C02E.pdf
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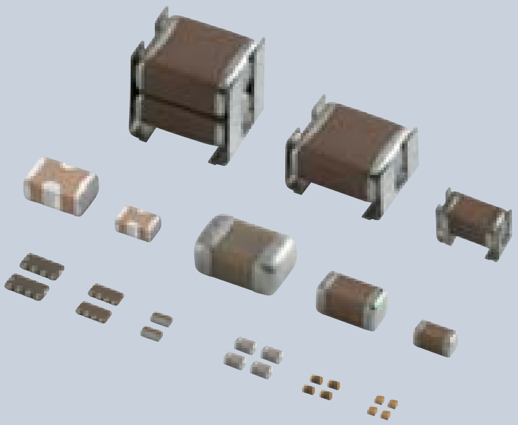
INNOVATOR IN ELECTRONICS

Chip Multilayer Ceramic Capacitors for General

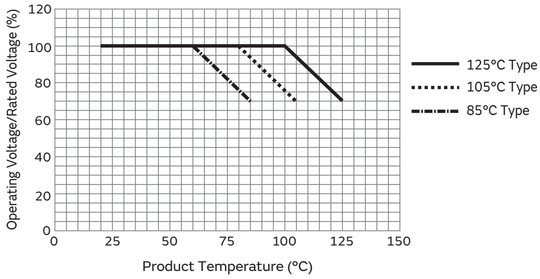
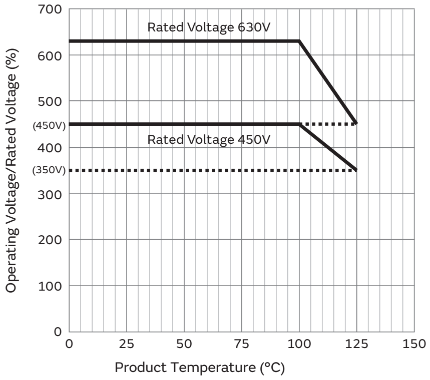
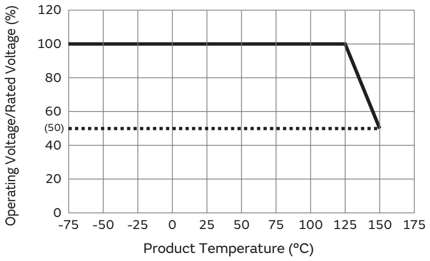


2018

Explanation of Symbols in This Catalog

WEB	Links are provided to the latest information from the PDF version of the catalog, which is available on the web.

General	For applications that do not require the particular reliability such as the general equipment
Info-tainment	Infotainment for Automotive The product for entertainment equipment like car navigations, car audios, and body control equipment like wipers, power windows.
Power-train	Powertrain/Safety for Automotive Product used for applications (running, turning, stopping and safety devices) which particularly concern human life, such as in devices for automobiles.
Medical Device	Medical-grade products for Implanted Medical Devices These products are intended for use in implanted medical devices such as cardiac pacemakers, cochlear implants, insulin pumps and gastric electrostimulators. They are suitable for use in non-critical circuits. *1 *1 Non-critical circuits This term refers to circuits in implanted medical devices that are not directly linked to life support, i.e. circuits that will not directly endanger the life of the patient should the functionality of the device be reduced or halted by failure of the circuit.
AEC-Q200	AEC-Q200 compliant product
Safety standard	Safety Standard Certified Product Products that acquired safety standard certification IEC60384-14 and products based on the Electrical Appliance and Material Safety Law of Japan.
Japanese Safety Law	Based on the Electrical Appliance and Material Safety Law of Japan Products that are based on the electrical appliance and material safety law of Japan.
High Q	Low dissipation for high frequency By devising ceramic materials and electrode materials, low dissipation is achieved in frequency bands of VHF, UHF and microwave or beyond.
Low ESL	Low inductance This capacitor is designed so that the parasitic inductance component (ESL) that the capacitor has on the high frequency side becomes lower.
Fail safe	Fail safe product This capacitor is designed to prevent failures as much as possible by short mode.
Deflecting crack	Product resistant to deflection cracking This capacitor is designed to prevent failures as much as possible by short mode caused by cracking when there is board deflection.
Soldering crack	Product with solder cracking suppression "This capacitor is configured with metal terminals and leads connected to the chip. The metal terminals and leads relieve the stress from expansion and contraction of the solder, to suppress solder cracking."
Anti-noise	Product suitable for acoustic noise reduction and low distortion This product suppresses acoustic noise, which occurs when a ceramic capacitor is used, by devising the materials and configuration.
Effective Cap	No DC bias characteristics Polymer capacitor is no capacitance change with DC bias due to aluminum oxidized film for dielectric.
EMI FIL®	Low-inductance product suitable for noise suppression. This product has extremely low ESL and is suitable for suppression of noise, including high frequencies. This product can also be used as a low-ESL, high-performance bypass capacitor.
Bonding	Product for bonding Since gold is used for the external electrodes, the capacitor can be mounted by die bonding/wire bonding.

D1 Derating 1	Derating 1 This product is suitable when a voltage continuously applied to a capacitor in an operating circuit, is used below (derated) the rated voltage of the capacitor. This model guarantees the test conditions in the endurance test, at a rated voltage x 100% at the maximum operating temperature. A reliability assurance level equivalent to a common product can be secured, by using this product within the voltage and temperature derated conditions recommended in the figure below. Recommended Conditions of the Derating Operating Voltage and Temperature 
D2 Derating 2	Derating 2 When the product temperature exceeds 105°C, please use this product within the voltage and temperature derated conditions in the figure below. 
D3 Derating 3	Derating 3 Please apply the derating curve according to the operating temperature. Please refer to detailed specifications sheet for details.
D4 Derating 4	Derating 4 When the product temperature exceeds 125°C, please use this product within the voltage and temperature derated conditions in the figure below. 
D5 Derating 5	Derating 5 Please apply the rated voltage derating over 150 °C. Please refer to detailed specifications sheet for details.

Selection Guide for Capacitors

For general

General

SMD

Solder mounting

Chip type

GRM			p40
GRM		For LCD backlight inverter circuit only	WEB
GR3	Anti-noise	High effective capacitance & high ripple current	p109
GRJ	Deflecting crack	Soft termination	p120
GXM	Water Repellent		WEB
GR4		For information devices only	p125
GR7		For camera flash circuit only	p130
GJM	High Q		p135
GQM	High Q	High power	p164
GA2	Japanese Safety Law	Based on the Electrical Appliance and Material Safety Law of Japan	p184
GA3	Safety standard		p189
LLL	Low ESL	LW reversed	p219
LLA	Low ESL	8 terminals	p222
LLM	Low ESL	10 terminals	p228
LLR	Low ESL	LW reversed controlled ESR	p232
NFM	Low ESL	3 terminals	p236
GJ4	Anti-noise	Low distortion	WEB
GJ8	Anti-noise	Low acoustic noise	WEB

On interposer board

ZRA	Anti-noise		WEB
ZRB	Anti-noise		WEB

Metal terminal type

KRM	Anti-noise Deflecting crack Soldering crack		p239
KR3	Anti-noise Deflecting crack Soldering crack	High effective capacitance & high ripple current	p243

Resin molding SMD type

DK1	Safety standard		WEB

Wire bonding mounting

Bonding

Chip type

GMA		Microchip	p249
GMD			p256

Lead type

Solder mounting

RDE	Anti-noise Deflecting crack Soldering crack		WEB
DEH		High temperature low loss	WEB
DEA		High temperature Class 1	WEB
DEB		Class 2	WEB
DEC			WEB
DEF		For LCD backlight inverter circuit only	WEB
DHR	Ultrahigh-voltage Deflecting crack Soldering crack		WEB
DEJ	Japanese Safety Law	Based on the Electrical Appliance and Material Safety Law of Japan	WEB
DE1	Safety standard	X1/Y1 Class certified product	WEB
DE2	Safety standard	X1/Y2 Class certified product	WEB

Screw termination mounting

DHS	Ultrahigh-voltage		WEB
DHK	Ultrahigh-voltage	High voltage AC rated	WEB

Infotainment for automotive

Info-tainment
AEC-Q200

SMD

Solder mounting

Chip type

GRT			WEB

Powertrain/Safety for automotive

Power-train
AEC-Q200

SMD

Solder mounting

Chip type

GCM			WEB
GC3	Anti-noise	High effective capacitance & high ripple current	WEB
GCJ	Fail safe Deflecting crack	Soft termination	WEB
GGM	Water Repellent		WEB
GCQ	High Q		WEB
GCD	Fail safe Deflecting crack	MLSC design	WEB
GCE	Fail safe Deflecting crack	Soft termination MLSC design	WEB
GGD	Fail safe Deflecting crack Water Repellent	MLSC design	WEB
NFM	Low ESL	3 terminals	WEB

Metal terminal type

KCM	Anti-noise Deflecting crack Soldering crack		WEB
KC3	Anti-noise Deflecting crack Soldering crack	High effective capacitance & high ripple current	WEB
KCA	Safety standard Anti-noise Deflecting crack Soldering crack		WEB

Limited to Conductive Glue Mounting

Limited to conductive glue mounting

Chip type

GCB	Deflecting crack Soldering crack	Ni plating + Pd plating termination conductive glue mounting	WEB
GCG	Deflecting crack Soldering crack	AgPd termination conductive glue mounting	WEB

Lead type

Solder mounting

RCE	Anti-noise Deflecting crack Soldering crack		WEB
RHE	Anti-noise Deflecting crack Soldering crack	150°C operation leaded	WEB
RHS	Anti-noise Deflecting crack Soldering crack	200°C operation leaded	WEB
DE6	Safety standard		WEB

Medical-grade products for implanted medical devices

Medical Device

SMD

Solder mounting

Chip type

GCH			WEB

● Part Numbering

Chip Multilayer Ceramic Capacitors for General

WEB

(Part Number)	GR	M	18	8	B1	1H	102	K	A01	D
	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩

①Product ID ②Series

Product ID	Code	Series
GA	2	Based on the Electrical Appliance and Material Safety Law of Japan Chip Multilayer Ceramic Capacitors for General Purpose
	3	Safety Standard Certified Chip Multilayer Ceramic Capacitors for General Purpose
GJ	M	High Q Chip Multilayer Ceramic Capacitors for General Purpose
GM	A	Wire Bonding Mount Multilayer Microchip Capacitors for General Purpose
	D	Wire Bonding/AuSn Soldering Mount Chip Multilayer Ceramic Capacitors for General Purpose
GQ	M	High Q and High Power Chip Multilayer Ceramic Capacitors for General Purpose
GR	3	High Effective Capacitance & High Ripple Current Chip Multilayer Ceramic Capacitors for General Purpose
	4	Chip Multilayer Ceramic Capacitors for Camera Flash Circuit only
	7	Chip Multilayer Ceramic Capacitors for Ethernet LAN and Primary-secondary Coupling of DC-DC Converters
	J	Soft Termination Chip Multilayer Ceramic Capacitors for General Purpose
	M	Chip Multilayer Ceramic Capacitors for General Purpose
KR	3	High Effective Capacitance & High Allowable Ripple Current Metal Terminal Type Multilayer Ceramic Capacitors for General Purpose
	M	Metal Terminal Type Multilayer Ceramic Capacitors for General Purpose
LL	A	8 Terminals Low ESL Chip Multilayer Ceramic Capacitors for General Purpose
	L	LW Reversed Low ESL Chip Multilayer Ceramic Capacitors for General Purpose
	M	10 Terminals Low ESL Chip Multilayer Ceramic Capacitors for General Purpose
	R	LW Reversed Controlled ESR Low ESL Chip Multilayer Ceramic Capacitors for General Purpose

③Chip Dimensions (LxW)

Code	Dimensions (LxW)	EIA
02	0.4x0.2mm	01005
0D	0.38x0.38mm	015015
03	0.6x0.3mm	0201
05	0.5x0.5mm	0202
08	0.8x0.8mm	0303
1U	0.6x1.0mm	02404
15	1.0x0.5mm	0402
18	1.6x0.8mm	0603
21	2.0x1.25mm	0805
22	2.8x2.8mm	1111
31	3.2x1.6mm	1206
32	3.2x2.5mm	1210
42	4.5x2.0mm	1808
43	4.5x3.2mm	1812
52	5.7x2.8mm	2211
55	5.7x5.0mm	2220

Continued on the following page. ↗

(Part Number)

GR	M	18	8	B1	1H	102	K	A01	D
❶	❷	❸	❹	❺	❻	❼	❽	❾	❿

Continued from the preceding page. ↘

❹Height Dimension (T) (Except **KR**☐)

Code	Dimension (T)
2	0.2mm
3	0.3mm
4	0.4mm
5	0.5mm
6	0.6mm
7	0.7mm
8	0.8mm
9	0.85mm
A	1.0mm
B	1.25mm
C	1.6mm
D	2.0mm
E	2.5mm
M	1.15mm
Q	1.5mm
X	Depends on individual standards.

❹Height Dimension (T) (**KR**☐ Only)

Code	Dimension (T)
E	1.8mm
F	1.9mm
K	2.7mm
L	2.8mm
Q	3.7mm
T	4.8mm
W	6.4mm

❺Temperature Characteristics

Temperature Characteristic Codes			Temperature Characteristics			Operating Temperature Range	Capacitance Change Each Temperature (%)					
Code	Public STD Code		Reference Temperature	Temperature Range	Capacitance Change or Temperature Coefficient		−55°C		*6		−10°C	
							Max.	Min.	Max.	Min.	Max.	Min.
1X	SL	JIS	20°C	20 to 85°C	+350 to −1000ppm/°C	−55 to 125°C	-	-	-	-	-	-
2C	CH	JIS	20°C	20 to 125°C	0±60ppm/°C	−55 to 125°C	0.82	−0.45	0.49	−0.27	0.33	−0.18
3C	CJ	JIS	20°C	20 to 125°C	0±120ppm/°C	−55 to 125°C	1.37	−0.9	0.82	−0.54	0.55	−0.36
3U	UJ	JIS	20°C	20 to 85°C	−750±120ppm/°C	−25 to 85°C	-	-	4.94	2.84	3.29	1.89
4C	CK	JIS	20°C	20 to 125°C	0±250ppm/°C	−55 to 125°C	2.56	−1.88	1.54	−1.13	1.02	−0.75
5C	C0G	EIA	25°C	25 to 125°C	0±30ppm/°C	−55 to 125°C	0.58	−0.24	0.4	−0.17	0.25	−0.11
5G	X8G	*2	25°C	25 to 150°C	0±30ppm/°C	−55 to 150°C	0.58	−0.24	0.4	−0.17	0.25	−0.11
7U	U2J	EIA	25°C	25 to 125°C *3	−750±120ppm/°C	−55 to 125°C	8.78	5.04	6.04	3.47	3.84	2.21
B1	B *1	JIS	20°C	−25 to 85°C	±10%	−25 to 85°C	-	-	-	-	-	-
B3	B	JIS	20°C	−25 to 85°C	±10%	−25 to 85°C	-	-	-	-	-	-
C7	X7S	EIA	25°C	−55 to 125°C	±22%	−55 to 125°C	-	-	-	-	-	-
C8	X6S	EIA	25°C	−55 to 105°C	±22%	−55 to 105°C	-	-	-	-	-	-
D7	X7T	EIA	25°C	−55 to 125°C	+22%, −33%	−55 to 125°C	-	-	-	-	-	-
D8	X6T	EIA	25°C	−55 to 105°C	+22%, −33%	−55 to 105°C	-	-	-	-	-	-
E7	X7U	EIA	25°C	−55 to 125°C	+22%, −56%	−55 to 125°C	-	-	-	-	-	-
R1	R *1	JIS	20°C	−55 to 125°C	±15%	−55 to 125°C	-	-	-	-	-	-
R6	X5R	EIA	25°C	−55 to 85°C	±15%	−55 to 85°C	-	-	-	-	-	-
R7	X7R	EIA	25°C	−55 to 125°C	±15%	−55 to 125°C	-	-	-	-	-	-
W0	X7T	EIA	25°C	−55 to 125°C	±10% *4	−55 to 125°C	-	-	-	-	-	-
					+22%, −33% *5		-	-	-	-	-	-

*1 Capacitance change is specified with 50% rated voltage applied.
*2 Murata Temperature Characteristic Code.
*3 Rated Voltage 100Vdc max: 25 to 85°C
*4 Apply DC350V bias.
*5 No DC bias.
*6 −25°C (Reference Temperature 20°C) / −30°C (Reference Temperature 25°C)

Continued on the following page. ↗

(Part Number)

GR	M	18	8	B1	1H	102	K	A01	D
❶	❷	❸	❹	❺	❻	❼	❽	❾	❿

Continued from the preceding page.↘

❻Rated Voltage

Code	Rated Voltage
0E	DC2.5V
0G	DC4V
0J	DC6.3V
1A	DC10V
1C	DC16V
1E	DC25V
1H	DC50V
1J	DC63V
1K	DC80V
2A	DC100V
2D	DC200V
2E	DC250V
2W	DC450V
2H	DC500V
2J	DC630V
3A	DC1kV
3D	DC2kV
3F	DC3.15kV
BB	DC350V
E2	AC250V
GB	X2; AC250V (Safety Standard Certified Type GB)
GD	Y3; AC250V (Safety Standard Certified Type GD)
GF	Y2, X1/Y2; AC250V (Safety Standard Certified Type GF)
YA	DC35V

❼Capacitance

Expressed by three-digit alphanumerics. The unit is picofarad (pF). The first and second figures are significant digits, and the third figure expresses the number of zeros which follow the two numbers. If there is a decimal point, it is expressed by the capital letter "**R**." In this case, all figures are significant digits.
If any alphabet, other than "**R**", is included, this indicates the specific part number is a non-standard part.

Ex.)

Code	Capacitance
R50	0.50pF
1R0	1.0pF
100	10pF
103	10000pF

❽Capacitance Tolerance

Code	Capacitance Tolerance
B	±0.1pF
C	±0.25pF
D	±0.5pF (Less than 10pF) ±0.5% (10pF and over)
F	±1%
G	±2%
J	±5%
K	±10%
M	±20%
W	±0.05pF

❾Individual Specification Code (Except **LLR**)

Expressed by three figures.

❾ESR (**LLR** Only)

Code	ESR
E01	100mΩ
E03	220mΩ
E05	470mΩ
E07	1000mΩ

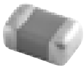
❿Packaging

Code	Packaging
L	ø180mm Embossed Taping
D/E/W	ø180mm Paper Taping
K	ø330mm Embossed Taping
J/F	ø330mm Paper Taping
T	Bulk Tray

Please contact us if you find any part number not provided in this table.

Soft Termination Chip Multilayer Ceramic Capacitors for General Purpose

GRJ Series



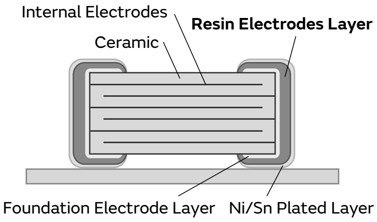
Deflecting crack WEB

Cracking caused by flexing stress after board mounting is minimized due to resin external electrodes!

Features

① The resin external electrodes suppress cracks by board deflection.

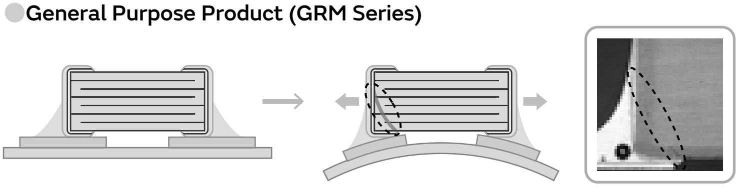
Cracking of the ceramic element is suppressed by the resin of the external electrodes, which releases the stress.



Resin electrodes relieve the stress

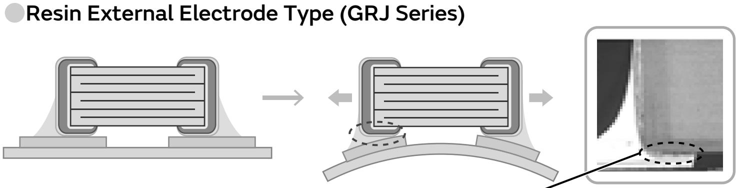
<Example of Structure>

General Purpose Product (GRM Series)



Occurrence of cracking on edge of terminal electrode

Resin External Electrode Type (GRJ Series)

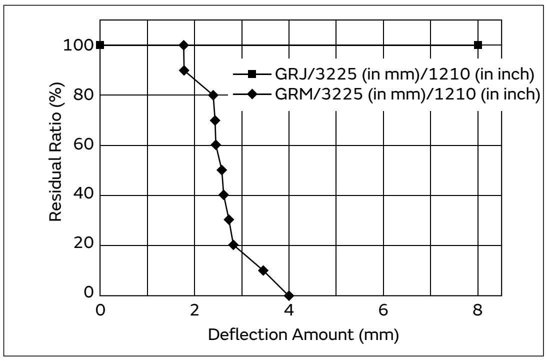


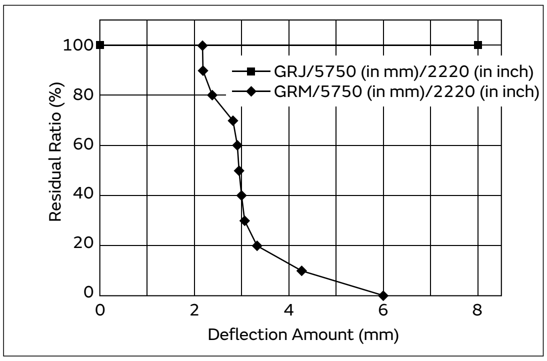
Conductive resin layer relieves the mechanical stress of the ceramic

Separated foundation electrode and resin electrode

Note: Cracks may occur in the capacitor body if excessive stress beyond the "guaranteed range of board bending strength (*) " provided in the specifications is applied. Capacitors with cracks in them may cause a drop in insulation resistance, which could lead to a short circuit.
(*) For details on the guaranteed range of board bending strength, check the "Detailed Specification Sheet" on the Product Details Page.

② Suppresses the occurrence of cracking caused by deflection stress at the time of board mounting, etc.



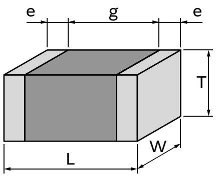


Due to the specification of the measuring instrument, measurements can be performed up to 8mm.

③ Ideal for consumer and industrial electronic equipment, etc. where there heat stress, vibration and impact are applied.

Specifications

Size (mm)	0.6×0.3mm to 5.7×5.0mm
Rated Voltage	6.3Vdc to 1000Vdc
Capacitance	220pF to 47μF
Main Applications	Consumer & Industrial Electronic Equipment



<Dimensions>

This catalog contains only a portion of the product lineup.
Please refer to the capacitor search tool on the Murata Web site for details.

GRJ Series High Dielectric Constant Type Deflecting crack Part Number List

1.6×0.8mm

T max.	Rated Voltage	TC Code	Cap.	Tol.	Part Number	
0.9mm	100Vdc	X7R	1000pF	±10%	**GRJ188R72A102KE11#**	
				±20%	**GRJ188R72A102ME11#**	
			2200pF	±10%	**GRJ188R72A222KE11#**	
				±20%	**GRJ188R72A222ME11#**	
			4700pF	±10%	**GRJ188R72A472KE11#**	
				±20%	**GRJ188R72A472ME11#**	
			10000pF	±10%	**GRJ188R72A103KE11#**	
				±20%	**GRJ188R72A103ME11#**	
			22000pF	±10%	**GRJ188R72A223KE11#**	
				±20%	**GRJ188R72A223ME11#**	
			0.10μF	±10%	**GRJ188R72A104KE11#**	
				±20%	**GRJ188R72A104ME11#**	
	50Vdc	X7R	1000pF	±10%	**GRJ188R71H102KE11#**	
				±20%	**GRJ188R71H102ME11#**	
			2200pF	±10%	**GRJ188R71H222KE11#**	
				±20%	**GRJ188R71H222ME11#**	
			4700pF	±10%	**GRJ188R71H472KE11#**	
				±20%	**GRJ188R71H472ME11#**	
			10000pF	±10%	**GRJ188R71H103KE11#**	
				±20%	**GRJ188R71H103ME11#**	
			22000pF	±10%	**GRJ188R71H223KE11#**	
				±20%	**GRJ188R71H223ME11#**	
			47000pF	±10%	**GRJ188R71H473KE11#**	
				±20%	**GRJ188R71H473ME11#**	
			0.10μF	±10%	**GRJ188R71H104KE11#**	
				±20%	**GRJ188R71H104ME11#**	
			0.22μF	±10%	**GRJ188R71H224KE11#**	
				±20%	**GRJ188R71H224ME11#**	
	35Vdc	X5R	1.0μF	±10%	**GRJ188R6YA105KE11#**	
	25Vdc	X7R	47000pF	±10%	**GRJ188R71E473KE11#**	
				±20%	**GRJ188R71E473ME11#**	
			0.22μF	±10%	**GRJ188R71E224KE11#**	
				±20%	**GRJ188R71E224ME11#**	
			1.0μF	±10%	**GRJ188R71E105KE11#**	
				±20%	**GRJ188R71E105ME11#**	
	16Vdc	X7R	0.47μF	±10%	**GRJ188R71C474KE11#**	
				±20%	**GRJ188R71C474ME11#**	
	6.3Vdc	X7R	2.2μF	±10%	**GRJ188R70J225KE11#**	
				±20%	**GRJ188R70J225ME11#**	
1.0mm	6.3Vdc	X7S	4.7μF	±10%	**GRJ188C70J475KE11#**	
				±20%	**GRJ188C70J475ME11#**	

2.0×1.25mm

T max.	Rated Voltage	TC Code	Cap.	Tol.	Part Number	
0.7mm	100Vdc	X7R	1000pF	±10%	**GRJ216R72A102KE01#**	
				±20%	**GRJ216R72A102ME01#**	
			2200pF	±10%	**GRJ216R72A222KE01#**	
				±20%	**GRJ216R72A222ME01#**	
			4700pF	±10%	**GRJ216R72A472KE01#**	
				±20%	**GRJ216R72A472ME01#**	
0.7mm	100Vdc	X7R	10000pF	±10%	**GRJ216R72A103KE01#**	
				±20%	**GRJ216R72A103ME01#**	
			22000pF	±10%	**GRJ216R72A223KE01#**	
				±20%	**GRJ216R72A223ME01#**	
	50Vdc	X7R	470pF	±10%	**GRJ216R71H471KE01#**	
				±20%	**GRJ216R71H471ME01#**	
			1000pF	±10%	**GRJ216R71H102KE01#**	
				±20%	**GRJ216R71H102ME01#**	
			2200pF	±10%	**GRJ216R71H222KE01#**	
				±20%	**GRJ216R71H222ME01#**	
			4700pF	±10%	**GRJ216R71H472KE01#**	
				±20%	**GRJ216R71H472ME01#**	
			10000pF	±10%	**GRJ216R71H103KE01#**	
				±20%	**GRJ216R71H103ME01#**	
			22000pF	±10%	**GRJ216R71H223KE01#**	
				±20%	**GRJ216R71H223ME01#**	
0.95mm	100Vdc	X7R	220pF	±10%	**GRJ219R72A221KE01#**	
				±20%	**GRJ219R72A221ME01#**	
			470pF	±10%	**GRJ219R72A471KE01#**	
				±20%	**GRJ219R72A471ME01#**	
1.0mm	250Vdc	X7R	1000pF	±10%	**GRJ21AR72E102KWJ1#**	
			1500pF	±10%	**GRJ21AR72E152KWJ1#**	
			2200pF	±10%	**GRJ21AR72E222KWJ1#**	
			3300pF	±10%	**GRJ21AR72E332KWJ1#**	
			4700pF	±10%	**GRJ21AR72E472KWJ1#**	
			6800pF	±10%	**GRJ21AR72E682KWJ1#**	
1.45mm	250Vdc	X7R	10000pF	±10%	**GRJ21BR72E103KWJ3#**	
			15000pF	±10%	**GRJ21BR72E153KWJ3#**	
			22000pF	±10%	**GRJ21BR72E223KWJ3#**	
	100Vdc	X7R	47000pF	±10%	**GRJ21BR72A473KE01#**	
				±20%	**GRJ21BR72A473ME01#**	
			0.10μF	±10%	**GRJ21BR72A104KE01#**	
				±20%	**GRJ21BR72A104ME01#**	
	50Vdc	X7R	47000pF	±10%	**GRJ21BR71H473KE01#**	
				±20%	**GRJ21BR71H473ME01#**	
			0.10μF	±10%	**GRJ21BR71H104KE01#**	
				±20%	**GRJ21BR71H104ME01#**	
			0.22μF	±10%	**GRJ21BR71H224KE01#**	
				±20%	**GRJ21BR71H224ME01#**	
			0.47μF	±10%	**GRJ21BR71H474KE01#**	
				±20%	**GRJ21BR71H474ME01#**	
			1.0μF	±10%	**GRJ21BR71H105KE01#**	
				±20%	**GRJ21BR71H105ME01#**	
	25Vdc	X7R	1.0μF	±10%	**GRJ21BR71E105KE11#**	
				±20%	**GRJ21BR71E105ME11#**	
			2.2μF	±10%	**GRJ21BR71E225KE01#**	
				±20%	**GRJ21BR71E225ME01#**	
	16Vdc	X7R	4.7μF	±10%	**GRJ21BR71C475KE01#**	
				±20%	**GRJ21BR71C475ME01#**	
	10Vdc	X7R	10μF	±10%	**GRJ21BR71A106KE01#**	
				±20%	**GRJ21BR71A106ME01#**	
1.5mm	100Vdc	X7S	1.0μF	±10%	**GRJ21BC72A105KE11#**	
				±20%	**GRJ21BC72A105ME11#**	

Part number # indicates the package specification code.

GRJ Series High Dielectric Constant Type Deflecting crack Part Number List

3.2×1.6mm

T max.	Rated Voltage	TC Code	Cap.	Tol.	Part Number	
0.95mm	100Vdc	X7R	0.10µF	±10%	GRJ319R72A104KE11#	
				±20%	GRJ319R72A104ME11#	
	50Vdc	X7R	0.10µF	±10%	GRJ319R71H104KE11#	
				±20%	GRJ319R71H104ME11#	
1.25mm	1000Vdc	X7R	470pF	±10%	GRJ31BR73A471KWJ1#	
			680pF	±10%	GRJ31BR73A681KWJ1#	
			1000pF	±10%	GRJ31BR73A102KWJ1#	
			1500pF	±10%	GRJ31BR73A152KWJ1#	
			2200pF	±10%	GRJ31BR73A222KWJ1#	
			3300pF	±10%	GRJ31BR73A332KWJ1#	
			4700pF	±10%	GRJ31BR73A472KWJ1#	
	630Vdc	X7R	1000pF	±10%	GRJ31BR72J102KWJ1#	
			1500pF	±10%	GRJ31BR72J152KWJ1#	
			2200pF	±10%	GRJ31BR72J222KWJ1#	
			3300pF	±10%	GRJ31BR72J332KWJ1#	
			4700pF	±10%	GRJ31BR72J472KWJ1#	
			6800pF	±10%	GRJ31BR72J682KWJ1#	
			10000pF	±10%	GRJ31BR72J103KWJ1#	
	250Vdc	X7R	15000pF	±10%	GRJ31BR72E153KWJ1#	
			22000pF	±10%	GRJ31BR72E223KWJ1#	
			68000pF	±10%	GRJ31BR72E683KWJ1#	
1.35mm	100Vdc	X7R	0.22µF	±10%	GRJ31MR72A224KE01#	
				±20%	GRJ31MR72A224ME01#	
	50Vdc	X7R	0.10µF	±10%	GRJ31MR71H104KE01#	
				±20%	GRJ31MR71H104ME01#	
			0.22µF	±10%	GRJ31MR71H224KE01#	
				±20%	GRJ31MR71H224ME01#	
			0.47µF	±10%	GRJ31MR71H474KE01#	
				±20%	GRJ31MR71H474ME01#	
			1.0µF	±10%	GRJ31MR71H105KE01#	
				±20%	GRJ31MR71H105ME01#	
	25Vdc	X7R	2.2µF	±10%	GRJ31MR71E225KE11#	
				±20%	GRJ31MR71E225ME11#	
	16Vdc	X7R	2.2µF	±10%	GRJ31MR71C225KE11#	
				±20%	GRJ31MR71C225ME11#	
1.8mm	1000Vdc	X7R	6800pF	±10%	GRJ31CR73A682KWJ3#	
			10000pF	±10%	GRJ31CR73A103KWJ3#	
	630Vdc	X7R	15000pF	±10%	GRJ31CR72J153KWJ3#	
			22000pF	±10%	GRJ31CR72J223KWJ3#	
	250Vdc	X7R	33000pF	±10%	GRJ31CR72E333KWJ3#	
			47000pF	±10%	GRJ31CR72E473KWJ3#	
			0.10µF	±10%	GRJ31CR72E104KWJ3#	
1.9mm	100Vdc	X7R	1.0µF	±10%	GRJ31CR72A105KE11#	
				±20%	GRJ31CR72A105ME11#	
	50Vdc	X7R	1.0µF	±10%	GRJ31CR71H105KE11#	
				±20%	GRJ31CR71H105ME11#	
			2.2µF	±10%	GRJ31CR71H225KE11#	
				±20%	GRJ31CR71H225ME11#	
			4.7µF	±10%	GRJ31CR71H475KE11#	
				±20%	GRJ31CR71H475ME11#	
	35Vdc	X6S	10µF	±10%	GRJ31CC8YA106KE01#	D1
				±20%	GRJ31CC8YA106ME01#	D1
1.9mm	25Vdc	X7R	10µF	±10%	GRJ31CR71E106KE11#	
				±20%	GRJ31CR71E106ME11#	
	16Vdc	X7R	4.7µF	±10%	GRJ31CR71C475KE11#	
				±20%	GRJ31CR71C475ME11#	
			10µF	±10%	GRJ31CR71C106KE11#	
				±20%	GRJ31CR71C106ME11#	
	10Vdc	X7R	10µF	±10%	GRJ31CR71A106KE11#	
				±20%	GRJ31CR71A106ME11#	
			22µF	±10%	GRJ31CR71A226KE12#	
				±20%	GRJ31CR71A226ME12#	
	6.3Vdc	X7R	22µF	±10%	GRJ31CR70J226KE12#	
				±20%	GRJ31CR70J226ME12#	

3.2×2.5mm

T max.	Rated Voltage	TC Code	Cap.	Tol.	Part Number	
1.5mm	1000Vdc	X7R	6800pF	±10%	GRJ32QR73A682KWJ1#	
			10000pF	±10%	GRJ32QR73A103KWJ1#	
	630Vdc	X7R	22000pF	±10%	GRJ32QR72J223KWJ1#	
	250Vdc	X7R	68000pF	±10%	GRJ32QR72E683KWJ1#	
			0.15µF	±10%	GRJ32QR72E154KWJ1#	
2.0mm	1000Vdc	X7R	15000pF	±10%	GRJ32DR73A153KWJ1#	
			22000pF	±10%	GRJ32DR73A223KWJ1#	
	630Vdc	X7R	33000pF	±10%	GRJ32DR72J333KWJ1#	
			47000pF	±10%	GRJ32DR72J473KWJ1#	
	250Vdc	X7R	0.10µF	±10%	GRJ32DR72E104KWJ1#	
			0.22µF	±10%	GRJ32DR72E224KWJ1#	
2.3mm	100Vdc	X7R	2.2µF	±10%	GRJ32DR72A225KE11#	
				±20%	GRJ32DR72A225ME11#	
		X7S	4.7µF	±10%	GRJ32DC72A475KE11#	
				±20%	GRJ32DC72A475ME11#	
2.8mm	50Vdc	X7R	4.7µF	±10%	GRJ32ER71H475KE11#	
				±20%	GRJ32ER71H475ME11#	
			10µF	±10%	GRJ32ER71H106KE11#	
				±20%	GRJ32ER71H106ME11#	
		X7S	10µF	±10%	GRJ32EC71H106KE11#	
				±20%	GRJ32EC71H106ME11#	
	25Vdc	X7R	10µF	±10%	GRJ32ER71E106KE11#	
				±20%	GRJ32ER71E106ME11#	
	16Vdc	X7R	22µF	±10%	GRJ32ER71C226KE11#	
				±20%	GRJ32ER71C226ME11#	
	10Vdc	X7R	22µF	±10%	GRJ32ER71A226KE11#	
				±20%	GRJ32ER71A226ME11#	
			47µF	±10%	GRJ32ER71A476KE11#	
				±20%	GRJ32ER71A476ME11#	
	6.3Vdc	X7R	47µF	±10%	GRJ32ER70J476KE11#	
				±20%	GRJ32ER70J476ME11#	
2.85mm	25Vdc	X7S	22µF	±10%	GRJ32EC71E226KE11#	

Part number # indicates the package specification code.

GRJ Series High Dielectric Constant Type Deflecting crack Part Number List

4.5×3.2mm

T max.	Rated Voltage	TC Code	Cap.	Tol.	Part Number	
1.5mm	630Vdc	X7R	68000pF	±10%	**GRJ43QR72J683KWJ1#**	
	250Vdc	X7R	0.15μF	±10%	**GRJ43QR72E154KWJ1#**	
2.0mm	1000Vdc	X7R	33000pF	±10%	**GRJ43DR73A333KWJ1#**	
			47000pF	±10%	**GRJ43DR73A473KWJ1#**	
	630Vdc	X7R	0.10μF	±10%	**GRJ43DR72J104KWJ1#**	
	250Vdc	X7R	0.22μF	±10%	**GRJ43DR72E224KWJ1#**	
			0.33μF	±10%	**GRJ43DR72E334KWJ1#**	
			0.47μF	±10%	**GRJ43DR72E474KWJ1#**	

5.7×5.0mm

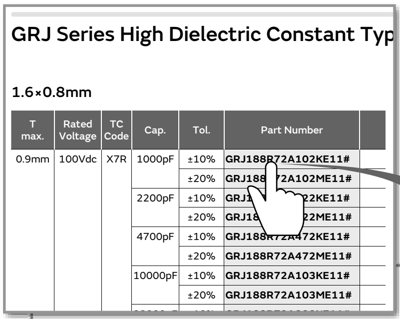
T max.	Rated Voltage	TC Code	Cap.	Tol.	Part Number	
2.0mm	1000Vdc	X7R	68000pF	±10%	**GRJ55DR73A683KWJ1#**	
			0.10μF	±10%	**GRJ55DR73A104KWJ1#**	
	630Vdc	X7R	0.15μF	±10%	**GRJ55DR72J154KWJ1#**	
			0.22μF	±10%	**GRJ55DR72J224KWJ1#**	
	250Vdc	X7R	0.33μF	±10%	**GRJ55DR72E334KWJ1#**	
			0.47μF	±10%	**GRJ55DR72E474KWJ1#**	
			0.68μF	±10%	**GRJ55DR72E684KWJ1#**	
			1.0μF	±10%	**GRJ55DR72E105KWJ1#**	

Part number # indicates the package specification code.

GRJ Series Specifications and Test Methods

Specifications and Test Methods, please refer to the search web page.
https://www.murata.com/en-global/products/capacitor

Links are provided to the product detail pages on the web, and are shown below in the product number table from the PDF version of the catalog which is available on the web.


GRJ Series High Dielectric Constant Typ

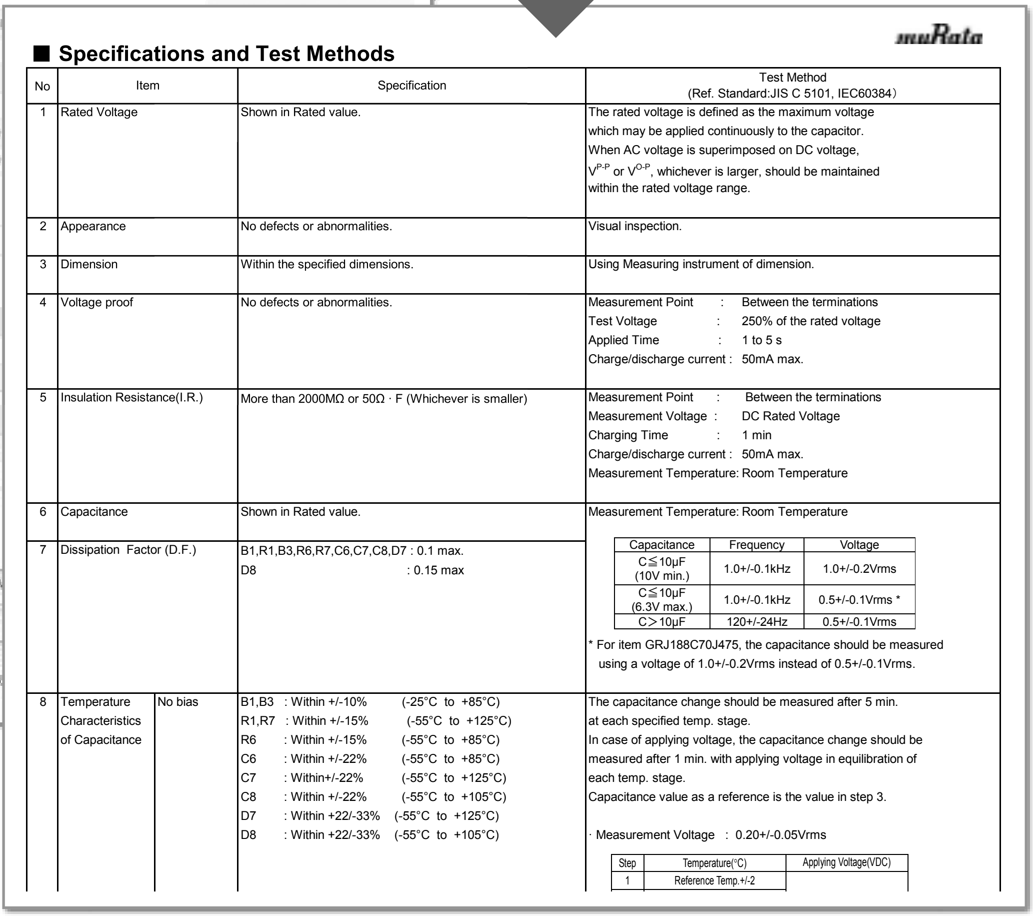
1.6×0.8mm

T max.	Rated Voltage	TC Code	Cap.	Tol.	Part Number	
0.9mm	100Vdc	X7R	1000pF	±10%	GRJ188R72A102KE11#	
				±20%	GRJ188 72A102ME11#	
			2200pF	±10%	GRJ1 22KE11#	
				±20%	GRJ18 22ME11#	
			4700pF	±10%	GRJ188R72A472KE11#	
				±20%	GRJ188R72A472ME11#	
			10000pF	±10%	GRJ188R72A103KE11#	
				±20%	GRJ188R72A103ME11#	


GRJ188C70J475KE11#

Detailed Specifications Sheet

- Rated value
- Specifications and Test Methods
- Package
- Caution, Notice


■ 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 : 250% of the rated voltage Applied Time : 1 to 5 s Charge/discharge current : 50mA max.
5	Insulation Resistance(I.R.)		More than 2000MΩ or 50Ω · F (Whichever is smaller)	Measurement Point : Between the terminations Measurement Voltage : DC Rated Voltage Charging Time : 1 min Charge/discharge current : 50mA max. Measurement Temperature: Room Temperature
6	Capacitance		Shown in Rated value.	Measurement Temperature: Room Temperature Capacitance / Frequency / Voltage C≦10μF (10V min.) / 1.0+/-0.1kHz / 1.0+/-0.2Vrms C≦10μF (6.3V max.) / 1.0+/-0.1kHz / 0.5+/-0.1Vrms * C>10μF / 120+/-24Hz / 0.5+/-0.1Vrms * For item GRJ188C70J475, the capacitance should be measured using a voltage of 1.0+/-0.2Vrms instead of 0.5+/-0.1Vrms.
7	Dissipation Factor (D.F.)		B1,R1,B3,R6,R7,C6,C7,C8,D7 : 0.1 max. D8 : 0.15 max	
8	Temperature Characteristics of Capacitance	No bias	B1,B3 : Within +/-10% (-25°C to +85°C) R1,R7 : Within +/-15% (-55°C to +125°C) R6 : Within +/-15% (-55°C to +85°C) C6 : Within +/-22% (-55°C to +85°C) C7 : Within+/-22% (-55°C to +125°C) C8 : Within +/-22% (-55°C to +105°C) D7 : Within +22/-33% (-55°C to +125°C) D8 : Within +22/-33% (-55°C to +105°C)	The capacitance change should be measured after 5 min. at each specified temp. stage. In case of applying voltage, the capacitance change should be measured after 1 min. with applying voltage in equilibration of each temp. stage. Capacitance value as a reference is the value in step 3. · Measurement Voltage : 0.20+/-0.05Vrms Step / Temperature(°C) / Applying Voltage(VDC) 1 / Reference Temp.+/-2 /

GRM, GR3, GRJ, GR4, GR7, GJM, GQM, GA2, GA3, LLL, LLA, LLM, LLR, NFM, KRM, KR3, GMA, GMD ⚠Caution/Notice

WEB

⚠Caution

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⚠Caution

Storage and Operation Conditions

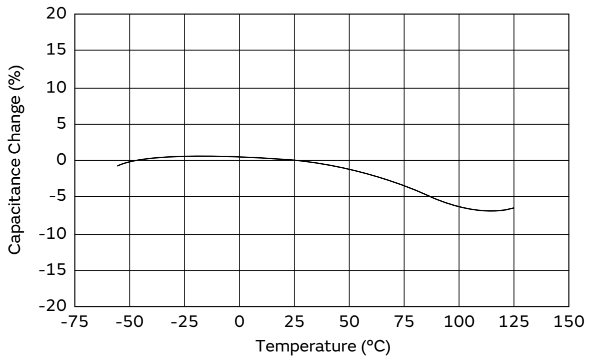
1. The performance of chip multilayer ceramic capacitors and chip EMIFIL NFM series (henceforth just “capacitors”) may be affected by the storage conditions.
Please use them promptly after delivery.
   1-1. Maintain appropriate storage for the capacitors using the following conditions: Room Temperature of +5 to +40°C and a Relative Humidity of 20 to 70%.
   High temperature and humidity conditions and/or prolonged storage may cause deterioration of the packaging materials. If more than six months have elapsed since delivery, check packaging, mounting, etc. before use.
   In addition, this may cause oxidation of the electrodes. If more than one year has elapsed since delivery, also check the solderability before use.
   1-2. Corrosive gas can react with the termination (external) electrodes or lead wires of capacitors, and result in poor solderability. Do not store the capacitors in an atmosphere consisting of corrosive gas (e.g., hydrogen sulfide, sulfur dioxide, chlorine, ammonia gas, etc.).
   1-3. Due to moisture condensation caused by rapid humidity changes, or the photochemical change caused by direct sunlight on the terminal electrodes and/or the resin/epoxy coatings, the solderability and electrical performance may deteriorate. Do not store capacitors under direct sunlight or in high humidity conditions.

Rating

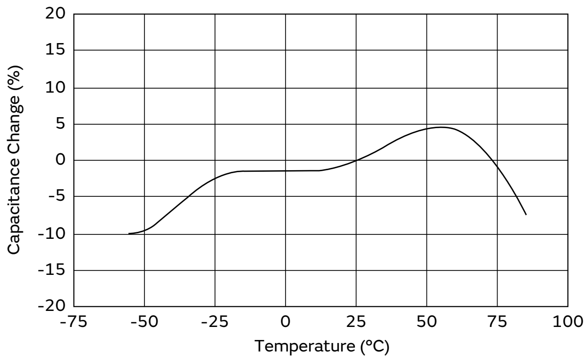
1. Temperature Dependent Characteristics

1. The electrical characteristics of a capacitor can change with temperature.
   1-1. For capacitors having larger temperature dependency, the capacitance may change with temperature changes.
   The following actions are recommended in order to ensure suitable capacitance values.
   (1) Select a suitable capacitance for the operating temperature range.
   (2) The capacitance may change within the rated temperature.
   When you use a high dielectric constant type capacitor in a circuit that needs a tight (narrow) capacitance tolerance (e.g., a time-constant circuit), please carefully consider the temperature characteristics, and carefully confirm the various characteristics in actual use conditions and the actual system.

[Example of Temperature Characteristics X7R (R7)]
Sample: 0.1μF, Rated Voltage 50VDC



[Example of Temperature Characteristics X5R (R6)]
Sample: 22μF, Rated Voltage 4VDC



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 an AC circuit.

Continued on the following page.↗

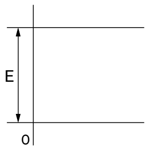
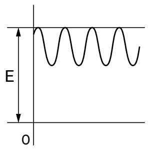
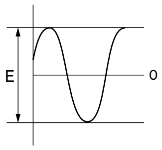
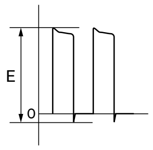
⚠Caution

Continued from the preceding page.↘

3. Applied Voltage and Applied Current

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.

Typical Voltage Applied to the DC Capacitor

DC Voltage	DC Voltage+AC	AC Voltage	Pulse Voltage
			

(E: Maximum possible applied 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.
2. Use a safety standard certified capacitor in a power supply input circuit (AC filter), as it is also necessary to consider the withstand voltage and impulse withstand voltage defined for each device.

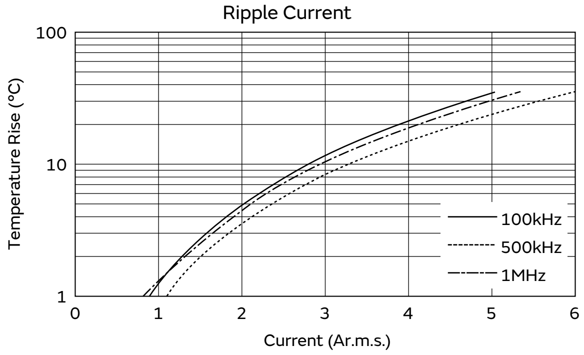
<Applicable to NFM Series>

3. The capacitors also have rated currents.
   The current flowing between the terminals of a capacitor shall be less than or equal to the rated current. Using the capacitor beyond this range could lead to excessive heat.

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 so that the self-heating of the capacitor body remains below 20°C, when measuring at an ambient temperature of 25°C.

[Example of Temperature Rise (Heat Generation) in Chip Multilayer Ceramic Capacitors in Contrast to Ripple Current]
Sample: R (R1) characteristics 10μF,
Rated voltage: DC10V



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⚠Caution

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<Applicable to Temperature Characteristics X7R (R7), X7T (D7), X7T (W0) beyond Rated Voltage of 200VDC>

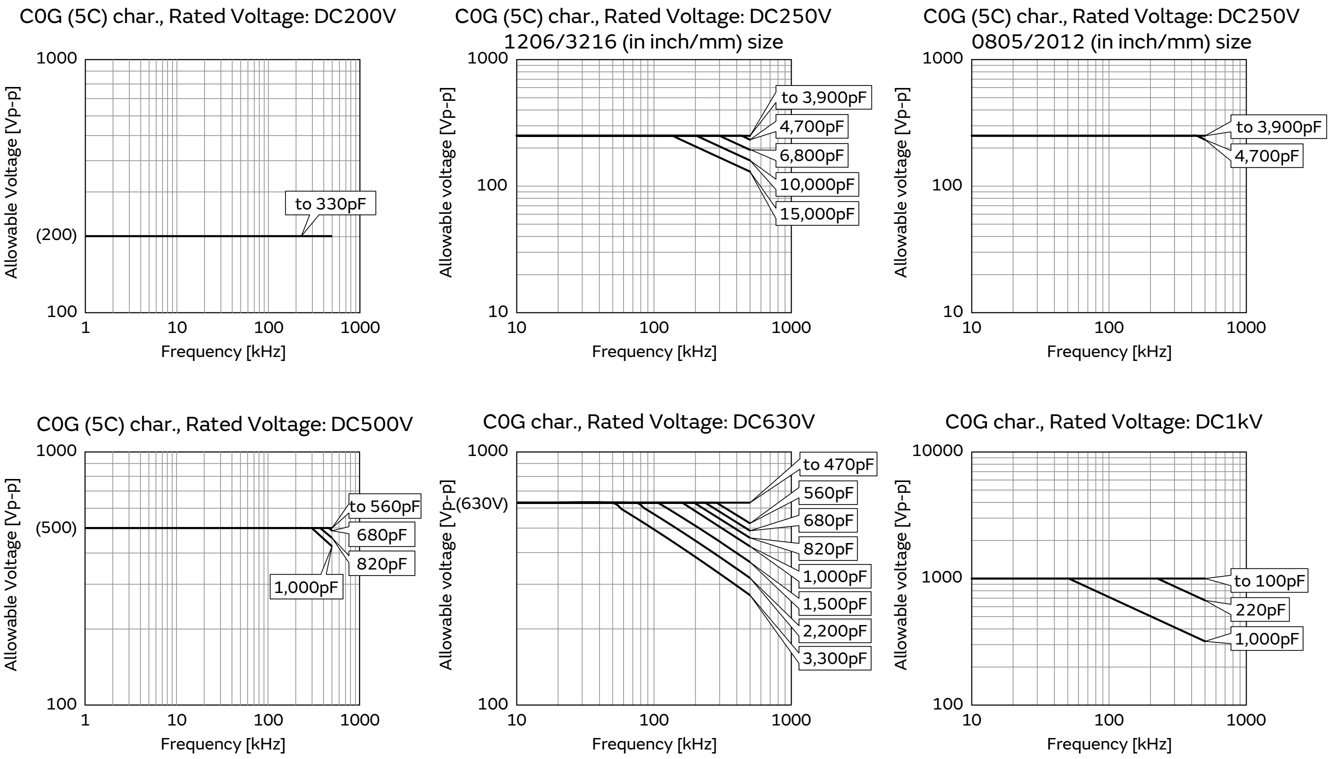
1-2. The load should be contained so that the self-heating of the capacitor body remains below 20°C, when measuring at an ambient temperature of 25°C. In addition, use a K thermocouple of ø0.1mm with less heat capacity when measuring, and measure in a condition where there is no effect from the radiant heat of other components or air flow caused by convection. Excessive generation of heat may cause deterioration of the characteristics and reliability of the capacitor. (Absolutely do not perform measurements while the cooling fan is operating, as an accurate measurement may not be performed.)

<Applicable to Temperature Characteristics U2J (7U), C0G (5C) beyond Rated Voltage of 200VDC>

1-3. Since the self-heating is low in the low loss series, the allowable power becomes extremely high compared to the common X7R (R7) characteristics.
However, when a load with self-heating of 20°C is applied at the rated voltage, the allowable power may be exceeded. When the capacitor is used in a high-frequency voltage circuit of 1kHz or more, the frequency of the applied voltage should be less than 500kHz sine wave (less than 100kHz for a product with rated voltage of DC3.15kV), to limit the voltage load so that the load remains within the derating shown in the following figure. In the case of non-sine wave, high-frequency components exceeding the fundamental frequency may be included. In such a case, please contact Murata. The excessive generation of heat may cause deterioration of the characteristics and reliability of the capacitor.
(Absolutely do not perform measurements while the cooling fan is operating, as an accurate measurement may not be performed.)

[The sine-wave frequency VS allowable voltage]

The surface temperature of the capacitor: 125°C or less
(including self-heating)



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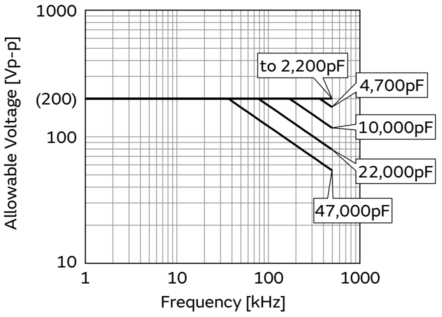
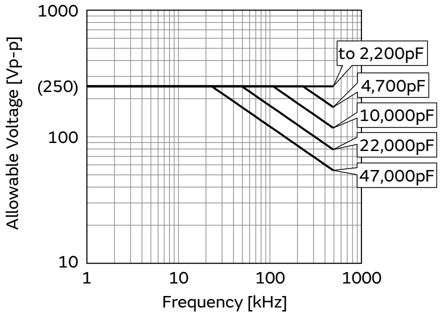
[The sine-wave frequency VS allowable voltage]

The surface temperature of the capacitor: 125°C or less
(including self-heating)

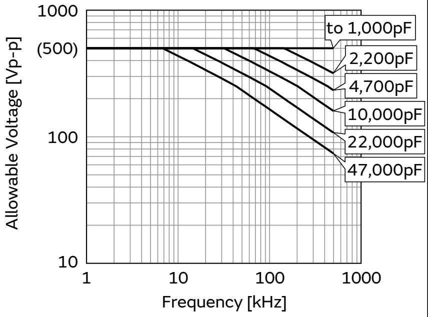
U2J (7U) char., Rated Voltage: DC200V



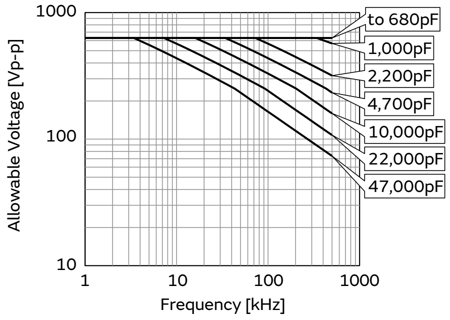
U2J (7U) char., Rated Voltage: DC250V



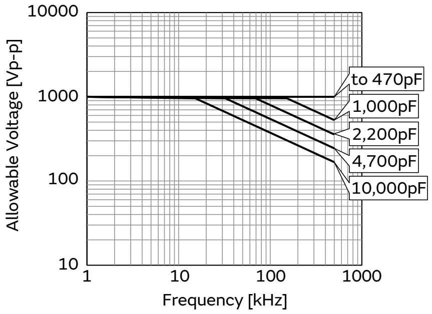
U2J (7U) char., Rated Voltage: DC500V



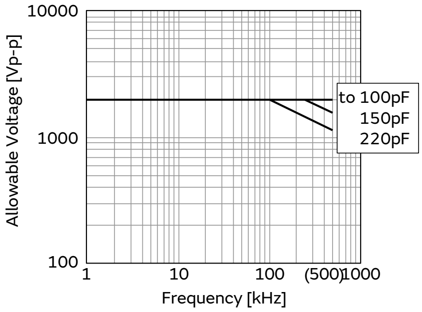
U2J (7U) char., Rated Voltage: DC630V



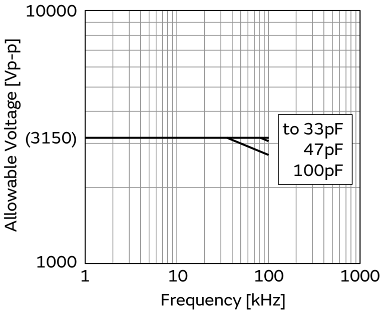
U2J (7U) char., Rated Voltage: DC1kV



U2J (7U) char., Rated Voltage: DC2kV



U2J (7U) char., Rated Voltage: DC3.15kV



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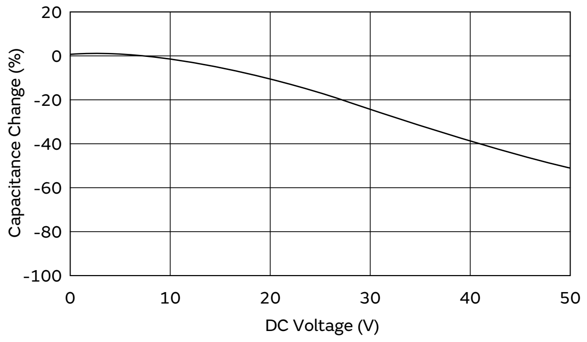
5. DC Voltage and AC Voltage Characteristics

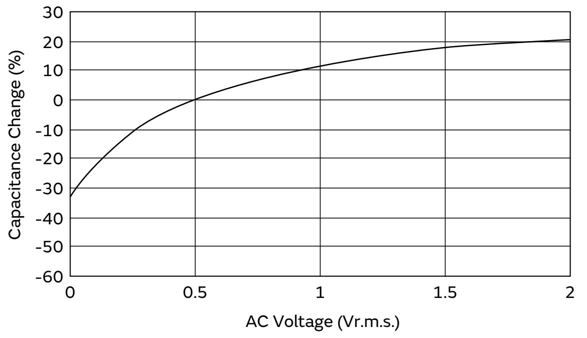
1. The capacitance value of a high dielectric constant type capacitor changes depending on the DC voltage applied. Please consider the DC voltage characteristics when a capacitor is selected for use in a DC circuit.
   - 1-1. The capacitance of ceramic capacitors may change sharply depending on the applied voltage (see figure). Please confirm the following in order to secure the capacitance.
     - (1) Determine whether the capacitance change caused by the applied voltage is within the allowed range.
     - (2) In the DC voltage characteristics, the rate of capacitance change becomes larger as voltage increases, even if the applied voltage is below the rated voltage. When a high dielectric constant type capacitor is used in a circuit that requires a tight (narrow) capacitance tolerance (e.g., a time constant circuit), please carefully consider the voltage characteristics, and confirm the various characteristics in the actual operating conditions of the system.

[Example of DC Voltage Characteristics]
Sample: X7R (R7) Characteristics 0.1μF,
Rated Voltage 50VDC



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

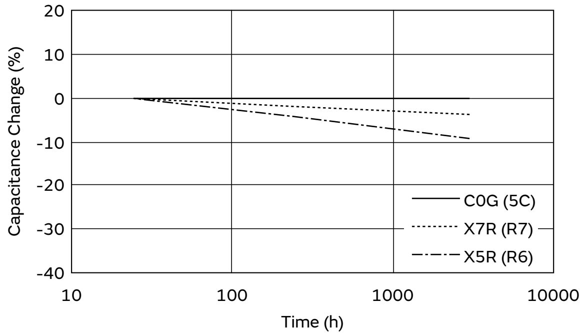
[Example of AC Voltage Characteristics]
Sample: X7R (R7) Characteristics 10μF,
Rated Voltage 6.3VDC



6. Capacitance Aging

1. The high dielectric constant type capacitors have an Aging characteristic in which the capacitance value decreases with the passage of time.
   When you use high dielectric constant type capacitors in a circuit that needs a tight (narrow) capacitance tolerance (e.g., a time-constant circuit), please carefully consider the characteristics of these capacitors, such as their aging, voltage, and temperature characteristics. In addition, check capacitors using your actual appliances at the intended environment and operating conditions.

[Example of Change Over Time (Aging Characteristics)]



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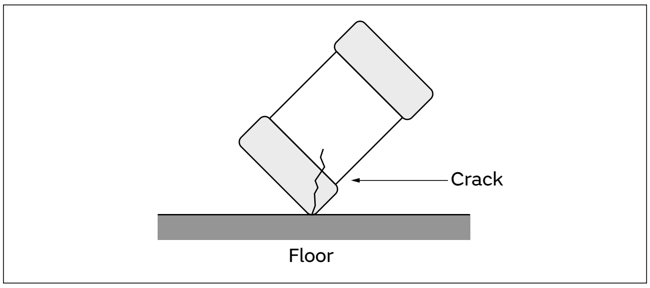
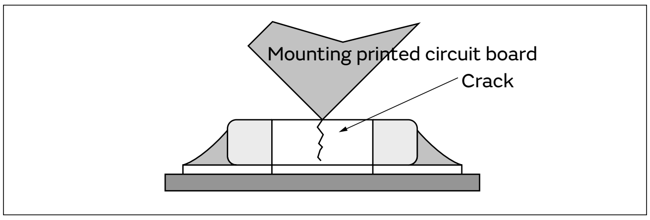
7. Vibration and Shock

1. Please confirm the kind of vibration and/or shock, its condition, and any generation of resonance.
   Please mount the capacitor so as not to generate resonance, and do not allow any impact on the terminals.
2. Mechanical shock due to being dropped may cause damage or a crack in the dielectric material of the capacitor.
   Do not use a dropped capacitor because the quality and reliability may be deteriorated.



3. When printed circuit boards are piled up or handled, the corner of another printed circuit board should not be allowed to hit the capacitor, in order to avoid a crack or other damage to the capacitor.

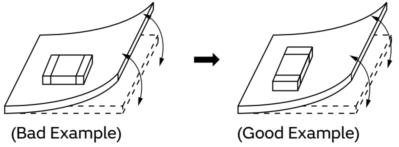


Soldering and Mounting

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]

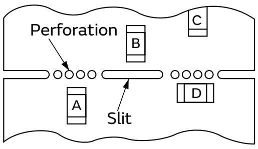


Locate chip horizontal to the direction in which stress acts.

[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.

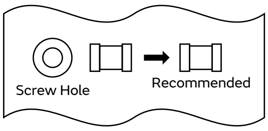
Contents of Measures	Stress Level
(1) Turn the mounting direction of the component parallel to the board separation surface.	A > D *1
(2) Add slits in the board separation part.	A > B
(3) Keep the mounting position of the component away from the board separation surface.	A > C



*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.



<Applicable to NFM Series>

2. If you mount the capacitor near components that generate heat, take note of the heat from the other components and carefully check the self-heating of the capacitor before using.
   If there is significant heat radiation from other components, it could lower the insulation resistance of the capacitor or produce excessive heat.

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⚠Caution

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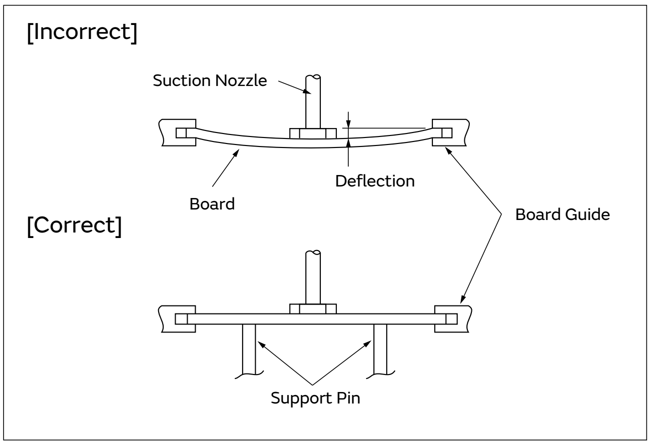
2. Information before Mounting

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.
8. We have also produced a DVD which shows a summary of our recommendations, regarding the precautions for mounting. Please contact our sales representative to request the DVD.

3. Maintenance of the Mounting (pick and place) Machine

1. Make sure that the following excessive forces are not applied to the capacitors. Check the mounting in the actual device under actual use conditions ahead of time.
   1-1. In mounting the capacitors on the printed circuit board, any bending force against them shall be kept to a minimum to prevent them from any damage or cracking. Please take into account the following precautions and recommendations for use in your process.
      (1) Adjust the lowest position of the pickup nozzle so as not to bend the printed circuit board.



2. Dirt particles and dust accumulated in the suction nozzle and suction mechanism prevent the nozzle from moving smoothly. This creates excessive force on the capacitor during mounting, causing cracked chips. Also, the locating claw, when worn out, imposes uneven forces on the chip when positioning, causing cracked chips. The suction nozzle and the locating claw must be maintained, checked, and replaced periodically.

<Applicable to ZRB Series>

3. To adjust the inspection tolerance for automated appearance sorting machine of mounting position, because ZRB series are easier to shift the mounting position than standard MLCC.
4. To check the overturn and reverse of chip.
5. To control mounting speed carefully, because ZRB series is heavier than standard MLCC.

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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. 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 table 1.

Table 1

Series	Chip Dimension Code (L/W)	Temperature Differential
GRM/GJM/GQM/GR3/ GRJ/KRM/LLR/NFM/GR7	**02/03/15/18/21/31**	ΔT≦190°C
LLL	**02/03/15/18/1U/21/31**	
ZRB	**15/18**	
GR3/GRJ/GRM/KR3/KRM GA2/GA3/GR4	**32/42/43/52/55**	ΔT≦130°C
LLA/LLM	**18/21/31**	
GQM	**22**	

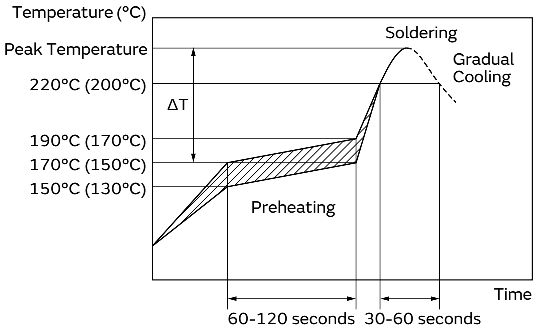
Recommended Conditions

	Pb-Sn Solder	Lead Free Solder
Peak Temperature	230 to 250°C	240 to 260°C
Atmosphere	Air	Air or N_2

Pb-Sn Solder: Sn-37Pb
Lead Free Solder: Sn-3.0Ag-0.5Cu

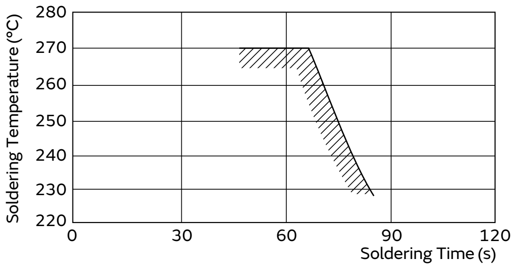
3. When a capacitor is mounted at a temperature lower than the peak reflow temperature recommended by the solder manufacturer, the following quality problems can occur. Consider factors such as the placement of peripheral components and the reflow temperature setting to prevent the capacitor's reflow temperature from dropping below the peak temperature specified. Be sure to evaluate the mounting situation beforehand and verify that none of the following problems occur.
   - Drop in solder wettability
   - Solder voids
   - Possible occurrence of whiskering
   - Drop in bonding strength
   - Drop in self-alignment properties
   - Possible occurrence of tombstones and/or shifting on the land patterns of the circuit board

[Example of Temperature Conditions for Reflow Soldering]



Temperature
Incase of Lead Free Solder
( ): In case of Pb-Sn Solder

[Allowable Reflow Soldering Temperature and Time]



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

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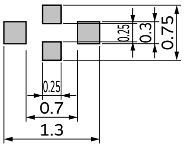
4. Optimum Solder Amount for Reflow Soldering
   - 4-1. Overly thick application of solder paste results in a excessive solder fillet height.
     This makes the chip more susceptible to mechanical and thermal stress on the board and may cause the chips to crack.
   - 4-2. Too little solder paste results 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.

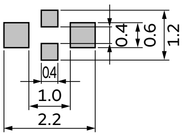
<Applicable to NFM Series>

[Guideline of solder paste thickness]
100-150μm: NFM15/18/21/3D/31
100-200μm: NFM41

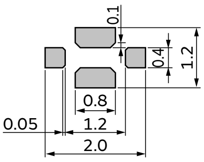
NFM15CC/15PC



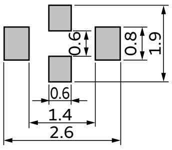
NFM18CC/18PC



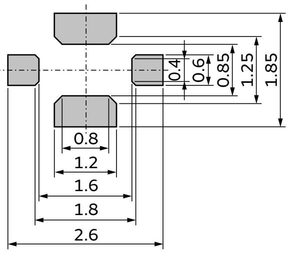
NFM18PS



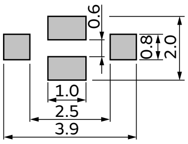
NFM21CC/21PC



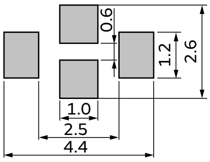
NFM21PS



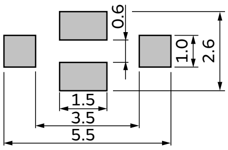
NFM3DCC/3DPC



NFM31PC/31KC



NFM41CC/41PC



Inverting the PCB

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

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4-2. Flow Soldering

1. Do not apply flow soldering to chips not listed in table 2.

Table 2

Series	Chip Dimension Code (L/W)	Temperature Differential
GR3/GRM	**18/21/31**	ΔT≦150°C
GQM	**18/21**	
LLL	**21/31**	
GRJ	**18/21/31**	
NFM	**3D/31/41**	

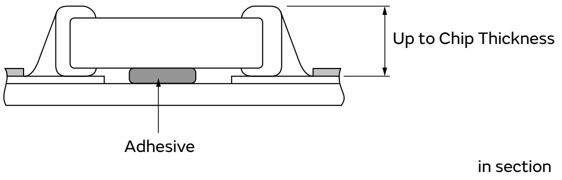
2. When sudden heat is applied to the components, the mechanical strength of the components will decrease because a sudden temperature change causes deformation inside the components. In order to prevent mechanical damage to the components, preheating is required for both of the components and the PCB. Preheating conditions are shown in table 2. It is required to keep the temperature differential between the solder and the components surface (ΔT) as low as possible.
3. Excessively long soldering time or high soldering temperature can result in leaching of the terminations, causing poor adhesion or a reduction in capacitance value due to loss of contact between the inner electrodes and terminations.
4. When components are immersed in solvent after mounting, be sure to maintain the temperature differential (ΔT) between the component and solvent within the range shown in the table 2.

Recommended Conditions

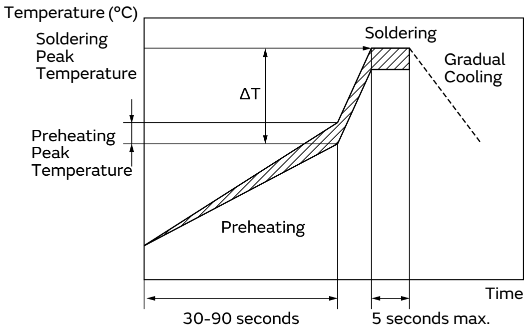
	Pb-Sn Solder	Lead Free Solder
Preheating Peak Temperature	90 to 110°C	100 to 120°C 140 to 160°C (**NFM**)
Soldering Peak Temperature	240 to 250°C	250 to 260°C
Atmosphere	Air	Air or N_2

Pb-Sn Solder: Sn-37Pb
Lead Free Solder: Sn-3.0Ag-0.5Cu

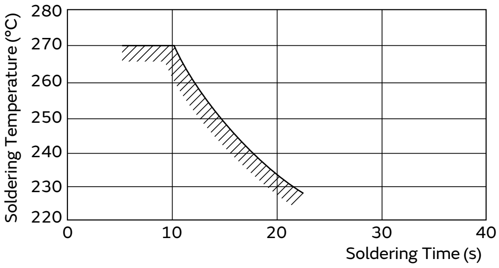
5. Optimum Solder Amount for Flow Soldering
   5-1. The top of the solder fillet should be lower than the thickness of the components. If the solder amount is excessive, the risk of cracking is higher during board bending or any other stressful condition.



[Example of Temperature Conditions for Flow Soldering]



[Allowable Flow Soldering Temperature and Time]



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

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4-3. Correction of Soldered Portion

When sudden heat is applied to the capacitor, distortion caused by the large temperature difference occurs internally, and can be the cause of cracks. Capacitors also tend to be affected by mechanical and thermal stress depending on the board preheating temperature or the soldering fillet shape, and can be the cause of cracks. Please refer to "1. PCB Design" or "3. Optimum solder amount" for the solder amount and the fillet shapes.
Do not correct with a soldering iron for ZRB series.
Correction with a soldering iron for ZRB series may cause loss suppress acoustic noise, because the solder amount become excessive.

1. Correction with a Soldering Iron
   1-1. In order to reduce damage to the capacitor, be sure to preheat the capacitor and the mounting board. Preheat to the temperature range shown in Table 3. A hot plate, hot air type preheater, etc. can be used for preheating.
   1-2. After soldering, do not allow the component/PCB to cool down rapidly.
   1-3. Perform the corrections with a soldering iron as quickly as possible. If the soldering iron is applied too long, there is a possibility of causing solder leaching on the terminal electrodes, which will cause deterioration of the adhesive strength and other problems.

Table 3

Series	Chip Dimension Code (L/W)	Temperature of Soldering Iron Tip	Preheating Temperature	Temperature Differential (ΔT)	Atmosphere
GJM/GQM/GR3/GRJ/GRM/GR7	**03/15/18/21/31**	350°C max.	150°C min.	ΔT≦190°C	Air
GRJ/GRM/GR4/GA2/GA3	**32/42/43/52/55**	280°C max.	150°C min.	ΔT≦130°C	Air
GQM	**22**				
NFM	**3D/41**	350°C max.	150°C min.	ΔT≦190°C	Air
	15	340°C max.			

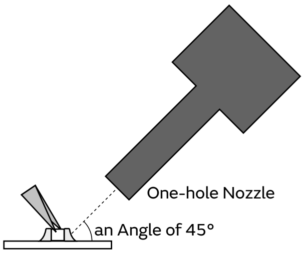
*Applicable for both Pb-Sn and Lead Free Solder.
Pb-Sn Solder: Sn-37Pb
Lead Free Solder: Sn-3.0Ag-0.5Cu
*Please manage ΔT in the temperature of soldering iron and the preheating temperature.

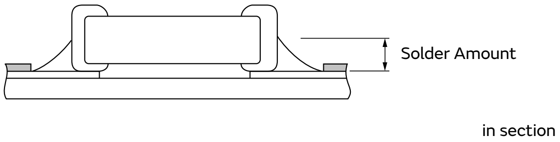
2. Correction with Spot Heater
   Compared to local heating with a soldering iron, hot air heating by a spot heater heats the overall component and board, therefore, it tends to lessen the thermal shock. In the case of a high density mounted board, a spot heater can also prevent concerns of the soldering iron making direct contact with the component.
   2-1. If the distance from the hot air outlet of the spot heater to the component is too close, cracks may occur due to thermal shock. To prevent this problem, follow the conditions shown in Table 4.
   2-2. In order to create an appropriate solder fillet shape, it is recommended that hot air be applied at the angle shown in Figure 1.

Table 4

Distance	5mm or more
Hot Air Application Angle	45° *Figure 1
Hot Air Temperature Nozzle Outlet	400°C max.
Application Time	Less than 10 seconds (1206 (3216M) size or smaller)
	Less than 30 seconds (1210 (3225M) size or larger)

[*Figure 1]





3. Optimum solder amount when re-working with a soldering iron
   3-1. If the solder amount is excessive, the risk of cracking is higher during board bending or any other stressful condition.
   Too little solder amount results in a lack of adhesive strength on the termination, which may result in chips breaking loose from the PCB.
   Please confirm that solder has been applied smoothly and rising to the end surface of the chip.

Continued on the following page.↗

⚠Caution

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3-2. A soldering iron with a tip of ø3mm or smaller should be used. It is also necessary to keep the soldering iron from touching the components during the re-work.

3-3. Solder wire with ø0.5mm or smaller is required for soldering.

<Applicable to KR3/KRM Series>

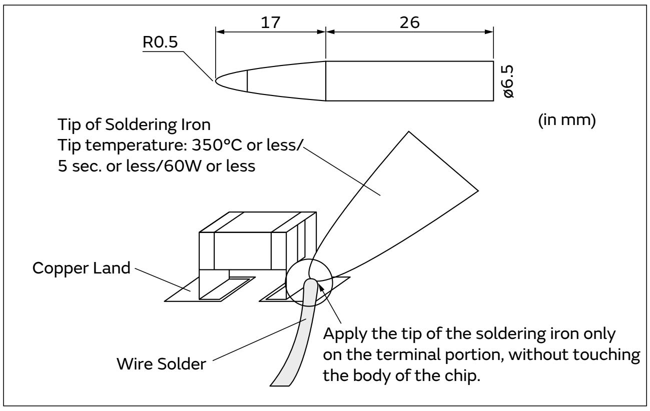
4. For the shape of the soldering iron tip, refer to the figure on the right.
Regarding the type of solder, use a wire diameter of ø0.5mm or less (rosin core wire solder).

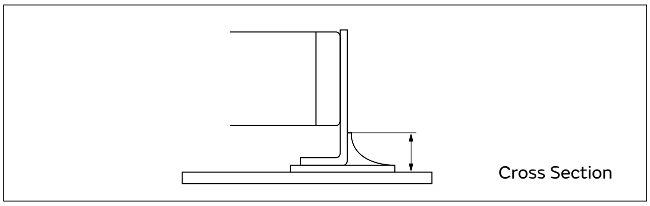
4-1. How to Apply the Soldering Iron
Apply the tip of the soldering iron against the lower end of the metal terminal.

1) In order to prevent cracking caused by sudden heating of the ceramic device, do not touch the ceramic base directly.

2) In order to prevent deviations and dislocating of the chip, do not touch the junction of the chip and the metal terminal, and the metal portion on the outside directly.

4-2. Appropriate Amount of Solder
The amount of solder for corrections by soldering iron, should be lower than the height of the lower side of the chip.





5. Washing

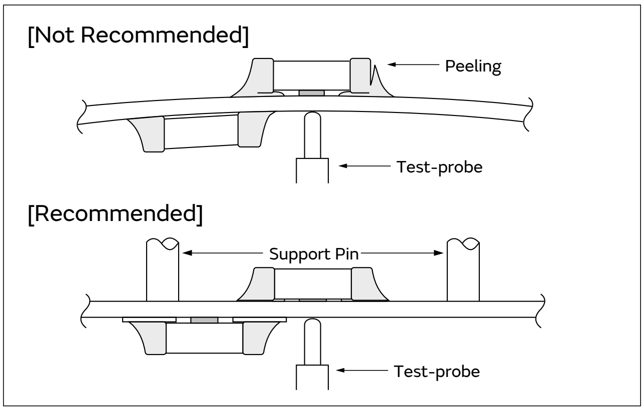
Excessive ultrasonic oscillation during cleaning can cause the PCBs to resonate, resulting in cracked chips or broken solder joints. Before starting your production process, test your cleaning equipment/process to insure it does not degrade the capacitors.

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.

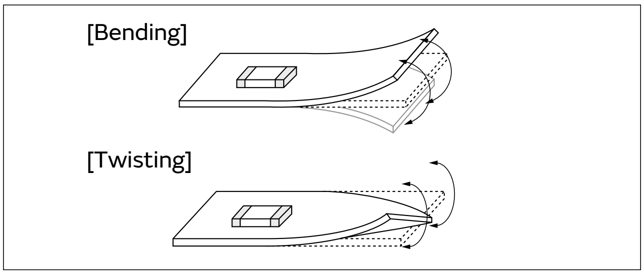
1-2. Avoid vibration of the board by shock when a test-probe contacts a printed circuit board.



7. Printed Circuit Board Cropping

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

1-1. In cropping the board, the stress as shown at right 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.



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⚠Caution

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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

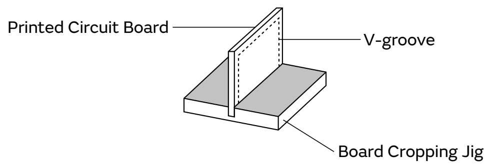
* When a board separation jig or disc separator is used, if the following precautions are not observed, a large board deflection stress will occur and the capacitors may crack. Use router type separator if at all possible.

(1) Example of a suitable jig

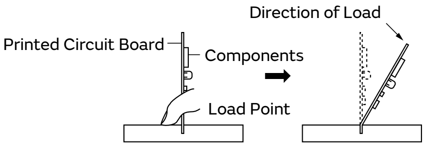
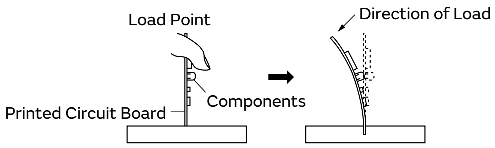
[In the case of Single-side Mounting]

An outline of the board separation jig is shown as follows. Recommended example: Stress on the component mounting position can be minimized by holding the portion close to the jig, and bend in the direction towards the side where the capacitors are mounted. Not recommended example: The risk of cracks occurring in the capacitors increases due to large stress being applied to the component mounting position, if the portion away from the jig is held and bent in the direction opposite the side where the capacitors are mounted.

[Outline of Jig]



Hand Separation

Recommended	Not Recommended
	

[In the case of Double-sided Mounting]

Since components are mounted on both sides of the board, the risk of cracks occurring can not be avoided with the above method.

Therefore, implement the following measures to prevent stress from being applied to the components.

(Measures)

(1) Consider introducing a router type separator.
If it is difficult to introduce a router type separator, implement the following measures. (Refer to item 1. Mounting Position)

(2) Mount the components parallel to the board separation surface.

(3) When mounting components near the board separation point, add slits in the separation position near the component.

(4) Keep the mounting position of the components away from the board separation point.

Continued on the following page.↗

⚠Caution

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(2) Example of a Disc Separator

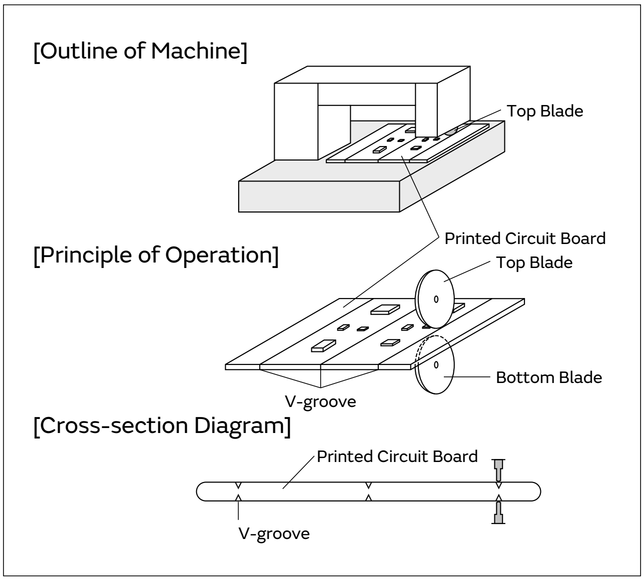
An outline of a disc separator is shown as follows. As shown in the Principle of Operation, the top blade and bottom blade are aligned with the V-grooves on the printed circuit board to separate the board.

In the following case, board deflection stress will be applied and cause cracks in the capacitors.

(1) When the adjustment of the top and bottom blades are misaligned, such as deviating in the top-bottom, left-right or front-rear directions

(2) The angle of the V groove is too low, depth of the V groove is too shallow, or the V groove is misaligned top-bottom

IF V groove is too deep, it is possible to brake when you handle and carry it. Carefully design depth of the V groove with consideration about strength of material of the printed circuit board.

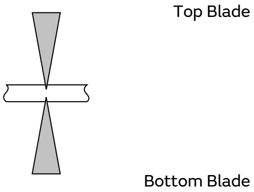
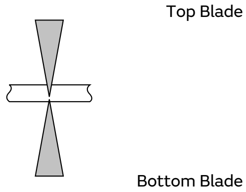
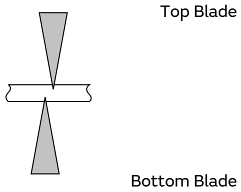
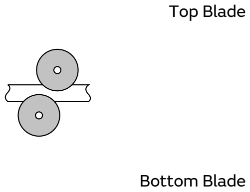


[Outline of Machine]

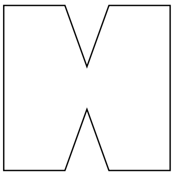
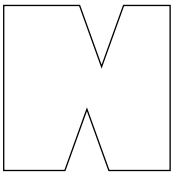
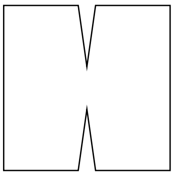
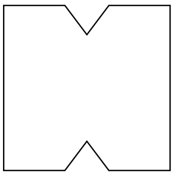
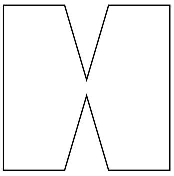
[Principle of Operation]

[Cross-section Diagram]

Disc Separator

Recommended	Not Recommended		
	Top-bottom Misalignment	Left-right Misalignment	Front-rear Misalignment
			

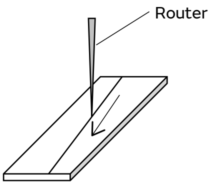
V-groove Design

Example of Recommended V-groove Design	Not Recommended			
	Left-right Misalignment	Low-Angle	Depth too Shallow	Depth too Deep
				

(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]

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⚠Caution

Continued from the preceding page.↘

8. Assembly

1. Handling

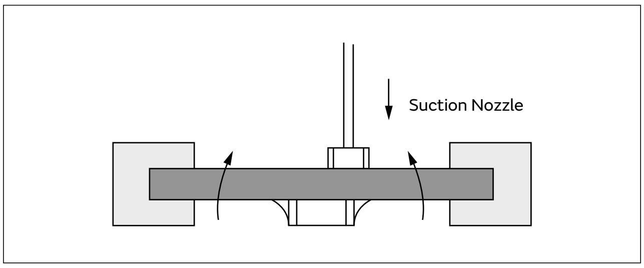
If a board mounted with capacitors is held with one hand, the board may bend. Firmly hold the edges of the board with both hands when handling.
If a board mounted with capacitors is dropped, cracks may occur in the capacitors.
Do not use dropped boards, as there is a possibility that the quality of the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

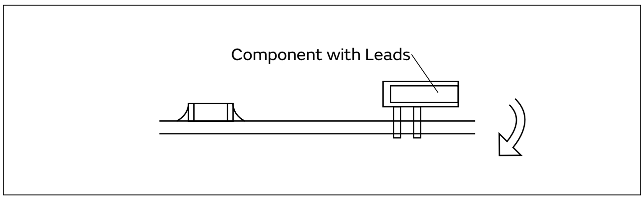
· After the board is straightened, set the bottom dead point of the nozzle on the upper surface of the board.
· Periodically check and adjust the bottom dead point.



2-2. Inserting Components with Leads into Boards

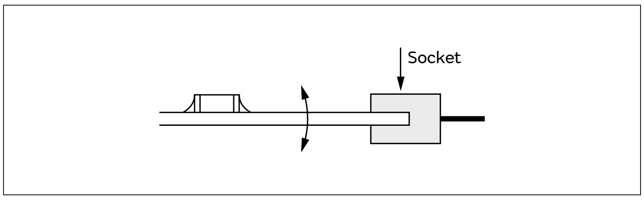
When inserting components (transformers, IC, etc.) into boards, bending the board may cause cracks in the capacitors or cracks in the solder.
Pay attention to the following.

· 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 support pins on the board, periodically confirm that there is no difference in the height of each support pin.



2-3. Attaching/Removing Sockets and/or Connectors

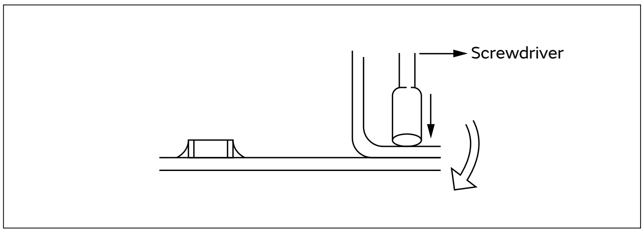
Insertion and removal of sockets and connectors, etc., might cause the board to bend. Please insure that the board does not warp during insertion and removal of sockets and connectors, etc., or the bending may damage mounted components on the board.



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.



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⚠Caution

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<Applicable to GMA or GMD Series>

9. Die Bonding/Wire Bonding

1. Die Bonding of Capacitors
   1-1. Use the following materials for the Brazing alloys:
   Au-Sn (80/20) 300 to 320 °C in N_2 atmosphere
   1-2. Mounting
   (1) Control the temperature of the substrate so it matches the temperature of the brazing alloy.
   (2) Place the brazing alloy on the substrate and place the capacitor on the alloy. Hold the capacitor and gently apply the load. Be sure to complete the operation within 1 minute.
2. Wire Bonding
   2-1. Wire
   Gold wire: 25 micro m (0.001 inch) diameter
   2-2. Bonding
   (1) Thermo compression, ultrasonic ball bonding.
   (2) Required stage temperature: 150 to 200 °C
   (3) Required wedge or capillary weight: 0.2N to 0.5N
   (4) Bond the capacitor and base substrate or other devices with gold wire.

Other

1. Under Operation of Equipment

1-1. Do not touch a capacitor directly with bare hands during operation in order to avoid the danger of an electric shock.

1-2. Do not allow the terminals of a capacitor to come in contact with any conductive objects (short-circuit). Do not expose a capacitor to a conductive liquid, including any acid or alkali solutions.

1-3. Confirm the environment in which the equipment will operate is under the specified conditions.
Do not use the equipment under the following environments.
(1) Being spattered with water or oil.
(2) Being exposed to direct sunlight.
(3) Being exposed to ozone, ultraviolet rays, or radiation.
(4) Being exposed to toxic gas (e.g., hydrogen sulfide, sulfur dioxide, chlorine, ammonia gas, etc.)
(5) Any vibrations or mechanical shocks exceeding the specified limits.
(6) Moisture condensing environments.

1-4. Use damp proof countermeasures if using under any conditions that can cause condensation.

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⚠Caution

Continued from the preceding page.↘

2. Other

2-1. In an Emergency

(1) If the equipment should generate smoke, fire, or smell, immediately turn off or unplug the equipment.
If the equipment is not turned off or unplugged, the hazards may be worsened by supplying continuous power.

(2) In this type of situation, do not allow face and hands to come in contact with the capacitor or burns may be caused by the capacitor's high temperature.

2-2. Disposal of Waste

When capacitors are disposed of, they must be burned or buried by an industrial waste vendor with the appropriate licenses.

2-3. Circuit Design

(1) Addition of Fail Safe Function
Capacitors that are cracked by dropping or bending of the board may cause deterioration of the insulation resistance, and result in a short.
If the circuit being used may cause an electrical shock, smoke or fire when a capacitor is shorted, be sure to install fail-safe functions, such as a fuse, to prevent secondary accidents.

(2) Capacitors used to prevent electromagnetic interference in the primary AC side circuit, or as a connection/insulation, must be a safety standard certified product, or satisfy the contents stipulated in the Electrical Appliance and Material Safety Law.
Install a fuse for each line in case of a short.

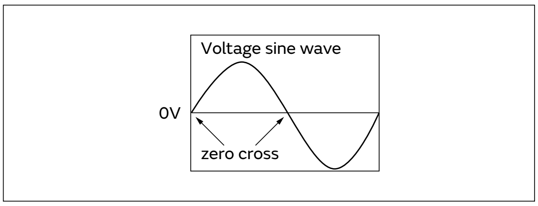
(3) The GJM, GMA, GMD, GQM, GR3, GRJ, GRM, KR3, KRM, LLA, LLL, LLM, LLR, NFM and ZRB series are not safety standard certified products.

2-4. Test Condition for AC Withstanding Voltage

(1) Test Equipment
Test equipment for AC withstanding voltage should be made with equipment capable of creating a wave similar to a 50/60Hz sine wave.

(2) Voltage Applied Method
The capacitor's lead or terminal should be firmly connected to the output of the withstanding voltage test equipment, and then the voltage should be raised from near zero to the test voltage.
If the test voltage is applied directly to the capacitor without raising it from near zero, it should be applied with the zero cross. *At the end of the test time, the test voltage should be reduced to near zero, and then capacitor's lead or terminals should be taken off the output of the withstanding voltage test equipment.
If the test voltage applied directly to the capacitor without raising it from near zero, surge voltage may occur and cause a defect.

*ZERO CROSS is the point where voltage sine wave passes 0V. - See the figure at right -



2-5. Remarks

Failure to follow the cautions may result, worst case, in a short circuit and smoking when the product is used.
The above notices are for standard applications and conditions. Contact us when the products are used in special mounting conditions.
Select optimum conditions for operation as they determine the reliability of the product after assembly.
The data herein are given in typical values, not guaranteed ratings.

Notice

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 the capacitor, noise may occur.

Soldering and Mounting

1. PCB Design

1. Notice for Pattern Forms
   1-1. Unlike leaded components, chip components are susceptible to flexing stresses since they are mounted directly on the substrate.
   They are also more sensitive to mechanical and thermal stresses than leaded components.
   Excess solder fillet height can multiply these stresses and cause chip cracking. When designing substrates, take land patterns and dimensions into consideration to eliminate the possibility of excess solder fillet height.
   1-2. There is a possibility of chip cracking caused by PCB expansion/contraction with heat, because stress on a chip is different depending on PCB material and structure. When the thermal expansion coefficient greatly differs between the board used for mounting and the chip, it will cause cracking of the chip due to the thermal expansion and contraction.
   When capacitors are mounted on a fluorine resin printed circuit board or on a single-layered glass epoxy board, it may also cause cracking of the chip for the same reason.

<Applicable to NFM Series>

1-3. Because noise is suppressed by shunting unwanted high-frequency components to the ground, when designing a land for the NFM series, design the ground pattern to be as large as possible in order to better bring out this characteristic.
As shown in the figure below, noise countermeasures can be made more effective by using a via to connect the ground pattern on the chip mounting surface to a larger ground pattern on the inner layer.

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Notice

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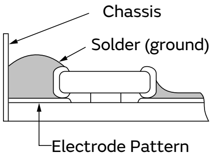
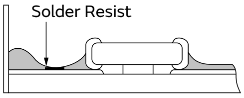
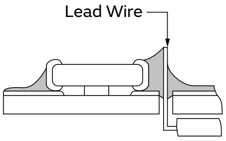
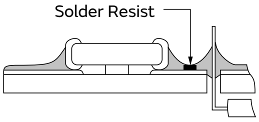
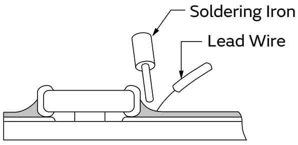
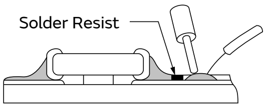
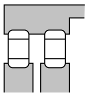
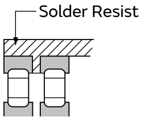
Pattern Forms

	Prohibited	Correct
Placing Close to Chassis	 in section	 in section
Placing of Chip Components and Leaded Components	 in section	 in section
Placing of Leaded Components after Chip Component	 in section	 in section
Lateral Mounting		

2. Land Dimensions

2-1. Please refer to the land dimensions in table 1 for flow soldering, table 2 for reflow soldering, table 3 for reflow soldering for ZRB Series, table 4 for reflow soldering for LLA Series, table 5 for reflow soldering for LLM Series.
Please confirm the suitable land dimension by evaluating of the actual SET / PCB.

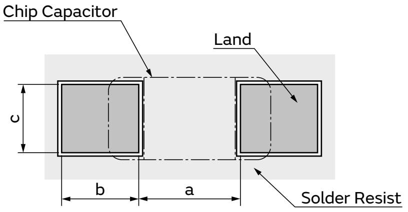


Table 1 Flow Soldering Method

Series	Chip Dimension Code (L/W)	Chip (L×W)	a	b	c
GQM/GR3/GRJ/GRM	**18**	1.6×0.8	0.6 to 1.0	0.8 to 0.9	0.6 to 0.8
GQM/GR3/GRJ/GRM	**21**	2.0×1.25	1.0 to 1.2	0.9 to 1.0	0.8 to 1.1
GR3/GRJ/GRM	**31**	3.2×1.6	2.2 to 2.6	1.0 to 1.1	1.0 to 1.4
LLL	**21**	1.25×2.0	0.4 to 0.7	0.5 to 0.7	1.4 to 1.8
LLL	**31**	1.6×3.2	0.6 to 1.0	0.8 to 0.9	2.6 to 2.8

Flow soldering can only be used for products with a chip size from 1.6x0.8mm to 3.2x1.6mm.

(in mm)

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Table 2 Reflow Soldering Method

Series	Chip Dimension Code (L/W)	Chip (L✕W)	a	b	c
GJM/GRM	**02**	0.4✕0.2	0.16 to 0.2	0.12 to 0.18	0.2 to 0.23
GJM/GRM	**03**	0.6✕0.3 (±0.03)	0.2 to 0.25	0.2 to 0.3	0.25 to 0.35
		0.6✕0.3 (±0.05)	0.2 to 0.25	0.25 to 0.35	0.3 to 0.4
		0.6✕0.3 (±0.09)	0.23 to 0.3	0.25 to 0.35	0.3 to 0.4
GJM/GRM	**15**	1.0✕0.5 (within ±0.10)	0.3 to 0.5	0.35 to 0.45	0.4 to 0.6
		1.0✕0.5 (±0.15/±0.20)	0.4 to 0.6	0.4 to 0.5	0.5 to 0.7
GQM/GR3/GRJ/GRM	**18**	1.6✕0.8 (within ±0.10)	0.6 to 0.8	0.6 to 0.7	0.6 to 0.8
		1.6✕0.8 (±0.15/±0.20)	0.7 to 0.9	0.7 to 0.8	0.8 to 1.0
GQM	**21**	2.0✕1.25	1.0 to 1.2	0.6 to 0.7	0.8 to 1.1
GR3/GRJ/GRM/GR7	**21**	2.0×✕1.25 (within ±0.10)	1.2	0.6	1.25
		2.0✕1.25 (±0.15)	1.2	0.6 to 0.8	1.2 to 1.4
		2.0✕1.25 (±0.20)	1.0 to 1.4	0.6 to 0.8	1.2 to 1.4
GQM	**22**	2.8✕2.8	2.2 to 2.5	0.8 to 1.0	1.9 to 2.3
GR3/GRJ/GRM/GR7	**31**	3.2✕1.6 (within ±0.20)	1.8 to 2.0	0.9 to 1.2	1.5 to 1.7
		3.2✕1.6 (±0.30)	1.9 to 2.1	1.0 to 1.3	1.7 to 1.9
GR3/GRJ/GRM	**32**	3.2✕2.5	2.0 to 2.4	1.0 to 1.2	1.8 to 2.3
GA2/GA3/GR4	**42**	4.5✕2.0	2.8 to 3.4	1.2 to 1.4	1.4 to 1.8
GR3/GRJ/GRM/GA2/ GA3/GR4	**43**	4.5✕3.2	3.0 to 3.5	1.2 to 1.4	2.3 to 3.0
GA2/GA3	**52**	5.7✕2.8	4.0 to 4.6	1.4 to 1.6	2.1 to 2.6
GR3/GRJ/GRM/GA2/ GA3/GR4	**55**	5.7✕5.0	4.0 to 4.6	1.4 to 1.6	3.5 to 4.8
LLL	**15**	0.5✕1.0	0.15 to 0.2	0.2 to 0.25	0.7 to 1.0
LLL	**1U**	0.6✕1.0	0.20 to 0.25	0.25 to 0.35	0.7 to 1.0
LLL/LLR	**18**	0.8✕1.6	0.2 to 0.3	0.3 to 0.4	1.4 to 1.6
LLL	**21**	1.25✕2.0	0.4 to 0.5	0.4 to 0.5	1.4 to 1.8
LLL	**31**	1.6✕3.2	0.6 to 0.8	0.6 to 0.7	2.6 to 2.8

(in mm)

<Applicable to Part Number KR3/KRM>

Series	Chip Dimension Code (L/W)	Chip (L✕W)	a	b	c
KRM	**21**	2.0✕1.25	1.0 to 1.2	0.6 to 0.7	0.8 to 1.1
KRM	**31**	3.2✕1.6	2.2 to 2.4	0.8 to 0.9	1.0 to 1.4
KR3/KRM	**55**	5.7✕5.0	2.6	2.7	5.6

(in mm)

Table 3 ZRB Series Reflow Soldering Method

Series	Chip Dimension Code (L/W)	Chip (L✕W)	a	b	c
ZRB	**15**	1.0✕0.5	0.4 to 0.6	0.4 to 0.5	0.5 to 0.7
ZRB	**18***	1.6✕0.8	0.7 to 0.9	0.7 to 0.8	0.8 to 1.0

(in mm)

*If distance between parts is too short, there is risk to cause electrical short. Please confirm the mounting pitch (distance between centers of parts) has 1.275mm or more. (ZRB18 only)

[Land for ZRB Series]

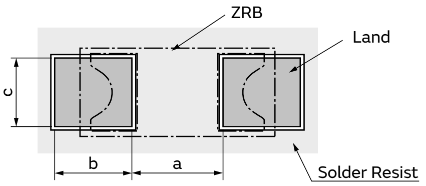

Table 4 LLA Series Reflow Soldering Method

Series	Chip Dimension Code (L/W)	Chip (L✕W)	a	b	c	p
LLA	**18**	1.6✕0.8	0.3 to 0.4	0.25 to 0.35	0.15 to 0.25	0.4
LLA	**21**	2.0✕1.25	0.5 to 0.7	0.35 to 0.6	0.2 to 0.3	0.5

(in mm)

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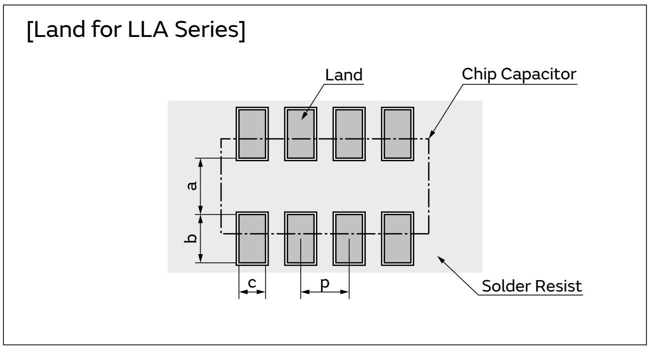
Table 5 LLM Series Reflow Soldering Method

Series	Chip Dimension Code (L/W)	Chip (L×W)	a	b, b'	c, c'	d	e	f	p
LLM	**21**	2.0×1.25	0.6 to 0.8	(0.3 to 0.5)	0.3	2.0 to 2.6	1.3 to 1.8	1.4 to 1.6	0.5

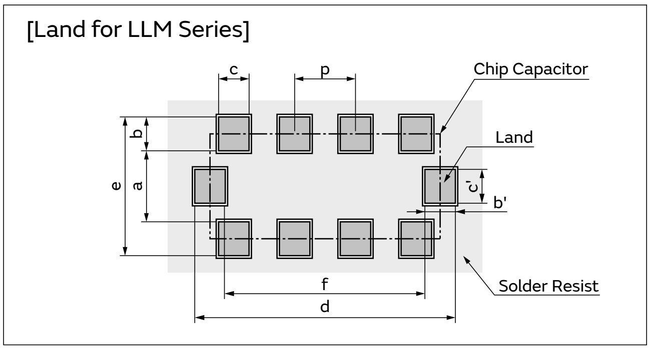
b=(c-e)/2, b'=(d-f)/2

(in mm)

[Land for LLA Series]



[Land for LLM Series]



<Applicable to beyond Rated Voltage of 200VDC>

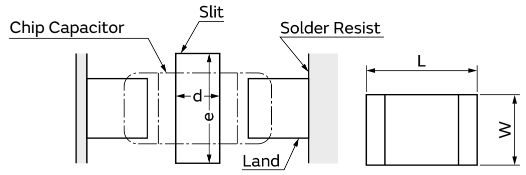
2-2. Dimensions of Slit (Example)

Preparing the slit helps flux cleaning and resin coating on the back of the capacitor.

However, the length of the slit design should be as short as possible to prevent mechanical damage in the capacitor.

A longer slit design might receive more severe mechanical stress from the PCB.

Recommended slit design is shown in the Table.



L×W	d	e
1.6×0.8	–	–
2.0×1.25	–	–
3.2×1.6	1.0 to 2.0	3.2 to 3.7
3.2×2.5	1.0 to 2.0	4.1 to 4.6
4.5×2.0	1.0 to 2.8	3.6 to 4.1
4.5×3.2	1.0 to 2.8	4.8 to 5.3
5.7×2.8	1.0 to 4.0	4.4 to 4.9
5.7×5.0	1.0 to 4.0	6.6 to 7.1

(in mm)

Continued on the following page.↗

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<Applicable to NFM Series>

▨ Land Pattern + Solder Resist
▨ Land Pattern
☐ Solder Resist

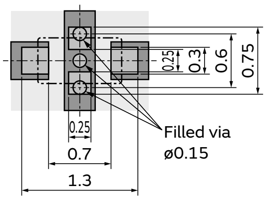
(in mm)

Series	Land Dimensions

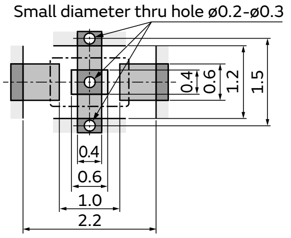
NFM15CC
NFM15PC
NFM18CC
NFM18PC
NFM18PS
NFM21CC
NFM21PC
NFM21PS

● Reflow Soldering

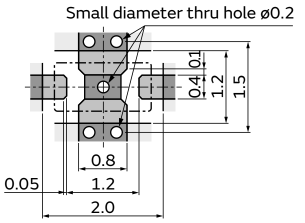
NFM15CC/NFM15PC



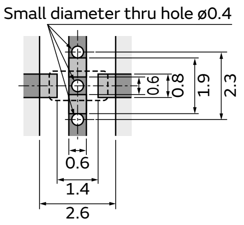
NFM18CC/NFM18PC



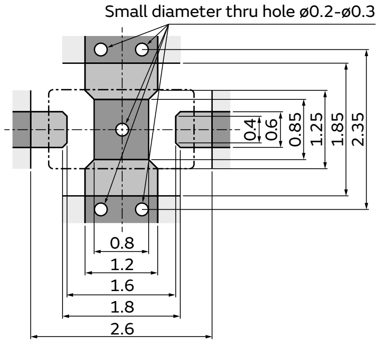
NFM18PS



NFM21CC/NFM21PC



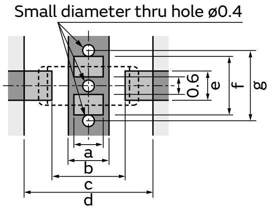
NFM21PS



NFM3DCC
NFM3DPC
NFM31PC
NFM31KC
NFM41CC
NFM41PC

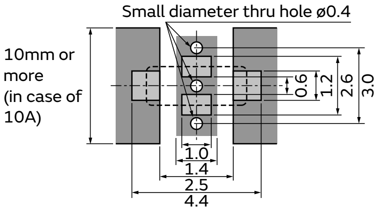
● Reflow Soldering Chip mounting side

NFM3DCC/NFM3DPC/NFM31PC/NFM41CC/NFM41PC



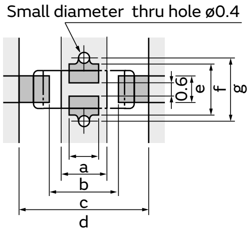
Part Number	Size (mm)						
	a	b	c	d	e	f	g
NFM3DCC NFM3DPC	1.0	1.4	2.5	4.4	1.0	2.0	2.4
NFM31PC	1.0	1.4	2.5	4.4	1.2	2.6	3.0
NFM41CC NFM41PC	1.5	2.0	3.5	6.0	1.2	2.6	3.0

NFM31KC*1



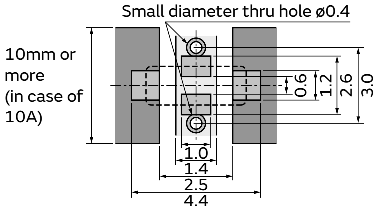
*1 For large current design, width of signal land pattern should be wider not less than 1mm per 1A (1mm/A).
For example, in case of 10A, signal land pattern width should be 10mm or more.
(1mm/A*10A=10mm)

● Flow Soldering Chip mounting side



Part Number	Size (mm)						
	a	b	c	d	e	f	g
NFM3DCC NFM3DPC	1.0	1.4	2.5	4.4	1.0	2.0	2.4
NFM31PC	1.0	1.4	2.5	4.4	1.2	2.6	3.0
NFM41CC NFM41PC	1.5	2.0	3.5	6.0	1.2	2.6	3.0

NFM31KC*1



*1 For large current design, width of signal land pattern should be wider not less than 1mm per 1A (1mm/A).
For example, in case of 10A, signal land pattern width should be 10mm or more.
(1mm/A*10A=10mm)

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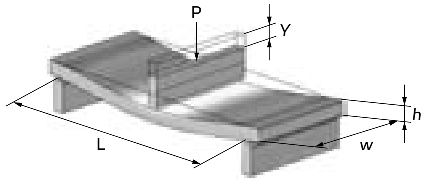
3. Board Design

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.

2. Adhesive Application

If you want to temporarily attach the capacitor to the board using an adhesive agent before soldering the capacitor, first be sure that the conditions are appropriate for affixing the capacitor. If the dimensions of the land, the type of adhesive, the amount of coating, the contact surface area, the curing temperature, or other conditions are inappropriate, the characteristics of the capacitor may deteriorate.

1. Selection of Adhesive

1-1. Depending on the type of adhesive, there may be a decrease in insulation resistance. In addition, there is a chance that the capacitor might crack from contractile stress due to the difference in the contraction rate of the capacitor and the adhesive.

1-2. If there is not enough adhesive, the contact surface area is too small, or the curing temperature or curing time are inadequate, the adhesive strength will be insufficient and the capacitor may loosen or become disconnected during transportation or soldering.

If there is too much adhesive, for example if it overflows onto the land, the result could be soldering defects, loss of electrical connection, insufficient curing, or slippage after the capacitor is mounted.

Furthermore, if the curing temperature is too high or the curing time is too long, not only will the adhesive strength be reduced, but solderability may also suffer due to the effects of oxidation on the terminations (outer electrodes) of the capacitor and the land surface on the board.

(1) Selection of Adhesive

Epoxy resins are a typical class of adhesive.
To select the proper adhesive, consider the following points.

1) There must be enough adhesive strength to prevent the component from loosening or slipping during the mounting process.
2) The adhesive strength must not decrease when exposed to moisture during soldering.
3) The adhesive must have good coatability and shape retention properties.
4) The adhesive must have a long pot life.
5) The curing time must be short.
6) The adhesive must not be corrosive to the exterior of the capacitor or the board.
7) The adhesive must have good insulation properties.
8) The adhesive must not emit toxic gases or otherwise be harmful to health.
9) The adhesive must be free of halogenated compounds.

Continued on the following page.↗

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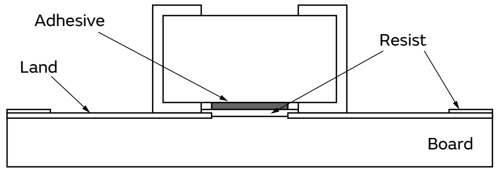
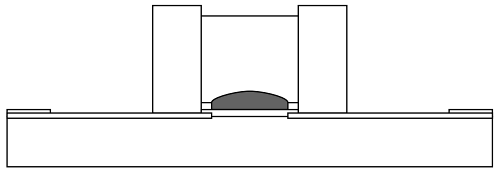
(2) Use the following illustration as a guide to the amount of adhesive to apply.

[Sizes: 0603(1608M) / 0805(2012M) / 1206(3216M)]

Cross Sectional View

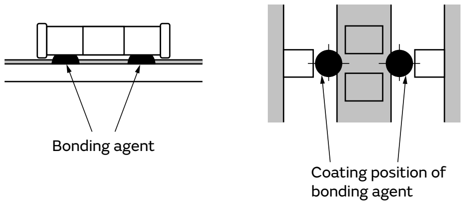


Side View



<Applicable to NFM Series>

[Sizes: 1205(3212M) / 1206(3216M) / 1806(4516M)]



3. Adhesive Curing

1. Insufficient curing of the adhesive can cause chips to disconnect during flow soldering and causes deterioration in the insulation resistance between the terminations due to moisture absorption.

Control curing temperature and time in order to prevent insufficient hardening.

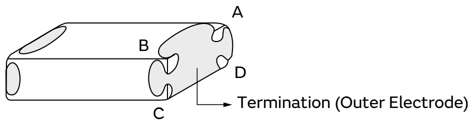
4. Flux for Flow Soldering

1. An excessive amount of flux generates a large quantity of flux gas, which can cause a deterioration of solderability, so apply flux thinly and evenly throughout. (A foaming system is generally used for flow soldering.)
2. Flux containing too high a percentage of halide may cause corrosion of the terminations unless there is sufficient cleaning. Use flux with a halide content of 0.1% max.
3. Strong acidic flux can corrode the capacitor and degrade its performance.
   Please check the quality of capacitor after mounting.

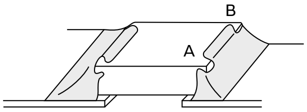
5. Flow Soldering

● Set temperature and time to ensure that leaching of the terminations does not exceed 25% of the chip end area as a single chip (full length of the edge A-B-C-D shown at right) and 25% of the length A-B shown as mounted on substrate.

[As a Single Chip]



[As Mounted on Substrate]



6. Reflow Soldering

The flux in the solder paste contains halogen-based substances and organic acids as activators.
Strong acidic flux can corrode the capacitor and degrade its performance.

Please check the quality after mounting, please use.

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7. Washing

1. Please evaluate the capacitor using actual cleaning equipment and conditions to confirm the quality, and select the solvent for cleaning.
2. Unsuitable cleaning may leave residual flux or other foreign substances, causing deterioration of electrical characteristics and the reliability of the capacitors.

8. Coating

1. A crack may be caused in the capacitor due to the stress of the thermal contraction of the resin during curing process.
   The stress is affected by the amount of resin and curing contraction.
   Select a resin with low curing contraction.
   The difference in the thermal expansion coefficient between a coating resin or a molding resin and the capacitor may cause the destruction and deterioration of the capacitor such as a crack or peeling, and lead to the deterioration of insulation resistance or dielectric breakdown.
   Select a resin for which the thermal expansion coefficient is as close to that of the capacitor as possible.
   A silicone resin can be used as an under-coating to buffer against the stress.
2. Select a resin that is less hygroscopic.
   Using hygroscopic resins under high humidity conditions may cause the deterioration of the insulation resistance of a capacitor.
   An epoxy resin can be used as a less hygroscopic resin.
3. The halogen system substance and organic acid are included in coating material, and a chip corrodes by the kind of Coating material.
   Do not use strong acid type.

<Applicable to ZRB Series>

4. Loss suppress acoustic noise may be caused in ZRB series due to the resin during curing process. Please contact our sales representative or product engineers on the apply to resin during curing process.

Other

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°C
         - change of temperature air/air: -25°C/+25°C
         - 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.

<Applicable to NFM Series>

4. The effects of noise suppression can vary depending on the usage conditions, including differences in the circuit or IC to be used, the type of noise, the shape of the pattern to be mounted, and the mounting location. Be sure to verify the effect on the actual device in advance.