

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 $\pm 15\%$ 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.

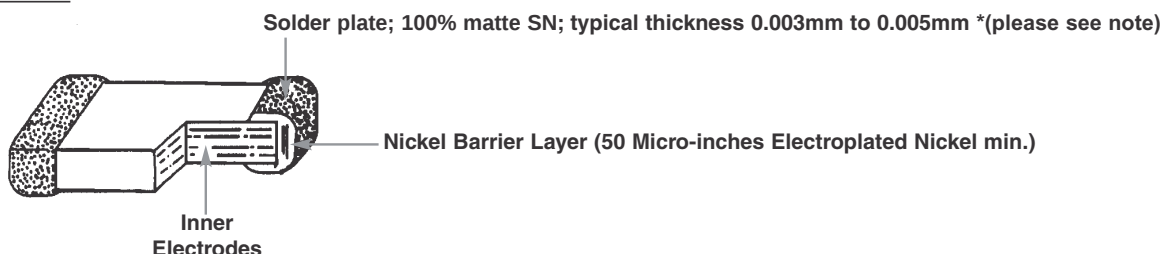
Capacitor Termination

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

Size Code

CG

Dielectric

102

Capacitance (pF)

J

Capacitance
Tolerance
(EIA Code)

50

Voltage

N

Termination

T

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	.01uF
104	.1uF
105	1.0uF
106	10uF

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

NX* - Optional "SoftTerm"

P = Optional Palladium

Sliver (Pd/Ag)

termination

G = Optional Gold

termination

All 3 available

in select values,

contact your

sales

associate for

more information

T* Tape and Reel

*Optional "TD" designates
large 10 inch or 13 inch reels
- see packaging on pg.13 & 14

GMC01 = 01005	GMC10 = 0603	GMC32 = 1210	GMC45 = 1825
GMC02 = 0201	GMC21 = 0805	GMC40 = 1808	GMC55 = 2220
GMC04 = 0402	GMC31 = 1206	GMC43 = 1812	GMC57 = 2225

Note: Calchip has completed the Lead-Free transition. All parts shipped will be Lead-Free. The customer designator of "LF" is no longer available. Lead-Free material will continue to have an LF at the end of the Lot Code and a green RoHS symbol on the label.

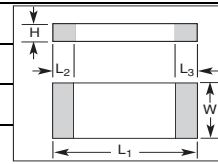


01005

DIMENSION (MM)

GMC01

L(L1)		0.4 ± 0.02							
W		0.2 ± 0.02							
H		0.2 ± 0.02							
BW(L2/L3)		0.07 ~ 0.14							
dielectric		NPO/COG		X7R		X5R		Y5V/Z5U	
Rated Voltage		6.3	10/16	6.3	10		6.3		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								
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560	561								
680	681								
820	821								
1.0nF	102								
1.2	122								
1.5	152								
1.8	182								
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6.8	682								
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68	683								
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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								



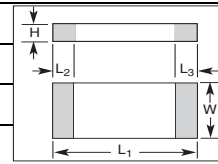


0201

DIMENSION (MM)

GMC02

L(L1)		0.6 ± 0.03						
W		0.3 ± 0.03						
H		0.3 ± 0.03						
BW(L2/L3)		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							
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27	270							
33	330							
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560	564							
680	684							
820	824							
1.0uF	105							
2.2	225							





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	100	6.3	10	16	6.3 /10	16	25	50	100	6.3	10	16	25	50	25	50	100	6.3	10	16/25	6.3	10	16	25	50/ 100	6.3	10	16	25	50
Cap Range																															
Code																															
0.5pF																															
1.0																															
1.2																															
1.5																															
2.0																															
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COG/NPO

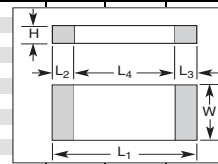
		GMC21			GMC31			GMC32			GMC40			GMC43			GMC45			GMC55			GMC57		
Type		0805			1206			1210			1808			1812			1825			2220			2225		
Length (L1)	mm	2.0±0.3			3.2±0.3			3.2±0.3			4.57±0.25			4.5±0.35			4.5±0.35			5.7±0.4			5.7±0.4		
	Inches	0.08±0.012			0.125±0.012			0.125±0.012			0.18±0.01			0.18±0.014			0.18±0.014			0.225±0.016			0.225±0.016		
Width (W)	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		
Thick(Max) (H)	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 (L2 & L3)	mm	Min	Max		Min	Max		Min	Max		Min	Max		Min	Max		Min	Max		Min	Max		Min	Max	
	Inches	0.25 0.01	0.75 0.03		0.25 0.01	0.75 0.03		0.25 0.01	0.75 0.03		0.25 0.01	0.75 0.03		0.25 0.01	0.75 0.03		0.25 0.01	0.75 0.03		0.25 0.01	0.75 0.03		0.25 0.01	0.75 0.03	
Band Gap (L4)	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		50/63		50/63	
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																								
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5.6	5R6																								
6.0	6R0																								
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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 (L1) 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 (W) 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	
Thick(Max) mm	1.3		1.6		1.8		2.03		1.8		1.8		1.8		1.8	
(H) Inches	0.051		0.063		0.07		0.08		0.07		0.07		0.07		0.07	
Termination Band (L2 & L3) mm	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Inches	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
Band Gap mm	0.5		1.4		1.4		2.0		2.2		2.2		2.9		2.9	
(L4) 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															
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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															



[illegible]

X7R (cont)

	GMC21		GMC31		GMC32		GMC40		GMC43		GMC45		GMC55		GMC57			
Type	0805		1206		1210		1808		1812		1825		2220		2225			
Length(L1) mm Inches	2.0±0.3 0.08±0.012		3.2±0.3 0.125±0.012		3.2±0.3 0.125±0.012		4.57±0.25 0.18±0.01		4.5±0.35 0.18±0.014		4.5±0.35 0.18±0.014		5.7±0.4 0.225±0.016		5.7±0.4 0.225±0.016			
Width (W) mm Inches	1.25±0.2 0.05±0.008		1.6±0.2 0.063±0.008		2.5±0.3 0.10±0.012		2.03±0.25 0.08±0.01		3.2±0.3 0.125±0.012		6.3±0.4 0.25±0.016		5.0±0.4 0.197±0.016		6.3±0.4 0.25±0.016			
Thick(Max) mm (H) Inches	1.3 0.051		1.8 0.063		2.8 0.07		3.0 0.08		3.0 0.07		3.2 0.07		3.5 0.07		3.5 0.07			
Termination Band (L2 & L3) mm Inches	Min 0.25 0.01	Max 0.75 0.03	Min 0.25 0.01	Max 0.75 0.03	Min 0.25 0.01	Max 0.75 0.03	Min 0.25 0.01	Max 0.75 0.03	Min 0.25 0.01	Max 0.75 0.03	Min 0.25 0.01	Max 0.75 0.03	Min 0.25 0.01	Max 0.75 0.03	Min 0.25 0.01	Max 0.75 0.03		
Band Gap mm (L4) Inches	0.5 0.019		1.4 0.055		1.4 0.055		2.0 0.078		2.2 0.087		2.2 0.087		2.9 0.114		2.9 0.114			
Rated Voltage d.c.	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																	
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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																	

Y5V/Z5U

GMC21				GMC31				GMC32				GMC40				GMC43				GMC45				GMC55				GMC57				
Type	0805				1206				1210				1808				1812				1825				2220				2225			
Length(L1) 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 (W) 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			
Thick(Max) mm (H)	1.5				1.8				2.8				3.0				3.0				3.2				3.5				3.5			
	Inches 0.059				0.07				0.110				0.118				0.118				0.126				0.138				0.138			
Termination Band (L2 & L3) mm	Min		Max		Min		Max		Min		Max		Min		Max		Min		Max		Min		Max		Min		Max					
	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				Inches				Inches				Inches				Inches				Inches				Inches				Inches			
Band Gap (L4) mm	0.5				1.4				1.4				2.0				2.2				2.2				2.9				2.9			
Rated Voltage d.c.	0.019				0.055				0.055				0.078				0.087				0.087				0.114				0.114			
Cap. Range	6.3	10	16	25	6.3	10	16	25/35	6.3	10	16	25/35	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
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																															
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1.0uF	105																															
2.2	225																												</			

Y5V/Z5U (cont)

		GMC21			GMC31			GMC32			GMC40			GMC43			GMC45			GMC57						
Type		0805			1206			1210			1808			1812			1825			2220			2225			
Length (L1) 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 (W) 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			
Thick(Max) mm (H)		1.5			1.8			2.8			3.0			3.0			3.2			3.5			3.5			
	Inches	0.059			0.07			0.110			0.118			0.118			0.126			0.138			0.138			
Termination Band (L2 & L3) mm	Min	0.25		Max	Min	0.25		Max	Min	0.25		Max	Min	0.25		Max	Min	0.25		Max	Min	0.25		Max		
	Inches	0.01		0.75	0.01		0.75	0.01	0.03	0.01		0.75	0.01	0.03	0.01		0.75	0.01	0.03	0.01		0.75	0.01	0.75		
Band Gap (L4) 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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6.8	685																									
10	106																									
22	226																									
33	336																									
47	476																									
68	686																									
100	107																									

Multilayer Ceramic Chip Capacitors



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 (ΔC_{Max} @ V_{DCW})	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, V_{DCW}: >100GΩF or 1000ΩF, whichever is less • 125°C, V_{DCW}: >10GΩF or 100ΩF, whichever is less	3 X V_{DCW}	0% per decade hour	• $C \leq 1000pF$ f=1MHz V=1.0Vrms ±0.2Vrms T=25°C • $C > 1000pF$ f=1KHz V=1.0Vrms ±0.2Vrms T=25°C

X7R/X5R Dielectric

Stable class II dielectric

Operating Temperature Range	Temperature Coefficient	Temperature Voltage Coefficient (ΔC_{Max} @ V_{DCW})	Dissipation Factor	Insulation Resistance	Dielectric withstanding Voltage	Aging Rate	Test Parameters
X7R = -55C to +125C X5R = -55C to +85C	±15%	X7R/X5R Not Applicable	2.5% Max, 1.8% Typical	• 25°C, V_{DCW}: >100GΩFor 1000ΩF, whichever is less • 125°C, V_{DCW}: >10GΩF or 100ΩF, whichever is less	2.5 X V_{DCW}	<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

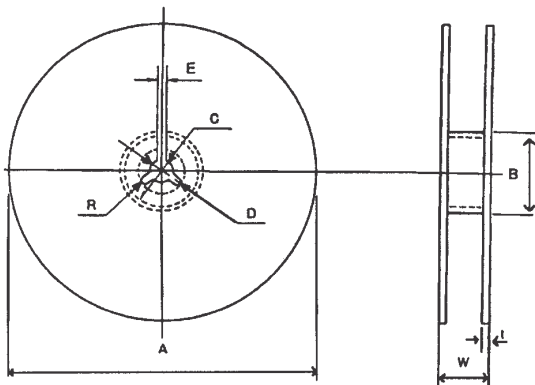


High capacitance per unit volume: general purpose product

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, V _{DCW}	2.5 X V _{DCW}	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

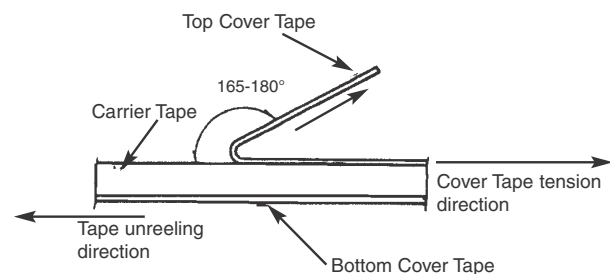
A	B	C	D	E	W	t	R
ø178 ±2.0	ø50 min.	ø13.0 ±0.5	ø21.0 ±0.8	2.0 ±0.5	14.9 ±1.5	0.8 ±0.2	1.0

"TD" designator for optional 10/13 inch reels

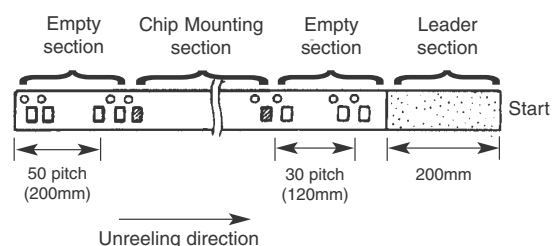
Unit:mm

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.



Multilayer Ceramic Chip Capacitors

- 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	Std Reel Qty. 7in (10/13in)*
0402	0.7±0.2	1.3±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	1.1 max	1.4 max	Angular Punch Hole	10,000 (20,000)
0603	1.1±0.2	1.9±0.2											4,000 (10,000)
0805	1.65±0.2	2.4±0.2											4,000 (10,000)
1206	2.0±0.2	3.6±0.2											4,000 (10,000)

*quantities listed are considered as "standard" and subject to change

- 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	Std Reel Qty. 7in (10/13in)*
0805	1.45±0.2	2.3±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	Angular Embossed Hole	3,000 (10,000)
1206	2.0±0.2	3.6±0.2											2,500 (10,000)
1210	2.9±0.2	3.6±0.2											2,000 (4,000)

*quantities listed are considered as "standard" and subject to change

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

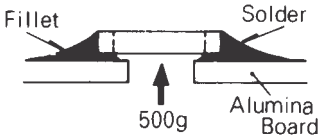
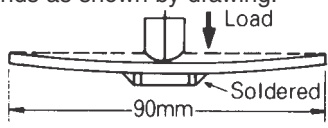
Unit: mm

Type	A	B	W	F	E	P ₁	P ₂	P ₀	D ₀	t ₁	t ₂	Mounting Hole	Std Reel Qty. 7in (10/13in)*
1812	3.6±0.2	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.	Angular Embossed Hole	1,000 (2,000)
1825	6.8±0.3	4.9±0.2											1,000 (1,500)
2220	5.5±0.3	6.2±0.3											1,000 (1,500)
2225	6.8±0.3	6.2±0.3											500 (1,000)

*quantities listed are considered as "standard" and subject to change



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/X5R:DF≤2.5% Y5V/Z5U:DF≤3.0%	
Insulation Resistance(IR)	NPO thru X5R: 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	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	
	IR	



RELIABILITY AND TEST CONDITIONS

Item	Specification	Test Method
Moisture Test	ΔC - Class (I) No more than $\pm 5\%$ or $\pm 0.5\text{pF}$ whichever is larger - Class (II) X7R/X5R: $\pm 10\%$ Y5V/Z5U: $\pm 30\%$	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) $C < 10\text{pF}$: $Q > 200 + 10 \times C$ $10 \leq C < 30\text{pF}$: $Q \geq 275 + 5/2 \times C$ $C \geq 30\text{pF}$: $Q \geq 350$ - Class (II) X7R/X5R: $DF \leq 5.0\%$ Y5V/Z5U: $DF \leq 7.5\%$	
	IR 1000M Ω or 50 ΩF , whichever is less	
Moisture Resistance Test	ΔC - Class (I) No more than $\pm 7.5\%$ or $\pm 0.75\text{pF}$ whichever is larger - Class (II) X7R/X5R: $\pm 10\%$ Y5V/Z5U: $\pm 30\%$	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) $C < 30\text{pF}$: $Q > 100 + 100/3 \times C$ $C \geq 30\text{pF}$: $Q \geq 200$ - Class (II) X7R/X5R: $DF \leq 5.0\%$ Y5V/Z5U: $DF \leq 7.5\%$	
	IR 500M Ω or 25 ΩF , min whichever is less	
Temperature Cycle	ΔC - Class (I) No more than $\pm 2.5\%$ or $\pm 0.25\text{pF}$ whichever is larger - Class (II) X7R/X5R: $\pm 5\%$ Y5V/Z5U: $\pm 20\%$	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 $230 \pm 5^{\circ}\text{C}$ *Solder: Sn 63.
Resistance to Solder Heat Test	ΔC - Class (I) No more than $\pm 2.5\%$ or $\pm 0.25\text{pF}$ whichever is larger - Class (II) X7R/X5R: $\pm 5\%$ Y5V/Z5U: $\pm 20\%$	Immerse into molten solder at $270 \pm 5^{\circ}\text{C}$ for 3 ± 0.5 seconds. Preheat before immersion. 1. $80 \sim 100^{\circ}\text{C}$ for 2 minutes. 2. $150 \sim 180^{\circ}\text{C}$ for 2 minutes. 3. $270 \pm 5^{\circ}\text{C}$ 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

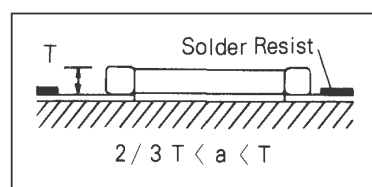
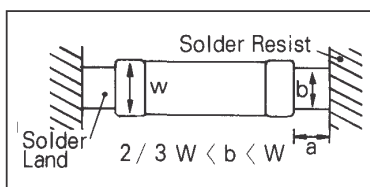
1. Temperature / Humidity Control

Since dew condensation may occur by the differences in temperature when the products are taken 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

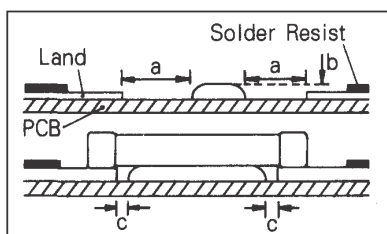
MLCCs generally require the use of an adhesive to adhere the chips to the circuit board prior to wave soldering.

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.



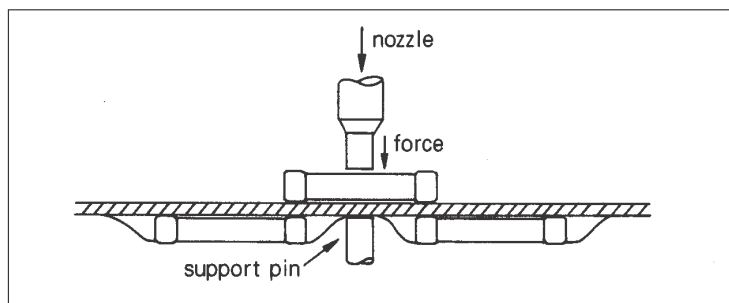
4. Mounting

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 graph 6-4.



Soldering (Continued)

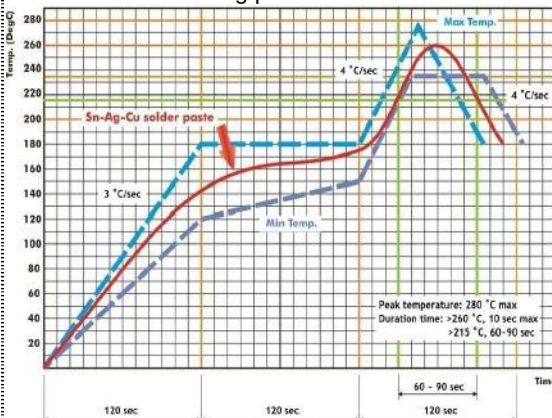
6-3 Flux selection

Although highly-activated flux gives better solderability, substances which increase activity may also degrade the insulation of the chip capacitors. To avoid such degradation, the following is recommended.

- 1) It is recommended to use a mildly activated rosin flux (less than 0.1 wt% chlorine). Strong flux is not recommended.
- 2) Excessive flux must be avoided. Please provide proper amount of flux.
- 3) When water-soluble flux is used, enough washing is necessary.

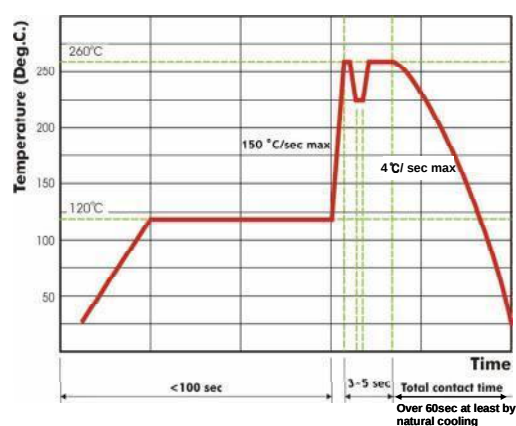
6-4 Recommended soldering profile by various methods

IR reflow soldering profile



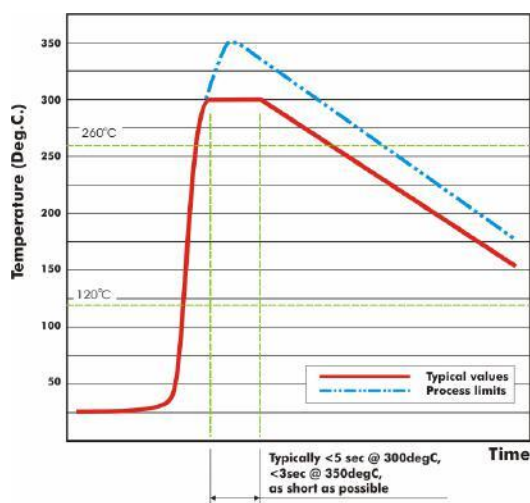
Recommended IR reflow soldering profile for SMT process with SnAgCu series solder paste.

Wave soldering profile



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

Manual soldering (solder iron)



Wave soldering is recommended only for the following case sizes:
0603(1608); 0805(2012)&1206(3216)
thickness< 1mm



Soldering (Continued)

6-5 Avoiding thermal shock

1) Preheating condition

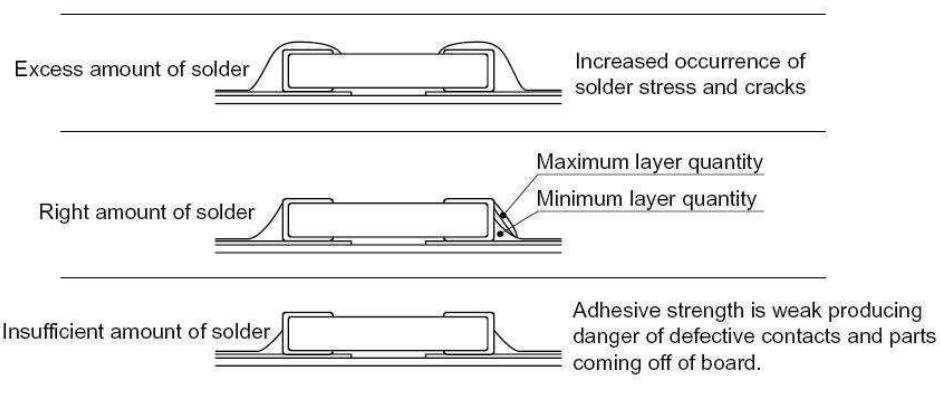
Soldering	Size	Temperature difference(ΔT)
Wave soldering	1206 (3216) or less	$\Delta T \leq 150^{\circ}\text{C}$
Reflow soldering	1206 (3216) or less	$\Delta T \leq 190^{\circ}\text{C}$
	1210 (3225) or more	$\Delta T \leq 130^{\circ}\text{C}$
Manual soldering	1206 (3216) or less	$\Delta T \leq 190^{\circ}\text{C}$
	1210 (3225) or more	$\Delta T \leq 130^{\circ}\text{C}$

2) Cooling condition

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

6-6 Amount of solder

Excessive solder will induce higher tensile force in chip capacitor when temperature changes and may result in chip cracking. Insufficient solder may detach the capacitor from the P.C. board.



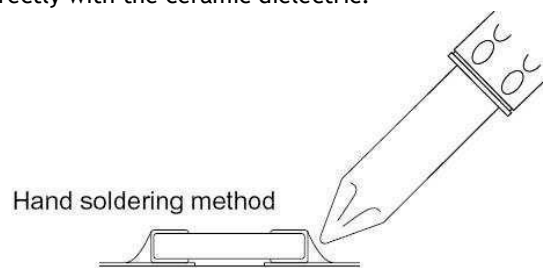
6-7 Solder repair by solder iron

1) Selection of the soldering iron tip

Tip temperature of solder iron varies by its type, P.C. board material and solder pad size. Higher tip temperature may be faster, but the heat shock may crack the chip capacitor. (Following conditions are recommended.)

Temp. ($^{\circ}\text{C}$)	Wattage (W)	Shape (mm)
300 Max	20 Max	$\Phi 3.0$ Max

2) Direct contact of the soldering iron with ceramic dielectric of chip capacitor may cause cracking. Do not make contact directly with the ceramic dielectric.



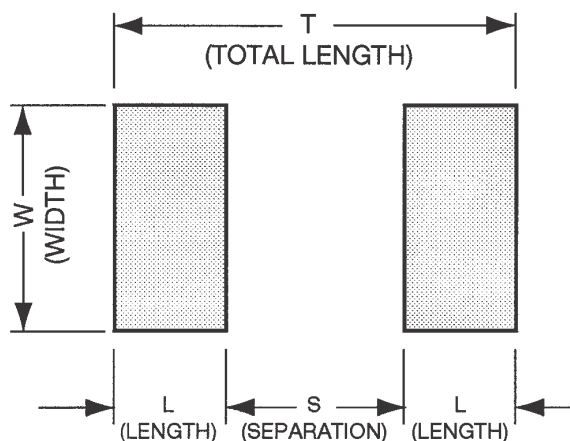


APPLICATION INFORMATION ON SOLDER PAD DESIGN FOR SURFACE MOUNT CHIP CAPACITOR

Recommended Pad Dimensions

Chip Size	Dimensions (inches)			
	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.



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Product Storage Instructions:

- 1) Product must be kept away from direct sunlight.
- 2) Product must be stored in the following conditions - Temperature; 5 to 35 degrees Celsius/40 to 95 degrees Fahrenheit
Humidity; 45 to 85%
- 3) Product to be kept free of moisture, dirt and debris.

*****WHEN THESE CONDITIONS ARE NOT MET, PRODUCT LIFE COULD BE SHORTENED*****

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