

PRODUCT SPECIFICATION

PRODUCT: MULTILAYER CERAMIC CAPACITOR
TYPE : CHIP CAPACITOR

APPROVED BY CUSTOMER

PAN OVERSEAS ELECTRONIC CO., LTD.

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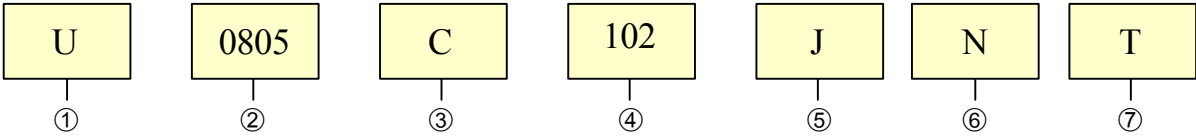
QUALITY ASSURANCE DEPARTMENT

APPROVED	CHECKED	PREPARED

1. SCOPE

This specification is applicable to Pan Overseas multilayer ceramic capacitors.

2.CODE CONSTRUCTION :



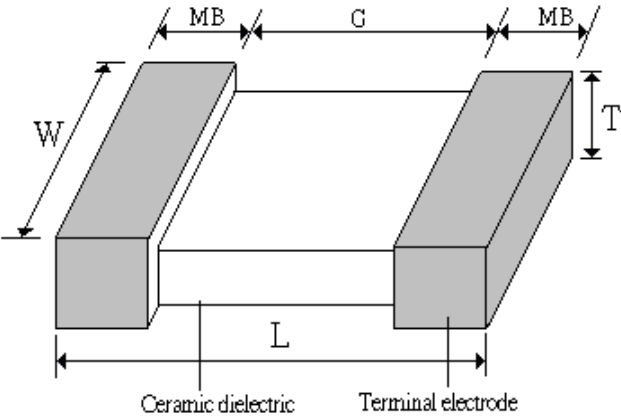
① Rated Voltage:

Code	Rated voltage	Code	Rated voltage	Code	Rated voltage	Code	Rated voltage	Code	Rated voltage
K	6.3V	T	25V	G	200V	D	630V	M3	3000V
N	10V	U	50V	H	250V	M	1000V	M4	4000V
B	16V	A	100V	C	500V	M2	2000V	M5	5000V

② Part Dimension :

Unit: mm

	Dimension					
	Length (L)	Width (W)	Thickness (T)	MB(Min)	G(Min)	
0402	1.0±0.05	0.5±0.05	0.5±0.05	0.10	0.30	6.3 ~ 50V
0603	1.6±0.1	0.8±0.1	0.8±0.1	0.20	0.40	6.3 ~ 250V
0805	2.0±0.2	1.25±0.1	1.40 max.	0.25	0.70	6.3 ~ 500V
1206	3.2±0.2	1.60±0.2	1.52 max.	0.25	1.40	6.3 ~ 1KV
1210	3.2±0.3	2.5±0.3	1.8 max.	0.25	1.40	6.3 ~ 1KV
1808	4.5±0.35	2.0±0.3	2.0 max.	0.25	2.15	6.3 ~ 5KV
1812	4.5±0.35	3.2±0.3	1.8 max.	0.25	2.15	16 ~ 5KV
2220	5.7±0.4	5.0±0.4	1.8 max.	0.25	3.30	16 ~ 5KV
2225	5.7±0.4	6.3±0.4	1.8 max.	0.25	3.30	16 ~ 5KV
3640	9.2±0.5	10.16±0.5	2.0 max.	0.50	2.70	16 ~ 5KV
5550	14.0±0.5	12.7±0.5	2.5 max.	0.50	10.5	16 ~ 5KV
8060	20.3±0.5	15.24±0.5	2.5 max.	0.50	16.8	16 ~ 5KV



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③ Temperature Characteristics Code:

Code	Temp. Coefficient	Operation Temp.	Capacitance Change
C	NP0 (Class I)	-55℃ ~ +125℃	0 ± 30 ppm/℃
R	X7R (Class II)	-55℃ ~ +125℃	± 15%
X	X5R (Class II)	-55℃ ~ +85℃	± 15%
F	Y5V (Class II)	-30℃ ~ +85℃	+22% ~ -82%
E	Z5U (Class II)	+10℃ ~ +85℃	+22% ~ -56%

④ Capacitance Code :

Code	Capacitance(pF)	Code	Capacitance(pF)
010	1 *	102	1 000 *
1R5	1.5	222	2 200 *
100	10 *	472	4 700 *
101	100 *	103	10000 *

⑤ Tolerance Code :

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

- PS: 1. * -- Two significant digits followed by no. of zeros
2. Temperature coefficient (T.C.) vs. Proper tolerance applied:
NPO: For all tolerance
X7R、X5R: K、M Tolerance
Y5V、Z5U: M、Z Tolerance

⑥ Termination Code :

Code	N
Termination Type	Nickel

⑦ Packaging Code :

Code	B	T
Packaging Type	Bulk	Tape & Reel

3. STANDARD TEST CONDITIONS :

Tests shall, unless otherwise specified, be carried out at 15 to 35℃ and RH 45 to 75%.

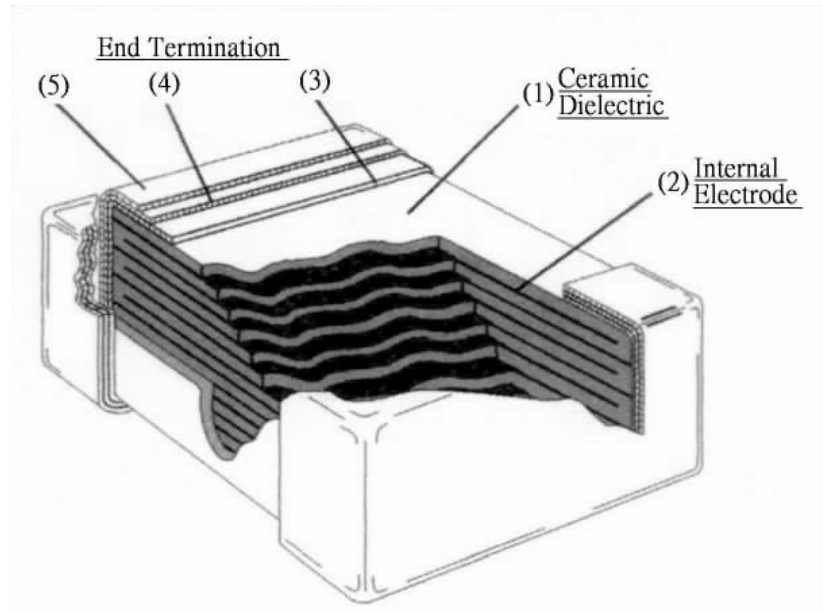
If any doubt and argument has been encounter in judgement, the final test shall be done at 25±2℃, RH45 to 55% and 860~1060mbar. (Based on JIS standard)

4. DISPOSITION

If question to the measuring result in judgement, take the capacitor under a specified temperature for 30 minutes at least before measurement.

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5. STRUCTURE:



Ag / Pd SERIES :

NO	Specifications	Material	Termination Plating thickness
1	Ceramic dielectric	Ceramic	
2	Internal Electrode	Ag-Pd	
3	End Terminal	Ag layer	40 μ m min
4		Ni layer	1.5-3.5 μ m min
5		Sn-Pb layer or Sn layer	3-8 μ m min

BME SERIES :

NO	Specifications	Material	Termination Plating thickness
1	Ceramic dielectric	Ceramic	
2	Internal Electrode	Ni	
3	End Termination	Cu layer	40 μ m min
4		Ni layer	1.5-3.5 μ m min
5		Sn-Pb layer or Sn layer	3-8 μ m min

6. STORING CONDITION AND TERM

Recommends the storing of products within 6 months at temperature 15~35°C and humidity 70%RH max. If the product stored over 6 months, please reconfirm its solderability before use.

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7. PERFORMANCE:

NO.	Item	Performance	Test or Inspection method				
(1)	External Appearance	No defects which may affect performance.	Visual inspection & Dimension measurement				
(2)	Voltage Proof	Withstand test voltage without Insulation breakdown or other damage.	DC Tested voltage shall be applied for 1 ~ 5sec. Charge/discharge current shall not exceed 50 mA . (PS: Ra – Rated Voltage)				
			Rated voltage	DC Tested voltage			
				NPO	X7R/X5R	Y5V	
			≤ 200V	2.5Ra			
			250V	2.0Ra			
			500V/630V	1.5Ra			
			≥ 1KV	1.5Ra	1.25Ra	-----	
(3)	Insulation Resistance	NPO: 100,000MΩ Min. or R • C ≥ 1,000 Ω • F (Whichever is smaller) X7R, X5R, Y5V, Z5U: 10,000MΩ Min or R • C ≥ 1,000Ω • F (Whichever is smaller)	Apply DC tested voltage for 60± 5 minute. (PS: Ra – Rated Voltage)				
			Rated voltage		DC Tested voltage		
			< 1KV		1.0 Ra		
			≥ 1KV		1KV		
(4)	Capacitance (Cap.)	Within the specified tolerance that refers on page 2	Measuring frequency: Z5U、Y5V、X7R、X5R : 1KHz± 50Hz ◦				
(5)	Dissipation Factor (D. F.)	NPO : ≥ 30pF : Q ≥ 1000 < 30pF : Q ≥ 400 + 20C PS: C: Nominal Capacitance (pF) X7R、X5R、Y5V & Z5U : (Max. value)	NPO : > 1000pF : 1KHz± 50Hz ◦ ≤ 1000pF : 1MHz± 100KHz				
			Measuring voltage: Z5U : 0.5 Vrms				
			NPO、X7R、X5R、Y5V : 1.0± 0.2 Vrms				
			T.C.	≥ 50V	25V	16V	≤ 10V
			X7R/X5R	2.5%	3.0%	3.5%	5.0%
			Z5U	4.0%	---	---	---
Y5V	5.0%	7.5%	9.0%	12.5%			

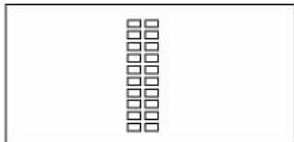
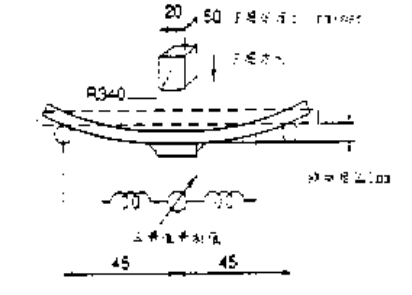
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NO.	Item	Performance			Test or Inspection method			
(6)	Temperature Characteristic of Capacitance	Temperatures Coefficient			The temperature coefficient is determined using the capacitance measured in step 3 as a reference. Test the specimen from step 1 through step 5, the capacitance shall be within the specified tolerance for the capacitance coefficient and capacitance change as left table.			
		T.C.	Operating Temperature	Capacitance Change(ΔC)				
		NPO	-55~+125℃	0±30(ppm/℃)				
		X7R	-55~+125℃	± 15%				
		X5R	-55~+85℃	± 15%	Step	Temperature(℃)		
		Y5V	-30~+85℃	+ 22%~— 82%	1	Base Temp.(25℃)± 2 °C		
		Z5U	+10~+85℃	+22%~ -56%	2	Min. Operation Temp.± 2 °C		
					3	Base Temp.(25℃)± 2 °C		
			4	Max. Operation Temp.± 2 °C				
			5	Base Temp.(25℃)± 2 °C				
(7)	Solderability	New solder to over 95% of termination			Completely soak both terminal electrodes in solder at specified temperature for 3±0.5 sec.: a. For Tin-Lead Sn/Pb) Termination product: 235±5℃ b. For Lead-free (Pure Sn) Termination product: 245±5℃			
(8)	Leaching	New solder to over 95% of termination			Completely soak both terminal electrodes in solder at 270±5℃ for 40±1 sec.			
(9)	Soldering to Heat	External appearance	No mechanical damage.			Completely immerse both terminations in solder at 270±5℃ for 10±3 sec.		
		Cap. change (ΔC/C)	NPO	±2.5% or ± 0.25 pF max. (Whichever is larger)				
			X7R/X5R	±7.5%		Leave the capacitors in ambient condition for 24± 2 hours before measurement.		
			Z5U	±20%				
			Y5V	±20%				
		D.F.	NPO: C ≥ 30pF : Q ≥ 1000 C < 30pF : Q ≥ 400+20*C PS: C: Nominal Capacitance (pF) X7R、X5R、Y5V & Z5U: (Max. value) T.C. ≤ 50V 25V 16V ≤ 10V					
			X7R/X5R	2.5%	3.0%	3.5%	5.0%	*Preconditioning : (only for Class 2): Perform a heat treatment at 150 +0-10℃ for one hour and then let sit for 24 ± 2 hours at room temperature. Perform the initial measurement.
			Z5U	4.0%	---	---	---	
			Y5V	5.0%	7.5%	9.0%	12.5%	
		I.R.	NPO: 100,000MΩ Min. or R • C ≥ 1,000 Ω • F (Whichever is smaller) X7R、X5R、Y5V、Z5U: 10,000MΩ Min or R • C ≥ 1,000Ω • F (Whichever is smaller)					

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NO.	Item	Performance	Test or Inspection method
(10)	Humidity (Steady state) & Humidity load	External appearance	A. Humidity load: (Not apply for the product with rated voltage $\geq 250\text{V}$): Apply the rated voltage at temperature $40\pm 2^\circ\text{C}$ and humidity 90 to 95%RH for $1000+48/-0$ hours. Leave the capacitors in ambient condition for the following time before measurement. Class 1 : 1~2 hours. Class 2 : 24 ± 2 hours. * Charge / discharge current shall. not exceed 50 mA. * Preconditioning : (only for Class 2): Apply the rated DC voltage for 1hour at $40\pm 2^\circ\text{C}$. Remove and let sit for 48 ± 4 hours at room temperature. Perform initial measurement. B. Humidity (Steady state): The test procedure is same as that in Humidity load but only without rated voltage applied.
		Cap. change ($\Delta C/C$)	
		D.F.	
		I.R.	
(11)	Load Life	External appearance	Apply $2\times$ rated voltage at maximum operating temperature $\pm 2^\circ\text{C}$ for $1000+48/-0$ hours. Leave the capacitors in ambient condition for the following time before measurement. Class I: 1~2 hours Class II: 24 ± 2 hours * Charge / discharge current shall. not exceed 50 mA. * Preconditioning : (only for Class 2): Apply 200% of the rated DC voltage for 1 hour at the maximum operating temperature $\pm 3^\circ\text{C}$. Remove and let sit for 24 ± 2 hours at room temperature. Perform initial measurement.
		Cap. change ($\Delta C/C$)	
		D.F.	
		I.R.	

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NO.	Item		Performance					Test or Inspection method		
(12)	Vibration	External appearance	Without distinct damage					(Not apply for 0402 product) Solder the capacitors to the test jig as shown in figure below with IR-Reflow method. The capacitor shall be subjected to a simple harmonic motion with the entire frequency range, from 10 to 55 Hz and return to 10 Hz ,shall be transverse in 1 min. Amplitude(total excursion):1.5mm Amplitude tolerance:± 15% This motion shall be applied for a period of 2 hours in each of 3 mutually perpendicular directions (a total of 6 hours) 		
		Cap. change (Δ C/C)	NPO: ±2.5% or ±0.25pF max. (Whichever is larger) X7R/ X5R: ± 7.5% Y5V 、Z5U: ±20%							
		D.F. or Q	NPO: C ≥ 30pF : Q ≥ 1000 C < 30pF : Q ≥ 400+20*C PS: C: Nominal Capacitance (pF) X7R、X5R、Y5V& Z5U : (Max. value)							
			T.C.	≥ 50V	25V	16V	≤ 10V			
X7R/ X5R	2.5%		3.0%	3.5%	5.0%					
Z5U	4.0%		---	---	---					
Y5V	5.0%	7.5%	9.0%	12.5%						
(13)	Deflection	External appearance	No cracking or marking defects shall occur							
		Bending strength	Flexure ≥ 1mm							
		Cap. change (Δ C/C)	NPO: ±5% or±0.5pFmax. (Whichever is larger) X7R/ X5R: ±12.5% Y5V: ±30%							
(14)	Temperature cycle	External appearance	No mechanical damage.					(Not apply for 0402 product) The capacitor shall be subject 5 cycles according to four heat treatments listed in the following table. Then Leave the capacitors in ambient condition for the following time before measurement. Class II: 2 ~ 24 hours		
		Cap. change (Δ C/C)	NPO: ±2.5% or ±0.25pFmax. (Whichever is larger) X7R/ X5R: ± 7.5% Y5V: ± 20%							
		D.F.	NPO: C ≥ 30pF : Q ≥ 1000 C < 30pF : Q ≥ 400+20*C X7R、X5R Y5V&Z5U: (Max. value)							
			T.C.	≥ 50V	25V	16V	≤ 10V			
			X7R/ X5R	2.5%	3.0%	3.5%	5.0%			
			Z5U	4.0%	---	---	---			
			Y5V	5.0%	7.5%	9.0%	12.5%			
		I.R.	10000MΩ min. or 500 Ω *F (Whichever is smaller)							
								Step		
								Temperature (°C)		
						Duration (min.)				
						1 Min. Operation Temp.±3 30±3				
						2 Room Temp. (25°C) 2 ~ 5				
						3 Max. Operation Temp.±3 30±3				
						4 Room Temp. (25°C) 2 ~ 5				
						*Preconditioning : (only for Class 2): Perform a heat treatment at 150 +0-10°C for one hour and then let sit for 24±2 hours at room temperature. Perform the initial measurement.				

Capacitance Range Table (Class D)																									Unit: pF			
SIZE		0402	0603		0805				1206					1210					1808									
T. C.		NPO																										
Rated Voltage(VDC)	Code	50	200/250	100	50	500	200/250	100	50	1K	630	500	200/250	100	50	25	1K	630	500	200/500	100	3K	2K	1K	630			
0.5	0R5																											
0.75	0R75																											
1	1R																											
1.5	1R5																											
2	020																											
3	030																											
3.9	3R9																											
4	040																											
5	050																											
6	060																											
7	070																											
8	080																											
9	090																											
10	100																											
11	110																											
12	120																											
13	130																											
15	150																											
16	160																											
18	180																											
20	200																											
22	220																											
24	240																											
27	270																											
30	300																											
33	330																											
36	360																											
39	390																											
43	430																											
47	470																											
51	510																											
56	560																											
62	620																											
68	680																											
75	750																											
82	820																											
91	910																											
100	101																											
110	111																											
120	121																											
130	131																											
150	151																											
160	161																											
180	181																											
200	201																											
220	221																											
240	241																											
270	271																											
300	301																											
330	331																											
360	361																											
390	391																											
430	431																											
470	471																											
510	511																											
560	561																											
620	621																											
680	681																											
750	751																											
820	821																											
910	911																											
1000	102																											
1100	112																											
1200	122																											
1300	132																											
1500	152																											
1600	162																											
1800	182																											
2000	202																											
2200	222																											
2400	242																											
2700	272																											
3000	302																											
3300	332																											
3600	362																											
3900	392																											
4300	432																											
4700	472																											
5100	512																											
5600	562																											
6200	622																											
6800	682																											
7500	752																											
8200	822																											
9100	912																											
10000	103																											

Capacitance Range Table (Class I)

Unit: pF

SIZE		1812								2220								2225								3640							
T. C.		NPO																															
Rated Voltage VDC	Code	3K	2K	1K	630	500	200/250	100	3K	2K	1K	630	500	200/250	100	3K	2K	1K	630	500	200/250	100	5K	4K	3K	2K	1K	500					
10	100																																
11	110																																
12	120																																
13	130																																
15	150																																
16	160																																
18	180																																
20	200																																
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33	330																																
36	360																																
39	390																																
43	430																																
47	470																																
51	510																																
56	560																																
62	620																																
68	680																																
75	750																																
82	820																																
91	910																																
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560	561																																
620	621																																
680	681																																
750	751																																
820	821																																
910	911																																
1000	102																																
1100	112																																
1200	122																																
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1500	152																																
1600	162																																
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4700	472																																
5100	512																																
5600	562																																
6200	622																																
6800	682																																
7500	752																																
8200	822																																
9100	912																																
10000	103																																
12000	123																																
15000	153																																
18000	183																																
22000	223																																
27000	273																																
33000	333																																
39000	393																																
47000	473																																
56000	563																																

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Capacitance Range Table (Class II)

Unit: pF

SIZE		0402											0603										
T. C.		X7R			X5R					Y5V			X7R					X5R					Z5U
Rated Voltage(VDC)	Code	50	25	16	50	25	16	10	6.3	50	25	16	200/250	100	50	25	16	50	25	16	10	6.3	50
100	101																						
150	151																						
180	181																						
220	221																						
270	271																						
330	331																						
390	391																						
470	471																						
560	561																						
680	681																						
820	821																						
1000	102																						
1200	122																						
1500	152																						
1800	182																						
2200	222																						
2700	272																						
3300	332																						
3900	392																						
4700	472																						
5600	562																						
6800	682																						
8200	822																						
10000	103																						
12000	123																						
15000	153																						
18000	183																						
22000	223																						
27000	273																						
33000	333																						
39000	393																						
47000	473																						
56000	563																						
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100000	104																						
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270000	274																						
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390000	394																						
470000	474																						
560000	564																						
680000	684																						
820000	824																						
1000000	105																						
1200000	125																						
1500000	155																						
1800000	185																						
2200000	225																						
2700000	275																						
3300000	335																						
3900000	395																						
4700000	475																						
5600000	565																						
6800000	685																						
8200000	825																						
10000000	106																						

Capacitance Range Table (Class II)

Unit: pF

SIZE		0603				0805																
T. C.		Y5V				X7R					X5R					Z5U		Y5V				
Rated Voltage(VDC)	Code	50	25	16	10	200/250	100	50	25	16	50	25	16	10	6.3	50	25	50	25	16	10	
100	101																					
150	151																					
180	181																					
220	221																					
270	271																					
330	331																					
390	391																					
470	471																					
560	561																					
680	681																					
820	821																					
1000	102																					
1200	122																					
1500	152																					
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2200	222																					
2700	272																					
3300	332																					
3900	392																					
4700	472																					
5600	562																					
6800	682																					
8200	822																					
10000	103																					
12000	123																					
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18000	183																					
22000	223																					
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39000	393																					
47000	473																					
56000	563																					
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1000000	105																					
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3300000	335																					
3900000	395																					
4700000	475																					
5600000	565																					
6800000	685																					
8200000	825																					
10000000	106																					

Capacitance Range Table (Class II)

Unit: pF

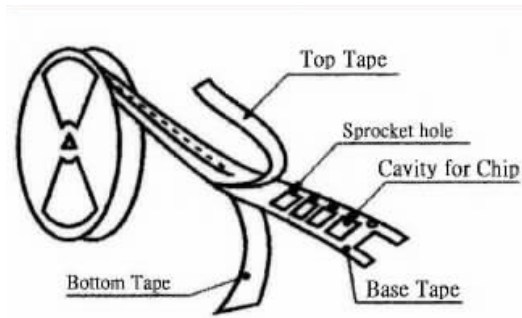
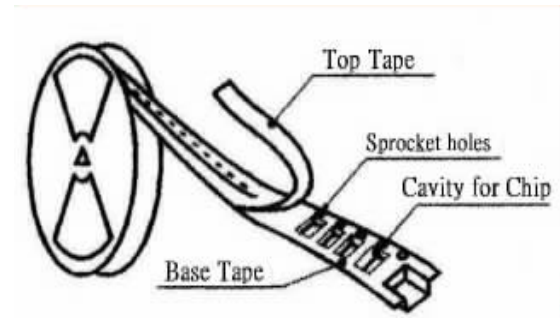
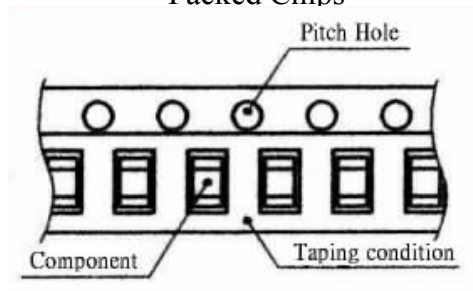
SIZE		1206																		1210					
T. C.		X7R								X5R						Z5U	Y5V				X7R				
Rated Voltage(VDC)	Code	1K	630	500	200/250	100	50	25	16	250	50	25	16	10	6.3	50	50	25	16	10	1K	630	500	200/250	100
100	101																								
150	151																								
180	181																								
220	221																								
270	271																								
330	331																								
390	391																								
470	471																								
560	561																								
680	681																								
820	821																								
1000	102																								
1200	122																								
1500	152																								
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3300	332																								
3900	392																								
4700	472																								
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470000	474																								
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680000	684																								
820000	824																								
1000000	105																				</				

Capacitance Range Table (Class II)

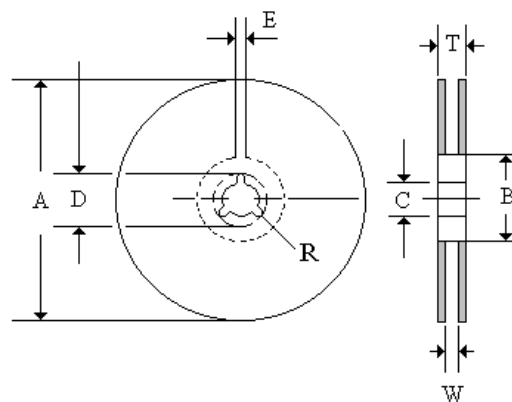
Unit: pF

SIZE		1210				1808				1812								2220									
T. C.		X5R				X7R				X7R						X5R				X7R							
Rated Voltage(VDC)	Code	25	16	10	6.3	3K	2K	1K	630	3K	2K	1K	630	500	200/250	100	25	16	10	6.3	3K	2K	1K	630	500	200/250	100
100	101																										
150	151																										
180	181																										
220	221																										
270	271																										
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5600000	565																										
6800000	685																										
8200000	825																										
10000000	106																										
22000000	226																										
47000000	476																										
100000000	107																										

Capacitance Range Table (Class II)																								Unit: pF	
SIZE		2225							3640					5550					8060						
T. C.		X7R																							
Rated Voltage(VDC)	Code	3K	2K	1K	630	500	200/250	100	4K	3K	2K	1K	500	5K	4K	3K	2K	1K	500	5K	4K	3K	2K	1K	500
100	101																								
150	151																								
180	181																								
220	221																								
270	271																								
330	331																								
390	391																								
470	471																								
560	561																								
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1200	122																								
1500	152																								
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4700000	475																								
5600000	565																								
6800000	685																								
8200000	825																								
10000000	106																								

10. Packaging :**(1)Reel specification:** Standard reel diameter is 7" and 13"Paper TapePlastic TapePacked Chips**(2) Quantity for each reel**

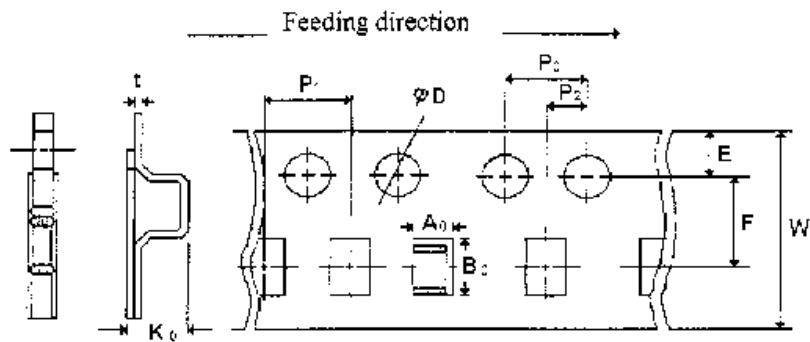
Chip Size		0402	0603	0805	1206	1210	1808	1812	2220	2225	3640	5550	8060
Reel Size	7"	10000	4000	3000	2500	2000	2000	1000	1000	1000	N/A	N/A	N/A
	13"	50000	16000	12000	10000	8000	8000	4000	4000	4000	N/A	N/A	N/A
Tape wide(mm)		8	8	8	8/12	8/12	8/12	8/12	8/12	8/12	N/A	N/A	N/A

(3) Dimension of Reel:

Dimension		A	B	C	D	E	T	W
Reel Size	7"	178±2	50 min.	13±0.5	21±0.8	2.0±0.5	12±2.0	10±1.5
	13"	330 max					18.4max.	12.4 +1.5/-0

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(4) Tape Dimension :



Unit: inch (mm)

Symbol	Description	8 mm tape	12 mm tape
W	Wide of Tape	8(0.135)±0.2(0.008)	12(0.472)±0.2(0.008)
F	Distance between drive hole center and cavity center	3.5(0.138)±0.05(0.002)	5.5(0.213)±0.05(0.002)
E	Distance between drive hole center and tape edge	1.75(0.069)±0.1(0.004)	
P ₁	Distance between cavity center	4(0.156)±0.1(0.004)	8(0.135)±0.1(0.004)
P ₂	Axial distance between drive hole center and cavity center	2(0.079)±0.05(0.002)	
P ₀	Axial distance between drive hole	4(0.156)±0.1(0.004)	
D ₀	Drive hole diameter	1.5(0.059)±0.1(0.004)-0	
t ₁	Base tape thickness	0.3(0.012)±0.1(0.004)	0.4(0.016)±0.1(0.004)
t ₂	Total tape thickness	0.1(0.004) max.	

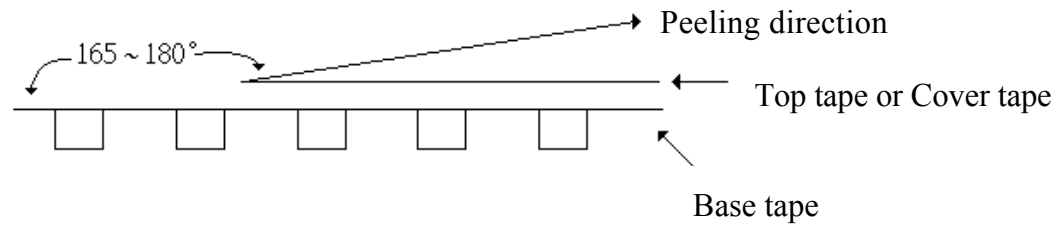
	0402	0603	0805	1206	1210 and above
A ₀ (Wide of Cavity)	0.65±0.1	1.05±0.1	1.55±0.15	2.0±0.2	Dependent on chip size to minimize rotation
B ₀ (Length of Cavity)	1.15±0.1	1.85±0.1	2.3±0.15	3.6±0.2	

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(5) Peeling off strength of Top tape

The angle between top tape and base tape is $165 \sim 180^\circ$, and the peeling speed is control in 300 ± 10 mm/min, and the peeling force as follows:

- 8mm tape or base tape : 10 ~ 100 grams (0.1~1.0N)
- 12mm tape or base tape: 10 ~ 130 grams (0.1~ 1.3N)



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<u>PRECAUTION FOR HANDLING</u> The multi-layer ceramic chip capacitors, may fall in a short circuit mode or in an open-circuit mode when subjected to severe conditions of electrical, environmental and/or mechanical stress beyond the specified “Ratings” and specified “Condition” in the Catalog and the Specifications, resulting in burnout, flaming or glowing in the worst case. So some common sense of application by customer is necessary. <u>Here the following article are some key points that need to take attention in application for customer reference only:</u> 1. Operating Conditions and Circuit Design 1.1 Operating temperature range The specified “Operating Temperature Range” in the catalog is absolute maximum and minimum temperature rating. So in any case, each the Capacitor shall be operated within the specified “Operating Temperature Range”. 1.2 Design of Voltage Applications The capacitors shall not be operated exceeding the specified “Rated Voltage” in the catalog. If voltage ratings are exceeded the Capacitors could result in failure of damage. In case of application of DC and AC voltage to the capacitors, the designed peak voltage shall be within the specified “Rated Voltage”. 1.3 Charging and Discharging Current The capacitors shall not be operated beyond the specified “Maximum Charging / Discharging Current Rated” in the specification, Application to a low impedance circuit such as a “secondary power circuit” are not recommended for safety. 1.4 Temperature Rise by Dielectric Loss of the capacitor The “Operating Temperature Range” mentioned above shall include a maximum surface temperature rise of 20°C, which is caused by the Dielectric loss of the Capacitor and applied electrical stress (such as voltage, frequency and wave form etc.) It is recommended to measure and check “Surface temperature of the Capacitor” in your equipment at your estimated / designed maximum ambient temperature.		

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1.5 Restriction on Environmental Conditions

The Capacitors shall not be operated and / or stored under following environmental conditions:

- (a) To be exposed directly to water or salt water.
- (b) To be exposed directly to sunlight.
- (c) Under conditions of dew formation.
- (d) Under conditions of corrosive atmosphere such as hydrogen sulfas, sulfurous acid, chlorine, or ammonia etc.
- (e) Under severe condition of vibrations or shock beyond the specified conditions in the Specifications.

1.6 Secular change in Capacitance

- (1) Peculiar characteristics of “Secular Changes in Capacitance” are observed in the Capacitors (Class 2 High Dielectric Constant Temperature Characteristics “X7R” and “Y5V”. The “secular change” shall be considered in your circuit design.
- (2) The Capacitance change, due to the individual characteristics of ceramic dielectric materials applied, can be recovered to the each initial values at shipping by a heat treatment (140 to 150℃ for 1 hour).

2. Design of Printed Circuit Board

2.1 Selection of Printed Circuit Boards

When the Capacitors are mounted and soldered on an “Aluminum’s Substrate has influences on Capacitor’s reliability against “Temperatures Cycles” and “Heat shock” because of difference of thermal expansion dose not deterioration the characteristics of the Capacitors.

There are some thermal expansion factor for different kink of PC board material as follows:

PC board material	Thermal expansion factor (mm/℃)
Glass epoxy	1.4×10 ⁻⁵
Paper phenol	2.2×10 ⁻⁵
Composite	2.2×10 ⁻⁵
Alumina	6.5×10 ⁻⁶

2.2 Design of Land Pattern

(1) Recommended Dimensions of Lands. As shown in Table 1 and Fig 1.

Note : * Too large land required excess amount of solder.

** The Dimensions shall be symmetrical.

Fig.1 Recommended Land Dimensions :

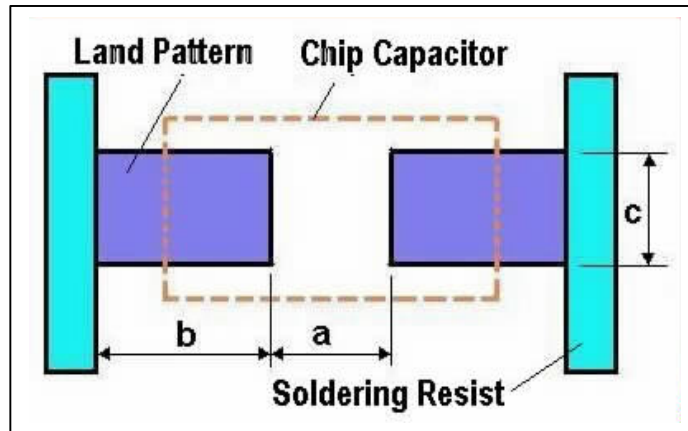


Table 1: Recommended Land Dimensions in mm.

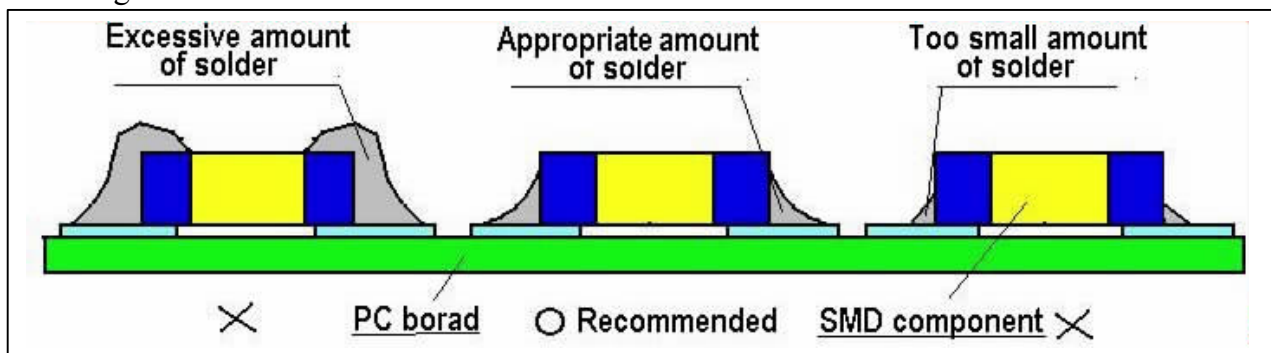
Size	Chip Dimension		Land Dimension		
	L	W	a	b	c
0402	1.0	0.5	0.30~0.50	0.35~0.45	0.40~0.60
0603	1.6	0.8	0.70~1.00	0.80~1.00	0.60~0.80
0805	2.0	1.25	1.00~1.30	1.00~1.20	0.80~1.10
1206	3.2	1.6	2.10~2.50	1.10~1.30	1.10~1.30
1210	3.2	2.5	2.10~2.50	1.10~1.30	1.90~2.30
1808	4.5	2.0	2.50~3.20	1.80~2.30	1.50~1.80
1812	4.5	3.2	2.50~3.20	1.80~2.30	2.60~3.00
2220	5.7	5.0	4.20~4.70	2.00~2.50	4.20~4.70

(2) Recommend amount of solder:

Recommended amount of solder: As shown in Fig 2.

Excess amount of solder gives large mechanical stresses to the capacitors / Components.

Fig 2: Recommended amount of solder



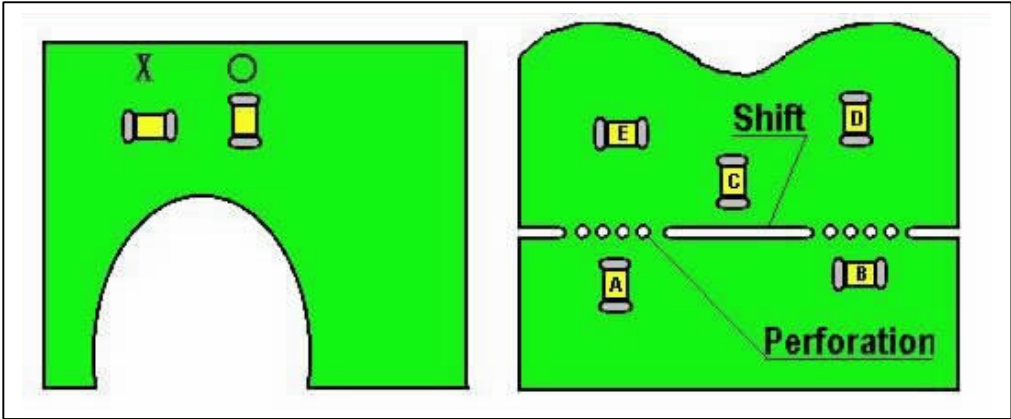
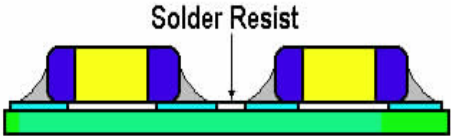
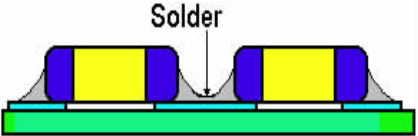
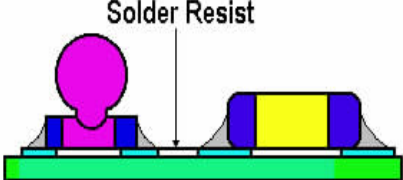
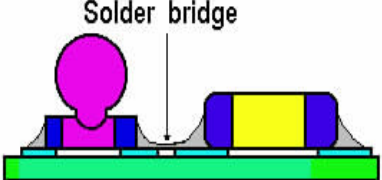
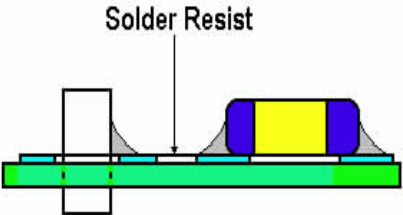
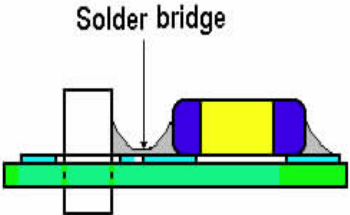
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2.3 Component Layout When placing / mounting the capacitors / components near an area which is apt to bend or a grid groove on the PC board. It is advisable to have both electrodes subjected to uniform stresses, or to position the component electrodes at right angles to the grid groove or bending line. Fig 3 : Component Layout  Uneven mounting density O : Proper ×: Improper Probability at which the chip capacitor is broken by the stress on PC board break $A > B = C > D > E$ 2.4 Mounting Density and Spaces Placements in too narrow spaces between components may cause “Solder Bridges” during soldering. The minimum space between components shall be 0.5mm in view of the positioning tolerances of the mounting machines and the dimensional tolerances of the components and PC boards. 2.5 Applications of Solder Resist: Application of Solder Resist are effective to prevent solder bridges and to control amounts of solder on PC boards (As shown in Table 2).		

Table 2: Application Examples of Solder Resist

	Recommended Application Examples	Examples of Solder Bridges
Narrow Spacing between Chip Components		
Radial Components are directly connected to Chip Components		
Common lands are close to Chip Components		

3. Precautions for Assembly

3.1 Adhesives for Mounting

(1) Selection of adhesives

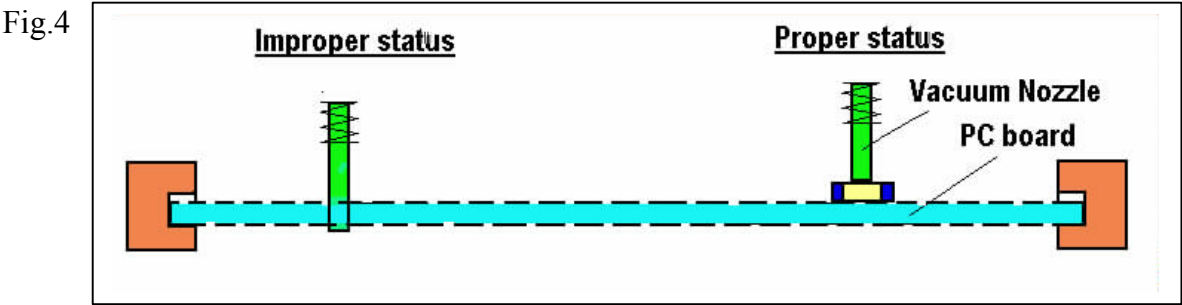
- The viscosity of a adhesive for mountings shall be such that the adhesive dose not flow off on the land during it's curing.
- If the adhesive is too low in its viscosity, mounted components may be out of alignment after or during soldering.
- The adhesives shall not be corrosive of chemically active to the mounted components and the PC boards.
- The amount of adhesive shall be such that the adhesive dose not flow off or be out of alignment.
- Adhesives for mountings can be cured by ultraviolet or infrared radiation. In order to prevent the terminal electrodes of the Capacitors The curing shall be done at conditions of 180°C max, for 2 minutes max.

3.2 Chip Mounting consideration

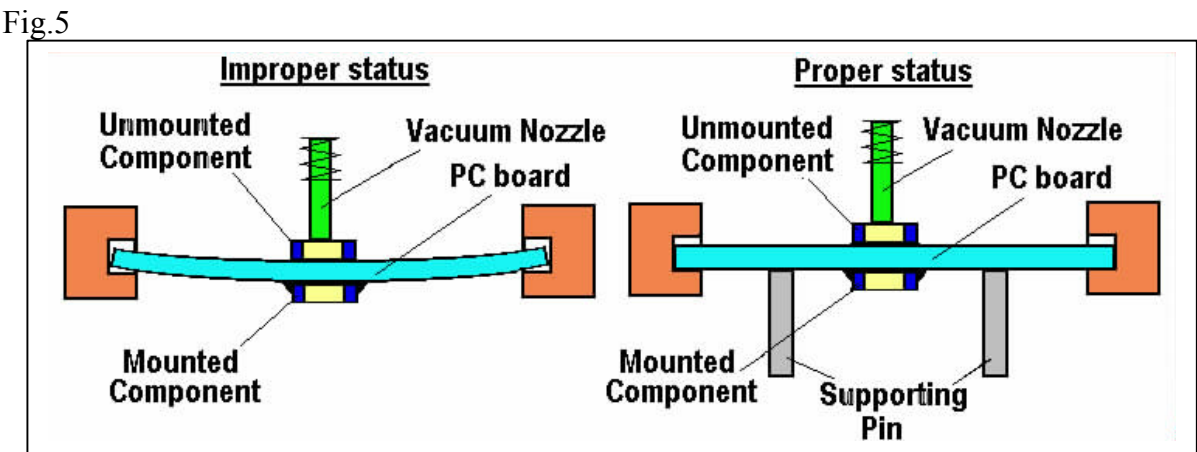
In mounting the Capacitors / components on a printed circuit board, any bending and expanding force against them shall be kept minimum to prevent them from being damaged or cracked.

Following precautions and recommendation shall be observed carefully in the process:

- (1) Maximum stroke of the vacuum nozzle shall be adjusted so that the pushing force to the printed circuit board shall be limited to a static of 1 to 3 N (100 to 300 gf) (See Fig.4).
- (2) Maximum stroke of the nozzle shall be adjusted so that the maximum bending of printed circuit board dose not exceeded 0.5mm (See Fig.4)



- (3) The printed circuit board shall be supported by means of adequate supporting pins as shown in Fig.5-(b)



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3.3 Soldering Flux and Solder

(1) Solder Flux:

- a. The content of halogen in the soldering shall be 0.2 wt% or less.
- b. Rosin-based and non-activated soldering flux is recommended.

(2) Water soluble type Soldering Flux:

In case of water soluble type soldering flux being applied, the flux residue on the surface of PC boards may have influences on the reliability of the components and cause deterioration and failures of them.

(3) Solder:

An eutectic solder (Sn63 : Pb37) is recommended.

3.4 Soldering

Since a multilayer ceramic chip 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. Adhere to the following guidelines.

3.4.1 Hand soldering:

In hand soldering of the Capacitors, large temperature gradient between preheated the capacitors and the tip of soldering iron may cause electrical failures and mechanical damages such as cracking or breaking of the devices. The soldering shall be carefully controlled and carried out so that the temperature gradient is kept minimum with following recommended conditions for hand soldering.

Recommended Soldering Conditions:

(1) Solder:

φ 1mm Thread eutectic solder (Sn63:Pb37) with soldering flux *in the core.

*Rosin-based, and non-activated flux is recommended.

(2) Preheating:

The capacitors shall be preheated so that "Temperature Gradient" between the devices and the tip of soldering iron is 150°C or below.

(3) Soldering iron:

Rated Power of 20W Max with 3mm soldering tip in diameter.

Temperature of soldering iron tip: 300°C max.

(The required amount of solder shall be melted in advance on the soldering tip.)

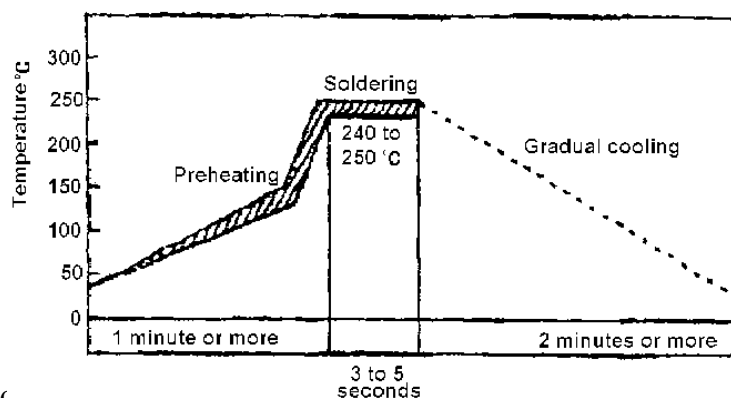
(4) Cooling:

After soldering, the Capacitors shall cooled gradually at room ambient temperature.

3.4.2.Flow Soldering

In flow soldering process, abnormal and thermal and mechanical stresses, caused by “Temperature Gradient” between the mounted Capacitors, resulting in failures and damages of the capacitors. So it is essential that the soldering process shall controlled to the following recommended conditions and precautions.(See Fig.6)

Fig.6. Recommended Soldering Temperature Time Profile (Flow soldering)



(1) Application of Flux:

The soldering flux(3.3) shall applied to the mounted Capacitors thinly and uniformly by forming method.

(2)Preheating:

The mounted Capacitors / Components shall be preheated sufficiently so that the “Temperature Gradient” between the Capacitors / Components and the melted solder shall be 150°C or below.

(3)Immersion to Soldering Bath:

The Capacitors shall be immersed into a soldering bath of 240 to 250°C for 3 to 5 seconds.

(4)Cooling:

The Capacitors shall be cooled gradually to room ambient temperature with the cooling temperature rates of 8°C/s max. from 250°C to 170°C and 4°C/s max. from 170°C to 130°C.

(5)Flux Cleaning:

When the Capacitors are immersed into cleaning solvent, it shall be confirmed that the surface temperature of devices do not exceed 100°C (See 3.5).

3.4.3 Reflow soldering.

In reflow soldering process, the mounted Capacitors / Components are generally heated and Soldering by a thermal conduction system such as an “Infrared radiation and hot blast soldering system” or a “Vapor Phase Soldering System(VPS)”, Large temperature gradients such as a rapid heating and cooling in the process may cause electrical and mechanical damages if the device. It is essential that the soldering process shall be controlled by following recommended conditions and precaution.(See Fig.7)

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3.4.3.1 For Tin-Lead (Sn/Pb) Termination component:

(1)Preheating 1.

The mounted Capacitors / Components shall be preheated sufficiently, for 60 to 90 seconds so that the surface temperature of them to be 140 to 150°C.

(2)Preheating 2.

After “Preheating 1”, the mounted Capacitors / Components shall be the elevated temperature of 150 to 200°C for 2 to 6 Seconds.

(3)Soldering:

The mounted Capacitors / Components shall be heated under the specified heating conditions (200 to 240 to 200°C for total 20 to 40 seconds, See Fig.7) and shall be soldered at the maximum temperature of 240°C for 10 seconds of less.

(4)Cooling:

After the soldering, the mounted Capacitors / Components shall be gradually cooled to room ambient temperature for preventing mechanical damages such as cracking of the devices.

(5)Flux Cleaning:

When the mounted Capacitors / Components are immersed into cleaning solvent, it shall be confirmed the surfaces temperatures of them do not exceeding 100°C.

Note: If the mounted Capacitors / Components are partially heated in the soldering process, the devices may be separated form the printed circuit board by the surface tension of partially melted solder, and stand up like a “Tomb Stone”.

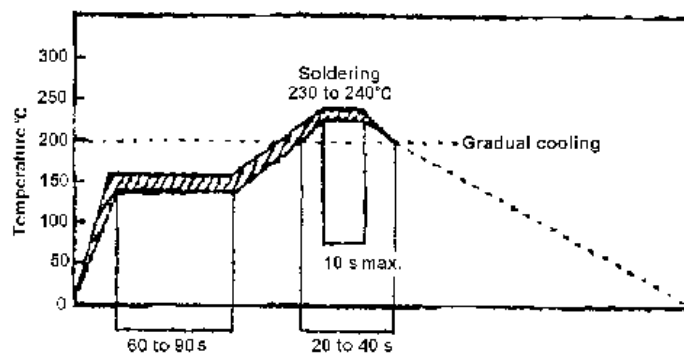


Fig.7. Recommended Soldering Temperature Time Profile for Tin-Lead component
(Reflow Soldering)

3.4.3.2 For Lead-free (Pure Tin plating termination) Termination component:

Essentially, the soldering temperature for Lead-free component is a little higher than that for Tin-Lead component, but need to take consideration of the thermal effect for all other components mounting on board at the same time. The below picture is a recommended soldering profile for Lead-free component :

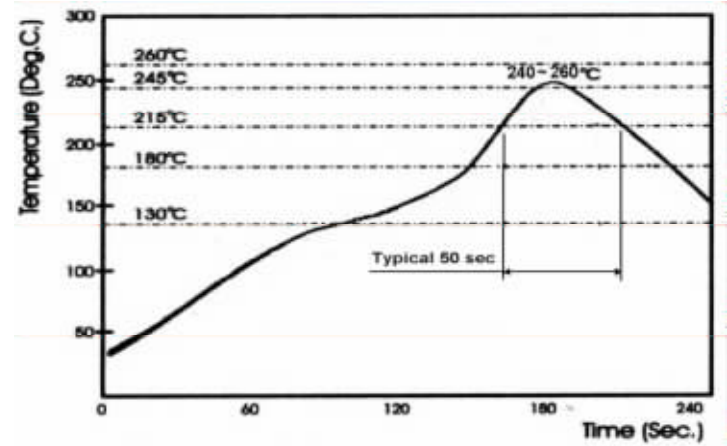


Fig.8 Recommended Soldering Temperature Time Profile for Lead-free component (Reflow Soldering)

3.5 Post soldering Cleaning

(1)Residues of corrosive soldering fluxes on the PC board after cleaning may greatly have influences on the electrical characteristics and the reliability, (such as humidity resistance) of the Capacitors, which have been mounted on the board. It shall be confirmed that the characteristic and reliability at the devices are no effected by applied cleaning conditions.

(2)Solubility of alternative cleaning solvent such as alcohol etc., is inferior to that of Freon cleaning solvent in the flux cleaning.

So in case of alternative cleaning solvents, fresh cleaning solvent shall be used, and sufficient rinsing and drying shall carried out.

(3)When an ultrasonic cleaning is applied to the mounted Capacitors on PC board, following conditions energy and the recommended for preventing failures or damages of the devices due to the large vibration energy and the resonant caused by the ultrasonic waves.

Frequency :29KHz max.

Radiated Power :20 W/liter max.

Period :5 minutes max.

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3.6 Process Inspection

When the mounted printed circuit are inspected with measuring terminal pins, abnormal and excess mechanical stresses shall not be applied to the PC board mounted components, to prevent failure or damages of the devices.

- (1) The mounted PC board shall be supported a same adequate supporting pins prevent their banding.
- (2) It shall be confirmed that the measuring pin have the right tip in shape, equal in height and are set in the tight positions.
- (3) The amount of adhesive shall be such that the adhesive dose flow off or be out of alignment.

3.7 Protective Coating

When the surface of a printed board on which the Capacitors has been mounted is coated with Resin to protect against moisture and dust, it shall be confirmed that the protective coat dose not have influences on reliability of the capacitors in the actual equipment.

- (1) Coating materials, such as being corrosive and chemically active, shall not be applied to the capacitors and other components.
- (2) Coating materials with a large expansively shall not be applied to the Capacitors for preventing failures or damages (such as cracking) of the devices in the curing process.

3.8 Dividing / Breaking of PC boards

- (1) Abnormal and excessive mechanical stresses, such as bending or expanding force on the components on the printed circuit board, shall be kept minimum in the dividing / breaking.
- (2) Dividing / Breaking of the PC board shall be done carefully at moderate speed using a Jig boards from mechanical damages.

3.9 Long Term Storage

The Capacitors shall not be stored under severe conditions of high temperatures and high humidity. Store them under 40°C max. and 75%RH max. Use them within 6 months and check the solderability before use.