

Multilayer Ceramic Capacitors for General Electronic Equipment for Consumer
Multilayer Ceramic Capacitors
for Medical Devices classified as GHTF Classes A or B (Japan Classes I or II)

■ 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
		B5	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		

2. Storage Conditions

Specified Value	Temperature Compensating (Class1)	Standard	-55 to +125°C	
		High Frequency Type		
Specified Value	High Permittivity (Class2)		Specification	Temperature Range
		B5	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		

3. Rated Voltage

Specified Value	Temperature Compensating (Class1)	Standard	50VDC, 25VDC, 16VDC
		High Frequency Type	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	
Test Methods and Remarks	High Permittivity (Class2) Note 1		$C \leq 0.047 \mu F$: 10000 MΩ min.
			$C > 0.047 \mu F$: $500 M\Omega \cdot \mu F$ (C: Nominal capacitance)
	Applied voltage	: Rated voltage	
Duration	: 60 ± 5 sec.		
Charge/discharge current	: 50mA max.		

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6. Capacitance (Tolerance)

Specified Value	Temperature Compensating (Class1)	Standard	$0.2\text{pF} \leq C \leq 5\text{pF} : \pm 0.25\text{pF}$ $5\text{pF} \leq C \leq 10\text{pF} : \pm 0.5\text{pF}$ $C > 10\text{pF} : \pm 5\%$	
		High Frequency Type	Refer to detailed specification	
	High Permittivity (Class2)		$\pm 10\%$ or $\pm 20\%$	
Test Methods and Remarks		Class 1		Class 2
		Standard	High Frequency Type	$C \leq 10 \mu\text{F}$ $C > 10 \mu\text{F}$
	Preconditioning	None		Thermal treatment (at 150°C for 1hr) Note 2
	Measuring frequency	1MHz \pm 10%	1GHz	$1\text{kHz} \pm 10\%$ $120 \pm 10\text{Hz}$
	Measuring voltage Note 1	0.5 to 5Vrms		$1 \pm 0.2\text{Vrms}$ $0.5 \pm 0.1\text{Vrms}$
Bias application	None			

7. Q or Dissipation Factor

Specified Value	Temperature Compensating (Class1)	Standard	$C < 30\text{pF} : Q \geq 400 + 20C$ $C \geq 30\text{pF} : Q \geq 1000$ (C: Nominal capacitance)	
		High Frequency Type	Refer to detailed specification	
	High Permittivity (Class2) Note 1		2.5% max.	
Test Methods and Remarks		Class 1		Class 2
		Standard	High Frequency Type	$C \leq 10 \mu\text{F}$ $C > 10 \mu\text{F}$
	Preconditioning	None		Thermal treatment (at 150°C for 1hr) Note 2
	Measuring frequency	1MHz \pm 10%	1GHz	$1\text{kHz} \pm 10\%$ $120 \pm 10\text{Hz}$
	Measuring voltage Note 1	0.5 to 5Vrms		$1 \pm 0.2\text{Vrms}$ $0.5 \pm 0.1\text{Vrms}$
Bias application	None			

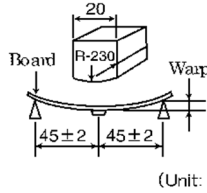
8. Temperature Characteristic (Without voltage application)

Specified Value	Temperature Compensating (Class1)	Standard	Temperature Characteristic [ppm/°C]		Tolerance [ppm/°C]	
			$C \square : 0$	CG(C0G) CH(C0H) CJ(C0J) CK(C0K)	G: ± 30 H: ± 60 J: ± 120 H: ± 250	
	High Frequency Type	Temperature Characteristic [ppm/°C]		Tolerance [ppm/°C]		
			$C \square : 0$	CG(C0G) CH(C0H)	G: ± 30 H: ± 60	
	High Permittivity (Class2)		Specification	Capacitance change	Reference temperature	Temperature Range
			B5	B X5R $\pm 10\%$	20°C 25°C	-25 to +85°C -55 to +85°C
			B7	X7R $\pm 15\%$	25°C	-55 to +125°C
			C6	XS $\pm 22\%$	25°C	-55 to +105°C
			C7	X7S $\pm 22\%$	25°C	-55 to +125°C

Test Methods and Remarks	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				
$\frac{(C - C_2)}{C_2} \times 100 (\%) \quad C : \text{Capacitance in Step 1 or Step 3}$ $C_2 : \text{Capacitance in Step 2}$					
※Measuring frequency and voltage: Refer to detailed specification					

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9. Deflection

Specified Value	Temperature Compensating (Class1)	Standard	Appearance : No abnormality Capacitance change : Within $\pm 5\%$ or ± 0.5 pF, whichever is larger.	
		High Frequency Type	Appearance : No abnormality Capacitance change : Within ± 0.5 pF	
	High Permittivity (Class2)		Appearance : No abnormality Capacitance change : Within $\pm 12.5\%$	
Test Methods and Remarks	Multilayer Ceramic Capacitors		 <p style="font-size: small;">(Unit: mm) Capacitance measurement shall be conducted with the board bent</p>	
		0201, 0402, 0603, ※1005 Type		The other types
	Board	Glass epoxy-resin substrate		
	Thickness	0.8mm		1.6mm
	Warp	1mm		
	Duration	10 sec.		
	※1005 Type thickness, 2: 0.2mm, 3: 0.3mm.			

10. 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		0201Type	0402, 0603Type	1005Type or more
	Applied force	1N	2N	5N
	Duration	10 ± 1 sec		30 ± 5 sec

11. Vibration

Specified Value	Temperature Compensating (Class1)	Standard	Initial performance shall be satisfied.
		High Frequency Type	
	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)	Standard	At least 95% of terminal electrode is covered by new solder.
		High Frequency Type	
	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	
	Duration	4 ± 1 sec.	

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 $\pm 2.5\%$ 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			
		0201, 0402, 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 \pm 5°C		
	Duration	3 \pm 0.5 sec.		
	Recovery	24 \pm 2 hrs (Standard condition) Note 5		
	Class 2			
		0201, 0402, 0603 Type	1005, 1608, 2012 Type	3216, 3225, 4532 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 $\pm 2.5\%$ 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	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	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: Nominal capacitance) Insulation resistance : 1000 M Ω min.
		High Frequency Type	Appearance : No abnormality Capacitance change : Within $\pm 5\%$ or $\pm 0.5\text{pF}$, whichever is larger. 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 : Thermal treatment (at 150°C for 1hr) Note2 (Only High permittivity) Temperature : 40 $\pm 2^\circ\text{C}$ Humidity : 90 to 95%RH Duration : 500 +24/−0 hrs Recovery : 24 ± 2 hrs under the standard condition Note 1,5		

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: Nominal capacitance) Insulation resistance : 500 M Ω min.
		High Frequency Type	Appearance : No abnormality Capacitance change : $C \leq 2\text{pF} : \text{Within } \pm 0.4 \text{ pF}$ $C > 2\text{pF} : \text{Within } \pm 0.75 \text{ pF}$ $C > 10\text{pF} : \text{Within } \pm 0.75\% \text{ (C: Nominal capacitance)}$ Insulation resistance : 500 M Ω min.
	High Permittivity (Class2) Note 1		Appearance : No abnormality Capacitance change : Within $\pm 12.5\%$ Dissipation factor : 5.0% max. Insulation resistance : 25 M Ω μF or 500 M Ω , 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 : 40 $\pm 2^\circ\text{C}$ Humidity : 90 to 95%RH Duration : 500 +24/−0 hrs Applied voltage : Rated voltage Charge/discharge current : 50mA max. Recovery : 24 ± 2 hrs under the standard condition Note 1,5		

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 : $1000 \text{ M}\Omega$ min.
		High Frequency Type	Appearance : No abnormality Capacitance change : Within $\pm 3\%$ or $\pm 0.3\text{pF}$, whichever is larger. Insulation resistance : $1000 \text{ M}\Omega$ 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 : 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 ± 2 hrs under the 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 $150 \pm 0 / -10^\circ\text{C}$ for an hour and kept at room temperature for 24 ± 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 ± 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: $20 \pm 2^\circ\text{C}$, Relative humidity: 60 to 70% RH, Air pressure: 86 to 106kPa Unless otherwise specified, all the tests are conducted under the "standard condition".