

# Multilayer Ceramic Capacitors

## RELIABILITY DATA

### 1. Operating Temperature Range

Specified Value	Temperature Compensating(Class1)	Standard	-55 to +125°C		
		High Frequency Type			
Specified Value	High Permittivity (Class2)		Specification	Temperature Range	
		BJ	B	-25 to +85°C	
			X5R	-55 to +85°C	
		B7	X7R	-55 to +125°C	
		C6	X6S	-55 to +105°C	
		C7	X7S	-55 to +125°C	
	LD(※)	X5R	-55 to +85°C		
Note: ※LD Low distortion high value multilayer ceramic capacitor					

### 2. Storage Conditions

Specified Value	Temperature Compensating(Class1)	Standard	-55 to +125°C		
		High Frequency Type			
Specified Value	High Permittivity (Class2)		Specification	Temperature Range	
		BJ	B	-25 to +85°C	
			X5R	-55 to +85°C	
		B7	X7R	-55 to +125°C	
		C6	X6S	-55 to +105°C	
		C7	X7S	-55 to +125°C	
	LD(※)	X5R	-55 to +85°C		
Note: ※LD Low distortion high value multilayer ceramic capacitor					

### 3. Rated Voltage

Specified Value	Temperature Compensating(Class1)	Standard	50VDC, 25VDC, 16VDC
		High Frequency Type	50VDC, 25VDC, 16VDC
	High Permittivity (Class2)		50VDC, 35VDC, 25VDC, 16VDC, 10VDC, 6.3VDC, 4VDC, 2.5VDC

### 4. Withstanding Voltage (Between terminals)

Specified Value	Temperature Compensating(Class1)	Standard	No breakdown or damage	
		High Frequency Type		
Test Methods and Remarks	High Permittivity (Class2)		Class 1	Class 2
	Applied voltage		Rated voltage × 3	Rated voltage × 2.5
	Duration		1 to 5 sec.	
	Charge/discharge current		50mA max.	

### 5. Insulation Resistance

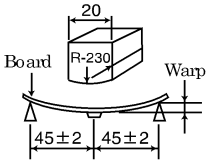
Specified Value	Temperature Compensating(Class1)	Standard	10000 MΩ min.
		High Frequency Type	
Specified Value	High Permittivity (Class2) Note 1		C ≤ 0.047 μF : 10000 MΩ min. C > 0.047 μF : 500MΩ·μF
	Test Methods and Remarks	Applied voltage	: Rated voltage
	Duration	: 60 ± 5 sec.	
	Charge/discharge current	: 50mA max.	

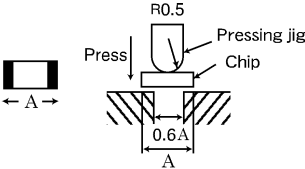
6. Capacitance (Tolerance)						
Specified Value	Temperature Compensating(Class1)	Standard	C□	0.2pF ≤ C ≤ 5pF : ±0.25pF		
			U□	0.2pF ≤ C ≤ 10pF : ±0.5pF		
	SL	C > 10pF : ±5% or ±10%				
High Permittivity (Class2)	High Frequency Type	CG	0.2pF ≤ C ≤ 2pF	: ±0.1pF		
			C > 2pF	: ±5%		
High Permittivity (Class2)		±10% or ±20%				
Test Methods and Remarks			Class 1		Class 2	
			Standard	High Frequency Type	C ≤ 10 μF	C > 10 μF
	Preconditioning		None		Thermal treatment (at 150°C for 1hr) Note 2	
	Measuring frequency		1MHz ± 10%		1kHz ± 10%	120 ± 10Hz
	Measuring voltage Nte		0.5 to 5Vrms		1 ± 0.2Vrms	0.5 ± 0.1Vrms
Bias application		None				

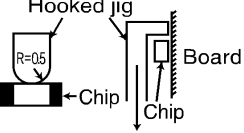
7. Q or Dissipation Factor						
Specified Value	Temperature Compensating(Class1)	Standard	C < 30pF : Q ≥ 400 + 20C			
			C ≥ 30pF : Q ≥ 1000 (C: Nominal capacitance)			
	High Frequency Type	Refer to detailed specification				
High Permittivity (Class2) Note 1		BJ, B7, C6, C7: 2.5% max.				
Test Methods and Remarks			Class 1		Class 2	
			Standard	High Frequency Type	C ≤ 10 μF	C > 10 μF
	Preconditioning		None		Thermal treatment (at 150°C for 1hr) Note 2	
	Measuring frequency		1MHz ± 10%	1GHz	1kHz ± 10%	120 ± 10Hz
	Measuring voltage Note 1		0.5 to 5Vrms		1 ± 0.2Vrms	0.5 ± 0.1Vrms
Bias application		None				
High Frequency Type		Measuring equipment : HP4291A				
		Measuring jig : HP16192A				

8. Temperature Characteristic (Without voltage application)						
Specified Value	Temperature Compensating(Class1)	Standard	Temperature Characteristic [ppm/°C]		Tolerance [ppm/°C]	
			C□ : 0	CG	G : ±30	
			U□ : -750	UJ, UK	J : ±120 K : ±250	
		SL : +350 to -1000				
High Permittivity (Class2)	High Frequency Type	Temperature Characteristic [ppm/°C]		Tolerance [ppm/°C]		
		C□ : 0	CG	G : ±30		
			Specification	Capacitance change	Reference temperature	Temperature Range
		BJ	B	±10%	20°C	-25 to +85°C
			X5R	±15%	25°C	-55 to +85°C
		B7	X7R	±15%	25°C	-55 to +125°C
		C6	XS	±22%	25°C	-55 to +105°C
		C7	X7S	±22%	25°C	-55 to +125°C
		LD(※)	X5R	±15%	25°C	-55 to +85°C
Note : ※LD Low distortion high value multilayer ceramic capacitor						
Class 1						
Capacitance at 20°C and 85°C shall be measured in thermal equilibrium, and the temperature characteristic shall be calculated from the following equation.						
$\frac{(C_{85} - C_{20})}{C_{20} \times \Delta T} \times 10^6 (\text{ppm}/^\circ\text{C}) \quad \Delta T = 65$						
Class 2						
Capacitance at each step shall be measured in thermal equilibrium, and the temperature characteristic shall be calculated from the following equation.						
		Step	B	X5R, X7R, X6S, X7S		
		1	Minimum operating temperature			
		2	20°C	25°C		
		3	Maximum operating temperature			
$\frac{(C - C_2)}{C_2} \times 100 (\%) \quad C : \text{Capacitance in Step 1 or Step 3}$ $C_2 : \text{Capacitance in Step 2}$						

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9. Deflection																				
Specified Value	Temperature Compensating(Class1)	Standard	Appearance : No abnormality Capacitance change : Within $\pm 5\%$ or $\pm 0.5$ pF, whichever is larger.																	
		High Frequency Type	Appearance : No abnormality Capacitance change : Within $\pm 0.5$ pF																	
	High Permittivity (Class2)		Appearance : No abnormality Capacitance change : Within $\pm 12.5\%$																	
Test Methods and Remarks	<table border="1"> <thead> <tr> <th rowspan="2"></th> <th colspan="2">Multilayer Ceramic Capacitors</th> </tr> <tr> <th>021, 042, 063, *105 Type</th> <th>The other types</th> </tr> </thead> <tbody> <tr> <td>Board</td> <td colspan="2">Glass epoxy-resin substrate</td> </tr> <tr> <td>Thickness</td> <td>0.8mm</td> <td>1.6mm</td> </tr> <tr> <td>Warp</td> <td colspan="2">1mm</td> </tr> <tr> <td>Duration</td> <td colspan="2">10 sec.</td> </tr> </tbody> </table> <p>*105 Type thickness, C: 0.2mm ,P: 0.3mm.</p>			Multilayer Ceramic Capacitors		021, 042, 063, *105 Type	The other types	Board	Glass epoxy-resin substrate		Thickness	0.8mm	1.6mm	Warp	1mm		Duration	10 sec.		 <p>(Unit: mm)</p> <p>Capacitance measurement shall be conducted with the board bent</p>
		Multilayer Ceramic Capacitors																		
021, 042, 063, *105 Type		The other types																		
Board	Glass epoxy-resin substrate																			
Thickness	0.8mm	1.6mm																		
Warp	1mm																			
Duration	10 sec.																			

10. Body Strength			
Specified Value	Temperature Compensating(Class1)	Standard	—
		High Frequency Type	No mechanical damage.
	High Permittivity (Class2)		—
Test Methods and Remarks	High Frequency 105Type Applied force : 5N Duration : 10 sec.		

11. Adhesive Strength of Terminal Electrodes														
Specified Value	Temperature Compensating(Class1)	Standard	No terminal separation or its indication.											
		High Frequency Type												
	High Permittivity (Class2)													
Test Methods and Remarks	<table border="1"> <thead> <tr> <th rowspan="2"></th> <th colspan="2">Multilayer Ceramic Capacitors</th> </tr> <tr> <th>021, 042, 063 Type</th> <th>105 Type or more</th> </tr> </thead> <tbody> <tr> <td>Applied force</td> <td>2N</td> <td>5N</td> </tr> <tr> <td>Duration</td> <td colspan="2">30±5 sec.</td> </tr> </tbody> </table>			Multilayer Ceramic Capacitors		021, 042, 063 Type	105 Type or more	Applied force	2N	5N	Duration	30±5 sec.		
		Multilayer Ceramic Capacitors												
		021, 042, 063 Type	105 Type or more											
Applied force	2N	5N												
Duration	30±5 sec.													

12. Solderability															
Specified Value	Temperature Compensating(Class1)	Standard	At least 95% of terminal electrode is covered by new solder.												
		High Frequency Type													
	High Permittivity (Class2)														
Test Methods and Remarks	<table border="1"> <thead> <tr> <th></th> <th>Eutectic solder</th> <th>Lead-free solder</th> </tr> </thead> <tbody> <tr> <td>Solder type</td> <td>H60A or H63A</td> <td>Sn-3.0Ag-0.5Cu</td> </tr> <tr> <td>Solder temperature</td> <td>230±5°C</td> <td>245±3°C</td> </tr> <tr> <td>Duration</td> <td colspan="2">4±1 sec.</td> </tr> </tbody> </table>			Eutectic solder	Lead-free solder	Solder type	H60A or H63A	Sn-3.0Ag-0.5Cu	Solder temperature	230±5°C	245±3°C	Duration	4±1 sec.		
		Eutectic solder	Lead-free solder												
	Solder type	H60A or H63A	Sn-3.0Ag-0.5Cu												
	Solder temperature	230±5°C	245±3°C												
Duration	4±1 sec.														

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### 13. Resistance to Soldering

Specified Value	Temperature Compensating(Class1)	Standard	Appearance : No abnormality Capacitance change : Within $\pm 2.5\%$ or $\pm 0.25\text{pF}$ , whichever is larger. Q : Initial value Insulation resistance : Initial value Withstanding voltage (between terminals) : No abnormality
		High Frequency Type	Appearance : No abnormality Capacitance change : Within $\pm 2.5\%$ Q : Initial value Insulation resistance : Initial value Withstanding voltage (between terminals) : No abnormality
	High Permittivity (Class2) Note 1		Appearance : No abnormality Capacitance change : Within $\pm 7.5\%$ Dissipation factor : Initial value Insulation resistance : Initial value Withstanding voltage (between terminals): No abnormality

Test Methods and Remarks	Class 1			
		021, 042, 063 Type	105 Type	
	Preconditioning	None		
	Preheating	150°C, 1 to 2 min.	80 to 100°C, 2 to 5 min. 150 to 200°C, 2 to 5 min.	
	Solder temp.	270 $\pm$ 5°C		
	Duration	3 $\pm$ 0.5 sec.		
	Recovery	6 to 24 hrs (Standard condition) Note 5		
	Class 2			
		021, 042, 063 Type	105, 107, 212 Type	316, 325, 432 Type
	Preconditioning	Thermal treatment (at 150°C for 1 hr) Note 2		
	Preheating	150°C, 1 to 2 min.	80 to 100°C, 2 to 5 min. 150 to 200°C, 2 to 5 min.	80 to 100°C, 5 to 10 min. 150 to 200°C, 5 to 10 min.
	Solder temp.	270 $\pm$ 5°C		
	Duration	3 $\pm$ 0.5 sec.		
	Recovery	24 $\pm$ 2 hrs (Standard condition) Note 5		

### 14. Temperature Cycle (Thermal Shock)

Specified Value	Temperature Compensating(Class1)	Standard	Appearance : No abnormality Capacitance change : Within $\pm 2.5\%$ or $\pm 0.25\text{pF}$ , whichever is larger. Q : Initial value Insulation resistance : Initial value Withstanding voltage (between terminals) : No abnormality
		High Frequency Type	Appearance : No abnormality Capacitance change : Within $\pm 0.25\text{pF}$ Q : Initial value Insulation resistance : Initial value Withstanding voltage (between terminals) : No abnormality
	High Permittivity (Class2) Note 1		Appearance : No abnormality Capacitance change : Within $\pm 7.5\%$ Dissipation factor : Initial value Insulation resistance : Initial value Withstanding voltage (between terminals) : No abnormality

Test Methods and Remarks	Class 1		Class 2		
	Preconditioning	None		Thermal treatment (at 150°C for 1 hr) Note 2	
	1 cycle	Step	Temperature (°C)	Time (min.)	
		1	Minimum operating temperature	30 $\pm$ 3	
		2	Normal temperature	2 to 3	
3		Maximum operating temperature	30 $\pm$ 3		
4	Normal temperature	2 to 3			
Number of cycles	5 times				
Recovery	6 to 24 hrs (Standard condition) Note 5		24 $\pm$ 2 hrs (Standard condition) Note 5		

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15. Humidity (Steady State)				
Specified Value	Temperature Compensating(Class1)	Standard	Appearance : No abnormality Capacitance change : Within $\pm 5\%$ or $\pm 0.5\text{pF}$ , whichever is larger. Q : $C < 10\text{pF} : Q \geq 200 + 10C$ $10 \leq C < 30\text{pF} : Q \geq 275 + 2.5C$ $C \geq 30\text{pF} : Q \geq 350 (C : \text{Nominal capacitance})$ Insulation resistance : $1000 \text{ M}\Omega \text{ min.}$	
		High Frequency Type	Appearance : No abnormality Capacitance change : Within $\pm 0.5\text{pF}$ , Insulation resistance : $1000 \text{ M}\Omega \text{ min.}$	
	High Permittivity (Class2) Note 1		Appearance : No abnormality Capacitance change : Within $\pm 12.5\%$ Dissipation factor : $5.0\%$ max. Insulation resistance : $50 \text{ M}\Omega/\mu\text{F}$ or $1000 \text{ M}\Omega$ whichever is smaller.	
Test Methods and Remarks		Class 1		Class 2
		Standard	High Frequency Type	All items
	Preconditioning	None		Thermal treatment ( at $150^\circ\text{C}$ for 1 hr) Note 2
	Temperature	$40 \pm 2^\circ\text{C}$	$60 \pm 2^\circ\text{C}$	$40 \pm 2^\circ\text{C}$
	Humidity	90 to 95%RH		90 to 95%RH
	Duration	$500 + 24 / - 0$ hrs		$500 + 24 / - 0$ hrs
	Recovery	6 to 24 hrs (Standard condition) Note 5		$24 \pm 2$ hrs (Standard condition) Note 5

16. Humidity Loading				
Specified Value	Temperature Compensating(Class1)	Standard	Appearance : No abnormality Capacitance change : Within $\pm 7.5\%$ or $\pm 0.75\text{pF}$ , whichever is larger. Q : $C < 30\text{pF} : Q \geq 100 + 10C/3$ $C \geq 30\text{pF} : Q \geq 200 (C : \text{Nominal capacitance})$ Insulation resistance : $500 \text{ M}\Omega \text{ min.}$	
		High Frequency Type	Appearance : No abnormality Capacitance change : $C \leq 2\text{pF} : \text{Within } \pm 0.4 \text{ pF}$ $C > 2\text{pF} : \text{Within } \pm 0.75 \text{ pF}$ (C:Nominal capacitance) Insulation resistance : $500 \text{ M}\Omega \text{ min.}$	
	High Permittivity (Class2) Note 1		Appearance : No abnormality Capacitance change : Within $\pm 12.5\%$ Dissipation factor : $5.0\%$ max. Insulation resistance : $25 \text{ M}\Omega/\mu\text{F}$ or $500 \text{ M}\Omega$ whichever is smaller.	
Test Methods and Remarks		Class 1		Class 2
		Standard	High Frequency Type	All items
	Preconditioning	None		Voltage treatment (Rated voltage are applied for 1 hour at $40^\circ\text{C}$ ) Note 3
	Temperature	$40 \pm 2^\circ\text{C}$	$60 \pm 2^\circ\text{C}$	$40 \pm 2^\circ\text{C}$
	Humidity	90 to 95%RH		90 to 95%RH
	Duration	$500 + 24 / - 0$ hrs		$500 + 24 / - 0$ hrs
	Applied voltage	Rated voltage		Rated voltage
	Charge/discharge current	50mA max.		50mA max.
Recovery	6 to 24 hrs (Standard condition) Note 5		$24 \pm 2$ hrs (Standard condition) Note 5	

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17. High Temperature Loading

Specified Value	Temperature Compensating(Class1)	Standard	Appearance : No abnormality Capacitance change : Within $\pm 3\%$ or $\pm 0.3\text{pF}$ , whichever is larger. Q : $C < 10\text{pF}$ : $Q \geq 200 + 10C$ $10 \leq C < 30\text{pF}$ : $Q \geq 275 + 2.5C$ $C \geq 30\text{pF}$ : $Q \geq 350$ (C: Nominal capacitance) Insulation resistance : 1000 M $\Omega$ min.
		High Frequency Type	Appearance : No abnormality Capacitance change : Within $\pm 3\%$ or $\pm 0.3\text{pF}$ , whichever is larger. Insulation resistance : 1000 M $\Omega$ min.
	High Permittivity (Class2) Note 1		Appearance : No abnormality Capacitance change : Within $\pm 12.5\%$ Dissipation factor : 5.0% max. Insulation resistance : 50 M $\Omega\mu\text{F}$ or 1000 M $\Omega$ whichever is smaller.

Test Methods and Remarks		Class 1		Class 2		
		Standard	High Frequency Type	BJ, LD(※)	C6	B7, C7
	Preconditioning	None		Voltage treatment (Twice the rated voltage shall be applied for 1 hour at 85°C, 105°C or 125°C) Note 3, 4		
	Temperature	Maximum operating temperature		Maximum operating temperature		
	Duration	1000+48/-0 hrs		1000+48/-0 hrs		
	Applied voltage	Rated voltage $\times 2$ Note 4		Rated voltage $\times 2$ Note 4		
	Charge/discharge current	50mA max.		50mA max.		
	Recovery	6 to 24hr (Standard condition) Note 5		24 $\pm 2$ hrs (Standard condition) Note 5		
Note: ※LD Low distortion high value multilayer ceramic capacitor						

Note 1 The figures indicate typical specifications. Please refer to individual specifications in detail.

Note 2 Thermal treatment : Initial value shall be measured after test sample is heat-treated at 150+0/-10°C for an hour and kept at room temperature for 24 $\pm 2$ hours.

Note 3 Voltage treatment : Initial value shall be measured after test sample is voltage-treated for an hour at both the temperature and voltage specified in the test conditions, and kept at room temperature for 24 $\pm 2$ hours.

Note 4 150% of rated voltage is applicable to some items. Please refer to their specifications for further information.

Note 5 Standard condition: Temperature: 5 to 35°C, Relative humidity: 45 to 85 % RH, Air pressure: 86 to 106kPa When there are questions concerning measurement results, in order to provide correlation data, the test shall be conducted under the following condition.  
Temperature: 20 $\pm 2$ °C, Relative humidity: 60 to 70 % RH, Air pressure: 86 to 106kPa Unless otherwise specified, all the tests are conducted under the "standard condition".