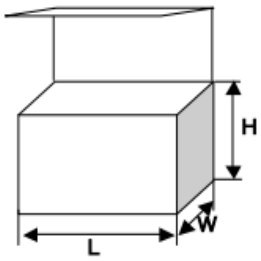


Packing

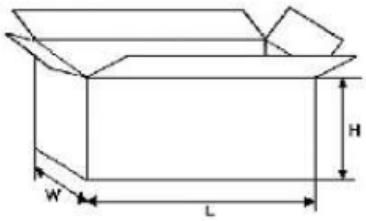
(7) Packing Label(* Reference image)

① Customer
② Part No.
③ Lot No
④ Q/ty

(8) Packing Box



Inner box drawing



Out box drawing

Packing Box Dimensions (Unit : mm)

Division		Size		
		L	W	H
Inner Box	7 " Reel Box (in 5 reels)	183	65	185
	7 " Reel Box (in 10 reels)	185	135	185
	13 " Reel Box	330	65	337
Out Box	7 " Reel Box	430	390	210
	13 " Reel Box	350	350	360

Caution

▶ Storage Condition

When solderability is considered, capacitor are recommended to be used in 12 months.

MLCC should be stored at 5~40℃ with a relative humidity of 20~70%

High humidity can reduce solderability due to oxidation.

Use the product within 6 months of the outgoing delivery date, and check the packaging if more than 6 months have passed.

It's recommended to use within 1 year to avoid solderability issues from long-term storage.

If over 1 year, verify solderability before use.

▶ The Regulation of Environmental Pollution Materials

Never use materials mentioned below in MLCC products regulated this document.

Pb, Cd, Hg, Cr+6, PBB(Polybrominated biphenyl), PBDE(Polybrominated diphenyl ethers), asbestos

▶ Reflow Soldering

1. The sudden temperature change easily causes mechanical damages to ceramic components. Therefore, the preheating procedures should be required for the soldering of ceramic components.

2. Please refer to the recommended soldering profiles as shown in figures, and keep the temperature difference(△T) within the range recommended in Table 1.

▶ Standard condition for reflow soldering

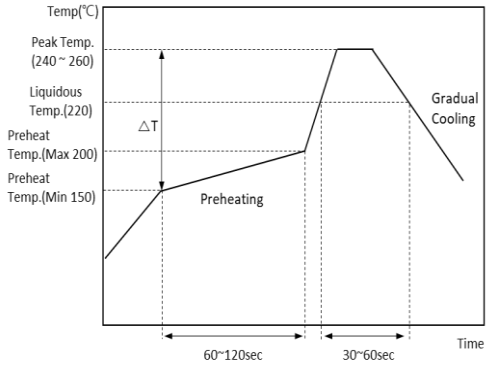


Table 1

Size code (EIA Code)	Temperature Difference
0603, 1005, 1608, 2012, 3216	△T≤150°C
3225 size and over	△T≤130°C

Recommended Conditions

Size code (EIA Code)	Lead Free Solder
Peak Temperature	240 - 260°C
Atmosphere	Air or N_2

* Compliant Standard JESD22

▶ Flow Soldering

1. The sudden temperature change easily causes mechanical damages to ceramic components. Therefore, the preheating procedures should be required for the soldering of ceramic components.

2. Please refer to the recommended soldering profiles as shown in figures, and keep the temperature difference(△T) within the range recommended in Table 2.

▶ Flow Profile

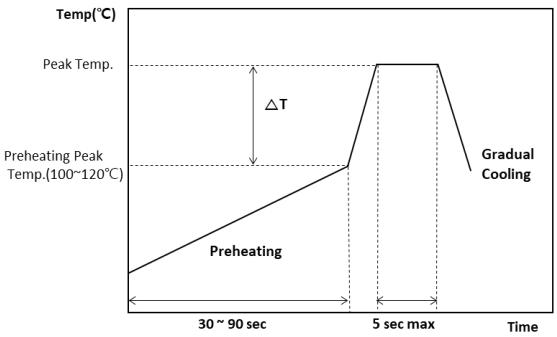


Table 2

Size code	Temperature Difference
1608, 2012, 3216	△T≤150°C

Recommended Conditions

Conditions	Lead Free Solder
Soldering Peak Temperature	250 - 260°C
Atmosphere	Air or N_2

*Lead Free Solder : Sn-3.0Ag-0.5Cu

Notice

▶ Land Dimension

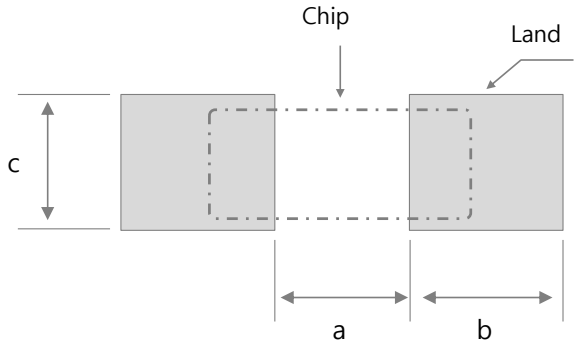


Table . Reflow Soldering Method

Chip size [mm]	Chip tol. [mm]	a [mm]	b [mm]	c [mm]
0603	±0.03	0.2~0.25	0.2~0.3	0.25~0.35
	±0.05/±0.09	0.23~0.3	0.25~0.35	0.3~0.4
1005	±0.1	0.3~0.5	0.35~0.45	0.4~0.6
	±0.2	0.4~0.6	0.4~0.5	0.5~0.7
1608	±0.1	0.6~0.8	0.6~0.7	0.6~0.8
	±0.2	0.7~0.9	0.7~0.8	0.8~1.0
2012	±0.1	0.9~1.3	0.6~0.8	1.2~1.4
	±0.2	1.0~1.4	0.6~0.8	1.2~1.4
3216	±0.2	1.8~2.0	0.9~1.2	1.5~1.7
	±0.3	1.9~2.1	1.0~1.3	1.7~1.9
3225		2.0~2.4	1.0~1.2	1.8~2.3
4532		3.0~3.5	1.2~1.4	2.3~3.0
5750		4.0~4.6	1.4~1.6	3.5~4.8

*Please confirm the suitable land dimensions, which are determined through the evaluation of the actual SET and PCB

Note

(1) 'Aging'/'De-aging' behavior of high dielectric constant type MLCCs

(Typically represented by X7R temperature characteristic of which main composition is $BaTiO_3$)

'Aging' / 'De-aging' Behavior of high dielectric MLCCs Please note that high dielectric type dielectric ceramic capacitors have a "normal" 'aging' behavior / characteristic, that is; their capacitance value decreases with time from its value when it was first manufactured. From that date, the capacitance value begins to decrease at a logarithmic rate defined by :

$Ct = C_{24} (1 - k \log10\ t)$

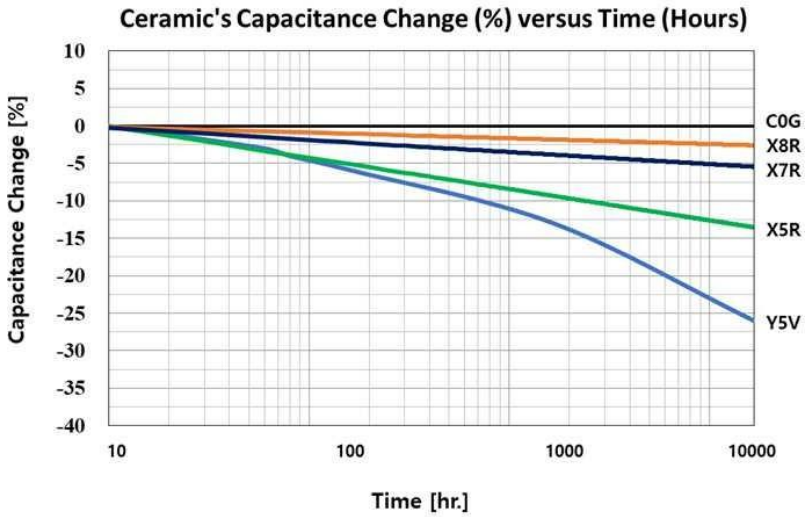
where,

Ct : Capacitance value, t hours after the start of 'aging

C_{24} : Capacitance value, 24 hours after its manufacture

k : Aging constant (capacitance decrease per decade-hour)

t : time, in hours, from the start of 'aging'



The capacitance value can be restored (also known as 'de-aged') by exposing the component to elevated temperatures approaching its curie temperature (approximately 120°C). This 'de-aging' can occur during the component's solder-assembly onto the PCB, during life or temperature cycle testing, or by baking at 150°C for about 1 hour.

(2) Caution of Application

Please contact our sales representatives or product engineers before using the products in this catalog for the applications listed below, which require especially high reliability for the prevention of defects which might directly damage a third party's life, body or property, or when one of our products is intended for use in applications other than those specified in this catalog.

ⓐ Aircraft equipment ⓑ Aerospace equipment ⓒ Undersea equipment ⓓ Power plant equipment
ⓔ Medical equipment ⓕ Transportation equipment (vehicles, trains, ships, etc.)
ⓖ Traffic signal equipment ⓗ Disaster prevention / crime prevention equipment
ⓘ Industrial equipment (Conveyors, Robot equipment, etc) ⓙ Led equipment
ⓚ Application of similar complexity and/or reliability requirements to the applications listed above