SPECIFICATION

SPEC. No. A-High-d

D A T E : Aug , 2018

To

CUSTOMER'S PRODUCT NAME	TDK'S PRODUCT NAME Multilayer Ceramic Chip Capacitors High Voltage Series Bulk and Tape packaging【RoHS compliant】 CGA6,CGA7,CGA8,CGA9 Type C0G,X7R Characteristics

Please return this specification to TDK representatives with your signature.
If orders are placed without returned specification, please allow us to judge that specification is accepted by your side.

RECEIPT CONFIRMATION

DATE: YEAR MONTH DAY

Test conditions in this specification based on AEC-Q200 for automotive application.

TDK Corporation

Sales
Electronic Components
Sales & Marketing Group

Engineering
Electronic Components Business Company
Ceramic Capacitors Business Group

APPROVED	Person in charge

APPROVED	CHECKED	Person in charge

Catalog Number Construction

CGA • 8 • M • 1 • X7R • 3A • 103 • K • 200 • K • A

Series Name

Dimensions L x W (mm)

Code	Length	Width	Terminal
6	3.20 ± 0.40	2.50 ± 0.30	0.20 min.
7	4.50 ± 0.40	2.00 ± 0.30	0.20 min.
8	4.50 ± 0.40	3.20 ± 0.40	0.20 min.
9	5.70 ± 0.40	5.00 ± 0.40	0.20 min.

Thickness T Code (mm)

Code	Thickness	Code	Thickness
F	0.85 mm	M	2.00 mm
G	1.10 mm	N	2.30 mm
K	1.30 mm	P	2.50 mm
L	1.60 mm	Q	2.80 mm

Voltage Condition for Life Test

Symbol	Condition
1	1 × R.V.

Temperature Characteristics

Temperature Characteristics	Temperature Coefficient or Capacitance Change	Temperature Range
C0G	0±30 ppm/°C	-55 to +125°C
X7R	±15%	-55 to +125°C

Rated Voltage (DC)

Code	Voltage (DC)
3A	1,000V
3D	2,000V
3F	3,000V

Nominal Capacitance (pF)

The capacitance is expressed in three digit codes and in units of pico Farads (pF). The first and second digits identify the first and second significant figures of the capacitance. The third digit identifies the multiplier.

Ex. 100=10pF; 101=100pF; 333=33,000pF

Capacitance Tolerance

Code	Tolerance
F	± 1pF
J	± 5%
K	± 10%
M	± 20%

Nominal Thickness

Code	Thickness	Code	Thickness	Code	Thickness
085	0.85 mm	160	1.60 mm	250	2.50 mm
110	1.10 mm	200	2.00 mm	280	2.80 mm
130	1.30 mm	230	2.30 mm		

Packaging Style

Code	Style
A	178 mm Reel, 4 mm Pitch
K	178 mm Reel, 8 mm Pitch

Special Reserved Code

Code	Description
A, C	TDK Internal Code

1. SCOPE

This specification is applicable to chip type multilayer ceramic capacitors with a priority over the other relevant specifications.
Production places defined in this specification shall be TDK Corporation Japan, TDK(Suzhou)Co.,Ltd and TDK Components U.S.A. Inc.

EXPLANATORY NOTE:
This specification warrants the quality of the ceramic chip capacitor. Capacitors should be evaluated or confirmed a state of mounted on your product.
If the use of capacitors goes beyond the bounds of this specification, we can not afford to guarantee.

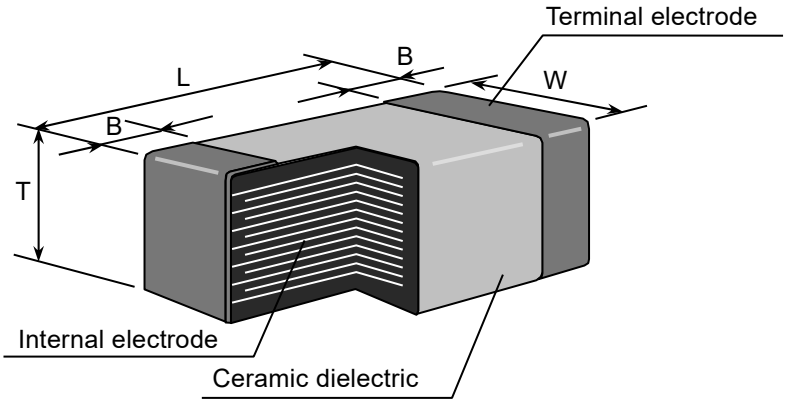
2. CODE CONSTRUCTION

(Example)	CGA	6	M	1	C0G	3 A	102	J	T	○○○
	CGA	8	K	1	X7R	3 D	222	M	T	○○○
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)

(1) Series

Symbol	Series
CGA	For automotive application

(2) Type



Case size Symbol	Type (EIA style)	Dimensions (Unit : mm)			
		L	W	T	B
6	CGA6 (CC1210)	3.20±0.40	2.50±0.30	2.00±0.20	0.20 min.
				2.50±0.30	
7	CGA7 (CC1808)	4.50±0.40	2.00±0.20	0.85±0.15	0.20 min.
				1.10±0.20	
				1.30±0.20	
				1.60±0.20	
				2.00±0.20	
8	CGA8 (CC1812)	4.50±0.40	3.20±0.40	1.30±0.20	0.20 min.
				1.60±0.20	
				2.00±0.20	
				2.50±0.30	
9	CGA9 (CC2220)	5.70±0.40	5.00±0.40	2.80±0.30	0.20 min.

*As for each item, please refer to the table A in the end of the specification.

(3) Thickness

Thickness	Dimension(mm)
F	0.85
G	1.10
K	1.30
L	1.60

Thickness	Dimension(mm)
M	2.00
P	2.50
Q	2.80

(4) Voltage condition in the life test

* Details are shown in table1 No.16 at 8.PERFORMANCE.

Sign	Condition
1	Rated Voltage

(5) Temperature Characteristics

* Details are shown in table 1 No.6 and No.7 at 8.PERFORMANCE.

(6) Rated Voltage

Symbol	Rated Voltage
3 A	DC 1kV
3 D	DC 2kV
3 F	DC 3kV

(7) Rated Capacitance

Stated in three digits and in units of pico farads (pF). The first and second digits identify the first and second significant figures of the capacitance, the third digit identifies the multiplier.

(Example)

Symbol	Rated Capacitance
101	100 pF
222	2,200 pF

(8) Capacitance tolerance

Symbol	Tolerance	Capacitance
F	± 1 pF	10pF
J	± 5 %	Over 10pF
K	± 10 %	
M	± 20 %	

(9) Packaging

Symbol	Packaging
B	Bulk
T	Taping

(10) TDK internal code

3. RATED CAPACITANCE AND TOLERANCE

3.1 Standard combination of rated capacitance and tolerances

Class	Temperature Characteristics	Capacitance tolerance		Rated capacitance
1	C0G	10pF	F (±1 pF)	10
		Over 10pF	K (± 10 %)	E – 12 series
2	X7R	K (± 10 %) M (± 20 %)		E – 3 series

3.2 Capacitance Step in E series

E series	Capacitance Step											
E- 3	1.0				2.2				4.7			
E-12	1.0	1.2	1.5	1.8	2.2	2.7	3.3	3.9	4.7	5.6	6.8	8.2

4. OPERATING TEMPERATURE RANGE

T.C.	Min. operating Temperature	Max. operating Temperature	Reference Temperature
C0G	-55°C	125°C	25°C
X7R	-55°C	125°C	25°C

5. STORING CONDITION AND TERM

5 to 40°C at 20 to 70%RH
6 months Max. upon receipt.

6. P.C. BOARD

This specification not applicable to Aluminum or some other substrate for such application, please state so and inquire separate specification.

7. INDUSTRIAL WASTE DISPOSAL

Dispose this product as industrial waste in accordance with the Industrial Waste Law.

8. PERFORMANCE

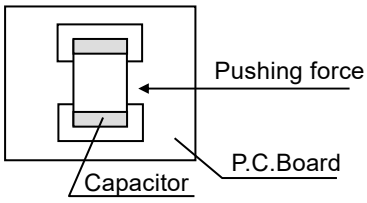
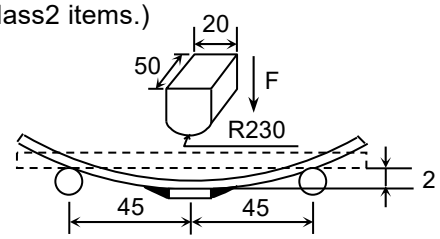
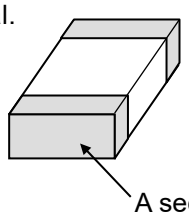
table 1

<table>
<tr><th>No.</th><th>Item</th><th>Performance</th><th>Test or inspection method</th></tr>
<tr><td>1</td><td>External Appearance</td><td>No defects which may affect performance.</td><td>Inspect with magnifying glass (3×).</td></tr>
<tr><td>2</td><td>Insulation Resistance</td><td>10,000MΩ min.</td><td>Apply 500V DC for 60s.</td></tr>
<tr><td>3</td><td>Voltage Proof</td><td>Withstand test voltage without insulation breakdown or other damage.</td><td>1.2 times of rated voltage
Above DC voltage shall be applied for 1s.
Charge / discharge current shall not exceed 50mA.</td></tr>
<tr><td>4</td><td>Capacitance</td><td>Within the specified tolerance.</td><td>《Class 1》<table><tr><th>Capacitance</th><th>Measuring frequency</th><th>Measuring voltage</th></tr><tr><td>1000pF and under</td><td>1MHz±10%</td><td rowspan="2">0.5~5 Vrms.</td></tr><tr><td>Over 1000pF</td><td>1kHz±10%</td></tr></table>《Class 2》<table><tr><th>Measuring frequency</th><th>Measuring voltage</th></tr><tr><td>1kHz±10%</td><td>1.0±0.2Vrms</td></tr></table></td></tr>
<tr><td>5</td><td>Q
(Class1)

Dissipation Factor
(Class2)</td><td>Please refer to the table A in the end of the specification.</td><td>See No.4 in this table for measuring condition.</td></tr>
<tr><td>6</td><td>Temperature Characteristics of Capacitance
(Class1)</td><td><table><tr><th>T.C.</th><th>Temperature Coefficient (ppm/°C)</th></tr><tr><td>C0G</td><td>0 ± 30</td></tr></table>Capacitance drift within ± 0.2% or ± 0.05pF, whichever larger.</td><td>Temperature coefficient shall be calculated based on values at 25°C and 85°C temperature.

Measuring temperature below 25°C shall be -10°C and -25°C.</td></tr>
<tr><td>7</td><td>Temperature Characteristics of Capacitance
(Class2)</td><td><table><tr><th>Capacitance Change (%)</th></tr><tr><td>No voltage applied</td></tr><tr><td>X7R : ± 15</td></tr></table></td><td>Capacitance shall be measured by the steps shown in the following table after thermal equilibrium is obtained for each step.
ΔC be calculated ref. STEP3 reading<table><tr><th>Step</th><th>Temperature(°C)</th></tr><tr><td>1</td><td>25 ± 2</td></tr><tr><td>2</td><td>-55 ± 2</td></tr><tr><td>3</td><td>25 ± 2</td></tr><tr><td>4</td><td>125 ± 2</td></tr></table>As for measuring voltage, please refer to the table A.</td></tr>
</table>

(continued)

No.	Item	Performance	Test or inspection method
8	Robustness of Terminations	No sign of termination coming off, breakage of ceramic, or other abnormal signs.	Reflow solder the capacitors on a P.C.Board shown in Appendix 2 and apply a pushing force of 17.7N with 10±1s. 
9	Bending	No mechanical damage.	Reflow solder the capacitors on a P.C.Board shown in Appendix 1 and bend it for 2mm. (1mm is applied for 1.30mm or thinner thickness of Class2 items.)  (Unit : mm)
10	Solderability	New solder to cover over 75% of termination. 25% may have pin holes or rough spots but not concentrated in one spot. Ceramic surface of A sections shall not be exposed due to melting or shifting of termination material.  	Completely soak both terminations in solder at the following conditions. Solder : Sn-3.0Ag-0.5Cu or Sn-37Pb Temperature : 245±5°C(Sn-3.0Ag-0.5Cu) 235±5°C(Sn-37Pb) Soaking time : 3±0.3s(Sn-3.0Ag-0.5Cu) 2±0.2s(Sn-37Pb) Flux: Isopropyl alcohol (JIS K 8839) Rosin (JIS K 5902) 25% solid solution.

(continued)

<table>
<tr><th>No.</th><th colspan="2">Item</th><th>Performance</th><th>Test or inspection method</th></tr>
<tr><td rowspan="6">11</td><td rowspan="6">Resistance to solder heat</td><td>External appearance</td><td>No cracks are allowed and terminations shall be covered at least 60% with new solder.</td><td rowspan="6">Completely soak both terminations in solder at the following conditions.
260±5°C for 10±1s.

Preheating condition
Temp.: 110 ~ 140°C
Time : 30 ~ 60s.

Solder : Sn-3.0Ag-0.5Cu or Sn-37Pb

Flux : Isopropyl alcohol (JIS K 8839) Rosin (JIS K 5902) 25% solid solution.

Leave the capacitors in ambient condition for 6 to 24h (Class1) or 24±2h (Class2) before measurement.</td></tr>
<tr><td>Capacitance</td><td><table><tr><th colspan="2">Characteristics</th><th>Change from the value before test</th></tr><tr><td>Class1</td><td>C0G</td><td>± 2.5 %</td></tr><tr><td>Class2</td><td>X7R</td><td>± 7.5 %</td></tr></table></td></tr>
<tr><td>Q (Class1)</td><td>Meet the initial spec.</td></tr>
<tr><td>D.F. (Class2)</td><td>Meet the initial spec.</td></tr>
<tr><td>Insulation Resistance</td><td>Meet the initial spec.</td></tr>
<tr><td>Voltage proof</td><td>No insulation breakdown or other damage.</td></tr>
<tr><td rowspan="4">12</td><td rowspan="4">Vibration</td><td>External appearance</td><td>No mechanical damage.</td><td rowspan="4">Reflow solder the capacitors on a P.C.Board shown in Appendix 2 before testing.

Vibrate the capacitors with following conditions.
Applied force : 5G max.
Frequency : 10~2,000Hz
Duration : 20 min.
Cycle : 12 cycles in each 3 mutually perpendicular directions.</td></tr>
<tr><td>Capacitance</td><td><table><tr><th colspan="2">Characteristics</th><th>Change from the value before test</th></tr><tr><td>Class1</td><td>C0G</td><td>± 2.5 %</td></tr><tr><td>Class2</td><td>X7R</td><td>± 7.5 %</td></tr></table></td></tr>
<tr><td>Q (Class1)</td><td>Meet the initial spec.</td></tr>
<tr><td>D.F. (Class2)</td><td>Meet the initial spec.</td></tr>
</table>

(continued)

<table>
<tr><th>No.</th><th colspan="2">Item</th><th>Performance</th><th>Test or inspection method</th></tr>
<tr><td rowspan="5">13</td><td rowspan="5">Temperature cycle</td><td>External appearance</td><td>No mechanical damage.</td><td rowspan="5">Reflow solder the capacitors on a P.C.Board shown in Appendix 2 before testing.

Expose the capacitors in the condition step1 through step 4 and repeat 1,000 times consecutively.

Leave the capacitors in ambient condition for 6 to 24h (Class 1) or 24±2h (Class 2) before measurement.

<table><tr><th>Step</th><th>Temperature(°C)</th><th>Time (min.)</th></tr><tr><td>1</td><td>-55 ± 3</td><td>30 ± 3</td></tr><tr><td>2</td><td>Ambient Temp.</td><td>2 ~ 5</td></tr><tr><td>3</td><td>125 ± 2</td><td>30 ± 2</td></tr><tr><td>4</td><td>Ambient Temp.</td><td>2 ~ 5</td></tr></table></td></tr>
<tr><td>Capacitance</td><td><table><tr><th colspan="2">Characteristics</th><th>Change from the value before test</th></tr><tr><td>Class1</td><td>C0G</td><td rowspan="2">Please refer to the table A in the end of the specification.</td></tr><tr><td>Class2</td><td>X7R</td></tr></table></td></tr>
<tr><td>Q
(Class1)</td><td>Meet the initial spec.</td></tr>
<tr><td>D.F.
(Class2)</td><td>Meet the initial spec.</td></tr>
<tr><td>Insulation Resistance</td><td>Meet the initial spec.</td></tr>
<tr><td rowspan="5">14</td><td rowspan="5">Moisture Resistance (Steady State)</td><td>External appearance</td><td>No mechanical damage.</td><td rowspan="5">Reflow solder the capacitors on a P.C.Board shown in Appendix 2 before testing.

Leave at temperature 40±2°C, 90 to 95%RH for 500 +24,0h.

Leave the capacitors in ambient condition for 6 to 24h (Class1) or 24±2h (Class2) before measurement.</td></tr>
<tr><td>Capacitance</td><td><table><tr><th colspan="2">Characteristics</th><th>Change from the value before test</th></tr><tr><td>Class1</td><td>C0G</td><td rowspan="2">Please refer to the table A in the end of the specification.</td></tr><tr><td>Class2</td><td>X7R</td></tr></table></td></tr>
<tr><td>Q
(Class1)</td><td><table><tr><th>Capacitance</th><th>Q</th></tr><tr><td>30pF and over</td><td>350 min.</td></tr><tr><td>10pF and over under 30pF</td><td>275+5/2×C min.</td></tr></table>C : Rated capacitance (pF)</td></tr>
<tr><td>D.F.
(Class2)</td><td>200% of initial spec. max.</td></tr>
<tr><td>Insulation Resistance</td><td>1,000MΩ min.</td></tr>
</table>

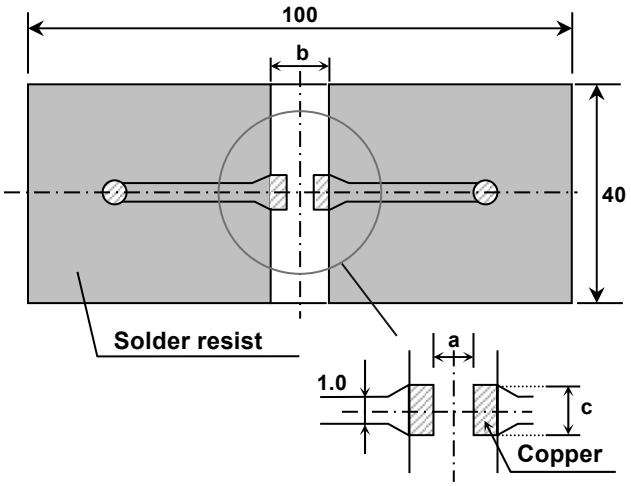
(continued)

<table>
<tr><th>No.</th><th colspan="2">Item</th><th>Performance</th><th>Test or inspection method</th></tr>
<tr><td>15</td><td>Moisture Resistance</td><td>External appearance</td><td>No mechanical damage.</td><td rowspan="5">Reflow solder the capacitors on a P.C.Board shown in Appendix2 before testing.
Apply DC1kV at temperature 85±2°C and 85%RH for 1,000 +48,0h.
Charge/discharge current shall not exceed 50mA.
Leave the capacitors in ambient condition for 6 to 24h (Class1) or 24±2h (Class2) before measurement.
Voltage conditioning (only for class 2)
Voltage treat the capacitors under testing temperature and voltage for 1 hour.
Leave the capacitors in ambient condition for 24±2h before measurement.
Use this measurement for initial value.</td></tr>
<tr><td></td><td></td><td>Capacitance</td><td><table><tr><th colspan="2">Characteristics</th><th>Change from the value before test</th></tr><tr><td>Class1</td><td>C0G</td><td rowspan="2">Please refer to the table A in the end of the specification.</td></tr><tr><td>Class2</td><td>X7R</td></tr></table></td></tr>
<tr><td></td><td></td><td>Q
(Class1)</td><td><table><tr><th>Capacitance</th><th>Q</th></tr><tr><td>30pF and over</td><td>200 min.</td></tr><tr><td>Under 30pF</td><td>100+10/3×C min.</td></tr></table>C : Rated capacitance (pF)</td></tr>
<tr><td></td><td></td><td>D.F.
(Class2)</td><td>200% of initial spec. max.</td></tr>
<tr><td></td><td></td><td>Insulation Resistance</td><td>500MΩ min.</td></tr>
<tr><td>16</td><td>Life</td><td>External appearance</td><td>No mechanical damage.</td><td rowspan="5">Reflow solder the capacitors on a P.C.Board shown in Appendix2 before testing.
Test condition : maximum operating temperature ±2°C for 1,000 +48,0h
As for applied voltage, please refer to the table A in the end of the specification.
Charge/discharge current shall not exceed 50mA.
Leave the capacitors in ambient condition for 6 to 24h (Class1) or 24±2h (Class2) before measurement.
Voltage conditioning (only for class 2)
Voltage treat the capacitors under testing temperature and voltage for 1 hour.
Leave the capacitors in ambient condition for 24±2h before measurement.
Use this measurement for initial value.</td></tr>
<tr><td></td><td></td><td>Capacitance</td><td><table><tr><th colspan="2">Characteristics</th><th>Change from the value before test</th></tr><tr><td>Class1</td><td>C0G</td><td rowspan="2">Please refer to the table A in the end of the specification.</td></tr><tr><td>Class2</td><td>X7R</td></tr></table></td></tr>
<tr><td></td><td></td><td>Q
(Class1)</td><td><table><tr><th>Capacitance</th><th>Q</th></tr><tr><td>30pF and over</td><td>350 and over</td></tr><tr><td>10pF and over under 30pF</td><td>275+5/2×C min.</td></tr></table>C : Rated capacitance (pF)</td></tr>
<tr><td></td><td></td><td>D.F.
(Class2)</td><td>200% of initial spec. max.</td></tr>
<tr><td></td><td></td><td>Insulation Resistance</td><td>1,000MΩ min.</td></tr>
</table>

*As for the initial measurement of capacitors (Class2) on number 7,11,12,13 and 14 leave capacitors at 150 –10,0°C for 1 hour and measure the value after leaving capacitors for 24±2h in ambient condition.

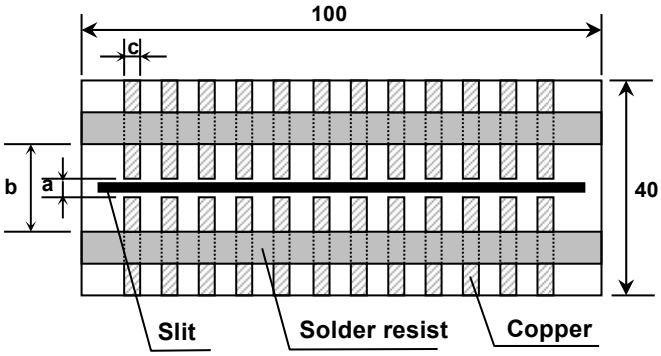
Appendix1

P.C.Board for bending test



Appendix 2

P.C. Board for reliability test



（Unit：mm）

Type	Dimensions		
TDK(EIA style)	a	b	c
CGA6 (CC1210)	2.2	5.0	2.9
CGA7 (CC1808)	3.5	7.0	2.5
CGA8 (CC1812)	3.5	7.0	3.7
CGA9 (CC2220)	4.5	8.0	5.6

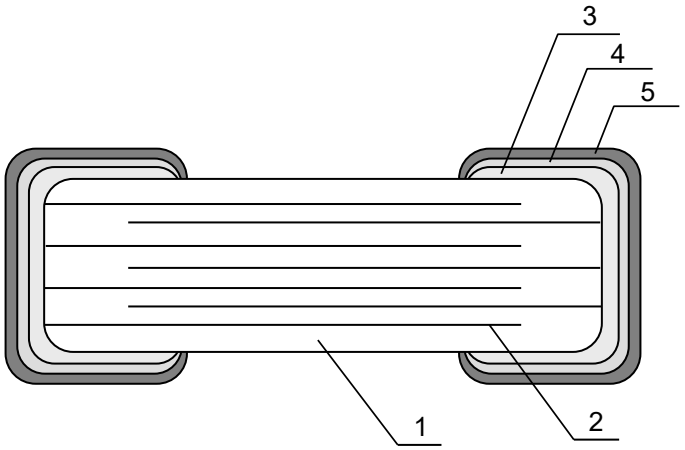
1. Material : Glass Epoxy(As per JIS C6484 GE4)

2. Thickness : 1.6mm

Copper(Thickness:0.035mm)

Solder resist

9. INSIDE STRUCTURE AND MATERIAL



No.	NAME	MATERIAL	
		Class1	Class2
1	Dielectric	$CaZrO_3$	$BaTiO_3$
2	Electrode	Nickel (Ni)	
3	Termination	Copper (Cu)	
4		Nickel (Ni)	
5		Tin (Sn)	

10. PACKAGING

Packaging shall be done to protect the components from the damage during transportation and storing, and a label which has the following information shall be attached.

1) Total number of components in a plastic bag for bulk packaging : 1000pcs
2) Tape packaging is as per 14. TAPE PACKAGING SPECIFICATION.

1) Inspection No.
2) TDK P/N
3) Customer's P/N
4) Quantity

*Composition of Inspection No.

Example F 8 A – 23 – 001
(a) (b) (c) (d) (e)

a) Line code
b) Last digit of the year
c) Month and A for January and B for February and so on. (Skip I)
d) Inspection Date of the month.
e) Serial No. of the day

*Composition of new Inspection No.
(Will be implemented on and after Jan. 1, 2019)

Example

I	F	9	A	2	3	A	0	0	1
(a)	(b)	(c)	(d)	(e)		(f)		(g)	

(a) Prefix
(b) Line code
(c) Last digit of the year
(d) Month and A for January and B for February and so on. (Skip I)
(e) Inspection Date of the month.
(f) Serial No. of the day(00 ~ ZZ)
(g) Suffix(00 ~ ZZ)

* It is planned to shift to the new inspection No. on and after January 2019, but the implementation timing may be different depending on shipment bases.
Until the shift is completed, either current or new composition of inspection No. will be applied.

11. RECOMMENDATION

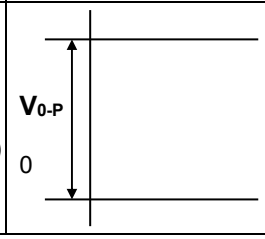
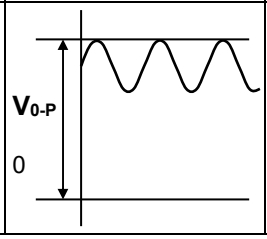
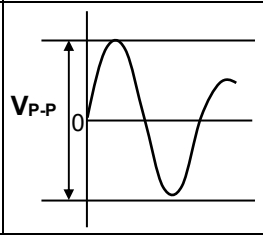
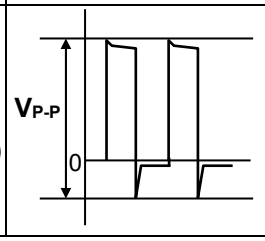
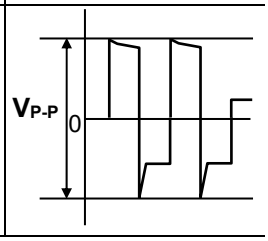
It is recommended to provide a slit (about 1mm wide) in the board under the components to improve washing Flux. And please make sure to dry detergent up completely before.

It is recommended to use activated flux (Chlorine content : less than 0.1wt%) such Rosin due to high voltage usage.

12. SOLDERING CONDITION

Reflow soldering only.

13. CAUTION

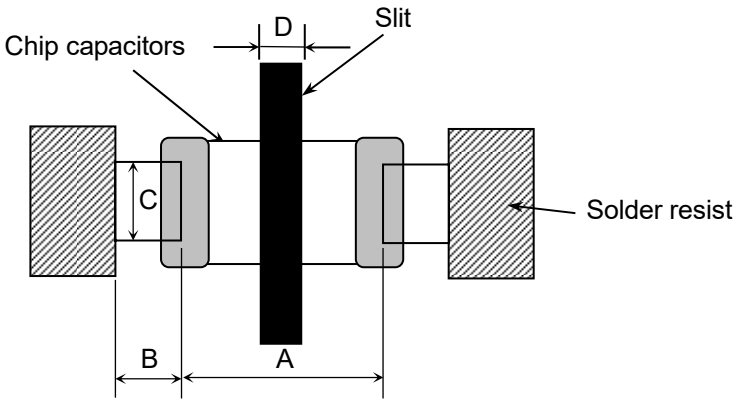
<table>
<tr><th>No.</th><th>Process</th><th>Condition</th></tr>
<tr><td>1</td><td>Operating Condition (Storage, Use, Transportation)</td><td>1-1. Storage, Use
1) The capacitors must be stored in an ambient temperature of 5 to 40°C with a relative humidity of 20 to 70%RH. The products should be used within 6 months upon receipt.
2) The capacitors must be operated and stored in an environment free of dew condensation and these gases such as Hydrogen Sulphide, Hydrogen Sulphate, Chlorine, Ammonia and sulfur.
3) Avoid storing in sun light and falling of dew.
4) Do not use capacitors under high humidity and high and low atmospheric pressure which may affect capacitors reliability.
5) Capacitors should be tested for the solderability when they are stored for long time.
1-2. Handling in transportation
In case of the transportation of the capacitors, the performance of the capacitors may be deteriorated depending on the transportation condition.
(Refer to JEITA RCR-2335C 9.2 Handling in transportation)</td></tr>
<tr><td>2</td><td>Circuit design
⚠ Caution</td><td>2-1. Operating temperature
Operating temperature should be followed strictly within this specification, especially be careful with maximum temperature.
1) Do not use capacitors above the maximum allowable operating temperature.
2) Surface temperature including self heating should be below maximum operating temperature.
(Due to dielectric loss, capacitors will heat itself when AC is applied. Especially at high frequencies around its SRF, the heat might be so extreme that it may damage itself or the product mounted on. Please design the circuit so that the maximum temperature of the capacitors including the self heating to be below the maximum allowable operating temperature. Temperature rise at capacitor surface shall be below 20°C)
3) The electrical characteristics of the capacitors will vary depending on the temperature. The capacitors should be selected and designed in taking the temperature into consideration.
2-2. Operating voltage
1) Operating voltage across the terminals should be below the rated voltage.
When AC and DC are super imposed, $V_{0\text{-}P}$ must be below the rated voltage.
— (1) and (2)
AC or pulse with overshooting, $V_{P\text{-}P}$ must be below the rated voltage.
— (3), (4) and (5)
When the voltage is started to apply to the circuit or it is stopped applying, the irregular voltage may be generated for a transit period because of resonance or switching. Be sure to use the capacitors within rated voltage containing these Irregular voltage.
<table>
<tr><th>Voltage</th><th>(1) DC voltage</th><th>(2) DC+AC voltage</th><th>(3) AC voltage</th></tr>
<tr><td>Positional Measurement (Rated voltage)</td><td> 
</td><td> 
</td><td> 
</td></tr>
</table>
<table>
<tr><th>Voltage</th><th>(4) Pulse voltage (A)</th><th>(5) Pulse voltage (B)</th></tr>
<tr><td>Positional Measurement (Rated voltage)</td><td> 
</td><td> 
</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>No.</th><th>Process</th><th>Condition</th></tr>
<tr><td>2</td><td>Circuit design
⚠ Caution</td><td>2) Even below the rated voltage, if repetitive high frequency AC or pulse is applied, the reliability of the capacitors may be reduced.

3) The effective capacitance will vary depending on applied DC and AC voltages. The capacitors should be selected and designed in taking the voltages into consideration.

2-3. Frequency
When the capacitors (Class 2) are used in AC and/or pulse voltages, the capacitors may vibrate themselves and generate audible sound.</td></tr>
<tr><td>3</td><td>Designing
P.C.board</td><td>The amount of solder at the terminations has a direct effect on the reliability of the capacitors.
1) The greater the amount of solder, the higher the stress on the chip capacitors, and the more likely that it will break. When designing a P.C.board, determine the shape and size of the solder lands to have proper amount of solder on the terminations.

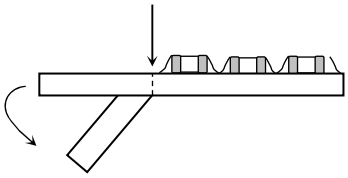
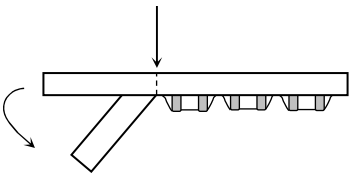
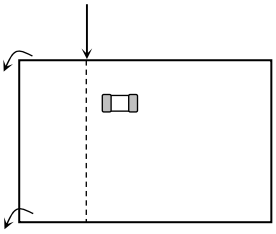
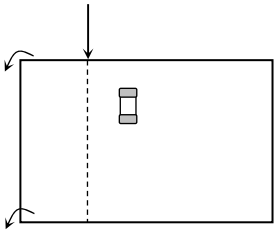
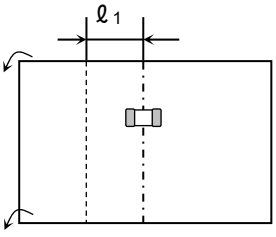
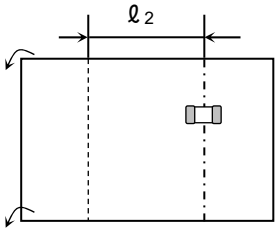
2) Avoid using common solder land for multiple terminations and provide individual solder land for each terminations.

3) Size and recommended land dimensions.
 

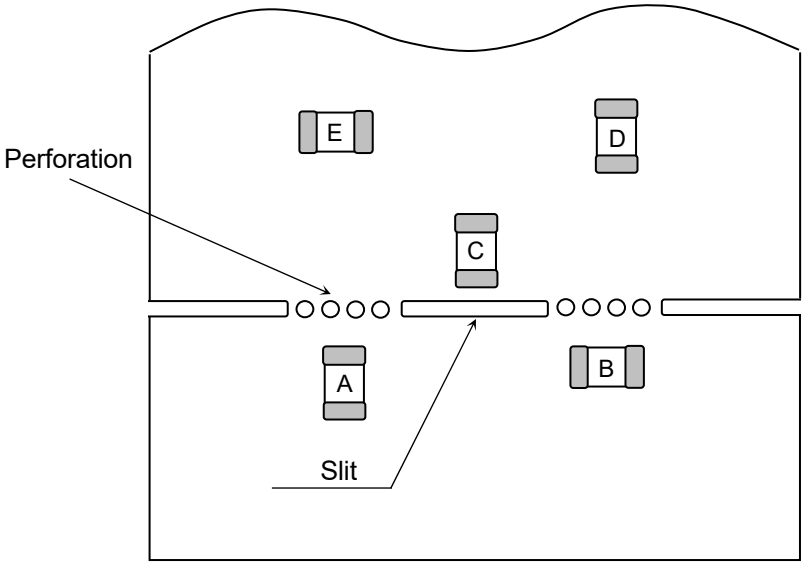
Reflow soldering (mm)
<table>
<tr><th>Type / Symbol</th><th>CGA6 (CC1210)</th><th>CGA7 (CC1808)</th><th>CGA8 (CC1812)</th><th>CGA9 (CC2220)</th></tr>
<tr><td>A</td><td>2.0 - 2.4</td><td>3.1 - 3.7</td><td>3.1 - 3.7</td><td>4.1 - 4.8</td></tr>
<tr><td>B</td><td>1.0 - 1.2</td><td>1.2 - 1.4</td><td>1.2 - 1.4</td><td>1.2 - 1.4</td></tr>
<tr><td>C</td><td>1.9 - 2.5</td><td>1.5 – 2.0</td><td>2.4 - 3.2</td><td>4.0 - 5.0</td></tr>
<tr><td>D</td><td>1.0 - 1.3</td><td>1.0 - 1.3</td><td>1.0 - 1.3</td><td>1.0 - 1.3</td></tr>
</table>
4) It is recommended to provide a slit (about 1mm width) in the board under the components to improve washing flux. And please make sure to dry detergent up completely before.

It is recommended to use low activated flux (Chlorine content : less than 0.1wt%) such Rosin due to high voltage usage.</td></tr>
</table>

No.	Process	Condition
3	Designing P.C.board	5) Recommended chip capacitors layout is as following.

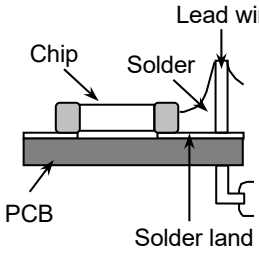
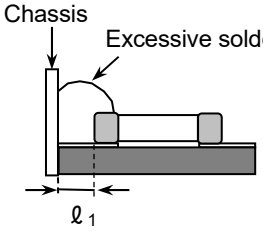
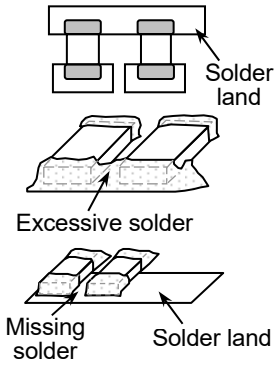
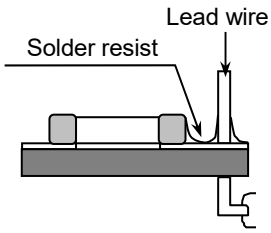
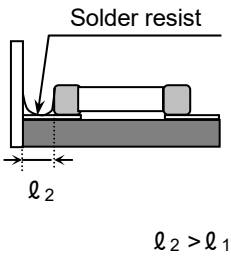
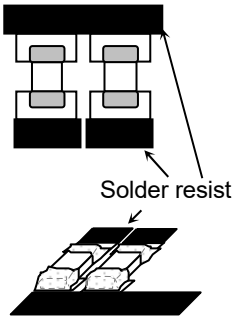
	Disadvantage against bending stress	Advantage against bending stress
Mounting face	Perforation or slit  Break P.C.board with mounted side up.	Perforation or slit  Break P.C.board with mounted side down.
Chip arrangement (Direction)	Mount perpendicularly to perforation or slit Perforation or slit 	Mount in parallel with perforation or slit Perforation or slit 
Distance from slit	Closer to slit is higher stress  ($\ell_1 < \ell_2$)	Away from slit is less stress  ($\ell_1 < \ell_2$)

No.	Process	Condition
3	Designing P.C.board	6) Mechanical stress varies according to location of chip capacitors on the P.C.board.



The stress in capacitors is in the following order.
A > B = C > D > E

7) Layout recommendation

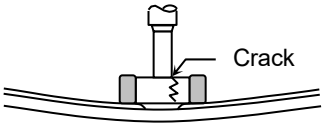
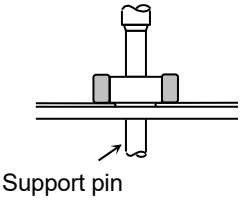
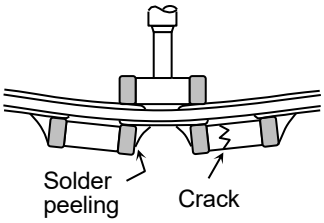
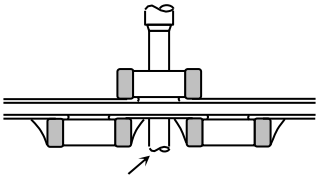
Example	Use of common solder land	Soldering with chassis	Use of common solder land with other SMD
Need to avoid			
Recommen-dation			

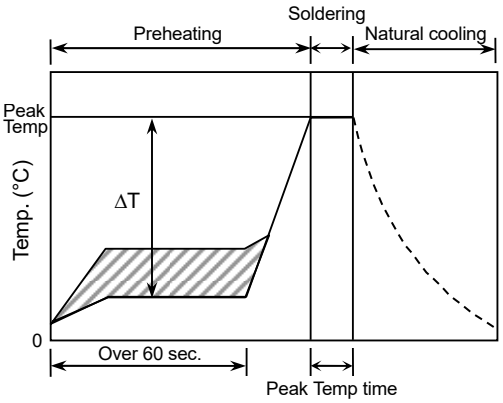
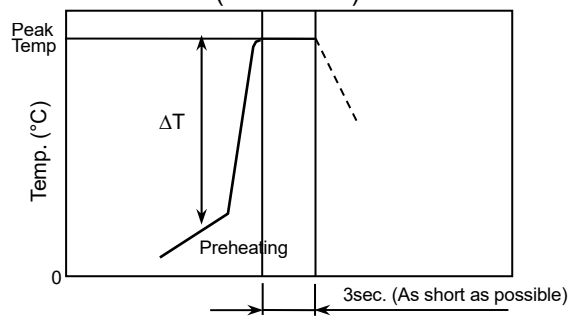
8) When mounting on an aluminum substrate, it is more likely to be affected by heat stress from the substrate.
Please inquire separate specification when mounted on the substrate.

<table>
<tr><th>No.</th><th>Process</th><th>Condition</th></tr>
<tr><td>4</td><td>Mounting</td><td>
4-1. Stress from mounting head
If the mounting head is adjusted too low, it may induce excessive stress in the chip capacitors to result in cracking. Please take following precautions.

1) Adjust the bottom dead center of the mounting head to reach on the P.C.board surface and not press it.

2) Adjust the mounting head pressure to be 1 to 3N of static weight.

3) To minimize the impact energy from mounting head, it is important to provide support from the bottom side of the P.C.board.
See following examples.
<table>
<tr><th></th><th>Not recommended</th><th>Recommended</th></tr>
<tr><td>Single sided mounting</td><td> 
</td><td> 
</td></tr>
<tr><td>Double-sides mounting</td><td> 
</td><td> 
</td></tr>
</table>
When the centering jaw is worn out, it may give mechanical impact on the capacitors to cause crack. Please control the close up dimension of the centering jaw and provide sufficient preventive maintenance and replacement of it.
</td></tr>
</table>

No.	Process	Condition
5	Soldering	5-1. Flux selection Flux can seriously affect the performance of capacitors. Confirm the following to select the appropriate flux. 1) It is recommended to use a mildly activated rosin flux (less than 0.1wt% 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. 5-2. Recommended soldering profile by various methods Reflow soldering  Manual soldering (Solder iron)  ※ As for peak temperature of manual soldering, please refer "5-6. Solder repair by solder iron". 5-3. Recommended soldering peak temp and peak temp duration Temp./Duration / Solder Reflow soldering Peak temp(°C) / Duration(sec.) Sn-Pb Solder: 230 max. / 20 max. Lead Free Solder: 260 max. / 10 max. Recommended solder compositions Lead Free Solder : Sn-3.0Ag-0.5Cu Sn-Pb solder : Sn-37Pb

No.	Process	Condition
5	Soldering	5-4. Avoiding thermal shock 1) Preheating condition

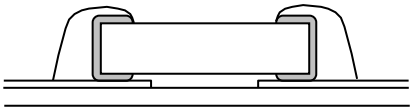
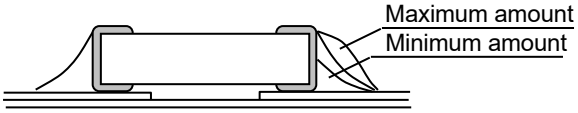
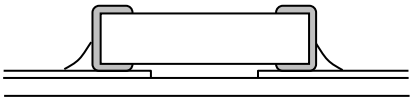
Soldering	Temp. (°C)
Reflow soldering	ΔT ≦ 130
Manual soldering	ΔT ≦ 130

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°C.

5-5. Amount of solder

Excessive solder will induce higher tensile force in chip capacitors when temperature changes and it may result in chip cracking. In sufficient solder may detach the capacitors from the P.C.board.

Excessive solder		Higher tensile force in chip capacitors to cause crack
Adequate		
Insufficient solder		Low robustness may cause contact failure or chip capacitors come off the P.C.board.

5-6. 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 land size. The higher the tip temperature, the quicker the operation. However, heat shock may cause a crack in the chip capacitors.
Please make sure the tip temp. before soldering and keep the peak temp and time in accordance with following recommended condition.

Recommended solder iron condition (Sn-Pb Solder and Lead Free Solder)

Temp. (°C)	Duration (sec.)	Wattage (W)	Shape (mm)
280 max.	3 max.	20 max.	Ø 3.0 max.

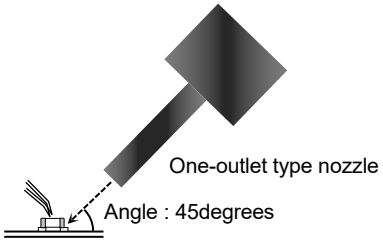
* Please preheat the chip capacitors with the condition in 5-4 to avoid the thermal shock.

2) Direct contact of the soldering iron with ceramic dielectric of chip capacitors may cause crack. Do not touch the ceramic dielectric and the terminations by solder iron.

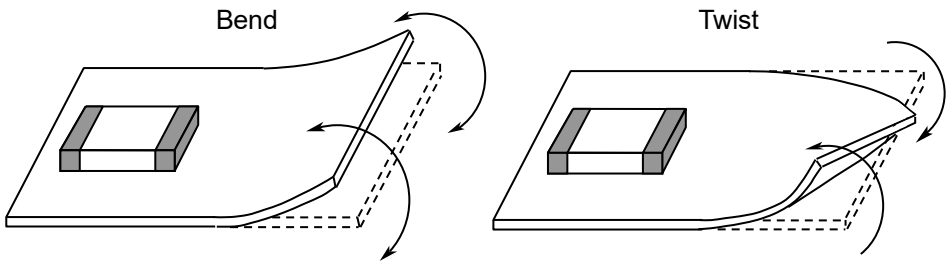
No.	Process	Condition
5	Soldering	5-7.Soldering rework using spot heater Heat stress during rework may possibly be reduced by using a spot heater (also called a “blower”) rather than a soldering iron. It is applied only to adding solder in the case of insufficient solder amount. 1) Reworking using a spot heater may suppress the occurrence of cracks in the capacitor compared to using a soldering iron. A spot heater can heat up a capacitor uniformly with a small heat gradient which leads to lower thermal stress caused by quick heating and cooling or localized heating. Moreover, where ultra-small capacitors are mounted close together on a printed circuit board, reworking with a spot heater can eliminate the risk of direct contact between the tip of a soldering iron and a capacitor. 2) Rework condition If the blower nozzle of a spot heater is too close to a capacitor, a crack in the capacitor may occur due to heat stress. Below are recommendations for avoiding such an occurrence. Keep more than 5mm between a capacitor and a spot heater nozzle. The blower temperature of the spot heater shall be lower than 400°C. The airflow shall be set as weak as possible. The diameter of the nozzle is recommended to be 2mm(one-outlet type).The size is standard and common. Duration of blowing hot air is recommended to be 30s or less, considering surface area of the capacitor and melting temperature of solder. The angle between the nozzle and the capacitor is recommended to be 45degrees in order to work easily and to avoid partial area heating. As is the case when using a soldering iron, preheating reduces thermal stress on capacitors and improves operating efficiency. ・Recommended rework condition（Consult the component manufactures for details.）

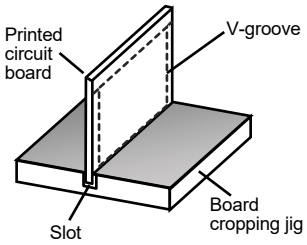
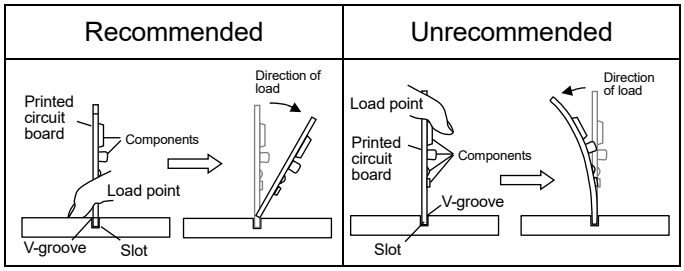
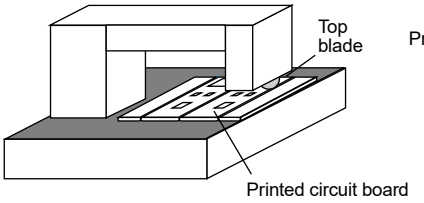
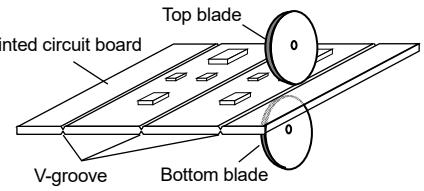
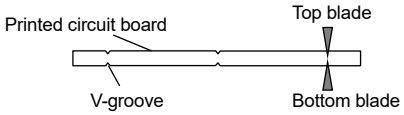
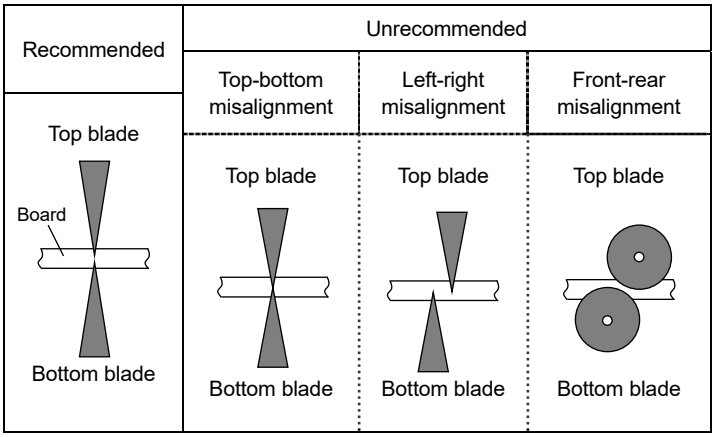
Distance from nozzle	5mm and over
Nozzle angle	45degrees
Nozzle temp.	400°C and less
Airflow	Set as weak as possible (The airflow shall be the minimum value necessary for solder to melt in the conditions mentioned above.)
Nozzle diameter	ϕ2mm（one-outlet type）
Blowing duration	30s and less

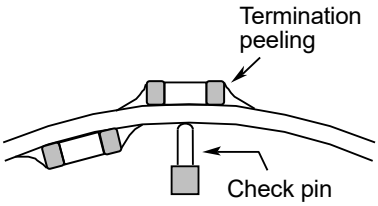
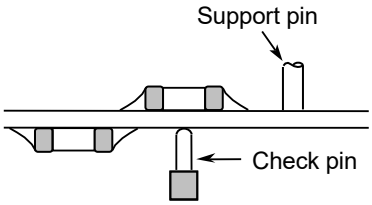
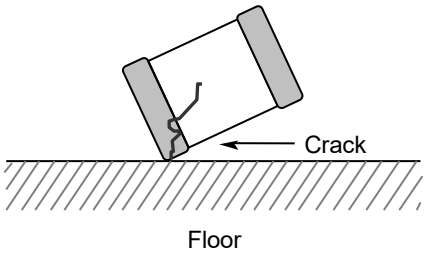
・Example of recommended spot heater use

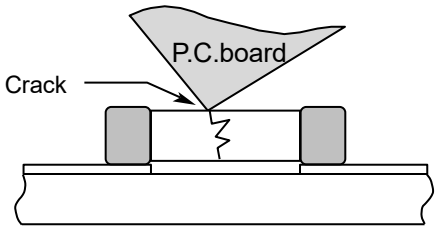


5-8. Sn-Zn solder
Sn-Zn solder affects product reliability.
Please contact TDK in advance when utilize Sn-Zn solder.

No.	Process	Condition
5	Soldering	5-9. Countermeasure for tombstone The misalignment between the mounted positions of the capacitors and the land patterns should be minimized. The tombstone phenomenon may occur especially the capacitors are mounted (in longitudinal direction) in the same direction of the reflow soldering. (Refer to JEITA RCR-2335C Annex A (Informative) Recommendations to prevent the tombstone phenomenon)
6	Cleaning	1) If an unsuitable cleaning fluid is used, flux residue or some foreign articles may stick to chip capacitors surface to deteriorate especially the insulation resistance. 2) If cleaning condition is not suitable, it may damage the chip capacitors. 2)-1. Insufficient washing (1) Terminal electrodes may corrode by Halogen in the flux. (2) Halogen in the flux may adhere on the surface of capacitors, and lower the insulation resistance. (3) Water soluble flux has higher tendency to have above mentioned problems (1) and (2). 2)-2. Excessive washing When ultrasonic cleaning is used, excessively high ultrasonic energy output can affect the connection between the ceramic chip capacitor's body and the terminal electrode. To avoid this, following is the recommended condition. Power : 20 W/ ℓ max. Frequency : 40 kHz max. Washing time : 5 minutes max. 2)-3. If the cleaning fluid is contaminated, density of Halogen increases, and it may bring the same result as insufficient cleaning.
7	Coating and molding of the P.C.board	1) When the P.C.board is coated, please verify the quality influence on the product. 2) Please verify carefully that there is no harmful decomposing or reaction gas emission during curing which may damage the chip capacitors. 3) Please verify the curing temperature.
8	Handling after chip mounted ⚠ Caution	1) Please pay attention not to bend or distort the P.C.board after soldering in handling otherwise the chip capacitors may crack. 

No.	Process	Condition
8	Handling after chip mounted ⚠ Caution	2) Printed circuit board cropping should not be carried out by hand, but by using the proper tooling. Printed circuit board cropping should be carried out using a board cropping jig as shown in the following figure or a board cropping apparatus to prevent inducing mechanical stress on the board. (1)Example of a board cropping jig Recommended example: The board should be pushed from the back side, close to the cropping jig so that the board is not bent and the stress applied to the capacitor is compressive. Unrecommended example: If the pushing point is far from the cropping jig and the pushing direction is from the front side of the board, large tensile stress is applied to the capacitor, which may cause cracks. Outline of jig   (2)Example of a board cropping machine An outline of a printed circuit board cropping machine is shown below. The top and bottom blades are aligned with one another along the lines with the V-grooves on printed circuit board when cropping the board. Unrecommended example: Misalignment of blade position between top and bottom, right and left, or front and rear blades may cause a crack in the capacitor. Outline of machine  Principle of operation  Cross-section diagram  

<table>
<tr><th>No.</th><th>Process</th><th>Condition</th></tr>
<tr><td>8</td><td>Handling after chip mounted
⚠ Caution</td><td>3) When functional check of the P.C.board is performed, check pin pressure tends to be adjusted higher for fear of loose contact. But if the pressure is excessive and bend the P.C.board, it may crack the chip capacitors or peel the terminations off. Please adjust the check pins not to bend the P.C.board.
<table>
<tr><th>Item</th><th>Not recommended</th><th>Recommended</th></tr>
<tr><td>Board bending</td><td> 
</td><td> 
</td></tr>
</table></td></tr>
<tr><td>9</td><td>Handling of loose chip capacitors</td><td>1) If dropped the chip capacitors may crack. Once dropped do not use it. Especially, the large case sized chip capacitors are tendency to have cracks easily, so please handle with care.


2) Piling the P.C.board after mounting for storage or handling, the corner of the P.C. board may hit the chip capacitors of another board to cause crack.

</td></tr>
<tr><td>10</td><td>Capacitance aging</td><td>The capacitors (Class 2) have aging in the capacitance. They may not be used in precision time constant circuit. In case of the time constant circuit, the evaluation should be done well.</td></tr>
<tr><td>11</td><td>Estimated life and estimated failure rate of capacitors</td><td>As per the estimated life and the estimated failure rate depend on the temperature and the voltage. This can be calculated by the equation described in JEITA RCR-2335C Annex F (Informative) Calculation of the estimated lifetime and the estimated failure rate (Voltage acceleration coefficient : 3 multiplication rule, Temperature acceleration coefficient : 10°C rule)
The failure rate can be decreased by reducing the temperature and the voltage but they will not be guaranteed.</td></tr>
</table>

No.	Process	Condition
12	Caution during operation of equipment	1) A capacitor shall not be touched directly with bare hands during operation in order to avoid electric shock. Electric energy held by the capacitor may be discharged through the human body when touched with a bare hand. Even when the equipment is off, a capacitor may stay charged. The capacitor should be handled after being completely discharged using a resistor. 2) The terminals of a capacitor shall not be short-circuited by any accidental contact with a conductive object. A capacitor shall not be exposed to a conductive liquid such as an acid or alkali solution. A conductive object or liquid, such as acid and alkali, between the terminals may lead to the breakdown of a capacitor due to short circuit 3) Confirm that the environment to which the equipment will be exposed during transportation and operation meets the specified conditions. Do not to use the equipment in the following environments. (1) Environment where a capacitor is spattered with water or oil (2) Environment where a capacitor is exposed to direct sunlight (3) Environment where a capacitor is exposed to Ozone, ultraviolet rays or radiation (4) Environment where a capacitor exposed to corrosive gas(e.g. hydrogen sulfide, sulfur dioxide, chlorine. ammonia gas etc.) (5) Environment where a capacitor exposed to vibration or mechanical shock exceeding the specified limits. (6) Atmosphere change with causes condensation
13	Others ⚠ Caution	The product listed in this specification is intended for use in automotive applications under-normal operation and usage conditions. The product is not designed or warranted to meet the requirements of application listed below, whose performance and/or quality requires a more stringent level of safety or reliability, or whose failure, malfunction or defect could cause serious damage to society, person or property. Please understand that we are not responsible for any damage or liability caused by use of the products in any of the applications below or for any other use exceeding the range or conditions set forth in this specification sheet. If you intend to use the products in the applications listed below or if you have special requirements exceeding the range or conditions set forth in this specification, please contact us. (1) Aerospace/Aviation equipment (2) Transportation equipment (electric trains, ships etc.) (3) Medical equipment (Excepting Pharmaceutical Affairs Law classification Class1, 2) (4) Power-generation control equipment (5) Atomic energy-related equipment (6) Seabed equipment (7) Transportation control equipment (8) Public information-processing equipment (9) Military equipment (10) Electric heating apparatus, burning equipment (11) Disaster prevention/crime prevention equipment (12) Safety equipment (13) Other applications that are not considered general-purpose applications When designing your equipment even for general-purpose applications, you are kindly requested to take into consideration securing protection circuit/device or providing backup circuits in your equipment. In addition, although the product listed in this specification is intended for use in automotive applications as described above, it is not prohibited to use for general electronic equipment, whose performance and/or quality doesn't require a more stringent level of safety or reliability, or whose failure, malfunction or defect could not cause serious damage to society, person or property. Therefore, the description of this caution will be applied, when the product is used in general electronic equipment under a normal operation and usage conditions.

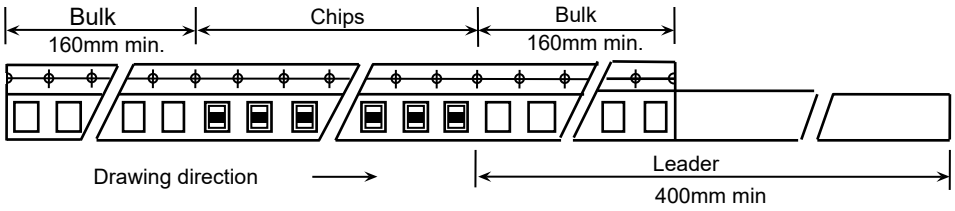
14. TAPE PACKAGING SPECIFICATION

1. CONSTRUCTION AND DIMENSION OF TAPING

1-1. Dimensions of carrier tape

Dimensions of plastic tape shall be according to Appendix 3, 4.

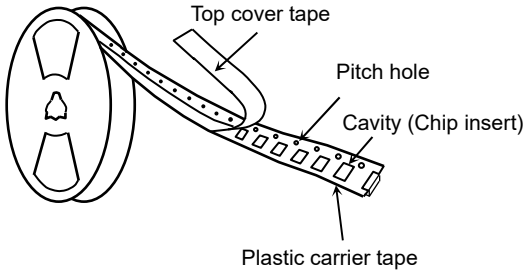
1-2. Bulk part and leader of taping



1-3. Dimensions of reel

Dimensions of Ø178 reel shall be according to Appendix 5, 6.
Dimensions of Ø330 reel shall be according to Appendix 7, 8.

1-4. Structure of taping



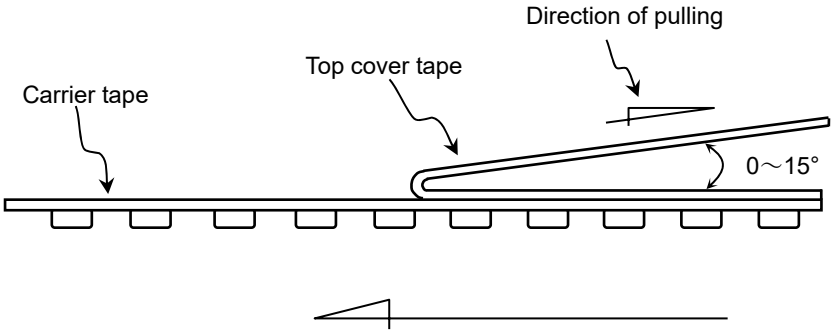
2. CHIP QUANTITY

Please refer to the table A in the end of the specification.

3. PERFORMANCE SPECIFICATIONS

3-1. Fixing peeling strength (top cover tape)

0.05N < Peeling strength < 0.7N



3-2. Carrier tape shall be flexible enough to be wound around a minimum radius of 30mm with components in tape.

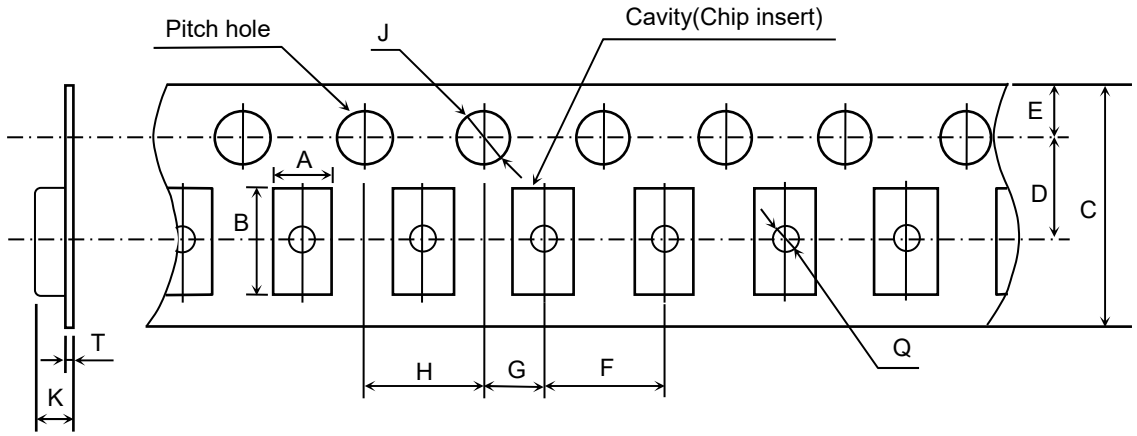
3-3. The missing of components shall be less than 0.1%

3-4. Components shall not stick to fixing tape.

3-5. When removing the cover tape, there shall not be difficulties by unfitting clearance gap, burrs and crushes of cavities. Also the sprocket holes shall not be covered by absorbing dust into the suction nozzle.

Appendix 3

Plastic Tape



(Unit : mm)

Symbol / Type	A	B	C	D	E	F
CGA6 (CC1210)	(2.90)	(3.60)	8.00 ± 0.30 ∗12.0 ± 0.30	3.50 ± 0.05 ∗5.50 ± 0.05	1.75 ± 0.10	4.00 ± 0.10

Symbol / Type	G	H	J	K	T	Q
CGA6 (CC1210)	2.00 ± 0.05	4.00 ± 0.10	Ø 1.5 $^{+0.10}_{0}$	3.20 max.	0.60 max.	Ø 0.50 min.

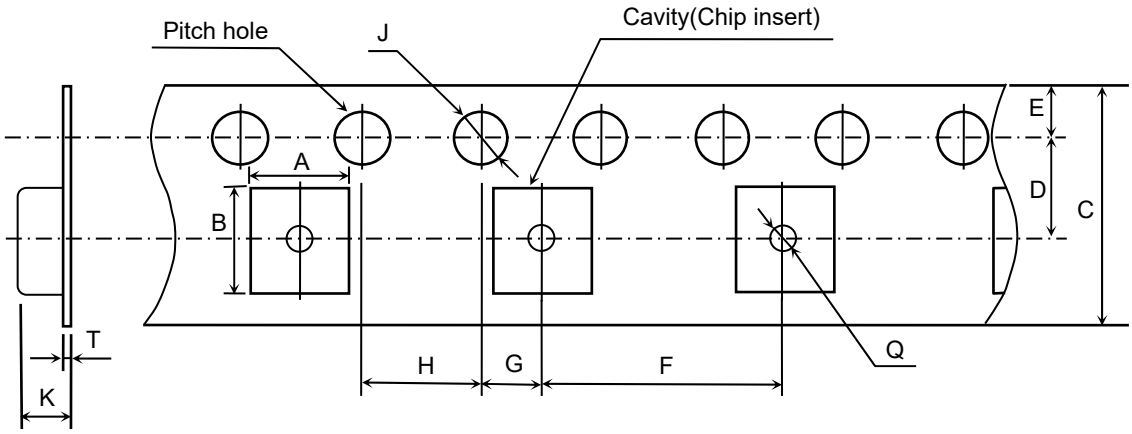
( ) Reference value.

Exceptionally no hole in the cavity is applied. Please inquire if hole in cavity is mandatory.

∗ Applied to thickness, 2.5mm products.

Appendix 4

Plastic Tape



(Unit : mm)

Symbol / Type	A	B	C	D	E	F
CGA7 (CC1808)	(2.50)	(5.10)	12.0 ± 0.30	5.50 ± 0.05	1.75 ± 0.10	8.00 ± 0.10
CGA8 (CC1812)	(3.60)	(5.20)				
CGA9 (CC2220)	(5.40)	(6.10)				

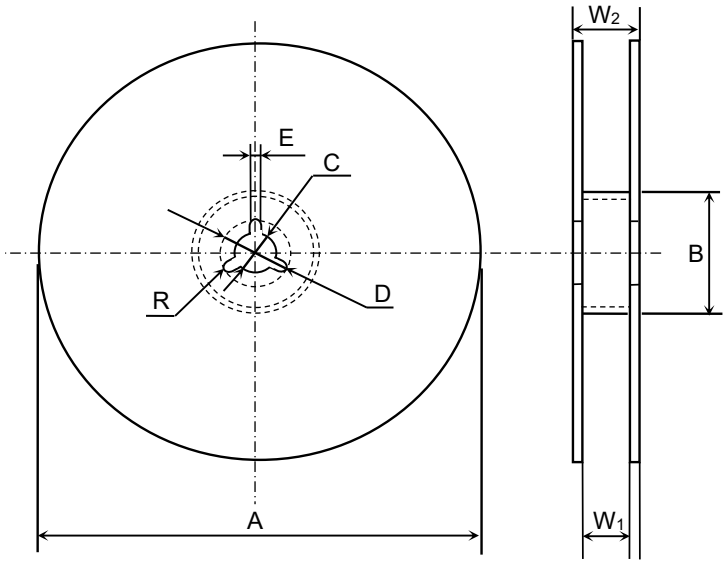
Symbol / Type	G	H	J	K	T	Q
CGA7 (CC1808)	2.00 ± 0.05	4.00 ± 0.10	Ø 1.5 $^{+0.10}_{0}$	6.50 max.	0.60 max.	Ø 1.50 min.
CGA8 (CC1812)						
CGA9 (CC2220)						

( ) Reference value.

Appendix 5

Dimensions of reel (Material : Polystyrene)

CGA6



(Unit : mm)

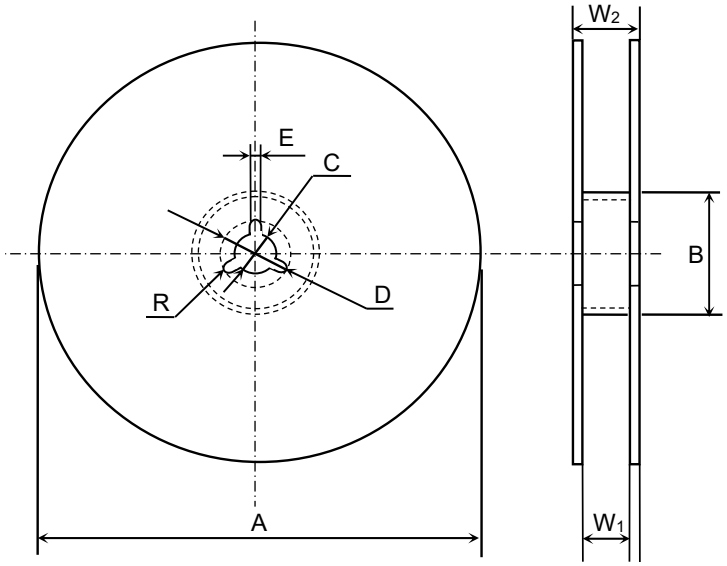
Symbol	A	B	C	D	E	W_1
Dimension	Ø178 ± 2.0	Ø60 ± 2.0	Ø13 ± 0.5	Ø21 ± 0.8	2.0 ± 0.5	9.0 ± 0.3

Symbol	W_2	R
Dimension	13.0 ± 1.4	1.0

Appendix 6

Dimensions of reel (Material : Polystyrene)

CGA6(2.5mm thickness products), CGA7, CGA8, CGA9



(Unit : mm)

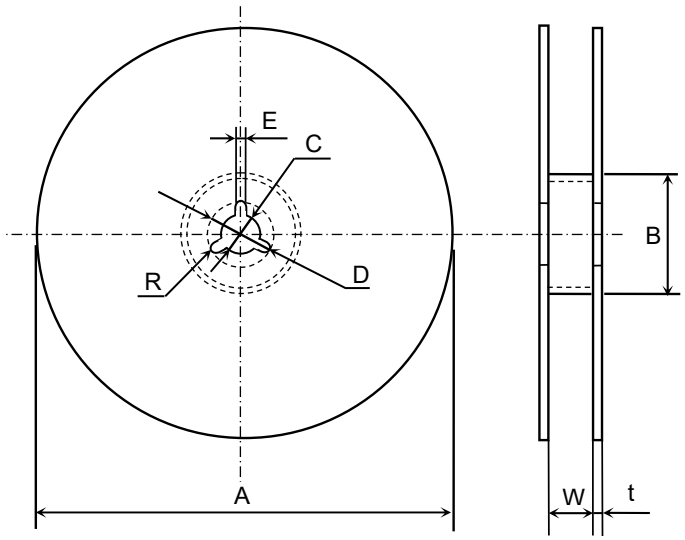
Symbol	A	B	C	D	E	W_1
Dimension	Ø178 ± 2.0	Ø60 ± 2.0	Ø13 ± 0.5	Ø21 ± 0.8	2.0 ± 0.5	13.0 ± 0.3

Symbol	W_2	R
Dimension	17.0 ± 1.4	1.0

Appendix 7

Dimensions of reel (Material : Polystyrene)

CGA6



(Unit : mm)

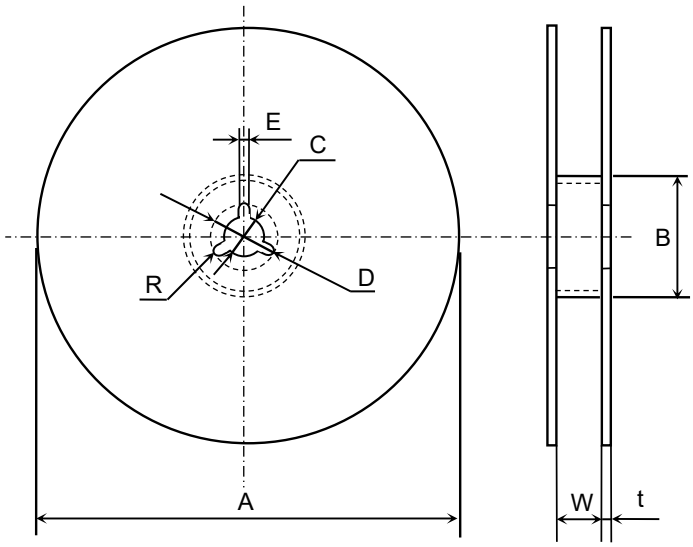
Symbol	A	B	C	D	E	W
Dimension	Ø382 max. (Nominal Ø330)	Ø50 min.	Ø13 ± 0.5	Ø21 ± 0.8	2.0 ± 0.5	10.0 ± 1.5

Symbol	t	R
Dimension	2.0 ± 0.5	1.0

Appendix 8

Dimensions of reel (Material : Polystyrene)

CGA6(2.5mm thickness products), CGA7, CGA8, CGA9



(Unit : mm)

Symbol	A	B	C	D	E	W
Dimension	Ø382 max. (Nominal Ø330)	Ø50 min.	Ø13 ± 0.5	Ø21 ± 0.8	2.0 ± 0.5	14.0 ± 1.5

Symbol	t	R
Dimension	2.0 ± 0.5	1.0

15.Table A (TDK products line up)

No	Your Part No.	TDK product	Dimensions			Q (min.)	tanδ (max.)	Temp. Characteristics of Cap.		Temp cycle	Moisture Resistance (Steady state)	Moisture Resistance	Life		Tape packaging materials	Qty. per 1 reel	
			L (mm)	W (mm)	T (mm)			Measuring frequency	Measuring voltage	ΔC/C	ΔC/C	ΔC/C	ΔC/C	Test voltage		φ178mm	φ330mm
1		CGA6M1C0G3A102J	3.20±0.40	2.50±0.30	2.00±0.20	1,000		1MHz	0.5～5Vrms	±2.5%	±5.0%	±7.5%	±3.0%	1.0 x R.V.	Plastic	1,000	5,000
2		CGA6M1C0G3A152J	3.20±0.40	2.50±0.30	2.00±0.20	1,000		1kHz	0.5～5Vrms	±2.5%	±5.0%	±7.5%	±3.0%	1.0 x R.V.	Plastic	1,000	5,000
3		CGA6M1C0G3A222J	3.20±0.40	2.50±0.30	2.00±0.20	1,000		1kHz	0.5～5Vrms	±2.5%	±5.0%	±7.5%	±3.0%	1.0 x R.V.	Plastic	1,000	5,000
4		CGA6M1C0G3A332J	3.20±0.40	2.50±0.30	2.00±0.20	1,000		1kHz	0.5～5Vrms	±2.5%	±5.0%	±7.5%	±3.0%	1.0 x R.V.	Plastic	1,000	5,000
5		CGA6M1C0G3A472J	3.20±0.40	2.50±0.30	2.00±0.20	1,000		1kHz	0.5～5Vrms	±2.5%	±5.0%	±7.5%	±3.0%	1.0 x R.V.	Plastic	1,000	5,000
6		CGA6M1C0G3A682J	3.20±0.40	2.50±0.30	2.00±0.20	1,000		1kHz	0.5～5Vrms	±2.5%	±5.0%	±7.5%	±3.0%	1.0 x R.V.	Plastic	1,000	5,000
7		CGA6P1C0G3A103J	3.20±0.40	2.50±0.30	2.50±0.30	1,000		1kHz	0.5～5Vrms	±2.5%	±5.0%	±7.5%	±3.0%	1.0 x R.V.	Plastic	1,000	5,000
8		CGA6P1C0G3A153J	3.20±0.40	2.50±0.30	2.50±0.30	1,000		1kHz	0.5～5Vrms	±2.5%	±5.0%	±7.5%	±3.0%	1.0 x R.V.	Plastic	1,000	5,000
9		CGA6P1C0G3A223J	3.20±0.40	2.50±0.30	2.50±0.30	1,000		1kHz	0.5～5Vrms	±2.5%	±5.0%	±7.5%	±3.0%	1.0 x R.V.	Plastic	1,000	5,000
10		CGA7F1C0G3F100F	4.50±0.40	2.00±0.20	0.85±0.15	600		1MHz	0.5～5Vrms	±2.5%	±5.0%	±7.5%	±3.0%	1.0 x R.V.	Plastic	1,000	5,000
11		CGA7G1C0G3F150K	4.50±0.40	2.00±0.20	1.10±0.20	700		1MHz	0.5～5Vrms	±2.5%	±5.0%	±7.5%	±3.0%	1.0 x R.V.	Plastic	1,000	5,000
12		CGA7G1C0G3F220K	4.50±0.40	2.00±0.20	1.10±0.20	840		1MHz	0.5～5Vrms	±2.5%	±5.0%	±7.5%	±3.0%	1.0 x R.V.	Plastic	1,000	5,000
13		CGA7L1C0G3F330K	4.50±0.40	2.00±0.20	1.60±0.20	1,000		1MHz	0.5～5Vrms	±2.5%	±5.0%	±7.5%	±3.0%	1.0 x R.V.	Plastic	1,000	3,000
14		CGA7L1C0G3F470K	4.50±0.40	2.00±0.20	1.60±0.20	1,000		1MHz	0.5～5Vrms	±2.5%	±5.0%	±7.5%	±3.0%	1.0 x R.V.	Plastic	1,000	3,000
15		CGA7M1C0G3F680K	4.50±0.40	2.00±0.20	2.00±0.20	1,000		1MHz	0.5～5Vrms	±2.5%	±5.0%	±7.5%	±3.0%	1.0 x R.V.	Plastic	1,000	3,000
16		CGA7M1C0G3F101K	4.50±0.40	2.00±0.20	2.00±0.20	1,000		1MHz	0.5～5Vrms	±2.5%	±5.0%	±7.5%	±3.0%	1.0 x R.V.	Plastic	1,000	3,000
17		CGA7K1X7R3D471K	4.50±0.40	2.00±0.20	1.30±0.20		0.03	1kHz	1.0Vrms	±7.5%	±12.5%	±12.5%	±15%	1.0 x R.V.	Plastic	1,000	5,000
18		CGA7K1X7R3D102K	4.50±0.40	2.00±0.20	1.30±0.20		0.03	1kHz	1.0Vrms	±7.5%	±12.5%	±12.5%	±15%	1.0 x R.V.	Plastic	1,000	5,000
19		CGA7K1X7R3A471K	4.50±0.40	2.00±0.20	1.30±0.20		0.03	1kHz	1.0Vrms	±7.5%	±12.5%	±12.5%	±15%	1.0 x R.V.	Plastic	1,000	5,000
20		CGA7K1X7R3A102K	4.50±0.40	2.00±0.20	1.30±0.20		0.03	1kHz	1.0Vrms	±7.5%	±12.5%	±12.5%	±15%	1.0 x R.V.	Plastic	1,000	5,000
21		CGA8L1C0G3F101K	4.50±0.40	3.20±0.40	1.60±0.20	1,000		1MHz	0.5～5Vrms	±2.5%	±5.0%	±7.5%	±3.0%	1.0 x R.V.	Plastic	1,000	3,000
22		CGA8L1C0G3F151K	4.50±0.40	3.20±0.40	1.60±0.20	1,000		1MHz	0.5～5Vrms	±2.5%	±5.0%	±7.5%	±3.0%	1.0 x R.V.	Plastic	1,000	3,000
23		CGA8M1C0G3F221K	4.50±0.40	3.20±0.40	2.00±0.20	1,000		1MHz	0.5～5Vrms	±2.5%	±5.0%	±7.5%	±3.0%	1.0 x R.V.	Plastic	1,000	3,000
24		CGA8P1C0G3F331K	4.50±0.40	3.20±0.40	2.50±0.30	1,000		1MHz	0.5～5Vrms	±2.5%	±5.0%	±7.5%	±3.0%	1.0 x R.V.	Plastic	500	3,000
25		CGA8K1X7R3D222K	4.50±0.40	3.20±0.40	1.30±0.20		0.03	1kHz	1.0Vrms	±7.5%	±12.5%	±12.5%	±15%	1.0 x R.V.	Plastic	1,000	5,000
26		CGA8L1X7R3A472K	4.50±0.40	3.20±0.40	1.60±0.20		0.03	1kHz	1.0Vrms	±7.5%	±12.5%	±12.5%	±15%	1.0 x R.V.	Plastic	1,000	3,000
27		CGA8M1X7R3A103K	4.50±0.40	3.20±0.40	2.00±0.20		0.03	1kHz	1.0Vrms	±7.5%	±12.5%	±12.5%	±15%	1.0 x R.V.	Plastic	1,000	3,000
28		CGA9Q1C0G3A103J	5.70±0.40	5.00±0.40	2.80±0.30	1,000		1kHz	0.5～5Vrms	±2.5%	±5.0%	±7.5%	±3.0%	1.0 x R.V.	Plastic	500	2,000
29		CGA9Q1C0G3A153J	5.70±0.40	5.00±0.40	2.80±0.30	1,000		1kHz	0.5～5Vrms	±2.5%	±5.0%	±7.5%	±3.0%	1.0 x R.V.	Plastic	500	2,000
30		CGA9Q1C0G3A223J	5.70±0.40	5.00±0.40	2.80±0.30	1,000		1kHz	0.5～5Vrms	±2.5%	±5.0%	±7.5%	±3.0%	1.0 x R.V.	Plastic	500	2,000
31		CGA9Q1C0G3A333J	5.70±0.40	5.00±0.40	2.80±0.30	1,000		1kHz	0.5～5Vrms	±2.5%	±5.0%	±7.5%	±3.0%	1.0 x R.V.	Plastic	500	2,000

M(±20%) is also available to support for X7R.