

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"> 1. $\Delta C/C_R \leq 15\%$ of initial value^[2] 2. $\tan\delta \leq 1.75$ times spec. limit^[2] 3. $I_{LEAK} \leq$ spec. limit 4. No visible damage 5. No leakage of electrolyte 6. Marking legible |
| 2 | Temperature cycling | <ol style="list-style-type: none"> 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 | <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 |
| 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"> 1. $\Delta C/C_R \leq 20\%$ of initial value for general purpose grade products^[1]. $\Delta C/C_R \leq 10\%$ of initial value for long life grade products^[1]. 2. $\tan\delta \leq 1.2$ times of spec. limit 3. $I_{LEAK} \leq$ spec. limit 4. No visible damage 5. No leakage of electrolyte 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 | <ol style="list-style-type: none"> 1. $\Delta C/C_R \leq 15\%$ of initial value^[2] 2. $\tan\delta \leq 1.75$ times spec. limit^[2] 3. $I_{LEAK} \leq$ spec. limit 4. No visible damage 5. No leakage of electrolyte 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 | <ol style="list-style-type: none"> 1. $\Delta C/C_R \leq 15\%$ of initial value^[2] 2. $\tan\delta \leq 1.75$ times spec. limit^[2] 3. $I_{LEAK} \leq$ spec. limit 4. No visible damage 5. No leakage of electrolyte 6. Marking legible |
| 6 | Solvent resistance of marking | <ol style="list-style-type: none"> a. Solvent to be used: IPA b. Solvent temperature: 23°C ± 5°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 | <ol style="list-style-type: none"> a. Frequency: 10 ~ 55 Hz b. Swing (single peak) and acceleration: 0.75mm or 98m/s² 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. <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 |

RELIABILITY TESTS ▪ STANDARD

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

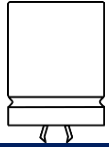
| No. | Test | Test Specification | Test Standard | Sample Quantity | Test Criteria |
|-----|---|---|--|-----------------|---|
| 8 | Resistance to solder heat | Max. temperature: 260°C (0 ~ +3°C) Duration: 10s ± 1s | JIS C 5101-4 No. 4.5 JIS C 5101-1 No. 4.14 | 10 pcs | <ol style="list-style-type: none"> 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 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 |

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.

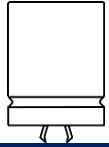
RELIABILITY TESTS ▪ HIGH RELIABILITY

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

| 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"> 1. $\Delta C/C_R \leq 15\%$ of initial value^[2] 2. $\tan\delta \leq 1.75$ times spec. limit^[2] 3. $I_{LEAK} \leq$ spec. limit 4. No visible damage 5. No leakage of electrolyte 6. Marking legible |
| 2 | Temperature cycling | <ol style="list-style-type: none"> 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 | <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 |
| 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"> 1. $\Delta C/C_R \leq 20\%$ of initial value for general purpose grade products^[1] $\Delta C/C_R \leq 10\%$ of initial value for long life grade products^[1] 2. $\tan\delta \leq 1.2$ times of spec. limit 3. $I_{LEAK} \leq$ spec. limit 4. No visible damage 5. No leakage of electrolyte 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 | <ol style="list-style-type: none"> 1. $\Delta C/C_R \leq 15\%$ of initial value^[2] 2. $\tan\delta \leq 1.75$ times spec. limit^[2] 3. $I_{LEAK} \leq$ spec. limit 4. No visible damage 5. No leakage of electrolyte 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 | <ol style="list-style-type: none"> 1. $\Delta C/C_R \leq 15\%$ of initial value^[2] 2. $\tan\delta \leq 1.75$ times spec. limit^[2] 3. $I_{LEAK} \leq$ spec. limit 4. No visible damage 5. No leakage of electrolyte 6. Marking legible |
| 6 | Solvent resistance of marking | <ol style="list-style-type: none"> a. Solvent to be used: IPA b. Solvent temperature: 23°C ± 5°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 | <ol style="list-style-type: none"> a. Frequency: 10 ~ 55 Hz b. Swing (single peak) and acceleration: 0.75mm or 98m/s² 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. <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 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 | 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 |

RELIABILITY TESTS ▪ HIGH RELIABILITY

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

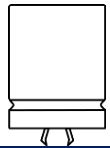
| No. | Test | Test Specification | Test Standard | Sample Quantity | Test Criteria |
|-----|-----------------------|--|-----------------------|-----------------|---|
| 14 | Insulation resistance | Measured capacitor terminal, terminal anode and coat (insulation coat) insulation resistance (should charge 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 | <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 |
| 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 | <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 |

Note:

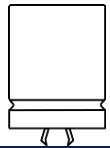
 [1] General purpose grade: lifetime (V_R applied) ≤ 2000 hours.

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

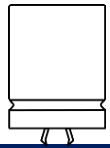
 [2] $\Delta C/C_R$ & $\tan\delta$ criterion, please refer to CapXon datasheet.

RELIABILITY TESTS ▪ 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 |
| 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 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 | | | | | |
| 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. 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. |
| | | 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. | | | | | | | | | | | | | | | | | | | | | |
| <table border="1"> <tr> <th>Stage</th> <th>Temp. (°C)</th> </tr> <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> </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 | b. Test frequency: 120Hz c. Each stage of time: Reached time of hot balance (temperature stability) | Stage 2 stage 3 stage 5 | 1. $ \Delta C/C_R \leq 30\%$ of initial value 2. $\tan\delta \leq$ spec. limit 3. $I_{LEAK} \leq 5$ times spec. limit | | | | | |
| 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 | | | | | | | | | | | | | | | | | | | | | |
| 12 | 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 5101-1 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. No visible damage 5. No leakage of electrolyte 6. Marking legible | | | | | | | | | | | | | | | | | |

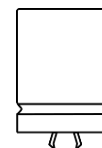
Note:

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

RELIABILITY TESTS ▪ PULSE & PHOTO-FLASH

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"> $\Delta C/C_R \leq 10\%$ of initial value^[1] $\tan\delta \leq 1.5$ times spec. limit^[1] $I_{LEAK} \leq 1.5$ times spec. limit^[1] 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: 250h | 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 $\tan\delta \leq 1.2$ times of spec. limit $I_{LEAK} \leq$ spec. limit No visible damage No leakage of electrolyte Marking legible |
| 4 | 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 |
| 5 | 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 |
| 6 | 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 | <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 |
| 7 | 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. |

RELIABILITY TESTS ▪ PULSE & PHOTO-FLASH

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

| No. | Test | Test Specification | Test Standard | Sample Quantity | Test Criteria |
|-----|----------------------------|---|--|-----------------|--|
| 8 | Surge voltage | a. Test temp.: Room temp. b. Add surge voltage to the connections: See detail specification 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 |
| 9 | 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 |
| 10 | 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 |
| 11 | Charge/Discharge test | See catalog or detail specification | JIS C 5101-4 No. 4.20 JIS C 5101-4 No. 4.20 | 2 pcs | See catalog or detail specification |

Note:

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