Automotive Applications

Features

- SAMWHA Series meet AEC-Q200 requirements
- SAMWHA Series Certify IATF 16949(ISO/TS 16949), ISO 9001, ISO 14001
- SAMWHA Series are RoHS Compliant

Applications

- Automotive electronic equipment

How to Order(Product Identification)

CQ 1608 X7R 104 K 500 N R B

1 2 3 4 5 6 7 8 9

1 Monolithic Multilayer Ceramic Capacitor Leadless Type for Automotive Application

2 Size Code

This is expressed in tens of a millimeter.

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

3 Temperature Coefficient Code

Classification	Code	Temperature Range	Capacitance Change or Temperature Coefficient
Class I	C0G	–55 to +125℃	±30 ppm/℃
Class II	X7R	–55 to +125℃	±15%
Class II	X8R	–55 to +150℃	±15%

4 Capacitance Code(Pico farads)

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 = 100000pF

R denotes decimal

8R2 = 8.2pF

5 Capacitance Tolerance Code

Code	Tolerance	Code	Tolerance
B	±0.1pF	G	±2.0%
C	±0.25pF	J	±5%
D	±0.5pF	K	±10%
F	±1.0%	M	±20%

6 Voltage Code

Code	6R3	100	160	250	500	101	201	251	501	631	102	202	302
Rated Voltage	DC 6.3V	DC 10V	DC 16V	DC 25V	DC 50V	DC 100V	DC 200V	DC 250V	DC 500V	DC 630V	DC 1KV	DC 2KV	DC 3KV

7 Termination & Design Code

N : Nickel-Tin Plate A : Nickel-Tin Plate(Soft Termination) O : Open Mode F : Floating electrode

S : Ag/Ni-SN(Ag Epoxy/Nickel-Tin Plate)+Open mode type

Normal Type

Open Mode Type

Soft Termination Type

8 Packing Code

R : Reel Type, B : Bulk Type

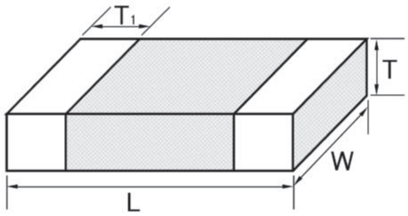
9 Thickness Option

Size(mm)	Thickness(mm)		Code	Size(mm)	Thickness(mm)		Code
	t	Tol(±)			t	Tol(±)	
0603/1005	0.3	0.03	-	3216	1.15	0.15	E
1005	0.5	0.05	-	3216/3225	1.6	0.2	I
2012	0.6	0.1	A	3225	1.8	0.2	J
1608	0.8	0.1	B	3225/4532/5750	2	0.25	K
2012/3216	0.85	0.15	B	3225/4532/5750	2.5	0.25	L
2012	1.25	0.15	E				

Size(mm)	Code	Packaging	Size(mm)	Code	Packaging
0603/1005	-	Paper Taping	3216	E	Embossed Taping
1005	-	Paper Taping	3216/3225	I	Embossed Taping
2012	A	Paper Taping	3225	J	Embossed Taping
1608	B	Paper Taping	3225/4532/5750	K	Embossed Taping
2012/3216	B	Paper Taping	3225/4532/5750	L	Embossed Taping
2012	E	Embossed Taping			

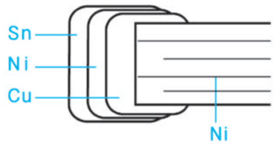
Temperature Characteristics See Page 39 (No.21)

Dimensions

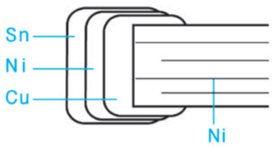


Code	Dimensions				
	Length		Width		T1(min)
	L	Tol(±)	W	Tol(±)	
1005(0402)	1.00	0.05	0.50	0.05	0.05
1608(0603)	1.60	0.15	0.80	0.10	0.10
2012(0805)	2.00	0.20	1.25	0.15	0.10
3216(1206)	3.20	0.30	1.60	0.20	0.15
3225(1210)	3.20	0.40	2.50	0.25	0.15

Construction of Termination

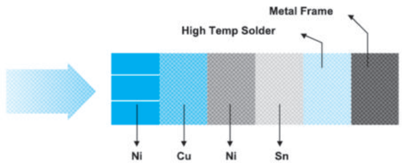


a. Ni Type Ⅰ



b. Ni Type Ⅱ
(Soft Termination)

c. Metal Frame Type



Termination Details

Capacitance Table.

Class I (C0G)

Size Code (EIA Code) / Rated Volt.(V) / Cap.	1005(0402)				1608(0603)				2012(0805)				3216(1206)				3225(1210)			
	16	25	50	100	16	25	50	100	16	25	50	100	16	25	50	100	16	25	50	100
0.5pF(0R5)																				
1pF(010)																				
2.2pF(2R2)																				
3pF(030)																				
4pF(040)																				
4.7pF(4R7)																				
5pF(050)																				
6.8pF(6R8)																				
7pF(070)																				
8pF(080)																				
9pF(090)																				
10pF(100)																				
12pF(120)																				
15pF(150)																				
18pF(180)																				
22pF(220)																				
27pF(270)																				
33pF(330)																				
39pF(390)																				
47pF(470)																				
56pF(560)																				
68pF(680)																				
82pF(820)																				
100pF(101)																				
120pF(121)																				
150pF(151)																				
180pF(181)																				
220pF(221)																				
270pF(271)																				
330pF(331)																				
390pF(391)																				
470pF(471)																				
560pF(561)																				
680pF(681)																				
820pF(821)																				
1000pF(102)																				
1200pF(102)																				
1500pF(152)																				
1800pF(182)																				
2200pF(222)																				
3300pF(332)																				
4700pF(472)																				

Class II (X7R)

Size Code (EIA Code)	1005(0402)				1608(0603)				2012(0805)				3216(1206)				3225(1210)			
Rated Volt.(V) / Cap.	16	25	50	100	16	25	50	100	16	25	50	100	16	25	50	100	16	25	50	100
1000pF(102)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
1500pF(152)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
2200pF(222)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
3300pF(332)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
4700pF(472)	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
6800pF(682)	G	G	G		G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
10000pF(103)	G	G	G		G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
15000pF(153)	G	G	G		G	G	G		G	G	G	G	G	G	G	G	G	G	G	G
22000pF(223)	G	G	G		G	G	G		G	G	G	G	G	G	G	G	G	G	G	G
33000pF(333)	G	G	T		G	G	G		G	G	G	G	G	G	G	G	G	G	G	G
47000pF(473)	G	G			G	G	G		G	G	G	G	G	G	G		G	G	G	G
68000pF(683)	G	G			G	G	G		G	G	G	G	G	G	G		G	G	G	G
0.1uF(104)	T	T			G	G	G		G	G	G	G	G	G	G		G	G	G	G
0.15uF(154)					G	G	T		G	G	T	T	G	G	G		G	G	G	G
0.22uF(224)					T	T	T		G	T	T	T	G	G	G		G	G	G	G
0.33uF(334)					T	T			T	T	T		G	G	G		G	G	G	G
0.47uF(474)					T	T			T	T	T		G	G	G		G	G	G	G
0.68uF(684)					T	T			T	T	T		G	G	T		G	G	G	
1.0uF(105)					T	T			T	T			G	G	T		G	G	G	
2.2uF(225)									T	T			T	T	T		G	G	T	
4.7uF(475)									T				T	T			T	T	T	
10uF(106)													T	T			T	T		
22uF(226)																	T			

G: General Type for Automotive Application
T: Thin Layer Large-Capacitance Type for Automotive Application

Typical Performance Characteristics

X8R

Application

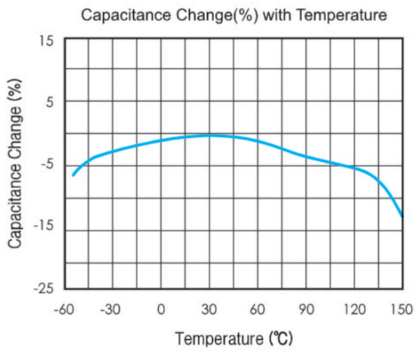
The X8R series could be applicable to devices that operating in high-temperature environments

Temperature Characteristics (x8r, -55 to 150℃, Capacitance Change ±15%)

Excellent DC-bias, Temperature and Aging properties

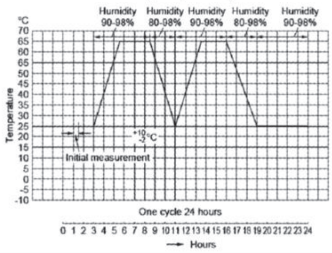
Dielectric Characteristics

Temperature Characteristic	±15%
Operating Temperature	–55~150℃
Capacitance Tolerance	±10%, ±20%,
Dissipation Factor	50V : 2.5% max. 25V : 3.0% max. 16V : 3.5% max. 10V : 5.0% max
Insulation Resistance	More than 10,000MΩ or 50ΩF (Whichever is smaller)
Dielectric Strength	>2.5×RVDC
Test Voltage	0.5 ~1.0Vrms
Test Frequency	1±0.1kHz



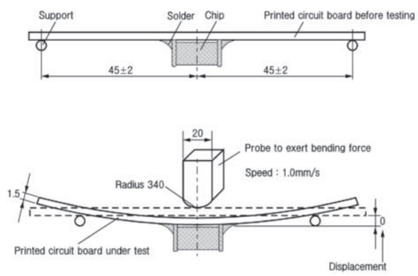
Size Code (EIA Code) / Rated Volt.(V) / Cap.	1608(0603)				2012(0805)				3216(1206)			
	16	25	50	100	16	25	50	100	16	25	50	100
1000pF(102)												
4700pF(472)												
6800pF(682)												
10000pF(103)												
22000pF(223)												
470000pF(473)												
680000pF(683)												
0.1uF(104)												
0.15uF(154)												
0.22uF(224)												
0.47uF(474)												
0.68uF(684)												
1.0uF(105)												
2.2uF(225)												
4.7uF(475)												
10uF(106)												
22uF(226)												
47uF(226)												
100uF(226)												

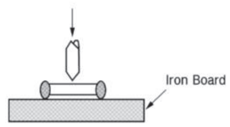
Specifications and Test Methods(For Automotive Applications)

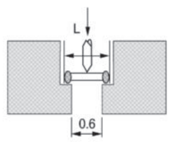
<table>
<tr><th rowspan="2">No.</th><th rowspan="2" colspan="2">AEC-Q200</th><th colspan="2">Specification</th><th rowspan="2">Test Methods and Conditions</th></tr>
<tr><th>Class I</th><th>Class II</th></tr>
<tr><td>1.</td><td colspan="2">Pre-and Post-Stress Electrical Test</td><td colspan="3"></td></tr>
<tr><td rowspan="4">2.</td><td rowspan="4">High Temperature Exposure (Storage)</td><td>Appearance</td><td>No marking defects</td><td></td><td rowspan="4">Temperature : 150±3℃
Maintenance Time : 1000+48/-0 hrs
Let sit for 24±2 hours at room temperature, then measure.</td></tr>
<tr><td>Capacitance Change</td><td>Within ±2.5% or ±0.25pF (Whichever is larger)</td><td>Within±10.0%</td></tr>
<tr><td>Q/D.F.</td><td>30pF Min.: Q≥1000
30pF Max.: Q≥400+20×C
C: Nominal Capacitance(pF)</td><td>Rated Voltage
16V Min.: 0.05 Max.
10V: 0.075 Max.</td></tr>
<tr><td>I.R.</td><td colspan="2">More than 10,000MΩ or 500Ω·F(Whichever is smaller)</td></tr>
<tr><td rowspan="4">3.</td><td rowspan="4">Temperature Cycle</td><td>Appearance</td><td>No marking defects</td><td></td><td rowspan="4">Perform the 1000 cycles according to the four heat treatments listed in the following table.
Let sit for 24±2 hours at room temperature, then measure.<table><tr><th>Step</th><th>1</th><th>2</th><th>3</th><th>4</th></tr><tr><td>Temp.(℃)</td><td>-55+0/-3</td><td>25±2</td><td>125+3/-0</td><td>25±2</td></tr><tr><td>Time(min)</td><td>15±3</td><td>1</td><td>15±3</td><td>1</td></tr></table>Initial measurement
Perform the initial measurement according to Note 1 for Class II.</td></tr>
<tr><td>Capacitance Change</td><td>Within ±2.5% or ±0.25pF (Whichever is larger)</td><td>Within±10.0%</td></tr>
<tr><td>Q/D.F.</td><td>30pF Min.: Q≥1000
30pF Max.: Q≥400+20×C
C: Nominal Capacitance(pF)</td><td>Rated Voltage
16V Min.: 0.05 Max.
10V: 0.075 Max.</td></tr>
<tr><td>I.R.</td><td colspan="2">More than 10,000MΩ or 500Ω·F(Whichever is smaller)</td></tr>
<tr><td>4.</td><td colspan="2">Destructive Physical Analysis</td><td colspan="2">No defects or abnormalities</td><td>Per EIA-469</td></tr>
<tr><td rowspan="4">5.</td><td rowspan="4">Moisture Resistance</td><td>Appearance</td><td>No marking defects</td><td></td><td rowspan="4">Temperature : 25~65℃, Humidity : 80~98%
Cycle Time : 24 hrs/cycle, 10 cycles
</td></tr>
<tr><td>Capacitance Change</td><td>Within ±3.0% or ±0.30pF (Whichever is larger)</td><td>Within±12.5%</td></tr>
<tr><td>Q/D.F.</td><td>30pF Min.: Q≥350
10pF Min. and 30pF Max.: Q≥275+5/2×C
10pF Max.: Q≥200+10×C
C: Nominal Capacitance(pF)</td><td>Rated Voltage
16V Min.: 0.05 Max.
10V: 0.075 Max.</td></tr>
<tr><td>I.R.</td><td colspan="2">More than 10,000MΩ or 500Ω·F(Whichever is smaller)</td></tr>
<tr><td rowspan="4">6.</td><td rowspan="4">Biased Humidity</td><td>Appearance</td><td>No marking defects</td><td></td><td rowspan="4">Temperature : 85±3℃
Humidity : 80~85%
Applied Voltage : Rated Voltage and 1.3+0.2/-0V
Maintenance Time : 1000+48/-0 hrs
Let sit for 24±2 hours at room temperature, then measure.
The charge/discharge current is less than 50mA.</td></tr>
<tr><td>Capacitance Change</td><td>Within ±3.0% or ±0.30pF (Whichever is larger)</td><td>Within±12.5%</td></tr>
<tr><td>Q/D.F.</td><td>30pF Min.: Q≥200
30pF Max.: Q≥100+10/3×C
C: Nominal Capacitance(pF)</td><td>Rated Voltage
16V Min.: 0.05 Max.
10V: 0.075 Max.</td></tr>
<tr><td>I.R.</td><td colspan="2">More than 10,000MΩ or 500Ω·F(Whichever is smaller)</td></tr>
<tr><td rowspan="4">7.</td><td rowspan="4">Operational Life</td><td>Appearance</td><td>No marking defects</td><td></td><td rowspan="4">Temperature : 125±3℃
Applied Voltage : Rated Voltage× 200%
Maintenance Time : 1000+48/-0 hrs
Let sit for 24±2 hours at room temperature, then measure. The charge/discharge current is less than 50mA.
Initial Measurement for Class II
Applied 200% of the rated voltage for one hour at 125±3℃ Remove and let sit for 24±2 hours at room temperature, then measure.</td></tr>
<tr><td>Capacitance Change</td><td>Within ±3.0% or ±0.30pF (Whichever is larger)</td><td>Within±12.5%</td></tr>
<tr><td>Q/D.F.</td><td>30pF Min.: Q≥350
10pF Min. and 30pF Max.: Q≥275+5/2×C
10pF Max.: Q≥200+10×C
C: Nominal Capacitance(pF)</td><td>Rated Voltage
16V Min.: 0.05 Max.
10V: 0.075 Max.</td></tr>
<tr><td>I.R.</td><td colspan="2">More than 10,000MΩ or 500Ω·F(Whichever is smaller)</td></tr>
</table>

No.	AEC-Q200		Specification		Test Methods and Conditions
			Class I	Class II	
8.	External Visual		No defects or abnormalities		Visual inspection
9.	Physical Dimension		Within the specified dimensions		Using calipers
10.	Resistance to Solvents	Appearance	No marking defects		Per MIL-STD-202 Method 215
		Capacitance Change	Within the specified tolerance		
		Q/D.F.	30pF Min.: Q≥1000 30pF Max.: Q≥400+20×C C: Nominal Capacitance(pF)	Rated Voltage 50V: 0.025 Max. 25V: 0.03 Max. 16V: 0.035 Max. 10V: 0.05 Max.	
		I.R.	More than 10,000MΩ or 500Ω·F(Whichever is smaller)		
11.	Mechanical Shock	Appearance	No marking defects		Three shocks in each direction should be applied along 3 mutually perpendicular axes of the test specimen (18 shocks) Test Pulse Wave form : Half-sine Duration : 0.5ms Peak value : 1,500G Velocity change : 4.7m/s
		Capacitance Change	Within the specified tolerance		
		Q/D.F.	30pF Min.: Q≥1000 30pF Max.: Q≥400+20×C C: Nominal Capacitance(pF)	Rated Voltage 50V: 0.025 Max. 25V: 0.03 Max. 16V: 0.035 Max. 10V: 0.05 Max.	
		I.R.	More than 10,000MΩ or 500Ω·F(Whichever is smaller)		
12.	Vibration	Appearance	No defects or abnormalities		The specimens should be subjected to a simple harmonic motion having a total amplitude of 1.5mm. The entire frequency range of 10 to 2,000 Hz and return to 10 Hz should be traversed in 20 minutes. This cycle should be performed 12 times in each of three mutually perpendicular directions (total of 36 times).
		Capacitance Change	Within the specified tolerance		
		Q/D.F.	30pF Min.: Q≥1000 30pF Max.: Q≥400+20×C C: Nominal Capacitance(pF)	Rated Voltage 50V: 0.025 Max. 25V: 0.03 Max. 16V: 0.035 Max. 10V: 0.05 Max.	
		I.R.	More than 10,000MΩ or 500Ω·F(Whichever is smaller)		
13.	Resistance to Soldering Heat	Appearance	No marking defects		Temperature(Eutectic solder solution) : 260±5℃ Dipping Time : 10±1s Let sit for 24±2 hours at room temperature, then measure. Initial measurement Perform the initial measurement according to Note 1 for Class II.
		Capacitance Change	Within the specified tolerance		
		Q/D.F.	30pF Min.: Q≥1000 30pF Max.: Q≥400+20×C C: Nominal Capacitance(pF)	Rated Voltage 50V: 0.025 Max. 25V: 0.03 Max. 16V: 0.035 Max. 10V: 0.05 Max.	
		I.R.	More than 10,000MΩ or 500Ω.F(Whichever is smaller)		

<table>
<tr><th rowspan="2">No.</th><th rowspan="2" colspan="2">AEC-Q200</th><th colspan="2">Specification</th><th rowspan="2">Test Methods and Conditions</th></tr>
<tr><th>Class I</th><th>Class II</th></tr>
<tr><td rowspan="4">14.</td><td rowspan="4">Thermal Shock</td><td>Appearance</td><td colspan="2">No marking defects</td><td rowspan="4">Perform the 300 cycles according to the two heat treatments listed in the following table.
Transfer Time : 20s Max.
Let sit for 24±2 hours at room temperature, then measure.
<table><tr><th>Step</th><th>1</th><th>2</th></tr><tr><td>Temp.(℃)</td><td>-55+0/-3</td><td>125+3/-0</td></tr><tr><td>Time(min)</td><td>15±3</td><td>15±3</td></tr></table>Initial measurement
Perform the initial measurement according to Note 1 for Class II.</td></tr>
<tr><td>Capacitance Change</td><td>Within ±3.0% or ±0.30pF
(Whichever is larger)</td><td>Within±12.5%</td></tr>
<tr><td>Q/D.F.</td><td>30pF Min.: Q≥1000
30pF Max.: Q≥400+20×C
C: Nominal Capacitance(pF)</td><td>Rated Voltage
50V: 0.025 Max.
25V: 0.03 Max.
16V: 0.035 Max.
10V: 0.05 Max.</td></tr>
<tr><td>I.R.</td><td colspan="2">More than 10,000MΩ or 500Ω·F(Whichever is smaller)</td></tr>
<tr><td rowspan="4">15.</td><td rowspan="4">ESD</td><td>Appearance</td><td colspan="2">No marking defects</td><td rowspan="4">Per AEC-Q200-002</td></tr>
<tr><td>Capacitance Change</td><td colspan="2">Within the specified tolerance</td></tr>
<tr><td>Q/D.F.</td><td>30pF Min.: Q≥1000
30pF Max.: Q≥400+20×C
C: Nominal Capacitance(pF)</td><td>Rated Voltage
50V: 0.025 Max.
25V: 0.03 Max.
16V: 0.035 Max.
10V: 0.05 Max.</td></tr>
<tr><td>I.R.</td><td colspan="2">More than 10,000MΩ or 500Ω·F(Whichever is smaller)</td></tr>
<tr><td>16.</td><td>Solderability</td><td></td><td colspan="2">95% of the terminations is to be soldered evenly and continuously.</td><td>(a) Preheat at 155℃ for 4 hours, and then immerse the capacitor in a solution of ethanol and rosin. Immerse in eutectic solder solution for 5+0/-0.5 seconds at 235±5℃.
(b) Steam aging for 8 hours, and then immerse the capacitor in a solution of ethanol and rosin. Immerse in eutectic solder solution for 5+0/-0.5 seconds at 235±5℃.
(c) Steam aging for 8 hours, and then immerse the capacitor in a solution of ethanol and rosin. Immerse in eutectic solder solution for 120±5 seconds at 260±5℃.</td></tr>
<tr><td rowspan="5">17.</td><td rowspan="5">Electrical Characteriza-tion</td><td>Appearance</td><td colspan="2">No defects or abnormalities</td><td rowspan="3">The capacitance/Q/D.F. should be measured at 25℃ at the frequency and voltage shown in the table
<table><tr><th>Class</th><th>Capacitance (C)</th><th>Frequency</th><th>Voltage</th></tr><tr><td rowspan="2">Class I</td><td>C≤1000pF</td><td>1±0.1MHz</td><td>0.5~5Vrms</td></tr><tr><td>C>1000pF</td><td>1±0.1kHz</td><td>1±0.2Vrms</td></tr><tr><td rowspan="2">Class II</td><td>C≤110μF</td><td>1±0.1kHz</td><td>1±0.2Vrms</td></tr><tr><td>C>10μF</td><td>120±24Hz</td><td>0.5±0.1Vrms</td></tr></table></td></tr>
<tr><td>Capacitance Change</td><td colspan="2">Within the specified tolerance</td></tr>
<tr><td>Q/D.F.</td><td>30pF Min.: Q≥1000
30pF Max.: Q≥400+20×C
C: Nominal Capacitance(pF)</td><td>Rated Voltage
50V: 0.025 Max.
25V: 0.03 Max.
16V: 0.035 Max.
10V: 0.05 Max.</td></tr>
<tr><td>I.R. at 25℃</td><td>More than 100,000MΩ
or 1,000Ω·F
(Whichever is smaller)</td><td>More than 100,000MΩ
or 500Ω·F
(Whichever is smaller)</td><td rowspan="2">Should be measured with a DC voltage not exceeding rated voltage at 25℃ and 125℃ for 2 minutes of charging.</td></tr>
<tr><td>I.R. at 125℃</td><td>More than 10,000MΩ
or 100Ω·F
(Whichever is smaller)</td><td>More than 10,000MΩ
or 10Ω·F
(Whichever is smaller)</td></tr>
</table>

<table>
<tr><th rowspan="2">No.</th><th rowspan="2" colspan="2">AEC-Q200</th><th colspan="2">Specification</th><th rowspan="2">Test Methods and Conditions</th></tr>
<tr><th>Class Ⅰ</th><th>Class ⅠⅠ</th></tr>
<tr><td>17.</td><td></td><td>Dielectric Strength</td><td colspan="2">No dielectric breakdown or mechanical breakdown</td><td>Applied 250% of the rated voltage for 1~5 seconds
The charge/discharge current is less than 50mA.</td></tr>
<tr><td rowspan="2">18.</td><td rowspan="2">Board Flex</td><td>Appearance</td><td colspan="2">No marking defects</td><td rowspan="2">Apply a force in the direction shown in the following figure for 5±1 seconds.


Flexure for Class I: ≤3mm
for Class II: ≤2mm</td></tr>
<tr><td>Capacitance Change</td><td>Within ±5.0% or ±0.5pF
(Whichever is larger)</td><td>Within±10.0%</td></tr>
<tr><td rowspan="2">19.</td><td rowspan="2">Terminal Strength</td><td>Appearance</td><td>No marking defects</td><td></td><td rowspan="2">Apply *18N force in parallel with the test jig for 60±1 seconds.
*10N for 1608(EIA:0603) size
2N for 1005(EIA:0402) size</td></tr>
<tr><td>Capacitance Change</td><td>Within ±5.0% or ±0.5pF
(Whichever is larger)</td><td>Within±10.0%</td></tr>
<tr><td>20.</td><td colspan="2">Beam Load Test</td><td colspan="2">The chip endure following force.
<table>
<tr><th>Chip Length</th><th>Thickness (T)</th><th>Force</th></tr>
<tr><td rowspan="2">2.5mm Max.</td><td>T≤0.5mm</td><td>8N</td></tr>
<tr><td>T>0.5mm</td><td>20N</td></tr>
<tr><td rowspan="2">3.2mm Min.</td><td>T<1.25mm</td><td>15N</td></tr>
<tr><td>T≥1.25</td><td>54.5N</td></tr>
</table></td><td>Apply a force as shown in the following figure.
(i) Chip Length : 2.5mm Max.
Beam Speed : 0.5mm/s


(ii) Chip Length : 3.2mm Min.
Beam Speed : 2.5mm/s

</td></tr>
</table>

<table>
<thead>
<tr><th rowspan="2">No.</th><th rowspan="2" colspan="2">AEC-Q200</th><th colspan="2">Specification</th><th rowspan="2">Test Methods and Conditions</th></tr>
<tr><th>Class I</th><th>Class II</th></tr>
</thead>
<tbody>
<tr><td rowspan="3">21.</td><td rowspan="3">Capacitance Temperature Characteristics</td><td>Capacitance Change</td><td></td><td>Within±15%</td><td rowspan="3">(i) Class I
The temperature coefficient is determined using the capacitance measured in step 3 as a reference. When cycling the temperature sequentially from step 1 through 5, the capacitance should be within the specified tolerance for the temperature coefficient.
The capacitance drift is calculated by dividing the differences
between the maximum and minimum measured values in steps
1, 3 and 5 by the capacitance value in step 3.
<table><tr><th>Step</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th></tr><tr><td>Temp.(℃)</td><td>25±2</td><td>-55±3</td><td>25±2</td><td>125±3</td><td>25±2</td></tr></table>(ii) Class II
The ranges of capacitance change compared with the 25℃ value over the temperature range from -55℃ to 125℃
Initial measurement
Perform the initial measurement according to Note 1 for Class II.</td></tr>
<tr><td>Temperature Coefficient</td><td>0±30 ppm/℃</td><td></td></tr>
<tr><td>Capacitance Drift</td><td>Within ±0.2% or ±0.05pF
(Whichever is larger)</td><td></td></tr>
</tbody>
</table>

*Note 1. Initial Measurement for Class II

Perform a heat treatment at 150+0/-10℃ for one hour, and then let sit for 24±2 hours at room temperature, then measure.

Packing

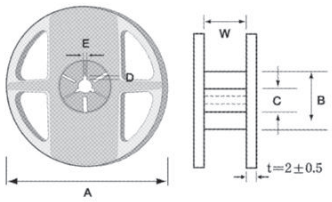
Bulk packing

① 1000 pcs per Polybag
② 5 Polybags per Inner box
③ 10 Inner boxes per Out box

Reel Packing

① 8~10 Reels per Inner box
② 10 Inner boxes per Out box

Reel Dimensions

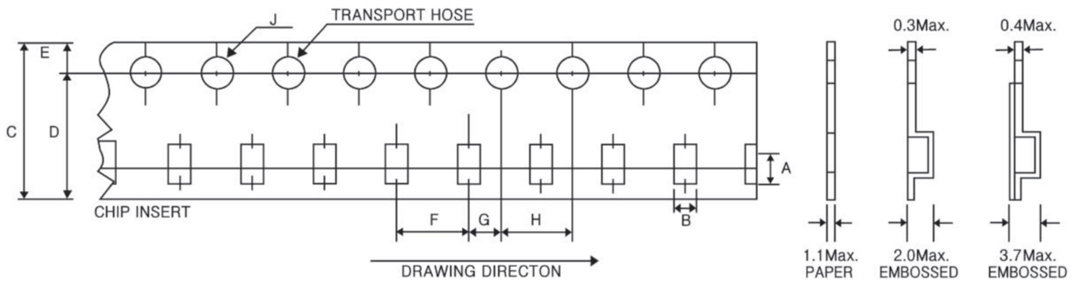


Mark	Size Code	EIA Code	A	B	C	D	E	W
7″ REEL	1005~3225	0402~1210	Ø178±2	Ø50Min.	Ø13±0.5	Ø21±0.8	2±0.5	10±1.5
13″ REEL	1005~3225	0402~1210	Ø330±2	Ø70Min.	Ø13±0.5	Ø21±0.8	2±0.5	10±1.5

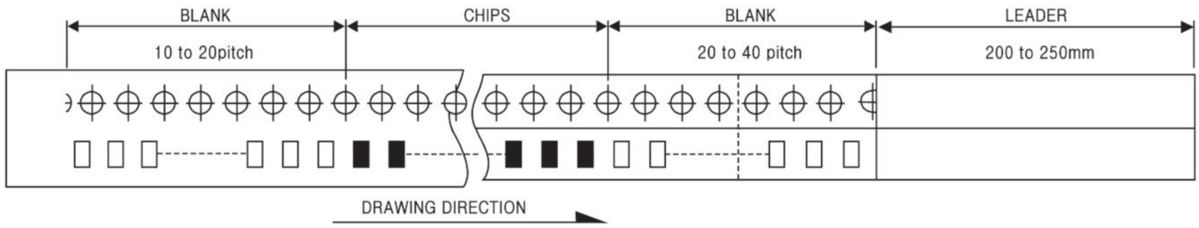
Number of Packages

Type	EIA CODE	7″ Quantity(EA)/Reel	13″ Quantity(EA)/Reel
1005	0402	10,000	50,000
1608	0603	4,000	16,000
2012	0805	3,000 ~ 4,000	10,000
3216	1206	2,000 ~ 4,000	6,000 ~ 10,000
3225	1210	1,000 ~ 3,000	4,000 ~ 10,000

Tape Dimensions



TYPE	EIA CODE	A	B	C	D	E	F	G	H	J
1005	0402	1.15±0.1	0.65±0.1	8.0±0.3	3.5±0.05	1.75±0.1	2.0±0.05	2.0±0.1	4.0±0.1	1.5±0.1
1608	0603	1.9±0.2	1.10±0.2	8.0±0.3	3.5±0.05	1.75±0.1	4.0±0.1	2.0±0.1	4.0±0.1	1.5±0.1
2012	0805	2.4±0.2	1.65±0.2	8.0±0.3	3.5±0.05	1.75±0.1	4.0±0.1	2.0±0.1	4.0±0.1	1.5±0.1
3216	1206	3.6±0.2	2.00±0.2	8.0±0.3	3.5±0.05	1.75±0.1	4.0±0.1	2.0±0.1	4.0±0.1	1.5±0.1
3225	1210	3.6±0.2	2.80±0.2	8.0±0.3	3.5±0.05	1.75±0.1	4.0±0.1	2.0±0.1	4.0±0.1	1.5±0.1



Caution

▶ Storage Condition

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

(1) Temperature: 25℃ ± 10℃

(2) Relative Humidity: Below 70% RH

▶ The Regulation of Environmental Pollution Materials

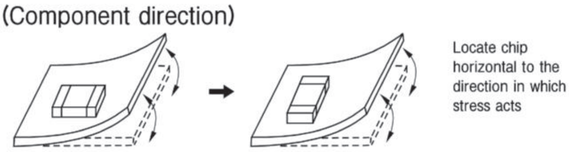
Never use materials mentioned below in MLCC products regulated this document.

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

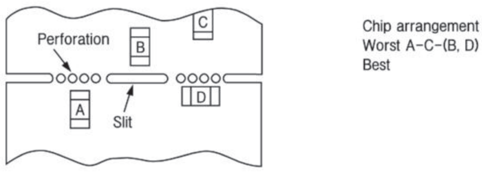
▶ Mounting Position

Choose a mounting position that minimizes the stress imposed on the chip during flexing or bending of the board.

(Component direction)



(Chip Mounting Close to Board Separation Point)



▶ Reflow Soldering

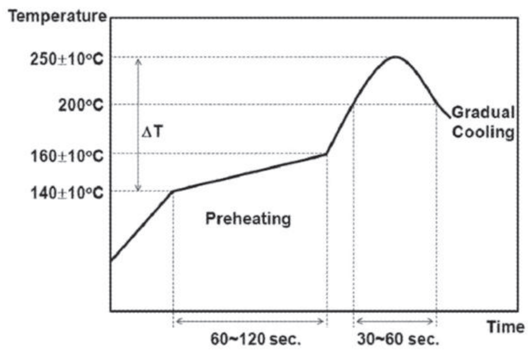
1. The sudden temperature change easily causes mechanical damages to ceramic components. Therefore, the preheating procedures should be required for the soldering of ceramic components.

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.

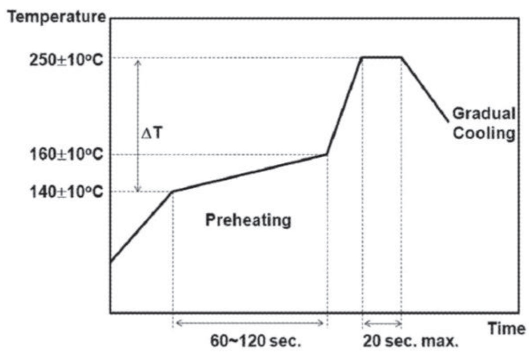
Table 1.

Size code (EIA Code)	Temperature Difference
1005~3216 (0402~1206)	△T≤190℃
3225 (1210)	△T≤130℃

Infrared Reflow



Vapor Reflow



▶ 'Aging'/'De-aging' behavior of high dielectric constant type MLCCs

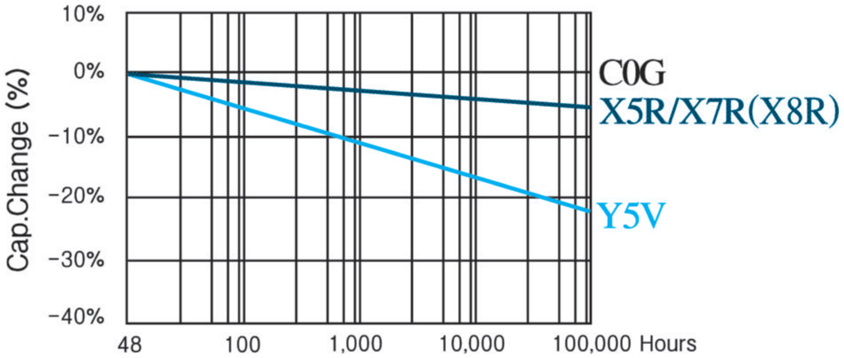
(Typically represented by X7R temperature characteristic of which main composition is $BaTiO_3$)

'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:

$$C_t = C_{48}(1 - k \log10\ t)$$

C_t : Capacitance value, t hours after the start of 'aging'
C_{48} : Capacitance value, 48 hours after its manufacture
k : Aging constant (capacitance decrease per decade-hour)
t : time, in hours, from the start of 'aging'

Ceramic's Capacitance Change(%) versus Time (hours)



The capacitance value can be restored(also known as 'de-aged') by exposing the component to elevated temperatures approaching its curie temperature(approximately 120℃). 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℃ for about 1 hour.

Dielectric	Maximum percent capacitance loss per decade hour, k
C0G	0
X7R	~3%