

Multilayer Ceramic Capacitors for Automotive Body & Chassis and Infotainment

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)	Standard	50VDC, 25VDC
		High Frequency Type	250VDC
	High Permittivity (Class2)		630VDC, 250VDC, 100VDC 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 voltage × 3 Rated voltage (Code Q) × 2	Rated voltage × 2.5 Rated voltage (Code Q) × 2, Rated voltage (Code S) × 1.2
	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 ≤ 0.047 μF : 10000 MΩ min. C > 0.047 μF : 500 MΩ · μF (C: Nominal capacitance)
Test Methods and Remarks	Applied voltage	: Rated voltage, 500V (Code S)
	Duration	: 60 ± 5 sec.
	Charge/discharge current	: 50mA max.

6. Capacitance (Tolerance)

Specified Value	Temperature Compensating (Class1)	Standard	$C \leq 5\text{pF} : \pm 0.25\text{pF}$ $5\text{pF} < C \leq 10\text{pF} : \pm 0.5\text{pF}$ $C > 10\text{pF} : \pm 5\%$ (C: Nominal capacitance)		
		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) No.9	
	Measuring frequency	1MHz $\pm 10\%$		1kHz $\pm 10\%$	120 $\pm 10\text{Hz}$
	Measuring voltage Note 1	0.5 to 5Vrms		1 $\pm 0.2\text{Vrms}$	0.5 $\pm 0.1\text{rms}$
	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) No.9	
	Measuring frequency	1MHz $\pm 10\%$		1kHz $\pm 10\%$	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. Pre- and Post-Stress Electrical test

Measurement at 25 $\pm 5^\circ\text{C}$

9. Heat treatment

Value shall be measured after test sample is heat treated at 150 $\pm 10^\circ\text{C}$ for an hour and kept at room temperature for 24 ± 2 hrs.
 ※ Heat treatment is applicable to High dielectric type.

10. High Temperature Exposure (Storage)

Specified Value	Temperature Compensating (Class1)	Standard	Appearance : No abnormality Cap. 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) IR : 1000M Ω min	
		High Frequency Type	Appearance : No abnormality Cap. Change : Within $\pm 3\%$ or $\pm 0.3\text{pF}$, whichever is larger. IR : 1000M Ω min	
	High Permittivity (Class2) Note 1			Appearance : No abnormality Cap. Change : Within $\pm 12.5\%$ tan δ : 5% max IR : Within 50M $\Omega \mu\text{F}$ or 100M Ω , whichever is smaller.
Test Methods and Remarks	Heat treatment specified in this specification shall be conducted prior to test. No.9 Temperature: The maximum operating temperature shall be used. Duration: Unpowered 1000 hrs. Measurement shall be performed after test sample following the test is heated at 150 $\pm 10^\circ\text{C}$ for an hour and kept at room temperature for 24 ± 2 hrs. No.9			

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11. Temperature Cycling			
Specified Value	Temperature Compensating (Class1)	Standard	Appearance : No abnormality Cap. Change : Within $\pm 2.5\%$ or $\pm 0.25\text{pF}$, whichever is larger. Q : Initial value IR : Initial value
		High Frequency Type	Appearance : No abnormality Cap. Change : Within $\pm 2.5\%$ or $\pm 0.25\text{pF}$, whichever is larger. IR : Initial value
	High Permittivity (Class2)		Appearance : No abnormality Cap. Change : Within $\pm 7.5\%$ $\tan \delta$: Initial value IR : Initial value
Test Methods and Remarks	Heat treatment specified in this specification shall be conducted prior to test. No.9 Temperature: Minimum operating temperature to Maximum operating temperature Number of cycles: 1000 cycles Maximum dwell time at each temperature extreme: 30 min Maximum transition time: Within 1 min Measurement shall be performed after test sample following the test is heated at $150+0/-10^\circ\text{C}$ for an hour and kept at room temperature for 24 ± 2 hours. No.9		

12. Destructive Physical Analysis	
Specified Value	No abnormality
Test Methods and Remarks	Per EIA-469

13. Biased Humidity			
Specified Value	Temperature Compensating (Class1)	Standard	Appearance : No abnormality Cap. 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) IR : $500M\Omega \text{ min}$
		High Frequency Type	Appearance : No abnormality Cap. Change : $C \leq 2.0\text{pF} : \pm 0.4\text{pF}$ $2.0\text{pF} < C < 10\text{pF} : \pm 0.75\text{pF}$ $C \geq 10\text{pF} : \pm 7.5\%$ (C: Nominal capacitance) IR : $500M\Omega \text{ min}$
	High Permittivity (Class2) Note 1		Appearance : No abnormality Cap. Change : Within $\pm 12.5\%$ $\tan \delta$: 5% max IR : Within $25M\Omega \mu\text{F}$ or $500M\Omega$ whichever is smaller.
Test Methods and Remarks	Heat treatment specified in this specification shall be conducted prior to test. No.9 Temperature: 85°C Humidity: 85%RH Duration: 1000hrs Applied voltage: Rated voltage and 1.3 to 1.5V. Measurement shall be performed after test sample following the test is heated at $150+0/-10^\circ\text{C}$ for an hour and kept at room temperature for 24 ± 2 hours. No.9		

14. Temperature Cycle (Thermal Shock)			
Specified Value	Temperature Compensating (Class1)	Standard	Appearance : No abnormality Cap. Change : Within $\pm 3.0\%$ 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) IR : $1000M\Omega \text{ min}$
		High Frequency Type	Appearance : No abnormality Cap. Change : Within $\pm 3.0\%$ or $\pm 0.3\text{pF}$, whichever is larger. IR : $1000M\Omega \text{ min}$
	High Permittivity (Class2) Note 1		Appearance : No abnormality Cap. Change : Within $\pm 12.5\%$ $\tan \delta$: 5% max IR : Within $50M\Omega\mu\text{F}$ or $1000M\Omega$ whichever is smaller.
Test Methods and Remarks	Heat treatment specified in this specification shall be conducted prior to test. No.9 Temperature: Maximum operating temperature Duration: 1000hrs Applied voltage: Rated voltage Measurement shall be performed after test sample following the test is heated at $150+0/-10^\circ\text{C}$ for an hour and kept at room temperature for 24 ± 2 hours. No.9		

15. External Visual	
Specified Value	No abnormality
Test Methods and Remarks	Visual inspection shall be performed.

16. Physical Dimension	
Specified Value	Refer to detailed specification
Test Methods and Remarks	Verify physical dimensions to the applicable device specification.

17. Resistance to Solvents	
Specified Value	Appearance : No abnormality Cap. Change : Initial value Q or $\tan \delta$: Initial value IR : Initial value
Test Methods and Remarks	Heat treatment specified in this specification shall be conducted prior to test. No.9 Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent.

18. Mechanical Shock	
Specified Value	Appearance : No abnormality Cap. Change : Initial value Q or $\tan \delta$: Initial value IR : Initial value
Test Methods and Remarks	Heat treatment specified in this specification shall be conducted prior to test. No.9 Three shocks in each direction should be applied along 3 mutually perpendicular axes of the test specimen (18 shocks). Peak value: 1500g Duration: 0.5ms Test pulse: Half-sine Velocity change: 4.7m/s.

19. Vibration	
Specified Value	Appearance : No abnormality Cap. Change : Initial value Q or $\tan \delta$: Initial value IR : Initial value
Test Methods and Remarks	Heat treatment specified in this specification shall be conducted prior to test. No.9 5g's for 20 min., 12 cycles each of 3 orientations. (Total: 36 cycles) Frequency range: 10Hz~2000Hz

20. Resistance to Soldering Heat

Specified Value	Temperature Compensating (Class1)	Standard	Appearance : No abnormality Cap. Change : Within $\pm 2.5\%$ or $\pm 0.25\text{pF}$, whichever is larger. Q : Initial value IR : Initial value
		High Frequency Type	Appearance : No abnormality Cap. Change : Within $\pm 2.5\%$ or $\pm 0.25\text{pF}$, whichever is larger. IR : Initial value
	High Permittivity (Class2) Note 1		Appearance : No abnormality Cap. Change : Within $\pm 7.5\%$ $\tan \delta$: Initial value IR : Initial value
Test Methods and Remarks	Heat treatment specified in this specification shall be conducted prior to test. No.9 Dipping Solder: $260 \pm 5^\circ\text{C}$ Time: 10 ± 1 sec. Measurement shall be performed after test sample following the test kept at room temperature for 24 ± 2 hours.		

21. ESC

Specified Value	Appearance: No abnormality IR: Initial value
Test Methods and Remarks	Heat treatment specified in this specification shall be conducted prior to test. No.9 Per AEC-Q200-002

22. Solderability

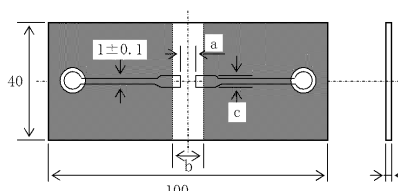
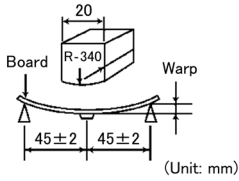
Specified Value	More than 95% of terminal electrode shall be covered with fresh solder.
Test Methods and Remarks	(a) Pb Free Solder Solder at $235 \pm 5^\circ\text{C}$ for 5sec. (b) SnPb Solder Solder at $215 \pm 5^\circ\text{C}$ for 5sec. (c) Wave Soldering (Pb Free Solder) Solder at $260 \pm 5^\circ\text{C}$ for 7sec.

23. Temperature Characteristic

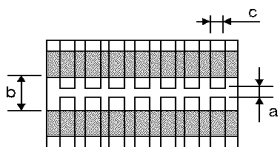
Specified Value	Temperature Compensating (Class1)	Temp. chara. [ppm/ $^\circ\text{C}$]		Tolerance [ppm/ $^\circ\text{C}$]		
		$C \square : 0$	CG, CH, CJ, CK	G: ± 30 H: ± 60 J: ± 120 K: ± 250		
	High Permittivity (Class2)		Capacitance change rate	Reference temperature	Temperature range	
		B5	X5R	$\pm 15\%$	25°C	$-55 \sim +85^\circ\text{C}$
		B7	X7R	$\pm 15\%$	25°C	$-55 \sim +125^\circ\text{C}$
		C6	X6S	$\pm 22\%$	25°C	$-55 \sim +105^\circ\text{C}$
		C7	X7S	$\pm 22\%$	25°C	$-55 \sim +125^\circ\text{C}$
		D7	X7T	$+22 / -33\%$	25°C	$-55 \sim +125^\circ\text{C}$
Test Methods and Remarks	Heat treatment specified in this specification shall be conducted prior to test. No.9 Capacitance shall be measured at room temperature as well as minimum and maximum operating temperatures.					

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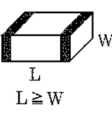
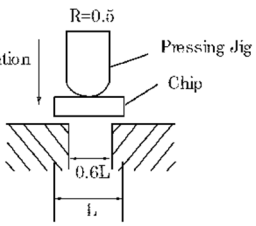
24. Board Flex

Specified Value	Appearance: No abnormality Cap. Change: $\pm 12.5\%$																																															
Test Methods and Remarks	<p>Heat treatment specified in this specification shall be conducted prior to test. No.9 Test sample is soldered onto the test board shown in Fig 1. The board is bent 2.0mm for 60 seconds as shown in Fig 2. Measurement shall be conducted as the board is bent 2.0mm.</p> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">  <p>Fig 1</p> </div> <table border="1" style="border-collapse: collapse; text-align: center;"> <thead> <tr> <th rowspan="2">Dimension</th> <th colspan="7">Case size [mm]</th> </tr> <tr> <th>0603</th> <th>1005</th> <th>1608</th> <th>2012</th> <th>3216</th> <th>3225</th> <th>4532</th> </tr> </thead> <tbody> <tr> <td>a</td> <td>0.3</td> <td>0.4</td> <td>1.0</td> <td>1.2</td> <td>2.2</td> <td>2.2</td> <td>3.5</td> </tr> <tr> <td>b</td> <td>0.9</td> <td>1.5</td> <td>3.0</td> <td>4.0</td> <td>5.0</td> <td>5.0</td> <td>7.0</td> </tr> <tr> <td>c</td> <td>0.3</td> <td>0.5</td> <td>1.2</td> <td>1.65</td> <td>2.0</td> <td>2.9</td> <td>3.7</td> </tr> <tr> <td>Thickness</td> <td colspan="7">0.8</td> </tr> </tbody> </table> </div> <div style="text-align: center; margin-top: 10px;">  <p>Fig 2</p> </div>	Dimension	Case size [mm]							0603	1005	1608	2012	3216	3225	4532	a	0.3	0.4	1.0	1.2	2.2	2.2	3.5	b	0.9	1.5	3.0	4.0	5.0	5.0	7.0	c	0.3	0.5	1.2	1.65	2.0	2.9	3.7	Thickness	0.8						
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25. Terminal Strength

Specified Value	Appearance: No abnormality																																							
Test Methods and Remarks	<p>Per AEC-Q200-006 Test sample is soldered onto the test board shown in Fig 3. 0603 or greater (case size): 17.7N for 60\pm5 sec 0402 (case size): 5N for 30\pm5 sec. 0201 (case size): 2N for 30\pm5 sec.</p> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">  <p>Fig 3</p> </div> <table border="1" style="border-collapse: collapse; text-align: center;"> <thead> <tr> <th rowspan="2">Dimension</th> <th colspan="7">Case size [mm]</th> </tr> <tr> <th>0603</th> <th>1005</th> <th>1608</th> <th>2012</th> <th>3216</th> <th>3225</th> <th>4532</th> </tr> </thead> <tbody> <tr> <td>a</td> <td>0.3</td> <td>0.4</td> <td>1.0</td> <td>1.2</td> <td>2.2</td> <td>2.2</td> <td>3.5</td> </tr> <tr> <td>b</td> <td>0.9</td> <td>1.5</td> <td>3.0</td> <td>4.0</td> <td>5.0</td> <td>5.0</td> <td>7.0</td> </tr> <tr> <td>c</td> <td>0.3</td> <td>0.5</td> <td>1.2</td> <td>1.65</td> <td>2.0</td> <td>2.9</td> <td>3.7</td> </tr> </tbody> </table> </div>	Dimension	Case size [mm]							0603	1005	1608	2012	3216	3225	4532	a	0.3	0.4	1.0	1.2	2.2	2.2	3.5	b	0.9	1.5	3.0	4.0	5.0	5.0	7.0	c	0.3	0.5	1.2	1.65	2.0	2.9	3.7
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26. Beam Load Test

Specified Value	Destruction value should exceed 5N.
Test Methods and Remarks	<p>Per AEC-Q200-003</p> <div style="display: flex; align-items: center;"> <div style="margin-right: 20px;">  </div> <div>  </div> </div>

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