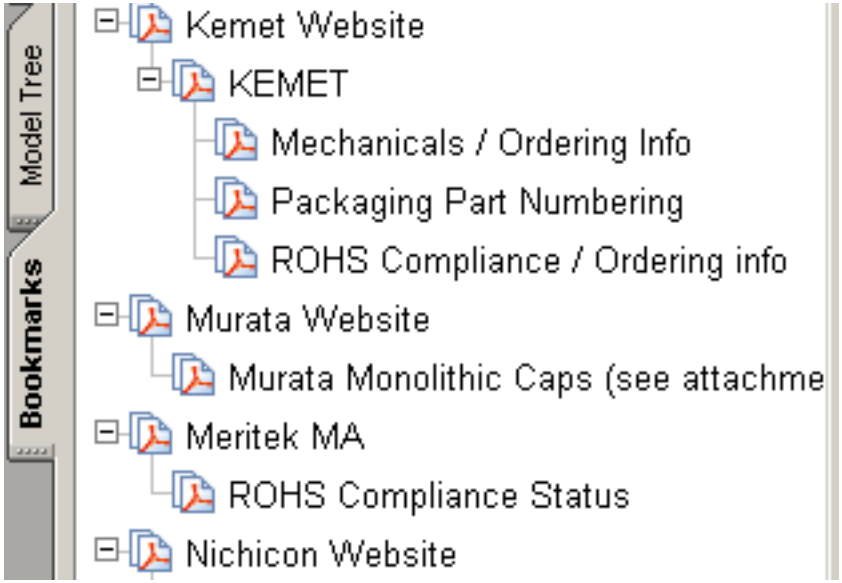
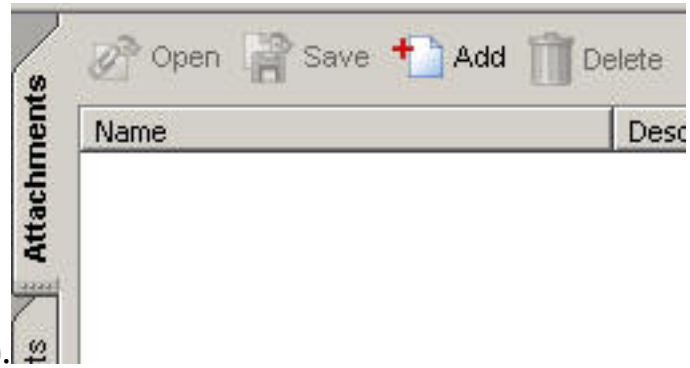
Non-Polar Capacitor Datasheet Collection

This is a collection of datasheets for several types of standard surface mount capacitors without polarity.

To navigate thru this document, expand the Bookmarks tab on the left side to view index of bookmarked datasheets.



Also, if the datasheet doesn't appear in this list, expand the Attachments tab at the bottom left, and click on the attachment to open datasheet (these are secure documents and must be attached).



Low Profile Multi Layer Ceramic Capacitor

Samsung Electro-Mechanics (SEM) has announced a new lineup of low-profile multi-layer ceramic capacitors (MLCCs) that are much thinner than their conventional counterparts yet provide the same level of capacitance. These new devices help designers to create slimmer LCD modules, hard disc drives and other electronic products.
Low-profile MLCCs have the same width and length of regular models, but they are not nearly as thick. In other words, the footprint on the PCB is the same, so they can replace the thicker versions without requiring any design changes.

General Features

- Thinner MLCC than general product (Same Length and Width of general product)

Applications

- LCD Module
- CPU socket
- Hard Disc Driver
- Mobile Product etc

Part Numbering

CL	31	A	106	K	O	C	L	N	N	C
❶	❷	❸	❹	❺	❻	❼	❽	❾	❿	⓫

❶ Samsung Multilayer Ceramic Capacitor
❷ Size(mm)
❸ Capacitance Temperature Characteristic
❹ Nominal Capacitance
❺ Capacitance Tolerance
❻ Rated Voltage
❼ Thickness Option
❽ Product & Plating Method
❾ Samsung Control Code
❿ Reserved For Future Use
⓫ Packaging Type

❶ Samsung Multilayer Ceramic Capacitor

❷ SIZE(mm)

Code	EIA Code	Size(mm)	Code	EIA Code	Size(mm)
03	0201	0.6 × 0.3	**31**	1206	3.1 × 1.6
05	0402	1.0 × 0.5	**32**	1210	3.2 × 2.5
10	0603	1.6 × 0.8	**43**	1812	4.5 × 3.2
21	0805	2.0 × 1.25	**55**	2220	5.7 × 5.0

Part Numbering

❸ CAPACITANCE TEMPERATURE CHARACTERISTIC

Code	Temperature Characteristics				Temperature Range
C	Class Ⅰ	COG	C△	0±30(ppm/℃)	-55 ~ +125℃
P		P2H	P△	-150±60	
R		R2H	R△	-220±60	
S		S2H	S△	-330±60	
T		T2H	T△	-470±60	
U		U2J	U△	-750±60	
L		S2L	S△	+350 ~ -1000	
A	Class Ⅱ	X5R	X5R	±15%	-55 ~ +85℃
B		X7R	X7R	±15%	-55 ~ +125℃
X		X6S	X6S	±22%	-55 ~ +105℃
F		Y5V	Y5V	+22 ~ -82%	-30 ~ +85℃

❹ NOMINAL CAPACITANCE

Nominal capacitance is identified by 3 digits. The first and second digits identify the first and second significant figures of the capacitance.
The third digit identifies the multiplier. 'R' identifies a decimal point.

- **Example**

Code	Nominal Capacitance	
1R5	1.5 pF	* uF = 10^3 nF = 10^6 pF
103	10,000 pF, 10 nF, 0.01μF	

❺ CAPACITANCE TOLERANCE

Code	Tolerance	Nominal Capacitance	Code	Tolerance	Nominal Capacitance
A	±0.05pF	Less than 10pF (Including 10pF)	F	±1%	More than 10pF
B	±0.1pF		G	±2%	
C	±0.25pF		J	±5%	
D	±0.5pF		K	±10%	
F	±1pF		M	±20%	
			Z	+80, -20%	

Part Numbering

❻ RATED VOLTAGE

Code	Rated Voltage	Code	Rated Voltage	Code	Rated Voltage
R	4.0V	L	35V	G	500V
Q	6.3V	B	50V	H	630V
P	10V	C	100V	I	1,000V
O	16V	D	200V	J	2,000V
A	25V	E	250V	K	3,000V

❼ THICKNESS OPTION

Size	Code	Thickness(T)	Size	Code	Thickness(T)
0201(0603)	3	0.30±0.03	1210(3225)	F	1.25±0.20
0402(1005)	5	0.50±0.05		H	1.6±0.20
0603(1608)	6	0.60±0.10		T	1.6±0.10
	8	0.80±0.10		I	2.0±0.20
0805(2012)	5	0.45±0.05		J	2.5±0.20
	A	0.65±0.10		V	2.5±0.30
	C	0.85±0.10	1812(4532)	F	1.25±0.20
	F	1.25±0.10		H	1.6±0.20
	Q	1.25±0.15		I	2.0±0.20
1206(3216)	6	0.60±0.10		J	2.5±0.20
	C	0.85±0.15		L	3.2±0.30
	F	1.25±0.15	2220(5750)	F	1.25±0.20
	H	1.6±0.20		H	1.6±0.20
1210(3225)	6	0.60±0.10		I	2.0±0.20
	C	0.85±0.10		J	2.5±0.20
	9	0.90±0.10		L	3.2±0.30

❽ PRODUCT & PLATING METHOD

Code	Thickness	Electrode	Termination	Plating Type
A	Normal	Pd	Ag	Sn_100%
N	Normal	Ni	Cu	Sn_100%
G	Normal	Cu	Cu	Sn_100%
L	**Low Profile**	**Ni**	**Cu**	**Sn_100%**

Part Numbering

❾ SAMSUNG CONTROL CODE

Code	Description of the code	Code	Description of the code
A	Array (2-element)	N	Normal
B	Array (4-element)	P	Automotive
C	High - Q	L	LICC

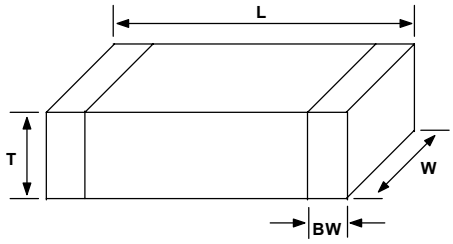
❿ RESERVED FOR FUTURE USE

Code	Description of the code
N	Reserved for future use

⓫ PACKAGING TYPE

Code	Packaging Type	Code	Packaging Type
B	Bulk	F	Embossing 13" (10,000EA)
P	Bulk Case	L	Paper 13" (15,000EA)
C	Paper 7"	O	Paper 10"
D	Paper 13" (10,000EA)	S	Embossing 10"
E	Embossing 7"		

APPEARANCE AND DIMENSION



CODE	EIA CODE	DIMENSION (mm)				
		L	W	T	THICKNESS CODE	BW
05	0402	1.0 ± 0.05	0.50 ± 0.05	0.50 ± 0.05	5	0.2 +0.15/-0.1
10	0603	1.60 ± 0.10	0.80 ± 0.10	0.50 ± 0.05	5	0.3 ± 0.2
21	0805	2.00 ± 0.10	1.25 ± 0.10	0.60 ± 0.10	6	0.5 +0.2/-0.3
				0.85 ± 0.10	C	
				1.25 ± 0.10	F	
31	1206	3.20 ± 0.15	1.60 ± 0.15	0.60 ± 0.10	6	0.5 ± 0.3
				0.85 ± 0.10	C	
				1.60 ± 0.15	H	
32	1210	3.20 ± 0.30	2.50 ± 0.20	0.60 ± 0.10	6	0.6 ± 0.3
				0.85 ± 0.10	C	
				1.60 ± 0.10	T	

CHARACTERISTIC LINE UP

Size	0603(**10**)			0805(**21**)				1206(**31**)					1210(**32**)			
TC	X5R(**A**)			X5R(**A**)				X5R(**A**)				X7R (**B**)	X5R(**A**)			
Rated V	6.3 (**Q**)	10(**P**)	16(**O**)	6.3 (**Q**)	10(**P**)	16(**O**)	25(**A**)	6.3 (**Q**)	10(**P**)	16(**O**)	25(**A**)	25(**A**)	6.3 (**Q**)	10(**P**)	16(**O**)	25(**A**)
Capacitance -nF- (part numbering code) and thickness -mm-																
1000(**105**)	(**5**)	(**5**)	(**5**)		(**6**)	(**6**)	(**C**)					(**P**)				
1500(**155**)																
2200(**225**)										(**6**)	(**6**)				(**6**)	(**6**)
3300(**335**)					(**C**)			(**C**)		(**C**)	(**C**)					(**C**)
4700(**475**)				(**6**)					(**6**)					(**6**)		
10000(**106**)				(**C**)					(**C**)	(**P**)			(**6**)	(**C**)	(**9**)	(**T**)
22000(**226**)													(**C**)	(**S**)	(**T**)	

* The thickness code in the product line up is available minimum thickness.

If you need the thicker product, we can also support your needs.

RELIABILITY TEST CONDITION

NO	ITEM		PERFORMANCE	TEST CONDITION
1	Appearance		No Abnormal Exterior Appearance	Through Microscope(×10)
2	Insulation Resistance		10,000MΩ or 500MΩ·μF whichever is smaller Rated Voltage is below 16V ; 10,000MΩ or 100MΩ·μF whichever is smaller	Apply the Rated Voltage For 60 ~ 120 Sec.
3	Withstanding Voltage		No Dielectric Breakdown or Mechanical Breakdown	Class Ⅰ : 300% of the Rated Voltage for 1~5 sec. Class Ⅱ :250% of the Rated Voltage for 1~5 sec. is applied with less than 50㎃ current
4	Capacitance	Class Ⅰ	Within the specified tolerance	Capacitance / Frequency / Voltage ≤1,000pF / 1㎒±10% / 0.5 ~ 5 Vrms >1,000pF / 1㎑±10% / 0.5 ~ 5 Vrms
		Class Ⅱ	Within the specified tolerance	Capacitance / Frequency / Voltage ≤10μF / 1㎑±10% / 1.0±0.2Vrms >10μF / 120㎐±20% / 0.5±0.1Vrms
5	Q	Class Ⅰ	Capacitance ≥ 30pF : Q ≥1,000 < 30pF : Q ≥400 +20C (C : Capacitance)	Capacitance / Frequency / Voltage ≤1,000pF / 1㎒±10% / 0.5 ~ 5 Vrms >1,000pF / 1㎑±10% / 0.5 ~ 5 Vrms
6	Tanδ	Class Ⅱ	X5R/X7R/X6S : 0.10max Y5V : 0.16max	Capacitance / Frequency / Voltage ≤10μF / 1㎑±10% / 1.0±0.2Vrms >10μF / 120㎐±20% / 0.5±0.1Vrms
7	Temperature Characteristics of Capacitance	Class Ⅰ		Capacitance shall be measured by the steps shown in the following table.
		Class Ⅱ		

Characteristics	Temp. Coefficient (PPM/℃)
C0G	0 ± 30
PH	-150 ± 60
RH	-220 ± 60
SH	-330 ± 60
TH	-470 ± 60
UL	-750 ± 120
SL	+350 ~ -1000

Step	Temp.(℃)
1	25 ± 2
2	Min. operating temp. ± 2
3	25 ± 2
4	Max. operating temp ± 2
5	25 ± 2

(1) Class Ⅰ

Temperature Coefficient shall be calculated from the formula as below.

$$\text{Temp, Coefficient} = \frac{C2 - C1}{C1 \times \triangle T} \times 10^6 \ [\text{ppm}/℃]$$

C1; Capacitance at step 3

C2: Capacitance at 85℃

△T: 60℃(=85℃-25℃)

Characteristics	Capacitance Change with No Bias
A(X5R)/ B(X7R)	±15%
X(X6S)	±22%
F(Y5V)	+22% ~ -82%

(2) CLASS Ⅱ

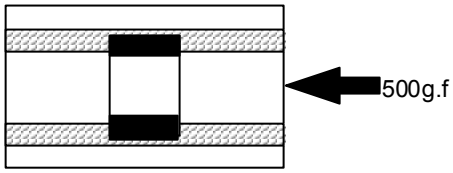
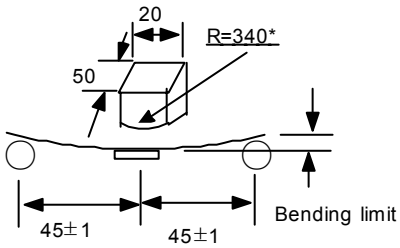
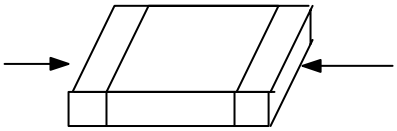
Capacitance Change shall be calculated from the formula as below.

$$\triangle C = \frac{C2 - C1}{C1} \times 100(\%)$$

C1; Capacitance at step 3

C2: Capacitance at step 2 or 4

RELIABILITY TEST CONDITION

NO	ITEM		PERFORMANCE			TEST CONDITION
8	Adhesive Strength of Termination		No Indication Of Peeling Shall Occur On The Terminal Electrode.			Apply 500g.f * Pressure for 10±1 sec. * 200g.f for 0201 case size. 
9	Bending Strength	Apperance	No mechanical damage shall occur.			Bending limit ; 1mm Test speed ; 1.0mm/SEC. Keep the test board at the limit point in 5 sec., Then measure capacitance.  R=230 For 0201 Case size
		Capacitance	Characteristics		Capacitance Change	
			Class I		Within ±5% or ±0.5 pF whichever is larger	
			Class II	A(X5R)/ B(X7R)/ X(X6S)	Within ±12.5%	
				F(Y5V)	Within ±30%	
10	Solderability		More Than 95% of the terminal surface is to be soldered newly, So metal part does not come out or dissolve 			<table><tr><td>Solder</td><td>63Sn-37Pb</td><td>Sn-3Ag-0.5Cu</td></tr><tr><td>Soldering Temp.</td><td>235±5℃</td><td>245±5℃</td></tr><tr><td>Dip time</td><td>5±0.5 SEC.</td><td>3±0.3 SEC.</td></tr><tr><td>Pre-heating</td><td colspan="2">at 80~120℃ for 10~30 SEC.</td></tr></table>

RELIABILITY TEST CONDITION

NO	ITEM		PERFORMANCE			TEST CONDITION
11	Resistance to Soldering heat	Apperance	No mechanical damage shall occur.			Solder Temperature : 270±5℃ Dip Time : 10±1 sec. Each termination shall be fully immersed and preheated as below : Leave the capacitor in ambient condition for specified time* before measurement Class Ⅰ : 24 ± 2 hours Class Ⅱ : 48 ± 4 hours
		Capacitance	Characteristics		Capacitance Change	
			Class Ⅰ		Within ±2.5% or ±0.25pF whichever is larger	
			Class Ⅱ	A(X5R)/ B(X7R)	Within ±7.5%	
				X(X6S)	Within ±15%	
				F	Within ±20%	
		Q (Class Ⅰ)	Capacitance ≥30pF : Q≥ 1000 <30pF : Q≥ 400+20×C (C: Capacitance)			
		Tanδ (Class Ⅱ)	Within the specified initial value			
		Insulation Resistance	Within the specified initial value			
		Withstanding Voltage	Within the specified initial value			
12	Vibration Test	Appearance	No mechanical damage shall occur.			The capacitor shall be subjected to a Harmonic Motion having a total amplitude of 1.5mm changing frequency from 10Hz to 55Hz and back to 10Hz In 1 min. Repeat this for 2hours each in 3 mutually perpendicular directions
		Capacitance	Characteristics		Capacitance Change	
			Class Ⅰ		Within ±2.5% or ±0.25pF whichever is larger	
			Class Ⅱ	A(X5R)/ B(X7R)	Within ±5%	
				X(X6S)	Within ±10%	
				F(Y5V)	Within ±20%	
		Q (Class Ⅰ)	Within the specified initial value			
		Tanδ (Class Ⅱ)	Within the specified initial value			
		Insulation Resistance	Within the specified initial value			

* The initial value of high dielectric constant series shall be measured after the heat treatment of 150 +0/-10℃, 1hr and sitting of 48±4hr. at room temperature & humidity. .

RELIABILITY TEST CONDITION

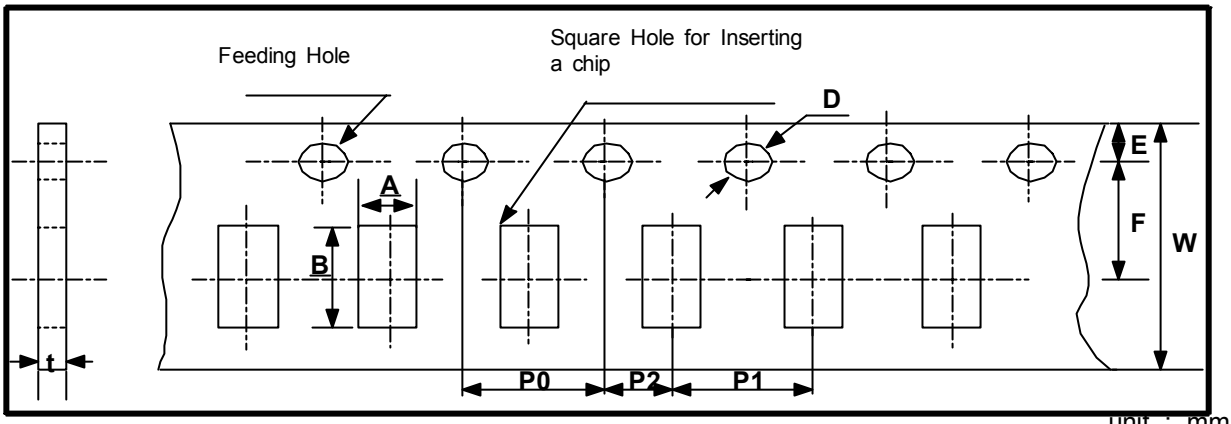
NO	ITEM		PERFORMANCE			TEST CONDITION
13	Humidity (Steady State)	Appearance	No mechanical damage shall occur.			Temperature : 40±2 ℃ Relative humidity : 90~95 %RH Duration time : 500 +12/-0 hr. Leave the capacitor in ambient condition for specified time* before measurement. CLASS Ⅰ : 24±2 Hr. CLASS Ⅱ : 48±4 Hr.
		Capacitance	Characteristics		Capacitance Change	
			Class Ⅰ		Within ±5.0% or ±0.5pF whichever is larger	
			Class Ⅱ	A(X5R)/ B(X7R)	Within ±12.5%	
				X(X6S)	Within ±25%	
				F(Y5V)	Within ±30%	
		Q CLASS Ⅰ	Capacitance ≥ 30pF : Q≥ 350 10≤ Capacitance <30pF : Q≥ 275 + 2.5×C Capacitance < 10pF : Q≥ 200 + 10×C (C: Capacitance)			
		Tanδ CLASS Ⅱ	X5R/X7R/X6S : 0.125max Y5V : 0.195max			
		Insulation Resistance	1,000 MΩ or 50MΩ·μF whichever is smaller.			
14	Moisture Resistance	Appearance	No mechanical damage shall occur.			Applied voltage : Rated Voltage Temperature : 40±2 ℃ Humidity : :90~95%RH Duration time : 500 +12/-0 hr. Charge/discharge current : 50mA max. **<Initial Measurement>** Perform the heat treatment at 150℃ +0/-10℃ for 1 hr. Then leave the capacitor in ambient condition for 48±4 hrs. before measurement. Then perform the measurement. **<Latter Measurement>** 1. Class Ⅰ Leave the capacitor in ambient condition for 24±2 Hrs. before measurement Then perform the measurement. 2. Class Ⅱ Perform the heat treatment at 150℃ +0/-10℃ for 1 hr. Then leave the capacitor in ambient condition for 48±4 hrs. before measurement. Then perform the measurement.
		Capacitance	Characteristics		Capacitance Change	
			Class Ⅰ		Within ±5.0% or ±0.5pF whichever is larger	
			Class Ⅱ	A(X5R)/ B(X7R)	Within ±12.5%	
				X(X6S)	Within ±30%	
				F(Y5V)	Within ±30%	
					Within +30~－40% 0201(0603) C>0.022μF 0402(1005) C>0.47μF 0603(1608) C>1.0μF 0805(2012) C>4.7μF 1206(3216) C>10.0μF 1210(3225) C>22.0μF 1812(4532) C>47.0μF	
		Q (Class Ⅰ)	Capacitance ≥30pF : Q≥ 200 Capacitance <30pF : Q≥ 100 + 10/3×C (C: Capacitance)			
		Tanδ (Class Ⅱ)	X5R/X7R/X6S : 0.125max Y5V : 0.195max			
		Insulation Resistance	500 MΩ or 25MΩ·μF whichever is smaller.			

RELIABILITY TEST CONDITION

NO	ITEM		PERFORMANCE			TEST CONDITION
15	High Temperature Resistance	Appearance	No mechanical damage shall occur.			Applied Voltage : 100% of Rated Voltage Test Time : 1000 +48/-0 Hr. Current Applied : 50㎃ Max. Characteristics / Temp. Class Ⅰ / 125 ±3 ℃ Class Ⅱ A(X5R)/F(Y5V) / 85 ±3 ℃ Class Ⅱ X(X6S) / 105 ±3 ℃ Class Ⅱ B(X7R) / 125 ±3 ℃ **<Initial Measurement>** Perform the heat treatment at 150℃+0/-10℃ for 1hr. Then leave the capacitor in ambient condition for 48±4 hrs. before measurement. Then perform the measurement. **<Latter Measurement>** 1. Class Ⅰ Leave the capacitor in ambient condition for 24±2 Hrs. before measurement Then perform the measurement. 2. Class Ⅱ Perform the heat treatment at 150℃+0/-10℃ for 1hr. Then leave the capacitor in ambient condition for 48±4 hrs. before measurement. Then perform the measurement.
		Capacitance	Characteristics		Capacitance Change	
			Class Ⅰ		Within ±3% or ±0.3㎊, Whichever is larger	
			Class Ⅱ	A(X5R)/B(X7R)	Within ±12.5%	
				X(X6S)	Within ±25%	
				F(Y5V)	Within ±30%	
					Within +30~ −40% 0201(0603) C>0.022㎌ 0402(1005) C>0.47㎌ 0603(1608) C>1.0㎌ 0805(2012) C>4.7㎌ 1206(3216) C>10.0㎌ 1210(3225) C>22.0㎌ 1812(4532) C>47.0㎌	
		Q (Class Ⅰ)	Capacitance ≥30㎊ : Q ≥ 350 10≤ Capacitance <30 ㎊ : Q ≥ 275 + 2.5×C Capacitance < 10㎊ :Q ≥200 +10×C (C: Capacitance)			
		Tanδ (Class Ⅱ)	X5R/X7R/X6S : 0.125max Y5V : 0.195max			
		Insulation Resistance	1,000 ㏁ or 50㏁·㎌ whichever is smaller.			
16	Temperature Cycle	Appearance	No mechanical damage shall occur.			Capacitor shall be subjected to 5 cycles. Condition for 1 cycle : Step / Temp.(℃) / Time(min.) 1 / Min. operating temp.+0/-3 / 30 2 / 25 / 2~3 3 / Max. operating temp.+3/-0 / 30 4 / 25 / 2~3 Leave the capacitor in ambient condition for specified time* before measurement Class Ⅰ : 24 ± 2 hours Class Ⅱ : 48 ± 4 hours
		Capacitance	Characteristics		Capacitance Change	
			Class Ⅰ		Within ±2.5% or ±0.25㎊ Whichever is larger	
			Class Ⅱ	A(X5R)/B(X7R)/	Within ±7.5%	
				X(X6S)	Within ±15%	
				F(Y5V)	Within ±20%	
		Q (Class Ⅰ)	Within the specified initial value			
		Tanδ (Class Ⅱ)	Within the specified initial value			
		Insulation Resistance	Within the specified initial value			

PACKAGING

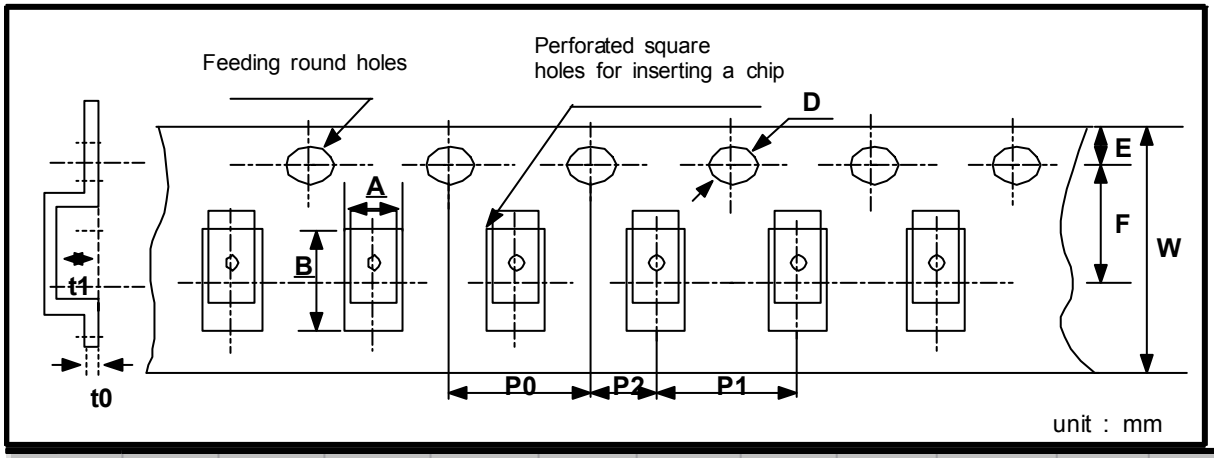
● CARD BOARD PAPER TAPE



unit : mm

Symbol / Type		W	F	E	P1	P2	P0	D	t	A	B
Dimension	03	8.0 ±0.3	3.5 ±0.05	1.75 ±0.1	2.0 ±0.05	2.0 ±0.05	4.0 ±0.1	Φ1.5 +0.1/-0	0.37 ±0.03	0.38 ±0.03	0.68 ±0.03
	05								0.6 ±0.05	0.62 ±0.04	1.12 ±0.04
	10				4.0 ±0.1				1.1 MAX	1.1 ±0.2	1.9 ±0.2
	21									1.6 ±0.2	2.4 ±0.2
	31									2.0 ±0.2	3.6 ±0.2

● EMBOSSED PLASTIC TAPE

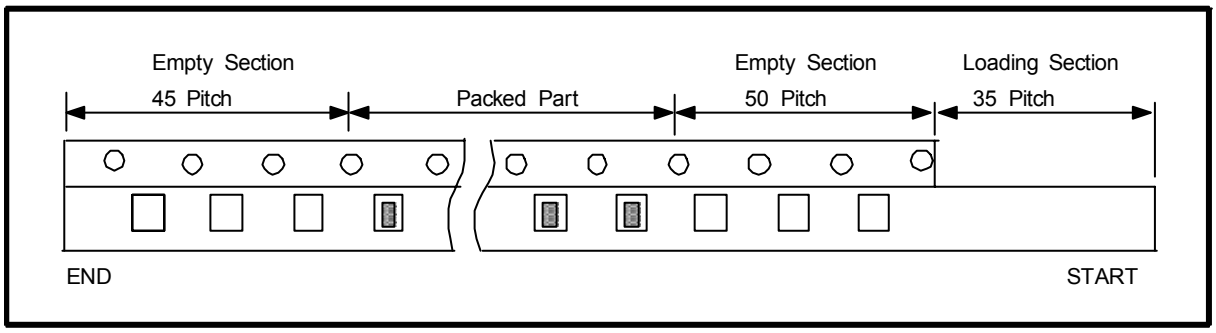


unit : mm

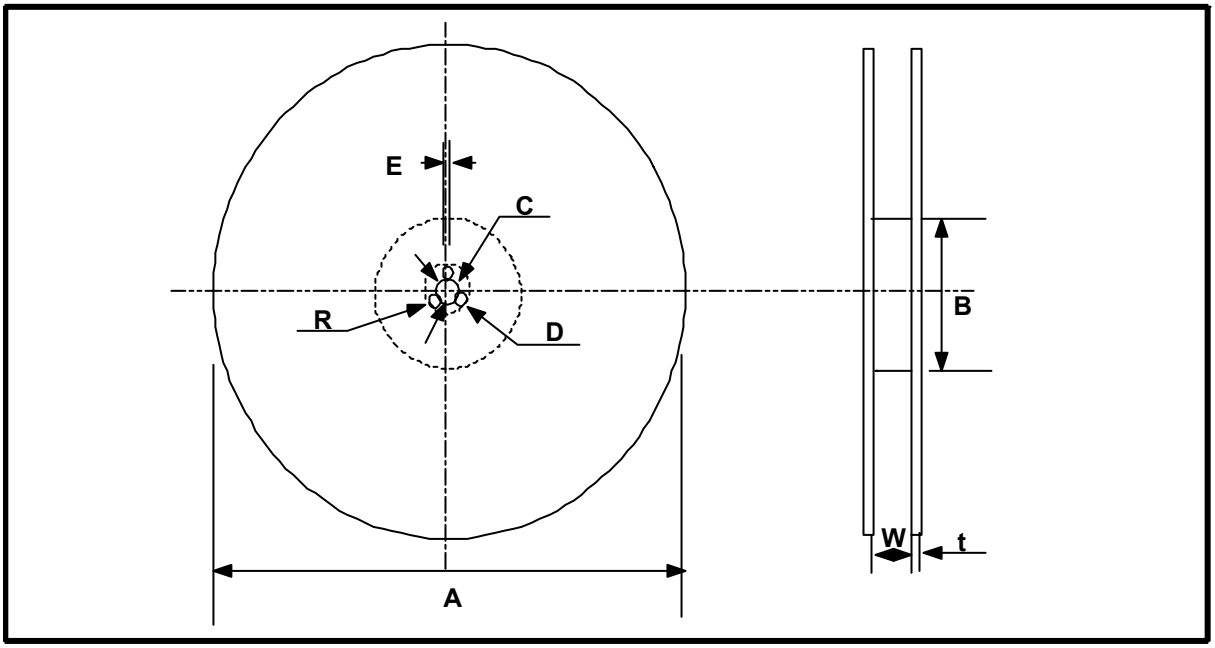
Symbol / Type		W	F	E	P1	P2	P0	D	t0	t1	A	B
Dimension	21	8.0 ±0.3	3.5 ±0.05	1.75 ±0.1	4.0 ±0.1	2.0 ±0.05	4.0 ±0.1	Φ1.5 +0.1/-0	0.6 max	2.5 max	1.45 ±0.2	2.3 ±0.2
	31										1.9 ±0.2	3.5 ±0.2
	32										2.9 ±0.2	3.7 ±0.2
	43	12.0 ±0.3	5.6 ±0.05		8.0 ±0.1					3.8 max	3.6 ±0.2	4.9 ±0.2
	55										5.4 ±0.2	6.0 ±0.2

PACKAGING

● TAPING SIZE



● REEL DIMENSION



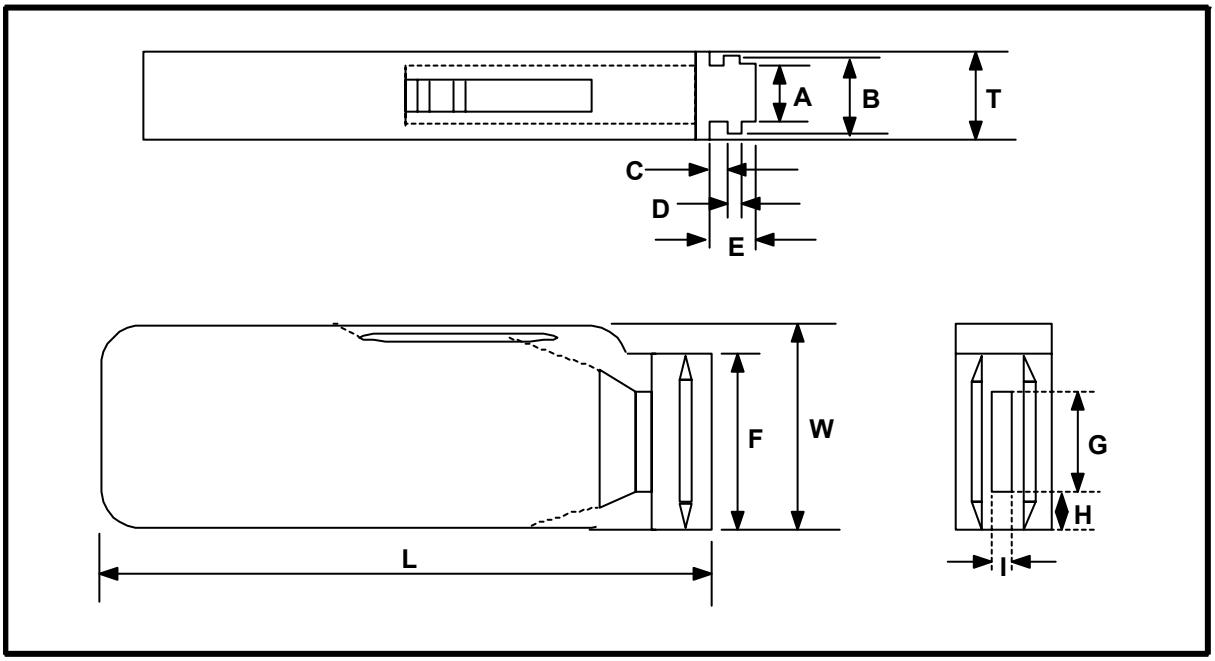
unit : mm

Symbol	A	B	C	D	E	W	t	R
7" Reel	ϕ180+0/ -3	ϕ60+1/ -3	ϕ13±0.3	25±0.5	2.0±0.5	9±1.5	1.2±0.2	1.0
13" Reel	ϕ330±2.0	ϕ80+1/ -3					2.2±0.2	

PACKAGING

● BULK CASE PACKAGING

- Bulk case packaging can reduce the stock space and transportation costs.
- The bulk feeding system can increase the productivity.
- It can eliminate the components loss.



unit : mm

Symbol	A	B	T	C	D	E
Dimension	6.8±0.1	8.8±0.1	12±0.1	1.5+0.1/-0	2+0/-0.1	3.0+0.2/-0

Symbol	F	W	G	H	L	I
Dimension	31.5+0.2/-0	36+0/-0.2	19±0.35	7±0.35	110±0.7	5±0.35

● QUANTITY OF BULK CASE PACKAGING

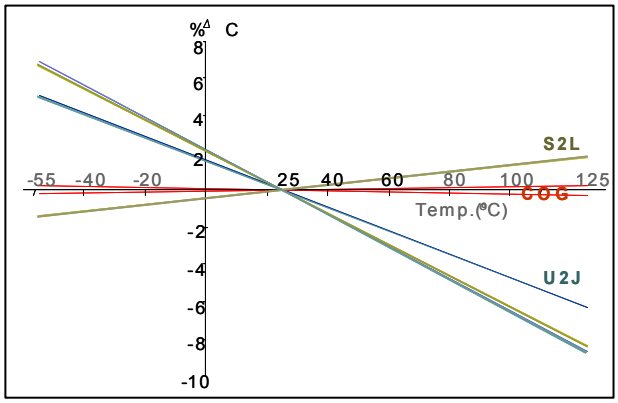
unit : pcs

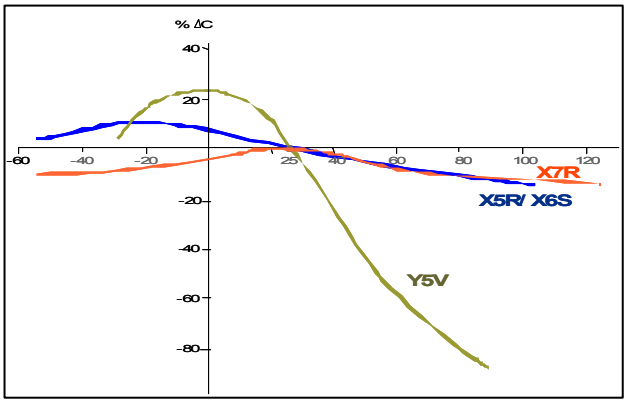
Size	05(0402)	10(0603)	21(0805)	
			T≤0.85mm	T≥1.0mm
Quantity	50,000	10,000 or 15,000	10,000	5,000

APPLICATION MANUAL

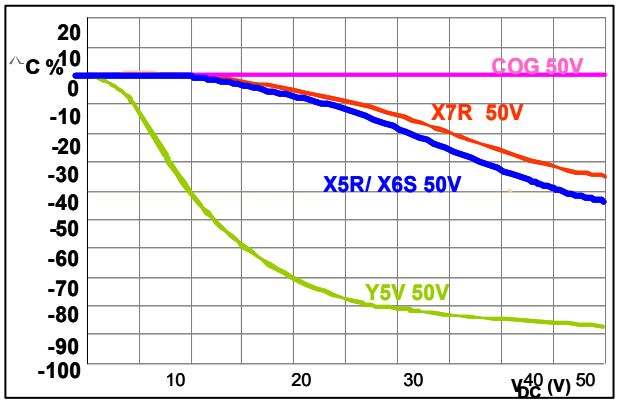
● ELECTRICAL CHARACTERISTICS

▶ CAPACITANCE - TEMPERATURE CHARACTERISTICS

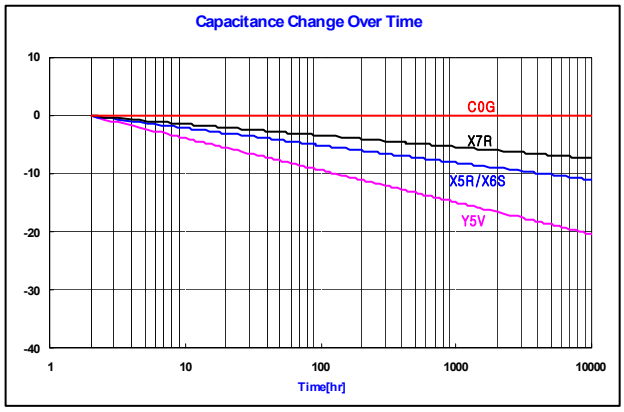




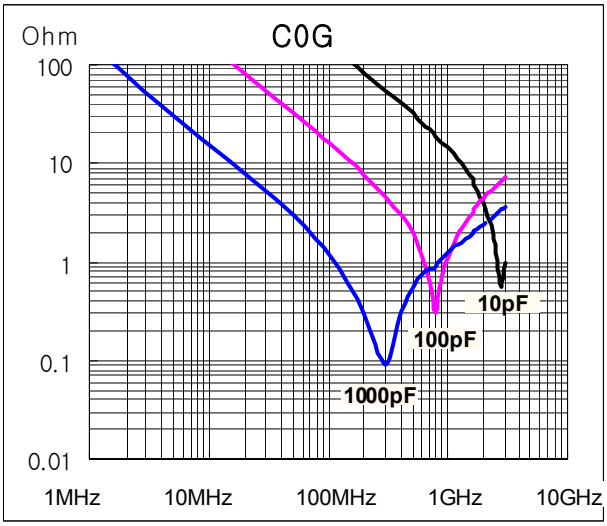
▶ CAPACITANCE - DC VOLTAGE CHARACTERISTICS

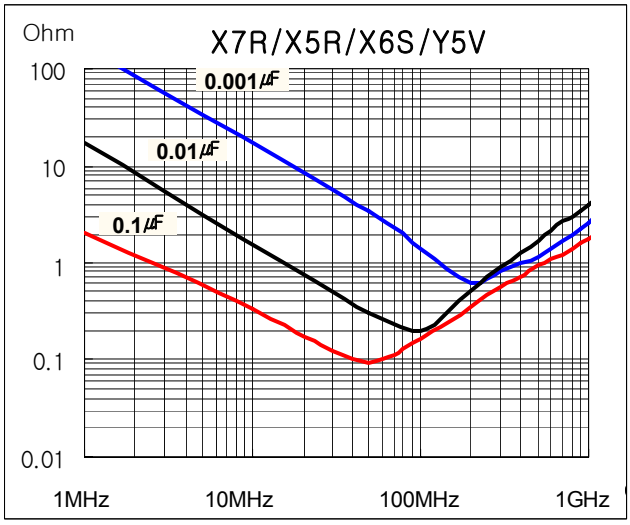


▶ CAPACITANCE CHANGE - AGING



▶ IMPEDANCE - FREQUENCY CHARACTERISTICS





● Storage Condition

▶ Storage Environment

The electrical characteristics of MLCCs were degraded by the environment of high temperature or humidity. Therefore, the MLCCs shall be stored in the ambient temperature and the relative humidity of less than 40℃ and 70%, respectively. Guaranteed storage period is within 6 months from the outgoing date of delivery.

▶ Corrosive Gases

Since the solderability of the end termination in MLCC was degraded by a chemical atmosphere such as chlorine, acid or sulfide gases, MLCCs must be avoid from these gases.

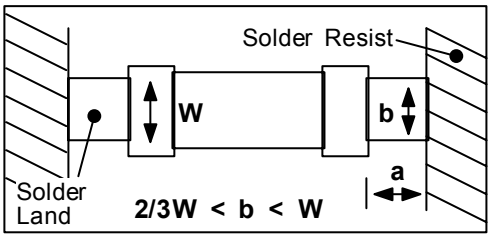
▶ Temperature Fluctuations

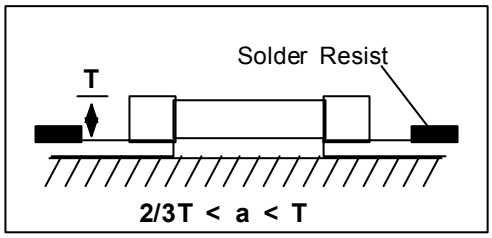
Since dew condensation may occur by the differences in temperature when the MLCCs are taken out of storage, it is important to maintain the temperature-controlled environment.

● Design of Land Pattern

When designing printed circuit boards, the shape and size of the lands must allow for the proper amount of solder on the capacitor. The amount of solder at the end terminations has a direct effect on the crack. The crack in MLCC will be easily occurred by the tensile stress which was due to too much amount of solder. In contrast, if too little solder is applied, the termination strength will be insufficiently. Use the following illustrations as guidelines for proper land design.

Recommendation of Land Shape and Size





● Adhesives

▶ Requirements for Adhesives

They must have enough adhesion, so that, the chips will not fall off or move during the handling of the circuit board.

They must maintain their adhesive strength when exposed to soldering temperature.

They should not spread or run when applied to the circuit board.

They should harden quickly.

They should not corrode the circuit board or chip material.

They should be a good insulator.

They should be non-toxic, and not produce harmful gases, nor be harmful when touched.

▶ Application Method

It is important to use the proper amount of adhesive. Too little and much adhesive will cause poor adhesion and overflow into the land, respectively.

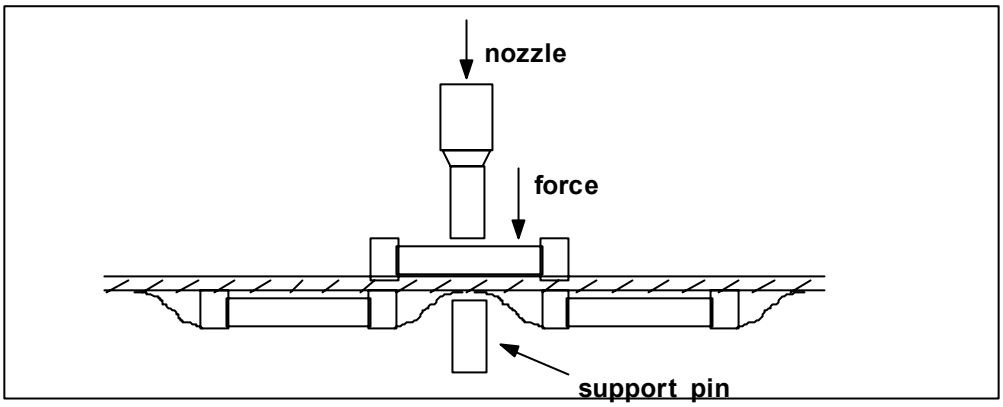
● Mounting

▶ Mounting Head Pressure

Excessive pressure will cause crack to MLCCs. The pressure of nozzle will be 300g maximum during mounting.

▶ Bending Stress

When double-sided circuit boards are used, MLCCs first are mounted and soldered onto one side of the board. When the MLCCs are mounted onto the other side, it is important to support the board as shown in the illustration. If the circuit board is not supported, the crack occur to the ready-installed MLCCs by the bending stress.



● Flux

Although the solderability increased by the highly-activated flux, increase of activity in flux may also degrade the insulation of the chip capacitors. To avoid such degradation, it is recommended that a mildly activated rosin flux(less than 0.2% chlorine) be used.

● Soldering

Since a multilayer ceramic chip capacitor comes into direct contact with melted solder during soldering, it is exposed to potentially mechanical stress caused by the sudden temperature change. The capacitor may also be subject to silver migration, and to contamination by the flux. Because of these factors, soldering technique is critical.

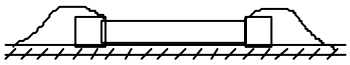
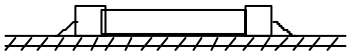
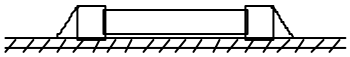
▶ Soldering Methods

Method	Classification	
Reflow soldering	- Overall heating	- Infrared rays - Hot plate - VPS(vapor phase)
	- Local heating	- Air heater - Laser - Light beam
Flow soldering	- Single wave - Double wave	-

* We recommend the reflow soldering method.

● Soldering

▶ Amount of Solder

Too much Solder		Cracks tend to occur due to large stress
Not enough Solder		Weak holding force may cause bad connections or detaching of the capacitor
Good		

▶ Cooling

Natural cooling using air is recommended. If the chips are dipped into solvent for cleaning, the temperature difference(△T) must be less than 100℃

▶ Cleaning

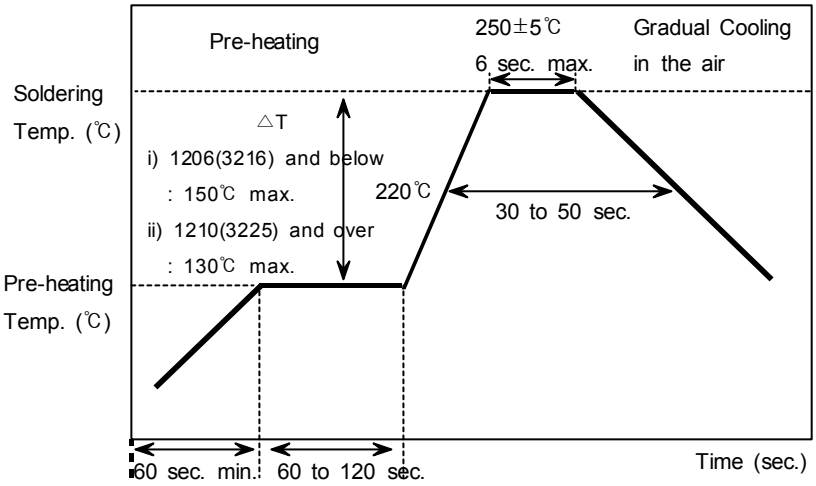
If rosin flux is used, cleaning usually is unnecessary. When strongly activated flux is used, chlorine in the flux may dissolve into some types of cleaning fluids, thereby affecting the chip capacitors. This means that the cleaning fluid must be carefully selected, and should always be new.

▶ Notes for Separating Multiple, Shared PC Boards.

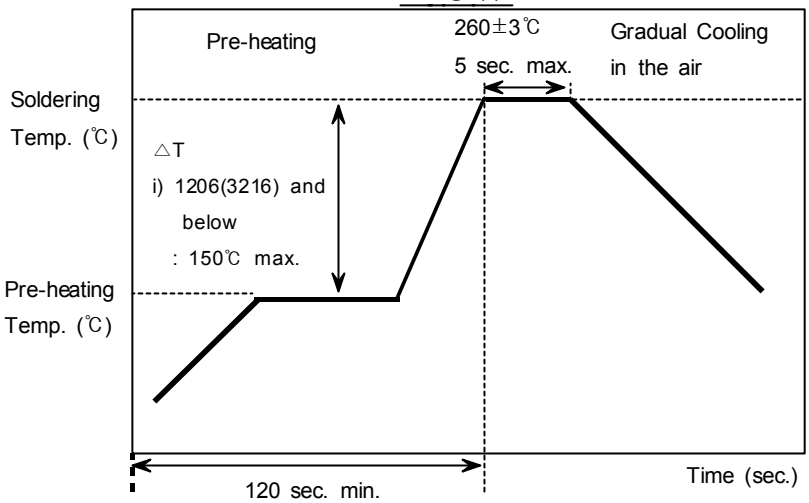
A multi-PC board is separated into many individual circuit boards after soldering has been completed. If the board is bent or distorted at the time of separation, cracks may occur in the chip capacitors. Carefully choose a separation method that minimizes the bending of the circuit board.

▶ Recommended Soldering Profile

Reflow



Flow



Soldering Iron

Variation of Temp.	Soldering Temp (℃)	Pre-heating Time (Sec)	Soldering Time(Sec)	Cooling Time(Sec)
△T≤130	300±10℃max	≥ 60	≤ 4	-

Condition of Iron facilities		
Wattage	Tip Diameter	Soldering Time
20W Max	3㎜ Max	4 Sec Max

*** Caution - Iron Tip Should Not Contact With Ceramic Body Directly.**

Multilayer Ceramic Chip Capacitors

Introduction

Multilayer Surface Mount Ceramic Capacitors are constructed by screen printing alternative layers of internal metallic electrodes onto ceramic dielectric materials and firing into a concrete monolithic body, then completed by application of metal end terminations which are fired to assure permanent bonding with the individual internal electrodes.

Multilayer ceramic capacitors have various features such as large capacitance values in small sizes and excellent high frequency characteristics.

Moreover, chip capacitors can be used on surface mount assembly equipment. Our fully integrated manufacturing and total quality control systems ensure unprecedented high standards of quality and reliability.

Chip Capacitor Selection

Selection of the most suitable capacitor for any application is based on the following:

Dielectric Type

The choice of dielectric is largely determined by the temperature stability required.

COG (NPO)

Capacitance change with temperature is 0-30ppm/°C which is less than -0.3%°C from -55°C to +125°C. Typical capacitance change with life is less than -0.1% for NPOs, one-fifth that shown by most other dielectrics. NPO formulations show no aging characteristics.

X7R/X5R

Its temperature variation of capacitance is within ±15% from -55°C to +125°C (-55°C to +85°C for X5R). The capacitance change is non-linear.

Z5U

Despite their capacitance instability, Z5U formulations are very popular because of their small size, temperature range low ESL, low ESR and excellent frequency response. These features are particularly important for decoupling application where only a minimum capacitance value is required.

Y5V

Y5V formulations are for general purpose use in a limited temperature range. They have a wide temperature characteristic of +22% - 82% capacitance change over the operating temperature range of -30°C to +85°C. Y5Vs high dielectric constant allows the manufacture of very high capacitance values (up to 22MF) in small physical sizes.

Capacitance Value & Tolerance

Determined by circuit requirements. Note that chip prices decrease with lower capacitance value and looser tolerance.

Voltage

Determined by circuit requirements. Units are designed to exceed the withstanding voltage specification, i.e., the user need not incorporate an additional safety margin.

Capacitor Size

Select the smallest unit permitted by the circuit constraints that provides the required capacitance and voltage rating. All Cal-Chip capacitors conform to EIA specifications.

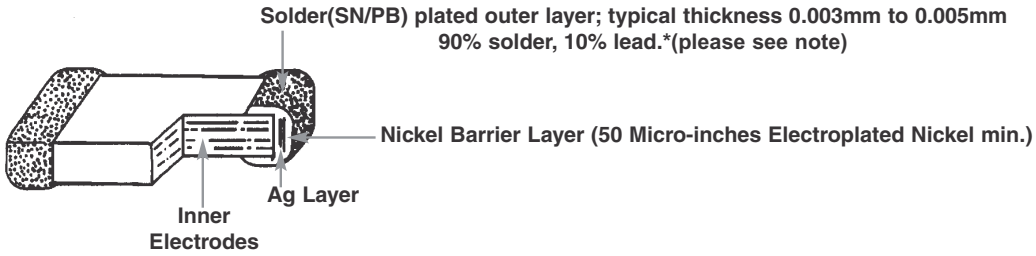
Capacitor Termination

Termination choice is largely determined by the chip attachment method. Silver-palladium is adequate for most applications involving soldering or solder reflow.

Nickel barrier is standard and recommended for units exposed to repeated solder cycles, to minimize leaching of the termination.

Multilayer Ceramic Chip Capacitors

Construction



Example

GMC21	CG	102	J	50	N	T
Size Code	Dielectric	Capacitance (pF)	Capacitance Tolerance (EIA Code)	Voltage	Termination	Packaging Code

CG (COG) (NPO)
X7R or X5R
Z5U
Y5V

Capacitance values are represented in 3 digits, and expressed in pF. The first two digits are significant, and the third is the number of zeros. The letter "R" is used as a decimal point.

0R5	0.5pF
5R0	5pF
100	10pF
101	100pF
102	1000pF
103	.01mF
104	.1mF
105	1.0mF
106	10mF

B	±0.1pf	for ≤10pF
C	±0.25pF	for ≤10pF
D	±0.5pF	for ≤10pF
F	±1%	
G	±2%	
J	±5%	
K	±10%	
M	±20%	
Z	-20%~+80%	

6r3	**6.3 DC**
10	**10 DC**
16	**16 DC**
25	**25 DC**
50	**50 DC**
100	**100 DC**
200	**200 DC**

N	Nickel Barrier

T	Tape and Reel

*Note for Lead Free: Cal-Chip is beginning to phase in Lead-Free products. Upon checking availabilty with the factory, please specify "TLF" at the end of the part number, so the sales team knows you require lead-free product. When you receive the parts you will notice "LF" at the end of the Lot Code indicating the parts are lead-free.

Multilayer Ceramic Chip Capacitors

0201

DIMENSION (MM)

GMC02

L		0.6 ± 0.03						
W		0.3 ± 0.03						
T(MAX)		0.3 ± 0.03						
BW		0.15 ± 0.05						
dielectric		NPO/COG	X5R		X7R			Y5V/Z5U
Rated Voltage		25	6.3	10	6.3	10	16	6.3
Cap. Range								
0.5pF	0R5							
1.0	1R0							
1.2	1R2							
1.5	1R5							
1.8	1R8							
2.2	2R2							
2.7	2R7							
3.3	3R3							
3.9	3R9							
4.7	4R7							
5.6	5R6							
6.8	6R8							
8.2	8R2							
10	100							
12	120							
15	150							
18	180							
22	220							
27	270							
33	330							
39	390							
47	470							
56	560							
68	680							
82	820							
100	101							
120	121							
150	151							
180	181							
220	221							
270	271							
330	331							
390	391							
470	471							
560	561							
680	681							
820	821							
1.0nF	102							
1.2	122							
1.5	152							
1.8	182							
2.2	222							
2.7	272							
3.3	332							
3.9	392							
4.7	472							
5.6	562							
6.8	682							
8.2	822							
10	103							
12	123							
15	153							
18	183							
22	223							
27	273							
33	333							
39	393							
47	473							
56	563							
68	683							
82	823							
100	104							
120	124							
150	154							
180	184							
220	224							
270	274							
330	334							
390	394							
470	474							
560	564							
680	684							
820	824							
1.0uF	105							
2.2	225							

Multilayer Ceramic Chip Capacitors

0402 & 0603

	GMC04															GMC10														
Type	0402															0603														
Length (L1) mm inches	1.0±0.05 0.04±0.002															1.6±0.2 0.063±0.008														
Width (W) mm inches	0.5±0.05 0.02±0.002															0.8±0.2 0.031±0.008														
Thickness (H) mm inches	0.5±0.1 0.02±0.004															0.8±0.2 0.031±0.008														
Termination Band (L2+L3) mm inches	Min 0.1 0.004								Max 0.35 0.014							Min 0.1 0.004									Max 0.4 0.015					
Band Gap (L4)mm (Min) inches	0.3 0.012															0.6 0.015														
Dielectric	COG		X5R			X7R					Y5V & Z5U					COG			X5R			X7R					Y5V & Z5U				
Rated Voltage d.c.	25	50	6.3	10	16	6.3	10	16	25	50	6.3	10	16	25	50	25	50	100	6.3	10	16	6.3	10	16	25	50/100	6.3	10	16	25	50
Cap Range / Code																															
0.5pF / 0R5	■	■														■	■	■													
1.0 / 1R0	■	■														■	■	■													
1.2 / 1R2	■	■														■	■	■													
1.5 / 1R5	■	■														■	■	■													
1.8 / 1R8	■	■														■	■	■													
2.2 / 2R2	■	■														■	■	■													
2.7 / 2R7	■	■														■	■	■													
3.3 / 3R3	■	■														■	■	■													
3.9 / 3R9	■	■														■	■	■													
4.7 / 4R7	■	■														■	■	■													
5.6 / 5R6	■	■														■	■	■													
6.8 / 6R8	■	■														■	■	■													
8.2 / 8R2	■	■														■	■	■													
10 / 100	■	■														■	■	■													
12 / 120	■	■														■	■	■													
15 / 150	■	■														■	■	■													
18 / 180	■	■														■	■	■													
22 / 220	■	■														■	■	■													
27 / 270	■	■														■	■	■													
33 / 330	■	■														■	■	■													
39 / 390	■	■														■	■	■													
47 / 470	■	■														■	■	■													
56 / 560	■	■														■	■	■													
68 / 680	■	■														■	■	■													
82 / 820	■	■														■	■	■													
100 / 101						■	■	■	■	■												■	■	■	■	■					
120 / 121						■	■	■	■	■												■	■	■	■	■					
150 / 151						■	■	■	■	■												■	■	■	■	■					
180 / 181						■	■	■	■	■												■	■	■	■	■					
220 / 221						■	■	■	■	■												■	■	■	■	■					
270 / 271						■	■	■	■	■												■	■	■	■	■					
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390 / 391						■	■	■	■	■												■	■	■	■	■					
470 / 471						■	■	■	■	■												■	■	■	■	■					
560 / 561						■	■	■	■	■												■	■	■	■	■					
680 / 681						■	■	■	■	■												■	■	■	■	■					
820 / 821						■	■	■	■	■												■	■	■	■	■					
1.0nF / 102						■	■	■	■	■						■	■					■	■	■	■	■					
1.2 / 122						■	■	■	■	■						■	■					■	■	■	■	■					
1.5 / 152						■	■	■	■	■						■	■					■	■	■	■	■					
1.8 / 182						■	■	■	■	■						■	■					■	■	■	■	■					
2.2 / 222						■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
2.7 / 272						■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
3.3 / 332						■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
3.9 / 392						■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
4.7 / 472						■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
5.6 / 562						■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
6.8 / 682						■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
8.2 / 822						■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
10 / 103						■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
12 / 123						■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
15 / 153						■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
18 / 183						■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
22 / 223						■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
27 / 273						■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
33 / 333						■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
39 / 393						■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
47 / 473						■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
56 / 563						■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
68 / 683						■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
82 / 823						■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
100 / 104				■	■	■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
150 / 154			■	■	■	■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
220 / 224			■	■	■	■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
270 / 274			■	■	■	■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
330 / 334			■	■	■	■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
390 / 394			■	■	■	■	■	■	■	■	■	■	■	■	■							■	■	■	■	■	■	■	■	■	■
470 / 474			■	■	■	■	■	■	■	■	■	■	■	■	■				■	■	■	■	■	■	■	■	■	■	■	■	■
560 / 564			■	■	■	■	■	■	■	■	■	■	■	■	■				■	■	■	■	■	■	■	■	■	■	■	■	■
680 / 684			■	■	■	■	■	■	■	■	■	■	■	■	■				■	■	■	■	■	■	■	■	■	■	■	■	■
820 / 824			■	■	■	■	■	■	■	■	■	■	■	■	■				■	■	■	■	■	■	■	■	■	■	■	■	■
1.0uF / 105			■	■	■	■	■	■	■	■	■	■	■	■	■				■	■	■	■	■	■	■	■	■	■	■	■	■
2.2 / 225																											■	■	■	■	■
2.7 / 275																											■	■	■	■	■
3.3 / 335																											■	■	■	■	■
3.9 / 395																											■	■	■	■	■
4.7 / 475																											■	■	■	■	■
5.6 / 565																											■	■	■	■	■
6.8 / 685																											■	■	■	■	■
8.2 / 825																											■	■	■	■	■
10 / 106																											■	■	■	■	■
15 / 156																											■	■	■	■	■
22 / 226																											■	■	■	■	■
33 / 336																											■	■	■	■	■
47 / 476																											■	■	■	■	■

Multilayer Ceramic Chip Capacitors

COG/NPO

	GMC21	GMC31	GMC32	GMC40	GMC43	GMC45	GMC55	GMC57
Type	0805	1206	1210	1808	1812	1825	2220	2225
Length mm	2.0±0.3	3.2±0.3	3.2±0.3	4.57±0.25	4.5±0.35	4.5±0.35	5.7±0.4	5.7±0.4
Inches	0.08±0.012	0.125±0.012	0.125±0.012	0.18±0.01	0.18±0.014	0.18±0.014	0.225±0.016	0.225±0.016
Width mm	1.25±0.2	1.6±0.2	2.5±0.3	2.03±0.25	3.2±0.3	6.3±0.4	5.0±0.4	6.3±0.4
Inches	0.05±0.008	0.063±0.008	0.10±0.012	0.08±0.01	0.125±0.012	0.25±0.016	0.197±0.016	0.25±0.016
Thickness mm	1.3	1.6	1.8	2.03	1.8	1.8	1.8	1.8
Inches	0.051	0.063	0.07	0.08	0.07	0.07	0.07	0.07
Termination Band	Min / Max	Min / Max	Min / Max	Min / Max	Min / Max	Min / Max	Min / Max	Min / Max
mm	0.25 / 0.75	0.25 / 0.75	0.25 / 0.75	0.25 / 0.75	0.25 / 0.75	0.25 / 0.75	0.25 / 0.75	0.25 / 0.75
Inches	0.01 / 0.03	0.01 / 0.03	0.01 / 0.03	0.01 / 0.03	0.01 / 0.03	0.01 / 0.03	0.01 / 0.03	0.01 / 0.03
Band Gap mm	0.5	1.4	1.4	2.0	2.2	2.2	2.9	2.9
Inches	0.019	0.055	0.055	0.078	0.087	0.087	0.114	0.114
Rated Voltage d.c.	16 / 25 / 50	25 / 50	16 / 25 / 50/63	50/63	50/63	50/63	50/63	50/63

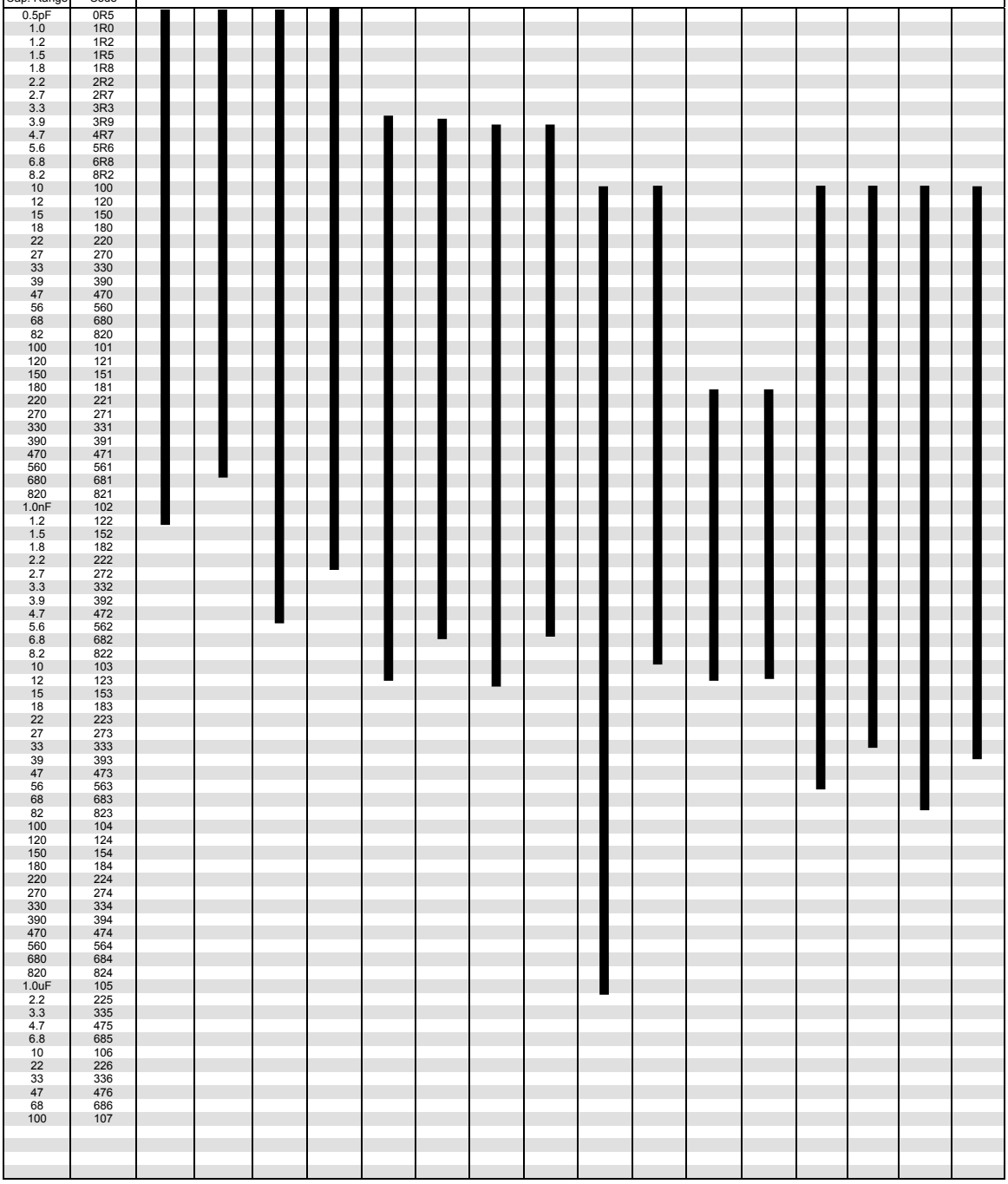
Cap. Range	Code	GMC21	GMC31	GMC32	GMC40	GMC43	GMC45	GMC55	GMC57
0.5pF	0R5	▮	▮						
1.0	1R0	▮	▮						
1.2	1R2	▮	▮						
1.5	1R5	▮	▮						
1.8	1R8	▮	▮						
2.2	2R2	▮	▮						
2.7	2R7	▮	▮						
3.3	3R3	▮	▮	▮					
3.9	3R9	▮	▮	▮					
4.7	4R7	▮	▮	▮					
5.6	5R6	▮	▮	▮					
6.8	6R8	▮	▮	▮					
8.0	8R0	▮	▮	▮					
10	100	▮	▮	▮	▮	▮		▮	▮
12	120	▮	▮	▮	▮	▮		▮	▮
15	150	▮	▮	▮	▮	▮		▮	▮
18	180	▮	▮	▮	▮	▮		▮	▮
22	220	▮	▮	▮	▮	▮		▮	▮
27	270	▮	▮	▮	▮	▮		▮	▮
33	330	▮	▮	▮	▮	▮		▮	▮
39	390	▮	▮	▮	▮	▮		▮	▮
47	470	▮	▮	▮	▮	▮		▮	▮
56	560	▮	▮	▮	▮	▮		▮	▮
68	680	▮	▮	▮	▮	▮		▮	▮
82	820	▮	▮	▮	▮	▮		▮	▮
100	101	▮	▮	▮	▮	▮		▮	▮
120	121	▮	▮	▮	▮	▮		▮	▮
150	151	▮	▮	▮	▮	▮		▮	▮
180	181	▮	▮	▮	▮	▮		▮	▮
220	221	▮	▮	▮	▮	▮		▮	▮
270	271	▮	▮	▮	▮	▮		▮	▮
330	331	▮	▮	▮	▮	▮		▮	▮
390	391	▮	▮	▮	▮	▮		▮	▮
470	471	▮	▮	▮	▮	▮		▮	▮
560	561	▮	▮	▮	▮	▮		▮	▮
680	681	▮	▮	▮	▮	▮		▮	▮
820	821	▮	▮	▮	▮	▮		▮	▮
1.0nF	102	▮	▮	▮	▮	▮		▮	▮
1.2	122	▮	▮	▮	▮	▮		▮	▮
1.5	152	▮	▮	▮	▮	▮		▮	▮
1.8	182	▮	▮	▮	▮	▮		▮	▮
2.2	222	▮	▮	▮	▮	▮		▮	▮
2.7	272	▮	▮	▮	▮	▮		▮	▮
3.3	332	▮	▮	▮	▮	▮		▮	▮
3.9	392	▮	▮	▮	▮	▮		▮	▮
4.7	472	▮	▮	▮	▮	▮		▮	▮
5.6	562	▮	▮	▮	▮	▮		▮	▮
6.8	682	▮	▮	▮	▮	▮		▮	▮
8.2	822	▮	▮	▮	▮	▮		▮	▮
10	103	▮	▮	▮	▮	▮		▮	▮
12	123	▮	▮	▮	▮	▮		▮	▮
15	153	▮	▮	▮	▮	▮		▮	▮
18	183	▮	▮	▮	▮	▮		▮	▮
22	223	▮	▮	▮	▮	▮		▮	▮
27	273	▮	▮	▮	▮	▮		▮	▮
33	333	▮	▮	▮	▮	▮		▮	▮
39	393	▮	▮	▮	▮	▮		▮	▮
47	473	▮	▮	▮	▮	▮		▮	▮
56	563	▮	▮	▮	▮	▮		▮	▮
68	683	▮	▮	▮	▮	▮		▮	▮
82	823	▮	▮	▮	▮	▮		▮	▮
100	104	▮	▮	▮	▮	▮		▮	▮
120	124	▮	▮	▮	▮	▮		▮	▮
150	154	▮	▮	▮	▮	▮		▮	▮
180	184	▮	▮	▮	▮	▮		▮	▮
220	224	▮	▮	▮	▮	▮		▮	▮
270	274	▮	▮	▮	▮	▮		▮	▮
330	334	▮	▮	▮	▮	▮		▮	▮
390	394	▮	▮	▮	▮	▮		▮	▮
470	474	▮	▮	▮	▮	▮		▮	▮
560	564	▮	▮	▮	▮	▮		▮	▮
680	684	▮	▮	▮	▮	▮		▮	▮
820	824	▮	▮	▮	▮	▮		▮	▮
1.0uF	105	▮	▮	▮	▮	▮		▮	▮
2.2	225	▮	▮	▮	▮	▮		▮	▮
3.3	335	▮	▮	▮	▮	▮		▮	▮
4.7	475	▮	▮	▮	▮	▮		▮	▮
6.8	685	▮	▮	▮	▮	▮		▮	▮
10	106	▮	▮	▮	▮	▮		▮	▮
22	226	▮	▮	▮	▮	▮		▮	▮
33	336	▮	▮	▮	▮	▮		▮	▮
47	476	▮	▮	▮	▮	▮		▮	▮
100	107	▮	▮	▮	▮	▮		▮	▮

Multilayer Ceramic Chip Capacitors

COG/NPO (cont.)

	GMC21		GMC31		GMC32		GMC40		GMC43		GMC45		GMC55		GMC57	
Type	0805		1206		1210		1808		1812		1825		2220		2225	
Length mm	2.0±0.3		3.2±0.3		3.2±0.3		4.57±0.25		4.5±0.35		4.5±0.35		5.7±0.4		5.7±0.4	
Inches	0.08±0.012		0.125±0.012		0.125±0.012		0.18±0.01		0.18±0.014		0.18±0.014		0.225±0.016		0.225±0.016	
Width mm	1.25±0.2		1.6±0.2		2.5±0.3		2.03±0.25		3.2±0.3		6.3±0.4		5.0±0.4		6.3±0.4	
Inches	0.05±0.008		0.063±0.008		0.10±0.012		0.08±0.01		0.125±0.012		0.25±0.016		0.197±0.016		0.25±0.016	
Thickness mm	1.3		1.6		1.8		2.03		1.8		1.8		1.8		1.8	
Inches	0.051		0.063		0.07		0.08		0.07		0.07		0.07		0.07	
Termination Band	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
mm	0.25	0.75	0.25	0.75	0.25	0.75	0.25	0.75	0.25	0.75	0.25	0.75	0.25	0.75	0.25	0.75
Inches	0.01	0.03	0.01	0.03	0.01	0.03	0.01	0.03	0.01	0.03	0.01	0.03	0.01	0.03	0.01	0.03
Band Gap mm	0.5		1.4		1.4		2.0		2.2		2.2		2.9		2.9	
Inches	0.019		0.055		0.055		0.078		0.087		0.087		0.114		0.114	
Rated Voltage d.c.	100	200	100	200	100	200	100	200	100	200	100	200	100	200	100	200

Cap. Range	Code
0.5pF	0R5
1.0	1R0
1.2	1R2
1.5	1R5
1.8	1R8
2.2	2R2
2.7	2R7
3.3	3R3
3.9	3R9
4.7	4R7
5.6	5R6
6.8	6R8
8.2	8R2
10	100
12	120
15	150
18	180
22	220
27	270
33	330
39	390
47	470
56	560
68	680
82	820
100	101
120	121
150	151
180	181
220	221
270	271
330	331
390	391
470	471
560	561
680	681
820	821
1.0nF	102
1.2	122
1.5	152
1.8	182
2.2	222
2.7	272
3.3	332
3.9	392
4.7	472
5.6	562
6.8	682
8.2	822
10	103
12	123
15	153
18	183
22	223
27	273
33	333
39	393
47	473
56	563
68	683
82	823
100	104
120	124
150	154
180	184
220	224
270	274
330	334
390	394
470	474
560	564
680	684
820	824
1.0uF	105
2.2	225
3.3	335
4.7	475
6.8	685
10	106
22	226
33	336
47	476
68	686
100	107



Multilayer Ceramic Chip Capacitors

X7R

		GMC21				GMC31				GMC32			GMC40			GMC43			GMC45			GMC55			GMC57		
Type		0805				1206				1210			1808			1812			1825			2220			2225		
Length	mm	2.0±0.3				3.2±0.3				3.2±0.3			4.57±0.25			4.5±0.35			4.5±0.35			5.7±0.4			5.7±0.4		
	Inches	0.08±0.012				0.125±0.012				0.125±0.012			0.18±0.01			0.18±0.014			0.18±0.014			0.225±0.016			0.225±0.016		
Width	mm	1.25±0.2				1.6±0.2				2.5±0.3			2.03±0.25			3.2±0.3			6.3±0.4			5.0±0.4			6.3±0.4		
	Inches	0.05±0.008				0.063±0.008				0.10±0.012			0.08±0.01			0.125±0.012			0.25±0.016			0.197±0.016			0.25±0.016		
Thickness	mm	1.3				1.6				1.8			2.03			1.8			1.8			1.8			1.8		
	Inches	0.051				0.063				0.07			0.08			0.07			0.07			0.07			0.07		
Termination Band		Min		Max		Min		Max		Min		Max	Min		Max	Min		Max	Min		Max	Min		Max	Min		Max
	mm	0.25		0.75		0.25		0.75		0.25		0.75	0.25		0.75	0.25		0.75	0.25		0.75	0.25		0.75	0.25		0.75
	Inches	0.01		0.03		0.01		0.03		0.01		0.03	0.01		0.03	0.01		0.03	0.01		0.03	0.01		0.03	0.01		0.03
Band Gap	mm	0.5				1.4				1.4			2.0			2.2			2.2			2.9			2.9		
	Inches	0.019				0.055				0.055			0.078			0.087			0.087			0.114			0.114		
Rated Voltage d.c.		6.3	10	16	25	6.3	10	16	25	10	16	25	10	16	25	10	16	25	10	16	25	10	16	25	10	16	25
Cap. Range	Code																										
0.5pF	0R5																										
1.0	1R0																										
1.2	1R2																										
1.5	1R5																										
1.8	1R8																										
2.2	2R2																										
2.7	2R7																										
3.3	3R3																										
3.9	3R9																										
4.7	4R7																										
5.6	5R6																										
6.8	6R8																										
8.2	8R2																										
10	100																										
12	120																										
15	150																										
18	180																										
22	220																										
27	270																										
33	330																										
39	390																										
47	470																										
56	560																										
68	680																										
82	820																										
100	101																										
120	121																										
150	151																										
180	181																										
220	221																										
270	271																										
330	331																										
390	391																										
470	471																										
560	561																										
680	681																										
820	821																										
1.0nF	102																										
1.2	122																										
1.5	152																										
1.8	182																										
2.2	222																										
2.7	272																										
3.3	332																										
3.9	392																										
4.7	472																										
5.6	562																										
6.8	682																										
8.2	822																										
10	103																										
12	123																										
15	153																										
18	183																										
22	223																										
27	273																										
33	333																										
39	393																										
47	473																										
56	563																										
68	683																										
82	823																										
100	104																										
120	124																										
150	154																										
180	184																										
220	224																										
270	274																										
330	334																										
390	394																										
470	474																										
560	564																										
680	684																										
820	824																										
1.0uF	105																										
2.2	225																										
3.3	335																										
4.7	475																										
6.8	685																										
10	106																										
22	226																										
33	336																										
47	476																										
68	686																										
100	107																										

Multilayer Ceramic Chip Capacitors

X7R (cont)

		GMC21			GMC31			GMC32			GMC40			GMC43			GMC45			GMC55			GMC57		
Type		0805			1206			1210			1808			1812			1825			2220			2225		
Length	mm	2.0±0.3			3.2±0.3			3.2±0.3			4.57±0.25			4.5±0.35			4.5±0.35			5.7±0.4			5.7±0.4		
	Inches	0.08±0.012			0.125±0.012			0.125±0.012			0.18±0.01			0.18±0.014			0.18±0.014			0.225±0.016			0.225±0.016		
Width	mm	1.25±0.2			1.6±0.2			2.5±0.3			2.03±0.25			3.2±0.3			6.3±0.4			5.0±0.4			6.3±0.4		
	Inches	0.05±0.008			0.063±0.008			0.10±0.012			0.08±0.01			0.125±0.012			0.25±0.016			0.197±0.016			0.25±0.016		
Thickness	mm	1.3			1.6			1.8			2.03			1.8			1.8			1.8			1.8		
	Inches	0.051			0.063			0.07			0.08			0.07			0.07			0.07			0.07		
Termination Band		Min		Max	Min		Max	Min		Max	Min		Max	Min		Max	Min		Max	Min		Max	Min		Max
	mm	0.25		0.75	0.25		0.75	0.25		0.75	0.25		0.75	0.25		0.75	0.25		0.75	0.25		0.75	0.25		0.75
	Inches	0.01		0.03	0.01		0.03	0.01		0.03	0.01		0.03	0.01		0.03	0.01		0.03	0.01		0.03	0.01		0.03
Band Gap	mm	0.5			1.4			1.4			2.0			2.2			2.2			2.9			2.9		
	Inches	0.019			0.055			0.055			0.078			0.087			0.087			0.114			0.114		
Rated Voltage d.c.		50	100	200	50	100	200	50	100	200	50	100	200	50	100	200	50	100	200	50	100	200	50	100	200
Cap. Range	Code																								
0.5pF	0R5																								
1.0	1R0																								
1.2	1R2																								
1.5	1R5																								
1.8	1R8																								
2.2	2R2																								
2.7	2R7																								
3.3	3R3																								
3.9	3R9																								
4.7	4R7																								
5.6	5R6																								
6.8	6R8																								
8.2	8R2																								
10	100																								
12	120																								
15	150																								
18	180																								
22	220																								
27	270																								
33	330																								
39	390																								
47	470																								
56	560																								
68	680																								
82	820																								
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820	821																								
1.0nF	102																								
1.2	122																								
1.5	152																								
1.8	182																								
2.2	222																								
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270	274																								
330	334																								
390	394																								
470	474																								
560	564																								
680	684																								
820	824																								
1.0uF	105																								
2.2	225																								
3.3	335																								
4.7	475																								
6.8	685																								
10	106																								
22	226																								

Multilayer Ceramic Chip Capacitors

X5R

	GMC21	GMC31	GMC32	GMC40	GMC43	GMC45	GMC55	GMC57
Type	0805	1206	1210	1808	1812	1825	2220	2225
Length mm	2.0±0.3	3.2±0.3	3.2±0.3	4.57±0.25	4.5±0.35	4.5±0.35	5.7±0.4	5.7±0.4
Inches	0.08±0.012	0.125±0.012	0.125±0.012	0.18±0.01	0.18±0.014	0.18±0.014	0.225±0.016	0.225±0.016
Width mm	1.25±0.2	1.6±0.2	2.5±0.3	2.03±0.25	3.2±0.3	6.3±0.4	5.0±0.4	6.3±0.4
Inches	0.05±0.008	0.063±0.008	0.10±0.012	0.08±0.01	0.125±0.012	0.25±0.016	0.197±0.016	0.25±0.016
Thickness mm	1.3	1.6	1.8	2.03	1.8	1.8	1.8	1.8
Inches	0.051	0.063	0.07	0.08	0.07	0.07	0.07	0.07
Termination Band	Min / Max	Min / Max	Min / Max	Min / Max	Min / Max	Min / Max	Min / Max	Min / Max
mm	0.25 / 0.75	0.25 / 0.75	0.25 / 0.75	0.25 / 0.75	0.25 / 0.75	0.25 / 0.75	0.25 / 0.75	0.25 / 0.75
Inches	0.01 / 0.03	0.01 / 0.03	0.01 / 0.03	0.01 / 0.03	0.01 / 0.03	0.01 / 0.03	0.01 / 0.03	0.01 / 0.03
Band Gap mm	0.5	1.4	1.4	2.0	2.2	2.2	2.9	2.9
Inches	0.019	0.055	0.055	0.078	0.087	0.087	0.114	0.114
Rated Voltage d.c.	6.3 / 10 / 16	6.3 / 10 / 16 / 25	6.3 / 10 / 16/25	N/A	6.3 / 10 / 16	N/A	N/A	N/A

Cap. Range	Code	GMC21			GMC31				GMC32			GMC40	GMC43			GMC45	GMC55	GMC57
0.5pF	0R5																	
1.0	1R0																	
1.2	1R2																	
1.5	1R5																	
1.8	1R8																	
2.2	2R2																	
2.7	2R7																	
3.3	3R3																	
3.9	3R9																	
4.7	4R7																	
5.6	5R6																	
6.8	6R8																	
8.2	8R2																	
10	100																	
12	120																	
15	150																	
18	180																	
22	220																	
27	270																	
33	330																	
39	390																	
47	470																	
56	560																	
68	680																	
82	820																	
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820	821																	
1.0nF	102																	
1.2	122																	
1.5	152																	
1.8	182																	
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3.3	335																	
4.7	475																	
6.8	685																	
10	106																	
22	226																	
33	336																	
47	476																	
100	107																	

Multilayer Ceramic Chip Capacitors

Y5V/Z5U

		GMC21				GMC31				GMC32				GMC40				GMC43				GMC45				GMC55				GMC57			
Type		0805				1206				1210				1808				1812				1825				2220				2225			
Length	mm	2.0±0.3				3.2±0.3				3.2±0.3				4.57±0.25				4.5±0.35				4.5±0.35				5.7±0.4				5.7±0.4			
	Inches	0.08±0.012				0.125±0.012				0.125±0.012				0.18±0.01				0.18±0.014				0.18±0.014				0.225±0.016				0.225±0.016			
Width	mm	1.25±0.2				1.6±0.2				2.5±0.3				2.03±0.25				3.2±0.3				6.3±0.4				5.0±0.4				6.3±0.4			
	Inches	0.05±0.008				0.063±0.008				0.10±0.012				0.08±0.01				0.125±0.012				0.25±0.016				0.197±0.016				0.25±0.016			
Thickness	mm	1.3				1.6				1.8				2.03				1.8				1.8				1.8				1.8			
	Inches	0.051				0.063				0.07				0.08				0.07				0.07				0.07				0.07			
Termination Band		Min		Max		Min		Max		Min		Max		Min		Max		Min		Max		Min		Max		Min		Max		Min		Max	
	mm	0.25		0.75		0.25		0.75		0.25		0.75		0.25		0.75		0.25		0.75		0.25		0.75		0.25		0.75		0.25		0.75	
	Inches	0.01		0.03		0.01		0.03		0.01		0.03		0.01		0.03		0.01		0.03		0.01		0.03		0.01		0.03		0.01		0.03	
Band Gap	mm	0.5				1.4				1.4				2.0				2.2				2.2				2.9				2.9			
	Inches	0.019				0.055				0.055				0.078				0.087				0.087				0.114				0.114			
Rated Voltage d.c.		6.3	10	16	25	6.3	10	16	25	6.3	10	16	25/35	6.3	10	16	25	6.3	10	16	25	6.3	10	16	25	6.3	10	16	25	6.3	10	16	25
Cap. Range	Code																																
0.5pF	0R5																																
1.0	1R0																																
1.2	1R2																																
1.5	1R5																																
1.8	1R8																																
2.2	2R2																																
2.7	2R7																																
3.3	3R3																																
3.9	3R9																																
4.7	4R7																																
5.6	5R6																																
6.8	6R8																																
8.2	8R2																																
10	100																																
12	120																																
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-The use of Nickle(Ni) as material for both the internal & external electrodes improves the solderability & heat resistance characteristics. This almost completely eliminates migration & raises the level of reliability significantly.

-Low equivalent series resistance (ESR) provides excellent noise absorption characteristics.

-Compared to tantalum or aluminum electrolytic capacitors these ceramic capacitors offer a number of excellent features, including: Higher permissible ripple current values, Smaller case sizes relative to rated voltage, and Improved reliability due to higher insulation resistance and breakdown voltage.

Multilayer Ceramic Chip Capacitors

Y5V/Z5U (cont)

		GMC21			GMC31			GMC32			GMC40			GMC43			GMC45			GMC55			GMC57		
Type		0805			1206			1210			1808			1812			1825			2220			2225		
Length	mm	2.0±0.3			3.2±0.3			3.2±0.3			4.57±0.25			4.5±0.35			4.5±0.35			5.7±0.4			5.7±0.4		
	Inches	0.08±0.012			0.125±0.012			0.125±0.012			0.18±0.01			0.18±0.014			0.18±0.014			0.225±0.016			0.225±0.016		
Width	mm	1.25±0.2			1.6±0.2			2.5±0.3			2.03±0.25			3.2±0.3			6.3±0.4			5.0±0.4			6.3±0.4		
	Inches	0.05±0.008			0.063±0.008			0.10±0.012			0.08±0.01			0.125±0.012			0.25±0.016			0.197±0.016			0.25±0.016		
Thickness	mm	1.3			1.6			1.8			2.03			1.8			1.8			1.8			1.8		
	Inches	0.051			0.063			0.07			0.08			0.07			0.07			0.07			0.07		
Termination Band		Min	Max		Min	Max		Min	Max		Min	Max		Min	Max		Min	Max		Min	Max		Min	Max	
	mm	0.25	0.75		0.25	0.75		0.25	0.75		0.25	0.75		0.25	0.75		0.25	0.75		0.25	0.75		0.25	0.75	
	Inches	0.01	0.03		0.01	0.03		0.01	0.03		0.01	0.03		0.01	0.03		0.01	0.03		0.01	0.03		0.01	0.03	
Band Gap	mm	0.5			1.4			1.4			2.0			2.2			2.2			2.9			2.9		
	Inches	0.019			0.055			0.055			0.078			0.087			0.087			0.114			0.114		
Rated Voltage d.c.		50	100	200	50	100	200	50	100	200	50	100	200	50	100	200	50	100	200	50	100	200	50	100	200
Cap. Range	Code																								
0.5pF	0R5																								
1.0	1R0																								
1.2	1R2																								
1.5	1R5																								
1.8	1R8																								
2.2	2R2																								
2.7	2R7																								
3.3	3R3																								
3.9	3R9																								
4.7	4R7																								
5.6	5R6																								
6.8	6R8																								
8.2	8R2																								
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-Low equivalent series resistance (ESR) provides excellent noise absorption characteristics.

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COG Dielectric

Ultra stable class I dielectric: linear temperature coefficient, low loss, negligible change of electrical properties with time, voltage and frequency.

Operating Temperature Range	Temperature Coefficient	Temperature Voltage Coefficient (ΔcMax @ VDCW)	Dissipation Factor	Insulation Resistance	Dielectric withstanding Voltage	Aging Rate	Test Parameters
-55°C to +125°C	0±30ppm°C	0±30ppm/°C	0.1% Max, 0.02% Typical	• 25°C, VDCW:: >100GΩF or 1000ΩF, whichever is less •125°C, VDCW: >10GΩF or 100ΩF whichever is less	3 X VDCW	0% per decade hour	• C≤1000pF f=1MHz V=1.0Vrms ±0.2Vrms T=25°C • C>1000pF f=1KHz V=1.0Vrms ±0.2Vrms T=25°C

X7R Dielectric

Stable class II dielectric (EIA X7R)

Operating Temperature Range	Temperature Coefficient	Temperature Voltage Coefficient (ΔcMax @ VDCW)	Dissipation Factor	Insulation Resistance	Dielectric withstanding Voltage	Aging Rate	Test Parameters
-55°C to +125°C	±15%	X7R Not Applicable	2.5% Max, 1.8% Typical	• 25°C, VDCW:: >100GΩFor 1000ΩF, whichever is less •125°C, VDCW: >10GΩF or 100ΩF whichever is less	2.5 X VDCW	<2% per decade hour	1KHz, 1.0Vrms ±0.2Vrms 25°C values > or = to 10uF 1.0Vrms 120Hz

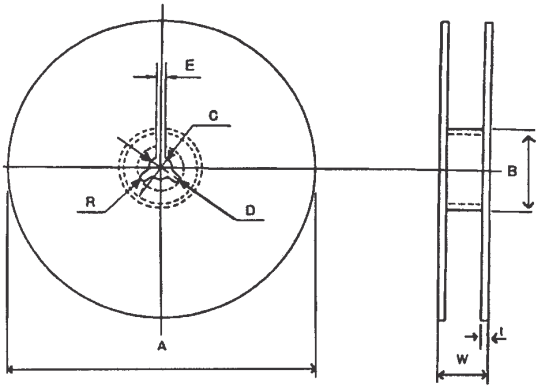
Multilayer Ceramic Chip Capacitors - Z5U (Y5V) Dielectric

High capacitance per unit volume: general purpose product

Operating Temperature Range	Temperature Coefficient	Dissipation Factor	Insulation Resistance	Dielectric withstanding Voltage	Aging Rate	Test Parameters
-30°C to +85°C	+22% -82%	3.0% Max, 2.0% Typical	10GΩ or 100ΩF whichever is less, 25°C, VDCW	2.5 X VDCW	3.0% per decade hour	1KHz, 1Vrms 25°C values > or = to 10uF 1.0Vrms 120Hz

Packaging (Taping)

(Reel Type-Size)



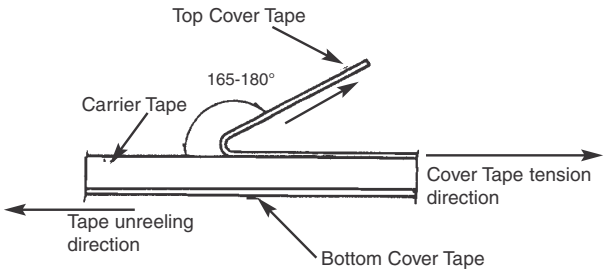
Standard Reel Unit:mm

A	B	C	D	E	W	t	R
ø178 ±2.0	ø50 min.	ø13.0 ±0.5	ø21.0 ±0.8	2.0 ±0.5	14.9 ±1.5	0.8 ±0.2	1.0

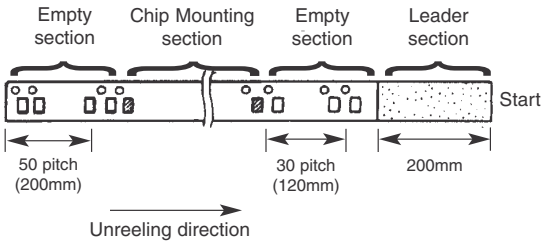
10000 units per reel OPTIONAL Unit:mm

A	B	C	D	E	W	t	R
ø250 ±2.0	ø50 min.	ø13.0 ±0.5	ø21.0 ±0.8	2.0 ±0.5	10.0 ±1.5	0.8 ±0.2	1.0

Carrier Tape (Standard)



- To peel off the cover tape by the method shown in the right figure apply a peel-off force of 20 gf - 60 gf (card board); 35 gf - 75 gf (plastic tape).
- The cover tape should not touch the top or bottom of the chip.
- If the cover tape has been peeled off it may be difficult to remove the chip due to punch-hole clearance, dirt, and debris. Make sure therefore that no paper waste will adhere to and block the absorption nozzle.
- If the cover tape has been peeled off from the top, stick it back on with a suitable adhesive.
- Follow the illustration for the start and end of the winding operation.



- **Cardboard carrier tape for 0402, 0603 type and 0805/1206 type**

Unit: mm

Type A	B W	F E	P_1 P_2	P_0 D_0	t_1 t_2							Mounting Hole	Quantity per Reel
0402	0.7±0.2	1.3±0.2				2.0±0.05							10000
0603	1.1±0.2	1.9±0.2										Angular Punch Hole	4000
0805	1.65±0.2	2.4±0.2	8.0±0.3	3.5±0.05	1.75±0.1	4.0±0.1	2.0±0.05	4.0±0.1	ø1.5$^{+0.1}_{-0}$	1.1 max	1.4 max		4000 to 5000*
1206	2.0±0.2	3.6±0.2											4000 to 5000*

**Dependent on chip thickness*

- **Embossed plastic carrier tape for 0805/1206 type and 1210 type**

Unit: mm

Type	A	B	W	F	E	P_1	P_2	P_0	D_0	t_1	t_2	Mounting Hole	Quantity per Reel
0805	1.45±0.2	2.3±0.2										Angular Embossed Hole	2000 to 5000*
1206	2.0±0.2	3.6±0.2	8.0±0.3	3.5±0.05	1.75±0.1	4.0±0.1	2.0±0.05	4.0±0.1	ø1.5$^{+0.1}_{-0}$	0.6 max	2.5 max		2000 to 5000*
1210	2.9±0.2	3.6±0.2											2000 to 4000*

**Dependent on chip thickness*

- **Embossed plastic carrier tape for 1812, 1825, 2220 and 2225 type**

Unit: mm

Type	A	B	W	F	E	P_1	P_2	P_0	D_0	t_1	t_2	Mounting Hole	Quantity per Reel
1812	3.6±0.2	4.9±0.2										Angular Embossed Hole	1000
1825	6.8±0.3	4.9±0.2	12.0±0.3	5.5±0.05	1.75±0.1	8.0±0.1	2.0±0.05	4.0±0.1	ø1.5±0.1	0.6 max.	6.5 max.		1000
2220	5.5±0.3	6.2±0.3											1000
2225	6.8±0.3	6.2±0.3											1000

**Dependent on chip thickness*

Tape and Reel Packing Quantities

Chip Size	178 mm (7") Reel	330 mm (13") Reel
0402	10,000	N/A
0603	4,000	16,000
0805	4,000	12,000
1206	4,000	15,000
1210	2,000 , 4,000	8,000
1812	1,000	4,000
1825	1,000	4,000
2220	1,000	4,000
2225	1,000	4,000

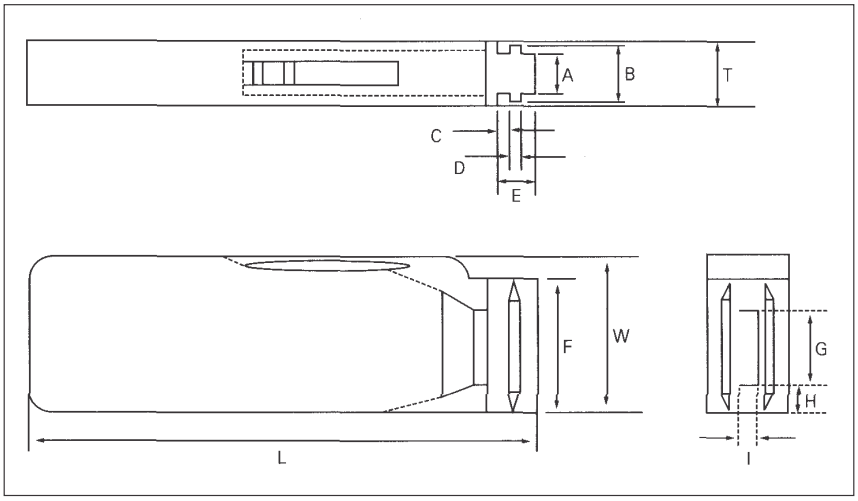
The tape and reel packing quantities apply to voltages up to 200V rating only.

The 0402 and 0603 size chips have similar width and thickness dimensions.

Bulk Case

- Bulk case packaging can reduce the stock space and transportation costs.
- The bulk feeding system can increase the productivity.
- It can eliminate the components loss.

• Structure and Dimension



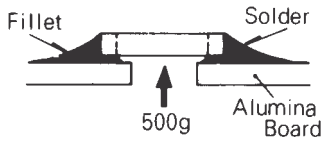
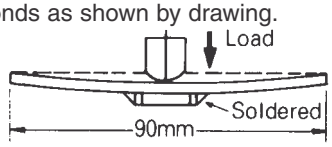
Symbol	A	B	T	C	D	E
Dimension	6.8±0.1	8.8±0.1	12±0.1	$1.5^{+0.1}_{-0}$	$2^{+0}_{-0.1}$	4.7±0.1

Symbol	F	W	G	H	L	I
Dimension	$31.5^{+0.2}_{-0}$	$36^{+0.}_{-0.2}$	19±0.35	7±0.35	110±0.7	5±0.35

• Quantity

Size	04(0402)	10(0603)	21(0805)	
			T≤0.85mm	T≥1.0mm
Quantity	80,000	15,000	10,000	5,000

RELIABILITY AND TEST CONDITIONS

Item		Specification	Test Method
Capacitance		Within tolerance shown by part number code	• Class (I) C<1000pF:1MHz±10%, 0.5 to 5Vrms C≥1000pF:1KHz±10%, 1.0±0.2Vrms • Class (II) 1KHz±10%, 1.0±0.2Vrms values > or = to 10uF 1.0Vrms 120Hz
Dissipation Factor (tanδ or Q)		• Class (I) C<30pF:Q≥400+20xC C≥30pF:Q≥1000 • Class (II) X7R:DF≤2.5% Y5V/Z5U:DF≤3.0%	
Insulation Resistance(IR)		NPO–XR7: C≤50,000pF: IR≥100GΩ C>50,000pF: IR≥500MΩ. Per Uf. Y5V/Z5U: IR≥10GΩ	Apply rated voltage for 60 seconds at room temperature and normal humidity. (70% RH max)
Dielectric Withstanding Voltage		There shall be no evidence of damage or flash over during the test	Apply 3 x rated voltage (Class I) or 2.5 x rated voltage (Class II) to both terminations for 5 seconds. Charge and discharge current are less than 50mA.
Termination Adherence		No mechanical damage	 Care shall be taken to avoid thermal shock. 500g of steady pull is applied in direction of arrow for 1 minute.
Bend Strength		No mechanical damage	After soldering capacitor on the glass-epoxy PWB, 2 mm of vending shall be applied for 10 seconds as shown by drawing. 
Life Test (High Temperature Loading Test)	ΔC	• Class (I) No more than ±3% or ±0.3pF whichever is less • Class (II) X7R:±10% max Y5V/Z5U:±30% max	Applied 2 x rated voltage at maximum operating temperature for 1000 hours. The surge current shall not exceed 50mA after above testing condition, test samples shall be kept in room temperature for 24 hours (Class I) or 48 hours (Class II), and then shall be measured.
	Q or DF	• Class (I) C<10pF:Q>200+10xC 10≤C<30pF:Q≥275+5/2xC C≥30pF:Q≥350 • Class (II) X7R:DF≤5.0% Y5V/Z5U:DF≤7.5%	
	IR	1000MΩ or 50ΩF, min whichever is less	

Reliability and Test Conditions

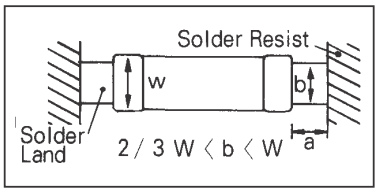
Item		Specification	Test Method
Moisture Test	ΔC	• Class (I) No more than ±5% or ±0.5pF whichever is larger • Class (II) X7R:±10% Y5V/Z5U:±30%	The capacitors shall be subjected to 40°C, 90-95%RH for 500 hours. After above testing condition, samples shall be kept in room temperature for 24 hours (Class I) or 48 hours (Class II), and then shall be measured.
	Q or DF	• Class (I) C<10pF:Q>200+10xC 10≤C<30pF:Q≥275+5/2xC C≥30pF:Q≥350 • Class (II) X7R:DF≤5.0% Y5V/Z5U:DF≤7.5%	
	IR	1000MΩ or 50ΩF, whichever is less	
Moisture Resistance Test	ΔC	• Class (I) No more than ±7.5% or ±0.75pF whichever is larger • Class (II) X7R:±10% Y5V/Z5U:±30%	Apply rated voltage at 40°C, 90-95%RH for 500 hours. The surge current shall not exceed 50mA. After testing with above condition, samples shall be kept in room temperature for 24 hours (Class I) or 48 hours (Class II), and then shall be measured.
	Q or DF	• Class (I) C<30pF:Q>100+100/3xC C≥30pF:Q≥200 • Class (II) X7R:DF≤5.0% Y5V/Z5U:DF≤7.5%	
	IR	500MΩ or 25ΩF, min whichever is less	
Temperature Cycle	ΔC	• Class (I) No more than ±2.5% or ±0.25pF whichever is larger • Class (II) X7R:±5% Y5V/Z5U:±20%	Perform 5 cycles as follow: 1. Room temperature. Dwell for 15 minutes. 2. Minimum operating temperature, dwell for 30 minutes. 3. Room temperature, dwell for 30 minutes. 4. Maximum operating temperature, dwell for 30 minutes. After above testing condition, samples shall be kept in room temperature for 24 hours (Class I) or 48 hours (Class II), and then shall be measured.
	Q or DF	To satisfy the specified initial value.	
	IR	To satisfy the specified initial value.	
Solderability		Termination area shall be at least 95% covered with a new solder coating. There shall be no crack and ceramic exposure of terminated surface by melting.	The capacitors are completely immersed during 4±0.5 seconds in the molten solder with a temperature of 230±5˚C *Solder: Sn 63.
Resistance to Solder Heat Test	ΔC	• Class (I) No more than ±2.5% or ±0.25pF whichever is larger • Class (II) X7R:±5% Y5V/Z5U:±20%	Immerse into molten solder at 270±5˚C for 3±0.5 seconds. Preheat before immersion. 1. 80~100˚C for 2 minutes. 2. 150~180˚C for 2 minutes. 3. 270±5˚C for 3±0.5 seconds. The capacitance measurement shall be made after sample keeping at room temperature for 24 hours.
	Q or DF	To satisfy the specified initial value.	
	IR	To satisfy the specified initial value.	

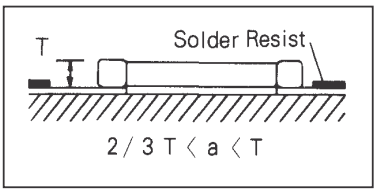
Application Manual For Surface Mounting

1. **Temperature / Humidity Control**
Since dew condensation may occur by the differences in temperature when the products are take out of storage, it is important to maintain a temperature-controlled environment.

2. **Design of Solder Land Pattern**
When designing printed circuit boards, the shape and size of the solder lands must allow for the proper amount of solder on the capacitor. The amount of solder at the end terminations has a direct effect on the probability that the chip will crack. The greater amount of solder, the larger amount of stress on the chip, and the more likely that it will break. Use the following illustrations as guidelines for proper solder land design.

Recommendation of solder land shape and size.

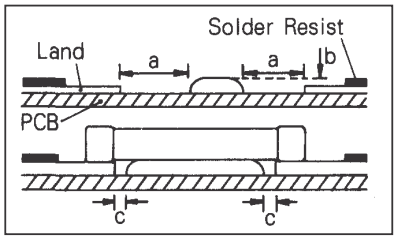




3. **Adhesives**
MLCCs generally require the use of an adhesive to adhere the chips to the circuit board prior to wave soldering.

3-1. **Requirements for Adhesives**
- They must have enough adhesion so that the chips will not fall off or move during the handling of the circuit board.
- They must maintain their adhesive strength when exposed to soldering temperatures.
- They should not spread or run when applied to the circuit board.
- They should have a long pot life.
- They should harden quickly.
- They should not corrode the circuit board or chip material.
- They should be a good insulator.
- They should be non-toxic, and not produce harmful gases, nor be harmful when touched.

3-2. **Application Method**
It is important to use the proper amount of adhesive. Too little will cause poor adhesion to the circuit board, and too much may strain the conductor pattern, thereby causing defective soldering. The following illustrations show the proper quantity of adhesive.



(Unit: mm)

Type	21	31
a	0.2 min	0.2 min
b	70~100μm	70~100μm
c	>0	>0

3-3. **Adhesive Hardening Characteristics**
To prevent oxidation of the terminations, the adhesive must harden at 160°C or less, within 2 minutes or less.

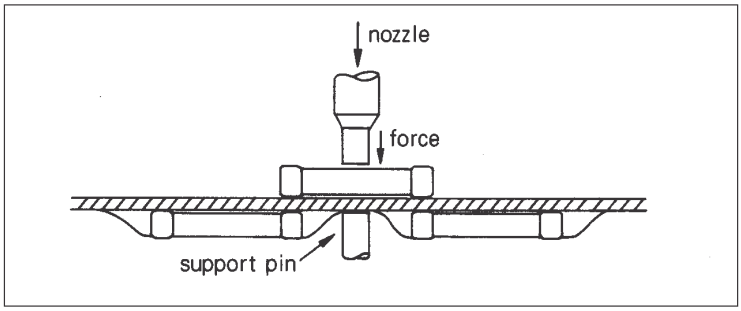
4. **Mounting**

4-1. **Mounting Head Pressure**

Excessive pressure will cause chip capacitors to crack. The pressure between nozzle and chip capacitor will be 300g maximum during mounting.

4-2. **Bending Stress**

Bending of printed circuit board by mounting head when double-sided circuit boards are used, chip capacitors first are mounted and soldered onto one side of the board. When the capacitors are mounted onto the other side, it is important to support the board as shown in the illustration. If the circuit board is not supported, it may bend, causing the already installed capacitors to crack.



5. **Flux**

Although highly activated flux gives better solderability, substances which increase activity may also degrade the insulation of the chip capacitors. To avoid such degradation, it is recommended that a mildly activated rosin flux (less than 0.2% chlorine) be used.

6. **Soldering**

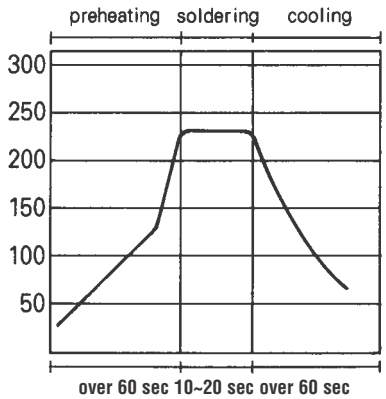
Since a multilayer chip ceramic capacitor comes into direct contact with melted solder during soldering, it is exposed to potentially damaging mechanical stress caused by the sudden temperature change. The capacitor may also be subject to silver migration, and to contamination by the flux. Because of these factors, soldering technique is critical.

6-1. **Soldering Methods**

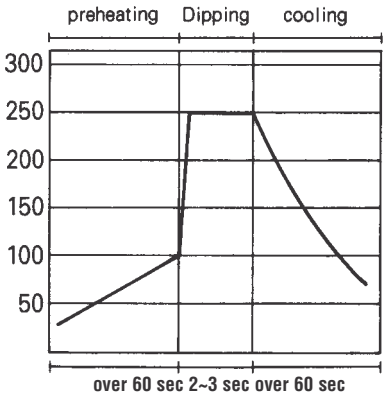
Method	Classification	
Reflow Soldering	**Mass reflow**	**• IR/Convection • VPS (Vapor phase)**
	Selective reflow	**• Hot air/gas • Laser**
Flow Soldering	**Dual Wave**	

6-2. **Soldering Profile**

To avoid the crack problem by sudden temperature change, follow the temperature profile in the adjacent graph.



Reflow Soldering

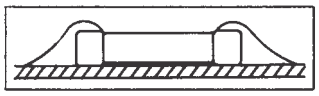
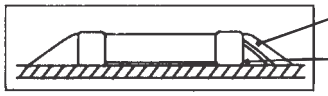
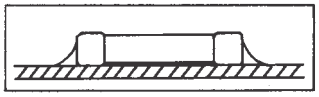


Flow Soldering

6-3. **Manual Soldering**

Manual Soldering can pose a great risk of creating thermal cracks in chip capacitors. The hot soldering iron tip comes into direct contact with the end terminations, and operator's carelessness may cause the tip of the soldering iron to come into direct contact with the ceramic body of the capacitor. Therefore the soldering iron must be handled carefully, and close attention must be paid to the selection of the soldering iron tip and to temperature control of the tip.

6-4. **Amount of Solder**

Too much solder		Cracks tend to occur due to large stress
Amount of solder is adequate		Maximum amount of solder Minimum amount of solder
Not enough solder		Weak holding force may cause bad connections or detaching of the capacitor

6-5. **Cooling**

Natural cooling using air is recommended. If the chips are dipped into solvent for cleaning, the temperature difference (ΔT) must be less than 100°C.

6-6. **Cleaning**

If rosin flux is used, cleaning usually is unnecessary. When strongly activated flux is used, chlorine in the flux may dissolve into some types of cleaning fluids, thereby affecting the chip capacitors. This means that the cleaning fluid must be carefully selected, and should always be new.

7. **Notes for Separating Multiple, Shared PC Boards**

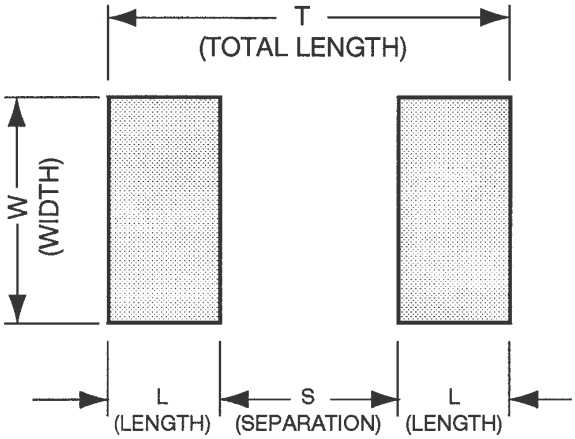
A multi-PC board is separated into many individual circuit boards after soldering has been completed. If the board is bent or distorted at the time of separation, cracks may occur in the chip capacitors. Carefully choose a separation method that minimizes the bending of the circuit board.

Application Information on Solder Pad Design for Surface Mount Chip Capacitor

Recommended Pad Dimensions

		Dimensions (inches)		
Chip Size	L	W	S	T
0402*	0.021	0.022	0.017	0.059
0603*	0.035	0.030	0.030	0.100
0805	0.040	0.050	0.040	0.120
1206	0.040	0.065	0.080	0.160
1210	0.040	0.100	0.080	0.160
1812*	0.050	0.120	0.130	0.230
1825*	0.050	0.250	0.130	0.230
2220	0.050	0.250	0.130	0.230
2225*	0.050	0.250	0.170	0.270
3640*	0.060	0.400	0.300	0.420

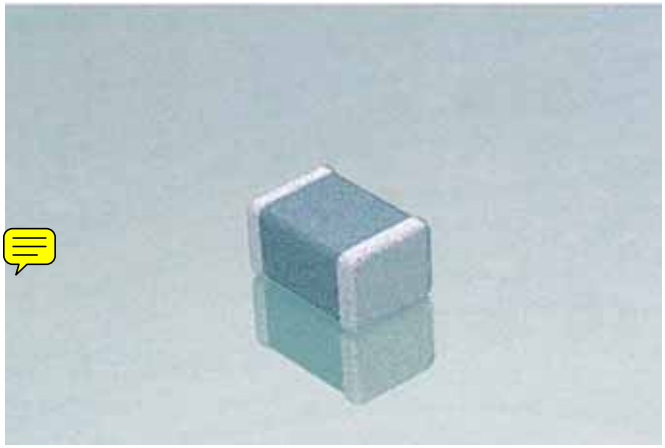
***These sizes are recommended for use with IR and vapor phase soldering only.**



NOTICE: Specifications are subject to change without notice. Contact your nearest Cal-Chip Sales Office for the latest specifications. All statements, information and data given herein are believed to be accurate and reliable, but are presented without guarantee, warranty, or responsibility of any kind, expressed or implied. Statements or suggestions concerning possible use of our products are made without representation or warranty that any such use is free of patent infringement and are not recommendations to infringe any patent. The user should not assume that all safety measures are indicated or that other measures may not be required. Specifications are typical and may not apply to all applications.

C0G (NP0) Dielectric

General Specifications



C0G (NP0) is the most popular formulation of the "temperature-compensating," EIA Class I ceramic materials. Modern C0G (NP0) formulations contain neodymium, samarium and other rare earth oxides.

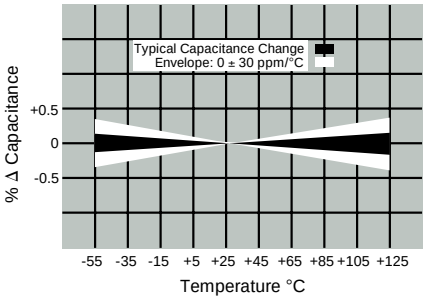
C0G (NP0) ceramics offer one of the most stable capacitor dielectrics available. Capacitance change with temperature is 0 ±30ppm/°C which is less than ±0.3% Δ C from -55°C to +125°C. Capacitance drift or hysteresis for C0G (NP0) ceramics is negligible at less than ±0.05% versus up to ±2% for films. Typical capacitance change with life is less than ±0.1% for C0G (NP0), one-fifth that shown by most other dielectrics. C0G (NP0) formulations show no aging characteristics.

The C0G (NP0) formulation usually has a "Q" in excess of 1000 and shows little capacitance or "Q" changes with frequency. Their dielectric absorption is typically less than 0.6% which is similar to mica and most films.

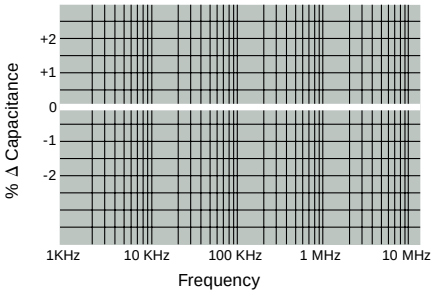
PART NUMBER (see page 2 for complete part number explanation)

0805	5	A	101	J	A	T	2	A
Size (L" x W")	**Voltage** 6.3V = 6, 10V = Z, 16V = Y, 25V = 3, 50V = 5, 100V = 1, 200V = 2, 500V = 7	**Dielectric** C0G (NP0) = A	**Capacitance Code (In pF)** 2 Sig. Digits + Number of Zeros	**Capacitance Tolerance** B = ±.10 pF (<10pF), C = ±.25 pF (<10pF), D = ±.50 pF (<10pF), F = ±1% (≥ 10 pF), G = ±2% (≥ 10 pF), J = ±5%, K = ±10%	**Failure Rate** A = Not Applicable	**Terminations** T = Plated Ni and Sn, 7 = Gold Plated, **Contact Factory For 1 = Pd/Ag Term**	**Packaging** 2 = 7" Reel, 4 = 13" Reel, 7 = Bulk Cass., 9 = Bulk, **Contact Factory For Multiples**	**Special Code** A = Std. Product

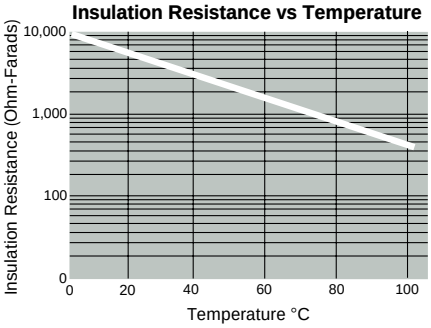
Temperature Coefficient



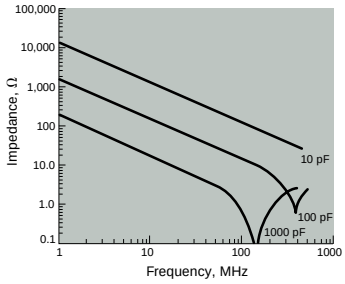
Δ Capacitance vs. Frequency



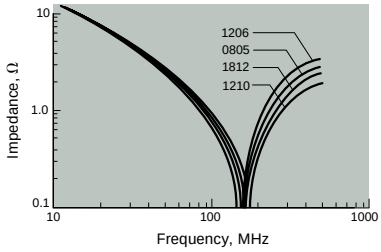
Insulation Resistance vs Temperature



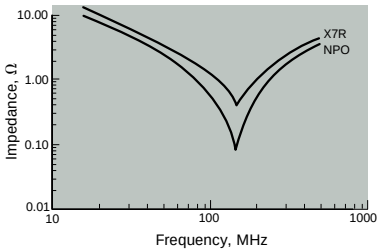
Variation of Impedance with Cap Value Impedance vs. Frequency 0805 - C0G (NP0) 10 pF vs. 100 pF vs. 1000 pF



Variation of Impedance with Chip Size Impedance vs. Frequency 1000 pF - C0G (NP0)

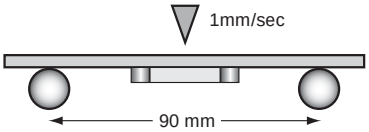


Variation of Impedance with Ceramic Formulation Impedance vs. Frequency 1000 pF - C0G (NP0) vs X7R 0805



C0G (NP0) Dielectric

Specifications and Test Methods

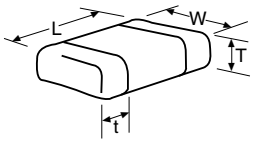
Parameter/Test		NP0 Specification Limits	Measuring Conditions	
Operating Temperature Range		-55ºC to +125ºC	Temperature Cycle Chamber	
Capacitance		Within specified tolerance	Freq.: 1.0 MHz ± 10% for cap ≤ 1000 pF 1.0 kHz ± 10% for cap > 1000 pF Voltage: 1.0Vrms ± .2V	
Q		<30 pF: Q≥ 400+20 x Cap Value ≥30 pF: Q≥ 1000		
Insulation Resistance		100,000MΩ or 1000MΩ - µF, whichever is less	Charge device with rated voltage for 60 ± 5 secs @ room temp/humidity	
Dielectric Strength		No breakdown or visual defects	Charge device with 300% of rated voltage for 1-5 seconds, w/charge and discharge current limited to 50 mA (max) Note: Charge device with 150% of rated voltage for 500V devices.	
Resistance to Flexure Stresses	Appearance	No defects	Deflection: 2mm Test Time: 30 seconds 	
	Capacitance Variation	±5% or ±.5 pF, whichever is greater		
	Q	Meets Initial Values (As Above)		
	Insulation Resistance	≥ Initial Value x 0.3		
Solderability		≥ 95% of each terminal should be covered with fresh solder	Dip device in eutectic solder at 230 ± 5ºC for 5.0 ± 0.5 seconds	
Resistance to Solder Heat	Appearance	No defects, <25% leaching of either end terminal	Dip device in eutectic solder at 260ºC for 60 seconds. Store at room temperature for 24 ± 2 hours before measuring electrical properties.	
	Capacitance Variation	≤ ±2.5% or ±.25 pF, whichever is greater		
	Q	Meets Initial Values (As Above)		
	Insulation Resistance	Meets Initial Values (As Above)		
	Dielectric Strength	Meets Initial Values (As Above)		
Thermal Shock	Appearance	No visual defects	Step 1: -55ºC ± 2º	30 ± 3 minutes
	Capacitance Variation	≤ ±2.5% or ±.25 pF, whichever is greater	Step 2: Room Temp	≤ 3 minutes
	Q	Meets Initial Values (As Above)	Step 3: +125ºC ± 2º	30 ± 3 minutes
	Insulation Resistance	Meets Initial Values (As Above)	Step 4: Room Temp	≤ 3 minutes
	Dielectric Strength	Meets Initial Values (As Above)	Repeat for 5 cycles and measure after 24 hours at room temperature	
Load Life	Appearance	No visual defects	Charge device with twice rated voltage in test chamber set at 125ºC ± 2ºC for 1000 hours (+48, -0). Remove from test chamber and stabilize at room temperature for 24 hours before measuring.	
	Capacitance Variation	≤ ±3.0% or ± .3 pF, whichever is greater		
	Q (C=Nominal Cap)	≥ 30 pF: Q≥ 350 ≥10 pF, <30 pF: Q≥ 275 +5C/2 <10 pF: Q≥ 200 +10C		
	Insulation Resistance	≥ Initial Value x 0.3 (See Above)		
	Dielectric Strength	Meets Initial Values (As Above)		
Load Humidity	Appearance	No visual defects	Store in a test chamber set at 85ºC ± 2ºC/ 85% ± 5% relative humidity for 1000 hours (+48, -0) with rated voltage applied. Remove from chamber and stabilize at room temperature for 24 ± 2 hours before measuring.	
	Capacitance Variation	≤ ±5.0% or ± .5 pF, whichever is greater		
	Q	≥ 30 pF: Q≥ 350 ≥10 pF, <30 pF: Q≥ 275 +5C/2 <10 pF: Q≥ 200 +10C		
	Insulation Resistance	≥ Initial Value x 0.3 (See Above)		
	Dielectric Strength	Meets Initial Values (As Above)		

C0G (NP0) Dielectric

Capacitance Range

PREFERRED SIZES ARE SHADED

SIZE		0201			0402			0603				0805					1206					
Soldering		Reflow Only			Reflow Only			Reflow Only				Reflow/Wave					Reflow/Wave					
Packaging		All Paper			All Paper			All Paper				Paper/Embossed					Paper/Embossed					
(L) Length	MM	0.60 ± 0.03			1.00 ± 0.10			1.60 ± 0.15				2.01 ± 0.20					3.20 ± 0.20					
	(in.)	(0.024 ± 0.001)			(0.040 ± 0.004)			(0.063 ± 0.006)				(0.079 ± 0.008)					(0.126 ± 0.008)					
(W) Width	MM	0.30 ± 0.03			0.50 ± 0.10			0.81 ± 0.15				1.25 ± 0.20					1.60 ± 0.20					
	(in.)	(0.011 ± 0.001)			(0.020 ± 0.004)			(0.032 ± 0.006)				(0.049 ± 0.008)					(0.063 ± 0.008)					
(t) Terminal	MM	0.15 ± 0.05			0.25 ± 0.15			0.35 ± 0.15				0.50 ± 0.25					0.50 ± 0.25					
	(in.)	(0.006 ± 0.002)			(0.010 ± 0.006)			(0.014 ± 0.006)				(0.020 ± 0.010)					(0.020 ± 0.010)					
	WVDC	10	16	25	16	25	50	6.3	25	50	100	16	25	50	100	200	16	25	50	100	200	500
Cap (pF)	0.5			A	C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	1.0			A	C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	1.2			A	C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	1.5			A	C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	1.8			A	C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	2.2			A	C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	2.7			A	C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	3.3			A	C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	3.9			A	C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	4.7			A	C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	5.6			A	C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	6.8			A	C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	8.2			A	C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	10			A	C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	12			A	C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	15			A	C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	18			A	C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	22			A	C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	27			A	C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	33			A	C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	39		A		C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	47		A		C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	56		A		C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	68		A		C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	82	A			C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	100	A			C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	120				C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	150				C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	180				C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	J
	220				C	C	C	G	G	G	G	J	J	J	J	J	J	J	J	J	J	M
	270				C			G	G	G	G	J	J	J	J	M	J	J	J	J	J	M
	330				C			G	G	G	G	J	J	J	J	M	J	J	J	J	J	M
	390							G	G	G		J	J	J	J	M	J	J	J	J	J	M
	470							G	G	G		J	J	J	J	M	J	J	J	J	J	M
	560							G	G	G		J	J	J	J	M	J	J	J	J	J	M
	680							G	G	G		J	J	J	J	M	J	J	J	J	J	P
	820							G	G	G		J	J	J	J		J	J	J	J	M	
	1000							G	G	G		J	J	J	J		J	J	J	J	Q	
	1200											J	J	J			J	J	J	J	Q	
	1500											J	J	J			J	J	J	M	Q	
	1800											J	J	J			J	J	M	M		
	2200											J	J	M			J	J	M	P		
	2700											J	J	M			J	J	M	P		
	3300											N	N	M			J	J	M	P		
	3900											N	N	M			J	J	M	P		
	4700											N	N				J	J	M	P		
	5600											N	N				J	J	M			
	6800											N					M	M				
	8200											N					M	M				
Cap (µF)	0.010											N					M	M				
	0.012																					
	0.015																					
	0.018																					
	0.022																					
	0.027																					
	0.033																					
	0.039																					
	0.047																					
	0.068																					
	0.082																					
	0.1																					
	WVDC	10	16	25	16	25	50	6.3	25	50	100	16	25	50	100	200	16	25	50	100	200	500
	SIZE	0201			0402			0603				0805					1206					



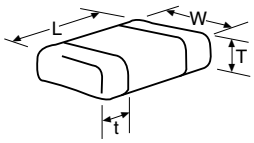
Letter	A	C	E	G	J	K	M	N	P	Q	X	Y	Z
Max. Thickness	0.33 (0.013)	0.56 (0.022)	0.71 (0.028)	0.86 (0.034)	0.94 (0.037)	1.02 (0.040)	1.27 (0.050)	1.40 (0.055)	1.52 (0.060)	1.78 (0.070)	2.29 (0.090)	2.54 (0.100)	2.79 (0.110)
	PAPER					EMBOSSED							

C0G (NP0) Dielectric

Capacitance Range

PREFERRED SIZES ARE SHADED

SIZE		1210					1812					1825				2225			
Soldering		Reflow Only					Reflow Only					Reflow Only				Reflow Only			
Packaging		Paper/Embossed					All Embossed					All Embossed				All Embossed			
(L) Length	MM	3.20 ± 0.20					4.50 ± 0.30					4.50 ± 0.30				5.72 ± 0.25			
	(in.)	(0.126 ± 0.008)					(0.177 ± 0.012)					(0.177 ± 0.012)				(0.225 ± 0.010)			
(W) Width	MM	2.50 ± 0.20					3.20 ± 0.20					6.40 ± 0.40				6.35 ± 0.25			
	(in.)	(0.098 ± 0.008)					(0.126 ± 0.008)					(0.252 ± 0.016)				(0.250 ± 0.010)			
(t) Terminal	MM	0.50 ± 0.25					0.61 ± 0.36					0.61 ± 0.36				0.64 ± 0.39			
	(in.)	(0.020 ± 0.010)					(0.024 ± 0.014)					(0.024 ± 0.014)				(0.025 ± 0.015)			
	WVDC	25	50	100	200	500	25	50	100	200	500	50	100	200	500	50	100	200	500
Cap (pF)	0.5																		
	1.0																		
	1.2																		
	1.5																		
	1.8																		
	2.2																		
	2.7																		
	3.3																		
	3.9																		
	4.7																		
	5.6																		
	6.8																		
	8.2																		
	10					J													
	12					J													
	15					J													
	18					J													
	22					J													
	27					J													
	33					J													
	39					J													
	47					J													
	56					J													
	68					J													
	82					J													
	100					J													
	120					J													
	150					J													
	180					J													
	220					J													
	270					J													
	330					J													
	390					M													
	470					M													
	560	J	J	J	J	M													
	680	J	J	J	J	M													
	820	J	J	J	J	M													
	1000	J	J	J	J	M	K	K	K	K	M	M	M	M		M	M	P	
	1200	J	J	J	M		K	K	K	K	M	M	M	M		M	M	P	
	1500	J	J	J	M		K	K	K	K	M	M	M	M		M	M	P	
	1800	J	J	J	M		K	K	K	K	M	M	M	M		M	M	P	
	2200	J	J	J	Q		K	K	K	K	P	M	M	M		M	M	P	
	2700	J	J	J	Q		K	K	K	P	Q	M	M	M		M	M	P	
	3300	J	J	J			K	K	K	P	Q	M	M	M		M	M	P	
	3900	J	J	M			K	K	K	P	Q	M	M	M		M	M	P	
	4700	J	J	M			K	K	K	P	Q	M	M	M		M	M	P	
	5600	J	J	M			K	K	M	P	X	M	M	M		M	M	P	
	6800	J	J				K	K	M	X		M	M	M	P	M	M	P	
	8200	J	J				K	M	M	X		M	M		P	M	M	P	
Cap (µF)	0.010	N	N				K	M	M	X		M	M		P	M	M	P	Q
	0.012	N	N				K	M				M	M			M	M	P	Q
	0.015						M	M				M	M			M	M	Y	Q
	0.018						M	M				P	M			M	M	Y	Q
	0.022						M	M				P				M	Y	Y	
	0.027						M	P								P	Y	Y	
	0.033						M	P								P	Y	Z	
	0.039						M	P								P	Y	Z	
	0.047						X	P								P			
	0.068						X	X								P			
	0.082						X	X								P			
	0.1						Y	Y								Q			
	WVDC	25	50	100	200	500	25	50	100	200	500	50	100	200	500	50	100	200	500
SIZE		1210					1812					1825				2225			



Letter	A	C	E	G	J	K	M	N	P	Q	X	Y	Z
Max. Thickness	0.33 (0.013)	0.56 (0.022)	0.71 (0.028)	0.86 (0.034)	0.94 (0.037)	1.02 (0.040)	1.27 (0.050)	1.40 (0.055)	1.52 (0.060)	1.78 (0.070)	2.29 (0.090)	2.54 (0.100)	2.79 (0.110)
	PAPER					EMBOSSED							

Packaging of Chip Components

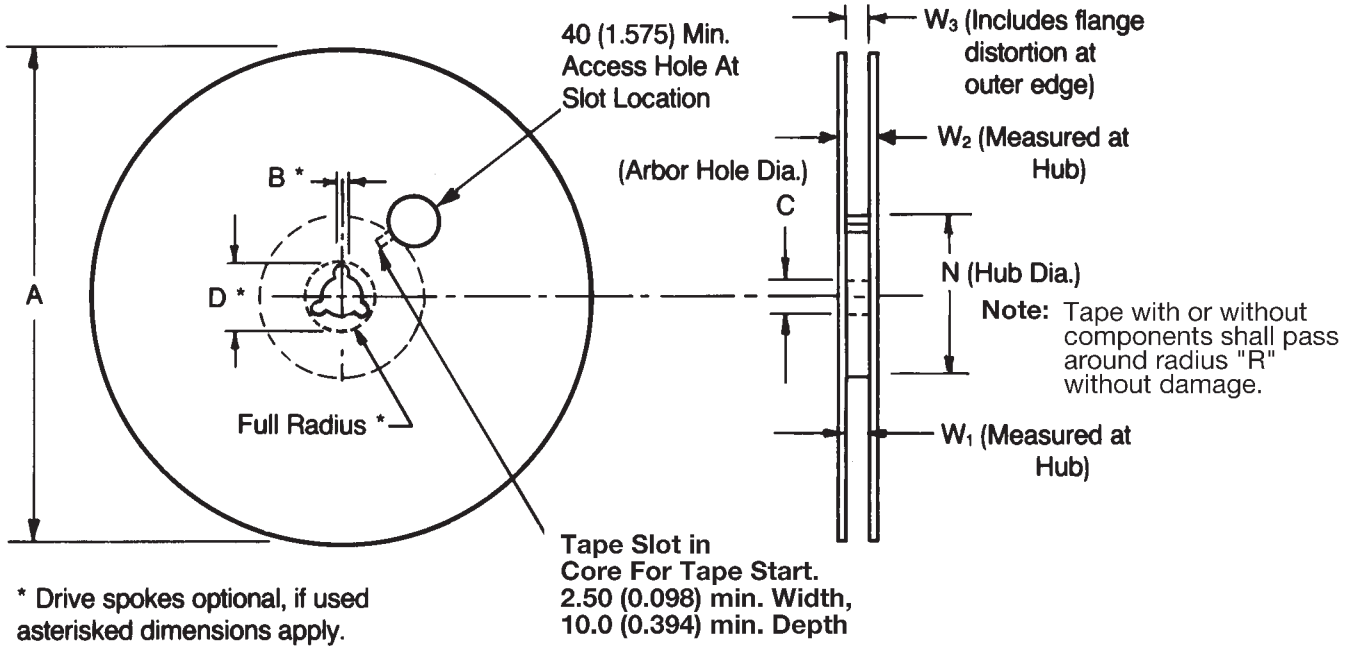
Automatic Insertion Packaging

TAPE & REEL QUANTITIES

All tape and reel specifications are in compliance with RS481.

	8mm	12mm	
Paper or Embossed Carrier	0612, 0508, 0805, 1206, 1210		
Embossed Only		1808	1812, 1825 2220, 2225
Paper Only	0201, 0306, 0402, 0603		
Qty. per Reel/7" Reel	2,000, 3,000 or 4,000, 10,000, 15,000 Contact factory for exact quantity	3,000	500, 1,000 Contact factory for exact quantity
Qty. per Reel/13" Reel	5,000, 10,000, 50,000 Contact factory for exact quantity	10,000	4,000

REEL DIMENSIONS

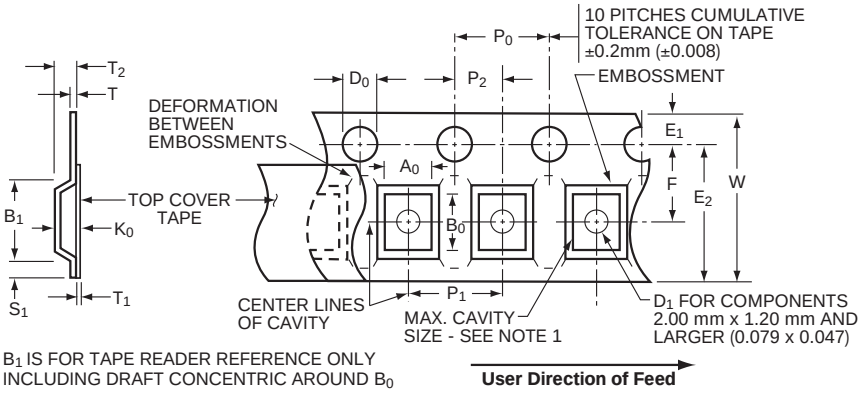


Tape Size(1)	A Max.	B* Min.	C	D* Min.	N Min.	W_1	W_2 Max.	W_3
8mm	330 (12.992)	1.5 (0.059)	$13.0^{+0.50}_{-0.20}$ ($0.512^{+0.020}_{-0.008}$)	20.2 (0.795)	50.0 (1.969)	$8.40^{+1.5}_{-0.0}$ ($0.331^{+0.059}_{-0.0}$)	14.4 (0.567)	7.90 Min. (0.311) 10.9 Max. (0.429)
12mm						$12.4^{+2.0}_{-0.0}$ ($0.488^{+0.079}_{-0.0}$)	18.4 (0.724)	11.9 Min. (0.469) 15.4 Max. (0.607)

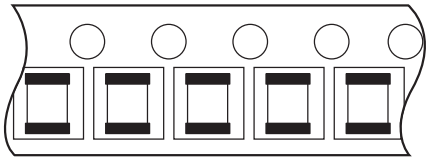
Metric dimensions will govern.
English measurements rounded and for reference only.
(1) For tape sizes 16mm and 24mm (used with chip size 3640) consult EIA RS-481 latest revision.

Embossed Carrier Configuration

8 & 12mm Tape Only



Chip Orientation



8 & 12mm Embossed Tape Metric Dimensions Will Govern

CONSTANT DIMENSIONS

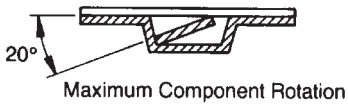
Tape Size	D_0	E	P_0	P_2	S_1 Min.	T Max.	T_1
8mm and 12mm	$1.50^{+0.10}_{-0.0}$ ($0.059^{+0.004}_{-0.0}$)	1.75 ± 0.10 (0.069 ± 0.004)	4.0 ± 0.10 (0.157 ± 0.004)	2.0 ± 0.05 (0.079 ± 0.002)	0.60 (0.024)	0.60 (0.024)	0.10 (0.004) Max.

VARIABLE DIMENSIONS

Tape Size	B_1 Max.	D_1 Min.	E_2 Min.	F	P_1 See Note 5	R Min. See Note 2	T_2	W Max.	A_0 B_0 K_0
8mm	4.35 (0.171)	1.00 (0.039)	6.25 (0.246)	3.50 ± 0.05 (0.138 ± 0.002)	4.00 ± 0.10 (0.157 ± 0.004)	25.0 (0.984)	2.50 Max. (0.098)	8.30 (0.327)	See Note 1
12mm	8.20 (0.323)	1.50 (0.059)	10.25 (0.404)	5.50 ± 0.05 (0.217 ± 0.002)	4.00 ± 0.10 (0.157 ± 0.004)	30.0 (1.181)	6.50 Max. (0.256)	12.3 (0.484)	See Note 1
8mm 1/2 Pitch	4.35 (0.171)	1.00 (0.039)	6.25 (0.246)	3.50 ± 0.05 (0.138 ± 0.002)	2.00 ± 0.10 (0.079 ± 0.004)	25.0 (0.984)	2.50 Max. (0.098)	8.30 (0.327)	See Note 1
12mm Double Pitch	8.20 (0.323)	1.50 (0.059)	10.25 (0.404)	5.50 ± 0.05 (0.217 ± 0.002)	8.00 ± 0.10 (0.315 ± 0.004)	30.0 (1.181)	6.50 Max. (0.256)	12.3 (0.484)	See Note 1

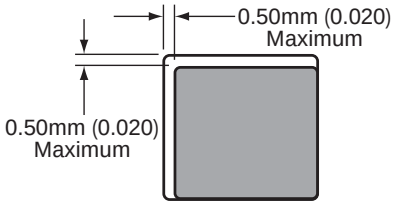
NOTES:

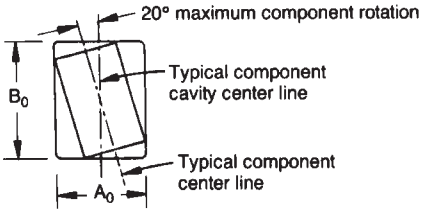
1. The cavity defined by A_0, B_0, and K_0 shall be configured to provide the following:
   Surround the component with sufficient clearance such that:
   a) the component does not protrude beyond the sealing plane of the cover tape.
   b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the cover tape has been removed.
   c) rotation of the component is limited to 20º maximum (see Sketches D & E).
   d) lateral movement of the component is restricted to 0.5mm maximum (see Sketch F).
2. Tape with or without components shall pass around radius "R" without damage.
3. Bar code labeling (if required) shall be on the side of the reel opposite the round sprocket holes. Refer to EIA-556.
4. B_1 dimension is a reference dimension for tape feeder clearance only.
5. If P_1 = 2.0mm, the tape may not properly index in all tape feeders.



Side or Front Sectional View
Sketch "C"

Top View, Sketch "F"
Component Lateral Movements

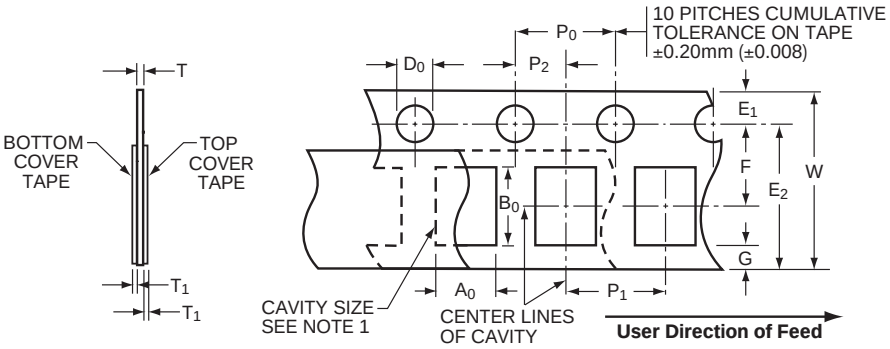




Top View
Sketch "D"

Paper Carrier Configuration

8 & 12mm Tape Only



8 & 12mm Paper Tape Metric Dimensions Will Govern

CONSTANT DIMENSIONS

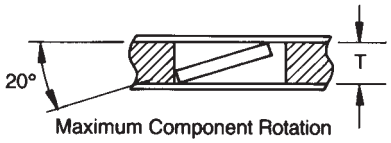
Tape Size	D_0	E	P_0	P_2	T_1	G. Min.	R Min.
8mm and 12mm	$1.50^{+0.10}_{-0.0}$ ($0.059^{+0.004}_{-0.0}$)	1.75 ± 0.10 (0.069 ± 0.004)	4.00 ± 0.10 (0.157 ± 0.004)	2.00 ± 0.05 (0.079 ± 0.002)	0.10 (0.004) Max.	0.75 (0.030) Min.	25.0 (0.984) See Note 2 Min.

VARIABLE DIMENSIONS

Tape Size	P_1 See Note 4	E_2 Min.	F	W	A_0 B_0	T
8mm	4.00 ± 0.10 (0.157 ± 0.004)	6.25 (0.246)	3.50 ± 0.05 (0.138 ± 0.002)	$8.00^{+0.30}_{-0.10}$ ($0.315^{+0.012}_{-0.004}$)	See Note 1	1.10mm (0.043) Max. for Paper Base Tape and 1.60mm (0.063) Max. for Non-Paper Base Compositions
12mm	4.00 ± 0.010 (0.157 ± 0.004)	10.25 (0.404)	5.50 ± 0.05 (0.217 ± 0.002)	12.0 ± 0.30 (0.472 ± 0.012)		
8mm 1/2 Pitch	2.00 ± 0.05 (0.079 ± 0.002)	6.25 (0.246)	3.50 ± 0.05 (0.138 ± 0.002)	$8.00^{+0.30}_{-0.10}$ ($0.315^{+0.012}_{-0.004}$)		
12mm Double Pitch	8.00 ± 0.10 (0.315 ± 0.004)	10.25 (0.404)	5.50 ± 0.05 (0.217 ± 0.002)	12.0 ± 0.30 (0.472 ± 0.012)		

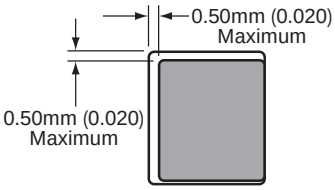
NOTES:

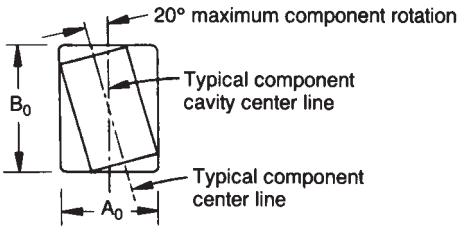
1. The cavity defined by A_0, B_0, and T shall be configured to provide sufficient clearance surrounding the component so that:
   a) the component does not protrude beyond either surface of the carrier tape;
   b) the component can be removed from the cavity in a vertical direction without mechanical restriction after the top cover tape has been removed;
   c) rotation of the component is limited to 20º maximum (see Sketches A & B);
   d) lateral movement of the component is restricted to 0.5mm maximum (see Sketch C).
2. Tape with or without components shall pass around radius "R" without damage.
3. Bar code labeling (if required) shall be on the side of the reel opposite the sprocket holes. Refer to EIA-556.
4. If P_1 = 2.0mm, the tape may not properly index in all tape feeders.



Side or Front Sectional View
Sketch "A"

Top View, Sketch "C"
Component Lateral





Top View
Sketch "B"

Bar Code Labeling Standard

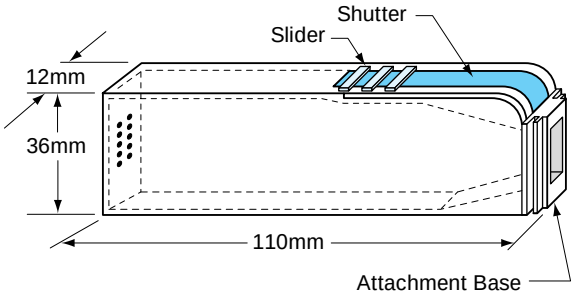
AVX bar code labeling is available and follows latest version of EIA-556

Bulk Case Packaging

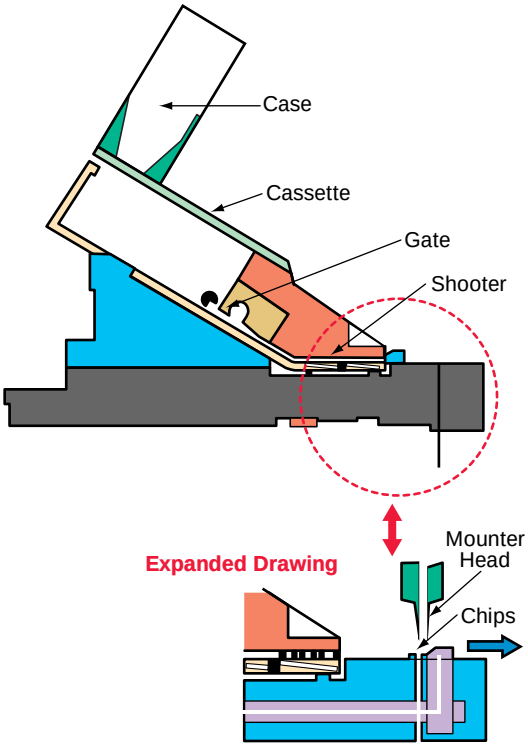
BENEFITS

- Easier handling
- Smaller packaging volume
  (1/20 of T/R packaging)
- Easier inventory control
- Flexibility
- Recyclable

CASE DIMENSIONS



BULK FEEDER



CASE QUANTITIES

Part Size	0402	0603	0805	1206
Qty. (pcs / cassette)	80,000	15,000	10,000 (T=.023") 8,000 (T=.031") 6,000 (T=.043")	5,000 (T=.023") 4,000 (T=.032") 3,000 (T=.044")

Basic Capacitor Formulas

I. Capacitance (farads)

English: $C = \frac{.224\ K\ A}{T_D}$

Metric: $C = \frac{.0884\ K\ A}{T_D}$

II. Energy stored in capacitors (Joules, watt - sec)

$E = \frac{1}{2} CV^2$

III. Linear charge of a capacitor (Amperes)

$I = C \frac{dV}{dt}$

IV. Total Impedance of a capacitor (ohms)

$Z = \sqrt{R_S^2 + (X_C - X_L)^2}$

V. Capacitive Reactance (ohms)

$x_C = \frac{1}{2 \pi fC}$

VI. Inductive Reactance (ohms)

$x_L = 2 \pi fL$

VII. Phase Angles:

Ideal Capacitors: Current leads voltage 90°
Ideal Inductors: Current lags voltage 90°
Ideal Resistors: Current in phase with voltage

VIII. Dissipation Factor (%)

D.F.= tan δ (loss angle) = $\frac{E.S.R.}{X_C}$ = $(2 \pi fC)$ (E.S.R.)

IX. Power Factor (%)

P.F. = Sine δ (loss angle) = Cos ϕ (phase angle)
P.F. = (when less than 10%) = DF

X. Quality Factor (dimensionless)

Q = Cotan δ (loss angle) = $\frac{1}{D.F.}$

XI. Equivalent Series Resistance (ohms)

E.S.R. = (D.F.) (Xc) = (D.F.) / $(2 \pi fC)$

XII. Power Loss (watts)

Power Loss = $(2 \pi fCV^2)$ (D.F.)

XIII. KVA (Kilowatts)

KVA = $2 \pi fCV^2 \times 10^{-3}$

XIV. Temperature Characteristic (ppm/°C)

T.C. = $\frac{Ct - C_{25}}{C_{25} (T_t - 25)} \times 10^6$

XV. Cap Drift (%)

C.D. = $\frac{C_1 - C_2}{C_1} \times 100$

XVI. Reliability of Ceramic Capacitors

$\frac{L_0}{L_t} = \left(\frac{V_t}{V_o}\right)^X \left(\frac{T_t}{T_o}\right)^Y$

XVII. Capacitors in Series (current the same)

Any Number: $\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} --- \frac{1}{C_N}$

Two: $C_T = \frac{C_1 C_2}{C_1 + C_2}$

XVIII. Capacitors in Parallel (voltage the same)

$C_T = C_1 + C_2 --- + C_N$

XIX. Aging Rate

A.R. = %Δ C/decade of time

XX. Decibels

db = $20 \log \frac{V_1}{V_2}$

METRIC PREFIXES

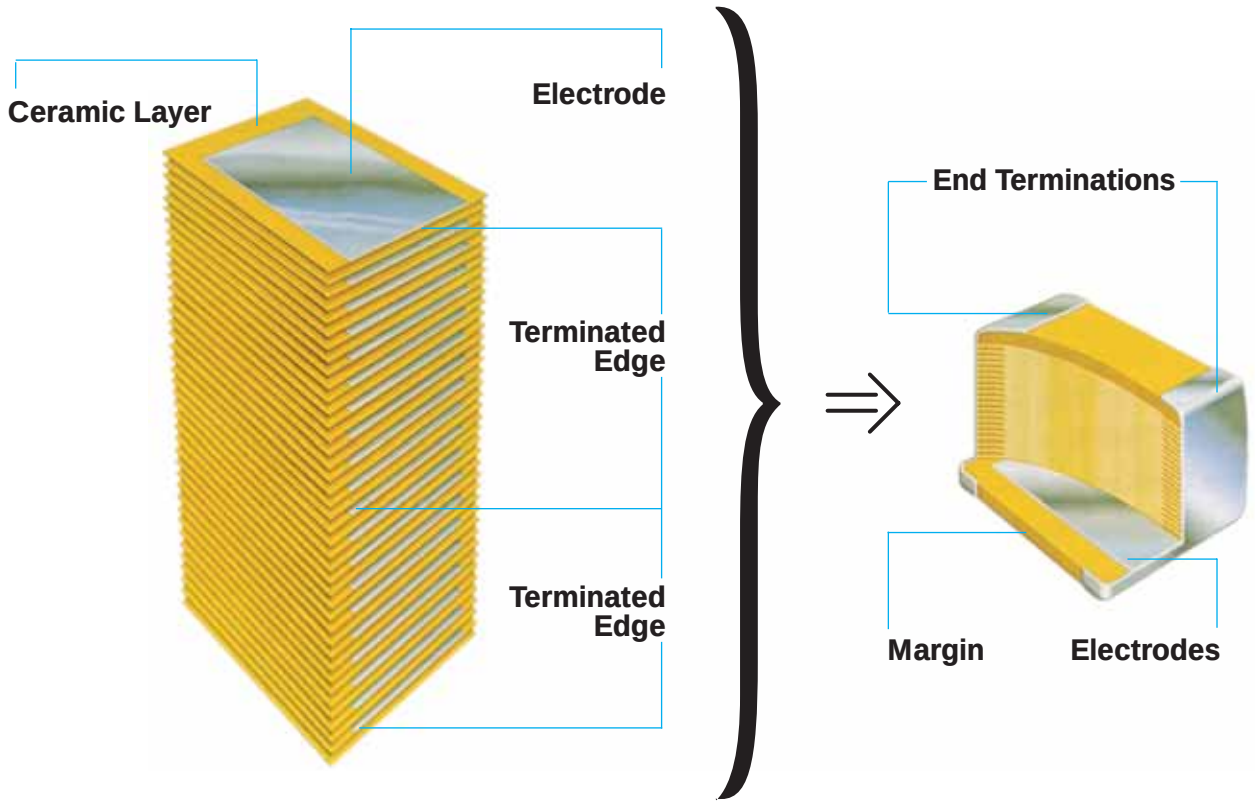
Pico	$X\ 10^{-12}$
Nano	$X\ 10^{-9}$
Micro	$X\ 10^{-6}$
Milli	$X\ 10^{-3}$
Deci	$X\ 10^{-1}$
Deca	$X\ 10^{+1}$
Kilo	$X\ 10^{+3}$
Mega	$X\ 10^{+6}$
Giga	$X\ 10^{+9}$
Tera	$X\ 10^{+12}$

SYMBOLS

K	= Dielectric Constant	f	= frequency	L_t	= Test life
A	= Area	L	= Inductance	V_t	= Test voltage
T_D	= Dielectric thickness	δ	= Loss angle	V_o	= Operating voltage
V	= Voltage	ϕ	= Phase angle	T_t	= Test temperature
t	= time	X & Y	= exponent effect of voltage and temp.	T_o	= Operating temperature
R_S	= Series Resistance	L_o	= Operating life		

General Description

Basic Construction – A multilayer ceramic (MLC) capacitor is a monolithic block of ceramic containing two sets of offset, interleaved planar electrodes that extend to two opposite surfaces of the ceramic dielectric. This simple structure requires a considerable amount of sophistication, both in material and manufacture, to produce it in the quality and quantities needed in today's electronic equipment.



Multilayer Ceramic Capacitor

Figure 1

Formulations – Multilayer ceramic capacitors are available in both Class 1 and Class 2 formulations. Temperature compensating formulation are Class 1 and temperature stable and general application formulations are classified as Class 2.

Class 1 – Class 1 capacitors or temperature compensating capacitors are usually made from mixtures of titanates where barium titanate is normally not a major part of the mix. They have predictable temperature coefficients and in general, do not have an aging characteristic. Thus they are the most stable capacitor available. The most popular Class 1 multilayer ceramic capacitors are C0G (NP0) temperature compensating capacitors (negative-positive 0 ppm/°C).

Class 2 – EIA Class 2 capacitors typically are based on the chemistry of barium titanate and provide a wide range of capacitance values and temperature stability. The most commonly used Class 2 dielectrics are X7R and Y5V. The X7R provides intermediate capacitance values which vary only ±15% over the temperature range of -55°C to 125°C. It finds applications where stability over a wide temperature range is required.

The Y5V provides the highest capacitance values and is used in applications where limited temperature changes are expected. The capacitance value for Y5V can vary from 22% to -82% over the -30°C to 85°C temperature range.

All Class 2 capacitors vary in capacitance value under the influence of temperature, operating voltage (both AC and DC), and frequency. For additional information on performance changes with operating conditions, consult AVX's software, SpiCap.

Table 1: EIA and MIL Temperature Stable and General Application Codes

EIA CODE Percent Capacity Change Over Temperature Range	
RS198	**Temperature Range**
X7	-55°C to +125°C
X6	-55°C to +105°C
X5	-55°C to +85°C
Y5	-30°C to +85°C
Z5	+10°C to +85°C
Code	**Percent Capacity Change**
D	±3.3%
E	±4.7%
F	±7.5%
P	±10%
R	±15%
S	±22%
T	+22%, -33%
U	+22%, - 56%
V	+22%, -82%
EXAMPLE – A capacitor is desired with the capacitance value at 25°C to increase no more than 7.5% or decrease no more than 7.5% from -30°C to +85°C. EIA Code will be Y5F.	

MIL CODE		
Symbol	**Temperature Range**	
A	-55°C to +85°C	
B	-55°C to +125°C	
C	-55°C to +150°C	
Symbol	**Cap. Change Zero Volts**	**Cap. Change Rated Volts**
R	+15%, -15%	+15%, -40%
S	+22%, -22%	+22%, -56%
W	+22%, -56%	+22%, -66%
X	+15%, -15%	+15%, -25%
Y	+30%, -70%	+30%, -80%
Z	+20%, -20%	+20%, -30%
Temperature characteristic is specified by combining range and change symbols, for example BR or AW. Specification slash sheets indicate the characteristic applicable to a given style of capacitor.		

In specifying capacitance change with temperature for Class 2 materials, EIA expresses the capacitance change over an operating temperature range by a 3 symbol code. The first symbol represents the cold temperature end of the temperature range, the second represents the upper limit of the operating temperature range and the third symbol represents the capacitance change allowed over the operating temperature range. Table 1 provides a detailed explanation of the EIA system.

Effects of Voltage – Variations in voltage have little effect on Class 1 dielectric but does affect the capacitance and dissipation factor of Class 2 dielectrics. The application of DC voltage reduces both the capacitance and dissipation factor while the application of an AC voltage within a reasonable range tends to increase both capacitance and dissipation factor readings. If a high enough AC voltage is applied, eventually it will reduce capacitance just as a DC voltage will. Figure 2 shows the effects of AC voltage.

Cap. Change vs. A.C. Volts
X7R

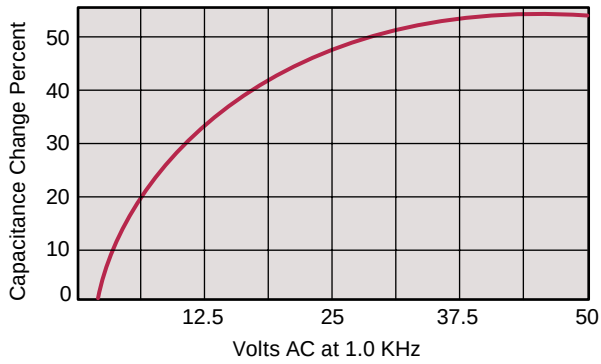


Figure 2

Capacitor specifications specify the AC voltage at which to measure (normally 0.5 or 1 VAC) and application of the wrong voltage can cause spurious readings. Figure 3 gives the voltage coefficient of dissipation factor for various AC voltages at 1 kilohertz. Applications of different frequencies will affect the percentage changes versus voltages.

D.F. vs. A.C. Measurement Volts
X7R

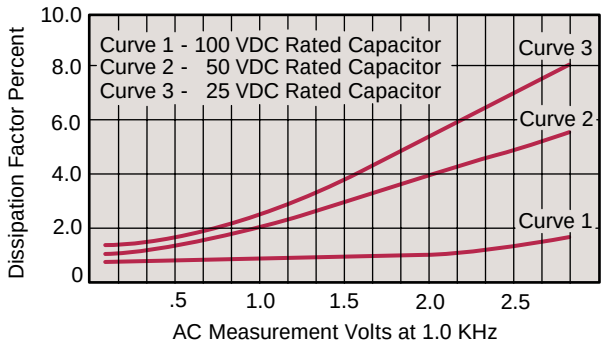


Figure 3

Typical effect of the application of DC voltage is shown in Figure 4. The voltage coefficient is more pronounced for higher K dielectrics. These figures are shown for room temperature conditions. The combination characteristic known as voltage temperature limits which shows the effects of rated voltage over the operating temperature range is shown in Figure 5 for the military BX characteristic.

Typical Cap. Change vs. D.C. Volts
X7R

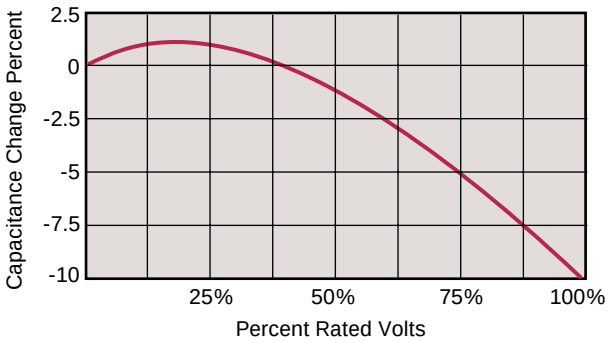


Figure 4

Typical Cap. Change vs. Temperature
X7R

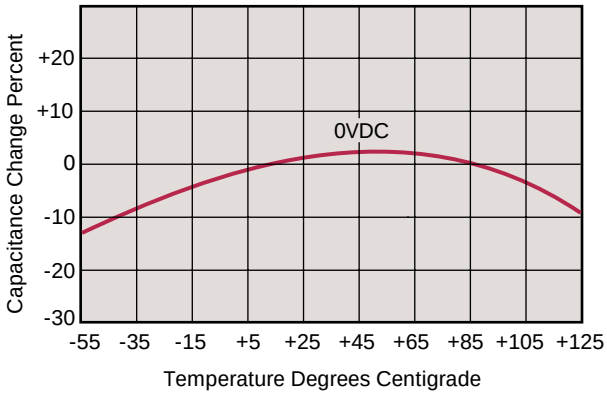
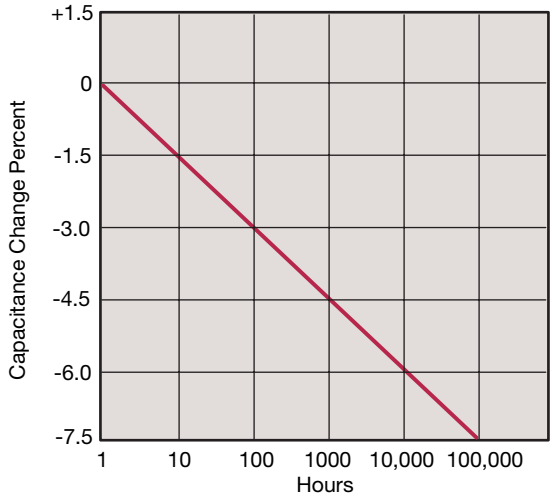


Figure 5

Effects of Time – Class 2 ceramic capacitors change capacitance and dissipation factor with time as well as temperature, voltage and frequency. This change with time is known as aging. Aging is caused by a gradual re-alignment of the crystalline structure of the ceramic and produces an exponential loss in capacitance and decrease in dissipation factor versus time. A typical curve of aging rate for semi-stable ceramics is shown in Figure 6.

If a Class 2 ceramic capacitor that has been sitting on the shelf for a period of time, is heated above its curie point, (125°C for 4 hours or 150°C for ½ hour will suffice) the part will de-age and return to its initial capacitance and dissipation factor readings. Because the capacitance changes rapidly, immediately after de-aging, the basic capacitance measurements are normally referred to a time period sometime after the de-aging process. Various manufacturers use different time bases but the most popular one is one day or twenty-four hours after "last heat." Change in the aging curve can be caused by the application of voltage and other stresses. The possible changes in capacitance due to de-aging by heating the unit explain why capacitance changes are allowed after test, such as temperature cycling, moisture resistance, etc., in MIL specs. The application of high voltages such as dielectric withstanding voltages also tends to de-age capacitors and is why re-reading of capacitance after 12 or 24 hours is allowed in military specifications after dielectric strength tests have been performed.

Typical Curve of Aging Rate
X7R



Characteristic	Max. Aging Rate %/Decade
C0G (NP0)	None
X7R, X5R	2
Y5V	7

Figure 6

Effects of Frequency – Frequency affects capacitance and impedance characteristics of capacitors. This effect is much more pronounced in high dielectric constant ceramic formulation than in low K formulations. AVX's SpiCap software generates impedance, ESR, series inductance, series resonant frequency and capacitance all as functions of frequency, temperature and DC bias for standard chip sizes and styles. It is available free from AVX and can be downloaded for free from AVX website: www.avx.com.

Effects of Mechanical Stress – High "K" dielectric ceramic capacitors exhibit some low level piezoelectric reactions under mechanical stress. As a general statement, the piezoelectric output is higher, the higher the dielectric constant of the ceramic. It is desirable to investigate this effect before using high "K" dielectrics as coupling capacitors in extremely low level applications.

Reliability – Historically ceramic capacitors have been one of the most reliable types of capacitors in use today. The approximate formula for the reliability of a ceramic capacitor is:

$$\frac{L_o}{L_t} = \left(\frac{V_t}{V_o}\right)^X \left(\frac{T_t}{T_o}\right)^Y$$

where

L_o = operating life
L_t = test life
V_t = test voltage
V_o = operating voltage
T_t = test temperature and
T_o = operating temperature in °C
X,Y = see text

Historically for ceramic capacitors exponent X has been considered as 3. The exponent Y for temperature effects typically tends to run about 8.

A capacitor is a component which is capable of storing electrical energy. It consists of two conductive plates (electrodes) separated by insulating material which is called the dielectric. A typical formula for determining capacitance is:

$$C = \frac{.224\,KA}{t}$$

C = capacitance (picofarads)
K = dielectric constant (Vacuum = 1)
A = area in square inches
t = separation between the plates in inches (thickness of dielectric)
.224 = conversion constant (.0884 for metric system in cm)

Capacitance – The standard unit of capacitance is the farad. A capacitor has a capacitance of 1 farad when 1 coulomb charges it to 1 volt. One farad is a very large unit and most capacitors have values in the micro (10^{-6}), nano (10^{-9}) or pico (10^{-12}) farad level.

Dielectric Constant – In the formula for capacitance given above the dielectric constant of a vacuum is arbitrarily chosen as the number 1. Dielectric constants of other materials are then compared to the dielectric constant of a vacuum.

Dielectric Thickness – Capacitance is indirectly proportional to the separation between electrodes. Lower voltage requirements mean thinner dielectrics and greater capacitance per volume.

Area – Capacitance is directly proportional to the area of the electrodes. Since the other variables in the equation are usually set by the performance desired, area is the easiest parameter to modify to obtain a specific capacitance within a material group.

Energy Stored – The energy which can be stored in a capacitor is given by the formula:

$$E = \tfrac{1}{2}CV^2$$

E = energy in joules (watts-sec)
V = applied voltage
C = capacitance in farads

Potential Change – A capacitor is a reactive component which reacts against a change in potential across it. This is shown by the equation for the linear charge of a capacitor:

$$I_{ideal} = C\frac{dV}{dt}$$

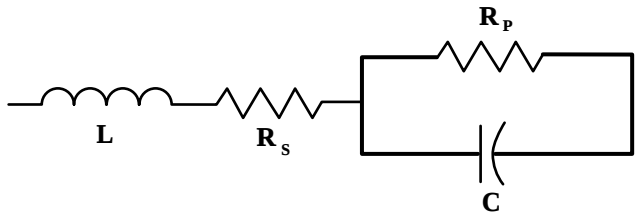
where

I = Current
C = Capacitance
dV/dt = Slope of voltage transition across capacitor

Thus an infinite current would be required to instantly change the potential across a capacitor. The amount of current a capacitor can "sink" is determined by the above equation.

Equivalent Circuit – A capacitor, as a practical device, exhibits not only capacitance but also resistance and inductance. A simplified schematic for the equivalent circuit is:

C = Capacitance
R_s = Series Resistance
L = Inductance
R_p = Parallel Resistance



Reactance – Since the insulation resistance (R_p) is normally very high, the total impedance of a capacitor is:

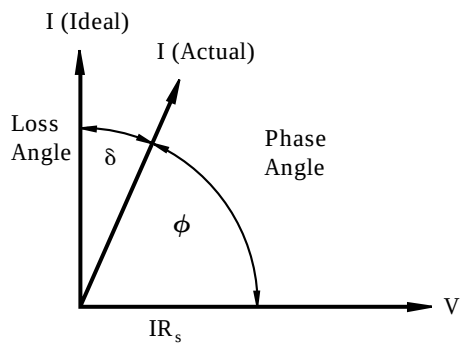
$$Z = \sqrt{R_S^2 + (X_C - X_L)^2}$$

where

Z = Total Impedance
R_s = Series Resistance
X_C = Capacitive Reactance $= \frac{1}{2\pi fC}$
X_L = Inductive Reactance $= 2\pi fL$

The variation of a capacitor's impedance with frequency determines its effectiveness in many applications.

Phase Angle – Power Factor and Dissipation Factor are often confused since they are both measures of the loss in a capacitor under AC application and are often almost identical in value. In a "perfect" capacitor the current in the capacitor will lead the voltage by 90°.

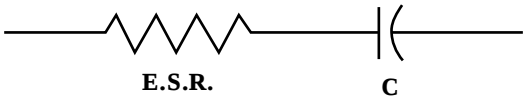


In practice the current leads the voltage by some other phase angle due to the series resistance R_S. The complement of this angle is called the loss angle and:

Power Factor (P.F.) = Cos ϕ or Sine δ
Dissipation Factor (D.F.) = tan δ

for small values of δ the tan and sine are essentially equal which has led to the common interchangeability of the two terms in the industry.

Equivalent Series Resistance – The term E.S.R. or Equivalent Series Resistance combines all losses both series and parallel in a capacitor at a given frequency so that the equivalent circuit is reduced to a simple R-C series connection.



Dissipation Factor – The DF/PF of a capacitor tells what percent of the apparent power input will turn to heat in the capacitor.

$$\textbf{Dissipation Factor} = \frac{\textbf{E.S.R.}}{\textbf{X}_c} = (2\pi fC)(\text{E.S.R.})$$

The watts loss are:

$$\textbf{Watts loss} = (2\pi fCV^2)(\text{D.F.})$$

Very low values of dissipation factor are expressed as their reciprocal for convenience. These are called the "Q" or Quality factor of capacitors.

Parasitic Inductance – The parasitic inductance of capacitors is becoming more and more important in the decoupling of today's high speed digital systems. The relationship between the inductance and the ripple voltage induced on the DC voltage line can be seen from the simple inductance equation:

$$V = L\frac{di}{dt}$$

The $\frac{di}{dt}$ seen in current microprocessors can be as high as 0.3 A/ns, and up to 10A/ns. At 0.3 A/ns, 100pH of parasitic inductance can cause a voltage spike of 30mV. While this does not sound very drastic, with the Vcc for microprocessors decreasing at the current rate, this can be a fairly large percentage.

Another important, often overlooked, reason for knowing the parasitic inductance is the calculation of the resonant frequency. This can be important for high frequency, bypass capacitors, as the resonant point will give the most signal attenuation. The resonant frequency is calculated from the simple equation:

$$f_{res} = \frac{1}{2\pi\sqrt{LC}}$$

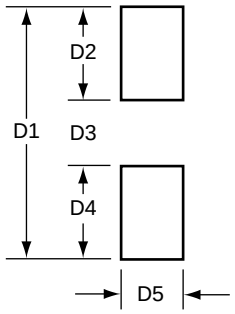
Insulation Resistance – Insulation Resistance is the resistance measured across the terminals of a capacitor and consists principally of the parallel resistance R_P shown in the equivalent circuit. As capacitance values and hence the area of dielectric increases, the I.R. decreases and hence the product (C x IR or RC) is often specified in ohm faradsor more commonly megohm-microfarads. Leakage current is determined by dividing the rated voltage by IR (Ohm's Law).

Dielectric Strength – Dielectric Strength is an expression of the ability of a material to withstand an electrical stress. Although dielectric strength is ordinarily expressed in volts, it is actually dependent on the thickness of the dielectric and thus is also more generically a function of volts/mil.

Dielectric Absorption – A capacitor does not discharge instantaneously upon application of a short circuit, but drains gradually after the capacitance proper has been discharged. It is common practice to measure the dielectric absorption by determining the "reappearing voltage" which appears across a capacitor at some point in time after it has been fully discharged under short circuit conditions.

Corona – Corona is the ionization of air or other vapors which causes them to conduct current. It is especially prevalent in high voltage units but can occur with low voltages as well where high voltage gradients occur. The energy discharged degrades the performance of the capacitor and can in time cause catastrophic failures.

REFLOW SOLDERING



Case Size	D1	D2	D3	D4	D5
0402	1.70 (0.07)	0.60 (0.02)	0.50 (0.02)	0.60 (0.02)	0.50 (0.02)
0603	2.30 (0.09)	0.80 (0.03)	0.70 (0.03)	0.80 (0.03)	0.75 (0.03)
0805	3.00 (0.12)	1.00 (0.04)	1.00 (0.04)	1.00 (0.04)	1.25 (0.05)
1206	4.00 (0.16)	1.00 (0.04)	2.00 (0.09)	1.00 (0.04)	1.60 (0.06)
1210	4.00 (0.16)	1.00 (0.04)	2.00 (0.09)	1.00 (0.04)	2.50 (0.10)
1808	5.60 (0.22)	1.00 (0.04)	3.60 (0.14)	1.00 (0.04)	2.00 (0.08)
1812	5.60 (0.22)	1.00 (0.04))	3.60 (0.14)	1.00 (0.04)	3.00 (0.12)
1825	5.60 (0.22)	1.00 (0.04)	3.60 (0.14)	1.00 (0.04)	6.35 (0.25)
2220	6.60 (0.26)	1.00 (0.04)	4.60 (0.18)	1.00 (0.04)	5.00 (0.20)
2225	6.60 (0.26)	1.00 (0.04)	4.60 (0.18)	1.00 (0.04)	6.35 (0.25)

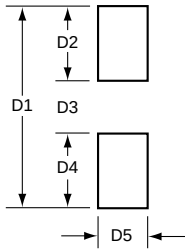
Dimensions in millimeters (inches)

Component Pad Design

Component pads should be designed to achieve good solder filets and minimize component movement during reflow soldering. Pad designs are given below for the most common sizes of multilayer ceramic capacitors for both wave and reflow soldering. The basis of these designs is:

- Pad width equal to component width. It is permissible to decrease this to as low as 85% of component width but it is not advisable to go below this.
- Pad overlap 0.5mm beneath component.
- Pad extension 0.5mm beyond components for reflow and 1.0mm for wave soldering.

WAVE SOLDERING

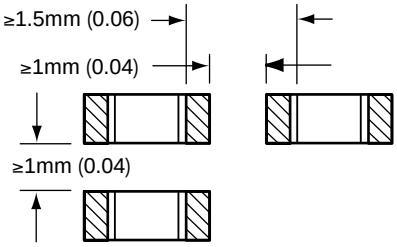


Case Size	D1	D2	D3	D4	D5
0603	3.10 (0.12)	1.20 (0.05)	0.70 (0.03)	1.20 (0.05)	0.75 (0.03)
0805	4.00 (0.15)	1.50 (0.06)	1.00 (0.04)	1.50 (0.06)	1.25 (0.05)
1206	5.00 (0.19)	1.50 (0.06)	2.00 (0.09)	1.50 (0.06)	1.60 (0.06)

Dimensions in millimeters (inches)

Component Spacing

For wave soldering components, must be spaced sufficiently far apart to avoid bridging or shadowing (inability of solder to penetrate properly into small spaces). This is less important for reflow soldering but sufficient space must be allowed to enable rework should it be required.



Preheat & Soldering

The rate of preheat should not exceed 4°C/second to prevent thermal shock. A better maximum figure is about 2°C/second.

For capacitors size 1206 and below, with a maximum thickness of 1.25mm, it is generally permissible to allow a temperature differential from preheat to soldering of 150°C. In all other cases this differential should not exceed 100°C.

For further specific application or process advice, please consult AVX.

Cleaning

Care should be taken to ensure that the capacitors are thoroughly cleaned of flux residues especially the space beneath the capacitor. Such residues may otherwise become conductive and effectively offer a low resistance bypass to the capacitor.

Ultrasonic cleaning is permissible, the recommended conditions being 8 Watts/litre at 20-45 kHz, with a process cycle of 2 minutes vapor rinse, 2 minutes immersion in the ultrasonic solvent bath and finally 2 minutes vapor rinse.

APPLICATION NOTES

Storage
Good solderability is maintained for at least twelve months, provided the components are stored in their "as received" packaging at less than 40°C and 70% RH.

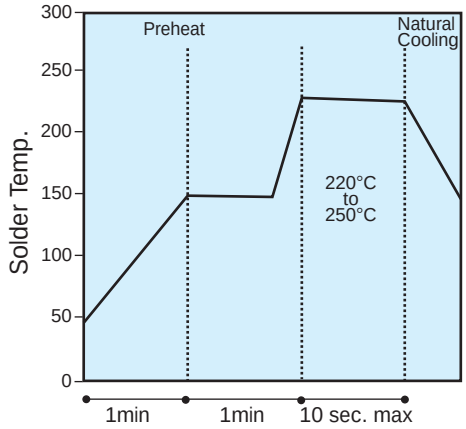
Solderability
Terminations to be well soldered after immersion in a 60/40 tin/lead solder bath at 235 ± 5°C for 2 ± 1 seconds.

Leaching
Terminations will resist leaching for at least the immersion times and conditions shown below.

Termination Type	Solder Tin/Lead/Silver	Solder Temp. °C	Immersion Time Seconds
Nickel Barrier	60/40/0	260 ± 5	30 ± 1

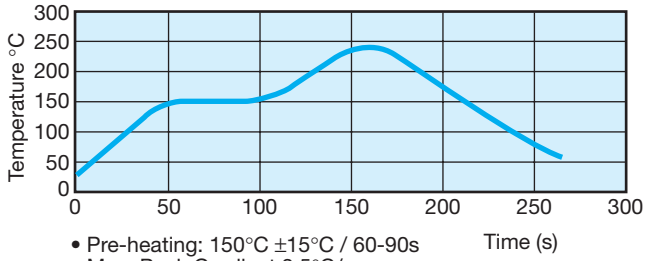
Recommended Soldering Profiles

Reflow



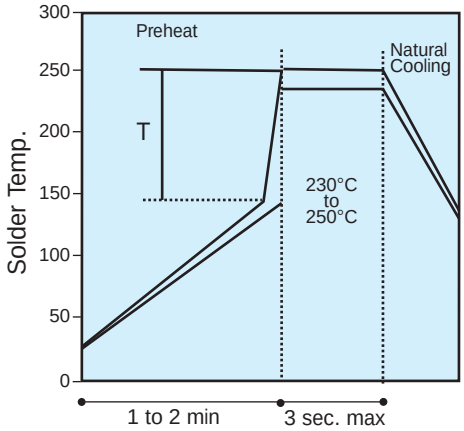
(Minimize soldering time)

Lead-Free Reflow Profile



- Pre-heating: 150°C ±15°C / 60-90s
- Max. Peak Gradient 2.5°C/s
- Peak Temperature: 245°C ±5°C
- Time at >230°C: 40s Max.

Wave



(Preheat chips before soldering)
T/maximum 150°C

Lead-Free Wave Soldering
The recommended peak temperature for lead-free wave soldering is 250°C-260°C for 3-5 seconds. The other parameters of the profile remains the same as above.

The following should be noted by customers changing from lead based systems to the new lead free pastes.

a) The visual standards used for evaluation of solder joints will need to be modified as lead free joints are not as bright as with tin-lead pastes and the fillet may not be as large.

b) Resin color may darken slightly due to the increase in temperature required for the new pastes.

c) Lead-free solder pastes do not allow the same self alignment as lead containing systems. Standard mounting pads are acceptable, but machine set up may need to be modified.

General
Surface mounting chip multilayer ceramic capacitors are designed for soldering to printed circuit boards or other substrates. The construction of the components is such that they will withstand the time/temperature profiles used in both wave and reflow soldering methods.

Handling
Chip multilayer ceramic capacitors should be handled with care to avoid damage or contamination from perspiration and skin oils. The use of tweezers or vacuum pick ups is strongly recommended for individual components. Bulk handling should ensure that abrasion and mechanical shock are minimized. Taped and reeled components provides the ideal medium for direct presentation to the placement machine. Any mechanical shock should be minimized during handling chip multilayer ceramic capacitors.

Preheat
It is important to avoid the possibility of thermal shock during soldering and carefully controlled preheat is therefore required. The rate of preheat should not exceed 4°C/second

and a target figure 2°C/second is recommended. Although an 80°C to 120°C temperature differential is preferred, recent developments allow a temperature differential between the component surface and the soldering temperature of 150°C (Maximum) for capacitors of 1210 size and below with a maximum thickness of 1.25mm. The user is cautioned that the risk of thermal shock increases as chip size or temperature differential increases.

Soldering

Mildly activated rosin fluxes are preferred. The minimum amount of solder to give a good joint should be used. Excessive solder can lead to damage from the stresses caused by the difference in coefficients of expansion between solder, chip and substrate. AVX terminations are suitable for all wave and reflow soldering systems. If hand soldering cannot be avoided, the preferred technique is the utilization of hot air soldering tools.

Cooling

Natural cooling in air is preferred, as this minimizes stresses within the soldered joint. When forced air cooling is used, cooling rate should not exceed 4°C/second. Quenching is not recommended but if used, maximum temperature differentials should be observed according to the preheat conditions above.

Cleaning

Flux residues may be hygroscopic or acidic and must be removed. AVX MLC capacitors are acceptable for use with all of the solvents described in the specifications MIL-STD-202 and EIA-RS-198. Alcohol based solvents are acceptable and properly controlled water cleaning systems are also acceptable. Many other solvents have been proven successful, and most solvents that are acceptable to other components on circuit assemblies are equally acceptable for use with ceramic capacitors.

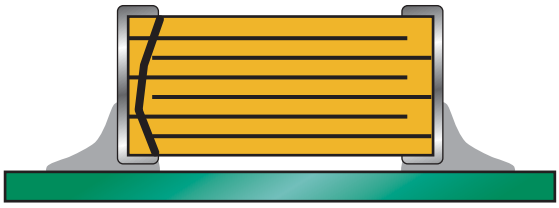
POST SOLDER HANDLING

Once SMP components are soldered to the board, any bending or flexure of the PCB applies stresses to the soldered joints of the components. For leaded devices, the stresses are absorbed by the compliancy of the metal leads and generally don't result in problems unless the stress is large enough to fracture the soldered connection.

Ceramic capacitors are more susceptible to such stress because they don't have compliant leads and are brittle in nature. The most frequent failure mode is low DC resistance or short circuit. The second failure mode is significant loss of capacitance due to severing of contact between sets of the internal electrodes.

Cracks caused by mechanical flexure are very easily identified and generally take one of the following two general forms:

Type A:
Angled crack between bottom of device to top of solder joint.



Type B:
Fracture from top of device to bottom of device.

Mechanical cracks are often hidden underneath the termination and are difficult to see externally. However, if one end termination falls off during the removal process from PCB, this is one indication that the cause of failure was excessive mechanical stress due to board warping.

COMMON CAUSES OF MECHANICAL CRACKING

The most common source for mechanical stress is board depanelization equipment, such as manual breakapart, v-cutters and shear presses. Improperly aligned or dull cutters may cause torqueing of the PCB resulting in flex stresses being transmitted to components near the board edge. Another common source of flexural stress is contact during parametric testing when test points are probed. If the PCB is allowed to flex during the test cycle, nearby ceramic capacitors may be broken.

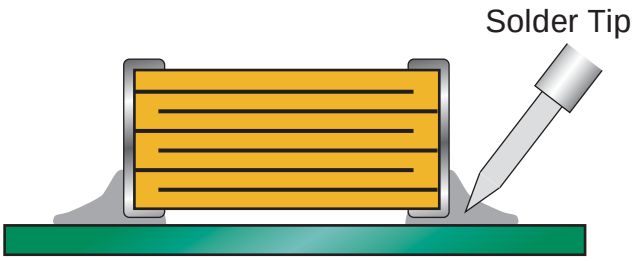
A third common source is board to board connections at vertical connectors where cables or other PCBs are connected to the PCB. If the board is not supported during the plug/unplug cycle, it may flex and cause damage to nearby components.

Special care should also be taken when handling large (>6" on a side) PCBs since they more easily flex or warp than smaller boards.

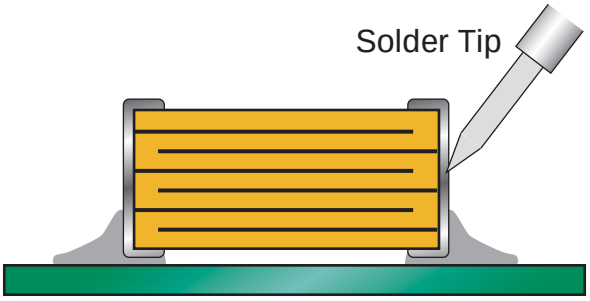
REWORKING OF MLCs

Thermal shock is common in MLCs that are manually attached or reworked with a soldering iron. *AVX strongly recommends that any reworking of MLCs be done with hot air reflow rather than soldering irons.* It is practically impossible to cause any thermal shock in ceramic capacitors when using hot air reflow.

However direct contact by the soldering iron tip often causes thermal cracks that may fail at a later date. If rework by soldering iron is absolutely necessary, it is recommended that the wattage of the iron be less than 30 watts and the tip temperature be <300ºC. *Rework should be performed by applying the solder iron tip to the pad and not directly contacting any part of the ceramic capacitor.*



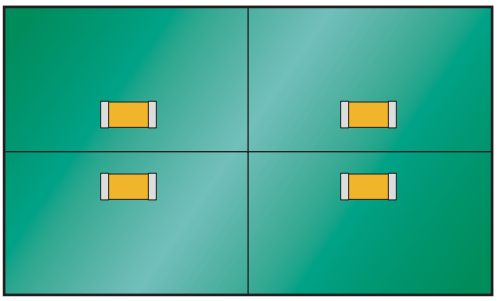
Preferred Method - No Direct Part Contact



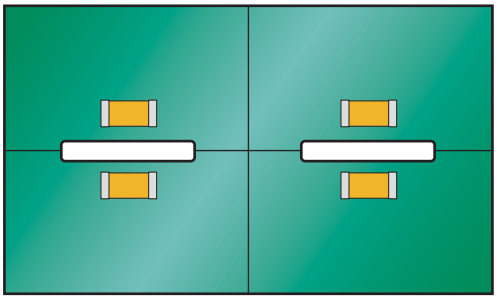
Poor Method - Direct Contact with Part

PCB BOARD DESIGN

To avoid many of the handling problems, AVX recommends that MLCs be located at least .2" away from nearest edge of board. However when this is not possible, AVX recommends that the panel be routed along the cut line, adjacent to where the MLC is located.



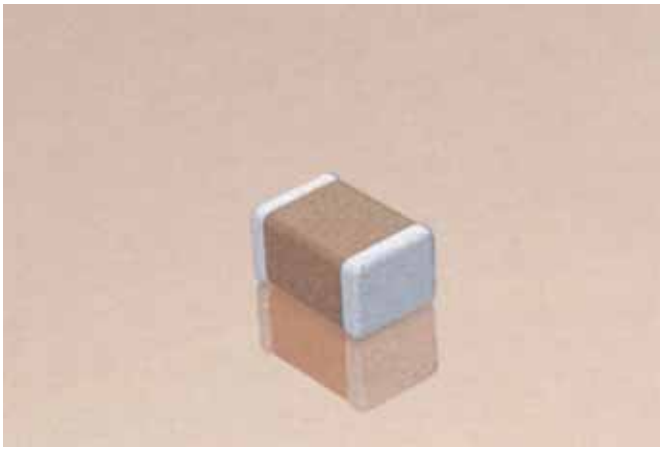
No Stress Relief for MLCs



Routed Cut Line Relieves Stress on MLC

X7R Dielectric

General Specifications



X7R formulations are called “temperature stable” ceramics and fall into EIA Class II materials. X7R is the most popular of these intermediate dielectric constant materials. Its temperature variation of capacitance is within ±15% from -55°C to +125°C. This capacitance change is non-linear.

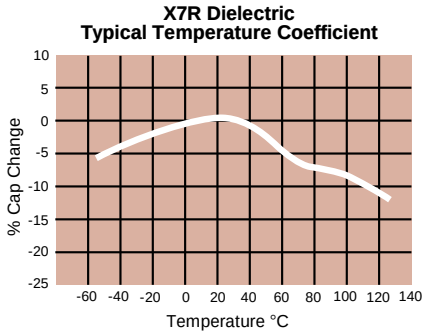
Capacitance for X7R varies under the influence of electrical operating conditions such as voltage and frequency.

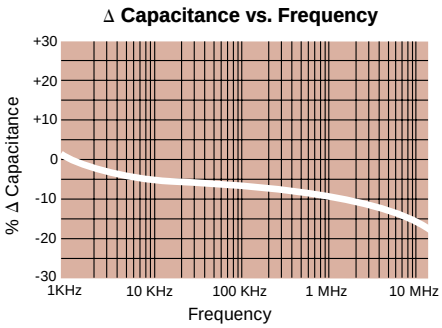
X7R dielectric chip usage covers the broad spectrum of industrial applications where known changes in capacitance due to applied voltages are acceptable.

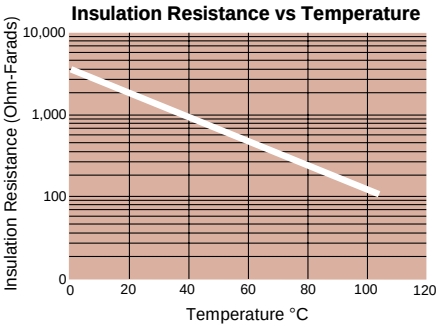
PART NUMBER (see page 2 for complete part number explanation)

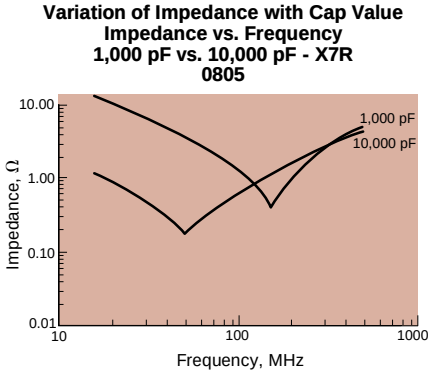
0805	5	C	103	M	A	T	2	A
Size (L" x W")	**Voltage** 4V = 4, 6.3V = 6, 10V = Z, 16V = Y, 25V = 3, 50V = 5, 100V = 1, 200V = 2, 500V = 7	**Dielectric** X7R = C	**Capacitance Code (In pF)** 2 Sig. Digits + Number of Zeros	**Capacitance Tolerance** J = ± 5%, K = ±10%, M = ± 20%	**Failure Rate** A = Not Applicable	**Terminations** T = Plated Ni and Sn, 7 = Gold Plated	**Packaging** 2 = 7" Reel, 4 = 13" Reel, 7 = Bulk Cass., 9 = Bulk	**Special Code** A = Std. Product

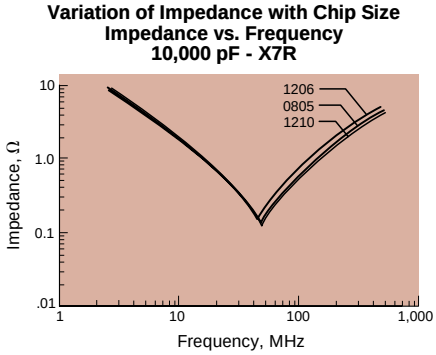
Contact Factory For Multiples

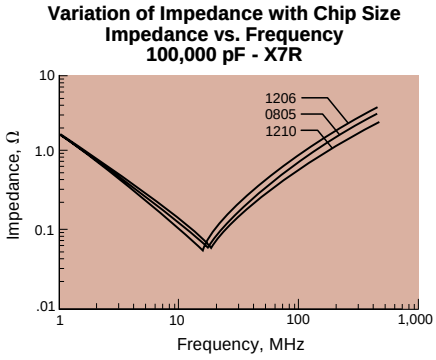






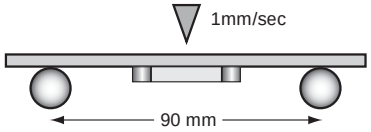






X7R Dielectric

Specifications and Test Methods

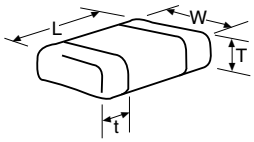
Parameter/Test		X7R Specification Limits	Measuring Conditions	
Operating Temperature Range		-55ºC to +125ºC	Temperature Cycle Chamber	
Capacitance		Within specified tolerance	Freq.: 1.0 kHz ± 10% Voltage: 1.0Vrms ± .2V For Cap > 10 µF, 0.5Vrms @ 120Hz	
Dissipation Factor		≤ 2.5% for ≥ 50V DC rating ≤ 3.0% for 25V DC rating ≤ 3.5% for 16V DC rating ≤ 5.0% for ≤ 10V DC rating		
Insulation Resistance		100,000MΩ or 1000MΩ - µF, whichever is less	Charge device with rated voltage for 120 ± 5 secs @ room temp/humidity	
Dielectric Strength		No breakdown or visual defects	Charge device with 300% of rated voltage for 1-5 seconds, w/charge and discharge current limited to 50 mA (max) Note: Charge device with 150% of rated voltage for 500V devices.	
Resistance to Flexure Stresses	Appearance	No defects	Deflection: 2mm Test Time: 30 seconds 	
	Capacitance Variation	≤ ±12%		
	Dissipation Factor	Meets Initial Values (As Above)		
	Insulation Resistance	≥ Initial Value x 0.3		
Solderability		≥ 95% of each terminal should be covered with fresh solder	Dip device in eutectic solder at 230 ± 5ºC for 5.0 ± 0.5 seconds	
Resistance to Solder Heat	Appearance	No defects, <25% leaching of either end terminal	Dip device in eutectic solder at 260ºC for 60 seconds. Store at room temperature for 24 ± 2 hours before measuring electrical properties.	
	Capacitance Variation	≤ ±7.5%		
	Dissipation Factor	Meets Initial Values (As Above)		
	Insulation Resistance	Meets Initial Values (As Above)		
	Dielectric Strength	Meets Initial Values (As Above)		
Thermal Shock	Appearance	No visual defects	Step 1: -55ºC ± 2º	30 ± 3 minutes
	Capacitance Variation	≤ ±7.5%	Step 2: Room Temp	≤ 3 minutes
	Dissipation Factor	Meets Initial Values (As Above)	Step 3: +125ºC ± 2º	30 ± 3 minutes
	Insulation Resistance	Meets Initial Values (As Above)	Step 4: Room Temp	≤ 3 minutes
	Dielectric Strength	Meets Initial Values (As Above)	Repeat for 5 cycles and measure after 24 ± 2 hours at room temperature	
Load Life	Appearance	No visual defects	Charge device with twice rated voltage in test chamber set at 125ºC ± 2ºC for 1000 hours (+48, -0) Remove from test chamber and stabilize at room temperature for 24 ± 2 hours before measuring.	
	Capacitance Variation	≤ ±12.5%		
	Dissipation Factor	≤ Initial Value x 2.0 (See Above)		
	Insulation Resistance	≥ Initial Value x 0.3 (See Above)		
	Dielectric Strength	Meets Initial Values (As Above)		
Load Humidity	Appearance	No visual defects	Store in a test chamber set at 85ºC ± 2ºC/ 85% ± 5% relative humidity for 1000 hours (+48, -0) with rated voltage applied. Remove from chamber and stabilize at room temperature and humidity for 24 ± 2 hours before measuring.	
	Capacitance Variation	≤ ±12.5%		
	Dissipation Factor	≤ Initial Value x 2.0 (See Above)		
	Insulation Resistance	≥ Initial Value x 0.3 (See Above)		
	Dielectric Strength	Meets Initial Values (As Above)		

X7R Dielectric

Capacitance Range

PREFERRED SIZES ARE SHADED

SIZE		0201	0402			0603					0805						1206						
Soldering		Reflow Only	Reflow Only			Reflow Only					Reflow/Wave						Reflow/Wave						
Packaging		All Paper	All Paper			All Paper					Paper/Embossed						Paper/Embossed						
(L) Length	MM	0.60 ± 0.03	1.00 ± 0.10			1.60 ± 0.15					2.01 ± 0.20						3.20 ± 0.20						
	(in.)	(0.024 ± 0.001)	(0.040 ± 0.004)			(0.063 ± 0.006)					(0.079 ± 0.008)						(0.126 ± 0.008)						
(W) Width	MM	0.30 ± 0.03	0.50 ± 0.10			0.81 ± 0.15					1.25 ± 0.20						1.60 ± 0.20						
	(in.)	(0.011 ± 0.001)	(0.020 ± 0.004)			(0.032 ± 0.006)					(0.049 ± 0.008)						(0.063 ± 0.008)						
(t) Terminal	MM	0.15 ± 0.05	0.25 ± 0.15			0.35 ± 0.15					0.50 ± 0.25						0.50 ± 0.25						
	(in.)	(0.006 ± 0.002)	(0.010 ± 0.006)			(0.014 ± 0.006)					(0.020 ± 0.010)						(0.020 ± 0.010)						
	WVDC	16	16	25	50	10	16	25	50	100	10	16	25	50	100	200	10	16	25	50	100	200	500
Cap (pF)	100	A																					
	150	A																					
	220	A			C																		
	330	A			C				G	G	J	J	J	J	J	J							K
	470	A			C				G	G	J	J	J	J	J	J							K
	680	A			C				G	G	J	J	J	J	J	J							K
	1000	A			C				G	G	J	J	J	J	J	J							K
	1500				C				G	G	J	J	J	J	J	J	J	J	J	J	J	J	M
	2200				C				G	G	J	J	J	J	J	J	J	J	J	J	J	J	M
	3300			C	C				G	G	J	J	J	J	J	J	J	J	J	J	J	J	M
	4700			C					G		J	J	J	J	J	J	J	J	J	J	J	J	M
	6800		C	C					G		J	J	J	J	J	J	J	J	J	J	J	J	P
Cap (µF)	0.010		C						G		J	J	J	J	J	J	J	J	J	J	J	J	P
	0.015		C					G	G		J	J	J	J	J	J	J	J	J	J	J	M	
	0.022		C					G			J	J	J	J	J	M	J	J	J	J	J	M	
	0.033							G			J	J	J	J	M		J	J	J	J	J	M	
	0.047						G	G			J	J	J	J	M		J	J	J	J	J	M	
	0.068						G				J	J	J	J			J	J	J	J	J	P	
	0.10					G	G	G			J	J	J	J			J	J	J	J	M		
	0.15					G					J	J	J				J	J	J	J			
	0.22					G					J	J	M				J	J	J	J			
	0.33										M	M					J	J	M	M			
	0.47										N	M					M	M	M				
	0.68										N						M	M					
	1.0										N						M	M	Q				
	1.5																P						
	2.2																Q						
	3.3																						
	4.7																						
	10																						
	22																						
	47																						
	100																						
	WVDC	16	16	25	50	10	16	25	50	100	10	16	25	50	100	200	10	16	25	50	100	200	500
	SIZE	0201	0402			0603					0805						1206						



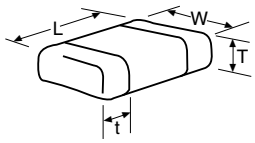
Letter	A	C	E	G	J	K	M	N	P	Q	X	Y	Z
Max. Thickness	0.33 (0.013)	0.56 (0.022)	0.71 (0.028)	0.86 (0.034)	0.94 (0.037)	1.02 (0.040)	1.27 (0.050)	1.40 (0.055)	1.52 (0.060)	1.78 (0.070)	2.29 (0.090)	2.54 (0.100)	2.79 (0.110)
	PAPER					EMBOSSED							

X7R Dielectric

Capacitance Range

PREFERRED SIZES ARE SHADED

SIZE		1210							1812				1825		2220				2225	
Soldering		Reflow Only							Reflow Only				Reflow Only		Reflow Only				Reflow Only	
Packaging		Paper/Embossed							All Embossed				All Embossed		All Embossed				All Embossed	
(L) Length	MM	3.20 ± 0.20							4.50 ± 0.30				4.50 ± 0.30		5.70 ± 0.40				5.72 ± 0.25	
	(in.)	(0.126 ± 0.008)							(0.177 ± 0.012)				(0.177 ± 0.012)		(0.225 ± 0.016)				(0.225 ± 0.010)	
(W) Width	MM	2.50 ± 0.20							3.20 ± 0.20				6.40 ± 0.40		5.00 ± 0.40				6.35 ± 0.25	
	(in.)	(0.098 ± 0.008)							(0.126 ± 0.008)				(0.252 ± 0.016)		(0.197 ± 0.016)				(0.250 ± 0.010)	
(t) Terminal	MM	0.50 ± 0.25							0.61 ± 0.36				0.61 ± 0.36		0.64 ± 0.39				0.64 ± 0.39	
	(in.)	(0.020 ± 0.010)							(0.024 ± 0.014)				(0.024 ± 0.014)		(0.025 ± 0.015)				(0.025 ± 0.015)	
	WVDC	10	16	25	50	100	200	500	50	100	200	500	50	100	6.3	50	100	200	50	100
Cap (pF)	100																			
	150																			
	220																			
	330																			
	470																			
	680																			
	1000																			
	1500	J	J	J	J	J	J	M												
	2200	J	J	J	J	J	J	M												
	3300	J	J	J	J	J	J	M												
	4700	J	J	J	J	J	J	M												
	6800	J	J	J	J	J	J	M												
Cap (µF)	0.010	J	J	J	J	J	J	M	K	K	K	K	M	M	X	X	X	X	M	P
	0.015	J	J	J	J	J	J	P	K	K	K	P	M	M	X	X	X	X	M	P
	0.022	J	J	J	J	J	J	Q	K	K	K	P	M	M	X	X	X	X	M	P
	0.033	J	J	J	J	J	J		K	K	K	X	M	M	X	X	X	X	M	P
	0.047	J	J	J	J	J	J		K	K	K	Z	M	M	X	X	X	X	M	P
	0.068	J	J	J	J	J	M		K	K	K		M	M	X	X	X	X	M	P
	0.10	J	J	J	J	J	M		K	K	K		M	M	X	X	X	X	M	P
	0.15	J	J	J	J	M			K	K	P		M	M	X	X	X	X	M	P
	0.22	J	J	J	J	P			K	K	P		M	M	X	X	X		M	P
	0.33	J	J	J	J	Z			K	M			M	M	X	X	X		M	P
	0.47	M	M	M	M	Z			K	P			M	M	X	X	X		M	P
	0.68	M	M	P	X	Z			M	Q			M		X	X	X		M	P
	1.0	N	N	P	X	Z			M	X			M				Z		M	P
	1.5	N	N										M						M	X
	2.2			X					Z										M	
	3.3																			
	4.7	Q	Z																	
	10	Z																		
	22																			
	47																			
	100																			
	WVDC	10	16	25	50	100	200	500	50	100	200	500	50	100	6.3	50	100	200	50	100
SIZE		1210							1812				1825		2220				2225	



Letter	A	C	E	G	J	K	M	N	P	Q	X	Y	Z
Max. Thickness	0.33 (0.013)	0.56 (0.022)	0.71 (0.028)	0.86 (0.034)	0.94 (0.037)	1.02 (0.040)	1.27 (0.050)	1.40 (0.055)	1.52 (0.060)	1.78 (0.070)	2.29 (0.090)	2.54 (0.100)	2.79 (0.110)
	PAPER					EMBOSSED							

Packaging of Chip Components

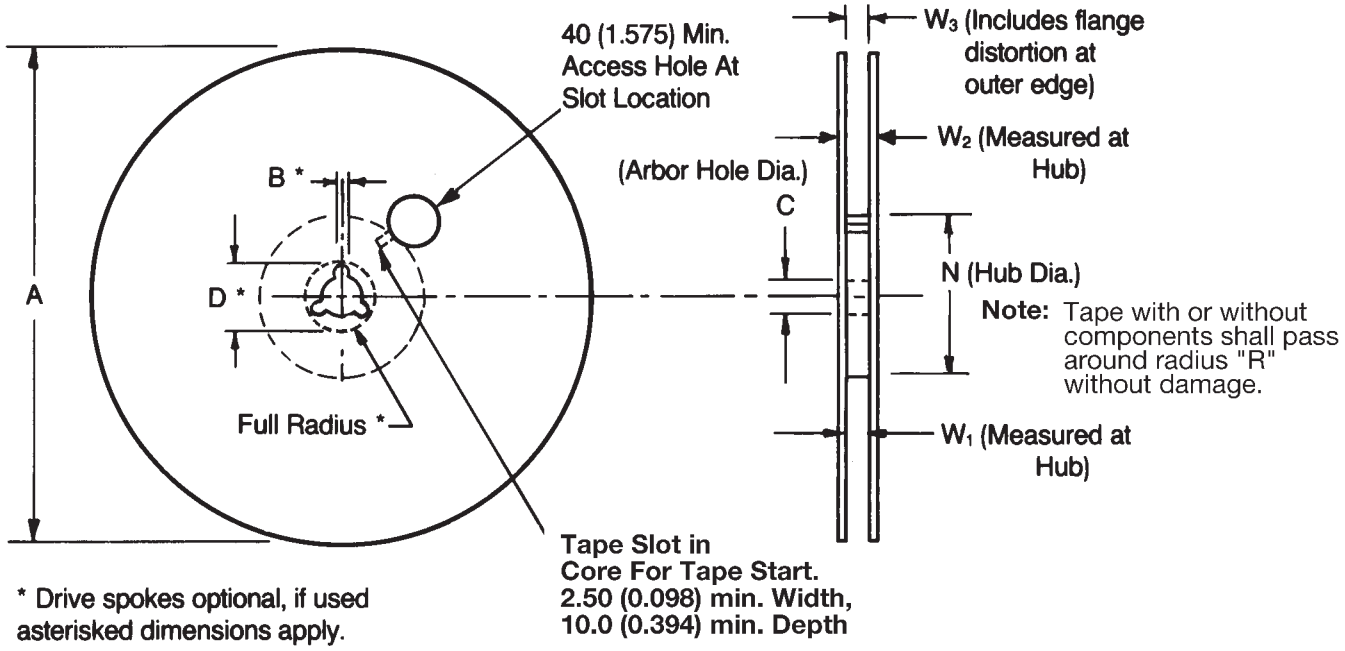
Automatic Insertion Packaging

TAPE & REEL QUANTITIES

All tape and reel specifications are in compliance with RS481.

	8mm	12mm	
Paper or Embossed Carrier	0612, 0508, 0805, 1206, 1210		
Embossed Only		1808	1812, 1825 2220, 2225
Paper Only	0201, 0306, 0402, 0603		
Qty. per Reel/7" Reel	2,000, 3,000 or 4,000, 10,000, 15,000 Contact factory for exact quantity	3,000	500, 1,000 Contact factory for exact quantity
Qty. per Reel/13" Reel	5,000, 10,000, 50,000 Contact factory for exact quantity	10,000	4,000

REEL DIMENSIONS

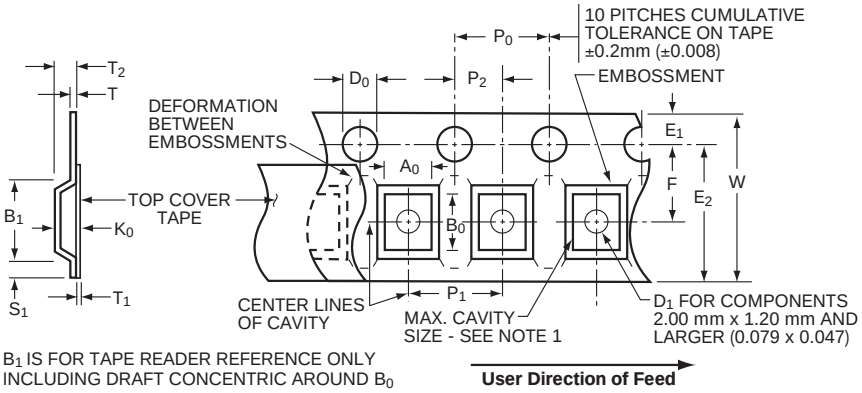


Tape Size(1)	A Max.	B* Min.	C	D* Min.	N Min.	W_1	W_2 Max.	W_3
8mm	330 (12.992)	1.5 (0.059)	$13.0^{+0.50}_{-0.20}$ ($0.512^{+0.020}_{-0.008}$)	20.2 (0.795)	50.0 (1.969)	$8.40^{+1.5}_{-0.0}$ ($0.331^{+0.059}_{-0.0}$)	14.4 (0.567)	7.90 Min. (0.311) 10.9 Max. (0.429)
12mm						$12.4^{+2.0}_{-0.0}$ ($0.488^{+0.079}_{-0.0}$)	18.4 (0.724)	11.9 Min. (0.469) 15.4 Max. (0.607)

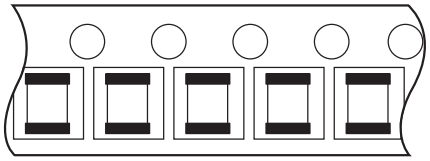
Metric dimensions will govern.
English measurements rounded and for reference only.
(1) For tape sizes 16mm and 24mm (used with chip size 3640) consult EIA RS-481 latest revision.

Embossed Carrier Configuration

8 & 12mm Tape Only



Chip Orientation



8 & 12mm Embossed Tape Metric Dimensions Will Govern

CONSTANT DIMENSIONS

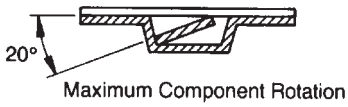
Tape Size	D_0	E	P_0	P_2	S_1 Min.	T Max.	T_1
8mm and 12mm	$1.50^{+0.10}_{-0.0}$ ($0.059^{+0.004}_{-0.0}$)	1.75 ± 0.10 (0.069 ± 0.004)	4.0 ± 0.10 (0.157 ± 0.004)	2.0 ± 0.05 (0.079 ± 0.002)	0.60 (0.024)	0.60 (0.024)	0.10 (0.004) Max.

VARIABLE DIMENSIONS

Tape Size	B_1 Max.	D_1 Min.	E_2 Min.	F	P_1 See Note 5	R Min. See Note 2	T_2	W Max.	A_0 B_0 K_0
8mm	4.35 (0.171)	1.00 (0.039)	6.25 (0.246)	3.50 ± 0.05 (0.138 ± 0.002)	4.00 ± 0.10 (0.157 ± 0.004)	25.0 (0.984)	2.50 Max. (0.098)	8.30 (0.327)	See Note 1
12mm	8.20 (0.323)	1.50 (0.059)	10.25 (0.404)	5.50 ± 0.05 (0.217 ± 0.002)	4.00 ± 0.10 (0.157 ± 0.004)	30.0 (1.181)	6.50 Max. (0.256)	12.3 (0.484)	See Note 1
8mm 1/2 Pitch	4.35 (0.171)	1.00 (0.039)	6.25 (0.246)	3.50 ± 0.05 (0.138 ± 0.002)	2.00 ± 0.10 (0.079 ± 0.004)	25.0 (0.984)	2.50 Max. (0.098)	8.30 (0.327)	See Note 1
12mm Double Pitch	8.20 (0.323)	1.50 (0.059)	10.25 (0.404)	5.50 ± 0.05 (0.217 ± 0.002)	8.00 ± 0.10 (0.315 ± 0.004)	30.0 (1.181)	6.50 Max. (0.256)	12.3 (0.484)	See Note 1

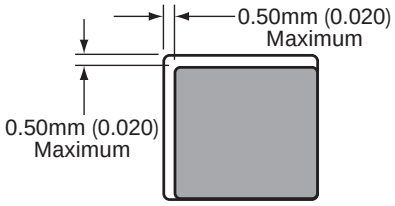
NOTES:

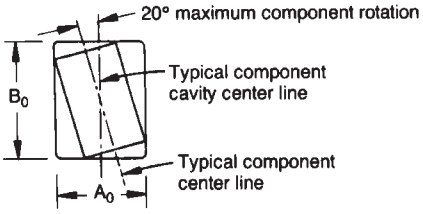
1. The cavity defined by A_0, B_0, and K_0 shall be configured to provide the following:
   Surround the component with sufficient clearance such that:
   a) the component does not protrude beyond the sealing plane of the cover tape.
   b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the cover tape has been removed.
   c) rotation of the component is limited to 20º maximum (see Sketches D & E).
   d) lateral movement of the component is restricted to 0.5mm maximum (see Sketch F).
2. Tape with or without components shall pass around radius "R" without damage.
3. Bar code labeling (if required) shall be on the side of the reel opposite the round sprocket holes. Refer to EIA-556.
4. B_1 dimension is a reference dimension for tape feeder clearance only.
5. If P_1 = 2.0mm, the tape may not properly index in all tape feeders.



Side or Front Sectional View
Sketch "C"

Top View, Sketch "F"
Component Lateral Movements

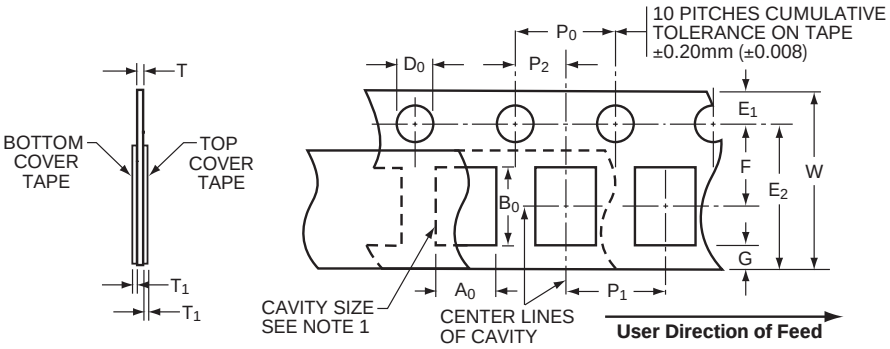




Top View
Sketch "D"

Paper Carrier Configuration

8 & 12mm Tape Only



8 & 12mm Paper Tape Metric Dimensions Will Govern

CONSTANT DIMENSIONS

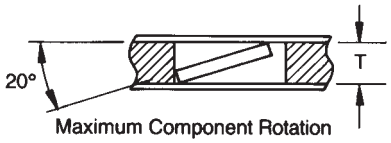
Tape Size	D_0	E	P_0	P_2	T_1	G. Min.	R Min.
8mm and 12mm	$1.50^{+0.10}_{-0.0}$ ($0.059^{+0.004}_{-0.0}$)	1.75 ± 0.10 (0.069 ± 0.004)	4.00 ± 0.10 (0.157 ± 0.004)	2.00 ± 0.05 (0.079 ± 0.002)	0.10 (0.004) Max.	0.75 (0.030) Min.	25.0 (0.984) See Note 2 Min.

VARIABLE DIMENSIONS

Tape Size	P_1 See Note 4	E_2 Min.	F	W	A_0 B_0	T
8mm	4.00 ± 0.10 (0.157 ± 0.004)	6.25 (0.246)	3.50 ± 0.05 (0.138 ± 0.002)	$8.00^{+0.30}_{-0.10}$ ($0.315^{+0.012}_{-0.004}$)	See Note 1	1.10mm (0.043) Max. for Paper Base Tape and 1.60mm (0.063) Max. for Non-Paper Base Compositions
12mm	4.00 ± 0.010 (0.157 ± 0.004)	10.25 (0.404)	5.50 ± 0.05 (0.217 ± 0.002)	12.0 ± 0.30 (0.472 ± 0.012)		
8mm 1/2 Pitch	2.00 ± 0.05 (0.079 ± 0.002)	6.25 (0.246)	3.50 ± 0.05 (0.138 ± 0.002)	$8.00^{+0.30}_{-0.10}$ ($0.315^{+0.012}_{-0.004}$)		
12mm Double Pitch	8.00 ± 0.10 (0.315 ± 0.004)	10.25 (0.404)	5.50 ± 0.05 (0.217 ± 0.002)	12.0 ± 0.30 (0.472 ± 0.012)		

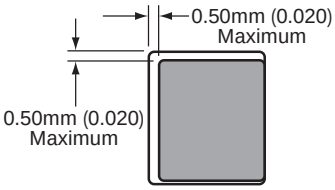
NOTES:

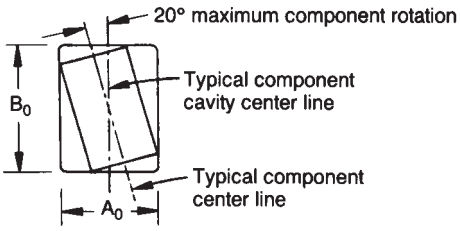
1. The cavity defined by A_0, B_0, and T shall be configured to provide sufficient clearance surrounding the component so that:
   a) the component does not protrude beyond either surface of the carrier tape;
   b) the component can be removed from the cavity in a vertical direction without mechanical restriction after the top cover tape has been removed;
   c) rotation of the component is limited to 20º maximum (see Sketches A & B);
   d) lateral movement of the component is restricted to 0.5mm maximum (see Sketch C).
2. Tape with or without components shall pass around radius "R" without damage.
3. Bar code labeling (if required) shall be on the side of the reel opposite the sprocket holes. Refer to EIA-556.
4. If P_1 = 2.0mm, the tape may not properly index in all tape feeders.



Side or Front Sectional View
Sketch "A"

Top View, Sketch "C"
Component Lateral





Top View
Sketch "B"

Bar Code Labeling Standard

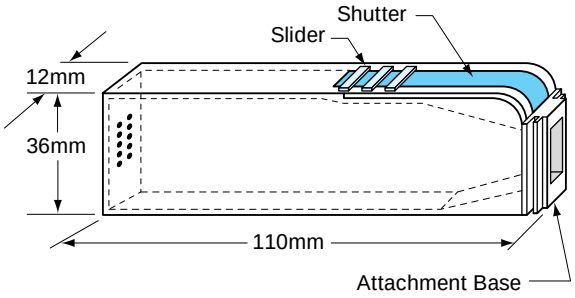
AVX bar code labeling is available and follows latest version of EIA-556

Bulk Case Packaging

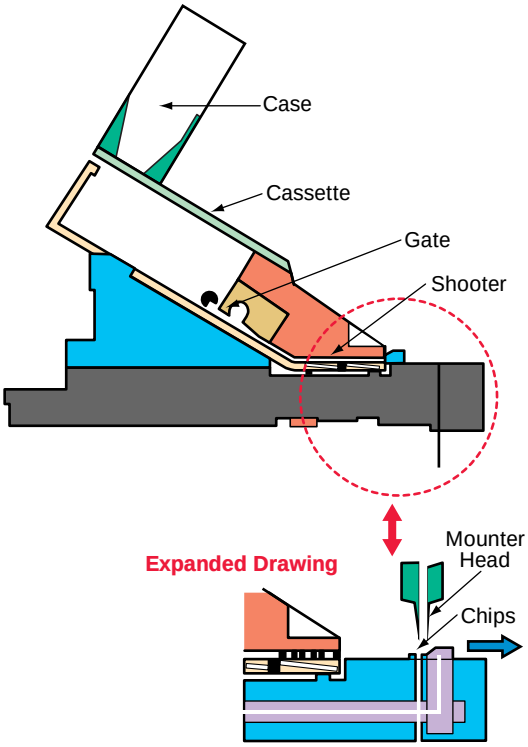
BENEFITS

- Easier handling
- Smaller packaging volume
  (1/20 of T/R packaging)
- Easier inventory control
- Flexibility
- Recyclable

CASE DIMENSIONS



BULK FEEDER



CASE QUANTITIES

Part Size	0402	0603	0805	1206
Qty. (pcs / cassette)	80,000	15,000	10,000 (T=.023") 8,000 (T=.031") 6,000 (T=.043")	5,000 (T=.023") 4,000 (T=.032") 3,000 (T=.044")

Basic Capacitor Formulas

I. Capacitance (farads)

English: $C = \frac{.224\ K\ A}{T_D}$

Metric: $C = \frac{.0884\ K\ A}{T_D}$

II. Energy stored in capacitors (Joules, watt - sec)

$E = \frac{1}{2} CV^2$

III. Linear charge of a capacitor (Amperes)

$I = C \frac{dV}{dt}$

IV. Total Impedance of a capacitor (ohms)

$Z = \sqrt{R_S^2 + (X_C - X_L)^2}$

V. Capacitive Reactance (ohms)

$x_C = \frac{1}{2 \pi fC}$

VI. Inductive Reactance (ohms)

$x_L = 2 \pi fL$

VII. Phase Angles:

Ideal Capacitors: Current leads voltage 90°
Ideal Inductors: Current lags voltage 90°
Ideal Resistors: Current in phase with voltage

VIII. Dissipation Factor (%)

D.F.= tan δ (loss angle) = $\frac{E.S.R.}{X_C}$ = $(2 \pi fC)$ (E.S.R.)

IX. Power Factor (%)

P.F. = Sine δ (loss angle) = Cos ϕ (phase angle)
P.F. = (when less than 10%) = DF

X. Quality Factor (dimensionless)

Q = Cotan δ (loss angle) = $\frac{1}{D.F.}$

XI. Equivalent Series Resistance (ohms)

E.S.R. = (D.F.) (Xc) = (D.F.) / $(2 \pi fC)$

XII. Power Loss (watts)

Power Loss = $(2 \pi fCV^2)$ (D.F.)

XIII. KVA (Kilowatts)

KVA = $2 \pi fCV^2 \times 10^{-3}$

XIV. Temperature Characteristic (ppm/°C)

T.C. = $\frac{Ct - C_{25}}{C_{25} (T_t - 25)} \times 10^6$

XV. Cap Drift (%)

C.D. = $\frac{C_1 - C_2}{C_1} \times 100$

XVI. Reliability of Ceramic Capacitors

$\frac{L_0}{L_t} = \left(\frac{V_t}{V_o}\right)^X \left(\frac{T_t}{T_o}\right)^Y$

XVII. Capacitors in Series (current the same)

Any Number: $\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} --- \frac{1}{C_N}$

Two: $C_T = \frac{C_1 C_2}{C_1 + C_2}$

XVIII. Capacitors in Parallel (voltage the same)

$C_T = C_1 + C_2 --- + C_N$

XIX. Aging Rate

A.R. = %Δ C/decade of time

XX. Decibels

db = $20 \log \frac{V_1}{V_2}$

METRIC PREFIXES

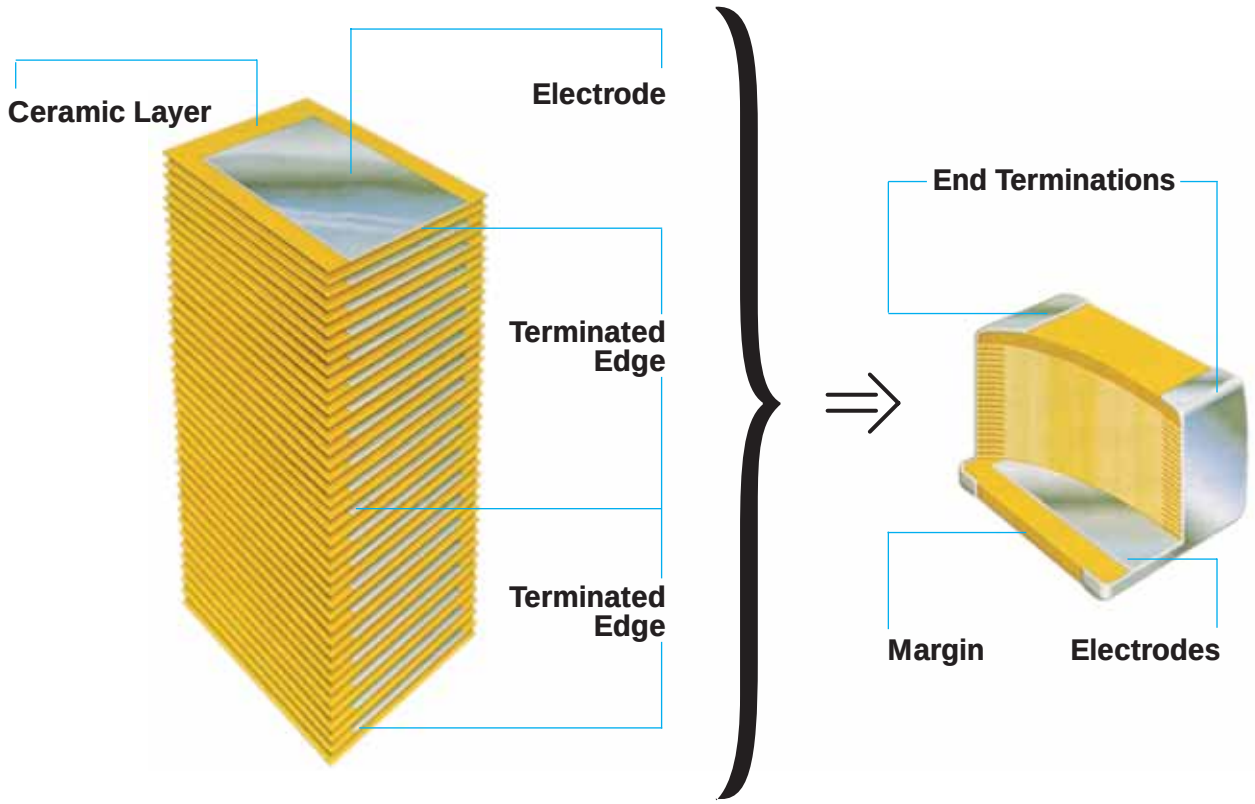
Pico	$X\ 10^{-12}$
Nano	$X\ 10^{-9}$
Micro	$X\ 10^{-6}$
Milli	$X\ 10^{-3}$
Deci	$X\ 10^{-1}$
Deca	$X\ 10^{+1}$
Kilo	$X\ 10^{+3}$
Mega	$X\ 10^{+6}$
Giga	$X\ 10^{+9}$
Tera	$X\ 10^{+12}$

SYMBOLS

K	= Dielectric Constant	f	= frequency	L_t	= Test life
A	= Area	L	= Inductance	V_t	= Test voltage
T_D	= Dielectric thickness	δ	= Loss angle	V_o	= Operating voltage
V	= Voltage	ϕ	= Phase angle	T_t	= Test temperature
t	= time	X & Y	= exponent effect of voltage and temp.	T_o	= Operating temperature
R_S	= Series Resistance	L_o	= Operating life		

General Description

Basic Construction – A multilayer ceramic (MLC) capacitor is a monolithic block of ceramic containing two sets of offset, interleaved planar electrodes that extend to two opposite surfaces of the ceramic dielectric. This simple structure requires a considerable amount of sophistication, both in material and manufacture, to produce it in the quality and quantities needed in today's electronic equipment.



Multilayer Ceramic Capacitor

Figure 1

Formulations – Multilayer ceramic capacitors are available in both Class 1 and Class 2 formulations. Temperature compensating formulation are Class 1 and temperature stable and general application formulations are classified as Class 2.

Class 1 – Class 1 capacitors or temperature compensating capacitors are usually made from mixtures of titanates where barium titanate is normally not a major part of the mix. They have predictable temperature coefficients and in general, do not have an aging characteristic. Thus they are the most stable capacitor available. The most popular Class 1 multilayer ceramic capacitors are C0G (NP0) temperature compensating capacitors (negative-positive 0 ppm/°C).

Class 2 – EIA Class 2 capacitors typically are based on the chemistry of barium titanate and provide a wide range of capacitance values and temperature stability. The most commonly used Class 2 dielectrics are X7R and Y5V. The X7R provides intermediate capacitance values which vary only ±15% over the temperature range of -55°C to 125°C. It finds applications where stability over a wide temperature range is required.

The Y5V provides the highest capacitance values and is used in applications where limited temperature changes are expected. The capacitance value for Y5V can vary from 22% to -82% over the -30°C to 85°C temperature range.

All Class 2 capacitors vary in capacitance value under the influence of temperature, operating voltage (both AC and DC), and frequency. For additional information on performance changes with operating conditions, consult AVX's software, SpiCap.

Table 1: EIA and MIL Temperature Stable and General Application Codes

EIA CODE Percent Capacity Change Over Temperature Range	
RS198	**Temperature Range**
X7	-55°C to +125°C
X6	-55°C to +105°C
X5	-55°C to +85°C
Y5	-30°C to +85°C
Z5	+10°C to +85°C
Code	**Percent Capacity Change**
D	±3.3%
E	±4.7%
F	±7.5%
P	±10%
R	±15%
S	±22%
T	+22%, -33%
U	+22%, - 56%
V	+22%, -82%
EXAMPLE – A capacitor is desired with the capacitance value at 25°C to increase no more than 7.5% or decrease no more than 7.5% from -30°C to +85°C. EIA Code will be Y5F.	

MIL CODE		
Symbol	**Temperature Range**	
A	-55°C to +85°C	
B	-55°C to +125°C	
C	-55°C to +150°C	
Symbol	**Cap. Change Zero Volts**	**Cap. Change Rated Volts**
R	+15%, -15%	+15%, -40%
S	+22%, -22%	+22%, -56%
W	+22%, -56%	+22%, -66%
X	+15%, -15%	+15%, -25%
Y	+30%, -70%	+30%, -80%
Z	+20%, -20%	+20%, -30%
Temperature characteristic is specified by combining range and change symbols, for example BR or AW. Specification slash sheets indicate the characteristic applicable to a given style of capacitor.		

In specifying capacitance change with temperature for Class 2 materials, EIA expresses the capacitance change over an operating temperature range by a 3 symbol code. The first symbol represents the cold temperature end of the temperature range, the second represents the upper limit of the operating temperature range and the third symbol represents the capacitance change allowed over the operating temperature range. Table 1 provides a detailed explanation of the EIA system.

Effects of Voltage – Variations in voltage have little effect on Class 1 dielectric but does affect the capacitance and dissipation factor of Class 2 dielectrics. The application of DC voltage reduces both the capacitance and dissipation factor while the application of an AC voltage within a reasonable range tends to increase both capacitance and dissipation factor readings. If a high enough AC voltage is applied, eventually it will reduce capacitance just as a DC voltage will. Figure 2 shows the effects of AC voltage.

Cap. Change vs. A.C. Volts
X7R

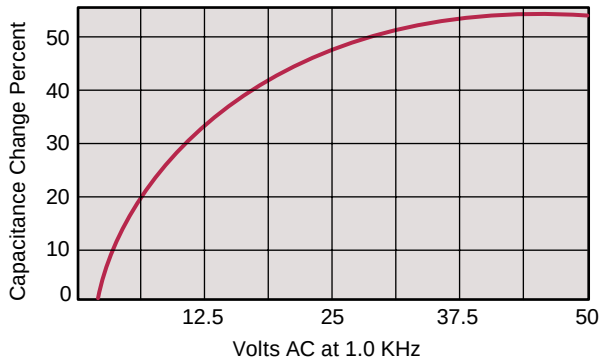


Figure 2

Capacitor specifications specify the AC voltage at which to measure (normally 0.5 or 1 VAC) and application of the wrong voltage can cause spurious readings. Figure 3 gives the voltage coefficient of dissipation factor for various AC voltages at 1 kilohertz. Applications of different frequencies will affect the percentage changes versus voltages.

D.F. vs. A.C. Measurement Volts
X7R

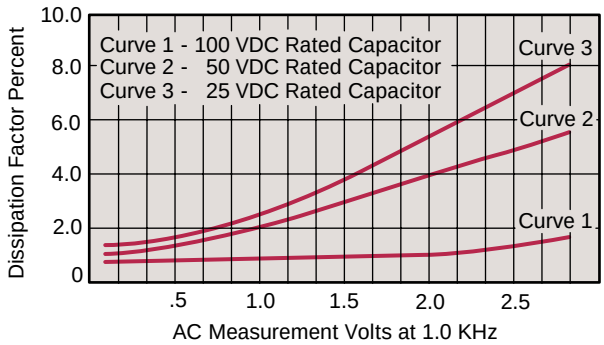


Figure 3

Typical effect of the application of DC voltage is shown in Figure 4. The voltage coefficient is more pronounced for higher K dielectrics. These figures are shown for room temperature conditions. The combination characteristic known as voltage temperature limits which shows the effects of rated voltage over the operating temperature range is shown in Figure 5 for the military BX characteristic.

Typical Cap. Change vs. D.C. Volts
X7R

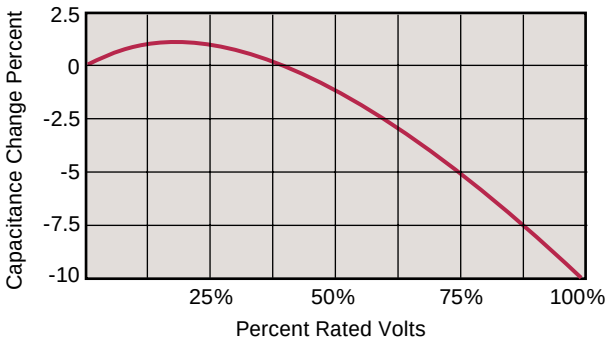


Figure 4

Typical Cap. Change vs. Temperature
X7R

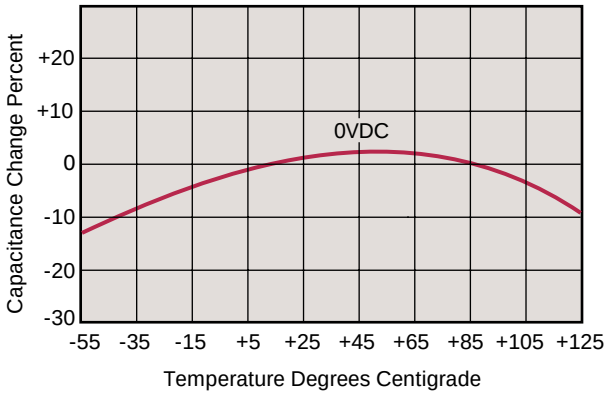
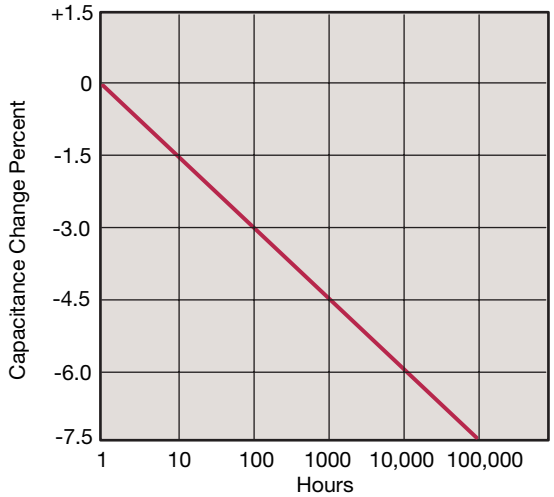


Figure 5

Effects of Time – Class 2 ceramic capacitors change capacitance and dissipation factor with time as well as temperature, voltage and frequency. This change with time is known as aging. Aging is caused by a gradual re-alignment of the crystalline structure of the ceramic and produces an exponential loss in capacitance and decrease in dissipation factor versus time. A typical curve of aging rate for semi-stable ceramics is shown in Figure 6.

If a Class 2 ceramic capacitor that has been sitting on the shelf for a period of time, is heated above its curie point, (125°C for 4 hours or 150°C for ½ hour will suffice) the part will de-age and return to its initial capacitance and dissipation factor readings. Because the capacitance changes rapidly, immediately after de-aging, the basic capacitance measurements are normally referred to a time period sometime after the de-aging process. Various manufacturers use different time bases but the most popular one is one day or twenty-four hours after "last heat." Change in the aging curve can be caused by the application of voltage and other stresses. The possible changes in capacitance due to de-aging by heating the unit explain why capacitance changes are allowed after test, such as temperature cycling, moisture resistance, etc., in MIL specs. The application of high voltages such as dielectric withstanding voltages also tends to de-age capacitors and is why re-reading of capacitance after 12 or 24 hours is allowed in military specifications after dielectric strength tests have been performed.

Typical Curve of Aging Rate
X7R



Characteristic	Max. Aging Rate %/Decade
C0G (NP0)	None
X7R, X5R	2
Y5V	7

Figure 6

Effects of Frequency – Frequency affects capacitance and impedance characteristics of capacitors. This effect is much more pronounced in high dielectric constant ceramic formulation than in low K formulations. AVX's SpiCap software generates impedance, ESR, series inductance, series resonant frequency and capacitance all as functions of frequency, temperature and DC bias for standard chip sizes and styles. It is available free from AVX and can be downloaded for free from AVX website: www.avx.com.

Effects of Mechanical Stress – High "K" dielectric ceramic capacitors exhibit some low level piezoelectric reactions under mechanical stress. As a general statement, the piezoelectric output is higher, the higher the dielectric constant of the ceramic. It is desirable to investigate this effect before using high "K" dielectrics as coupling capacitors in extremely low level applications.

Reliability – Historically ceramic capacitors have been one of the most reliable types of capacitors in use today. The approximate formula for the reliability of a ceramic capacitor is:

$$\frac{L_o}{L_t} = \left(\frac{V_t}{V_o}\right)^X \left(\frac{T_t}{T_o}\right)^Y$$

where

L_o = operating life
L_t = test life
V_t = test voltage
V_o = operating voltage
T_t = test temperature and
T_o = operating temperature in °C
X,Y = see text

Historically for ceramic capacitors exponent X has been considered as 3. The exponent Y for temperature effects typically tends to run about 8.

A capacitor is a component which is capable of storing electrical energy. It consists of two conductive plates (electrodes) separated by insulating material which is called the dielectric. A typical formula for determining capacitance is:

$$C = \frac{.224\,KA}{t}$$

C = capacitance (picofarads)
K = dielectric constant (Vacuum = 1)
A = area in square inches
t = separation between the plates in inches (thickness of dielectric)
.224 = conversion constant (.0884 for metric system in cm)

Capacitance – The standard unit of capacitance is the farad. A capacitor has a capacitance of 1 farad when 1 coulomb charges it to 1 volt. One farad is a very large unit and most capacitors have values in the micro (10^{-6}), nano (10^{-9}) or pico (10^{-12}) farad level.

Dielectric Constant – In the formula for capacitance given above the dielectric constant of a vacuum is arbitrarily chosen as the number 1. Dielectric constants of other materials are then compared to the dielectric constant of a vacuum.

Dielectric Thickness – Capacitance is indirectly proportional to the separation between electrodes. Lower voltage requirements mean thinner dielectrics and greater capacitance per volume.

Area – Capacitance is directly proportional to the area of the electrodes. Since the other variables in the equation are usually set by the performance desired, area is the easiest parameter to modify to obtain a specific capacitance within a material group.

Energy Stored – The energy which can be stored in a capacitor is given by the formula:

$$E = \tfrac{1}{2}CV^2$$

E = energy in joules (watts-sec)
V = applied voltage
C = capacitance in farads

Potential Change – A capacitor is a reactive component which reacts against a change in potential across it. This is shown by the equation for the linear charge of a capacitor:

$$I_{ideal} = C\frac{dV}{dt}$$

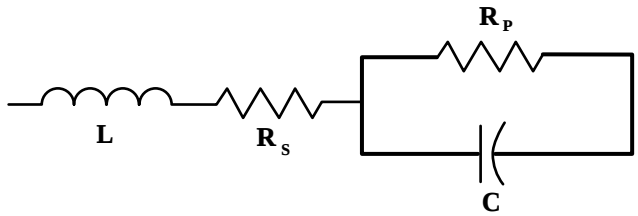
where

I = Current
C = Capacitance
dV/dt = Slope of voltage transition across capacitor

Thus an infinite current would be required to instantly change the potential across a capacitor. The amount of current a capacitor can "sink" is determined by the above equation.

Equivalent Circuit – A capacitor, as a practical device, exhibits not only capacitance but also resistance and inductance. A simplified schematic for the equivalent circuit is:

C = Capacitance
R_s = Series Resistance
L = Inductance
R_p = Parallel Resistance



Reactance – Since the insulation resistance (R_p) is normally very high, the total impedance of a capacitor is:

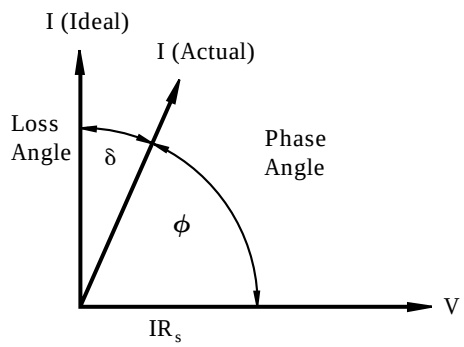
$$Z = \sqrt{R_S^2 + (X_C - X_L)^2}$$

where

Z = Total Impedance
R_s = Series Resistance
X_C = Capacitive Reactance $= \frac{1}{2\pi fC}$
X_L = Inductive Reactance $= 2\pi fL$

The variation of a capacitor's impedance with frequency determines its effectiveness in many applications.

Phase Angle – Power Factor and Dissipation Factor are often confused since they are both measures of the loss in a capacitor under AC application and are often almost identical in value. In a "perfect" capacitor the current in the capacitor will lead the voltage by 90°.

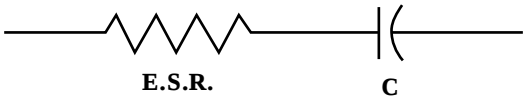


In practice the current leads the voltage by some other phase angle due to the series resistance R_S. The complement of this angle is called the loss angle and:

Power Factor (P.F.) = Cos ϕ or Sine δ
Dissipation Factor (D.F.) = tan δ

for small values of δ the tan and sine are essentially equal which has led to the common interchangeability of the two terms in the industry.

Equivalent Series Resistance – The term E.S.R. or Equivalent Series Resistance combines all losses both series and parallel in a capacitor at a given frequency so that the equivalent circuit is reduced to a simple R-C series connection.



Dissipation Factor – The DF/PF of a capacitor tells what percent of the apparent power input will turn to heat in the capacitor.

$$\textbf{Dissipation Factor} = \frac{\textbf{E.S.R.}}{\textbf{X}_c} = (2\pi fC)(\text{E.S.R.})$$

The watts loss are:

$$\textbf{Watts loss} = (2\pi fCV^2)(\text{D.F.})$$

Very low values of dissipation factor are expressed as their reciprocal for convenience. These are called the "Q" or Quality factor of capacitors.

Parasitic Inductance – The parasitic inductance of capacitors is becoming more and more important in the decoupling of today's high speed digital systems. The relationship between the inductance and the ripple voltage induced on the DC voltage line can be seen from the simple inductance equation:

$$V = L\frac{di}{dt}$$

The $\frac{di}{dt}$ seen in current microprocessors can be as high as 0.3 A/ns, and up to 10A/ns. At 0.3 A/ns, 100pH of parasitic inductance can cause a voltage spike of 30mV. While this does not sound very drastic, with the Vcc for microprocessors decreasing at the current rate, this can be a fairly large percentage.

Another important, often overlooked, reason for knowing the parasitic inductance is the calculation of the resonant frequency. This can be important for high frequency, bypass capacitors, as the resonant point will give the most signal attenuation. The resonant frequency is calculated from the simple equation:

$$f_{res} = \frac{1}{2\pi\sqrt{LC}}$$

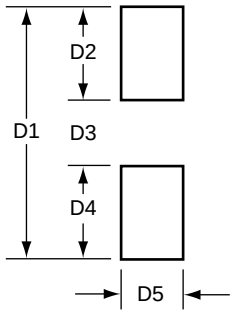
Insulation Resistance – Insulation Resistance is the resistance measured across the terminals of a capacitor and consists principally of the parallel resistance R_P shown in the equivalent circuit. As capacitance values and hence the area of dielectric increases, the I.R. decreases and hence the product (C x IR or RC) is often specified in ohm faradsor more commonly megohm-microfarads. Leakage current is determined by dividing the rated voltage by IR (Ohm's Law).

Dielectric Strength – Dielectric Strength is an expression of the ability of a material to withstand an electrical stress. Although dielectric strength is ordinarily expressed in volts, it is actually dependent on the thickness of the dielectric and thus is also more generically a function of volts/mil.

Dielectric Absorption – A capacitor does not discharge instantaneously upon application of a short circuit, but drains gradually after the capacitance proper has been discharged. It is common practice to measure the dielectric absorption by determining the "reappearing voltage" which appears across a capacitor at some point in time after it has been fully discharged under short circuit conditions.

Corona – Corona is the ionization of air or other vapors which causes them to conduct current. It is especially prevalent in high voltage units but can occur with low voltages as well where high voltage gradients occur. The energy discharged degrades the performance of the capacitor and can in time cause catastrophic failures.

REFLOW SOLDERING



Case Size	D1	D2	D3	D4	D5
0402	1.70 (0.07)	0.60 (0.02)	0.50 (0.02)	0.60 (0.02)	0.50 (0.02)
0603	2.30 (0.09)	0.80 (0.03)	0.70 (0.03)	0.80 (0.03)	0.75 (0.03)
0805	3.00 (0.12)	1.00 (0.04)	1.00 (0.04)	1.00 (0.04)	1.25 (0.05)
1206	4.00 (0.16)	1.00 (0.04)	2.00 (0.09)	1.00 (0.04)	1.60 (0.06)
1210	4.00 (0.16)	1.00 (0.04)	2.00 (0.09)	1.00 (0.04)	2.50 (0.10)
1808	5.60 (0.22)	1.00 (0.04)	3.60 (0.14)	1.00 (0.04)	2.00 (0.08)
1812	5.60 (0.22)	1.00 (0.04))	3.60 (0.14)	1.00 (0.04)	3.00 (0.12)
1825	5.60 (0.22)	1.00 (0.04)	3.60 (0.14)	1.00 (0.04)	6.35 (0.25)
2220	6.60 (0.26)	1.00 (0.04)	4.60 (0.18)	1.00 (0.04)	5.00 (0.20)
2225	6.60 (0.26)	1.00 (0.04)	4.60 (0.18)	1.00 (0.04)	6.35 (0.25)

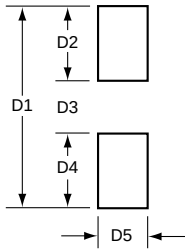
Dimensions in millimeters (inches)

Component Pad Design

Component pads should be designed to achieve good solder filets and minimize component movement during reflow soldering. Pad designs are given below for the most common sizes of multilayer ceramic capacitors for both wave and reflow soldering. The basis of these designs is:

- Pad width equal to component width. It is permissible to decrease this to as low as 85% of component width but it is not advisable to go below this.
- Pad overlap 0.5mm beneath component.
- Pad extension 0.5mm beyond components for reflow and 1.0mm for wave soldering.

WAVE SOLDERING

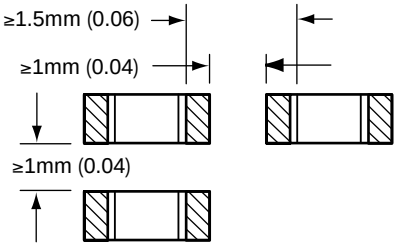


Case Size	D1	D2	D3	D4	D5
0603	3.10 (0.12)	1.20 (0.05)	0.70 (0.03)	1.20 (0.05)	0.75 (0.03)
0805	4.00 (0.15)	1.50 (0.06)	1.00 (0.04)	1.50 (0.06)	1.25 (0.05)
1206	5.00 (0.19)	1.50 (0.06)	2.00 (0.09)	1.50 (0.06)	1.60 (0.06)

Dimensions in millimeters (inches)

Component Spacing

For wave soldering components, must be spaced sufficiently far apart to avoid bridging or shadowing (inability of solder to penetrate properly into small spaces). This is less important for reflow soldering but sufficient space must be allowed to enable rework should it be required.



Preheat & Soldering

The rate of preheat should not exceed 4°C/second to prevent thermal shock. A better maximum figure is about 2°C/second.

For capacitors size 1206 and below, with a maximum thickness of 1.25mm, it is generally permissible to allow a temperature differential from preheat to soldering of 150°C. In all other cases this differential should not exceed 100°C.

For further specific application or process advice, please consult AVX.

Cleaning

Care should be taken to ensure that the capacitors are thoroughly cleaned of flux residues especially the space beneath the capacitor. Such residues may otherwise become conductive and effectively offer a low resistance bypass to the capacitor.

Ultrasonic cleaning is permissible, the recommended conditions being 8 Watts/litre at 20-45 kHz, with a process cycle of 2 minutes vapor rinse, 2 minutes immersion in the ultrasonic solvent bath and finally 2 minutes vapor rinse.

APPLICATION NOTES

Storage
Good solderability is maintained for at least twelve months, provided the components are stored in their "as received" packaging at less than 40°C and 70% RH.

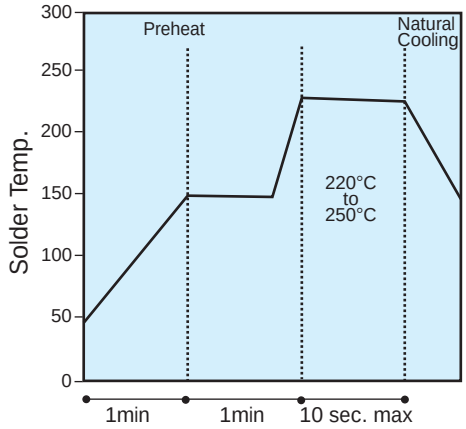
Solderability
Terminations to be well soldered after immersion in a 60/40 tin/lead solder bath at 235 ± 5°C for 2 ± 1 seconds.

Leaching
Terminations will resist leaching for at least the immersion times and conditions shown below.

Termination Type	Solder Tin/Lead/Silver	Solder Temp. °C	Immersion Time Seconds
Nickel Barrier	60/40/0	260 ± 5	30 ± 1

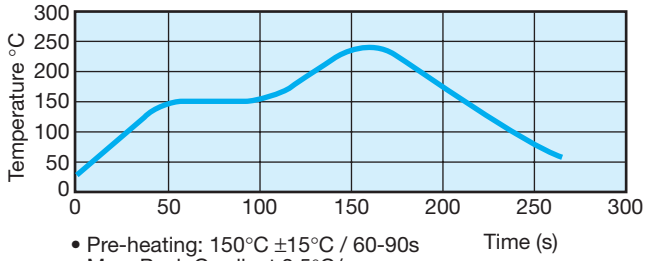
Recommended Soldering Profiles

Reflow



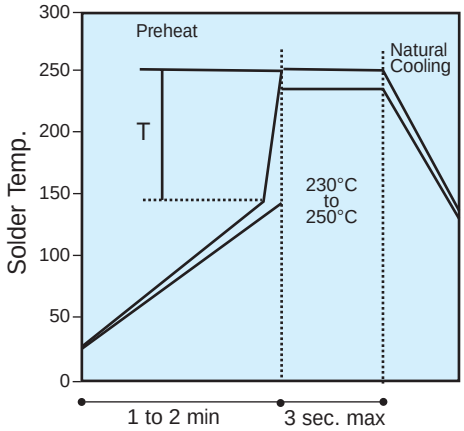
(Minimize soldering time)

Lead-Free Reflow Profile



- Pre-heating: 150°C ±15°C / 60-90s
- Max. Peak Gradient 2.5°C/s
- Peak Temperature: 245°C ±5°C
- Time at >230°C: 40s Max.

Wave



(Preheat chips before soldering)
T/maximum 150°C

Lead-Free Wave Soldering
The recommended peak temperature for lead-free wave soldering is 250°C-260°C for 3-5 seconds. The other parameters of the profile remains the same as above.

The following should be noted by customers changing from lead based systems to the new lead free pastes.

a) The visual standards used for evaluation of solder joints will need to be modified as lead free joints are not as bright as with tin-lead pastes and the fillet may not be as large.

b) Resin color may darken slightly due to the increase in temperature required for the new pastes.

c) Lead-free solder pastes do not allow the same self alignment as lead containing systems. Standard mounting pads are acceptable, but machine set up may need to be modified.

General
Surface mounting chip multilayer ceramic capacitors are designed for soldering to printed circuit boards or other substrates. The construction of the components is such that they will withstand the time/temperature profiles used in both wave and reflow soldering methods.

Handling
Chip multilayer ceramic capacitors should be handled with care to avoid damage or contamination from perspiration and skin oils. The use of tweezers or vacuum pick ups is strongly recommended for individual components. Bulk handling should ensure that abrasion and mechanical shock are minimized. Taped and reeled components provides the ideal medium for direct presentation to the placement machine. Any mechanical shock should be minimized during handling chip multilayer ceramic capacitors.

Preheat
It is important to avoid the possibility of thermal shock during soldering and carefully controlled preheat is therefore required. The rate of preheat should not exceed 4°C/second

and a target figure 2°C/second is recommended. Although an 80°C to 120°C temperature differential is preferred, recent developments allow a temperature differential between the component surface and the soldering temperature of 150°C (Maximum) for capacitors of 1210 size and below with a maximum thickness of 1.25mm. The user is cautioned that the risk of thermal shock increases as chip size or temperature differential increases.

Soldering

Mildly activated rosin fluxes are preferred. The minimum amount of solder to give a good joint should be used. Excessive solder can lead to damage from the stresses caused by the difference in coefficients of expansion between solder, chip and substrate. AVX terminations are suitable for all wave and reflow soldering systems. If hand soldering cannot be avoided, the preferred technique is the utilization of hot air soldering tools.

Cooling

Natural cooling in air is preferred, as this minimizes stresses within the soldered joint. When forced air cooling is used, cooling rate should not exceed 4°C/second. Quenching is not recommended but if used, maximum temperature differentials should be observed according to the preheat conditions above.

Cleaning

Flux residues may be hygroscopic or acidic and must be removed. AVX MLC capacitors are acceptable for use with all of the solvents described in the specifications MIL-STD-202 and EIA-RS-198. Alcohol based solvents are acceptable and properly controlled water cleaning systems are also acceptable. Many other solvents have been proven successful, and most solvents that are acceptable to other components on circuit assemblies are equally acceptable for use with ceramic capacitors.

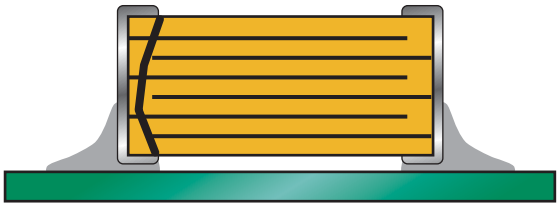
POST SOLDER HANDLING

Once SMP components are soldered to the board, any bending or flexure of the PCB applies stresses to the soldered joints of the components. For leaded devices, the stresses are absorbed by the compliancy of the metal leads and generally don't result in problems unless the stress is large enough to fracture the soldered connection.

Ceramic capacitors are more susceptible to such stress because they don't have compliant leads and are brittle in nature. The most frequent failure mode is low DC resistance or short circuit. The second failure mode is significant loss of capacitance due to severing of contact between sets of the internal electrodes.

Cracks caused by mechanical flexure are very easily identified and generally take one of the following two general forms:

Type A:
Angled crack between bottom of device to top of solder joint.



Type B:
Fracture from top of device to bottom of device.

Mechanical cracks are often hidden underneath the termination and are difficult to see externally. However, if one end termination falls off during the removal process from PCB, this is one indication that the cause of failure was excessive mechanical stress due to board warping.

COMMON CAUSES OF MECHANICAL CRACKING

The most common source for mechanical stress is board depanelization equipment, such as manual breakapart, v-cutters and shear presses. Improperly aligned or dull cutters may cause torqueing of the PCB resulting in flex stresses being transmitted to components near the board edge. Another common source of flexural stress is contact during parametric testing when test points are probed. If the PCB is allowed to flex during the test cycle, nearby ceramic capacitors may be broken.

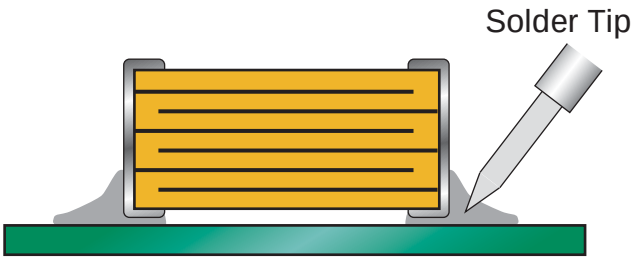
A third common source is board to board connections at vertical connectors where cables or other PCBs are connected to the PCB. If the board is not supported during the plug/unplug cycle, it may flex and cause damage to nearby components.

Special care should also be taken when handling large (>6" on a side) PCBs since they more easily flex or warp than smaller boards.

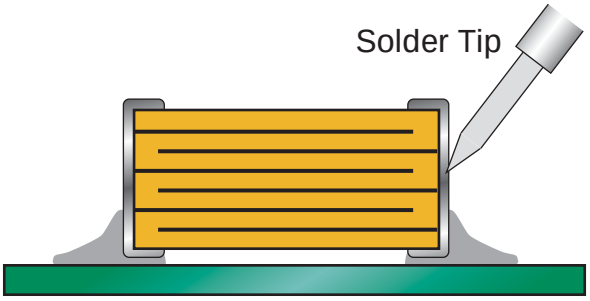
REWORKING OF MLCs

Thermal shock is common in MLCs that are manually attached or reworked with a soldering iron. *AVX strongly recommends that any reworking of MLCs be done with hot air reflow rather than soldering irons.* It is practically impossible to cause any thermal shock in ceramic capacitors when using hot air reflow.

However direct contact by the soldering iron tip often causes thermal cracks that may fail at a later date. If rework by soldering iron is absolutely necessary, it is recommended that the wattage of the iron be less than 30 watts and the tip temperature be <300ºC. *Rework should be performed by applying the solder iron tip to the pad and not directly contacting any part of the ceramic capacitor.*



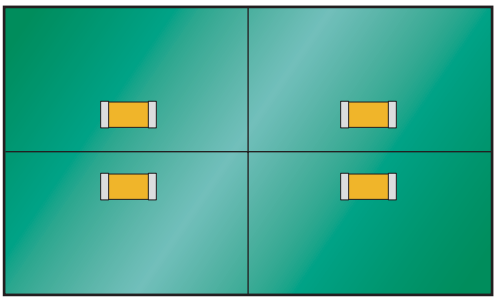
Preferred Method - No Direct Part Contact



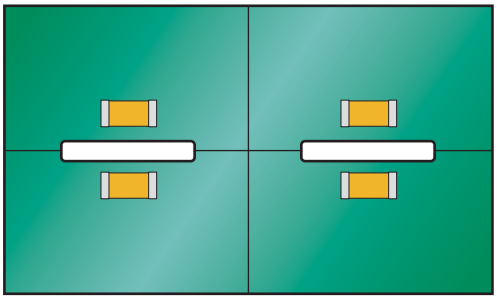
Poor Method - Direct Contact with Part

PCB BOARD DESIGN

To avoid many of the handling problems, AVX recommends that MLCs be located at least .2" away from nearest edge of board. However when this is not possible, AVX recommends that the panel be routed along the cut line, adjacent to where the MLC is located.



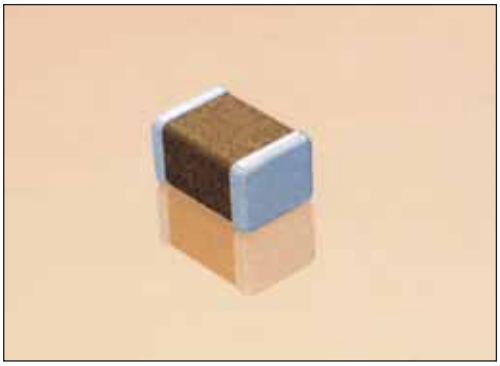
No Stress Relief for MLCs



Routed Cut Line Relieves Stress on MLC

X5R Dielectric

General Specifications



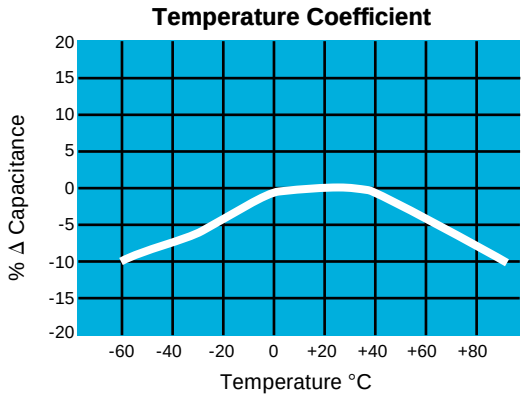
GENERAL DESCRIPTION

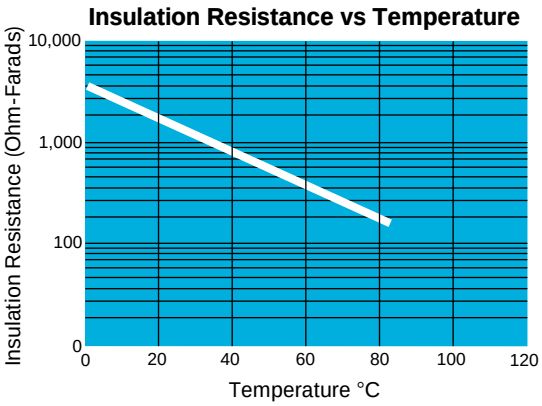
- General Purpose Dielectric for Ceramic Capacitors
- EIA Class II Dielectric
- Temperature variation of capacitance is within ±15% from -55°C to +85°C
- Well suited for decoupling and filtering applications
- Available in High Capacitance values (up to 100µF)

PART NUMBER (see page 2 for complete part number explanation)

2220	6	D	107	M	A	T	2	A
Size (L" x W")	**Voltage** 4 = 4V, 6 = 6.3V, Z = 10V, Y = 16V, 3 = 25V, D = 35V, 5 = 50V	**Dielectric** D = X5R	**Capacitance Code (In pF)** 2 Sig. Digits + Number of Zeros	**Capacitance Tolerance** K = ±10%, M = ±20%	**Failure Rate** A = N/A	**Terminations** T = Plated Ni and Sn	**Packaging** 2 = 7" Reel, 4 = 13" Reel, 7 = Bulk Cass., 9 = Bulk	**Special Code** A = Std.

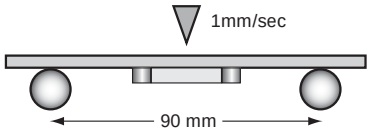
TYPICAL ELECTRICAL CHARACTERISTICS





X5R Dielectric

Specifications and Test Methods

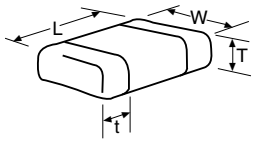
Parameter/Test		X5R Specification Limits	Measuring Conditions	
Operating Temperature Range		-55ºC to +85ºC	Temperature Cycle Chamber	
Capacitance		Within specified tolerance	Freq.: 1.0 kHz ± 10% Voltage: 1.0Vrms ± .2V For Cap > 10 µF, 0.5Vrms @ 120Hz	
Dissipation Factor		≤ 2.5% for ≥ 50V DC rating ≤ 3.0% for 25V DC rating ≤ 3.5% for 16V DC rating ≤ 5.0% for ≤ 10V DC rating		
Insulation Resistance		100,000MΩ or 500MΩ - µF, whichever is less	Charge device with rated voltage for 120 ± 5 secs @ room temp/humidity	
Dielectric Strength		No breakdown or visual defects	Charge device with 300% of rated voltage for 1-5 seconds, w/charge and discharge current limited to 50 mA (max)	
Resistance to Flexure Stresses	Appearance	No defects	Deflection: 2mm Test Time: 30 seconds 	
	Capacitance Variation	≤ ±12%		
	Dissipation Factor	Meets Initial Values (As Above)		
	Insulation Resistance	≥ Initial Value x 0.3		
Solderability		≥ 95% of each terminal should be covered with fresh solder	Dip device in eutectic solder at 230 ± 5ºC for 5.0 ± 0.5 seconds	
Resistance to Solder Heat	Appearance	No defects, <25% leaching of either end terminal	Dip device in eutectic solder at 260ºC for 60 seconds. Store at room temperature for 24 ± 2 hours before measuring electrical properties.	
	Capacitance Variation	≤ ±7.5%		
	Dissipation Factor	Meets Initial Values (As Above)		
	Insulation Resistance	Meets Initial Values (As Above)		
	Dielectric Strength	Meets Initial Values (As Above)		
Thermal Shock	Appearance	No visual defects	Step 1: -55ºC ± 2º	30 ± 3 minutes
	Capacitance Variation	≤ ±7.5%	Step 2: Room Temp	≤ 3 minutes
	Dissipation Factor	Meets Initial Values (As Above)	Step 3: +85ºC ± 2º	30 ± 3 minutes
	Insulation Resistance	Meets Initial Values (As Above)	Step 4: Room Temp	≤ 3 minutes
	Dielectric Strength	Meets Initial Values (As Above)	Repeat for 5 cycles and measure after 24 ± 2 hours at room temperature	
Load Life	Appearance	No visual defects	Charge device with 1.5X rated voltage in test chamber set at 85ºC ± 2ºC for 1000 hours (+48, -0). Note: Contact factory for specific high CV devices that are tested at 1.5X rated voltage. Remove from test chamber and stabilize at room temperature for 24 ± 2 hours before measuring.	
	Capacitance Variation	≤ ±12.5%		
	Dissipation Factor	≤ Initial Value x 2.0 (See Above)		
	Insulation Resistance	≥ Initial Value x 0.3 (See Above)		
	Dielectric Strength	Meets Initial Values (As Above)		
Load Humidity	Appearance	No visual defects	Store in a test chamber set at 85ºC ± 2ºC/ 85% ± 5% relative humidity for 1000 hours (+48, -0) with rated voltage applied. Remove from chamber and stabilize at room temperature and humidity for 24 ± 2 hours before measuring.	
	Capacitance Variation	≤ ±12.5%		
	Dissipation Factor	≤ Initial Value x 2.0 (See Above)		
	Insulation Resistance	≥ Initial Value x 0.3 (See Above)		
	Dielectric Strength	Meets Initial Values (As Above)		

X5R Dielectric

Capacitance Range

PREFERRED SIZES ARE SHADED

SIZE		0201			0402					0603						0805					
Soldering		Reflow Only			Reflow Only					Reflow Only						Reflow/Wave					
Packaging		All Paper			All Paper					All Paper						Paper/Embossed					
(L) Length	MM	0.60 ± 0.03			1.00 ± 0.10					1.60 ± 0.15						2.01 ± 0.20					
	(in.)	(0.024 ± 0.001)			(0.040 ± 0.004)					(0.063 ± 0.006)						(0.079 ± 0.008)					
(W) Width	MM	0.30 ± 0.03			0.50 ± 0.10					0.81 ± 0.15						1.25 ± 0.20					
	(in.)	(0.011 ± 0.001)			(0.020 ± 0.004)					(0.032 ± 0.006)						(0.049 ± 0.008)					
(t) Terminal	MM	0.15 ± 0.05			0.25 ± 0.15					0.35 ± 0.15						0.50 ± 0.25					
	(in.)	(0.006 ± 0.002)			(0.010 ± 0.006)					(0.014 ± 0.006)						(0.020 ± 0.010)					
	WVDC	10	16	25	4	6.3	10	16	25	4	6.3	10	16	25	35	6.3	10	16	25	35	50
Cap (pF)	100			A																	
	150			A																	
	220			A																	
	330			A																	
	470			A																	
	680			A																	
	1000			A																	
	1500		A																		
	2200	A	A																		
	3300	A																			
	4700	A																			
	6800	A																			
Cap (µF)	0.010	A							C												
	0.015								C						G						
	0.022								C						G						
	0.033							C							G						
	0.047							C						G	G						
	0.068							C						G							N
	0.10						C	C						G							N
	0.15						C							G						N	
	0.22						C						G	G						N	
	0.33				C	C							G	G					N		
	0.47				C								G						N		
	0.68				C								G					N	N		
	1.0				C	C					G	G	G					N	N		
	1.5																N	N			
	2.2									G	G						N	N			
	3.3																N				
	4.7									G	G					N	N				
	6.8																				
	10															N					
	22																				
	47																				
	100																				
	WVDC	10	16	25	4	6.3	10	16	25	4	6.3	10	16	25	35	6.3	10	16	25	35	50
	SIZE	0201			0402					0603						0805					



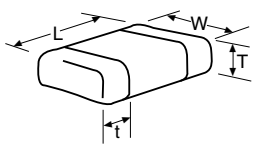
Letter	A	C	E	G	J	K	M	N	P	Q	X	Y	Z
Max. Thickness	0.33 (0.013)	0.56 (0.022)	0.71 (0.028)	0.86 (0.034)	0.94 (0.037)	1.02 (0.040)	1.27 (0.050)	1.40 (0.055)	1.52 (0.060)	1.78 (0.070)	2.29 (0.090)	2.54 (0.100)	2.79 (0.110)
	PAPER					EMBOSSED							

X5R Dielectric

Capacitance Range

PREFERRED SIZES ARE SHADED

SIZE		1206					1210					1812		
Soldering		Reflow/Wave					Reflow Only					Reflow Only		
Packaging		Paper/Embossed					Paper/Embossed					All Embossed		
(L) Length	MM	3.20 ± 0.20					3.20 ± 0.20					4.50 ± 0.30		
	(in.)	(0.126 ± 0.008)					(0.126 ± 0.008)					(0.177 ± 0.012)		
(W) Width	MM	1.60 ± 0.20					2.50 ± 0.20					3.20 ± 0.20		
	(in.)	(0.063 ± 0.008)					(0.098 ± 0.008)					(0.126 ± 0.008)		
(t) Terminal	MM	0.50 ± 0.25					0.50 ± 0.25					0.61 ± 0.36		
	(in.)	(0.020 ± 0.010)					(0.020 ± 0.010)					(0.024 ± 0.014)		
	WVDC	6.3	10	16	25	35	6.3	10	16	25	35	6.3	10	25
Cap (pF)	100													
	150													
	220													
	330													
	470													
	680													
	1000													
	1500													
	2200													
	3300													
	4700													
	6800													
Cap (µF	0.010													
	0.015													
	0.022													
	0.033													
	0.047													
	0.068													
	0.10													
	0.15													
	0.22													
	0.33													
	0.47					M								
	0.68													
	1.0					Q					N			
	1.5													
	2.2			Q	Q						X			
	3.3													
	4.7		Q	Q	Q					Z				
	6.8													
	10	Q	Q	Q					Z					Z
	22	Q					Z	Z	Z				Z	
	47						Z					Z		
	100						Z							
	WVDC	6.3	10	16	25	35	6.3	10	16	25	35	6.3	10	25
SIZE		1206					1210					1812		



Letter	A	C	E	G	J	K	M	N	P	Q	X	Y	Z
Max. Thickness	0.33 (0.013)	0.56 (0.022)	0.71 (0.028)	0.86 (0.034)	0.94 (0.037)	1.02 (0.040)	1.27 (0.050)	1.40 (0.055)	1.52 (0.060)	1.78 (0.070)	2.29 (0.090)	2.54 (0.100)	2.79 (0.110)
	PAPER					EMBOSSED							

Packaging of Chip Components

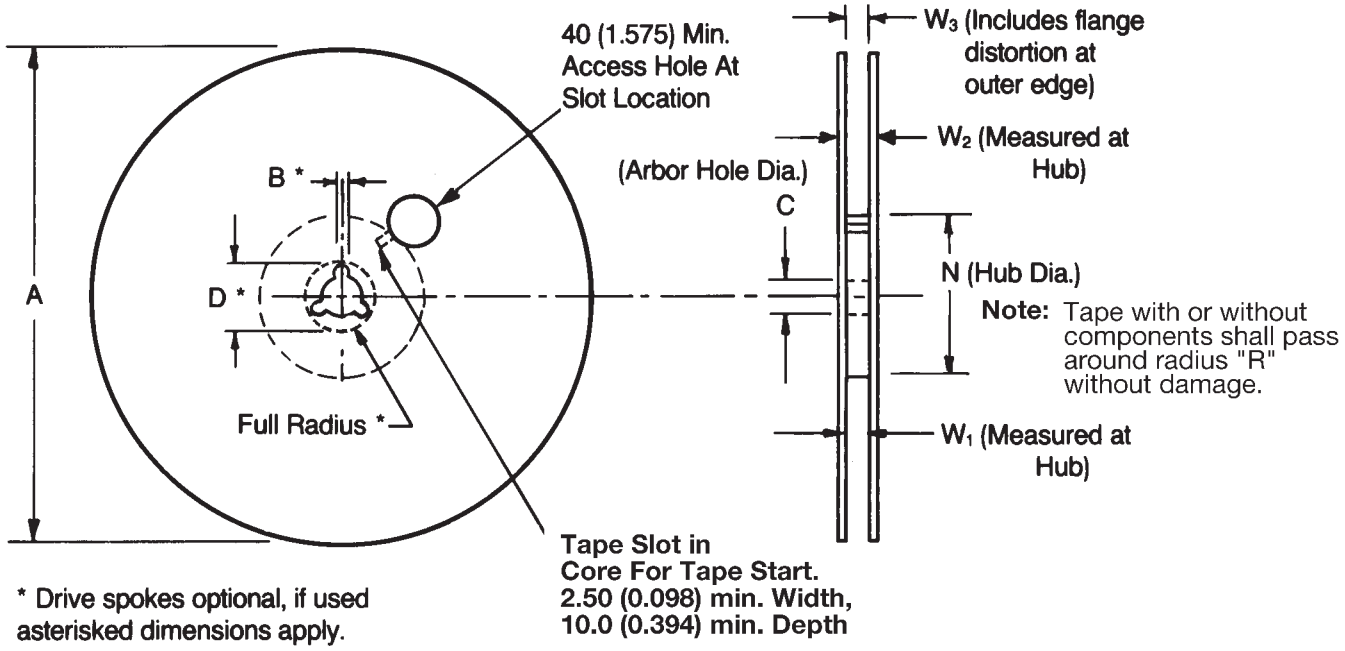
Automatic Insertion Packaging

TAPE & REEL QUANTITIES

All tape and reel specifications are in compliance with RS481.

	8mm	12mm	
Paper or Embossed Carrier	0612, 0508, 0805, 1206, 1210		
Embossed Only		1808	1812, 1825 2220, 2225
Paper Only	0201, 0306, 0402, 0603		
Qty. per Reel/7" Reel	2,000, 3,000 or 4,000, 10,000, 15,000 Contact factory for exact quantity	3,000	500, 1,000 Contact factory for exact quantity
Qty. per Reel/13" Reel	5,000, 10,000, 50,000 Contact factory for exact quantity	10,000	4,000

REEL DIMENSIONS

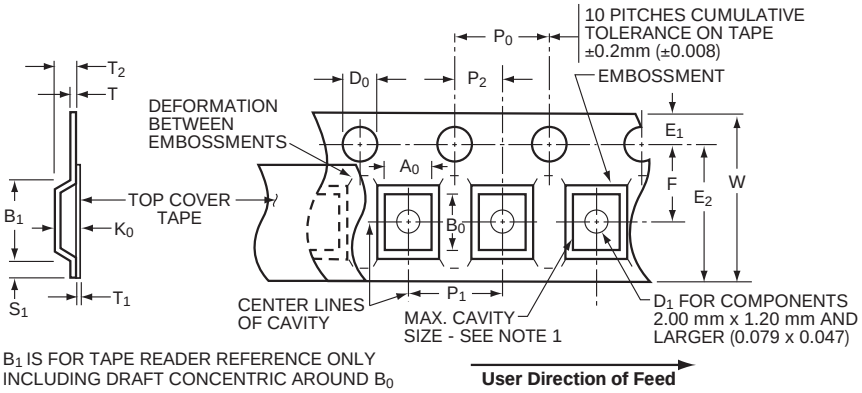


Tape Size(1)	A Max.	B* Min.	C	D* Min.	N Min.	W_1	W_2 Max.	W_3
8mm	330 (12.992)	1.5 (0.059)	$13.0^{+0.50}_{-0.20}$ ($0.512^{+0.020}_{-0.008}$)	20.2 (0.795)	50.0 (1.969)	$8.40^{+1.5}_{-0.0}$ ($0.331^{+0.059}_{-0.0}$)	14.4 (0.567)	7.90 Min. (0.311) 10.9 Max. (0.429)
12mm						$12.4^{+2.0}_{-0.0}$ ($0.488^{+0.079}_{-0.0}$)	18.4 (0.724)	11.9 Min. (0.469) 15.4 Max. (0.607)

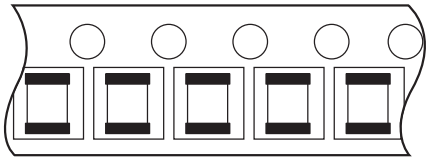
Metric dimensions will govern.
English measurements rounded and for reference only.
(1) For tape sizes 16mm and 24mm (used with chip size 3640) consult EIA RS-481 latest revision.

Embossed Carrier Configuration

8 & 12mm Tape Only



Chip Orientation



8 & 12mm Embossed Tape Metric Dimensions Will Govern

CONSTANT DIMENSIONS

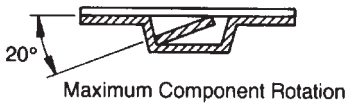
Tape Size	D_0	E	P_0	P_2	S_1 Min.	T Max.	T_1
8mm and 12mm	$1.50^{+0.10}_{-0.0}$ ($0.059^{+0.004}_{-0.0}$)	1.75 ± 0.10 (0.069 ± 0.004)	4.0 ± 0.10 (0.157 ± 0.004)	2.0 ± 0.05 (0.079 ± 0.002)	0.60 (0.024)	0.60 (0.024)	0.10 (0.004) Max.

VARIABLE DIMENSIONS

Tape Size	B_1 Max.	D_1 Min.	E_2 Min.	F	P_1 See Note 5	R Min. See Note 2	T_2	W Max.	A_0 B_0 K_0
8mm	4.35 (0.171)	1.00 (0.039)	6.25 (0.246)	3.50 ± 0.05 (0.138 ± 0.002)	4.00 ± 0.10 (0.157 ± 0.004)	25.0 (0.984)	2.50 Max. (0.098)	8.30 (0.327)	See Note 1
12mm	8.20 (0.323)	1.50 (0.059)	10.25 (0.404)	5.50 ± 0.05 (0.217 ± 0.002)	4.00 ± 0.10 (0.157 ± 0.004)	30.0 (1.181)	6.50 Max. (0.256)	12.3 (0.484)	See Note 1
8mm 1/2 Pitch	4.35 (0.171)	1.00 (0.039)	6.25 (0.246)	3.50 ± 0.05 (0.138 ± 0.002)	2.00 ± 0.10 (0.079 ± 0.004)	25.0 (0.984)	2.50 Max. (0.098)	8.30 (0.327)	See Note 1
12mm Double Pitch	8.20 (0.323)	1.50 (0.059)	10.25 (0.404)	5.50 ± 0.05 (0.217 ± 0.002)	8.00 ± 0.10 (0.315 ± 0.004)	30.0 (1.181)	6.50 Max. (0.256)	12.3 (0.484)	See Note 1

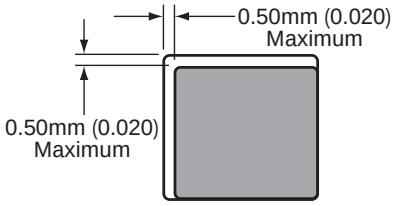
NOTES:

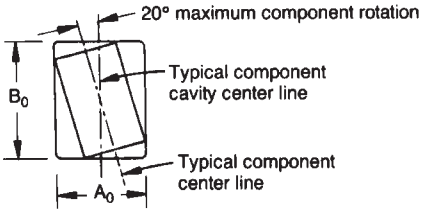
1. The cavity defined by A_0, B_0, and K_0 shall be configured to provide the following:
   Surround the component with sufficient clearance such that:
   a) the component does not protrude beyond the sealing plane of the cover tape.
   b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the cover tape has been removed.
   c) rotation of the component is limited to 20º maximum (see Sketches D & E).
   d) lateral movement of the component is restricted to 0.5mm maximum (see Sketch F).
2. Tape with or without components shall pass around radius "R" without damage.
3. Bar code labeling (if required) shall be on the side of the reel opposite the round sprocket holes. Refer to EIA-556.
4. B_1 dimension is a reference dimension for tape feeder clearance only.
5. If P_1 = 2.0mm, the tape may not properly index in all tape feeders.



Side or Front Sectional View
Sketch "C"

Top View, Sketch "F"
Component Lateral Movements

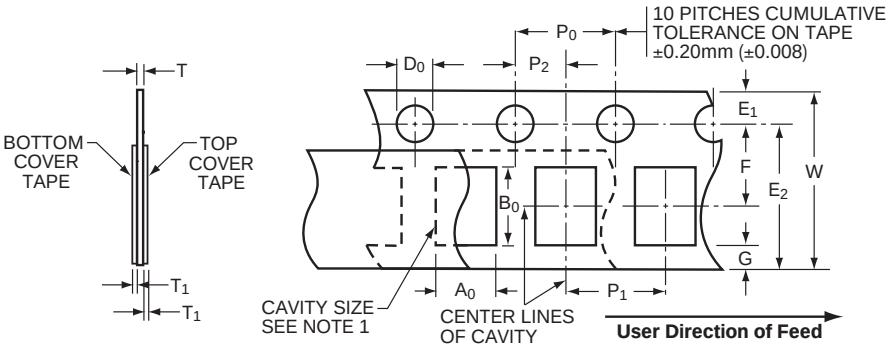




Top View
Sketch "D"

Paper Carrier Configuration

8 & 12mm Tape Only



8 & 12mm Paper Tape Metric Dimensions Will Govern

CONSTANT DIMENSIONS

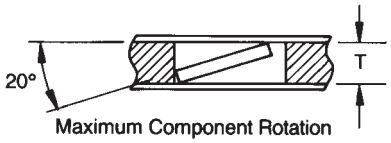
Tape Size	D_0	E	P_0	P_2	T_1	G. Min.	R Min.
8mm and 12mm	$1.50^{+0.10}_{-0.0}$ ($0.059^{+0.004}_{-0.0}$)	1.75 ± 0.10 (0.069 ± 0.004)	4.00 ± 0.10 (0.157 ± 0.004)	2.00 ± 0.05 (0.079 ± 0.002)	0.10 (0.004) Max.	0.75 (0.030) Min.	25.0 (0.984) See Note 2 Min.

VARIABLE DIMENSIONS

Tape Size	P_1 See Note 4	E_2 Min.	F	W	A_0 B_0	T
8mm	4.00 ± 0.10 (0.157 ± 0.004)	6.25 (0.246)	3.50 ± 0.05 (0.138 ± 0.002)	$8.00^{+0.30}_{-0.10}$ ($0.315^{+0.012}_{-0.004}$)	See Note 1	1.10mm (0.043) Max. for Paper Base Tape and 1.60mm (0.063) Max. for Non-Paper Base Compositions
12mm	4.00 ± 0.010 (0.157 ± 0.004)	10.25 (0.404)	5.50 ± 0.05 (0.217 ± 0.002)	12.0 ± 0.30 (0.472 ± 0.012)		
8mm 1/2 Pitch	2.00 ± 0.05 (0.079 ± 0.002)	6.25 (0.246)	3.50 ± 0.05 (0.138 ± 0.002)	$8.00^{+0.30}_{-0.10}$ ($0.315^{+0.012}_{-0.004}$)		
12mm Double Pitch	8.00 ± 0.10 (0.315 ± 0.004)	10.25 (0.404)	5.50 ± 0.05 (0.217 ± 0.002)	12.0 ± 0.30 (0.472 ± 0.012)		

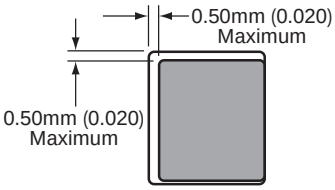
NOTES:

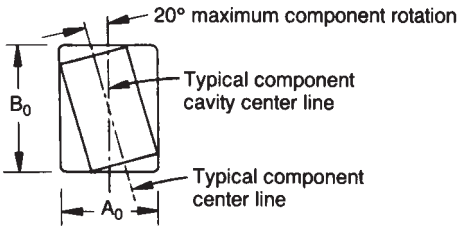
1. The cavity defined by A_0, B_0, and T shall be configured to provide sufficient clearance surrounding the component so that:
   a) the component does not protrude beyond either surface of the carrier tape;
   b) the component can be removed from the cavity in a vertical direction without mechanical restriction after the top cover tape has been removed;
   c) rotation of the component is limited to 20º maximum (see Sketches A & B);
   d) lateral movement of the component is restricted to 0.5mm maximum (see Sketch C).
2. Tape with or without components shall pass around radius "R" without damage.
3. Bar code labeling (if required) shall be on the side of the reel opposite the sprocket holes. Refer to EIA-556.
4. If P_1 = 2.0mm, the tape may not properly index in all tape feeders.



Side or Front Sectional View
Sketch "A"

Top View, Sketch "C"
Component Lateral





Top View
Sketch "B"

Bar Code Labeling Standard

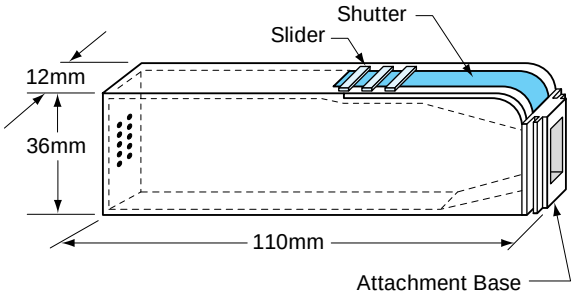
AVX bar code labeling is available and follows latest version of EIA-556

Bulk Case Packaging

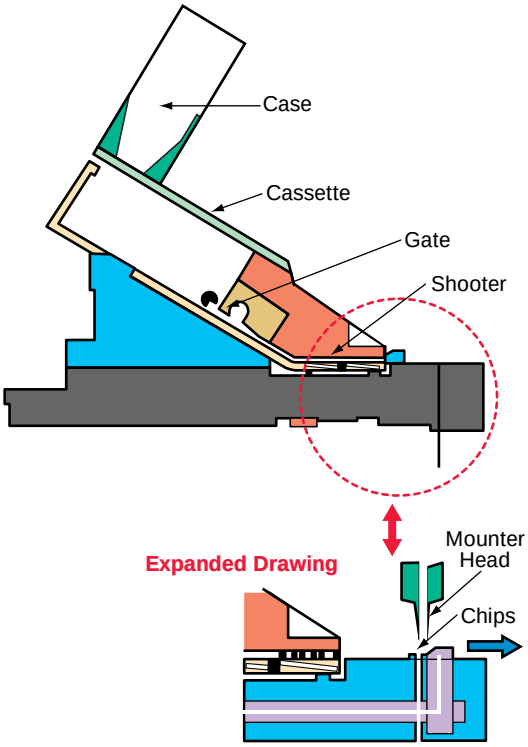
BENEFITS

- Easier handling
- Smaller packaging volume
  (1/20 of T/R packaging)
- Easier inventory control
- Flexibility
- Recyclable

CASE DIMENSIONS



BULK FEEDER



CASE QUANTITIES

Part Size	0402	0603	0805	1206
Qty. (pcs / cassette)	80,000	15,000	10,000 (T=.023") 8,000 (T=.031") 6,000 (T=.043")	5,000 (T=.023") 4,000 (T=.032") 3,000 (T=.044")

Basic Capacitor Formulas

I. Capacitance (farads)

English: $C = \frac{.224\ K\ A}{T_D}$

Metric: $C = \frac{.0884\ K\ A}{T_D}$

II. Energy stored in capacitors (Joules, watt - sec)

$E = \frac{1}{2} CV^2$

III. Linear charge of a capacitor (Amperes)

$I = C \frac{dV}{dt}$

IV. Total Impedance of a capacitor (ohms)

$Z = \sqrt{R_S^2 + (X_C - X_L)^2}$

V. Capacitive Reactance (ohms)

$x_C = \frac{1}{2 \pi fC}$

VI. Inductive Reactance (ohms)

$x_L = 2 \pi fL$

VII. Phase Angles:

Ideal Capacitors: Current leads voltage 90°
Ideal Inductors: Current lags voltage 90°
Ideal Resistors: Current in phase with voltage

VIII. Dissipation Factor (%)

D.F.= tan δ (loss angle) = $\frac{E.S.R.}{X_C}$ = $(2 \pi fC)$ (E.S.R.)

IX. Power Factor (%)

P.F. = Sine δ (loss angle) = Cos ϕ (phase angle)
P.F. = (when less than 10%) = DF

X. Quality Factor (dimensionless)

Q = Cotan δ (loss angle) = $\frac{1}{D.F.}$

XI. Equivalent Series Resistance (ohms)

E.S.R. = (D.F.) (Xc) = (D.F.) / $(2 \pi fC)$

XII. Power Loss (watts)

Power Loss = $(2 \pi fCV^2)$ (D.F.)

XIII. KVA (Kilowatts)

KVA = $2 \pi fCV^2 \times 10^{-3}$

XIV. Temperature Characteristic (ppm/°C)

T.C. = $\frac{Ct - C_{25}}{C_{25} (T_t - 25)} \times 10^6$

XV. Cap Drift (%)

C.D. = $\frac{C_1 - C_2}{C_1} \times 100$

XVI. Reliability of Ceramic Capacitors

$\frac{L_0}{L_t} = \left(\frac{V_t}{V_o}\right)^X \left(\frac{T_t}{T_o}\right)^Y$

XVII. Capacitors in Series (current the same)

Any Number: $\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} --- \frac{1}{C_N}$

Two: $C_T = \frac{C_1 C_2}{C_1 + C_2}$

XVIII. Capacitors in Parallel (voltage the same)

$C_T = C_1 + C_2 --- + C_N$

XIX. Aging Rate

A.R. = %Δ C/decade of time

XX. Decibels

db = $20 \log \frac{V_1}{V_2}$

METRIC PREFIXES

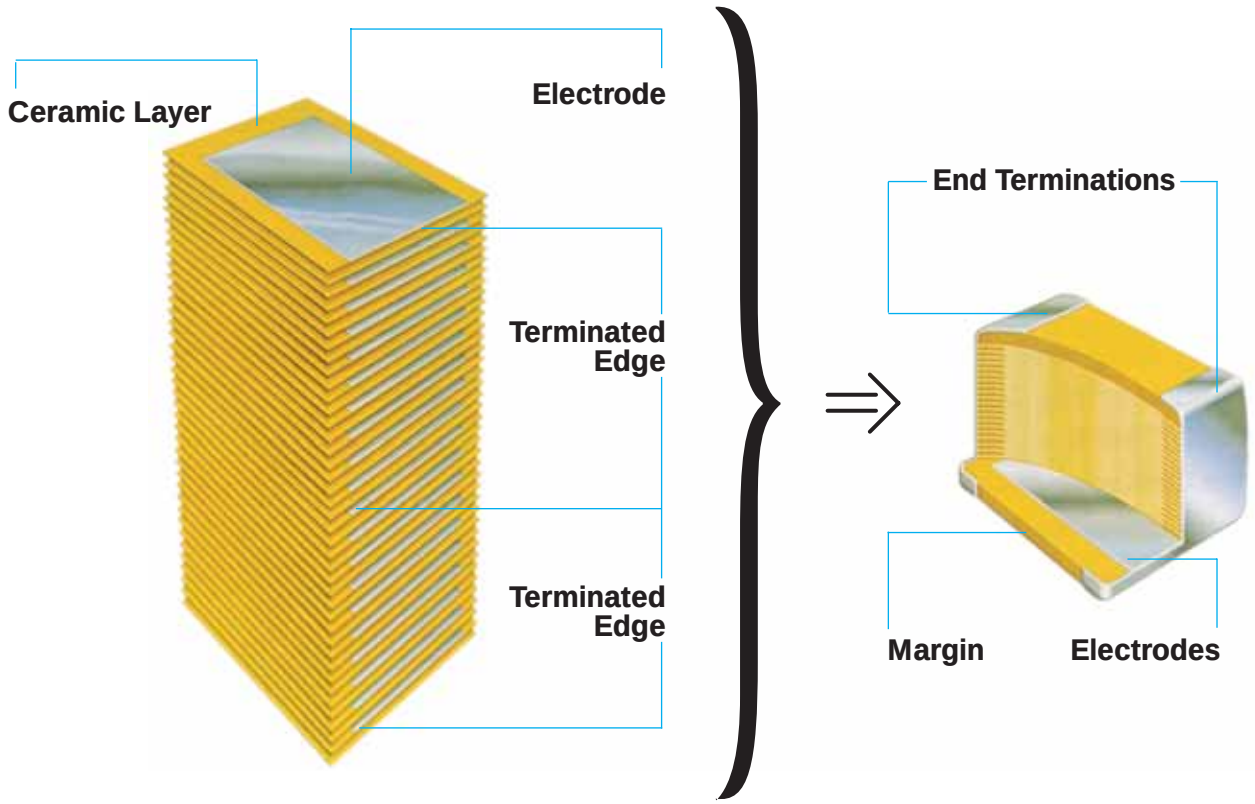
Pico	$X\ 10^{-12}$
Nano	$X\ 10^{-9}$
Micro	$X\ 10^{-6}$
Milli	$X\ 10^{-3}$
Deci	$X\ 10^{-1}$
Deca	$X\ 10^{+1}$
Kilo	$X\ 10^{+3}$
Mega	$X\ 10^{+6}$
Giga	$X\ 10^{+9}$
Tera	$X\ 10^{+12}$

SYMBOLS

K	= Dielectric Constant	f	= frequency	L_t	= Test life
A	= Area	L	= Inductance	V_t	= Test voltage
T_D	= Dielectric thickness	δ	= Loss angle	V_o	= Operating voltage
V	= Voltage	ϕ	= Phase angle	T_t	= Test temperature
t	= time	X & Y	= exponent effect of voltage and temp.	T_o	= Operating temperature
R_S	= Series Resistance	L_o	= Operating life		

General Description

Basic Construction – A multilayer ceramic (MLC) capacitor is a monolithic block of ceramic containing two sets of offset, interleaved planar electrodes that extend to two opposite surfaces of the ceramic dielectric. This simple structure requires a considerable amount of sophistication, both in material and manufacture, to produce it in the quality and quantities needed in today's electronic equipment.



Multilayer Ceramic Capacitor

Figure 1

Formulations – Multilayer ceramic capacitors are available in both Class 1 and Class 2 formulations. Temperature compensating formulation are Class 1 and temperature stable and general application formulations are classified as Class 2.

Class 1 – Class 1 capacitors or temperature compensating capacitors are usually made from mixtures of titanates where barium titanate is normally not a major part of the mix. They have predictable temperature coefficients and in general, do not have an aging characteristic. Thus they are the most stable capacitor available. The most popular Class 1 multilayer ceramic capacitors are C0G (NP0) temperature compensating capacitors (negative-positive 0 ppm/°C).

Class 2 – EIA Class 2 capacitors typically are based on the chemistry of barium titanate and provide a wide range of capacitance values and temperature stability. The most commonly used Class 2 dielectrics are X7R and Y5V. The X7R provides intermediate capacitance values which vary only ±15% over the temperature range of -55°C to 125°C. It finds applications where stability over a wide temperature range is required.

The Y5V provides the highest capacitance values and is used in applications where limited temperature changes are expected. The capacitance value for Y5V can vary from 22% to -82% over the -30°C to 85°C temperature range.

All Class 2 capacitors vary in capacitance value under the influence of temperature, operating voltage (both AC and DC), and frequency. For additional information on performance changes with operating conditions, consult AVX's software, SpiCap.

Table 1: EIA and MIL Temperature Stable and General Application Codes

EIA CODE Percent Capacity Change Over Temperature Range	
RS198	**Temperature Range**
X7	-55°C to +125°C
X6	-55°C to +105°C
X5	-55°C to +85°C
Y5	-30°C to +85°C
Z5	+10°C to +85°C
Code	**Percent Capacity Change**
D	±3.3%
E	±4.7%
F	±7.5%
P	±10%
R	±15%
S	±22%
T	+22%, -33%
U	+22%, - 56%
V	+22%, -82%
EXAMPLE – A capacitor is desired with the capacitance value at 25°C to increase no more than 7.5% or decrease no more than 7.5% from -30°C to +85°C. EIA Code will be Y5F.	

MIL CODE		
Symbol	**Temperature Range**	
A	-55°C to +85°C	
B	-55°C to +125°C	
C	-55°C to +150°C	
Symbol	**Cap. Change Zero Volts**	**Cap. Change Rated Volts**
R	+15%, -15%	+15%, -40%
S	+22%, -22%	+22%, -56%
W	+22%, -56%	+22%, -66%
X	+15%, -15%	+15%, -25%
Y	+30%, -70%	+30%, -80%
Z	+20%, -20%	+20%, -30%
Temperature characteristic is specified by combining range and change symbols, for example BR or AW. Specification slash sheets indicate the characteristic applicable to a given style of capacitor.		

In specifying capacitance change with temperature for Class 2 materials, EIA expresses the capacitance change over an operating temperature range by a 3 symbol code. The first symbol represents the cold temperature end of the temperature range, the second represents the upper limit of the operating temperature range and the third symbol represents the capacitance change allowed over the operating temperature range. Table 1 provides a detailed explanation of the EIA system.

Effects of Voltage – Variations in voltage have little effect on Class 1 dielectric but does affect the capacitance and dissipation factor of Class 2 dielectrics. The application of DC voltage reduces both the capacitance and dissipation factor while the application of an AC voltage within a reasonable range tends to increase both capacitance and dissipation factor readings. If a high enough AC voltage is applied, eventually it will reduce capacitance just as a DC voltage will. Figure 2 shows the effects of AC voltage.

Cap. Change vs. A.C. Volts
X7R

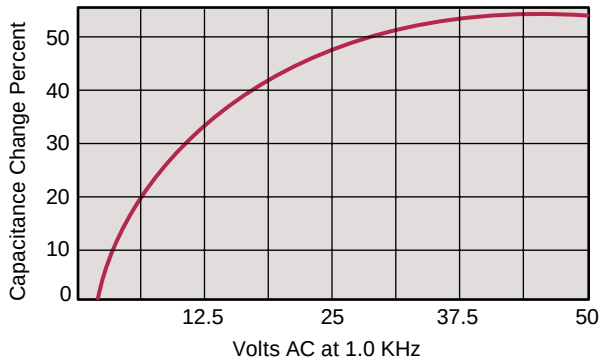


Figure 2

Capacitor specifications specify the AC voltage at which to measure (normally 0.5 or 1 VAC) and application of the wrong voltage can cause spurious readings. Figure 3 gives the voltage coefficient of dissipation factor for various AC voltages at 1 kilohertz. Applications of different frequencies will affect the percentage changes versus voltages.

D.F. vs. A.C. Measurement Volts
X7R

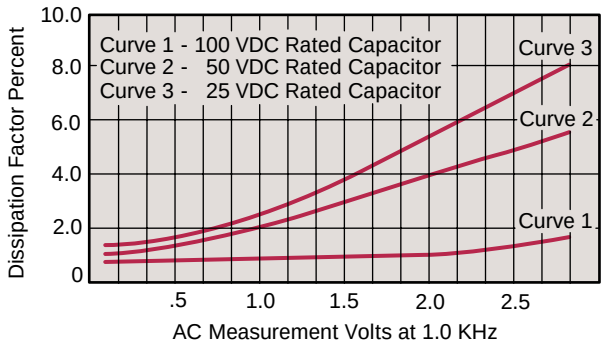


Figure 3

Typical effect of the application of DC voltage is shown in Figure 4. The voltage coefficient is more pronounced for higher K dielectrics. These figures are shown for room temperature conditions. The combination characteristic known as voltage temperature limits which shows the effects of rated voltage over the operating temperature range is shown in Figure 5 for the military BX characteristic.

Typical Cap. Change vs. D.C. Volts
X7R

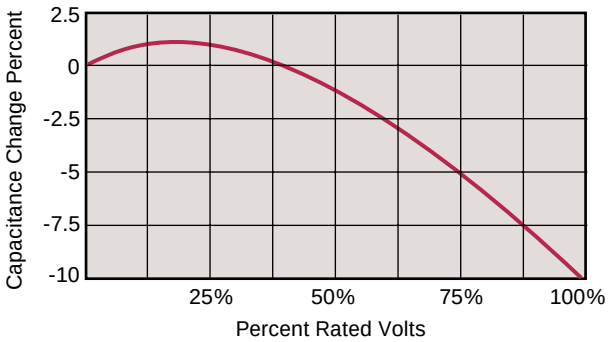


Figure 4

Typical Cap. Change vs. Temperature
X7R

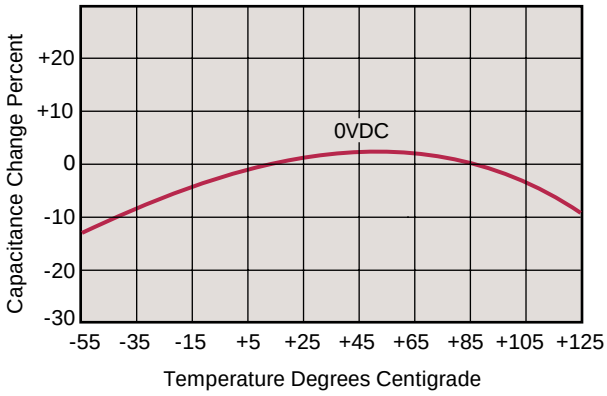
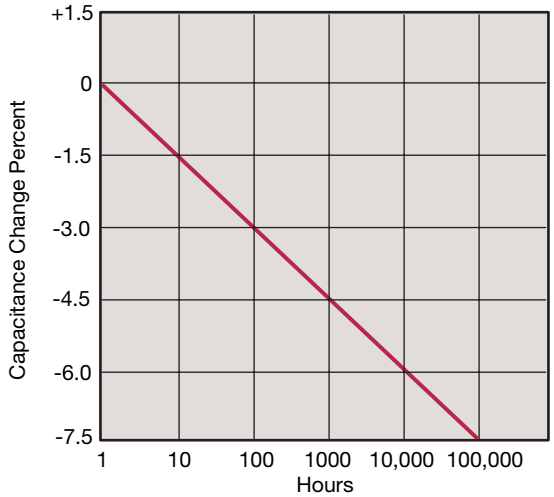


Figure 5

Effects of Time – Class 2 ceramic capacitors change capacitance and dissipation factor with time as well as temperature, voltage and frequency. This change with time is known as aging. Aging is caused by a gradual re-alignment of the crystalline structure of the ceramic and produces an exponential loss in capacitance and decrease in dissipation factor versus time. A typical curve of aging rate for semi-stable ceramics is shown in Figure 6.

If a Class 2 ceramic capacitor that has been sitting on the shelf for a period of time, is heated above its curie point, (125°C for 4 hours or 150°C for ½ hour will suffice) the part will de-age and return to its initial capacitance and dissipation factor readings. Because the capacitance changes rapidly, immediately after de-aging, the basic capacitance measurements are normally referred to a time period sometime after the de-aging process. Various manufacturers use different time bases but the most popular one is one day or twenty-four hours after "last heat." Change in the aging curve can be caused by the application of voltage and other stresses. The possible changes in capacitance due to de-aging by heating the unit explain why capacitance changes are allowed after test, such as temperature cycling, moisture resistance, etc., in MIL specs. The application of high voltages such as dielectric withstanding voltages also tends to de-age capacitors and is why re-reading of capacitance after 12 or 24 hours is allowed in military specifications after dielectric strength tests have been performed.

Typical Curve of Aging Rate
X7R



Characteristic	Max. Aging Rate %/Decade
C0G (NP0)	None
X7R, X5R	2
Y5V	7

Figure 6

Effects of Frequency – Frequency affects capacitance and impedance characteristics of capacitors. This effect is much more pronounced in high dielectric constant ceramic formulation than in low K formulations. AVX's SpiCap software generates impedance, ESR, series inductance, series resonant frequency and capacitance all as functions of frequency, temperature and DC bias for standard chip sizes and styles. It is available free from AVX and can be downloaded for free from AVX website: www.avx.com.

Effects of Mechanical Stress – High "K" dielectric ceramic capacitors exhibit some low level piezoelectric reactions under mechanical stress. As a general statement, the piezoelectric output is higher, the higher the dielectric constant of the ceramic. It is desirable to investigate this effect before using high "K" dielectrics as coupling capacitors in extremely low level applications.

Reliability – Historically ceramic capacitors have been one of the most reliable types of capacitors in use today. The approximate formula for the reliability of a ceramic capacitor is:

$$\frac{L_o}{L_t} = \left(\frac{V_t}{V_o}\right)^X \left(\frac{T_t}{T_o}\right)^Y$$

where

L_o = operating life
L_t = test life
V_t = test voltage
V_o = operating voltage
T_t = test temperature and
T_o = operating temperature in °C
X,Y = see text

Historically for ceramic capacitors exponent X has been considered as 3. The exponent Y for temperature effects typically tends to run about 8.

A capacitor is a component which is capable of storing electrical energy. It consists of two conductive plates (electrodes) separated by insulating material which is called the dielectric. A typical formula for determining capacitance is:

$$C = \frac{.224\,KA}{t}$$

C = capacitance (picofarads)
K = dielectric constant (Vacuum = 1)
A = area in square inches
t = separation between the plates in inches (thickness of dielectric)
.224 = conversion constant (.0884 for metric system in cm)

Capacitance – The standard unit of capacitance is the farad. A capacitor has a capacitance of 1 farad when 1 coulomb charges it to 1 volt. One farad is a very large unit and most capacitors have values in the micro (10^{-6}), nano (10^{-9}) or pico (10^{-12}) farad level.

Dielectric Constant – In the formula for capacitance given above the dielectric constant of a vacuum is arbitrarily chosen as the number 1. Dielectric constants of other materials are then compared to the dielectric constant of a vacuum.

Dielectric Thickness – Capacitance is indirectly proportional to the separation between electrodes. Lower voltage requirements mean thinner dielectrics and greater capacitance per volume.

Area – Capacitance is directly proportional to the area of the electrodes. Since the other variables in the equation are usually set by the performance desired, area is the easiest parameter to modify to obtain a specific capacitance within a material group.

Energy Stored – The energy which can be stored in a capacitor is given by the formula:

$$E = \tfrac{1}{2}CV^2$$

E = energy in joules (watts-sec)
V = applied voltage
C = capacitance in farads

Potential Change – A capacitor is a reactive component which reacts against a change in potential across it. This is shown by the equation for the linear charge of a capacitor:

$$I_{ideal} = C\frac{dV}{dt}$$

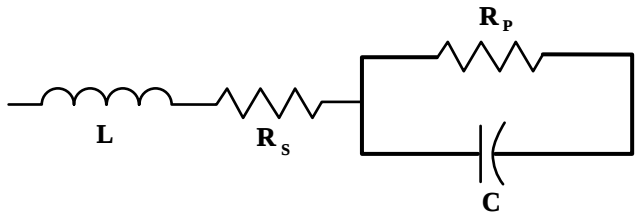
where

I = Current
C = Capacitance
dV/dt = Slope of voltage transition across capacitor

Thus an infinite current would be required to instantly change the potential across a capacitor. The amount of current a capacitor can "sink" is determined by the above equation.

Equivalent Circuit – A capacitor, as a practical device, exhibits not only capacitance but also resistance and inductance. A simplified schematic for the equivalent circuit is:

C = Capacitance
R_s = Series Resistance
L = Inductance
R_p = Parallel Resistance



Reactance – Since the insulation resistance (R_p) is normally very high, the total impedance of a capacitor is:

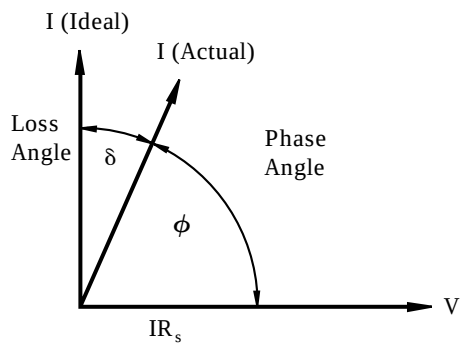
$$Z = \sqrt{R_S^2 + (X_C - X_L)^2}$$

where

Z = Total Impedance
R_s = Series Resistance
X_C = Capacitive Reactance $= \frac{1}{2\pi fC}$
X_L = Inductive Reactance $= 2\pi fL$

The variation of a capacitor's impedance with frequency determines its effectiveness in many applications.

Phase Angle – Power Factor and Dissipation Factor are often confused since they are both measures of the loss in a capacitor under AC application and are often almost identical in value. In a "perfect" capacitor the current in the capacitor will lead the voltage by 90°.

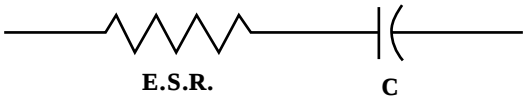


In practice the current leads the voltage by some other phase angle due to the series resistance R_S. The complement of this angle is called the loss angle and:

Power Factor (P.F.) = Cos ϕ or Sine δ
Dissipation Factor (D.F.) = tan δ

for small values of δ the tan and sine are essentially equal which has led to the common interchangeability of the two terms in the industry.

Equivalent Series Resistance – The term E.S.R. or Equivalent Series Resistance combines all losses both series and parallel in a capacitor at a given frequency so that the equivalent circuit is reduced to a simple R-C series connection.



Dissipation Factor – The DF/PF of a capacitor tells what percent of the apparent power input will turn to heat in the capacitor.

$$\textbf{Dissipation Factor} = \frac{\textbf{E.S.R.}}{\textbf{X}_c} = (2\pi fC)(\text{E.S.R.})$$

The watts loss are:

$$\textbf{Watts loss} = (2\pi fCV^2)(\text{D.F.})$$

Very low values of dissipation factor are expressed as their reciprocal for convenience. These are called the "Q" or Quality factor of capacitors.

Parasitic Inductance – The parasitic inductance of capacitors is becoming more and more important in the decoupling of today's high speed digital systems. The relationship between the inductance and the ripple voltage induced on the DC voltage line can be seen from the simple inductance equation:

$$V = L\frac{di}{dt}$$

The $\frac{di}{dt}$ seen in current microprocessors can be as high as 0.3 A/ns, and up to 10A/ns. At 0.3 A/ns, 100pH of parasitic inductance can cause a voltage spike of 30mV. While this does not sound very drastic, with the Vcc for microprocessors decreasing at the current rate, this can be a fairly large percentage.

Another important, often overlooked, reason for knowing the parasitic inductance is the calculation of the resonant frequency. This can be important for high frequency, bypass capacitors, as the resonant point will give the most signal attenuation. The resonant frequency is calculated from the simple equation:

$$f_{res} = \frac{1}{2\pi\sqrt{LC}}$$

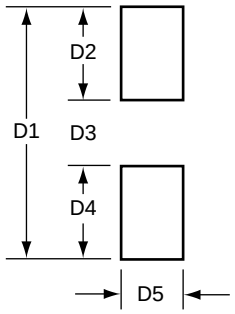
Insulation Resistance – Insulation Resistance is the resistance measured across the terminals of a capacitor and consists principally of the parallel resistance R_P shown in the equivalent circuit. As capacitance values and hence the area of dielectric increases, the I.R. decreases and hence the product (C x IR or RC) is often specified in ohm faradsor more commonly megohm-microfarads. Leakage current is determined by dividing the rated voltage by IR (Ohm's Law).

Dielectric Strength – Dielectric Strength is an expression of the ability of a material to withstand an electrical stress. Although dielectric strength is ordinarily expressed in volts, it is actually dependent on the thickness of the dielectric and thus is also more generically a function of volts/mil.

Dielectric Absorption – A capacitor does not discharge instantaneously upon application of a short circuit, but drains gradually after the capacitance proper has been discharged. It is common practice to measure the dielectric absorption by determining the "reappearing voltage" which appears across a capacitor at some point in time after it has been fully discharged under short circuit conditions.

Corona – Corona is the ionization of air or other vapors which causes them to conduct current. It is especially prevalent in high voltage units but can occur with low voltages as well where high voltage gradients occur. The energy discharged degrades the performance of the capacitor and can in time cause catastrophic failures.

REFLOW SOLDERING



Case Size	D1	D2	D3	D4	D5
0402	1.70 (0.07)	0.60 (0.02)	0.50 (0.02)	0.60 (0.02)	0.50 (0.02)
0603	2.30 (0.09)	0.80 (0.03)	0.70 (0.03)	0.80 (0.03)	0.75 (0.03)
0805	3.00 (0.12)	1.00 (0.04)	1.00 (0.04)	1.00 (0.04)	1.25 (0.05)
1206	4.00 (0.16)	1.00 (0.04)	2.00 (0.09)	1.00 (0.04)	1.60 (0.06)
1210	4.00 (0.16)	1.00 (0.04)	2.00 (0.09)	1.00 (0.04)	2.50 (0.10)
1808	5.60 (0.22)	1.00 (0.04)	3.60 (0.14)	1.00 (0.04)	2.00 (0.08)
1812	5.60 (0.22)	1.00 (0.04))	3.60 (0.14)	1.00 (0.04)	3.00 (0.12)
1825	5.60 (0.22)	1.00 (0.04)	3.60 (0.14)	1.00 (0.04)	6.35 (0.25)
2220	6.60 (0.26)	1.00 (0.04)	4.60 (0.18)	1.00 (0.04)	5.00 (0.20)
2225	6.60 (0.26)	1.00 (0.04)	4.60 (0.18)	1.00 (0.04)	6.35 (0.25)

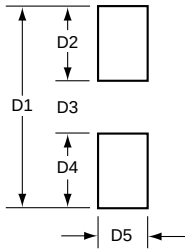
Dimensions in millimeters (inches)

Component Pad Design

Component pads should be designed to achieve good solder filets and minimize component movement during reflow soldering. Pad designs are given below for the most common sizes of multilayer ceramic capacitors for both wave and reflow soldering. The basis of these designs is:

- Pad width equal to component width. It is permissible to decrease this to as low as 85% of component width but it is not advisable to go below this.
- Pad overlap 0.5mm beneath component.
- Pad extension 0.5mm beyond components for reflow and 1.0mm for wave soldering.

WAVE SOLDERING

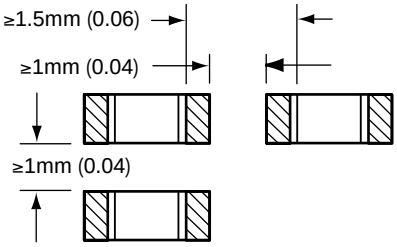


Case Size	D1	D2	D3	D4	D5
0603	3.10 (0.12)	1.20 (0.05)	0.70 (0.03)	1.20 (0.05)	0.75 (0.03)
0805	4.00 (0.15)	1.50 (0.06)	1.00 (0.04)	1.50 (0.06)	1.25 (0.05)
1206	5.00 (0.19)	1.50 (0.06)	2.00 (0.09)	1.50 (0.06)	1.60 (0.06)

Dimensions in millimeters (inches)

Component Spacing

For wave soldering components, must be spaced sufficiently far apart to avoid bridging or shadowing (inability of solder to penetrate properly into small spaces). This is less important for reflow soldering but sufficient space must be allowed to enable rework should it be required.



Preheat & Soldering

The rate of preheat should not exceed 4°C/second to prevent thermal shock. A better maximum figure is about 2°C/second.

For capacitors size 1206 and below, with a maximum thickness of 1.25mm, it is generally permissible to allow a temperature differential from preheat to soldering of 150°C. In all other cases this differential should not exceed 100°C.

For further specific application or process advice, please consult AVX.

Cleaning

Care should be taken to ensure that the capacitors are thoroughly cleaned of flux residues especially the space beneath the capacitor. Such residues may otherwise become conductive and effectively offer a low resistance bypass to the capacitor.

Ultrasonic cleaning is permissible, the recommended conditions being 8 Watts/litre at 20-45 kHz, with a process cycle of 2 minutes vapor rinse, 2 minutes immersion in the ultrasonic solvent bath and finally 2 minutes vapor rinse.

APPLICATION NOTES

Storage
Good solderability is maintained for at least twelve months, provided the components are stored in their "as received" packaging at less than 40°C and 70% RH.

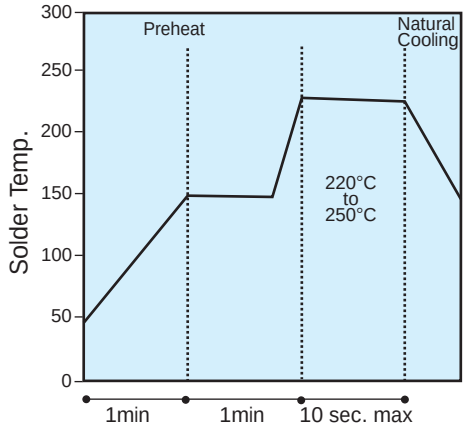
Solderability
Terminations to be well soldered after immersion in a 60/40 tin/lead solder bath at 235 ± 5°C for 2 ± 1 seconds.

Leaching
Terminations will resist leaching for at least the immersion times and conditions shown below.

Termination Type	Solder Tin/Lead/Silver	Solder Temp. °C	Immersion Time Seconds
Nickel Barrier	60/40/0	260 ± 5	30 ± 1

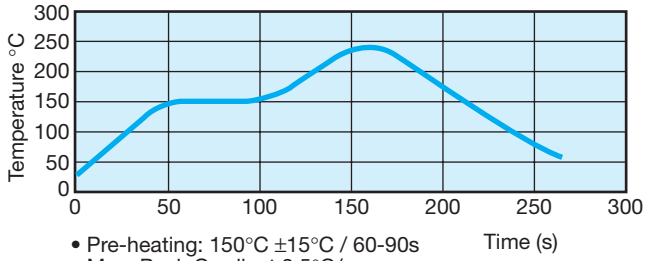
Recommended Soldering Profiles

Reflow



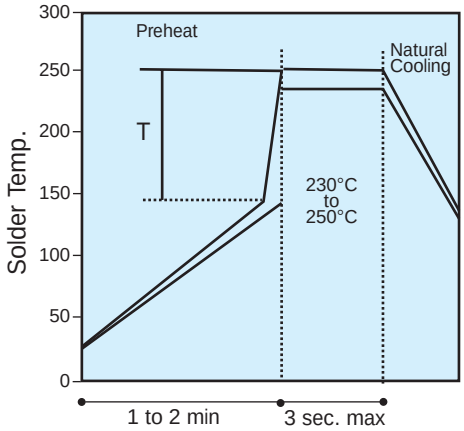
(Minimize soldering time)

Lead-Free Reflow Profile



- Pre-heating: 150°C ±15°C / 60-90s
- Max. Peak Gradient 2.5°C/s
- Peak Temperature: 245°C ±5°C
- Time at >230°C: 40s Max.

Wave



(Preheat chips before soldering)
T/maximum 150°C

Lead-Free Wave Soldering
The recommended peak temperature for lead-free wave soldering is 250°C-260°C for 3-5 seconds. The other parameters of the profile remains the same as above.

The following should be noted by customers changing from lead based systems to the new lead free pastes.

a) The visual standards used for evaluation of solder joints will need to be modified as lead free joints are not as bright as with tin-lead pastes and the fillet may not be as large.

b) Resin color may darken slightly due to the increase in temperature required for the new pastes.

c) Lead-free solder pastes do not allow the same self alignment as lead containing systems. Standard mounting pads are acceptable, but machine set up may need to be modified.

General
Surface mounting chip multilayer ceramic capacitors are designed for soldering to printed circuit boards or other substrates. The construction of the components is such that they will withstand the time/temperature profiles used in both wave and reflow soldering methods.

Handling
Chip multilayer ceramic capacitors should be handled with care to avoid damage or contamination from perspiration and skin oils. The use of tweezers or vacuum pick ups is strongly recommended for individual components. Bulk handling should ensure that abrasion and mechanical shock are minimized. Taped and reeled components provides the ideal medium for direct presentation to the placement machine. Any mechanical shock should be minimized during handling chip multilayer ceramic capacitors.

Preheat
It is important to avoid the possibility of thermal shock during soldering and carefully controlled preheat is therefore required. The rate of preheat should not exceed 4°C/second

and a target figure 2°C/second is recommended. Although an 80°C to 120°C temperature differential is preferred, recent developments allow a temperature differential between the component surface and the soldering temperature of 150°C (Maximum) for capacitors of 1210 size and below with a maximum thickness of 1.25mm. The user is cautioned that the risk of thermal shock increases as chip size or temperature differential increases.

Soldering

Mildly activated rosin fluxes are preferred. The minimum amount of solder to give a good joint should be used. Excessive solder can lead to damage from the stresses caused by the difference in coefficients of expansion between solder, chip and substrate. AVX terminations are suitable for all wave and reflow soldering systems. If hand soldering cannot be avoided, the preferred technique is the utilization of hot air soldering tools.

Cooling

Natural cooling in air is preferred, as this minimizes stresses within the soldered joint. When forced air cooling is used, cooling rate should not exceed 4°C/second. Quenching is not recommended but if used, maximum temperature differentials should be observed according to the preheat conditions above.

Cleaning

Flux residues may be hygroscopic or acidic and must be removed. AVX MLC capacitors are acceptable for use with all of the solvents described in the specifications MIL-STD-202 and EIA-RS-198. Alcohol based solvents are acceptable and properly controlled water cleaning systems are also acceptable. Many other solvents have been proven successful, and most solvents that are acceptable to other components on circuit assemblies are equally acceptable for use with ceramic capacitors.

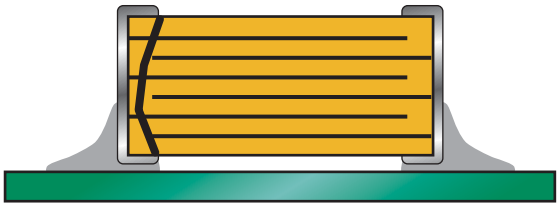
POST SOLDER HANDLING

Once SMP components are soldered to the board, any bending or flexure of the PCB applies stresses to the soldered joints of the components. For leaded devices, the stresses are absorbed by the compliancy of the metal leads and generally don't result in problems unless the stress is large enough to fracture the soldered connection.

Ceramic capacitors are more susceptible to such stress because they don't have compliant leads and are brittle in nature. The most frequent failure mode is low DC resistance or short circuit. The second failure mode is significant loss of capacitance due to severing of contact between sets of the internal electrodes.

Cracks caused by mechanical flexure are very easily identified and generally take one of the following two general forms:

Type A:
Angled crack between bottom of device to top of solder joint.



Type B:
Fracture from top of device to bottom of device.

Mechanical cracks are often hidden underneath the termination and are difficult to see externally. However, if one end termination falls off during the removal process from PCB, this is one indication that the cause of failure was excessive mechanical stress due to board warping.

COMMON CAUSES OF MECHANICAL CRACKING

The most common source for mechanical stress is board depanelization equipment, such as manual breakapart, v-cutters and shear presses. Improperly aligned or dull cutters may cause torqueing of the PCB resulting in flex stresses being transmitted to components near the board edge. Another common source of flexural stress is contact during parametric testing when test points are probed. If the PCB is allowed to flex during the test cycle, nearby ceramic capacitors may be broken.

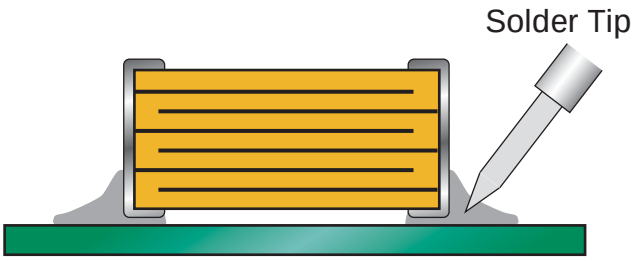
A third common source is board to board connections at vertical connectors where cables or other PCBs are connected to the PCB. If the board is not supported during the plug/unplug cycle, it may flex and cause damage to nearby components.

Special care should also be taken when handling large (>6" on a side) PCBs since they more easily flex or warp than smaller boards.

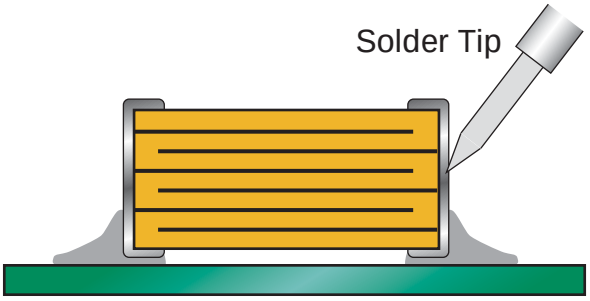
REWORKING OF MLCs

Thermal shock is common in MLCs that are manually attached or reworked with a soldering iron. *AVX strongly recommends that any reworking of MLCs be done with hot air reflow rather than soldering irons.* It is practically impossible to cause any thermal shock in ceramic capacitors when using hot air reflow.

However direct contact by the soldering iron tip often causes thermal cracks that may fail at a later date. If rework by soldering iron is absolutely necessary, it is recommended that the wattage of the iron be less than 30 watts and the tip temperature be <300ºC. *Rework should be performed by applying the solder iron tip to the pad and not directly contacting any part of the ceramic capacitor.*



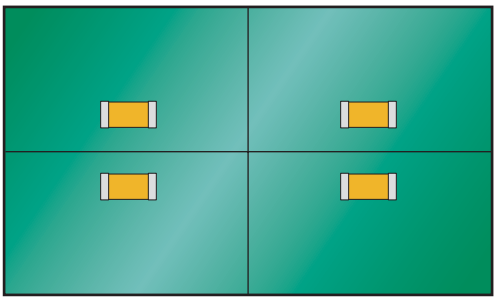
Preferred Method - No Direct Part Contact



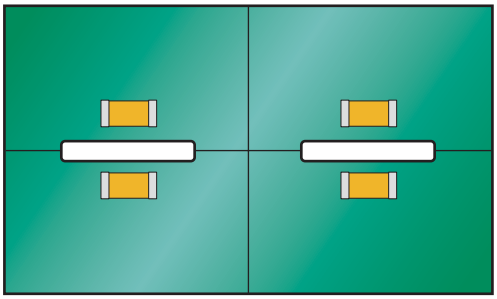
Poor Method - Direct Contact with Part

PCB BOARD DESIGN

To avoid many of the handling problems, AVX recommends that MLCs be located at least .2" away from nearest edge of board. However when this is not possible, AVX recommends that the panel be routed along the cut line, adjacent to where the MLC is located.



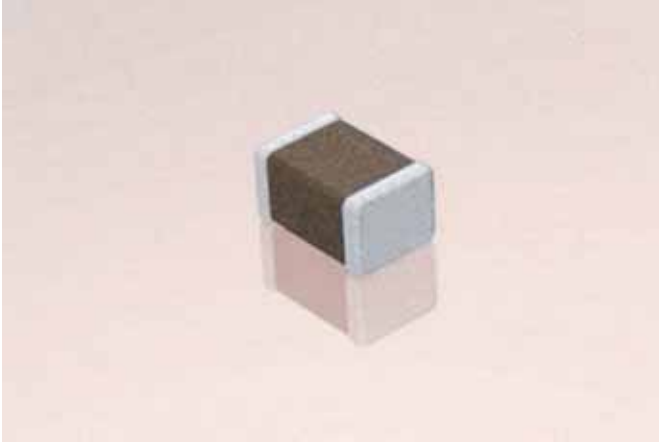
No Stress Relief for MLCs



Routed Cut Line Relieves Stress on MLC

Y5V Dielectric

General Specifications

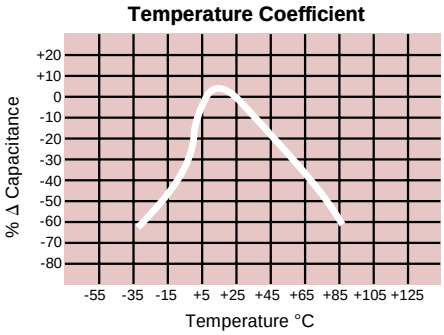


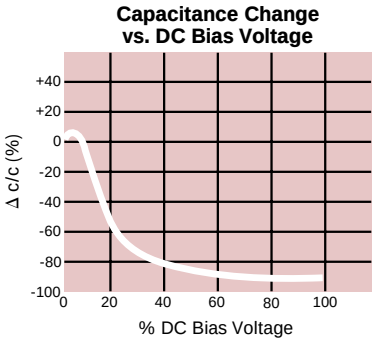
Y5V formulations are for general-purpose use in a limited temperature range. They have a wide temperature characteristic of +22% –82% capacitance change over the operating temperature range of –30°C to +85°C.

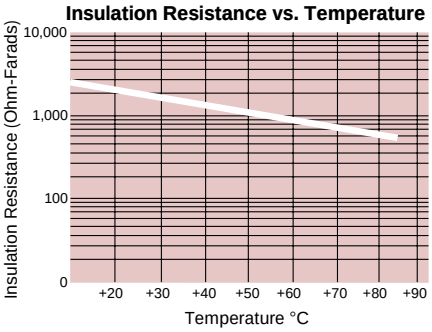
These characteristics make Y5V ideal for decoupling applications within limited temperature range.

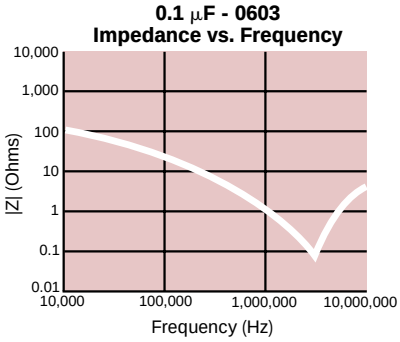
PART NUMBER (see page 2 for complete part number explanation)

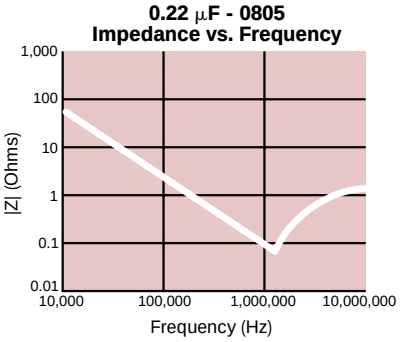
0805	3	G	104	Z	A	T	2	A
Size (L" x W")	**Voltage** 6.3V = 6, 10V = Z, 16V = Y, 25V = 3, 50V = 5	**Dielectric** Y5V = G	**Capacitance Code (In pF)** 2 Sig. Digits + Number of Zeros	**Capacitance Tolerance** Z = +80 –20%	**Failure Rate** A = Not Applicable	**Terminations** T = Plated Ni and Sn	**Packaging** 2 = 7" Reel, 4 = 13" Reel	**Special Code** A = Std. Product

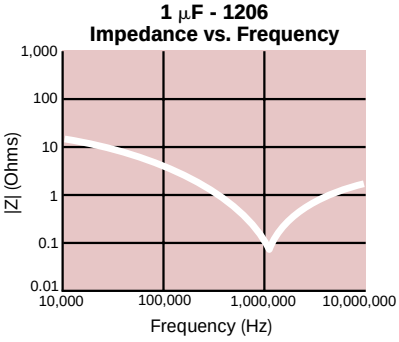






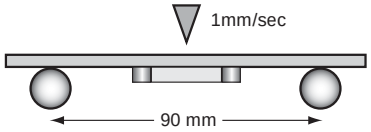






Y5V Dielectric

Specifications and Test Methods

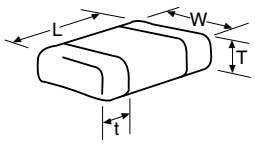
Parameter/Test		Y5V Specification Limits	Measuring Conditions	
Operating Temperature Range		-30ºC to +85ºC	Temperature Cycle Chamber	
Capacitance		Within specified tolerance	Freq.: 1.0 kHz ± 10% Voltage: 1.0Vrms ± .2V For Cap > 10 µF, 0.5Vrms @ 120Hz	
Dissipation Factor		≤ 5.0% for ≥ 50V DC rating ≤ 7.0% for 25V DC rating ≤ 9.0% for 16V DC rating ≤ 12.5% for ≤ 10V DC rating		
Insulation Resistance		100,000MΩ or 500MΩ - µF, whichever is less	Charge device with rated voltage for 120 ± 5 secs @ room temp/humidity	
Dielectric Strength		No breakdown or visual defects	Charge device with 300% of rated voltage for 1-5 seconds, w/charge and discharge current limited to 50 mA (max)	
Resistance to Flexure Stresses	Appearance	No defects	Deflection: 2mm Test Time: 30 seconds 	
	Capacitance Variation	≤ ±30%		
	Dissipation Factor	Meets Initial Values (As Above)		
	Insulation Resistance	≥ Initial Value x 0.1		
Solderability		≥ 95% of each terminal should be covered with fresh solder	Dip device in eutectic solder at 230 ± 5ºC for 5.0 ± 0.5 seconds	
Resistance to Solder Heat	Appearance	No defects, <25% leaching of either end terminal	Dip device in eutectic solder at 260ºC for 60 seconds. Store at room temperature for 24 ± 2 hours before measuring electrical properties.	
	Capacitance Variation	≤ ±20%		
	Dissipation Factor	Meets Initial Values (As Above)		
	Insulation Resistance	Meets Initial Values (As Above)		
	Dielectric Strength	Meets Initial Values (As Above)		
Thermal Shock	Appearance	No visual defects	Step 1: -30ºC ± 2º	30 ± 3 minutes
	Capacitance Variation	≤ ±20%	Step 2: Room Temp	≤ 3 minutes
	Dissipation Factor	Meets Initial Values (As Above)	Step 3: +85ºC ± 2º	30 ± 3 minutes
	Insulation Resistance	Meets Initial Values (As Above)	Step 4: Room Temp	≤ 3 minutes
	Dielectric Strength	Meets Initial Values (As Above)	Repeat for 5 cycles and measure after 24 ±2 hours at room temperature	
Load Life	Appearance	No visual defects	Charge device with twice rated voltage in test chamber set at 85ºC ± 2ºC for 1000 hours (+48, -0) Remove from test chamber and stabilize at room temperature for 24 ± 2 hours before measuring.	
	Capacitance Variation	≤ ±30%		
	Dissipation Factor	≤ Initial Value x 1.5 (See Above)		
	Insulation Resistance	≥ Initial Value x 0.1 (See Above)		
	Dielectric Strength	Meets Initial Values (As Above)		
Load Humidity	Appearance	No visual defects	Store in a test chamber set at 85ºC ± 2ºC/ 85% ± 5% relative humidity for 1000 hours (+48, -0) with rated voltage applied. Remove from chamber and stabilize at room temperature and humidity for 24 ± 2 hours before measuring.	
	Capacitance Variation	≤ ±30%		
	Dissipation Factor	≤ Initial Value x 1.5 (See above)		
	Insulation Resistance	≥ Initial Value x 0.1 (See Above)		
	Dielectric Strength	Meets Initial Values (As Above)		

Y5V Dielectric

Capacitance Range

PREFERRED SIZES ARE SHADED

SIZE		0201		0402			0603				0805				1206				1210			
Soldering		Reflow Only		Reflow Only			Reflow Only				Reflow/Wave				Reflow/Wave				Reflow Only			
Packaging		All Paper		All Paper			All Paper				Paper/Embossed				Paper/Embossed				Paper/Embossed			
(L) Length	MM (in.)	0.60 ± 0.03 (0.024 ± 0.001)		1.00 ± 0.10 (0.040 ± 0.004)			1.60 ± 0.15 (0.063 ± 0.006)				2.01 ± 0.20 (0.079 ± 0.008)				3.20 ± 0.20 (0.126 ± 0.008)				3.20 ± 0.20 (0.126 ± 0.008)			
(W) Width	MM (in.)	0.30 ± 0.03 (0.011 ± 0.001)		0.50 ± 0.10 (0.020 ± 0.004)			.81 ± 0.15 (0.032 ± 0.006)				1.25 ± 0.20 (0.049 ± 0.008)				1.60 ± 0.20 (0.063 ± 0.008)				2.50 ± 0.20 (0.098 ± 0.008)			
(t) Terminal	MM (in.)	0.15 ± 0.05 (0.006 ± 0.002)		0.25 ± 0.15 (0.010 ± 0.006)			0.35 ± 0.15 (0.014 ± 0.006)				0.50 ± 0.25 (0.020 ± 0.010)				0.50 ± 0.25 (0.020 ± 0.010)				.50 ± 0.25 (0.020 ± 0.010)			
	WVDC	6.3	10	16	25	50	10	16	25	50	10	16	25	50	10	16	25	50	10	16	25	50
Cap (pF)	820																					
	1000		A																			
	2200		A																			
Cap (µF)	4700		A			C																
	0.010	A	A		C	C				G												
	0.022	A		C	C					G												
	0.047	A		C					G	G			J	K								
	0.10			C					G				K	N								
	0.22							G	G													
	0.47							G				K	N					M				
	1.0						G	G				N	N									N
	2.2										N	N				M	M					
	4.7										N					M					N	
	10.0														Q	Q				Q	Q	
	22.0														Q				X			
	47.0																					
	WVDC	6.3	10	16	25	50	10	16	25	50	10	16	25	50	10	16	25	50	10	16	25	50
SIZE		0201		0402			0603				0805				1206				1210			



Letter	A	C	E	G	J	K	M	N	P	Q	X	Y	Z
Max. Thickness	0.33 (0.013)	0.56 (0.022)	0.71 (0.028)	0.86 (0.034)	0.94 (0.037)	1.02 (0.040)	1.27 (0.050)	1.40 (0.055)	1.52 (0.060)	1.78 (0.070)	2.29 (0.090)	2.54 (0.100)	2.79 (0.110)
	PAPER					EMBOSSED							

Packaging of Chip Components

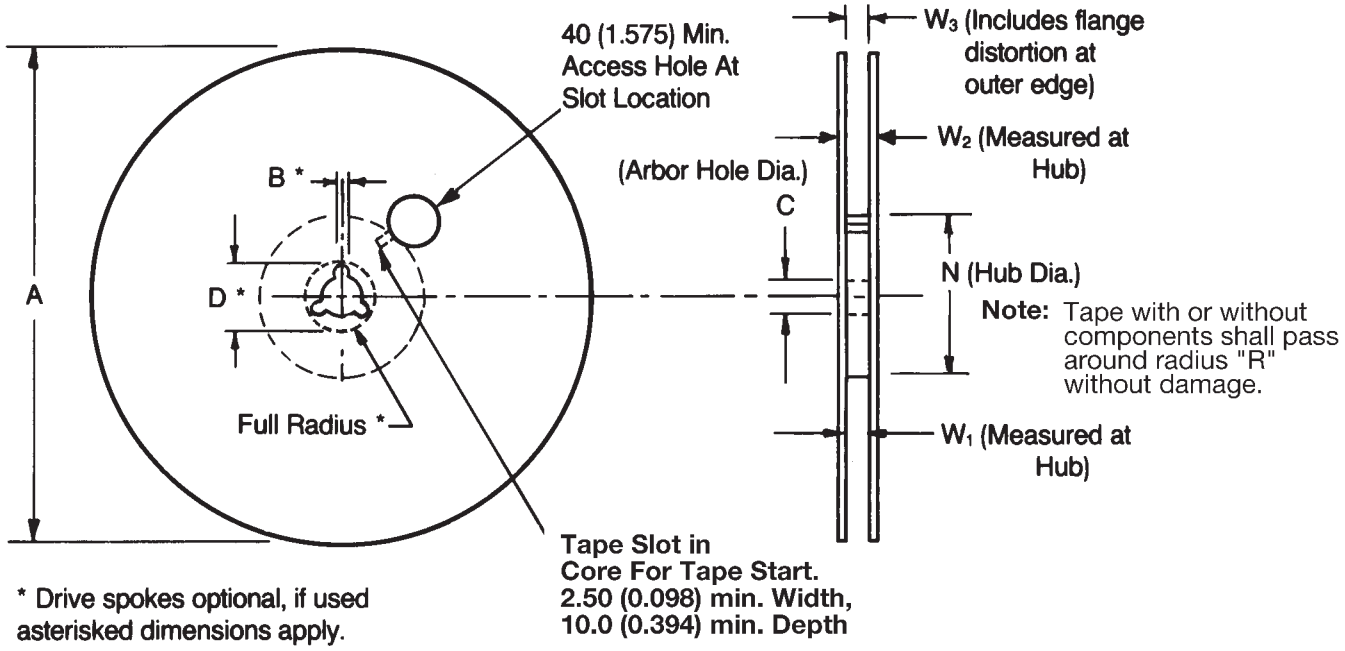
Automatic Insertion Packaging

TAPE & REEL QUANTITIES

All tape and reel specifications are in compliance with RS481.

	8mm	12mm	
Paper or Embossed Carrier	0612, 0508, 0805, 1206, 1210		
Embossed Only		1808	1812, 1825 2220, 2225
Paper Only	0201, 0306, 0402, 0603		
Qty. per Reel/7" Reel	2,000, 3,000 or 4,000, 10,000, 15,000 Contact factory for exact quantity	3,000	500, 1,000 Contact factory for exact quantity
Qty. per Reel/13" Reel	5,000, 10,000, 50,000 Contact factory for exact quantity	10,000	4,000

REEL DIMENSIONS

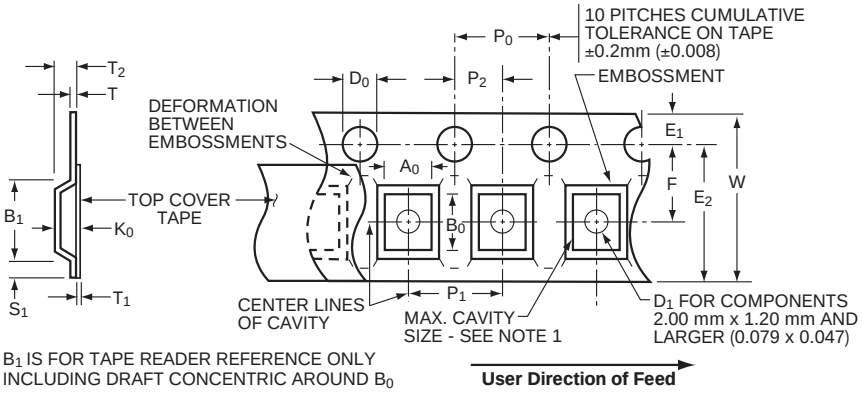


Tape Size(1)	A Max.	B* Min.	C	D* Min.	N Min.	W_1	W_2 Max.	W_3
8mm	330 (12.992)	1.5 (0.059)	$13.0^{+0.50}_{-0.20}$ ($0.512^{+0.020}_{-0.008}$)	20.2 (0.795)	50.0 (1.969)	$8.40^{+1.5}_{-0.0}$ ($0.331^{+0.059}_{-0.0}$)	14.4 (0.567)	7.90 Min. (0.311) 10.9 Max. (0.429)
12mm						$12.4^{+2.0}_{-0.0}$ ($0.488^{+0.079}_{-0.0}$)	18.4 (0.724)	11.9 Min. (0.469) 15.4 Max. (0.607)

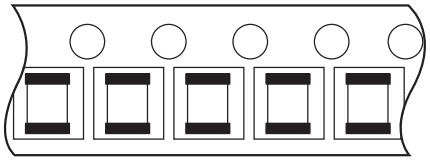
Metric dimensions will govern.
English measurements rounded and for reference only.
(1) For tape sizes 16mm and 24mm (used with chip size 3640) consult EIA RS-481 latest revision.

Embossed Carrier Configuration

8 & 12mm Tape Only



Chip Orientation



8 & 12mm Embossed Tape Metric Dimensions Will Govern

CONSTANT DIMENSIONS

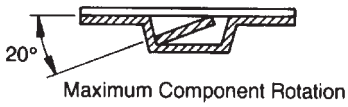
Tape Size	D_0	E	P_0	P_2	S_1 Min.	T Max.	T_1
8mm and 12mm	$1.50^{+0.10}_{-0.0}$ ($0.059^{+0.004}_{-0.0}$)	1.75 ± 0.10 (0.069 ± 0.004)	4.0 ± 0.10 (0.157 ± 0.004)	2.0 ± 0.05 (0.079 ± 0.002)	0.60 (0.024)	0.60 (0.024)	0.10 (0.004) Max.

VARIABLE DIMENSIONS

Tape Size	B_1 Max.	D_1 Min.	E_2 Min.	F	P_1 See Note 5	R Min. See Note 2	T_2	W Max.	A_0 B_0 K_0
8mm	4.35 (0.171)	1.00 (0.039)	6.25 (0.246)	3.50 ± 0.05 (0.138 ± 0.002)	4.00 ± 0.10 (0.157 ± 0.004)	25.0 (0.984)	2.50 Max. (0.098)	8.30 (0.327)	See Note 1
12mm	8.20 (0.323)	1.50 (0.059)	10.25 (0.404)	5.50 ± 0.05 (0.217 ± 0.002)	4.00 ± 0.10 (0.157 ± 0.004)	30.0 (1.181)	6.50 Max. (0.256)	12.3 (0.484)	See Note 1
8mm 1/2 Pitch	4.35 (0.171)	1.00 (0.039)	6.25 (0.246)	3.50 ± 0.05 (0.138 ± 0.002)	2.00 ± 0.10 (0.079 ± 0.004)	25.0 (0.984)	2.50 Max. (0.098)	8.30 (0.327)	See Note 1
12mm Double Pitch	8.20 (0.323)	1.50 (0.059)	10.25 (0.404)	5.50 ± 0.05 (0.217 ± 0.002)	8.00 ± 0.10 (0.315 ± 0.004)	30.0 (1.181)	6.50 Max. (0.256)	12.3 (0.484)	See Note 1

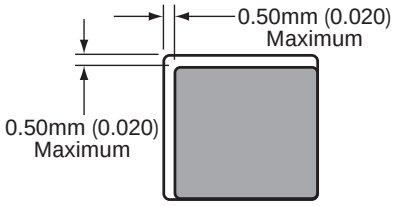
NOTES:

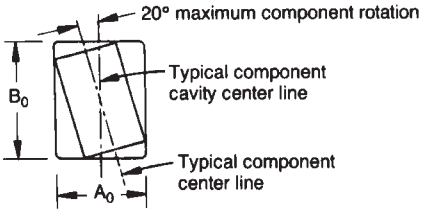
1. The cavity defined by A_0, B_0, and K_0 shall be configured to provide the following:
   Surround the component with sufficient clearance such that:
   a) the component does not protrude beyond the sealing plane of the cover tape.
   b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the cover tape has been removed.
   c) rotation of the component is limited to 20º maximum (see Sketches D & E).
   d) lateral movement of the component is restricted to 0.5mm maximum (see Sketch F).
2. Tape with or without components shall pass around radius "R" without damage.
3. Bar code labeling (if required) shall be on the side of the reel opposite the round sprocket holes. Refer to EIA-556.
4. B_1 dimension is a reference dimension for tape feeder clearance only.
5. If P_1 = 2.0mm, the tape may not properly index in all tape feeders.



Side or Front Sectional View
Sketch "C"

Top View, Sketch "F"
Component Lateral Movements

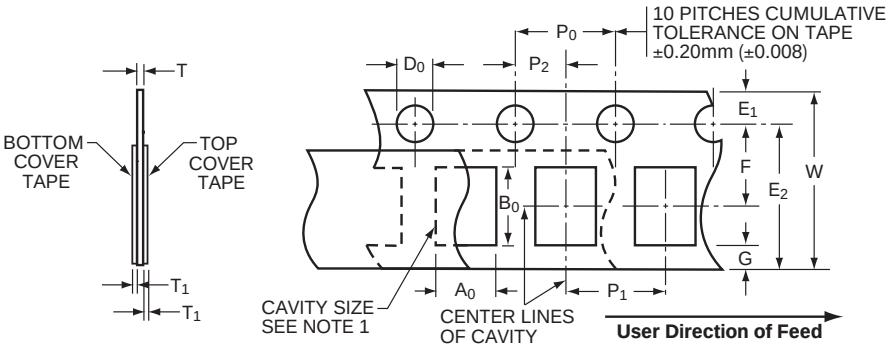




Top View
Sketch "D"

Paper Carrier Configuration

8 & 12mm Tape Only



8 & 12mm Paper Tape Metric Dimensions Will Govern

CONSTANT DIMENSIONS

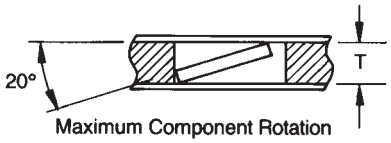
Tape Size	D_0	E	P_0	P_2	T_1	G. Min.	R Min.
8mm and 12mm	$1.50^{+0.10}_{-0.0}$ ($0.059^{+0.004}_{-0.0}$)	1.75 ± 0.10 (0.069 ± 0.004)	4.00 ± 0.10 (0.157 ± 0.004)	2.00 ± 0.05 (0.079 ± 0.002)	0.10 (0.004) Max.	0.75 (0.030) Min.	25.0 (0.984) See Note 2 Min.

VARIABLE DIMENSIONS

Tape Size	P_1 See Note 4	E_2 Min.	F	W	A_0 B_0	T
8mm	4.00 ± 0.10 (0.157 ± 0.004)	6.25 (0.246)	3.50 ± 0.05 (0.138 ± 0.002)	$8.00^{+0.30}_{-0.10}$ ($0.315^{+0.012}_{-0.004}$)	See Note 1	1.10mm (0.043) Max. for Paper Base Tape and 1.60mm (0.063) Max. for Non-Paper Base Compositions
12mm	4.00 ± 0.010 (0.157 ± 0.004)	10.25 (0.404)	5.50 ± 0.05 (0.217 ± 0.002)	12.0 ± 0.30 (0.472 ± 0.012)		
8mm 1/2 Pitch	2.00 ± 0.05 (0.079 ± 0.002)	6.25 (0.246)	3.50 ± 0.05 (0.138 ± 0.002)	$8.00^{+0.30}_{-0.10}$ ($0.315^{+0.012}_{-0.004}$)		
12mm Double Pitch	8.00 ± 0.10 (0.315 ± 0.004)	10.25 (0.404)	5.50 ± 0.05 (0.217 ± 0.002)	12.0 ± 0.30 (0.472 ± 0.012)		

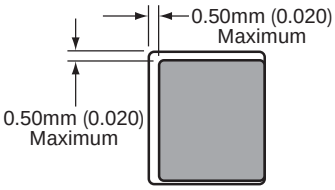
NOTES:

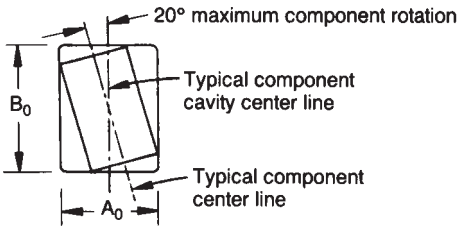
1. The cavity defined by A_0, B_0, and T shall be configured to provide sufficient clearance surrounding the component so that:
   a) the component does not protrude beyond either surface of the carrier tape;
   b) the component can be removed from the cavity in a vertical direction without mechanical restriction after the top cover tape has been removed;
   c) rotation of the component is limited to 20º maximum (see Sketches A & B);
   d) lateral movement of the component is restricted to 0.5mm maximum (see Sketch C).
2. Tape with or without components shall pass around radius "R" without damage.
3. Bar code labeling (if required) shall be on the side of the reel opposite the sprocket holes. Refer to EIA-556.
4. If P_1 = 2.0mm, the tape may not properly index in all tape feeders.



Side or Front Sectional View
Sketch "A"

Top View, Sketch "C"
Component Lateral





Top View
Sketch "B"

Bar Code Labeling Standard

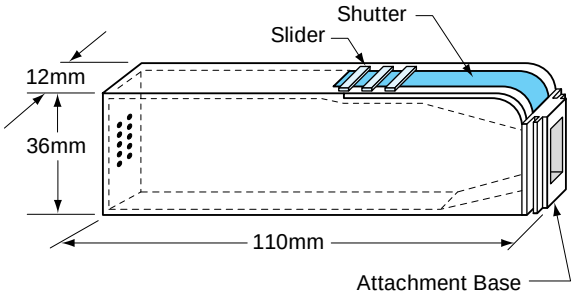
AVX bar code labeling is available and follows latest version of EIA-556

Bulk Case Packaging

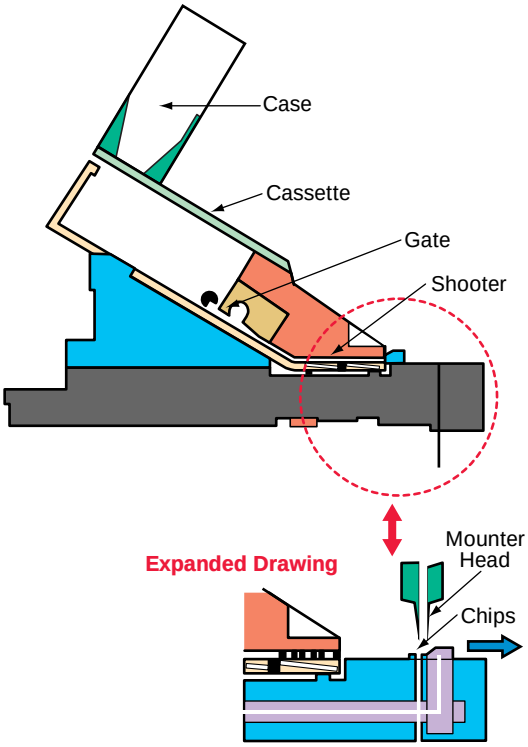
BENEFITS

- Easier handling
- Smaller packaging volume
  (1/20 of T/R packaging)
- Easier inventory control
- Flexibility
- Recyclable

CASE DIMENSIONS



BULK FEEDER



CASE QUANTITIES

Part Size	0402	0603	0805	1206
Qty. (pcs / cassette)	80,000	15,000	10,000 (T=.023") 8,000 (T=.031") 6,000 (T=.043")	5,000 (T=.023") 4,000 (T=.032") 3,000 (T=.044")

Basic Capacitor Formulas

I. Capacitance (farads)

English: $C = \frac{.224\ K\ A}{T_D}$

Metric: $C = \frac{.0884\ K\ A}{T_D}$

II. Energy stored in capacitors (Joules, watt - sec)

$E = \frac{1}{2} CV^2$

III. Linear charge of a capacitor (Amperes)

$I = C \frac{dV}{dt}$

IV. Total Impedance of a capacitor (ohms)

$Z = \sqrt{R_S^2 + (X_C - X_L)^2}$

V. Capacitive Reactance (ohms)

$x_C = \frac{1}{2 \pi fC}$

VI. Inductive Reactance (ohms)

$x_L = 2 \pi fL$

VII. Phase Angles:

Ideal Capacitors: Current leads voltage 90°
Ideal Inductors: Current lags voltage 90°
Ideal Resistors: Current in phase with voltage

VIII. Dissipation Factor (%)

D.F.= tan δ (loss angle) = $\frac{E.S.R.}{X_C}$ = $(2 \pi fC)$ (E.S.R.)

IX. Power Factor (%)

P.F. = Sine δ (loss angle) = Cos ϕ (phase angle)
P.F. = (when less than 10%) = DF

X. Quality Factor (dimensionless)

Q = Cotan δ (loss angle) = $\frac{1}{D.F.}$

XI. Equivalent Series Resistance (ohms)

E.S.R. = (D.F.) (Xc) = (D.F.) / $(2 \pi fC)$

XII. Power Loss (watts)

Power Loss = $(2 \pi fCV^2)$ (D.F.)

XIII. KVA (Kilowatts)

KVA = $2 \pi fCV^2 \times 10^{-3}$

XIV. Temperature Characteristic (ppm/°C)

T.C. = $\frac{Ct - C_{25}}{C_{25} (T_t - 25)} \times 10^6$

XV. Cap Drift (%)

C.D. = $\frac{C_1 - C_2}{C_1} \times 100$

XVI. Reliability of Ceramic Capacitors

$\frac{L_0}{L_t} = \left(\frac{V_t}{V_o}\right)^X \left(\frac{T_t}{T_o}\right)^Y$

XVII. Capacitors in Series (current the same)

Any Number: $\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} --- \frac{1}{C_N}$

Two: $C_T = \frac{C_1 C_2}{C_1 + C_2}$

XVIII. Capacitors in Parallel (voltage the same)

$C_T = C_1 + C_2 --- + C_N$

XIX. Aging Rate

A.R. = %Δ C/decade of time

XX. Decibels

db = $20 \log \frac{V_1}{V_2}$

METRIC PREFIXES

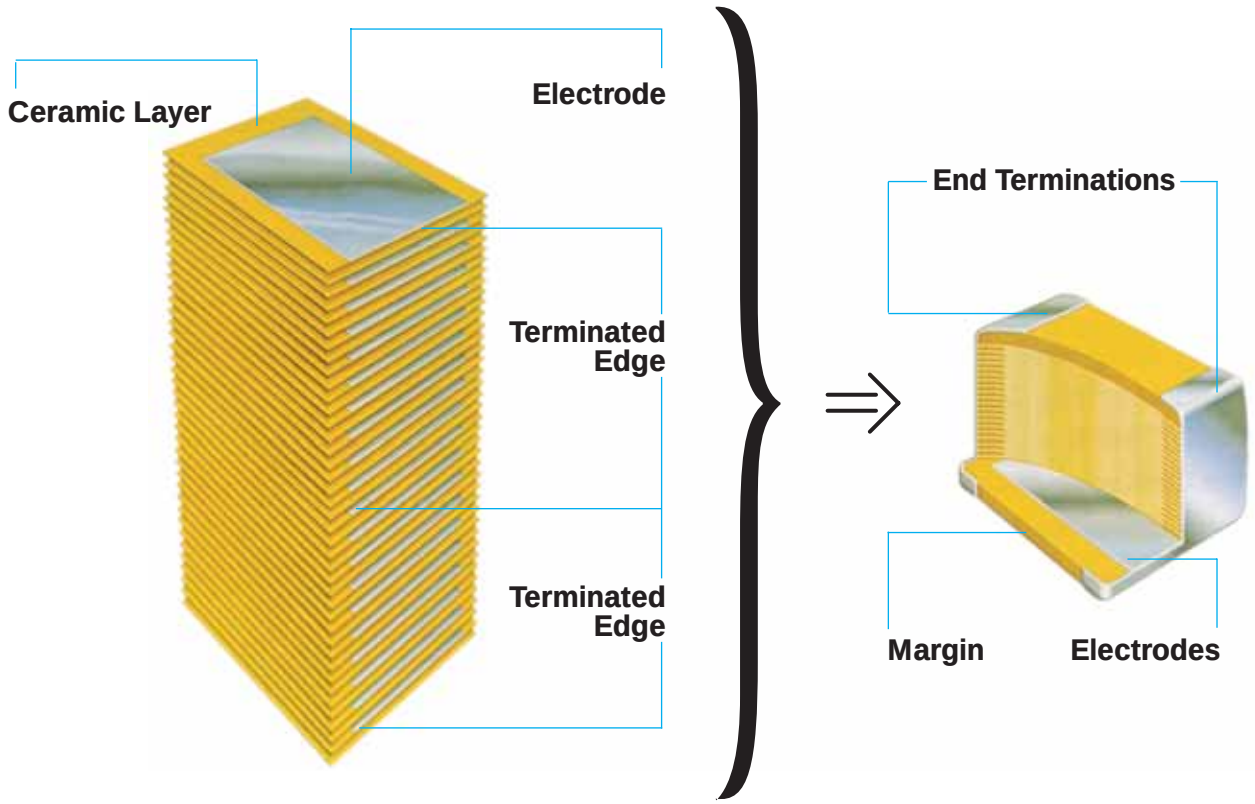
Pico	$X\ 10^{-12}$
Nano	$X\ 10^{-9}$
Micro	$X\ 10^{-6}$
Milli	$X\ 10^{-3}$
Deci	$X\ 10^{-1}$
Deca	$X\ 10^{+1}$
Kilo	$X\ 10^{+3}$
Mega	$X\ 10^{+6}$
Giga	$X\ 10^{+9}$
Tera	$X\ 10^{+12}$

SYMBOLS

K	= Dielectric Constant	f	= frequency	L_t	= Test life
A	= Area	L	= Inductance	V_t	= Test voltage
T_D	= Dielectric thickness	δ	= Loss angle	V_o	= Operating voltage
V	= Voltage	ϕ	= Phase angle	T_t	= Test temperature
t	= time	X & Y	= exponent effect of voltage and temp.	T_o	= Operating temperature
R_S	= Series Resistance	L_o	= Operating life		

General Description

Basic Construction – A multilayer ceramic (MLC) capacitor is a monolithic block of ceramic containing two sets of offset, interleaved planar electrodes that extend to two opposite surfaces of the ceramic dielectric. This simple structure requires a considerable amount of sophistication, both in material and manufacture, to produce it in the quality and quantities needed in today's electronic equipment.



Multilayer Ceramic Capacitor

Figure 1

Formulations – Multilayer ceramic capacitors are available in both Class 1 and Class 2 formulations. Temperature compensating formulation are Class 1 and temperature stable and general application formulations are classified as Class 2.

Class 1 – Class 1 capacitors or temperature compensating capacitors are usually made from mixtures of titanates where barium titanate is normally not a major part of the mix. They have predictable temperature coefficients and in general, do not have an aging characteristic. Thus they are the most stable capacitor available. The most popular Class 1 multilayer ceramic capacitors are C0G (NP0) temperature compensating capacitors (negative-positive 0 ppm/°C).

Class 2 – EIA Class 2 capacitors typically are based on the chemistry of barium titanate and provide a wide range of capacitance values and temperature stability. The most commonly used Class 2 dielectrics are X7R and Y5V. The X7R provides intermediate capacitance values which vary only ±15% over the temperature range of -55°C to 125°C. It finds applications where stability over a wide temperature range is required.

The Y5V provides the highest capacitance values and is used in applications where limited temperature changes are expected. The capacitance value for Y5V can vary from 22% to -82% over the -30°C to 85°C temperature range.

All Class 2 capacitors vary in capacitance value under the influence of temperature, operating voltage (both AC and DC), and frequency. For additional information on performance changes with operating conditions, consult AVX's software, SpiCap.

Table 1: EIA and MIL Temperature Stable and General Application Codes

EIA CODE Percent Capacity Change Over Temperature Range	
RS198	**Temperature Range**
X7	-55°C to +125°C
X6	-55°C to +105°C
X5	-55°C to +85°C
Y5	-30°C to +85°C
Z5	+10°C to +85°C
Code	**Percent Capacity Change**
D	±3.3%
E	±4.7%
F	±7.5%
P	±10%
R	±15%
S	±22%
T	+22%, -33%
U	+22%, - 56%
V	+22%, -82%
EXAMPLE – A capacitor is desired with the capacitance value at 25°C to increase no more than 7.5% or decrease no more than 7.5% from -30°C to +85°C. EIA Code will be Y5F.	

MIL CODE		
Symbol	**Temperature Range**	
A	-55°C to +85°C	
B	-55°C to +125°C	
C	-55°C to +150°C	
Symbol	**Cap. Change Zero Volts**	**Cap. Change Rated Volts**
R	+15%, -15%	+15%, -40%
S	+22%, -22%	+22%, -56%
W	+22%, -56%	+22%, -66%
X	+15%, -15%	+15%, -25%
Y	+30%, -70%	+30%, -80%
Z	+20%, -20%	+20%, -30%
Temperature characteristic is specified by combining range and change symbols, for example BR or AW. Specification slash sheets indicate the characteristic applicable to a given style of capacitor.		

In specifying capacitance change with temperature for Class 2 materials, EIA expresses the capacitance change over an operating temperature range by a 3 symbol code. The first symbol represents the cold temperature end of the temperature range, the second represents the upper limit of the operating temperature range and the third symbol represents the capacitance change allowed over the operating temperature range. Table 1 provides a detailed explanation of the EIA system.

Effects of Voltage – Variations in voltage have little effect on Class 1 dielectric but does affect the capacitance and dissipation factor of Class 2 dielectrics. The application of DC voltage reduces both the capacitance and dissipation factor while the application of an AC voltage within a reasonable range tends to increase both capacitance and dissipation factor readings. If a high enough AC voltage is applied, eventually it will reduce capacitance just as a DC voltage will. Figure 2 shows the effects of AC voltage.

Cap. Change vs. A.C. Volts
X7R

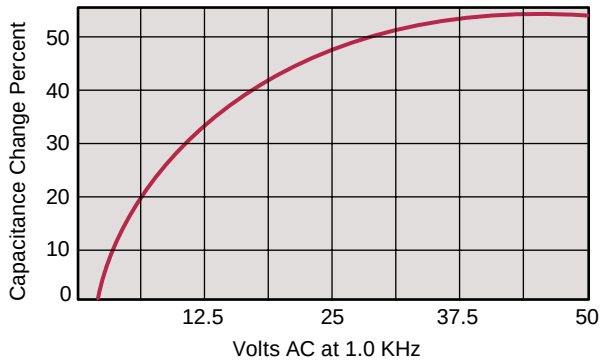


Figure 2

Capacitor specifications specify the AC voltage at which to measure (normally 0.5 or 1 VAC) and application of the wrong voltage can cause spurious readings. Figure 3 gives the voltage coefficient of dissipation factor for various AC voltages at 1 kilohertz. Applications of different frequencies will affect the percentage changes versus voltages.

D.F. vs. A.C. Measurement Volts
X7R

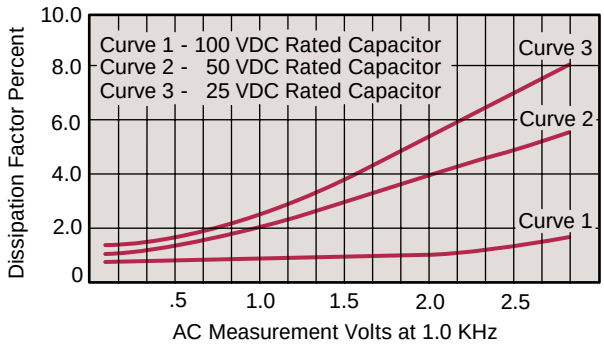


Figure 3

Typical effect of the application of DC voltage is shown in Figure 4. The voltage coefficient is more pronounced for higher K dielectrics. These figures are shown for room temperature conditions. The combination characteristic known as voltage temperature limits which shows the effects of rated voltage over the operating temperature range is shown in Figure 5 for the military BX characteristic.

Typical Cap. Change vs. D.C. Volts
X7R

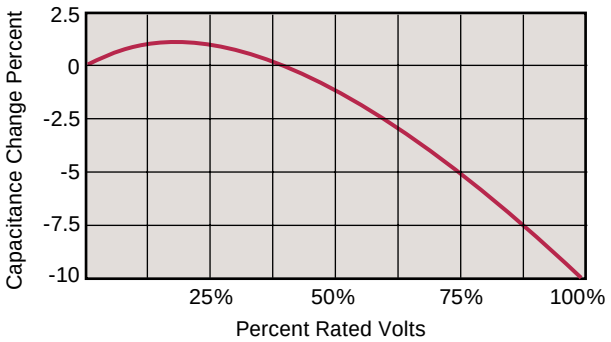


Figure 4

Typical Cap. Change vs. Temperature
X7R

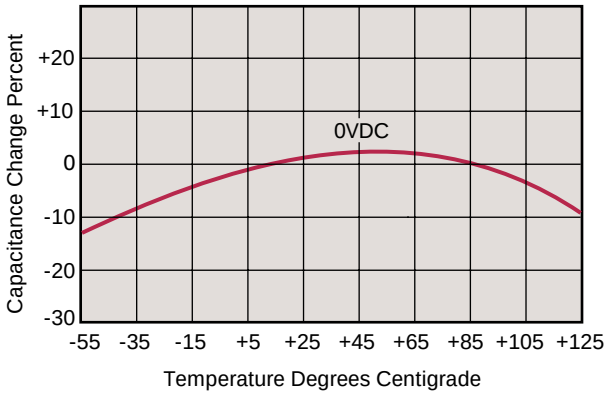
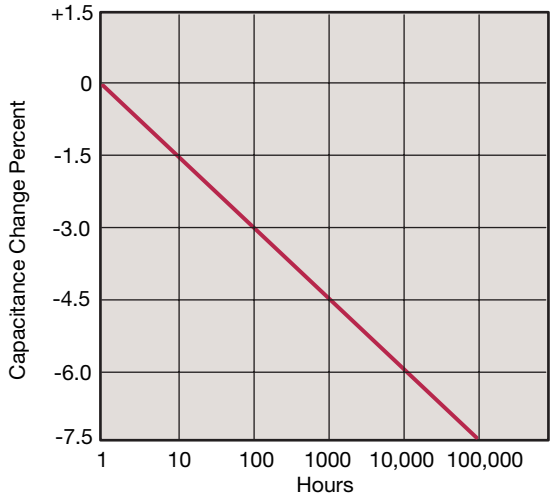


Figure 5

Effects of Time – Class 2 ceramic capacitors change capacitance and dissipation factor with time as well as temperature, voltage and frequency. This change with time is known as aging. Aging is caused by a gradual re-alignment of the crystalline structure of the ceramic and produces an exponential loss in capacitance and decrease in dissipation factor versus time. A typical curve of aging rate for semi-stable ceramics is shown in Figure 6.

If a Class 2 ceramic capacitor that has been sitting on the shelf for a period of time, is heated above its curie point, (125°C for 4 hours or 150°C for ½ hour will suffice) the part will de-age and return to its initial capacitance and dissipation factor readings. Because the capacitance changes rapidly, immediately after de-aging, the basic capacitance measurements are normally referred to a time period sometime after the de-aging process. Various manufacturers use different time bases but the most popular one is one day or twenty-four hours after "last heat." Change in the aging curve can be caused by the application of voltage and other stresses. The possible changes in capacitance due to de-aging by heating the unit explain why capacitance changes are allowed after test, such as temperature cycling, moisture resistance, etc., in MIL specs. The application of high voltages such as dielectric withstanding voltages also tends to de-age capacitors and is why re-reading of capacitance after 12 or 24 hours is allowed in military specifications after dielectric strength tests have been performed.

Typical Curve of Aging Rate
X7R



Characteristic	Max. Aging Rate %/Decade
C0G (NP0)	None
X7R, X5R	2
Y5V	7

Figure 6

Effects of Frequency – Frequency affects capacitance and impedance characteristics of capacitors. This effect is much more pronounced in high dielectric constant ceramic formulation than in low K formulations. AVX's SpiCap software generates impedance, ESR, series inductance, series resonant frequency and capacitance all as functions of frequency, temperature and DC bias for standard chip sizes and styles. It is available free from AVX and can be downloaded for free from AVX website: www.avx.com.

Effects of Mechanical Stress – High "K" dielectric ceramic capacitors exhibit some low level piezoelectric reactions under mechanical stress. As a general statement, the piezoelectric output is higher, the higher the dielectric constant of the ceramic. It is desirable to investigate this effect before using high "K" dielectrics as coupling capacitors in extremely low level applications.

Reliability – Historically ceramic capacitors have been one of the most reliable types of capacitors in use today. The approximate formula for the reliability of a ceramic capacitor is:

$$\frac{L_o}{L_t} = \left(\frac{V_t}{V_o}\right)^X \left(\frac{T_t}{T_o}\right)^Y$$

where

L_o = operating life
L_t = test life
V_t = test voltage
V_o = operating voltage
T_t = test temperature and
T_o = operating temperature in °C
X,Y = see text

Historically for ceramic capacitors exponent X has been considered as 3. The exponent Y for temperature effects typically tends to run about 8.

A capacitor is a component which is capable of storing electrical energy. It consists of two conductive plates (electrodes) separated by insulating material which is called the dielectric. A typical formula for determining capacitance is:

$$C = \frac{.224\,KA}{t}$$

C = capacitance (picofarads)
K = dielectric constant (Vacuum = 1)
A = area in square inches
t = separation between the plates in inches (thickness of dielectric)
.224 = conversion constant (.0884 for metric system in cm)

Capacitance – The standard unit of capacitance is the farad. A capacitor has a capacitance of 1 farad when 1 coulomb charges it to 1 volt. One farad is a very large unit and most capacitors have values in the micro (10^{-6}), nano (10^{-9}) or pico (10^{-12}) farad level.

Dielectric Constant – In the formula for capacitance given above the dielectric constant of a vacuum is arbitrarily chosen as the number 1. Dielectric constants of other materials are then compared to the dielectric constant of a vacuum.

Dielectric Thickness – Capacitance is indirectly proportional to the separation between electrodes. Lower voltage requirements mean thinner dielectrics and greater capacitance per volume.

Area – Capacitance is directly proportional to the area of the electrodes. Since the other variables in the equation are usually set by the performance desired, area is the easiest parameter to modify to obtain a specific capacitance within a material group.

Energy Stored – The energy which can be stored in a capacitor is given by the formula:

$$E = \tfrac{1}{2}CV^2$$

E = energy in joules (watts-sec)
V = applied voltage
C = capacitance in farads

Potential Change – A capacitor is a reactive component which reacts against a change in potential across it. This is shown by the equation for the linear charge of a capacitor:

$$I_{ideal} = C\frac{dV}{dt}$$

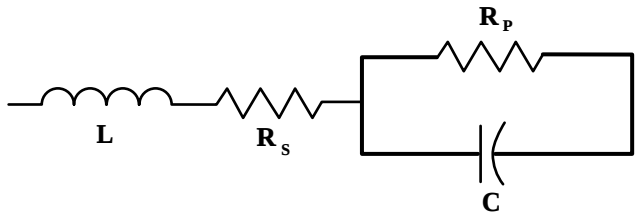
where

I = Current
C = Capacitance
dV/dt = Slope of voltage transition across capacitor

Thus an infinite current would be required to instantly change the potential across a capacitor. The amount of current a capacitor can "sink" is determined by the above equation.

Equivalent Circuit – A capacitor, as a practical device, exhibits not only capacitance but also resistance and inductance. A simplified schematic for the equivalent circuit is:

C = Capacitance
R_s = Series Resistance
L = Inductance
R_p = Parallel Resistance



Reactance – Since the insulation resistance (R_p) is normally very high, the total impedance of a capacitor is:

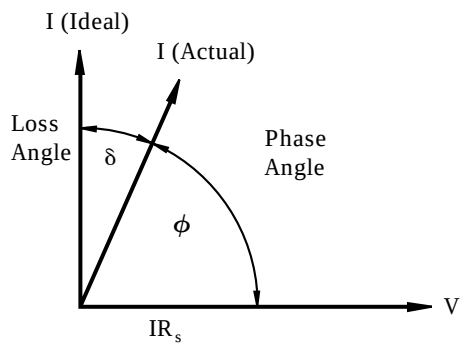
$$Z = \sqrt{R_S^2 + (X_C - X_L)^2}$$

where

Z = Total Impedance
R_s = Series Resistance
X_C = Capacitive Reactance $= \frac{1}{2\pi fC}$
X_L = Inductive Reactance $= 2\pi fL$

The variation of a capacitor's impedance with frequency determines its effectiveness in many applications.

Phase Angle – Power Factor and Dissipation Factor are often confused since they are both measures of the loss in a capacitor under AC application and are often almost identical in value. In a "perfect" capacitor the current in the capacitor will lead the voltage by 90°.

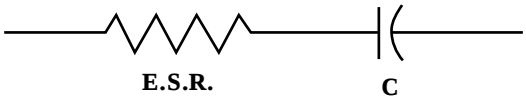


In practice the current leads the voltage by some other phase angle due to the series resistance R_S. The complement of this angle is called the loss angle and:

Power Factor (P.F.) = Cos ϕ or Sine δ
Dissipation Factor (D.F.) = tan δ

for small values of δ the tan and sine are essentially equal which has led to the common interchangeability of the two terms in the industry.

Equivalent Series Resistance – The term E.S.R. or Equivalent Series Resistance combines all losses both series and parallel in a capacitor at a given frequency so that the equivalent circuit is reduced to a simple R-C series connection.



Dissipation Factor – The DF/PF of a capacitor tells what percent of the apparent power input will turn to heat in the capacitor.

$$\textbf{Dissipation Factor} = \frac{\textbf{E.S.R.}}{\textbf{X}_c} = (2\pi fC)(\text{E.S.R.})$$

The watts loss are:

$$\textbf{Watts loss} = (2\pi fCV^2)(\text{D.F.})$$

Very low values of dissipation factor are expressed as their reciprocal for convenience. These are called the "Q" or Quality factor of capacitors.

Parasitic Inductance – The parasitic inductance of capacitors is becoming more and more important in the decoupling of today's high speed digital systems. The relationship between the inductance and the ripple voltage induced on the DC voltage line can be seen from the simple inductance equation:

$$V = L\frac{di}{dt}$$

The $\frac{di}{dt}$ seen in current microprocessors can be as high as 0.3 A/ns, and up to 10A/ns. At 0.3 A/ns, 100pH of parasitic inductance can cause a voltage spike of 30mV. While this does not sound very drastic, with the Vcc for microprocessors decreasing at the current rate, this can be a fairly large percentage.

Another important, often overlooked, reason for knowing the parasitic inductance is the calculation of the resonant frequency. This can be important for high frequency, bypass capacitors, as the resonant point will give the most signal attenuation. The resonant frequency is calculated from the simple equation:

$$f_{res} = \frac{1}{2\pi\sqrt{LC}}$$

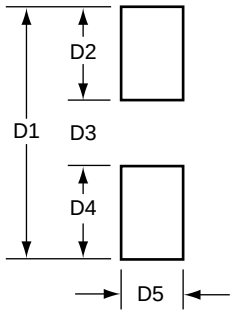
Insulation Resistance – Insulation Resistance is the resistance measured across the terminals of a capacitor and consists principally of the parallel resistance R_P shown in the equivalent circuit. As capacitance values and hence the area of dielectric increases, the I.R. decreases and hence the product (C x IR or RC) is often specified in ohm faradsor more commonly megohm-microfarads. Leakage current is determined by dividing the rated voltage by IR (Ohm's Law).

Dielectric Strength – Dielectric Strength is an expression of the ability of a material to withstand an electrical stress. Although dielectric strength is ordinarily expressed in volts, it is actually dependent on the thickness of the dielectric and thus is also more generically a function of volts/mil.

Dielectric Absorption – A capacitor does not discharge instantaneously upon application of a short circuit, but drains gradually after the capacitance proper has been discharged. It is common practice to measure the dielectric absorption by determining the "reappearing voltage" which appears across a capacitor at some point in time after it has been fully discharged under short circuit conditions.

Corona – Corona is the ionization of air or other vapors which causes them to conduct current. It is especially prevalent in high voltage units but can occur with low voltages as well where high voltage gradients occur. The energy discharged degrades the performance of the capacitor and can in time cause catastrophic failures.

REFLOW SOLDERING



Case Size	D1	D2	D3	D4	D5
0402	1.70 (0.07)	0.60 (0.02)	0.50 (0.02)	0.60 (0.02)	0.50 (0.02)
0603	2.30 (0.09)	0.80 (0.03)	0.70 (0.03)	0.80 (0.03)	0.75 (0.03)
0805	3.00 (0.12)	1.00 (0.04)	1.00 (0.04)	1.00 (0.04)	1.25 (0.05)
1206	4.00 (0.16)	1.00 (0.04)	2.00 (0.09)	1.00 (0.04)	1.60 (0.06)
1210	4.00 (0.16)	1.00 (0.04)	2.00 (0.09)	1.00 (0.04)	2.50 (0.10)
1808	5.60 (0.22)	1.00 (0.04)	3.60 (0.14)	1.00 (0.04)	2.00 (0.08)
1812	5.60 (0.22)	1.00 (0.04))	3.60 (0.14)	1.00 (0.04)	3.00 (0.12)
1825	5.60 (0.22)	1.00 (0.04)	3.60 (0.14)	1.00 (0.04)	6.35 (0.25)
2220	6.60 (0.26)	1.00 (0.04)	4.60 (0.18)	1.00 (0.04)	5.00 (0.20)
2225	6.60 (0.26)	1.00 (0.04)	4.60 (0.18)	1.00 (0.04)	6.35 (0.25)

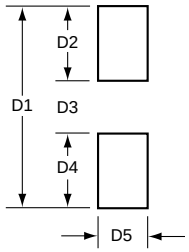
Dimensions in millimeters (inches)

Component Pad Design

Component pads should be designed to achieve good solder filets and minimize component movement during reflow soldering. Pad designs are given below for the most common sizes of multilayer ceramic capacitors for both wave and reflow soldering. The basis of these designs is:

- Pad width equal to component width. It is permissible to decrease this to as low as 85% of component width but it is not advisable to go below this.
- Pad overlap 0.5mm beneath component.
- Pad extension 0.5mm beyond components for reflow and 1.0mm for wave soldering.

WAVE SOLDERING

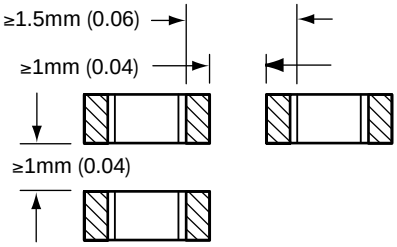


Case Size	D1	D2	D3	D4	D5
0603	3.10 (0.12)	1.20 (0.05)	0.70 (0.03)	1.20 (0.05)	0.75 (0.03)
0805	4.00 (0.15)	1.50 (0.06)	1.00 (0.04)	1.50 (0.06)	1.25 (0.05)
1206	5.00 (0.19)	1.50 (0.06)	2.00 (0.09)	1.50 (0.06)	1.60 (0.06)

Dimensions in millimeters (inches)

Component Spacing

For wave soldering components, must be spaced sufficiently far apart to avoid bridging or shadowing (inability of solder to penetrate properly into small spaces). This is less important for reflow soldering but sufficient space must be allowed to enable rework should it be required.



Preheat & Soldering

The rate of preheat should not exceed 4°C/second to prevent thermal shock. A better maximum figure is about 2°C/second.

For capacitors size 1206 and below, with a maximum thickness of 1.25mm, it is generally permissible to allow a temperature differential from preheat to soldering of 150°C. In all other cases this differential should not exceed 100°C.

For further specific application or process advice, please consult AVX.

Cleaning

Care should be taken to ensure that the capacitors are thoroughly cleaned of flux residues especially the space beneath the capacitor. Such residues may otherwise become conductive and effectively offer a low resistance bypass to the capacitor.

Ultrasonic cleaning is permissible, the recommended conditions being 8 Watts/litre at 20-45 kHz, with a process cycle of 2 minutes vapor rinse, 2 minutes immersion in the ultrasonic solvent bath and finally 2 minutes vapor rinse.

APPLICATION NOTES

Storage
Good solderability is maintained for at least twelve months, provided the components are stored in their "as received" packaging at less than 40°C and 70% RH.

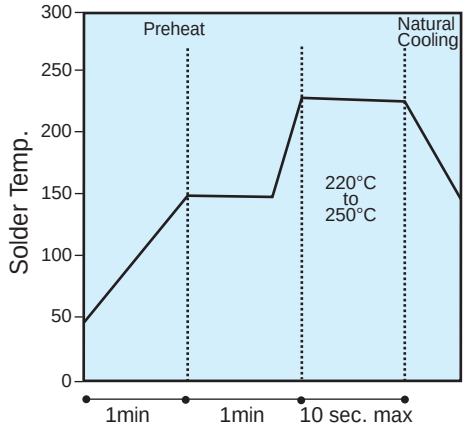
Solderability
Terminations to be well soldered after immersion in a 60/40 tin/lead solder bath at 235 ± 5°C for 2 ± 1 seconds.

Leaching
Terminations will resist leaching for at least the immersion times and conditions shown below.

Termination Type	Solder Tin/Lead/Silver	Solder Temp. °C	Immersion Time Seconds
Nickel Barrier	60/40/0	260 ± 5	30 ± 1

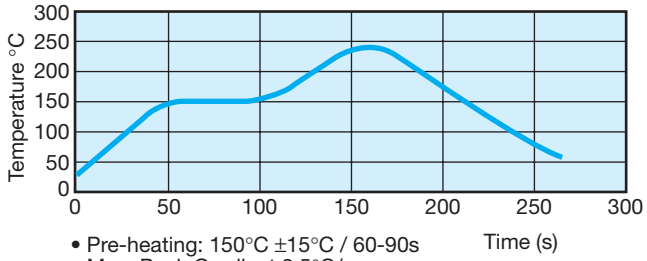
Recommended Soldering Profiles

Reflow



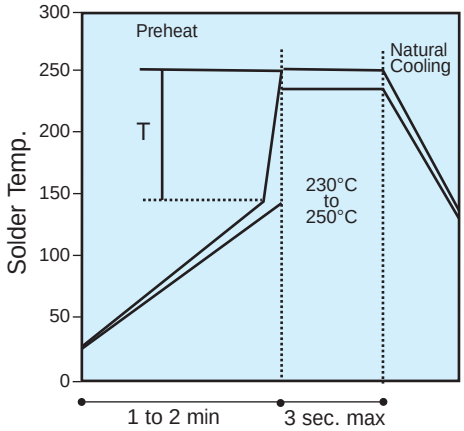
(Minimize soldering time)

Lead-Free Reflow Profile



- Pre-heating: 150°C ±15°C / 60-90s
- Max. Peak Gradient 2.5°C/s
- Peak Temperature: 245°C ±5°C
- Time at >230°C: 40s Max.

Wave



(Preheat chips before soldering)
T/maximum 150°C

Lead-Free Wave Soldering
The recommended peak temperature for lead-free wave soldering is 250°C-260°C for 3-5 seconds. The other parameters of the profile remains the same as above.

The following should be noted by customers changing from lead based systems to the new lead free pastes.

a) The visual standards used for evaluation of solder joints will need to be modified as lead free joints are not as bright as with tin-lead pastes and the fillet may not be as large.

b) Resin color may darken slightly due to the increase in temperature required for the new pastes.

c) Lead-free solder pastes do not allow the same self alignment as lead containing systems. Standard mounting pads are acceptable, but machine set up may need to be modified.

General
Surface mounting chip multilayer ceramic capacitors are designed for soldering to printed circuit boards or other substrates. The construction of the components is such that they will withstand the time/temperature profiles used in both wave and reflow soldering methods.

Handling
Chip multilayer ceramic capacitors should be handled with care to avoid damage or contamination from perspiration and skin oils. The use of tweezers or vacuum pick ups is strongly recommended for individual components. Bulk handling should ensure that abrasion and mechanical shock are minimized. Taped and reeled components provides the ideal medium for direct presentation to the placement machine. Any mechanical shock should be minimized during handling chip multilayer ceramic capacitors.

Preheat
It is important to avoid the possibility of thermal shock during soldering and carefully controlled preheat is therefore required. The rate of preheat should not exceed 4°C/second

and a target figure 2°C/second is recommended. Although an 80°C to 120°C temperature differential is preferred, recent developments allow a temperature differential between the component surface and the soldering temperature of 150°C (Maximum) for capacitors of 1210 size and below with a maximum thickness of 1.25mm. The user is cautioned that the risk of thermal shock increases as chip size or temperature differential increases.

Soldering

Mildly activated rosin fluxes are preferred. The minimum amount of solder to give a good joint should be used. Excessive solder can lead to damage from the stresses caused by the difference in coefficients of expansion between solder, chip and substrate. AVX terminations are suitable for all wave and reflow soldering systems. If hand soldering cannot be avoided, the preferred technique is the utilization of hot air soldering tools.

Cooling

Natural cooling in air is preferred, as this minimizes stresses within the soldered joint. When forced air cooling is used, cooling rate should not exceed 4°C/second. Quenching is not recommended but if used, maximum temperature differentials should be observed according to the preheat conditions above.

Cleaning

Flux residues may be hygroscopic or acidic and must be removed. AVX MLC capacitors are acceptable for use with all of the solvents described in the specifications MIL-STD-202 and EIA-RS-198. Alcohol based solvents are acceptable and properly controlled water cleaning systems are also acceptable. Many other solvents have been proven successful, and most solvents that are acceptable to other components on circuit assemblies are equally acceptable for use with ceramic capacitors.

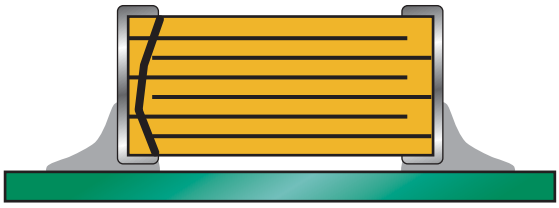
POST SOLDER HANDLING

Once SMP components are soldered to the board, any bending or flexure of the PCB applies stresses to the soldered joints of the components. For leaded devices, the stresses are absorbed by the compliancy of the metal leads and generally don't result in problems unless the stress is large enough to fracture the soldered connection.

Ceramic capacitors are more susceptible to such stress because they don't have compliant leads and are brittle in nature. The most frequent failure mode is low DC resistance or short circuit. The second failure mode is significant loss of capacitance due to severing of contact between sets of the internal electrodes.

Cracks caused by mechanical flexure are very easily identified and generally take one of the following two general forms:

Type A:
Angled crack between bottom of device to top of solder joint.



Type B:
Fracture from top of device to bottom of device.

Mechanical cracks are often hidden underneath the termination and are difficult to see externally. However, if one end termination falls off during the removal process from PCB, this is one indication that the cause of failure was excessive mechanical stress due to board warping.

COMMON CAUSES OF MECHANICAL CRACKING

The most common source for mechanical stress is board depanelization equipment, such as manual breakapart, v-cutters and shear presses. Improperly aligned or dull cutters may cause torqueing of the PCB resulting in flex stresses being transmitted to components near the board edge. Another common source of flexural stress is contact during parametric testing when test points are probed. If the PCB is allowed to flex during the test cycle, nearby ceramic capacitors may be broken.

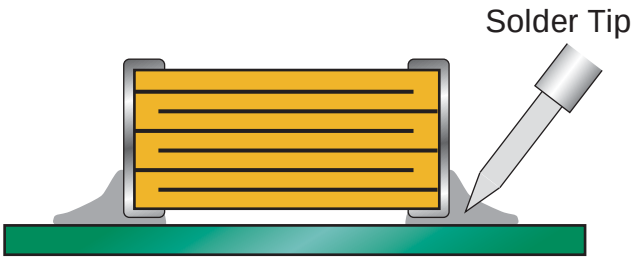
A third common source is board to board connections at vertical connectors where cables or other PCBs are connected to the PCB. If the board is not supported during the plug/unplug cycle, it may flex and cause damage to nearby components.

Special care should also be taken when handling large (>6" on a side) PCBs since they more easily flex or warp than smaller boards.

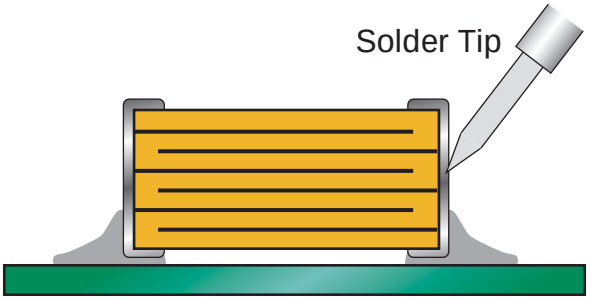
REWORKING OF MLCs

Thermal shock is common in MLCs that are manually attached or reworked with a soldering iron. *AVX strongly recommends that any reworking of MLCs be done with hot air reflow rather than soldering irons.* It is practically impossible to cause any thermal shock in ceramic capacitors when using hot air reflow.

However direct contact by the soldering iron tip often causes thermal cracks that may fail at a later date. If rework by soldering iron is absolutely necessary, it is recommended that the wattage of the iron be less than 30 watts and the tip temperature be <300ºC. *Rework should be performed by applying the solder iron tip to the pad and not directly contacting any part of the ceramic capacitor.*



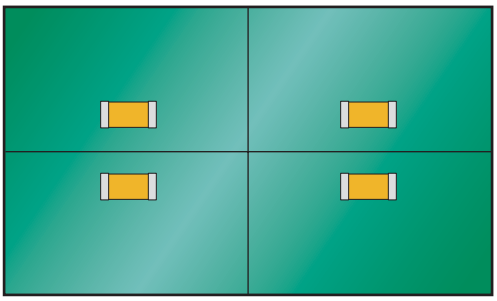
Preferred Method - No Direct Part Contact



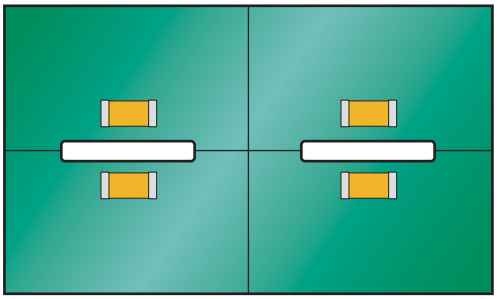
Poor Method - Direct Contact with Part

PCB BOARD DESIGN

To avoid many of the handling problems, AVX recommends that MLCs be located at least .2" away from nearest edge of board. However when this is not possible, AVX recommends that the panel be routed along the cut line, adjacent to where the MLC is located.



No Stress Relief for MLCs



Routed Cut Line Relieves Stress on MLC

INTRODUCTION

Ceramic chips consist of formulated ceramic dielectric materials which have been fabricated into thin layers, interspersed with metal electrodes alternately exposed on opposite edges of the laminated structure. The entire structure is then fired at high temperature to produce a monolithic block which provides high capacitance values in a small physical volume. After firing, conductive terminations are applied to opposite ends of the chip to make contact with the exposed electrodes. Standard end terminations use a nickel barrier layer and a tin overplate to provide excellent solderability for the customer.

KEMET multilayer ceramic chip capacitors are produced in plants designed specifically for chip capacitor manufacture. The process features a high degree of mechanization as well as precise controls over raw materials and process conditions. Manufacturing is supplemented by extensive Technology, Engineering and Quality Assurance programs.

KEMET ceramic chip capacitors are offered in the five most popular temperature characteristics. These are designated by the Electronics Industies Association (EIA) as the ultra-stable C0G (also known as NP0, military version BP), the stable X7R (military BX or BR), the stable X5R, and the general purpose Z5U and Y5V. A wide range of sizes are available. KEMET multilayer ceramic chip capacitors are available in KEMET's tape and reel packaging, compatible with automatic placement equipment. Bulk cassette packaging is also available (0805,0603 and 0402 only) for those pick and place machines requiring its use.

ELECTRICAL CHARACTERISTICS

1. Working Voltage:

Refers to the maximum continuous DC working voltage permissible across the entire operating temperature range. The reliability of multilayer ceramic capacitors is not extremely sensitive to voltage, and brief applications of voltage above rated will not result in immediate failure. However, reliability will be degraded by sustained exposure to voltages above rated.

2. Temperature Characteristics:

Within the EIA classifications, various temperature characteristics are identified by a three-symbol code; for example: C0G, X7R, X5R, Z5U and Y5V.

For Class I temperature compensating dielectrics (includes C0G), the first symbol designates the significant figures of the temperature coefficient in PPM per degree Celsius, the second designates the multiplier to be applied, and the third designates the tolerance in PPM per degrees Celsius. EIA temperature characteristic codes for Class I dielectrics are shown in Table 1.

Table 1 – EIA Temperature Characteristic Codes for Class I Dielectrics

Significant Figure of Temperature Coefficient		Multiplier Applied to Temperature Coefficient		Tolerance of Temperature Coefficient	
PPM per Degree C	Letter Symbol	Multi-plier	Number Symbol	PPM per Degree C	Letter Symbol
0.0	C	-1	0	± 30	G
0.3	B	-10	1	± 60	H
0.9	A	-100	2	± 120	J
1.0	M	-1000	3	± 250	K
1.5	P	-10000	4	± 500	L

KEMET supplies the C0G characteristic.

For Class II and III dielectrics (including X7R, X5R, Z5U & Y5V), the first symbol indicates the lower limit of the operating temperature range, the second indicates the upper limit of the operating temperature range, and the third indicates the maximum capacitance change allowed over the operating temperature range. EIA type designation codes for Class II and III dielectrics are shown in Table 2.

Table 2 – EIA Temperature Characteristic Codes for Class II & III Dielectrics

Low Temperature Rating		High Temperature Rating		Maximum Capacitance Shift		
Degree Celsius	Letter Symbol	Degree Celsius	Number Symbol	Percent	Letter Symbol	EIA Class
+10C	Z	+45C	2	± 1.0%	A	II
-30C	Y	+65C	4	± 1.5%	B	II
-55C	X	+85C	5	± 2.2%	C	II
		+105C	6	± 3.3%	D	II
		+125C	7	± 4.7%	E	II
		+150C	8	± 7.5%	F	II
		+200C	9	± 10.0%	P	II
				± 15.0%	R	II
				± 22.0%	S	III
				+ 22/-33%	T	III
				+22/-56%	U	III
				+22/-82%	V	III

KEMET supplies the X7R, X5R, Z5U and Y5V characteristics.

3. Capacitance Tolerance:

See tables on pages 72-75.

4. Capacitance:

Within specified tolerance when measured per Table 3.

The standard unit of capacitance is the farad. For practical capacitors, capacitance is usually expressed in microfarads (10^{-6} farad), nanofarads (10^{-9} farad), or picofarads (10^{-12} farad). Standard measurement conditions are listed in Table 3 - Specified Electrical Limits.

Like all other practical capacitors, multilayer ceramic capacitors also have resistance and inductance. A simplified schematic for the single frequency equivalent circuit is shown in Figure 1. At high frequency more complex models apply - see KEMET SPICE models at www.kemet.com for details.

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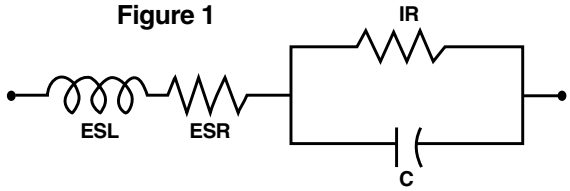
Figure 1



C = Capacitance

ESR = Equivalent Series Resistance

ESL = Equivalent Series Inductance

IR = Insulation Resistance

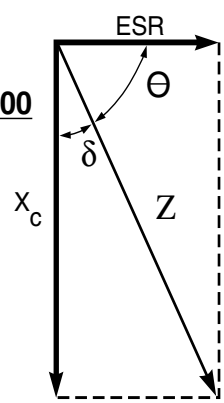
5. Dissipation Factor: Measured under same conditions as capacitance. (See Table 3)

Dissipation factor (DF) is a measure of the losses in a capacitor under AC application. It is the ratio of the equivalent series resistance to the capacitive reactance, and is usually expressed in percent. It is normally measured simultaneously with capacitance, and under the same conditions. The vector diagram below illustrates the relationship between DF, ESR and impedance. The reciprocal of the dissipation factor is called the "Q" or quality factor. For convenience, the "Q" factor is often used for very low values of dissipation factor especially when measured at high frequencies. DF is sometimes called the "loss tangent" or "tangent δ", as shown in Figure 2.

Figure 2

$$DF(\%) = \frac{ESR \times 100}{X_C}$$

$$X_C = \frac{1}{2\pi fC}$$



6. Impedance:

Since the parallel resistance (IR) is normally very high, the total impedance of the capacitor can be approximated by:

Figure 3

$$Z = \sqrt{ESR^2 + (X_L - X_C)^2}$$

Where: Z = Total Impedance

ESR = Equivalent Series Resistance

X_C = Capacitive Reactance = $1/(2\pi fC)$

X_L = Inductive Reactance = $(2\pi f)(ESL)$

The variation of a capacitor's impedance with frequency determines its effectiveness in many applications. At high frequency more detailed models apply - see KEMET SPICE models for such instances.

7. Insulation Resistance: Measured after 2 minutes electrification at 25°C and rated voltage: Limits per Table 3.

Insulation Resistance is the measure of a capacitor to resist the flow of DC leakage current. It is sometimes referred to as "leakage resistance". Insulation resistance (IR) is the DC resistance measured across the terminals of a capacitor, represented by the parallel resistance (IR) shown in Figure 1. For a given dielectric type, electrode area increases with capacitance, resulting in a decrease in the insulation resistance. Consequently, insulation resistance limits are usually specified as the "RC" (IR x C) product, in terms of ohm-farads or megohm-micro-farads. The insulation resistance for a specific capacitance value is determined by dividing this product by the capacitance. However, as the nominal capacitance values become small, the insulation resistance calculated from the RC product reaches values which are impractical. Consequently, IR specifications usually include both a minimum RC product and a maximum limit based on the IR calculated

Table 3 – Specified Electrical Limits

Parameter	Temperature Characteristics			
	C0G	X7R/X5R	Z5U	Y5V
Capacitance & Dissipation Factor: Measured at following conditions: C0G – 1kHz and 1 vrms if capacitance >1000 pF 1MHz and 1 vrms if capacitance ≤1000 pF X7R/X5R/Y5V – 1kHz and 1 vrms* if capacitance ≤ 10 µF X7R/X5R/Y5V – 120Hz and 0.5 vrms if capacitance > 10 µF Z5U – 1kHz and 0.5 vrms				
DF Limits: **X5R / Cap / DF <25V / <564 / 5.0% <25V / ≥564 / 10.0% 50 - 200 volts – 25 volts – 16 volts – 6.3/10 volts –	0.10% 0.10% -------- --------	2.5% 2.5% 3.5% 5.0% 3.5% ** 5.0% **	4.0% 4.0% -------	5.0% 7.0% 7.0% 10.0%
Dielectric Strength: At 2.5 times rated DC voltage	Pass Subsequent IR Test			
Insulation Resistance (IR): At rated DC voltage, whichever of the two is smaller. To get IR limit, divide MΩ–µF value by the capacitance and compare to GΩ limit. Select the lower of the two limits.	1,000 MΩ – µF or 100 GΩ (100,000 MΩ)	1,000 MΩ – µF or 100 GΩ (100,000 MΩ)	100 MΩ – µF or 10 GΩ (10,000 MΩ)	100 MΩ – µF or 10 G (≥16 volt) 50 MΩ – µF or 10G (≤10v) (10,000 MΩ)
Temperature: Range, °C Capacitance Change (without DC voltage)	-55 to +125 0 ± 30 ppm/°C	X7R: -55 to +125 ±15% X5R: -55 to +85 ±15%	+10 to +85 +22% -56%	-30 to +85 +22% -82%

***Note: Some values measured at ½ volt, see X7R Table for specific details on pages 73 and 74.**

from that value. For example, a typical IR specification might read "1,000 megohm-microfarads or 100 gigohms, whichever is less". The DC leakage current may be calculated by dividing the applied voltage by the insulation resistance (Ohm's Law).

8. Dielectric Withstanding Voltage:
250% of rated voltage for 5 seconds with current limited to 50mA at 25°C. Limits per Table 3.

Dielectric withstanding voltage (DWV) is the peak DC voltage which a capacitor is designed to withstand without damage for short periods of time. All KEMET multilayer ceramic surface mount capacitors will withstand a DC test voltage of 2.5 x the rated voltage for 60 seconds.

KEMET specification limits for all electrical characteristics at standard measurement conditions are shown in Table 3. Variations in these properties caused by changing conditions (temperature, voltage, frequency, and time) are covered in the following sections.

9. Aging Rate:
Maximum % Capacitance Loss/Decade Hour
C0G - 0%
X7R - 2.0%
X5R - 5.0%
Z5U - 7.0%
Y5V - 7.0%
Actual rates may be lower. Consult factory for details.

The capacitance of Class II and III dielectric changes with time as well as with temperature, voltage and frequency. The change with time is known as "aging". It is caused by gradual realignment of the crystalline structure of the ceramic dielectric material as it is cooled below its Curie temperature, which produces a loss of capacitance with time. The aging process is predictable and follows a logarithmic decay.

The aging process is reversible. If the capacitor is heated to a temperature above its Curie point for some period of time, de-aging will occur and the capacitor will regain the capacitance lost during the aging process. The amount of de-aging depends on both the elevated temperature and the length of time at that temperature. Exposure to 150°C for one-half hour is sufficient to return the capacitor to its initial value.

Because the capacitance changes rapidly immediately after de-aging, capacitance measurements are usually delayed for at least 24-48 hours after the de-aging process, which is often referred to as the "last heat". In addition, manufacturers utilize the aging rates to set factory test limits which will bring the capacitance within the specified tolerance at some future time, to allow for customer receipt and use.

10. Effect of Temperature:

Both capacitance and dissipation factor are affected by variations in temperature. The maximum capacitance change with temperature is defined by the temperature characteristic.

However, this only defines an "envelope" bounded by the upper and lower operating temperatures and the minimum and maximum capacitance values. Within this "envelope", the variation with temperature depends upon the specific dielectric formulation.

Insulation resistance decreases with increasing temperature. Typically, the insulation resistance limit at maximum rated temperature is 10% of the 25°C value.

11. Effect of Voltage:

Certain high dielectric constant ceramic capacitors may show variation in values of capacitance and dissipation factor with various levels of applied AC and DC voltages. Such variation is a natural characteristic of ceramic capacitors, and should be considered by the circuit designer.

In general, ceramic capacitors with the lowest dielectric constant (C0G or NP0) are extremely stable, and show little or no variation in capacitance and/or dissipation factor. On the other hand, ceramic capacitors with the highest dielectric constant (Z5U & Y5V) may show significant variation, particularly in capacitance. Other dielectric formulations such as X7R and X5R will show less variation than Y5V, but more than C0G.

The application of AC voltages in the range of 10 to 20 VAC tends to increase the values of both the capacitance and dissipation factor, while higher AC voltages tend to produce decreases in both.

However, the variation of capacitance with applied DC is the parameter of most interest to design engineers. Figure 8 shows typical variation of capacitance with applied DC voltage for some standard dielectrics. As can be seen, the decrease in capacitance is greatest for the Y5V dielectric (the C0G is not plotted, since it would not have a perceptible capacitance nor dissipation factor change.)

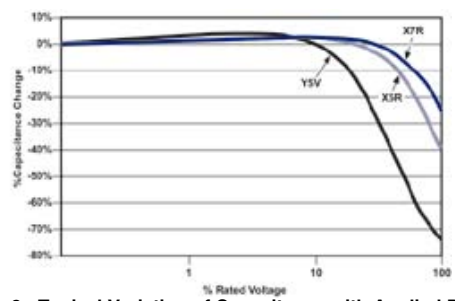


Figure 8 - Typical Variation of Capacitance with Applied DC Voltage

More detailed modelling information on the effect of various voltages on specific capacitor ratings can be obtained by use of the KEMET SPICE models, available for free downloading at our website (www.kemet.com).

12. Effect of Frequency:

Frequency affects both capacitance and dissipation factor. Typical curves for KEMET multilayer ceramic capacitors are shown in Figures 4, 5, 6 and 7.

The variation of impedance with frequency is an important consideration in the application of multilayer ceramic capacitors. Total impedance of the capacitor is

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the vector summation of the capacitive reactance, the inductive reactance, and the ESR, as illustrated in Figure 2. As frequency increases, the capacitive reactance decreases. However, the series inductance (L) shown in Figure 1 produces some inductive reactance, which increases with frequency. At some frequency, the impedance ceases to be capacitive and becomes inductive. This point, at the bottom of the V-shaped impedance versus frequency curves, is the self-resonant frequency. At the self-resonant frequency, the reactance is zero, and the impedance consists of the ESR only. At high frequency more detailed models apply - See KEMET SPICE models for such instances.

Typical impedance versus frequency curves for KEMET multilayer ceramic capacitors are shown in Figures 4, 5, 6 and 7.

ENVIRONMENTAL AND PHYSICAL

13. **Thermal Shock:**
EIA-198, Method 202, Condition B (5 cycles -55° to + 125°C).

14. **Life Test:**
EIA-198, Method 201, 1000 hours at 200% of rated voltage at 125°C. (Except 85°C for Z5U and Y5V).
See Table 4 on page 70 for limits.

15. **Humidity Test:**
EIA-198, Method 206, (Except 1000 hours,85°C, 85% RH, Rated Voltage).
See Table 4 on page 70 for limits.

16. **Moisture Resistance:**
EIA-198, Method 204, Condition B (20 cycles with 50 volts applied.
See Table 4 on page 70 for limits.

17. **Solderability:**
EIA-198, Method 301 (245°, 5 secs, Sn62 solder) 95% smooth solder on terminations. See page 14 for recommended profiles.

18. **Resistance to Soldering Heat:**
EIA-198, Method 302, Condition B (260°C, 10 seconds) no leaching of nickel barrier.

19. **Terminal Strength:**
EIA-198, Method 303, Condition D .

RELIABILITY

20. A well constructed multilayer ceramic capacitor chip is extremely reliable and, for all practical purposes, has no wearout mechanism when used within the maximum voltage and temperature ratings. Most failures occur as a result of mechanical or thermal damage during mounting on the board, or during subsequent testing. Capacitor failure may also be induced by sustained operation at voltages that exceed the rated DC voltage, voltage spikes or transients that exceed the dielectric's voltage capability, sustained operation at temperatures above the maximum rated temperature, internal defects, or excessive temperature rise due to power dissipation. As with any practical device, multilayer ceramic capacitors also possess an inherent, although low, failure rate when operated within rated conditions. The primary failure mode is by short-circuit or low insulation resistance, resulting from cracks or from dielectric breakdown at a defect site. KEMET monitors reliability with a periodic sampling program for selected values. Results are available in our FIT (Failure in Time) report for commercial chips.

21. **Storage and Handling:**
Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp, and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40 degrees C, and maximum storage humidity not exceed 70% relative humidity. In addition, temperature fluctuations should be minimized to avoid condensation on the parts, and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability, chip stock should be used promptly, preferably within 1.5 years of receipt.

MISAPPLICATION

22. Ceramic capacitors, like any other capacitors, may fail if they are misapplied. Some misapplications include mechanical damage, such as impact or excessive flexing of the circuit board. Others include severe mounting or rework cycles that may also introduce thermal shock. Still others include exposure to excessive voltage, current or temperature. If the dielectric layer of the capacitor is damaged by misapplication, the circuit may fail. The electrical energy of the circuit can be released as heat, which may damage the circuit board and other components as well.

ADDITIONAL INFORMATION

23. Detailed application information can be found in KEMET Engineering Bulletins.

F-2100	Surface Mount-Mounting Pad Dimensions and Considerations
F-2102	Reflow Soldering Process
F-2105	Wave Solder Process
F-2103	Surface Mount Repair
F-2110	Capacitance Monitoring while Flex Testing
F-2111	Ceramic Chip Capacitors “Flex Cracks” - Understanding and Solutions

For analysis of high frequency applications, KEMET has SPICE models of most chip capacitors. Models may be downloaded from KEMET’s website www.kemet.com.

Additional information is also available - See your KEMET representative for details or post your questions to KEMET's homepage on the web http://www.kemet.com.

TABLE 4 – ENVIRONMENTAL LIMITS

Body	Rated DC Voltage	Initial DF (%)	IR (GΩ or ΩF) whichever is less	DF (%) Post Life/ Hum/Moisture Resistance	Cap Shift (% or pf, whichever is greater) Post Life/ Hum/Moisture Resistance	IR (GΩ or ΩF) whichever is less Post Life/ Hum/Moisture Resistance
C0G	200*	0.1	100/1000	0.5	0.3% or ± 0.25 pf	10/100
	100	0.1	100/1000	0.5	0.3% or ± 0.25 pf	10/100
	50	0.1	100/1000	0.5	0.3% or ± 0.25 pf	10/100
	25	0.1	100/1000	0.5	0.3% or ± 0.25 pf	10/100
	16	0.1	100/1000	0.5	0.3% or ± 0.25 pf	10/100
X7R	200*	2.5	100/1000	3.0	± 20%	10/100
	100	2.5	100/1000	3.0	± 20%	10/100
	50	2.5	100/1000	3.0	± 20%	10/100
	25	3.5	100/1000	5.0	± 20%	10/100
	16	3.5	100/1000	5.0	± 20%	10/100
	6.3/10	5.0	100/1000	7.5	± 20%	10/100
X5R	50V all cap values	2.5	100/1000	3.0	± 20%	10/100
	25V all cap values	5.0	100/1000	7.5	± 20%	10/100
	<25≤564 cap value	5.0	100/1000	7.5	± 20%	10/100
	>564 cap value	10.0	100/1000	12.0	± 20%	10/100
Z5U	100	4.0	10/100	5.0	± 30%	1/10
	50	4.0	10/100	5.0	± 30%	1/10
	25	4.0	10/100	7.5	± 30%	1/10
Y5V	100	5.0	10/100	7.5	± 30%	1/10
	50	5.0	10/100	7.5	± 30%	1/10
	25	7.0	10/100	10.0	± 30%	1/10
	16	7.0	10/100	10.0	± 30%	1/10
	6.3/10	10.0	10/50	15.0	± 30%	1/5

*200 Volt limits not currently included in EIA-198.

PERFORMANCE CURVES
EFFECT OF FREQUENCY
(See SPICE models for specific ratings.)

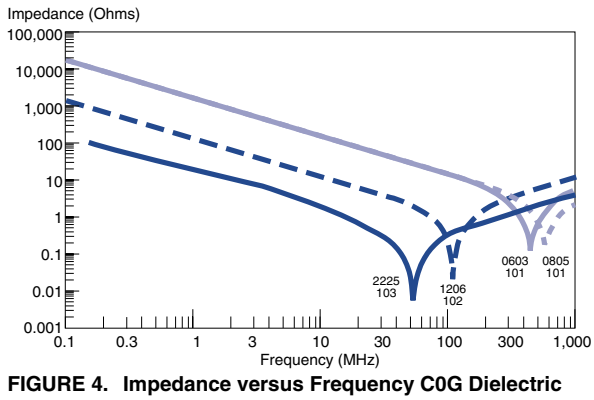

FIGURE 4. Impedance versus Frequency C0G Dielectric

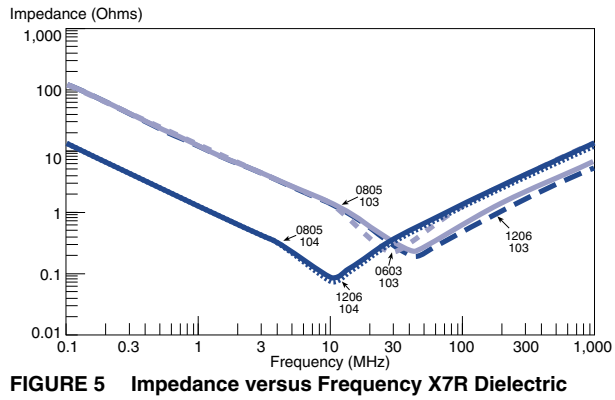

FIGURE 5 Impedance versus Frequency X7R Dielectric

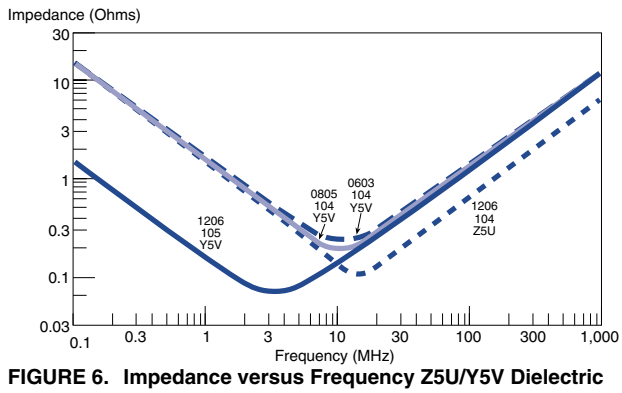

FIGURE 6. Impedance versus Frequency Z5U/Y5V Dielectric

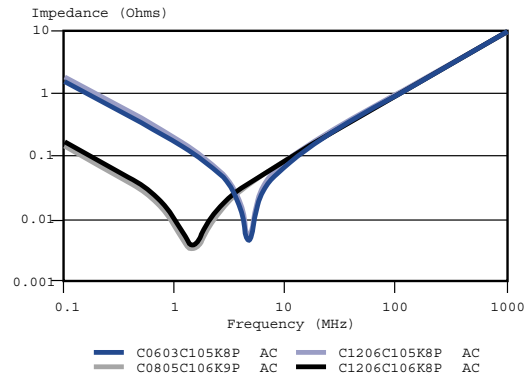

FIGURE 7. Impedence versus Frequency X5R Dielectric

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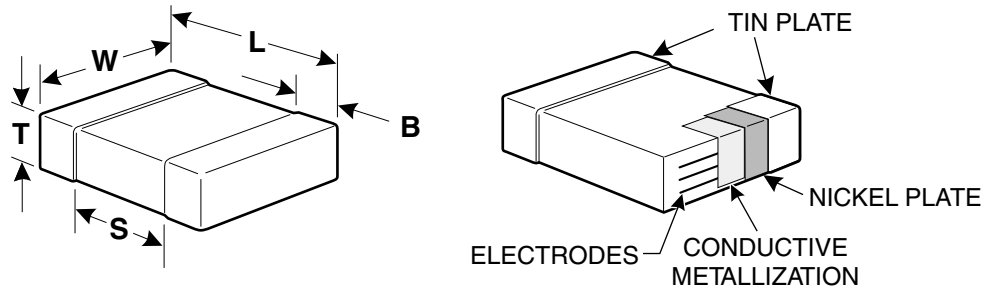
KEMET

FEATURES

- C0G (NP0), X7R, X5R, Z5U and Y5V Dielectrics
- 10, 16, 25, 50, 100 and 200 Volts
- Standard End Metalization: Tin-plate over nickel barrier
- Available Capacitance Tolerances: ±0.10 pF; ±0.25 pF; ±0.5 pF; ±1%; ±2%; ±5%; ±10%; ±20%; and +80%-20%
- Tape and reel packaging per EIA481-1. (See page 92 for specific tape and reel information.) Bulk Cassette packaging (0402, 0603, 0805 only) per IEC60286-6 and EIAJ 7201.
- RoHS Compliant

CAPACITOR OUTLINE DRAWINGS



DIMENSIONS—MILLIMETERS AND (INCHES)

EIA SIZE CODE	METRIC SIZE CODE (Ref only)	L # LENGTH	W # WIDTH		B BANDWIDTH	S MIN. SEPARATION	MOUNTING TECHNIQUE
0402*	1005	1.0 (.04) ± .05(.002)	0.5 (.02) ± .05 (.002)	See page 77 for thickness dimensions.	0.20 (0.008)-0.40 (0.016)	0.3 (.012)	Solder Reflow
0603*	1608	1.6 (.063) ± 0.15 (.006)	0.8 (.032) ± 0.15 (.006)		0.35 (.014) ±0.15 (.006)	0.7 (.028)	Solder Wave † or Solder Reflow
0805*	2012	2.0 (.079) ± 0.2 (.008)	1.25 (.049) ± 0.2 (.008)		0.5 (.02) ±.25 (.010)	0.75 (.030)	
1206*	3216	3.2 (.126) ± 0.2 (.008)	1.6 (.063) ± 0.2 (.008)		0.5 (.02) ±.25 (.010)	N/A	
1210*	3225	3.2 (.126) ± 0.2 (.008)	2.5 (.098) ± 0.2 (.008)		0.5 (.02) ±.25 (.010)	N/A	
1812	4532	4.5 (.177) ± 0.3 (.012)	3.2 (.126) ± 0.3 (.012)		0.6 (.024) ±.35 (.014)	N/A	Solder Reflow
1825*	4564	4.5 (.177) ± 0.3 (.012)	6.4 (.252) ± 0.4 (.016)		0.6 (.024) ±.35 (.014)	N/A	
2220	5650	5.6 (.220) ± 0.4 (.016)	5.0 (.197) ± 0.4 (.016)		0.6 (.024) ±.35 (.014)	N/A	
2225	5664	5.6 (.220) ± 0.4 (.016)	6.3 (.248) ± 0.4 (.016)		0.6 (.024) ±.35 (.014)	N/A	

* Note: Indicates EIA Preferred Case Sizes (Tightened tolerances apply for 0402, 0603, and 0805 packaged in bulk cassette, see page 96.)
† For extended value 1210 case size – solder reflow only.

CAPACITOR ORDERING INFORMATION (Standard Chips - For Military see page 90)

C 0805 C 103 K 5 R A C*

CERAMIC

SIZE CODE

SPECIFICATION
C - Standard

CAPACITANCE CODE
Expressed in Picofarads (pF)
First two digits represent significant figures.
Third digit specifies number of zeros. (Use 9 for 1.0 through 9.9pF. Use 8 for 0.5 through 0.99pF)
(Example: 2.2pF = 229 or 0.50 pF = 508)

CAPACITANCE TOLERANCE

B – ±0.10pF	J – ±5%
C – ±0.25pF	K – ±10%
D – ±0.5pF	M – ±20%
F – ±1%	P – (GMV) – special order only
G – ±2%	Z – +80%, -20%

VOLTAGE

1 - 100V	3 - 25V
2 - 200V	4 - 16V
5 - 50V	8 - 10V
	9 - 6.3V

TEMPERATURE CHARACTERISTIC
Designated by Capacitance Change Over Temperature Range
G – C0G (NP0) (±30 PPM/°C)
R – X7R (±15%) (-55°C + 125°C)
P– X5R (±15%) (-55°C + 85°C)
U – Z5U (+22%, -56%) (+10°C + 85°C)
V – Y5V (+22%, -82%) (-30°C + 85°C)

FAILURE RATE LEVEL
A- Not Applicable

END METALLIZATION
C-Standard (Tin-plated nickel barrier)

*** Part Number Example: C0805C103K5RAC (14 digits - no spaces)**

Created: 04/17/2000 **Product:** Ceramic
Updated: 04/26/2006 **Categories:** Labeling, Packaging, Part Markings, Part Number

KEMET Ceramic P/N Suffixes - Marking & Packaging

Notify Me Upon Change I would like to ask a followup question

Description :
KEMET Ceramic P/N Suffixes - Marking & Packaging

Answer :
KEMET ceramic chips are available marked or unmarked (preferred) in several packaging styles. These ordering details are included as suffixes to the KEMET 14 digit part number, and will be used during the order entry process by KEMET sales personnel and distributors. (Notice that ordering a KEMET part number without a suffix will result in shipment of unmarked chips loose packed in a bag - so be sure to use a suffix if other packaging is needed.)
To speed up the ordering process, we use "shortcut" suffixes for the most common ordering modes. The most popular shortcut ordering suffix is "TU", which indicates unmarked chips, in labelled 7" tape & reel packaging. Alternatively, ordering suffix "TM" indicates marked chips, in labelled 7" reels. However, remember that marked chips are less likely to be in stock, and will have a cost premium associated with marking. Details on marking appear in our catalog, available on the website. Note that all 0402 chips and all Y5V chips are not available marked.

Other special ordering suffixes also exist, covering options such as 13" reels, bulk cassette, and bulk in bag packaging. In addition, special customer requirements will also be included in custom ordering suffixes, up to 2 groups of 4 numerical digits each.

When the capacitors are shipped, the labels will be printed with the 14 digit KEMET part number, plus the numerical suffixes ordered (or corresponding to the shortcut suffixes). These will include one or more 4 digit numerical suffix(es), which indicate the exact mode of marking and packaging. These will be based on the information given to KEMET sales at the time of order entry, and and are detailed in the following table. (Note - to improve delivery, marked chips may occasionally be supplied when unmarked are acceptable.)

CATEGORY	DESCRIPTION	Unmarked	Marking Required (Marking not available for any 0402 or Y5V chips)
Standard Reeling 7" Plastic Tape	0805 - 2225 (0402 & 0603 are reeled only on paper)	7800 (same as "TU")	7025 (same as "TM")
Standard Reeling 7" Paper Tape	0402 & 0603	7867(same as "TU")	7013(same as "TM")
Special Reeling 13" Plastic Tape	0805 - 2225 (0402 & 0603 are reeled only on paper)	7210	7215
Special Reeling 7" Paper Tape	0805 (0.78 mm thickness - selected values only)	7867 & 9239	7013 & 9239

Special Reeling 7" Paper Tape	1206 - 1210 (selected values only)	7867	7013
Special Reeling 13" Paper Tape	0402 & 0603	7411	7040
Special Reeling 13" Paper Tape	0805 (0.78 mm thickness - selected values only)	7411 & 9239	7040 & 9239
Special Reeling 13" Paper Tape	1206 - 1210 (selected values only)	7411	7040
Special Packaging Bulk Cassette for 0402, 0603 & 0805. 0402's are never marked.	Use ONLY with special 0.6 mm 0805.	9028	9028 & 3325
Special Packaging Loose Chips in Plastic Bags	0603 - 2225	No Suffix	3325

Notify Me Upon Change | I would like to ask a followup question

New Technical Articles:

Stable, Low-ESR Tantalum Capacitors
Tantalum in Power Supply Applications
Ripple Current Capabilities
Replacing MnO2 with Polymers
Performance Improvements with Polymer (Ta and Al)
Derating Differences Ta/Ta-Polymer/ Al-Polymer

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KEMET Corporation, Greenville, SC

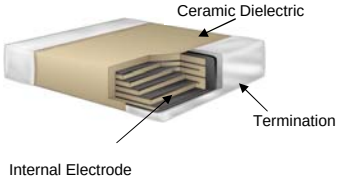
KEMET Surface Mount Ceramic

Revision Nil, 01 November 2005

Note: Information subject to change without notice. Monitor website regularly for updates. KEMET is not liable for any damages, direct or indirect, consequential or otherwise, that the reader might incur as a result of ignoring this warning, or that any third party might suffer as a result of the reader's ignoring this warning.

Characteristics and Typical Construction

- Standard EIA Chip Sizes
- C0G, X5R, X7R, Y5V, Z5U Dielectrics
- Termination code 'C' products support manufacture of RoHS-compliant EEE
- 6.3 - 3000 Volts
- Tape & Reel Packaging
- Bulk Cassette packaging available
- Matte Tin finish terminations standard
- SnPb terminations available beginning August, 2005



RoHS Restricted Substance Content

Key for Determining Adherence to 2002/95/EC and 2005/618/EC Content Criteria[1]

☑ = Meets criteria ✓ = Meets criteria, in some cases by reliance on 2002/95/EC Annex 1 exemptions 5, 7c[2] ☒ = Does not meet criteria

KEMET Product	Series	Substance and MCV[1] Termination Code	Restricted Substance: Cd < 0.01%	Cr^{6+} < 0.1%	Pb < 0.1%	Hg < 0.1%	PBB < 0.1%	PBDE < 0.1%	Compliant Version: Size and Dielectric	Available since	Standard since
Ceramic Chip / Standard Ceramic Chip / High Voltage Tip & Ring	CxxxxC	C	☑	☑	✓ C0G and X7R< 1.0nF[2] ☑ X7R≥1.0nF X5R, Y5V, Z5U	☑	☑	☑	0402 C0G 0402 X7R	Jun-04	Jun-04
Ceramic Open Mode Capacitors	CxxxxF								> 0402 C0G	Jul-03	Jul-03
KEMET Commerical-Off-The-Shelf (KCOTS)	CxxxxT								All others	Aug-93	Aug-93
Ceramic Chip / Standard Ceramic Chip / High Voltage Tip & Ring	CxxxxC	L	☑	☑	☒	☑	☑	☑			
Ceramic Open Mode Capacitors	CxxxxF										
KEMET Commerical-Off-The-Shelf (KCOTS)	CxxxxT										

[1] MCV = Maximum Concentration Values per 2005/618/EC ammending RoHS Directive 2002/95/EC.

[2] All KEMET X7R and C0G surface mount offerings already meet RoHS requirements. A limited group of these components contain a small portion of lead (Pb) that is exempt per Annex 1 to 2002/95/EC. These components are in transition to a completely lead-free material set. This transition will be complete by 2QCY2006.

Soldering Capability Characteristics

	Matte Tin Termination	SnPb Termination
Termination Material	Silver or Copper	Silver or Copper
Termination Plating (Barrier)	100% Matte Tin (Nickel)	90Sn10 Pb (Nickel)
Peak Temperature Capability	260°C	260°C
Soldering Process Compatibility	Backward & Forward Compatible	Backward & Forward Compatible
MSL Rating per J-STD-020C	Not Classified[3]	Not Classified[3]
Tin Whisker Test Results *based on NEMI September 2003 recommendations*[4]	Pass	Pass

[3] MSL not classified for ceramic capacitors. J-STD-020 is applicable to non-hermetic surface mount devices, and is intended for plastic package components. Kemet ceramic chips are not encapsulated in a plastic package, so they are not susceptible to these effects. If an MSL were required, the rating this product would be considered MSL 1 or better.

[4] Updated whisker evaluation results per JESD22-A121 available January, 2006. Tin whiskering is not considered a reliability risk within the capacitor industry for 100% tin finishes used in non-Miltary / Hi-Rel applications. For more information, refer to EIA / ECA component bulletin CB19.

Ordering

C 0805 C 103 K 5 R A C

CERAMIC

SIZE CODE

SPECIFICATION
C - Standard, High Voltage, or Tip & Ring
F - Open Mode
T - KCOTS

CAPACITANCE CODE

CAPACITANCE TOLERANCE

RATED VOLTAGE

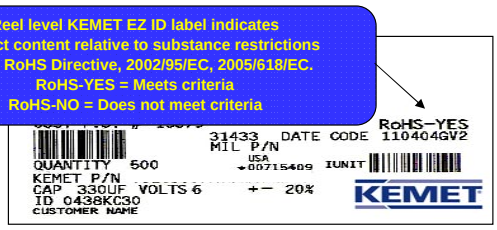
DIELECTRIC
EIA Designation
G - C0G
P - X5R
R - X7R
V - Y5V
U - Z5U

SPEC CODE

Termination Code for **END METALLIZATION**
C - 100% Matte Tin (Sn)
L - Tin/Lead (SnPb, 5% min. Pb)

Identification

Reel level KEMET EZ ID label indicates product content relative to substance restrictions of the RoHS Directive, 2002/95/EC, 2005/618/EC.
RoHS-YES = Meets criteria
RoHS-NO = Does not meet criteria



C0G CAPACITANCE RANGE – 0402, 0603, 0805, 1206

Cap pF	Cap Code	Cap Tol.	C0402*				C0603*						C0805*						C1206*					
			10V	16V	25V	50V	10V	16V	25V	50V	100V	200V	10V	16V	25V	50V	100V	200V	10V	16V	25V	50V	100V	200V
0.50	508	C,D	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC						
0.75	758	C,D	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC						
1.0	109	C,D	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
1.1	119	C,D	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
1.2	129	C,D	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
1.5	159	C,D	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
1.6	169	C,D	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
1.8	189	C,D	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
2.0	209	C,D	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
2.2	229	C,D	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
2.4	249	C,D	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
2.7	279	C,D K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
3.0	309	C,D K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
3.3	339	C,D K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
3.9	399	C,D K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
4.3	439	C,D K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
4.7	479	C,D K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
5.1	519	C,D K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
5.6	569	C,D J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
6.0	609	C,D J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
6.2	629	C,D J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
6.8	689	C,D J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
7.0	709	C,D J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
7.5	759	C,D J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
8.2	829	C,D J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
9.1	919	C,D J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
10.0	100	C,D J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
11.0	110	C,D J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
12.0	120	C,D J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
13.0	130	C,D J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
15.0	150	C,D G,J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
16.0	160	C,D G,J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
18.0	180	C,D G,J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
20.0	200	C,D G,J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
22.0	220	C,D G,J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
24.0	240	C,D G,J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
27.0	270	D,F,G,J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
30.0	300	D,F,G,J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
33.0	330	D,F,G,J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
36.0	360	D,F,G,J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
39.0	390	D,F,G,J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
43.0	430	D,F,G,J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
47.0	470	D,F,G,J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
51.0	510	D,F,G,J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
56.0	560	F,G,J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
62.0	620	F,G,J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
68.0	680	F,G,J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
75.0	750	F,G,J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
82.0	820	F,G,J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
91.0	910	F,G,J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB		DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
100.0	101	F,G,J,K,M	BB	BB	BB	BB	CB	CB	CB	CB	CB		DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
110.0	111	F,G,J,K,M					CB	CB	CB	CB	CB		DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
120.0	121	F,G,J,K,M					CB	CB	CB	CB	CB		DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
130.0	131	F,G,J,K,M					CB	CB	CB	CB	CB		DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
150.0	151	F,G,J,K,M					CB	CB	CB	CB	CB		DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
160.0	161	F,G,J,K,M					CB	CB	CB	CB	CB		DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
180.0	181	F,G,J,K,M					CB	CB	CB	CB	CB		DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
200.0	201	F,G,J,K,M					CB	CB	CB	CB	CB		DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
220.0	221	F,G,J,K,M					CB	CB	CB	CB	CB		DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
240.0	241	F,G,J,K,M					CB	CB	CB	CB	CB		DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
270.0	271	F,G,J,K,M					CB	CB	CB	CB	CB		DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
300.0	301	F,G,J,K,M					CB	CB	CB	CB	CB		DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
330.0	331	F,G,J,K,M					CB	CB	CB	CB	CB		DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
360.0	361	F,G,J,K,M					CB	CB	CB	CB			DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
390.0	391	F,G,J,K,M					CB	CB	CB	CB			DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
430.0	431	F,G,J,K,M					CB	CB	CB	CB			DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB
470.0	471	F,G,J,K,M					CB	CB	CB	CB			DC	DC	DC	DC	DC	DD	EB	EB	EB	EB	EB	EB
510.0	511	F,G,J,K,M					CB	CB	CB	CB			DC	DC	DC	DC	DC		EB	EB	EB	EB	EB	EB
560.0	561	F,G,J,K,M					CB	CB	CB	CC			DC	DC	DC	DC	DC		EB	EB	EB	EB	EB	EB
620.0	621	F,G,J,K,M					CB	CB	CB	CC			DC	DC	DC	DC	DC		EB	EB	EB	EB	EB	EC
680.0	681	F,G,J,K,M					CB	CB	CB	CC			DC	DC	DC	DC	DC		EB	EB	EB	EB	EB	EC
750.0	751	F,G,J,K,M					CB	CB	CB	CC			DC	DC	DC	DC	DC		EB	EB	EB	EB	EB	EC
820.0	821	F,G,J,K,M					CB	CB	CB	CC			DC	DC	DC	DC	DC		EB	EB	EB	EB	EB	EC
910.0	911	F,G,J,K,M					CB	CB	CB	CC			DC	DC	DC	DC	DD		EB	EB	EB	EB	EB	ED
1000.0	102	F,G,J,K,M					CB	CB	CB	CC			DC	DC	DC	DC	DD		EB	EB	EB	EB	EB	EE
1100.0	112	F,G,J,K,M											DC	DC	DC	DC			EB	EB	EB	EB	EB	EB
1200.0	122	F,G,J,K,M											DC	DC	DC	DC			EB	EB	EB	EB	EB	EB
1300.0	132	F,G,J,K,M											DD	DD	DD	DD			EB	EB	EB	EB	EC	EC
1500.0	152	F,G,J,K,M											DD	DD	DD	DD			EB	EB	EB	EB	ED	EC
1600.0	162	F,G,J,K,M											DD	DD	DD	DD			EB	EB	EB	EB	ED	ED
1800.0	182	F,G,J,K,M											DD	DD	DD	DD			EB	EB	EB	EB	ED	ED
2000.0	202	F,G,J,K,M											DC	DC	DC				EB	EB	EB	EB	ED	
2200.0	222	F,G,J,K,M											DC	DC	DC				EB	EB	EB	EB	ED	
2400.0	242	F,G,J,K,M											DC	DC	DC				EB	EB	EB	EB	EC	
2700.0	272	F,G,J,K,M											DC	DC	DC				EB	EB	EB	EB	EC	
3000.0	302	F,G,J,K,M											DD	DD	DD				EC	EC	EC	EC	EC	
3300.0	332	F,G,J,K,M											DD	DD	DD				EC	EC	EC	EC	EC	
3600.0	362	F,G,J,K,M											DD	DD	DD				EC	EC	EC	EC	EE	
3900.0	392	F,G,J,K,M											DE	DE	DE				EC	EC	EC	EC	EF	
4300.0	432	F,G,J,K,M																	EC	EC	EC	EC		
4700.0	472	F,G,J,K,M																	EC	EC	EC	EC		
5100.0	512	F,G,J,K,M																	ED	ED	ED	ED		
5600.0	562	F,G,J,K,M																	ED	ED	ED	ED		
6200.0	622	F,G,J,K,M																	EB	EB	EB			
6800.0	682	F,G,J,K,M																	EB	EB	EB			
7500.0	752	F,G,J,K,M																	EB	EB	EB			
8200.0	822	F,G,J,K,M																	EC	EC	EC			
9100.0	912	F,G,J,K,M																	EC	EC	EC			
10,000.0	103	F,G,J,K,M																	ED	ED	ED			

*** Indicates EIA preferred chip sizes.**
NOTE: For non-standard capacitance values or voltages, contact your local KEMET sales representative.
50 Volt Ceramic Chips can be used in 63 volt applications.

Improved product with higher ratings and tighter capacitance tolerance product may be substituted within the same size (length, width, and thickness) at KEMET's option.
Reels with such substitutions will be marked with the improved KEMET part numbers.

See page 77 for Thickness Code Reference Chart.

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KEMET

C0G CAPACITANCE RANGE – 1210, 1812, 1825, 2220, 2225

Cap pF	Cap Code	Cap Tol.	C1210*			C1812*			C1825*			C2220			C2225		
			50V	100V	200V	50V	100V	200V	50V	100V	200V	50V	100V	200V	50V	100V	200V
10	100	D J,K,M	FB	FB	FB												
12	120	D J,K,M	FB	FB	FB												
15	150	D G,J,K,M	FB	FB	FB												
18	180	D G,J,K,M	FB	FB	FB												
22	220	D G,J,K,M	FB	FB	FB												
27	270	D,F,G,J,K,M	FB	FB	FB												
33	330	D,F,G,J,K,M	FB	FB	FB												
39	390	D,F,G,J,K,M	FB	FB	FB												
47	470	D,F,G,J,K,M	FB	FB	FB												
56	560	F,G,J,K,M	FB	FB	FB												
68	680	F,G,J,K,M	FB	FB	FB												
82	820	F,G,J,K,M	FB	FB	FB												
100	101	F,G,J,K,M	FB	FB	FB												
120	121	F,G,J,K,M	FB	FB	FB												
150	131	F,G,J,K,M	FB	FB	FB												
180	181	F,G,J,K,M	FB	FB	FB												
220	221	F,G,J,K,M	FB	FB	FB												
270	271	F,G,J,K,M	FB	FB	FB												
330	331	F,G,J,K,M	FB	FB	FB												
390	391	F,G,J,K,M	FB	FB	FB												
470	471	F,G,J,K,M	FB	FB	FB	GB	GB	GB									
560	561	F,G,J,K,M	FB	FB	FB	GB	GB	GB									
680	681	F,G,J,K,M	FB	FB	FB	GB	GB	GB									
820	821	F,G,J,K,M	FB	FB	FB	GB	GB	GB									
1,000	102	F,G,J,K,M	FB	FB	FB	GB	GB	GB									
1,200	122	F,G,J,K,M	FB	FB	FB	GB	GB	GB									
1,500	152	F,G,J,K,M	FB	FB	FE	GB	GB	GB									
1,800	182	F,G,J,K,M	FB	FB	FE	GB	GB	GB									
2,200	222	F,G,J,K,M	FB	FC	FG	GB	GB	GB									
2,700	272	F,G,J,K,M	FB	FC	FC	GB	GB	GB									
3,300	332	F,G,J,K,M	FB	FF	FF	GB	GB	GB									
3,900	392	F,G,J,K,M	FB	FF		GB	GB	GB	HB	HB	HB						
4,700	472	F,G,J,K,M	FF	FF		GB	GB	GD	HB	HB	HB				KB	KB	KB
5,600	562	F,G,J,K,M	FB	FF		GB	GB	GH	HB	HB	HB				KB	KB	KB
6,800	682	F,G,J,K,M	FB	FG		GB	GB	GJ	HB	HB	HB	JB	JB		KB	KB	KB
8,200	822	F,G,J,K,M	FC			GB	GB		HB	HB	HB	JB	JB		KB	KB	KB
10,000	103	F,G,J,K,M	FF			GB	GD		HB	HB	HE	JB	JB		KB	KB	KB
12,000	123	F,G,J,K,M	FG			GB	GD		HB	HB	HE	JB	JB		KB	KB	KB
15,000	153	F,G,J,K,M							HB	HB		JB	JB		KB	KB	KE
18,000	183	F,G,J,K,M							HB	HB		JB	JB		KB	KB	
22,000	223	F,G,J,K,M							HB	HE		JB			KB	KB	
27,000	273	F,G,J,K,M							HB	HE		JB			KB	KB	
33,000	333	F,G,J,K,M													KB		

X7R CAPACITANCE RANGE – 0402, 0603, 0805, 1206

Cap pF	Cap Code	Cap Tol.	C0402*					C0603*							C0805*							C1206*						
			6.3V	10V	16V	25V	50V	6.3V	10V	16V	25V	50V	100V	200V	6.3V	10V	16V	25V	50V	100V	200V	6.3V	10V	16V	25V	50V	100V	200V
150	151	K,M,J	BB	BB	BB	BB	BB																					
180	181	K,M,J	BB	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	CB														
220	221	K,M,J	BB	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	DC							
270	271	K,M,J	BB	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	DC							
330	331	K,M,J	BB	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	DC							
390	391	K,M,J	BB	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	DC							
470	471	K,M,J	BB	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	DC							
560	561	K,M,J	BB	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	DC							
680	681	K,M,J	BB	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	DC							
820	821	K,M,J	BB	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	DC							
1,000	102	K,M,J	BB	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB	EB
1,200	122	K,M,J	BB	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	CC	DC	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB	EB
1,500	152	K,M,J	BB	BB	BB	BB	BB	CB	CB	CB	CB	CB	CB	CC	DC	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB	EB
1,800	182	K,M,J	BB	BB	BB	BB	BB#	CB	CB	CB	CB	CB	CB	CC	DC	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB	EB
2,200	222	K,M,J	BB	BB	BB	BB	BB#	CB	CB	CB	CB	CB	CB	CC	DC	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB	EB
2,700	272	K,M,J	BB	BB	BB	BB	BB#	CB	CB	CB	CB	CB	CB	CC	DC	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB	EB
3,300	332	K,M,J	BB	BB	BB	BB	BB#	CB	CB	CB	CB	CB	CB	CC	DC	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB	EB
3,900	392	K,M,J	BB	BB	BB	BB	BB#	CB	CB	CB	CB	CB	CB	CC	DC	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB	EB
4,700	472	K,M,J	BB	BB	BB	BB	BB#	CB	CB	CB	CB	CB	CB	CC	DC	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB	EB
5,600	562	K,M,J	BB	BB	BB	BB	BB#	CB	CB	CB	CB	CB	CB	CC	DC	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB	EB
6,800	682	K,M,J	BB	BB	BB	BB	BB#	CB	CB	CB	CB	CB	CB	CC	DC	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB	EB
8,200	822	K,M,J	BB	BB	BB	BB	BB#	CB	CB	CB	CB	CB	CB	CC	DC	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB	EB
10,000	103	K,M,J	BB	BB	BB	BB	BB#	CB	CB	CB	CB	CB	CB	CC	DC	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB	EB
12,000	123	K,M,J	BB	BB	BB			CB	CB	CB	CB	CB	CC		DC	DC	DC	DC	DC	DC	DC	EB	EB	EB	EB	EB	EB	EB
15,000	153	K,M,J	BB	BB	BB			CB	CB	CB	CB	CB	CC		DD	DD	DD	DD	DD	DD	DC	EB	EB	EB	EB	EB	EB	EB
18,000	183	K,M,J	BB	BB	BB			CB	CB	CB	CB	CB	CC		DC	DC	DC	DC	DC	DD	DC	EB	EB	EB	EB	EB	EB	EB
22,000	223	K,M,J	BB	BB	BB			CB	CB	CB	CB	CB	CC		DC	DC	DC	DC	DC	DD	DC	EB	EB	EB	EB	EB	EB	EB
27,000	273	K,M,J	BB	BB	BB			CB	CB	CB	CB	CB	CC		DC	DC	DC	DC	DC	DD	DE	EB	EB	EB	EB	EB	EB	EB
33,000	333	K,M,J	BB	BB	BB			CB	CB	CB	CB	CB	CC		DC	DC	DC	DC	DC	DD	DE	EB	EB	EB	EB	EB	EB	EB
39,000	393	K,M,J	BB	BB	BB			CB	CB	CB	CB	CB	CC		DD	DD	DD	DD	DD	DD	DE	EB	EB	EB	EB	EB	EC	EB
47,000	473	K,M,J	BB	BB	BB			CB	CB	CB	CB	CB			DD	DD	DD	DD	DD	DE	DG	EB	EB	EB	EB	EB	EC	ED
56,000	563	K,M,J	BB	BB	BB			CB	CB	CB	CB	CC			DD	DD	DD	DD	DD#	DE	DG	EB	EB	EB	EB	EB	EB	ED
68,000	683	K,M,J	BB	BB	BB			CB	CB	CB	CB	CC			DD	DD	DD	DD	DD#	DE		EB	EB	EB	EB	EB	EB	ED
82,000	823	K,M,J	BB	BB	BB			CB	CB	CB	CB	CC			DD	DD	DD	DD	DD#	DE		EB	EB	EB	EB	EB	EB	ED
100,000	104	K,M,J	BB	BB	BB			CB#	CB#	CB#	CB#	CC#			DD	DD	DD	DD	DD#	DE		EB	EB	EB	EB	EB	EB	EM
120,000	124	K,M,J						CB#	CB#	CB#					DC	DC	DC	DC	DD#	DG		EC	EC	EC	EC	EC	EC	EM
150,000	154	K,M,J						CB#	CB#	CB#					DC	DC	DC	DC	DD#			EC	EC	EC	EC	EC	EC	EG
180,000	184	K,M,J						CB#	CB#	CB#					DC	DC	DC	DC	DD#			EC	EC	EC	EC	EC#	EC#	
220,000	224	K,M,J						CB#	CB#	CB#					DC	DC	DC	DC	DD#			EC	EC	EC	EC	EC#	EC#	
270,000	274	K,M,J						CB	CB	CB					DD	DD	DD	DD				EB	EB	EB	EB	EC#	EM	
330,000	334	K,M,J						CB	CB	CB					DE	DE	DE	DE				EB	EB	EB	EB	EC#	EG	
390,000	394	K,M,J						CB	CB	CB					DG	DG	DG	DG				EB	EB	EB	EB	EG#	EG	
470,000	474	K,M,J						CB	CB	CB					DG	DG	DG	DG				EC	EC	EC	EC	EC#		
560,000	564	K,M,J													DG	DG	DG	DG				ED	ED	ED	ED	EC#		
680,000	684	K,M,J													DG	DG	DG					EE	EE	EE	EE	ED#		
820,000	824	K,M,J													DG	DG	DG					EF	EF	EF	EF			
1,000,000	105	K,M,J													DG	DG	DG					EE	EE	EF	EG			
1,200,000	125	K,M,J													DE	DE	DE					ED	ED	ED	EG			
1,500,000	155	K,M,J													DG	DG	DG					EF	EF	EF	EG			
1,800,000	185	K,M,J													DG	DG	DG					EF	EF	EF				
2,200,000	225	K,M,J													DG	DG	DG					EG	EG	EG				
2,700,000	275	K,M,J																				EN	EN	EK				
3,300,000	335	K,M,J																				ED	ED	ED				
3,900,000	395	K,M,J																				EL	EL	EL				
4,700,000	475	K,M,J																				EM	EM	EM				
5,600,000	565	K,M,J																				EH	EH	EH				
6,800,000	685	K,M,J																				EH	EH	EH				
8,200,000	825	K,M,J																				EH	EH	EH				
10,000,000	106	K,M,J																				EH	EH	EH				

* Indicates EIA preferred chip sizes.
NOTE: For non-standard capacitance values or voltages, contact your local KEMET sales representative.
X7R dielectric - Extended Range Values - Cap and DF measured @ 0.5 Vrms.

Improved product with higher ratings and tighter capacitance tolerance product may be substituted within the same size (length, width, and thickness) at KEMET's option.
Reels with such substitutions will be marked with the improved KEMET part numbers.

See page 77 for Thickness Code Reference Chart.

X7R CAPACITANCE RANGE – 1210, 1812, 1825, 2220, 2225

Cap pF	Cap Code	Cap Tol.	C1210*							C1812*			C1825*			C2220			C2225		
			6.3V	10V	16V	25V	50V	100V	200V	50V	100V	200V	50V	100V	200V	50V	100V	200V	50V	100V	200V
2,200	222	K,M,J	FB	FB	FB	FB	FB	FB	FB												
2,700	272	K,M,J	FB	FB	FB	FB	FB	FB	FB												
3,300	332	K,M,J	FB	FB	FB	FB	FB	FB	FB												
3,900	392	K,M,J	FB	FB	FB	FB	FB	FB	FB												
4,700	472	K,M,J	FB	FB	FB	FB	FB	FB	FB												
5,600	562	K,M,J	FB	FB	FB	FB	FB	FB	FB												
6,800	682	K,M,J	FB	FB	FB	FB	FB	FB	FB	GB	GB	GB									
8,200	822	K,M,J	FB	FB	FB	FB	FB	FB	FB	GB	GB	GB									
10,000	103	K,M,J	FB	FB	FB	FB	FB	FB	FB	GB	GB	GB									
12,000	123	K,M,J	FB	FB	FB	FB	FB	FB	FB	GB	GB	GB									
15,000	153	K,M,J	FB	FB	FB	FB	FB	FB	FB	GB	GB	GB									
18,000	183	K,M,J	FB	FB	FB	FB	FB	FB	FB	GB	GB	GB									
22,000	223	K,M,J	FB	FB	FB	FB	FB	FB	FB	GB	GB	GB	HB	HB	HB						
27,000	273	K,M,J	FB	FB	FB	FB	FB	FB	FB	GB	GB	GB	HB	HB	HB						
33,000	333	K,M,J	FB	FB	FB	FB	FB	FB	FB	GB	GB	GB	HB	HB	HB						
39,000	393	K,M,J	FB	FB	FB	FB	FB	FB	FB	GB	GB	GB	HB	HB	HB						
47,000	473	K,M,J	FB	FB	FB	FB	FB	FB	FC	GB	GB	GB	HB	HB	HB				KC	KC	KC
56,000	563	K,M,J	FB	FB	FB	FB	FB	FB	FC	GB	GB	GB	HB	HB	HB				KC	KC	KC
68,000	683	K,M,J	FB	FB	FB	FB	FB	FB	FC	GB	GB	GB	HB	HB	HB				KC	KC	KC
82,000	823	K,M,J	FB	FB	FB	FB	FC	FC	FF	GB	GB	GB	HB	HB	HB				KC	KC	KC
100,000	104	K,M,J	FB	FB	FB	FB	FB	FD	FG	GB	GB	GB	HB	HB	HB				KC	KC	KC
120,000	124	K,M,J	FB	FB	FB	FB	FB	FD		GB	GB	GB	HB	HB	HB				KC	KC	KC
150,000	154	K,M,J	FC	FC	FC	FC	FC	FD		GB	GB	GE	HB	HB	HB				KC	KC	KC
180,000	184	K,M,J	FC	FC	FC	FC	FC	FD		GB	GB	GG	HB	HB	HB				KC	KC	KC
220,000	224	K,M,J	FC	FC	FC	FC	FC	FD		GB	GB		HB	HB	HB				KC	KC	KC
270,000	274	K,M,J	FC	FC	FC	FC	FC#	FD#		GB	GH		HB	HB	HB	JC	JC	JC	KB	KC	KC
330,000	334	K,M,J	FD	FD	FD	FD	FD#	FD#		GB	GH		HB	HB	HB	JC	JC	JC	KB	KC	KC
390,000	394	K,M,J	FD	FD	FD	FD	FD#			GB	GG		HB	HB	HD	JC	JC	JC	KB	KC	KC
470,000	474	K,M,J	FD	FD	FD	FD	FD#			GB	GG		HB	HB		JC	JC		KB	KC	KD
560,000	564	K,M,J	FD	FD	FD	FD	FD#			GC	GG		HB	HD		JC	JC		KB	KC	
680,000	684	K,M,J	FD	FD	FD	FD	FD#			GC	GG		HB	HD		JC	JD		KB	KC	
820,000	824	K,M,J	FF	FF	FF	FF	FF#			GE	GG		HB			JC	JF		KB	KC	
1,000,000	105	K,M,J	FH	FH	FH	FH	FH#			GE	GG		HB			JC			KB	KD	
1,200,000	125	K,M,J	FH	FH	FH	FH							HB			JC			KB		
1,500,000	155	K,M,J	FH	FH	FH	FH							HB			JC			KC		
1,800,000	185	K,M,J	FH	FH	FH	FH							HD			JD			KD		
2,200,000	225	K,M,J	FJ	FJ	FJ	FJ							HF			JF			KD		
2,270,000	275	K,M,J	FG	FG	FG																
3,300,000	335	K,M,J	FG	FG	FG																
3,900,000	395	K,M,J	FH	FH	FH																
4,700,000	475	K,M,J	FJ	FJ	FJ																
5,600,000	565	K,M,J																			
6,800,000	685	K,M,J																			
8,200,000	825	K,M,J																			
10,000,000	106	K,M,J																			
12,000,000	126	K,M,J																			
15,000,000	156	K,M,J																			
18,000,000	186	K,M,J																			
22,000,000	226	K,M,J																			

*** Indicates EIA preferred chip sizes.**
NOTE: For non-standard capacitance values or voltages, contact your local KEMET sales representative.
50 Volt Ceramic Chips can be used for 63 volt applications.
Extended Range Values – Cap and DF measured @ 0.5 Vrms.

Improved product with higher ratings and tighter capacitance tolerance product may be substituted within the same size (length, width, and thickness) at KEMET's option. Reels with such substitutions will be marked with the improved KEMET part numbers.

Y5V CAPACITANCE RANGE

Cap pF	Cap Code	Cap Tol.	C0402*			C0603*				C0805*					C1206*					C1210*				
			6.3V	10V	16V	6.3V	10V	16V	25V	6.3V	10V	16V	25V	50V	6.3V	10V	16V	25V	50V	6.3V	10V	16V	25V	50V
22,000	223	Z												DC					EB					
33,000	333	Z												DC					EB					
47,000	473	Z	BB	BB	BB									DD					EB					
68,000	683	Z	BB	BB	BB									DD					EB					
100,000	104	Z	BB	BB	BB	CB	CB	CB	CB					DD					EB					
150,000	154	Z				CB	CB	CB	CB	DC	DC	DC	DC						EC					
220,000	224	Z				CB	CB	CB	CB	DC	DC	DC	DC						EC				FD+	FD+
330,000	334	Z				CB	CB	CB	CB	DC	DC	DC	DC					EB					FD+	FD+
470,000	474	Z				CC	CC			DC	DC	DC	DC					EC					FD+	FD+
680,000	684	Z				CC	CC			DE	DE	DE	DE					EB					FD+	FD+
1,000,000	105	Z				CC	CC			DG	DG	DG	DG					EB					FH+	FH+
1,500,000	155	Z								DG	DG	DG			EC	EC	EC					FD+		
2,200,000	225	Z								DG	DG	DG			ED	ED	ED					FD+		
3,300,000	335	Z								DE	DE				EF	EF	EF					FE+		
4,700,000	475	Z								DG	DG				EJ	EJ	EJ			FG+	FG+	FG+		
6,800,000	685	Z													EJ	EJ				FH+	FH+	FH+		
10,000,000	106	Z								DH					EJ	EJ				FH+	FH+	FH+		
15,000,000	156	Z																		FD+	FD+			
22,000,000	226	Z													EJ					FH+	FH+			

NOTE: For non-standard capacitance values or voltages, contact your local KEMET sales representative.
50 Volt Ceramic Chips can be used for 63 volt applications.
*** EIA preferred chip sizes**

+ Reflow only

See page 77 for Thickness Code Reference Chart

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X5R CAPACITANCE RANGE

Cap pF	Cap Code	Cap Tol.	C0402*			C0603*			C0805*				C1206*				C1210*				
			6.3V	10V	16V	6.3V	10V	16V	6.3V	10V	16V	25V	6.3V	10V	16V	25V	6.3V	10V	16V	25V	50V
12,000	123	K,M	BB	BB	BB																
15,000	153	K,M	BB	BB	BB																
18,000	183	K,M	BB	BB	BB																
22,000	223	K,M	BB	BB	BB																
27,000	273	K,M	BB	BB	BB																
33,000	333	K,M	BB	BB	BB																
39,000	393	K,M	BB	BB	BB																
47,000	473	K,M	BB	BB	BB																
56,000	563	K,M	BB	BB	BB																
68,000	683	K,M	BB	BB	BB																
82,000	823	K,M	BB	BB	BB																
100,000	104	K,M	BB	BB	BB																
120,000	124	K,M																			
150,000	154	K,M																			
180,000	184	K,M																			
220,000	224	K,M																			
270,000	274	K,M				CC	CC	CC								EB					
330,000	334	K,M				CC	CC	CC								EB					
390,000	394	K,M				CC	CC	CC								EB					
470,000	474	K,M				CC	CC	CC				DC				EC					
560,000	564	K,M				CC	CC	CC				DD				ED					
680,000	684	K,M				CC	CC	CC				DE				EE					
820,000	824	K,M				CC	CC	CC				DF				EF					
1,000,000	105	K,M	BB			CC	CC	CC	DG	DG	DG	DG				EH			FH+	FH+	FH+
1,200,000	125	K,M							DD	DD	DD					EC			FD+	FD+	
1,500,000	155	K,M							DE	DE	DE		EC	EC	EC	EC			FD+	FD+	
1,800,000	185	K,M							DH	DH	DH		EC	EC	EC	EC			FD+	FD+	
2,200,000	225	K,M					CC		DD	DD	DD		EE	EE	EE	EE			FG+	FG+	
2,700,000	275	K,M											EF	EF	EF	EF			FG+	FG+	
3,300,000	335	K,M							DE	DE	DH		EH	EH	EH	EH			FH+	FH+	
4,700,000	475	K,M				CD			DH	DH	DH		EH	EH	EH	EH	FK+	FK+	FK+	FK+	
5,600,000	565	K,M																			
6,800,000	685	K,M							DG				EK	EK	EH		FJ+	FJ+	FJ+	FF+	
8,200,000	825	K,M											EK	EK	EH		FK+	FK+	FK+	FG+	
10,000,000	106	K,M							DJ	DJ			EH	EH	EH		FK+	FK+	FK+	FH+	
12,000,000	126	K,M															FD+	FD+	FG+		
15,000,000	156	K,M															FD+	FD+	FL+		
18,000,000	186	K,M															FL+	FL+	FH+		
22,000,000	226	K,M							DH°				EH	EG			FH+	FH+	FJ+		
27,000,000	276	K,M															FM+				
33,000,000	336	K,M															FM+				
39,000,000	396	K,M															FM+				
47,000,000	476	K,M											EH°				FQ+°				
100,000,000	107	K,M															FS+°				

NOTE: For non-standard capacitance values or voltages, contact your local KEMET sales representative.

+Reflow only ° Available M ±20% tolerance only

Improved product with higher ratings and tighter capacitance tolerance product may be substituted within the same size (length, width, and thickness) at KEMET's option.
Reels with such substitutions will be marked with the improved KEMET part numbers.

Z5U CAPACITANCE RANGE

(KEMET's Z5U also meets Y5V Characteristics)

Cap pF	Cap Code	Cap Tol.	C0805*		C1206*		C1210*		C1812*		C1825*		C2225	
			50V	100V	50V	100V	50V	100V	50V	100V	50V	100V	50V	100V
6,800	682	M,Z	DC	DC										
8,200	822	M,Z	DC	DC										
10,000	103	M,Z	DC	DC	EB	EB								
12,000	123	M,Z	DC		EB	EB								
15,000	153	M,Z	DC		EB	EB								
18,000	183	M,Z	DC		EB	EB								
22,000	223	M,Z	DC		EB	EB								
27,000	273	M,Z	DC		EB	EB								
33,000	333	M,Z	DC		EB	EB								
39,000	393	M,Z	DD		EB	EC								
47,000	473	M,Z	DD		EB	EC	FB	FB						
56,000	563	M,Z	DD		EB	EB	FB	FB						
68,000	683	M,Z	DD		EB	EB	FB	FB						
82,000	823	M,Z	DD		EB	EB	FB	FC	GB	GB				
100,000	104	M,Z	DD		EB	EB	FB	FD	GB	GB				
120,000	124	M,Z			EC		FB	FD	GB	GB				
150,000	154	M,Z			EC		FC	FD	GB	GB				
180,000	184	M,Z			EC		FC		GB		HB	HB		
220,000	224	M,Z			EC		FC		GB		HB	HB		
270,000	274	M,Z					FC		GB		HB	HB		
330,000	334	M,Z					FD		GB		HB	HB	KB	KC
390,000	394	M,Z					FD		GB		HB	HD	KB	KC
470,000	474	M,Z					FD		GB		HB		KB	KC
560,000	564	M,Z					FD		GC		HB		KB	
680,000	684	M,Z					FD		GC		HB		KB	
820,000	824	M,Z					FF		GE		HB		KB	
1,000,000	105	M,Z					FH		GE		HB		KB	
1,200,000	125	M,Z									HB		KB	
1,500,000	155	M,Z									HB		KC	
1,800,000	185	M,Z									HB		KD	
2,200,000	225	M,Z									HB		KD	
2,700,000	275	M,Z											KD	

NOTE: For non-standard capacitance values or voltages, contact your local KEMET sales representative.
50 Volt Ceramic Chips can be used for 63 volt applications.
*** EIA preferred chip sizes**

See page 77 for Thickness Code Reference Chart.

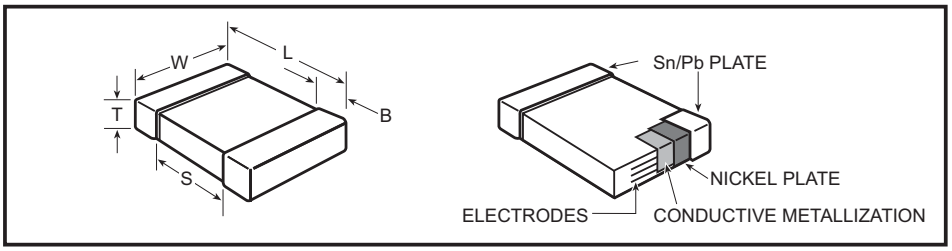
CERAMIC CHIP/CAPACITORS
Tin Lead L Termination

FEATURES

KEMET's line of Tin/Lead termination commercial MLCC surface mount capacitors are designed to meet the needs of the commercial, high reliability, and military customer applications where Tin/Lead plating is required. KEMET's Tin/Lead electroplating process is designed to meet a 5% minimum lead content in the termination of the component. As the bulk of the electronics industry marches to RoHS compliance it is important that KEMET provide the Tin/Lead terminated products for our valued high reliability and military customers.

KEMET Tiin/Lead MLCC surface mount capacitors are available in standard EIA case sizes from 0402 to 2225 and standard capacitance values in X7R, X5R, C0G dielectrics. Voltage ratings range from 6.3V to 200V. To order the Tin/Lead terminations indicate an "L" in the 14th digit of the part number. For additional dielectrics and voltage ratings please contact the factory or local Sales personnel.

CAPACITOR OUTLINE DRAWINGS



DIMENSIONS—MILLIMETERS AND (INCHES)

EIA SIZE CODE	METRIC SIZE CODE (Ref only)	L # LENGTH	W # WIDTH		B BANDWIDTH	S MIN. SEPARATION	MOUNTING TECHNIQUE
0402*	1005	1.0 (.04) ± .05(.002)	0.5 (.02) ± .05 (.002)	See page 77 for thickness dimensions.	0.20 (0.008)-0.40 (0.016)	0.3 (.012)	Solder Reflow
0603*	1608	1.6 (.063) ± 0.15 (.006)	0.8 (.032) ± 0.15 (.006)		0.35 (.014) ±0.15 (.006)	0.7 (.028)	Solder Wave † or Solder Reflow
0805*	2012	2.0 (.079) ± 0.2 (.008)	1.25 (.049) ± 0.2 (.008)		0.5 (.02) ±.25 (.010)	0.75 (.030)	
1206*	3216	3.2 (.126) ± 0.2 (.008)	1.6 (.063) ± 0.2 (.008)		0.5 (.02) ±.25 (.010)	N/A	
1210*	3225	3.2 (.126) ± 0.2 (.008)	2.5 (.098) ± 0.2 (.008)		0.5 (.02) ±.25 (.010)	N/A	Solder Reflow
1812	4532	4.5 (.177) ± 0.3 (.012)	3.2 (.126) ± 0.3 (.012)		0.6 (.024) ±.35 (.014)	N/A	
1825*	4564	4.5 (.177) ± 0.3 (.012)	6.4 (.252) ± 0.4 (.016)		0.6 (.024) ±.35 (.014)	N/A	
2220	5650	5.6 (.220) ± 0.4 (.016)	5.0 (.197) ± 0.4 (.016)		0.6 (.024) ±.35 (.014)	N/A	
2225	5664	5.6 (.220) ± 0.4 (.016)	6.3 (.248) ± 0.4 (.016)		0.6 (.024) ±.35 (.014)	N/A	

* Note: Indicates EIA Preferred Case Sizes (Tightened tolerances apply for 0402, 0603, and 0805 packaged in bulk cassette, see page 96.)
† For extended value 1210 case size – solder reflow only.

CAPACITOR ORDERING INFORMATION (Standard Chips - For Military see page 86)

C 0805 C 103 K 5 R A L*

CERAMIC

SIZE CODE

SPECIFICATION
C - Standard

CAPACITANCE CODE
Expressed in Picofarads (pF)
First two digits represent significant figures.
Third digit specifies number of zeros. (Use 9 for 1.0 through 9.9pF. Use 8 for 0.5 through 0.99pF)
(Example: 2.2pF = 229 or 0.50 pF = 508)

CAPACITANCE TOLERANCE
B – ±0.10pF J – ±5%
C – ±0.25pF K – ±10%
D – ±0.5pF M – ±20%
F – ±1%
G – ±2%

VOLTAGE
1 - 100V 3 - 25V
2 - 200V 4 - 16V
5 - 50V 8 - 10V
9 - 6.3V

TEMPERATURE CHARACTERISTIC
Designated by Capacitance Change Over Temperature Range
G – C0G (NP0) (±30 PPM/°C)
R – X7R (±15%) (-55°C + 125°C)
P – X5R (±15%) (-55°C + 85°C)

FAILURE RATE LEVEL
A- Not Applicable

END METALLIZATION
L - SnPb plated nickel barrier (SnPb 5% minimum)

*** Part Number Example: C0805C103K5RAL (14 digits - no spaces)**

Refer to pages 72-75 for NP0/C0G, X7R and X5R dielectric capacitance ranges available.

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THICKNESS CODE REFERENCE CHART

PACKAGING QTY BASED ON FINISHED CHIP THICKNESS SPECIFICATIONS

Thickness Code	Chip Size	Chip Thickness Range (mm)	Qty per Reel 7" Plastic	Qty per Reel 13" Plastic	Qty per Reel 7" Paper	Qty per Reel 13" Paper	Qty per Bulk Cassette
AA	0201	.30 ± .03	N/A	N/A	15,000	N/A	N/A
BB	0402	.50 ± .05	N/A	N/A	10,000	50,000	50,000
CB	0603	.80 ± .07	N/A	N/A	4,000	10,000	15,000
CC	0603	.80 ± .10	N/A	N/A	4,000	10,000	N/A
CD	0603	.80 ± .15	N/A	N/A	4,000	10,000	N/A
DB	0805	.60 ± .10	N/A	N/A	N/A	N/A	10,000
DC	0805	.78 ± .10	4,000	10,000	4,000	10,000	N/A
DD	0805	.90 ± .10	4,000	10,000	N/A	N/A	N/A
DE	0805	1.00 ± .10	2,500	10,000	N/A	N/A	N/A
DF	0805	1.10 ± .10	2,500	10,000	N/A	N/A	N/A
DG	0805	1.25 ± .15	2,500	10,000	N/A	N/A	N/A
DH	0805	1.25 ± .20	2,500	10,000	N/A	N/A	N/A
DJ	0805	1.25 ± .20	3,000	10,000	N/A	N/A	N/A
EB	1206	.78 ± .10	4,000	10,000	4,000	10,000	N/A
EC	1206	.90 ± .10	4,000	10,000	N/A	N/A	N/A
ED	1206	1.00 ± .10	2,500	10,000	N/A	N/A	N/A
EE	1206	1.10 ± .10	2,500	10,000	N/A	N/A	N/A
EF	1206	1.20 ± .15	2,500	10,000	N/A	N/A	N/A
EG	1206	1.60 ± .15	2,000	8,000	N/A	N/A	N/A
EH	1206	1.60 ± .20	2,000	8,000	N/A	N/A	N/A
EJ	1206	1.70 ± .20	2,000	8,000	N/A	N/A	N/A
EK	1206	.80 ± .10	2,000	8,000	N/A	N/A	N/A
EL	1206	1.15 ± .15	2,000	8,000	N/A	N/A	N/A
EM	1206	1.25 ± .15	2,500	10,000	N/A	N/A	N/A
EN	1206	0.95 ± .10	4,000	10,000	N/A	N/A	N/A
FB	1210	.78 ± .10	4,000	10,000	N/A	N/A	N/A
FC	1210	.90 ± .10	4,000	10,000	N/A	N/A	N/A
FD	1210	.95 ± .10	4,000	10,000	N/A	N/A	N/A
FE	1210	1.00 ± .10	2,500	10,000	N/A	N/A	N/A
FF	1210	1.10 ± .10	2,500	10,000	N/A	N/A	N/A
FG	1210	1.25 ± .15	2,500	10,000	N/A	N/A	N/A
FH	1210	1.55 ± .15	2,000	8,000	N/A	N/A	N/A
FJ	1210	1.85 ± .20	2,000	8,000	N/A	N/A	N/A
FK	1210	2.10 ± .20	2,000	8,000	N/A	N/A	N/A
FL	1210	1.40 ± .15	2,000	8,000	N/A	N/A	N/A
FM	1210	1.70 ± .20	2,000	8,000	N/A	N/A	N/A
FN	1210	1.85 ± .20	2,000	8,000	N/A	N/A	N/A
FO	1210	1.50 ± .20	2,000	8,000	N/A	N/A	N/A
FP	1210	1.60 ± .20	2,000	8,000	N/A	N/A	N/A
FQ	1210	2.5 ± .20	1,500	8,000	N/A	N/A	N/A
FR	1210	2.25 ± .20	2,000	8,000	N/A	N/A	N/A
FS	1210	2.1 ± .20	1,000	4,000	N/A	N/A	N/A
GB	1812	1.00 ± .10	1,000	4,000	N/A	N/A	N/A
GC	1812	1.10 ± .10	1,000	4,000	N/A	N/A	N/A
GD	1812	1.25 ± .15	1,000	4,000	N/A	N/A	N/A
GE	1812	1.30 ± .10	1,000	4,000	N/A	N/A	N/A
GF	1812	1.50 ± .10	1,000	4,000	N/A	N/A	N/A
GG	1812	1.55 ± .10	1,000	4,000	N/A	N/A	N/A
GH	1812	1.40 ± .15	1,000	4,000	N/A	N/A	N/A
GJ	1812	1.70 ± .15	1,000	4,000	N/A	N/A	N/A
GK	1812	1.60 ± .20	1,000	4,000	N/A	N/A	N/A
GL	1812	1.90 ± .20	1,000	4,000	N/A	N/A	N/A
GM	1812	2.00 ± .20	1,000	4,000	N/A	N/A	N/A
GN	1812	1.70 ± .20	1,000	4,000	N/A	N/A	N/A
HB	1825	1.10 ± .15	1,000	4,000	N/A	N/A	N/A
HC	1825	1.15 ± .15	1,000	4,000	N/A	N/A	N/A
HD	1825	1.30 ± .15	1,000	4,000	N/A	N/A	N/A
HE	1825	1.40 ± .15	1,000	4,000	N/A	N/A	N/A
HF	1825	1.50 ± .15	1,000	4,000	N/A	N/A	N/A
JB	2220	1.00 ± .15	1,000	4,000	N/A	N/A	N/A
JC	2220	1.10 ± .15	1,000	4,000	N/A	N/A	N/A
JD	2220	1.30 ± .15	1,000	4,000	N/A	N/A	N/A
JE	2220	1.40 ± .15	1,000	4,000	N/A	N/A	N/A
JF	2220	1.50 ± .15	1,000	4,000	N/A	N/A	N/A
KB	2225	1.00 ± .15	1,000	4,000	N/A	N/A	N/A
KC	2225	1.10 ± .15	1,000	4,000	N/A	N/A	N/A
KD	2225	1.30 ± .15	1,000	4,000	N/A	N/A	N/A
KE	2225	1.40 ± .15	1,000	4,000	N/A	N/A	N/A

This chart refers to ceramic chip thickness codes on pages 72-75.

CERAMIC OPEN MODE CAPACITORS

FEATURES

KEMET's Open Mode Ceramic Surface Mount Capacitor is designed to significantly minimize the probability of a low IR or Short Circuit Condition when forced to failure in a board flex situation. This reduces the potential for causing catastrophic failures. This product is RoHS Compliant.

Applications:
- Input side filtering (power plane/bus)
- High current applications (battery line)
- Circuits that cannot be fused to open when short circuits occur due to flex cracks

Markets:
- *Automotive*
  - All applications connected directly to the battery
  - Conversion to 42V power system
- *Power Conversion*
  - Raw power input side filtering

OUTLINE DRAWING

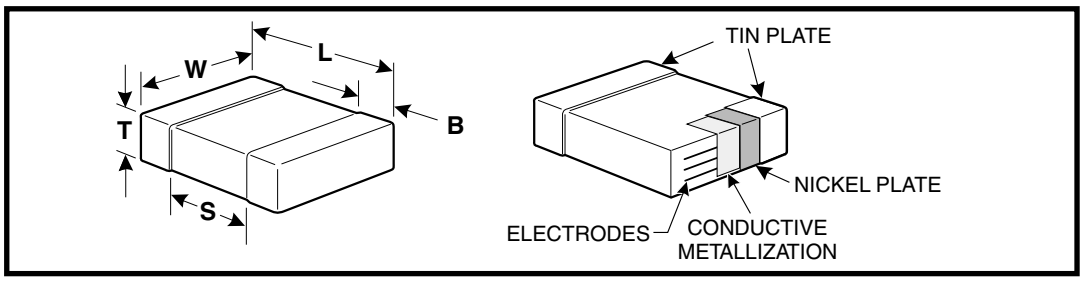


TABLE 1 - DIMENSIONS - MILLIMETERS (INCHES)

Metric Size Code	EIA Size Code	L - Length	W - Width	B - Bandwidth	Separation
2012	0805	2.0 (.079) ± .20 (.008)	1.25 (.049) ± 0.2 (.008)	0.50 (.02) ± .25 (.010)	0.75 (.030)
3216	1206	3.2 (.126) ± .20 (.008)	1.6 (.063) ± 0.2 (.008)	0.50 (.02) ± .25 (.010)	N/A
3225	1210	3.2 (.126) ± .20 (.008)	2.5 (.098) ± 0.2 (.008)	0.50 (.02) ± .25 (.010)	N/A
4532	1812	4.5 (.177) ± 0.3 (.012)	3.2 (.126) ± 0.3 (.012)	0.60 (.024) ± .35 (.014)	N/A

Note: For thickness dimensions, see Table 2.

CAPACITOR ORDERING INFORMATION

C 1812 F 105 K 1 R A C

Style
C - Ceramic

Size Code
0805, 1206, 1210, 1812

Specification
F - Open-Mode

Capacitance Code, pF
First two digits represent significant figures.
Third digit specifies number of zeros. 100 pF = 101.
(Use "9" for 1.0 through 9.9 pF)
(Use "8" for 0.1 through .99 pF)

Capacitance Tolerance
K = ±10% M = ±20%

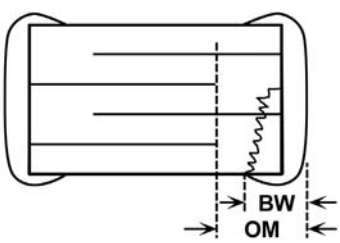
Voltage
2 = 200V 5 = 50V
1 = 100V 3 = 25V
4 = 16V

Temperature Characteristic
Designated by Capacitance Change over Temperature Range
R – X7R (±15%) (-55°C +125°C)

Failure Rate Level
A = Not Applicable

End Metallization
C = Standard

OPEN-MODE INTERNAL DESIGN



The open-mode dimension (OM) exceeds the termination bandwidth dimensions: OM >BW

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TABLE 2
X7R DIELECTRIC CAPACITANCE RANGE AND THICKNESS TARGETS (mm)

Cap Code	0805					1206					1210					1812			
	16V	25V	50V	100V	200V	16V	25V	50V	100V	200V	16V	25V	50V	100V	200V	25V	50V	100V	200V
103	DD	DD	DD	DD	DD														
123	DD	DD	DD	DD	DG														
153	DD	DD	DD	DD	DG														
183	DD	DD	DD	DD						EC									
223	DD	DD	DD	DG						EC									
273	DD	DD	DD	DG						EC									
333	DD	DD	DD	DG						EC									
393	DD	DD	DD	DG						EC									
473	DD	DD	DD			EC	EC	EC	EC	EG									GB
563	DD	DD	DD			EC	EC	EC	EC	EG									GB
683	DD	DD	DG			EC	EC	EC	EC	EG					FD				GB
823	DD	DD	DG			EC	EC	EC	EC	EG					FD				GB
104	DG	DG	DG			EC	EC	EC	EC	EG	FD	FD	FD	FD	FG	GB	GB	GB	GB
124	DG	DG				EC	EC	EC	EC		FD	FD	FD	FD	FG	GB	GB	GB	GB
154	DG	DG				EC	EC	EC	EG		FD	FD	FD	FD	FH	GB	GB	GB	GB
184	DG	DG				EC	EC	EC	EG		FD	FD	FD	FD	FH	GB	GB	GB	GB
224	DG					EC	EC	EC			FD	FD	FD	FG	FJ	GB	GB	GB	GC
274						EC	EC	EC			FD	FD	FD	FG		GB	GB	GB	GF
334						EG	EG				FD	FD	FD	FH		GB	GB	GB	GK
394						EG	EG				FD	FD	FG	FH		GB	GB	GB	GL
474						EG	EG				FD	FD	FG	FJ		GB	GB	GC	
564						EG					FD	FD	FG	FR		GB	GB	GD	
684						EG					FD	FG	FH	FR		GD	GD	GF	
824						EG					FD	FG	FJ			GD	GD	GK	
105						EG					FD	FH	FJ			GN	GN	GM	
125											FG								
155											FH								
185											FH								
225											FJ								

THICKNESS AND PACKAGING INFORMATION

Thickness Code	Series	Dimension	7" Reel Qty.	13" Reel Qty.
DD	0805	.90 ± .10	4000	10000
DG	0805	1.25 ± .15	2500	10000
EC	1206	.90 ± .10	4000	10000
EG	1206	1.60 ± .15	2000	8000
FD	1210	.95 ± .10	4000	10000
FG	1210	1.25 ± .15	2500	10000
FH	1210	1.55 ± .15	2000	8000
FJ	1210	1.85 ± .20	2000	8000
FR	1210	2.25 ± .20	2000	8000
GB	1812	1.0 ± .10	1000	4000
GC	1812	1.1 ± .10	1000	4000
GD	1812	1.25 ± .15	1000	4000
GF	1812	1.50 ± .15	1000	4000
GK	1812	1.60 ± .20	1000	4000
GN	1812	1.70 ± .20	1000	4000
GL	1812	1.90 ± .20	1000	4000
GM	1812	2.00 ± .20	1000	4000

KEMET's High Voltage Surface Mount Capacitors are designed to withstand high voltage applications. They offer high capacitance with low leakage current and low ESR at high frequency. The capacitors have pure tin (Sn) plated external electrodes for good solderability. X7R dielectrics are not designed for AC line filtering applications. An insulating coating may be required to prevent surface arcing. These components are RoHS compliant.

APPLICATIONS

- Switch Mode Power Supply
  - Input Filter
  - Resonators
  - Tank Circuit
  - Snubber Circuit
  - Output Filter
- High Voltage Coupling
- High Voltage DC Blocking
- Lighting Ballast
- Voltage Multiplier Circuits
- Coupling Capacitor/CUK

MARKETS

- Power Supply
- High Voltage Power Supply
- DC-DC Converter
- LCD Fluorescent Backlight Ballast
- HID Lighting
- Telecommunications Equipment
- Industrial Equipment/Control
- Medical Equipment/Control
- Computer (LAN/WAN Interface)
- Analog and Digital Modems
- Automotive

OUTLINE DRAWING

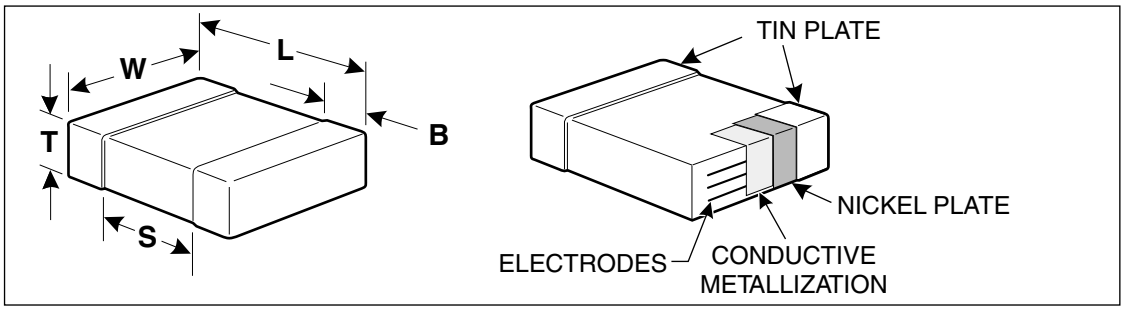

TABLE 1 - DIMENSIONS - MILLIMETERS (in.)

Metric Code	EIA Size Code	L - Length	W - Width	B - Bandwidth	Band Separation
2012	0805	2.0 (0.079) ± 0.2 (0.008)	1.2 (0.049) ± 0.2 (0.008)	0.5 (0.02 ±0.25 (0.010)	0.75 (0.030)
3216	1206	3.2 (0.126) ± 0.2 (0.008)	1.6 (0.063) ± 0.2 (0.008)	0.5 (0.02) ± 0.25 (0.010)	N/A
3225	1210	3.2 (0.126) ± 0.2 (0.008)	2.5 (0.098) ± 0.2 (0.008)	0.5 (0.02) ± 0.25 (0.010)	N/A
4520	1808	4.5 (0.177) ± 0.3 (0.012)	2.0 (0.079 ± 0.2 (0.008)	0.6 (0.024) ± 0.35 (0.014)	N/A
4532	1812	4.5 (0.177) ± 0.3 (0.012)	3.2 (0.126) ± 0.3 (0.012)	0.6 (0.024) ± 0.35 (0.014)	N/A
4564	1825	4.5 (0.177) ± 0.3 (0.012)	6.4 (0.250) ± 0.4 (0.016)	0.6 (0.024) ± 0.35 (0.014)	N/A
5650	2220	5.6 (0.224) ± 0.4 (0.016)	5.0 (0.197) ± 0.4 (0.016)	0.6 (0.024) ± 0.35 (0.014)	N/A
5664	2225	5.6 (0.224) ± 0.4 (0.016)	6.4 (0.250) ± 0.4 (0.016)	0.6 (0.024) ± 0.35 (0.014)	N/A

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C0G DIELECTRIC CAPACITANCE VALUES AND THICKNESS TARGETS (in.)

Cap pF	Capacitance Tolerance *	Series	0805		1206				1210				1808						1812						1825						2220						2225					
		Max Thickness (in)	0.050	0.050	0.065	0.065	0.065	0.065	0.101	0.101	0.101	0.101	0.080	0.080	0.080	0.080	0.080	0.080	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067
		Cap Code/ Voltage	500	1000	500	1000	1500	2000	500	1000	1500	2000	500	1000	1500	2000	2500	3000	500	1000	1500	2000	2500	3000	500	1000	1500	2000	2500	3000	500	1000	1500	2000	2500	3000	500	1000	1500	2000	2500	3000
1.0-2.4	C,D	109-249	■	■																																						
2.7-5.1	C,D K,M	279-519	■	■																																						
5.6-9.1	C,D J,K,M	569-919	■	■																																						
10	C,D J,K,M	100	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
11	C,D J,K,M	110	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
12	C,D J,K,M	120	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
13	C,D J,K,M	130	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
15	C,D G,J,K,M	150	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
16	C,D G,J,K,M	160	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
18	C,D G,J,K,M	180	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
20	C,D G,J,K,M	200	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
22	C,D G,J,K,M	220	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
24	C,D G,J,K,M	240	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
27	D,F,G,J,K,M	270	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
30	D,F,G,J,K,M	300	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
33	D,F,G,J,K,M	330	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
36	D,F,G,J,K,M	360	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
39	D,F,G,J,K,M	390	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
43	D,F,G,J,K,M	430	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
47	D,F,G,J,K,M	470	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
51	D,F,G,J,K,M	510	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
56	F,G,J,K,M	560	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
62	F,G,J,K,M	620	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
68	F,G,J,K,M	680	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
75	F,G,J,K,M	750	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
82	F,G,J,K,M	820	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
91	F,G,J,K,M	910	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
100	F,G,J,K,M	101	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
110	F,G,J,K,M	111	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
120	F,G,J,K,M	121	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
130	F,G,J,K,M	131	■		■	■	■		■	■	■	■	■	■	■	■			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
150	F,G,J,K,M	151	■		■	■	■		■	■	■	■	■	■	■	■			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
160	F,G,J,K,M	161	■		■	■	■		■	■	■	■	■	■	■	■			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
180	F,G,J,K,M	181	■		■	■	■		■	■	■	■	■	■	■	■			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
200	F,G,J,K,M	201			■	■			■	■	■	■	■	■	■	■			■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
220	F,G,J,K,M	221			■	■			■	■	■	■	■	■	■	■			■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
240	F,G,J,K,M	241			■	■			■	■	■	■	■	■	■	■			■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
270	F,G,J,K,M	271			■	■			■	■	■	■	■	■	■	■			■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
300	F,G,J,K,M	301			■	■			■	■	■	■	■	■	■	■			■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
330	F,G,J,K,M	331			■	■			■	■	■	■	■	■	■	■			■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
360	F,G,J,K,M	361			■	■			■	■	■	■	■	■	■				■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
390	F,G,J,K,M	391			■	■			■	■	■	■	■	■	■				■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
430	F,G,J,K,M	431			■	■			■	■	■	■	■	■	■				■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
470	F,G,J,K,M	471			■	■			■	■	■	■	■	■	■				■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
510	F,G,J,K,M	511			■	■			■	■	■		■	■	■				■	■	■				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
560	F,G,J,K,M	561			■	■			■	■	■		■	■	■				■	■	■				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
620	F,G,J,K,M	621			■				■	■	■		■	■					■	■	■				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
680	F,G,J,K,M	681			■				■	■	■		■	■					■	■	■				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
750	F,G,J,K,M	751			■				■	■			■	■					■	■	■				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
820	F,G,J,K,M	821			■				■	■			■	■					■	■	■				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
910	F,G,J,K,M	911			■				■	■			■	■					■	■					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
1000	F,G,J,K,M	102			■				■	■			■	■					■	■					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
1100	F,G,J,K,M	112							■	■			■	■					■	■					■	■	■	■			■	■	■	■	■		■	■	■	■	■	
1200	F,G,J,K,M	122							■	■			■	■					■	■					■	■	■	■			■	■	■	■			■	■	■	■	■	
1300	F,G,J,K,M	132							■	■			■	■					■	■					■	■					■	■	■				■	■	■	■		
1500	F,G,J,K,M	152							■	■			■	■					■	■					■	■	■				■	■	■				■	■	■	■		
1600	F,G,J,K,M	162							■				■						■	■					■	■	■				■	■	■				■	■	■			
1800	F,G,J,K,M	182							■	■			■						■	■					■	■	■				■	■	■				■	■	■			
2000	F,G,J,K,M	202							■				■						■	■					■	■					■	■					■	■	■			
2200	F,G,J,K,M	222							■				■						■	■					■	■					■	■					■	■	■			
2400	F,G,J,K,M	242							■				■						■						■	■					■	■					■	■				
2700	F,G,J,K,M	272							■				■						■						■	■					■	■					■	■				
3000	F,G,J,K,M	302							■										■						■	■					■	■					■	■				
3300	F,G,J,K,M	332							■										■						■	■					■	■					■	■				
3600	F,G,J,K,M	362																	■						■	■					■	■					■	■				
3900	F,G,J,K,M	392																	■						■	■					■	■					■	■				
4300	F,G,J,K,M	432																							■	■					■	■					■	■				
4700	F,G,J,K,M	472																							■	■					■	■					■	■				
5100	F,G,J,K,M	512																							■						■	■					■	■				
5600	F,G,J,K,M	562																							■						■	■					■	■				
6200	F,G,J,K,M	622																							■						■						■	■				
6800	F,G,J,K,M	682																							■						■						■	■				
7500	F,G,J,K,M	752																							■						■						■					
8200	F,G,J,K,M	822																							■						■						■					
9100	F,G,J,K,M	912																																			■					
10,000	F,G,J,K,M	103																																			■					

* Contact KEMET Sales Representative for C, D, F & G Capacitance Tolerance availability.

Note: Actual thickness dimensions may be less than stated maximum. Check the KEMET website, www.kemet.com, for additional values and chip sizes available.

X7R DIELECTRIC CAPACITANCE VALUES AND THICKNESS TARGETS (in.)

Cap pF	Capacitance Tolerance	Series	0805		1206				1210				1808					1812					1825					2220					2225					
		Max Thickness (in)	0.050	0.050	0.065	0.065	0.065	0.065	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067
		Cap Code/ Voltage	500	1000	500	1000	1500	2000	500	1000	1500	2000	500	1000	1500	2000	2500	3000	500	1000	1500	2000	2500	3000	500	1000	1500	2000	2500	3000	500	1000	1500	2000	2500	3000	500	1000	1500	2000	2500	3000
10	J,K,M	100	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
11	J,K,M	110	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
12	J,K,M	120	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
13	J,K,M	130	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
15	J,K,M	150	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
16	J,K,M	160	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
18	J,K,M	180	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
20	J,K,M	200	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
22	J,K,M	220	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
24	J,K,M	240	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
27	J,K,M	270	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
30	J,K,M	300	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
33	J,K,M	330	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
36	J,K,M	360	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
39	J,K,M	390	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
43	J,K,M	430	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
47	J,K,M	470	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
51	J,K,M	510	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
56	J,K,M	560	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
62	J,K,M	620	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
68	J,K,M	680	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
75	J,K,M	750	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
82	J,K,M	820	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
91	J,K,M	910	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
100	J,K,M	101	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
110	J,K,M	111	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
120	J,K,M	121	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
130	J,K,M	131	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
150	J,K,M	151	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
180	J,K,M	181	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
220	J,K,M	221	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
270	J,K,M	271	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
330	J,K,M	331	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
390	J,K,M	391	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
470	J,K,M	471	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
560	J,K,M	561	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
680	J,K,M	681	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
820	J,K,M	821	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
1000	J,K,M	102	■	■	■	■	■	■	■	■	■	■	■	■	■	■	□	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
1200	J,K,M	122	■	□	■	■	■	□	■	■	■	■	■	■	■	■	□	■	■	■	■	■	□	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
1500	J,K,M	152	■	□	■	■	■	□	■	■	■	■	■	■	■	■	□	■	■	■	■	□	□	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
1800	J,K,M	182	■	□	■	■	□	□	■	■	■	■	■	■	■	■	□	■	■	■	■	□	□	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
2000	J,K,M	202	■	□	■	■	□	□	■	■	■	■	■	■	■	■	□	■	■	■	■	□	□	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
2200	J,K,M	222	■	□	■	■	□	□	■	■	■	■	■	■	■	■	□	■	■	■	■	□	□	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
2700	J,K,M	272	■	□	■	■	□	□	■	■	■	□	■	■	■	□	□	■	■	■	■	□	□	■	■	■	■	■	□	■	■	■	■	■	■	■	■	■
3300	J,K,M	332	■	□	■	■	□	□	■	■	■	□	■	■	■	□	□	■	■	■	■	□	□	■	■	■	■	■	□	■	■	■	■	■	□	■	■	■
3900	J,K,M	392	□	□	■	■	□	□	■	■	□	□	■	■	■	□	□	■	■	■	■	□	□	■	■	■	■	■	□	□	■	■	■	■	□	□	■	■
4700	J,K,M	472	□	□	■	■	□	□	■	■	□	□	■	■	■	□	□	■	■	■	□	□	□	■	■	■	■	□	□	□	■	■	■	■	■	■	■	□
5600	J,K,M	562	□	□	■	□	□	□	■	■	□	□	■	■	□	□	□	■	■	■	□	□	□	■	■	■	■	□	□	□	■	■	■	■	■	■	□	□
6800	J,K,M	682	□	□	■	□	□	□	■	■	□	□	■	■	□	□	□	■	■	■	□	□	□	■	■	■	■	□	□	□	■	■	■	■	■	■	□	□
8200	J,K,M	822	□	□	■	□	□	□	■	■	□	□	■	■	□	□	□	■	■	□	□	□	□	■	■	■	■	□	□	□	■	■	■	■	■	■	□	□
10,000	J,K,M	103	□	□	■	□	□	□	■	■	□	□	■	■	□	□	□	■	■	□	□	□	□	■	■	■	■	□	□	□	■	■	■	■	■	■	□	□
12,000	J,K,M	123	□	□	■	□	□	□	■	■	□	□	■	■	□	□	□	■	■	□	□	□	□	■	■	■	□	□	□	□	■	■	■	■	■	■	□	□
15,000	J,K,M	153	□	□	■	□	□	□	■	□	□	□	■	■	□	□	□	■	■	□	□	□	□	■	■	■	□	□	□	□	■	■	■	■	□	□	□	□
18,000	J,K,M	183	□	□	□	□	□	□	■	□	□	□	■	□	□	□	□	■	■	□	□	□	□	■	■	□	□	□	□	□	■	■	■	■	□	□	□	□
22,000	J,K,M	223	□	□	□	□	□	□	■	□	□	□	■	□	□	□	□	■	■	□	□	□	□	■	■	□	□	□	□	□	■	■	□	□	□	□	□	□
27,000	J,K,M	273	□	□	□	□	□	□	■	□	□	□	■	□	□	□	□	■	□	□	□	□	□	■	■	□	□	□	□	□	■	■	□	□	□	□	□	□
33,000	J,K,M	333	□	□	□	□	□	□	■	□	□	□	■	□	□	□	□	■	□	□	□	□	□	■	■	□	□	□	□	□	■	■	□	□	□	□	□	□
39,000	J,K,M	393	□	□	□	□	□	□	■	□	□	□	■	□	□	□	□	■	□	□	□	□	□	■	■	□	□	□	□	□	■	■	□	□	□	□	□	□
47,000	J,K,M	473	□	□	□	□	□	□	■	□	□	□	■	□	□	□	□	■	□	□	□	□	□	■	■	□	□	□	□	□	■	■	□	□	□	□	□	□
56,000	J,K,M	563	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	■	□	□	□	□	□	■	□	□	□	□	□	□	■	■	□	□	□	□	□	□
62,000	J,K,M	623	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	■	□	□	□	□	□	■	□	□	□	□	□	□	■	■	□	□	□	□	□	□
68,000	J,K,M	683	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	■	□	□	□	□	□	■	□	□	□	□	□	□	■	□	□	□	□	□	□	□
82,000	J,K,M	823	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	■	□	□	□	□	□	□	■	□	□	□	□	□	□	□
100,000	J,K,M	104	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	■	□	□	□	□	□	□	■	□	□	□	□	□	□	□
120,000	J,K,M	124	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	■	□	□	□	□	□	□	■	□	□	□	□	□	□	□
150,000	J,K,M	154	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	■	□	□	□	□	□	□	■	□	□	□	□	□	□	□
180,000	J,K,M	184	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	■	□	□	□	□	□	□	□
220,000	J,K,M	224	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	■	□	□	□	□	□	□	□

Note: Actual thickness dimensions may be less than stated maximum.
Check the KEMET website, www.kemet.com, for additional values and chip sizes available.

KEMET HIGH VOLTAGE SURFACE MOUNT CHIP (VOLTAGE CODES C,D,F,G,H, and Z) THICKNESS AND REELING QUANTITIES

Chip size		Max. Thickness (in)	Max. Thickness (mm)	Tape Width (mm)	Qty per Reel 7" Plastic	Qty per Reel 13" Plastic
EIA	Metric					
0805	2012	0.055	1.27	8	2,500	10,000
1206	3216	0.065	1.65	8	2,000	8,000
1210	3225	0.101	2.57	8	2,000	8,000
1808	4520	0.080	2.03	12	1,000	4,000
1812/1813	4532	0.067	1.70	12	1,000	4,000
1825	4564	0.067	1.70	12	1,000	4,000
2220	5650	0.067	1.70	12	1,000	4,000
2225	5664	0.067	1.70	12	1,000	4,000

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CAPACITOR ORDERING INFORMATION

C 0805 C 102 K C R A C

Style
C - Ceramic

Chip Size
0805; 1206; 1210; 1808;
1812; 1825; 2220; 2225

Specification
C - Standard

Capacitance Code, pF
First two digits represent significant figures.
Third digit specifies number of zeros. 100 pF = 101.
(Use "9" for 1.0 through 9.9 pF)
(Use "8" for 0.1 through .99 pF)

Capacitance Tolerance
C = ±0.25pF* J = ±5%
D = ±0.5pF* K = ±10%
F = ±1%* M = ±20%
G = ±2%*
* Contact KEMET Sales for availability.

Voltage
C = 500V G = 2000V
D = 1000V Z = 2500V
F = 1500V H = 3000V

Temperature Characteristic
Designated by Capacitance
Change over Temperature Range
G – (C0G) (±30ppm/C) (-55°C +125°C)
R – X7R (±15%) (-55°C +125°C)

Failure Rate Level
A = Not Applicable

End Metallization
C = Standard

ELECTRICAL PARAMETERS

Property	Specification
Capacitance	C0G: 1 pF to 0.010 µF X7R: 10 pF to 0.22 µF 25°C, 1.0 ± 0.2 Vrms, 1 kHz (1 MHz for ≤ 1000 pF (C0G only)
Cap Tolerance	C0G: C*, D*, F*, G*, J, K, M * Contact KEMET Sales for availability. X7R: J, K, M
DF	C0G: 0.1% Max X7R: 2.5% Max
Voltage Ratings	500 V, 1000 V, 1500 V, 2000 V, 2500 V, 3000 V
Operating Temperature Range	From -55ºC to +125ºC
25ºC IR @ 500V	100 GΩ or 1000 MΩ-µF, whichever is less
125ºC IR @ 500V	10 GΩ or 100 MΩ-µF, whichever is less
-55ºC TCC +125ºC TCC	X7R: ± 15% C0G: ± 30 ppm / ºC
Dielectric Strength	150% of Rated Voltage for Rated Voltage <1000 V 120% of Rated Voltage for Rated Voltage >=1000V
Ripple Current	Consult KEMET Sales Representative

MARKING

These chips are supplied unmarked. If required, they can be supplied LASER-marked at an extra cost. Details on the marking format is located on page 96.

PACKAGING

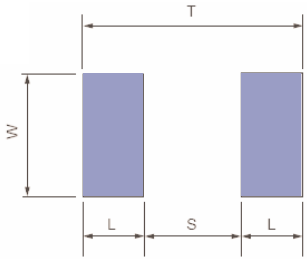
KEMET High Voltage Surface Mount MLCC are available packaged in tape and reel configuration, or bulk bag as outlined on page 82. Please consult factory for waffle packaging options.

SOLDERING PROCESS

The 0805 and 1206 case sizes are suitable for either reflow or wave soldering processes. Sizes 1210 and larger should be limited to reflow soldering only. All sizes incorporate the standard KEMET barrier layer of pure nickel with an overplating of pure tin (Sn) for excellent solderability and resistance to solder leaching of the termination.

RECOMMENDED SOLDER PAD DIMENSIONS

Chip Size	T (Total Length)		S (Separation		W (Pad Width)		L (Pad Length)	
	mm	in.	mm	in.	mm	in.	mm	in.
0805	3.30	0.130	0.70	0.028	1.60	0.063	1.30	0.051
1206	4.50	0.177	1.50	0.059	2.00	0.079	1.50	0.059
1210	4.50	0.177	1.50	0.059	2.90	0.114	1.50	0.059
1808	5.90	0.232	2.30	0.091	2.40	0.094	1.80	0.071
1812	5.90	0.232	2.30	0.091	3.70	0.146	1.80	0.071
1825	5.90	0.232	2.30	0.091	6.90	0.272	1.80	0.071
2220	7.00	0.276	3.30	0.130	5.50	0.217	1.85	0.073
2225	7.00	0.276	3.30	0.130	6.80	0.268	1.85	0.073



CERAMIC CAPACITOR ARRAY

FEATURES

- Four individual capacitors inside one 1206 monolithic structure
- Saves board and inventory space
- One placement instead of four - less costly
- Easier to handle and solder than 4 smaller chips
- Tape and reel per EIA 481-1
- RoHS Compliant

CAPACITOR OUTLINE DRAWING

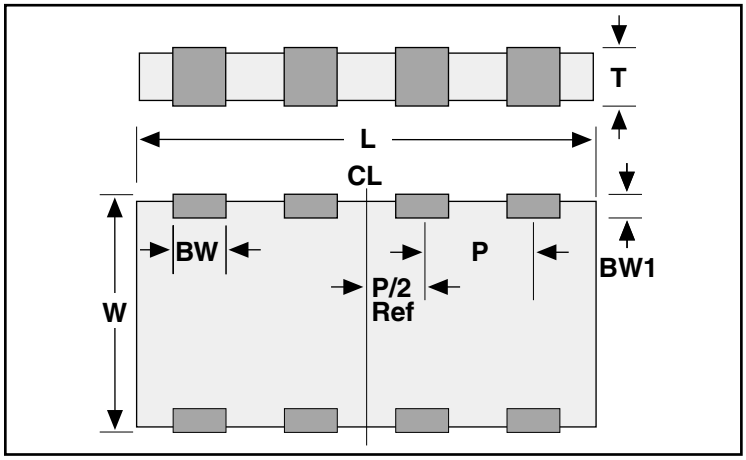


TABLE 1
EIA DIMENSIONS – MILLIMETERS (INCHES)

Size Code	Length L	Width W	Thickness T (max.)	Bandwidth BW	Bandwidth BW1	Pitch P
1632	3.2 (0.126) ± 0.2 (0.008)	1.6 (.063) ± 0.2 (.008)	0.7 - 1.35 (0.027 - 0.053)	0.40 (0.016) ± 0.2 (0.008)	0.1 - 0.5 (0.004 - 0.020)	0.8 (0.031) ± 0.1 (0.004)

Notes:
1. Metric is controlling - English for reference only.
2. Pitch (P) tolerances are non-cumulative along the package.
3. Thickness (T) depends on capacitance.

CERAMIC ARRAY ORDERING INFORMATION

C 1632 C 103 K 5 R A C

CERAMIC

EIA SIZE CODE
Ceramic chip array

SPECIFICATION
C - Standard

CAPACITANCE CODE
Expressed in Picofarads (pF)
First two digits represent significant figures.
Third digit specifies number of zeros. (Use 9 for 1.0 thru 9.9pF. (Example: 2.2pF = 229

CAPACITANCE TOLERANCE
K – ±10%: M – ±20% Standard Tolerances
Contact factory for any special requirements.

END METALLIZATION
C-Standard
(Tin-plated nickel barrier)

FAILURE RATE LEVEL
A- Not Applicable

TEMPERATURE CHARACTERISTIC
Designated by Capacitance Change Over Temperature Range
G – C0G (NP0) (±30 PPM/°C)
R – X7R (±15%)

VOLTAGE
5 = 50v; 3 = 25v; 4 = 16v; 8=10v

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TABLE 2A
C0G DIELECTRIC – CAPACITANCE RANGE

Capacitance Values (pF)	KEMET Part Number	Capacitance Tolerance	10V 16V	25V	50V	100V	200V
10	C1632C100(1)(2)GAC	K,M	100	100	100	100	100
12	C1632C120(1)(2)GAC	K,M	120	120	120	120	120
15	C1632C150(1)(2)GAC	K,M	150	150	150	150	150
18	C1632C180(1)(2)GAC	K,M	180	180	180	180	180
22	C1632C220(1)(2)GAC	K,M	220	220	220	220	220
27	C1632C270(1)(2)GAC	K,M	270	270	270	270	270
33	C1632C330(1)(2)GAC	K,M	330	330	330	330	330
39	C1632C390(1)(2)GAC	K,M	390	390	390	390	390
47	C1632C470(1)(2)GAC	K,M	470	470	470	470	470
56	C1632C560(1)(2)GAC	K,M	560	560	560	560	560
68	C1632C680(1)(2)GAC	K,M	680	680	680	680	680
82	C1632C820(1)(2)GAC	K,M	820	820	820	820	820
100	C1632C101(1)(2)GAC	K,M	101	101	101	101	
120	C1632C121(1)(2)GAC	K,M	121	121	121	121	
150	C1632C151(1)(2)GAC	K,M	151	151	151	151	
180	C1632C181(1)(2)GAC	K,M	181	181	181	181	
220	C1632C221(1)(2)GAC	K,M	221	221	221		
270	C1632C271(1)(2)GAC	K,M	271	271	271		
330	C1632C331(1)(2)GAC	K,M	331	331	331		
390	C1632C391(1)(2)GAC	K,M	391	391	391		
470	C1632C471(1)(2)GAC	K,M	471	471	471		

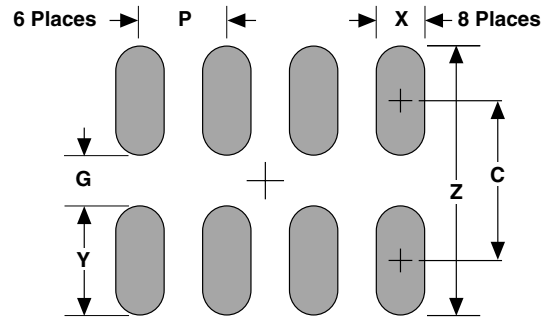
(1) To complete the KEMET part number, insert the alpha code for the tolerance desired.
K = ±10% and M = ±20% – standard tolerance. Contact factory for any special requirements.
(2) To complete the KEMET part number, insert appropriate number for voltage desired:
"5" = 50 volts, "3" = 25 volts, "4" = 16 volts, and "8" = 10 volts.

TABLE 2B
X7R DIELECTRIC – CAPACITANCE RANGE

Capacitance Values (pF)	KEMET Part Number	Capacitance Tolerance	10V 16V	25V	50V	100V	200V
330	C1632C331(1)(2)RAC	K,M	331	331	331	331	331
390	C1632C391(1)(2)RAC	K,M	391	391	391	391	391
470	C1632C471(1)(2)RAC	K,M	471	471	471	471	471
560	C1632C561(1)(2)RAC	K,M	561	561	561	561	561
680	C1632C681(1)(2)RAC	K,M	681	681	681	681	
820	C1632C821(1)(2)RAC	K,M	821	821	821	821	
1000	C1632C102(1)(2)RAC	K,M	102	102	102	102	
1200	C1632C122(1)(2)RAC	K,M	122	122	122	122	
1500	C1632C152(1)(2)RAC	K,M	152	152	152	152	
1800	C1632C182(1)(2)RAC	K,M	182	182	182	182	
2200	C1632C222(1)(2)RAC	K,M	222	222	222	222	
2700	C1632C272(1)(2)RAC	K,M	272	272	272	272	
3300	C1632C332(1)(2)RAC	K,M	332	332	332	332	
3900	C1632C392(1)(2)RAC	K,M	392	392	392	392	
4700	C1632C472(1)(2)RAC	K,M	472	472	472	472	
5600	C1632C562(1)(2)RAC	K,M	562	562	562		
6800	C1632C682(1)(2)RAC	K,M	682	682	682		
8200	C1632C822(1)(2)RAC	K,M	822	822	822		
10,000	C1632C103(1)(2)RAC	K,M	103	103	103		
12,000	C1632C123(1)(2)RAC	K,M	123	123	123		
15,000	C1632C153(1)(2)RAC	K,M	153	153	153		
18,000	C1632C183(1)(2)RAC	K,M	183	183	183		
22,000	C1632C223(1)(2)RAC	K,M	223	223	223		
27,000	C1632C273(1)(2)RAC	K,M	273				
33,000	C1632C333(1)(2)RAC	K,M	333				
39,000	C1632C393(1)(2)RAC	K,M	393				
47,000	C1632C473(1)(2)RAC	K,M	473				
56,000	C1632C563(1)(2)RAC	K,M	563				
68,000	C1632C683(1)(2)RAC	K,M	683				
82,000	C1632C823(1)(2)RAC	K,M	823				
100,000	C1632C104(1)(2)RAC	K,M	104				

(1) To complete the KEMET part number, insert the alpha code for the tolerance desired:
K = ±10% and M = ±20% – standard tolerances. Contact factory for any special requirements.
(2) To complete the KEMET part number, insert appropriate number for voltage desired:
"5" = 50 volts, "3" = 25 volts, "4" = 16 volts, and "8" = 10 volts.

1632 CERAMIC ARRAY
LAND PATTERN LAYOUT



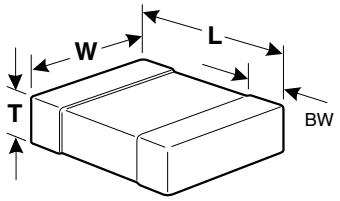
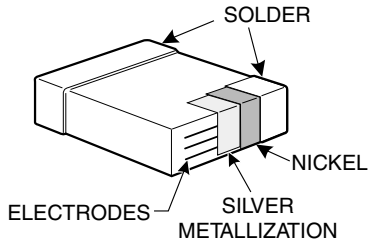
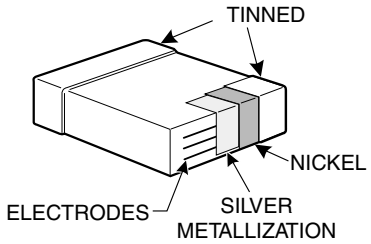
Additional pad dimension information is available in KEMET Technical Bulletin F-2100.

LAND PATTERN DIMENSIONS - CERAMIC CHIP CAPACITOR ARRAYS - MM

	Reflow Solder					
Dimension 3216	Z 2.80	G 0.40	X 0.52	Y(ref) 1.20	C(ref) 1.60	P(ref) 0.80

Calculation Formula
Z = Lmin + 2Jt + Tt
G = Smax - 2Jh -Th
X = Wmin + 2Js + Ts
Tt, Th, Ts = Combined tolerances

CAPACITOR OUTLINE DRAWINGS

CHIP DIMENSIONS	"SOLDERGUARD I" *	"SOLDERGUARD II"
		
	Military Designation - "S" or "U" KEMET Designation - "H"	Military Designation - "W" or "Y" KEMET Designation - "C"

DIMENSIONS—MILLIMETERS AND (INCHES)

STYLE	KEMET SIZE CODE	L	W	T MIN.	T MAX.	BW
CDR01	C0805	2.03 ±.38 (.080 ±.015)	1.27 ±.38 (.050 ±.015)	.56 (.022)	1.40 (.055)	.51 ± 0.25 (.020 ±.010)
CDR02	C1805	4.57 ±.38 (.180 ±.015)	1.27 ±.38 (.050 ±.015)	.56 (.022)	1.40 (.055)	.51 ± 0.25 (.020 ±.010)
CDR03	C1808	4.57 ±.38 (.180 ±.015)	2.03 ±.38 (.080 ±.015)	.56 (.022)	2.03 (.080)	.51 ± 0.25 (.020 ±.010)
CDR04	C1812	4.57 ±.38 (.180 ±.015)	3.18 ±.38 (.125 ±.015)	.56 (.022)	2.03 (.080)	.51 ± 0.25 (.020 ±.010)
CDR05	C1825	$4.57^{+.51}_{-.38}$ (.180 $^{+.020}_{-.015}$)	$6.35^{+.51}_{-.38}$ (.250 $^{+.020}_{-.015}$)	.51 (.020)	2.03 (.080)	.51 ± 0.25 (.020 ±.010)
CDR06	C2225	5.72 ±.51 (.225 ±.020)	6.35 ±.51 (.250 ±.020)	.51 (.020)	2.03 (.080)	.51 ± 0.25 (.020 ±.010)
CDR31	C0805	2.00 ±.20 (.078 ±.008)	1.25 ±.20 (.049 ±.008)		1.30 (.051)	.50 ± 0.20 (.020 ±.008)
CDR32	C1206	3.20 ±.20 (.125 ±.008)	1.60 ±.20 (.062 ±.008)		1.30 (.051)	.50 ± 0.20 (.020 ±.008)
CDR33	C1210	3.20 ±.25 (.125 ±.010)	2.50 ±.25 (.098 ±.010)		1.50 (.059)	.50 ± 0.25 (.020 ±.010)
CDR34	C1812	4.50 ±.25 (.176 ±.010)	3.20 ±.25 (.125 ±.010)		1.50 (.059)	.50 ± 0.25 (.020 ±.010)
CDR35	C1825	4.50 ±.30 (.176 ±.012)	6.40 ±.30 (.250 ±.012)		1.50 (.059)	.50 ± 0.30 (.020 ±.012)

Note: For Solderguard I (MIL-C55681 "S" or "U" Endmets), the length, width and thickness positive tolerances (including bandwidth) cited above are allowed to increase by the following amounts:

	Length	Width/Thickness
CDR01	0.51MM (.020)	0.38MM (.015)
CDR02-06	0.64MM (.025)	0.38MM (.015)
CDR31-35	0.60MM (.023)	0.30MM (.012)

MIL-PRF-55681 PART NUMBER ORDERING INFORMATION

CDR01 B P 101 B K S M

STYLE & SIZE CODE
STYLE
C— Ceramic
D— Dielectric, Fixed Chip
R— Established Reliability

RATED TEMPERATURE
–55°C to +125°C

DIELECTRICS
P—± 30 PPM/°C—WITH OR WITHOUT VOLTAGE
X—± 15%—without voltage
+ 15%, –25%—with voltage

CAPACITANCE
Expressed in picofarads (pF).
First 2 digits represent significant figures and the last digit specifies the number of zeros to follow.
(Use 9 for 1.0 through 9.9pF. Example: 2.2pF = 229)

FAILURE RATE LEVEL (%/1000 hrs.)
M — 1.0 R — 0.01
P — 0.1 S — 0.001

TERMINATION FINISH
S — Solder Coated, Final (SolderGuard I)
U — Base Metalization—Barrier Metal—Solder Coated (SolderGuard I)
W — Base Metalization—Barrier Metal—Tinned Tin or (Tin/Lead Alloy) SolderGuard II
Y — Base Metalization Barrier Metal—Tinned (100% Tin) Solderguard II

CAPACITANCE TOLERANCE

B	C	D	F	J	K	M
±.1 pF	±.25 pF	±.5 pF	±1%	±5%	±10%	±20%

RATED VOLTAGE
A — 50; B — 100

KEMET/MIL-PRF-55681 PART NUMBER EQUIVALENTS

C 0805 P 101 K 1 G M C*

CERAMIC

SIZE CODE
See Table Above

SPECIFICATION
P-MIL-PRF-55681 = CDR01-CDR06
N-MIL-PRF-55681 = CDR31-CDR35

CAPACITANCE CODE
Expressed in picofarads (pF).
First two digits represent significant figures.
Third digit specifies number of zeros. (Use 9 for 1.0 thru 9.9 pF. Example: 2.2 pF –229)

CAPACITANCE TOLERANCE

B	C	D	F	J	K	M
±.1 pF	±.25 pF	±.5 pF	±1%	±5%	±10%	±20%

END METALIZATION
C — SolderGuard II (Military equiv: Y, W)
H — SolderGuard I (Military equiv: S, U)

FAILURE RATE (%/1,000 hrs.)
M — 1.0 R — 0.01
P — 0.1 S — 0.001

VOLTAGE TEMPERATURE CHARACTERISTIC
Designated by Capacitance Change Over Temperature Range
G — BP (C0G/NP0) (±30 PPM/°C)
X — BX (±15% Without Voltage +15% -25% With Voltage)

VOLTAGE
1 — 100V, 5 — 50V

*** Part Number Example: C0805P101K1GMC (14 digits - no spaces)**

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RATINGS & PART NUMBER REFERENCE

CHARACTERISTIC	CAP. pF	AVAIL. TOL.	KEMET CAPACITORS	MIL-PRF-55681 PART NUMBER
100 Volt — C0805 SIZE (MILITARY CDR01)				
BP	10	J,K	C0805P100(3)1G(4)C	CDR01BP100B(3)W(4)
	12	J	C0805P120J1G(4)C	CDR01BP120BJW(4)
	15	J,K	C0805P150(3)1G(4)C	CDR01BP150B(3)W(4)
	18	J	C0805P180J1G(4)C	CDR01BP180BJW(4)
	22	J,K	C0805P220(3)1G(4)C	CDR01BP220B(3)W(4)
	27	J	C0805P270J1G(4)C	CDR01BP270BJW(4)
	33	J,K	C0805P330(3)1G(4)C	CDR01BP330B(3)W(4)
	39	J	C0805P390J1G(4)C	CDR01BP390BJW(4)
	47	J,K	C0805P470(3)1G(4)C	CDR01BP470B(3)W(4)
	56	J	C0805P560J1G(4)C	CDR01BP560BJW(4)
	68	J,K	C0805P680(3)1G(4)C	CDR01BP680B(3)W(4)
	82	J	C0805P820J1G(4)C	CDR01BP820BJW(4)
	100	J,K	C0805P101(3)1G(4)C	CDR01BP101B(3)W(4)
BP or BX	120	J,K	C0805P121(3)1(2)(4)C	CDR01B(1)121B(3)W(4)
	150	J,K	C0805P151(3)1(2)(4)C	CDR01B(1)151B(3)W(4)
	180	J,K	C0805P181(3)1(2)(4)C	CDR01B(1)181B(3)W(4)
BX	220	K,M	C0805P221(3)1X(4)C	CDR01BX221B(3)W(4)
	270	K	C0805P271K1X(4)C	CDR01BX271BKW(4)
	330	K,M	C0805P331(3)1X(4)C	CDR01BX331B(3)W(4)
	390	K	C0805P391K1X(4)C	CDR01BX391BKW(4)
	470	K,M	C0805P471(3)1X(4)C	CDR01BX471B(3)W(4)
	560	K	C0805P561K1X(4)C	CDR01BX561BKW(4)
	680	K,M	C0805P681(3)1X(4)C	CDR01BX681B(3)W(4)
	820	K	C0805P821K1X(4)C	CDR01BX821BKW(4)
	1,000	K,M	C0805P102(3)1X(4)C	CDR01BX102B(3)W(4)
	1,200	K	C0805P122K1X(4)C	CDR01BX122BKW(4)
	1,500	K,M	C0805P152(3)1X(4)C	CDR01BX152B(3)W(4)
	1,800	K	C0805P182K1X(4)C	CDR01BX182BKW(4)
	2,200	K,M	C0805P222(3)1X(4)C	CDR01BX222B(3)W(4)
	2,700	K	C0805P272K1X(4)C	CDR01BX272BKW(4)
	3,300	K,M	C0805P332(3)1X(4)C	CDR01BX332B(3)W(4)
50 Volt — C0805 SIZE (MILITARY CDR01)				
BX	3,900	K	C0805P392K5X(4)C	CDR01BX392AKW(4)
	4,700	K,M	C0805P472(3)5X(4)C	CDR01BX472A(3)W(4)
100 Volt — C1805 SIZE (MILITARY CDR02)				
BP	220	J,K	C1805P221(3)1G(4)C	CDR02BP221B(3)W(4)
	270	J	C1805P271J1G(4)C	CDR02BP271BJW(4)
BX	3,900	K	C1805P392K1X(4)C	CDR02BX392BKW(4)
	4,700	K,M	C1805P472(3)1X(4)C	CDR02BX472B(3)W(4)
	5,600	K	C1805P562K1X(4)C	CDR02BX562BKW(4)
	6,800	K,M	C1805P682(3)1X(4)C	CDR02BX682B(3)W(4)
	8,200	K	C1805P822K1X(4)C	CDR02BX822BKW(4)
	10,000	K,M	C1805P103(3)1X(4)C	CDR02BX103B(3)W(4)
50 Volt — C1805 SIZE (MILITARY CDR02)				
BX	12,000	K	C1805P123K5X(4)C	CDR02BX123AKW(4)
	15,000	K,M	C1805P153(3)5X(4)C	CDR02BX153A(3)W(4)
	18,000	K	C1805P183K5X(4)C	CDR02BX183AKW(4)
	22,000	K,M	C1805P223(3)5X(4)C	CDR02BX223A(3)W(4)
100 Volt — C1808 SIZE (MILITARY CDR03)				
BP	330	J,K	C1808P331(3)1G(4)C	CDR03BP331B(3)W(4)
	390	J	C1808P391J1G(4)C	CDR03BP391BJW(4)
	470	J,K	C1808P471(3)1G(4)C	CDR03BP471B(3)W(4)

CHARACTERISTIC	CAP. pF	AVAIL. TOL.	KEMET CAPACITORS	MIL-PRF-55681 PART NUMBER
100 Volt — C1808 SIZE (MILITARY CDR03) (Cont'd)				
BP	560	J	C1808P561J1G(4)C	CDR03BP561BJW(4)
	680	J,K	C1808P681(3)1G(4)C	CDR03BP681B(3)W(4)
	820	J	C1808P821J1G(4)C	CDR03BP821BJW(4)
	1,000	J,K	C1808P102(3)1G(4)C	CDR03BP102B(3)W(4)
BX	12,000	K	C1808P123K1X(4)C	CDR03BX123BKW(4)
	15,000	K,M	C1808P153(3)1X(4)C	CDR03BX153B(3)W(4)
	18,000	K	C1808P183K1X(4)C	CDR03BX183BKW(4)
	22,000	K,M	C1808P223(3)1X(4)C	CDR03BX223B(3)W(4)
	27,000	K	C1808P273K1X(4)C	CDR03BX273BKW(4)
	33,000	K,M	C1808P333(3)1X(4)C	CDR03BX333B(3)W(4)
50 Volt — C1808 SIZE (MILITARY CDR03)				
BX	39,000	K	C1808P393K5X(4)C	CDR03BX393AKW(4)
	47,000	K,M	C1808P473(3)5X(4)C	CDR03BX473A(3)W(4)
	56,000	K	C1808P563K5X(4)C	CDR03BX563AKW(4)
	68,000	K,M	C1808P683(3)5X(4)C	CDR03BX683A(3)W(4)
100 Volt — C1812 SIZE (MILITARY CDR04)				
BP	1,200	J	C1812P122J1G(4)C	CDR04BP122BJW(4)
	1,500	J,K	C1812P152(3)1G(4)C	CDR04BP152B(3)W(4)
	1,800	J	C1812P182J1G(4)C	CDR04BP182BJW(4)
	2,200	J,K	C1812P222(3)1G(4)C	CDR04BP222B(3)W(4)
	2,700	J	C1812P272J1G(4)C	CDR04BP272BJW(4)
	3,300	J,K	C1812P332(3)1G(4)C	CDR04BP332B(3)W(4)
BX	39,000	K	C1812P393K1X(4)C	CDR04BX393BKW(4)
	47,000	K,M	C1812P473(3)1X(4)C	CDR04BX473B(3)W(4)
	56,000	K	C1812P563K1X(4)C	CDR04BX563BKW(4)
50 Volt — C1812 SIZE (MILITARY CDR04)				
BX	82,000	K	C1812P823K5X(4)C	CDR04BX823AKW(4)
	100,000	K,M	C1812P104(3)5X(4)C	CDR04BX104A(3)W(4)
	120,000	K	C1812P124K5X(4)C	CDR04BX124AKW(4)
	150,000	K,M	C1812P154(3)5X(4)C	CDR04BX154A(3)W(4)
	180,000	K	C1812P184K5X(4)C	CDR04BX184AKW(4)
100 Volt — C1825 SIZE (MILITARY CDR05)				
BP	3,900	J,K	C1825P392(3)1G(4)C	CDR05BP392B(3)W(4)
	4,700	J,K	C1825P472(3)1G(4)C	CDR05BP472B(3)W(4)
	5,600	J,K	C1825P562(3)1G(4)C	CDR05BP562B(3)W(4)
BX	68,000	K,M	C1825P683(3)1X(4)C	CDR05BX683B(3)W(4)
	82,000	K	C1825P823K1X(4)C	CDR05BX823BKW(4)
	100,000	K,M	C1825P104(3)1X(4)C	CDR05BX104B(3)W(4)
	120,000	K	C1825P124K1X(4)C	CDR05BX124BKW(4)
	150,000	K,M	C1825P154(3)1X(4)C	CDR05BX154B(3)W(4)
50 Volt — C1825 SIZE (MILITARY CDR05)				
BX	220,000	K,M	C1825P224(3)5X(4)C	CDR05BX224A(3)W(4)
	270,000	K	C1825P274K5X(4)C	CDR05BX274AKW(4)
	330,000	K,M	C1825P334(3)5X(4)C	CDR05BX334A(3)W(4)
100 Volt — C2225 SIZE (MILITARY CDR06)				
BP	6,800	J,K	C2225P682(3)1G(4)C	CDR06BP682B(3)W(4)
	8,200	J,K	C2225P822(3)1G(4)C	CDR06BP822B(3)W(4)
	10,000	J,K	C2225P103(3)1G(4)C	CDR06BP103B(3)W(4)
50 Volt — C2225 SIZE (MILITARY CDR06)				
BX	390,000	K	C2225P394K5X(4)C	CDR06BX394AKW(4)
	470,000	K,M	C2225P474(3)5X(4)C	CDR06BX474A(3)W(4)

(1) To complete Part Number for Dielectric, insert P or X symbol – as defined by Military specification.
(2) To complete Part Number for Dielectric, insert G or X symbol. ("G" for Military "BP," or "X" for Military "BX.")
(3) To complete Part Number, insert Capacitance Tolerance Symbol (when applicable) as available in MIL-PRF-55681: B – ±0.1 pF, C – ±0.25 pF, D – ±0.5pF, F – ±1%, J – ±5%, K – ±10%, M – ±20%. **NOTE: Available tolerances are listed in columns above.**
(4) To complete Part Number, insert Failure Rate Symbol: M –1.0%; P –0.1%; R –0.01%; S –.001%.

Note: All MIL-PRF-55681 and KEMET Part Numbers tabulated above assume use of Solderguard II (MIL-PRF-55681 "W"; KEMET "C") end metalization. If MIL-PRF-55681 "U" or "S" (KEMET "H") or MIL-PRF-55681 "Y" (KEMET "C") is required, please change designators accordingly.

RATINGS & PART NUMBER REFERENCE

CAP. pF	AVAIL. TOL.	KEMET CAPACITORS	MIL-PRF-55681 PART NUMBER
100 Volt — BP — C0805 SIZE (MILITARY CDR31)			
1.0	B,C	C0805N109(3)1G(4)C	CDR31BP1R0B(3)W(4)
1.1	B,C	C0805N119(3)1G(4)C	CDR31BP1R1B(3)W(4)
1.2	B,C	C0805N129(3)1G(4)C	CDR31BP1R2B(3)W(4)
1.3	B,C	C0805N139(3)1G(4)C	CDR31BP1R3B(3)W(4)
1.5	B,C	C0805N159(3)1G(4)C	CDR31BP1R5B(3)W(4)
1.6	B,C	C0805N169(3)1G(4)C	CDR31BP1R6B(3)W(4)
1.8	B,C	C0805N189(3)1G(4)C	CDR31BP1R8B(3)W(4)
2.0	B,C	C0805N209(3)1G(4)C	CDR31BP2R0B(3)W(4)
2.2	B,C	C0805N229(3)1G(4)C	CDR31BP2R2B(3)W(4)
2.4	B,C	C0805N249(3)1G(4)C	CDR31BP2R4B(3)W(4)
2.7	B,C,D	C0805N279(3)1G(4)C	CDR31BP2R7B(3)W(4)
3.0	B,C,D	C0805N309(3)1G(4)C	CDR31BP3R0B(3)W(4)
3.3	B,C,D	C0805N339(3)1G(4)C	CDR31BP3R3B(3)W(4)
3.6	B,C,D	C0805N369(3)1G(4)C	CDR31BP3R6B(3)W(4)
3.9	B,C,D	C0805N399(3)1G(4)C	CDR31BP3R9B(3)W(4)
4.3	B,C,D	C0805N439(3)1G(4)C	CDR31BP4R3B(3)W(4)
4.7	B,C,D	C0805N479(3)1G(4)C	CDR31BP4R7B(3)W(4)
5.1	B,C,D	C0805N519(3)1G(4)C	CDR31BP5R1B(3)W(4)
5.6	B,C,D	C0805N569(3)1G(4)C	CDR31BP5R6B(3)W(4)
6.2	B,C,D	C0805N629(3)1G(4)C	CDR31BP6R2B(3)W(4)
6.8	B,C,D	C0805N689(3)1G(4)C	CDR31BP6R8B(3)W(4)
7.5	B,C,D	C0805N759(3)1G(4)C	CDR31BP7R5B(3)W(4)
8.2	B,C,D	C0805N829(3)1G(4)C	CDR31BP8R2B(3)W(4)
9.1	B,C,D	C0805N919(3)1G(4)C	CDR31BP9R1B(3)W(4)
10	F,J,K	C0805N100(3)1G(4)C	CDR31BP100B(3)W(4)
11	F,J,K	C0805N110(3)1G(4)C	CDR31BP110B(3)W(4)
12	F,J,K	C0805N120(3)1G(4)C	CDR31BP120B(3)W(4)
13	F,J,K	C0805N130(3)1G(4)C	CDR31BP130B(3)W(4)
15	F,J,K	C0805N150(3)1G(4)C	CDR31BP150B(3)W(4)
16	F,J,K	C0805N160(3)1G(4)C	CDR31BP160B(3)W(4)
18	F,J,K	C0805N180(3)1G(4)C	CDR31BP180B(3)W(4)
20	F,J,K	C0805N200(3)1G(4)C	CDR31BP200B(3)W(4)
22	F,J,K	C0805N220(3)1G(4)C	CDR31BP220B(3)W(4)
24	F,J,K	C0805N240(3)1G(4)C	CDR31BP240B(3)W(4)
27	F,J,K	C0805N270(3)1G(4)C	CDR31BP270B(3)W(4)
30	F,J,K	C0805N300(3)1G(4)C	CDR31BP300B(3)W(4)
33	F,J,K	C0805N330(3)1G(4)C	CDR31BP330B(3)W(4)
36	F,J,K	C0805N360(3)1G(4)C	CDR31BP360B(3)W(4)
39	F,J,K	C0805N390(3)1G(4)C	CDR31BP390B(3)W(4)
43	F,J,K	C0805N430(3)1G(4)C	CDR31BP430B(3)W(4)
47	F,J,K	C0805N470(3)1G(4)C	CDR31BP470B(3)W(4)
51	F,J,K	C0805N510(3)1G(4)C	CDR31BP510B(3)W(4)
56	F,J,K	C0805N560(3)1G(4)C	CDR31BP560B(3)W(4)
62	F,J,K	C0805N620(3)1G(4)C	CDR31BP620B(3)W(4)
68	F,J,K	C0805N680(3)1G(4)C	CDR31BP680B(3)W(4)
75	F,J,K	C0805N750(3)1G(4)C	CDR31BP750B(3)W(4)
82	F,J,K	C0805N820(3)1G(4)C	CDR31BP820B(3)W(4)

CAP. pF	AVAIL. TOL.	KEMET CAPACITORS	MIL-PRF-55681 PART NUMBER
100 Volt — BP — C0805 SIZE (MILITARY CDR31)			
91	F,J,K	C0805N910(3)1G(4)C	CDR31BP910B(3)W(4)
100	F,J,K	C0805N101(3)1G(4)C	CDR31BP101B(3)W(4)
110	F,J,K	C0805N111(3)1G(4)C	CDR31BP111B(3)W(4)
120	F,J,K	C0805N121(3)1G(4)C	CDR31BP121B(3)W(4)
130	F,J,K	C0805N131(3)1G(4)C	CDR31BP131B(3)W(4)
150	F,J,K	C0805N151(3)1G(4)C	CDR31BP151B(3)W(4)
160	F,J,K	C0805N161(3)1G(4)C	CDR31BP161B(3)W(4)
180	F,J,K	C0805N181(3)1G(4)C	CDR31BP181B(3)W(4)
200	F,J,K	C0805N201(3)1G(4)C	CDR31BP201B(3)W(4)
220	F,J,K	C0805N221(3)1G(4)C	CDR31BP221B(3)W(4)
240	F,J,K	C0805N241(3)1G(4)C	CDR31BP241B(3)W(4)
270	F,J,K	C0805N271(3)1G(4)C	CDR31BP271B(3)W(4)
300	F,J,K	C0805N301(3)1G(4)C	CDR31BP301B(3)W(4)
330	F,J,K	C0805N331(3)1G(4)C	CDR31BP331B(3)W(4)
360	F,J,K	C0805N361(3)1G(4)C	CDR31BP361B(3)W(4)
390	F,J,K	C0805N391(3)1G(4)C	CDR31BP391B(3)W(4)
430	F,J,K	C0805N431(3)1G(4)C	CDR31BP431B(3)W(4)
470	F,J,K	C0805N471(3)1G(4)C	CDR31BP471B(3)W(4)
50 Volt — BP — C0805 SIZE (MILITARY CDR31)			
510	F,J,K	C0805N511(3)5G(4)C	CDR31BP511A(3)W(4)
560	F,J,K	C0805N561(3)5G(4)C	CDR31BP561A(3)W(4)
620	F,J,K	C0805N621(3)5G(4)C	CDR31BP621A(3)W(4)
680	F,J,K	C0805N681(3)5G(4)C	CDR31BP681A(3)W(4)
100 Volt — BX — C0805 SIZE (MILITARY CDR31)			
470	K,M	C0805N471(3)1X(4)C	CDR31BX471B(3)W(4)
560	K,M	C0805N561(3)1X(4)C	CDR31BX561B(3)W(4)
680	K,M	C0805N681(3)1X(4)C	CDR31BX681B(3)W(4)
820	K,M	C0805N821(3)1X(4)C	CDR31BX821B(3)W(4)
1,000	K,M	C0805N102(3)1X(4)C	CDR31BX102B(3)W(4)
1,200	K,M	C0805N122(3)1X(4)C	CDR31BX122B(3)W(4)
1,500	K,M	C0805N152(3)1X(4)C	CDR31BX152B(3)W(4)
1,800	K,M	C0805N182(3)1X(4)C	CDR31BX182B(3)W(4)
2,200	K,M	C0805N222(3)1X(4)C	CDR31BX222B(3)W(4)
2,700	K,M	C0805N272(3)1X(4)C	CDR31BX272B(3)W(4)
3,300	K,M	C0805N332(3)1X(4)C	CDR31BX332B(3)W(4)
3,900	K,M	C0805N392(3)1X(4)C	CDR31BX392B(3)W(4)
4,700	K,M	C0805N472(3)1X(4)C	CDR31BX472B(3)W(4)
50 Volt — BX — C0805 SIZE (MILITARY CDR31)			
5,600	K,M	C0805N562(3)5X(4)C	CDR31BX562A(3)W(4)
6,800	K,M	C0805N682(3)5X(4)C	CDR31BX682A(3)W(4)
8,200	K,M	C0805N822(3)5X(4)C	CDR31BX822A(3)W(4)
10,000	K,M	C0805N103(3)5X(4)C	CDR31BX103A(3)W(4)
12,000	K,M	C0805N123(3)5X(4)C	CDR31BX123A(3)W(4)
15,000	K,M	C0805N153(3)5X(4)C	CDR31BX153A(3)W(4)
18,000	K,M	C0805N183(3)5X(4)C	CDR31BX183A(3)W(4)

(1) To complete Part Number for Dielectric, insert P or X symbol – as defined by Military specification.
(2) To complete Part Number for Dielectric, insert G or X symbol. ("G" for Military "BP," or "X" for Military "BX.")
(3) To complete Part Number, insert Capacitance Tolerance Symbol (when applicable) as available in MIL-PRF-55681: B – ±0.1 pF, C – ±0.25 pF. D – ±0.5pF, F – ±1%, J – ±5%, K – ±10%, M – ±20%. **NOTE: Available tolerances are listed in columns above.**
(4) To complete Part Number, insert Failure Rate Symbol: M –1.0%; P –0.1%; R –0.01%; S –.001%.

Note: All MIL-PRF-55681 and KEMET Part Numbers tabulated above assume use of Solderguard II (MIL-PRF-55681 "W"; KEMET "C") end metalization. If MIL-PRF-55681 "U" or "S" (KEMET "H") or MIL-PRF-55681 "Y" (KEMET "C") is required, please change designators accordingly.

MARKING

See page 90 for MIL-PRF-55681 Marking

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RATINGS & PART NUMBER REFERENCE

CAP. pF	AVAIL. TOL.	KEMET CAPACITORS	MIL-PRF-55681 PART NUMBER
100 Volt — BP — C1206 SIZE (MILITARY CDR32)			
1.0	B,C	C1206N109(3)1G(4)C	CDR32BP1R0B(3)W(4)
1.1	B,C	C1206N119(3)1G(4)C	CDR32BP1R1B(3)W(4)
1.2	B,C	C1206N129(3)1G(4)C	CDR32BP1R2B(3)W(4)
1.3	B,C	C1206N139(3)1G(4)C	CDR32BP1R3B(3)W(4)
1.5	B,C	C1206N159(3)1G(4)C	CDR32BP1R5B(3)W(4)
1.6	B,C	C1206N169(3)1G(4)C	CDR32BP1R6B(3)W(4)
1.8	B,C	C1206N189(3)1G(4)C	CDR32BP1R8B(3)W(4)
2.0	B,C	C1206N209(3)1G(4)C	CDR32BP2R0B(3)W(4)
2.2	B,C	C1206N229(3)1G(4)C	CDR32BP2R2B(3)W(4)
2.4	B,C	C1206N249(3)1G(4)C	CDR32BP2R4B(3)W(4)
2.7	B,C,D	C1206N279(3)1G(4)C	CDR32BP2R7B(3)W(4)
3.0	B,C,D	C1206N309(3)1G(4)C	CDR32BP3R0B(3)W(4)
3.3	B,C,D	C1206N339(3)1G(4)C	CDR32BP3R3B(3)W(4)
3.6	B,C,D	C1206N369(3)1G(4)C	CDR32BP3R6B(3)W(4)
3.9	B,C,D	C1206N399(3)1G(4)C	CDR32BP3R9B(3)W(4)
4.3	B,C,D	C1206N439(3)1G(4)C	CDR32BP4R3B(3)W(4)
4.7	B,C,D	C1206N479(3)1G(4)C	CDR32BP4R7B(3)W(4)
5.1	B,C,D	C1206N519(3)1G(4)C	CDR32BP5R1B(3)W(4)
5.6	B,C,D	C1206N569(3)1G(4)C	CDR32BP5R6B(3)W(4)
6.2	B,C,D	C1206N629(3)1G(4)C	CDR32BP6R2B(3)W(4)
6.8	B,C,D	C1206N689(3)1G(4)C	CDR32BP6R8B(3)W(4)
7.5	B,C,D	C1206N759(3)1G(4)C	CDR32BP7R5B(3)W(4)
8.2	B,C,D	C1206N829(3)1G(4)C	CDR32BP8R2B(3)W(4)
9.1	B,C,D	C1206N919(3)1G(4)C	CDR32BP9R1B(3)W(4)
10	F,J,K	C1206N100(3)1G(4)C	CDR32BP100B(3)W(4)
11	F,J,K	C1206N110(3)1G(4)C	CDR32BP110B(3)W(4)
12	F,J,K	C1206N120(3)1G(4)C	CDR32BP120B(3)W(4)
13	F,J,K	C1206N130(3)1G(4)C	CDR32BP130B(3)W(4)
15	F,J,K	C1206N150(3)1G(4)C	CDR32BP150B(3)W(4)
16	F,J,K	C1206N160(3)1G(4)C	CDR32BP160B(3)W(4)
18	F,J,K	C1206N180(3)1G(4)C	CDR32BP180B(3)W(4)
20	F,J,K	C1206N200(3)1G(4)C	CDR32BP200B(3)W(4)
22	F,J,K	C1206N220(3)1G(4)C	CDR32BP220B(3)W(4)
24	F,J,K	C1206N240(3)1G(4)C	CDR32BP240B(3)W(4)
27	F,J,K	C1206N270(3)1G(4)C	CDR32BP270B(3)W(4)
30	F,J,K	C1206N300(3)1G(4)C	CDR32BP300B(3)W(4)
33	F,J,K	C1206N330(3)1G(4)C	CDR32BP330B(3)W(4)
36	F,J,K	C1206N360(3)1G(4)C	CDR32BP360B(3)W(4)
39	F,J,K	C1206N390(3)1G(4)C	CDR32BP390B(3)W(4)
43	F,J,K	C1206N430(3)1G(4)C	CDR32BP430B(3)W(4)
47	F,J,K	C1206N470(3)1G(4)C	CDR32BP470B(3)W(4)
51	F,J,K	C1206N510(3)1G(4)C	CDR32BP510B(3)W(4)
56	F,J,K	C1206N560(3)1G(4)C	CDR32BP560B(3)W(4)
62	F,J,K	C1206N620(3)1G(4)C	CDR32BP620B(3)W(4)
68	F,J,K	C1206N680(3)1G(4)C	CDR32BP680B(3)W(4)
75	F,J,K	C1206N750(3)1G(4)C	CDR32BP750B(3)W(4)
82	F,J,K	C1206N820(3)1G(4)C	CDR32BP820B(3)W(4)
91	F,J,K	C1206N910(3)1G(4)C	CDR32BP910B(3)W(4)
100	F,J,K	C1206N101(3)1G(4)C	CDR32BP101B(3)W(4)

CAP. pF	AVAIL. TOL.	KEMET CAPACITORS	MIL-PRF-55681 PART NUMBER
100 Volt — BP — C1206 SIZE (MILITARY CDR32)			
110	F,J,K	C1206N111(3)1G(4)C	CDR32BP111B(3)W(4)
120	F,J,K	C1206N121(3)1G(4)C	CDR32BP121B(3)W(4)
130	F,J,K	C1206N131(3)1G(4)C	CDR32BP131B(3)W(4)
150	F,J,K	C1206N151(3)1G(4)C	CDR32BP151B(3)W(4)
160	F,J,K	C1206N161(3)1G(4)C	CDR32BP161B(3)W(4)
180	F,J,K	C1206N181(3)1G(4)C	CDR32BP181B(3)W(4)
200	F,J,K	C1206N201(3)1G(4)C	CDR32BP201B(3)W(4)
220	F,J,K	C1206N221(3)1G(4)C	CDR32BP221B(3)W(4)
240	F,J,K	C1206N241(3)1G(4)C	CDR32BP241B(3)W(4)
270	F,J,K	C1206N271(3)1G(4)C	CDR32BP271B(3)W(4)
300	F,J,K	C1206N301(3)1G(4)C	CDR32BP301B(3)W(4)
330	F,J,K	C1206N331(3)1G(4)C	CDR32BP331B(3)W(4)
360	F,J,K	C1206N361(3)1G(4)C	CDR32BP361B(3)W(4)
390	F,J,K	C1206N391(3)1G(4)C	CDR32BP391B(3)W(4)
430	F,J,K	C1206N431(3)1G(4)C	CDR32BP431B(3)W(4)
470	F,J,K	C1206N471(3)1G(4)C	CDR32BP471B(3)W(4)
510	F,J,K	C1206N511(3)1G(4)C	CDR32BP511B(3)W(4)
560	F,J,K	C1206N561(3)1G(4)C	CDR32BP561B(3)W(4)
620	F,J,K	C1206N621(3)1G(4)C	CDR32BP621B(3)W(4)
680	F,J,K	C1206N681(3)1G(4)C	CDR32BP681B(3)W(4)
750	F,J,K	C1206N751(3)1G(4)C	CDR32BP751B(3)W(4)
820	F,J,K	C1206N821(3)1G(4)C	CDR32BP821B(3)W(4)
910	F,J,K	C1206N911(3)1G(4)C	CDR32BP911B(3)W(4)
1,000	F,J,K	C1206N102(3)1G(4)C	CDR32BP102B(3)W(4)
50 Volt — BP — C1206 SIZE (MILITARY CDR32)			
1,100	F,J,K	C1206N112(3)5G(4)C	CDR32BP112A(3)W(4)
1,200	F,J,K	C1206N122(3)5G(4)C	CDR32BP122A(3)W(4)
1,300	F,J,K	C1206N132(3)5G(4)C	CDR32BP132A(3)W(4)
1,500	F,J,K	C1206N152(3)5G(4)C	CDR32BP152A(3)W(4)
1,600	F,J,K	C1206N162(3)5G(4)C	CDR32BP162A(3)W(4)
1,800	F,J,K	C1206N182(3)5G(4)C	CDR32BP182A(3)W(4)
2,000	F,J,K	C1206N202(3)5G(4)C	CDR32BP202A(3)W(4)
2,200	F,J,K	C1206N222(3)5G(4)C	CDR32BP222A(3)W(4)
100 Volt — BX — C1206 SIZE (MILITARY CDR32)			
4,700	K,M	C1206N472(3)1X(4)C	CDR32BX472B(3)W(4)
5,600	K,M	C1206N562(3)1X(4)C	CDR32BX562B(3)W(4)
6,800	K,M	C1206N682(3)1X(4)C	CDR32BX682B(3)W(4)
8,200	K,M	C1206N822(3)1X(4)C	CDR32BX822B(3)W(4)
10,000	K,M	C1206N103(3)1X(4)C	CDR32BX103B(3)W(4)
12,000	K,M	C1206N123(3)1X(4)C	CDR32BX123B(3)W(4)
15,000	K,M	C1206N153(3)1X(4)C	CDR32BX153B(3)W(4)
50 Volt — BX — C1206 SIZE (MILITARY CDR32)			
18,000	K,M	C1206N183(3)5X(4)C	CDR32BX183A(3)W(4)
22,000	K,M	C1206N223(3)5X(4)C	CDR32BX223A(3)W(4)
27,000	K,M	C1206N273(3)5X(4)C	CDR32BX273A(3)W(4)
33,000	K,M	C1206N333(3)5X(4)C	CDR32BX333A(3)W(4)
39,000	K,M	C1206N393(3)5X(4)C	CDR32BX393A(3)W(4)

(1) To complete Part Number for Dielectric, insert P or X symbol – as defined by Military specification.
(2) To complete Part Number for Dielectric, insert G or X symbol. ("G" for Military "BP," or "X" for Military "BX.")
(3) To complete Part Number, insert Capacitance Tolerance Symbol (when applicable) as available in MIL-PRF-55681: B – ±0.1 pF, C – ±0.25 pF. D – ±0.5pF, F – ±1%, J – ±5%, K – ±10%, M – ±20%. **NOTE: Available tolerances are listed in columns above.**
(4) To complete Part Number, insert Failure Rate Symbol: M –1.0%; P –0.1%; R –0.01%; S –.001%.

Note: All MIL-PRF-55681 and KEMET Part Numbers tabulated above assume use of Solderguard II (MIL-PRF-55681 "W"; KEMET "C") end metalization. If MIL-PRF-55681 "U" or "S" (KEMET "H") or MIL-PRF-55681 "Y" (KEMET "C") is required, please change designators accordingly.

RATINGS & PART NUMBER REFERENCE

CAP. pF	AVAIL. TOL.	KEMET CAPACITORS	MIL-PRF-55681 PART NUMBER
100 Volt — BP — C1210 SIZE (MILITARY CDR33)			
1,000	F,J,K	C1210N102(3)1G(4)C	CDR33BP102B(3)W(4)
1,100	F,J,K	C1210N112(3)1G(4)C	CDR33BP112B(3)W(4)
1,200	F,J,K	C1210N122(3)1G(4)C	CDR33BP122B(3)W(4)
1,300	F,J,K	C1210N132(3)1G(4)C	CDR33BP132B(3)W(4)
1,500	F,J,K	C1210N152(3)1G(4)C	CDR33BP152B(3)W(4)
1,600	F,J,K	C1210N162(3)1G(4)C	CDR33BP162B(3)W(4)
1,800	F,J,K	C1210N182(3)1G(4)C	CDR33BP182B(3)W(4)
2,000	F,J,K	C1210N202(3)1G(4)C	CDR33BP202B(3)W(4)
2,200	F,J,K	C1210N222(3)1G(4)C	CDR33BP222B(3)W(4)
50 Volt — BP — C1210 SIZE (MILITARY CDR33)			
2,400	F,J,K	C1210N242(3)5G(4)C	CDR33BP242A(3)W(4)
2,700	F,J,K	C1210N272(3)5G(4)C	CDR33BP272A(3)W(4)
3,000	F,J,K	C1210N302(3)5G(4)C	CDR33BP302A(3)W(4)
3,300	F,J,K	C1210N332(3)5G(4)C	CDR33BP332A(3)W(4)
100 Volt — BX — C1210 SIZE (MILITARY CDR33)			
15,000	K,M	C1210N153(3)1X(4)C	CDR33BX153B(3)W(4)
18,000	K,M	C1210N183(3)1X(4)C	CDR33BX183B(3)W(4)
22,000	K,M	C1210N223(3)1X(4)C	CDR33BX223B(3)W(4)
27,000	K,M	C1210N273(3)1X(4)C	CDR33BX273B(3)W(4)
50 Volt — BX — C1210 SIZE (MILITARY CDR33)			
39,000	K,M	C1210N393(3)5X(4)C	CDR33BX393A(3)W(4)
47,000	K,M	C1210N473(3)5X(4)C	CDR33BX473A(3)W(4)
56,000	K,M	C1210N563(3)5X(4)C	CDR33BX563A(3)W(4)
68,000	K,M	C1210N683(3)5X(4)C	CDR33BX683A(3)W(4)
82,000	K,M	C1210N823(3)5X(4)C	CDR33BX823A(3)W(4)
100,000	K,M	C1210N104(3)5X(4)C	CDR33BX104A(3)W(4)
100 Volt — BP — C1812 SIZE (MILITARY CDR34)			
2,200	F,J,K	C1812N222(3)1G(4)C	CDR34BP222B(3)W(4)
2,400	F,J,K	C1812N242(3)1G(4)C	CDR34BP242B(3)W(4)
2,700	F,J,K	C1812N272(3)1G(4)C	CDR34BP272B(3)W(4)
3,000	F,J,K	C1812N302(3)1G(4)C	CDR34BP302B(3)W(4)
3,300	F,J,K	C1812N332(3)1G(4)C	CDR34BP332B(3)W(4)
3,600	F,J,K	C1812N362(3)1G(4)C	CDR34BP362B(3)W(4)
3,900	F,J,K	C1812N392(3)1G(4)C	CDR34BP392B(3)W(4)
4,300	F,J,K	C1812N432(3)1G(4)C	CDR34BP432B(3)W(4)
4,700	F,J,K	C1812N472(3)1G(4)C	CDR34BP472B(3)W(4)
50 Volt — BP — C1812 SIZE (MILITARY CDR34)			
5,100	F,J,K	C1812N512(3)5G(4)C	CDR34BP512A(3)W(4)
5,600	F,J,K	C1812N562(3)5G(4)C	CDR34BP562A(3)W(4)
6,200	F,J,K	C1812N622(3)5G(4)C	CDR34BP622A(3)W(4)
6,800	F,J,K	C1812N682(3)5G(4)C	CDR34BP682A(3)W(4)
7,500	F,J,K	C1812N752(3)5G(4)C	CDR34BP752A(3)W(4)
8,200	F,J,K	C1812N822(3)5G(4)C	CDR34BP822A(3)W(4)
9,100	F,J,K	C1812N912(3)5G(4)C	CDR34BP912A(3)W(4)
10,000	F,J,K	C1812N103(3)5G(4)C	CDR34BP103A(3)W(4)

CAP. pF	AVAIL. TOL.	KEMET CAPACITORS	MIL-PRF-55681 PART NUMBER
100 Volt — BX — C1812 SIZE (MILITARY CDR34)			
27,000	K,M	C1812N273(3)1X(4)C	CDR34BX273B(3)W(4)
33,000	K,M	C1812N333(3)1X(4)C	CDR34BX333B(3)W(4)
39,000	K,M	C1812N393(3)1X(4)C	CDR34BX393B(3)W(4)
47,000	K,M	C1812N473(3)1X(4)C	CDR34BX473B(3)W(4)
56,000	K,M	C1812N563(3)1X(4)C	CDR34BX563B(3)W(4)
50 Volt — BX — C1812 SIZE (MILITARY CDR34)			
100,000	K,M	C1812N104(3)5X(4)C	CDR34BX104A(3)W(4)
120,000	K,M	C1812N124(3)5X(4)C	CDR34BX124A(3)W(4)
150,000	K,M	C1812N154(3)5X(4)C	CDR34BX154A(3)W(4)
180,000	K,M	C1812N184(3)5X(4)C	CDR34BX184A(3)W(4)
100 Volt — BP — C1825 SIZE (MILITARY CDR35)			
4,700	F,J,K	C1825N472(3)1G(4)C	CDR35BP472B(3)W(4)
5,100	F,J,K	C1825N512(3)1G(4)C	CDR35BP512B(3)W(4)
5,600	F,J,K	C1825N562(3)1G(4)C	CDR35BP562B(3)W(4)
6,200	F,J,K	C1825N622(3)1G(4)C	CDR35BP622B(3)W(4)
6,800	F,J,K	C1825N682(3)1G(4)C	CDR35BP682B(3)W(4)
7,500	F,J,K	C1825N752(3)1G(4)C	CDR35BP752B(3)W(4)
8,200	F,J,K	C1825N822(3)1G(4)C	CDR35BP822B(3)W(4)
9,100	F,J,K	C1825N912(3)1G(4)C	CDR35BP912B(3)W(4)
10,000	F,J,K	C1825N103(3)1G(4)C	CDR35BP103B(3)W(4)
50 Volt — BP — C1825 SIZE (MILITARY CDR35)			
11,000	F,J,K	C1825N113(3)5G(4)C	CDR35BP113A(3)W(4)
12,000	F,J,K	C1825N123(3)5G(4)C	CDR35BP123A(3)W(4)
13,000	F,J,K	C1825N133(3)5G(4)C	CDR35BP133A(3)W(4)
15,000	F,J,K	C1825N153(3)5G(4)C	CDR35BP153A(3)W(4)
16,000	F,J,K	C1825N163(3)5G(4)C	CDR35BP163A(3)W(4)
18,000	F,J,K	C1825N183(3)5G(4)C	CDR35BP183A(3)W(4)
20,000	F,J,K	C1825N203(3)5G(4)C	CDR35BP203A(3)W(4)
22,000	F,J,K	C1825N223(3)5G(4)C	CDR35BP223A(3)W(4)
100 Volt — BX — C1825 SIZE (MILITARY CDR35)			
56,000	K,M	C1825N563(3)1X(4)C	CDR35BX563B(3)W(4)
68,000	K,M	C1825N683(3)1X(4)C	CDR35BX683B(3)W(4)
82,000	K,M	C1825N823(3)1X(4)C	CDR35BX823B(3)W(4)
100,000	K,M	C1825N104(3)1X(4)C	CDR35BX104B(3)W(4)
120,000	K,M	C1825N124(3)1X(4)C	CDR35BX124B(3)W(4)
150,000	K,M	C1825N154(3)1X(4)C	CDR35BX154B(3)W(4)
50 Volt — BX — C1825 SIZE (MILITARY CDR35)			
180,000	K,M	C1825N184(3)5X(4)C	CDR35BX184A(3)W(4)
220,000	K,M	C1825N224(3)5X(4)C	CDR35BX224A(3)W(4)
270,000	K,M	C1825N274(3)5X(4)C	CDR35BX274A(3)W(4)
330,000	K,M	C1825N334(3)5X(4)C	CDR35BX334A(3)W(4)
390,000	K,M	C1825N394(3)5X(4)C	CDR35BX394A(3)W(4)
470,000	K,M	C1825N474(3)5X(4)C	CDR35BX474A(3)W(4)

(1) To complete Part Number for Dielectric, insert P or X symbol – as defined by Military specification.
(2) To complete Part Number for Dielectric, insert G or X symbol. ("G" for Military "BP," or "X" for Military "BX.")
(3) To complete Part Number, insert Capacitance Tolerance Symbol (when applicable) as available in MIL-PRF-55681: B – ±0.1 pF, C – ±0.25 pF, D – ±0.5pF, F – ±1%, J – ±5%, K – ±10%, M – ±20%. **NOTE: Available tolerances are listed in columns above.**
(4) To complete Part Number, insert Failure Rate Symbol: M –1.0%; P –0.1%; R –0.01%; S –.001%.

Note: All MIL-PRF-55681 and KEMET Part Numbers tabulated above assume use of Solderguard II (MIL-PRF-55681 "W"; KEMET "C") end metalization. If MIL-PRF-55681 "U" or "S" (KEMET "H") or MIL-PRF-55681 "Y" (KEMET "C") is required, please change designators accordingly.

MIL-PRF-55681 MAXIMUM INDIVIDUAL PACKAGING QUANTITIES

CHIP SIZE	REELED	BULK - STD BAG	BULK - ANTI-STATIC BAG	CHIP SIZE	REELED	BULK - STD BAG	BULK - ANTI-STATIC BAG
C0805	2,500	25,000	10,000	C1808	2,500	7,500	3,000
C1206	2,500	25,000	10,000	C1812	1,100	7,500	3,000
C1210	2,500	25,000	10,000	C1825	1,100	7,500	1,000
C1805	2,500	7,500	3,000	C2225	1,100	5,000	1,000

MIL-PRF-55681 chips available in 7" reels only.

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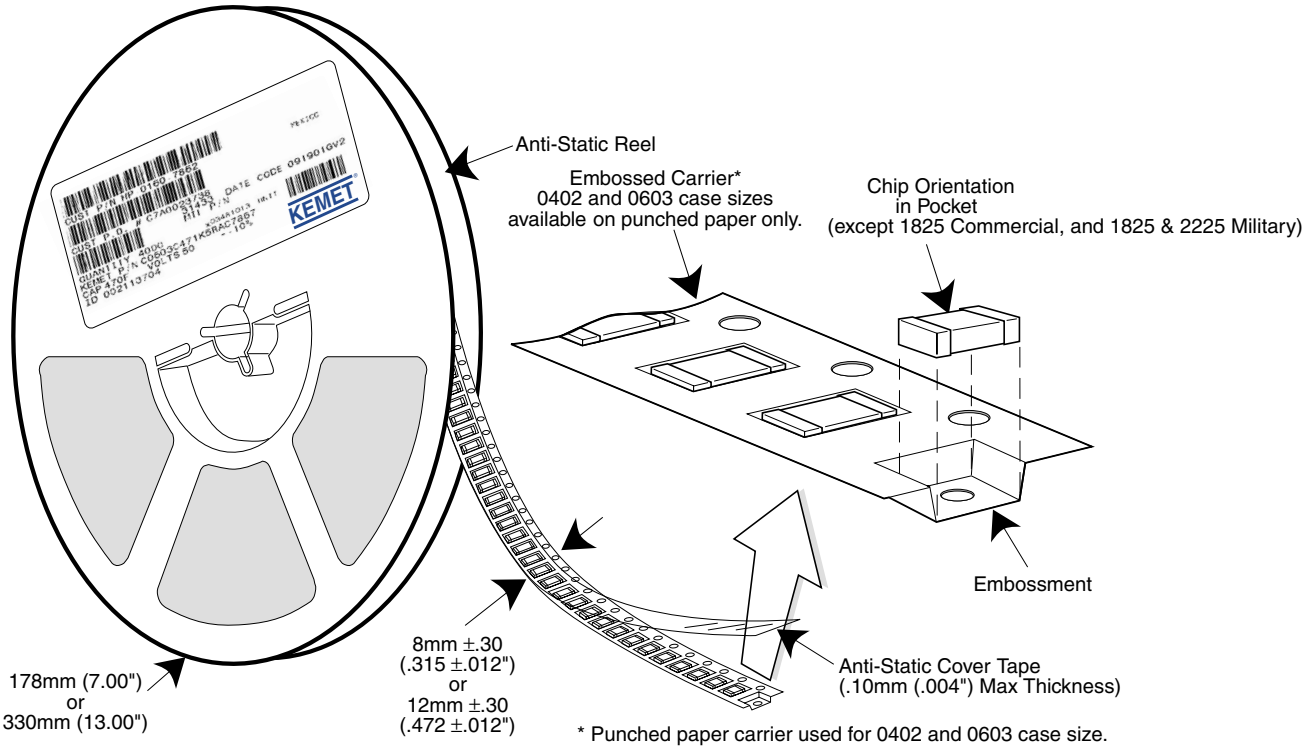
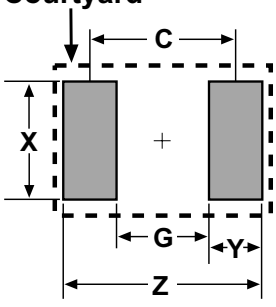
Tape & Reel Packaging

KEMET offers Multilayer Ceramic Chip Capacitors packaged in 8mm and 12mm plastic tape on 7" and 13" reels in accordance with EIA standard 481-1: Taping of surface mount components for automatic handling. This packaging system is compatible with all tape fed automatic pick and place systems. See page 777 for details on reeling quantities for commercial chips and page 90 for MIL-PRF-55681 chips.



SURFACE MOUNT LAND DIMENSIONS - CERAMIC CHIP CAPACITORS - MM

Grid Placement Courtyard



	Reflow Solder					Wave Solder				
Dimension	**Z**	**G**	**X**	**Y(ref)**	**C(ref)**	**Z**	**G**	**X**	**Y(ref)**	**Smin**
0402	2.14	0.28	0.74	0.93	1.21	Not Recommended				
0603	2.78	0.68	1.08	1.05	1.73	3.18	0.68	0.80	1.25	1.93
0805	3.30	0.70	1.60	1.30	2.00	3.70	0.70	1.10	1.50	2.20
1206	4.50	1.50	2.00	1.50	3.00	4.90	1.50	1.40	1.70	3.20
1210	4.50	1.50	2.90	1.50	3.00	4.90	1.50	2.00	1.70	3.20
1812	5.90	2.30	3.70	1.80	4.10	Not Recommended				
1825	5.90	2.30	6.90	1.80	4.10					
2220	7.00	3.30	5.50	1.85	5.15					
2225	7.00	3.30	6.80	1.85	5.15					

Calculation Formula
Z = Lmin + 2Jt + Tt
G = Smax - 2Jh -Th
X = Wmin + 2Js + Ts
Tt, Th, Ts = Combined tolerances

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Performance Notes

1. **Cover Tape Break Force:** 1.0 Kg Minimum.
2. **Cover Tape Peel Strength:** The total peel strength of the cover tape from the carrier tape shall be:

Tape Width	Peel Strength
8 mm	0.1 Newton to 1.0 Newton (10g to 100g)
12 mm	0.1 Newton to 1.3 Newton (10g to 130g)

   The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ±10 mm/minute.
3. **Reel Sizes:** Molded tantalum capacitors are available on either 180 mm (7") reels (standard) or 330 mm (13") reels (with C-7280). Note that 13" reels are preferred.
4. **Labeling:** Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. Refer to EIA-556.

Embossed Carrier Tape Configuration: Figure 1

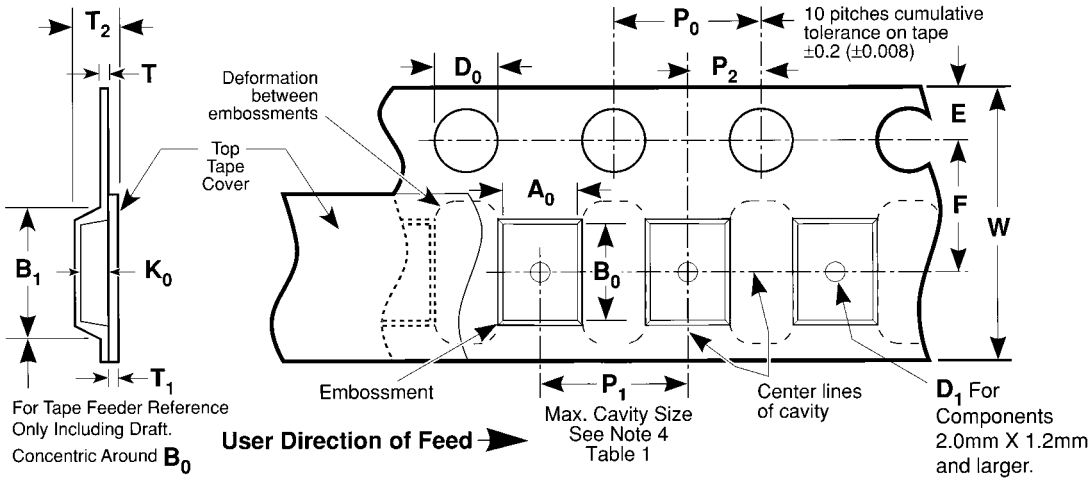


Table 1 — EMBOSSED TAPE DIMENSIONS (Metric will govern)

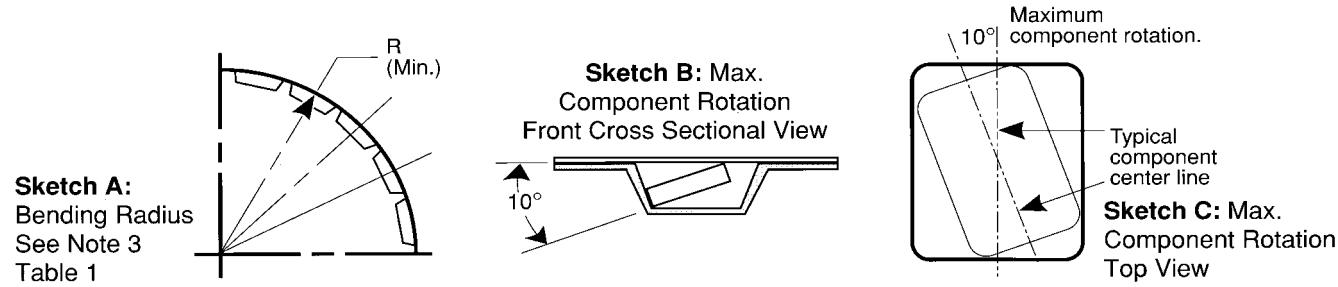
Constant Dimensions — Millimeters (Inches)							
Tape Size	**D_0**	**E**	**P_0**	**P_2**	**T Max**	**T_1 Max**	
8 mm and 12 mm	1.5 +0.10 -0.0 (0.059 +0.004, -0.0)	1.75 ±0.10 (0.069 ±0.004)	4.0 ±0.10 (0.157 ±0.004)	2.0 ±0.05 (0.079 ±0.002)	0.600 (0.024)	0.100 (0.004)	

Variable Dimensions — Millimeters (Inches)									
Tape Size	**Pitch**	**B_1 Max. Note 1**	**D_1 Min. Note 2**	**F**	**P_1**	**R Min. Note 3**	**T_2 Max**	**W**	**$A_0B_0K_0$ Note 4**
8 mm	Single (4 mm)	4.4 (0.173)	1.0 (0.039)	3.5 ±0.05 (0.138 ±0.002)	4.0 ±0.10 (0.157 ±0.004)	25.0 (0.984)	2.5 (0.098)	8.0 ±0.30 (.315 ±0.012)	
12 mm	Double (8 mm)	8.2 (0.323)	1.5 (0.059)	5.5 ±0.05 (0.217 ±0.002)	8.0 ±0.10 (0.315 ±0.004)	30.0 (1.181)	4.6 (0.181)	12.0 ±0.30 (0.472 ±0.012)	

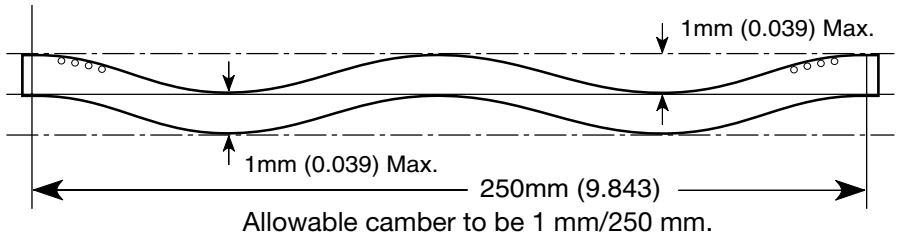
NOTES

1. B1 dimension is a reference dimension for tape feeder clearance only.
2. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.
3. Tape with components shall pass around radius "R" without damage (see sketch A). The minimum trailer length (Fig. 2) may require additional length to provide R min. for 12 mm embossed tape for reels with hub diameters approaching N min. (Table 2)
4. The cavity defined by A_0, B_0, and K_0 shall be configured to surround the part with sufficient clearance such that the chip does not protrude beyond the sealing plane of the cover tape, the chip can be removed from the cavity in a vertical direction without mechanical restriction, rotation of the chip is limited to 20 degrees maximum in all 3 planes, and lateral movement of the chip is restricted to 0.5 mm maximum in the pocket (not applicable to vertical clearance.)

Embossed Carrier Tape Configuration (cont.)



Sketch D: Tape Camber (Top View)



Allowable camber to be 1 mm/250 mm.

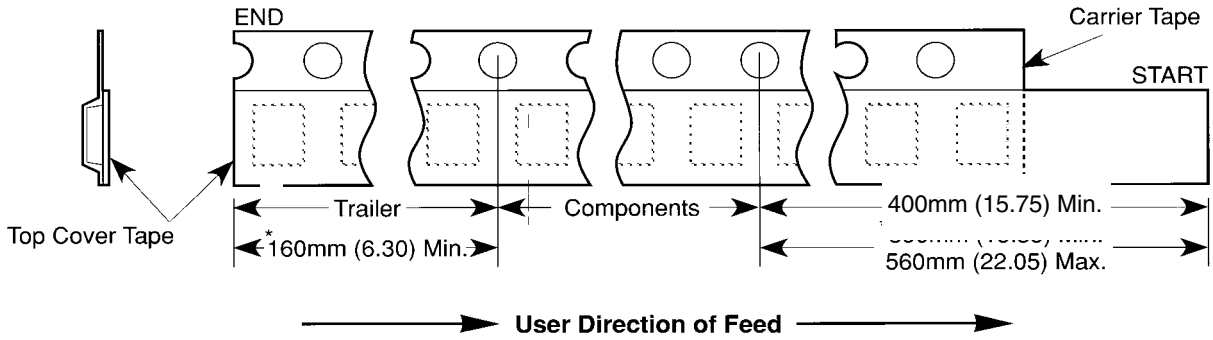


Figure 2: Tape Leader & Trailer Dimensions (Metric Dimensions Will Govern)

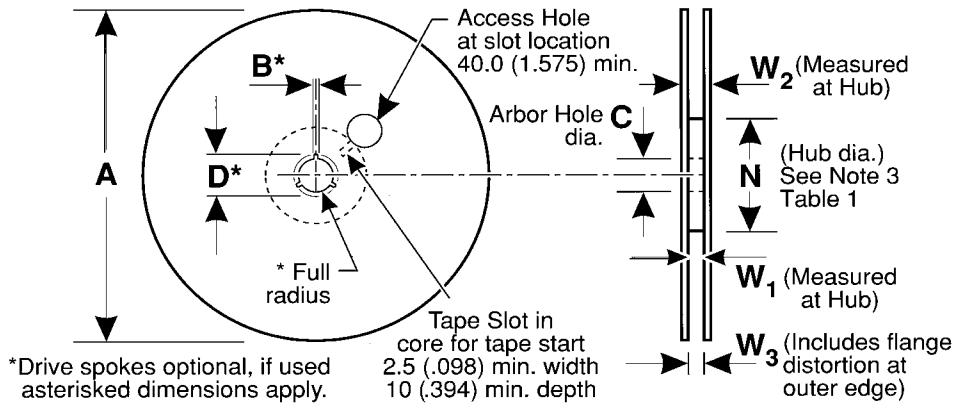


Figure 3: Reel Dimensions (Metric Dimensions will govern)

Table 2 – REEL DIMENSIONS (Metric will govern)

Tape Size	A Max	B* Min	C	D* Min	N Min	W_1	W_2 Max	W_3
8 mm	330.0 (12.992)	1.5 (0.059)	13.0 ± 0.20 (0.512 ± 0.008)	20.2 (0.795)	50.0 (1.969) See Note 3 Table 1	8.4 +1.5, -0.0 (0.331 +0.059, -0.0)	14.4 (0.567)	7.9 Min (0.311) 10.9 Max (0.429)
12 mm	330.0 (12.992)	1.5 (0.059)	13.0 ± 0.20 (0.512 ± 0.008)	20.2 (0.795)		12.4 +2.0, -0.0 (0.488 +0.078, -0.0)	18.4 (0.724)	11.9 Min (0.469) 15.4 Max (0.606)

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Punched Carrier (Paper Tape) Configuration (Ceramic Chips Only):

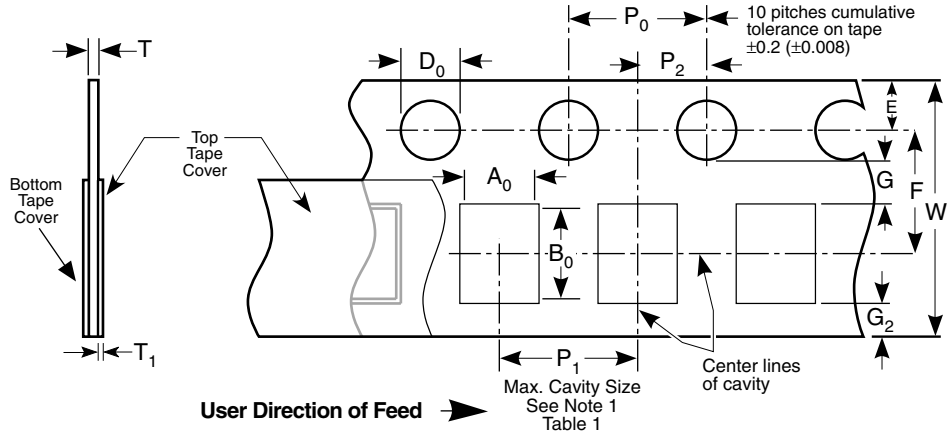


Table 1: 8 & 12mm Punched Tape
(Metric Dimensions Will Govern)

Constant Dimensions - Millimeters (Inches)

Tape Size	D_0	E	P_0	P_2	T_1	G_1	G_2	R Min.
8mm and 12mm	1.5 +0.10, -0.0 (.059 +0.004, -0.0)	1.75 ±0.10 (.069 ±0.004)	4.0 ± 0.10 (.157 ± 0.004)	2.0 ± 0.05 (.079 ± 0.002)	0.10 (.004) Max.	0.75 (.030) Min.	0.75 (.030) Min.	25 (.984) See Note 2 Table 1

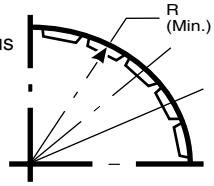
Table 1: 8 & 12mm Punched Tape
(Metric Dimensions Will Govern)

Variable Dimensions - Millimeters (Inches)

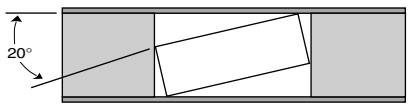
Tape Size	P_1	F	W	A_0B_0	T
8mm 1/2 Pitch	2.0 ± 0.10 (.079 ±.004) See Requirements Section 3.3 (d)	3.5 ± 0.05 (.138 ± .002)	8.0 ± 0.3 (.315 ± 0.012)	See Note 1 Table 1	1.1mm (.043) Max. for Paper Base Tape and 1.6mm (.063) Max. for Non-Paper Base Compositions. See Note 3.
8mm	4.0 ± 0.10 (0.157 ± .004)				
12mm	4.0 ± 0.10 (0.157 ± .004)	5.5 ± 0.05 (.217 ± .002)	12.0 ± 0.3 (.472 ± .012)		
12mm Double Pitch	8.0 ± 0.10 (0.315 ± .004)				

Note:
1. A_0, B_0 and T determined by the maximum dimensions to the ends of the terminals extending from the body and/or the body dimensions of the component. The clearance between the ends of the terminals or body of the component to the sides and depth of the cavity (A_0, B_0 and T) must be within 0.05mm (.002) minimum and 0.50mm (.020) maximum. The clearance allowed must also prevent rotation of the component within the cavity of not more than 20 degrees (see sketches A and B).
2. Tape with components shall pass around radius "R" without damage.
3. KEMET nominal thicknesses are: 0402 = 0.6mm and all others 0.95mm minimum.

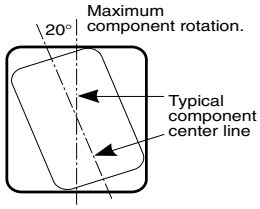
Sketch A:
Bending Radius
See Note 2
Table 1



Sketch B:
Max. Component Rotation - Front Cross Sectional View



Sketch C:
Component Rotation - Top View



Bulk Cassette Packaging (Ceramic Chips only)
(Meets Dimensional Requirements IEC-286-6 and EIAJ 7201)

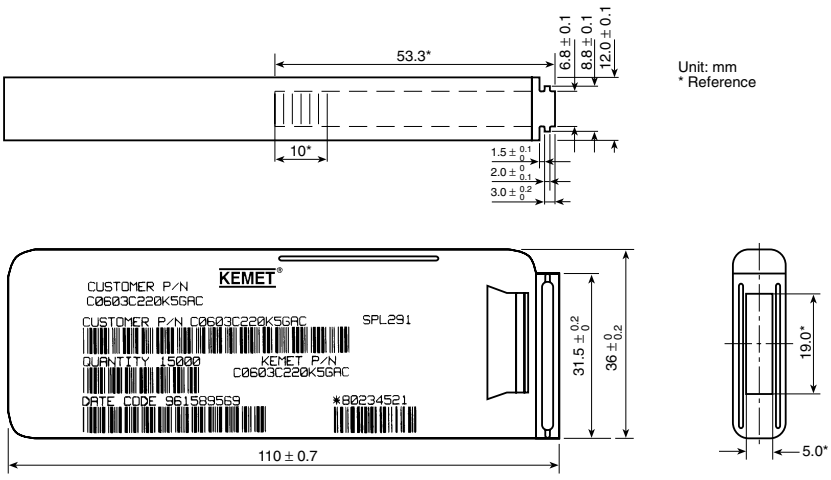


Table 2 – Capacitance Values Available In Bulk Cassette Packaging

Case Size	Dielectric	Voltage	Min. Cap Value	Max. Cap Value
0402	All	All	All	All
0603	All	All	All	All
0805	C0G	200 100 50	109 109 109	181 331 102
	X7R	200 100 50 25 16	221 221 221 221 221	392 103 273 104 104
	Y5V	25 16	104 104	224 224

Table 1 – Capacitor Dimensions for Bulk Cassette Packaging – Millimeters

Metric Size Code	EIA Size Code	Length L	Width W	Thickness T	Bandwidth B	Minimum Separation S	Number of Pcs/Cassette
1005	0402	1.0 ± 0.05	0.5 ± 0.05	0.5 ± .05	0.2 to 0.4	0.3	50,000
1608	0603	1.6 ± 0.07	0.8 ± 0.07	0.8 ± .07	0.2 to 0.5	0.7	15,000
2012	0805	2.0 ± 0.10	1.25 ± 0.10	0.6 ± .10	0.5 to 0.75	0.75	10,000

Terminations: KEMET nickel barrier layer with a tin overplate.

CAPACITOR MARKING TABLE (Marking Optional - Not Available for 0402 Size or Y5V Dielectric)

Alpha Character \ Numeral	Capacitance (pF) For Various Numeral Identifiers								
	9	0	1	2	3	4	5	6	7
A	0.10	1.0	10	100	1000	10,000	100,000	1,000,000	10,000,000
B	0.11	1.1	11	110	1100	11,000	110,000	1,100,000	11,000,000
C	0.12	1.2	12	120	1200	12,000	120,000	1,200,000	12,000,000
D	0.13	1.3	13	130	1300	13,000	130,000	1,300,000	13,000,000
E	0.15	1.5	15	150	1500	15,000	150,000	1,500,000	15,000,000
F	0.16	1.6	16	160	1600	16,000	160,000	1,600,000	16,000,000
G	0.18	1.8	18	180	1800	18,000	180,000	1,800,000	18,000,000
H	0.20	2.0	20	200	2000	20,000	200,000	2,000,000	20,000,000
J	0.22	2.2	22	220	2200	22,000	220,000	2,200,000	22,000,000
K	0.24	2.4	24	240	2400	24,000	240,000	2,400,000	24,000,000
L	0.27	2.7	27	270	2700	27,000	270,000	2,700,000	27,000,000
M	0.30	3.0	30	300	3000	30,000	300,000	3,000,000	30,000,000
N	0.33	3.3	33	330	3300	33,000	330,000	3,300,000	33,000,000
P	0.36	3.6	36	360	3600	36,000	360,000	3,600,000	36,000,000
Q	0.39	3.9	39	390	3900	39,000	390,000	3,900,000	39,000,000
R	0.43	4.3	43	430	4300	43,000	430,000	4,300,000	43,000,000
S	0.47	4.7	47	470	4700	47,000	470,000	4,700,000	47,000,000
T	0.51	5.1	51	510	5100	51,000	510,000	5,100,000	51,000,000
U	0.56	5.6	56	560	5600	56,000	560,000	5,600,000	56,000,000
V	0.62	6.2	62	620	6200	62,000	620,000	6,200,000	62,000,000
W	0.68	6.8	68	680	6800	68,000	680,000	6,800,000	68,000,000
X	0.75	7.5	75	750	7500	75,000	750,000	7,500,000	75,000,000
Y	0.82	8.2	82	820	8200	82,000	820,000	8,200,000	82,000,000
Z	0.91	9.1	91	910	9100	91,000	910,000	9,100,000	91,000,000
a	0.25	2.5	25	250	2500	25,000	250,000	2,500,000	25,000,000
b	0.35	3.5	35	350	3500	35,000	350,000	3,500,000	35,000,000
d	0.40	4.0	40	400	4000	40,000	400,000	4,000,000	40,000,000
e	0.45	4.5	45	450	4500	45,000	450,000	4,500,000	45,000,000
f	0.50	5.0	50	500	5000	50,000	500,000	5,000,000	50,000,000
m	0.60	6.0	60	600	6000	60,000	600,000	6,000,000	60,000,000
n	0.70	7.0	70	700	7000	70,000	700,000	7,000,000	70,000,000
t	0.80	8.0	80	800	8000	80,000	800,000	8,000,000	80,000,000
y	0.90	9.0	90	900	9000	90,000	900,000	9,000,000	90,000,000

Laser marking is available as an extra-cost option for most KEMET ceramic chips. Such marking is two sided, and includes a $\overline{K}$ to identify KEMET, followed by two characters (per EIA-198 - see table below) to identify the capacitance value. Note that marking is not available for size 0402 nor for any Y5V chip. In addition, the 0603 marking option is limited to the $\overline{K}$ only.

Example shown is 1,000 pF capacitor.

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KOA SPEER ELECTRONICS, INC.

NPO, X5R, X7R, Y5V

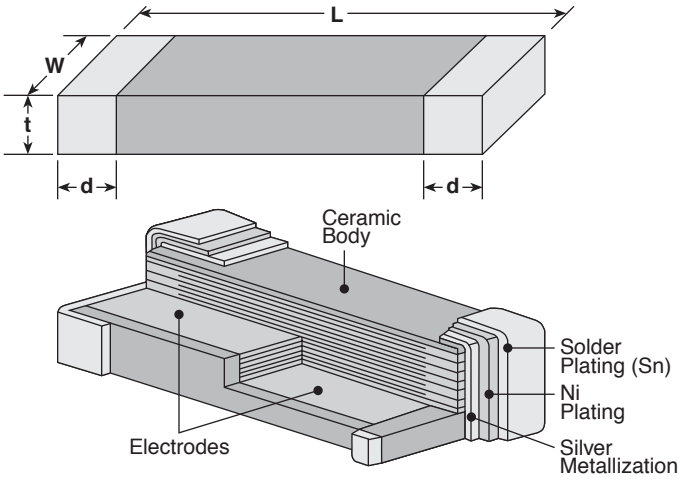
ceramic chip capacitors

RoHS COMPLIANT

features

- High Q factor
- Low T.C.C.
- Available in high capacitance values (up to 100 μF)
- Products with lead-free terminations meet RoHS requirements

dimensions and construction



Case Size	Dimensions inches *(mm)*			
	L	W	t (Max.)	d
0402	.039±.004 *(1.0±0.1)*	.02±.004 *(0.5±0.1)*	.021 *(0.55)*	.01±.006 *(0.25±0.15)*
0603	.063±.006 *(1.6±0.15)*	.032±.006 *(0.81±0.15)*	.035 *(0.9)*	.014±.006 *(0.35±0.15)*
0805	.079±.008 *(2.01±0.2)*	.049±.008 *(1.25±0.2)*	.051 *(1.3)*	.02±.01 *(0.50±0.25)*
1206	.126±.008 *(3.2±0.2)*	.063±.008 *(1.6±0.2)*	.059 *(1.5)*	.02±.01 *(0.5±0.25)*
1210	.126±.008 *(3.2±0.2)*	.098±.008 *(2.5±0.2)*	.067 *(1.7)*	.02±.01 *(0.5±0.25)*

ordering information

New Part # NPO 0805 H T TD 101 K

Dielectric	Size	Voltage	Termination Material	Packaging	Capacitance	Tolerance
NPO X5R X7R Y5V	0402 0603 0805 1206 1210	A = 10V C = 16V E = 25V H = 50V I = 100V J = 200V K = 6.3V	T: Sn	TP: 7" 2mm pitch (0402 only) TD: 7" paper tape TE: 7" embossed plastic TDB: 13" paper tape TEB: 13" embossed plastic	NPO, X5R, X7R,Y5V: 2 significant digits + no. of zeros. "R" indicates decimal point	B: ±0.1pF C: ±0.25pF D: ±0.5pF F: ±1% G: ±2% J: ±5% K: ±10% M: ±20% Z: +80, -20%

For further information on packaging, please refer to Appendix B.

capacitors

Specifications given herein may be changed at any time without prior notice. Please confirm technical specifications before you order and/or use. 6/13/06

applications and ratings

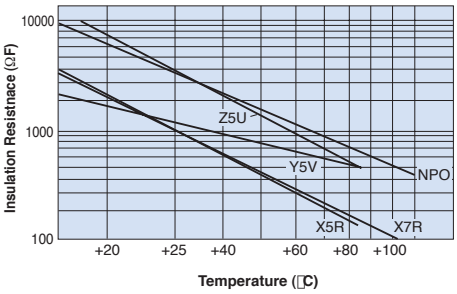
Dielectric	Capacitance Range	Capacitance Tolerance*	Voltage Ratings	Dissipation Factor	T.C.C.	Test Voltage	Operating Temperature	Insulation Resistance
NPO	0.47pF - 0.010μF	.47pF~8.2pF= C:±0.25pF 5.6pF~8.2pF= D±0.5pF 10pF~ 10000pF= F:±1%, G:±2%,J:±5%	16V 25V 50V 100V 200V	For Values >30pF: 0.1% max., ≤30pF: Q = 400 + 20 x C DF = 1/Q C is in pF	0 ± 30 ppm/°C	1.0 ± 0.2 Vrms	-55°C to +125°C	+25°C 100,000MΩ min. or 1000 MΩ - μF min. whichever is less
X5R	0.068μF - 22μF	K: ±10%	6.3V 10V	6.3V = 7.5% max. 10V = 10% max.	±15% (0 VDC)	1.0 ± 0.2 Vrms	-55°C to +85°C	+25°C 100,000MΩ min. or 500 MΩ - μF min. whichever is less
X7R	100pF - 4.7μF	K: ±10%	10V 16V 25V 50V 100V 200V	10V = 10% max. 16V = 3.5% max. 25V, 50V, 100V = 2.5% max.	±15% (0 VDC)	1.0 ± 0.2 Vrms	-55°C to +125°C	+25°C 100,000MΩ min. or 1000 MΩ - μF min. whichever is less
Y5V	10000pF - 22μF	Z: +80, -20%	10V 16V 25V 50V	16V & 25V = 7.0% 50V = 5.0%	+22% to -82% max.	1.0 ± 0.2 Vrms	-30°C to +85°C	+25°C 10,000MΩ min. or 1000 MΩ - μF min. whichever is less

* Special tolerances available, please consult factory.

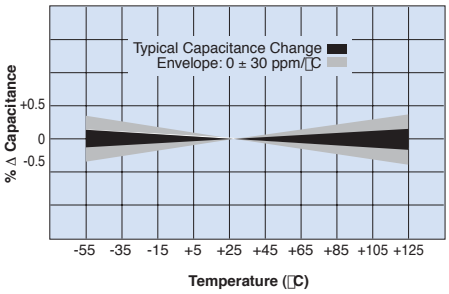
capacitors

environmental applications

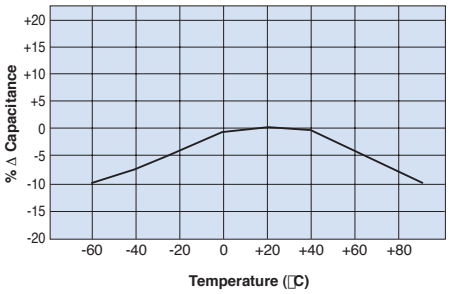
Insulation Resistance vs Temp.



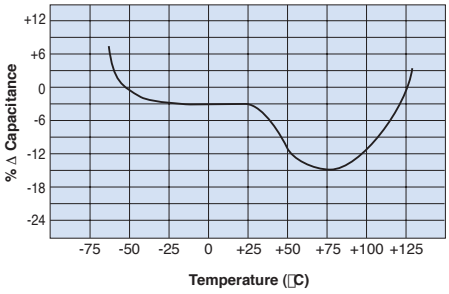
NPO - Temperature Coefficient



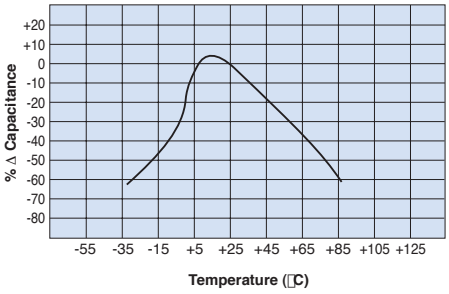
X5R - Temperature Coefficient



X7R - Temperature Coefficient



Y5V - Temperature Coefficient



Specifications given herein may be changed at any time without prior notice. Please confirm technical specifications before you order and/or use.

NPO capacitance voltage availability

Size				0402*			0603*		0805			1206			1210	
Capacitance values pF	µF	Cap. Code	WVDC	16 (C)	25 (E)	50 (H)	50 (H)	100 (I)	50 (H)	100 (I)	200 (J)	50 (H)	100 (I)	200 (J)	50 (H)	200 (J)
0.47		R47														
0.56		R56														
0.68		R68														
0.82		R82														
1		1R0														
1.2		1R2														
1.5		1R5														
1.8		1R8														
2.2		2R2														
2.7		2R7														
3.3		3R3														
3.9		3R9														
4.7		4R7														
5.6		5R6														
6.8		6R8														
8.2		8R2														
10		100														
12		120														
15		150														
18		180														
22		220														
27		270														
33		330														
39		390														
47		470														
56		560														
68		680														
82		820														
100	.0001	101														
120	.00012	121														
150	.00015	151														
180	.00018	181														
220	.00022	221														
270	.00027	271														
330	.00033	331														
390	.00039	391														
470	.00047	471														
560	.00056	561														
680	.00068	681														
820	.00082	821														
1000	.0010	102														
1200	.0012	122														
1500	.0015	152														
1800	.0018	182														
2200	.0022	222														
2700	.0027	272														
3300	.0033	332														
3900	.0039	392														
4700	.0047	472														
5600	.0056	562														
6800	.0068	682														
8200	.0082	822														
10000	.010	103														
12000	.012	123														
15000	.015	153														
18000	.018	183														
22000	.022	223														
27000	.027	273														
33000	.033	333														
39000	.039	393														

* IR and vapor phase solder only recommended

Capacitance tolerance available:
.47pF~8.2pF = C: ±0.25pF
5.6pF~8.2pF = D: ±0.5pF
10pF~10000pF = F: ±1%, G: ±2%, J: ±5%

Specifications given herein may be changed at any time without prior notice. Please confirm technical specifications before you order and/or use. 6/14/07

capacitors

X5R capacitance voltage availability

Size	0402			0603				0805				1206				1210	
Capacitance values pF µF	6.3 (K)	10 (A)	16 (C)	6.3 (K)	10 (A)	16 (C)	25 (E)	6.3 (K)	10 (A)	16 (C)	25 (E)	6.3 (K)	10 (A)	16 (C)	25 (E)	6.3 (K)	10 (A)
100																	
150																	
220																	
330																	
470																	
680																	
1000																	
1200																	
1500																	
1800																	
2200																	
2700																	
3300																	
3900																	
4700																	
5600																	
6800																	
8200																	
0.010																	
0.012																	
0.015																	
0.018																	
0.022																	
0.027																	
0.033																	
0.039																	
0.047																	
0.056																	
0.068																	
0.082																	
0.10																	
0.12																	
0.15																	
0.18																	
0.22																	
0.27																	
0.33																	
0.47																	
0.56																	
0.68																	
0.82																	
1.0																	
1.2																	
1.5																	
1.8																	
2.2																	
3.3																	
4.7																	
6.8																	
10																	
22																	
47																	
100																	

Capacitance tolerance available: ±10%

capacitors

X7R capacitance voltage availability

Size			0402*				0603*				0805						1206						1210		
Capacitance values pF	µF	Cap. Code	10 (A)	16 (C)	25 (E)	50 (H)	10 (A)	16 (C)	25 (E)	50 (H)	10 (A)	16 (C)	25 (E)	50 (H)	100 (I)	200 (J)	10 (A)	16 (C)	25 (E)	50 (H)	100 (I)	200 (J)	50 (H)	100 (I)	200 (J)
100	.0001	101																							
120	.00012	121																							
150	.00015	151																							
180	.00018	181																							
220	.00022	221																							
270	.00027	271																							
330	.00033	331																							
390	.00039	391																							
470	.00047	471																							
560	.00056	561																							
680	.00068	681																							
820	.00082	821																							
1000	.0010	102																							
1200	.0012	122																							
1500	.0015	152																							
1800	.0018	182																							
2200	.0022	222																							
2700	.0027	272																							
3300	.0033	332																							
3900	.0039	392																							
4700	.0047	472																							
5600	.0056	562																							
6800	.0068	682																							
8200	.0082	822																							
10000	.010	103																							
12000	.012	123																							
15000	.015	153																							
18000	.018	183																							
22000	.022	223																							
27000	.027	273																							
33000	.033	333																							
39000	.039	393																							
47000	.047	473																							
56000	.056	563																							
68000	.068	683																							
82000	.082	823																							
100000	.100	104																							
120000	.120	124																							
150000	.150	154																							
180000	.180	184																							
220000	.220	224																							
270000	.270	274																							
330000	.330	334																							
390000	.390	394																							
470000	.470	474																							
560000	.560	564																							
680000	.680	684																							
1000000	1.00	105																							
1200000	1.20	125																							
1500000	1.50	155																							
1800000	1.80	185																							
2200000	2.20	225																							
3900000	3.90	395																							
4700000	4.70	475																							

* IR and vapor phase solder only recommended

Capacitance tolerance available: ±10%

Specifications given herein may be changed at any time without prior notice. Please confirm technical specifications before you order and/or use. 9/09/07

Y5V capacitance voltage availability

Size			0402*		0603*				0805				1206			
Capacitance values pF	µF	Cap. Code	10 (A)	16 (C)	10 (A)	16 (C)	25 (E)	50 (H)	10 (A)	16 (C)	25 (E)	50 (H)	10 (A)	16 (C)	25 (E)	50 (H)
2200	.0022	222														
2700	.0027	272														
3300	.0033	332														
3900	.0039	392														
4700	.0047	472														
5600	.0056	562														
6800	.0068	682														
8200	.0082	822														
10000	.010	103														
12000	.012	123														
15000	.015	153														
18000	.018	183														
22000	.022	223														
27000	.027	273														
33000	.033	333														
39000	.039	393														
47000	.047	473														
56000	.056	563														
68000	.068	683														
82000	.082	823														
100000	.100	104														
120000	.120	124														
150000	.150	154														
180000	.180	184														
220000	.220	224														
270000	.270	274														
330000	.330	334														
390000	.390	394														
470000	.470	474														
560000	.560	564														
680000	.680	684														
820000	.820	824														
1000000	1.0	105														
1200000	1.2	125														
1500000	1.5	155														
1800000	1.8	185														
2200000	2.2	225														
2700000	2.7	275														
3300000	3.3	335														
3900000	3.9	395														
4700000	4.7	475														
5600000	5.6	565														
6800000	6.8	685														
10000000	10	106														
22000000	22	226														

* IR and vapor phase solder only recommended

Capacitance tolerance available: +80, -20%

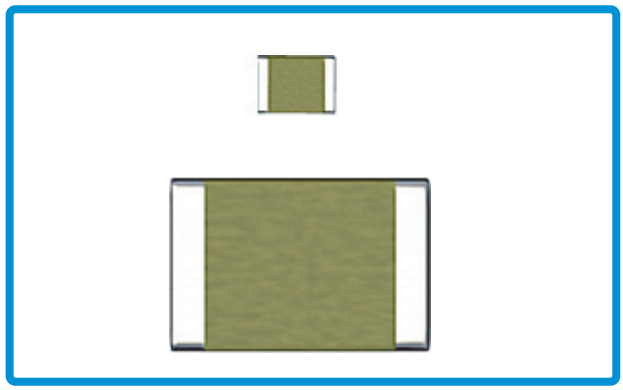
Mutilayer Ceramic Chip Capacitors

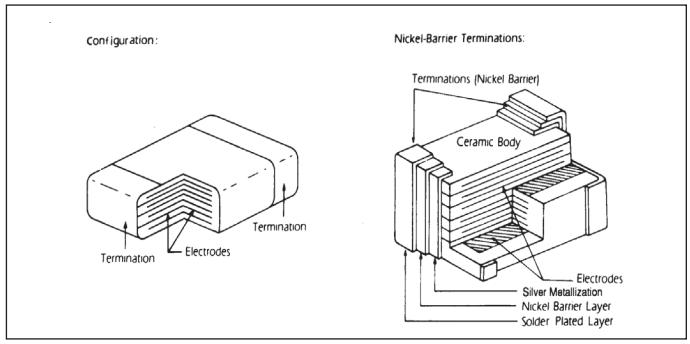
MA Series

MERITEK

FEATURES AND APPLICATIONS

Dielectric	Features	Applications
NPO	Ultra-stable Low dissipation factor Tight tolerance available Good frequency performance No aging of capacitance	LC and RC tuned circuit Filtering Timing
X7R	Semi-stable high K High volumetric efficiency Highly reliable in high temperature applications High insulation resistance	Blocking Coupling Timing Bypassing Frequency discriminating Filtering
Y5V	Highest volumetric efficiency Non-polar construction General purpose, high K	Bypassing Decoupling Filtering





PART NUMBERING SYSTEM

MA 1206 XR 103 K 500

Meritek Series

Size

Dielectric

CODE	CG	XR	YV
	NPO	X7R	Y5V

Capacitance

CODE	8R2	101	223	104
pF	8.2	100	22000	100000
nF	--	0.1	22	100
µF	--	--	0.022	0.1

Tolerance

CODE	Tolerance	CODE	Tolerance	CODE	Tolerance
B	±.1pF	C	±.25pF	D	±.5pF
F	±1%	G	± 2%	J	± 5%
K	±10%	M	±20%	Z	+80/-20%

For values less than 10 pF C or D tolerance preferred

Rated Voltage

2 significant digits + number of zeros.

Code	006	100	160	250	500	101
	6.3V	10V	16V	25V	50V	100V

EIA CASE SIZE	0402	0603	0805	1206	1210	1812	2225
Length (L)	1.0 ±0.05	1.6 ±0.15	2.0 ±0.2	3.2 ±0.2	3.2 ±0.3	4.5 ±0.3	5.7 ±0.4
Width (W)	0.5 ±0.05	0.8 ±0.15	1.25 ±0.2	1.6 ±0.12	2.5 ±0.3	3.2 ±0.3	6.35 ±0.25
Max. Thickness (T)	0.60	1.0	1.30	1.50	1.70	1.70	1.78
Termination Width (E)	0.2 ±0.1	0.4 ±0.2	0.5 ±0.2	0.5 ±0.2	0.5 ±0.2	0.64 ±0.38	0.64 ±0.38

Meritek RoHS Compliance Status

Date: September 1, 2005

Series	RoHS status	Test Report
Capacitors, disc CC / HV	available	CC_HV_NPO, CC_HV_SL, CC_HV_X7R, CC_HV_Y5P, CC_HV_Y5V, CC_HV_Z5U
Capacitors, chip MA,HQ	available	MA
Capacitors, disc, safety AC/ AH	available	AC_AH
Capacitors,Tantalum,chip TC	available	TC
Capacitors,Tantalum disc DT	available	DT
Capacitors, mono radial RD	available	RD_NPO, RD_X7R, RD_Y5V
Capacitors, mono, axial AD	available	AD_NPO, AD_X7R, AD_Y5V, AD_Z5U
Caps, Al Electrolytic	available	AE Cap
Caps, film	available	Film Cap
Resistors, Chip CR, RTA	available	CR_RTA
Resistors, axial MF/MO/ CF	available	MF, MO, CF
Resistors network RA/RB/ CN	Q3/2005 note2	
PPTC MPTx	available	MPTH, MPTR30V, MPTR90V, MPTS1206, MPTS1210, MPTS1812, MPTS2920

MOV MVR	available	MVR
Bridge rectifier	available	Bridge Diode 1, Bridge Diode 2
Diode,TVS leads/SMD	available	Diode_TVS, Diode_TVS SMD
Gas Discharge Tube MGT	available	MGT

Note:

1. No P/N change, green sticker on package and RoHS on each label will be used to distinguish from non-compliant parts
2. Lead free terminations are available
3. RoHS compliant parts will start transition from Q1/2005 and will be completed by Q4/2005

Mutilayer Ceramic Chip Capacitors

MA Series

MERITEK

NPO CAPACITANCE RANGE CHART

EIA CASE SIZE			0402		0603			0805		1206		1210		1812		2225	
Working Voltage			25	50	25	50	100	50	100	50	100	50	100	50	100	50	100
Cap (pF)	0.5	0R5															
	1.0	1R0															
	1.2	1R2															
	1.5	1R5															
	1.8	1R8															
	2.2	2R2															
	2.7	2R7															
	3.3	3R3															
	3.9	3R9															
	4.7	4R7															
	5.6	5R6															
	6.8	6R8															
	8.2	8R2															
	10	100															
	12	120															
	15	150															
	18	180															
	22	220															
	27	270															
	33	330															
	39	390															
	47	470															
	56	560															
	68	680															
	82	820															
	100	101															
	120	121															
	150	151															
	180	181															
	220	221															
	270	271															
	330	331															
	390	391															
	470	471															
	560	561															
	680	681															
	820	821															
	1000	102															
	1200	122															
	1500	152															
	1800	182															
	2200	222															
	3300	332															
	3900	392															
	4700	472															
	5600	562															
	6800	682															
	8200	822															
Cap (μF)	0.010	103															
	0.012	123															
	0.015	153															
	0.018	183															
	0.022	223															
	0.027	273															
	0.033	333															
	0.039	393															
	0.047	473															
	0.056	563															
	0.068	683															
	0.082	823															

Mutilayer Ceramic Chip Capacitors

MA Series

MERITEK

X7R CAPACITANCE RANGE CHART (0402 to 1206)

EIA CASE SIZE			0402				0603					0805					1206				
Working Voltage			10	16	25	50	6.3	10	16	25	50	6.3	10	16	25	50	6.3	10	16	25	50
Cap	100	101	■	■	■	■		■	■	■	■		■	■	■	■					
(pF)	120	121	■	■	■	■		■	■	■	■		■	■	■	■					
	150	151	■	■	■	■		■	■	■	■		■	■	■	■					
	180	181	■	■	■	■		■	■	■	■		■	■	■	■					
	220	221	■	■	■	■		■	■	■	■		■	■	■	■					
	270	271	■	■	■	■		■	■	■	■		■	■	■	■					
	330	331	■	■	■	■		■	■	■	■		■	■	■	■					
	390	391	■	■	■	■		■	■	■	■		■	■	■	■					
	470	471	■	■	■	■		■	■	■	■		■	■	■	■					
	560	561	■	■	■	■		■	■	■	■		■	■	■	■					
	680	681	■	■	■	■		■	■	■	■		■	■	■	■					
	820	821	■	■	■	■		■	■	■	■		■	■	■	■					
	1000	102	■	■	■	■		■	■	■	■		■	■	■	■		■	■	■	■
	1200	122	■	■	■	■		■	■	■	■		■	■	■	■		■	■	■	■
	1500	152	■	■	■	■		■	■	■	■		■	■	■	■		■	■	■	■
	1800	182	■	■	■	■		■	■	■	■		■	■	■	■		■	■	■	■
	2200	222	■	■	■	■		■	■	■	■		■	■	■	■		■	■	■	■
	2700	272	■	■	■	■		■	■	■	■		■	■	■	■		■	■	■	■
	3300	332	■	■	■	■		■	■	■	■		■	■	■	■		■	■	■	■
	3900	392	■	■	■	■		■	■	■	■		■	■	■	■		■	■	■	■
	4700	472	■	■	■	■		■	■	■	■		■	■	■	■		■	■	■	■
	5600	562	■	■	■	■		■	■	■	■		■	■	■	■		■	■	■	■
	6800	682	■	■	■	■		■	■	■	■		■	■	■	■		■	■	■	■
	8200	822	■	■	■	■		■	■	■	■		■	■	■	■		■	■	■	■
Cap	0.010	103	■	■	■	■		■	■	■	■		■	■	■	■		■	■	■	■
(μF)	0.012	123	■	■				■	■	■	■		■	■	■	■		■	■	■	■
	0.015	153	■	■				■	■	■	■		■	■	■	■		■	■	■	■
	0.018	183	■	■				■	■	■	■		■	■	■	■		■	■	■	■
	0.022	223	■	■				■	■	■	■		■	■	■	■		■	■	■	■
	0.027	273	■	■				■	■	■	■		■	■	■	■		■	■	■	■
	0.033	333	■	■				■	■	■	■		■	■	■	■		■	■	■	■
	0.039	393	■	■				■	■	■			■	■	■	■		■	■	■	■
	0.047	473	■	■				■	■	■			■	■	■	■		■	■	■	■
	0.056	563	■	■				■	■				■	■	■	■		■	■	■	■
	0.068	683	■	■				■	■				■	■	■	■		■	■	■	■
	0.082	823	■	■				■	■				■	■	■	■		■	■	■	■
	0.10	104	■				■	■	■				■	■	■	■		■	■	■	■
	0.12	124					■	■	■				■	■	■	■		■	■	■	■
	0.15	154					■	■	■				■	■	■	■		■	■	■	■
	0.18	184					■	■	■				■	■	■	■		■	■	■	■
	0.22	224					■	■	■				■	■	■	■		■	■	■	■
	0.27	274					■	■	■				■	■	■	■		■	■	■	■
	0.33	334					■	■					■	■	■			■	■	■	■
	0.39	394					■	■					■	■	■			■	■	■	■
	0.47	474					■	■					■	■	■			■	■	■	■
	0.56	564					■						■	■				■	■	■	
	0.68	684					■						■	■				■	■	■	
	0.82	824					■						■	■				■	■	■	
Cap	1.0	105					■					■	■	■				■	■	■	
(μF)	1.5	155										■						■	■		
	1.8	185										■						■	■		
	2.2	225										■						■	■		
	2.7	275										■						■	■		
	3.3	335										■						■	■		
	3.9	395										■									
	4.7	475										■					■	■			
	5.6	565															■				
	6.8	685															■				
	10.0	106															■				
	22	226															■				

X7R CAPACITANCE RANGE CHART (1210 to 2225)

EIA CASE SIZE			1210					1812					2225		
Working Voltage			6.3	10	16	25	50	10	16	25	50	100	25	50	100
Cap (pF)	1000	102		■	■	■	■								
	1200	122		■	■	■	■								
	1500	152		■	■	■	■								
	1800	182		■	■	■	■								
	2200	222		■	■	■	■								
	2700	272		■	■	■	■								
	3300	332		■	■	■	■								
	3900	392		■	■	■	■								
	4700	472		■	■	■	■						■	■	■
	5600	562		■	■	■	■						■	■	■
	6800	682		■	■	■	■						■	■	■
	8200	822		■	■	■	■						■	■	■
Cap (μF)	0.010	103		■	■	■	■				■	■	■	■	■
	0.012	123		■	■	■	■				■	■	■	■	■
	0.015	153		■	■	■	■				■	■	■	■	■
	0.018	183		■	■	■	■				■	■	■	■	■
	0.022	223		■	■	■	■				■	■	■	■	■
	0.027	273		■	■	■	■				■	■	■	■	■
	0.033	333		■	■	■	■				■	■	■	■	■
	0.039	393		■	■	■	■				■	■	■	■	■
	0.047	473		■	■	■	■				■	■	■	■	■
	0.056	563		■	■	■	■				■	■	■	■	■
	0.068	683		■	■	■	■				■	■	■	■	■
	0.082	823		■	■	■	■				■	■	■	■	■
	0.10	104		■	■	■	■				■	■	■	■	■
	0.12	124		■	■	■	■				■	■	■	■	■
	0.15	154		■	■	■	■				■	■	■	■	■
	0.18	184		■	■	■	■				■	■	■	■	■
	0.22	224		■	■	■	■				■	■	■	■	■
	0.27	274		■	■	■	■				■	■	■	■	■
	0.33	334		■	■	■	■		■	■	■	■	■	■	■
	0.39	394		■	■	■	■		■	■	■	■	■	■	■
	0.47	474		■	■	■	■		■	■	■	■	■	■	■
	0.56	564		■	■	■			■	■	■	■	■	■	■
	0.68	684		■	■	■			■	■	■	■	■	■	■
	0.82	824		■	■	■			■	■	■	■	■	■	■
Cap (μF)	1.0	105		■	■	■			■	■	■	■	■	■	■
	1.5	155		■	■				■	■	■	■	■	■	■
	1.8	185		■	■				■	■	■	■	■	■	■
	2.2	225		■	■				■	■	■	■	■	■	■
	2.7	275		■	■				■	■	■	■	■	■	■
	3.3	335		■	■				■	■	■	■	■	■	■
	3.9	395		■	■				■	■					
	4.7	475		■	■				■	■					
	5.6	565		■	■				■	■					
	6.8	685		■	■				■						
	10.0	106		■	■				■						
	22	226	■					■							

Other capacitance values, voltages and sizes are available upon request

Mutilayer Ceramic Chip Capacitors

MA Series

MERITEK

Y5V CAPACITANCE RANGE CHART

EIA CASE SIZE			0402				0603				0805				1206				1210			
Working Voltage			10	16	25	50	10	16	25	50	10	16	25	50	10	16	25	50	10	16	25	50
Cap	2200	222	■	■	■	■	■	■	■	■												
(pF)	2700	272	■	■	■	■	■	■	■	■												
	3300	332	■	■	■	■	■	■	■	■												
	3900	392	■	■	■	■	■	■	■	■												
	4700	472	■	■	■	■	■	■	■	■												
	5600	562	■	■	■	■	■	■	■	■												
	6800	682	■	■	■	■	■	■	■	■												
	8200	822	■	■	■	■	■	■	■	■												
Cap	0.010	103	■	■	■	■	■	■	■	■		■	■	■		■	■	■				
(μF)	0.012	123	■	■	■	■	■	■	■	■		■	■	■		■	■	■				
	0.015	153	■	■	■	■	■	■	■	■		■	■	■		■	■	■				
	0.018	183	■	■	■	■	■	■	■	■		■	■	■		■	■	■				
	0.022	223	■	■	■	■	■	■	■	■		■	■	■		■	■	■				
	0.027	273	■	■	■	■	■	■	■	■		■	■	■		■	■	■				
	0.033	333	■	■	■	■	■	■	■	■		■	■	■		■	■	■				
	0.039	393	■	■	■	■	■	■	■	■		■	■	■		■	■	■				
	0.047	473	■	■	■	■	■	■	■	■		■	■	■		■	■	■				
	0.056	563	■	■	■	■	■	■	■	■		■	■	■		■	■	■				
	0.068	683	■	■	■	■	■	■	■	■		■	■	■		■	■	■				
	0.082	823	■	■	■	■	■	■	■	■		■	■	■		■	■	■				
	0.10	104	■	■	■	■	■	■	■	■		■	■	■		■	■	■				
	0.12	124	■	■	■	■	■	■	■	■		■	■	■		■	■	■				
	0.15	154	■	■	■	■	■	■	■	■		■	■	■		■	■	■				
	0.18	184	■	■	■	■	■	■	■	■		■	■	■		■	■	■				
	0.22	224	■	■	■	■	■	■	■	■		■	■	■		■	■	■				
	0.27	274	■	■	■	■	■	■	■	■		■	■	■		■	■	■				
	0.33	334	■	■	■	■	■	■	■	■		■	■	■		■	■	■				
	0.39	394	■	■	■	■	■	■	■	■		■	■	■		■	■	■				
	0.47	474	■	■	■	■	■	■	■	■		■	■	■		■	■	■				
	0.56	564	■	■	■	■	■	■	■	■		■	■	■		■	■	■				
	0.68	684	■	■	■	■	■	■	■	■		■	■	■		■	■	■				
	0.82	824	■	■	■	■	■	■	■	■		■	■	■		■	■	■				
Cap	1.0	105	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■				
(μF)	1.2	125	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■				
	1.5	155	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■				
	1.8	185	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■				
	2.2	225	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■				
	2.7	275	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■				
	3.3	335	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■				
	3.9	395	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■				
	4.7	475	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■				
	5.6	565	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■				
	6.8	685	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
	10	106	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
	22.0	226	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

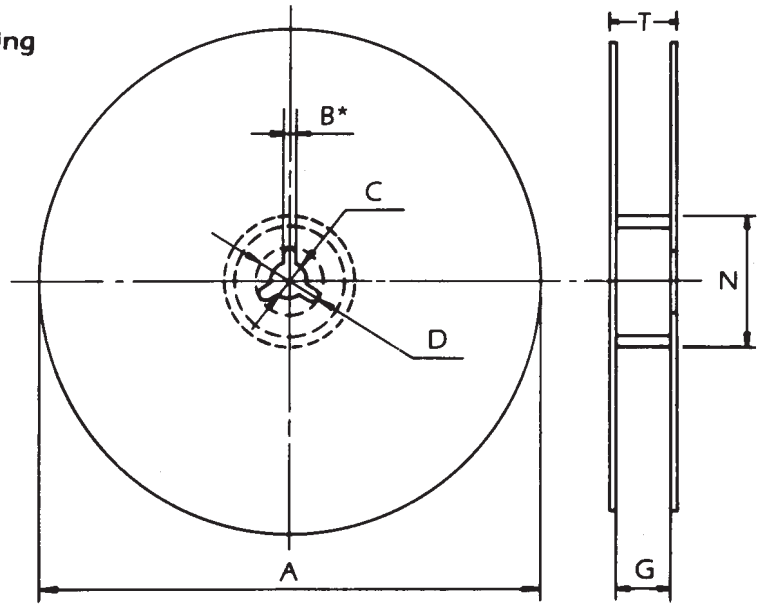
Other capacitance values, voltages and sizes are available upon request

PACKAGING

1. Tape and Reel Package

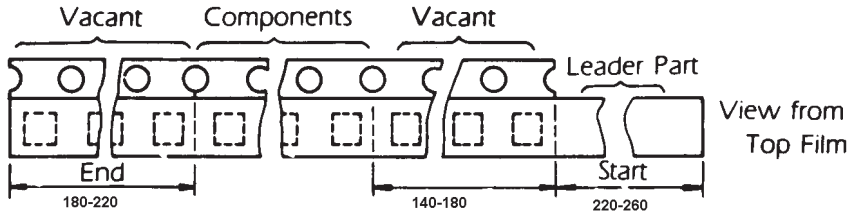
Taping is in accordance with EIA RS-481 or IEC 286-3

Reel for Taping



Unit: mm

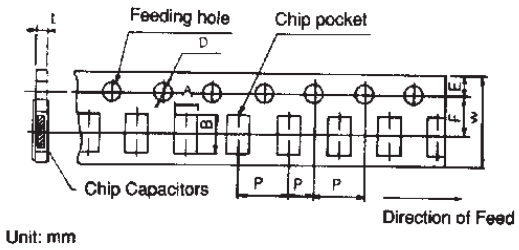
Symbol	A	N	C	D	B*	G	T
Dimension	178 ± 2.0	50 min.	13.0 ± 0.5	20 min	2.0	10.0 ± 1.5	14.9 max.



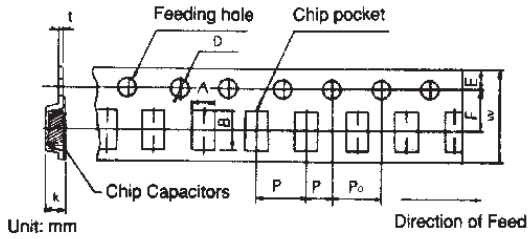
(Unit: mm)

Note: 13” reel available upon request.

1.CARDBOARD TAPE DIMENSIONS



2.EMBOSSED TAPE DIMENSIONS



CARDBOARD TAPE

Unit: mm

SYMBOL / CODE	A	B	W	F	E	P_1	P_2	P_0	f D	t_1
0603	1.25 ±0.2	2.05 ±0.2	8.0 ±0.2	3.5 ±0.05	1.75 ±0.1	4.0 ±0.1	2.0 ±0.05	4.0 ±0.1	1.5 +0.1/-0	1.1 max
0805	1.65 ±0.2	2.4 ±0.2								
1206	2.0 ±0.2	3.6 ±0.2								

EMBOSSED TAPE

Unit: mm

SYMBOL / CODE	A	B	W	F	E	P_1	P_2	P_0	fD	t_1	K
0603	1.6 ±0.2	2.4 ±0.2	8.0 ±0.2	3.5 ±0.05	1.75 ±0.1	4.0 ±0.1	2.0 ±0.05	4.0 ±0.1	1.5 +0.1/-0	0.3 max	2.0 max
0805	1.95 ±0.2	3.6 ±0.2									
1206	2.8 ±0.2	3.7 ±0.2									
1812	3.6 ±0.2	4.9 ±0.2	1.20 ±0.3	5.5 ±0.1	1.75 ±0.1	8.0 ±0.1	2.0 ±0.1	8.0 ±0.1	1.5 +0.1/-0	0.3 max	2.5 max

Standard tape for 0805 and 1206 sizes is cardboard tape.
Embossed tape is only available upon special request.

Standard Package Quantity Per Reel

CHIP SIZE	CHIP THICKNESS MAX	CARDBOARD TAPE	EMBOSSED TAPE
0402	0.6	10,000	-
0603 0805 1206	1.0	4,000	-
1210	1.30	-	3,000
1812	1.30	-	1,500

PERFORMANCE SPECIFICATION

1. ELECTRICAL

DIELECTRIC CODE	EIA	NPO	X7R	Y5V
Temperature Characteristics *1		0 ±30ppm/°C , C>20pF 0 $^{+120}/_{-40}$ ppm/°C, C≤20pF	△C ±15% maximum over -55°C to +125°C	△C +22/-82% maximum over -30°C to +85°C
Operating Temperature Range		-55°C to +125°C	-55°C to +125°C	-30°C to +85°C
Measuring Conditions for Capacitance and D.F. *2		1MHz, 1Vrms, C ≤ 1000pF 1 KHz, 1 Vrms, C>1000pF	1KHz, 1Vrms	1KHz, 10Vrms
Dissipation Factor (D.F.) and Tangent of Loss Angle (tan)		≤0.1% for C≥30pF ≤ $^{100\%}/_{(400+20C)}$ for C<30pF	≤ 2.5% at ≥ 50V rated ≤ 3.5% at 16V, 25V rated ≤ 5.0% at 6.3V, 10V rated	≤ 5% at 50V rated ≤7% at 16V, 25V rated ≤10 % at 6.3V, 10V rated
Insulation Resistance (I.R.) after 60 secs. charging at rated voltage, 25°C, 55% RH max.		≥100GΩ or ≥1000MΩ μF whichever is less	≥10GΩ or ≥100MΩ μF whichever is less	≥10GΩ or ≥100MΩ μF whichever is less
Voltage Proof, 25 °C, 1-5 secs.		2.5 x Rated Voltage	2.5 x Rated Voltage	2.5 x Rated Voltage
Capacitance Aging		0	≈2.5% per decade hour	≈7% per decade hour

*1 Class II (X7R, Z5U, Y5V) capacitors shall be made a special pre-conditioning before a test or a sequence of tests under the following conditions: Exposure at 150 ±10°C for 1 hr, followed by setting the capacitor at room temperature for 24 ±1 hr.

*2 Capacitance is within specified tolerance; measured 1000 hours after date of manufacture because of capacitance aging of Class II capacitor.

2. ENVIRONMENTAL

Test	Test Conditions	Post-Test Inspection Requirements
Solderability	IEC 384-10 4.11 /JIS C 5102 8.13 Solder 60 Sn/40 Pb, 235 ±5°C Immersed for 5 secs.	At least 75% of termination area should be well tinned No visible damage
Resistance to Soldering Heat *1	IEC 384-10 4.10 /JIS C 5102 8.14 Immersed in solder bath at 260 ±5°C for 10 ±1 secs. Recovery: 6 to 24 hrs. (NPO) 24 ±2 hrs. (X7R, Y5V)	At least 75% of termination should be covered by solder No visible damage △C/C: NPO ≤ ±0.5% or ±0.5pF whichever is greater; X7R ≤ +10/-5%; Y5V ≤ +20/-10%
Rapid Change of Temperature *2	IEC 384-10 4.12 /JIS C 5102 9.3 -55°C to +125°C, 5 cycles (NPO, X7R) Duration: 30 mins. Recovery: 6 to 24 hrs. (NPO) 24 ±2 hrs. (X7R)	No visible damage △C/C: NPO ≤ ±1% or ±1pF whichever is greater; X7R ≤ ±10% D.F: ≤1.5 x initial requirement I.R: ≥0.25 x initial requirement
Endurance (Life Test) *3	IEC 384-10 4.15 1000 hrs. at maximum temperature with x 1.5 rated voltage applied Recovery: 6 to 24 hrs. (NPO) 24 ±2 hrs. (X7R, Y5V)	No visible damage △C/C: NPO ≤ ±2% or ±1pF whichever is greater; X7R ≤ ±20%; Y5V ≤ ±30% D.F.: ≤ 2.0 x initial requirement; ≤1.5 x initial requirement I.R.: ≥0.25 x initial requirement
Humidity Test (Damp heat, steady state) *4	IEC 384-10 4.14 /JIS C 5102 9.5 500 hrs. at 40 ±2°C, 90-95% RH Recovery: 6 to 24 hrs. (NPO) 24 ±2 hrs. (X7R, Y5V)	No visible damage △C/C: NPO ≤ ±2% or ±1pF whichever is greater; X7R ≤ ±10%; Y5V ≤ ±30% D.F.: ≤ 2.0 x initial requirement; ≤1.5 x initial requirement I.R.: ≥0.25 x initial requirement
Adhesion	IEC 384-10 4.8 /JIS C 5102 8.11.2 Capacitors mounted on a substrate, a force of 5N applied perpendicular to the plane of substrate and parallel to the line joining the center of terminations for 10 ±1 secs.	No visible damage

*1-4 Class II (X7R,Y5V) capacitors shall be made a special pre-conditioning before a test or a sequence of tests under the following conditions: Exposure at 150 ±10°C for 1 hr, followed by setting the capacitor at room temperature for 24 ±1 hr.

PRODUCT
» NIC Series A~Z
» Products
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» Kits | » Samples
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Capacitors: High Capacitance | High Q | High Voltage | Safety Caps | Cap Arrays

Ceramic Capacitors
Surface Mount (SMT) MLCC, Cap Arrays & R-C Arrays

SG Selection Guide

Maximum Available Value Ranges: link
By Case Size & Temperature Coefficient (TC)

Technical Product Info | X1/Y2 & X2/Y3: UL & TUV Listed

PDF Cross Reference | Taping Specs | Samples: link

SMT Multilayer Ceramic Chip Capacitors

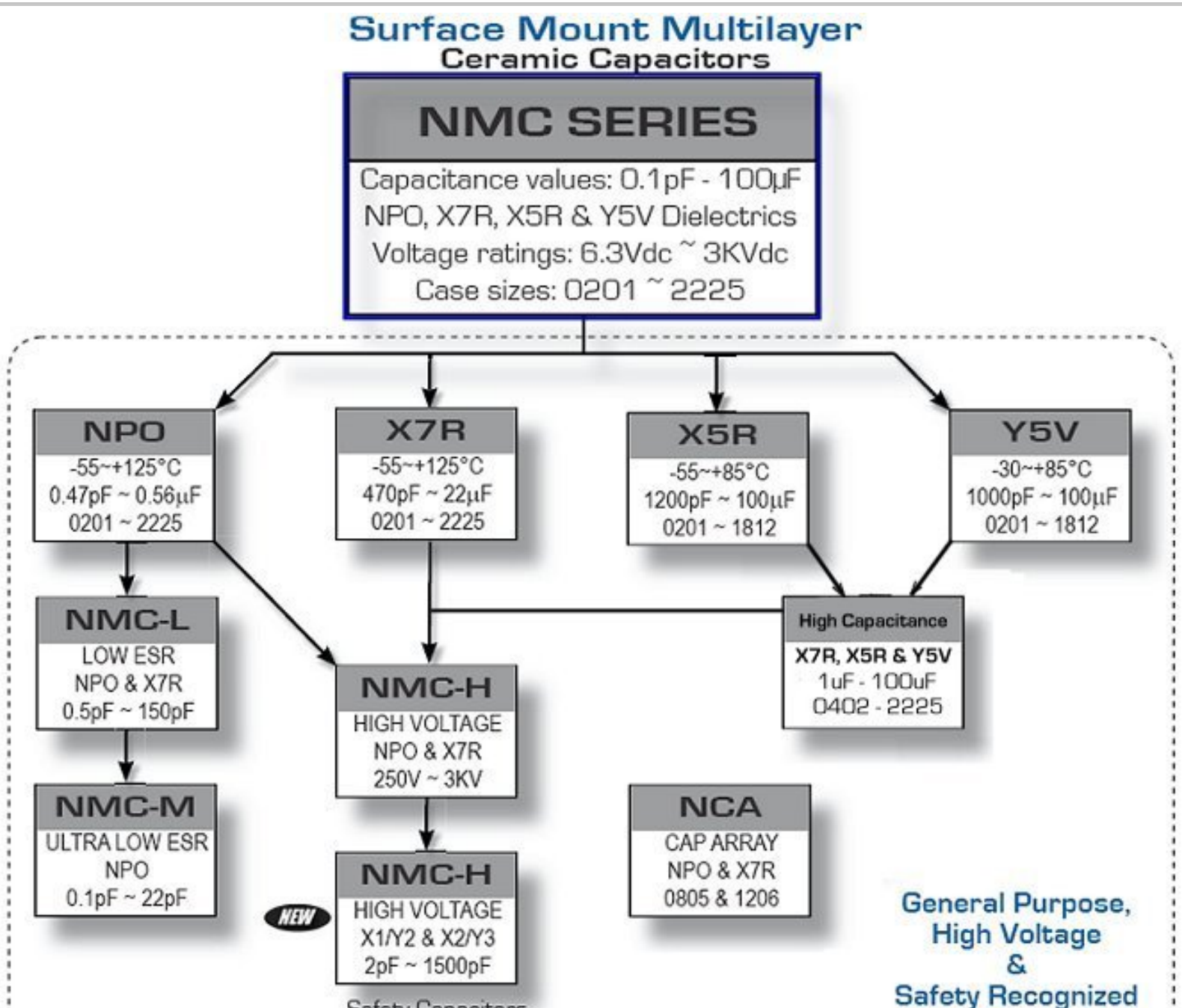
Type	Series	Temperature Rating	Description	Capacitance Range	Voltage Rating	Sizes
	NMC NPO	-55 ~ +125°C	Class I: NPO Low Loss - High Stability	0.5pF~0.10uF	50VDC 100VDC	0201 ~ 2225
	NMC-L NPO	-55 ~ +125°C	Class I: NPO Low ESR @ High Frequency	0.5pF~150pF	50VDC 100VDC	0402 0603 0805
	NMC-M NPO NEW	-55 ~ +125°C	Class I: NPO High Q @ High Frequency	0.4pF~22pF	50VDC	0201 0402 0603

Multilayer Ceramic Chip (MLCC)	**NMC X7R**	**-55 ~ +125°C**	Class II: **X7R** Semi-Stable TC	100pF~2.2uF	25VDC 50VDC 100VDC	0201 ~ 2225
	NMC X5R	**-55 ~ +85°C**	Class II: **X5R** Semi-Stable TC, High Cap	0.012uF ~ **100uF**	6.3V, 10, 16, 25, 35 & 50VDC	0201 ~ 1812
	NMC High Cap EXPANDED	**-55 ~ +85°C** **-30 ~ +85°C**	Class II: **X5R & Y5V** Semi-Stable TC, High Cap	1uF ~ **100uF**	6.3V, 10, 16, 25, 35 & 50VDC	0201 ~ 1812
	NMC Y5V	**-30 ~ +85°C**	Class III: **Y5V** High K, High Cap	.001uF ~ **100uF**	16, 25 & 50VDC	0201 ~ 2225
	NMC-H	**-55 ~ +125°C**	**High Voltage** NPO, X7R	1.0pF ~ 1.2uF	200, 500 & 1KVDC	0603 ~ 2225
	NMC-H **X1 / Y2** NEW	**-55 ~ + 125°C**	UL Listed **Class X1 / Y2** Across the Line **Safety Agency Approved** Capacitors **NPO, X7R**	2pF ~ 0.0015uF	5000VDC / 250VAC	1808 1812
	NMC-H **X2 / Y3**	**-55 ~ + 125°C**	TUV & UL Listed **Class X2 / Y3** Across the Line **Safety Agency Approved** Capacitors **NPO, X7R**	5pF ~ 0.0015uF	3000VDC / 250VAC	1808

SMT 8-Terminal Ceramic Capacitor Arrays

Type	Series	Temperature Rating	Description	Capacitance Range	Voltage Rating	Sizes

Cap Arrays	**NCA**	**-55 ~ +125°C** **+10 ~ +85°C**	8 Terminal NPO, X7R & Y5V **Capacitor Array**	10pF~0.47uF	16VDC 25VDC 50VDC 100VDC	0508 0612



Safety Capacitors

Safety Recognized

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TDK

High Voltage Multilayer Ceramic Chip Capacitors
C Series C4520 and C4532 Types

Temperature Characteristic JIS CH, EIA C0G

FEATURES

- Advanced design prevents discharges on the ceramic surface and provides improved withstand voltage characteristics.
- TDK's proprietary internal electrode structure and the use of high-dielectric-strength material result in highly reliable performance in high-voltage applications.
- Complies with ISO8802-3 for LAN applications.
- Designed exclusively for reflow soldering.

APPLICATIONS

Inverter circuits with a liquid crystal backlight, LAN products, and general high voltage circuits.

PRODUCT IDENTIFICATION

C	4520	C0G	3F	101	K	□
(1)	(2)	(3)	(4)	(5)	(6)	(7)

(1) Series name

(2) Dimensions L×W

4520	4.5×2.0mm
4532	4.5×3.2mm

(3) Capacitance temperature characteristics

Class 1

Temperature characteristics	Temperature coefficient	Temperature range
CH	0±60ppm/°C	–25 to +85°C
C0G	0±30ppm/°C	–55 to +125°C

(4) Rated voltage Edc

3F	3kV

(5) Nominal capacitance

The capacitance is expressed in three digit codes and in units of pico farads(pF).The first and second digits identify the first and second significant figures of the capacitance.
The third digit identifies the multiplier.

101	100pF

(6) Capacitance tolerance

F	±1pF[10pF]
K	±10%[over 10pF]

(7) Packaging style

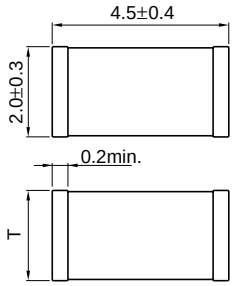
T	Taping (reel)
B	Bulk

PRECAUTIONS

- This product intended solely for reflow soldering.
- A slit of about 1mm on the circuit board is recommended to improve washability of the flux after soldering.
- Ensure that this product is completely dried following washing.
- Because this product will be subjected to high voltages, use only low-activity rosin flux (with 0.2% max. of chlorine).
- Using this product with aluminum circuit boards must be considered a special implementation. Due consideration must be given in such implementations because of the high heat stress levels involved.

• All specifications are subject to change without notice.

C4520(EIA CC1808) TYPE
SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 1
TEMPERATURE CHARACTERISTICS:
JIS CH(0±60ppm/°C), EIA C0G(0±30ppm/°C)

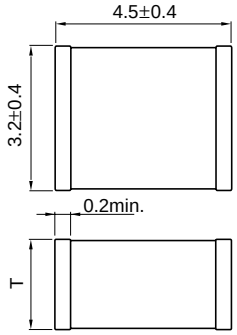
RATED VOLTAGE Edc: 3kV

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
10	±1pF	0.85±0.2	C4520CH3F100F
12	±10%	0.85±0.2	C4520CH3F120K
15	±10%	1.1±0.2	C4520CH3F150K
18	±10%	1.1±0.2	C4520CH3F180K
22	±10%	1.1±0.2	C4520CH3F220K
27	±10%	1.6±0.2	C4520CH3F270K
33	±10%	1.6±0.2	C4520CH3F330K
39	±10%	1.6±0.2	C4520CH3F390K
47	±10%	1.6±0.2	C4520CH3F470K
56	±10%	2.0±0.2	C4520CH3F560K
68	±10%	2.0±0.2	C4520CH3F680K
82	±10%	2.0±0.2	C4520CH3F820K
100	±10%	2.0±0.2	C4520CH3F101K

- Part number for temperature characteristic C0G
  Please substitute "C0G" for "CH" in the part number when ordering.

- For more information about the products of other capacitance or data, please contact us.

C4532(EIA CC1812) TYPE
SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 1
TEMPERATURE CHARACTERISTICS:
JIS CH(0±60ppm/°C), EIA C0G(0±30ppm/°C)

RATED VOLTAGE Edc: 3kV

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
100	±10%	1.6±0.2	C4532CH3F101K
120	±10%	1.6±0.2	C4532CH3F121K
150	±10%	1.6±0.2	C4532CH3F151K
180	±10%	1.6±0.2	C4532CH3F181K
220	±10%	2.0±0.2	C4532CH3F221K
270	±10%	2.3±0.2	C4532CH3F271K
330	±10%	2.5±0.3	C4532CH3F331K

- Part number for temperature characteristic C0G
  Please substitute "C0G" for "CH" in the part number when ordering.

- All specifications are subject to change without notice.

TDK

Mid Voltage Multilayer Ceramic Chip Capacitors
C Series

FEATURES

- The unique design structure for mid voltage enables a compact size with high voltage withstanding.
- Rated voltage Edc: 100, 250 and 630V.
- C3225, C4532 and C5750 types are specific to reflow soldering.

APPLICATIONS

Snubber circuits for switching power supply, ringer circuits for telephone and modem, or other general high voltage circuits.

PRODUCT IDENTIFICATION

C	1608	CH	2E	101	J	□
(1)	(2)	(3)	(4)	(5)	(6)	(7)

(1) Series name

(2) Dimensions

1608	1.6×0.8mm
2012	2.0×1.25mm
3216	3.2×1.6mm
3225	3.2×2.5mm
4532	4.5×3.2mm
5750	5.7×5.0mm

(3) Capacitance temperature characteristics

Class 1 (Temperature compensation)

Temperature characteristics	Capacitance change	Temperature range
CH	0±60ppm/°C	–25 to +85°C
C0G	0±30ppm/°C	–55 to +125°C

Class 2

Temperature characteristics	Capacitance change	Temperature range
B(JB*)	±10%	–25 to +85°C
X7R	±15%	–55 to +125°C
X5R	±15%	–55 to +85°C

*JB(JIS: BJ)

(4) Rated voltage Edc

2A	100V
2E	250V
2J	630V

(5) Nominal capacitance

The capacitance is expressed in three digit codes and in units of pico farads (pF).

The first and second digits identify the first and second significant figures of the capacitance.

The third digit identifies the multiplier.

R designates a decimal point.

101	100pF
102	1,000pF
333	33,000pF
474	470,000pF

(6) Capacitance tolerance

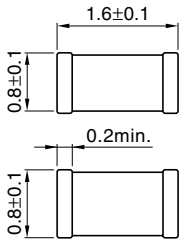
J	±5%
K	±10%
M	±20%

(7) Packaging style

T	Taping (reel)
B	Bulk

• All specifications are subject to change without notice.

C1608 (EIA CC0603) TYPE
SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 1
TEMPERATURE CHARACTERISTICS:
JIS CH(0±60ppm/°C), EIA C0G(0±30ppm/°C)

RATED VOLTAGE Edc: 250V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
100	±5%	0.8±0.1	C1608CH2E101J
	±10%	0.8±0.1	C1608CH2E101K
120	±5%	0.8±0.1	C1608CH2E121J
	±10%	0.8±0.1	C1608CH2E121K
150	±5%	0.8±0.1	C1608CH2E151J
	±10%	0.8±0.1	C1608CH2E151K
180	±5%	0.8±0.1	C1608CH2E181J
	±10%	0.8±0.1	C1608CH2E181K
220	±5%	0.8±0.1	C1608CH2E221J
	±10%	0.8±0.1	C1608CH2E221K
270	±5%	0.8±0.1	C1608CH2E271J
	±10%	0.8±0.1	C1608CH2E271K
330	±5%	0.8±0.1	C1608CH2E331J
	±10%	0.8±0.1	C1608CH2E331K
390	±5%	0.8±0.1	C1608CH2E391J
	±10%	0.8±0.1	C1608CH2E391K
470	±5%	0.8±0.1	C1608CH2E471J
	±10%	0.8±0.1	C1608CH2E471K
560	±5%	0.8±0.1	C1608CH2E561J
	±10%	0.8±0.1	C1608CH2E561K
680	±5%	0.8±0.1	C1608CH2E681J
	±10%	0.8±0.1	C1608CH2E681K

RATED VOLTAGE Edc: 100V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
100	±5%	0.8±0.1	C1608CH2A101J
	±10%	0.8±0.1	C1608CH2A101K
120	±5%	0.8±0.1	C1608CH2A121J
	±10%	0.8±0.1	C1608CH2A121K
150	±5%	0.8±0.1	C1608CH2A151J
	±10%	0.8±0.1	C1608CH2A151K
180	±5%	0.8±0.1	C1608CH2A181J
	±10%	0.8±0.1	C1608CH2A181K
220	±5%	0.8±0.1	C1608CH2A221J
	±10%	0.8±0.1	C1608CH2A221K
270	±5%	0.8±0.1	C1608CH2A271J
	±10%	0.8±0.1	C1608CH2A271K
330	±5%	0.8±0.1	C1608CH2A331J
	±10%	0.8±0.1	C1608CH2A331K
390	±5%	0.8±0.1	C1608CH2A391J
	±10%	0.8±0.1	C1608CH2A391K
470	±5%	0.8±0.1	C1608CH2A471J
	±10%	0.8±0.1	C1608CH2A471K
560	±5%	0.8±0.1	C1608CH2A561J
	±10%	0.8±0.1	C1608CH2A561K
680	±5%	0.8±0.1	C1608CH2A681J
	±10%	0.8±0.1	C1608CH2A681K
1,000	±5%	0.8±0.1	C1608CH2A102J
	±10%	0.8±0.1	C1608CH2A102K
1,200	±5%	0.8±0.1	C1608CH2A122J
	±10%	0.8±0.1	C1608CH2A122K

- Part number for temperature characteristic C0G
  Please substitute "C0G" for "CH" in the part number when ordering.

CAPACITANCE RANGES: CLASS 2
TEMPERATURE CHARACTERISTICS:
JIS B(BJ)(±10%), EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 100V

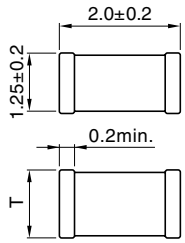
Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,000	±10%	0.8±0.1	C1608JB2A102K
	±20%	0.8±0.1	C1608JB2A102M
1,500	±10%	0.8±0.1	C1608JB2A152K
	±20%	0.8±0.1	C1608JB2A152M
2,200	±10%	0.8±0.1	C1608JB2A222K
	±20%	0.8±0.1	C1608JB2A222M
3,300	±10%	0.8±0.1	C1608JB2A332K
	±20%	0.8±0.1	C1608JB2A332M
4,700	±10%	0.8±0.1	C1608JB2A472K
	±20%	0.8±0.1	C1608JB2A472M
6,800	±10%	0.8±0.1	C1608JB2A682K
	±20%	0.8±0.1	C1608JB2A682M
10,000	±10%	0.8±0.1	C1608JB2A103K
	±20%	0.8±0.1	C1608JB2A103M
15,000	±10%	0.8±0.1	C1608JB2A153K
	±20%	0.8±0.1	C1608JB2A153M
22,000	±10%	0.8±0.1	C1608JB2A223K
	±20%	0.8±0.1	C1608JB2A223M

- Part number for temperature characteristic X5R or X7R
  Please substitute "X5R" or "X7R" for "JB" in the part number when ordering.
- Standard tolerance is ±20% for B and X7R products.

- For more information about the products of other capacitance or data, please contact us.

• All specifications are subject to change without notice.

C2012 (EIA CC0805) TYPE
SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 1
TEMPERATURE CHARACTERISTICS:
JIS CH(0±60ppm/°C), EIA C0G(0±30ppm/°C)

RATED VOLTAGE Edc: 250V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
820	±5%	0.6±0.1	C2012CH2E821J
	±10%	0.6±0.1	C2012CH2E821K
1,000	±5%	0.85±0.15	C2012CH2E102J
	±10%	0.85±0.15	C2012CH2E102K
1,200	±5%	0.85±0.15	C2012CH2E122J
	±10%	0.85±0.15	C2012CH2E122K
1,500	±5%	0.85±0.15	C2012CH2E152J
	±10%	0.85±0.15	C2012CH2E152K
1,800	±5%	1.25±0.2	C2012CH2E182J
	±10%	1.25±0.2	C2012CH2E182K
2,200	±5%	1.25±0.2	C2012CH2E222J
	±10%	1.25±0.2	C2012CH2E222K
2,700	±5%	1.25±0.2	C2012CH2E272J
	±10%	1.25±0.2	C2012CH2E272K

RATED VOLTAGE Edc: 100V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,000	±5%	0.6±0.1	C2012CH2A102J
	±10%	0.6±0.1	C2012CH2A102K
1,200	±5%	0.6±0.1	C2012CH2A122J
	±10%	0.6±0.1	C2012CH2A122K
1,500	±5%	0.6±0.1	C2012CH2A152J
	±10%	0.6±0.1	C2012CH2A152K
1,800	±5%	0.85±0.15	C2012CH2A182J
	±10%	0.85±0.15	C2012CH2A182K
2,200	±5%	0.85±0.15	C2012CH2A222J
	±10%	0.85±0.15	C2012CH2A222K
2,700	±5%	1.25±0.2	C2012CH2A272J
	±10%	1.25±0.2	C2012CH2A272K
3,300	±5%	1.25±0.2	C2012CH2A332J
	±10%	1.25±0.2	C2012CH2A332K
3,900	±5%	1.25±0.2	C2012CH2A392J
	±10%	1.25±0.2	C2012CH2A392K
4,700	±5%	1.25±0.2	C2012CH2A472J
	±10%	1.25±0.2	C2012CH2A472K

- Part number for temperature characteristic C0G
  Please substitute "C0G" for "CH" in the part number when ordering.

CAPACITANCE RANGES: CLASS 2
TEMPERATURE CHARACTERISTICS:
JIS B(BJ)(±10%), EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 250V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,000	±10%	0.85±0.15	C2012JB2E102K
	±20%	0.85±0.15	C2012JB2E102M
1,500	±10%	0.85±0.15	C2012JB2E152K
	±20%	0.85±0.15	C2012JB2E152M
2,200	±10%	0.85±0.15	C2012JB2E222K
	±20%	0.85±0.15	C2012JB2E222M
3,300	±10%	0.85±0.15	C2012JB2E332K
	±20%	0.85±0.15	C2012JB2E332M
4,700	±10%	0.85±0.15	C2012JB2E472K
	±20%	0.85±0.15	C2012JB2E472M
6,800	±10%	1.25±0.2	C2012JB2E682K
	±20%	1.25±0.2	C2012JB2E682M
10,000	±10%	1.25±0.2	C2012JB2E103K
	±20%	1.25±0.2	C2012JB2E103M
15,000	±10%	1.25±0.2	C2012JB2E153K
	±20%	1.25±0.2	C2012JB2E153M
22,000	±10%	1.25±0.2	C2012JB2E223K
	±20%	1.25±0.2	C2012JB2E223M

RATED VOLTAGE Edc: 100V

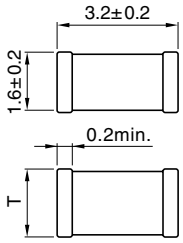
Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,000	±10%	0.85±0.15	C2012JB2A102K
	±20%	0.85±0.15	C2012JB2A102M
1,500	±10%	0.85±0.15	C2012JB2A152K
	±20%	0.85±0.15	C2012JB2A152M
2,200	±10%	0.85±0.15	C2012JB2A222K
	±20%	0.85±0.15	C2012JB2A222M
3,300	±10%	0.85±0.15	C2012JB2A332K
	±20%	0.85±0.15	C2012JB2A332M
4,700	±10%	0.85±0.15	C2012JB2A472K
	±20%	0.85±0.15	C2012JB2A472M
6,800	±10%	0.85±0.15	C2012JB2A682K
	±20%	0.85±0.15	C2012JB2A682M
10,000	±10%	0.85±0.15	C2012JB2A103K
	±20%	0.85±0.15	C2012JB2A103M
15,000	±10%	1.25±0.2	C2012JB2A153K
	±20%	1.25±0.2	C2012JB2A153M
22,000	±10%	1.25±0.2	C2012JB2A223K
	±20%	1.25±0.2	C2012JB2A223M
33,000	±10%	1.25±0.2	C2012JB2A333K
	±20%	1.25±0.2	C2012JB2A333M
47,000	±10%	1.25±0.2	C2012JB2A473K
	±20%	1.25±0.2	C2012JB2A473M
68,000	±10%	1.25±0.2	C2012JB2A683K
	±20%	1.25±0.2	C2012JB2A683M
100,000	±10%	1.25±0.2	C2012JB2A104K
	±20%	1.25±0.2	C2012JB2A104M

- Part number for temperature characteristic X5R or X7R
  Please substitute "X5R" or "X7R" for "JB" in the part number when ordering.
- Standard tolerance is ±20% for B and X7R products.

- For more information about the products of other capacitance or data, please contact us.

- All specifications are subject to change without notice.

C3216 (EIA CC1206) TYPE
SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 1
TEMPERATURE CHARACTERISTICS:
JIS CH(0±60ppm/°C), EIA C0G(0±30ppm/°C)

RATED VOLTAGE Edc: 630V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
100	±5%	0.6±0.1	C3216CH2J101J
	±10%	0.6±0.1	C3216CH2J101K
120	±5%	0.6±0.1	C3216CH2J121J
	±10%	0.6±0.1	C3216CH2J121K
150	±5%	0.6±0.1	C3216CH2J151J
	±10%	0.6±0.1	C3216CH2J151K
180	±5%	0.6±0.1	C3216CH2J181J
	±10%	0.6±0.1	C3216CH2J181K
220	±5%	0.6±0.1	C3216CH2J221J
	±10%	0.6±0.1	C3216CH2J221K
270	±5%	0.6±0.1	C3216CH2J271J
	±10%	0.6±0.1	C3216CH2J271K
330	±5%	0.6±0.1	C3216CH2J331J
	±10%	0.6±0.1	C3216CH2J331K
390	±5%	0.6±0.1	C3216CH2J391J
	±10%	0.6±0.1	C3216CH2J391K
470	±5%	0.85±0.15	C3216CH2J471J
	±10%	0.85±0.15	C3216CH2J471K
560	±5%	0.85±0.15	C3216CH2J561J
	±10%	0.85±0.15	C3216CH2J561K
680	±5%	0.85±0.15	C3216CH2J681J
	±10%	0.85±0.15	C3216CH2J681K
1,000	±5%	0.85±0.15	C3216CH2J102J
	±10%	0.85±0.15	C3216CH2J102K
1,200	±5%	0.85±0.15	C3216CH2J122J
	±10%	0.85±0.15	C3216CH2J122K
1,500	±5%	1.15±0.15	C3216CH2J152J
	±10%	1.15±0.15	C3216CH2J152K
1,800	±5%	1.15±0.15	C3216CH2J182J
	±10%	1.15±0.15	C3216CH2J182K
2,200	±5%	1.15±0.15	C3216CH2J222J
	±10%	1.15±0.15	C3216CH2J222K
2,700	±5%	1.6±0.2	C3216CH2J272J
	±10%	1.6±0.2	C3216CH2J272K
3,300	±5%	1.6±0.2	C3216CH2J332J
	±10%	1.6±0.2	C3216CH2J332K

RATED VOLTAGE Edc: 250V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
3,300	±5%	0.85±0.15	C3216CH2E332J
	±10%	0.85±0.15	C3216CH2E332K
3,900	±5%	1.15±0.15	C3216CH2E392J
	±10%	1.15±0.15	C3216CH2E392K
4,700	±5%	1.15±0.15	C3216CH2E472J
	±10%	1.15±0.15	C3216CH2E472K
5,600	±5%	1.15±0.15	C3216CH2E562J
	±10%	1.15±0.15	C3216CH2E562K
6,800	±5%	1.6±0.2	C3216CH2E682J
	±10%	1.6±0.2	C3216CH2E682K
8,200	±5%	1.6±0.2	C3216CH2E822J
	±10%	1.6±0.2	C3216CH2E822K

RATED VOLTAGE Edc: 100V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
3,900	±5%	0.6±0.1	C3216CH2A392J
	±10%	0.6±0.1	C3216CH2A392K
4,700	±5%	0.85±0.15	C3216CH2A472J
	±10%	0.85±0.15	C3216CH2A472K
5,600	±5%	0.85±0.15	C3216CH2A562J
	±10%	0.85±0.15	C3216CH2A562K
6,800	±5%	1.15±0.15	C3216CH2A682J
	±10%	1.15±0.15	C3216CH2A682K
8,200	±5%	1.15±0.15	C3216CH2A822J
	±10%	1.15±0.15	C3216CH2A822K
10,000	±5%	1.15±0.15	C3216CH2A103J
	±10%	1.15±0.15	C3216CH2A103K

- Part number for temperature characteristic C0G
  Please substitute "C0G" for "CH" in the part number when ordering.

- For more information about the products of other capacitance or data, please contact us.

- All specifications are subject to change without notice.

TDK

CAPACITANCE RANGES: CLASS 2
TEMPERATURE CHARACTERISTICS:
JIS B(BJ)(±10%), EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 630V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,000	±10%	1.15±0.15	C3216JB2J102K
	±20%	1.15±0.15	C3216JB2J102M
1,500	±10%	1.15±0.15	C3216JB2J152K
	±20%	1.15±0.15	C3216JB2J152M
2,200	±10%	1.15±0.15	C3216JB2J222K
	±20%	1.15±0.15	C3216JB2J222M
3,300	±10%	1.15±0.15	C3216JB2J332K
	±20%	1.15±0.15	C3216JB2J332M
4,700	±10%	1.15±0.15	C3216JB2J472K
	±20%	1.15±0.15	C3216JB2J472M
6,800	±10%	1.15±0.15	C3216JB2J682K
	±20%	1.15±0.15	C3216JB2J682M
10,000	±10%	1.15±0.15	C3216JB2J103K
	±20%	1.15±0.15	C3216JB2J103M
15,000	±10%	1.3±0.2	C3216JB2J153K
	±20%	1.3±0.2	C3216JB2J153M
22,000	±10%	1.3±0.2	C3216JB2J223K
	±20%	1.3±0.2	C3216JB2J223M
33,000	±10%	1.6±0.2	C3216JB2J333K
	±20%	1.6±0.2	C3216JB2J333M

RATED VOLTAGE Edc: 250V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
15,000	±10%	1.15±0.15	C3216JB2E153K
	±20%	1.15±0.15	C3216JB2E153M
22,000	±10%	1.15±0.15	C3216JB2E223K
	±20%	1.15±0.15	C3216JB2E223M
33,000	±10%	1.6±0.2	C3216JB2E333K
	±20%	1.6±0.2	C3216JB2E333M
47,000	±10%	1.6±0.2	C3216JB2E473K
	±20%	1.6±0.2	C3216JB2E473M
68,000	±10%	1.6±0.2	C3216JB2E683K
	±20%	1.6±0.2	C3216JB2E683M
100,000	±10%	1.6±0.2	C3216JB2E104K
	±20%	1.6±0.2	C3216JB2E104M

RATED VOLTAGE Edc: 100V

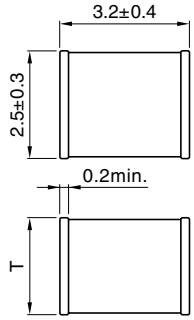
Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
33,000	±10%	1.15±0.15	C3216JB2A333K
	±20%	1.15±0.15	C3216JB2A333M
47,000	±10%	1.15±0.15	C3216JB2A473K
	±20%	1.15±0.15	C3216JB2A473M
68,000	±10%	1.6±0.2	C3216JB2A683K
	±20%	1.6±0.2	C3216JB2A683M
100,000	±10%	1.6±0.2	C3216JB2A104K
	±20%	1.6±0.2	C3216JB2A104M
150,000	±10%	1.6±0.2	C3216JB2A154K
	±20%	1.6±0.2	C3216JB2A154M
220,000	±10%	1.15±0.15	C3216JB2A224K
	±20%	1.15±0.15	C3216JB2A224M
330,000	±10%	1.3±0.2	C3216JB2A334K
	±20%	1.3±0.2	C3216JB2A334M
470,000	±10%	1.6±0.2	C3216JB2A474K
	±20%	1.6±0.2	C3216JB2A474M

- Part number for temperature characteristic X5R or X7R
  Please substitute "X5R" or "X7R" for "JB" in the part number when ordering.
- Standard tolerance is ±20% for B and X7R products.

- For more information about the products of other capacitance or data, please contact us.

- All specifications are subject to change without notice.

C3225 (EIA CC1210) TYPE
SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 1
TEMPERATURE CHARACTERISTICS:
JIS CH(0±60ppm/°C), EIA C0G(0±30ppm/°C)

RATED VOLTAGE Edc: 630V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
3,900	±5%	1.25±0.2	C3225CH2J392J
	±10%	1.25±0.2	C3225CH2J392K
4,700	±5%	1.6±0.2	C3225CH2J472J
	±10%	1.6±0.2	C3225CH2J472K
5,600	±5%	1.6±0.2	C3225CH2J562J
	±10%	1.6±0.2	C3225CH2J562K
6,800	±5%	2.0±0.2	C3225CH2J682J
	±10%	2.0±0.2	C3225CH2J682K

RATED VOLTAGE Edc: 250V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
10,000	±5%	1.6±0.2	C3225CH2E103J
	±10%	1.6±0.2	C3225CH2E103K
15,000	±5%	2.0±0.2	C3225CH2E153J
	±10%	2.0±0.2	C3225CH2E153K

RATED VOLTAGE Edc: 100V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
15,000	±5%	1.25±0.2	C3225CH2A153J
	±10%	1.25±0.2	C3225CH2A153K
22,000	±5%	1.6±0.2	C3225CH2A223J
	±10%	1.6±0.2	C3225CH2A223K
33,000	±5%	2.0±0.2	C3225CH2A333J
	±10%	2.0±0.2	C3225CH2A333K
47,000	±5%	2.3±0.2	C3225CH2A473J
	±10%	2.3±0.2	C3225CH2A473K

- Part number for temperature characteristic C0G
  Please substitute "C0G" for "CH" in the part number when ordering.

CAPACITANCE RANGES: CLASS 2
TEMPERATURE CHARACTERISTICS:
JIS B(BJ)(±10%), EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 630V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
47,000	±10%	2.0±0.2	C3225JB2J473K
	±20%	2.0±0.2	C3225JB2J473M
68,000	±10%	2.0±0.2	C3225JB2J683K
	±20%	2.0±0.2	C3225JB2J683M

RATED VOLTAGE Edc: 250V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
100,000	±10%	2.0±0.2	C3225JB2E104K
	±20%	2.0±0.2	C3225JB2E104M
150,000	±10%	2.0±0.2	C3225JB2E154K
	±20%	2.0±0.2	C3225JB2E154M
220,000	±10%	2.0±0.2	C3225JB2E224K
	±20%	2.0±0.2	C3225JB2E224M

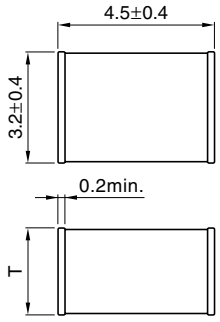
RATED VOLTAGE Edc: 100V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
330,000	±10%	2.0±0.2	C3225JB2A334K
	±20%	2.0±0.2	C3225JB2A334M
470,000	±10%	2.0±0.2	C3225JB2A474K
	±20%	2.0±0.2	C3225JB2A474M
680,000	±10%	1.6±0.2	C3225JB2A684K
	±20%	1.6±0.2	C3225JB2A684M
1,000,000 [1μF]	±10%	2.0±0.2	C3225JB2A105K
	±20%	2.0±0.2	C3225JB2A105M

- Part number for temperature characteristic X5R or X7R
  Please substitute "X5R" or "X7R" for "JB" in the part number when ordering.

- For more information about the products of other capacitance or data, please contact us.

C4532 (EIA CC1812) TYPE
SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 1
TEMPERATURE CHARACTERISTICS:
JIS CH(0±60ppm/°C), EIA C0G(0±30ppm/°C)

RATED VOLTAGE Edc: 630V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
8,200	±5%	1.6±0.2	C4532CH2J822J
	±10%	1.6±0.2	C4532CH2J822K
10,000	±5%	1.6±0.2	C4532CH2J103J
	±10%	1.6±0.2	C4532CH2J103K
15,000	±5%	2.5±0.3	C4532CH2J153J
	±10%	2.5±0.3	C4532CH2J153K
22,000	±5%	3.2±0.3	C4532CH2J223J
	±10%	3.2±0.3	C4532CH2J223K

RATED VOLTAGE Edc: 250V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
22,000	±5%	1.6±0.2	C4532CH2E223J
	±10%	1.6±0.2	C4532CH2E223K
33,000	±5%	2.0±0.2	C4532CH2E333J
	±10%	2.0±0.2	C4532CH2E333K
47,000	±5%	3.2±0.3	C4532CH2E473J
	±10%	3.2±0.3	C4532CH2E473K

RATED VOLTAGE Edc: 100V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
47,000	±5%	2.0±0.2	C4532CH2A473J
	±10%	2.0±0.2	C4532CH2A473K
68,000	±5%	2.5±0.3	C4532CH2A683J
	±10%	2.5±0.3	C4532CH2A683K
100,000	±5%	3.2±0.4	C4532CH2A104J
	±10%	3.2±0.4	C4532CH2A104K

- Part number for temperature characteristic C0G
  Please substitute "C0G" for "CH" in the part number when ordering.

CAPACITANCE RANGES: CLASS 2
TEMPERATURE CHARACTERISTICS:
JIS B(BJ)(±10%), EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 630V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
68,000	±10%	1.6±0.2	C4532JB2J683K
	±20%	1.6±0.2	C4532JB2J683M
100,000	±10%	2.3±0.2	C4532JB2J104K
	±20%	2.3±0.2	C4532JB2J104M

RATED VOLTAGE Edc: 250V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
150,000	±10%	1.6±0.2	C4532JB2E154K
	±20%	1.6±0.2	C4532JB2E154M
220,000	±10%	2.3±0.2	C4532JB2E224K
	±20%	2.3±0.2	C4532JB2E224M
330,000	±10%	2.3±0.2	C4532JB2E334K
	±20%	2.3±0.2	C4532JB2E334M
470,000	±10%	2.3±0.2	C4532JB2E474K
	±20%	2.3±0.2	C4532JB2E474M

RATED VOLTAGE Edc: 100V

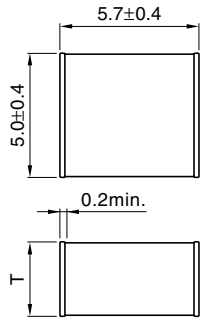
Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
680,000	±10%	2.3±0.2	C4532JB2A684K
	±20%	2.3±0.2	C4532JB2A684M
1,000,000 [1μF]	±10%	2.3±0.2	C4532JB2A105K
	±20%	2.3±0.2	C4532JB2A105M
1,500,000	±10%	2.3±0.2	C4532JB2A155K
	±20%	2.3±0.2	C4532JB2A155M
2,200,000	±10%	2.3±0.2	C4532JB2A225K
	±20%	2.3±0.2	C4532JB2A225M

- Part number for temperature characteristic X5R or X7R
  Please substitute "X5R" or "X7R" for "JB" in the part number when ordering.

- For more information about the products of other capacitance or data, please contact us.

- All specifications are subject to change without notice.

C5750 (EIA CC2220) TYPE
SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 2
TEMPERATURE CHARACTERISTICS:
JIS B(BJ)(±10%), EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 630V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
150,000	±10%	1.6±0.2	C5750JB2J154K
	±20%	1.6±0.2	C5750JB2J154M
220,000	±10%	2.3±0.2	C5750JB2J224K
	±20%	2.3±0.2	C5750JB2J224M

RATED VOLTAGE Edc: 250V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
330,000	±10%	1.6±0.2	C5750JB2E334K
	±20%	1.6±0.2	C5750JB2E334M
470,000	±10%	2.3±0.2	C5750JB2E474K
	±20%	2.3±0.2	C5750JB2E474M
680,000	±10%	2.3±0.2	C5750JB2E684K
	±20%	2.3±0.2	C5750JB2E684M
1,000,000 [1μF]	±10%	2.3±0.2	C5750JB2E105K
	±20%	2.3±0.2	C5750JB2E105M

RATED VOLTAGE Edc: 100V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
680,000	±10%	1.6±0.2	C5750JB2A684K
	±20%	1.6±0.2	C5750JB2A684M
1,000,000 [1μF]	±10%	2.3±0.2	C5750JB2A105K
	±20%	2.3±0.2	C5750JB2A105M
1,500,000	±10%	2.3±0.2	C5750JB2A155K
	±20%	2.3±0.2	C5750JB2A155M
2,200,000	±10%	2.3±0.2	C5750JB2A225K
	±20%	2.3±0.2	C5750JB2A225M
3,300,000	±10%	2.3±0.2	C5750JB2A335K
	±20%	2.3±0.2	C5750JB2A335M
4,700,000	±10%	2.3±0.2	C5750JB2A475K
	±20%	2.3±0.2	C5750JB2A475M

- Part number for temperature characteristic X5R or X7R
  Please substitute "X5R" or "X7R" for "JB" in the part number when ordering.

- For more information about the products of other capacitance or data, please contact us.

• All specifications are subject to change without notice.

TDK

General Multilayer Ceramic Chip Capacitors
C Series

FEATURES

- High capacitance has been achieved through precision technologies that enable the use of multiple thinner ceramic dielectric layers.
- A monolithic structure ensures superior mechanical strength and reliability.
- High-accuracy automatic mounting is facilitated through the maintenance of very precise dimensional tolerances.
- Composed of only ceramics and metals, these capacitors provide extremely dependable performance, exhibiting virtually no degradation even when subjected to temperature extremes.
- Low stray capacitance ensures high conformity with nominal values, thereby simplifying the circuit design process.
- Low residual inductance assures superior frequency characteristics.
- Because electrostatic capacity has been obtained up to the electrolytic capacitor range, these capacitors offer long service life and are optimally suited for power supply designs that require high levels of reliability.
- Owing to their low ESR and excellent frequency characteristics, these products are optimally suited for high frequency and high-density type power supplies.

PRODUCT IDENTIFICATION

C	0603	CH	1H	100	D	□
(1)	(2)	(3)	(4)	(5)	(6)	(7)

(1) Series name

(2) Dimensions L×W

0603	0.6×0.3mm
1005	1.0×0.5mm
1608	1.6×0.8mm
2012	2.0×1.25mm
3216	3.2×1.6mm
3225	3.2×2.5mm
4532	4.5×3.2mm
5750	5.7×5.0mm

(3) Capacitance temperature characteristics

Class 1 (Temperature compensation)

Temperature characteristics	Capacitance change	Temperature range
CH	0±60ppm/°C	–25 to +85°C
C0G	0±30ppm/°C	–55 to +125°C
SL	+350 to –1000ppm/°C	+20 to +85°C

Class 2

Temperature characteristics	Capacitance change	Temperature range
B(JB*)	±10%	–25 to +85°C
F(JF*)	+30, –80%	–25 to +85°C
X7R	±15%	–55 to +125°C
X5R	±15%	–55 to +85°C
Y5V	+22, –82%	–30 to +85°C

*JB(JIS: BJ), JF(JIS: FJ)

(4) Rated voltage Edc

0J	6.3V
1A	10V
1C	16V
1E	25V
1H	50V

(5) Nominal capacitance

The capacitance is expressed in three digit codes and in units of pico farads (pF).

The first and second digits identify the first and second significant figures of the capacitance.

The third digit identifies the multiplier.

R designates a decimal point.

010	1pF
100	10pF
102	1,000pF
0R5	0.5pF

(6) Capacitance tolerance

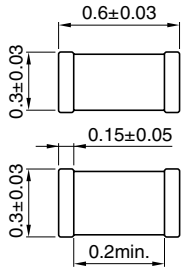
Symbol	Tolerance	Applicable capacitance range
C	±0.25pF	10pF or less
D	±0.5pF	
J	±5%	Over 10pF
K	±10%	
M	±20%	
Z	+80, –20%	

(7) Packaging style

T	Taping (reel)
B	Bulk

• All specifications are subject to change without notice.

C0603 (EIA CC0201) TYPE
SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 1
TEMPERATURE CHARACTERISTICS:
JIS CH(0±60ppm/°C), EIA C0G(0±30ppm/°C)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
0.5	±0.25pF	0.3±0.03	C0603CH1H0R5C
0.75	±0.25pF	0.3±0.03	C0603CH1HR75C
1	±0.25pF	0.3±0.03	C0603CH1H010C
1.5	±0.25pF	0.3±0.03	C0603CH1H1R5C
2	±0.25pF	0.3±0.03	C0603CH1H020C
3	±0.25pF	0.3±0.03	C0603CH1H030C
4	±0.25pF	0.3±0.03	C0603CH1H040C
5	±0.25pF	0.3±0.03	C0603CH1H050C
6	±0.5pF	0.3±0.03	C0603CH1H060D
7	±0.5pF	0.3±0.03	C0603CH1H070D
8	±0.5pF	0.3±0.03	C0603CH1H080D
9	±0.5pF	0.3±0.03	C0603CH1H090D
10	±0.5pF	0.3±0.03	C0603CH1H100D
12	±5%	0.3±0.03	C0603CH1H120J
15	±5%	0.3±0.03	C0603CH1H150J
18	±5%	0.3±0.03	C0603CH1H180J
22	±5%	0.3±0.03	C0603CH1H220J
27	±5%	0.3±0.03	C0603CH1H270J
33	±5%	0.3±0.03	C0603CH1H330J
39	±5%	0.3±0.03	C0603CH1H390J
47	±5%	0.3±0.03	C0603CH1H470J
56	±5%	0.3±0.03	C0603CH1H560J
68	±5%	0.3±0.03	C0603CH1H680J
82	±5%	0.3±0.03	C0603CH1H820J
100	±5%	0.3±0.03	C0603CH1H101J

- Part number for temperature characteristic C0G
  Please substitute "C0G" for "CH" in the part number when ordering.

CAPACITANCE RANGES: CLASS 2
TEMPERATURE CHARACTERISTICS:
JIS B(BJ)(±10%), EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
100	±10%	0.3±0.03	C0603JB1H101K
150	±10%	0.3±0.03	C0603JB1H151K
220	±10%	0.3±0.03	C0603JB1H221K
330	±10%	0.3±0.03	C0603JB1H331K
470	±10%	0.3±0.03	C0603JB1H471K

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
680	±10%	0.3±0.03	C0603JB1E681K
1,000	±10%	0.3±0.03	C0603JB1E102K
1,500	±10%	0.3±0.03	C0603JB1E152K
2,200	±10%	0.3±0.03	C0603JB1E222K

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
3,300	±10%	0.3±0.03	C0603JB1C332K
4,700	±10%	0.3±0.03	C0603JB1C472K

RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
6,800	±10%	0.3±0.03	C0603JB1A682K
10,000	±10%	0.3±0.03	C0603JB1A103K

- Part number for temperature characteristic X5R or X7R
  Please substitute "X5R" or "X7R" for "JB" in the part number when ordering.

TEMPERATURE CHARACTERISTICS:
JIS B(BJ)(±10%), EIA X5R(±15%)

RATED VOLTAGE Edc: 6.3V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
22,000	±10%	0.3±0.03	C0603JB0J223K
47,000	±10%	0.3±0.03	C0603JB0J473K
68,000	±10%	0.3±0.03	C0603JB0J683K
100,000	±10%	0.3±0.03	C0603JB0J104K

- Part number for temperature characteristic X5R
  Please substitute "X5R" for "JB" in the part number when ordering.

TEMPERATURE CHARACTERISTICS:
JIS F(FJ)(+30, –80%), EIA Y5V(+22, –82%)

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,000	+80, –20%	0.3±0.03	C0603JF1E102Z

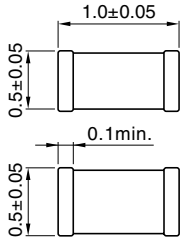
RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
10,000	+80, –20%	0.3±0.03	C0603JF1C103Z

- Part number for temperature characteristic Y5V
  Please substitute "Y5V" for "JF" in the part number when ordering.

- For more information about the products of other capacitance or data, please contact us.

C1005 (EIA CC0402) TYPE
SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 1
TEMPERATURE CHARACTERISTICS:
JIS CH(0±60ppm/°C), EIA C0G(0±30ppm/°C)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
0.5	±0.25pF	0.5±0.05	C1005CH1H0R5C
0.75	±0.25pF	0.5±0.05	C1005CH1HR75C
1	±0.25pF	0.5±0.05	C1005CH1H010C
1.5	±0.25pF	0.5±0.05	C1005CH1H1R5C
2	±0.25pF	0.5±0.05	C1005CH1H020C
3	±0.25pF	0.5±0.05	C1005CH1H030C
4	±0.25pF	0.5±0.05	C1005CH1H040C
5	±0.25pF	0.5±0.05	C1005CH1H050C
6	±0.5pF	0.5±0.05	C1005CH1H060D
7	±0.5pF	0.5±0.05	C1005CH1H070D
8	±0.5pF	0.5±0.05	C1005CH1H080D
9	±0.5pF	0.5±0.05	C1005CH1H090D
10	±0.5pF	0.5±0.05	C1005CH1H100D
12	±5%	0.5±0.05	C1005CH1H120J
15	±5%	0.5±0.05	C1005CH1H150J
18	±5%	0.5±0.05	C1005CH1H180J
22	±5%	0.5±0.05	C1005CH1H220J
27	±5%	0.5±0.05	C1005CH1H270J
33	±5%	0.5±0.05	C1005CH1H330J
39	±5%	0.5±0.05	C1005CH1H390J
47	±5%	0.5±0.05	C1005CH1H470J
56	±5%	0.5±0.05	C1005CH1H560J
68	±5%	0.5±0.05	C1005CH1H680J
82	±5%	0.5±0.05	C1005CH1H820J
100	±5%	0.5±0.05	C1005CH1H101J
120	±5%	0.5±0.05	C1005CH1H121J
150	±5%	0.5±0.05	C1005CH1H151J
180	±5%	0.5±0.05	C1005CH1H181J
220	±5%	0.5±0.05	C1005CH1H221J
270	±5%	0.5±0.05	C1005CH1H271J
330	±5%	0.5±0.05	C1005CH1H331J
390	±5%	0.5±0.05	C1005CH1H391J
470	±5%	0.5±0.05	C1005CH1H471J

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
560	±5%	0.5±0.05	C1005CH1E561J
680	±5%	0.5±0.05	C1005CH1E681J
820	±5%	0.5±0.05	C1005CH1E821J
1,000	±5%	0.5±0.05	C1005CH1E102J

- Part number for temperature characteristic C0G
  Please substitute "C0G" for "CH" in the part number when ordering.

TEMPERATURE CHARACTERISTICS:
JIS SL(+350 to –1000ppm/°C)

RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,200	±5%	0.5±0.05	C1005SL1A122J
1,500	±5%	0.5±0.05	C1005SL1A152J
1,800	±5%	0.5±0.05	C1005SL1A182J
2,200	±5%	0.5±0.05	C1005SL1A222J
2,700	±5%	0.5±0.05	C1005SL1A272J
3,300	±5%	0.5±0.05	C1005SL1A332J
3,900	±5%	0.5±0.05	C1005SL1A392J

CAPACITANCE RANGES: CLASS 2
TEMPERATURE CHARACTERISTICS:
JIS B(BJ)(±10%), EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
220	±10%	0.5±0.05	C1005JB1H221K
330	±10%	0.5±0.05	C1005JB1H331K
470	±10%	0.5±0.05	C1005JB1H471K
680	±10%	0.5±0.05	C1005JB1H681K
1,000	±10%	0.5±0.05	C1005JB1H102K
1,500	±10%	0.5±0.05	C1005JB1H152K
2,200	±10%	0.5±0.05	C1005JB1H222K
3,300	±10%	0.5±0.05	C1005JB1H332K
4,700	±10%	0.5±0.05	C1005JB1H472K
6,800	±10%	0.5±0.05	C1005JB1H682K

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
10,000	±10%	0.5±0.05	C1005JB1E103K
15,000	±10%	0.5±0.05	C1005JB1E153K
22,000	±10%	0.5±0.05	C1005JB1E223K
33,000	±10%	0.5±0.05	C1005JB1E333K
47,000	±10%	0.5±0.05	C1005JB1E473K

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
33,000	±10%	0.5±0.05	C1005JB1C333K
47,000	±10%	0.5±0.05	C1005JB1C473K
68,000	±10%	0.5±0.05	C1005JB1C683K
100,000	±10%	0.5±0.05	C1005JB1C104K

- Part number for temperature characteristic X5R or X7R
  Please substitute "X5R" or "X7R" for "JB" in the part number when ordering.

- For more information about the products of other capacitance or data, please contact us.

TEMPERATURE CHARACTERISTICS:

JIS B(BJ)(±10%), EIA X5R(±15%)

RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
100,000	±10%	0.5±0.05	C1005JB1A104K

RATED VOLTAGE Edc: 6.3V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
150,000	±10%	0.5±0.05	C1005JB0J154K
	±20%	0.5±0.05	C1005JB0J154M
220,000	±10%	0.5±0.05	C1005JB0J224K
	±20%	0.5±0.05	C1005JB0J224M
330,000	±10%	0.5±0.05	C1005JB0J334K
	±20%	0.5±0.05	C1005JB0J334M
470,000	±10%	0.5±0.05	C1005JB0J474K
	±20%	0.5±0.05	C1005JB0J474M
680,000	±10%	0.5±0.05	C1005JB0J684K
	±20%	0.5±0.05	C1005JB0J684M
1,000,000 [1μF]	±10%	0.5±0.05	C1005JB0J105K
	±20%	0.5±0.05	C1005JB0J105M

- Part number for temperature characteristic X5R
  Please substitute "X5R" for "JB" in the part number when ordering.

TEMPERATURE CHARACTERISTICS:

JIS F(FJ)(+30, –80%), EIA Y5V(+22, –82%)

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
100,000	+80, –20%	0.5±0.05	C1005JF1C104Z

RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
220,000	+80, –20%	0.5±0.05	C1005JF1A224Z
470,000	+80, –20%	0.5±0.05	C1005JF1A474Z

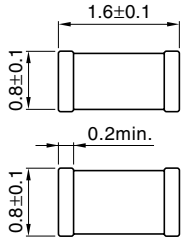
RATED VOLTAGE Edc: 6.3V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,000,000 [1μF]	+80, –20%	0.5±0.05	C1005JF0J105Z

- Part number for temperature characteristic Y5V
  Please substitute "Y5V" for "JF" in the part number when ordering.

- For more information about the products of other capacitance or data, please contact us.

C1608 (EIA CC0603) TYPE
SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 1
TEMPERATURE CHARACTERISTICS:
JIS CH(0±60ppm/°C), EIA C0G(0±30ppm/°C)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
0.5	±0.25pF	0.8±0.1	C1608CH1H0R5C
0.75	±0.25pF	0.8±0.1	C1608CH1HR75C
1	±0.25pF	0.8±0.1	C1608CH1H010C
1.5	±0.25pF	0.8±0.1	C1608CH1H1R5C
2	±0.25pF	0.8±0.1	C1608CH1H020C
3	±0.25pF	0.8±0.1	C1608CH1H030C
4	±0.25pF	0.8±0.1	C1608CH1H040C
5	±0.25pF	0.8±0.1	C1608CH1H050C
6	±0.5pF	0.8±0.1	C1608CH1H060D
7	±0.5pF	0.8±0.1	C1608CH1H070D
8	±0.5pF	0.8±0.1	C1608CH1H080D
9	±0.5pF	0.8±0.1	C1608CH1H090D
10	±0.5pF	0.8±0.1	C1608CH1H100D
12	±5%	0.8±0.1	C1608CH1H120J
15	±5%	0.8±0.1	C1608CH1H150J
18	±5%	0.8±0.1	C1608CH1H180J
22	±5%	0.8±0.1	C1608CH1H220J
27	±5%	0.8±0.1	C1608CH1H270J
33	±5%	0.8±0.1	C1608CH1H330J
39	±5%	0.8±0.1	C1608CH1H390J
47	±5%	0.8±0.1	C1608CH1H470J
56	±5%	0.8±0.1	C1608CH1H560J
68	±5%	0.8±0.1	C1608CH1H680J
82	±5%	0.8±0.1	C1608CH1H820J
100	±5%	0.8±0.1	C1608CH1H101J
120	±5%	0.8±0.1	C1608CH1H121J
150	±5%	0.8±0.1	C1608CH1H151J
180	±5%	0.8±0.1	C1608CH1H181J
220	±5%	0.8±0.1	C1608CH1H221J
270	±5%	0.8±0.1	C1608CH1H271J
330	±5%	0.8±0.1	C1608CH1H331J
390	±5%	0.8±0.1	C1608CH1H391J
470	±5%	0.8±0.1	C1608CH1H471J
560	±5%	0.8±0.1	C1608CH1H561J
680	±5%	0.8±0.1	C1608CH1H681J
820	±5%	0.8±0.1	C1608CH1H821J
1,000	±5%	0.8±0.1	C1608CH1H102J
1,200	±5%	0.8±0.1	C1608CH1H122J
1,500	±5%	0.8±0.1	C1608CH1H152J
1,800	±5%	0.8±0.1	C1608CH1H182J
2,200	±5%	0.8±0.1	C1608CH1H222J
2,700	±5%	0.8±0.1	C1608CH1H272J
3,300	±5%	0.8±0.1	C1608CH1H332J

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
3,900	±5%	0.8±0.1	C1608CH1E392J
4,700	±5%	0.8±0.1	C1608CH1E472J
5,600	±5%	0.8±0.1	C1608CH1E562J
6,800	±5%	0.8±0.1	C1608CH1E682J
8,200	±5%	0.8±0.1	C1608CH1E822J
10,000	±5%	0.8±0.1	C1608CH1E103J

- Part number for temperature characteristic C0G
  Please substitute "C0G" for "CH" in the part number when ordering.

TEMPERATURE CHARACTERISTICS:
JIS SL(+350 to –1000ppm/°C)

RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
15,000	±5%	0.5±0.05	C1608SL1A153J
22,000	±5%	0.5±0.05	C1608SL1A223J

- For more information about the products of other capacitance or data, please contact us.

TDK

CAPACITANCE RANGES: CLASS 2

TEMPERATURE CHARACTERISTICS: JIS B(BJ)(±10%), EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
220	±10%	0.8±0.1	C1608JB1H221K
330	±10%	0.8±0.1	C1608JB1H331K
470	±10%	0.8±0.1	C1608JB1H471K
680	±10%	0.8±0.1	C1608JB1H681K
1,000	±10%	0.8±0.1	C1608JB1H102K
1,500	±10%	0.8±0.1	C1608JB1H152K
2,200	±10%	0.8±0.1	C1608JB1H222K
3,300	±10%	0.8±0.1	C1608JB1H332K
4,700	±10%	0.8±0.1	C1608JB1H472K
6,800	±10%	0.8±0.1	C1608JB1H682K
10,000	±10%	0.8±0.1	C1608JB1H103K
15,000	±10%	0.8±0.1	C1608JB1H153K
22,000	±10%	0.8±0.1	C1608JB1H223K
33,000	±10%	0.8±0.1	C1608JB1H333K
47,000	±10%	0.8±0.1	C1608JB1H473K
68,000	±10%	0.8±0.1	C1608JB1H683K
100,000	±10%	0.8±0.1	C1608JB1H104K

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
100,000	±10%	0.8±0.1	C1608JB1E104K
150,000	±10%	0.8±0.1	C1608JB1E154K
	±20%	0.8±0.1	C1608JB1E154M
220,000	±10%	0.8±0.1	C1608JB1E224K
	±20%	0.8±0.1	C1608JB1E224M

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
330,000	±10%	0.8±0.1	C1608JB1C334K
	±20%	0.8±0.1	C1608JB1C334M
470,000	±10%	0.8±0.1	C1608JB1C474K
	±20%	0.8±0.1	C1608JB1C474M
680,000	±10%	0.8±0.1	C1608JB1C684K
	±20%	0.8±0.1	C1608JB1C684M
1,000,000 [1μF]	±10%	0.8±0.1	C1608JB1C105K
	±20%	0.8±0.1	C1608JB1C105M

- Part number for temperature characteristic X5R or X7R
  Please substitute "X5R" or "X7R" for "JB" in the part number when ordering.

TEMPERATURE CHARACTERISTICS: JIS B(BJ)(±10%), EIA X5R(±15%)

RATED VOLTAGE Edc: 6.3V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,500,000 [1.5μF]	±10%	0.8±0.1	C1608JB0J155K
	±20%	0.8±0.1	C1608JB0J155M
2,200,000	±10%	0.8±0.1	C1608JB0J225K
	±20%	0.8±0.1	C1608JB0J225M
3,300,000	±10%	0.8±0.1	C1608JB0J335K
	±20%	0.8±0.1	C1608JB0J335M
4,700,000	±10%	0.8±0.1	C1608JB0J475K
	±20%	0.8±0.1	C1608JB0J475M

- Part number for temperature characteristic X5R
  Please substitute "X5R" for "JB" in the part number when ordering.

TEMPERATURE CHARACTERISTICS: EIA X5R(±15%)

RATED VOLTAGE Edc: 6.3V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,500,000 [1.5μF]	±10%	0.8±0.1	C1608X5R0J155K
	±20%	0.8±0.1	C1608X5R0J155M
2,200,000	±10%	0.8±0.1	C1608X5R0J225K
	±20%	0.8±0.1	C1608X5R0J225M

TEMPERATURE CHARACTERISTICS: JIS F(FJ)(+30, –80%), EIA Y5V(+22, –82%)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
100,000	+80, –20%	0.8±0.1	C1608JF1H104Z
220,000	+80, –20%	0.8±0.1	C1608JF1H224Z

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
470,000	+80, –20%	0.8±0.1	C1608JF1E474Z

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,000,000 [1μF]	+80, –20%	0.8±0.1	C1608JF1C105Z

RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
2,200,000 [2.2μF]	+80, –20%	0.8±0.1	C1608JF1A225Z

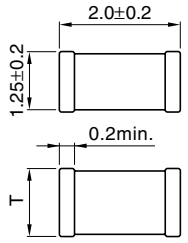
RATED VOLTAGE Edc: 6.3V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
4,700,000 [4.7μF]	+80, –20%	0.8±0.1	C1608JF0J475Z

- Part number for temperature characteristic Y5V
  Please substitute "Y5V" for "JF" in the part number when ordering.

- For more information about the products of other capacitance or data, please contact us.

C2012 (EIA CC0805) TYPE
SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 1
TEMPERATURE CHARACTERISTICS:
JIS CH(0±60ppm/°C), EIA C0G(0±30ppm/°C)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
2,700	±5%	0.6±0.1	C2012CH1H272J
3,300	±5%	0.6±0.1	C2012CH1H332J
3,900	±5%	0.85±0.15	C2012CH1H392J
4,700	±5%	0.85±0.15	C2012CH1H472J
5,600	±5%	0.85±0.15	C2012CH1H562J
6,800	±5%	1.25±0.2	C2012CH1H682J
8,200	±5%	1.25±0.2	C2012CH1H822J
10,000	±5%	1.25±0.2	C2012CH1H103J

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
3,900	±5%	0.6±0.1	C2012CH1E392J
4,700	±5%	0.6±0.1	C2012CH1E472J
5,600	±5%	0.6±0.1	C2012CH1E562J
6,800	±5%	0.6±0.1	C2012CH1E682J
8,200	±5%	0.6±0.1	C2012CH1E822J
10,000	±5%	0.6±0.1	C2012CH1E103J
15,000	±5%	0.85±0.15	C2012CH1E153J
22,000	±5%	1.25±0.2	C2012CH1E223J
33,000	±5%	1.25±0.2	C2012CH1E333J

- Part number for temperature characteristic C0G
  Please substitute "C0G" for "CH" in the part number when ordering.

TEMPERATURE CHARACTERISTICS:
JIS SL(+350 to –1000ppm/°C)

RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
33,000	±5%	0.6±0.1	C2012SL1A333J
47,000	±5%	0.85±0.15	C2012SL1A473J
68,000	±5%	1.25±0.2	C2012SL1A683J
100,000	±5%	1.25±0.2	C2012SL1A104J

- For more information about the products of other capacitance or data, please contact us.

CAPACITANCE RANGES: CLASS 2
TEMPERATURE CHARACTERISTICS:
JIS B(BJ)(±10%), EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
150,000	±10%	1.25±0.2	C2012JB1H154K
	±20%	1.25±0.2	C2012JB1H154M
220,000	±10%	1.25±0.2	C2012JB1H224K
	±20%	1.25±0.2	C2012JB1H224M
330,000	±10%	1.25±0.2	C2012JB1H334K
	±20%	1.25±0.2	C2012JB1H334M

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
470,000	±10%	1.25±0.2	C2012JB1E474K
	±20%	1.25±0.2	C2012JB1E474M
680,000	±10%	1.25±0.2	C2012JB1E684K
	±20%	1.25±0.2	C2012JB1E684M
1,000,000 [1μF]	±10%	1.25±0.2	C2012JB1E105K
	±20%	1.25±0.2	C2012JB1E105M

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,500,000 [1.5μF]	±10%	1.25±0.2	C2012JB1C155K
	±20%	1.25±0.2	C2012JB1C155M
2,200,000	±10%	1.25±0.2	C2012JB1C225K
	±20%	1.25±0.2	C2012JB1C225M

- Part number for temperature characteristic X5R or X7R
  Please substitute "X5R" or "X7R" for "JB" in the part number when ordering.

TEMPERATURE CHARACTERISTICS:
JIS B(BJ)(±10%), EIA X5R(±15%)

RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
3,300,000 [3.3μF]	±10%	1.25±0.2	C2012JB1A335K
	±20%	1.25±0.2	C2012JB1A335M
4,700,000	±10%	1.25±0.2	C2012JB1A475K
	±20%	1.25±0.2	C2012JB1A475M

RATED VOLTAGE Edc: 6.3V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
6,800,000 [6.8μF]	±10%	1.25±0.2	C2012JB0J685K
	±20%	1.25±0.2	C2012JB0J685M
10,000,000	±10%	1.25±0.2	C2012JB0J106K
	±20%	1.25±0.2	C2012JB0J106M
15,000,000	±20%	1.25±0.2	C2012JB0J156M
22,000,000	±20%	1.25±0.2	C2012JB0J226M

- Part number for temperature characteristic X5R
  Please substitute "X5R" for "JB" in the part number when ordering.

- All specifications are subject to change without notice.

TDK

TEMPERATURE CHARACTERISTICS: EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,000,000 [1μF]	±10%	1.25±0.2	C2012X5R1E105K
	±20%	1.25±0.2	C2012X5R1E105M
1,500,000	±10%	1.25±0.2	C2012X5R1E155K
	±20%	1.25±0.2	C2012X5R1E155M

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,000,000 [1μF]	±10%	0.85±0.15	C2012X5R1C105K
	±20%	0.85±0.15	C2012X5R1C105M
1,500,000	±10%	1.25±0.2	C2012X5R1C155K
	±20%	1.25±0.2	C2012X5R1C155M
2,200,000	±10%	1.25±0.2	C2012X5R1C225K
	±20%	1.25±0.2	C2012X5R1C225M

- Part number for temperature characteristic X7R
  Please substitute "X7R" for "X5R" in the part number when ordering.

TEMPERATURE CHARACTERISTICS: EIA X5R(±15%)

RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,500,000 [1.5μF]	±10%	0.85±0.15	C2012X5R1A155K
	±20%	0.85±0.15	C2012X5R1A155M
2,200,000	±10%	1.25±0.2	C2012X5R1A225K
	±20%	1.25±0.2	C2012X5R1A225M
3,300,000	±10%	1.25±0.2	C2012X5R1A335K
	±20%	1.25±0.2	C2012X5R1A335M

RATED VOLTAGE Edc: 6.3V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
2,200,000 [2.2μF]	±10%	0.85±0.15	C2012X5R0J225K
	±20%	0.85±0.15	C2012X5R0J225M
3,300,000	±10%	0.85±0.15	C2012X5R0J335K
	±20%	0.85±0.15	C2012X5R0J335M
4,700,000	±10%	0.85±0.15	C2012X5R0J475K
	±20%	0.85±0.15	C2012X5R0J475M
6,800,000	±10%	1.25±0.2	C2012X5R0J685K
	±20%	1.25±0.2	C2012X5R0J685M
10,000,000	±10%	1.25±0.2	C2012X5R0J106K
	±20%	1.25±0.2	C2012X5R0J106M

TEMPERATURE CHARACTERISTICS:
JIS F(FJ)(+30, –80%), EIA Y5V(+22, –82%)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
470,000	+80, –20%	0.85±0.15	C2012JF1H474Z
1,000,000 [1μF]	+80, –20%	1.25±0.15	C2012JF1H105Z

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
2,200,000 [2.2μF]	+80, –20%	1.25±0.15	C2012JF1E225Z

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
4,700,000 [4.7μF]	+80, –20%	1.25±0.2	C2012JF1C475Z

RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
10,000,000 [10μF]	+80, –20%	1.25±0.2	C2012JF1A106Z

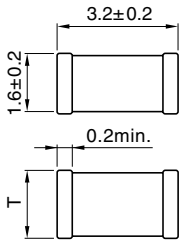
RATED VOLTAGE Edc: 6.3V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
22,000,000 [22μF]	+80, –20%	1.25±0.2	C2012JF0J226Z

- Part number for temperature characteristic Y5V
  Please substitute "Y5V" for "JF" in the part number when ordering.

- For more information about the products of other capacitance or data, please contact us.

C3216 (EIA CC1206) TYPE
SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 1
TEMPERATURE CHARACTERISTICS:
JIS CH(0±60ppm/°C), EIA C0G(0±30ppm/°C)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
3,900	±5%	0.6±0.1	C3216CH1H392J
4,700	±5%	0.6±0.1	C3216CH1H472J
5,600	±5%	0.6±0.1	C3216CH1H562J
6,800	±5%	0.6±0.1	C3216CH1H682J
8,200	±5%	0.85±0.15	C3216CH1H822J
10,000	±5%	0.85±0.15	C3216CH1H103J
15,000	±5%	1.15±0.15	C3216CH1H153J
22,000	±5%	1.15±0.15	C3216CH1H223J
33,000	±5%	1.6±0.2	C3216CH1H333J

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
8,200	±5%	0.6±0.1	C3216CH1E822J
10,000	±5%	0.6±0.1	C3216CH1E103J
15,000	±5%	0.6±0.1	C3216CH1E153J
22,000	±5%	0.6±0.1	C3216CH1E223J
33,000	±5%	0.85±0.15	C3216CH1E333J
47,000	±5%	1.15±0.15	C3216CH1E473J
68,000	±5%	1.6±0.2	C3216CH1E683J
100,000	±5%	1.6±0.2	C3216CH1E104J

- Part number for temperature characteristic C0G
  Please substitute "C0G" for "CH" in the part number when ordering.

TEMPERATURE CHARACTERISTICS:
JIS SL(+350 to –1000ppm/°C)

RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
150,000	±5%	1.15±0.15	C3216SL1A154J
220,000	±5%	1.6±0.2	C3216SL1A224J

- For more information about the products of other capacitance or data, please contact us.

CAPACITANCE RANGES: CLASS 2
TEMPERATURE CHARACTERISTICS:
JIS B(BJ)(±10%), EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
470,000	±10%	1.6±0.2	C3216JB1H474K
	±20%	1.6±0.2	C3216JB1H474M
680,000	±10%	1.6±0.2	C3216JB1H684K
	±20%	1.6±0.2	C3216JB1H684M
1,000,000 [1μF]	±10%	1.6±0.2	C3216JB1H105K
	±20%	1.6±0.2	C3216JB1H105M

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,000,000 [1μF]	±10%	1.6±0.2	C3216JB1E105K
	±20%	1.6±0.2	C3216JB1E105M
1,500,000	±10%	1.6±0.2	C3216JB1E155K
	±20%	1.6±0.2	C3216JB1E155M
2,200,000	±10%	1.6±0.2	C3216JB1E225K
	±20%	1.6±0.2	C3216JB1E225M
3,300,000	±10%	1.6±0.2	C3216JB1E335K
	±20%	1.6±0.2	C3216JB1E335M
4,700,000	±10%	1.6±0.2	C3216JB1E475K
	±20%	1.6±0.2	C3216JB1E475M

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
6,800,000 [6.8μF]	±10%	1.6±0.2	C3216JB1C685K
	±20%	1.6±0.2	C3216JB1C685M
10,000,000	±10%	1.6±0.2	C3216JB1C106K
	±20%	1.6±0.2	C3216JB1C106M

- Part number for temperature characteristic X5R or X7R
  Please substitute "X5R" or "X7R" for "JB" in the part number when ordering.

TEMPERATURE CHARACTERISTICS:
JIS B(BJ)(±10%), EIA X5R(±15%)

RATED VOLTAGE Edc: 6.3V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
33,000,000 [33μF]	±20%	1.6+0.3,–0.1	C3216JB0J336M
47,000,000	±20%	1.6+0.3,–0.1	C3216JB0J476M

- Part number for temperature characteristic X5R
  Please substitute "X5R" for "JB" in the part number when ordering.

TDK

TEMPERATURE CHARACTERISTICS: EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,000,000 [1μF]	±10%	1.6±0.2	C3216X5R1H105K
	±20%	1.6±0.2	C3216X5R1H105M

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
2,200,000 [2.2μF]	±10%	0.85±0.15	C3216X5R1C225K
	±20%	0.85±0.15	C3216X5R1C225M
3,300,000	±10%	1.10±0.15	C3216X5R1C335K
	±20%	1.10±0.15	C3216X5R1C335M
4,700,000	±10%	1.6±0.2	C3216X5R1C475K
	±20%	1.6±0.2	C3216X5R1C475M

- Part number for temperature characteristic X7R
  Please substitute "X7R" for "X5R" in the part number when ordering.

TEMPERATURE CHARACTERISTICS: EIA X5R(±15%)

RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
3,300,000 [3.3μF]	±10%	0.85±0.15	C3216X5R1A335K
	±20%	0.85±0.15	C3216X5R1A335M
4,700,000	±10%	1.15±0.15	C3216X5R1A475K
	±20%	1.15±0.15	C3216X5R1A475M
6,800,000	±10%	1.6±0.2	C3216X5R1A685K
	±20%	1.6±0.2	C3216X5R1A685M
10,000,000	±10%	1.6±0.2	C3216X5R1A106K
	±20%	1.6±0.2	C3216X5R1A106M

RATED VOLTAGE Edc: 6.3V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
4,700,000 [4.7μF]	±10%	0.85±0.15	C3216X5R0J475K
	±20%	0.85±0.15	C3216X5R0J475M
6,800,000	±10%	0.85±0.15	C3216X5R0J685K
	±20%	0.85±0.15	C3216X5R0J685M
10,000,000	±10%	0.85±0.15	C3216X5R0J106K
	±20%	0.85±0.15	C3216X5R0J106M
15,000,000	±20%	1.6±0.2	C3216X5R0J156M
22,000,000	±20%	1.6±0.2	C3216X5R0J226M

TEMPERATURE CHARACTERISTICS:
JIS F(FJ)(+30, –80%), EIA Y5V(+22, –82%)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
2,200,000 [2.2μF]	+80, –20%	1.15±0.2	C3216JF1H225Z

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
4,700,000 [4.7μF]	+80, –20%	1.15±0.2	C3216JF1E475Z

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
10,000,000 [10μF]	+80, –20%	1.6±0.2	C3216JF1C106Z

RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
22,000,000 [22μF]	+80, –20%	1.6±0.2	C3216JF1A226Z

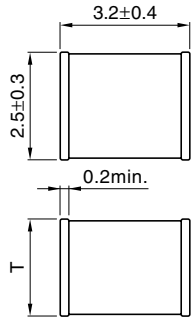
RATED VOLTAGE Edc: 6.3V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
47,000,000 [47μF]	+80, –20%	1.6±0.2	C3216JF0J476Z

- Part number for temperature characteristic Y5V
  Please substitute "Y5V" for "JF" in the part number when ordering.

- For more information about the products of other capacitance or data, please contact us.

C3225(EIA CC1210) TYPE
SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 1
TEMPERATURE CHARACTERISTICS:
JIS CH(0±60ppm/°C), EIA C0G(0±30ppm/°C)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
33,000	±5%	1.25±0.2	C3225CH1H333J
47,000	±5%	2.0±0.2	C3225CH1H473J
68,000	±5%	2.0±0.2	C3225CH1H683J
100,000	±5%	2.5±0.3	C3225CH1H104J

- Part number for temperature characteristic C0G
  Please substitute "C0G" for "CH" in the part number when ordering.

CAPACITANCE RANGES: CLASS 2
TEMPERATURE CHARACTERISTICS:
JIS B(BJ)(±10%), EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,000,000 [1μF]	±10%	1.6±0.2	C3225JB1H105K
	±20%	1.6±0.2	C3225JB1H105M
1,500,000	±10%	2.0±0.2	C3225JB1H155K
	±20%	2.0±0.2	C3225JB1H155M
2,200,000	±10%	2.0±0.2	C3225JB1H225K
	±20%	2.0±0.2	C3225JB1H225M
3,300,000	±10%	2.5±0.3	C3225JB1H335K
	±20%	2.5±0.3	C3225JB1H335M

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
3,300,000 [3.3μF]	±10%	1.6±0.2	C3225JB1E335K
	±20%	1.6±0.2	C3225JB1E335M
4,700,000	±10%	2.0±0.2	C3225JB1E475K
	±20%	2.0±0.2	C3225JB1E475M
6,800,000	±10%	2.0±0.2	C3225JB1E685K
	±20%	2.0±0.2	C3225JB1E685M
10,000,000	±10%	2.5±0.3	C3225JB1E106K
	±20%	2.5±0.3	C3225JB1E106M

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
6,800,000 [6.8μF]	±10%	2.0±0.2	C3225JB1C685K
	±20%	2.0±0.2	C3225JB1C685M
10,000,000	±10%	2.0±0.2	C3225JB1C106K
	±20%	2.0±0.2	C3225JB1C106M
15,000,000	±20%	2.5±0.3	C3225JB1C156M
22,000,000	±20%	2.5±0.3	C3225JB1C226M

- Part number for temperature characteristic X5R or X7R
  Please substitute "X5R" or "X7R" for "JB" in the part number when ordering.

TEMPERATURE CHARACTERISTICS:
JIS B(BJ)(±10%), EIA X5R(±15%)

RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
15,000,000 [15μF]	±20%	2.3±0.2	C3225JB1A156M

RATED VOLTAGE Edc: 6.3V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
22,000,000 [22μF]	±20%	2.0±0.2	C3225JB0J226M
68,000,000	±20%	2.0±0.3	C3225JB0J686M
100,000,000	±20%	2.5±0.3	C3225JB0J107M

- Part number for temperature characteristic X5R
  Please substitute "X5R" for "JB" in the part number when ordering.

TEMPERATURE CHARACTERISTICS: EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
2,200,000 [2.2μF]	±10%	2.0±0.2	C3225X5R1H225K
	±20%	2.0±0.2	C3225X5R1H225M
3,300,000	±10%	2.5±0.3	C3225X5R1H335K
	±20%	2.5±0.3	C3225X5R1H335M

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
6,800,000 [6.8μF]	±10%	2.5±0.3	C3225X5R1E685K
	±20%	2.5±0.3	C3225X5R1E685M
10,000,000	±10%	2.5±0.3	C3225X5R1E106K
	±20%	2.5±0.3	C3225X5R1E106M

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
10,000,000 [10μF]	±10%	2.0±0.2	C3225X5R1C106K
	±20%	2.0±0.2	C3225X5R1C106M
15,000,000	±20%	2.5±0.3	C3225X5R1C156M
22,000,000	±20%	2.5±0.3	C3225X5R1C226M

- Part number for temperature characteristic X7R
  Please substitute "X7R" for "X5R" in the part number when ordering.

- For more information about the products of other capacitance or data, please contact us.

TDK

TEMPERATURE CHARACTERISTICS: EIA X5R(±15%)

RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
15,000,000	±20%	2.5±0.3	C3225X5R1A156M
22,000,000	±20%	2.3±0.2	C3225X5R1A226M

RATED VOLTAGE Edc: 6.3V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
22,000,000 [22μF]	±20%	1.6±0.2	C3225X5R0J226M
33,000,000	±20%	2.0±0.2	C3225X5R0J336M
47,000,000	±20%	2.5±0.3	C3225X5R0J476M

TEMPERATURE CHARACTERISTICS:
JIS F(FJ)(+30, –80%), EIA Y5V(+22, –82%)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
4,700,000 [4.7μF]	+80, –20%	1.6±0.2	C3225JF1H475Z

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
10,000,000 [10μF]	+80, –20%	1.6±0.2	C3225JF1E106Z

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
22,000,000 [22μF]	+80, –20%	2.0±0.2	C3225JF1C226Z

RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
47,000,000 [47μF]	+80, –20%	2.0±0.2	C3225JF1A476Z

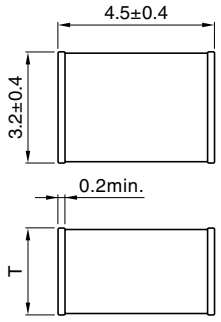
RATED VOLTAGE Edc: 6.3V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
100,000,000 [100μF]	+80, –20%	2.5±0.3	C3225JF0J107Z

- Part number for temperature characteristic Y5V
  Please substitute "Y5V" for "JF" in the part number when ordering.

- For more information about the products of other capacitance or data, please contact us.

C4532(EIA CC1812) TYPE
SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 1
TEMPERATURE CHARACTERISTICS:
JIS CH(0±60ppm/°C), EIA C0G(0±30ppm/°C)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
47,000	±5%	1.60±0.2	C4532CH1H473J
68,000	±5%	1.60±0.2	C4532CH1H683J
100,000	±5%	2.0±0.2	C4532CH1H104J
150,000	±5%	2.5±0.3	C4532CH1H154J
220,000	±5%	3.2±0.3	C4532CH1H224J

- Part number for temperature characteristic C0G
  Please substitute "C0G" for "CH" in the part number when ordering.

CAPACITANCE RANGES: CLASS 2
TEMPERATURE CHARACTERISTICS:
JIS B(BJ)(±10%), EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,500,000 [1.5μF]	±10%	1.6±0.2	C4532JB1H155K
	±20%	1.6±0.2	C4532JB1H155M
2,200,000	±10%	1.6±0.2	C4532JB1H225K
	±20%	1.6±0.2	C4532JB1H225M
3,300,000	±10%	2.0±0.2	C4532JB1H335K
	±20%	2.0±0.2	C4532JB1H335M
4,700,000	±10%	2.3±0.2	C4532JB1H475K
	±20%	2.3±0.2	C4532JB1H475M
6,800,000	±10%	2.5±0.3	C4532JB1H685K
	±20%	2.5±0.3	C4532JB1H685M

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
4,700,000 [4.7μF]	±10%	1.6±0.2	C4532JB1E475K
	±20%	1.6±0.2	C4532JB1E475M
6,800,000	±10%	2.0±0.2	C4532JB1E685K
	±20%	2.0±0.2	C4532JB1E685M
10,000,000	±10%	2.5±0.3	C4532JB1E106K
	±20%	2.5±0.3	C4532JB1E106M
15,000,000	±20%	2.5±0.3	C4532JB1E156M
22,000,000	±20%	2.5±0.3	C4532JB1E226M

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
22,000,000 [22μF]	±20%	2.5±0.3	C4532JB1C226M
33,000,000	±20%	2.5±0.3	C4532JB1C336M

- Part number for temperature characteristic X5R or X7R
  Please substitute "X5R" or "X7R" for "JB" in the part number when ordering.

TEMPERATURE CHARACTERISTICS: EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
4,700,000 [4.7μF]	±10%	2.0±0.2	C4532X5R1H475K
	±20%	2.0±0.2	C4532X5R1H475M
6,800,000	±10%	2.5±0.3	C4532X5R1H685K
	±20%	2.5±0.3	C4532X5R1H685M

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
15,000,000 [15μF]	±20%	2.8±0.3	C4532X5R1E156M
22,000,000	±20%	2.5±0.3	C4532X5R1E226M

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
15,000,000 [15μF]	±20%	2.0±0.2	C4532X5R1C156M
22,000,000	±20%	2.3±0.3	C4532X5R1C226M
33,000,000	±20%	2.5±0.3	C4532X5R1C336M

- Part number for temperature characteristic X7R
  Please substitute "X7R" for "X5R" in the part number when ordering.

TEMPERATURE CHARACTERISTICS: EIA X5R(±15%)

RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
33,000,000 [33μF]	±20%	2.0±0.2	C4532X5R1A336M
47,000,000	±20%	2.8±0.3	C4532X5R1A476M

RATED VOLTAGE Edc: 6.3V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
68,000,000 [68μF]	±20%	2.8±0.3	C4532X5R0J686M
100,000,000	±20%	2.8±0.3	C4532X5R0J107M

- For more information about the products of other capacitance or data, please contact us.

TEMPERATURE CHARACTERISTICS:

JIS F(FJ)(+30, –80%), EIA Y5V(+22, –82%)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
10,000,000 [10μF]	+80, –20%	2.0±0.2	C4532JF1H106Z

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
22,000,000 [22μF]	+80, –20%	2.0±0.2	C4532JF1E226Z

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
47,000,000 [47μF]	+80, –20%	2.5±0.3	C4532JF1C476Z

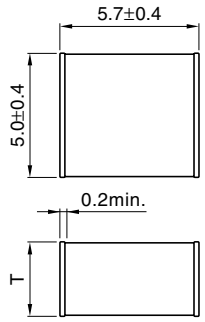
RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
100,000,000 [100μF]	+80, –20%	2.5±0.3	C4532JF1A107Z

- Part number for temperature characteristic Y5V
  Please substitute "Y5V" for "JF" in the part number when ordering.

- For more information about the products of other capacitance or data, please contact us.

C5750(EIA CC2220) TYPE
SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 2
TEMPERATURE CHARACTERISTICS:
JIS B(BJ)(±10%), EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
4,700,000 [4.7μF]	±10%	2.0±0.2	C5750JB1H475K
	±20%	2.0±0.2	C5750JB1H475M
6,800,000	±10%	2.5±0.3	C5750JB1H685K
	±20%	2.5±0.3	C5750JB1H685M

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
10,000,000 [10μF]	±10%	2.0±0.2	C5750JB1E106K
	±20%	2.0±0.2	C5750JB1E106M
15,000,000	±20%	2.3±0.2	C5750JB1E156M
22,000,000	±20%	2.5±0.2	C5750JB1E226M

- Part number for temperature characteristic X5R or X7R
  Please substitute "X5R" or "X7R" for "JB" in the part number when ordering.

TEMPERATURE CHARACTERISTICS: EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
10,000,000 [10μF]	±10%	2.3±0.2	C5750X5R1H106K
	±20%	2.3±0.2	C5750X5R1H106M

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
10,000,000 [10μF]	±10%	2.0±0.2	C5750X5R1E106K
	±20%	2.0±0.2	C5750X5R1E106M
15,000,000	±20%	2.3±0.2	C5750X5R1E156M
22,000,000	±20%	2.3±0.2	C5750X5R1E226M

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
33,000,000 [33μF]	±20%	2.0±0.2	C5750X5R1C336M
47,000,000	±20%	2.3±0.2	C5750X5R1C476M

- Part number for temperature characteristic X7R
  Please substitute "X7R" for "X5R" in the part number when ordering.

TEMPERATURE CHARACTERISTICS: EIA X5R(±15%)

RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
68,000,000 [68μF]	±20%	2.3±0.2	C5750X5R1A686M

RATED VOLTAGE Edc: 6.3V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
100,000,000 [100μF]	±20%	2.8±0.3	C5750X5R0J107M

TEMPERATURE CHARACTERISTICS:
JIS F(FJ)(+30, –80%), EIA Y5V(+22, –82%)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
22,000,000 [22μF]	+80, –20%	2.0±0.2	C5750JF1H226Z

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
47,000,000 [47μF]	+80, –20%	2.0±0.2	C5750JF1E476Z

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
100,000,000 [100μF]	+80, –20%	2.5±0.3	C5750JF1C107Z

- Part number for temperature characteristic Y5V
  Please substitute "Y5V" for "JF" in the part number when ordering.

- For more information about the products of other capacitance or data, please contact us.

- All specifications are subject to change without notice.

TDK

Low Profile Multilayer Chip Ceramic Capacitors
C Series

FEATURES

- These capacitors are optimally suited for thin sets such as IC cards and LCD panels because they feature high capacities in a low profile configuration.

PRODUCT IDENTIFICATION

C	1608	JB	1H	104	K	□
(1)	(2)	(3)	(4)	(5)	(6)	(7)

(1)Series name

(2)DimensionsL×W

1608	1.6×0.8mm
2012	2.0×1.25mm
3216	3.2×1.6mm

(3)Capacitance temperature characteristics

Class 2

Temaperature characteristics	Capacitance change	Temperature range
B(JB*)	±10%	–25 to +85°C
X7R	±15%	–55 to +125°C
X5R	±15%	–55 to +85°C

*JB(JIS: BJ)

(4)Rated voltage Edc

0J	6.3V
1A	10V
1C	16V
1E	25V
1H	50V

(5)Nominal capacitance

The capacitance is expressed in three digit codes and in units of pico farads (pF).

The first and second digits identify the first and second significant figures of the capacitance.

The third digit identifies the multiplier.

104	100,000pF
106	10,000,000pF[10μF]

(6)Capacitance tolerance

Symbol	Tolerance
K	±10%
M	±20%

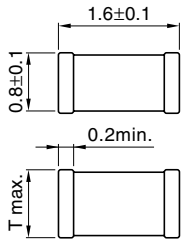
(7)Packaging style

T	Taping (reel)
B	Bulk

• All specifications are subject to change without notice.

C1608(EIA CC0603)TYPE

SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 2

TEMPERATURE CHARACTERISTICS:

JIS B(BJ)(±10%), EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
100,000	±10%	0.9	C1608JB1H104K
	±20%	0.9	C1608JB1H104M

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
100,000	±10%	0.7	C1608JB1E104K
	±20%	0.7	C1608JB1E104M
150,000	±10%	0.7	C1608JB1E154K
	±20%	0.7	C1608JB1E154M
220,000	±10%	0.9	C1608JB1E224K
	±20%	0.9	C1608JB1E224M
330,000	±10%	0.9	C1608JB1E334K
	±20%	0.9	C1608JB1E334M
470,000	±10%	0.9	C1608JB1E474K
	±20%	0.9	C1608JB1E474M
680,000	±10%	0.9	C1608JB1E684K
	±20%	0.9	C1608JB1E684M
1,000,000	±10%	0.9	C1608JB1E105K
	±20%	0.9	C1608JB1E105M

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
220,000	±10%	0.7	C1608JB1C224K
	±20%	0.7	C1608JB1C224M
330,000	±10%	0.7	C1608JB1C334K
	±20%	0.7	C1608JB1C334M

- Part number for temperature characteristic X5R or X7R
  Please substitute "X5R" or "X7R" for "JB" in the part number when ordering.

TEMPERATURE CHARACTERISTICS:

JIS B(BJ)(±10%), EIA X5R(±15%)

RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,000,000 [1μF]	±10%	0.55	C1608JB1A105K
	±20%	0.55	C1608JB1A105M

RATED VOLTAGE Edc: 6.3V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,500,000 [1.5μF]	±10%	0.9	C1608JB0J155K
	±20%	0.9	C1608JB0J155M
2,200,000	±10%	0.9	C1608JB0J225K
	±20%	0.9	C1608JB0J225M

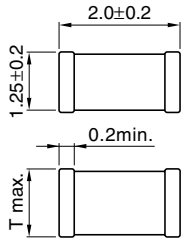
- Part number for temperature characteristic X5R
  Please substitute "X5R" for "JB" in the part number when ordering.

- For more information about the products of other capacitance or data, please contact us.

• All specifications are subject to change without notice.

C2012(EIA CC0805)TYPE

SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 2

TEMPERATURE CHARACTERISTICS:

JIS B(BJ)(±10%), EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
100,000	±10%	0.9	C2012JB1H104K
	±20%	0.9	C2012JB1H104M
150,000	±10%	0.9	C2012JB1H154K
	±20%	0.9	C2012JB1H154M
220,000	±10%	0.95	C2012JB1H224K
	±20%	0.95	C2012JB1H224M

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
330,000	±10%	0.7	C2012JB1E334K
	±20%	0.7	C2012JB1E334M
470,000	±10%	0.7	C2012JB1E474K
	±20%	0.7	C2012JB1E474M
680,000	±10%	0.95	C2012JB1E684K
	±20%	0.95	C2012JB1E684M
1,000,000 [1μF]	±10%	0.95	C2012JB1E105K
	±20%	0.95	C2012JB1E105M
1,500,000	±10%	0.95	C2012JB1E155K
	±20%	0.95	C2012JB1E155M
2,200,000	±10%	0.95	C2012JB1E225K
	±20%	0.95	C2012JB1E225M

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
680,000	±10%	0.7	C2012JB1C684K
	±20%	0.7	C2012JB1C684M
1,000,000 [1μF]	±10%	0.9	C2012JB1C105K
	±20%	0.9	C2012JB1C105M

- Part number for temperature characteristic X5R or X7R
  Please substitute "X5R" or "X7R" for "JB" in the part number when ordering.

TEMPERATURE CHARACTERISTICS:

JIS B(BJ)(±10%), EIA X5R(±15%)

RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,000,000 [1μF]	±10%	0.7	C2012JB1A105K
	±20%	0.7	C2012JB1A105M
1,500,000	±10%	0.9	C2012JB1A155K
	±20%	0.9	C2012JB1A155M
2,200,000	±10%	0.95	C2012JB1A225K
	±20%	0.95	C2012JB1A225M

RATED VOLTAGE Edc: 6.3V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
3,300,000 [3.3μF]	±10%	0.95	C2012JB0J335K
	±20%	0.95	C2012JB0J335M
4,700,000	±10%	0.95	C2012JB0J475K
	±20%	0.95	C2012JB0J475M
6,800,000	±10%	0.95	C2012JB0J685K
	±20%	0.95	C2012JB0J685M
10,000,000	±10%	0.95	C2012JB0J106K
	±20%	0.95	C2012JB0J106M

- Part number for temperature characteristic X5R
  Please substitute "X5R" for "JB" in the part number when ordering.

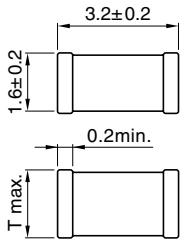
- For more information about the products of other capacitance or data, please contact us.

• All specifications are subject to change without notice.

TDK

C3216(EIA CC1206)TYPE

SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 2

TEMPERATURE CHARACTERISTICS:

JIS B(BJ)(±10%), EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
220,000	±10%	0.9	C3216JB1H224K
	±20%	0.9	C3216JB1H224M
330,000	±10%	0.95	C3216JB1H334K
	±20%	0.95	C3216JB1H334M
470,000	±10%	0.95	C3216JB1H474K
	±20%	0.95	C3216JB1H474M
680,000	±10%	1.25	C3216JB1H684K
	±20%	1.25	C3216JB1H684M

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
680,000	±10%	0.9	C3216JB1E684K
	±20%	0.9	C3216JB1E684M
1,000,000 [1μF]	±10%	0.9	C3216JB1E105K
	±20%	0.9	C3216JB1E105M
1,500,000	±10%	0.9	C3216JB1E155K
	±20%	0.9	C3216JB1E155M
2,200,000	±10%	0.95	C3216JB1E225K
	±20%	0.95	C3216JB1E225M

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
2,200,000	±10%	0.9	C3216JB1C225K
	±20%	0.9	C3216JB1C225M
3,300,000	±10%	0.95	C3216JB1C335K
	±20%	0.95	C3216JB1C335M
4,700,000	±10%	0.95	C3216JB1C475K
	±20%	0.95	C3216JB1C475M
6,800,000	±10%	1.25	C3216JB1C685K
	±20%	1.25	C3216JB1C685M

- Part number for temperature characteristic X5R or X7R
  Please substitute "X5R" or "X7R" for "JB" in the part number when ordering.

TEMPERATURE CHARACTERISTICS:

JIS B(BJ)(±10%), EIA X5R(±15%)

RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
4,700,000 [4.7μF]	±10%	0.9	C3216JB1A475K
	±20%	0.9	C3216JB1A475M
6,800,000	±10%	0.9	C3216JB1A685K
	±20%	0.9	C3216JB1A685M

RATED VOLTAGE Edc: 6.3V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
10,000,000 [10μF]	±10%	0.95	C3216JB0J106K
	±20%	0.95	C3216JB0J106M

- Part number for temperature characteristic X5R
  Please substitute "X5R" for "JB" in the part number when ordering.

- For more information about the products of other capacitance or data, please contact us.

• All specifications are subject to change without notice.

TDK

High Voltage Multilayer Ceramic Chip Capacitors
C Series C4520 and C4532 Types

Temperature Characteristic EIA X7R

FEATURES

- No polarity.
- Suits 100Base-T LAN cards, LAN board, and HUB.
- Complies with ISO8802-3 for LAN applications.
- Designed exclusively for reflow soldering.

APPLICATIONS

Input signal filtering circuit of modem and LAN interface, and general high voltage circuits.

PRODUCT IDENTIFICATION

C	4520	X7R	3A	471	K	□
(1)	(2)	(3)	(4)	(5)	(6)	(7)

(1)Series name

(2)Dimensions L×W

4520	4.5×2.0mm
4532	4.5×3.2mm

(3) Capacitance temperature characteristics
Class 2

Temperature characteristics	Temperature coefficient	Temperature range
X7R	±15%	–55 to +125°C

(4) Rated voltage Edc

3A	1kV
3D	2kV

(5) Nominal capacitance
The capacitance is expressed in three digit codes and in units of pico farads(pF).
The first and second digits identity the first and second significant figures of the capacitance.
The third digit identifies the multiplier.

471	470pF

(6) Capacitance tolerance

K	±10%

(7) Packaging style

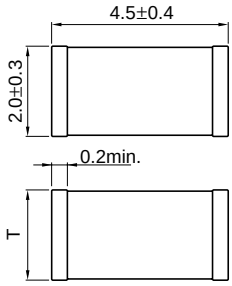
T	Taping (reel)
B	Bulk

PRECAUTIONS

- This product intended solely for reflow soldering.
- A slit of about 1mm on the circuit board is recommended to improve washability of the flux after soldering.
- Ensure that this product is completely dried following washing.
- Because this product will be subjected to high voltages, use only low-activity rosin flux (with 0.2% max. of chlorine).
- Using this product with aluminum circuit boards must be considered a special implementation because the high heat stress levels are involved. In case of using aluminum circuit boards, please contact TDK.

• All specifications are subject to change without notice.

C4520(EIA CC1808) TYPE
SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 2
TEMPERATURE CHARACTERISTICS: EIA X7R(±15%)

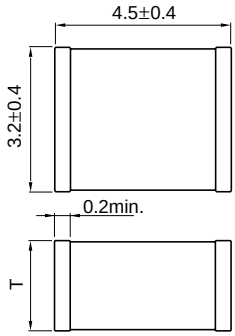
RATED VOLTAGE Edc: 2kV

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
470	±10%	1.3±0.2	C4520X7R3D471K
1,000	±10%	1.3±0.2	C4520X7R3D102K

RATED VOLTAGE Edc: 1kV

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
470	±10%	1.3±0.2	C4520X7R3A471K
1,000	±10%	1.3±0.2	C4520X7R3A102K

C4532(EIA CC1812) TYPE
SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 2
TEMPERATURE CHARACTERISTICS: EIA X7R(±15%)

RATED VOLTAGE Edc: 2kV

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
2,200	±10%	1.3±0.2	C4532X7R3D222K

RATED VOLTAGE Edc: 1kV

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
4,700	±10%	1.6±0.2	C4532X7R3A472K
10,000	±10%	2.0±0.2	C4532X7R3A103K

- For more information about the products of other capacitance or data, please contact us.

- All specifications are subject to change without notice.

TDK

Multilayer Ceramic Chip Capacitors
C Series

Guaranteed at High Temperature

FEATURES

- These products have no polarity.
- Their electrostatic capacity temperature response is stable at 15% even in high temperature ranges (up to 150°C).
- Provides high-precision performance because their electrostatic capacity temperature response is ±7.5% in semi-high temperature ranges (up to 125°C).

APPLICATIONS

- On-vehicle units mounted in motor vehicle engine rooms.
- Measuring instruments used in high temperature environments.
- For time constants and filter circuitry (up to 125°C).
- For temperature compensation (Class 1), Multilayer ceramic chip capacitors with support for high temperatures are prepared as the C0G or NP0 (with Ni internal electrodes) Series.

PRODUCT IDENTIFICATION

C	1608	X8R	2A	102	K	□
(1)	(2)	(3)	(4)	(5)	(6)	(7)

(1) Series name

(2) Dimensions L×W

C1608	1.6×0.8mm
C2012	2.0×1.25mm
C3216	3.2×1.6mm

(3) Capacitance temperature characteristics

Class2

Temperature characteristics	Capacitance change	Temperature range
X8R	±15%	–55 to +150°C

(4) Rated voltage Edc

2A	100V
1H	50V
1E	25V

(5) Nominal capacitance

The capacitance is expressed in three digit codes and in units of pico farads (pF).

The first and second digits identify the first and second significant figures of the capacitance.

The third digit identifies the multiplier.

R designates a decimal point.

102	1,000pF
103	10,000pF

(6) Capacitance tolerance

Symbol	Tolerance
K	±10%

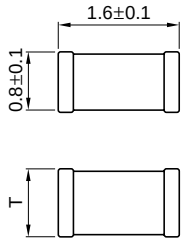
(7) Packaging style

T	Taping (reel)
B	Bulk

- All specifications are subject to change without notice.

C1608(EIA CC0603) TYPE

SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 2

TEMPERATURE CHARACTERISTICS: EIA X8R(±15%)

RATED VOLTAGE Edc: 100V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,000	±10%	0.80±0.10	C1608X8R2A102K
1,500	±10%	0.80±0.10	C1608X8R2A152K
2,200	±10%	0.80±0.10	C1608X8R2A222K
3,300	±10%	0.80±0.10	C1608X8R2A332K
4,700	±10%	0.80±0.10	C1608X8R2A472K
6,800	±10%	0.80±0.10	C1608X8R2A682K
10,000	±10%	0.80±0.10	C1608X8R2A103K
15,000	±10%	0.80±0.10	C1608X8R2A153K

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,000	±10%	0.80±0.10	C1608X8R1H102K
1,500	±10%	0.80±0.10	C1608X8R1H152K
2,200	±10%	0.80±0.10	C1608X8R1H222K
3,300	±10%	0.80±0.10	C1608X8R1H332K
4,700	±10%	0.80±0.10	C1608X8R1H472K
6,800	±10%	0.80±0.10	C1608X8R1H682K
10,000	±10%	0.80±0.10	C1608X8R1H103K
15,000	±10%	0.80±0.10	C1608X8R1H153K
22,000	±10%	0.80±0.10	C1608X8R1H223K
33,000	±10%	0.80±0.10	C1608X8R1H333K
47,000	±10%	0.80±0.10	C1608X8R1H473K

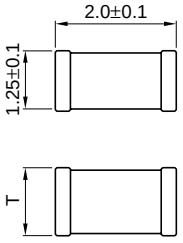
RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
68,000	±10%	0.80±0.10	C1608X8R1E683K
100,000	±10%	0.80±0.10	C1608X8R1E104K

- For more information about the products of other capacitance or data, please contact us.

C2012(EIA CC0805) TYPE

SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 2

TEMPERATURE CHARACTERISTICS: EIA X8R(±15%)

RATED VOLTAGE Edc: 100V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
22,000	±10%	1.25±0.2	C2012X8R2A223K

RATED VOLTAGE Edc: 50V

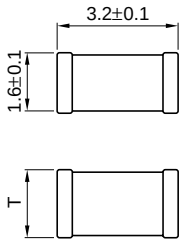
Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
68,000	±10%	1.25±0.2	C2012X8R1H683K
100,000	±10%	1.25±0.2	C2012X8R1H104K

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
150,000	±10%	0.85±0.15	C2012X8R1E154K
220,000	±10%	1.25±0.2	C2012X8R1E224K
330,000	±10%	1.25±0.2	C2012X8R1E334K

- All specifications are subject to change without notice.

C3216(EIA CC1206) TYPE
SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 2
TEMPERATURE CHARACTERISTICS: EIA X8R(±15%)

RATED VOLTAGE Edc: 100V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
33,000	±10%	0.85±0.15	C3216X8R2A333K
47,000	±10%	0.85±0.15	C3216X8R2A473K
68,000	±10%	1.15±0.15	C3216X8R2A683K
100,000	±10%	1.15±0.15	C3216X8R2A104K
150,000	±10%	1.6±0.2	C3216X8R2A154K

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
150,000	±10%	0.85±0.15	C3216X8R1H154K
220,000	±10%	1.15±0.15	C3216X8R1H224K
330,000	±10%	1.6±0.2	C3216X8R1H334K
470,000	±10%	1.6±0.2	C3216X8R1H474K

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
330,000	±10%	0.85±0.15	C3216X8R1E334K
470,000	±10%	0.85±0.15	C3216X8R1E474K
680,000	±10%	1.15±0.15	C3216X8R1E684K
1,000,000 [1µF]	±10%	1.6±0.2	C3216X8R1E105K

- For more information about the products of other capacitance or data, please contact us.

- All specifications are subject to change without notice.

TDK

LW Flipped Type Multilayer Ceramic Chip Capacitors C Series

FEATURES

- Positioning the electrodes along the length of the chip device, reduces ESR and ESL components over conventional products.
- Provides high frequency noise suppression effect because the resonating frequency is high.
- Target application : IC decoupling.

APPLICATIONS

Personal computers, word processors, portable telephones, cordless telephones, camcorders, etc.

PRODUCT IDENTIFICATION

C	1220	JB	1E	104	K	□
(1)	(2)	(3)	(4)	(5)	(6)	(7)

(1) Series name

(2) Dimensions L×W

0816	0.8×1.6mm
1220	1.25×2.0mm
1632	1.6×3.2mm

(3) Capacitance temperature characteristics
Class 2

Temperature characteristics	Capacitance change	Temperature range
B(JB*)	±10%	–25 to +85°C
X7R	±15%	–55 to +125°C
X5R	±15%	–55 to +85°C

*JB(JIS: BJ)

(4) Rated voltage Edc

1H	50V
1E	25V
1C	16V
1A	10V
0J	6.3V

(5) Nominal capacitance
The capacitance is expressed in three digit codes and in units of pico farads (pF).
The first and second digits identify the first and second significant figures of the capacitance.
The third digit identifies the multiplier.
R designates a decimal point.

104	100,000pF

(6) Capacitance tolerance

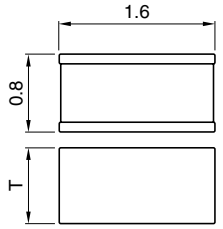
K	±10%
M	±20%

(7) Packaging style

T	Taping (reel)
B	Bulk

• All specifications are subject to change without notice.

C0816 (EIA CC0306) TYPE
SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 2
TEMPERATURE CHARACTERISTICS:
JIS B(BJ)(±10%), EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
10,000	±10%	0.50±0.05	C0816JB1C103K
	±20%	0.50±0.05	C0816JB1C103M
22,000	±10%	0.50±0.05	C0816JB1C223K
	±20%	0.50±0.05	C0816JB1C223M
47,000	±10%	0.50±0.05	C0816JB1C473K
	±20%	0.50±0.05	C0816JB1C473M
100,000	±10%	0.50±0.05	C0816JB1C104K
	±20%	0.50±0.05	C0816JB1C104M

- Part number for temperature characteristic X5R or X7R
  Please substitute "X5R" or "X7R" for "JB" in the part number when ordering.

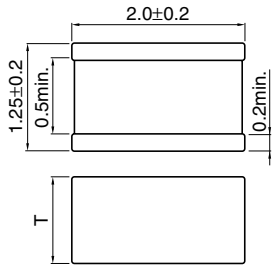
TEMPERATURE CHARACTERISTICS:
JIS B(BJ)(±10%), EIA X5R(±15%)

RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
220,000	±10%	0.50±0.05	C0816JB1A224K
	±20%	0.50±0.05	C0816JB1A224M

- Part number for temperature characteristic X5R
  Please substitute "X5R" for "JB" in the part number when ordering.

C1220 (EIA CC0508) TYPE
SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 2
TEMPERATURE CHARACTERISTICS:
JIS B(BJ)(±10%), EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
10,000	±10%	0.85±0.15	C1220JB1H103K
	±20%	0.85±0.15	C1220JB1H103M
22,000	±10%	0.85±0.15	C1220JB1H223K
	±20%	0.85±0.15	C1220JB1H223M
47,000	±10%	0.85±0.15	C1220JB1H473K
	±20%	0.85±0.15	C1220JB1H473M

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
100,000	±10%	0.85±0.15	C1220JB1E104K
	±20%	0.85±0.15	C1220JB1E104M

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
220,000	±10%	0.85±0.15	C1220JB1C224K
	±20%	0.85±0.15	C1220JB1C224M

- Part number for temperature characteristic X5R or X7R
  Please substitute "X5R" or "X7R" for "JB" in the part number when ordering.

TEMPERATURE CHARACTERISTICS:
JIS B(BJ)(±10%), EIA X5R(±15%)

RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
470,000	±10%	0.85±0.15	C1220JB1A474K
	±20%	0.85±0.15	C1220JB1A474M
1,000,000 [1μF]	±10%	0.85±0.15	C1220JB1A105K
	±20%	0.85±0.15	C1220JB1A105M

- Part number for temperature characteristic X5R
  Please substitute "X5R" for "JB" in the part number when ordering.

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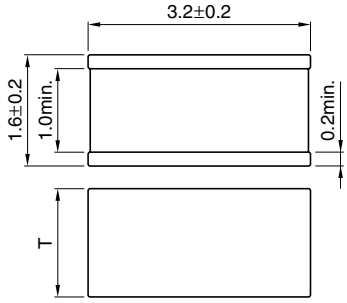
C1632 (EIA CC0612) TYPE

SHAPES AND DIMENSIONS



Dimensions in mm

CAPACITANCE RANGES: CLASS 2

TEMPERATURE CHARACTERISTICS:

JIS B(BJ)(±10%), EIA X5R/X7R(±15%)

RATED VOLTAGE Edc: 50V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
10,000	±10%	0.7±0.1	C1632JB1H103K
	±20%	0.7±0.1	C1632JB1H103M
22,000	±10%	0.7±0.1	C1632JB1H223K
	±20%	0.7±0.1	C1632JB1H223M
47,000	±10%	0.7±0.1	C1632JB1H473K
	±20%	0.7±0.1	C1632JB1H473M
100,000	±10%	0.7±0.1	C1632JB1H104K
	±20%	0.7±0.1	C1632JB1H104M
220,000	±10%	1.15±0.15	C1632JB1H224K
	±20%	1.15±0.15	C1632JB1H224M

RATED VOLTAGE Edc: 25V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
220,000	±10%	0.7±0.1	C1632JB1E224K
	±20%	0.7±0.1	C1632JB1E224M
470,000	±10%	1.15±0.15	C1632JB1E474K
	±20%	1.15±0.15	C1632JB1E474M

RATED VOLTAGE Edc: 16V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
470,000	±10%	0.7±0.1	C1632JB1C474K
	±20%	0.7±0.1	C1632JB1C474M
1,000,000 [1μF]	±10%	1.15±0.15	C1632JB1C105K
	±20%	1.15±0.15	C1632JB1C105M

- Part number for temperature characteristic X5R or X7R
  Please substitute "X5R" or "X7R" for "JB" in the part number when ordering.

TEMPERATURE CHARACTERISTICS:

JIS B(BJ)(±10%), EIA X5R(±15%)

RATED VOLTAGE Edc: 10V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
1,000,000 [1μF]	±10%	0.7±0.1	C1632JB1A105K
	±20%	0.7±0.1	C1632JB1A105M
2,200,000	±10%	1.15±0.15	C1632JB1A225K
	±20%	1.15±0.15	C1632JB1A225M

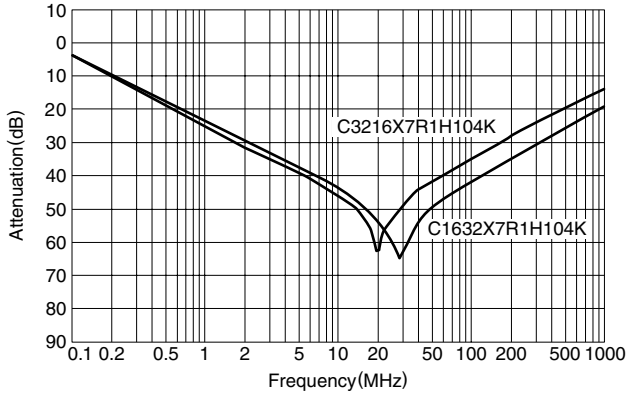
RATED VOLTAGE Edc: 6.3V

Capacitance (pF)	Tolerance	Thickness T (mm)max.	Part number
4,700,000 [4.7μF]	±10%	1.3±0.15	C1632JB0J475K
	±20%	1.3.±0.15	C1632JB0J475M

- Part number for temperature characteristic X5R
  Please substitute "X5R" for "JB" in the part number when ordering.

TYPICAL ELECTRICAL CHARACTERISTICS

ATTENUATION vs. FREQUENCY CHARACTERISTICS



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大容量積層セラミックコンデンサ
HIGH VALUE MULTILAYER CERAMIC CAPACITORS

	code	Temp.characteristics	operating Temp. range
OPERATING TEMP.	BJ	B	−25～+85℃
		X7R	−55～+125℃
		X5R	−55～+85℃
	F	F	−25～+85℃
		Y5V	−30～+85℃

フロー／WAVE　リフロー／REFLOW

特長　FEATURES

・電極にNi金属を使用し、端子電極部にメッキをしてあることにより、はんだ付け性および耐熱性にすぐれ、マイグレーションもほとんど発生せず、高い信頼性を示します
・等価直列抵抗(ESR)が小さく、ノイズ吸収性にすぐれています。特にタンタルおよびアルミ電解コンデンサに比較した場合
・高い許容リップル電流値
・高い定格電圧でありながら小型形状
・絶縁抵抗、破壊電圧が高く信頼性にすぐれる
等の特徴があります

・The use of Nickel(Ni) as material for both the internal and external electrodes improves the solderability and heat resistance characteristics. This almost completely eliminates migration and raises the level of reliability significantly.
・Low equivalent series resistance(ESR) provides excellent noise absorption characteristics.
・Compared to tantalum or aluminum electrolytic capacitors these ceramic capacitors offer a number of excellent features, including:
Higher permissible ripple current values
Smaller case sizes relative to rated voltage
Improved reliability due to higher insulation resistance and breakdown voltage.

用途　APPLICATIONS

・デジタル回路全般
・電源バイパスコンデンサ
液晶モジュール用
液晶駆動電圧ライン用
電源電圧の高いLSI、IC、OPアンプ用
・平滑コンデンサ
DC-DCコンバータ(入力、出力側用)
スイッチング電源(2次側用)

・General digital circuit
・Power supply bypass capacitors
Liquid crystal modules
Liquid crystal drive voltage lines
LS I, I C, converters(both for input and output)
・Smoothing capacitors
DC-DC converters (both for input and output)
Switching power supplies (secondary side)

形名表記法　ORDERING CODE

1 定格電圧〔VDC〕

A	4
J	6.3
L	10
E	16
T	25
G	35
U	50

2 シリーズ名

M	積層コンデンサ

3 端子電極

K	メッキ品

4 形状寸法〔EIA〕L×W(mm)

107(0603)	1.6×0.8
212(0805)	2.0×1.25
316(1206)	3.2×1.6
325(1210)	3.2×2.5
432(1812)	4.5×3.2

5 温度特性〔%〕

△F	+30 −80
B J	±10

△= スペース

6 公称静電容量〔pF〕

例	
473	47,000
105	1,000,000

7 容量許容差

K	±10	%
M	±20	%
Z	+80 −20	%

8 製品厚み〔mm〕

K	0.45
A	0.8
D	0.85
F	1.15
G	1.25
H	1.5
L	1.6
N	1.9
Y	2.0max
M	2.5
U	3.2

9 個別仕様

−	標準

10 包装

T	リールテーピング

11 当社管理記号

△	標準品

△= スペース

J M K 3 1 6 B J 1 0 6 M L − T ○

1 2 3 4 5 6 7 8 9 10 11

1 Rated voltage〔VDC〕

A	4
J	6.3
L	10
E	16
T	25
G	35
U	50

2 Series name

M	Multilayer Ceramic Capacitors

3 End termination

K	Plated

4 Dimensions〔case size〕(mm)

107(0603)	1.6×0.8
212(0805)	2.0×1.25
316(1206)	3.2×1.6
325(1210)	3.2×2.5
432(1812)	4.5×3.2

5 Temperature characteristics code

△F	Y5V	−30～+85℃ +22／−82%
B J	X7R	−55～+125℃ ±15%
B J	X5R	−55～+85℃ ±15%

△=Blank space

6 Nominal capacitance〔pF〕

example	
473	47,000
105	1,000,000

7 Capacitance tolerances〔%〕

K	±10
M	±20
Z	+80 −20

8 Thickness〔mm〕

K	0.45
A	0.8
D	0.85
F	1.15
G	1.25
H	1.5
L	1.6
N	1.9
Y	2.0max
M	2.5
U	3.2

9 Special code

−	Standard products

10 Packaging

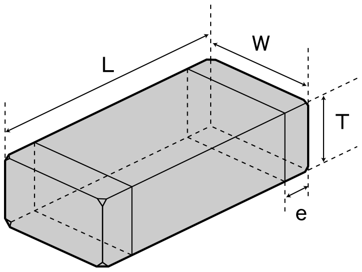
T	Tape & reel

11 Internal code

△	Standard products

△=Blank space

外形寸法　EXTERNAL DIMENSIONS



Type (EIA)	L	W	T		e
□MK107 (0603)	1.6±0.10*4 (0.063±0.004)	0.8±0.10*4 (0.031±0.004)	0.45±0.05 (0.018±0.002)	K	0.35±0.25 (0.014±0.010)
			0.8±0.10*4 (0.031±0.004)	A	
□MK212 (0805)	2.0±0.10*1 (0.079±0.004)	1.25±0.10*1 (0.049±0.004)	0.45±0.05 (0.018±0.002)	K	0.5±0.25 (0.020±0.010)
			0.85±0.10 (0.033±0.004)	D	
			1.25±0.10 *1 (0.049±0.004)	G	
□MK316 (1206)	3.2±0.15*3 (0.126±0.006)	1.6±0.15*3 (0.063±0.006)	0.85±0.10 (0.033±0.004)	D	$0.5^{+0.35}_{-0.25}$ $(0.020^{+0.014}_{-0.010})$
			1.15±0.10 (0.045±0.004)	F	
			1.25±0.10 (0.049±0.004)	G	
			1.6±0.20 (0.063±0.008)	L	
□MK325 (1210)	3.2±0.30 (0.126±0.012)	2.5±0.20*2 (0.098±0.008)	0.85±0.10 (0.033±0.004)	D	0.6±0.3 (0.024±0.012)
			1.15±0.10 (0.045±0.004)	F	
			1.5±0.10 (0.059±0.004)	H	
			1.9±0.20 (0.075±0.008)	N	
			$1.9^{+0.1}_{-0.2}$ $(0.075^{+0.004}_{-0.008})$	Y	
			2.5±0.20 *2 (0.098±0.008)	M	
□MK432 (1812)	4.5±0.40 (0.177±0.016)	3.2±0.30 (0.126±0.012)	$1.9^{+0.1}_{-0.2}$ $(0.075^{+0.004}_{-0.008})$	Y	0.9±0.6 (0.035±0.024)
			2.5±0.20 (0.098±0.008)	M	
			3.2±0.30 (0.125±0.012)	U	

Unit：mm (inch)

注：＊1. ±0.15mm公差あり
＊2. ±0.3mm公差あり
＊3. ±0.2mm公差あり
＊4. +0.15/−0.1mm公差あり

Note: ＊1. Including dimension tolerance±0.15mm (±0.006 inch).
Note: ＊2. Including dimension tolerance±0.3mm (±0.012 inch).
Note: ＊3. Including dimension tolerance±0.2mm (±0.008 inch).
Note: ＊4. Including dimension tolerance+0.15/−0.1mm (+0.006/−0.004 inch).

概略バリエーション　AVAILABLE CAPACITANCE RANGE

Cap	Type	107														
	TC	B/X7R			B/X5R						X5R		F/Y5V			
	VDC	25	16	10	50	35	25	16	10	6.3	6.3	4	50	25	16	10
μF	3[digits]															
0.022	223	A														
0.033	333		A			A										
0.047	473		A			A										
0.068	683		A				A									
0.1	104		A		A		A						A			
0.15	154						A	A								
0.22	224		A				A	A							A	
0.33	334						A	A	A							
0.47	474			A			A	A	A					A	A	
0.68	684								A							
1	105		A	A		A	A	A	A						A	A
1.5	155															
2.2	225							A	A	A					A	A
3.3	335										A					
4.7	475								A		A					
6.8	685															
10	106										A	A				
22	226															
47	476															
100	107															
220	227															

Cap	Type	212																	
	TC	B/X7R						B/X5R						X5R		F/Y5V			
	VDC	50	35	25	16	10	6.3	50	35	25	16	10	6.3	6.3	4	50	16	10	6.3
μF	3[digits]																		
0.022	223																		
0.033	333																		
0.047	473	G																	
0.068	683	G																	
0.1	104	G																	
0.15	154	G																	
0.22	224							G											
0.33	334		G																
0.47	474							G	G							G			
0.68	684				G														
1	105			G	G	G			G	G	G					G			
1.5	155																		
2.2	225				G	G				G	G	G					G		
3.3	335					G						G							
4.7	475					G	G				G	G	G					G	
6.8	685																		
10	106										G	G	G					G	G
22	226												G	G					
47	476														G				
100	107																		
220	227																		

Cap	Type	316																
	TC	B/X7R						B/X5R				X5R		F/Y5V				
	VDC	50	35	25	16	10	6.3	25	16	10	6.3	6.3	4	50	35	25	16	10
μF	3[digits]																	
0.022	223																	
0.033	333																	
0.047	473																	
0.068	683																	
0.1	104																	
0.15	154	F																
0.22	224	L		F														
0.33	334			F														
0.47	474	L																
0.68	684		L	L	F													
1	105		L		F													
1.5	155																	
2.2	225			L	L									G				
3.3	335				L	L		L	L									
4.7	475			L	L	L		L	L						G			
6.8	685										F							
10	106				L	L	L	L	L	L	L.F				L	L	L	F
22	226						L		L	L	L							L
47	476										L	L						
100	107												L					
220	227																	

Cap	Type	325															
	TC	B/X7R				B/X5R					X5R		F/Y5V				
	VDC	50	25	16	10	35	25	16	10	6.3	6.3	4	50	35	16	10	6.3
μF	3[digits]																
0.022	223																
0.033	333																
0.047	473																
0.068	683																
0.1	104																
0.15	154																
0.22	224																
0.33	334																
0.47	474																
0.68	684																
1	105	H															
1.5	155																
2.2	225		H			N											
3.3	335		N														
4.7	475			N			N	N					H				
6.8	685																
10	106		M.Y		N	N	M.N	N						H	F		
22	226			M				M	M						N	N.F	
47	476							M	M	M.N							N
100	107									Y	M	Y					M
220	227																

Cap	Type	432					
	TC	B/X5R				F/Y5V	
	VDC	25	16	10	6.3	10	6.3
μF	3[digits]						
0.022	223						
0.033	333						
0.047	473						
0.068	683						
0.1	104						
0.15	154						
0.22	224						
0.33	334						
0.47	474						
0.68	684						
1	105						
1.5	155						
2.2	225						
3.3	335						
4.7	475						
6.8	685						
10	106	M					
22	226		M	M			
47	476				M	M	
100	107				U		M
220	227						

■低背積層セラミックコンデンサ　Low profile Multilayer Ceramic Capacitors

Cap	Type	107					212													
	TC	B/X5R		X5R		F/Y5V	B/X7R				B/X5R				X5R			F/Y5V		
	VDC	10	6.3	6.3	4	6.3	50	25	16	10	25	16	10	6.3	10	6.3	4	50	10	6.3
μF	3[digits]																			
0.022	223						D													
0.033	333						D													
0.047	473							D												
0.068	683							D												
0.100	104																			
0.150	154																			
0.220	224												K					D		
0.330	334																			
0.470	474		K						D		D									
0.680	684								D											
1.000	105	K	K			K		D		D	D	D・K	K	K						
1.500	155											D								
2.200	225			K	K				D			D	D						D	
3.300	335																			
4.700	475				K							D	D	D		K	K			D
6.800	685																			
10.000	106												D		D	D				
22.000	226																D			
47.000	476																			
82.000	826																			
100.000	107																			

Cap	Type	316							325				
	TC	B/X7R	B/X5R				F/Y5V		B/X7R	B/X5R			
	VDC	10	25	16	10	6.3	10	6.3	25	25	16	10	6.3
μF	3[digits]												
0.022	223												
0.033	333												
0.047	473												
0.068	683												
0.100	104												
0.150	154	D											
0.220	224												
0.330	334												
0.470	474												
0.680	684												
1.000	105		D						D				
1.500	155			D									
2.200	225	D		D									
3.300	335				D							D	
4.700	475				D		D					D	
6.800	685												D
10.000	106			D	D	D		D		D	D	D	
22.000	226										D		Y
47.000	476												
82.000	826												
100.000	107												Y

温度特性コード Temp. char.Code	温度特性 Temperature characteristics					静電容量許容差〔%〕 Capacitance tolerance	tanδ〔%〕 Dissipation factor
	準拠規格 Applicable standard		温度範囲〔℃〕 Temperature range	基準温度〔℃〕 Ref. Temp.	静電容量変化率〔%〕 Capacitance change		
BJ	JIS	B	−25～85	20	±10	±20(M) ±10(K)	2.5%max.**
	EIA	X7R*	−55～125	25	±15		
F	JIS	F	−25～85	20	+30／−80	$^{+80}_{-20}$(Z)	7.0%max.**
	EIA	Y5V	−30～85	25	+22／−82		

＊：X5Rのみ対応するアイテムがあります。詳細はアイテム一覧を参照ください。
＊＊：代表的な値を記載しています。詳細はアイテム一覧表を参照ください。
＊：Some of the parts are only applicable to X5R. Please refer to PART NUMBERS table.
＊＊：The figure indicates typical value. Please refer to PART NUMBERS table.

セレクションガイド Selection Guide ◀ P.10 etc
アイテム一覧 Part Numbers P.40 ▶
特性図 Electrical Characteristics P.44 ▶
梱包 Packaging P.78 ▶
信頼性 Reliability Data P.80 ▶
使用上の注意 Precautions P.86 ▶

一般積層セラミックコンデンサ（温度補償用・Class 1）

STANDARD MULTILAYER CERAMIC CAPACITORS (CLASS1 : TEMPERATURE COMPENSATING DIELECTRIC TYPE)

OPERATING TEMP.	−55～+125℃

フロー／WAVE＊　リフロー／REFLOW

＊042TYPE, 063TYPE, 105TYPEは除く
＊Except for 042TYPE, 063TYPE, 105TYPE

特長　FEATURES

・実装密度の向上が図れます
・モノリシックの構造のため、信頼性が高い
・同一形状、静電容量範囲が広い

・Improve Higher Mounting Densities.
・Multilayer block structure provides higher reliability
・A wide range of capacitance values available in standard case sizes.

用途　APPLICATIONS

・一般電子機器用
・通信機器用（携帯電話、PHS、コードレス電話 etc.）

・General electronic equipment
・Communication equipment (portable telephones, PHS, other wireless applications, etc.)

形名表記法　ORDERING CODE

1 定格電圧〔VDC〕

E	16
T	25
U	50

2 シリーズ名

M	積層コンデンサ

3 端子電極

K	メッキ品

4 形状寸法(EIA)L×W〔mm〕

042(01005)	0.4×0.2
063(0201)	0.6×0.3
105(0402)	1.0×0.5
107(0603)	1.6×0.8

5 温度特性〔ppm/℃〕

C□	0：CG、CH、CJ、CK		
P□	−150：PH、PJ、PK		
R□	−220：RH、RJ、RK		
S□	−330：SH、SJ、SK	G	± 30
T□	−470：TH、TJ、TK	H	± 60
U□	−750：UJ、UK	J	±120
S L	+350～−1000	K	±250

□= 許容差

6 公称静電容量〔pF〕

例	
0R5	0.5
010	1
100	10

※R= 小数点

7 容量許容差

C	± 0.25 pF
D	± 0.5 pF
F	± 1 pF
J	± 5 %
K	± 10 %

8 製品厚み〔mm〕

C	0.2
P	0.3
V	0.5
W	0.5
Z	0.8

9 個別仕様

−	標準

10 包装

F	テーピング(2mmピッチ・178φ)
T	テーピング(4mmピッチ・178φ)

11 当社管理記号

△	標準品

△=スペース

U M K 1 0 5 C H 1 0 1 J W − F ○

1 2 3 4 5 6 7 8 9 10 11

1 Rated voltage〔VDC〕

E	16
T	25
U	50

2 Series name

M	Multilayer ceramic capacitor

3 End termination

K	Plated

4 Dimensions (case size)(EIA)L×W〔mm〕

042(01005)	0.4×0.2
063(0201)	0.6×0.3
105(0402)	1.0×0.5
107(0603)	1.6×0.8

5 Temperature characteristics〔ppm/℃〕

C□	0：CG、CH、CJ、CK (C0G、C0H、C0J、C0K)		
P□	−150：PH、PJ、PK (P2H、P2J、P2K)		
R□	−220：RH、RJ、RK (R2H、R2J、R2K)		
S□	−330：SH、SJ、SK (S2H、S2J、S2K)	2	± 30
T□	−470：TH、TJ、TK (T2H、T2J、T2K)	H	± 60
U□	−750：UJ、UK (U2J、U2K)	2J	±120
S L	+350～−1000	K	±250

□=Tolerance

6 Nominal Capacitance〔pF〕

example	
0R5	0.5
010	1
100	10

*R=decimal point

7 Capacitance Tolerance

C	± 0.25 pF
D	± 0.5 pF
F	± 1 pF
J	± 5 %
K	± 10 %

8 Thickness[mm]

C	0.2
P	0.3
V	0.5
W	0.5
Z	0.8

9 Special code

−	Standard Products

10 Packaging

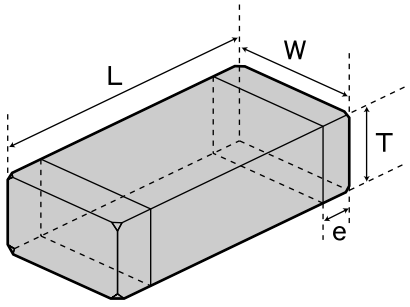
F	Tape(2mm pitch・178φ)
T	Tape(4mm pitch・178φ)

11 Internal code

△	Standard Products

△=Blank space

外形寸法　EXTERNAL DIMENSIONS



Type(EIA)	L	W	T		e
□MK042 (01005)	0.4±0.02 (0.016±0.001)	0.2±0.02 (0.008±0.001)	0.2±0.02 (0.008±0.001)	C	0.1±0.03 (0.004±0.001)
□MK063 (0201)	0.6±0.03 (0.024±0.001)	0.3±0.03 (0.012±0.001)	0.3±0.03 (0.012±0.001)	P	0.15±0.05 (0.006±0.002)
□MK105 (0402)	1.0±0.05 (0.039±0.002)	0.5±0.05 (0.020±0.002)	0.5±0.05 (0.020±0.002)	W, V	0.25±0.10 (0.010±0.004)
□MK107 (0603)	1.6±0.10 (0.063±0.004)	0.8±0.10 (0.031±0.004)	0.8±0.10 (0.031±0.004)	Z	0.35±0.25 (0.014±0.010)

Unit：mm(inch)

概略バリエーション　AVAILABLE CAPACITANCE RANGE

Type		042	063		105						107			
Temp.char.			C□	U□	R□	S□	T□	U□	C□	SL	C□	P□,T□,R□,S□	U□	SL
WV		16V	25V		16V			50V			50V			
[pF]	[pF 3digits]													
0.5	0R5	C	P	P	W	W	W	W	W		Z	Z	Z	Z
1	010	C	P	P	W	W	W	W	W		Z	Z	Z	Z
1.5	1R5	C	P	P	W	W	W	W	W		Z	Z	Z	Z
2	020	C	P	P	W	W	W	W	W		Z	Z	Z	Z
3	030	C	P	P	W	W	W	W	W		Z	Z	Z	Z
4	040	C	P	P	W	W	W	W	W		Z	Z	Z	Z
5	050	C	P	P	W	W	W	W	W		Z	Z	Z	Z
6	060	C	P	P	W	W	W	W	W		Z	Z	Z	Z
7	070	C	P	P	W	W	W	W	W		Z	Z	Z	Z
8	080	C	P	P	W	W	W	W	W		Z	Z	Z	Z
9	090	C	P	P	W	W	W	W	W		Z	Z	Z	Z
10	100	C	P	P	W	W	W	W	W		Z	Z	Z	Z
12	120	C	P	P	W	W	W	W	W		Z	Z	Z	Z
15	150	C	P	P	W	W	W	W	W		Z	Z	Z	Z
18	180		P					V	V		Z	Z	Z	Z
22	220		P					V	V		Z	Z	Z	Z
27	270		P					V	V		Z	Z	Z	Z
33	330		P					V	V		Z	Z	Z	Z
39	390		P					V	V		Z	Z	Z	Z
47	470		P					V	V		Z	Z	Z	Z
56	560		P					V	V		Z	Z	Z	Z
68	680		P					V	V		Z	Z	Z	Z
82	820		P					V	V		Z	Z	Z	Z
100	101		P					V	V		Z	Z	Z	Z
120	121									V	Z	Z	Z	Z
150	151									V	Z	Z	Z	Z
180	181									V	Z	Z	Z	Z
220	221									V	Z	Z	Z	Z
270	271									V	Z	Z	Z	Z
330	331									V	Z	Z	Z	Z
390	391									V	Z	Z	Z	Z
470	471									V	Z	Z	Z	Z
560	561									V	Z	Z	Z	Z
680	681									V	Z	Z	Z	Z
820	821									V	Z	Z	Z	Z
1000	102									V	Z	Z	Z	Z

注：グラフの記号は製品の厚み記号です。

Note: Letter code in shaded areas are thickness codes.

温度特性　Temperature Characteristics

温度特性 Temperature char.(EIA)	温度係数範囲 〔ppm/℃〕※1 Temperature coefficient range	使用温度範囲 Operating Temp. range
C K(C0K)	0±250	−55～+125℃
C J(C0J)	0±120	
C H(C0H)	0±60	
C G(C0G)	0±30	
P K(P2K)	−150±250	
P J(P2J)	−150±120	
P H(P2H)	−150±60	
R K(R2K)	−220±250	
R J(R2J)	−220±120	
R H(R2H)	−220±60	
S K(S2K)	−330±250	
S J(S2J)	−330±120	
S H(S2H)	−330±60	
T K(T2K)	−470±250	
T J(T2J)	−470±120	
T H(T2H)	−470±60	
U K(U2K)	−750±250	
U J(U2J)	−750±120	
S L	−1000～+350	

※1：20℃における静電容量を基準。
Based on the capacitance at 20℃

静電容量許容差　Capacitance Tolerance Symbol

記号 Symbol	許容差 Tolerance	区分 Item
C	±0.25pF	～5pF
D	±0.5 pF	～10pF
F	±1pF	6～10 pF
J	±5 %	11pF～
K	±10 %	11pF～

Q

Q※2 Symbol	区分 Item
≧400+20・C※1	～27pF
≧1000	30pF～

※1：C=公称静電容量　Nominal capacitance〔pF〕

※2：測定周波数　Measurement Frequency= 1±0.1MHz(C≦1000pF)
1±0.1kHz (C>1000pF)

測定電圧　Measurement voltage = 0.5～5Vrms(C≦1000pF)
1±0.2Vrms(C>1000pF)

セレクションガイド Selection Guide ◀ P.10
アイテム一覧 Part Numbers P.48 ▶
特性図 Electrical Characteristics ——— ▶
梱包 Packaging P.78 ▶
信頼性 Reliability Data P.80 ▶
使用上の注意 Precautions P.86 ▶
etc

一般積層セラミックコンデンサ（高誘電率系・Class 2）

STANDARD MULTILAYER CERAMIC CAPACITORS (CLASS2 :HIGH DIELECTRIC CONSTANT TYPE)

	code	Temp.characteristics	operating Temp. range
OPERATING TEMP.	B/BJ	B	−25～+85℃
		X7R	−55～+125℃
		X5R	−55～+85℃
	F	F	−25～+85℃
		Y5V	−30～+85℃

フロー／WAVE＊　リフロー／REFLOW

＊042TYPE, 063TYPE, 105TYPEは除く
＊Except for 042TYPE, 063TYPE, 105TYPE

特長　FEATURES

・実装密度の向上が図れます
・モノリシックの構造のため、信頼性が高い
・同一形状、静電容量範囲が広い

・Improve Higher Mounting Densities.
・Multilayer block structure provides higher reliability
・A wide range of capacitance values available in standard case sizes.

用途　APPLICATIONS

・一般電子機器用
・通信機器用（携帯電話、PHS、コードレス電話 etc.）

・General electronic equipment
・Communication equipment (portable telephones, PHS, other wireless applications, etc.)

形名表記法　ORDERING CODE

1 定格電圧〔VDC〕

A	4
J	6.3
L	10
E	16
T	25
U	50

2 シリーズ名

M	積層コンデンサ

3 端子電極

K	メッキ品

4 形状寸法(EIA)L×W〔mm〕

042(01005)	0.4×0.2
063(0201)	0.6×0.3
105(0402)	1.0×0.5
107(0603)	1.6×0.8

5 温度特性

△B,BJ	±10%
△F	$^{+30}_{-80}$%

△=スペース

6 公称静電容量〔pF〕

例	
102	1000
223	22000

7 容量許容差〔%〕

K	± 10
M	± 20
Z	$^{+80}_{-20}$

8 製品厚み〔mm〕

C	0.2
P	0.3
V	0.5
Z	0.8

9 個別仕様

―	標準

10 包装

F	テーピング(2mmピッチ・178φ)
T	テーピング(4mmピッチ・178φ)

11 当社管理記号

△	標準

△=スペース

L	M	K	1	0	5	B	J	1	0	4	K	V	–	F	○
1	2	3	4			5		6			7	8	9	10	11

1 Rated voltage〔VDC〕

A	4
J	6.3
L	10
E	16
T	25
U	50

2 Series name

M	Multilayer ceramic capacitors

3 End termination

K	Plated

4 Dimensions (case size)(L×W)〔mm〕

042(01005)	0.4×0.2
063(0201)	0.6×0.3
105(0402)	1.0×0.5
107(0603)	1.6×0.8

5 Temperature characteristics code

△B BJ	X7R	−55～+125℃ ±15%
	X5R	−55～+85℃ ±15%
△F	Y5V	−30～+85℃ $^{+22}_{-82}$%

△=Blank space

6 Nominal Capacitance〔pF〕

example	
102	1000
223	22000

7 Capacitance Tolerance〔%〕

K	± 10
M	± 20
Z	$^{+80}_{-20}$

8 Thickness〔mm〕

C	0.2
P	0.3
V	0.5
Z	0.8

9 Special code

―	Standard products

10 Packaging

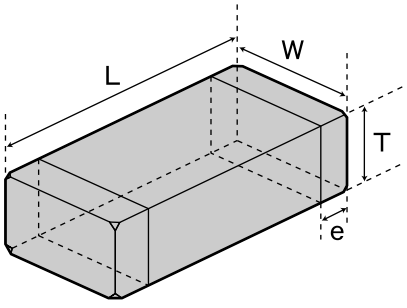
F	Tape&Reel(2mm pitch・178φ)
T	Tape&Reel(4mm pitch・178φ)

11 Internal code

△	Standard Products

△=Blank space

外形寸法　EXTERNAL DIMENSIONS



Type(EIA)	L	W	T		e
□MK042 (01005)	0.4±0.02 (0.016±0.001)	0.2±0.02 (0.008±0.001)	0.2±0.02 (0.008±0.001)	C	0.1±0.03 (0.004±0.001)
□MK063 (0201)	0.6±0.03 (0.024±0.001)	0.3±0.03 (0.012±0.001)	0.3±0.03 (0.012±0.001)	P	0.15±0.05 (0.006±0.002)
□MK105 (0402)	1.0±0.05 (0.039±0.002)	0.5±0.05 (0.020±0.002)	0.5±0.05 (0.020±0.002)	V	0.25±0.10 (0.010±0.002)
□MK107 (0603)	1.6±0.10 (0.063±0.004)	0.8±0.10 (0.031±0.004)	0.8±0.10 (0.031±0.004)	Z	0.35±0.25 (0.014±0.010)

Unit：mm(inch)

概略バリエーション　AVAILABLE CAPACITANCE RANGE

■汎用積層セラミックコンデンサ（General Multilayer Ceramic capacitors）

Type		042		063								105														107			
Temp.char.		BJ/X5R		BJ/X5R				X5R		F/Y5V		BJ/X7R			BJ/X5R				X5R		F/Y5V					B/X7R		F/Y5V	
WV		10V	6.3V	25V	16V	10V	6.3V	6.3V	4V	6.3V	4V	50V	25V	16V	25V	16V	10V	6.3V	6.3V	4V	50V	25V	16V	10V	6.3V	50V	25V	50V	25V
Cap [pF]	[pF 3digits]																												
100	101																												
150	151																												
220	221																												
330	331	C		P								V																	
470	471																												
680	681																												
1000	102																									Z			
1500	152																												
2200	222																												
3300	332		C		P																								
4700	472												V																
6800	682																												
10000	103																				V							Z	
15000	153																										Z		
22000	223					P				P				V								V						Z	
33000	333																												
47000	473						P			P													V						Z
68000	683																												
100000	104							P			P			V	V	V													Z
220000	224								P								V							V					
470000	474																	V											
1000000	105																								V				
2200000	225																		V	V									

注：グラフの記号は製品厚み記号です。　Note：Letter codes in shaded areas are thickness codes.

温度特性　Temperature Characteristics

温度特性 Temperature Characteristics	温度範囲 Operating temp. range [℃]	基準温度 Ref. Temp. [℃]	静電容量変化率 Capacitance Change [%]
B	−25～85	20	±10
X7R	−55～125	25	±15
X5R	−55～85	25	±15
F	−25～85	20	$^{+30}_{-80}$
Y5V	−30～85	25	$^{+22}_{-82}$

静電容量許容差　Capacitance Tolerance

記号 Code	許容差 Tolerance	区分 Item
K	±10%	B Char.
M	±20%	B Char.
Z	$^{+80}_{-20}$%	F Char.

tan δ

Type	tan δ ※1	区分 Item
063	≦3.5%	B Char. 25V
	≦5.0%	B Char. 16V
	≦10%	B Char. 6.3V, 10V
	≦16%	F Char. 6.3V
	≦20%	F Char. 4V
105	≦2.5%	B Char. 50V, 25V (0.0068μF)
	≦3.5%	B Char. 16V, 0.027~0.047μF, 25V (0.01μF)
	≦5.0%	F Char. 50V, 25V B Char. 0.056~0.22μF
	≦7.0%	F Char. 0.033μF, 0.047μF
	≦9.0%	F Char. 0.068μF～0.1μF
	≦10%	B Char. 0.47μF～1μF
	≦11%	F Char. 0.22μF
	≦16%	F Char. 0.47μF
	≦20%	F Char. 1μF
107	≦2.5%	B Char.
	≦5.0%	F Char.

※1　測定周波数　Measurement frequency=1±0.1kHz
　　測定電圧　Measurement voltage　=1±0.2Vrms

セレクションガイド Selection Guide ◀ P.10
アイテム一覧 Part Numbers P.54 ▶
特性図 Electrical Characteristics ——▶
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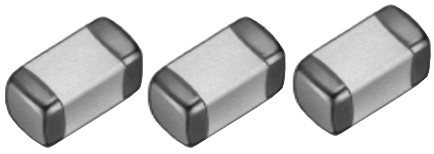
高周波積層セラミックコンデンサ
MULTILAYER CERAMIC CAPACITORS FOR HIGH FREQUENCY APPLICATIONS(1GHz+)



リフロー／REFLOW

OPERATING TEMP.	−55～+125℃

特長　FEATURES

・積層磁器コンデンサとしては高いQ値が高周波で得られる
・1005形状であるため、実装密度の向上、軽量化が図れる

・Q values in the high frequency range (1 GHz+) are excellent compared to other types of multilayer capacitors.
・The 1005(0402) case size is designed for high density mounting and weight reduction in various applications.

用途　APPLICATIONS

・高周波におけるコンデンサのQ値および小型化が求められる用途向き
VCO、TCXO etc
・高周波回路の特性調整用途

・Suitable for those high frequency applications in which a capacitor with both a high Q-value and small size is required such as portable communications and other wireless applications.
VCO, TCXO. etc.
・Adjustment of characteristics in high frequency circuit

形名表記法　ORDERING CODE

1 定格電圧〔VDC〕

E	16
U	50

2 シリーズ名

V	高周波用積層コンデンサ

3 端子電極

K	メッキ品

4 形状寸法(EIA)L×W〔mm〕

105(0402)	1.0×0.5

5 温度特性〔ppm/℃〕

CH	0±60
RH	−220±60

6 公称静電容量〔pF〕

例	
020	2
4R3	4.3

※R= 小数点

7 容量許容差

B	±0.1pF
J	±5%

8 製品厚み〔mm〕

W	0.5

9 個別仕様

—	標準

10 包装

B	単品(袋づめ)
F	リールテーピング品(178φ2mmピッチ)

U	V	K	1	0	5	R	H	4	R	3	J	W	–	F
1	2	3	4			5			6		7	8	9	10

1 Rated voltage〔VDC〕

E	16
U	50

2 Series name

V	MULTILAYER CERAMIC CAPACITORS FOR HIGH FREQUENCY

3 End termination

K	Plated

4 Dimensions (case size)(L×W)〔mm〕

105(0402)	1.0×0.5

5 Temperature characteristics〔ppm/℃〕

CH	0±60
RH	−220±60

6 Nominal Capacitance〔pF〕

example	
020	2
4R3	4.3

※R=Decimal point

7 Capacitance Tolerances

B	±0.1pF
J	±5%

8 Thickness〔mm〕

W	0.5

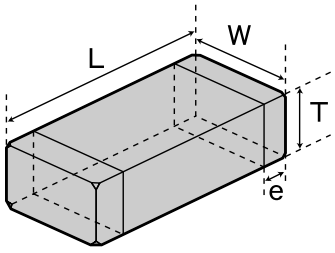
9 Special code

—	Standard Products

10 Packaging

B	Bulk
F	Tape&Reel(2mm pitch・178φ)

外形寸法　EXTERNAL DIMENSIONS



Type(EIA)	L	W	T	e
□VK105	1.0±0.05	0.5±0.05	0.5±0.05	0.25±0.1
(0402)	(0.039±0.002)	(0.020±0.002)	(0.020±0.002)	(0.010±0.004)

Unit：mm(inch)

アイテム一覧　PART NUMBERS

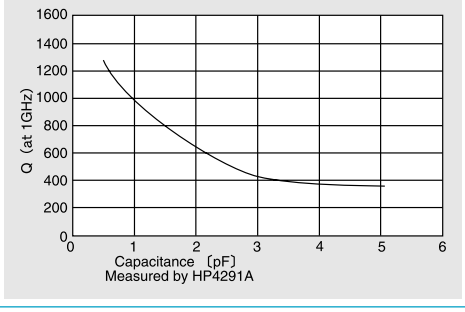
定格電圧 Rated Voltage (DC)	形　名 Ordering code		EHS (Environmental Hazardous Substances)	温度特性 Temperature characteristics CH	RH	公　称 静電容量 Capacitance [pF]	静電容量許容差 Capacitance tolerance	Q規格値 (at 1GHz) Q (min)	厚み Thickness [mm]	Q typ.値 (参考値) Typical Q
	□VK105 CH0R3BW		RoHS	●		0.3		300		1200
	□VK105 CH0R4BW		RoHS	●		0.4		300		1200
	□VK105 CH0R5BW		RoHS	●		0.5		300		1200
	□VK105 CH0R6BW		RoHS	●		0.6		300		1100
	□VK105 CH0R7BW		RoHS	●		0.7		300		1100
	□VK105 CH0R8BW		RoHS	●		0.8		300		1000
	□VK105 CH0R9BW		RoHS	●		0.9		300		950
	□VK105 CH010BW		RoHS	●		1.0	±0.1pF	300		950
	□VK105 CH1R1BW		RoHS	●		1.1		280		930
	□VK105 CH1R2BW		RoHS	●		1.2		270		850
	□VK105 CH1R3BW		RoHS	●		1.3		260		740
	□VK105 CH1R5BW		RoHS	●		1.5		240		710
	□VK105 CH1R6BW		RoHS	●		1.6		230		670
	□VK105 CH1R8BW		RoHS	●		1.8		210		650
	□VK105 CH020BW		RoHS	●		2.0		190		610
	□VK105 CH2R2JW		RoHS	●		2.2		180		530
	□VK105 CH2R4JW		RoHS	●		2.4		170		510
	□VK105 CH2R7JW		RoHS	●		2.7		150		460
	□VK105 CH030JW		RoHS	●		3.0		130		390
	□VK105 CH3R3JW		RoHS	●		3.3	±5%	120		370
	□VK105 CH3R6JW		RoHS	●		3.6		110		360
	□VK105 CH3R9JW		RoHS	●		3.9		99		360
	□VK105 CH4R3JW		RoHS	●		4.3		84		360
E: 16V	□VK105 CH4R7JW		RoHS	●		4.7		84		340
U: 50V	□VK105 CH5R1JW		RoHS	●		5.1		84	0.5±0.05	320
	□VK105 RH0R5BW		RoHS		●	0.5		300		1100
	□VK105 RH0R6BW		RoHS		●	0.6		300		1000
	□VK105 RH0R7BW		RoHS		●	0.7		300		1000
	□VK105 RH0R8BW		RoHS		●	0.8		300		970
	□VK105 RH0R9BW		RoHS		●	0.9		300		950
	□VK105 RH010BW		RoHS		●	1.0		300		900
	□VK105 RH1R1BW		RoHS		●	1.1	±0.1pF	280		900
	□VK105 RH1R2BW		RoHS		●	1.2		270		740
	□VK105 RH1R3BW		RoHS		●	1.3		260		700
	□VK105 RH1R5BW		RoHS		●	1.5		240		680
	□VK105 RH1R6BW		RoHS		●	1.6		230		640
	□VK105 RH1R8BW		RoHS		●	1.8		210		620
	□VK105 RH020BW		RoHS		●	2.0		190		570
	□VK105 RH2R2JW		RoHS		●	2.2		180		480
	□VK105 RH2R4JW		RoHS		●	2.4		170		470
	□VK105 RH2R7JW		RoHS		●	2.7		150		420
	□VK105 RH030JW		RoHS		●	3.0		130		360
	□VK105 RH3R3JW		RoHS		●	3.3	±5%	120		350
	□VK105 RH3R6JW		RoHS		●	3.6		110		340
	□VK105 RH3R9JW		RoHS		●	3.9		99		340
	□VK105 RH4R3JW		RoHS		●	4.3		84		340
	□VK105 RH4R7JW		RoHS		●	4.7		84		320
	□VK105 RH5R1JW		RoHS		●	5.1		84		310

注：□には定格電圧記号がはいります。　□Please specify the Rated Voltage code.

仕様 SPECIFICATIONS

温度特性 Temperature Characteristics	使用温度範囲 Operating Temperature range	温度係数範囲 Temperature Coefficient range [ppm/℃]	静電容量許容差 Capacitance Tolerance (区分)
CH	−55～+125℃	0±60	±0.1pF(～2.0pF)
RH		−220±60	±5%　(2.2pF～)

■容量値とQの関係例(CH特性例) Capacitance vs Q value (Typical for CH T.C.)



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etc