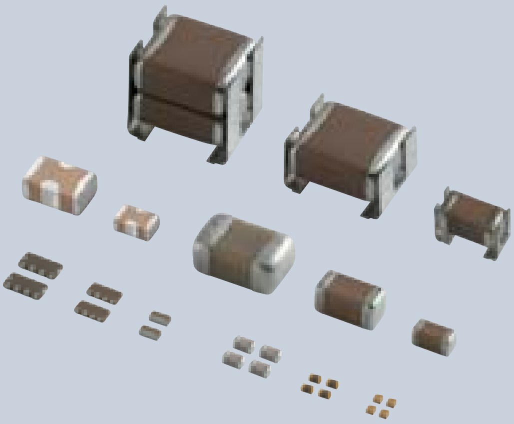
muRata
INNOVATOR IN ELECTRONICS

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.

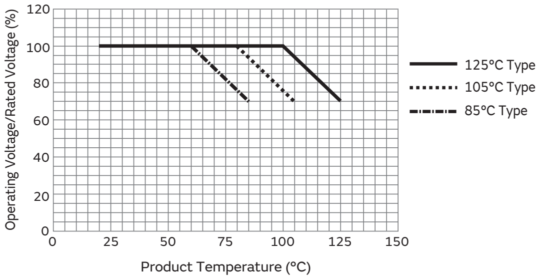
General	For applications that do not require the particular reliability such as the general equipment
Info-tainment	Infotainment for Automotive The product for entertainment equipment like car navigations, car audios, and body control equipment like wipers, power windows.
Power-train	Powertrain/Safety 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.

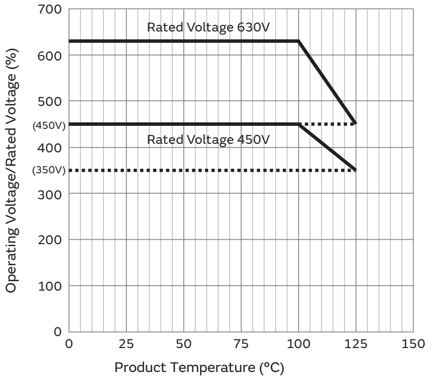
Recommended Conditions of the Derating Operating Voltage and Temperature



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

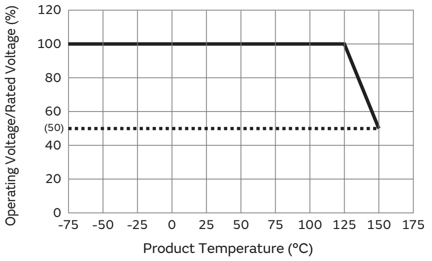
Please apply the derating curve according to the operating temperature.

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

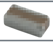
For general

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
❶	❷	❸	❹	❺	❻	❼	❽	❾	❿

❶Product ID ❷Series

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

❸Chip 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

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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.

High Q and High Power Chip Multilayer Ceramic Capacitors for General Purpose

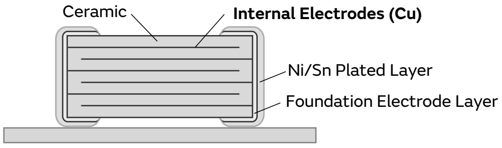
GQM Series

High Frequency Capacitor Ideal for PA Design of Base Stations

Features

① Mainly ideal for base stations of mobile communication devices and temperature compensation of related modules.

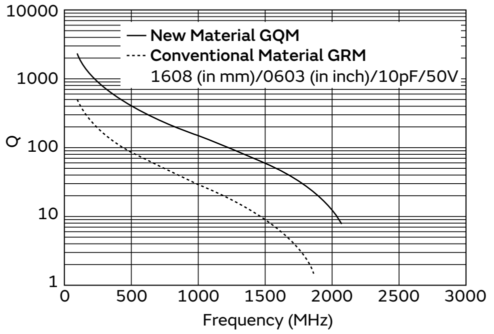
This product is ideal for temperature compensation of high frequency circuits, such as resonant circuits, tuning circuits, and impedance matching circuits where the operating characteristics of the device are greatly affected by the capacitance fluctuation.



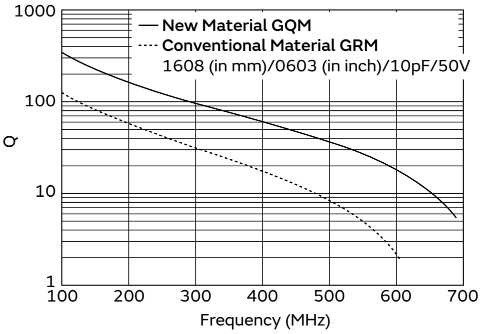
<Example of Structure>

② High Q and low ESR in VHF, UHF and microwave frequency bands.

High Q and low ESR were achieved at a high frequency by adopting ceramic material as the dielectric material which enables an extremely low loss at high frequency, and base metal electrodes as the internal electrodes.



<Comparison between Q - Frequency Characteristics>



<Comparison between Q - Frequency Characteristics>

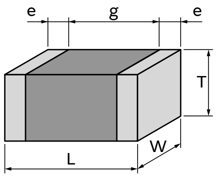
③ Can be used for tight tolerance.

In addition to standard tolerance, the allowable range of this product is also suitable for the following narrow tolerance.

Capacitance Range	Standard Capacitance Tolerance (Capacitance Tolerance Symbol)	Narrow Capacitance Tolerance (Capacitance Tolerance Symbol)
to 0.9pF	±0.1pF (B)	±0.05pF (W)
1.0 to 5.0pF	±0.25pF (C)	±0.05pF (W), ±0.1pF (B)
5.1 to 9.9pF	±0.5pF (D)	±0.05pF (W), ±0.1pF (B), ±0.25pF (C)
10pF to	±5% (J)	±2% (G)

Specifications

Size (mm)	1.0×0.5mm to 2.8×2.8mm
Rated Voltage	50Vdc to 500Vdc
Capacitance	0.10pF to 510pF
Main Applications	Measuring instruments, other ultra compact/thin devices



<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.

GQM Series Temperature Compensating Type Part Number List

1.0×0.5mm

T max.	Rated Voltage	TC Code	Cap.	Tol.	Part Number	p*
0.55mm	200Vdc	C0G	0.10pF	±0.1pF	**GQM1555C2DR10BB01#**	p172
			0.20pF	±0.1pF	**GQM1555C2DR20BB01#**	p172
			0.30pF	±0.1pF	**GQM1555C2DR30BB01#**	p172
				±0.25pF	**GQM1555C2DR30CB01#**	p172
			0.40pF	±0.1pF	**GQM1555C2DR40BB01#**	p172
				±0.25pF	**GQM1555C2DR40CB01#**	p172
			0.50pF	±0.1pF	**GQM1555C2DR50BB01#**	p172
				±0.25pF	**GQM1555C2DR50CB01#**	p172
			0.60pF	±0.1pF	**GQM1555C2DR60BB01#**	p172
				±0.25pF	**GQM1555C2DR60CB01#**	p172
			0.70pF	±0.1pF	**GQM1555C2DR70BB01#**	p172
				±0.25pF	**GQM1555C2DR70CB01#**	p172
			0.75pF	±0.1pF	**GQM1555C2DR75BB01#**	p172
				±0.25pF	**GQM1555C2DR75CB01#**	p172
			0.80pF	±0.1pF	**GQM1555C2DR80BB01#**	p172
				±0.25pF	**GQM1555C2DR80CB01#**	p172
			0.90pF	±0.1pF	**GQM1555C2DR90BB01#**	p172
				±0.25pF	**GQM1555C2DR90CB01#**	p172
			1.0pF	±0.1pF	**GQM1555C2D1R0BB01#**	p172
				±0.25pF	**GQM1555C2D1R0CB01#**	p172
			1.1pF	±0.1pF	**GQM1555C2D1R1BB01#**	p172
				±0.25pF	**GQM1555C2D1R1CB01#**	p172
			1.2pF	±0.1pF	**GQM1555C2D1R2BB01#**	p172
				±0.25pF	**GQM1555C2D1R2CB01#**	p172
			1.3pF	±0.1pF	**GQM1555C2D1R3BB01#**	p172
				±0.25pF	**GQM1555C2D1R3CB01#**	p172
			1.5pF	±0.1pF	**GQM1555C2D1R5BB01#**	p172
				±0.25pF	**GQM1555C2D1R5CB01#**	p172
			1.6pF	±0.1pF	**GQM1555C2D1R6BB01#**	p172
				±0.25pF	**GQM1555C2D1R6CB01#**	p172
			1.8pF	±0.1pF	**GQM1555C2D1R8BB01#**	p172
				±0.25pF	**GQM1555C2D1R8CB01#**	p172
			2.0pF	±0.1pF	**GQM1555C2D2R0BB01#**	p172
				±0.25pF	**GQM1555C2D2R0CB01#**	p172
			2.2pF	±0.1pF	**GQM1555C2D2R2BB01#**	p172
				±0.25pF	**GQM1555C2D2R2CB01#**	p172
			2.4pF	±0.1pF	**GQM1555C2D2R4BB01#**	p172
				±0.25pF	**GQM1555C2D2R4CB01#**	p172
			2.7pF	±0.1pF	**GQM1555C2D2R7BB01#**	p172
				±0.25pF	**GQM1555C2D2R7CB01#**	p172
			3.0pF	±0.1pF	**GQM1555C2D3R0BB01#**	p172
				±0.25pF	**GQM1555C2D3R0CB01#**	p172
			3.3pF	±0.1pF	**GQM1555C2D3R3BB01#**	p172
				±0.25pF	**GQM1555C2D3R3CB01#**	p172
			3.6pF	±0.1pF	**GQM1555C2D3R6BB01#**	p172
				±0.25pF	**GQM1555C2D3R6CB01#**	p172
			3.9pF	±0.1pF	**GQM1555C2D3R9BB01#**	p172
				±0.25pF	**GQM1555C2D3R9CB01#**	p172
			4.0pF	±0.1pF	**GQM1555C2D4R0BB01#**	p172
				±0.25pF	**GQM1555C2D4R0CB01#**	p172
			4.3pF	±0.1pF	**GQM1555C2D4R3BB01#**	p172
				±0.25pF	**GQM1555C2D4R3CB01#**	p172
0.55mm	200Vdc	C0G	4.7pF	±0.1pF	**GQM1555C2D4R7BB01#**	p172
				±0.25pF	**GQM1555C2D4R7CB01#**	p172
			5.0pF	±0.1pF	**GQM1555C2D5R0BB01#**	p172
				±0.25pF	**GQM1555C2D5R0CB01#**	p172
			5.1pF	±0.1pF	**GQM1555C2D5R1BB01#**	p172
				±0.25pF	**GQM1555C2D5R1CB01#**	p172
			5.6pF	±0.1pF	**GQM1555C2D5R6BB01#**	p172
				±0.25pF	**GQM1555C2D5R6CB01#**	p172
			6.0pF	±0.1pF	**GQM1555C2D6R0BB01#**	p172
				±0.25pF	**GQM1555C2D6R0CB01#**	p172
			6.2pF	±0.1pF	**GQM1555C2D6R2BB01#**	p172
				±0.25pF	**GQM1555C2D6R2CB01#**	p172
			6.8pF	±0.1pF	**GQM1555C2D6R8BB01#**	p172
				±0.25pF	**GQM1555C2D6R8CB01#**	p172
			7.0pF	±0.1pF	**GQM1555C2D7R0BB01#**	p172
				±0.25pF	**GQM1555C2D7R0CB01#**	p172
			7.5pF	±0.1pF	**GQM1555C2D7R5BB01#**	p172
				±0.25pF	**GQM1555C2D7R5CB01#**	p172
			8.0pF	±0.1pF	**GQM1555C2D8R0BB01#**	p172
				±0.25pF	**GQM1555C2D8R0CB01#**	p172
			8.2pF	±0.1pF	**GQM1555C2D8R2BB01#**	p172
				±0.25pF	**GQM1555C2D8R2CB01#**	p172
			9.0pF	±0.1pF	**GQM1555C2D9R0BB01#**	p172
				±0.25pF	**GQM1555C2D9R0CB01#**	p172
			9.1pF	±0.1pF	**GQM1555C2D9R1BB01#**	p172
				±0.25pF	**GQM1555C2D9R1CB01#**	p172
			10pF	±2%	**GQM1555C2D100GB01#**	p172
				±5%	**GQM1555C2D100JB01#**	p172
			11pF	±2%	**GQM1555C2D110GB01#**	p172
				±5%	**GQM1555C2D110JB01#**	p172
			12pF	±2%	**GQM1555C2D120GB01#**	p172
				±5%	**GQM1555C2D120JB01#**	p172
			13pF	±2%	**GQM1555C2D130GB01#**	p172
				±5%	**GQM1555C2D130JB01#**	p172
			15pF	±2%	**GQM1555C2D150GB01#**	p172
				±5%	**GQM1555C2D150JB01#**	p172
			16pF	±2%	**GQM1555C2D160GB01#**	p172
				±5%	**GQM1555C2D160JB01#**	p172
			18pF	±2%	**GQM1555C2D180GB01#**	p172
				±5%	**GQM1555C2D180JB01#**	p172
			20pF	±2%	**GQM1555C2D200GB01#**	p172
				±5%	**GQM1555C2D200JB01#**	p172
			22pF	±2%	**GQM1555C2D220GB01#**	p172
				±5%	**GQM1555C2D220JB01#**	p172
			24pF	±2%	**GQM1555C2D240GB01#**	p172
				±5%	**GQM1555C2D240JB01#**	p172
			27pF	±2%	**GQM1555C2D270GB01#**	p172
				±5%	**GQM1555C2D270JB01#**	p172
			30pF	±2%	**GQM1555C2D300GB01#**	p172
				±5%	**GQM1555C2D300JB01#**	p172
			33pF	±2%	**GQM1555C2D330GB01#**	p172
				±5%	**GQM1555C2D330JB01#**	p172
	100Vdc	C0G	36pF	±2%	**GQM1555C2A360GB01#**	p172
				±5%	**GQM1555C2A360JB01#**	p172

*: Refers to the page of the “Specifications and Test Methods”.

Part number # indicates the package specification code.

GQM Series Temperature Compensating Type   Part Number List

(→ 1.0×0.5mm)

T max.	Rated Voltage	TC Code	Cap.	Tol.	Part Number	p*
0.55mm	100Vdc	C0G	39pF	±2%	GQM1555C2A390GB01#	p172
				±5%	GQM1555C2A390JB01#	p172
			43pF	±2%	GQM1555C2A430GB01#	p172
				±5%	GQM1555C2A430JB01#	p172
			47pF	±2%	GQM1555C2A470GB01#	p172
				±5%	GQM1555C2A470JB01#	p172

1.6×0.8mm

T max.	Rated Voltage	TC Code	Cap.	Tol.	Part Number	p*
0.8mm	250Vdc	C0G	1.0pF	±0.1pF	GQM1875C2E1R0BB12#	p178
				±0.25pF	GQM1875C2E1R0CB12#	p178
			1.1pF	±0.1pF	GQM1875C2E1R1BB12#	p178
				±0.25pF	GQM1875C2E1R1CB12#	p178
			1.2pF	±0.1pF	GQM1875C2E1R2BB12#	p178
				±0.25pF	GQM1875C2E1R2CB12#	p178
			1.3pF	±0.1pF	GQM1875C2E1R3BB12#	p178
				±0.25pF	GQM1875C2E1R3CB12#	p178
			1.5pF	±0.1pF	GQM1875C2E1R5BB12#	p178
				±0.25pF	GQM1875C2E1R5CB12#	p178
			1.6pF	±0.1pF	GQM1875C2E1R6BB12#	p178
				±0.25pF	GQM1875C2E1R6CB12#	p178
			1.8pF	±0.1pF	GQM1875C2E1R8BB12#	p178
				±0.25pF	GQM1875C2E1R8CB12#	p178
			2.0pF	±0.1pF	GQM1875C2E2R0BB12#	p178
				±0.25pF	GQM1875C2E2R0CB12#	p178
			2.2pF	±0.1pF	GQM1875C2E2R2BB12#	p178
				±0.25pF	GQM1875C2E2R2CB12#	p178
			2.4pF	±0.1pF	GQM1875C2E2R4BB12#	p178
				±0.25pF	GQM1875C2E2R4CB12#	p178
			2.7pF	±0.1pF	GQM1875C2E2R7BB12#	p178
				±0.25pF	GQM1875C2E2R7CB12#	p178
			3.0pF	±0.1pF	GQM1875C2E3R0BB12#	p178
				±0.25pF	GQM1875C2E3R0CB12#	p178
			3.3pF	±0.1pF	GQM1875C2E3R3BB12#	p178
				±0.25pF	GQM1875C2E3R3CB12#	p178
			3.6pF	±0.1pF	GQM1875C2E3R6BB12#	p178
				±0.25pF	GQM1875C2E3R6CB12#	p178
			3.9pF	±0.1pF	GQM1875C2E3R9BB12#	p178
				±0.25pF	GQM1875C2E3R9CB12#	p178
			4.0pF	±0.1pF	GQM1875C2E4R0BB12#	p178
				±0.25pF	GQM1875C2E4R0CB12#	p178
			4.3pF	±0.1pF	GQM1875C2E4R3BB12#	p178
				±0.25pF	GQM1875C2E4R3CB12#	p178
			4.7pF	±0.1pF	GQM1875C2E4R7BB12#	p178
				±0.25pF	GQM1875C2E4R7CB12#	p178
			5.0pF	±0.1pF	GQM1875C2E5R0BB12#	p178
				±0.25pF	GQM1875C2E5R0CB12#	p178
			5.1pF	±0.25pF	GQM1875C2E5R1CB12#	p178
				±0.5pF	GQM1875C2E5R1DB12#	p178
			5.6pF	±0.25pF	GQM1875C2E5R6CB12#	p178
				±0.5pF	GQM1875C2E5R6DB12#	p178
			6.0pF	±0.25pF	GQM1875C2E6R0CB12#	p178
0.8mm	250Vdc	C0G	6.0pF	±0.5pF	GQM1875C2E6R0DB12#	p178
			6.2pF	±0.25pF	GQM1875C2E6R2CB12#	p178
				±0.5pF	GQM1875C2E6R2DB12#	p178
			6.8pF	±0.25pF	GQM1875C2E6R8CB12#	p178
				±0.5pF	GQM1875C2E6R8DB12#	p178
			7.0pF	±0.25pF	GQM1875C2E7R0CB12#	p178
				±0.5pF	GQM1875C2E7R0DB12#	p178
			7.5pF	±0.25pF	GQM1875C2E7R5CB12#	p178
				±0.5pF	GQM1875C2E7R5DB12#	p178
			8.0pF	±0.25pF	GQM1875C2E8R0CB12#	p178
				±0.5pF	GQM1875C2E8R0DB12#	p178
			8.2pF	±0.25pF	GQM1875C2E8R2CB12#	p178
				±0.5pF	GQM1875C2E8R2DB12#	p178
			9.0pF	±0.25pF	GQM1875C2E9R0CB12#	p178
				±0.5pF	GQM1875C2E9R0DB12#	p178
			9.1pF	±0.25pF	GQM1875C2E9R1CB12#	p178
				±0.5pF	GQM1875C2E9R1DB12#	p178
			10pF	±2%	GQM1875C2E100GB12#	p178
				±5%	GQM1875C2E100JB12#	p178
			11pF	±2%	GQM1875C2E110GB12#	p178
				±5%	GQM1875C2E110JB12#	p178
			12pF	±2%	GQM1875C2E120GB12#	p178
				±5%	GQM1875C2E120JB12#	p178
			13pF	±2%	GQM1875C2E130GB12#	p178
				±5%	GQM1875C2E130JB12#	p178
			15pF	±2%	GQM1875C2E150GB12#	p178
				±5%	GQM1875C2E150JB12#	p178
			16pF	±2%	GQM1875C2E160GB12#	p178
				±5%	GQM1875C2E160JB12#	p178
			18pF	±2%	GQM1875C2E180GB12#	p178
				±5%	GQM1875C2E180JB12#	p178
			20pF	±2%	GQM1875C2E200GB12#	p178
				±5%	GQM1875C2E200JB12#	p178
			22pF	±2%	GQM1875C2E220GB12#	p178
				±5%	GQM1875C2E220JB12#	p178
			24pF	±2%	GQM1875C2E240GB12#	p178
				±5%	GQM1875C2E240JB12#	p178
			27pF	±2%	GQM1875C2E270GB12#	p178
				±5%	GQM1875C2E270JB12#	p178
			30pF	±2%	GQM1875C2E300GB12#	p178
				±5%	GQM1875C2E300JB12#	p178
			33pF	±2%	GQM1875C2E330GB12#	p178
				±5%	GQM1875C2E330JB12#	p178
			36pF	±2%	GQM1875C2E360GB12#	p178
				±5%	GQM1875C2E360JB12#	p178
			39pF	±2%	GQM1875C2E390GB12#	p178
				±5%	GQM1875C2E390JB12#	p178
			43pF	±2%	GQM1875C2E430GB12#	p178
				±5%	GQM1875C2E430JB12#	p178
			47pF	±2%	GQM1875C2E470GB12#	p178
				±5%	GQM1875C2E470JB12#	p178
		X8G	1.0pF	±0.1pF	GQM1875G2E1R0BB12#	p175
				±0.25pF	GQM1875G2E1R0CB12#	p175
			1.1pF	±0.1pF	GQM1875G2E1R1BB12#	p175

*: Refers to the page of the “Specifications and Test Methods”.

Part number # indicates the package specification code.

GQM Series Temperature Compensating Type Part Number List

(→ 1.6×0.8mm)

T max.	Rated Voltage	TC Code	Cap.	Tol.	Part Number	p*
0.8mm	250Vdc	X8G	1.1pF	±0.25pF	**GQM1875G2E1R1CB12#**	p175
			1.2pF	±0.1pF	**GQM1875G2E1R2BB12#**	p175
				±0.25pF	**GQM1875G2E1R2CB12#**	p175
			1.3pF	±0.1pF	**GQM1875G2E1R3BB12#**	p175
				±0.25pF	**GQM1875G2E1R3CB12#**	p175
			1.5pF	±0.1pF	**GQM1875G2E1R5BB12#**	p175
				±0.25pF	**GQM1875G2E1R5CB12#**	p175
			1.6pF	±0.1pF	**GQM1875G2E1R6BB12#**	p175
				±0.25pF	**GQM1875G2E1R6CB12#**	p175
			1.8pF	±0.1pF	**GQM1875G2E1R8BB12#**	p175
				±0.25pF	**GQM1875G2E1R8CB12#**	p175
			2.0pF	±0.1pF	**GQM1875G2E2R0BB12#**	p175
				±0.25pF	**GQM1875G2E2R0CB12#**	p175
			2.2pF	±0.1pF	**GQM1875G2E2R2BB12#**	p175
				±0.25pF	**GQM1875G2E2R2CB12#**	p175
			2.4pF	±0.1pF	**GQM1875G2E2R4BB12#**	p175
				±0.25pF	**GQM1875G2E2R4CB12#**	p175
			2.7pF	±0.1pF	**GQM1875G2E2R7BB12#**	p175
				±0.25pF	**GQM1875G2E2R7CB12#**	p175
			3.0pF	±0.1pF	**GQM1875G2E3R0BB12#**	p175
				±0.25pF	**GQM1875G2E3R0CB12#**	p175
			3.3pF	±0.1pF	**GQM1875G2E3R3BB12#**	p175
				±0.25pF	**GQM1875G2E3R3CB12#**	p175
			3.6pF	±0.1pF	**GQM1875G2E3R6BB12#**	p175
				±0.25pF	**GQM1875G2E3R6CB12#**	p175
			3.9pF	±0.1pF	**GQM1875G2E3R9BB12#**	p175
				±0.25pF	**GQM1875G2E3R9CB12#**	p175
			4.0pF	±0.1pF	**GQM1875G2E4R0BB12#**	p175
				±0.25pF	**GQM1875G2E4R0CB12#**	p175
			4.3pF	±0.1pF	**GQM1875G2E4R3BB12#**	p175
				±0.25pF	**GQM1875G2E4R3CB12#**	p175
			4.7pF	±0.1pF	**GQM1875G2E4R7BB12#**	p175
				±0.25pF	**GQM1875G2E4R7CB12#**	p175
			5.0pF	±0.1pF	**GQM1875G2E5R0BB12#**	p175
				±0.25pF	**GQM1875G2E5R0CB12#**	p175
			5.1pF	±0.25pF	**GQM1875G2E5R1CB12#**	p175
				±0.5pF	**GQM1875G2E5R1DB12#**	p175
			5.6pF	±0.25pF	**GQM1875G2E5R6CB12#**	p175
				±0.5pF	**GQM1875G2E5R6DB12#**	p175
			6.0pF	±0.25pF	**GQM1875G2E6R0CB12#**	p175
				±0.5pF	**GQM1875G2E6R0DB12#**	p175
			6.2pF	±0.25pF	**GQM1875G2E6R2CB12#**	p175
				±0.5pF	**GQM1875G2E6R2DB12#**	p175
			6.8pF	±0.25pF	**GQM1875G2E6R8CB12#**	p175
				±0.5pF	**GQM1875G2E6R8DB12#**	p175
			7.0pF	±0.25pF	**GQM1875G2E7R0CB12#**	p175
				±0.5pF	**GQM1875G2E7R0DB12#**	p175
			7.5pF	±0.25pF	**GQM1875G2E7R5CB12#**	p175
				±0.5pF	**GQM1875G2E7R5DB12#**	p175
			8.0pF	±0.25pF	**GQM1875G2E8R0CB12#**	p175
				±0.5pF	**GQM1875G2E8R0DB12#**	p175
			8.2pF	±0.25pF	**GQM1875G2E8R2CB12#**	p175
				±0.5pF	**GQM1875G2E8R2DB12#**	p175
			9.0pF	±0.25pF	**GQM1875G2E9R0CB12#**	p175
0.8mm	250Vdc	X8G	9.0pF	±0.5pF	**GQM1875G2E9R0DB12#**	p175
			9.1pF	±0.25pF	**GQM1875G2E9R1CB12#**	p175
				±0.5pF	**GQM1875G2E9R1DB12#**	p175
			10pF	±2%	**GQM1875G2E100GB12#**	p175
				±5%	**GQM1875G2E100JB12#**	p175
			11pF	±2%	**GQM1875G2E110GB12#**	p175
				±5%	**GQM1875G2E110JB12#**	p175
			12pF	±2%	**GQM1875G2E120GB12#**	p175
				±5%	**GQM1875G2E120JB12#**	p175
			13pF	±2%	**GQM1875G2E130GB12#**	p175
				±5%	**GQM1875G2E130JB12#**	p175
			15pF	±2%	**GQM1875G2E150GB12#**	p175
				±5%	**GQM1875G2E150JB12#**	p175
			16pF	±2%	**GQM1875G2E160GB12#**	p175
				±5%	**GQM1875G2E160JB12#**	p175
			18pF	±2%	**GQM1875G2E180GB12#**	p175
				±5%	**GQM1875G2E180JB12#**	p175
			20pF	±2%	**GQM1875G2E200GB12#**	p175
				±5%	**GQM1875G2E200JB12#**	p175
			22pF	±2%	**GQM1875G2E220GB12#**	p175
				±5%	**GQM1875G2E220JB12#**	p175
			24pF	±2%	**GQM1875G2E240GB12#**	p175
				±5%	**GQM1875G2E240JB12#**	p175
			27pF	±2%	**GQM1875G2E270GB12#**	p175
				±5%	**GQM1875G2E270JB12#**	p175
			30pF	±2%	**GQM1875G2E300GB12#**	p175
				±5%	**GQM1875G2E300JB12#**	p175

2.0×1.25mm

T max.	Rated Voltage	TC Code	Cap.	Tol.	Part Number	p*
1.0mm	500Vdc	X8G	1.0pF	±0.1pF	**GQM2195G2H1R0BB12#**	p175
				±0.25pF	**GQM2195G2H1R0CB12#**	p175
			1.1pF	±0.1pF	**GQM2195G2H1R1BB12#**	p175
				±0.25pF	**GQM2195G2H1R1CB12#**	p175
			1.2pF	±0.1pF	**GQM2195G2H1R2BB12#**	p175
				±0.25pF	**GQM2195G2H1R2CB12#**	p175
			1.3pF	±0.1pF	**GQM2195G2H1R3BB12#**	p175
				±0.25pF	**GQM2195G2H1R3CB12#**	p175
			1.5pF	±0.1pF	**GQM2195G2H1R5BB12#**	p175
				±0.25pF	**GQM2195G2H1R5CB12#**	p175
			1.6pF	±0.1pF	**GQM2195G2H1R6BB12#**	p175
				±0.25pF	**GQM2195G2H1R6CB12#**	p175
			1.8pF	±0.1pF	**GQM2195G2H1R8BB12#**	p175
				±0.25pF	**GQM2195G2H1R8CB12#**	p175
			2.0pF	±0.1pF	**GQM2195G2H2R0BB12#**	p175
				±0.25pF	**GQM2195G2H2R0CB12#**	p175
			2.2pF	±0.1pF	**GQM2195G2H2R2BB12#**	p175
				±0.25pF	**GQM2195G2H2R2CB12#**	p175
			2.4pF	±0.1pF	**GQM2195G2H2R4BB12#**	p175
				±0.25pF	**GQM2195G2H2R4CB12#**	p175
			2.7pF	±0.1pF	**GQM2195G2H2R7BB12#**	p175
				±0.25pF	**GQM2195G2H2R7CB12#**	p175

*: Refers to the page of the "Specifications and Test Methods".

Part number # indicates the package specification code.

GQM Series Temperature Compensating Type Part Number List

(→ 2.0×1.25mm)

T max.	Rated Voltage	TC Code	Cap.	Tol.	Part Number	p*
1.0mm	500Vdc	X8G	3.0pF	±0.1pF	**GQM2195G2H3R0BB12#**	p175
				±0.25pF	**GQM2195G2H3R0CB12#**	p175
			3.3pF	±0.1pF	**GQM2195G2H3R3BB12#**	p175
				±0.25pF	**GQM2195G2H3R3CB12#**	p175
			3.6pF	±0.1pF	**GQM2195G2H3R6BB12#**	p175
				±0.25pF	**GQM2195G2H3R6CB12#**	p175
			3.9pF	±0.1pF	**GQM2195G2H3R9BB12#**	p175
				±0.25pF	**GQM2195G2H3R9CB12#**	p175
			4.0pF	±0.1pF	**GQM2195G2H4R0BB12#**	p175
				±0.25pF	**GQM2195G2H4R0CB12#**	p175
			4.3pF	±0.1pF	**GQM2195G2H4R3BB12#**	p175
				±0.25pF	**GQM2195G2H4R3CB12#**	p175
			4.7pF	±0.1pF	**GQM2195G2H4R7BB12#**	p175
				±0.25pF	**GQM2195G2H4R7CB12#**	p175
			5.0pF	±0.1pF	**GQM2195G2H5R0BB12#**	p175
				±0.25pF	**GQM2195G2H5R0CB12#**	p175
			5.1pF	±0.25pF	**GQM2195G2H5R1CB12#**	p175
				±0.5pF	**GQM2195G2H5R1DB12#**	p175
			5.6pF	±0.25pF	**GQM2195G2H5R6CB12#**	p175
				±0.5pF	**GQM2195G2H5R6DB12#**	p175
			6.0pF	±0.25pF	**GQM2195G2H6R0CB12#**	p175
				±0.5pF	**GQM2195G2H6R0DB12#**	p175
			6.2pF	±0.25pF	**GQM2195G2H6R2CB12#**	p175
				±0.5pF	**GQM2195G2H6R2DB12#**	p175
			6.8pF	±0.25pF	**GQM2195G2H6R8CB12#**	p175
				±0.5pF	**GQM2195G2H6R8DB12#**	p175
			7.0pF	±0.25pF	**GQM2195G2H7R0CB12#**	p175
				±0.5pF	**GQM2195G2H7R0DB12#**	p175
			7.5pF	±0.25pF	**GQM2195G2H7R5CB12#**	p175
				±0.5pF	**GQM2195G2H7R5DB12#**	p175
			8.0pF	±0.25pF	**GQM2195G2H8R0CB12#**	p175
				±0.5pF	**GQM2195G2H8R0DB12#**	p175
			8.2pF	±0.25pF	**GQM2195G2H8R2CB12#**	p175
				±0.5pF	**GQM2195G2H8R2DB12#**	p175
			9.0pF	±0.25pF	**GQM2195G2H9R0CB12#**	p175
				±0.5pF	**GQM2195G2H9R0DB12#**	p175
			9.1pF	±0.25pF	**GQM2195G2H9R1CB12#**	p175
				±0.5pF	**GQM2195G2H9R1DB12#**	p175
			10pF	±2%	**GQM2195G2H100GB12#**	p175
				±5%	**GQM2195G2H100JB12#**	p175
			11pF	±2%	**GQM2195G2H110GB12#**	p175
				±5%	**GQM2195G2H110JB12#**	p175
			12pF	±2%	**GQM2195G2H120GB12#**	p175
				±5%	**GQM2195G2H120JB12#**	p175
			13pF	±2%	**GQM2195G2H130GB12#**	p175
				±5%	**GQM2195G2H130JB12#**	p175
			15pF	±2%	**GQM2195G2H150GB12#**	p175
				±5%	**GQM2195G2H150JB12#**	p175
			16pF	±2%	**GQM2195G2H160GB12#**	p175
				±5%	**GQM2195G2H160JB12#**	p175
			18pF	±2%	**GQM2195G2H180GB12#**	p175
				±5%	**GQM2195G2H180JB12#**	p175
			20pF	±2%	**GQM2195G2H200GB12#**	p175
				±5%	**GQM2195G2H200JB12#**	p175
1.0mm	500Vdc	X8G	22pF	±2%	**GQM2195G2H220GB12#**	p175
				±5%	**GQM2195G2H220JB12#**	p175
	250Vdc	C0G	1.0pF	±0.1pF	**GQM2195C2E1R0BB12#**	p178
				±0.25pF	**GQM2195C2E1R0CB12#**	p178
			1.1pF	±0.1pF	**GQM2195C2E1R1BB12#**	p178
				±0.25pF	**GQM2195C2E1R1CB12#**	p178
			1.2pF	±0.1pF	**GQM2195C2E1R2BB12#**	p178
				±0.25pF	**GQM2195C2E1R2CB12#**	p178
			1.3pF	±0.1pF	**GQM2195C2E1R3BB12#**	p178
				±0.25pF	**GQM2195C2E1R3CB12#**	p178
			1.5pF	±0.1pF	**GQM2195C2E1R5BB12#**	p178
				±0.25pF	**GQM2195C2E1R5CB12#**	p178
			1.6pF	±0.1pF	**GQM2195C2E1R6BB12#**	p178
				±0.25pF	**GQM2195C2E1R6CB12#**	p178
			1.8pF	±0.1pF	**GQM2195C2E1R8BB12#**	p178
				±0.25pF	**GQM2195C2E1R8CB12#**	p178
			2.0pF	±0.1pF	**GQM2195C2E2R0BB12#**	p178
				±0.25pF	**GQM2195C2E2R0CB12#**	p178
			2.2pF	±0.1pF	**GQM2195C2E2R2BB12#**	p178
				±0.25pF	**GQM2195C2E2R2CB12#**	p178
			2.4pF	±0.1pF	**GQM2195C2E2R4BB12#**	p178
				±0.25pF	**GQM2195C2E2R4CB12#**	p178
			2.7pF	±0.1pF	**GQM2195C2E2R7BB12#**	p178
				±0.25pF	**GQM2195C2E2R7CB12#**	p178
			3.0pF	±0.1pF	**GQM2195C2E3R0BB12#**	p178
				±0.25pF	**GQM2195C2E3R0CB12#**	p178
			3.3pF	±0.1pF	**GQM2195C2E3R3BB12#**	p178
				±0.25pF	**GQM2195C2E3R3CB12#**	p178
			3.6pF	±0.1pF	**GQM2195C2E3R6BB12#**	p178
				±0.25pF	**GQM2195C2E3R6CB12#**	p178
			3.9pF	±0.1pF	**GQM2195C2E3R9BB12#**	p178
				±0.25pF	**GQM2195C2E3R9CB12#**	p178
			4.0pF	±0.1pF	**GQM2195C2E4R0BB12#**	p178
				±0.25pF	**GQM2195C2E4R0CB12#**	p178
			4.3pF	±0.1pF	**GQM2195C2E4R3BB12#**	p178
				±0.25pF	**GQM2195C2E4R3CB12#**	p178
			4.7pF	±0.1pF	**GQM2195C2E4R7BB12#**	p178
				±0.25pF	**GQM2195C2E4R7CB12#**	p178
			5.0pF	±0.1pF	**GQM2195C2E5R0BB12#**	p178
				±0.25pF	**GQM2195C2E5R0CB12#**	p178
			5.1pF	±0.25pF	**GQM2195C2E5R1CB12#**	p178
				±0.5pF	**GQM2195C2E5R1DB12#**	p178
			5.6pF	±0.25pF	**GQM2195C2E5R6CB12#**	p178
				±0.5pF	**GQM2195C2E5R6DB12#**	p178
			6.0pF	±0.25pF	**GQM2195C2E6R0CB12#**	p178
				±0.5pF	**GQM2195C2E6R0DB12#**	p178
			6.2pF	±0.25pF	**GQM2195C2E6R2CB12#**	p178
				±0.5pF	**GQM2195C2E6R2DB12#**	p178
			6.8pF	±0.25pF	**GQM2195C2E6R8CB12#**	p178
				±0.5pF	**GQM2195C2E6R8DB12#**	p178
			7.0pF	±0.25pF	**GQM2195C2E7R0CB12#**	p178
				±0.5pF	**GQM2195C2E7R0DB12#**	p178
			7.5pF	±0.25pF	**GQM2195C2E7R5CB12#**	p178
				±0.5pF	**GQM2195C2E7R5DB12#**	p178

*: Refers to the page of the "Specifications and Test Methods".

Part number # indicates the package specification code.

GQM Series Temperature Compensating Type Part Number List

(→ 2.0×1.25mm)

T max.	Rated Voltage	TC Code	Cap.	Tol.	Part Number	p*
1.0mm	250Vdc	C0G	8.0pF	±0.25pF	GQM2195C2E8R0CB12#	p178
				±0.5pF	GQM2195C2E8R0DB12#	p178
			8.2pF	±0.25pF	GQM2195C2E8R2CB12#	p178
				±0.5pF	GQM2195C2E8R2DB12#	p178
			9.0pF	±0.25pF	GQM2195C2E9R0CB12#	p178
				±0.5pF	GQM2195C2E9R0DB12#	p178
			9.1pF	±0.25pF	GQM2195C2E9R1CB12#	p178
				±0.5pF	GQM2195C2E9R1DB12#	p178
			10pF	±2%	GQM2195C2E100GB12#	p178
				±5%	GQM2195C2E100JB12#	p178
			11pF	±2%	GQM2195C2E110GB12#	p178
				±5%	GQM2195C2E110JB12#	p178
			12pF	±2%	GQM2195C2E120GB12#	p178
				±5%	GQM2195C2E120JB12#	p178
			13pF	±2%	GQM2195C2E130GB12#	p178
				±5%	GQM2195C2E130JB12#	p178
			15pF	±2%	GQM2195C2E150GB12#	p178
				±5%	GQM2195C2E150JB12#	p178
			16pF	±2%	GQM2195C2E160GB12#	p178
				±5%	GQM2195C2E160JB12#	p178
			18pF	±2%	GQM2195C2E180GB12#	p178
				±5%	GQM2195C2E180JB12#	p178
			20pF	±2%	GQM2195C2E200GB12#	p178
				±5%	GQM2195C2E200JB12#	p178
			22pF	±2%	GQM2195C2E220GB12#	p178
				±5%	GQM2195C2E220JB12#	p178
			24pF	±2%	GQM2195C2E240GB12#	p178
				±5%	GQM2195C2E240JB12#	p178
			27pF	±2%	GQM2195C2E270GB12#	p178
				±5%	GQM2195C2E270JB12#	p178
			30pF	±2%	GQM2195C2E300GB12#	p178
				±5%	GQM2195C2E300JB12#	p178
			33pF	±2%	GQM2195C2E330GB12#	p178
				±5%	GQM2195C2E330JB12#	p178
			36pF	±2%	GQM2195C2E360GB12#	p178
				±5%	GQM2195C2E360JB12#	p178
			39pF	±2%	GQM2195C2E390GB12#	p178
				±5%	GQM2195C2E390JB12#	p178
			43pF	±2%	GQM2195C2E430GB12#	p178
				±5%	GQM2195C2E430JB12#	p178
			47pF	±2%	GQM2195C2E470GB12#	p178
				±5%	GQM2195C2E470JB12#	p178
			51pF	±2%	GQM2195C2E510GB12#	p178
				±5%	GQM2195C2E510JB12#	p178
			56pF	±2%	GQM2195C2E560GB12#	p178
				±5%	GQM2195C2E560JB12#	p178
			62pF	±2%	GQM2195C2E620GB12#	p178
				±5%	GQM2195C2E620JB12#	p178
			68pF	±2%	GQM2195C2E680GB12#	p178
				±5%	GQM2195C2E680JB12#	p178
			75pF	±2%	GQM2195C2E750GB12#	p178
				±5%	GQM2195C2E750JB12#	p178
			82pF	±2%	GQM2195C2E820GB12#	p178
				±5%	GQM2195C2E820JB12#	p178
1.0mm	250Vdc	C0G	91pF	±2%	GQM2195C2E910GB12#	p178
				±5%	GQM2195C2E910JB12#	p178
			100pF	±2%	GQM2195C2E101GB12#	p178
				±5%	GQM2195C2E101JB12#	p178
		X8G	1.0pF	±0.1pF	GQM2195G2E1R0BB12#	p175
				±0.25pF	GQM2195G2E1R0CB12#	p175
			1.1pF	±0.1pF	GQM2195G2E1R1BB12#	p175
				±0.25pF	GQM2195G2E1R1CB12#	p175
			1.2pF	±0.1pF	GQM2195G2E1R2BB12#	p175
				±0.25pF	GQM2195G2E1R2CB12#	p175
			1.3pF	±0.1pF	GQM2195G2E1R3BB12#	p175
				±0.25pF	GQM2195G2E1R3CB12#	p175
			1.5pF	±0.1pF	GQM2195G2E1R5BB12#	p175
				±0.25pF	GQM2195G2E1R5CB12#	p175
			1.6pF	±0.1pF	GQM2195G2E1R6BB12#	p175
				±0.25pF	GQM2195G2E1R6CB12#	p175
			1.8pF	±0.1pF	GQM2195G2E1R8BB12#	p175
				±0.25pF	GQM2195G2E1R8CB12#	p175
			2.0pF	±0.1pF	GQM2195G2E2R0BB12#	p175
				±0.25pF	GQM2195G2E2R0CB12#	p175
			2.2pF	±0.1pF	GQM2195G2E2R2BB12#	p175
				±0.25pF	GQM2195G2E2R2CB12#	p175
			2.4pF	±0.1pF	GQM2195G2E2R4BB12#	p175
				±0.25pF	GQM2195G2E2R4CB12#	p175
			2.7pF	±0.1pF	GQM2195G2E2R7BB12#	p175
				±0.25pF	GQM2195G2E2R7CB12#	p175
			3.0pF	±0.1pF	GQM2195G2E3R0BB12#	p175
				±0.25pF	GQM2195G2E3R0CB12#	p175
			3.3pF	±0.1pF	GQM2195G2E3R3BB12#	p175
				±0.25pF	GQM2195G2E3R3CB12#	p175
			3.6pF	±0.1pF	GQM2195G2E3R6BB12#	p175
				±0.25pF	GQM2195G2E3R6CB12#	p175
			3.9pF	±0.1pF	GQM2195G2E3R9BB12#	p175
				±0.25pF	GQM2195G2E3R9CB12#	p175
			4.0pF	±0.1pF	GQM2195G2E4R0BB12#	p175
				±0.25pF	GQM2195G2E4R0CB12#	p175
			4.3pF	±0.1pF	GQM2195G2E4R3BB12#	p175
				±0.25pF	GQM2195G2E4R3CB12#	p175
			4.7pF	±0.1pF	GQM2195G2E4R7BB12#	p175
				±0.25pF	GQM2195G2E4R7CB12#	p175
			5.0pF	±0.1pF	GQM2195G2E5R0BB12#	p175
				±0.25pF	GQM2195G2E5R0CB12#	p175
			5.1pF	±0.25pF	GQM2195G2E5R1CB12#	p175
				±0.5pF	GQM2195G2E5R1DB12#	p175
			5.6pF	±0.25pF	GQM2195G2E5R6CB12#	p175
				±0.5pF	GQM2195G2E5R6DB12#	p175
			6.0pF	±0.25pF	GQM2195G2E6R0CB12#	p175
				±0.5pF	GQM2195G2E6R0DB12#	p175
			6.2pF	±0.25pF	GQM2195G2E6R2CB12#	p175
				±0.5pF	GQM2195G2E6R2DB12#	p175
			6.8pF	±0.25pF	GQM2195G2E6R8CB12#	p175
				±0.5pF	GQM2195G2E6R8DB12#	p175
			7.0pF	±0.25pF	GQM2195G2E7R0CB12#	p175
				±0.5pF	GQM2195G2E7R0DB12#	p175

*: Refers to the page of the “Specifications and Test Methods”.

Part number # indicates the package specification code.

GQM Series Temperature Compensating Type Part Number List

(→ 2.0×1.25mm)

T max.	Rated Voltage	TC Code	Cap.	Tol.	Part Number	p*
1.0mm	250Vdc	X8G	7.5pF	±0.25pF	GQM2195G2E7R5CB12#	p175
				±0.5pF	GQM2195G2E7R5DB12#	p175
			8.0pF	±0.25pF	GQM2195G2E8R0CB12#	p175
				±0.5pF	GQM2195G2E8R0DB12#	p175
			8.2pF	±0.25pF	GQM2195G2E8R2CB12#	p175
				±0.5pF	GQM2195G2E8R2DB12#	p175
			9.0pF	±0.25pF	GQM2195G2E9R0CB12#	p175
				±0.5pF	GQM2195G2E9R0DB12#	p175
			9.1pF	±0.25pF	GQM2195G2E9R1CB12#	p175
				±0.5pF	GQM2195G2E9R1DB12#	p175
			10pF	±2%	GQM2195G2E100GB12#	p175
				±5%	GQM2195G2E100JB12#	p175
			11pF	±2%	GQM2195G2E110GB12#	p175
				±5%	GQM2195G2E110JB12#	p175
			12pF	±2%	GQM2195G2E120GB12#	p175
				±5%	GQM2195G2E120JB12#	p175
			13pF	±2%	GQM2195G2E130GB12#	p175
				±5%	GQM2195G2E130JB12#	p175
			15pF	±2%	GQM2195G2E150GB12#	p175
				±5%	GQM2195G2E150JB12#	p175
			16pF	±2%	GQM2195G2E160GB12#	p175
				±5%	GQM2195G2E160JB12#	p175
			18pF	±2%	GQM2195G2E180GB12#	p175
				±5%	GQM2195G2E180JB12#	p175
			20pF	±2%	GQM2195G2E200GB12#	p175
				±5%	GQM2195G2E200JB12#	p175
			22pF	±2%	GQM2195G2E220GB12#	p175
				±5%	GQM2195G2E220JB12#	p175
			24pF	±2%	GQM2195G2E240GB12#	p175
				±5%	GQM2195G2E240JB12#	p175
			27pF	±2%	GQM2195G2E270GB12#	p175
				±5%	GQM2195G2E270JB12#	p175
			30pF	±2%	GQM2195G2E300GB12#	p175
				±5%	GQM2195G2E300JB12#	p175
			33pF	±2%	GQM2195G2E330GB12#	p175
				±5%	GQM2195G2E330JB12#	p175
			36pF	±2%	GQM2195G2E360GB12#	p175
				±5%	GQM2195G2E360JB12#	p175
			39pF	±2%	GQM2195G2E390GB12#	p175
				±5%	GQM2195G2E390JB12#	p175
			43pF	±2%	GQM2195G2E430GB12#	p175
				±5%	GQM2195G2E430JB12#	p175
			47pF	±2%	GQM2195G2E470GB12#	p175
				±5%	GQM2195G2E470JB12#	p175
			51pF	±2%	GQM2195G2E510GB12#	p175
				±5%	GQM2195G2E510JB12#	p175
			56pF	±2%	GQM2195G2E560GB12#	p175
				±5%	GQM2195G2E560JB12#	p175
			62pF	±2%	GQM2195G2E620GB12#	p175
				±5%	GQM2195G2E620JB12#	p175
			68pF	±2%	GQM2195G2E680GB12#	p175
				±5%	GQM2195G2E680JB12#	p175
			75pF	±2%	GQM2195G2E750GB12#	p175
				±5%	GQM2195G2E750JB12#	p175

T max.	Rated Voltage	TC Code	Cap.	Tol.	Part Number	p*
1.0mm	250Vdc	X8G	82pF	±2%	GQM2195G2E820GB12#	p175
				±5%	GQM2195G2E820JB12#	p175

2.8×2.8mm

T max.	Rated Voltage	TC Code	Cap.	Tol.	Part Number	p*
1.35mm	500Vdc	C0G	1.0pF	±0.1pF	GQM22M5C2H1R0BB01#	p181
				±0.25pF	GQM22M5C2H1R0CB01#	p181
			1.1pF	±0.1pF	GQM22M5C2H1R1BB01#	p181
				±0.25pF	GQM22M5C2H1R1CB01#	p181
			1.2pF	±0.1pF	GQM22M5C2H1R2BB01#	p181
				±0.25pF	GQM22M5C2H1R2CB01#	p181
			1.3pF	±0.1pF	GQM22M5C2H1R3BB01#	p181
				±0.25pF	GQM22M5C2H1R3CB01#	p181
			1.5pF	±0.1pF	GQM22M5C2H1R5BB01#	p181
				±0.25pF	GQM22M5C2H1R5CB01#	p181
			1.6pF	±0.1pF	GQM22M5C2H1R6BB01#	p181
				±0.25pF	GQM22M5C2H1R6CB01#	p181
			1.8pF	±0.1pF	GQM22M5C2H1R8BB01#	p181
				±0.25pF	GQM22M5C2H1R8CB01#	p181
			2.0pF	±0.1pF	GQM22M5C2H2R0BB01#	p181
				±0.25pF	GQM22M5C2H2R0CB01#	p181
			2.2pF	±0.1pF	GQM22M5C2H2R2BB01#	p181
				±0.25pF	GQM22M5C2H2R2CB01#	p181
			2.4pF	±0.1pF	GQM22M5C2H2R4BB01#	p181
				±0.25pF	GQM22M5C2H2R4CB01#	p181
			2.7pF	±0.1pF	GQM22M5C2H2R7BB01#	p181
				±0.25pF	GQM22M5C2H2R7CB01#	p181
			3.0pF	±0.1pF	GQM22M5C2H3R0BB01#	p181
				±0.25pF	GQM22M5C2H3R0CB01#	p181
			3.3pF	±0.1pF	GQM22M5C2H3R3BB01#	p181
				±0.25pF	GQM22M5C2H3R3CB01#	p181
			3.6pF	±0.1pF	GQM22M5C2H3R6BB01#	p181
				±0.25pF	GQM22M5C2H3R6CB01#	p181
			3.9pF	±0.1pF	GQM22M5C2H3R9BB01#	p181
				±0.25pF	GQM22M5C2H3R9CB01#	p181
			4.0pF	±0.1pF	GQM22M5C2H4R0BB01#	p181
				±0.25pF	GQM22M5C2H4R0CB01#	p181
			4.3pF	±0.1pF	GQM22M5C2H4R3BB01#	p181
				±0.25pF	GQM22M5C2H4R3CB01#	p181
			4.7pF	±0.1pF	GQM22M5C2H4R7BB01#	p181
				±0.25pF	GQM22M5C2H4R7CB01#	p181
			5.0pF	±0.1pF	GQM22M5C2H5R0BB01#	p181
				±0.25pF	GQM22M5C2H5R0CB01#	p181
			5.1pF	±0.25pF	GQM22M5C2H5R1CB01#	p181
				±0.5pF	GQM22M5C2H5R1DB01#	p181
			5.6pF	±0.25pF	GQM22M5C2H5R6CB01#	p181
				±0.5pF	GQM22M5C2H5R6DB01#	p181
			6.0pF	±0.25pF	GQM22M5C2H6R0CB01#	p181
				±0.5pF	GQM22M5C2H6R0DB01#	p181
			6.2pF	±0.25pF	GQM22M5C2H6R2CB01#	p181
				±0.5pF	GQM22M5C2H6R2DB01#	p181
			6.8pF	±0.25pF	GQM22M5C2H6R8CB01#	p181

*: Refers to the page of the "Specifications and Test Methods".

Part number # indicates the package specification code.

GQM Series Temperature Compensating Type Part Number List

(→ 2.8×2.8mm)

T max.	Rated Voltage	TC Code	Cap.	Tol.	Part Number	p*
1.35mm	500Vdc	C0G	6.8pF	±0.5pF	**GQM22M5C2H6R8DB01#**	p181
			7.0pF	±0.25pF	**GQM22M5C2H7R0CB01#**	p181
				±0.5pF	**GQM22M5C2H7R0DB01#**	p181
			7.5pF	±0.25pF	**GQM22M5C2H7R5CB01#**	p181
				±0.5pF	**GQM22M5C2H7R5DB01#**	p181
			8.0pF	±0.25pF	**GQM22M5C2H8R0CB01#**	p181
				±0.5pF	**GQM22M5C2H8R0DB01#**	p181
			8.2pF	±0.25pF	**GQM22M5C2H8R2CB01#**	p181
				±0.5pF	**GQM22M5C2H8R2DB01#**	p181
			9.0pF	±0.25pF	**GQM22M5C2H9R0CB01#**	p181
				±0.5pF	**GQM22M5C2H9R0DB01#**	p181
			9.1pF	±0.25pF	**GQM22M5C2H9R1CB01#**	p181
				±0.5pF	**GQM22M5C2H9R1DB01#**	p181
			10pF	±2%	**GQM22M5C2H100GB01#**	p181
				±5%	**GQM22M5C2H100JB01#**	p181
			11pF	±2%	**GQM22M5C2H110GB01#**	p181
				±5%	**GQM22M5C2H110JB01#**	p181
			12pF	±2%	**GQM22M5C2H120GB01#**	p181
				±5%	**GQM22M5C2H120JB01#**	p181
			13pF	±2%	**GQM22M5C2H130GB01#**	p181
				±5%	**GQM22M5C2H130JB01#**	p181
			15pF	±2%	**GQM22M5C2H150GB01#**	p181
				±5%	**GQM22M5C2H150JB01#**	p181
			16pF	±2%	**GQM22M5C2H160GB01#**	p181
				±5%	**GQM22M5C2H160JB01#**	p181
			18pF	±2%	**GQM22M5C2H180GB01#**	p181
				±5%	**GQM22M5C2H180JB01#**	p181
			20pF	±2%	**GQM22M5C2H200GB01#**	p181
				±5%	**GQM22M5C2H200JB01#**	p181
			22pF	±2%	**GQM22M5C2H220GB01#**	p181
				±5%	**GQM22M5C2H220JB01#**	p181
			24pF	±2%	**GQM22M5C2H240GB01#**	p181
				±5%	**GQM22M5C2H240JB01#**	p181
			27pF	±2%	**GQM22M5C2H270GB01#**	p181
				±5%	**GQM22M5C2H270JB01#**	p181
			30pF	±2%	**GQM22M5C2H300GB01#**	p181
				±5%	**GQM22M5C2H300JB01#**	p181
			33pF	±2%	**GQM22M5C2H330GB01#**	p181
				±5%	**GQM22M5C2H330JB01#**	p181
			36pF	±2%	**GQM22M5C2H360GB01#**	p181
				±5%	**GQM22M5C2H360JB01#**	p181
			39pF	±2%	**GQM22M5C2H390GB01#**	p181
				±5%	**GQM22M5C2H390JB01#**	p181
			43pF	±2%	**GQM22M5C2H430GB01#**	p181
				±5%	**GQM22M5C2H430JB01#**	p181
			47pF	±2%	**GQM22M5C2H470GB01#**	p181
				±5%	**GQM22M5C2H470JB01#**	p181
			51pF	±2%	**GQM22M5C2H510GB01#**	p181
				±5%	**GQM22M5C2H510JB01#**	p181
			56pF	±2%	**GQM22M5C2H560GB01#**	p181
				±5%	**GQM22M5C2H560JB01#**	p181
			62pF	±2%	**GQM22M5C2H620GB01#**	p181
				±5%	**GQM22M5C2H620JB01#**	p181
			68pF	±2%	**GQM22M5C2H680GB01#**	p181
1.35mm	500Vdc	C0G	68pF	±5%	**GQM22M5C2H680JB01#**	p181
			75pF	±2%	**GQM22M5C2H750GB01#**	p181
				±5%	**GQM22M5C2H750JB01#**	p181
			82pF	±2%	**GQM22M5C2H820GB01#**	p181
				±5%	**GQM22M5C2H820JB01#**	p181
			91pF	±2%	**GQM22M5C2H910GB01#**	p181
				±5%	**GQM22M5C2H910JB01#**	p181
			100pF	±2%	**GQM22M5C2H101GB01#**	p181
				±5%	**GQM22M5C2H101JB01#**	p181

*: Refers to the page of the “Specifications and Test Methods”.

Part number # indicates the package specification code.

1 GQM Series Specifications and Test Methods (1)

<table>
<tr><th>No</th><th colspan="2">Item</th><th>Specification</th><th>Test Method (Ref. Standard: JIS C 5101, IEC60384)</th></tr>
<tr><td>1</td><td colspan="2">Rated Voltage</td><td>Shown in Rated value.</td><td>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.</td></tr>
<tr><td>2</td><td colspan="2">Appearance</td><td>No defects or abnormalities.</td><td>Visual inspection.</td></tr>
<tr><td>3</td><td colspan="2">Dimension</td><td>Within the specified dimensions.</td><td>Using Measuring instrument of dimension.</td></tr>
<tr><td>4</td><td colspan="2">Voltage Proof</td><td>No defects or abnormalities.</td><td>Measurement Point: Between the terminations
Applied Time: 1 to 5s
Charge/discharge current: 50mA max.
Test Voltage:
<table>
<tr><th>Rated Voltage</th><th>Test Voltage</th></tr>
<tr><td>100V</td><td>300% of Rated Voltage</td></tr>
<tr><td>200V</td><td>250% of Rated Voltage</td></tr>
</table></td></tr>
<tr><td>5</td><td colspan="2">Insulation Resistance (I.R.)</td><td>More than 10000MΩ</td><td>Measurement Point: Between the terminations
Measurement Voltage: DC Rated Voltage
Charging Time: 2min
Charge/discharge current: 50mA max.
Measurement Temperature: Room Temperature</td></tr>
<tr><td>6</td><td colspan="2">Capacitance</td><td>Shown in Rated value.</td><td rowspan="2">Measurement Temperature: Room Temperature
<table>
<tr><th>Capacitance</th><th>Frequency</th><th>Voltage</th></tr>
<tr><td>C ≦ 1000pF</td><td>1.0±0.1kHz</td><td>0.5 to 5.0Vrms</td></tr>
</table></td></tr>
<tr><td>7</td><td colspan="2">Q</td><td>30pF and over: Q ≧ 1400
30pF and below: Q ≧ 800+20C
C: Nominal Capacitance(pF)</td></tr>
<tr><td>8</td><td colspan="2">Temperature Characteristics of Capacitance</td><td>Nominal values of the temperature coefficient is shown in
Rated value.
But, the Capacitance Change under 25°C is shown in Table A.
Capacitance Drift
Within ±0.2% or ±0.05pF
(Whichever is larger.)</td><td>The capacitance change should be measured after 5 minutes at each specified temp. stage.
Capacitance value as a reference is the value in step 3.
The capacitance drift is calculated by dividing the differences between the maximum and minimum measured values in the step 1, 3 and 5 by the cap. value in step 3.
<table>
<tr><th>Step</th><th>Temperature (°C)</th></tr>
<tr><td>1</td><td>Reference Temp. ±2</td></tr>
<tr><td>2</td><td>Min. Operating Temp. ±3</td></tr>
<tr><td>3</td><td>Reference Temp. ±2</td></tr>
<tr><td>4</td><td>Max. Operating Temp. ±3</td></tr>
<tr><td>5</td><td>Reference Temp. ±2</td></tr>
</table></td></tr>
<tr><td>9</td><td colspan="2">Adhesive Strength of Termination</td><td>No removal of the terminations or other defect should occur.</td><td>Solder the capacitor on the test substrate shown in Fig.3.
Applied Force: 5N
Holding Time: 10±1s
Applied Direction: In parallel with the test substrate and vertical with the capacitor side.</td></tr>
<tr><td rowspan="3">10</td><td rowspan="3">Vibration</td><td>Appearance</td><td>No defects or abnormalities.</td><td rowspan="3">Solder the capacitor on the test substrate shown in Fig.3.
Kind of Vibration: A simple harmonic motion 10Hz to 55Hz to 10Hz (1min)
Total amplitude: 1.5mm
This motion should be applied for a period of 2h in each 3 mutually perpendicular directions (total of 6h).</td></tr>
<tr><td>Capacitance</td><td>Within the specified initial value.</td></tr>
<tr><td>Q</td><td>Within the specified initial value.</td></tr>
<tr><td rowspan="2">11</td><td rowspan="2">Substrate Bending Test</td><td>Appearance</td><td>No defects or abnormalities.</td><td rowspan="2">Solder the capacitor on the test substrate shown in Fig.1.
Pressurization method: Shown in Fig.2
Flexure: 1mm
Holding Time: 5±1s
Soldering Method: Reflow soldering</td></tr>
<tr><td>Capacitance Change</td><td>Within ±5% or ±0.5pF
(Whichever is larger)</td></tr>
<tr><td>12</td><td colspan="2">Solderability</td><td>95% of the terminations is to be soldered evenly and continuously.</td><td>Test Method: Solder bath method
Flux: Solution of rosin ethanol 25 (mass)%
Preheat: 80 to 120°C for 10 to 30s
Solder: Sn-3.0Ag-0.5Cu
Solder Temp.: 245±5°C
Immersion time: 2±0.5s</td></tr>
<tr><td rowspan="5">13</td><td rowspan="5">Resistance to Soldering Heat</td><td>Appearance</td><td>No defects or abnormalities.</td><td rowspan="5">Test Method: Solder bath method
Solder: Sn-3.0Ag-0.5Cu
Solder Temp.: 270±5°C
Immersion time: 10±0.5s
Exposure Time: 24±2h
Preheat: 120 to 150°C for 1min</td></tr>
<tr><td>Capacitance Change</td><td>Within ±2.5% or ±0.25pF
(Whichever is larger)</td></tr>
<tr><td>Q</td><td>Within the specified initial value.</td></tr>
<tr><td>I.R.</td><td>Within the specified initial value.</td></tr>
<tr><td>Voltage Proof</td><td>No defects.</td></tr>
</table>

Continued on the following page.↗

GQM Series Specifications and Test Methods (1)

Continued from the preceding page.↘

<table>
<tr><th>No</th><th colspan="2">Item</th><th>Specification</th><th>Test Method (Ref. Standard: JIS C 5101, IEC60384)</th></tr>
<tr><td rowspan="5">14</td><td rowspan="5">Temperature Sudden Change</td><td>Appearance</td><td>No defects or abnormalities.</td><td rowspan="5">Solder the capacitor on the test substrate shown in Fig.3.
Perform the 5 cycles according to the four heat treatments shown in the following table.<table><tr><th>Step</th><th>Temp. (°C)</th><th>Time (min)</th></tr><tr><td>1</td><td>Min. Operating Temp. +0/-3</td><td>30±3</td></tr><tr><td>2</td><td>Room Temp.</td><td>2 to 3</td></tr><tr><td>3</td><td>Max. Operating Temp. +3/-0</td><td>30±3</td></tr><tr><td>4</td><td>Room Temp.</td><td>2 to 3</td></tr></table>Exposure Time: 24±2h</td></tr>
<tr><td>Capacitance Change</td><td>Within ±2.5% or ±0.25pF
(Whichever is larger)</td></tr>
<tr><td>Q</td><td>Within the specified initial value.</td></tr>
<tr><td>I.R.</td><td>Within the specified initial value.</td></tr>
<tr><td>Voltage Proof</td><td>No defects.</td></tr>
<tr><td rowspan="4">15</td><td rowspan="4">High Temperature High Humidity (Steady)</td><td>Appearance</td><td>No defects or abnormalities.</td><td rowspan="4">Solder the capacitor on the test substrate shown in Fig.3.
Test Temperature: 40±2°C
Test Humidity: 90 to 95%RH
Test Time: 500±12h
Applied Voltage: DC Rated Voltage
Charge/discharge current: 50mA max.
Exposure Time: 24±2h</td></tr>
<tr><td>Capacitance Change</td><td>Within ±7.5% or ±0.75pF
(Whichever is larger)</td></tr>
<tr><td>Q</td><td>30pF and over: Q ≧ 200
30pF and below: Q ≧ 100+10C/3
C: Nominal Capacitance(pF)</td></tr>
<tr><td>I.R.</td><td>More than 500MΩ</td></tr>
<tr><td rowspan="4">16</td><td rowspan="4">Durability</td><td>Appearance</td><td>No defects or abnormalities.</td><td rowspan="4">Solder the capacitor on the test substrate shown in Fig.3.
Test Temperature: Max. Operating Temp. ±3°C
Test Time: 1000±12h
Applied Voltage: 200% of the rated voltage
Charge/discharge current: 50mA max.
Exposure Time: 24±2h</td></tr>
<tr><td>Capacitance Change</td><td>Within ±3% or ±0.3pF
(Whichever is larger)</td></tr>
<tr><td>Q</td><td>30pF and over: Q ≧ 350
10pF and over, 30pF and below: Q ≧ 275+5C/2
10pF and below: Q ≧ 200+10C
C: Nominal Capacitance (pF)</td></tr>
<tr><td>I.R.</td><td>More than 1000MΩ</td></tr>
</table>

Table A

Char.	Capacitance Change from 25°C(%)					
	-55°C		-30°C		-10°C	
	Max.	Min.	Max.	Min.	Max.	Min.
5C	0.58	-0.24	0.40	-0.17	0.25	-0.11

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GQM Series Specifications and Test Methods (1)

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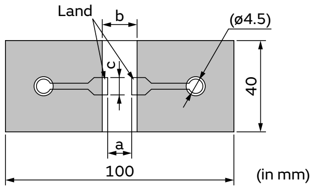
Substrate Bending Test

- Test Substrate
  Material: Copper-clad laminated sheets for PCBs (Glass fabric base, epoxy resin)
  Thickness: 0.8mm
  Copper foil thickness: 0.035mm
  ▨ : Solder resist (Coat with heat resistant resin for solder)



Part Number	Dimension (mm)		
	a	b	c
GQM15	0.4	1.5	0.5

Fig.1

- Kind of Solder: Sn-3.0Ag-0.5Cu
- Pressurization Method

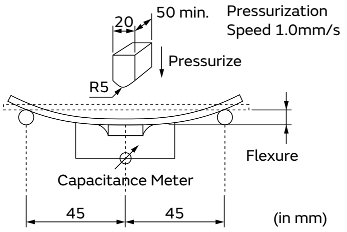
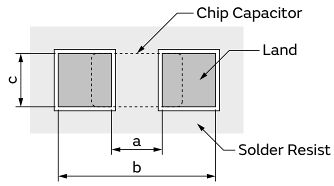


Fig.2

Adhesive Strength of Termination, Vibration, Temperature Sudden Change, High Temperature High Humidity (Steady) , Durability

- Test Substrate
  Material: Copper-clad laminated sheets for PCBs (Glass fabric base, epoxy resin)
  Thickness: 1.6mm or 0.8mm
  Copper foil thickness: 0.035mm

- Kind of Solder: Sn-3.0Ag-0.5Cu
- Land Dimensions



Part Number	Dimension (mm)		
	a	b	c
GQM15	0.4	1.5	0.5

Fig.3

2 GQM Series Specifications and Test Methods (2)

<table>
<tr><th>No</th><th colspan="2">Item</th><th>Specification</th><th>Test Method (Ref. Standard: JIS C 5101, IEC60384)</th></tr>
<tr><td>1</td><td colspan="2">Rated Voltage</td><td>Shown in Rated value.</td><td>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.</td></tr>
<tr><td>2</td><td colspan="2">Appearance</td><td>No defects or abnormalities.</td><td>Visual inspection.</td></tr>
<tr><td>3</td><td colspan="2">Dimension</td><td>Within the specified dimensions.</td><td>Using Measuring instrument of dimension.</td></tr>
<tr><td>4</td><td colspan="2">Voltage Proof</td><td>No defects or abnormalities.</td><td>Measurement Point: Between the terminations
Test Voltage : 250% of the rated voltage
Applied Time: 1 to 5s
Charge/discharge current: 50mA max.</td></tr>
<tr><td>5</td><td colspan="2">Insulation Resistance (I.R.)</td><td>More than 10000MΩ</td><td>Measurement Point: Between the terminations
Measurement Voltage: DC Rated Voltage
Charging Time: 1min
Charge/discharge current: 50mA max.
Measurement Temperature: Room Temperature</td></tr>
<tr><td>6</td><td colspan="2">Capacitance</td><td>Shown in Rated value.</td><td rowspan="2">Measurement Temperature :Room Temperature
<table>
<tr><th>Capacitance</th><th>Frequency</th><th>Voltage</th></tr>
<tr><td>C ≦ 1000pF</td><td>1.0±0.1MHz</td><td>0.5 to 5.0Vrms</td></tr>
</table></td></tr>
<tr><td>7</td><td colspan="2">Q</td><td>30pF and over: Q ≧ 1400
30pF and below: Q ≧ 800+20C
C: Nominal Capacitance(pF)</td></tr>
<tr><td>8</td><td colspan="2">Temperature Characteristics of Capacitance</td><td>Nominal values of the temperature coefficient is shown in
Rated value.
But, the Capacitance Change under 20°C/25°C is shown in Table A.
Capacitance Drift
Within ±0.2% or ±0.05pF
(Whichever is larger.)</td><td>The capacitance change should be measured after 5 minutes at each specified temp. stage.
Capacitance value as a reference is the value in step 3.
The capacitance drift is calculated by dividing the differences between the maximum and minimum measured values in the step 1, 3 and 5 by the cap. value in step 3.
<table>
<tr><th>Step</th><th>Temperature (°C)</th></tr>
<tr><td>1</td><td>Reference Temp. ±2</td></tr>
<tr><td>2</td><td>Min. Operating Temp. ±3</td></tr>
<tr><td>3</td><td>Reference Temp. ±2</td></tr>
<tr><td>4</td><td>Max. Operating Temp. ±3</td></tr>
<tr><td>5</td><td>Reference Temp. ±2</td></tr>
</table></td></tr>
<tr><td>9</td><td colspan="2">Adhesive Strength of Termination</td><td>No removal of the terminations or other defect should occur.</td><td>Solder the capacitor on the test substrate shown in Fig.3.
<table>
<tr><th>Part Number</th><th>Applied Force(N)</th></tr>
<tr><td>GQM18</td><td>5</td></tr>
<tr><td>GQM21</td><td>10</td></tr>
</table>
Holding Time: 10±1s
Applied Direction: In parallel with the test substrate and vertical with the capacitor side.</td></tr>
<tr><td rowspan="3">10</td><td rowspan="3">Vibration</td><td>Appearance</td><td>No defects or abnormalities.</td><td rowspan="3">Solder the capacitor on the test substrate shown in Fig.3.
Kind of Vibration: A simple harmonic motion 10Hz to 55Hz to 10Hz (1min)
Total amplitude: 1.5mm
This motion should be applied for a period of 2h in each 3 mutually perpendicular directions (total of 6h).</td></tr>
<tr><td>Capacitance</td><td>Within the specified initial value.</td></tr>
<tr><td>Q</td><td>Within the specified initial value.</td></tr>
<tr><td rowspan="2">11</td><td rowspan="2">Substrate Bending Test</td><td>Appearance</td><td>No defects or abnormalities.</td><td rowspan="2">Solder the capacitor on the test substrate shown in Fig.1.
Pressurization method: Shown in Fig.2
Flexure: 1mm
Holding Time: 5±1s
Soldering Method: Reflow soldering</td></tr>
<tr><td>Capacitance Change</td><td>Within ±5% or ±0.5pF
(Whichever is larger)</td></tr>
<tr><td>12</td><td colspan="2">Solderability</td><td>95% of the terminations is to be soldered evenly and continuously.</td><td>Test Method: Solder bath method
Flux: Solution of rosin ethanol 25 (mass)%
Preheat: 80 to 120°C for 10 to 30s
Solder: Sn-3.0Ag-0.5Cu
Solder Temp.: 245±5°C
Immersion time: 2±0.5s</td></tr>
</table>

Continued on the following page.↗

GQM Series Specifications and Test Methods (2)

Continued from the preceding page.↘

<table>
<tr><th>No</th><th colspan="2">Item</th><th>Specification</th><th>Test Method (Ref. Standard: JIS C 5101, IEC60384)</th></tr>
<tr><td rowspan="5">13</td><td rowspan="5">Resistance to Soldering Heat</td><td>Appearance</td><td>No defects or abnormalities.</td><td rowspan="5">Test Method: Solder bath method
Solder: Sn-3.0Ag-0.5Cu
Solder Temp.: 270±5°C
Immersion time: 10±0.5s
Exposure Time: 24±2h
Preheat: 120 to 150°C for 1min</td></tr>
<tr><td>Capacitance Change</td><td>Within ±2.5% or ±0.25pF
(Whichever is larger)</td></tr>
<tr><td>Q</td><td>Within the specified initial value.</td></tr>
<tr><td>I.R.</td><td>Within the specified initial value.</td></tr>
<tr><td>Voltage Proof</td><td>No defects.</td></tr>
<tr><td rowspan="5">14</td><td rowspan="5">Temperature Sudden Change</td><td>Appearance</td><td>No defects or abnormalities.</td><td rowspan="5">Solder the capacitor on the test substrate shown in Fig.3.
Perform the 5 cycles according to the four heat treatments shown in the following table.
<table>
<tr><th>Step</th><th>Temp. (°C)</th><th>Time (min)</th></tr>
<tr><td>1</td><td>Min. Operating Temp. +0/-3</td><td>30±3</td></tr>
<tr><td>2</td><td>Room Temp.</td><td>2 to 3</td></tr>
<tr><td>3</td><td>Max. Operating Temp. +3/-0</td><td>30±3</td></tr>
<tr><td>4</td><td>Room Temp.</td><td>2 to 3</td></tr>
</table>
Exposure Time: 24±2h</td></tr>
<tr><td>Capacitance Change</td><td>Within ±2.5% or ±0.25pF
(Whichever is larger)</td></tr>
<tr><td>Q.</td><td>Within the specified initial value.</td></tr>
<tr><td>I.R.</td><td>Within the specified initial value.</td></tr>
<tr><td>Voltage Proof</td><td>No defects.</td></tr>
<tr><td rowspan="4">15</td><td rowspan="4">High Temperature High Humidity (Steady)</td><td>Appearance</td><td>No defects or abnormalities.</td><td rowspan="4">Solder the capacitor on the test substrate shown in Fig.3.
Test Temperature: 40±2°C
Test Humidity: 90 to 95%RH
Test Time: 500±12h
Applied Voltage: DC Rated Voltage
Charge/discharge current: 50mA max.
Exposure Time: 24±2h</td></tr>
<tr><td>Capacitance Change</td><td>Within ±7.5% or ±0.75pF
(Whichever is larger)</td></tr>
<tr><td>Q</td><td>30pF and over: Q ≧ 200
30pF and below: Q ≧ 100+10C/3
C: Nominal Capacitance(pF)</td></tr>
<tr><td>I.R.</td><td>More than 500MΩ</td></tr>
<tr><td rowspan="4">16</td><td rowspan="4">Durability</td><td>Appearance</td><td>No defects or abnormalities.</td><td rowspan="4">Solder the capacitor on the test substrate shown in Fig.3.
Test Temperature: Max. Operating Temp. ±3°C
Test Time: 1000±12h
Applied Voltage: 200% of the rated voltage
Charge/discharge current: 50mA max.
Exposure Time: 24±2h</td></tr>
<tr><td>Capacitance Change</td><td>Within ±3% or ±0.3pF
(Whichever is larger)</td></tr>
<tr><td>Q</td><td>30pF and over: Q ≧ 350
10pF and over, 30pF and below: Q ≧ 275+5C/2
10pF and below: Q ≧ 200+10C
C: Nominal Capacitance (pF)</td></tr>
<tr><td>I.R.</td><td>More than 1000MΩ</td></tr>
</table>

Table A

Char.	Capacitance Change from 20°C/25°C (%)							
	-55°C		-30°C		-25°C		-10°C	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
2C	0.82	-0.45	-	-	0.49	-0.27	0.33	-0.18
5C/5G	0.58	-0.24	0.40	-0.17	-	-	0.25	-0.11

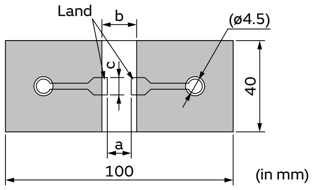
Continued on the following page.↗

GQM Series Specifications and Test Methods (2)

Continued from the preceding page.↘

Substrate Bending Test

- Test Substrate
  - Material: Copper-clad laminated sheets for PCBs (Glass fabric base, epoxy resin)
  - Thickness: 1.6mm
  - Copper foil thickness: 0.035mm
  - ▨ : Solder resist (Coat with heat resistant resin for solder)



Part Number	Dimension (mm)		
	a	b	c
GQM18	1.0	3.0	1.2
GQM21	1.2	4.0	1.65

Fig.1

- Kind of Solder: Sn-3.0Ag-0.5Cu
- Pressurization Method

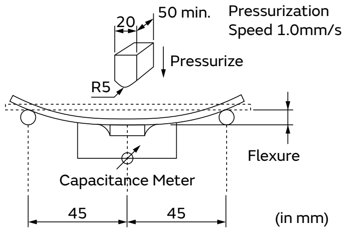
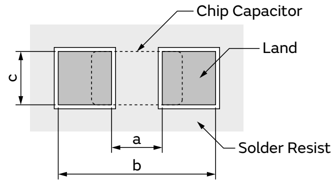


Fig.2

Adhesive Strength of Termination, Vibration, Temperature Sudden Change, High Temperature High Humidity (Steady) , Durability

- Test Substrate
  - Material: Copper-clad laminated sheets for PCBs (Glass fabric base, epoxy resin)
  - Thickness: 1.6mm or 0.8mm
  - Copper foil thickness: 0.035mm

- Kind of Solder: Sn-3.0Ag-0.5Cu
- Land Dimensions



Part Number	Dimension (mm)		
	a	b	c
GQM18	1.0	3.0	1.2
GQM21	1.2	4.0	1.65

Fig.3

3 GQM Series Specifications and Test Methods (3)

<table>
<tr><th>No</th><th colspan="2">Item</th><th>Specification</th><th>Test Method (Ref. Standard: JIS C 5101, IEC60384)</th></tr>
<tr><td>1</td><td colspan="2">Rated Voltage</td><td>Shown in Rated value.</td><td>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.</td></tr>
<tr><td>2</td><td colspan="2">Appearance</td><td>No defects or abnormalities.</td><td>Visual inspection.</td></tr>
<tr><td>3</td><td colspan="2">Dimension</td><td>Within the specified dimensions.</td><td>Using Measuring instrument of dimension.</td></tr>
<tr><td>4</td><td colspan="2">Voltage Proof</td><td>No defects or abnormalities.</td><td>Measurement Point: Between the terminations
Test Voltage: 250% of the rated voltage
Applied Time: 1 to 5s
Charge/discharge current: 50mA max.</td></tr>
<tr><td>5</td><td colspan="2">Insulation Resistance (I.R.)</td><td>More than 10000MΩ</td><td>Measurement Point: Between the terminations
Measurement Voltage: DC Rated Voltage
Charging Time: 2min
Charge/discharge current: 50mA max.
Measurement Temperature: Room Temperature</td></tr>
<tr><td>6</td><td colspan="2">Capacitance</td><td>Shown in Rated value.</td><td rowspan="2">Measurement Temperature: Room Temperature<table><tr><th>Capacitance</th><th>Frequency</th><th>Voltage</th></tr><tr><td>C ≦ 1000pF</td><td>1.0±0.1kHz</td><td>0.5 to 5.0Vrms</td></tr></table></td></tr>
<tr><td>7</td><td colspan="2">Q</td><td>30pF and over: Q ≧ 1400
30pF and below: Q ≧ 800+20C
C: Nominal Capacitance (pF)</td></tr>
<tr><td>8</td><td colspan="2">Temperature Characteristics of Capacitance</td><td>Nominal values of the temperature coefficient is shown in Rated value.
But, the Capacitance Change under 20°C/25°C is shown in Table A.
Capacitance Drift
Within ±0.2% or ±0.05pF
(Whichever is larger.)</td><td>The capacitance change should be measured after 5 minutes at each specified temp. stage.
Capacitance value as a reference is the value in step 3.
The capacitance drift is calculated by dividing the differences between the maximum and minimum measured values in the step 1, 3 and 5 by the cap. value in step 3.<table><tr><th>Step</th><th>Temperature (°C)</th></tr><tr><td>1</td><td>Reference Temp. ±2</td></tr><tr><td>2</td><td>Min. Operating Temp. ±3</td></tr><tr><td>3</td><td>Reference Temp. ±2</td></tr><tr><td>4</td><td>Max. Operating Temp. ±3</td></tr><tr><td>5</td><td>Reference Temp. ±2</td></tr></table></td></tr>
<tr><td>9</td><td colspan="2">Adhesive Strength of Termination</td><td>No removal of the terminations or other defect should occur.</td><td>Solder the capacitor on the test substrate shown in Fig.3.<table><tr><th>Part Number</th><th>Applied Force(N)</th></tr><tr><td>GQM18</td><td>5</td></tr><tr><td>GQM21</td><td>10</td></tr></table>Holding Time: 10±1s
Applied Direction: In parallel with the test substrate and vertical with the capacitor side.</td></tr>
<tr><td rowspan="3">10</td><td rowspan="3">Vibration</td><td>Appearance</td><td>No defects or abnormalities.</td><td rowspan="3">Solder the capacitor on the test substrate shown in Fig.3.
Kind of Vibration: A simple harmonic motion 10Hz to 55Hz to 10Hz (1min)
Total amplitude: 1.5mm
This motion should be applied for a period of 2h in each 3 mutually perpendicular directions (total of 6h).</td></tr>
<tr><td>Capacitance</td><td>Within the specified initial value.</td></tr>
<tr><td>Q</td><td>Within the specified initial value.</td></tr>
<tr><td rowspan="2">11</td><td rowspan="2">Substrate Bending Test</td><td>Appearance</td><td>No defects or abnormalities.</td><td rowspan="2">Solder the capacitor on the test substrate shown in Fig.1.
Pressurization method: Shown in Fig.2
Flexure: 1mm
Holding Time: 5±1s
Soldering Method: Reflow soldering</td></tr>
<tr><td>Capacitance Change</td><td>Within ±5% or ±0.5pF
(Whichever is larger)</td></tr>
<tr><td>12</td><td colspan="2">Solderability</td><td>95% of the terminations is to be soldered evenly and continuously.</td><td>Test Method: Solder bath method
Flux: Solution of rosin ethanol 25 (mass)%
Preheat: 80 to 120°C for 10 to 30s
Solder: Sn-3.0Ag-0.5Cu
Solder Temp.: 245±5°C
Immersion time: 2±0.5s</td></tr>
<tr><td rowspan="5">13</td><td rowspan="5">Resistance to Soldering Heat</td><td>Appearance</td><td>No defects or abnormalities.</td><td rowspan="5">Test Method: Solder bath method
Solder: Sn-3.0Ag-0.5Cu
Solder Temp.: 270±5°C
Immersion time: 10±0.5s
Exposure Time: 24±2h
Preheat: 120 to 150°C for 1min</td></tr>
<tr><td>Capacitance Change</td><td>Within ±2.5% or ± 0.25pF
(Whichever is larger)</td></tr>
<tr><td>Q</td><td>Within the specified initial value.</td></tr>
<tr><td>I.R.</td><td>Within the specified initial value.</td></tr>
<tr><td>Voltage Proof</td><td>No defects.</td></tr>
</table>

Continued on the following page.↗

GQM Series Specifications and Test Methods (3)

Continued from the preceding page.↘

<table>
<tr><th>No</th><th colspan="2">Item</th><th>Specification</th><th>Test Method (Ref. Standard: JIS C 5101, IEC60384)</th></tr>
<tr><td rowspan="5">14</td><td rowspan="5">Temperature Sudden Change</td><td>Appearance</td><td>No defects or abnormalities.</td><td rowspan="5">Solder the capacitor on the test substrate shown in Fig.3.
Perform the 5 cycles according to the four heat treatments shown in the following table.<table><tr><th>Step</th><th>Temp. (°C)</th><th>Time (min)</th></tr><tr><td>1</td><td>Min. Operating Temp. +0/-3</td><td>30±3</td></tr><tr><td>2</td><td>Room Temp.</td><td>2 to 3</td></tr><tr><td>3</td><td>Max. Operating Temp. +3/-0</td><td>30±3</td></tr><tr><td>4</td><td>Room Temp.</td><td>2 to 3</td></tr></table>Exposure Time: 24±2h</td></tr>
<tr><td>Capacitance Change</td><td>Within ±2.5% or ±0.25pF
(Whichever is larger)</td></tr>
<tr><td>Q</td><td>Within the specified initial value.</td></tr>
<tr><td>I.R.</td><td>Within the specified initial value.</td></tr>
<tr><td>Voltage Proof</td><td>No defects.</td></tr>
<tr><td rowspan="4">15</td><td rowspan="4">High Temperature High Humidity (Steady)</td><td>Appearance</td><td>No defects or abnormalities.</td><td rowspan="4">Solder the capacitor on the test substrate shown in Fig.3.
Test Temperature: 40±2°C
Test Humidity: 90 to 95%RH
Test Time: 500±12h
Applied Voltage: DC Rated Voltage
Charge/discharge current: 50mA max.
Exposure Time: 24±2h</td></tr>
<tr><td>Capacitance Change</td><td>Within ±7.5% or ±0.75pF
(Whichever is larger)</td></tr>
<tr><td>Q</td><td>30pF and over: Q ≧ 200
30pF and below: Q ≧ 100+10C/3
C: Nominal Capacitance(pF)</td></tr>
<tr><td>I.R.</td><td>More than 500MΩ</td></tr>
<tr><td rowspan="4">16</td><td rowspan="4">Durability</td><td>Appearance</td><td>No defects or abnormalities.</td><td rowspan="4">Solder the capacitor on the test substrate shown in Fig.3.
Test Temperature: Max. Operating Temp. ±3°C
Test Time: 1000±12h
Applied Voltage: 200% of the rated voltage
Charge/discharge current: 50mA max.
Exposure Time: 24±2h</td></tr>
<tr><td>Capacitance Change</td><td>Within ±3% or ±0.3pF
(Whichever is larger)</td></tr>
<tr><td>Q</td><td>30pF and over: Q ≧ 350
10pF and over, 30pF and below: Q ≧ 275+5C/2
10pF and below: Q ≧ 200+10C
C: Nominal Capacitance (pF)</td></tr>
<tr><td>I.R.</td><td>More than 1000MΩ</td></tr>
</table>

Table A

Char.	Capacitance Change from 20°C/25°C (%)							
	-55°C		-30°C		-25°C		-10°C	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
2C	0.82	-0.45	-	-	0.49	-0.27	0.33	-0.18
5C/5G	0.58	-0.24	0.40	-0.17	-	-	0.25	-0.11

Continued on the following page.↗

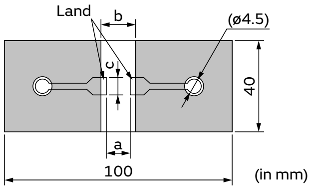
GRM
GR3
GRJ
GR4
GR7
GJM
GQM
GA2
GA3 GB
GA3 GD
GA3 GF
LLL
LLA
LLM
LLR
NFM
KRM
KR3
GMA
GMD
⚠Caution /Notice

GQM Series Specifications and Test Methods (3)

Continued from the preceding page.↘

Substrate Bending Test

- Test Substrate
  Material: Copper-clad laminated sheets for PCBs (Glass fabric base, epoxy resin)
  Thickness: 1.6mm
  Copper foil thickness: 0.035mm
  ▨: Solder resist (Coat with heat resistant resin for solder)



Part Number	Dimension (mm)		
	a	b	c
GQM18	1.0	3.0	1.2
GQM21	1.2	4.0	1.65

Fig.1

- Kind of Solder: Sn-3.0Ag-0.5Cu
- Pressurization Method

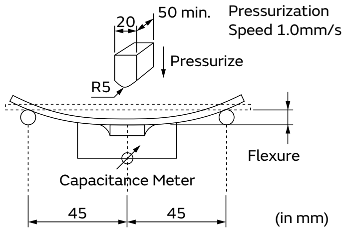
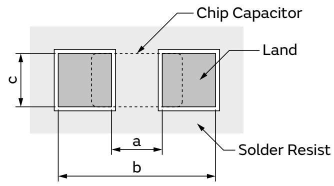


Fig.2

Adhesive Strength of Termination, Vibration, Temperature Sudden Change, High Temperature High Humidity (Steady) , Durability

- Test Substrate
  Material: Copper-clad laminated sheets for PCBs (Glass fabric base, epoxy resin)
  Thickness: 1.6mm or 0.8mm
  Copper foil thickness: 0.035mm

- Kind of Solder: Sn-3.0Ag-0.5Cu
- Land Dimensions



Part Number	Dimension (mm)		
	a	b	c
GQM18	1.0	3.0	1.2
GQM21	1.2	4.0	1.65

Fig.3

4 GQM Series Specifications and Test Methods (4)

<table>
<tr><th>No</th><th colspan="2">Item</th><th>Specification</th><th>Test Method (Ref. Standard: JIS C 5101, IEC60384)</th></tr>
<tr><td>1</td><td colspan="2">Rated Voltage</td><td>Shown in Rated value.</td><td>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.</td></tr>
<tr><td>2</td><td colspan="2">Appearance</td><td>No defects or abnormalities.</td><td>Visual inspection.</td></tr>
<tr><td>3</td><td colspan="2">Dimension</td><td>Within the specified dimensions.</td><td>Using Measuring instrument of dimension.</td></tr>
<tr><td>4</td><td colspan="2">Voltage Proof</td><td>No defects or abnormalities.</td><td>Measurement Point: Between the terminations
Test Voltage: 250% of the rated voltage
Applied Time: 1 to 5s
Charge/discharge current: 50mA max.</td></tr>
<tr><td>5</td><td colspan="2">Insulation Resistance (I.R.)</td><td>More than 10000MΩ</td><td>Measurement Point: Between the terminations
Measurement Voltage: DC Rated Voltage
Charging Time: 2min
Charge/discharge current: 50mA max.
Measurement Temperature: Room Temperature</td></tr>
<tr><td>6</td><td colspan="2">Capacitance</td><td>Shown in Rated value.</td><td rowspan="2">Measurement Temperature: Room Temperature<table><tr><th>Capacitance</th><th>Frequency</th><th>Voltage</th></tr><tr><td>C ≦ 1000pF</td><td>1.0±0.1kHz</td><td>0.5 to 5.0Vrms</td></tr></table></td></tr>
<tr><td>7</td><td colspan="2">Q</td><td>30pF and over: Q ≧ 1400
30pF and below: Q ≧ 800+20C
C: Nominal Capacitance(pF)</td></tr>
<tr><td>8</td><td colspan="2">Temperature Characteristics of Capacitance</td><td>Nominal values of the temperature coefficient is shown in
Rated value.
But, the Capacitance Change under 25°C is shown in Table A.
Capacitance Drift
Within ±0.2% or ±0.05pF
(Whichever is larger.)</td><td>The capacitance change should be measured after 5 minutes at each specified temp. stage.
Capacitance value as a reference is the value in step 3.
The capacitance drift is calculated by dividing the differences between the maximum and minimum measured values in the step 1, 3 and 5 by the cap. value in step 3.<table><tr><th>Step</th><th>Temperature (°C)</th></tr><tr><td>1</td><td>Reference Temp. ±2</td></tr><tr><td>2</td><td>Min. Operating Temp. ±3</td></tr><tr><td>3</td><td>Reference Temp. ±2</td></tr><tr><td>4</td><td>Max. Operating Temp. ±3</td></tr><tr><td>5</td><td>Reference Temp. ±2</td></tr></table></td></tr>
<tr><td>9</td><td colspan="2">Adhesive Strength of Termination</td><td>No removal of the terminations or other defect should occur.</td><td>Solder the capacitor on the test substrate shown in Fig.3.
Applied Force: 10N
Holding Time: 10±1s
Applied Direction: In parallel with the test substrate and vertical with the capacitor side.</td></tr>
<tr><td rowspan="3">10</td><td rowspan="3">Vibration</td><td>Appearance</td><td>No defects or abnormalities.</td><td rowspan="3">Solder the capacitor on the test substrate shown in Fig.3.
Kind of Vibration: A simple harmonic motion
10Hz to 55Hz to 10Hz (1min)
Total amplitude: 1.5mm
This motion should be applied for a period of 2h in each 3 mutually perpendicular directions (total of 6h).</td></tr>
<tr><td>Capacitance</td><td>Within the specified initial value.</td></tr>
<tr><td>Q</td><td>Within the specified initial value.</td></tr>
<tr><td rowspan="2">11</td><td rowspan="2">Substrate Bending Test</td><td>Appearance</td><td>No defects or abnormalities.</td><td rowspan="2">Solder the capacitor on the test substrate shown in Fig.1.
Pressurization method: Shown in Fig.2
Flexure:1mm
Holding Time: 5±1s
Soldering Method: Reflow soldering</td></tr>
<tr><td>Capacitance Change</td><td>Within ±5% or ±0.5pF
(Whichever is larger)</td></tr>
<tr><td>12</td><td colspan="2">Solderability</td><td>95% of the terminations is to be soldered evenly and continuously.</td><td>Test Method: Solder bath method
Flux: Solution of rosin ethanol 25 (mass)%
Preheat: 80 to 120°C for 10 to 30s
Solder: Sn-3.0Ag-0.5Cu
Solder Temp.: 245±5°C
Immersion time: 2±0.5s</td></tr>
<tr><td rowspan="5">13</td><td rowspan="5">Resistance to Soldering Heat</td><td>Appearance</td><td>No defects or abnormalities.</td><td rowspan="5">Test Method: Solder bath method
Solder: Sn-3.0Ag-0.5Cu
Solder Temp.: 270±5°C
Immersion time: 10±0.5s
Exposure Time: 24±2h
Preheat: 120 to 150°C for 1min</td></tr>
<tr><td>Capacitance Change</td><td>Within ±2.5% or ±0.25pF
(Whichever is larger)</td></tr>
<tr><td>Q</td><td>Within the specified initial value.</td></tr>
<tr><td>I.R.</td><td>Within the specified initial value.</td></tr>
<tr><td>Voltage Proof</td><td>No defects.</td></tr>
</table>

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GQM Series Specifications and Test Methods (4)

Continued from the preceding page.↘

<table>
<tr><th>No</th><th colspan="2">Item</th><th>Specification</th><th>Test Method (Ref. Standard: JIS C 5101, IEC60384)</th></tr>
<tr><td rowspan="5">14</td><td rowspan="5">Temperature Sudden Change</td><td>Appearance</td><td>No defects or abnormalities.</td><td rowspan="5">Solder the capacitor on the test substrate shown in Fig.3.
Perform the 5 cycles according to the four heat treatments shown in the following table.<table><tr><th>Step</th><th>Temp. (°C)</th><th>Time (min)</th></tr><tr><td>1</td><td>Min. Operating Temp. +0/-3</td><td>30±3</td></tr><tr><td>2</td><td>Room Temp.</td><td>2 to 3</td></tr><tr><td>3</td><td>Max. Operating Temp. +3/-0</td><td>30±3</td></tr><tr><td>4</td><td>Room Temp.</td><td>2 to 3</td></tr></table>Exposure Time: 24±2h</td></tr>
<tr><td>Capacitance Change</td><td>Within ±2.5% or ±0.25pF
(Whichever is larger)</td></tr>
<tr><td>Q</td><td>Within the specified initial value.</td></tr>
<tr><td>I.R.</td><td>Within the specified initial value.</td></tr>
<tr><td>Voltage Proof</td><td>No defects.</td></tr>
<tr><td rowspan="4">15</td><td rowspan="4">High Temperature High Humidity (Steady)</td><td>Appearance</td><td>No defects or abnormalities.</td><td rowspan="4">Solder the capacitor on the test substrate shown in Fig.3.
Test Temperature: 40±2°C
Test Humidity: 90 to 95%RH
Test Time: 500±12h
Applied Voltage: DC Rated Voltage
Charge/discharge current: 50mA max.
Exposure Time: 24±2h</td></tr>
<tr><td>Capacitance Change</td><td>Within ±7.5% or ±0.75pF
(Whichever is larger)</td></tr>
<tr><td>Q</td><td>30pF and over: Q ≧ 200
30pF and below: Q ≧ 100+10C/3
C: Nominal Capacitance(pF)</td></tr>
<tr><td>I.R.</td><td>More than 500MΩ</td></tr>
<tr><td rowspan="4">16</td><td rowspan="4">Durability</td><td>Appearance</td><td>No defects or abnormalities.</td><td rowspan="4">Solder the capacitor on the test substrate shown in Fig.3.
Test Temperature: Max. Operating Temp. ±3°C
Test Time: 1000±12h
Applied Voltage: 150% of the rated voltage
Charge/discharge current: 50mA max.
Exposure Time: 24±2h</td></tr>
<tr><td>Capacitance Change</td><td>Within ±3% or ±0.3pF
(Whichever is larger)</td></tr>
<tr><td>Q</td><td>30pF and over: Q ≧ 350
10pF and over, 30pF and below: Q ≧ 275+5C/2
10pF and below: Q ≧ 200+10C
C: Nominal Capacitance (pF)</td></tr>
<tr><td>I.R.</td><td>More than 1000MΩ</td></tr>
</table>

Table A

Char.	Capacitance Change from 25°C(%)					
	-55°C		-30°C		-10°C	
	Max.	Min.	Max.	Min.	Max.	Min.
5C	0.58	-0.24	0.40	-0.17	0.25	-0.11

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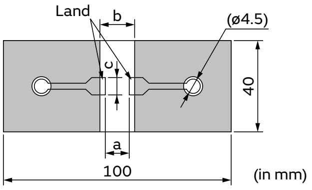
GQM Series Specifications and Test Methods (4)

Continued from the preceding page.↘

Substrate Bending Test

- Test Substrate
  - Material: Copper-clad laminated sheets for PCBs (Glass fabric base, epoxy resin)
  - Thickness: 1.6mm
  - Copper foil thickness: 0.035mm
  - ▨: Solder resist (Coat with heat resistant resin for solder)



Part Number	Dimension (mm)		
	a	b	c
GQM22	2.2	5.0	2.9

Fig.1

- Kind of Solder: Sn-3.0Ag-0.5Cu
- Pressurization Method

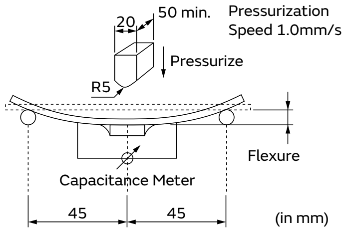
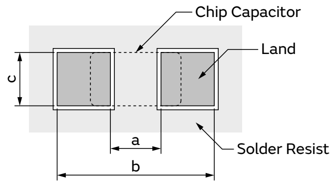


Fig.2

Adhesive Strength of Termination, Vibration, Temperature Sudden Change, High Temperature High Humidity (Steady) , Durability

- Test Substrate
  - Material: Copper-clad laminated sheets for PCBs (Glass fabric base, epoxy resin)
  - Thickness: 1.6mm or 0.8mm
  - Copper foil thickness: 0.035mm

- Kind of Solder: Sn-3.0Ag-0.5Cu
- Land Dimensions



Part Number	Dimension (mm)		
	a	b	c
GQM22	2.2	5.0	2.9

Fig.3

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

WEB

⚠Caution

Notice

⚠Caution

Storage and Operation Conditions

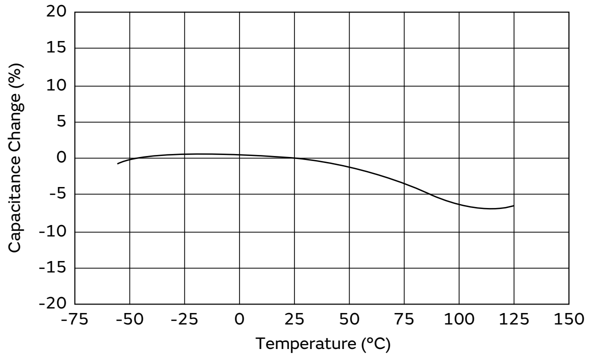
1. The performance of chip multilayer ceramic capacitors and chip EMIFIL NFM series (henceforth just "capacitors") may be affected by the storage conditions.
Please use them promptly after delivery.
   1-1. Maintain appropriate storage for the capacitors using the following conditions: Room Temperature 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

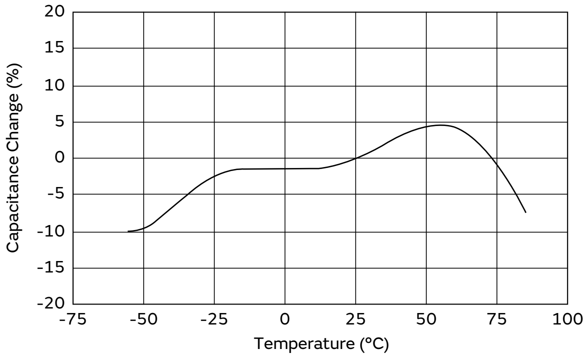
1. Temperature Dependent Characteristics

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.

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⚠Caution

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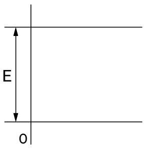
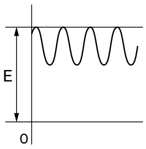
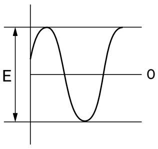
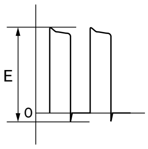
3. Applied Voltage and Applied Current

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.

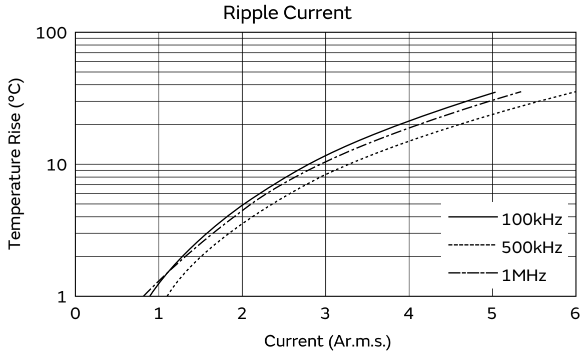
<Applicable to NFM Series>

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>

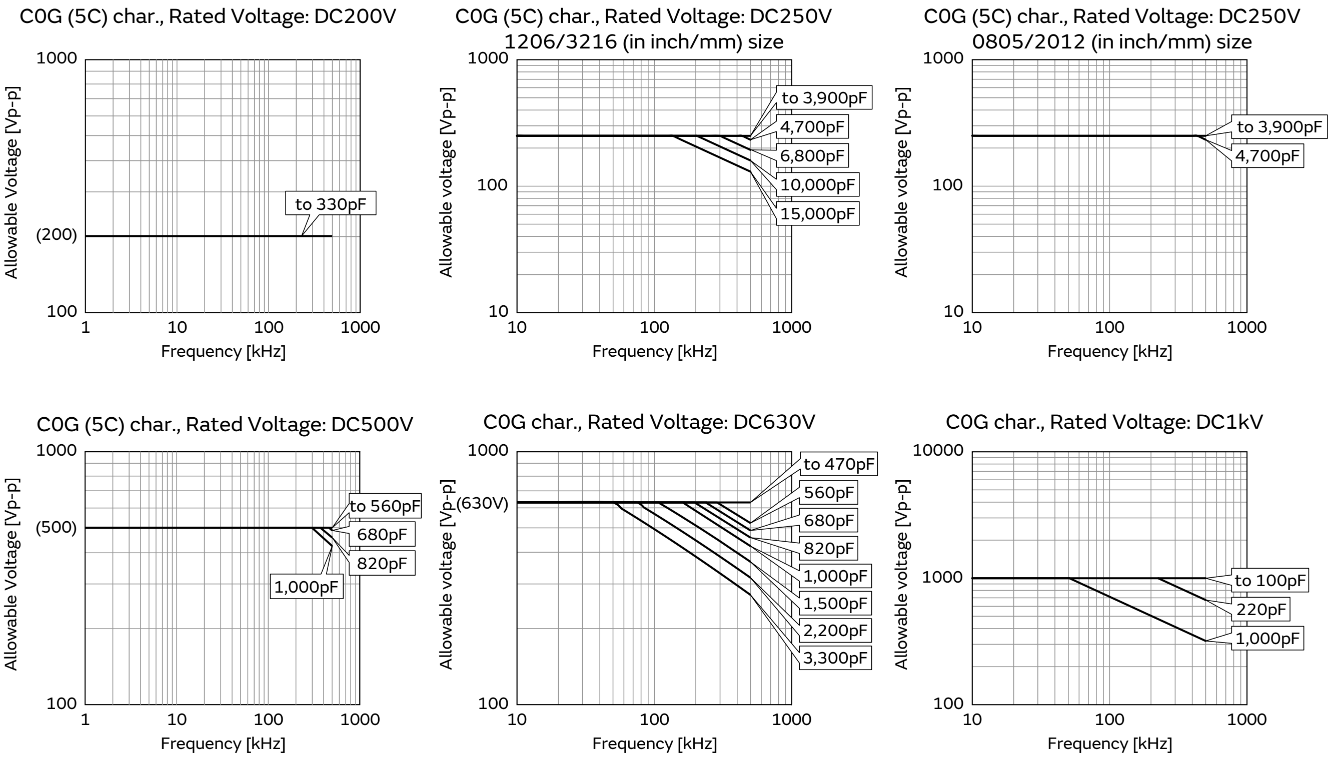
1-2. The load should be contained so that the self-heating of the capacitor body remains below 20°C, when measuring at an ambient temperature of 25°C. In addition, use a K thermocouple of ø0.1mm with less heat capacity when measuring, and measure in a condition where there is no effect from the radiant 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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⚠Caution

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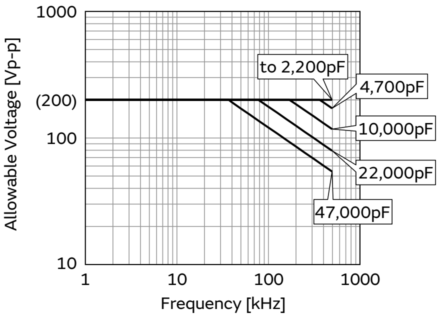
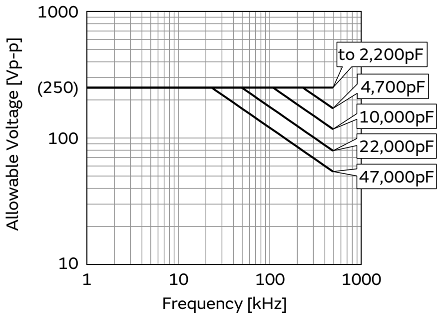
[The sine-wave frequency VS allowable voltage]

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

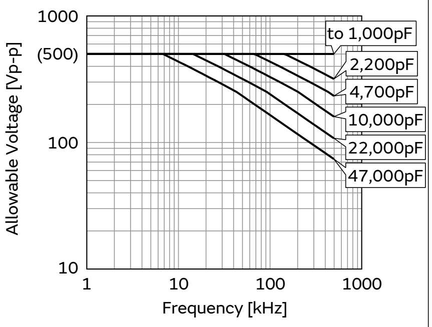
U2J (7U) char., Rated Voltage: DC200V



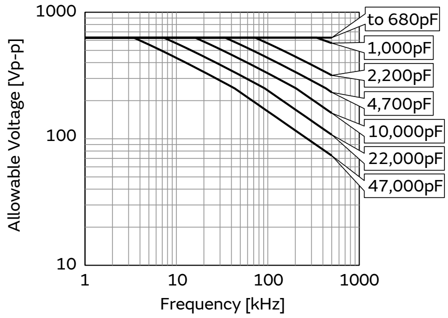
U2J (7U) char., Rated Voltage: DC250V



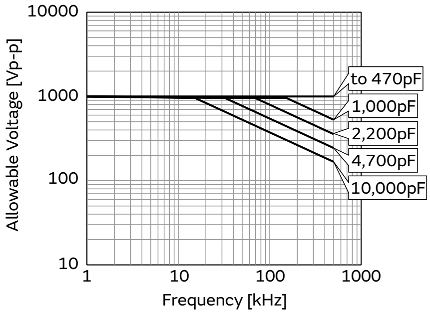
U2J (7U) char., Rated Voltage: DC500V



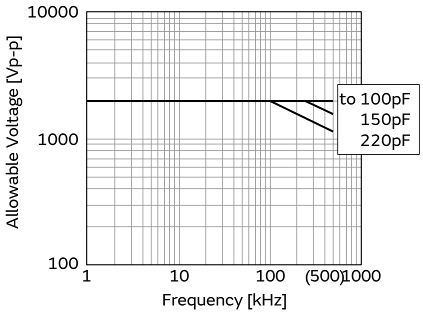
U2J (7U) char., Rated Voltage: DC630V



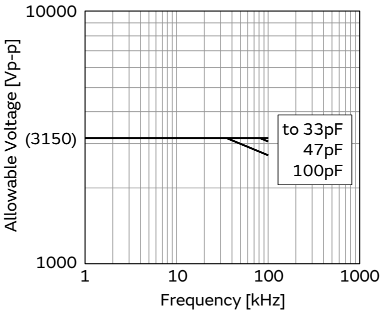
U2J (7U) char., Rated Voltage: DC1kV



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



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



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⚠Caution

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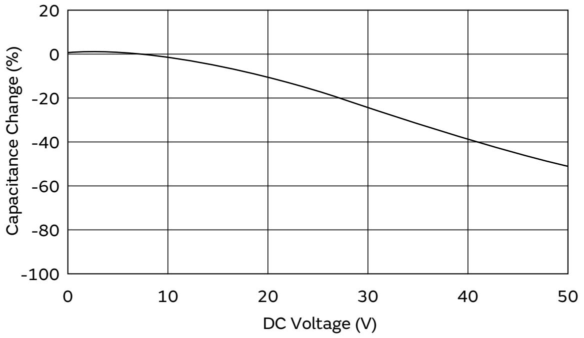
5. DC Voltage and AC Voltage Characteristics

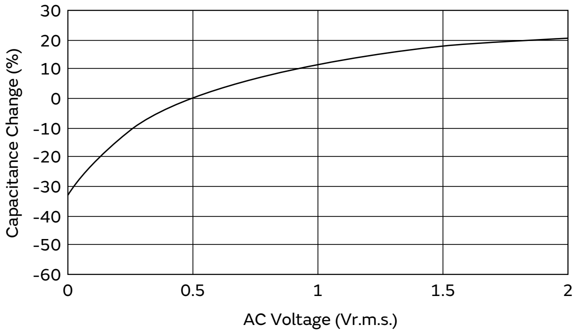
1. The capacitance value of a high dielectric constant type capacitor changes depending on the DC voltage applied. Please consider the DC voltage characteristics when a capacitor is selected for use in a DC circuit.
   1-1. The capacitance of ceramic capacitors may change sharply depending on the applied 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.

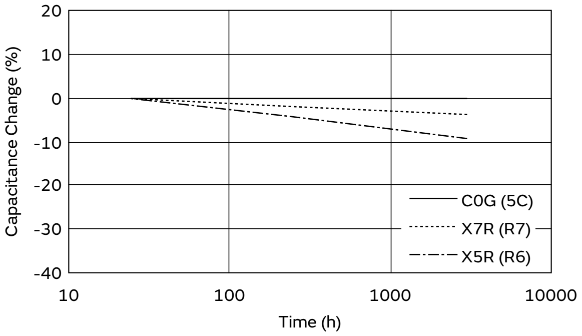
[Example of AC Voltage Characteristics]
Sample: X7R (R7) Characteristics 10μF,
Rated Voltage 6.3VDC



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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⚠Caution

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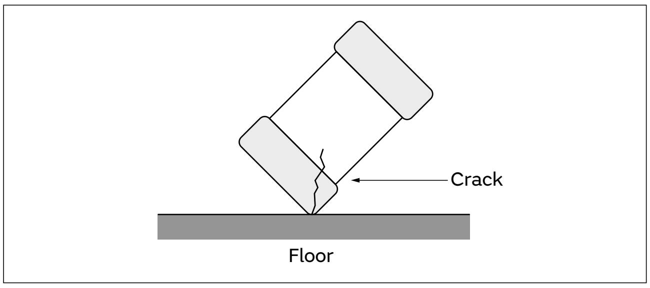
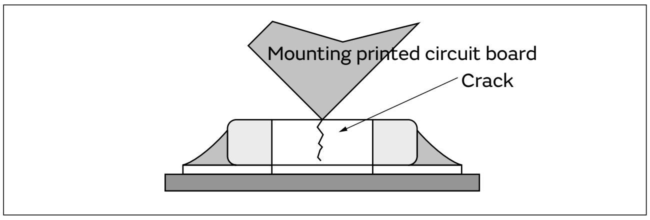
7. Vibration and Shock

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

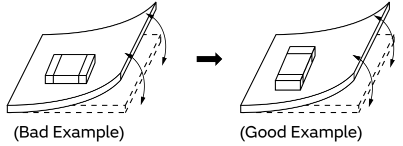
1. Mounting Position

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.

<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.

[Component Direction]

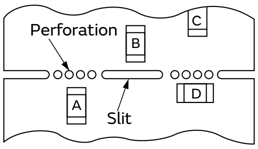


Locate chip horizontal to the direction in which stress acts.

[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.

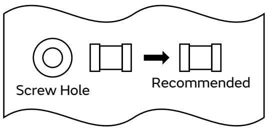
Contents of Measures	Stress Level
(1) Turn the mounting direction of the component parallel to the board separation surface.	A > D *1
(2) Add slits in the board separation part.	A > B
(3) Keep the mounting position of the component away from the board separation surface.	A > C



*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.



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⚠Caution

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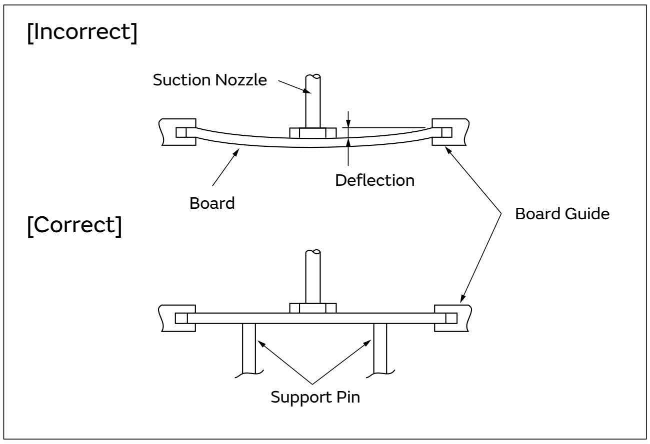
2. Information before Mounting

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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⚠Caution

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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

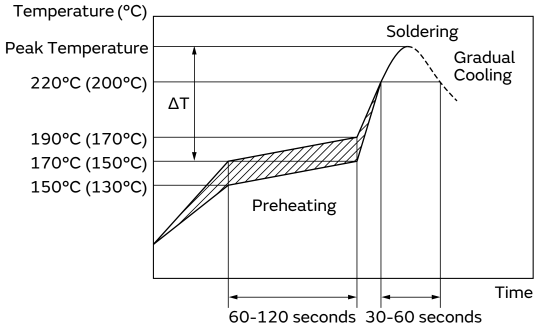
Series	Chip Dimension Code (L/W)	Temperature Differential
GRM/GJM/GQM/GR3/ GRJ/KRM/LLR/NFM/GR7	**02/03/15/18/21/31**	ΔT≦190°C
LLL	**02/03/15/18/1U/21/31**	
ZRB	**15/18**	
GR3/GRJ/GRM/KR3/KRM GA2/GA3/GR4	**32/42/43/52/55**	ΔT≦130°C
LLA/LLM	**18/21/31**	
GQM	**22**	

Recommended Conditions

	Pb-Sn Solder	Lead Free Solder
Peak Temperature	230 to 250°C	240 to 260°C
Atmosphere	Air	Air or N2

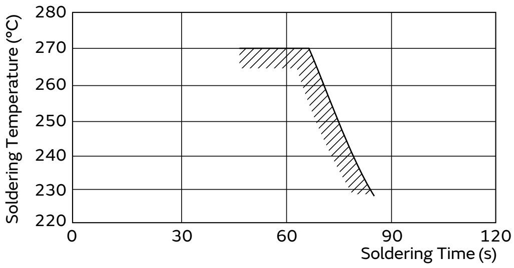
Pb-Sn Solder: Sn-37Pb
Lead Free Solder: Sn-3.0Ag-0.5Cu

[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.

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

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⚠Caution

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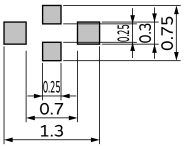
4. Optimum Solder Amount for Reflow Soldering
   4-1. Overly thick application of solder paste results in a excessive solder fillet height.
   This makes the chip more susceptible to mechanical and thermal stress on the board and may cause the chips to crack.
   4-2. Too little solder paste results in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

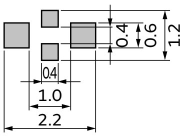
<Applicable to NFM Series>

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

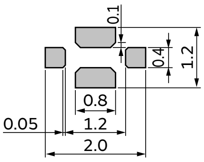
NFM15CC/15PC



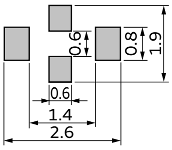
NFM18CC/18PC



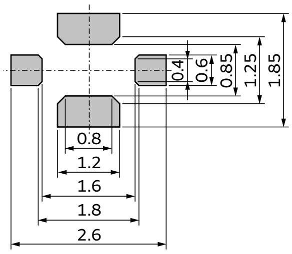
NFM18PS



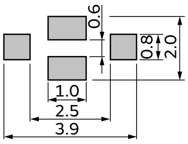
NFM21CC/21PC



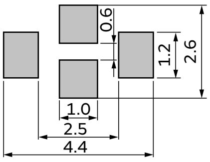
NFM21PS



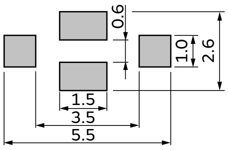
NFM3DCC/3DPC



NFM31PC/31KC



NFM41CC/41PC



Inverting the PCB

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

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⚠Caution

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4-2. Flow Soldering

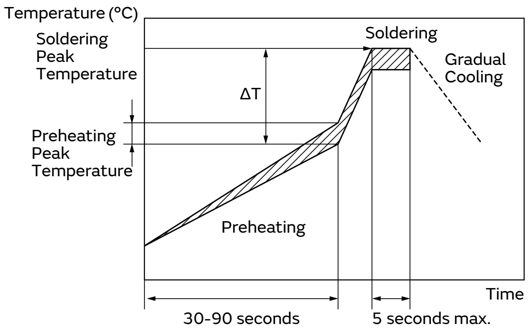
1. Do not apply flow soldering to chips not listed in table 2.

Table 2

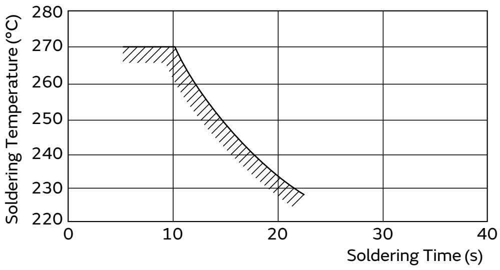
Series	Chip Dimension Code (L/W)	Temperature Differential
GR3/GRM	**18/21/31**	ΔT≦150°C
GQM	**18/21**	
LLL	**21/31**	
GRJ	**18/21/31**	
NFM	**3D/31/41**	

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.

[Example of Temperature Conditions for Flow Soldering]



[Allowable Flow Soldering Temperature and Time]



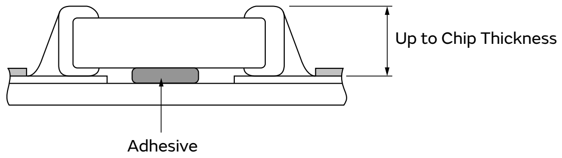
In the case of repeated soldering, the accumulated soldering time must be within the range shown above.

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.



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⚠Caution

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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.			

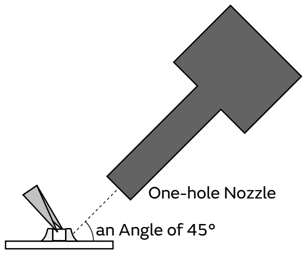
*Applicable for both Pb-Sn and Lead Free Solder.
Pb-Sn Solder: Sn-37Pb
Lead Free Solder: Sn-3.0Ag-0.5Cu
*Please manage ΔT in the temperature of soldering iron and the preheating temperature.

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.

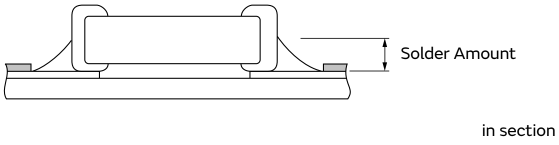
Table 4

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.



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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>

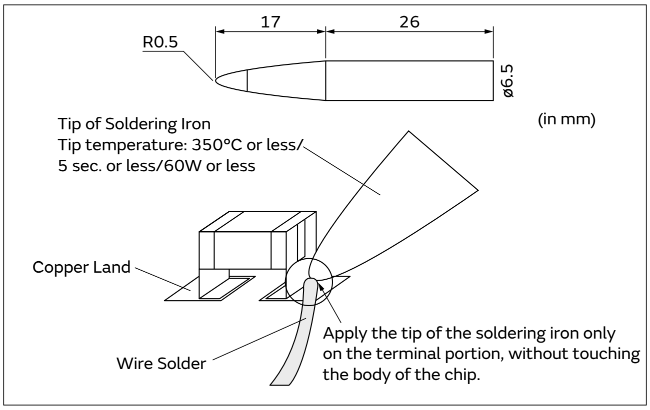
4. For the shape of the soldering iron tip, refer to the figure on the right.
Regarding the type of solder, use a wire diameter of ø0.5mm or less (rosin core wire solder).

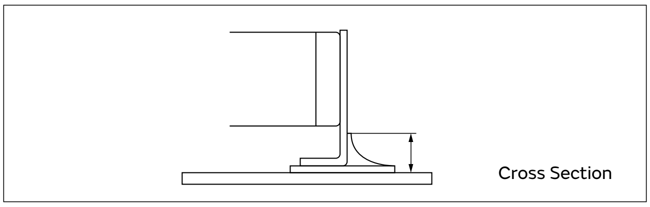
4-1. How to Apply the Soldering Iron
Apply the tip of the soldering iron against the lower end of the metal terminal.

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

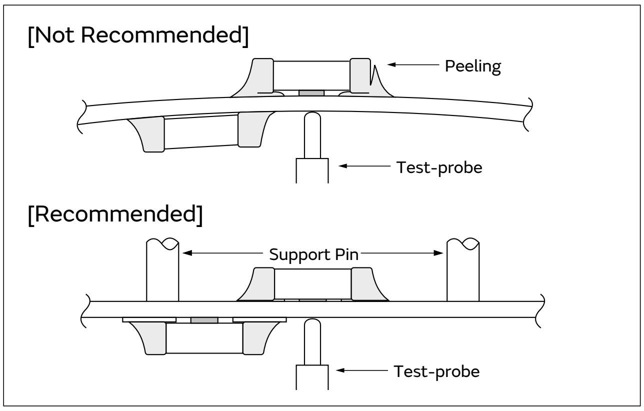
Excessive ultrasonic oscillation during cleaning can cause the PCBs to resonate, resulting in cracked chips or broken solder joints. Before starting your production process, test your cleaning equipment/process to insure it does not degrade the capacitors.

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.

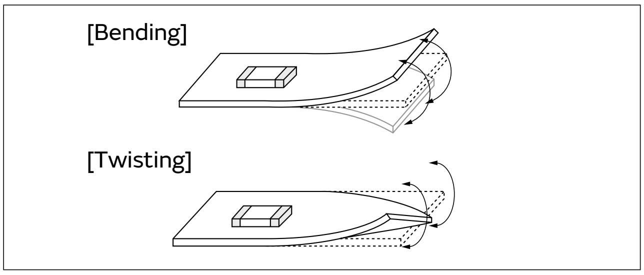
1-2. Avoid vibration of the board by shock when a test-probe contacts a printed circuit board.



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

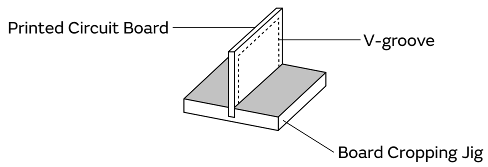
* When a board separation jig or disc separator is used, if the following precautions are not observed, a large board deflection stress will occur and the capacitors may crack. Use router type separator if at all possible.

(1) Example of a suitable jig

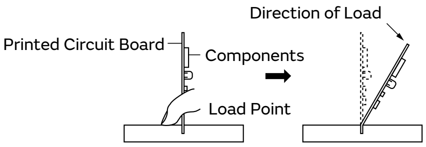
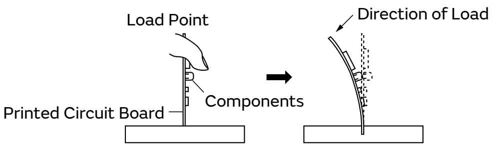
[In the case of Single-side Mounting]

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.

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⚠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.

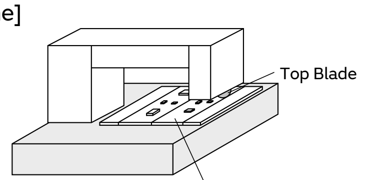
In the following case, board deflection stress will be applied and cause cracks in the capacitors.

(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

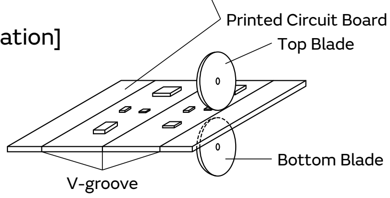
(2) The angle of the V groove is too low, depth of the V groove is too shallow, or the V groove is misaligned top-bottom

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.

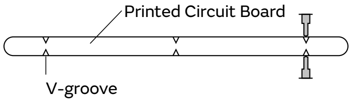
[Outline of Machine]



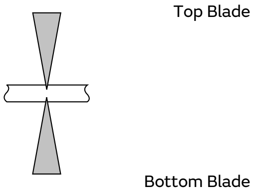
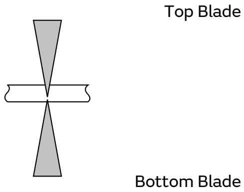
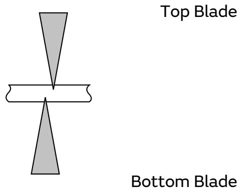
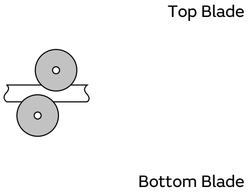
[Principle of Operation]



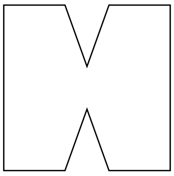
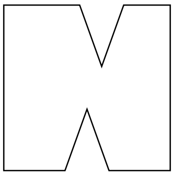
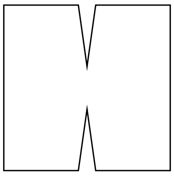
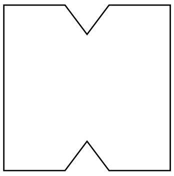
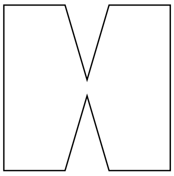
[Cross-section Diagram]



Disc Separator

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

V-groove Design

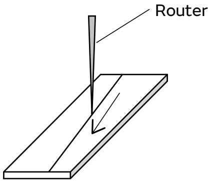
Example of Recommended V-groove Design	Not Recommended			
	Left-right Misalignment	Low-Angle	Depth too Shallow	Depth too Deep
				

(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

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8. Assembly

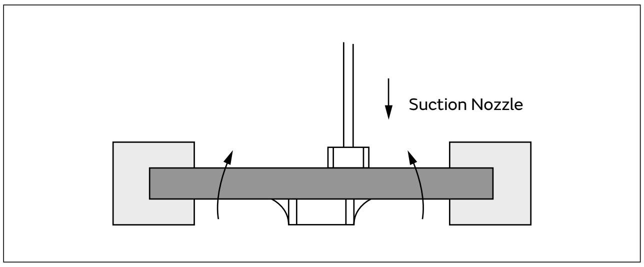
1. Handling

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

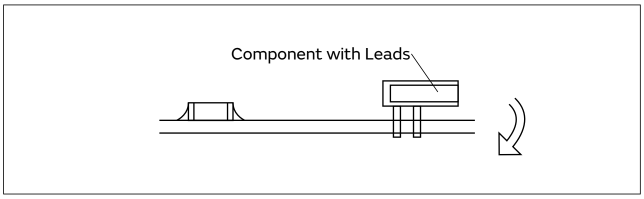
Pay attention to the following items, when mounting other components on the back side of the board after capacitors have been mounted on the opposite side.
When the bottom dead point of the suction nozzle is set too low, board deflection stress may be applied to the capacitors on the back side (bottom 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

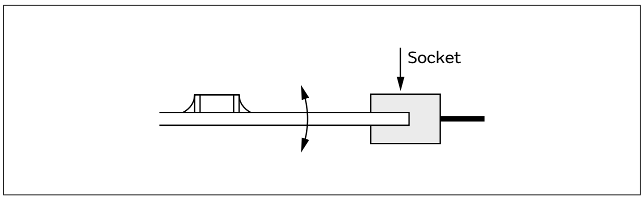
When inserting components (transformers, IC, etc.) into boards, bending the board may cause cracks in the capacitors or cracks in the solder.
Pay attention to the following.



· 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.

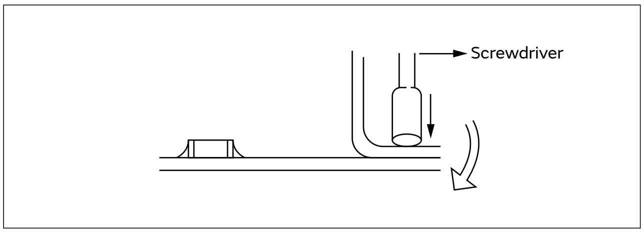
2-3. Attaching/Removing Sockets and/or Connectors

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.

Continued on the following page.↗

⚠Caution

Continued from the preceding page.↘

<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.

Continued on the following page.↗

⚠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.

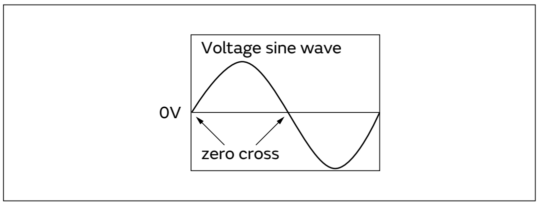
(3) The GJM, GMA, GMD, GQM, GR3, GRJ, GRM, KR3, KRM, LLA, LLL, LLM, LLR, NFM and ZRB series are not safety standard certified products.

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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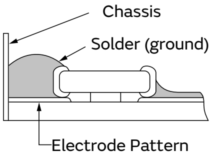
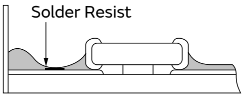
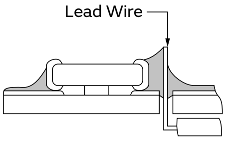
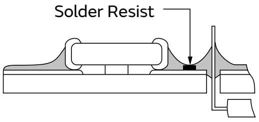
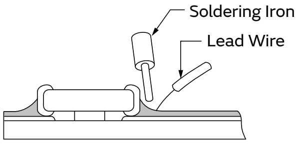
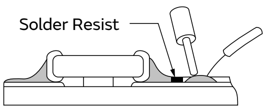
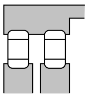
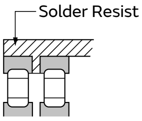
Pattern Forms

	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.

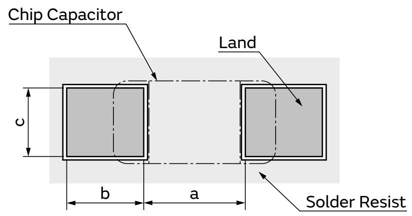


Table 1 Flow Soldering Method

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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Notice

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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]

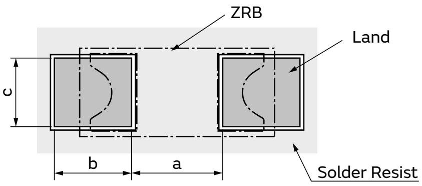

Table 4 LLA Series Reflow Soldering Method

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)

Continued on the following page.↗

Notice

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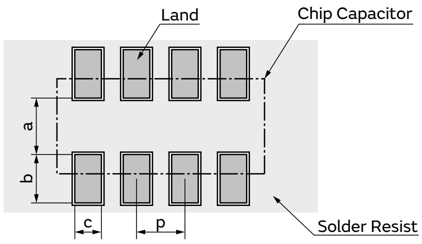
Table 5 LLM Series Reflow Soldering Method

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

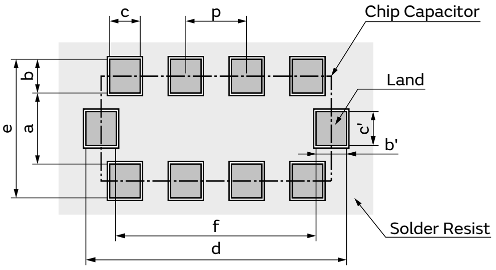
b=(c-e)/2, b'=(d-f)/2

(in mm)

[Land for LLA Series]



[Land for LLM Series]



<Applicable to beyond Rated Voltage of 200VDC>

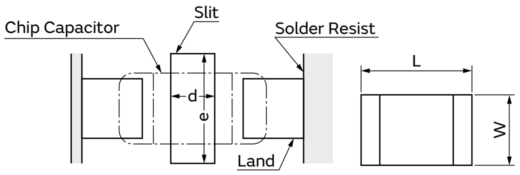
2-2. Dimensions of Slit (Example)

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.↗

Notice

Continued from the preceding page.↘

<Applicable to NFM Series>

■ Land Pattern + Solder Resist ▨ Land Pattern □ Solder Resist

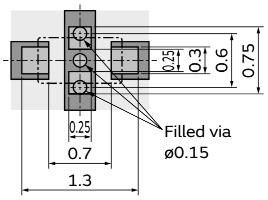
(in mm)

Series	Land Dimensions

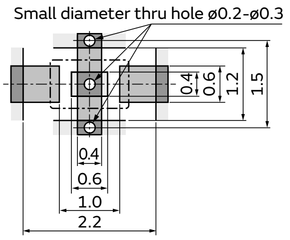
NFM15CC
NFM15PC
NFM18CC
NFM18PC
NFM18PS
NFM21CC
NFM21PC
NFM21PS

● Reflow Soldering

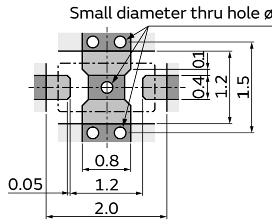
NFM15CC/NFM15PC



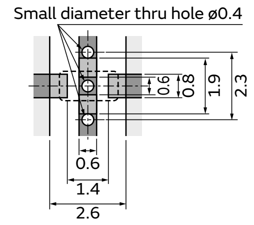
NFM18CC/NFM18PC



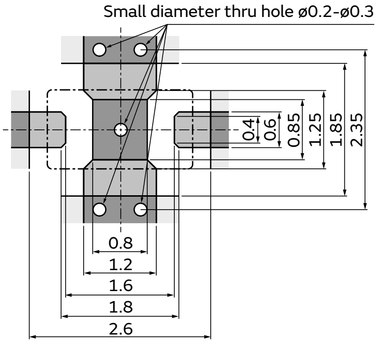
NFM18PS



NFM21CC/NFM21PC



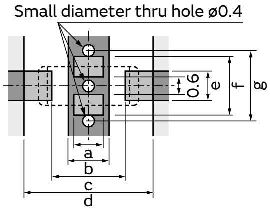
NFM21PS



NFM3DCC
NFM3DPC
NFM31PC
NFM31KC
NFM41CC
NFM41PC

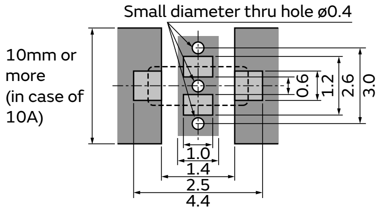
● Reflow Soldering Chip mounting side

NFM3DCC/NFM3DPC/NFM31PC/NFM41CC/NFM41PC



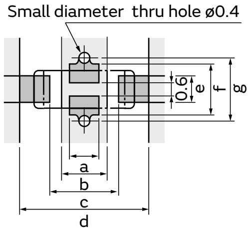
Part Number	Size (mm)						
	a	b	c	d	e	f	g
NFM3DCC NFM3DPC	1.0	1.4	2.5	4.4	1.0	2.0	2.4
NFM31PC	1.0	1.4	2.5	4.4	1.2	2.6	3.0
NFM41CC NFM41PC	1.5	2.0	3.5	6.0	1.2	2.6	3.0

NFM31KC*1



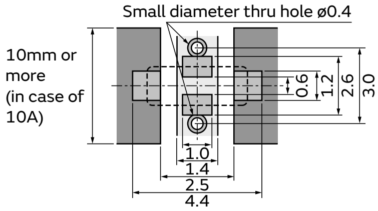
*1 For large current design, width of signal land pattern should be wider not less than 1mm per 1A (1mm/A).
For example, in case of 10A, signal land pattern width should be 10mm or more.
(1mm/A*10A=10mm)

● 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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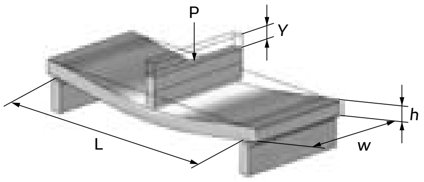
3. Board Design

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.

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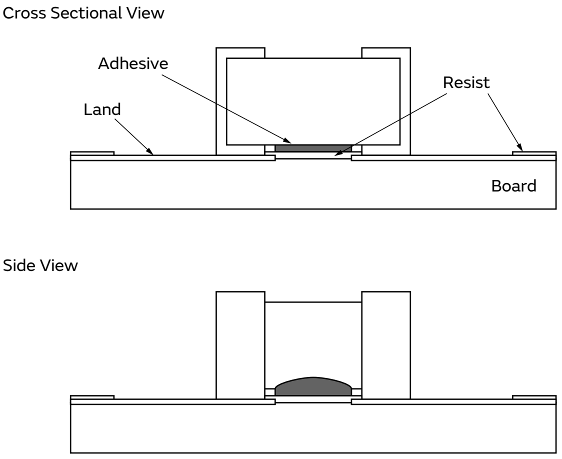
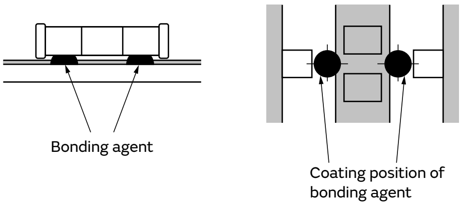
(2) Use the following illustration as a guide to the amount of adhesive to apply.

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



<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.

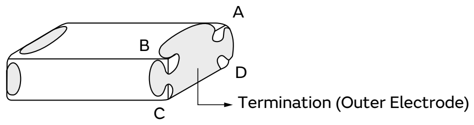
4. Flux for Flow Soldering

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.

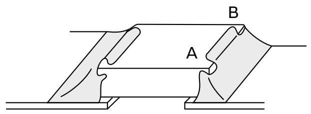
5. Flow Soldering

● 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.