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

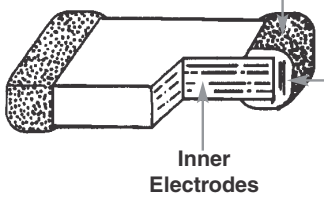
Select the smallest unit permitted by the circuit constraints that provides the required capacitance and voltage rating. All Cal-Chip capacitors conform to EIA specifications.

Capacitor Termination

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

Dielectric
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.

Capacitance (pF)	
0R5	0.5pF
5R0	5pF
100	10pF
101	100pF
102	1000pF
103	.01uF
104	.1uF
105	1.0uF
106	10uF

Capacitance Tolerance (EIA Code)		
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%	

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

Termination	
N	Nickel Barrier

NX* - Optional "SoftTerm"

Available in select values, contact your sales associate for more information

Packaging Code	
T*	Tape and Reel

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

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

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.

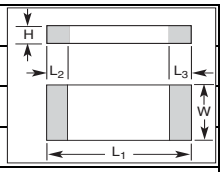
Multilayer Ceramic Chip Capacitors

0201

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	■			■	■	■	
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	1.0±0.05		1.6±0.2	
inches	0.04±0.002		0.063±0.008	
Width (W) mm	0.5±0.05		0.8±0.2	
inches	0.02±0.002		0.031±0.008	
Thickness (H) mm	0.5±0.1		0.8±0.2	
inches	0.02±0.004		0.031±0.008	
Termination Band (L2+L3) mm	Min 0.1	Max 0.35	Min 0.1	Max 0.4
inches	0.004	0.014	0.004	0.015
Band Gap (L4)mm (Min) inches	0.3		0.6	
	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																														
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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2.2	225																														
2.7	275																														
3.3	335																														
3.9	395																														
4.7	475																														
5.6	565																														
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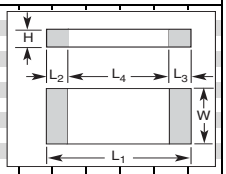

Cal-Chip Electronics, Incorporated

Multilayer Ceramic Chip Capacitors

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)		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 (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	
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																		
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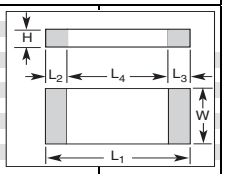
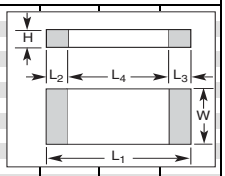


Multilayer Ceramic Chip Capacitors

COG/NPO (cont.)

	GMC21		GMC31		GMC32		GMC40		GMC43		GMC45		GMC55		GMC57	
Type	0805		1206		1210		1808		1812		1825		2220		2225	
Length (L1) mm 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		1.6 0.063		1.8 0.07		2.03 0.08		1.8 0.07		1.8 0.07		1.8 0.07		1.8 0.07	
Termination Band	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
(L2+L3) 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 (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.	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(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				0.071				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	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	0.01		0.03	0.01		0.03
Band Gap mm (L4)	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																									
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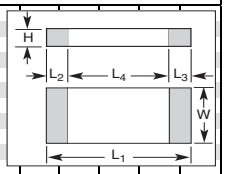

Multilayer Ceramic Chip Capacitors

X7R (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			1.8			2.8			3.0			3.0			3.2			3.5			3.5		
(H) 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
(L2+L3) 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		
(L4) 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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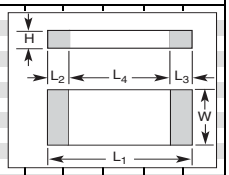

Multilayer Ceramic Chip Capacitors

X5R

	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	0.070	0.110	0.118	0.118	0.126	0.138	0.138
Termination Band (L2+L3) mm	Min 0.25 / Max 0.75	Min 0.25 / Max 0.75	Min 0.25 / Max 0.75	Min 0.25 / Max 0.75	Min 0.25 / Max 0.75	Min 0.25 / Max 0.75	Min 0.25 / Max 0.75	Min 0.25 / Max 0.75
Inches	Min 0.01 / Max 0.03	Min 0.01 / Max 0.03	Min 0.01 / Max 0.03	Min 0.01 / Max 0.03	Min 0.01 / Max 0.03	Min 0.01 / Max 0.03	Min 0.01 / Max 0.03	Min 0.01 / Max 0.03
Band Gap mm (L4)	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	6.3 / 10 / 16	6.3/10/16/25	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
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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
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560	564
680	684
820	824
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3.3	335
4.7	475
6.8	685
10	106
22	226
33	336
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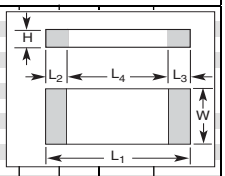
100	107



Multilayer Ceramic Chip Capacitors

Y5V/Z5U

	GMC21		GMC31		GMC32		GMC40		GMC43		GMC45		GMC55		GMC57	
Type	0805		1206		1210		1808		1812		1825		2220		2225	
Length(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	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
(L2+L3) 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	
(L4) 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 25/35		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
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
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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
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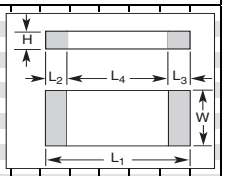
100	107



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 (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	1.5			1.8			2.8			3.0			3.0			3.2			3.5			3.5		
(H) 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
(L2+L3) 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		
(L4) 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																							
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820	821																							
1.0nF	102																							
1.2	122																							
1.5	152																							
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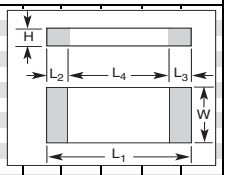


COG Dielectric

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/X5R Dielectric

Stable class II dielectric

Operating Temperature Range	Temperature Coefficient	Temperature Voltage Coefficient (ΔcMax @ VDCW)	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, 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

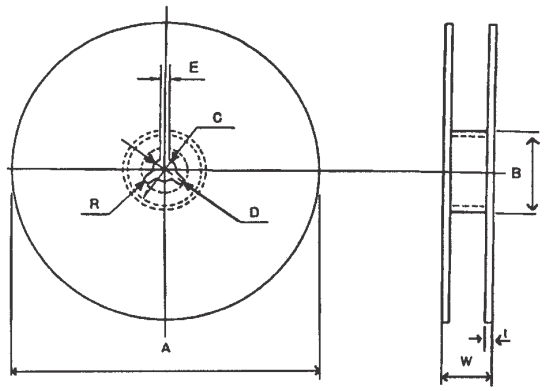
Multilayer Ceramic Chip Capacitors - Z5U (Y5V) Dielectric

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)



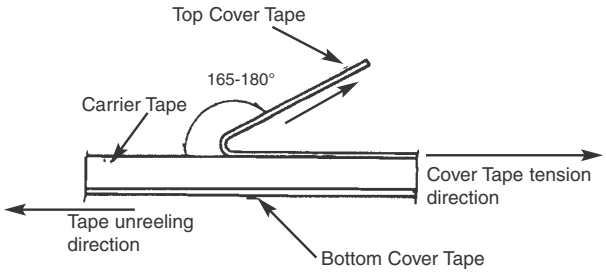
Standard Reel Unit:mm

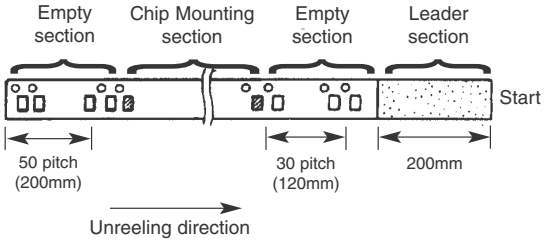
A	B	C	D	E	W	t	R
ø178 ±2.0	ø50 min.	ø13.0 ±0.5	ø21.0 ±0.8	2.0 ±0.5	14.9 ±1.5	0.8 ±0.2	1.0

"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.

• 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

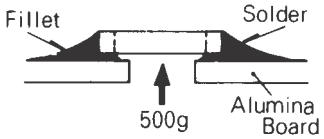
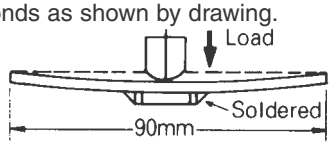
• Embossed plastic carrier tape for 1812,1825,2220 and 2225 type

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	• Class (I) No more than ±3% or ±0.3pF whichever is less • Class (II) X7R/X5R:±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/X5R:DF≤5.0% Y5V/Z5U:DF≤7.5%	
	IR	1000MΩ or 50ΩF, min whichever is less	

RELIABILITY AND TEST CONDITIONS

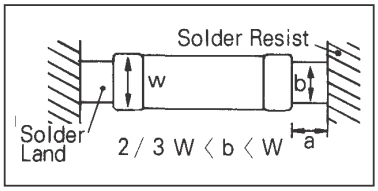
Item		Specification	Test Method
Moisture Test	ΔC	• Class (I) No more than ±5% or ±0.5pF whichever is larger • Class (II) X7R/X5R:±10% Y5V/Z5U:±30%	The capacitors shall be subjected to 40°C, 90-95%RH for 500 hours. After above testing condition, samples shall be kept in room temperature for 24 hours (Class 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/X5R: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/X5R:±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/X5R: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/X5R:±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/X5R:±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.	

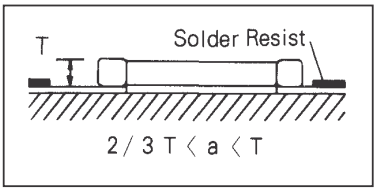
Application Manual For Surface Mounting

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.

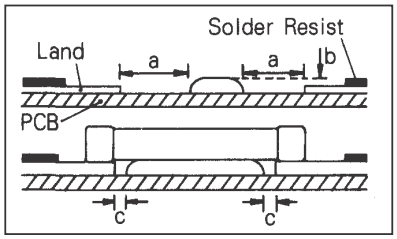




3. **Adhesives**
MLCCs generally require the use of an adhesive to adhere the chips to the circuit board prior to wave soldering.

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.

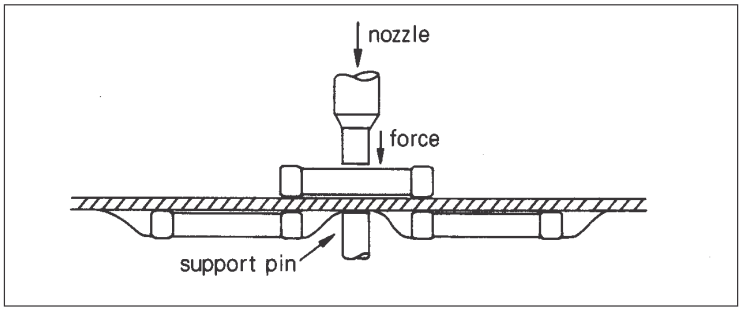
4. **Mounting**

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 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.

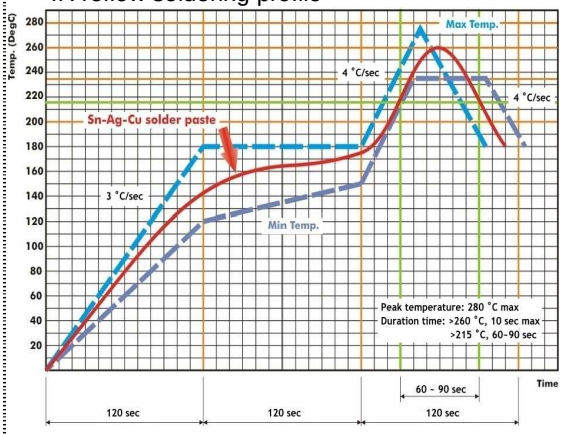
1) It is recommended to use a mildly activated rosin flux (less than 0.1 wt% chlorine). Strong flux is not recommended.

2) Excessive flux must be avoided. Please provide proper amount of flux.

3) When water-soluble flux is used, enough washing is necessary.

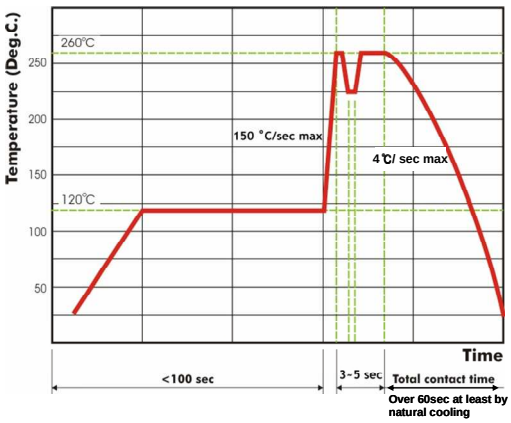
6-4 Recommended soldering profile by various methods

IR reflow soldering profile



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

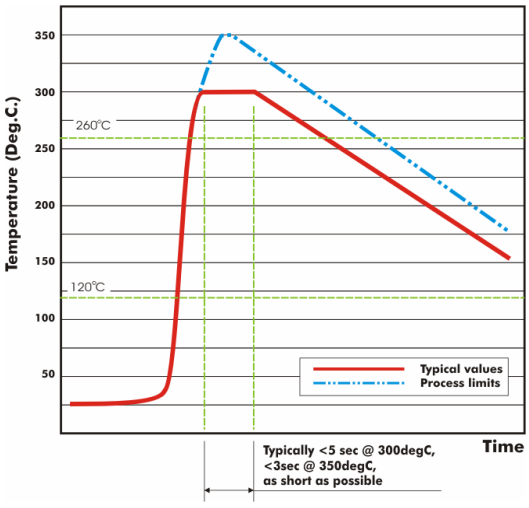
Wave soldering profile



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

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

Manual soldering (solder iron)



Soldering (Continued)

6-5 Avoiding thermal shock

1) Preheating condition

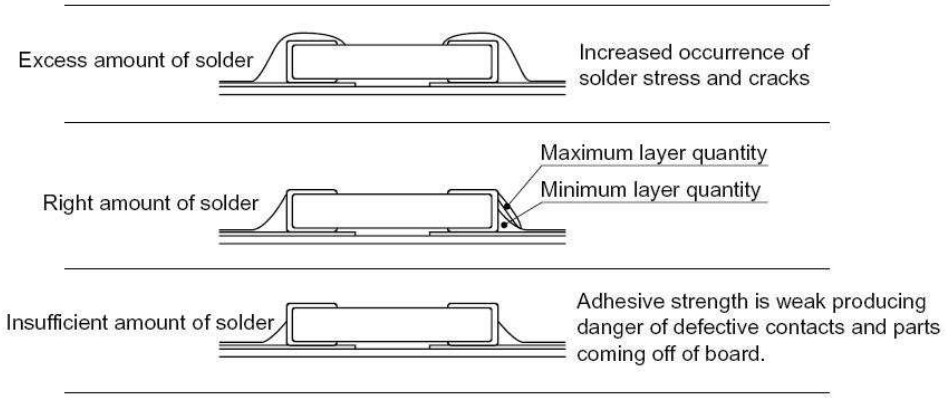
Soldering	Size	Temperature difference(ΔT)
Wave soldering	1206 (3216) or less	ΔT ≦ 150℃
Reflow soldering	1206 (3216) or less	ΔT ≦ 190℃
	1210 (3225) or more	ΔT ≦ 130℃
Manual soldering	1206 (3216) or less	ΔT ≦ 190℃
	1210 (3225) or more	ΔT ≦ 130℃

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℃.

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.



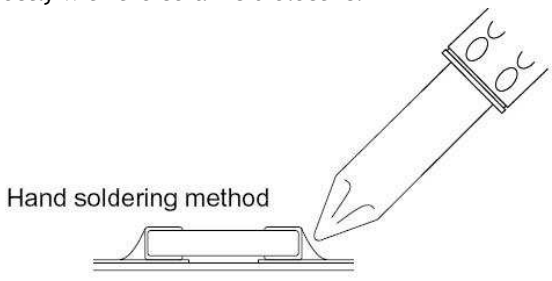
6-7 Solder repair by solder iron

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. (℃)	Wattage (W)	Shape (mm)
300 Max	20 Max	Φ3.0 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

		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.**