■ Specifications and Test Methods

No	Item		Specification	Test Method (Ref. Standard:JIS C 5101, IEC60384)
1	Rated Voltage		Shown in Rated value.	The rated voltage is defined as the maximum voltage which may be applied continuously to the capacitor. When AC voltage is superimposed on DC voltage, V^{P-P} or V^{O-P}, whichever is larger, should be maintained within the rated voltage range.
2	Appearance		No defects or abnormalities.	Visual inspection.
3	Dimension		Within the specified dimensions.	Using Measuring instrument of dimension.
4	Voltage proof		No defects or abnormalities.	Measurement Point : Between the terminations Test Voltage : 300% of the rated voltage Applied Time : 1s to 5 s Charge/discharge current : 50mA max.
5	Insulation Resistance(I.R.)		C≦0.047μF:More than 10000MΩ C＞0.047μF:More than 500Ω·F C:Nominal Capacitance	Measurement Point : Between the terminations Measurement Voltage : DC Rated Voltage Charging Time : 2 min Charge/discharge current : 50mA max. Measurement Temperature : Room Temperature
6	Capacitance		Shown in Rated value.	Measurement Temperature : Room Temperature Capacitance / Frequency / Voltage C≦1000pF / 1.0+/-0.1MHz / 0.5 to 5.0Vrms
7	Q		30pF and over:Q≧1000 30pF and below:Q≧400+20C C:Nominal Capacitance(pF)	
8	Temperature Characteristics of Capacitance		Nominal values of the temperature coefficient is shown in Rated value. But,the Capacitance Change under 20℃ is shown in Table A. Capacitance Drift Within +/-0.2% or +/-0.05pF (Whichever is larger.)	The capacitance change should be measured after 5 minutes at each specified temp. stage. Capacitance value as a reference is the value in step 3. The capacitance drift is calculated by dividing the differences between the maximum and minimum measured values in the step 1,3 and 5 by the cap. value in step 3. Step / Temperature(°C) 1 / Reference Temp.+/-2 2 / Min. Operating Temp.+/-3 3 / Reference Temp.+/-2 4 / Max. Operating Temp.+/-3 5 / Reference Temp.+/-2
9	Adhesive Strength of Termination		No removal of the terminations or other defect should occur.	Solder the capacitor on the test substrate shown in Fig.3. Type / Applied Force(N) GJM02 / 1 GJM03 / 2 GJM15 / 5 Holding Time : 10+/-1s Applied Direction : In parallel with the test substrate and vertical with the capacitor side.
10	Vibration	Appearance	No defects or abnormalities.	Solder the capacitor on the test substrate shown in Fig.3. Kind of Vibration : A simple harmonic motion 10Hz to 55Hz to 10Hz (1min) Total amplitude : 1.5mm This motion should be applied for a period of 2h in each 3 mutually perpendicular directions(total of 6h).
		Capacitance	Within the specified initial value.	
		Q	Within the specified initial value.	
11	Substrate Bending test	Appearance	No defects or abnormalities.	Solder the capacitor on the test substrate shown in Fig.1. Pressurization method : Shown in Fig.2 Flexure : 1mm Holding Time : 5+/-1s Soldering Method : Reflow soldering
		Capacitance Change	Within +/-5% or +/-0.5pF (Whichever is larger)	
12	Solderability		95% of the terminations is to be soldered evenly and continuously.	Test Method : Solder bath method Flux Solution of rosin ethanol 25(mass)% Preheat : 80℃ to 120℃ for 10s to 30s Solder : Sn-3.0Ag-0.5Cu Solder Temp. : 245+/-5℃ Immersion time : 2+/-0.5s

Table A

Char.	Capacitance Change from Value at Reference temp. (%)							
	-55℃		-30		-25℃		-10℃	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1C	0.54	-0.23	-	-	0.33	-0.14	0.22	-0.09
2C	0.82	-0.45	-	-	0.49	-0.27	0.33	-0.18
3C	1.37	-0.90	-	-	0.82	-0.54	0.55	-0.36
4C	2.56	-1.88	-	-	1.54	-1.13	1.02	-0.75
5C	0.58	-0.24	0.40	-0.17	-	-	0.25	-0.11
6C	0.87	-0.48	0.59	-0.33	-	-	0.38	-0.21

Substrate Bending test

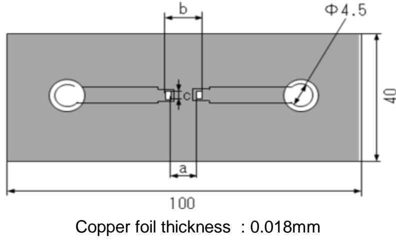
・Test substrate

Material : Copper-clad laminated sheets for PCBs
(Glass fabric base, epoxy resin)

Thickness :0.8mm

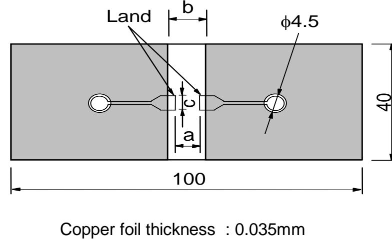
: Solder resist
(Coat with heat resistant resin for solder)

for GJM02



Copper foil thickness : 0.018mm

for GJM03/15



Copper foil thickness : 0.035mm

Type	Dimension (mm)		
	a	b	c
GJM02	0.2	0.56	0.23
GJM03	0.3	0.9	0.3
GJM15	0.4	1.5	0.5

Fig.1 (in mm)

・Kind of Solder : Sn-3.0Ag-0.5Cu

・Pressurization method

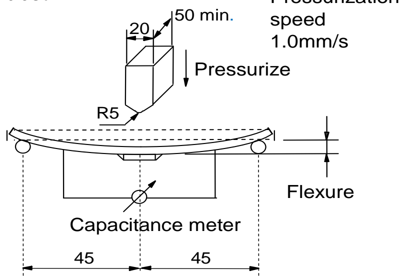


Fig.2 (in mm)

Adhesive Strength of Termination, Vibration, Temperature Sudden Change, Resistance to Soldering Heat (Reflow method)
High Temperature High Humidity(Steady) , Durability

・Test substrate

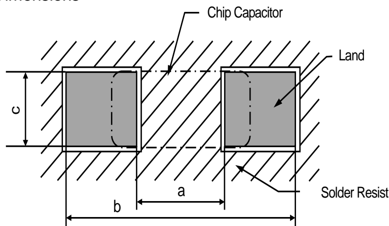
Material : Copper-clad laminated sheets for PCBs
(Glass fabric base, epoxy resin)

Thickness : 1.6mm or 0.8mm

Copper foil thickness : 0.035mm

・Kind of Solder : Sn-3.0Ag-0.5Cu

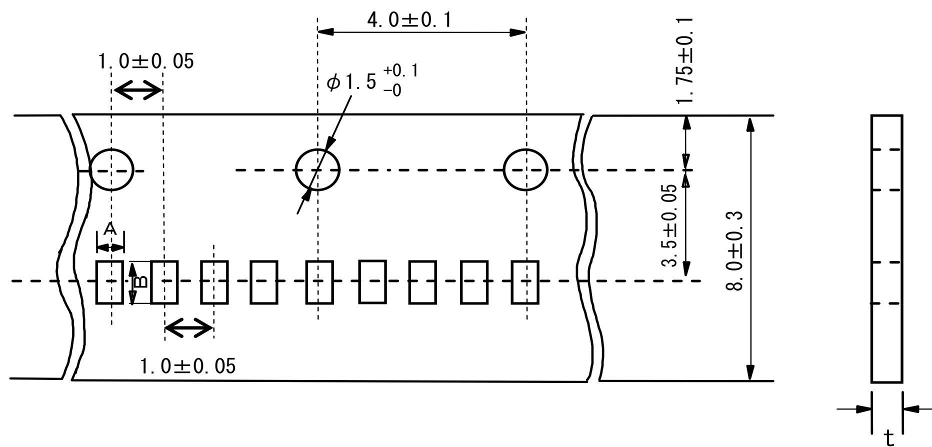
・Land Dimensions



Type	Dimension (mm)		
	a	b	c
GJM02	0.2	0.56	0.23
GJM03	0.3	0.9	0.3
GJM15	0.4	1.5	0.5

Fig.3

(3)GJM03/GJM15 <Paper Tape W8P2 CODE:W> (in mm)

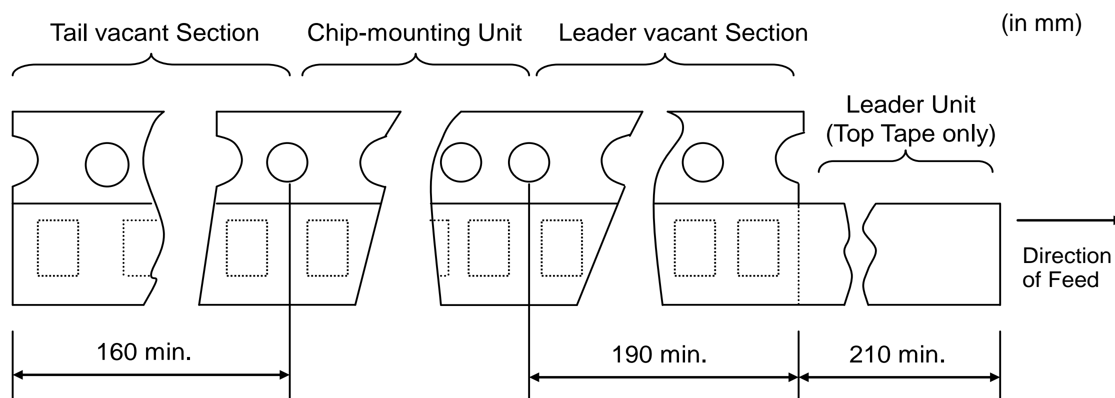


Type		Dimensions(Chip)			A *3	B *3	t
		L	W	T			
GJM03	3	0.6±0.03	0.3±0.03	0.3±0.03	0.37	0.67	0.5 max.
GJM15	5	1.0±0.05	0.5±0.05	0.5±0.05	0.65	1.15	0.8 max.

*3 Nominal value

1.3 Tapes for capacitors are wound clockwise shown in Fig.3.
(The sprocket holes are to the right as the tape is pulled toward the user.)

1.4 Part of the leader and part of the vacant section are attached as follows.



1.5 Accumulate tolerance of sprocket holes pitch = ±0.3mm / 10 pitch

1.6 Chip in the tape is enclosed by top tape and bottom tape as shown in Fig.1.

1.7 The top tape and base tape are not attached at the end of the tape for a minimum of 5 pitches.

1.8 There are no jointing for top tape and bottom tape.

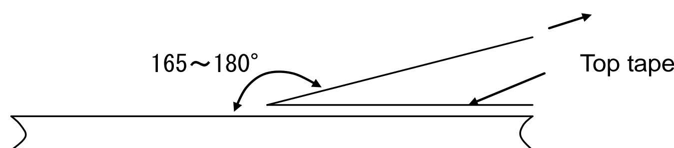
1.9 There are no fuzz in the cavity.

1.10 Break down force of top tape : 5N min.
Break down force of bottom tape : 5N min. (Only a bottom tape existence)

1.11 Reel is made by resin and appeaser and dimension is shown in Fig 1.
There are possibly to change the material and dimension due to some impairment.

1.12 Peeling off force : 0.1N to 0.6N* in the direction as shown below.

* GJM02/GJM03:0.05N to 0.5N



1.13 Label that show the customer parts number, our parts number, our company name, inspection number and quantity, will be put in outside of reel.

2.Measurement of Capacitance

1. Measure capacitance with the voltage and frequency specified in the product specifications.

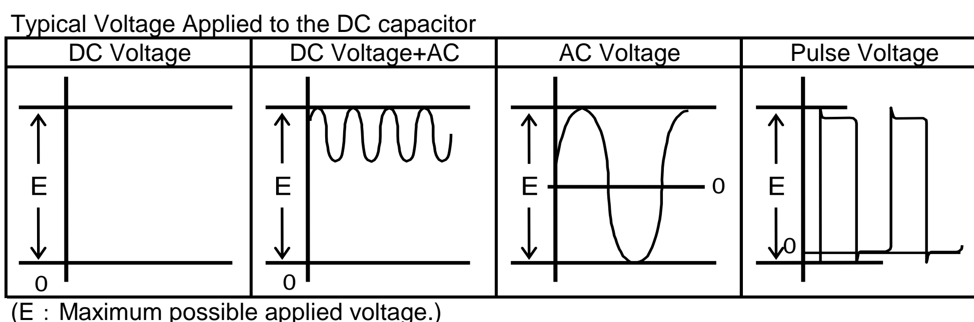
1-1. The output voltage of the measuring equipment may decrease occasionally when capacitance is high.
Please confirm whether a prescribed measured voltage is impressed to the capacitor.

1-2. The capacitance values of high dielectric constant type capacitors change depending on the AC voltage applied.
Please consider the AC voltage characteristics when selecting a capacitor to be used in a AC circuit.

3.Applied Voltage

1. Do not apply a voltage to the capacitor that exceeds the rated voltage as called out in the specifications.

1-1. Applied voltage between the terminals of a capacitor shall be less than or equal to the rated voltage.
(1) When AC voltage is superimposed on DC voltage, the zero-to-peak voltage shall not exceed the rated DC voltage.
When AC voltage or pulse voltage is applied, the peak-to-peak voltage shall not exceed the rated DC voltage.
(2) Abnormal voltages (surge voltage, static electricity, pulse voltage, etc.) shall not exceed the rated DC voltage.



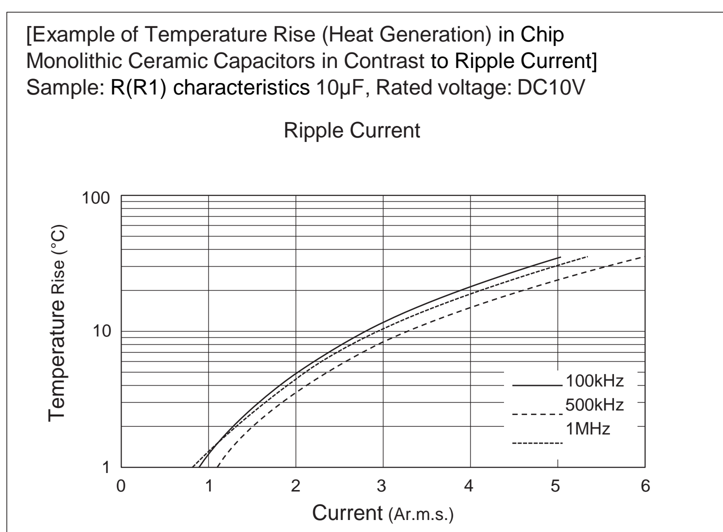
1-2. Influence of over voltage
Over voltage that is applied to the capacitor may result in an electrical short circuit caused by the breakdown of the internal dielectric layers .
The time duration until breakdown depends on the applied voltage and the ambient temperature.

4.Type of Applied Voltage and Self-heating Temperature

1.Confirm the operating conditions to make sure that no large current is flowing into the capacitor due to the continuous application of an AC voltage or pulse voltage.
When a DC rated voltage product is used in an AC voltage circuit or a pulse voltage circuit, the AC current or pulse current will flow into the capacitor; therefore check the self-heating condition.
Please confirm the surface temperature of the capacitor so that the temperature remains within the upper limits of the operating temperature, including the rise in temperature due to self-heating. When the capacitor is used with a high-frequency voltage or pulse voltage, heat may be generated by dielectric loss.

<Applicable to Rated Voltage of less than 100VDC>

1-1. The load should be contained to the level such that when measuring at atmospheric temperature of 25°C, the product's self-heating remains below 20°C and the surface temperature of the capacitor in the actual circuit remains within the maximum operating temperature.

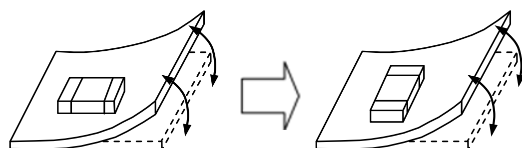


■Soldering and Mounting

1.Mounting Position

1. Confirm the best mounting position and direction that minimizes the stress imposed on the capacitor during flexing or bending the printed circuit board.

1-1.Choose a mounting position that minimizes the stress imposed on the chip during flexing or bending of the board.
[Component Direction]

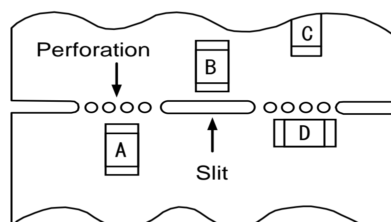


Locate chip horizontal to the direction in which stress acts.

(Bad Example) (Good Example)

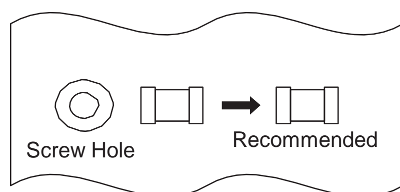
[Chip Mounting Close to Board Separation Point]
It is effective to implement the following measures, to reduce stress in separating the board.
It is best to implement all of the following three measures; however, implement as many measures as possible to reduce stress.

Contents of Measures	Stress Level
(1) Turn the mounting direction of the component parallel to the board separation surface.	A > D *1
(2) Add slits in the board separation part.	A > B
(3) Keep the mounting position of the component away from the board separation surface.	A > C



*1 A > D is valid when stress is added vertically to the perforation as with Hand Separation.
If a Cutting Disc is used, stress will be diagonal to the PCB, therefore A > D is invalid.

[Mounting Capacitors Near Screw Holes]
When a capacitor is mounted near a screw hole, it may be affected by the board deflection that occurs during the tightening of the screw. Mount the capacitor in a position as far away from the screw holes as possible.



2.Information before Mounting

1. Do not re-use capacitors that were removed from the equipment.

2. Confirm capacitance characteristics under actual applied voltage.

3. Confirm the mechanical stress under actual process and equipment use.

4. Confirm the rated capacitance, rated voltage and other electrical characteristics before assembly.

5. Prior to use, confirm the solderability of capacitors that were in long-term storage.

6. Prior to measuring capacitance, carry out a heat treatment for capacitors that were in long-term storage.

7.The use of Sn-Zn based solder will deteriorate the reliability of the MLCC.
Please contact our sales representative or product engineers on the use of Sn-Zn based solder in advance.

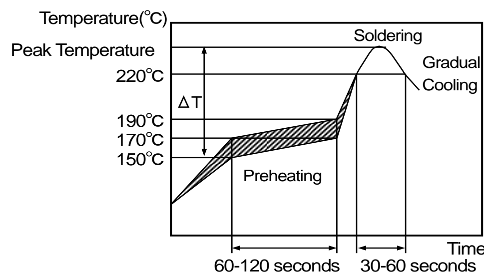
4-1.Reflow Soldering

1. When sudden heat is applied to the components, the mechanical strength of the components will decrease because a sudden temperature change causes deformation inside the components. In order to prevent mechanical damage to the components, preheating is required for both the components and the PCB. Preheating conditions are shown in table 1. It is required to keep the temperature differential between the solder and the components surface (ΔT) as small as possible.

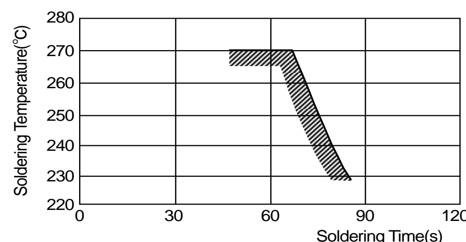
2. Solderability of tin plating termination chips might be deteriorated when a low temperature soldering profile where the peak solder temperature is below the melting point of tin is used. Please confirm the solderability of tin plated termination chips before use.

3. When components are immersed in solvent after mounting, be sure to maintain the temperature difference (ΔT) between the component and the solvent within the range shown in the table 1.

[Standard Conditions for Reflow Soldering]



[Allowable Reflow Soldering Temperature and Time]



In the case of repeated soldering, the accumulated soldering time must be within the range shown above.

Table 1

Series	Chip Dimension(L/W) Code	Temperature Differential
GJM	02/03/15	ΔT≦190℃

Recommended Conditions

	Lead Free Solder
Peak Temperature	240 to 260℃
Atmosphere	Air or N_2

Lead Free Solder: Sn-3.0Ag-0.5Cu

4. Optimum Solder Amount for Reflow Soldering

4-1. Overly thick application of solder paste results in a excessive solder fillet height.
This makes the chip more susceptible to mechanical and thermal stress on the board and may cause the chips to crack.

4-2. Too little solder paste results in a lack of adhesive strength on the termination, which may result in chips breaking loose from the PCB.

4-3. Please confirm that solder has been applied smoothly to the termination.

Inverting the PCB

Make sure not to impose any abnormal mechanical shocks to the PCB.

5.Washing

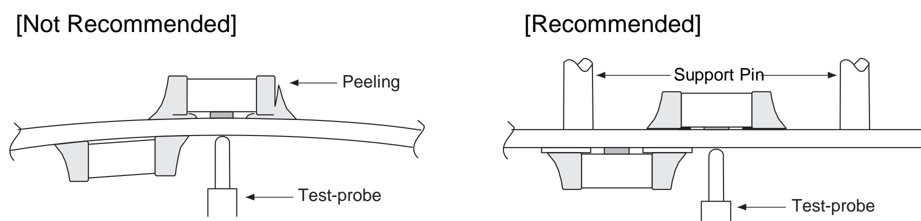
Excessive ultrasonic oscillation during cleaning can cause the PCBs to resonate, resulting in cracked chips or broken solder joints. Take note not to vibrate PCBs.

6.Electrical Test on Printed Circuit Board

1. Confirm position of the support pin or specific jig, when inspecting the electrical performance of a capacitor after mounting on the printed circuit board.

   1-1. Avoid bending the printed circuit board by the pressure of a test-probe, etc.
   The thrusting force of the test probe can flex the PCB, resulting in cracked chips or open solder joints. Provide support pins on the back side of the PCB to prevent warping or flexing.
   Install support pins as close to the test-probe as possible.

   1-2. Avoid vibration of the board by shock when a test -probe contacts a printed circuit board.



7.Printed Circuit Board Cropping

1. After mounting a capacitor on a printed circuit board, do not apply any stress to the capacitor that caused bending or twisting the board.

   1-1. In cropping the board, the stress as shown may cause the capacitor to crack.
   Cracked capacitors may cause deterioration of the insulation resistance, and result in a short.
   Avoid this type of stress to a capacitor.

2. Check the cropping method for the printed circuit board in advance.

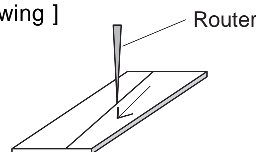
   2-1. Printed circuit board cropping shall be carried out by using a jig or an apparatus (Disc separator, router type separator, etc.) to prevent the mechanical stress that can occur to the board.

Board Separation Method	Hand Separation Nipper Separation	(1) Board Separation Jig	Board Separation Apparatus	
			2) Disc Separator	3) Router Type Separator
Level of stress on board	High	Medium	Medium	Low
Recommended	×	△*	△*	○
Notes	Hand and nipper separation apply a high level of stress. Use another method.	· Board handling · Board bending direction · Layout of capacitors	· Board handling · Layout of slits · Design of V groove · Arrangement of blades · Controlling blade life	Board handling

* When a board separation jig or disc separator is used, if the following precautions are not observed, a large board deflection stress will occur and the capacitors may crack.
Use router type separator if at all possible.

(3) Example of Router Type Separator
The router type separator performs cutting by a router rotating at a high speed. Since the board does not bend in the cutting process, stress on the board can be suppressed during board separation.
When attaching or removing boards to/from the router type separator, carefully handle the boards to prevent bending.

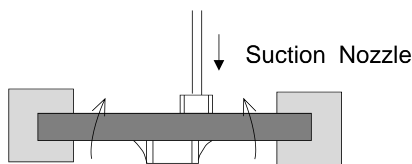
[Outline Drawing]



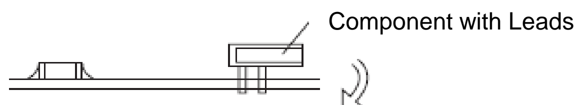
8. Assembly

1. Handling
If a board mounted with capacitors is held with one hand, the board may bend.
Firmly hold the edges of the board with both hands when handling.
If a board mounted with capacitors is dropped, cracks may occur in the capacitors.
Do not use dropped boards, as there is a possibility that the quality of the capacitors may be impaired.

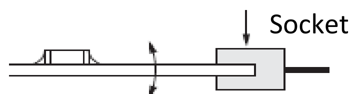
2. Attachment of Other Components
2-1. Mounting of Other Components
Pay attention to the following items, when mounting other components on the back side of the board after capacitors have been mounted on the opposite side.
When the bottom dead point of the suction nozzle is set too low, board deflection stress may be applied to the capacitors on the back side (bottom side), and cracks may occur in the capacitors.
・After the board is straightened, set the bottom dead point of the nozzle on the upper surface of the board.
・Periodically check and adjust the bottom dead point.



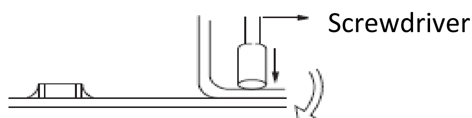
2-2. Inserting Components with Leads into Boards
When inserting components (transformers, IC, etc.) into boards, bending the board may cause cracks in the capacitors or cracks in the solder. Pay attention to the following.
・Increase the size of the holes to insert the leads, to reduce the stress on the board during insertion.
・Fix the board with support pins or a dedicated jig before insertion.
・Support below the board so that the board does not bend. When using multiple support pins on the board, periodically confirm that there is no difference in the height of each support pin.



2-3. Attaching/Removing Sockets
When the board itself is a connector, the board may bend when a socket is attached or removed.
Plan the work so that the board does not bend when a socket is attached or removed.



2-4. Tightening Screws
The board may be bent, when tightening screws, etc. during the attachment of the board to a shield or chassis. Pay attention to the following items before performing the work.
・Plan the work to prevent the board from bending.
・Use a torque screwdriver, to prevent over-tightening of the screws.
・The board may bend after mounting by reflow soldering, etc. Please note, as stress may be applied to the chips by forcibly flattening the board when tightening the screws.



■ Rating

1.Operating Temperature

1. The operating temperature limit depends on the capacitor.

1-1. Do not apply temperatures exceeding the maximum operating temperature.
It is necessary to select a capacitor with a suitable rated temperature that will cover the operating temperature range.
It is also necessary to consider the temperature distribution in equipment and the seasonal temperature variable factor.

1-2. Consider the self-heating factor of the capacitor
The surface temperature of the capacitor shall not exceed the maximum operating temperature including self-heating.

2.Atmosphere Surroundings (gaseous and liquid)

1. Restriction on the operating environment of capacitors.

1-1. Capacitors, when used in the above, unsuitable, operating environments may deteriorate due to the corrosion of the terminations and the penetration of moisture into the capacitor.

1-2. The same phenomenon as the above may occur when the electrodes or terminals of the capacitor are subject to moisture condensation.

1-3. The deterioration of characteristics and insulation resistance due to the oxidization or corrosion of terminal electrodes may result in breakdown when the capacitor is exposed to corrosive or volatile gases or solvents for long periods of time.

3.Piezo-electric Phenomenon

1. When using high dielectric constant type capacitors in AC or pulse circuits, the capacitor itself vibrates at specific frequencies and noise may be generated.
Moreover, when the mechanical vibration or shock is added to capacitor, noise may occur.

2. Land Dimensions

2-1. Chip capacitors can be cracked due to the stress of PCB bending , etc. if the land area is larger than needed and has an excess amount of solder. Please refer to the land dimensions in table 1 for reflow soldering.

Please confirm the suitable land dimension by evaluating of the actual SET / PCB.

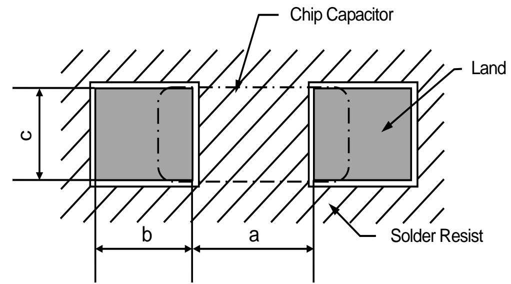


Table 1 Reflow Soldering Method

Series	Chip Dimension (L/W) Code	Chip(L×W)	a	b	c
GJM	02	0.4×0.2	0.16 to 0.2	0.12 to 0.18	0.2 to 0.23
GJM	03	0.6×0.3	0.2 to 0.3	0.2 to 0.35	0.2 to 0.4
GJM	15	1.0×0.5	0.3 to 0.5	0.35 to 0.45	0.4 to 0.6

(in mm)

3. Board Design
When designing the board, keep in mind that the amount of strain which occurs will increase depending on the size and material of the board.

Relationship with amount of strain to the board thickness, length, width, etc.]

$$\varepsilon = \frac{3PL}{2Ewh^2}$$ Relationship between load and strain

ε : Strain on center of board (μst)
L : Distance between supporting points (mm)
w : Board width (mm)
h : Board thickness (mm)
E : Elastic modulus of board (N/m^2=Pa)
Y : Deflection (mm)
P : Load (N)

When the load is constant, the following relationship can be established.
· As the distance between the supporting points (L) increases,the amount of strain also increases.
→Reduce the distance between the supporting points.
· As the elastic modulus (E) decreases, the amount of strain increases.
→Increase the elastic modulus.
· As the board width (w) decreases, the amount of strain increases.
→Increase the width of the board.
· As the board thickness (h) decreases, the amount of strain increases.
→Increase the thickness of the board.
Since the board thickness is squared, the effect on the amount of strain becomes even greater.

■ Others

1.Transportation

1. The performance of a capacitor may be affected by the conditions during transportation.

1-1. The capacitors shall be protected against excessive temperature, humidity and mechanical force during transportation.

(1) Climatic condition
- low air temperature : -40℃
- change of temperature air/air : -25℃/+25℃
- low air pressure : 30 kPa
- change of air pressure : 6 kPa/min.

(2) Mechanical condition
Transportation shall be done in such a way that the boxes are not deformed and forces are not directly passed on to the inner packaging.

1-2. Do not apply excessive vibration, shock, or pressure to the capacitor.

(1) When excessive mechanical shock or pressure is applied to a capacitor, chipping or cracking may occur in the ceramic body of the capacitor.

(2) When the sharp edge of an air driver, a soldering iron, tweezers, a chassis, etc. impacts strongly on the surface of the capacitor, the capacitor may crack and short-circuit.

1-3. Do not use a capacitor to which excessive shock was applied by dropping etc.
A capacitor dropped accidentally during processing may be damaged.

2.Characteristics Evaluation in the Actual System

1. Evaluate the capacitor in the actual system,to confirm that there is no problem with the performance and specification values in a finished product before using.

2. Since a voltage dependency and temperature dependency exists in the capacitance of high dielectric type ceramic capacitors, the capacitance may change depending on the operating conditions in the actual system.
Therefore,be sure to evaluate the various characteristics, such as the leakage current and noise absorptivity, which will affect the capacitance value of the capacitor.

3. In addition,voltages exceeding the predetermined surge may be applied to the capacitor by the inductance in the actual system. Evaluate the surge resistance in the actual system as required.