

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	<ol style="list-style-type: none"> $\Delta C/C_R \leq 15\%$ of initial value^[2] $\tan\delta \leq 1.75$ times spec. limit^[2] $I_{LEAK} \leq$ spec. limit No visible damage No leakage of electrolyte Marking legible
2	Temperature cycling	<ol style="list-style-type: none"> Lower category temperature: 30mins Temperature change: 3mins Upper category temperature: 30mins 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	<ol style="list-style-type: none"> $\Delta C/C_R \leq 5\%$ of initial value $\tan\delta \leq$ spec. limit $I_{LEAK} \leq$ spec. limit No visible damage No leakage of electrolyte Marking legible
3	Unbiased humidity	Temperature: 40°C Humidity: 90 ~ 95%RH Duration: <ul style="list-style-type: none"> 250h for general purpose grade products^[1] 500h for long life grade products^[1] 	JIS C 5101-4 No. 4.12 JIS C 5101-1 No. 4.22	10 pcs	<ol style="list-style-type: none"> $\Delta C/C_R \leq 20\%$ of initial value for general purpose grade products^[1]. $\Delta C/C_R \leq 10\%$ of initial value for long life grade products^[1]. $\tan\delta \leq 1.2$ times of spec. limit $I_{LEAK} \leq$ spec. limit No visible damage No leakage of electrolyte 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	<ol style="list-style-type: none"> $\Delta C/C_R \leq 15\%$ of initial value^[2] $\tan\delta \leq 1.75$ times spec. limit^[2] $I_{LEAK} \leq$ spec. limit No visible damage No leakage of electrolyte 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	<ol style="list-style-type: none"> $\Delta C/C_R \leq 15\%$ of initial value^[2] $\tan\delta \leq 1.75$ times spec. limit^[2] $I_{LEAK} \leq$ spec. limit No visible damage No leakage of electrolyte Marking legible
6	Solvent resistance of marking	<ol style="list-style-type: none"> Solvent to be used: IPA Solvent temperature: 23°C ± 5°C Conditioning: Method 1 (with rubbing) Rubbing material: Cotton wool 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	<ol style="list-style-type: none"> Frequency: 10 ~ 55 Hz Swing (single peak) and acceleration: 0.75mm or 98m/s² 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. <ol style="list-style-type: none"> $\Delta C/C_R \leq 5\%$ of initial value $\tan\delta \leq$ spec. limit $I_{LEAK} \leq$ spec. limit No visible damage No leakage of electrolyte 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. No visible damage 5. No leakage of electrolyte 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	Surge voltage	a. Test temp.: Max. temp. for long life grade products ^[1] or Room temp. for general purpose grade products ^[1] b. Add surge voltage to the connections: 1.15·V _R when V _R ≤ 315V 1.10·V _R when V _R > 315V c. 6 min as a cycle (charge time 30s, discharge time 330s) d. Cycle: 1000 cycles	JIS C 5101-4 No. 4.14 JIS C 5101-1 No. 4.26	10 pcs	1. $ \Delta C/C_R \leq 15\%$ of initial value 2. $\tan\delta \leq$ spec. limit 3. $I_{LEAK} \leq$ spec. limit 4. No visible damage 5. No leakage of electrolyte 6. Marking legible
12	Pressure relief	See detail specification	JIS C 5101-4 No. 4.16 JIS C 5101-1 No. 4.28	10 pcs	Device shall open without danger of explosion or fire
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. No visible damage 5. No leakage of electrolyte 6. Marking legible

Note:

 [1] General purpose grade: lifetime (V_R applied) ≤ 2000 hours.

 Long life grade: lifetime (V_R applied) > 2000 hours.

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

RELIABILITY TESTS ▪ HIGH RELIABILITY

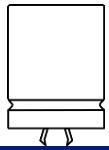
Reference JIS C 5101-1, JIS C 5101-4 and JIS 60068-2

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3	Unbiased humidity	Temperature: 40°C Humidity: 90 ~ 95%RH Duration: <ul style="list-style-type: none"> 250h for general purpose grade products^[1] 500h for long life grade products^[1] 	JIS C 5101-4 No. 4.12 JIS C 5101-1 No. 4.22	10 pcs	<ol style="list-style-type: none"> $\Delta C/C_R \leq 20\%$ of initial value for general purpose grade products^[1] $\Delta C/C_R \leq 10\%$ of initial value for long life grade products^[1] $\tan\delta \leq 1.2$ times of spec. limit $I_{LEAK} \leq$ spec. limit No visible damage No leakage of electrolyte Marking legible
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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	<ol style="list-style-type: none"> $\Delta C/C_R \leq 15\%$ of initial value^[2] $\tan\delta \leq 1.75$ times spec. limit^[2] $I_{LEAK} \leq$ spec. limit No visible damage No leakage of electrolyte Marking legible
6	Solvent resistance of marking	<ol style="list-style-type: none"> Solvent to be used: IPA Solvent temperature: 23°C ± 5°C Conditioning: Method 1 (with rubbing) Rubbing material: Cotton wool 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	<ol style="list-style-type: none"> Frequency: 10 ~ 55 Hz Swing (single peak) and acceleration: 0.75mm or 98m/s² 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. <ol style="list-style-type: none"> $\Delta C/C_R \leq 5\%$ of initial value $\tan\delta \leq$ spec. limit $I_{LEAK} \leq$ spec. limit No visible damage No leakage of electrolyte Marking legible

RELIABILITY TESTS ▪ HIGH RELIABILITY

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 soldering 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	<ol style="list-style-type: none"> 1. $\Delta C/C_R \leq 5\%$ of initial value 2. $\tan\delta \leq$ spec. limit 3. $I_{LEAK} \leq$ spec. limit 4. No visible damage 5. No leakage of electrolyte 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	Surge voltage	<ol style="list-style-type: none"> a. Test temp.: Max. temp. for long life grade products^[1] or Room temp. for general purpose grade products^[1] b. Add surge voltage to the connections: 1.15·V_R when V_R ≤ 315V 1.10·V_R when V_R > 315V c. 6 min as a cycle (charge time 30s, discharge time 330s) d. Cycle: 1000 cycles 	JIS C 5101-4 No. 4.14 JIS C 5101-1 No. 4.26	10 pcs	<ol style="list-style-type: none"> 1. $\Delta C/C_R \leq 15\%$ of initial value 2. $\tan\delta \leq$ spec. limit 3. $I_{LEAK} \leq$ spec. limit 4. No visible damage 5. No leakage of electrolyte 6. Marking legible
12	Pressure relief	See detail specification	JIS C 5101-4 No. 4.16 JIS C 5101-1 No. 4.28	10 pcs	Device shall open without danger of explosion or fire
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	<ol style="list-style-type: none"> 1. $\Delta C/C_R \leq 10\%$ of initial value 2. $\tan\delta \leq$ spec. limit 3. $I_{LEAK} \leq$ spec. limit 4. No visible damage 5. No leakage of electrolyte 6. Marking legible

RELIABILITY TESTS ▪ HIGH RELIABILITY

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

No.	Test	Test Specification	Test Standard	Sample Quantity	Test Criteria
14	Insulation resistance	Measured capacitor terminal, terminal anode and coat (insulation coat) insulation resistance (should charge and discharge before measurement) by 500V DC The insulation resistance shall be measured after the voltage has been applied for 60s ± 5s, unless otherwise prescribed in the detail specification	JIS C 5101-1 No. 4.5	10 pcs	The insulation resistance shall be not less than 100MΩ
15	Voltage proof	1000V AC for 1min ($V_R < 100V$) 2000V AC for 1min ($V_R \geq 100V$)	JIS C 5101-1 No. 4.6	10 pcs	There shall be no breakdown or flashover during the test
16	Reverse voltage	a. 125h at upper category temperature with 1VDC in the reverse voltage direction. b. 125h at upper category temperature with direct voltage equal to the category voltage in the forward polarity direction.	JIS C 5101-4 No. 4.15	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. No visible damage 5. No leakage of electrolyte 6. Marking legible
17	Charge and discharge	Temperature: 20°C Number of cycles: $V_R \sim 160V$: 10^6 $V_R > 160V$: under consideration Duration of charge: 0.5s Duration of discharge: 0.5s	JIS C 5101-4 No. 4.20	5 pcs	1. $ \Delta C/C_R \leq 10\%$ of initial value 2. $\tan\delta \leq$ spec. limit 3. $I_{LEAK} \leq$ spec. limit 4. No visible damage 5. No leakage of electrolyte 6. Marking legible

Note:

 [1] General purpose grade: lifetime (V_R applied) \leq 2000 hours.

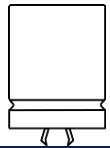
 Long life grade: lifetime (V_R applied) $>$ 2000 hours.

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

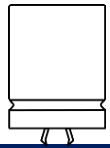
RELIABILITY TESTS ▪ AUTOMOTIVE

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: Using the highest temp. 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. 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. No visible damage 5. No leakage of electrolyte 6. Marking legible
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1	Lower category temperature	Within 30min																		
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4	Temperature change	Within 1min																		
3	Biased humidity	Temperature: 85°C Humidity: 85%RH Applied voltage: V_R Duration: 1000h 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. No visible damage 5. No leakage of electrolyte 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. No visible damage 5. No leakage of electrolyte															
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					
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Snap-In terminals	40N (4.08kg)																			
6	Resistance to solvents	a. Test solvent: 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. $\tan\delta \leq$ spec. limit 3. $I_{LEAK} \leq$ spec. limit 4. No visible damage 5. No leakage of electrolyte
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. $\tan\delta \leq$ spec. limit 3. $I_{LEAK} \leq$ spec. limit 4. No visible damage 5. No leakage of electrolyte
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. Measurement at 24h after test conclusion	MIL-STD-202 Method 210	30 pcs	1. $ \Delta C/C_R \leq 5\%$ of initial value 2. $\tan\delta \leq$ spec. limit 3. $I_{LEAK} \leq$ spec. limit 4. No visible damage 5. No leakage of electrolyte
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	<table border="1"> <tr> <td rowspan="6" style="writing-mode: vertical-rl; transform: rotate(180deg);">Impedance comparison</td> <td colspan="2">Products with lower category temperature -40°C</td> </tr> <tr> <td>Comparison of temp section</td> <td>Magnification</td> </tr> <tr> <td>Z-25°C / Z+20°C</td> <td>According to spec.</td> </tr> <tr> <td>Z-40°C / Z+20°C</td> <td>According to spec.</td> </tr> <tr> <td colspan="2">Products with lower category temperature -55°C</td> </tr> <tr> <td>Comparison of temp section</td> <td>Magnification</td> </tr> <tr> <td>Z-25°C / Z+20°C</td> <td>According to spec.</td> </tr> <tr> <td>Z-55°C / Z+20°C</td> <td>According to spec.</td> </tr> </table>	Impedance comparison	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.
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