

Multilayer Ceramic Capacitors for Telecommunications Infrastructure and Industrial Equipment

Multilayer Ceramic Capacitors for Medical Devices classified as GHTF Class C (Japan Class III)

RELIABILITY DATA

1. Operating Temperature Range

Specified Value	Temperature Compensating(Class1)	-55 to +125°C		
	High Permittivity (Class2)		Specification	Temperature Range
		B5	X5R	-55 to +85°C
		B7	X7R	-55 to +125°C
		C6	X6S	-55 to +105°C
		C7	X7S	-55 to +125°C
D7	X7T	-55 to +125°C		

2. Storage Conditions

Specified Value	Temperature Compensating(Class1)	-55 to +125°C		
	High Permittivity (Class2)		Specification	Temperature Range
		B5	X5R	-55 to +85°C
		B7	X7R	-55 to +125°C
		C6	X6S	-55 to +105°C
		C7	X7S	-55 to +125°C
D7	X7T	-55 to +125°C		

3. Rated Voltage

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

4. Withstanding Voltage (Between terminals)

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

5. Insulation Resistance

Specified Value	Temperature Compensating(Class1)	10000 MΩ min.
	High Permittivity (Class2) Note 1	$C \leq 0.047 \mu F$: 10000 MΩ min. $C > 0.047 \mu F$: $500M\Omega \cdot \mu F$ (C:Nominal capacitance)
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)	$C \leq 5pF$: ±0.25pF $5pF < C \leq 10pF$: ±0.5pF $C > 10pF$: ±5% (C:Nominal capacitance)		
	High Permittivity (Class2)	±10% or ±20%		
Test Methods and Remarks		Class 1	Class 2	
	Preconditioning	None	$C \leq 10 \mu F$	$C > 10 \mu F$
	Measuring frequency	1MHz±10%	Thermal treatment (at 150°C for 1hr) Note 2	
	Measuring voltage Note 1	0.5 to 5Vrms	1±0.2Vrms	120±10Hz
	Bias application	None		

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7. Q or Dissipation Factor

Specified Value	Temperature Compensating (Class1)	C < 30pF : Q ≥ 400 + 20C C ≥ 30pF : Q ≥ 1000 (C: Nominal capacitance)		
	High Permittivity (Class2) Note 1	2.5% max.		
Test Methods and Remarks		Class 1	Class 2	
			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 Note 1	0.5 to 5Vrms	1 ± 0.2Vrms	0.5 ± 0.1Vrms
Bias application	None			

8. Temperature Characteristic (Without voltage application)

Specified Value	Temperature Compensating (Class1)	Temperature Characteristic [ppm/°C]		Tolerance [ppm/°C]	
		C□: 0	CG, CH, CJ, CK	G : ±30	H : ±60
High Permittivity (Class2)				J : ±120	K : ±250
		Specification	Capacitance change	Reference temperature	Temperature Range
	B5	X5R	±15%	25°C	-55 to +85°C
	B7	X7R	±15%	25°C	-55 to +125°C
	C6	X6S	±22%	25°C	-55 to +105°C
	C7	X7S	±22%	25°C	-55 to +125°C
D7	X7T	+22/-33%	25°C	-55 to +125°C	

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	Temperature
1	Minimum operating temperature
2	25°C
3	Maximum operating temperature

$$\frac{(C - C_2)}{C_2} \times 100 (\%)$$

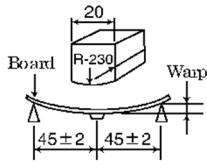
C : Capacitance in Step 1 or Step 3
C2 : Capacitance in Step 2
※Measuring Frequency, Measuring Voltage: Refer to detailed specification

9. Deflection

Specified Value	Temperature Compensating (Class1)	Appearance : No abnormality Capacitance change : Within ±5% or ±0.5 pF, whichever is larger.
	High Permittivity (Class2)	Appearance : No abnormality Capacitance change : Within ±12.5%

Test Methods and Remarks	Multilayer Ceramic Capacitors	
	0603, ※11005 Type	The other types
	Glass epoxy-resin substrate	
	Board	0.8mm 1.6mm
	Warp	1mm (Soft Termination type:3mm)
Duration	10 sec.	

※1: 1005 Type thickness, ,3: 0.3mm.



(Unit: mm)
Capacitance measurement shall be conducted with the board bent

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10. Adhesive Strength of Terminal Electrodes

Specified Value	Temperature Compensating(Class1)	No terminal separation or its indication.	
	High Permittivity (Class2)		
Test Methods and Remarks		0603 Type	1005 Type or more
	Applied force	2N	5N
	Duration	10±1 sec.	30±5 sec. (Soft Termination type: 10±1 sec.)

11. Vibration

Specified Value	Temperature Compensating(Class1)	Initial performance shall be satisfied.
	High Permittivity (Class2)	
Test Methods and Remarks	Preconditioning	: Thermal treatment (at 150°C for 1hr) Note2 (Only High permittivity)
	Frequency range	: 10 to 55 Hz
	Overall amplitude	: 1.5 mm
	Sweeping method	: 10 to 55 to 10 Hz for 1 min
		Two hours each in X, Y, Z directions: 6 hrs in total

12. Solderability

Specified Value	Temperature Compensating(Class1)	At least 95% of terminal electrode is covered by new solder.	
	High Permittivity (Class2)		
Test Methods and Remarks		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.	

13. Resistance to Soldering

Specified Value	Temperature Compensating(Class1)	Appearance	: No abnormality		
		Capacitance change	: Within ±2.5% or ±0.25pF, whichever is larger.		
Specified Value	High Permittivity (Class2) Note 1	Q	: Initial value		
		Insulation resistance	: Initial value		
Specified Value	High Permittivity (Class2) Note 1	Withstanding voltage	(between terminals) : No abnormality		
		Appearance	: No abnormality		
Specified Value	High Permittivity (Class2) Note 1	Capacitance change	: Within ±7.5%		
		Dissipation factor	: Initial value		
Specified Value	High Permittivity (Class2) Note 1	Insulation resistance	: Initial value		
		Withstanding voltage	(between terminals): No abnormality		
Test Methods and Remarks		Class 1			
		0603 Type	1005 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±5°C			
	Duration	3±0.5 sec.			
	Recovery	24±2hrs (Standard condition) Note 5			
		Class 2			
		0603 Type	1005, 1608, 2012 Type	3216, 3225 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±5°C			
	Duration	3±0.5 sec.			
	Recovery	24±2 hrs (Standard condition) Note 5			

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14. Temperature Cycle (Thermal Shock)

Specified Value	Temperature Compensating(Class1)	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 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	<table border="1"> <thead> <tr> <th>Step</th> <th>Temperature ($^\circ\text{C}$)</th> <th>Time (min.)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Minimum operating temperature</td> <td>30 ± 3</td> </tr> <tr> <td>2</td> <td>Normal temperature</td> <td>2 to 3</td> </tr> <tr> <td>3</td> <td>Maximum operating temperature</td> <td>30 ± 3</td> </tr> <tr> <td>4</td> <td>Normal temperature</td> <td>2 to 3</td> </tr> </tbody> </table>		Step	Temperature ($^\circ\text{C}$)	Time (min.)	1	Minimum operating temperature	30 ± 3	2	Normal temperature	2 to 3	3	Maximum operating temperature	30 ± 3	4	Normal temperature	2 to 3
	Step	Temperature ($^\circ\text{C}$)	Time (min.)															
1	Minimum operating temperature	30 ± 3																
2	Normal temperature	2 to 3																
3	Maximum operating temperature	30 ± 3																
4	Normal temperature	2 to 3																
Number of cycles	50 times																	
Recovery	24 ± 2 hrs (Standard condition) Note 5	24 ± 2 hrs (Standard condition) Note 5																

15. Humidity (Steady State)

Specified Value	Temperature Compensating(Class1)	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:Nominal capacitance) Insulation resistance : $1000 \text{ M}\Omega$ min.
	High Permittivity (Class2) Note 1	Appearance : No abnormality Capacitance change : Within $\pm 12.5\%$ Dissipation factor : 5.0% max. Insulation resistance : $50 \text{ M}\Omega \mu\text{F}$ or $1000 \text{ M}\Omega$ whichever is smaller.
Test Methods and Remarks	Preconditioning : Thermal treatment (at 150°C for 1 hr) Note 2 (Only High permittivity) Temperature : $40 \pm 2^\circ\text{C}$ Humidity : 90 to 95%RH Duration : $500 + 24 / -0$ hrs Recovery : 24 ± 2 hrs (Standard condition) Note 1,5	

16. Humidity Loading

Specified Value	Temperature Compensating(Class1)	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:Nominal capacitance) Insulation resistance : $500 \text{ M}\Omega$ 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	Preconditioning : Voltage treatment (Rated voltage are applied for 1 hour at 40°C) Note 1,3 (Only High permittivity) Temperature : $60 \pm 2^\circ\text{C}$ Humidity : 90 to 95%RH Duration : $500 + 24 / -0$ hrs Applied voltage : Rated voltage Charge/discharge current : 50mA max. Recovery : 24 ± 2 hrs (Standard condition) Note 1,5	

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17. High Temperature Loading

Specified Value	Temperature Compensating(Class1)	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 Ω min.
	High Permittivity (Class2) Note 1	Appearance : No abnormality Capacitance change : Within $\pm 12.5\%$ Dissipation factor : 5.0% max. Insulation resistance : 50 M Ω μF or 1000 M Ω , whichever is smaller.
Test Methods and Remarks	Preconditioning :Voltage treatment (Twice the rated voltage shall be applied for 1 hour at 85°C, 105°C or 125°C) Note 1,3,4 (Only High permittivity) Temperature :Maximum operating temperature Duration :1000+24/-0 hrs Applied voltage : Rated voltage $\times 2$ Note 4 Charge/discharge current : 50mA max. Recovery : 24 \pm 2 hrs (Standard condition) Note 1,5	

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 2hours.

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 2hours.

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".