

Multilayer Ceramic Capacitors for Automotive Powertrain and Safety

RELIABILITY DATA

1. Operating Temperature Range

Specified Value	X7R, X7S, X7T (−55°C to +125°C)
Test Methods and Remarks	Continuous use is available in this range. (reference temperature : 25°C)

2. Highest Operating temperature Range

Specified Value	X7R, X7S, X7T (−55°C to +125°C)
Test Methods and Remarks	Maximum operating temperature at which capacitors can be continuously used with rated voltage applied.

3. Rated Voltage

Specified Value	Please refer to the page of the "PART NUMBERS".
Test Methods and Remarks	Continuous maximum applied voltage. If an AC voltage is loaded on a DC voltage, the sum of the two peak voltages should be lower than the rated voltage of the capacitor.

4. Shape and Dimensions

Specified Value	Please refer to the page of the "EXTERNAL DIMENSIONS".
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5. Heat Treatment

Test Methods and Remarks	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 ± 2 hours.
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6. Dielectric Withstanding Voltage (between terminals)

Specified Value	No abnormality.
Test Methods and Remarks	Applied voltage : Rated voltage × 2.5 Duration : 1 to 5 seconds. Charging and discharging current shall be 50mA max.

7. Insulation Resistance

Specified Value Note 1	Larger than whichever smaller of 500 MΩ · μF or 10000 MΩ
Test Methods and Remarks	Applied voltage : Rated voltage Duration : 60±5 seconds. Charging and discharging current shall be 50mA max.

8. Capacitance and Tolerance

Specified Value	±10% or ±20%
Test Methods and Remarks	Measurement frequency : 1kHz±10% (C≤10 μF) Measurement voltage : 1±0.2Vrms (C≤10 μF) 0.5±0.1V (6.3V rated voltage) Note 1

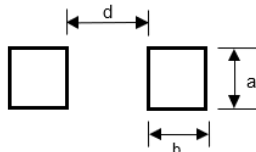
9. Dissipation factor (tan δ)

Specified Value	Please refer to the page of the "PART NUMBERS".
Test Methods and Remarks	Measurement frequency : 1kHz±10% (C≤10 μF) Measurement voltage : 1±0.2Vrms (C≤10 μF) 0.5±0.1V (6.3V rated voltage) Note 1

10. Temperature Characteristic (without DC bias)

Specified Value	X7R($\pm 15\%$), X7S($\pm 22\%$), X7T(+ 22%/– 33%)												
Test Methods and Remarks	<p>Heat treatment specified in No.5 of the specification shall be conducted prior to test. Change of the maximum capacitance deviation in step 1 to 5.</p> <table border="1"> <thead> <tr> <th>step</th><th>Temperature(°C)</th></tr> </thead> <tbody> <tr> <td>1</td><td>+25</td></tr> <tr> <td>2</td><td>Minimum operating temperature</td></tr> <tr> <td>3</td><td>+25</td></tr> <tr> <td>4</td><td>Maximum operating temperature</td></tr> <tr> <td>5</td><td>+25</td></tr> </tbody> </table>	step	Temperature(°C)	1	+25	2	Minimum operating temperature	3	+25	4	Maximum operating temperature	5	+25
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11. Adhesive Force of Terminal Electrodes

Specified Value	Appearance: Terminal electrodes shall be no exfoliation or a sign of exfoliation.																																									
Test Methods and Remarks		0603 size	1005 size		larger than 1608 size																																					
	Applying force	2N	5N		17.7N																																					
	Duration	60±1 seconds.																																								
	Board	Glass epoxy-resin substrate																																								
	Solder lands refer to fig.1.																																									
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	Fig.1																																									

12. Vibration

Specified Value	<p>Appearance : No abnormality</p> <p>Capacitance change : Initial value shall be satisfied.</p> <p>Dissipation factor : Initial value shall be satisfied.</p> <p>Insulation resistance : Initial value shall be satisfied.</p>
Test Methods and Remarks	<p>Heat treatment specified in No.5 of the specification shall be conducted prior to test.</p> <p>Solder lands refer to figure 1.</p> <p>Direction of the vibration test : X, Y, Z each of 3 orientations for 12 times respectively (Total 36 times)</p> <p>Vibration frequency : 10 to 2000 to 10Hz (20 minutes each)</p> <p>Total amplitude : 1.5 mm</p> <p>Measurement shall be performed after test sample following the test is heated at 150+0/–10°C for an hour and kept at room temperature for 24±2 hrs. No.5</p>

13. Solderability

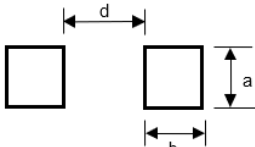
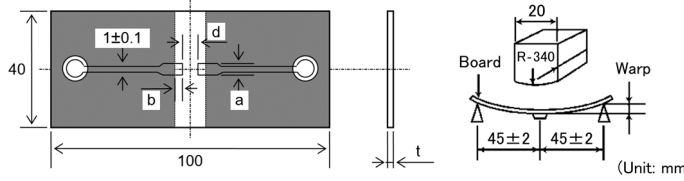
Specified Value	More than 95% of terminal electrode shall be covered with fresh solder.
Test Methods and Remarks	<p>Immerse test sample in an solder solution (Sn-3Ag-0.5Cu).</p> <p>Soldering temperature : 245°C±3°C</p> <p>Duration : 3±1 seconds</p>

14. Resistance to Soldering Heat

Specified Value Note 1	<p>Appearance : No abnormality</p> <p>Capacitance change : $\leq \pm 7.5\%$</p> <p>Dissipation factor : Initial value shall be satisfied.</p> <p>Insulation resistance : Initial value shall be satisfied.</p> <p>Dielectric withstanding voltage (between terminals) : No abnormality</p>
Test Methods and Remarks	<p>Heat treatment specified in No.5 of the specification shall be conducted prior to test.</p> <p>Immerse test sample in an solder solution (Sn-3Ag-0.5Cu).</p> <p>Soldering temperature : 260°C±5°C</p> <p>Duration : 10±1 seconds</p> <p>Soaking position : Test sample is soaked until the terminal electrode is covered in solder solution.</p> <p>Measurement shall be performed after test sample following the test is heated at 150+0/–10°C for an hour and kept at room temperature for 24±2 hrs. No.5</p>

15. Temperature Cycling			
Specified Value Note 1	Appearance	: No abnormality	
	Capacitance change	: $\leq \pm 7.5\%$	
	Dissipation factor	: Initial value shall be satisfied.	
	Insulation resistance	: Initial value shall be satisfied.	
Test Methods and Remarks	Heat treatment specified in No.5 of the specification shall be conducted prior to test. condition of the one cycle		
	Step	Temperature(°C)	Time(min.)
	1	Minimum usage temperature	30±3
	2	+25	2 to 3
	3	Maximum usage temperature	30±3
	4	+25	2 to 3
	Test cycles: 1000 times Solder lands refer to fig. 2. Measurement shall be performed after test sample following the test is heated at 150+0/−10°C for an hour and kept at room temperature for 24±2 hrs. No.5		
16. High Temperature Loading			
Specified Value Note1	Appearance	: No abnormality	
	Capacitance change	: $\leq \pm 12.5\%$	
	Dissipation factor	: 5.0%max.	
	Insulation resistance	: Larger than whichever smaller of 50MΩ · μF or 1000MΩ	
Test Methods and Remarks	Heat treatment specified in No.5 of the specification shall be conducted prior to test.		
	Temperature	: Maximum usage temperature	
	Duration	: 1000 +48/−0 hours.	
	Applied voltage	: Applied rated voltage.	
	Charging and discharging current	: 50mA max	
	Measurement shall be performed after test sample following the test is heated at 150+0/−10°C for an hour and kept at room temperature for 24±2 hrs. No.5		
17. Humidity Loading			
Specified Value Note1	Appearance	: No abnormality	
	Capacitance change	: $\leq \pm 12.5\%$	
	Dissipation factor	: 5.0%max.	
	Insulation resistance	: Larger than whichever smaller of 25MΩ · μF or 500MΩ	
Test Methods and Remarks	Heat treatment specified in No.5 of the specification shall be conducted prior to test.		
	Temperature	: 85°C	
	Humidity	: 85%RH	
	Duration	: 1000 +48/−0 hours.	
	Applied voltage	: Applied rated voltage. (Add 100kΩresistor)	
	Measurement shall be performed after test sample following the test is heated at 150+0/−10°C for an hour and kept at room temperature for 24±2 hrs. No.5		

18. Resistance to Flexure of substrate

Specified Value Note 1	Appearance : No abnormality Capacitance change : $\leq \pm 7.5\%$ Dissipation factor : Initial value shall be satisfied. Insulation resistance : Initial value shall be satisfied.																																										
Test Methods and Remarks	<div>Warp : 2mm for 60 seconds Testing board : Grass epoxy – resin substrate Test board and solder lands : Refer to fig. 2 and fig.3.</div> <div><table><thead><tr><th></th><th colspan="6">Case size</th></tr><tr><th>Dimension</th><th>0603</th><th>1005</th><th>1608</th><th>2012</th><th>3216</th><th>3225</th></tr></thead><tbody><tr><td>a</td><td>0.3</td><td>0.5</td><td>0.9</td><td>1.3</td><td>1.7</td><td>2.6</td></tr><tr><td>b</td><td>0.3</td><td>0.55</td><td>0.8</td><td>1.1</td><td>1.2</td><td>1.2</td></tr><tr><td>d</td><td>0.3</td><td>0.4</td><td>0.6</td><td>0.8</td><td>2.0</td><td>2.0</td></tr><tr><td>t</td><td>0.8</td><td colspan="5">1.6</td></tr></tbody></table></div> <div><p>Fig.3 Capacitance measurement shall be conducted with the board bent.</p></div>		Case size						Dimension	0603	1005	1608	2012	3216	3225	a	0.3	0.5	0.9	1.3	1.7	2.6	b	0.3	0.55	0.8	1.1	1.2	1.2	d	0.3	0.4	0.6	0.8	2.0	2.0	t	0.8	1.6				
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19. High Temperature Exposure

Specified Value Note1	<p>Appearance : No abnormality</p> <p>Capacitance change : $\leq \pm 7.5\%$</p> <p>Dissipation factor : Initial value shall be satisfied.</p> <p>Insulation resistance : Initial value shall be satisfied.</p>
Test Methods and Remarks	<p>Heat treatment specified in No.5 of the specification shall be conducted prior to test.</p> <p>Temperature : Maximum usage temperature</p> <p>Duration : 1000+48/-0 hours.</p> <p>Measurement shall be performed after test sample following the test is heated at 150+0/-10°C for an hour and kept at room temperature for 24±2 hrs. No.5</p>

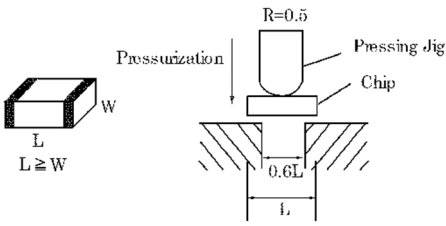
20. Resistance to Solvents

Specified Value Note1	<p>Appearance : No abnormality</p> <p>Capacitance change : $\leq \pm 7.5\%$</p> <p>Dissipation factor : Initial value shall be satisfied</p> <p>Insulation resistance : Initial value shall be satisfied</p>
Test Methods and Remarks	<p>Heat treatment specified in No.5 of the specification shall be conducted prior to test.</p> <p>Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent.</p> <p>Measurement shall be performed after test sample following the test is heated at 150+0/-10°C for an hour and kept at room temperature for 24±2 hrs. No.5</p>

21. Mechanical Shock

Specified Value Note 1	<p>Appearance : No abnormality</p> <p>Capacitance change : $\leq \pm 7.5\%$</p> <p>Dissipation factor : Initial value shall be satisfied</p> <p>Insulation resistance : Initial value shall be satisfied</p>
Test Methods and Remarks	<p>Heat treatment specified in No5 of the specification shall be conducted prior to test.</p> <p>Three shocks in each direction should be applied along 3 mutually perpendicular axes of the test specimen (18 shocks).</p> <p>Peak value: 1500g</p> <p>Duration: 0.5ms</p> <p>Test pulse: Half-sine</p> <p>Velocity change: 4.7m/s.</p> <p>Measurement shall be performed after test sample following the test is heated at 150+0/-10°C for an hour and kept at room temperature for 24±2 hrs. No.5</p>

22. ESD	
Specified Value Note 1	Appearance: No abnormality Insulation resistance: Initial value shall be satisfied
Test Methods and Remarks	Heat treatment specified in No.5 of the specification shall be conducted prior to test. Per AEC-Q200-002 Measurement shall be performed after test sample following the test is heated at 150+0/-10°C for an hour and kept at room temperature for 24±2 hrs. No.5

23. Beam Load Test	
Specified Value	2N min (0603 size) 8N min (1005 size min)
Test Methods and Remarks	Per AEC-Q200-003 
Note 1 The figures indicate typical specifications. Please refer to individual specifications in detail.	