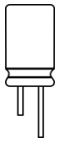


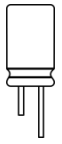
RELIABILITY TESTS ▪ STANDARD



Reference JIS C 5101-1, JIS C 5101-4 and JIS 60068-2

No.	Test	Test Specification	Test Standard	Sample Quantity	Test Criteria
1	Shelf life	Upper category temperature Duration: 1000h	JIS C 5101-4 No. 4.17 JIS C 5101-1 No. 4.25	10 pcs	1. $ \Delta C/C_R \leq 20\%$ of initial value ^[1] 2. $\tan\delta \leq 2$ times spec. limit ^[1] 3. $I_{LEAK} \leq$ spec. limit 4. $ESR \leq 2$ times spec. limit 5. No visible damage 6. Marking legible
2	Temperature cycling	a. Lower category temperature: 30mins b. Temperature change: 3mins c. Upper category temperature: 30mins d. Temperature change: 3mins Step 1 to 4 as a cycle Cycle: 10 cycles	JIS C 5101-4 No. 4.7 JIS C 5101-1 No. 4.16	10 pcs	1. $ \Delta C/C_R \leq 5\%$ of initial value 2. $\tan\delta \leq$ spec. limit 3. $I_{LEAK} \leq$ spec. limit 4. $ESR \leq$ spec. limit 5. No visible damage 6. Marking legible
3	Unbiased Humidity	Temperature: $60^\circ\text{C} \pm 2^\circ\text{C}$ Humidity: 90 ~ 95% RH Duration: 1000h	JIS C 5101-4 No. 4.12 JIS C 5101-1 No. 4.22	10 pcs	1. $ \Delta C/C_R \leq 20\%$ of initial value 2. $\tan\delta \leq 1.5$ times of spec. limit 3. $I_{LEAK} \leq$ spec. limit 4. $ESR \leq 1.5$ times spec. limit 5. No visible damage 6. Marking legible
4	Endurance (load Life)	Upper category temperature V_R applied Duration: specified or see detail specification	JIS C 5101-4 No. 4.13 JIS C 5101-1 No. 4.23	10 pcs	1. $ \Delta C/C_R \leq 20\%$ of initial value ^[1] 2. $\tan\delta \leq 1.5$ times spec. limit ^[1] 3. $I_{LEAK} \leq$ spec. limit 4. $ESR \leq 2$ times spec. limit 5. No visible damage 6. Marking legible
5	Endurance (Load ripple current life)	Upper category temperature I_R and V_R applied $AC + DC \approx V_R$ Duration: specified or see detail specification	JIS C 5101-4 No. 4.13 JIS C 5101-1 No. 4.23	10 pcs	1. $ \Delta C/C_R \leq 20\%$ of initial value ^[1] 2. $\tan\delta \leq 1.5$ times spec. limit ^[1] 3. $I_{LEAK} \leq$ spec. limit 4. $ESR \leq$ spec. limit 5. No visible damage 6. Marking legible
6	Solvent resistance of marking	a. Solvent to be used: IPA b. Solvent temperature: $23^\circ\text{C} \pm 5^\circ\text{C}$ c. Conditioning: Method 1 (with rubbing) d. Rubbing material: Cotton wool e. Recovery time: Not applicable, unless otherwise stated in the detail specification	JIS C 5101-1 No. 4.32 JIS C 60068-2-45 3.1.2	5 pcs	See detail specification
7	Vibration	a. Frequency: 10 ~ 55 Hz b. Swing (single peak) and acceleration: 0.75mm or 98m/s^2 c. Test direction and duration: X, Y, Z each one for 2h	JIS C 5101-4 No. 4.8 JIS C 5101-1 No. 4.17	10 pcs	Taking from the vibration table static placed in the horizontal to test the box and carton appearance, test the electrical characteristics. 1. $ \Delta C/C_R \leq 5\%$ of initial value 2. $\tan\delta \leq$ spec. limit 3. $I_{LEAK} \leq$ spec. limit 4. $ESR \leq$ spec. limit 5. No visible damage 6. Marking legible

RELIABILITY TESTS ▪ STANDARD



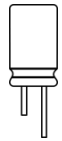
Reference JIS C 5101-1, JIS C 5101-4 and JIS 60068-2

No.	Test	Test Specification	Test Standard	Sample Quantity	Test Criteria
8	Resistance to solder heat	Max. temperature: 260°C (0 ~ +3°C) Duration: 10s ± 1s	JIS C 5101-4 No. 4.5 JIS C 5101-1 No. 4.14	10 pcs	1. $ \Delta C/C_R \leq 5\%$ of initial value 2. $\tan\delta \leq$ spec. limit 3. $I_{LEAK} \leq$ spec. limit 4. ESR \leq spec. limit 5. No visible damage 6. Marking legible
9	Solderability	Max. temperature: 245°C ± 5°C Duration: 2s ± 0.5s	JIS C 5101-4 No. 4.6 JIS C 5101-1 No. 4.15	10 pcs	The surface soldering attachment is greater than 95%, soldering should brightness and equality, non-soldering needle hole, drop weld or concentrate at some point are not allowed
10	Characteristics at high and low temperature	The capacitors shall be measured at each temperature step Step 1: 20°C Capacitance tangent of loss angle Impedance (at the same frequency as step 2) Step 2: Lower category temperature ▪ Impedance Step 3: Upper category temperature ▪ Leakage current See detail specification	JIS C 5101-4 No. 4.19 JIS C 5101-1 No. 4.29	10 pcs	See detail specification
11	Terminal strength	a. Use different lead wire diameter to added weights, vertical resistance pull for 10s ± 1s b. Fix the capacitor, use the different lead wire diameter to added weights, bending angle to 90° with the terminal, then against the direction to do the same operation for a cycle, as rules to operate two cycles	JIS C 5101-1 No. 4.13 JIS C 5104-1 No. 4.4	10 pcs	The tested terminal are not allowed those following defective situations: flexible, broken and touch defects
12	Surge voltage	a. Test temp: 15°C ~ 35°C b. Add surge voltage to the connections: 1.25·V _R when V _R ≤ 100V 1.15·V _R when V _R > 100V c. 6 min as a cycle (charge time 30s, discharge time 330s) d. Cycles: 1000 cycles	JIS C 5101-4 No. 4.14 JIS C 5101-1 No. 4.26	10 pcs	1. $ \Delta C/C_R \leq 10\%$ of initial value 2. $\tan\delta \leq$ spec. limit 3. $I_{LEAK} \leq$ spec. limit 4. ESR \leq spec. limit 5. No visible damage 6. Marking legible
13	Storage at low temperature	Duration: 16h or 4h after thermal stability has been reached Temperature: -40°C	JIS C 5101-4 No. 4.18 JIS C 5101-1 No. 4.25	10 pcs	1. $ \Delta C/C_R \leq 10\%$ of initial value 2. $\tan\delta \leq$ spec. limit 3. $I_{LEAK} \leq$ spec. limit 4. ESR \leq spec. limit 5. No visible damage 6. Marking legible

Note:

 [1] $\Delta C/C_R$ & $\tan\delta$ criterion, please refer to CapXon datasheet.

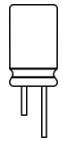
RELIABILITY TESTS ▪ AUTOMOTIVE



Reference MIL-STD-202, JESD22, J-STD-002 and AEC-Q200

No.	Test	Test Specification	Test Standard	Sample Quantity	Test Criteria															
1	High temperature exposure (Storage at upper category temperature)	Test temp: Upper category temperature No voltage applied Duration: 1000h Pre-treatment for measurements shall be conducted after application of DC working voltage for 30 minutes Measurement at 24h after test conclusion	MIL-STD-202 Method 108	77 pcs	1. $ \Delta C/C_R \leq 20\%$ of initial value 2. $\tan\delta \leq 2$ times spec. limit 3. $I_{LEAK} \leq$ spec. limit 4. $ESR \leq$ spec. limit 5. No visible damage															
2	Temperature cycling	<table border="1"> <thead> <tr> <th>Stage</th> <th>Temperature</th> <th>Time</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Lower category temperature</td> <td>Within 30min</td> </tr> <tr> <td>2</td> <td>Temperature change</td> <td>Within 1min</td> </tr> <tr> <td>3</td> <td>Upper category temperature</td> <td>Within 30min</td> </tr> <tr> <td>4</td> <td>Temperature change</td> <td>Within 1min</td> </tr> </tbody> </table> Stage 1 to 4 is one cycle Test time: 1000 cycles Measurement at 24h after test conclusion	Stage	Temperature	Time	1	Lower category temperature	Within 30min	2	Temperature change	Within 1min	3	Upper category temperature	Within 30min	4	Temperature change	Within 1min	JESD22 Method JA-104	77 pcs	1. $ \Delta C/C_R \leq 10\%$ of initial value 2. $\tan\delta \leq$ spec. limit 3. $I_{LEAK} \leq$ spec. limit 4. $ESR \leq$ spec. limit 5. No visible damage 6. Marking legible
Stage	Temperature	Time																		
1	Lower category temperature	Within 30min																		
2	Temperature change	Within 1min																		
3	Upper category temperature	Within 30min																		
4	Temperature change	Within 1min																		
3	Biased humidity	Temperature: 85°C Humidity: 85% RH Applied voltage: V_R Duration: 1000h Test condition: Measurement at 24h after test conclusion	MIL-STD-202 Method 103	77 pcs	1. $ \Delta C/C_R \leq 20\%$ of initial value 2. $\tan\delta \leq 1.2$ times spec. limit 3. $I_{LEAK} \leq$ spec. limit 4. $ESR \leq$ spec. limit 5. No visible damage 6. Marking legible															
4	Operational life	Test temp: Upper category temperature V_R applied (& I_R applied if specified) Duration: specified or see detail specification Measurement at 24h after test conclusion	MIL-STD-202 Method 108	77 pcs	1. $ \Delta C/C_R \leq 20\%$ of initial value 2. $\tan\delta \leq 2$ times spec. limit 3. $I_{LEAK} \leq$ spec. limit 4. $ESR \leq$ spec. limit 5. No visible damage															
5	Tensile strength (DIP)	<table border="1"> <thead> <tr> <th>Terminal wire Diameter (mm)</th> <th>Force/Weight ($\pm 10\%$)</th> </tr> </thead> <tbody> <tr> <td>$0.3 < d \leq 0.5$</td> <td>5N (0.51kg)</td> </tr> <tr> <td>$0.5 < d \leq 0.8$</td> <td>10N (1.02kg)</td> </tr> <tr> <td>$0.8 < d \leq 1.25$</td> <td>20N (2.04kg)</td> </tr> <tr> <td>Snap-In terminals</td> <td>40N (4.08kg)</td> </tr> </tbody> </table> Fix the tested capacitor, then add the hammer of above weight on the lead pin continuously, keep for $10s \pm 1s$	Terminal wire Diameter (mm)	Force/Weight ($\pm 10\%$)	$0.3 < d \leq 0.5$	5N (0.51kg)	$0.5 < d \leq 0.8$	10N (1.02kg)	$0.8 < d \leq 1.25$	20N (2.04kg)	Snap-In terminals	40N (4.08kg)	MIL-STD-202 Method 211	30 pcs	No visible damage					
Terminal wire Diameter (mm)	Force/Weight ($\pm 10\%$)																			
$0.3 < d \leq 0.5$	5N (0.51kg)																			
$0.5 < d \leq 0.8$	10N (1.02kg)																			
$0.8 < d \leq 1.25$	20N (2.04kg)																			
Snap-In terminals	40N (4.08kg)																			
6	Resistance to solvents	a. Solvent to be used: IPA b. Soak time: Using the brush according to mark place to brush with 10 times after 180s, repeat above step again with 2 times (namely is total 3 times) c. After test place in air nature drying d. Test temperature: $25^\circ C \pm 5^\circ C$	MIL-STD-202 Method 215	5 pcs	1. No visible damage 2. Marking legible															

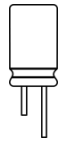
RELIABILITY TESTS ▪ AUTOMOTIVE



Reference MIL-STD-202, JESD22, J-STD-002 and AEC-Q200

No.	Test	Test Specification	Test Standard	Sample Quantity	Test Criteria
7	Mechanical shock	a. Pulse shape: Half-sine waveform b. Max. acceleration: 980m/s ² (100g's) c. Pulse duration time: 6ms d. Direction: X, Y, Z e. Shock time: 10 times in one direction, 30 times in total	MIL-STD-202 Method 213	30 pcs	1. $ \Delta C/C_R \leq 5\%$ of initial value 2. $\tan\delta \leq \text{spec. limit}$ 3. $I_{LEAK} \leq \text{spec. limit}$ 4. $ESR \leq \text{spec. limit}$ 5. No visible damage
8	Vibration	a. 10Hz ~ 2kHz ~ 10Hz (20min) b. Amplitude (unimodal): 0.35mm@10 ~ 55Hz c. Acceleration: 49m/s ² (5g's)@55Hz ~ 2kHz d. X direction 4h Y direction 4h Z direction 4h Total: 12h	MIL-STD-202 Method 204	30 pcs	1. $ \Delta C/C_R \leq 5\%$ of initial value 2. $\tan\delta \leq \text{spec. limit}$ 3. $I_{LEAK} \leq \text{spec. limit}$ 4. $ESR \leq \text{spec. limit}$ 5. No visible damage
9	Resistance to solder heat	DIP solder groove immerse method a. Kind of solder: Sn 96.5%; Ag 3%; Cu 0.5% b. Solder stove temp: 260°C -0°C/+5°C c. Immerse time: 10s ± 1s d. The tested terminal must be soldered into the groove with a speed of: 25mm/s ± 6mm/s e. Solder within 1.5mm of device body for lead f. Immerse time: once g. Test condition: Measurement at 24h after test conclusion	MIL-STD-202 Method 210	30 pcs	1. $ \Delta C/C_R \leq 5\%$ of initial value 2. $\tan\delta \leq \text{spec. limit}$ 3. $I_{LEAK} \leq \text{spec. limit}$ 4. $ESR \leq \text{spec. limit}$ 5. No visible damage
10	Solderability	DIP solder groove immerse method a. Kind of solder: Sn 96.5%; Ag 3%; Cu 0.5% b. Pre-handle: Water steam steams to cook 8hours + 15mins c. Solder stove temp.: 245°C ± 3°C d. Solder solvent: Resin alcohol solution (25 wts%) or resin IPA solution e. Immerse time: within 3s ± 0.5s f. Immerse speed: 25 ± 2.5mm/s	J-STD-002	15 pcs	Up to immerse position, above 95% area of surroundings surface shall be cover by the new soldering

RELIABILITY TESTS ▪ AUTOMOTIVE



Reference MIL-STD-202, JESD22, J-STD-002 and AEC-Q200

No.	Test	Test Specification	Test Standard	Sample Quantity	Test Criteria														
11	Electrical characterization	a. In different environment to deposit the products	User spec.	30 pcs	Products with lower category temperature -40°C Comparison of temp section Magnification Z-25°C / Z+20°C According to spec. Z-40°C / Z+20°C According to spec. Products with lower category temperature -55°C Comparison of temp section Magnification Z-25°C / Z+20°C According to spec. Z-55°C / Z+20°C According to spec.														
		<table border="1"> <thead> <tr> <th>Stage</th> <th>Temp. (°C)</th> </tr> </thead> <tbody> <tr> <td>1 (initial value)</td> <td>20 ± 2</td> </tr> <tr> <td>2</td> <td>-25 ± 3</td> </tr> <tr> <td>3</td> <td>-40 ± 3</td> </tr> <tr> <td>4</td> <td>20 ± 2</td> </tr> <tr> <td>5</td> <td>Upper category temperature ± 2</td> </tr> <tr> <td>6</td> <td>20 ± 2</td> </tr> </tbody> </table>				Stage	Temp. (°C)	1 (initial value)	20 ± 2	2	-25 ± 3	3	-40 ± 3	4	20 ± 2	5	Upper category temperature ± 2	6	20 ± 2
		Stage				Temp. (°C)													
		1 (initial value)				20 ± 2													
		2				-25 ± 3													
		3				-40 ± 3													
		4				20 ± 2													
		5				Upper category temperature ± 2													
		6				20 ± 2													
		b. Test frequency: 120Hz				Impedance comparison stage 2 stage 3 stage 5													
c. Each stage of time: Reached time of hot balance (temperature stability)																			
1. $ \Delta C/C_R \leq 30\%$ of initial value																			
2. $\tan\delta \leq$ spec. limit																			
3. $I_{LEAK} \leq 5$ times spec. limit																			
1. $ \Delta C/C_R \leq 15\%$ of initial value																			
2. $\tan\delta \leq$ spec. limit																			
3. $I_{LEAK} \leq$ spec. limit																			
4. $ESR \leq$ spec. limit																			
5. No visible damage																			
6. Marking legible																			
12	Surge voltage	a. Test temp.: 15°C ~ 35°C b. Add surge voltage to the connections: 1.25·V _R when V _R ≤ 100V 1.15·V _R when V _R > 100V c. 6 min as a cycle (charge time 30s, discharge time 330s) d. Cycles: 1000 cycles	JIS C 5101-1 No. 4.26	30 pcs	1. $ \Delta C/C_R \leq 15\%$ of initial value 2. $\tan\delta \leq$ spec. limit 3. $I_{LEAK} \leq$ spec. limit 4. $ESR \leq$ spec. limit 5. No visible damage 6. Marking legible														