Multi Layer Ceramic Capacitors

Introduction

SAMWHA's series of multilayer ceramic(MLC) chip capacitors is designed to meet a wide variety of need. Multilayer ceramic chip capacitors are available in both class I and class II formulations. Temperature compensation formulations are class I and temperature stable and general application formulations are classified at class II. The class I multilayer ceramic capacitors are COG with negligible dependence of electrical properties on temperature, voltage, frequency. The most of commonly used class II dielectric are X7R, X5R and Y5V. The X7R provides intermediate capacitance values which vary ±15% over the temperature range of -55℃ to 125℃. The X5R provides intermediate capacitance values which vary ±15% over the temperature range of -55℃ to 85℃. The Y5V provides the highest capacitance value which vary from 22% to -82% over the temperature range of -30℃ to 85℃. All class II capacitors vary in capacitance value under the influence of temperature, operating voltage and frequency. We offer a complete line of products for both class I and II .

Features

- Samwha's high density ceramic bodies offer superior performance and reliability
- Samwha offer various temperature characteristics, rated voltage and packing method
- Material with high dielectric constant and superior manufacturing technology allows very high values in a small size
- Solder coated terminals offer superior solderability

Applications

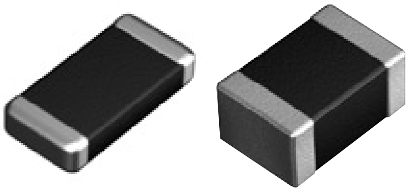
Wide applications throughout commercial and industrial market.

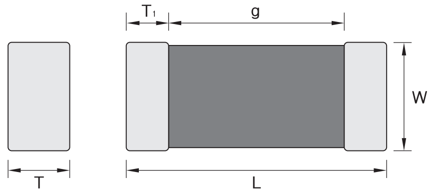
- Communication products like Cellular Phone, Pager, Codeless phone
- Multimedia products like DVD, CD-ROM, FDD, HDD, Game machine, Computer, Note book, Digital camera, LCD
- Audio visual products like TV, Camcorder, Minidisk, MP3 Player
- Communication products like Electronic tuner, Duplexer, VCXO, TCXO, Modem
- OA equipment products like Printer, Copy Machine, Fax Machine

※ special specification like a Automobile, Medical, Military, Aviation should be discuss with our sales representatives

SMD Type

Shape & Dimensions





(Unit : mm)

Code(inch)	Dimensions				
	Length		Width		T1(min)
	L	Tol(±)	W	Tol(±)	
0603(0201)	0.60	0.03	0.30	0.03	0.05
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
4520(1808)	4.50	0.40	2.00	0.25	0.20
4532(1812)	4.50	0.40	3.20	0.30	0.20
5750(2220)	5.70	0.50	5.00	0.40	0.30

*1608 Size ≥ 10㎌ ⇒ W : 0.8±0.15, T : 0.8±0.15

How to Order(Product Identification)

CS 1608 X7R 104 K 160 N R B

1 2 3 4 5 6 7 8 9

1 Type

CS : SMD

SA : ARRAY

2 Size Code

This is expressed in tens of a millimeter.

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

Size(mm)	0603	1005	1608	2012	3216	3225	4520	4532	5750

3 Temperature Coefficient Code

Temperature Characteristice	Temperature Range	Capacitance Change or Temperature Coefficient	Operating Temperature Range
C0G	–55 to 125℃	0±30ppm/℃	–55 to 125℃
X7R	–55 to 125℃	±15%	–55 to 125℃
X5R	–55 to 85℃	±15%	–55 to 85℃
Y5V	–30 to 85℃	+22, –82%	–30 to 85℃

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	M	±20%
C	±0.25pF	P	+100, −0%
D	±0.5pF	Z	+80, −20%
F	±1.0%	H	+0.25/−0pF
G	±2.0%	I	+0/−0.25pF
J	±5%	U	+5/−0%
K	±10%	V	+0/−5%

6 Voltage Code

Code	6R3	100	160	250	500	101	201	251	631	302
Vol.	DC 6.3V	DC 10V	DC 16V	DC 25V	DC 50V	DC 100V	DC 200V	DC 250V	DC 630V	DC 3000V

7 Termination Code

Ex.) N : Ni-Sn(Nickel-Tin Plate)

8 Packing Code

Ex.) R : Reel Type   B : Bulk Type

9 Thickness Option

Thickness(mm)		Code	Thickness(mm)		Code
t	Tol(±)		t	Tol(±)	
0.30	0.03	Blank	1.30	0.20	E
0.50	0.05	Blank	1.35	0.20	H
0.60	0.10	A	1.60	0.20	I
0.80	0.10	B	1.80	0.20	J
0.85	0.15	B	2.00	0.25	K
1.00	0.15	E	2.50	0.25	L
1.10	0.15	E	2.80	0.30	M
1.15	0.15	E	3.20	0.30	N
1.25	0.15	E	5.00	0.40	O

Typical Performance Characteristics

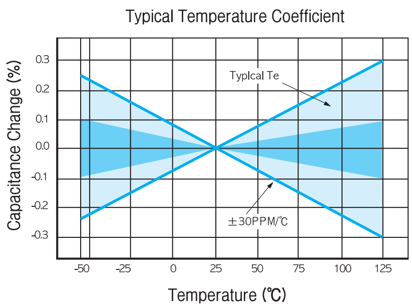
COG

Application

Suited for precision circuits, requiring stable dielectric characteristics, negligible dependence of capacitance and dissipation factor on time, voltage and frequency.

Dielectric Characteristics

Temperature Characteristic	0±30ppm/℃
Operating Temperature	–55~125℃
Capacitance Tolerance	>10pF : ±5%, ±10%,(±1%, ±2%, ±20%) ≤10pF : ±0.1pF, ±0.25pF, ±0.5pF
Dissipation Factor & Q	≥30pF : DF≤0.1%, Q≥1000 <30pF : Q≥400+20×C
Insulation Resistance	More than 10,000MΩ or 500ΩF (Whichever is smaller)
Dielectric Strength	>3×RVDC
Test Voltage	0.5 to 5Vrms(≤1000pF), 1±0.2Vrms(>1000pF)
Test Frequency	1±0.1MHz(≤1000pF), 1±0.1kHz(>1000pF)



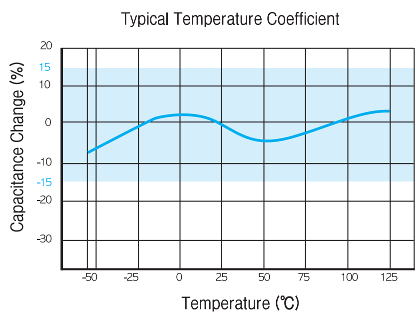
X7R

Application

Stable class Ⅱ dielectric properties, suited for by-pass and coupling purposes, filtering, frequency discrimination, DC blockage, and as voltage transient suppression elements.

Dielectric Characteristics

Temperature Characteristic	±15%
Operating Temperature	–55~125℃
Capacitance Tolerance	±10%, ±20%,(±5%, +80~–20%)
Dissipation Factor & Q	50V Min. : 2.5% Max. 25V Min. : 3.0% Max. 16V Min. : 3.5% Max. 10V Min. : 5.0% Max. 6.3V Min. : 5.0% Max.(<3.3μF), 10% Max.(≥3.3μF) Thin layer lange capacitors type 10% Max.
Insulation Resistance	More than 10,000MΩ or 500ΩF(Whichever is smaller) Thin layer lange capacitors type 50ΩF Min.
Dielectric Strength	>2.5×RVDC
Test Voltage	1±0.2Vrms(≤10μF, 10V Min.) 0.5±0.1Vrms(≤10μF, 6.3V Max.) 0.5±0.1Vrms(>10μF)
Test Frequency	1±0.1kHz(≤10μF, 10V Min.) 1±0.1kHz(≤10μF, 6.3V Max.) 120±24Hz(>10μF)



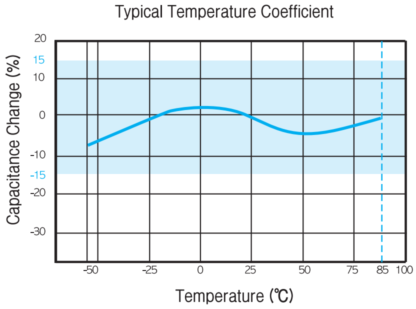
X5R

Application

Stable class Ⅱ dielectric properties, suited for by-pass and coupling purposes, filtering, frequency discrimination, DC blockage, and as voltage transient suppression elements.

Dielectric Characteristics

Temperature Characteristic	±15%
Operating Temperature	−55~85℃
Capacitance Tolerance	±10%, ±20%,(±5%, +80~−20%)
Dissipation Factor & Q	50V Min. : 2.5% Max. 25V Min. : 3.0% Max. 16V Min. : 3.5% Max. 10V Min. : 5.0% Max. 6.3V Min. : 5.0% Max.(<3.3㎌), 10% Max.(≥3.3㎌) Thin layer lange capacitors type 10% Max.
Insulation Resistance	More than 10,000㏁ or 500ΩF (Whichever is smaller) Thin layer lange capacitors type 50ΩF Min.
Dielectric Strength	>2.5×RVDC
Test Voltage	1±0.2Vrms(≤10㎌, 10V Min.) 0.5±0.1Vrms(≤10㎌, 6.3V Max.) 0.5±0.1Vrms(>10㎌)
Test Frequency	1±0.1㎑(≤10㎌, 10V Min.) 1±0.1㎑(≤10㎌, 6.3V Max.), 120±24㎐(>10㎌)



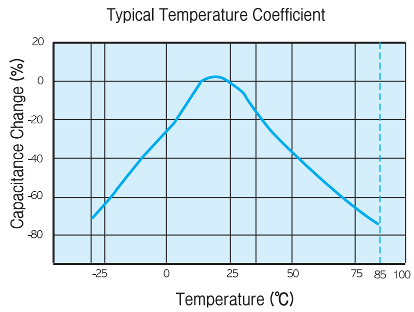
Y5V

Application

The Hi-K(Y5V) dielectrics deliver high capacitance density and are ideally suited for applications where space is at a premium, or as replacement for tantalum capacitors. Typically applications include use as by-pass or decoupling elements. Best performance is obtained at or near room temperature, with low DC bias.

Dielectric Characteristics

Temperature Characteristic	+22%~−82%
Operating Temperature	−30~85℃
Capacitance Tolerance	−20～+80%(±20%)
Dissipation Factor & Q	50V Min. : 5% Max. 25V Min. : 7% Max. 16V Min. : 9% Max. 10V Min. : 12.5% Max. 6.3V Min. : 15% Max. Thin layer lange capacitors type 20% Max.
Insulation Resistance	More than 10,000㏁ or 500ΩF(Whichever is smaller) Thin layer lange capacitors type 50ΩF Min.
Dielectric Strength	>2.5×RVDC
Test Voltage	1±0.2Vrms(≤10㎌, 10V Min.) 0.5±0.1Vrms(≤10㎌, 6.3V Max.) 0.5±0.1Vrms(>10㎌)
Test Frequency	1±0.1㎑(≤10㎌, 10V Min.) 1±0.1㎑(≤10㎌, 6.3V Max.), 120±24㎐(>10㎌)



Appendix |

C0G-Temperature Compensating Type(0603~3216)

Type / Size(inch) / Volt(V) / Cap.	C0G 0603(0201) 25	1005(0402) 25	1005(0402) 50	1608(0603) 25	1608(0603) 50	2012(0805) 25	2012(0805) 50	3216(1206) 25	3216(1206) 50
0.5pF(0R5)									
1pF(010)									
2pF(020)									
3pF(030)									
4pF(040)									
5pF(050)									
6pF(060)									
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)	0.3								
120pF(121)									
150pF(151)									
180pF(181)									
220pF(221)									
270pF(271)									
330pF(331)									
390pF(391)									
470pF(471)									
560pF(561)									
680pF(681)									
820pF(821)									
1000pF(102)		0.5	0.5						
1200pF(122)									
1500pF(152)								1.15	1.15
1800pF(182)									
2200pF(222)						0.6	0.6		
2700pF(272)				0.8	0.8				
3300pF(332)									
3900pF(392)									
4700pF(472)									
5600pF(562)									
6800pF(682)									
8200pF(822)									
10000pF(103)						1.25	1.25		
12000pF(123)									
15000pF(153)									
18000pF(183)									
22000pF(223)									
27000pF(273)									
33000pF(333)									
47000pF(473)									
56000pF(563)								1.60	1.60
68000pF(683)									
82000pF(823)									
0.1μF(104)									

Temperature Compensating Type : Dissipation Factor Page 22 (No.5)

Appendix II

X7R-High Dielectric Constant Type(0603~3225) & Thin Layer Large-Capacitance Type

Type	X7R																												
Size(inch)	0603(0201)				1005(0402)					1608(0603)					2012(0805)					3216(1206)					3225(1210)				
Volt(V) / Cap.	6.3	10	16	25	6.3	10	16	25	50	6.3	10	16	25	50	6.3	10	16	25	50	6.3	10	16	25	50	6.3	10	16	25	50
100pF(101)																													
470pF(471)																													
1000pF(102)				0.3																									
2200pF(222)																													
4700pF(472)																													
10000pF(103)	0.3	0.3	0.3																										
15000pF(153)																													
22000pF(223)									0.5																				
33000pF(333)															0.6	0.6	0.6	0.6	0.6										
47000pF(473)																													
68000pF(683)																													
0.1µF(104)							0.5	0.5						0.8	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85					
0.15µF(154)																													
0.22µF(224)					0.5	0.5																							
0.33µF(334)																													
0.47µF(474)													0.8							1.15	1.15	1.15	1.15	1.15					
0.68µF(684)																													
1.0µF(105)												0.8							1.25						2.0	2.0	2.0	2.0	2.0
1.5µF(155)																													
2.2µF(225)										0.8	0.8													1.6					2.5
4.7µF(475)																	1.25	1.25											
6.8µF(685)																													
10µF(106)															1.25	1.25				1.6	1.6	1.6	1.6					2.5	
22µF(226)																									2.5	2.5	2.5		
47µF(476)																													
100µF(107)																													

General Type : Dissipation Factor Page 22(No.5)

∗General Type : Dissipation Factor Page 22(No.5)

Thin Layer Large-Capacitance Type : Dissipation Factor Page 22(No.5)

X5R-High Dielectric Constant Type(0603~3225) & Thin Layer Large-Capacitance Type

Type	X5R																												
Size(inch)	0603(0201)				1005(0402)					1608(0603)					2012(0805)					3216(1206)					3225(1210)				
Volt(V) / Cap.	6.3	10	16	25	6.3	10	16	25	50	6.3	10	16	25	50	6.3	10	16	25	50	6.3	10	16	25	50	6.3	10	16	25	50
100pF(101)																													
470pF(471)																													
1000pF(102)				0.3																									
2200pF(222)			0.3																										
4700pF(472)																													
10000pF(103)																													
15000pF(153)																													
22000pF(223)									0.5																				
33000pF(333)																													
47000pF(473)																													
68000pF(683)																													
0.1µF(104)	0.3	0.3																	0.85	0.8	0.8	0.8	0.8	0.8					
0.15µF(154)								0.5								0.85	0.85	0.85											
0.22µF(224)														0.8															
0.33µF(334)															0.85														1.8
0.47µF(474)																													
0.68µF(684)																													
1.0µF(105)							0.5						0.8						1.25					1.15					
1.5µF(155)																							1.15						
2.2µF(225)						0.5						0.8								1.15	1.15	1.15		1.6	1.8	1.8	1.8	1.8	2.5
4.7µF(475)					0.5													1.25											
6.8µF(685)																									2.0	2.0	2.0	2.0	
10µF(106)											0.8						1.25						1.6						
22µF(226)										0.8						1.25					1.6	1.6						2.5	
47µF(476)															1.25											2.5	2.5		
100µF(107)																				1.6					2.5				

General Type : Dissipation Factor Page 22(No.5)

∗General Type : Dissipation Factor Page 22(No.5)

Thin Layer Large-Capacitance Type : Dissipation Factor Page 22(No.5)

Y5V-High Dielectric Constant Type(0603~3225) & Thin Layer Large-Capacitance Type

Type	Y5V																								
Size(inch)	1005(0402)					1608(0603)					2012(0805)					3216(1206)					3225(1210)				
Volt(V) / Cap.	6.3	10	16	25	50	6.3	10	16	25	50	6.3	10	16	25	50	6.3	10	16	25	50	6.3	10	16	25	50
1000pF(102)																									
2200pF(222)																									
4700pF(472)																									
10000pF(103)																									
15000pF(153)																									
22000pF(223)					0.5																				
33000pF(333)																									
47000pF(473)																									
68000pF(683)																									
0.1µF(104)				0.5																					
0.15µF(154)																									
0.22µF(224)										0.8															
0.33µF(334)																									
0.47µF(474)			0.5						0.8																
0.68µF(684)																									
1.0µF(105)	0.5	0.5													1.25				1.15	1.15					
1.5µF(155)																									
2.2µF(225)								0.8								1.15	1.15	1.15							
3.3µF(335)							0.8															1.8	1.8	1.8	1.8
4.7µF(475)						0.8							1.25	1.25							1.8				
6.8µF(685)																									2.0
10µF(106)											1.25	1.25									2.0	2.0	2.0	2.0	2.5
22µF(226)																						2.5			
47µF(476)																									
100µF(107)																1.6	1.6	1.6	1.6	1.6	2.5				

General Type : Dissipation Factor Page 22(No.5)

∗General Type : Dissipation Factor Page 22(No.5)

Thin Layer Large-Capacitance Type : Dissipation Factor Page 22(No.5)

SMD Type-High Voltage

Product Offering

SAMWHA high voltage MLCC products with the temperature characteristics of C0G and X7R are designed for commercial and industrial applications. The products are applied to DC-DC converters and ballast circuit to reduce ripple noise and diverting potentially unsafe transients in various sizes with working voltage up to DC 7kV. These high voltage capacitors feature a special internal electrode design which has capacitor network to reduce voltage concentrations by distributing voltage throughout the entire capacitor.

Features

- High reliability
- The highest voltage rating by the special internal electrode design
- Wide voltage level : from $100V_{DC}$ to $7{,}000V_{DC}$
- Surface mount suited for wave and reflow soldering
- RoHS compliant

Applications

- DC-DC Converters
- Network Equipments
- Back-Lighting Inverter
- Lighting Ballast
- Modem & Power Supply
- LAN/WLAN Interface

※ special specification like a Automobile, Medical, Military, Aviation should be discuss with our sales representatives

Special Options for the Safety

- Inset electrode margins to prevent short mode failure resulted from the crack by mechanical bending stress
- Soft termination is optionally available to reduce possibility for the crack of MLCCs by mechanical bending stress

How to Order(Product Identification)

CS 4520 COG 150 J 302 N R E

1 2 3 4 5 6 7 8 9

1 Type

CS : SMD

2 Size Code

Size(mm)	1608	2012	3216	3225	4520	4532	5750	7566	9595

3 Dielectric(Temp. Coefficient)

COG, X7R

4 Capacitance

1st two digits are value, 3rd digit denotes number of zeros;

331 = 330pF, 104 = 100000pF, 8R2 = 8.2pF

5 Tolerance

Code	Tolerance	Code	Tolerance
B	±0.1pF	C	±0.25pF
D	±0.50pF	F	±1%
G	±2%	J	±5%
K	±10%	M	±20%
Z	+80~−20%		

6 Rated Voltage Code

1st two digits are value, 3rd digit denotes number of zeros; 302 = 3,000V, 502 = 5,000V, 722 = 7,200V

7 Plating

Ni / Sn Plated

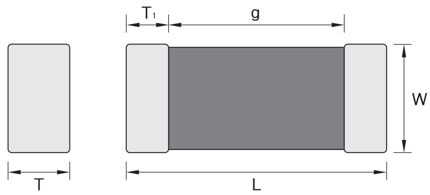
8 Packing

B : Bulk Pack R : Reel Pack C : Case Box

9 Thickness Option

Thickness(mm)		Code	Thickness(mm)		Code
t	Tol(±)		t	Tol(±)	
0.60	0.10	A	1.35	0.20	H
0.80	0.10	B	1.60	0.20	I
0.85	0.15	B	1.80	0.20	J
1.00	0.15	E	2.00	0.25	K
1.10	0.15	E	2.50	0.25	L
1.15	0.15	E	2.80	0.30	M
1.25	0.15	E	3.20	0.5	N
1.30	0.20	E	5.00	0.5	O

Shape & Dimensions



(Unit : mm)

Code	Dimensions				
	Length		Width		T1(min)
	L	Tol(±)	W	Tol(±)	
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
4520(1808)	4.50	0.40	2.00	0.25	0.20
4532(1812)	4.50	0.40	3.20	0.30	0.20
5750(2220)	5.70	0.50	5.00	0.40	0.30
7566(3026)	7.50	0.50	6.60	0.50	0.30
9595(3838)	9.50	0.50	9.50	0.50	0.30

*1608 Size ≥ 10㎌ ⇒ W : 0.8±0.15, T : 0.8±0.15

Typical Performance Characteristics

Dielectric Characteristics	COG(NPO)	X7R
Dielectric Classification	Ultra Stable	Stable
Rated temperature range	–55℃ to +125℃	–55℃ to +125℃
TCC(Temperature Characteristics Coefficient)	0±30ppm	±15%
Dissifation Factor(tan δ)	C≥30pF : Q≥1,000 (DF:≤ 0.1%) C<30pF : Q≥400+20C(DF: ≤1/(400+20C)	2.5% Max.
IR(Insulation Resistance)	500V Below : Rated voltage 60sec 500V Above : 500V 60sec More than 10,000 ㏁	500V Below:Rated voltage 60sec 500V Above:500V 60sec -DC100V~1KV :C≥0.01㎌:More than 100㏁㎌ :C<0.01㎌:More than 10,000㏁ -DC2~3KV:More than6,000 ㏁
Capacitance Tolerance	〈10pF : ±0.25pF, ±0.5pF ≥10pF : ±5%, ±0%	±10%, ±20%
Dielectric strength	630V:150% Rated Voltage 1kV~7.2kV:120% Rated Voltage	100V:150% Rated Voltage 630V:150% Rated Voltage 1kV~7.2kV: 120% Rated Voltage
Aging characteristics	0%	2.5% per decade hr, typical

Appendix High Voltage Type(100V~3000V)

COG-Temperature Compensation Type

High voltage type

Type	COG																															
Size(inch)	1608(0603)		2012(0805)		3216(1206)					3225(1210)					4520(1808)						4532(1812)						7066(3026)		9595(3838)			
Volt(V) / Cap.	100	250	100	250	100	250	630	1000	2000	100	250	630	1000	2000	100	250	630	1000	2000	3000	100	250	630	1000	2000	3000	3000	4000	3000	4000	5000	7000
4.7pF(4R7)																																
5pF(050)																																
7pF(070)																																
8pF(080)																																
9pF(090)																																
10pF(100)																																
12pF(120)																																
15pF(150)																																
18pF(180)																																
22pF(220)																																
47pF(470)																																
56pF(560)																																
68pF(680)																																
82pF(820)																																
100pF(101)																																
180pF(180)																																
220pF(221)																																
330pF(331)																																
470pF(471)																																
560pF(561)																																
680pF(681)																																
1000pF(102)																																
1500pF(152)																																
2200pF(222)																																
2700pF(272)																																
3300pF(332)																																
4700pF(472)																																
5600pF(562)																																
6800pF(682)																																
10000pF(103)																																
15000pF(153)																																
22000pF(223)																																
33000pF(333)																																

X7R-High Dielectric Type

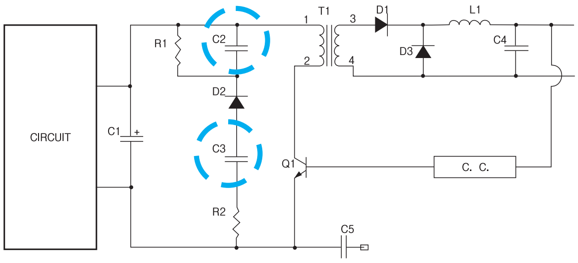
High voltage type

Type	X7R																									
Size(inch)	1608(0603)		2012(0805)		3216(1206)					3225(1210)					4520(1808)						4532(1812)					
Volt(V) / Cap.	100	250	100	250	100	250	630	1000	2000	100	250	630	1000	2000	100	250	630	1000	2000	3000	100	250	630	1000	2000	3000
220pF(221)																										
330pF(331)																										
470pF(471)																										
680pF(681)																										
1000pF(102)																										
1500pF(152)																										
2200pF(222)																										
3300pF(332)																										
4700pF(472)																										
5600pF(562)																										
6800pF(682)																										
10000pF(103)																										
15000pF(153)																										
18000pF(183)																										
22000pF(223)																										
33000pF(333)																										
47000pF(473)																										
68000pF(683)																										
0.1μF(104)																										
0.15μF(154)																										
0.22μF(224)																										
0.33μF(334)																										
0.47μF(474)																										
0.68μF(684)																										
1.0nF(105)																										
2.2nF(225)																										

Size	Vr(V)	100pF	470pF	1.0nF	2.2nF	10nF	47nF	100nF	150nF
3026	3,000								
	4,000								
3838	3,000								
	4,000								
	5,000								
	7,000								

Application(Typical circuit)

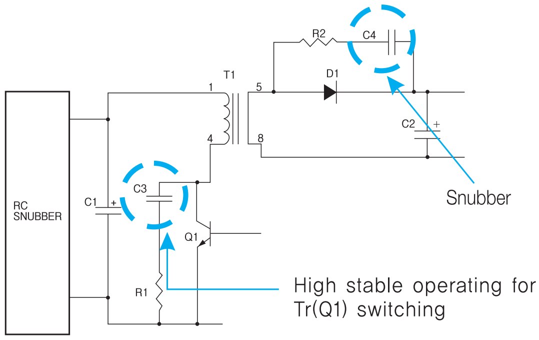
DC-DC Converter



High stable operating for Tr(Q1) switching

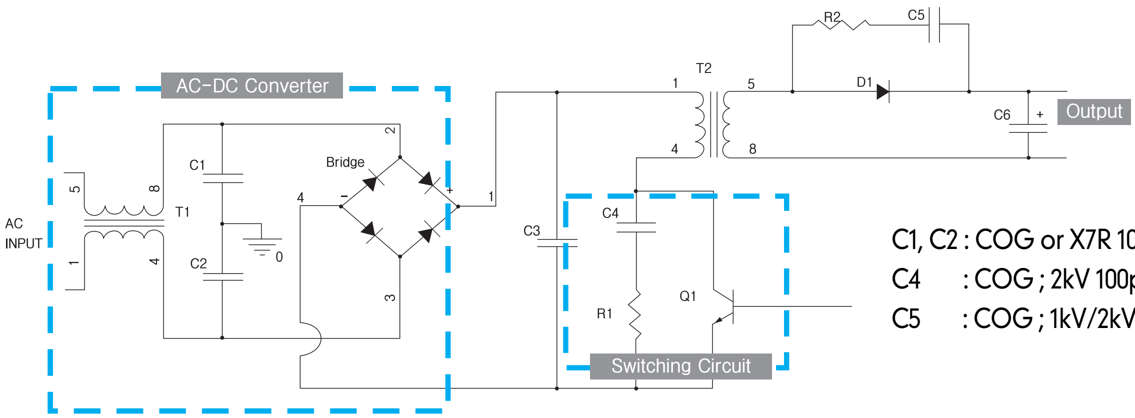
C2 : X7R ; 250V 10nF~47nF
C3 : COG ; 630V 47pF~100pF

Switching Power Supply



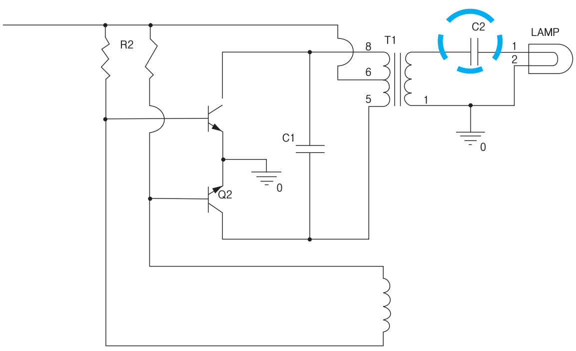
C3 : COG, X7R ; 2kV 100pF~1000pF
C4 : COG, X7R ; 2kV 100pF~1000pF

Primary circuit and Snubber switching power supply



C1, C2 : COG or X7R 1000pF~4700pF
C4 : COG ; 2kV 100pF~330pF
C5 : COG ; 1kV/2kV 100pF~470pF

LCD back light Inverter



C2 : COG ; 3kV 10 ~100pF

MLCC Applications for DC-DC Converter Modules

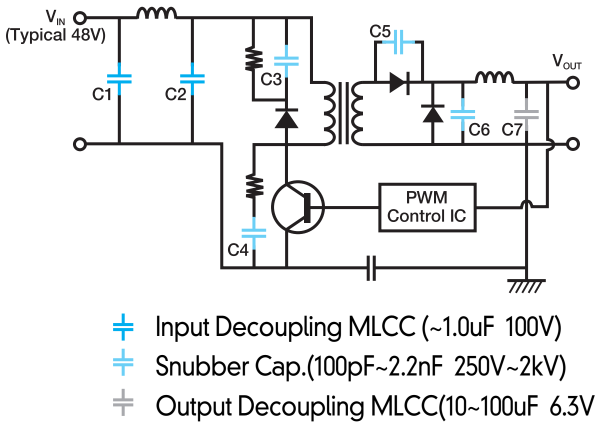
High voltage MLCCs are mainly used to DC-DC converter modules for industrial applications which have high input voltage of typical 48V. These are used as functions of high frequency noise filtering(decoupling) of power line and snubber capacitor to protect switching device from unsafe transients by inductance of transformer or connection line due to switching operation. For these applications, MLCCs have merits for high allowable ripple current and high reliability.

Figure 2 shows isolated DC-DC converter circuit diagram and MLCC applications such as decoupling and snubber. Input voltage is 36~75V_{DC}(typical 48V_{DC}) for general industrial applications such as base station, server and network equipments. Decoupling MLCCs are applied to input and output(based on viewpoint of switch or transformer) power line to reduce ripple voltage, and MLCCs for snubber application used to absorb surge energy. SAMWHA MLCCs are recommended for each application as shown in Table 1.

Table 1. MLCC recommendation for isolated type DC-DC converter module

Items	MLCC Recommendation
*Input (C1, C2)	1210 X7R 470nF 100V 1812 X7R 1.0uF 100V
Snubber (C3~C6)	Available wide range of products 250V ~2kV (Available up to 7.2 kV) 100pF~2.2nF(Available up to 470nF)
Output (C7)	(High Capacitance Application) 1210 X5R 100uF 6.3V 1206 X5R 47uF 6.3V 0805 X5R 47uF 6.3V

*Typical input voltage of 48V for industrial application



MLCC Applications for Ballast Circuits

High voltage MLCCs are suitable for the ballast circuit as a function of resonant capacitor as presented in Figure 3. MLCCs with high voltage rating from 1kV to 3kV(available up to 7.2kV) are mainly used for these application. SAMWHA offers wide range of capacitance and rated voltage with high reliability.

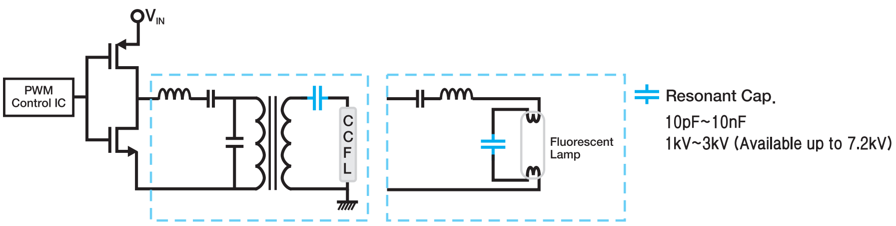
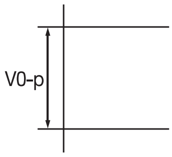
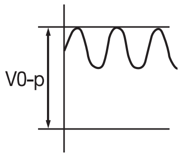
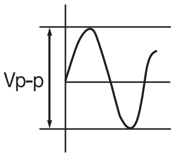
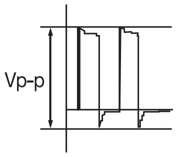
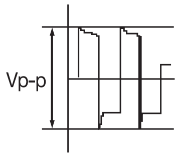


Fig. 3. Typical electronic ballast circuit and MLCC application

Caution(Rating)

1. Operating Voltage

When DC-rated capacitors are to be used in AC or ripple current circuits, be sure to maintain the Vp-p Value of the applied voltage or the Vo-p which contains DC bias within the rated voltage range.
When the voltage is applied to the circuit, starting or stopping may generate irregular voltage for a transit period because of resonance or switching. Be sure to use a capacitor with a rated voltage range that includes these irregular voltages.

Voltage	DV Voltage	DC+AC Voltage	AC Voltage	Pulse Voltage(1)	Pulse Voltage(2)
Positional Measurement					

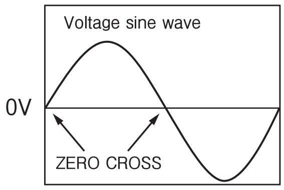
2. Test condition for AC withstanding Voltage

(1) Test Equipment

Tests for AC withstanding voltage should be made with equipment capable of creating a wave similar to a 50/60 Hz sine wave. If the distorted sine wave or overload exceeding the specified voltage value is applied, a defect may be caused.

(2) Voltage applied method

The capacitor's leads or terminals should be firmly connected to the output of the withstanding voltage test equipment, and then the voltage should be raised from near zero to the test voltage. If the test voltage is applied directly to the capacitor without raising it from near zero,it should be applied with the *zero cross. At the end of the test time, the test voltage should be reduced to near zero, and then the capacitor's leads or terminals should be taken off the output of the withstanding voltage test equipment. If the test voltage is applied directly to the capacitor without raising it from near zero, surge voltage may occur and cause a defect. *ZERO CROSS is the point where voltage sine wave



(3) Dielectric strength testing method

In case of dielectric strength test, the capacitor’s is applied between the terminations for 1 to 5 sec., provided the charge/discharge current is less than 50mA.

3. Soldering

If a chip component is heated or cooled abruptly during soldering, it may crack due to the thermal shock. To prevent this, follow our recommendations below for adequate soldering conditions. Carefully perform preheating so that temperature difference(ΔT) between the solder and component surface is in the following range. The smaller the temperatures difference(ΔT) between the solder and component surface is, the smaller the influence on the chip is.

Chip Size / Slodering Method	3.2×1.6mm and under	3.2×2.5mm and over
Reflow Method or Soldering Lron Method	ΔT≦ 190℃	ΔT≦ 130℃

SAMWHA CAPACITOR CO., LTD offers a line of MLCC(Multilayer Ceramic Capacitor). These parts are rated at 3kV dc and safety approved and certified to UL (Underwriters Laboratories Inc. ®)

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NWGQ8.E304146
Information Technology Equipment Including Electrical Business Equipment Certified for Canada - Component

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Information Technology Equipment Including Electrical Business Equipment Certified for Canada - Component

See General Information for Information Technology Equipment Including Electrical Business Equipment Certified for Canada - Component

SAMWHA CAPACITOR CO LTD E304146
124 BUK-RI
NAMSA-MYEUN
YONGIN-SHI, KYONGGI-DO 449-880 REPUBLIC OF KOREA

Component Recognition, Model(s) CS45XXYYYTTTA302NRE.

Marking: Company name, model designation and Recognized Component Mark for Canada, .

Last Updated on 2006-04-28

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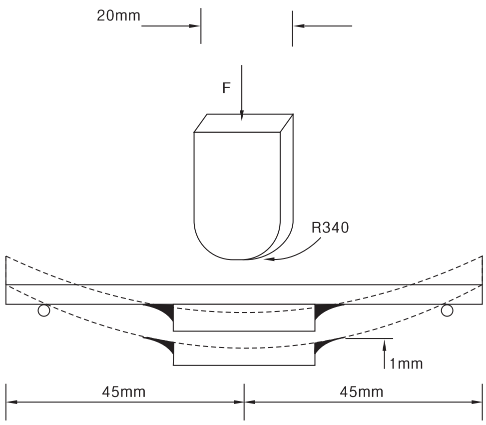
Reliability and Test Conditions(General Type)

<table>
<tr><th rowspan="2">No.</th><th rowspan="2" colspan="2">Item</th><th colspan="2">Characteristic</th><th rowspan="2">Test Methods and Conditions</th></tr>
<tr><th>Temperature Compensating Type</th><th>High Dielectric Constant Type</th></tr>
<tr><td>1</td><td colspan="2">Operating Temperature Range</td><td>C0G : –55 to +125℃</td><td>X7R : –55 to +125℃ X5R : –55 to +85℃
Y5V : –30 to +85℃</td><td></td></tr>
<tr><td>2</td><td colspan="2">Insulation Resistance</td><td colspan="2">More than 10,000MΩ or 500ΩF(Whichever is smaller)</td><td>- Applied the rated voltage for 2 minutes of charging.
- The charge/discharge current is less than 50mA.</td></tr>
<tr><td>3</td><td colspan="2">Dielectric Strength</td><td colspan="2">No defects or abnormalities</td><td>- C0G : The rated voltage×300%
- X7R, X5R, Y5V : 〃 ×250%
- Applied between the terminations for 1 to 5 seconds.
- The charge/discharge current is less than 50mA.</td></tr>
<tr><td>4</td><td colspan="2">Capacitance</td><td colspan="2">Within the specified tolerance</td><td></td></tr>
<tr><td>5</td><td colspan="2">Dissipation Factor</td><td>30pF Min. :
Q≥1,000(DF≤0.1%)
30pF Max. :
Q≥400+20C
(DF≤1/(400+20C))</td><td><table><tr><th>Char.</th><th>50V Min.</th><th>25V</th><th>16V</th><th>10V</th><th>6.3V</th></tr><tr><td>X7R
X5R</td><td>≤2.5%/
*≤5%</td><td>≤3%/
*≤7%</td><td>≤3.5%/
*≤7%</td><td>≤5%/
*≤10%</td><td>≤5%/
*≤10%</td></tr><tr><td>Y5V</td><td>≤5%/
*≤9%</td><td>≤7%/
*≤9%</td><td>≤9%
*≤12.5%</td><td>≤12.5%/
≤15%</td><td>≤15%</td></tr></table> You can check the specification at the appendix for each product with mark</td><td>The capacitance/Q/D.F. should be measured at 25℃ at the frequency and voltage shown in the table.<table><tr><th>Cap.</th><th>Testing Frequency</th><th>Testing Voltage</th></tr><tr><td>C0G
(C≤1000pF)</td><td>1±0.1MHz</td><td>0.5 to 5Vrms</td></tr><tr><td>C0G
(C>1000pF)</td><td>1±0.1kHz</td><td>1±0.2Vrms</td></tr><tr><td>X7R, X5R, Y5V
(C≤10μF
6.3V Min.)</td><td>1±0.1kHz</td><td>1±0.2Vrms</td></tr><tr><td>X7R, X5R, Y5V
(C>10μF)</td><td>120±24Hz</td><td>0.5±0.1Vrms</td></tr></table></td></tr>
<tr><td>6</td><td colspan="2">Solderability of Termination</td><td colspan="2">Termination should be covered with more than 75% of new solder</td><td>- Pb-Free Type
Solder : 96.5Sn-3Ag-0.5Cu
Solder Temperature : 260±5℃
Immersion Time : 3±0.1sec
- Pre-Heating
at 80~120℃ for 10~30sec</td></tr>
<tr><td rowspan="4">7</td><td rowspan="4">Resistance to Soldering Heat</td><td>Appearance</td><td colspan="2">No marked defect</td><td rowspan="4">- Preheat the capacitor at 120 to 150℃ for 1 minute. (Preheating for 3225, 4520, 4532 Step1 : 100℃ to 120℃, 1min Step2 : 170℃ to 200℃, 1min) Immerse the capacitor in a eutectic solder solution
- Soldering Temp. : 260±5℃
- Immersion Time : 10±0.5sec
- Initial measurement
Perform a heat treatment at 150+0, -10℃ for one hour and then let sit for 48±4 hours at room temperature.
Perform the intial measurement.
- Measurement after test
Take it out and set it for 24±2 hours (temperature compensating type) or 48±4 hours (high dielectric constant type)then measure</td></tr>
<tr><td>Capacitchange</td><td>Within ±2.5% or ±0.25pF (whichever is larger)</td><td>X7R, X5R : ≤ ±7.5%
Y5V : ≤ ±20%</td></tr>
<tr><td>Dissipation Factor (or Q)</td><td>30pF Min. :
Q≥1,000(DF≤0.1%)
30pF Max. :
Q≥400+20C
(DF≤1/(400+20C))</td><td><table><tr><th>Char.</th><th>50V Min.</th><th>25V</th><th>16V</th><th>10V</th><th>6.3V</th></tr><tr><td>X7R
X5R</td><td>≤2.5%/
*≤5%</td><td>≤3%/
*≤7%</td><td>≤3.5%/
*≤7%</td><td>≤5%/
*≤10%</td><td>≤5%/
*≤10%</td></tr><tr><td>Y5V</td><td>≤5%/
*≤9%</td><td>≤7%/
*≤9%</td><td>≤9%
*≤12.5%</td><td>≤12.5%/
*≤15%</td><td>≤15%</td></tr></table></td></tr>
<tr><td>I.R.</td><td colspan="2">More than 10,000MΩ or 500Ω.F (Whichever is smaller)</td></tr>
</table>

<table>
<tr><th rowspan="2">No.</th><th rowspan="2" colspan="2">Item</th><th colspan="2">Characteristic</th><th rowspan="2">Test Methods and Conditions</th></tr>
<tr><th>Temperature Compensating Type</th><th>High Dielectric Constant Type</th></tr>
<tr><td rowspan="4">8</td><td rowspan="4">Temperature Cycle</td><td>Appearance</td><td colspan="2">No marking defects</td><td rowspan="4">Perform the five cycless according to the four heat treatments listed in the following table.
<table>
<tr><th>Step</th><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><td>Temp. (℃)</td><td>Min. Operating Temp. +0, −3</td><td>Room Temp.</td><td>Max. Operating Temp. +3, −0</td><td>Room Temp.</td></tr>
<tr><td>Time (Min)</td><td>30±3</td><td>2 to 3</td><td>30±3</td><td>2 to 3</td></tr>
</table>
- Initial measurement
Perform a heat treatment at 150+0, -10℃ for one hour and then let sit for 48±4 hours at room temperature.
- Measurement after test
Take it out and set it for 24±2 hours (temperature compensating) or 48±4 hours(high dielectric constant type) at room temperature, then measure.</td></tr>
<tr><td>Capacitance Change</td><td>Within ±2.5% or ±0.25pF (whichever is larger)</td><td>X7R, X5R : Within ±7.5%
Y5V : Within ±20%</td></tr>
<tr><td>Dissipation Factor (or Q)</td><td>30pF Min. :
Q≥1,000 (DF≤0.1%)
30pF Max. :
Q≥400+20C
(DF≤1/(400+20C))</td><td>
<table>
<tr><th>Char.</th><th>50V Min.</th><th>25V</th><th>16V</th><th>10V</th><th>6.3V</th></tr>
<tr><td>X7R
X5R</td><td>≤5%/ *≤7.5%</td><td>≤5%/ *≤10%</td><td>≤5%/ *≤10%</td><td>≤7.5%/ *≤12.5%</td><td>≤7.5%/ *≤12.5%</td></tr>
<tr><td>Y5V</td><td>≤7.5%/ *≤12.5%</td><td>≤10%/ *≤12.5%</td><td>≤12.5% *≤15%</td><td>≤15%/ *≤20%</td><td>≤20%</td></tr>
</table></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">9</td><td rowspan="4">Humidity Load</td><td>Appearance</td><td>No marking defects</td><td></td><td rowspan="4">- Temperature : 40±2℃
- Humidity : 90~95%
- Hour : 500±12hrs
- Test Voltage : The rated voltage
- Take it out and set it for 24±2 hours (temperature compensating) or 48±4 hours(high dielectric constant type) at room temperature, then measure.
The charge/discharge current is less than 50mA</td></tr>
<tr><td>Capacitance Change</td><td>Within ±7.5% or ±0.75pF (whichever is larger)</td><td>X7R, X5R : Within ±12.5%
Y5V : Within +30%, -40% (Y5V/1.0μF, 2.2μF, 4.7μF/10V)
Within ±30% (others)</td></tr>
<tr><td>Dissipation Factor (or Q)</td><td>30pF Min. :
Q≥200 (DF≤0.5%)
30pF Max. :
Q≥100 +10/3C
(DF≤1/(100+10/3C))</td><td>
<table>
<tr><th>Char.</th><th>50V Min.</th><th>25V</th><th>16V</th><th>10V</th><th>6.3V</th></tr>
<tr><td>X7R
X5R</td><td>≤5%/ *≤7.5%</td><td>≤5%/ *≤10%</td><td>≤5%/ *≤10%</td><td>≤7.5%/ *≤12.5%</td><td>≤7.5%/ *≤12.5%</td></tr>
<tr><td>Y5V</td><td>≤7.5%/ *≤12.5%</td><td>≤10%/ *≤12.5%</td><td>≤12.5% *≤15%</td><td>≤15%/ *≤20%</td><td>≤20%</td></tr>
</table></td></tr>
<tr><td>I.R.</td><td colspan="2">More than 500MΩ or 25Ω.F(Whichever is smaller)</td></tr>
<tr><td rowspan="4">10</td><td rowspan="4">High Temperature Load</td><td>Appearance</td><td>No marking defects</td><td></td><td rowspan="4">- Testing time : 1000±12hrs
- Applied voltage :
Rated voltage < DC250V : ×200%
- Temperature :
C0G, X7R → 125±3℃
X5R , Y5V → 85±3℃
- Measurement after test
Take it out and set it for 24±2 hours(temperature compensating type)or 48±4 hours (high dielectric constant type) at room temperature, then measure.
The charge/discharge current is less than 50mA.</td></tr>
<tr><td>Capacitance Change</td><td>Within ±3% or ±0.3pF (whichever is larger)</td><td>X7R, X5R : Within ±12.5%
Y5V : Within ±30%(Cap. < 1.0μF)
Within +30%, −40%
(Cap. ≥ 1.0μF)</td></tr>
<tr><td>Dissipation Factor (or Q)</td><td>30pF Min. :
Q≥350 (DF≤0.3%)
10pF≤Cp ≤30pF :
Q≥275 +5/2C
(DF≤1/(275+5/2C))
10pF Max. :
Q≥200+10C
(DF≤1/(200+10C))</td><td>
<table>
<tr><th>Char.</th><th>50V Min.</th><th>25V</th><th>16V</th><th>10V</th><th>6.3V</th></tr>
<tr><td>X7R
X5R</td><td>≤5%/ *≤7.5%</td><td>≤5%/ *≤10%</td><td>≤5%/ *≤10%</td><td>≤7.5%/ *≤12.5%</td><td>≤7.5%/ *≤12.5%</td></tr>
<tr><td>Y5V</td><td>≤7.5%/ *≤12.5%</td><td>≤10%/ *≤12.5%</td><td>≤12.5% *≤15%</td><td>≤15%/ *≤20%</td><td>≤20%</td></tr>
</table></td></tr>
<tr><td>I.R.</td><td colspan="2">More than 10,000MΩ or 50Ω.F(Whichever & Smaller)</td></tr>
</table>

<table>
<tr><th rowspan="2">No.</th><th rowspan="2" colspan="2">Item</th><th colspan="2">Characteristic</th><th rowspan="2">Test Methods and Conditions</th></tr>
<tr><th>Temperature Compensating Type</th><th>High Dielectric Constant Type</th></tr>
<tr><td rowspan="2">11</td><td rowspan="2">Bending Strength</td><td></td><td colspan="2">

No cracking or marking defects shall occur</td><td rowspan="2">- Substrate Material :
Glass EPOXY Board
- Board Thickness :
1.6mm
0.8mm(0603/1005size)
※ Test Condition
- Bending Limit : 1mm
- Pressurizing Speed : 1mm/sec</td></tr>
<tr><td>Capacitance Change</td><td>Within ±5% or ±0.5pF
(whichever is larger)</td><td>X7R, X5R : Within ±12.5%
Y5V : Within ±30%</td></tr>
<tr><td rowspan="3">12</td><td rowspan="3">Vibration Resistance</td><td>Appearance</td><td colspan="2">No defects or abnormalities</td><td rowspan="3">* Shown in Fig. After soldering and then let sit for 24+4hr(temperature compensating type), 48±4hr (high dielectric constant type) at room temperature.
The capacitor should be subjected to a simple harmonic motion having a total amplitude of 1.5mm, the frequency being varied uniformly between the approximate limits of 10 and 55Hz, shall be traversed(from 10Hz to 55Hz then 10Hz again) in approximately 1 minute.
This motion shall be applied for a period of 2 hours in each 3mutually perpendicular directions(total is 6hours).</td></tr>
<tr><td>Capacitance</td><td colspan="2">Whin the specified tolerance</td></tr>
<tr><td>Q/DF</td><td>30pF Min. :
Q 1,000 (DF 0.1%)
30pF Max. :
Q 400+20C
(DF 1/ (400+20C))</td><td><table>
<tr><th>Char.</th><th>50V Min.</th><th>25V</th><th>16V</th><th>10V</th><th>6.3V</th></tr>
<tr><td>X7R
X5R</td><td>≤2.5%/
*≤5%</td><td>≤3%/
*≤7%</td><td>≤3.5%/
*≤7%</td><td>≤5%/
*≤10%</td><td>≤5%/
*≤10%</td></tr>
<tr><td>Y5V</td><td>≤5%/
*≤9%</td><td>≤7%/
*≤9%</td><td>≤9%
*≤12.5%</td><td>≤12.5%/
*≤15%</td><td>≤15%</td></tr>
</table></td></tr>
<tr><td rowspan="4">13</td><td rowspan="4">Humidity Steady State</td><td>Appearance</td><td colspan="2">No marking defects</td><td rowspan="4">- Temperature : 40±2℃
- Humidity : 90~95%
- Hour : 500±12hours
- Measurement after test
Take it out and set it for 24±2 hours (temperature compensating type) or 48±4 hours(high dielectric constant type) at room temperature, then measure.</td></tr>
<tr><td>Capacitance Change</td><td>Within ±5% or ±0.5pF
(whichever is larger)</td><td>X7R, X5R : Within ±12.5%
Y5V : Within ±30%</td></tr>
<tr><td>Dissipation (or Q)</td><td>30pF Min. :
Q≥350 (DF≤0.3%)
10pF≤Cp ≤30pF :
Q≥275 +5/2C
(DF≤1/(275+5/2C))
10pF Max. :
Q≥200+10C
(DF≤1/(200+10C))</td><td><table>
<tr><th>Char.</th><th>50V Min.</th><th>25V</th><th>16V</th><th>10V</th><th>6.3V</th></tr>
<tr><td>X7R
X5R</td><td>≤5%/
*≤7.5%</td><td>≤5%/
*≤10%</td><td>≤5%/
*≤10%</td><td>≤7.5%/
*≤12.5%</td><td>≤7.5%/
*≤12.5%</td></tr>
<tr><td>Y5V</td><td>≤7.5%/
*≤12.5%</td><td>≤10%/
*≤12.5%</td><td>≤12.5%
*≤15%</td><td>≤15%/
*≤20%</td><td>≤20%</td></tr>
</table></td></tr>
<tr><td>I.R</td><td colspan="2">More than 1,000MΩ or 50Ω.F (Whichever is Smaller)</td></tr>
</table>

<table>
<tr><th rowspan="2">No.</th><th colspan="2" rowspan="2">Item</th><th colspan="2">Characteristic</th><th rowspan="2">Test Methods and Conditions</th></tr>
<tr><th>Temperature Compensating Type</th><th>High Dielectric Constant Type</th></tr>
<tr><td rowspan="2">14</td><td rowspan="2">Capacitance Temperature Characteristics</td><td>Capacitance Change</td><td></td><td>
<table>
<tr><th>Char.</th><th>Temp. Range</th><th>Reference Temp.</th><th>Cap. Change</th></tr>
<tr><td>X7R</td><td>−55 to +125℃</td><td rowspan="3">25℃</td><td>Within ±15%</td></tr>
<tr><td>X5R</td><td>−55 to +85℃</td><td>Within ±15%</td></tr>
<tr><td>Y5V</td><td>−30 to +85℃</td><td>Within 22% −82%</td></tr>
</table>
</td><td>(1) Temperature Compensating Type:
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, (C0G: +25 to 125℃) the capacitance shall be with in the specified tolerance for the temperature coefficient.
The capacitance drift is calculated by dividing the difference between the maximum measured values in the step 1, 3 and 5 by the Cap. value in step 3</td></tr>
<tr><td>Temperature Coefficient</td><td>
<table>
<tr><th>Char.</th><th>Temp. Range</th><th>Temperature Coefficient</th></tr>
<tr><td>C0G</td><td>-55 to +125℃</td><td>±30ppm/℃</td></tr>
</table>
</td><td></td><td>
<table>
<tr><th>Step</th><th>Temperature(℃)</th></tr>
<tr><td>1</td><td>25±2</td></tr>
<tr><td>2</td><td>−55±3</td></tr>
<tr><td>3</td><td>25±2</td></tr>
<tr><td>4</td><td>125±3(for C0G)</td></tr>
<tr><td>5</td><td>25±2</td></tr>
</table>
(2) High Dielectric Constant Type :
The ranges of capacitance change compared with the 25℃ value over the temperature range shown in the table shall be in the specified range.</td></tr>
<tr><td>15</td><td colspan="2">Preservation(keeping)</td><td colspan="2">※When solderability is considered, capacitors are recommended to be used in 12 months</td><td>(1) Temperature : 25℃ ±10℃
(2) Relative Humidity : Below 70% RH</td></tr>
<tr><td>16</td><td colspan="2">The regulation of environmental pollution materials.</td><td colspan="3">※Never use materials mentioned below in MLCC products regulated this document.
Pb, Cd, Hg, Cr^{+6}, PBB(polybrominated biphenyl), PBDE(polybrominated diphenyl ethers), asbestos.</td></tr>
</table>

- In case of high Voltage and thin layer type Capacitor, it can be different from nomal specification.
So Please ask to our sales person.

SMD Type - High Frequency Capacitors

SAMWHA high frequency MLCC(CF) products offers excellent performance in demanding high RF power applications requiring consistent and reliable operation .
The copper electrodes allow for Ultra -low ESR and high Q in the GHz frequencies.

The CF series products are your best choice for high RF power applications from UHF through microwave frequencies.

Applications

- RF Power Amplifiers, Low Noise Amplifiers
- Filter Networks
- Cable TV and telecommunication networks
- GPS, Bluetooth and TV set-top boxes
- MRI Systems

Features

- Ultra Low ESR
- High Q
- High Self Resonance
- Capacitance Range : 0.5pF to 100pF
- Temperature characteristics : C0G

How to Order(Product Identification)

CF	2012	C0G	101	J	251	N	R	B
1	2	3	4	5	6	7	8	9

1 CF : High Frequency(SMD)

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 ToleranceClass
Class Ⅰ	C0G	−55 to +125℃	±30 ppm/℃

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	±2.0%

6 Voltage Code

Code	250	500	101	201	251
Rated Voltage	DC 25V	DC 50V	DC 100V	DC 200V	DC 250V

7 Termination Code

N : Nickel-Tin Plate

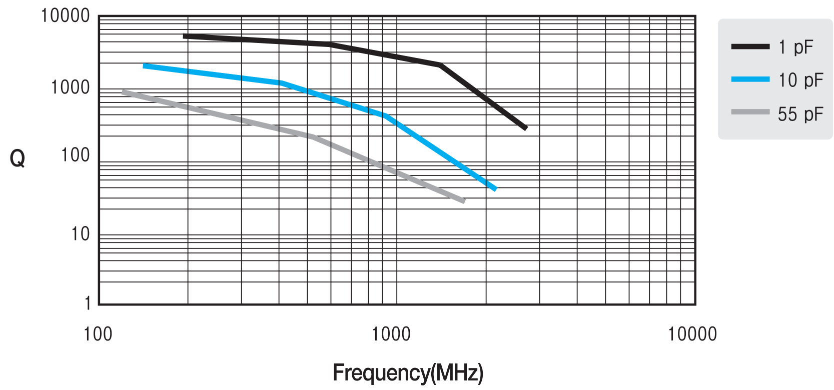
8 Packing Code

R : Reel Type, B : Bulk Type

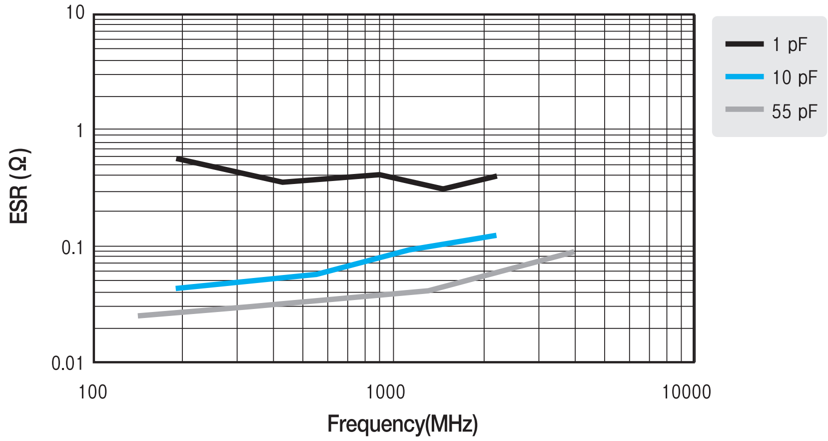
9 Thickness Option

Thickness(mm)		Code	Thickness(mm)		Code
t	Tol(±)		t	Tol(±)	
0.50	0.05	Blank	1.25	0.15	E
0.60	0.10	A	1.30	0.20	E
0.80	0.10	B	1.35	0.20	H
0.85	0.15	B	1.60	0.20	I
1.00	0.15	E	1.80	0.20	J
1.10	0.15	E	2.00	0.25	K
1.15	0.15	E	2.50	0.25	L

Q VS. Frequency (CF 1005 Series)



ESR VS. Frequency (CF 1005 Series)



Appendix Ⅰ

C0G-Temperature Compensating Type(0603~2012)

Type	C0G					
Size(inch)	1005(0402)		1608(0603)		2012(0805)	
Volt(V) / Cap.	25	50	50	100	50	100
0.5pF(0R5)						
1pF(010)						
2pF(020)						
3pF(030)						
4pF(040)						
5pF(050)						
6pF(060)						
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)						

Automotive Applications

Features

- SAMWHA Series meet AEC-Q200 requirements
- SAMWHA Series Certify ISO/TS 16949 and 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

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 ToleranceClass
Class I	C0G	−55 to +125℃	±30 ppm/℃
Class II	X7R	−55 to +125℃	±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

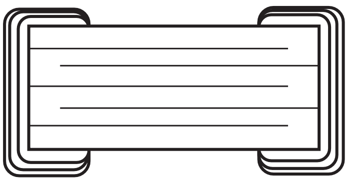
Code	Tolerance	Code	Tolerance
B	±0.1pF	G	±2.0%
C	±0.25pF	J	±5%
D	±0.5pF	K	±10%
F	±1.0%	M	±2.0%

6 Voltage Code

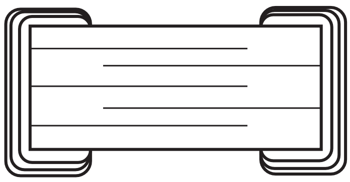
Code	6R3	100	160	250	500	101	201	251	501	631	102	202	302
Rated Voltage	DC 6.3V	DC 10V	DC 16V	DC 25V	DC 50V	DC 100V	DC 200V	DC 250V	DC 500V	DC 630V	DC 1KV	DC 2KV	DC 3KV

7 Termination & Design Code

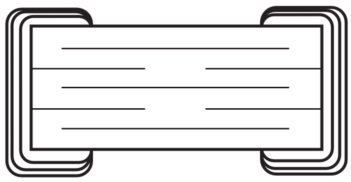
N : Nickel-Tin Plate A : Nickel-Tin Plate (Soft Termination) O : Open Mode F : Floating electrode



a. Normal type



b. Open mode



c. Floating electrode

8 Packing Code

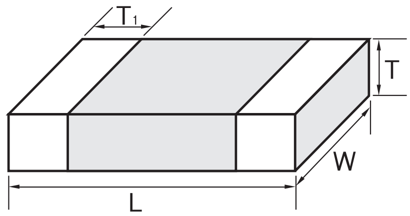
R : Reel Type, B : Bulk Type

9 Thickness Option

Thickness(mm)		Code	Thickness(mm)		Code
t	Tol(±)		t	Tol(±)	
0.50	0.05	Blank	1.25	0.15	E
0.60	0.10	A	1.30	0.20	E
0.80	0.10	B	1.35	0.20	H
0.85	0.15	B	1.60	0.20	I
1.00	0.15	E	1.80	0.20	J
1.10	0.15	E	2.00	0.25	K
1.15	0.15	E	2.50	0.25	L

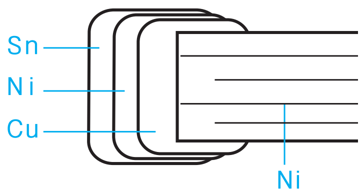
Temperature Characteristics See Page 35 (No.21)

Dimensions

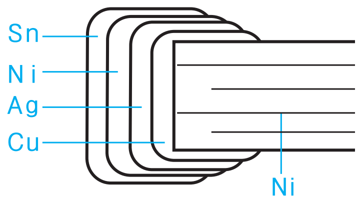


Code	Dimensions				
	Length		Width		T1(min)
	L	Tol(±)	W	Tol(±)	
1005(0402)	1.00	0.05	0.50	0.05	0.05
1608(0603)	1.60	0.15	0.80	0.10	0.10
2012(0805)	2.00	0.20	1.25	0.15	0.10
3216(1206)	3.20	0.30	1.60	0.20	0.15
3225(1210)	3.20	0.40	2.50	0.25	0.15

Construction of Termination



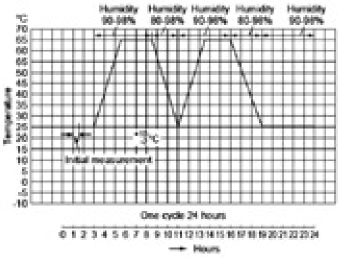
a. Ni Type Ⅰ



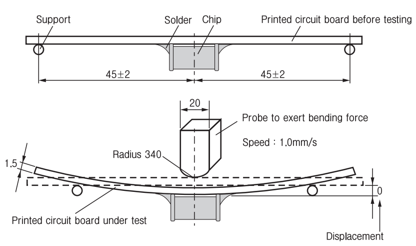
b. Ni Type Ⅱ (Soft Termination)

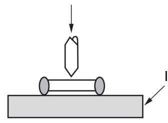
Specifications and Test Methods(For Automotive Applications)

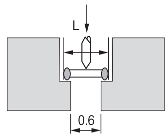
No.	AEC-Q200		Specification		Test Methods and Conditions
			Class Ⅰ	Class Ⅱ	
1.	Pre-and Post-Stress Electrical Test				
2.	High Temperature Exposure (Storage)	Appearance	No marking defects		Temperature : 150±3℃ Maintenance Time : 1000+48/-0 hrs Let sit for 24±2 hours at room temperature, then measure.
		Capacitance Change	Within ±2.5% or ±0.25pF (Whichever is larger)	Within±10.0%	
		Q/D.F.	30pF Min.: Q≥1000 30pF Max.: Q≥400+20×C C: Nominal Capacitance(pF)	Rated Voltage 16V Min.: 0.05 Max. 10V: 0.075 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">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>
<tr><td>8.</td><td colspan="2">External Visual</td><td colspan="2">No defects or abnormalities</td><td>Visual inspection</td></tr>
<tr><td>9.</td><td colspan="2">Physical Dimension</td><td colspan="2">Within the specified dimensions</td><td>Using calipers</td></tr>
<tr><td rowspan="4">10.</td><td rowspan="4">Resistance to Solvents</td><td>Appearance</td><td colspan="2">No marking defects</td><td rowspan="4">Per MIL-STD-202 Method 215</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>
</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 rowspan="4">11.</td><td rowspan="4">Mechanical Shock</td><td>Appearance</td><td>No marking defects</td><td></td><td rowspan="4">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</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 rowspan="4">12.</td><td rowspan="4">Vibration</td><td>Appearance</td><td colspan="2">No defects or abnormalities</td><td rowspan="4">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).</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 rowspan="4">13.</td><td rowspan="4">Resistance to Soldering Heat</td><td>Appearance</td><td colspan="2">No marking defects</td><td rowspan="4">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.</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 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>
</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>16.</td><td colspan="2">Solderability</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="6">17.</td><td rowspan="6">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≤10㎌</td><td>1±0.1kHz</td><td>1±0.2Vrms</td></tr><tr><td>C>10㎌</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>
<tr><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 colspan="2">No marking defects</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>
</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>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>
<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>
</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

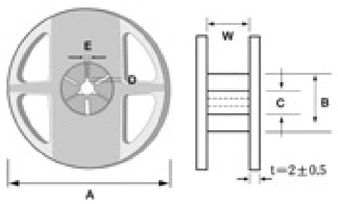
Bulk packing

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

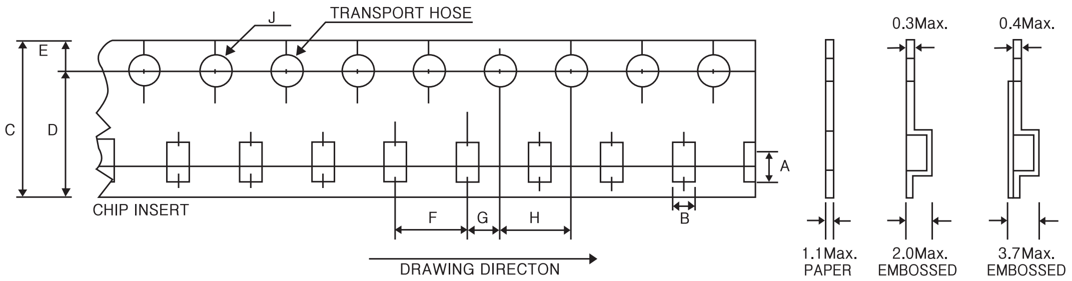


Mark	Size Code	EIA Code	A	B	C	D	E	W
7″ REEL	1005~3225	0402~1210	Ø178±2	Ø50Min.	Ø13±0.5	Ø21±0.8	2±0.5	10±1.5
13″ REEL	1005~3225	0402~1210	Ø330±2	Ø70Min.	Ø13±0.5	Ø21±0.8	2±0.5	10±1.5

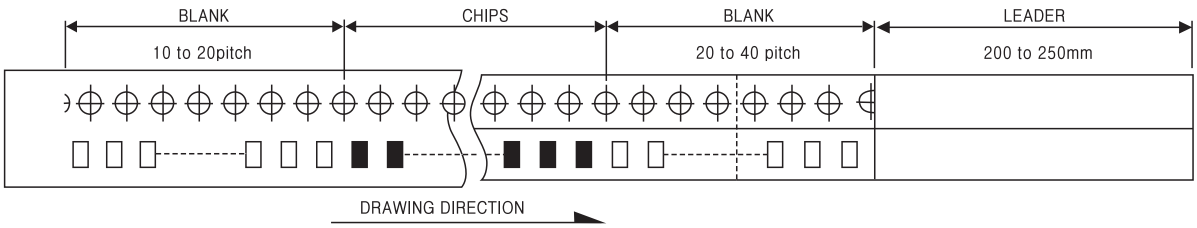
Number of Packages

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



Capacitance Table.

Class I (C0G)

Size Code (EIA Code)	1005(0402)				1608(0603)				2012(0805)				3216(1206)				3225(1210)			
Volt(V) / Cap.	16	25	50	100	16	25	50	100	16	25	50	100	16	25	50	100	16	25	50	100
0.5pF																				
1pF																				
2.2pF																				
4.7pF																				
6.8pF																				
10pF																				
22pF																				
47pF																				
68pF																				
100pF																				
220pF																				
470pF																				
680pF																				
1nF																				
1.8nF																				
2.2nF																				
3.3nF																				
4.7nF																				

Class II (X7R)

Size Code (EIA Code) / 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
1nF																				
2.2nF																				
4.7nF																				
6.8nF																				
10nF																				
22nF																				
47nF																				
68nF																				
100nF																				
220nF																				
470nF																				
680nF																				
1uF																				
2.2uF																				
4.7uF																				
10uF																				
22uF																				
47uF																				

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

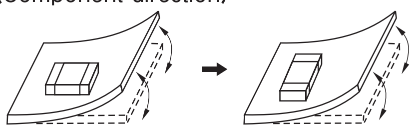
Never use materials mentioned below in MLCC products regulated this document.

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

▶ Mounting Position

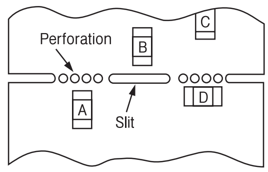
Choose a mounting position that minimizes the stress imposed on the chip during flexing or bending of the board.

(Component direction)



Locate chip horizontal to the direction in which stress acts

(Chip Mounting Close to Board Separation Point)



Chip arrangement
Worst A-C-(B, D) Best

▶ Reflow Soldering

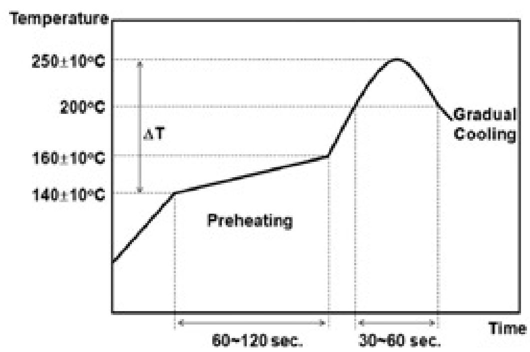
1. The sudden temperature change easily causes mechanical damages to ceramic components. Therefore, the preheating procedures should be required for the soldering of ceramic components.

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.

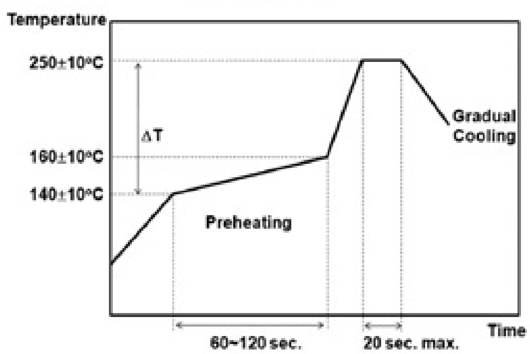
Table 1.

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

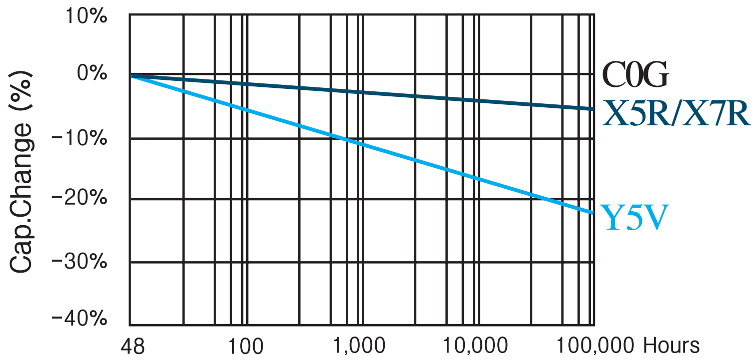
(Typically represented by X7R temperature characteristic of which main composition is BaTiO3)

'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:

$$C_t = C_{48}(1 - k \log 10\ t)$$

- 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%