· **Supplier : JSMICR0 electro-mechanics**
· **Product : Multi-layer Ceramic Capacitor**

· **JSMICR0 P/N :** **CL03A225MQ3CRNC**
· **Description :** **CAP, 2.2㎌, 6.3V, ±20%, X5R, 0201**

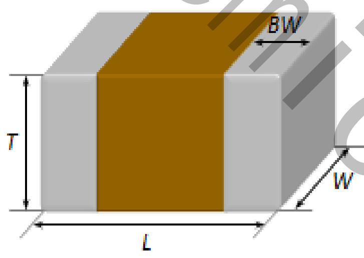
General | Standard | Normal | 85℃ | 2T | Normal | Reflow OK

A. JSMICR0 Part Number

CL	03	A	225	M	Q	3	C	R	N	C
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪

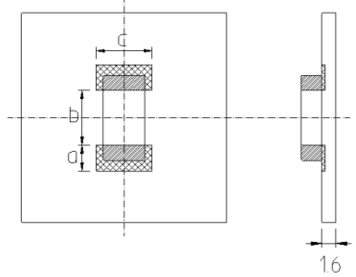
① **Series**	JSMICR0 Multi-layer Ceramic Capacitor		
② **Size**	0201 (inch code)	L : 0.60±0.09㎜	W : 0.30±0.09㎜
③ **Dielectric**	X5R	⑧ **Inner electrode**	Ni
④ **Capacitance**	2.2㎌	**Termination**	Control code
⑤ **Capacitance tolerance**	±20%	**Plating**	Ni/Sn 100% (Pb Free)
		⑨ **Product**	Size control code
⑥ **Rated Voltage**	6.3V	⑩ **Special**	Reserved for future use
⑦ **Thickness**	0.30±0.09㎜	⑪ **Packaging**	Cardboard Type, 7" Reel / Quantity : 10K

B. Structure & Dimension



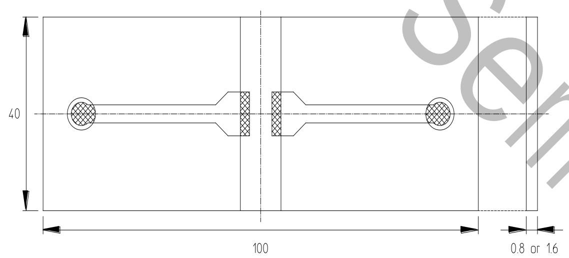
JSMICR0 P/N	Dimension(㎜)			
	L	W	T	BW
CL03A225MQ3CRNC	0.60±0.09	0.30±0.09	0.30±0.09	0.15±0.05

C. **Recommended TEST PCB**

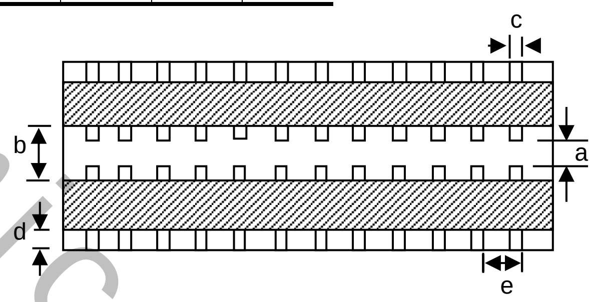


(Adhesive strength of termination)

Size code	Size (mm)	a	b	c
R1	0.25 × 0.125	0.11	0.10	0.13
02	0.4 × 0.2	0.20	0.17	0.26
03	0.6 × 0.3	0.30	0.30	0.30
05	1.0. × 0.5	0.40	0.55	0.50
10	1.6 × 0.8	1.00	1.00	1.20
21	2.0 × 1.25	1.20	1.40	1.65
31	3.2 × 1.6	2.20	1.40	2.00
32	3.2 × 2.5	2.20	1.40	2.90
43	4.5 × 3.2	3.50	1.75	3.70
55	5.7 × 5.0	4.50	1.75	5.60



(Substrate for bending strength test)



(Substrate for Reliability test)

Size code	Size (mm)	a	b	c	d	e
R1	0.25 × 0.125	0.1	0.35	0.14	5.0	5.5
02	0.4 × 0.2	0.2	0.6	0.2	5.0	5.5
03	0.6 × 0.3	0.3	0.9	0.3	5.0	5.5
05	1.0 × 0.5	0.4	1.5	0.5	5.0	5.5
10	1.6 × 0.8	1.0	3.0	1.2	5.0	5.5
21	2.0 × 1.25	1.2	4.0	1.65	5.0	5.5
31	3.2 × 1.6	2.2	5.0	2.0	5.0	5.5
32	3.2 × 2.5	2.2	5.0	2.9	5.0	5.5
43	4.5 × 3.2	3.5	7.0	3.7	5.0	5.5
55	5.7 × 5.0	4.5	8.0	5.6	5.0	5.5

☞ Material : Glass epoxy substrate ☞ Thickness : T=1.6 ㎜ (T= 0.8 ㎜ for 03/05)

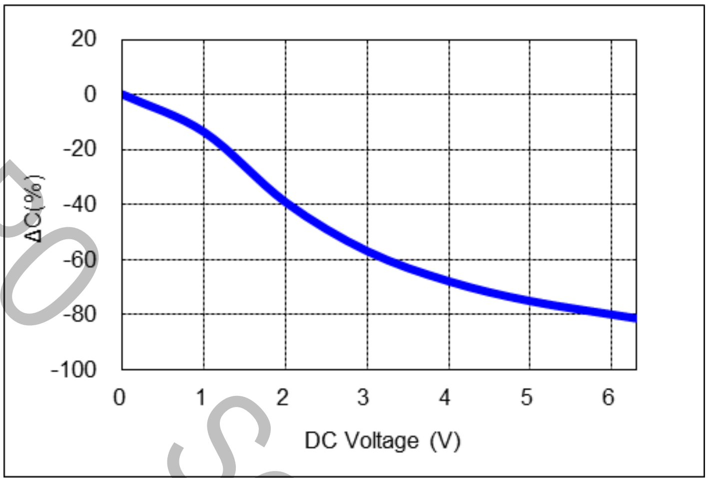
☞ ▭ : Copper foil (T=0.035 ㎜) ☞ ▨ : Solder resist

☞ Caution : Abnormality can occur if lead-based solder (KSD 6704) with 3% silver is used.

1. DC & AC Voltage Characteristics

It is required to consider voltage characteristics in the circuit since the capacitance value of high dielectric constant MLCC(Class II) is changed by applied DC & AC voltage.

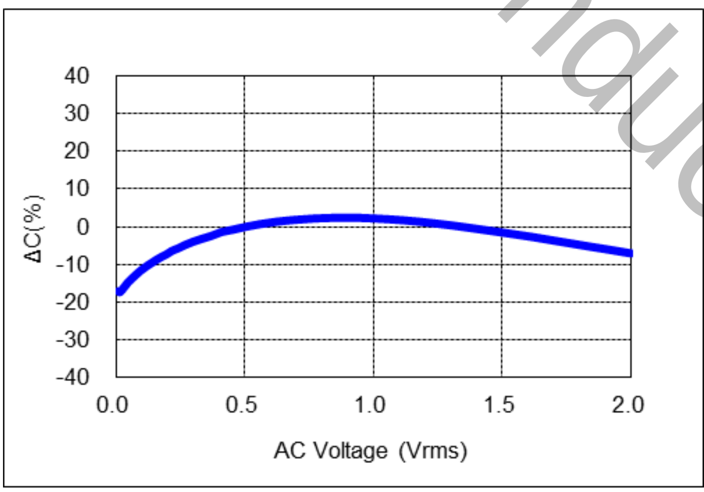
1-1-1. Please ensure the capacitance change is within the allowed operating range of a system. In particular, when high dielectric constant type MLCC (Class II) is used in circuit with narrow allowed capacitance tolerance, a system should be designed with considering DC voltage, temperature characteristics and aging characteristics of MLCC.



[Example of DC Bias characteristics]

* Sample : X5R 10uF, Rated voltage 6.3V

1-1-2. It is necessary to consider the AC voltage characteristics of MLCC and the AC voltage of a system, since the capacitance value of high dielectric constant type MLCC (Class II) varies with the applied AC voltage.



[Example of AC voltage characteristics]

* Sample : X5R 10uF, Rated voltage 6.3V

2. Impedance Characteristic

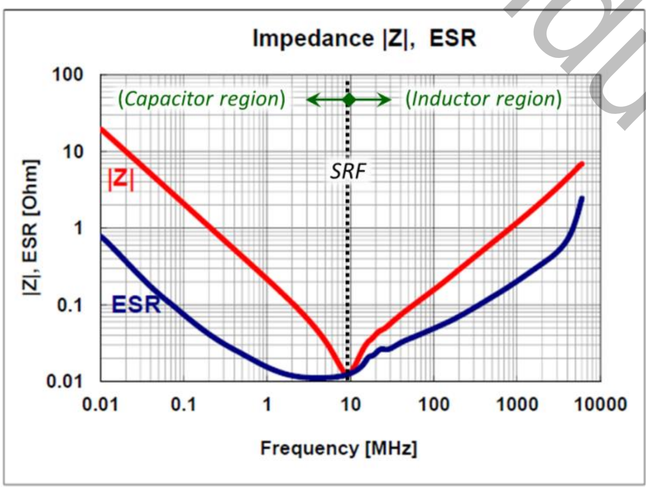
Electrical impedance (Z) of MLCC is the measurement of the opposition that MLCC presents to a current (I) when a voltage (V) is applied. It is defined as the ratio of the voltage to the current (Z=V/I). Impedance extends the concept of resistance to AC circuits and is a complex number consisting of the real part of resistance (R) and the imaginary part of reactance (X) as Z=R+jX. Therefore, it is required to design circuit with consideration of the impedance characteristics of MLCC based on the frequency (Z = R + jX)

2-1-1. MLCC operates as a capacitor in the low frequency and its reactance (XC) decreases as frequency increases ($X_C=1/j2\pi fC$) where f is frequency and C is capacitance.
The resistance (ESR; Equivalent Series Resistance) of MLCC in the low frequency mainly comes from the loss of its dielectric material.

2-1-2. MLCC operates as an inductor in the high frequency and the inductance of MLCC is called ESL (Equivalent Series Inductance). The reactance (XL) of MLCC in the high frequency increases as frequency increases ($X_L=j2\pi f\cdot ESL$). The resistance (ESR) of MLCC in the high frequency mainly comes from the loss of its electrode metal.

2-1-3. SRF (Self Resonant Frequency) of MLCC is the frequency where its capacitive reactance (XC) and inductive reactance(XL) cancel each other and the impedance of MLCC has only ESR at SRF.

2-1-4. The impedance of MLCC can be measured by a network analyzer or an impedance analyzer. When using the network analyzer, please note that the small-signal input may lead to the impedance of low capacitance caused by the AC voltage characteristic of MLCC.



[Example of Impedance characteristics]

* Sample : X5R 1uF, Rated voltage 6.3V

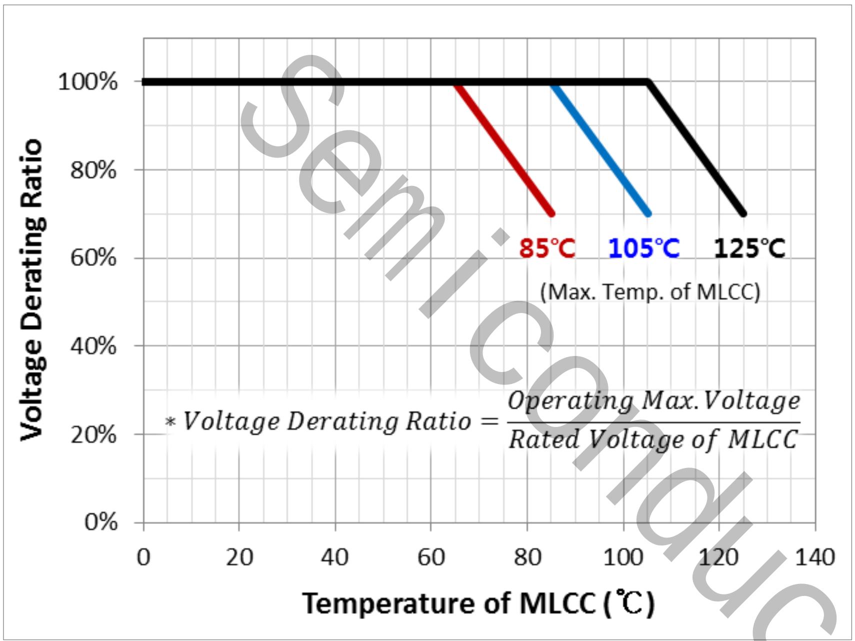
3. Electrical & Mechanical Caution

3-1. Derating

MLCC with the test voltage at 100% of the rated voltage in the high temperature resistance test are labeled as "derated MLCC." For this type of MLCC, the voltage and temperature should be derated as shown in the following graph for the equivalent life time of a normal MLCC with the test voltage at 150% of the rated voltage in the high temperature resistance test.

3-1-1. The derated MLCC should be applied with the derating voltage and temperature as shown in the following graph.

3-1-2. The "Temperature of MLCC" in the x-axis of the graph below indicates the surface temperature of MLCC including self-heating effect. The "Voltage Derating Ratio" in the y-axis of the graph below gives the maximum operating voltage of MLCC with reference to the maximum voltage (Vmax) as defined in section "3-2. Applied Voltage."



[Example of derating graph for derated MLCC]

* Vmax ≤ Derated Voltage

* Only the Derating marked models

3-2. Applied Voltage

The actual applied voltage on MLCC should not exceed the rated voltage set in the specifications.

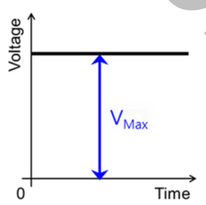
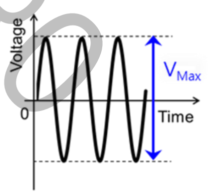
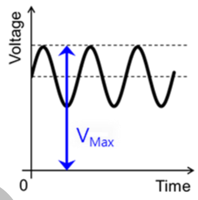
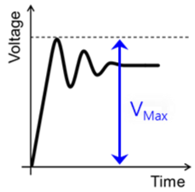
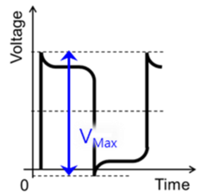
3-2-1. Cautions by types of voltage applied to MLCC

· For DC voltage or DC+AC voltage, DC voltage or the maximum value of DC + AC voltage should not exceed the rated voltage of MLCC.

· For AC voltage or pulse voltage, the peak-to-peak value of AC voltage or pulse voltage should not exceed the rated voltage of MLCC.

· Abnormal voltage such as surge voltage, static electricity should not exceed the rated voltage of MLCC.

[Types of Voltage Applied to the Capacitor]

DC Voltage	AC Voltage	DC+AC Voltage 1	DC+AC Voltage 2	DC+Pulse Voltage
				

3-2-2. Effect of EOS (Electrical Overstress)

· Electrical Overstress such as a surge voltage or EOS can cause damages to MLCC, resulting in the electrical short failure caused by the dielectric breakdown in MLCC.

· Down time of MLCC is varied with the applied voltage and the room temperature and a dielectric shock caused by EOS can accelerate heating on the dielectric. Therefore, it can bring about a failure of MLCC in a market at the early stage.

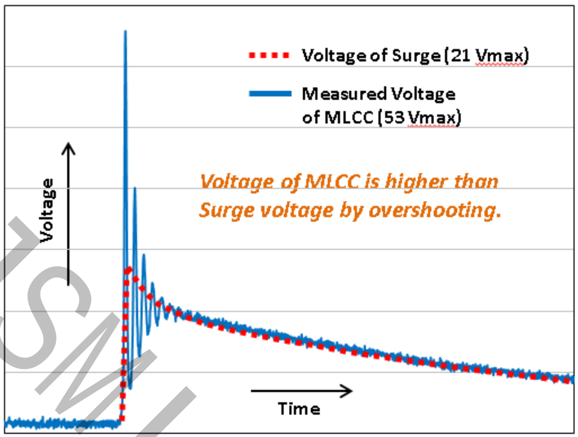
· Please use caution not to apply excessive electrical overstress including spike voltage MLCC when preparing MLCC for testing or evaluating.

(1) Surge

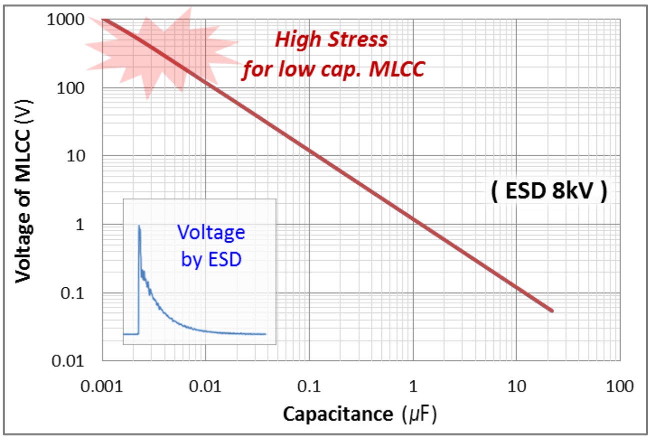
When the overcurrent caused by surge is applied to MLCC, the influx of current into MLCC can induce the overshooting phenomenon of voltage as shown in the graph below and result in the electrical short failure in MLCC. Therefore, it is necessary to be careful to prevent the influx of surge current into MLCC.

(2) ESD (Electrostatic Discharge)

Since the voltage of the static electricity is very high but the quantity of electric charge is small compared to the surge, ESD can cause damage to MLCC with low capacitance as shown in the following graph, whereas surge with lots of electric charge quantity can cause damages to even high capacitance MLCC.



[Example of Surge applied to MLCC]



[Example of ESD applied to MLCC]

* Simulation for ESD 8kV

3-3. Vibration

Please check the types of vibration and shock, and the status of resonance.
Manage MLCC not to generate resonance and avoid any kind of impact to terminals.
When MLCC is used in a vibration environment, please make sure to contact us for the situation and consider special MLCC such as Soft-term, etc.

3-4. Shock

Mechanical stress caused by a drop may cause damages to a dielectric or a crack in MLCC
Do not use a dropped MLCC to avoid any quality and reliability deterioration.
When piling up or handling printed circuit boards, do not hit MLCC with the corners of a PCB to prevent cracks or any other damages to the MLCC.

3-5. Piezo-electric Phenomenon

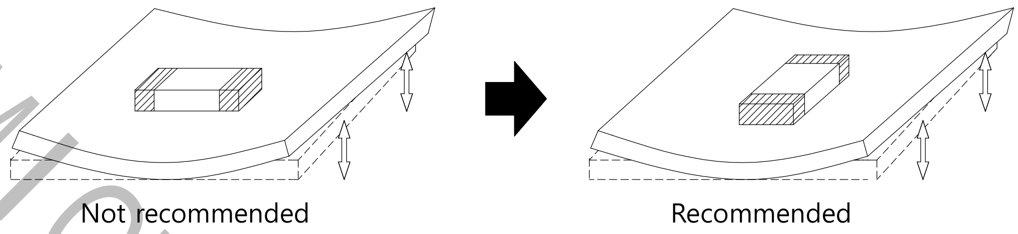
MLCC may generate a noise due to vibration at specific frequency when using the high dielectric constant MLCC (Class Ⅱ) at AC or Pulse circuits.
MLCC may cause a noise if MLCC is affected by any mechanical vibrations or shocks.

4. Process of Mounting and Soldering

4-1. Mounting

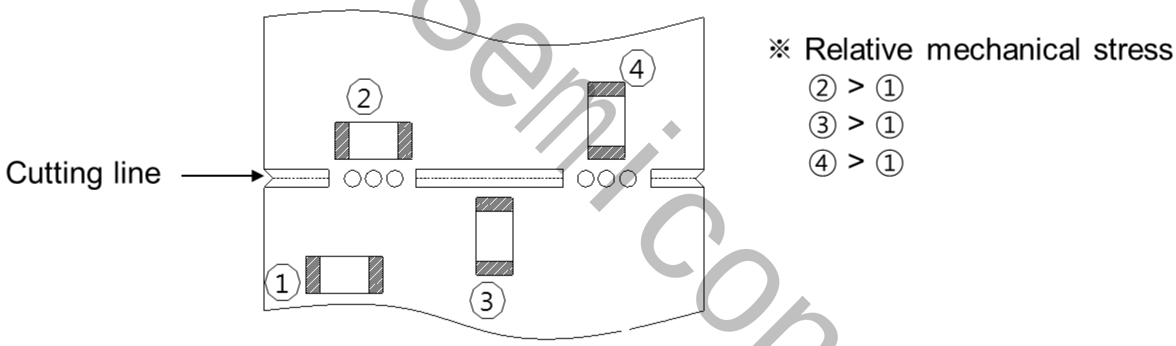
4-1-1. Mounting position

It is recommended to locate the major axis of MLCC in parallel to the direction in which the stress is applied.



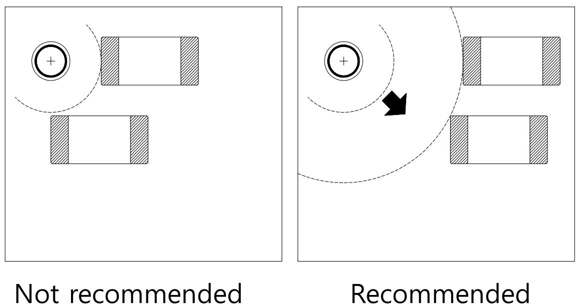
4-1-2. Cautions during mounting near the cutout

Please take the following measures to effectively reduce the stress generated from the cutting of PCB. Select the mounting location shown below, since the mechanical stress is affected by a location and a direction of MLCC mounted near the cutting line.



4-1-3. Cautions during mounting near screw

If MLCC is mounted near a screw hole, the board deflection may be occurred by screw torque. Mount MLCC as far from the screw holes as possible.



4-2. Caution before Mounting

4-2-1. It is recommended to store and use MLCC in a reel. Do not re-use MLCC that was isolated from the reel.

4-2-2. Check the capacitance characteristics under actual applied voltage.

4-2-3. Check the mechanical stress when actual process and equipment is in use.

4-2-4. Check the rated capacitance, rated voltage and other electrical characteristics before assembly. Heat treatment must be done prior to measurement of capacitance.

4-2-5. Check the solderability of MLCC that has passed shelf life before use.

4-2-6. The use of Sn-Zn based solder may deteriorate the reliability of MLCC.

4-3. Cautions during Mounting with Mounting (pick-and-place) Machines

4-3-1. Mounting Head Pressure

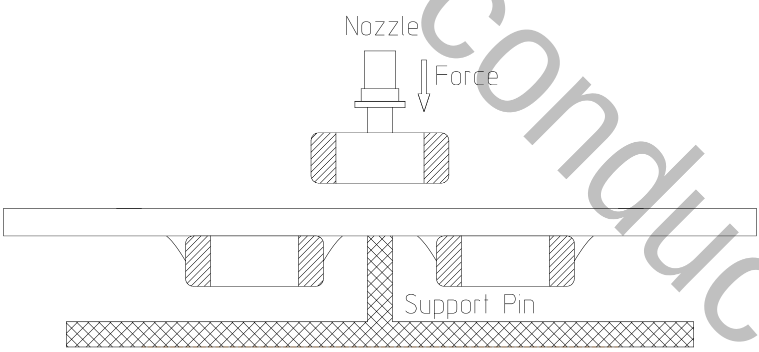
Excessive pressure may cause cracks in MLCC.

It is recommended to adjust the nozzle pressure within the maximum value of 300g.f.

Additional conditions must be set for both thin film and special purpose MLCC.

4-3-2. Bending Stress

When using a two-sided substrate, it is required to mount MLCC on one side first before mounting on the other side due to the bending of the substrate caused by the mounting head. Support the substrate as shown in the picture below when MLCC is mounted on the other side. If the substrate is not supported, bending of the substrate may cause cracks in MLCC.



4-3-3. Suction nozzle

Dust accumulated in a suction nozzle and suction mechanism can impede a smooth movement of the nozzle. This may cause cracks in MLCC due to the excessive force during mounting.

If the mounting claw is worn out, it may cause cracks in MLCC due to the uneven force during positioning.

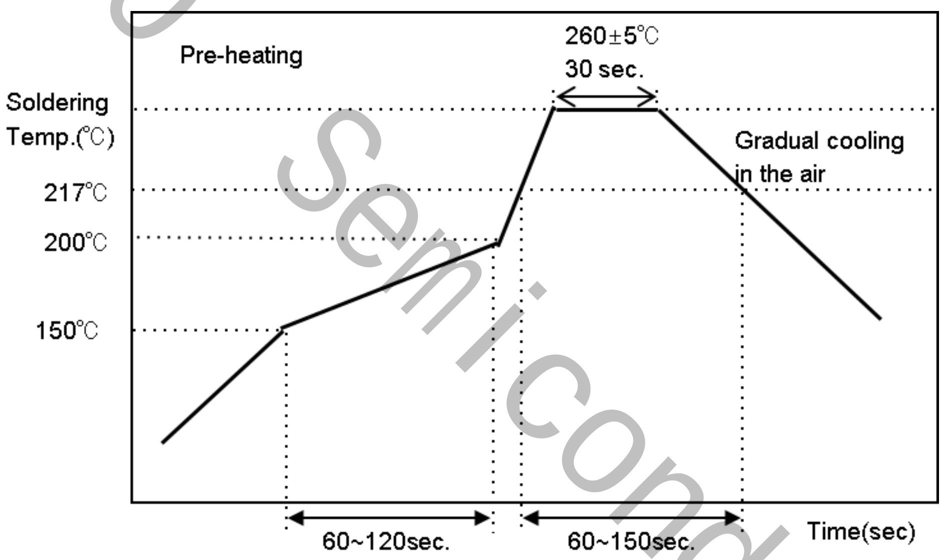
A regular inspection such as maintenance, monitor and replacement for the suction nozzle and mounting claw should be conducted.

4-4. Reflow soldering

MLCC is in a direct contact with the dissolved solder during soldering, which may be exposed to potential mechanical stress caused by the sudden temperature change.
Therefore, MLCC may be contaminated by the location movement and flux.
For the reason, the mounting process must be closely monitored.

Method		Classification
Reflow soldering	Overall heating	Infrared rays Hot plate VPS(Vapor phase)
	Local heating	Air heater Laser Light beam

4-4-1. Reflow Profile



[Reflow Soldering Conditions]

Use caution not to exceed the peak temperature (260℃) and time (30sec) as shown.
Pre-heating is necessary for all constituents including the PCB to prevent the mechanical damages on MLCC. The temperature difference between the PCB and the component surface must be kept to the minimum.

As for reflow soldering, it is recommended to keep the number of reflow soldering to less than three times. Please check with us when the number of reflow soldering needs to exceed three times. Care must be exercised especially for the ultra-small size, thin film and high capacitance MLCC as they can be affected by thermal stress more easily.

4-4-2. Reflow temperature

The following quality problem may occur when MLCC is mounted with a lower temperature than the reflow temperature recommended by a solder manufacturer. The specified peak temperature must be maintained after taking into consideration the factors such as the placement of peripheral constituent and the reflow temperature.

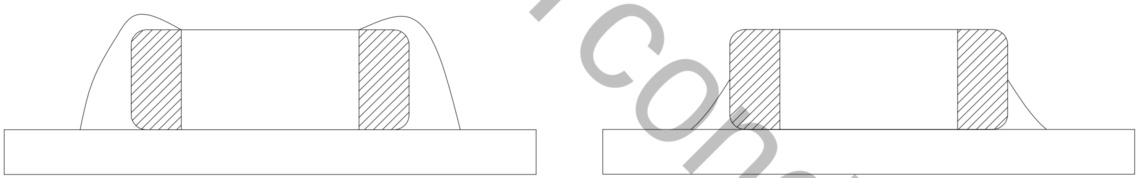
- Drop in solder wettability
- Solder voids
- Potential occurrence of whisker
- Drop in adhesive strength
- Drop in self-alignment properties
- Potential occurrence of tombstones

4-4-3. Cooling

Natural cooling with air is recommended.

4-4-4. Optimum solder flux for reflow soldering

- Overly the thick application of solder pastes results in an excessive solder fillet height. This makes MLCC more vulnerable to the mechanical and thermal stress from the board, which may cause cracks in MLCC.
- Too little solder paste results in a lack of the adhesive strength, which may cause MLCC to isolate from PCB
- Check if solder has been applied uniformly after soldering is completed.



Too Much Solder
large stress may cause cracks

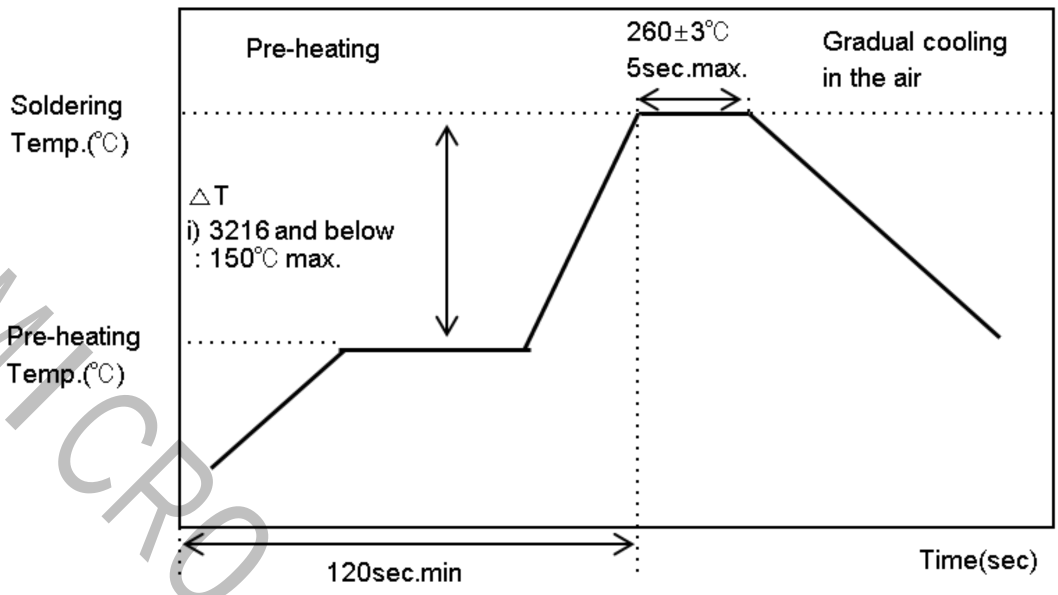
Not enough solder
Weak holding force may cause bad connections or detaching of the capacitor

- It is required to design a PCB with consideration of a solder land pattern and its size to apply an appropriate amount of solder to MLCC. The amount of the solder at the edge may impact directly on cracks in MLCC.

- The design of a suitable solder land is necessary since the more the solder amount is, the larger the force MLCC experiences and the higher the chance MLCC cracks.

4-5. Flow soldering

4-5-1. Flow profile



[Flow Soldering Conditions]

Take caution not to exceed peak temperature (260℃) and time (5sec) as shown.

Please contact us before use the type of high capacitance and thin film MLCC for some exceptions that may be caused.

4-5-2. Caution before Flow soldering

· When a sudden heat is applied to MLCC, the mechanical rigidity of MLCC is deteriorated by the internal deformation of MLCC. Preheating all the constituents including PCB is required to prevent the mechanical damages on MLCC. The temperature difference between the solder and the surface of MLCC must be kept to the minimum.

· If the flow time is too long or the flow temperature is too high, the adhesive strength with PCB may be deteriorated by the leaching phenomenon of the outer termination, or the capacitance value may be dropped by weak adhesion between the internal termination and the outer termination.

4-6. Soldering Iron

Manual soldering can pose a great risk on creating thermal cracks in MLCC. The high temperature soldering iron tip may come into a direct contact with the ceramic body of MLCC due to the carelessness of an operator. Therefore, the soldering iron must be handled carefully, and close attention must be paid to the selection of the soldering iron tip and to temperature control of the tip.

4-6-1. How to use a soldering Iron

· In order to minimize damages on MLCC, preheating MLCC and PCB is necessary.
  A hot plate and a hot air type preheater should be used for preheating

· Do not cool down MLCC and PCB rapidly after soldering.

· Keep the contact time between the outer termination of MLCC and the soldering iron as short as possible. Long soldering time may cause problems such as adhesion deterioration by the leaching phenomenon of the outer termination.

Variation of Temp.	Soldering Temp.(℃)	Pre-heating Time(sec)	Soldering Time(sec)	Cooling Time(sec)
ΔT ≤ 130	300±10℃ max	≥60	≤4	-

* Control Δ T in the solder iron and preheating temperature.

Condition of Iron facilities		
Wattage	Tip diameter	Soldering time
20W max	3 ㎜ max	4sec max

* Caution - Iron tip should not contact with ceramic body directly

Lead-free solder: Sn-3.0Ag-0.5CU

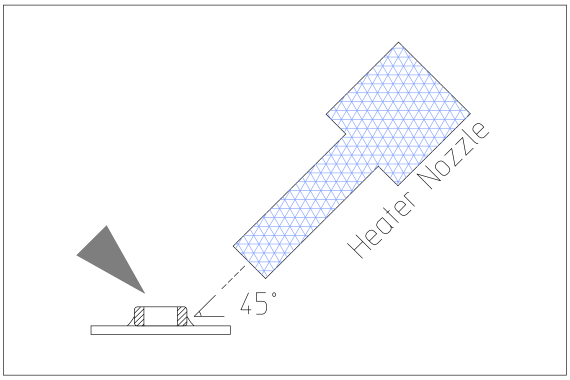
4-6-2. How to use a spot heater

· Compared to local heating using a solder iron, heat by a spot heater heats the overall MLCC and the PCB, which is likely to lessen the thermal shocks.
  For a high density PCB, a spot heater can prevent the problem to connect between a solder iron and MLCC directly.

· If the distance from the air nozzle outlet to MLCC is too close, MLCC may be cracked due to the thermal stress. Follow the conditions set in the table below to prevent this problem.
  The spot heater application angle as shown in the figure is recommended to create a suitable solder fillet shape.

· In case that heat of higher than 350℃ is applied to MLCC containing epoxy material, the epoxy material in MLCC may be damaged by heat.

Distance	≥ 5 mm
Hot Air Application angle	45℃
Hot Air Temperature Nozzle Outlet	≤ 400℃
Application Time	≤ 10s

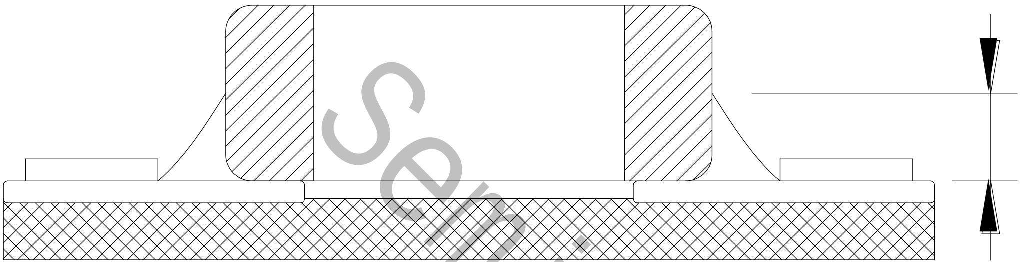


4-6-3. Cautions for re-work

· Too much solder amount will increase the risk of PCB bending or cause other damages.

· Too little solder amount will result in MLCC breaking loose from the PCB due to the inadequate adhesive strength.

· Check if the solder has been applied properly and ensure the solder fillet has a proper shape.



* Soldering wire below ø0.5mm is required for soldering.

4-7. Cleaning

4-7-1. In general, cleaning is unnecessary if rosin flux is used.

When acidic flux is used strongly, chlorine in the flux may dissolve into some types of cleaning fluids, thereby affecting the performance of MLCC.

This means that the cleansing solution must be carefully selected and should always be new.

4-7-2. Cautions for cleaning

MLCC or solder joint may be cracked with the vibration of PCB, if ultrasonic vibration is too strong during cleaning. When high pressure cleaning equipment is used, test should be done for the cleaning equipment and its process before the cleaning in order to avoid damages on MLCC.

4-8. Assembly Handling

4-8-1. Cautions for PCB handling

Hold the edges of the board mounted with MLCC with both hands since holding with one hand may bend the board.

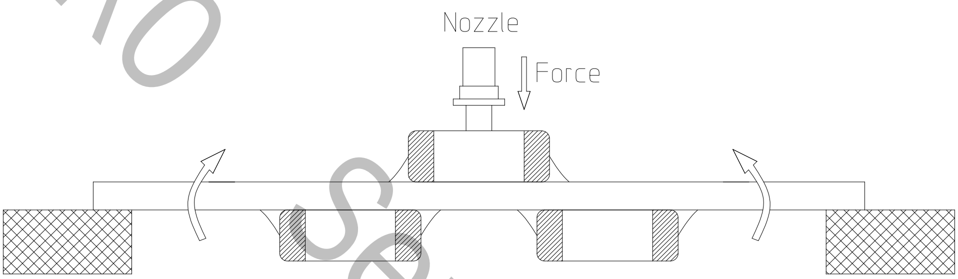
Do not use dropped boards, which may degrade the quality of MLCC.

4-8-2. Mounting other components

Pay attention to the following conditions when mounting other components on the back side of The board after MLCC has been mounted on the front side.

When the suction nozzle is placed too close to the board, board deflection stress may be applied to MLCC on the back side, resulting in cracks in MLCC.

Check if proper value is set on each chip mounter for a suction location, a mounting gap and a suction gap by the thickness of components.

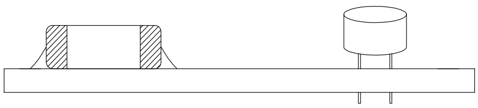


4-8-3. Board mounting components with leads

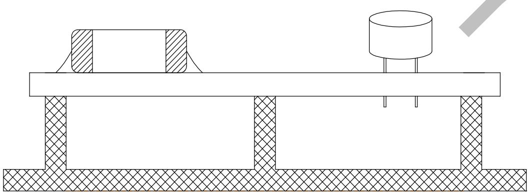
If the board is bent when inserting components (transformer, IC, etc.) into it, MLCC or solder joint may be cracked.

Pay attention to the following:

- Reduce the stress on the board during insertion by increasing the size of the lead insertion hole.
- Insert components with leads into the board after fixing the board with support pins or a dedicated jig.
- Support the bottom side of the board to avoid bending the board.
- Check the status of the height of each support pin regularly when the support pins are used.



Not recommended



Recommended

5. Design

5-1. Circuit design

When the board is dropped or bent, MLCC mounted on the board may be short-circuited by the drop in insulation resistance. Therefore, it is required to install safety equipment such as a fuse to prevent additional accidents when MLCC is short-circuited, otherwise, electric short and fire may occur. This product is not a safety guaranteed product..

5-2. PCB Design

5-2-1. Unlike lead type components, SMD type components that are designed to be mounted directly on the board are fragile to the stress. In addition, they are more sensitive to mechanical and thermal stress than lead type components.

5-2-2. MLCC crack by PCB material type

A great difference of the thermal expansion coefficient between PCB and MLCC causes thermal expansion and contraction, resulting in cracks in MLCC. Even though MLCC is mounted on a board with a fluorine resin or on a single-layered glass epoxy, cracks in MLCC may occur.

5-3. Design system evaluation

5-3-1. Evaluate the actual design with MLCC to make sure there is no functional issue or violation of specifications of the finished goods.

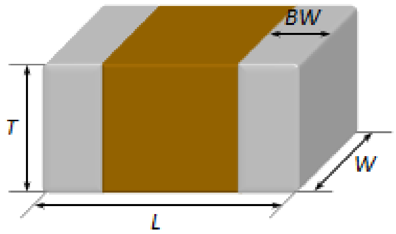
5-3-2. Please note that the capacitance may differ based on the operating condition of the actual system since Class 2 MLCC capacitance varies with applied voltage and temperature.

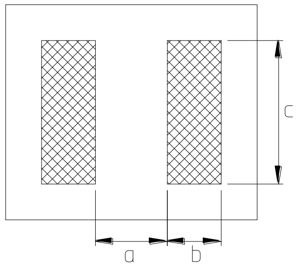
5-3-3. Surge resistance must be evaluated since the excessive surge caused by the inductance of the actual system may apply to MLCC.

5-3-4. Note the actual MLCC size and the termination shape.

5-4 Land dimension

The recommended land dimension is determined by evaluating the actual SET and a board.





Reflow Footprint

Chip Size [mm]	Chip Tol. [mm]	a [mm]	b [mm]	c [mm]	(a+2b) min	(a+2b) max
0201	± 0.013	0.10~0.11	0.07~0.12	0.125~0.145	0.24	0.35
0402	± 0.02	0.14~0.20	0.14~0.22	0.20~0.26	0.42	0.64
0603	± 0.03	0.16~0.20	0.24~0.32	0.30~0.35	0.64	0.84
	± 0.05	0.18~0.26	0.24~0.32	0.32~0.37	0.66	0.9
	± 0.07	0.20~0.28	0.25~0.35	0.35~0.39	0.7	0.98
	± 0.09	0.22~0.30	0.25~0.35	0.35~0.39	0.72	1
1005	± 0.05	0.35~0.40	0.37~0.47	0.50~0.55	1.09	1.34
	± 0.07	0.37~0.42	0.37~0.47	0.52~0.58	1.11	1.36
	± 0.10	0.40~0.45	0.37~0.47	0.55~0.60	1.14	1.39
	± 0.15	0.40~0.45	0.40~0.50	0.60~0.65	1.2	1.45
	± 0.20	0.45~0.50	0.40~0.50	0.65~0.70	1.25	1.5
	± 0.30	0.45~0.50	0.42~0.52	0.70~0.75	1.29	1.54
	± 0.40	0.50~0.55	0.45~0.55	0.75~0.80	1.4	1.65
1608	± 0.10	0.50~0.55	0.60~0.65	0.80~0.85	1.7	1.85
	± 0.15	0.55~0.60	0.62~0.67	0.85~0.90	1.79	1.94
	± 0.20	0.60~0.65	0.65~0.70	0.90~0.95	1.9	2.05
	± 0.25	0.65~0.70	0.70~0.75	0.95~1.00	2.05	2.2
	± 0.30	0.70~0.75	0.75~0.80	1.00~1.05	2.2	2.35
2012	±0.10	0.70~0.75	0.75~0.80	1.25~1.30	2.2	2.35
	±0.15	0.75~0.80	0.80~0.85	1.30~1.35	2.35	2.5
	±0.20	0.80~0.85	0.85~0.90	1.35~1.40	2.5	2.65
	±0.25	0.85~0.90	0.95~1.00	1.40~1.45	2.75	2.9
	±0.30	0.90~0.95	1.05~1.10	1.45~1.50	3	3.15
3216	±0.20	1.70~1.90	0.85~1.00	1.60~1.80	3.4	3.9
	±0.30	1.80~2.00	0.95~1.10	1.70~1.90	3.7	4.2
3225	-	2.00~2.40	1.00~1.40	1.80~2.20	4	5.2
4532	-	2.80~3.20	1.40~1.80	2.40~3.00	5.6	6.8
5750	-	4.00~4.60	1.70~2.30	4.10~4.90	7.4	9.2

Flow Footprint

Chip Size [mm]	Chip Tol. [mm]	a [mm]	b [mm]	c [mm]	(a+2b) min	(a+2b) max
1608	-	0.60~1.00	0.60~0.80	0.60~0.80	1.8	2.6
2012	-	1.00~1.20	0.80~1.20	0.80~1.20	2.6	3.6
3216	-	2.00~2.40	1.00~1.20	1.00~1.40	4.0	4.8