

## 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.

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### 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.

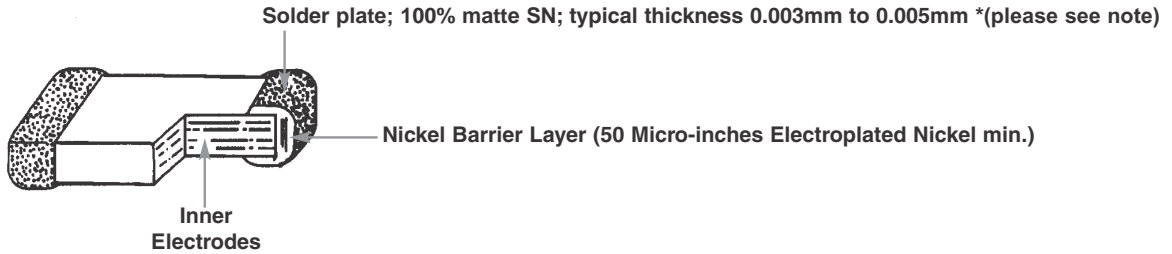
#### **Capacitor Termination**

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

<b>GMC21</b>	<b>CG</b>	<b>102</b>	<b>J</b>	<b>50</b>	<b>N</b>	<b>T</b>																		
Size Code	Dielectric	Capacitance (pF)	Capacitance Tolerance (EIA Code)	Voltage	Termination	Packaging Code																		
	CG (COG) (NPO) X7R or X5R Z5U Y5V		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" T* Tape and Reel																		
<p>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.</p> <table border="1"> <tr><td>0R5</td><td>0.5pF</td></tr> <tr><td>5R0</td><td>5pF</td></tr> <tr><td>100</td><td>10pF</td></tr> <tr><td>101</td><td>100pF</td></tr> <tr><td>102</td><td>1000pF</td></tr> <tr><td>103</td><td>.01uF</td></tr> <tr><td>104</td><td>.1uF</td></tr> <tr><td>105</td><td>1.0uF</td></tr> <tr><td>106</td><td>10uF</td></tr> </table>		0R5	0.5pF	5R0	5pF	100	10pF	101	100pF	102	1000pF	103	.01uF	104	.1uF	105	1.0uF	106	10uF				Available in select values, contact your sales associate for more information	*Optional "TD" designates large 10 inch or 13 inch reels - see packaging on pg.13 & 14
0R5	0.5pF																							
5R0	5pF																							
100	10pF																							
101	100pF																							
102	1000pF																							
103	.01uF																							
104	.1uF																							
105	1.0uF																							
106	10uF																							

Note: Calchip has completed the Lead-Free transition. All parts shipped with or without the "custom designator" LF at the end of the part number will be Lead-Free. Lead-Free material will still continue to have an LF at the end of the Lot Code and a green RoHS symbol on the label. Please contact your sales associate if you require non-RoHS material.



## Multilayer Ceramic Chip Capacitors

**0201**

**GMC02**

DIMENSION (MM)

<b>L</b>	$0.6 \pm 0.03$						
<b>W</b>	$0.3 \pm 0.03$						
<b>H</b>	$0.3 \pm 0.03$						
<b>BW</b>	$0.15 \pm 0.05$						
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)		1.0±0.05										1.6±0.2																				
mm																																
inches		0.04±0.002										0.063±0.008																				
Width (W)		0.5±0.05										0.8±0.2																				
mm																																
inches		0.02±0.002										0.031±0.008																				
Thickness (H)		0.5±0.1										0.8±0.2																				
mm																																
inches		0.02±0.004										0.031±0.008																				
Termination Band (L2+L3)		Min					Max					Min					Max															
		0.1					0.35					0.1					0.4															
mm																																
inches		0.004					0.014					0.004					0.015															
Band Gap (L4)mm (Min)		0.3										0.6																				
inches		0.012										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																															
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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	
Thick(Max)	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	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
		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	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																
3.9	3R9																
4.7	4R7																
5.6	5R6																
6.8	6R8																
8.0	8R0																
10	100																
12	120																
15	150																
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22	220																
27	270																
33	330																
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47	470																
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680	681																
820	821																
1.0nF	102																
1.2	122																
1.5	152																
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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	
Thick(Max)	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	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	
	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																
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390	391																
470	471																
560	561																
680	681																
820	821																
1.0nF	102																
1.2	122																
1.5	152																
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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			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			0.125±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			1.6±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			0.063±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			1.8			2.8			3.0			3.0			3.2			3.5			3.5		
	Inches			0.071			0.110			0.118			0.118			0.126			0.138			0.138		
Termination Band	Min		Max		Min		Max		Min		Max		Min		Max		Min		Max		Min		Max	
	mm		0.25		0.25		0.25		0.25		0.25		0.25		0.25		0.25		0.25		0.25		0.25	
	Inches		0.01		0.01		0.01		0.01		0.01		0.01		0.01		0.01		0.01		0.01		0.01	
Band Gap	mm			1.4			1.4			2.0			2.2			2.2			2.9			2.9		
	Inches			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	
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																							
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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	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			
	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	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			
	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)	1.3			1.8			2.8			3.0			3.0			3.2			3.5			3.5			
	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	
	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	
Band Gap	0.5			1.4			1.4			2.0			2.2			2.2			2.9			2.9			
	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																								
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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																								
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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	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		
	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	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		
	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)	1.5			1.8			2.8			3.0			3.0			3.2			3.5			3.5		
	0.059			0.070			0.110			0.118			0.118			0.126			0.138			0.138		
Termination Band	Min	Max		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		0.25	0.75	
	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	0.5			1.4			1.4			2.0			2.2			2.2			2.9			2.9		
	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	6.3	10	16	6.3	10	16	25	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																							
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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																							
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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

### 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					
Thick(Max) mm	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	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	25/35	6.3	10	16	25/35	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																			
15	150																			
18	180																			
22	220																			
27	270																			
33	330																			
39	390																			
47	470																			
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82	820																			
100	101																			
120	121																			
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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																			
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100	104																			
120	124																			
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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

### 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		
Thick(Max)	mm	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	mm	Min	Max		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		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	
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																								
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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																								
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1.0uF	105																								
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3.3	335																								
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47	476																								
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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 ( $\Delta C_{Max}$ @ $V_{DcW}$ )	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	<ul style="list-style-type: none"> <li>• 25°C, <math>V_{DcW}</math>:: &gt;100GΩF or 1000ΩF, whichever is less</li> <li>• 125°C, <math>V_{DcW}</math>:: &gt;10GΩF or 100ΩF whichever is less</li> </ul>	3 X $V_{DcW}$	0% per decade hour	<ul style="list-style-type: none"> <li>• <math>C \leq 1000pF</math> f=1MHz V=1.0Vrms ±0.2Vrms T=25°C</li> <li>• <math>C &gt; 1000pF</math> f=1KHz V=1.0Vrms ±0.2Vrms T=25°C</li> </ul>

#### X7R Dielectric

Stable class II dielectric (EIA X7R)

Operating Temperature Range	Temperature Coefficient	Temperature Voltage Coefficient ( $\Delta C_{Max}$ @ $V_{DcW}$ )	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	<ul style="list-style-type: none"> <li>• 25°C, <math>V_{DcW}</math>:: &gt;100GΩFor 1000ΩF, whichever is less</li> <li>• 125°C, <math>V_{DcW}</math>:: &gt;10GΩF or 100ΩF whichever is less</li> </ul>	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

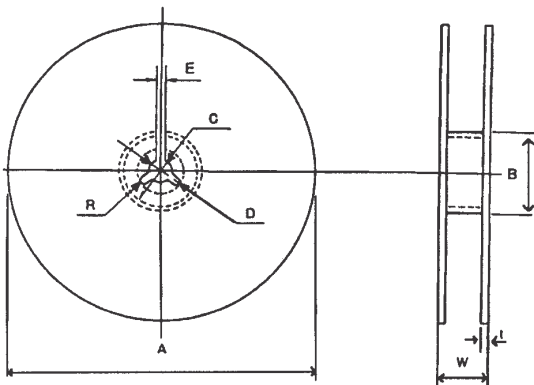


High capacitance per unit volume: general purpose product

Operating Temperature Range	Temperature Coefficient	Dissipation Factor	Insulation Resistance	Dielectric withstanding Voltage	Aging Rate	Test Parameters
-30°C to +85°C	+22% to -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

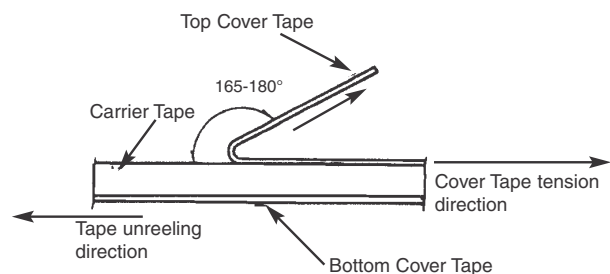
A	B	C	D	E	W	t	R
ø178 ±2.0	ø50 min.	ø13.0 ±0.5	ø21.0 ±0.8	2.0 ±0.5	14.9 ±1.5	0.8 ±0.2	1.0

#### "TD" designator for optional 10/13 inch reels

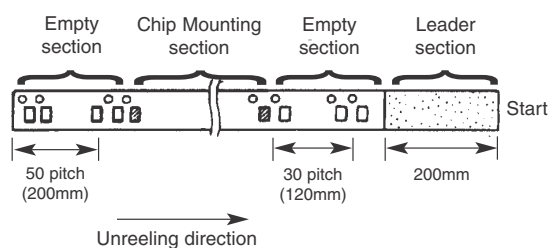
Unit:mm

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 <sub>1</sub>	P <sub>2</sub>	P <sub>0</sub>	D <sub>0</sub>	t <sub>1</sub>	t <sub>2</sub>	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 <sub>1</sub>	P <sub>2</sub>	P <sub>0</sub>	D <sub>0</sub>	t <sub>1</sub>	t <sub>2</sub>	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

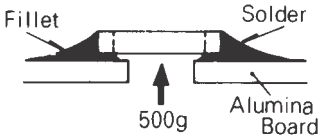
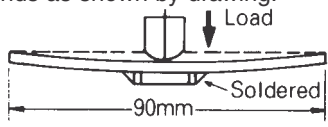
Unit: mm

Type	A	B	W	F	E	P <sub>1</sub>	P <sub>2</sub>	P <sub>0</sub>	D <sub>0</sub>	t <sub>1</sub>	t <sub>2</sub>	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
<b>Capacitance</b>	Within tolerance shown by part number code	<ul style="list-style-type: none"> <li>Class (I) C&lt;1000pF:1MHz±10%, 0.5 to 5Vrms C≥1000pF:1KHz±10%, 1.0±0.2Vrms</li> <li>Class (II) 1KHz±10%, 1.0±0.2Vrms values &gt; or = to 10uF 1.0Vrms 120Hz</li> </ul>
<b>Dissipation Factor (tanδ or Q)</b>	<ul style="list-style-type: none"> <li>Class (I) C&lt;30pF:Q≥400+20xC C≥30pF:Q≥1000</li> <li>Class (II) X7R:DF≤2.5% Y5V/Z5U:DF≤3.0%</li> </ul>	
<b>Insulation Resistance(IR)</b>	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)
<b>Dielectric Withstanding Voltage</b>	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.
<b>Termination Adherence</b>	No mechanical damage	 <p>Care shall be taken to avoid thermal shock. 500g of steady pull is applied in direction of arrow for 1 minute.</p>
<b>Bend Strength</b>	No mechanical damage	<p>After soldering capacitor on the glass-epoxy PWB, 2 mm of vending shall be applied for 10 seconds as shown by drawing.</p> 
<b>Life Test (High Temperature Loading Test)</b>	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
<b>Moisture Test</b>	<ul style="list-style-type: none"> <li>Class (I) No more than <math>\pm 5\%</math> or <math>\pm 0.5\text{pF}</math> whichever is larger</li> <li>Class (II) X7R: <math>\pm 10\%</math> Y5V/Z5U: <math>\pm 30\%</math></li> </ul>	<p>The capacitors shall be subjected to <math>40^\circ\text{C}</math>, 90-95%RH for 500 hours.</p> <p>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.</p>
	<ul style="list-style-type: none"> <li>Class (I) <math>C &lt; 10\text{pF}</math>: <math>Q &gt; 200 + 10 \times C</math> <math>10 \leq C &lt; 30\text{pF}</math>: <math>Q \geq 275 + 5/2 \times C</math> <math>C \geq 30\text{pF}</math>: <math>Q \geq 350</math></li> <li>Class (II) X7R: <math>\text{DF} \leq 5.0\%</math> Y5V/Z5U: <math>\text{DF} \leq 7.5\%</math></li> </ul>	
	IR 1000M $\Omega$ or 50 $\Omega\text{F}$ , whichever is less	
<b>Moisture Resistance Test</b>	<ul style="list-style-type: none"> <li>Class (I) No more than <math>\pm 7.5\%</math> or <math>\pm 0.75\text{pF}</math> whichever is larger</li> <li>Class (II) X7R: <math>\pm 10\%</math> Y5V/Z5U: <math>\pm 30\%</math></li> </ul>	<p>Apply rated voltage at <math>40^\circ\text{C}</math>, 90-95%RH for 500 hours.</p> <p>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.</p>
	<ul style="list-style-type: none"> <li>Class (I) <math>C &lt; 30\text{pF}</math>: <math>Q &gt; 100 + 100/3 \times C</math> <math>C \geq 30\text{pF}</math>: <math>Q \geq 200</math></li> <li>Class (II) X7R: <math>\text{DF} \leq 5.0\%</math> Y5V/Z5U: <math>\text{DF} \leq 7.5\%</math></li> </ul>	
	IR 500M $\Omega$ or 25 $\Omega\text{F}$ , min whichever is less	
<b>Temperature Cycle</b>	<ul style="list-style-type: none"> <li>Class (I) No more than <math>\pm 2.5\%</math> or <math>\pm 0.25\text{pF}</math> whichever is larger</li> <li>Class (II) X7R: <math>\pm 5\%</math> Y5V/Z5U: <math>\pm 20\%</math></li> </ul>	<p>Perform 5 cycles as follow:</p> <ol style="list-style-type: none"> <li>Room temperature. Dwell for 15 minutes.</li> <li>Minimum operating temperature, dwell for 30 minutes.</li> <li>Room temperature, dwell for 30 minutes.</li> <li>Maximum operating temperature, dwell for 30 minutes.</li> </ol> <p>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.</p>
	Q or DF To satisfy the specified initial value.	
	IR To satisfy the specified initial value.	
<b>Solderability</b>	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 $4 \pm 0.5$ seconds in the molten solder with a temperature of $230 \pm 5^\circ\text{C}$ *Solder: Sn 63.
<b>Resistance to Solder Heat Test</b>	<ul style="list-style-type: none"> <li>Class (I) No more than <math>\pm 2.5\%</math> or <math>\pm 0.25\text{pF}</math> whichever is larger</li> <li>Class (II) X7R: <math>\pm 5\%</math> Y5V/Z5U: <math>\pm 20\%</math></li> </ul>	<p>Immerse into molten solder at <math>270 \pm 5^\circ\text{C}</math> for <math>3 \pm 0.5</math> seconds. Preheat before immersion.</p> <ol style="list-style-type: none"> <li><math>80 \sim 100^\circ\text{C}</math> for 2 minutes.</li> <li><math>150 \sim 180^\circ\text{C}</math> for 2 minutes.</li> <li><math>270 \pm 5^\circ\text{C}</math> for <math>3 \pm 0.5</math> seconds.</li> </ol> <p>The capacitance measurement shall be made after sample keeping at room temperature for 24 hours.</p>
	Q or DF To satisfy the specified initial value.	
	IR To satisfy the specified initial value.	





### APPLICATION MANUAL FOR SURFACE MOUNTING

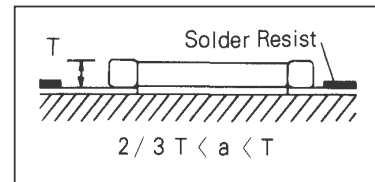
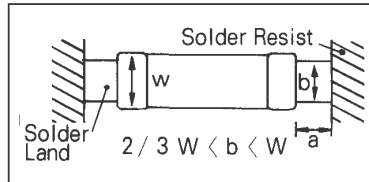
#### 1. Temperature / Humidity Control

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

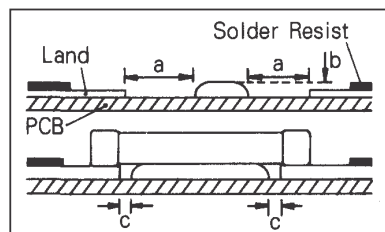
MLCCs generally require the use of an adhesive to adhere the chips to the circuit board prior to wave soldering.

##### 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.



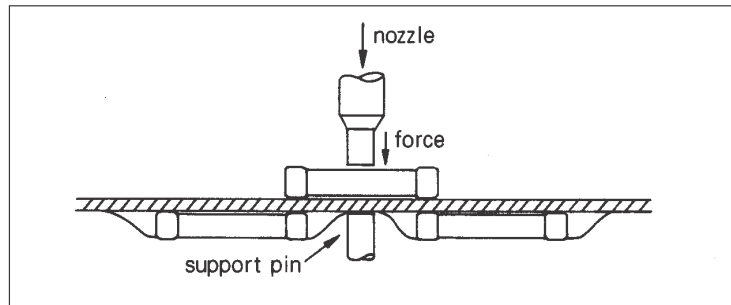
#### 4. Mounting

##### 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

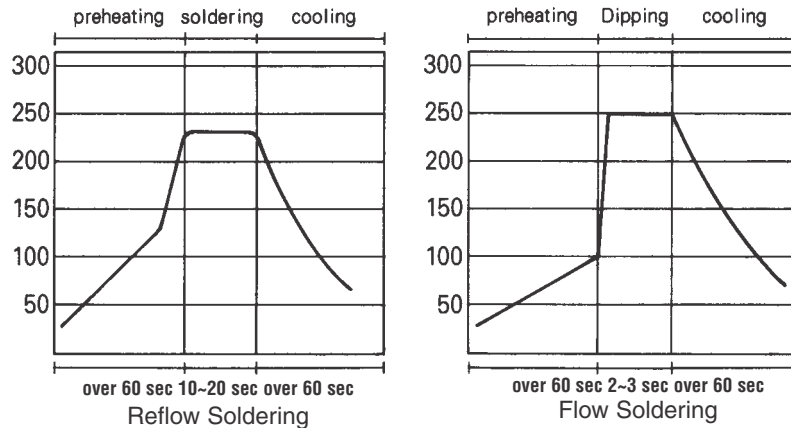
Since a multilayer chip ceramic capacitor comes into direct contact with melted solder during soldering, it is exposed to potentially damaging mechanical stress caused by the sudden temperature change. The capacitor may also be subject to silver migration, and to contamination by the flux. Because of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

##### 6-1. Soldering Methods

Method	Classification	
Reflow Soldering	Mass reflow	<ul style="list-style-type: none"> <li>• IR/Convection</li> <li>• VPS (Vapor phase)</li> </ul>
	Selective reflow	<ul style="list-style-type: none"> <li>• Hot air/gas</li> <li>• Laser</li> </ul>
Flow Soldering	Dual Wave	

##### 6-2. Soldering Profile

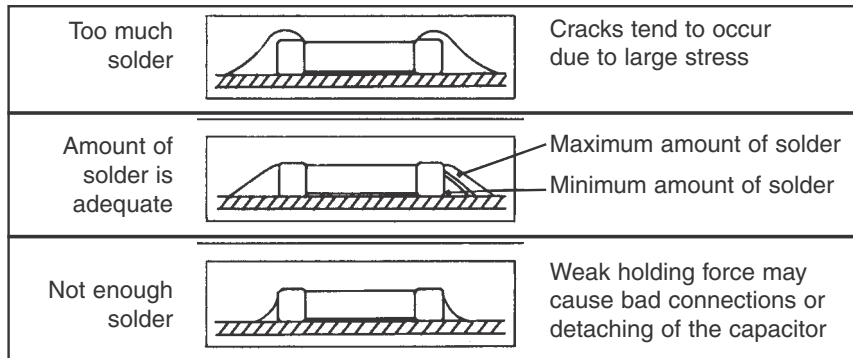
To avoid the crack problem by sudden temperature change, follow the temperature profile in the adjacent graph.



**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**



**6-5. Cooling**

Natural cooling using air is recommended. If the chips are dipped into solvent for cleaning, the temperature difference ( $\Delta T$ ) 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.

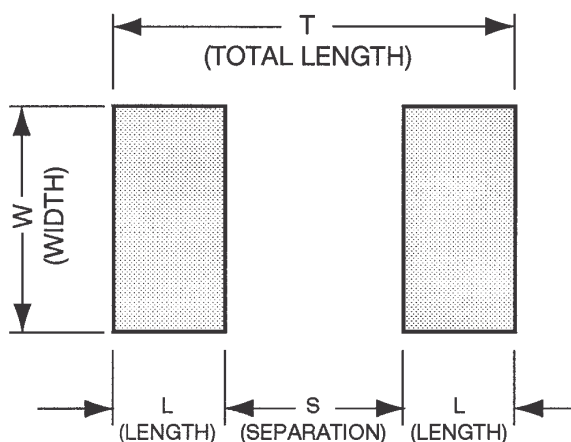


### APPLICATION INFORMATION ON SOLDER PAD DESIGN FOR SURFACE MOUNT CHIP CAPACITOR

### Recommended Pad Dimensions

Chip Size	Dimensions (inches)			T
	L	W	S	
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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