DELIVERY SPECIFICATION

SPEC. No. C-ULI-b

D A T E : Jun, 2019

To

CUSTOMER'S PRODUCT NAME	TDK PRODUCT NAME Multilayer Ceramic Chip Capacitors Ultra Low Inductance Bulk and Tape packaging【RoHS compliant】 CLLC1A Type X6S,X7R,X7S 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

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

CLL	C1A	X6S	0G	475	M	050	A	C
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

(1) Series

(2) Dimensions L x W (mm)

Dimensions code	EIA	Length	Width	Terminal width
C1A	CC0603	1.60	0.80	0.25
E1A	CC0805	2.00	1.25	0.25
G1A	CC1206	3.20	1.60	0.40

(3) Temperature characteristics

Temperature characteristics	Capacitance change	Temperature range
X6S	±22%	−55 to +105°C
X7R	±15%	−55 to +125°C
X7S	±22%	−55 to +125°C

(4) Rated voltage (DC)

Code	Voltage (DC)
0G	4V
0J	6.3V
1A	10V

(5) 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. R designates a decimal point.

(Example)0R5 = 0.5pF
101 = 100pF
225 = 2,200,000pF = 2.2μF

(6) Capacitance tolerance

Code	Tolerance
M	±20%

(7) Thickness

Code	Thickness
050	0.50mm
085	0.85mm

(8) Packaging style

Code	Style
A	178mm reel, 4mm pitch

(9) Special reserved code

Code	Description
C	TDK internal code

SCOPE

This delivery specification shall be applied to Multilayer ceramic chip capacitors to be delivered to _____.

PRODUCTION PLACES

Production places defined in this specification shall be TDK Corporation, TDK(Suzhou)Co.,Ltd and TDK Components U.S.A.,Inc.

PRODUCT NAME

The name of the product to be defined in this specifications shall be CLLC1A○○○△△□□□×.

REFERENCE STANDARD

JIS	C 5101－1：2010	Fixed capacitors for use in electronic equipment-Part 1: Generic specification
	C 5101－22：2014	Fixed capacitors for use in electronic equipment-Part 22 : Sectional specification : Fixed surface mount multilayer capacitors of ceramic dielectric,Class2
	C 0806－3：2014	Packaging of components for automatic handling - Part 3: Packaging of surface mount components on continuous tapes
JEITA	RCR－2335 C 2014	Safety application guide for fixed ceramic capacitors for use in electronic equipment

CONTENTS

<EXPLANATORY NOTE>

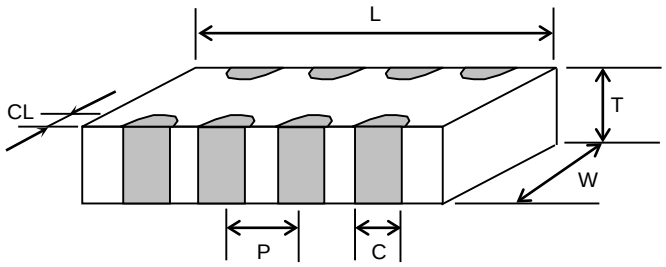
When the mistrust in the spec arises, this specification is given priority. And it will be confirmed by written spec change after conference of both posts involved.
This specification warrants the quality of the ceramic chip capacitor. Capacitors should be evaluated or confirmed a state of mounted on your product.
If the use of the capacitors goes beyond the bounds of this specification, we can not afford to guarantee.

Division	Date	SPEC. No.
Ceramic Capacitors Business Group	Jun, 2019	C-ULI-b

1. CODE CONSTRUCTION

(Example) CLLC1A (1) X7S (2) 0G (3) 105 (4) M (5) T (6) OOOO (7)

(1) Type



Case size [EIA style]	Dimensions (Unit : mm)					
	L	W	T	P	C	CL
CLLC1A [CC0603]	1.60 ± 0.10	0.80 ± 0.10	0.50 $^{+0.05}_{-0.10}$	0.40 ± 0.10	0.25 ± 0.10	0.15 ± 0.10

∗ As for each item, please refer to detail page on TDK Web.

(2) Temperature Characteristics

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

(3) Rated Voltage

Symbol	Rated Voltage
0G	DC 4 V

(4) 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
105	1,000,000 pF

(5) Capacitance tolerance

Symbol	Tolerance
M	± 20 %

(6) Packaging

Symbol	Packaging
B	Bulk
T	Taping

(7) TDK internal code

2. COMBINATION OF RATED CAPACITANCE AND TOLERANCE

Temperature Characteristics	Capacitance tolerance	Rated capacitance
X6S X7R X7S	M (± 20 %)	E – 6 series

Capacitance Step in E series

E series	Capacitance Step					
E- 6	1.0	1.5	2.2	3.3	4.7	6.8

3. OPERATING TEMPERATURE RANGE

T.C.	Min. operating Temperature	Max. operating Temperature	Reference Temperature
X6S	-55°C	105°C	25°C
X7R X7S	-55°C	125°C	25°C

4. STORING CONDITION AND TERM

Storing temperature	Storing humidity	Storing term
5~40°C	20~70%RH	Within 6 months upon receipt.

5. INDUSTRIAL WASTE DISPOSAL

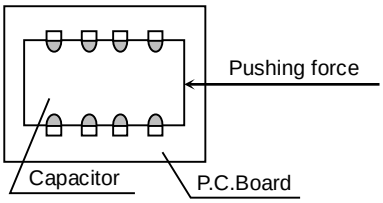
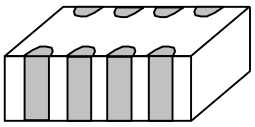
Dispose this product as industrial waste in accordance with the Industrial Waste Law.

6. 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>100MΩ·μF min.</td><td>Measuring voltage : Rated voltage
Voltage application time : 60s.
Measure 8 terminal electrodes at the same time.</td></tr>
<tr><td>3</td><td>Voltage Proof</td><td>Withstand test voltage without insulation breakdown or other damage.</td><td>Applied voltage : 2.5 times of rated voltage
Above DC voltage shall be applied between each terminal in equivalent circuit for 1s.
Charge / discharge current : 50mA or lower</td></tr>
<tr><td>4</td><td>Capacitance</td><td>Within the specified tolerance.</td><td><table><tr><th>Measuring frequency</th><th>Measuring voltage</th></tr><tr><td>1kHz±10%</td><td>0.5±0.2Vrms.</td></tr></table>Measure 8 terminal electrodes at the same time.</td></tr>
<tr><td>5</td><td>Dissipation Factor</td><td>Please refer to detail page on TDK Web.</td><td>See No.4 in this table for measuring condition.</td></tr>
<tr><td>6</td><td>Temperature Characteristics of Capacitance</td><td><table><tr><th>Capacitance Change (%)</th></tr><tr><td>No voltage applied</td></tr><tr><td>X6S : ±22
X7R : ±15
X7S : ±22</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.
Capacitance change shall be calculated by the value of the reference temperature in Step 3.<table><tr><th>Step</th><th>Temperature(°C)</th></tr><tr><td>1</td><td>Reference temp. ± 2</td></tr><tr><td>2</td><td>Min. operating temp. ± 2</td></tr><tr><td>3</td><td>Reference temp. ± 2</td></tr><tr><td>4</td><td>Max. operating temp. ± 2</td></tr></table>As for Min./Max. operating temp and Reference temp., please refer to “3.OPERATING TEMPERATURE RANGE”
As for measuring voltage, please contact with our sales representative.</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>7</td><td colspan="2">Robustness of Terminations</td><td>No sign of termination coming off, breakage of ceramic, or other abnormal signs.</td><td>Reflow solder the capacitors on a P.C.Board shown in Appendix1.
Apply a pushing force gradually at the center of a specimen in a horizontal direction of P.C.Board.
Pushing force : 5N
Holding time : 10±1s
 
</td></tr>
<tr><td>8</td><td colspan="2">Solderability</td><td>All terminations shall exhibit a continuous solder coating free from defects for a minimum of 75% of the surface area of any individual termination. Anomalies other than dewetting, non-wetting, and pin holes are not cause for rejection.
 
</td><td>Solder : Sn-3.0Ag-0.5Cu or Sn-37Pb
Flux : Isopropyl alcohol (JIS K 8839) Rosin (JIS K 5902) 25% solid solution.
Solder temp. : 245±5°C (Sn-3.0Ag-0.5Cu) 235±5°C (Sn-37Pb)
Dwell time : 3±0.3s.(Sn-3.0Ag-0.5Cu) 2±0.2s.(Sn-37Pb)
Solder position : Until both terminations are completely soaked.</td></tr>
<tr><td rowspan="4">9</td><td rowspan="4">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="4">Solder : Sn-3.0Ag-0.5Cu or Sn-37Pb
Flux : Isopropyl alcohol (JIS K 8839) Rosin (JIS K 5902) 25% solid solution.
Solder temp. : 260±5°C
Dwell time : 10±1s.
Solder position : Until both terminations are completely soaked.
Pre-heating : Temp. — 110~140°C Time — 30～60s.
Leave the capacitors in ambient condition for 24±2h before measurement.</td></tr>
<tr><td>Capacitance</td><td><table><tr><th>Characteristics</th><th>Change from the value before test</th></tr><tr><td>X6S
X7R
X7S</td><td>± 7.5 %</td></tr></table></td></tr>
<tr><td>D.F.</td><td>Meet the initial spec.</td></tr>
<tr><td>Insulation Resistance</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="3">10</td><td rowspan="3">Vibration</td><td>External appearance</td><td>No mechanical damage.</td><td rowspan="3">Frequency : 10~55~10Hz
Reciprocating sweep time : 1 min.
Amplitude : 1.5mm
Repeat this for 2h each in 3 perpendicular directions(Total 6h).

Reflow solder the capacitors on a P.C.Board shown in Appendix1 before testing.</td></tr>
<tr><td>Capacitance</td><td><table><tr><th>Characteristics</th><th>Change from the value before test</th></tr><tr><td>X6S
X7R
X7S</td><td>± 7.5 %</td></tr></table></td></tr>
<tr><td>D.F.</td><td>Meet the initial spec.</td></tr>
<tr><td rowspan="5">11</td><td rowspan="5">Temperature cycle</td><td>External appearance</td><td>No mechanical damage.</td><td rowspan="5">Expose the capacitors in the condition step1 through step 4 listed in the following table.

Temp. cycle : 5 cycles<table><tr><th>Step</th><th>Temperature(°C)</th><th>Time (min.)</th></tr><tr><td>1</td><td>Min. operating temp.±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>Max. operating temp.±2</td><td>30 ± 2</td></tr><tr><td>4</td><td>Ambient Temp.</td><td>2 ~ 5</td></tr></table>As for Min./Max. operating temp., please refer to “3. OPERATING TEMPERATURE RANGE”

Leave the capacitors in ambient condition for 24±2h before measurement.

Reflow solder the capacitors on a P.C.Board shown in Appendix1 before testing.</td></tr>
<tr><td>Capacitance</td><td><table><tr><th>Characteristics</th><th>Change from the value before test</th></tr><tr><td>X6S
X7R
X7S</td><td>Please contact with our sales representative.</td></tr></table></td></tr>
<tr><td>D.F.</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">Moisture Resistance (Steady State)</td><td>External appearance</td><td>No mechanical damage.</td><td rowspan="4">Test temp. : 40±2°C
Test humidity : 90~95%RH
Test time : 500 +24,0h
Leave the capacitors in ambient condition for 24±2h before measurement.

Reflow solder the capacitors on a P.C.Board shown in Appendix1 before testing.</td></tr>
<tr><td>Capacitance</td><td><table><tr><th>Characteristics</th><th>Change from the value before test</th></tr><tr><td>X6S
X7R
X7S</td><td>Please contact with our sales representative.</td></tr></table></td></tr>
<tr><td>D.F.</td><td>200% of initial spec. max.</td></tr>
<tr><td>Insulation Resistance</td><td>10MΩ·μF 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 rowspan="4">13</td><td rowspan="4">Moisture Resistance</td><td>External appearance</td><td>No mechanical damage.</td><td rowspan="4">Test temp. : 40±2°C
Test humidity : 90~95%RH
Applied voltage : Rated voltage
Test time : 500 +24,0h
Charge/discharge current : 50mA or lower
Leave the capacitors in ambient condition for 24±2h before measurement.

Reflow solder the capacitors on a P.C.Board shown in Appendix1 before testing.

Initial value setting
Voltage conditioning 《After 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>Capacitance</td><td><table><tr><th>Characteristics</th><th>Change from the value before test</th></tr><tr><td>X6S
X7R
X7S</td><td>Please contact with our sales representative.</td></tr></table></td></tr>
<tr><td>D.F.</td><td>200% of initial spec. max.</td></tr>
<tr><td>Insulation Resistance</td><td>5MΩ·μF min.</td></tr>
<tr><td rowspan="4">14</td><td rowspan="4">Life</td><td>External appearance</td><td>No mechanical damage.</td><td rowspan="4">Test temp. : Maximum operating temperature±2°C
Applied voltage : Please contact with our sales representative.
Test time : 1,000 +48,0h
Charge/discharge current : 50mA or lower
Leave the capacitors in ambient condition for 24±2h before measurement.

Reflow solder the capacitors on a P.C.Board shown in Appendix1 before testing.

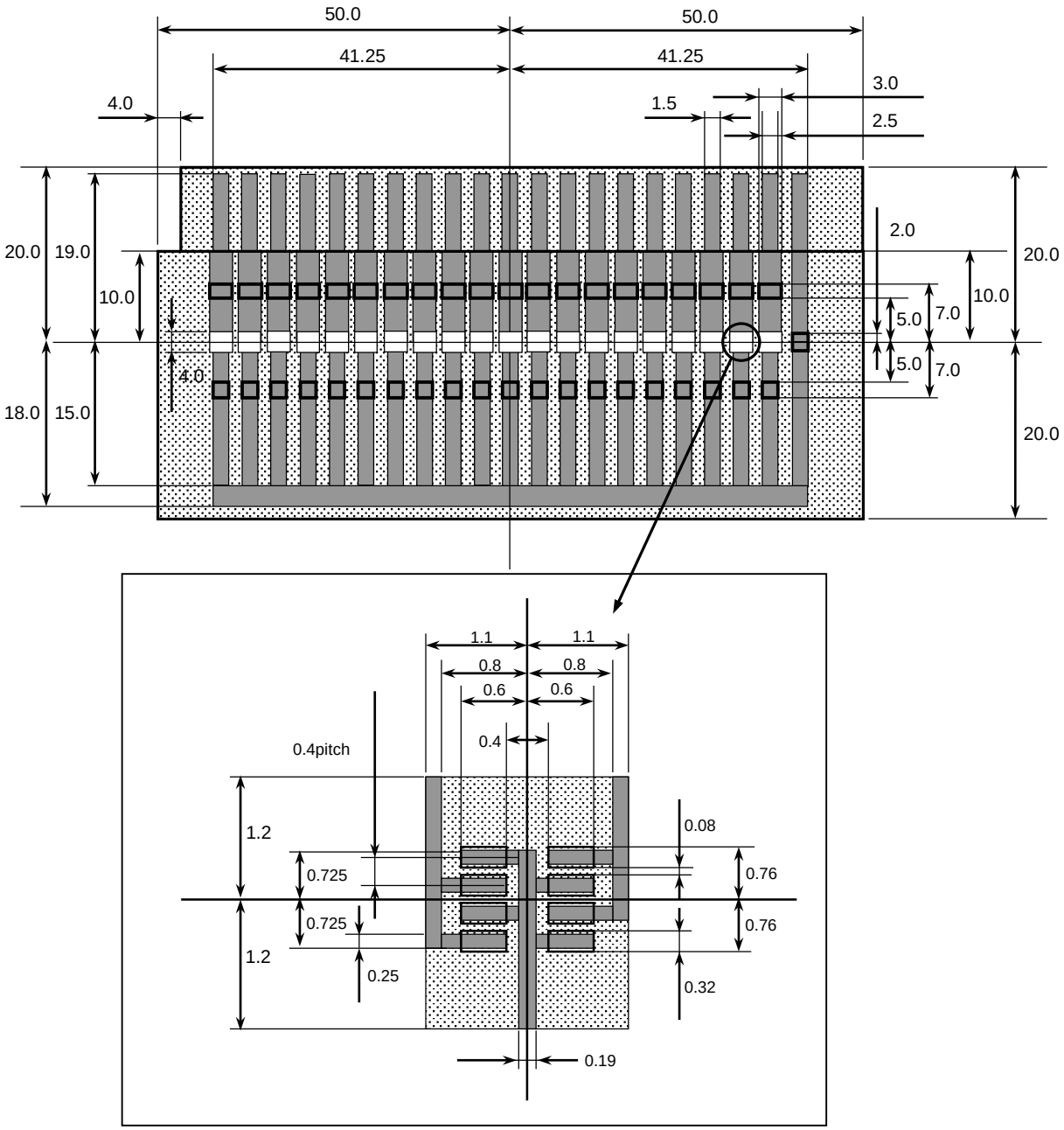
Initial value setting
Voltage conditioning 《After voltage treat the capacitors under testing temperature and voltage for 1 hour,》 leave the capacitors in ambient condition for 24±2h before measurement.
Use this measurement for initial value.</td></tr>
<tr><td>Capacitance</td><td><table><tr><th>Characteristics</th><th>Change from the value before test</th></tr><tr><td>X6S
X7R
X7S</td><td>Please contact with our sales representative.</td></tr></table></td></tr>
<tr><td>D.F.</td><td>200% of initial spec. max.</td></tr>
<tr><td>Insulation Resistance</td><td>10MΩ·μF min.</td></tr>
</table>

*As for the initial measurement of capacitors on number 6,9,10,11 and 12, leave capacitors at 150 0,-10°C for 1h and measure the value after leaving capacitors for 24±2h in ambient condition.

Appendix1

CLLC1A

P.C. Board for reliability test



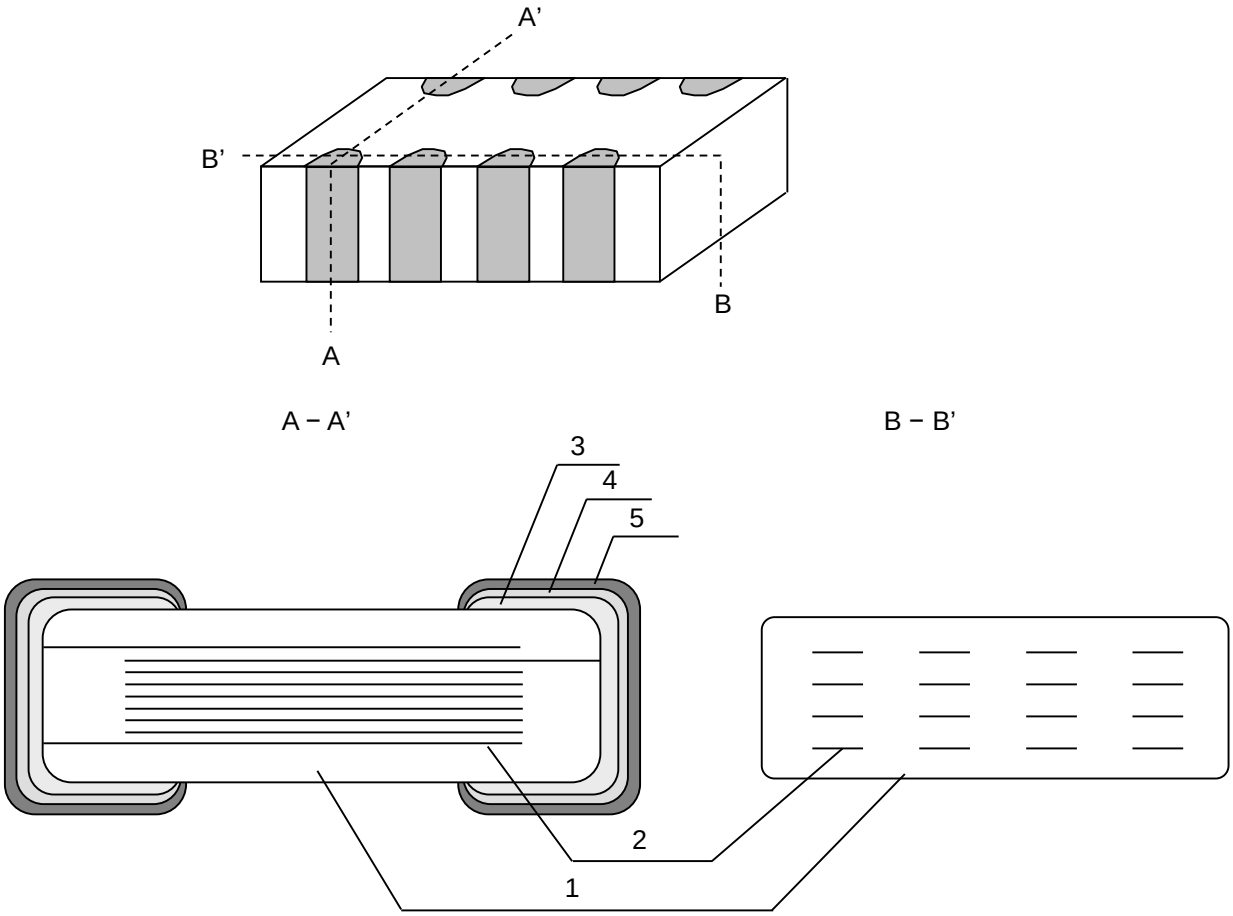
(Unit: mm)

1. Material : Glass Epoxy (As per JIS C6484 GE4)
2. Thickness : 0.8mm

Copper (Thickness: 0.035mm)

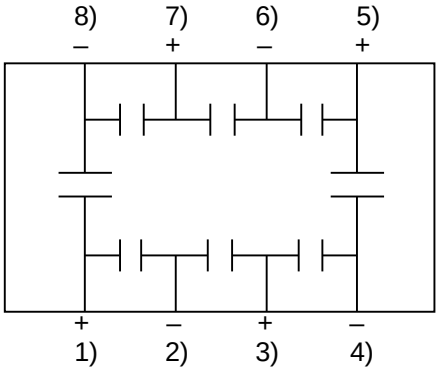
Solder resist

7. INSIDE STRUCTURE AND MATERIAL



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

8. EQUIVALENT CIRCUIT



+ 1) 3) 5) 7)
– 2) 4) 6) 8)

8 terminals are connected and measured at the same time.

9. 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.

9.1 Each plastic bag for bulk packaging contains 1000pcs. And the minimum quantity for Bulk packaging is 1000pcs.

9.2 Tape packaging is as per 12. TAPE PACKAGING SPECIFICATION.

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

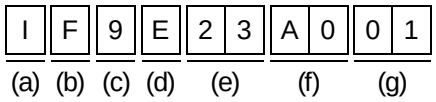
*Composition of Inspection No.

Example F 9 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 May 1, 2019)

Example



(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)

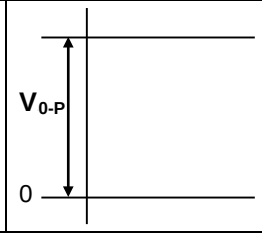
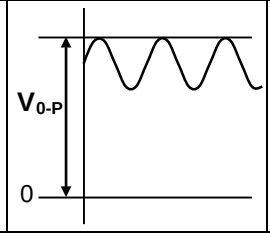
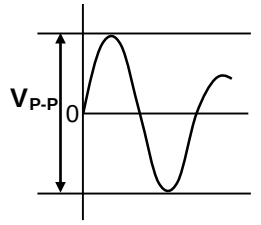
*It is planned to shift to the new inspection No. on and after May 2019, but the implementation timing may be different depending on shipment bases.
Until the shift is completed, either current or new composition of inspection No. will be applied.

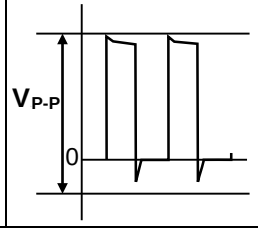
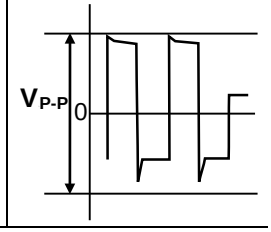
10. SOLDERING CONDITION

Reflow soldering only.

11. 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.
</td></tr>
</table>

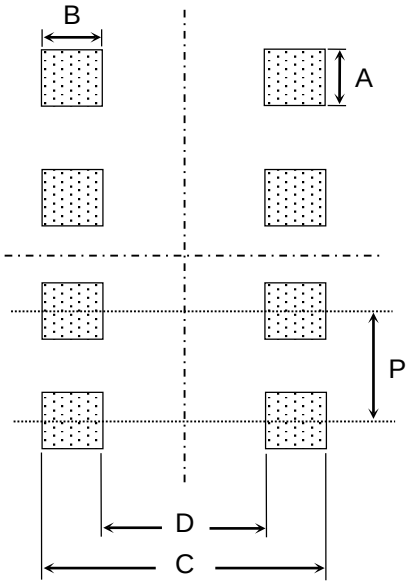
Voltage	(1) DC voltage	(2) DC+AC voltage	(3) AC voltage
Positional Measurement (Rated voltage)			

Voltage	(4) Pulse voltage (A)	(5) Pulse voltage (B)
Positional Measurement (Rated voltage)		

<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.

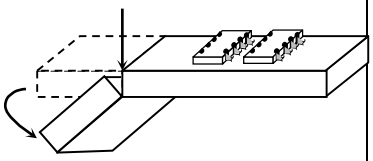
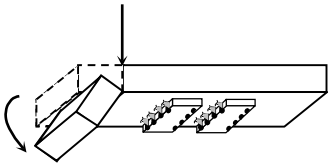
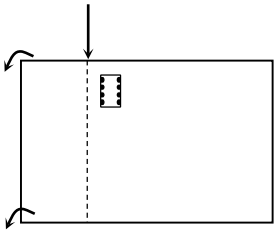
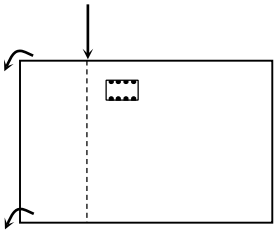
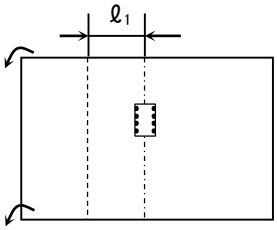
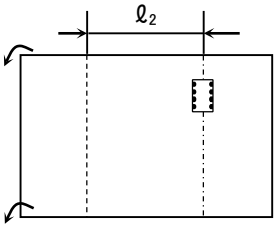
3) The effective capacitance will vary depending on applied DC and AC voltages. The capacitors should be selected and designed in taking the voltages into consideration.

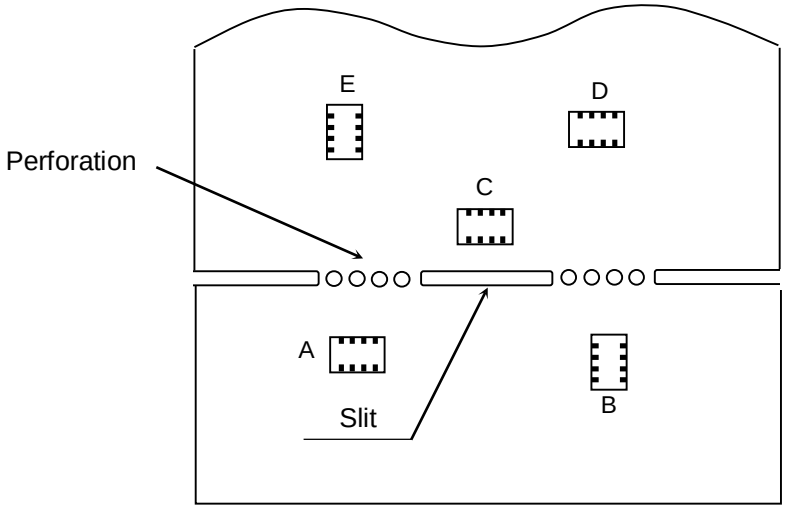
2-3. Frequency
When the capacitors are used in AC and/or pulse voltages, the capacitors may vibrate themselves and generate audible sound.</td></tr>
<tr><td>3</td><td>Designing
P.C. board</td><td>The amount of solder at the terminations has a direct effect on the reliability of the capacitors.
1) The greater the amount of solder, the higher the stress on the chip capacitor, 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.

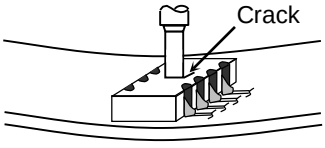
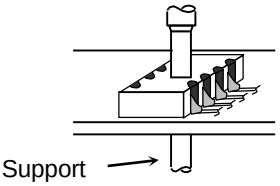
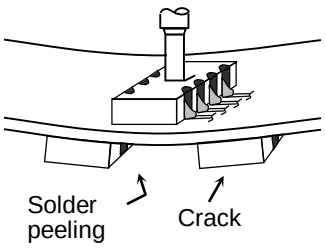
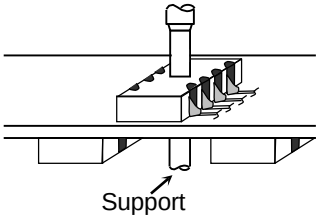
 

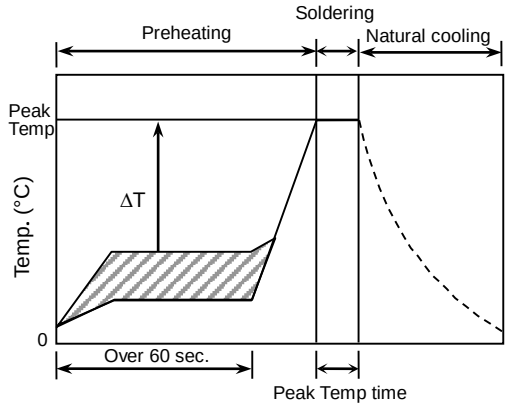
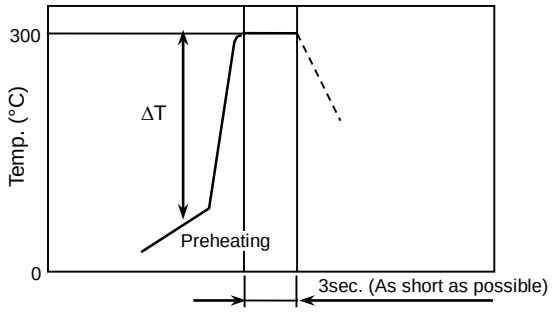
Recommended Land Dimensions (Unit : mm)
<table>
<tr><th>Case size / Symbol</th><th>CLLC1A
[CC0603]</th></tr>
<tr><td>A</td><td>0.25</td></tr>
<tr><td>B</td><td>0.40</td></tr>
<tr><td>C</td><td>1.20</td></tr>
<tr><td>D</td><td>0.40</td></tr>
<tr><td>P</td><td>0.40</td></tr>
</table></td></tr>
</table>

No.	Process	Condition
3	Designing P.C.board	4) Recommended chip capacitor layout is as following.

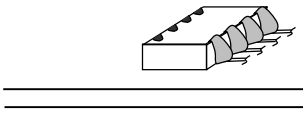
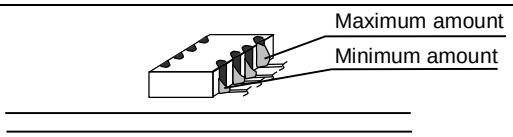
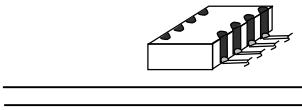
	Disadvantage against bending stress	Advantage against bending stress
Mounting face	Perforation or slit  Break P.C.board with mounted side up.	Perforation or slit  Break P.C.board with mounted side down.
Chip arrangement (Direction)	Mount perpendicularly to perforation or slit Perforation or slit 	Mount 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  ($\ell_1 < \ell_2$)

<table>
<tr><th>No.</th><th>Process</th><th>Condition</th></tr>
<tr><td>3</td><td>Designing P.C.board</td><td>5) 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</td></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 capacitor 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 capacitor 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)  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

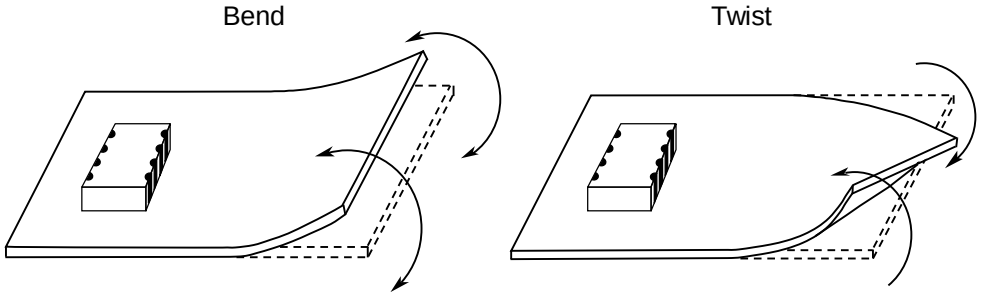
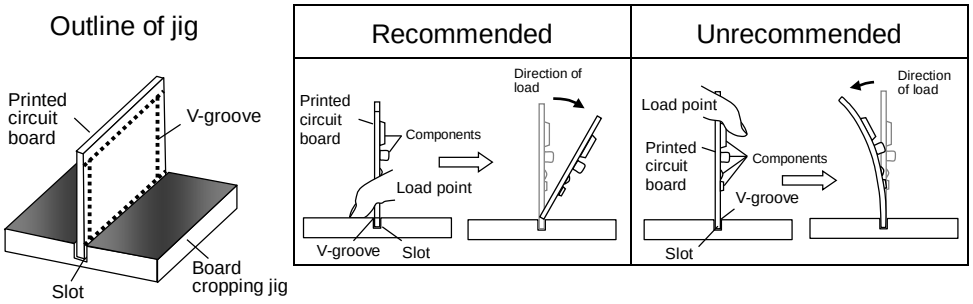
<table>
<tr><th>No.</th><th>Process</th><th>Condition</th></tr>
<tr><td>5</td><td>Soldering</td><td>
5-4. Avoiding thermal shock
1) Preheating condition
<table>
<tr><th>Soldering</th><th>Temp. (°C)</th></tr>
<tr><td>Reflow soldering</td><td>ΔT ≦ 150</td></tr>
<tr><td>Manual soldering</td><td>ΔT ≦ 150</td></tr>
</table>
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.
<table>
<tr><td>Excessive solder</td><td>  </td><td>Higher tensile force in chip capacitors to cause crack</td></tr>
<tr><td>Adequate</td><td>  </td><td></td></tr>
<tr><td>Insufficient solder</td><td>  </td><td>Low robustness may cause contact failure or chip capacitors come off the P.C.board.</td></tr>
</table>
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)
<table>
<tr><th>Temp. (°C)</th><th>Duration (sec.)</th><th>Wattage (W)</th><th>Shape (mm)</th></tr>
<tr><td>300 max.</td><td>3 max.</td><td>20 max.</td><td>⌀ 3.0 max.</td></tr>
</table>
∗ Please preheat the chip capacitors with the condition in 5-4 to avoid the thermal shock.

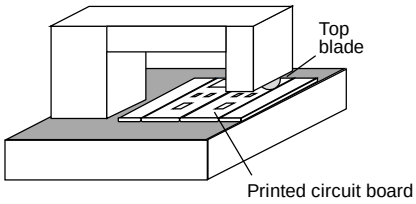
2) Direct contact of the soldering iron with ceramic dielectric of chip capacitors may cause crack. Do not touch the ceramic dielectric and the terminations by solder iron.
</td></tr>
</table>

No.	Process	Condition
5	Soldering	5-7. Sn-Zn solder Sn-Zn solder affects product reliability. Please contact TDK in advance when utilize Sn-Zn solder. 5-8. 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.

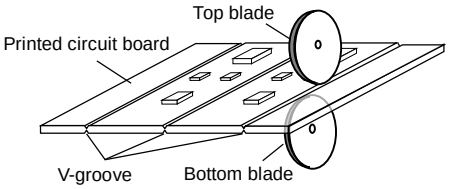
No.	Process	Condition
7	Coating and molding of the P.C.board	1) When the P.C.board is coated, please verify the quality influence on the product. 2) Please verify carefully that there is no harmful decomposing or reaction gas emission during curing which may damage the chip capacitors. 3) Please verify 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.  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. 

No.	Process	Condition
8	Handling after chip mounted ⚠ Caution	(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.

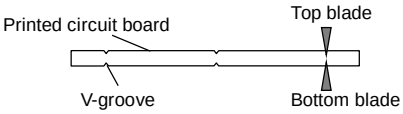
Outline of machine



Principle of operation

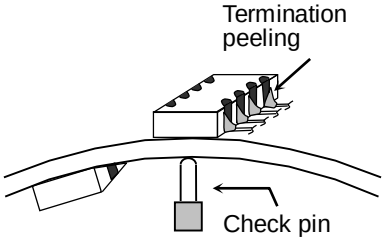
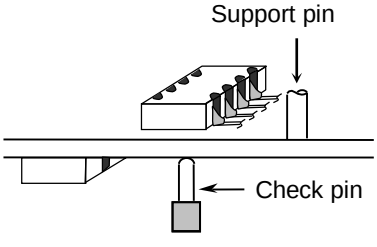


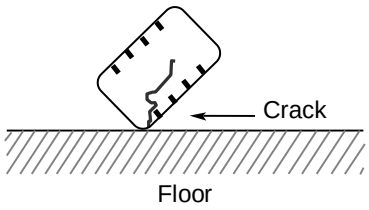
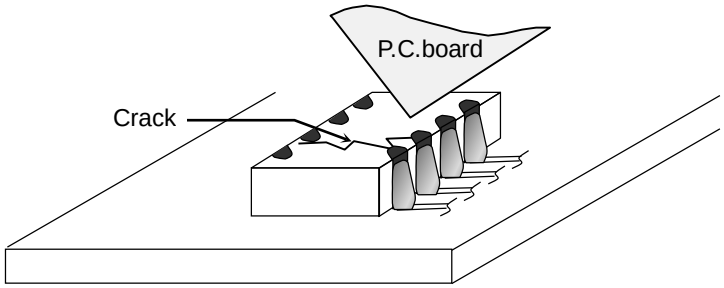
Cross-section diagram



Recommended	Unrecommended		
	Top-bottom misalignment	Left-right misalignment	Front-rear misalignment
Top blade Board Bottom blade	Top blade Bottom blade	Top blade Bottom blade	Top blade Bottom blade

2) 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.

Item	Not recommended	Recommended
Board bending		

No.	Process	Condition
9	Handling of loose chip capacitors	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. 
10	Capacitance aging	The capacitors 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.
11	Estimated life and estimated failure rate of capacitors	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.
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

No.	Process	Condition
13	Others ⚠ Caution	The products listed on this specification sheet are intended for use in general electronic equipment (AV equipment, telecommunications equipment, home appliances, amusement equipment, computer equipment, personal equipment, office equipment, measurement equipment, industrial robots) under a normal operation and use condition. The products are not designed or warranted to meet the requirements of the applications listed below, whose performance and/or quality require a more stringent level of safety or reliability, or whose failure, malfunction or trouble 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 (cars, 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.

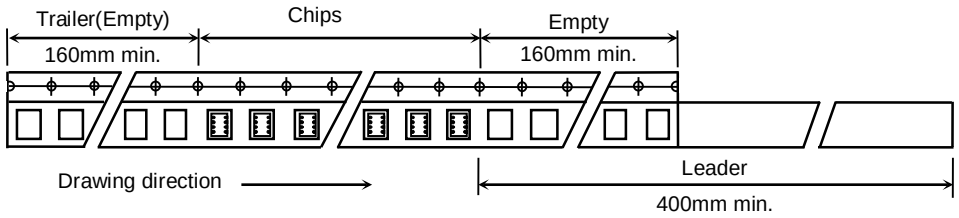
12. TAPE PACKAGING SPECIFICATION

1. CONSTRUCTION AND DIMENSION OF TAPING

1-1. Dimensions of carrier tape

Dimensions of plastic tape shall be according to Appendix 2.

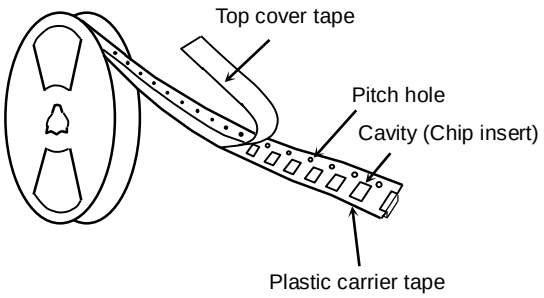
1-2. Trailer and leader of carrier tape



1-3. Dimensions of taping reel

Dimensions of ⌀178mm diameter reel shall be according to Appendix 3.
Dimensions of ⌀330mm diameter reel shall be according to Appendix 4.

1-4. Structure of taping



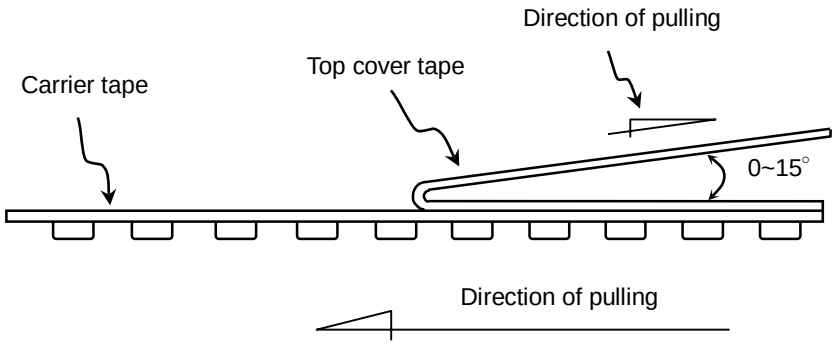
2. CHIP QUANTITY

Please refer to detail page on TDK Web.

3. PERFORMANCE SPECIFICATIONS

3-1. Peel back 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.

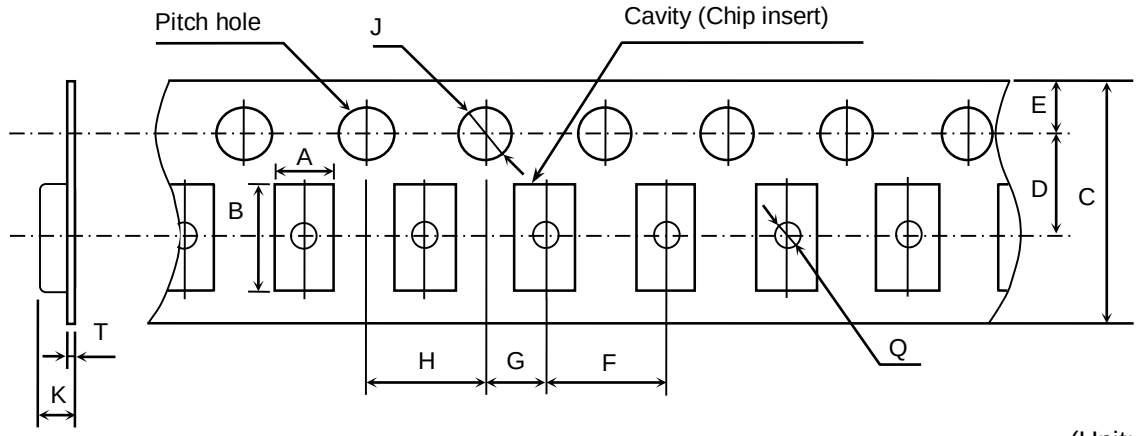
3-3. The missing of components shall be less than 0.1%

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 2

Plastic tape



(Unit: mm)

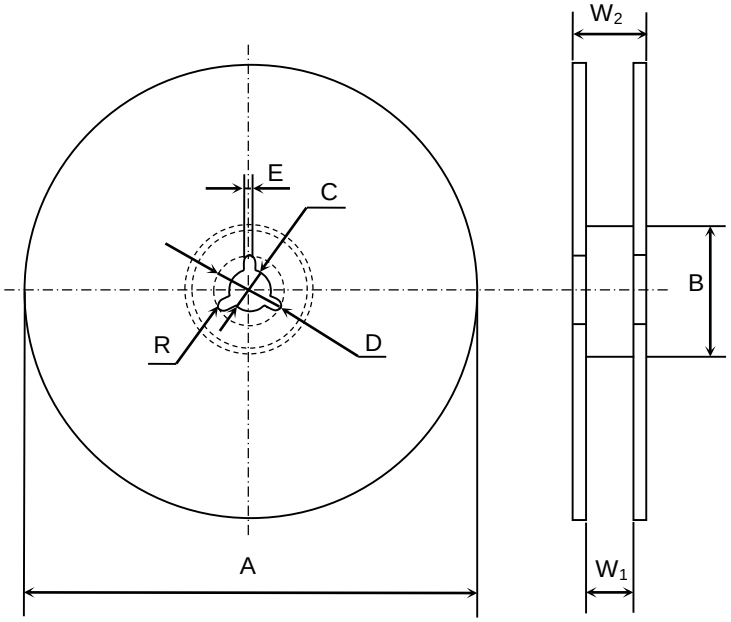
Symbol	A	B	C	D	E	F
Dimension	(1.10)	(1.90)	8.00±0.30	3.50±0.05	1.75±0.10	4.00±0.10

Symbol	G	H	J	K	T	Q
Dimension	2.00±0.05	4.00±0.10	⌀ 1.50 $^{+0.10}_{0}$	2.50 max.	0.30 max.	⌀ 0.50 min.

( ) Reference value.

Appendix 3

Dimensions of reel (Material : Polystyrene)



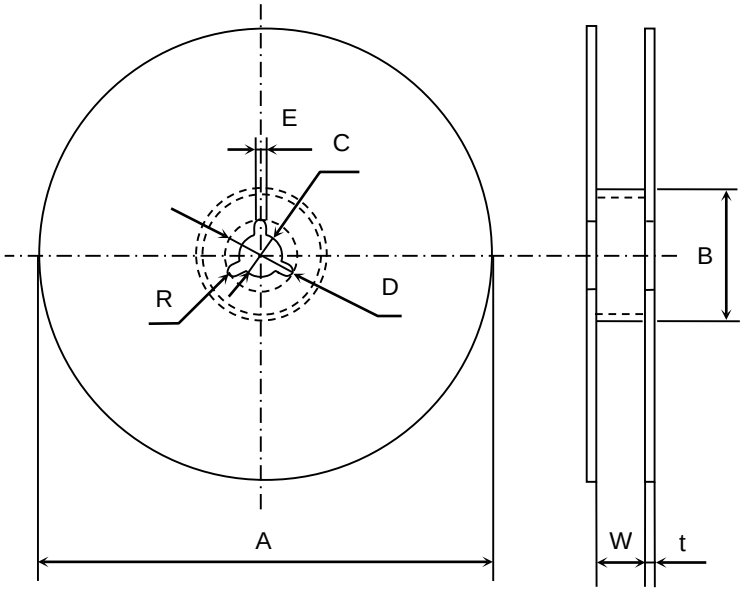
(Unit: mm)

Symbol	A	B	C	D	E	W_1
Dimension	⌀ 178 ± 2.0	⌀ 60 ± 2.0	⌀ 13 ± 0.5	⌀ 21 ± 0.8	2.0 ± 0.5	9.0 ± 0.3

Symbol	W_2	R
Dimension	13.0 ± 1.4	1.0

Appendix 4

Dimensions of reel (Material : Polystyrene)



(Unit: mm)

Symbol	A	B	C	D	E	W
Dimension	⌀ 382 max. (Nominal ⌀ 330)	⌀ 50 min.	⌀ 13 ± 0.5	⌀ 21 ± 0.8	2.0 ± 0.5	10.0 ± 1.5

Symbol	t	R
Dimension	2.0 ± 0.5	1.0