SCM Series
Series-Connected SuperCapacitor Modules

This new series of electrochemical, double-layer, series-connected SuperCapacitor modules offers excellent pulse power handling characteristics based on the combination of very high capacitance and very low ESR. Used by themselves or in conjunction with primary or secondary batteries, they provide extended back up time, longer battery life, and provide instantaneous power pulses as needed. Offers great solutions to Hold Up, Energy Harvesting, and Pulse Power Applications.

FEATURES
• Low ESR provides high efficiency and high-power density
• Withstands high vibrations and high current applications
• Lifetime capable of millions of cycles
• Active cell balancing

APPLICATIONS
• Heavy Industrial Equipment
• Grid Storage
• Regenerative Energy Capture
• Pitch Control
• Energy Harvesting
• GSM/GPRS Pulse Applications
• UPS/Industrial

HOW TO ORDER

<table>
<thead>
<tr>
<th>SCM</th>
<th>Z</th>
<th>1E</th>
<th>K</th>
<th>507</th>
<th>S</th>
<th>T</th>
<th>A</th>
<th>B</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z = 60mm</td>
<td>Two digits represent case length in mm</td>
<td>K = 16V</td>
<td>507 = 500F</td>
<td>S = +30%/-10%</td>
<td>T = Line Post Lead Out</td>
<td>A = Aluminum Case</td>
<td>B = Balanced</td>
<td>2 = Bolt Lead Out</td>
<td></td>
</tr>
</tbody>
</table>

QUALITY INSPECTION
Parts are qualified for life cycle, high temperature load life, and storage temperature characteristics. See page 27 for more information.

TERMINATION
This module uses a 4 pin connector Pin 4 has a 10K NTC device connected between it and the ground. Reads resistance of the NTC to determine temperature. See page 28 for more information on each pin and resistance values at select intermediate temperatures.

OPERATING TEMPERATURE
Operating: -40°C to +65°C
Storage: - 40°C to +70° (Uncharged)

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# RATINGS & PART NUMBER REFERENCES

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Case Width (mm)</th>
<th>Case Length (mm)</th>
<th>Capacitance (F)</th>
<th>Capacitance Tolerance</th>
<th>Rated Voltage (V)</th>
<th>Rated Temperature (°C)</th>
<th>DCL Max @ 72 Hrs (mA)</th>
<th>ESR Max @ 1000 Hz (mΩ)</th>
<th>ESR Max @ DC (mΩ)</th>
<th>Max Surge (V)</th>
<th>Peak Current (A)</th>
<th>Max Op. Current @ 40°C (A)</th>
<th>Max Energy (Wh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCM21EK507STAB2</td>
<td>68</td>
<td>418</td>
<td>500</td>
<td>+30% / -10%</td>
<td>16</td>
<td>65</td>
<td>6</td>
<td>-</td>
<td>2.5</td>
<td>17.1</td>
<td>1778</td>
<td>199</td>
<td>17.8</td>
</tr>
</tbody>
</table>

## Additional Information
- Typical Weight: 6.2kg (±0.3) kg
- Insulation Resistance: ≥ 20MΩ
- Insulation Strength: ≤ 5.5mA
- Recommended Torque for Power Terminals:
  - M8 - 20Nm
  - M10 - 30Nm
- Overvoltage Monitoring: 16.8 ± 0.3V
- Passive Cell Voltage Management
  - 6S1P Balance Board
- Cell Component – 6pcs of 2.7V 3000F, 60mm x 138mm

## QUALIFICATION TEST SUMMARY

<table>
<thead>
<tr>
<th>Test</th>
<th>Test Method</th>
<th>Parameter</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life Cycle</td>
<td>Capacitors are cycled between rated voltage and half-rated voltage under constant current at +25°C for 500,000 cycles</td>
<td>Capacitance</td>
<td>≥70% of spec value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ESR</td>
<td>≤100% of spec value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Appearance</td>
<td>No remarkable defects</td>
</tr>
<tr>
<td>Temperature Characteristics</td>
<td>Temperature: -40°C to +65°C</td>
<td>Capacitance</td>
<td>≥70% of spec value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ESR</td>
<td>≤100% of spec value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Appearance</td>
<td>No remarkable defects</td>
</tr>
<tr>
<td>Storage Temperature Characteristics</td>
<td>Storage Duration: 2 years No Load Temperature: +25°C ± 10°C</td>
<td>Capacitance</td>
<td>≤10% of spec value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ESR</td>
<td>≤100% of spec value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Appearance</td>
<td>No remarkable defects</td>
</tr>
<tr>
<td>Vibration Resistance</td>
<td>IEC 60068-2-27, 29 / IEC 60068-2-6</td>
<td>Capacitance</td>
<td>≥70% of spec value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ESR</td>
<td>≤100% of spec value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Appearance</td>
<td>No remarkable defects</td>
</tr>
</tbody>
</table>
QUALITY AND RELIABILITY

CAPACITANCE VS. TEMPERATURE

LEAKAGE CURRENT VS. TEMPERATURE

EQUIVALENT SERIES RESISTANCE VS. TEMPERATURE

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SCM Series
Series-Connected SuperCapacitor Modules

MECHANICAL SPECIFICATIONS
(All dimensions in mm)

<table>
<thead>
<tr>
<th>L (±1)</th>
<th>W (±1)</th>
<th>H (±1)</th>
<th>d (±0.05)</th>
<th>P (±0.8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>418</td>
<td>68.0</td>
<td>179</td>
<td>-</td>
<td>-</td>
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</table>

PIN INFORMATION

<table>
<thead>
<tr>
<th>Pin</th>
<th>Color</th>
<th>Designation</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>White</td>
<td>Ground</td>
</tr>
<tr>
<td>2</td>
<td>Red</td>
<td>Overvoltage</td>
</tr>
<tr>
<td>3</td>
<td>Green</td>
<td>Not used</td>
</tr>
<tr>
<td>4</td>
<td>Yellow</td>
<td>Temperature</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Temp (°C)</th>
<th>RT (Ω)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-40</td>
<td>332094</td>
</tr>
<tr>
<td>-25</td>
<td>129287</td>
</tr>
<tr>
<td>0</td>
<td>32554</td>
</tr>
<tr>
<td>25</td>
<td>10000</td>
</tr>
<tr>
<td>45</td>
<td>4372</td>
</tr>
<tr>
<td>65</td>
<td>2084</td>
</tr>
<tr>
<td>85</td>
<td>1070</td>
</tr>
<tr>
<td>100</td>
<td>677.3</td>
</tr>
<tr>
<td>125</td>
<td>338.7</td>
</tr>
<tr>
<td>150</td>
<td>182.6</td>
</tr>
</tbody>
</table>

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**TEST METHODS**

**IEC CAPACITANCE TEST METHOD**

**Procedure:** Charge module under constant current to rated voltage at room temperature, then hold 10 minutes on charge under constant voltage. After 10 minutes, discharge under constant current (as shown in chart below), recording voltage at V₁, V₂, and time intervals at t₁ and t₂. Use the capacitance formula to determine cap value.

\[
C = \frac{I \times (t_2 - t_1)}{V_1 - V_2}
\]

**DC ESR MEASUREMENT**

A six-step ESR<sub>DC</sub> test method is illustrated to the right and carried out as follows:

- Rest 10 Seconds
- Charge under constant current (I₁) to rated voltage (V₉)
- Rest 5 seconds
- Rest 10 seconds, record V₃ and t₄
- Discharge under constant current (I₂) to half rated voltage, record I₂, V₄, and t₅
- Rest 2 seconds, record V₅ and t₆

Repeat steps 1-6 recording I, V, and t accordingly, finally discharging to below 0.1V under constant current (I₂).

Formulas to calculate:

- Two cycle discharge capacitances: \( C_{dch1} = I_2 \times \frac{(t_5 - t_4)}{V_3 - V_4} ; C_{dch2} = I_2 \times \frac{(t_6 - t_5)}{V_4 - V_5} \)
- Discharge capacitance: \( C_{dc} = \frac{(C_{dch1} + C_{dch2})}{2} \)
- Two cycle discharge DC ESR: \( ESR_{dch1} = \frac{(V_5 - V_4)}{I_2} ; ESR_{dch2} = \frac{(V_11 - V_10)}{I_2} \)
- Discharge DC ESR: \( ESR_{dch} = \frac{(ESR_{dch1} + ESR_{dch2})}{2} \)

Note: I₁ = I₂ = 75mA/F, the rated capacitance in the chart means discharge capacitance, and DC ESR (ESR<sub>DC</sub>) means discharge DC resistance.
TEST METHODS (continued)

MAXIMUM CONTINUOUS CURRENT
• This is the maximum current when temperature rise of the supercapacitor during its operation is less than 15°C

MAXIMUM PEAK CURRENT
• This is the maximum current during 1 second time interval (dt)

WATT DENSITY
• Watt Density = \(0.12*V^2 / R_{DC}\) / mass

ENERGY DENSITY
• Energy Density = \((\frac{1}{2} CV^2) / (3600*mass)\)

POLARITY AND REVERSE VOLTAGE
For product consistency and optimum performance, it is recommended that the capacitor be connected with polarity indicated. Reversing polarity could result in permanent damage to the circuit including much higher leakage current for a short duration of time and the life time of the supercapacitors will be reduced.

LIFE TIME AND TEMPERATURE PERFORMANCE
The life of a supercapacitor is impacted by a combination of operating voltage and the operating temperature according to the following Time to Failure equation:

\[ t \propto V^n \times e^{\left(\frac{-Q}{kT}\right)} \]

where \(V\) is the operating voltage, \(Q\) is the activation energy in electron volts (eV), \(k\) is the Boltzmann constant in eV, and \(T\) is the operating temperature in Kelvin (K). Typical values for the voltage exponent, \(n\), is between 2.5-3.5, and \(Q\) is between 1.0-1.2 eV in the normal operating temperature range of -40° to 65°C.

The industry standard for supercapacitor end of life is when the equivalent series resistance, ESR, increases to 200% of the specified value and the capacitance drops by 30% from specified value. Typically a supercapacitor shows an initial “jump” in the ESR value and then levels off. If the supercapacitors are exposed to excessive temperatures the ESR will show a continuous degradation (increase). In the extreme case, if the temperature or voltage are substantially higher than the rated specifications, this could result in the part venting and the product showing a faster degradation of capacitance and ESR, which may be many times the specified value.
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SAFETY RECOMMENDATIONS

WARNINGS
• To Avoid Short Circuit, after usage or test, Super Capacitor voltage needs to discharge to ≤ 0.1V
• Do not Apply Overvoltage, Reverse Charge, Burn or Heat Higher than 150°C, explosion-proof valve may break open
• Do not Press, Damage or disassemble the Super Capacitor, housing could heat to high temperature causing Burns
• If you observe Overheating or Burning Smell from the capacitor disconnect Power immediately, and do not touch

EMERGENCY APPLICATIONS
• If Housing is Leaking:
  • Skin Contact: Use soap and water thoroughly to wash the area of the skin
  • Eye Contact: Flush with flowing water or saline, and immediately seek medical treatment
  • Ingestion: Immediately wash with water and seek medical treatment

TRANSPORTATION
Not subjected to US DOT or IATA regulations
UN3499, <10Wh, Non-Hazardous Goods
International shipping description – “Electronic Products – Capacitor”

REGULATORY
• RoHS Compliant
• REACH Compliant
• Halogen free according to IEC 61249-2-2: 2003 and IPC/JEDEC-JSTD-709

STORAGE
Capacitors may be stored within the temperature range of -40°C to +70°C with humidity < 60%. Lower storage temperature is preferred as it extends the shelf life of the capacitor. Product over one year and within two years of the date code, we recommend recharging the product at the beginning of use for at least 24 hours.

Optimum storage conditions are as follows:
• 25°C and RH ≤ 60% without voltage applied
• Not in direct sunlight
• Not in direct contact with water, salt oil or other chemicals
• Not in direct contact with corrosive materials, acids, alkalis, or toxic gases
• Not in dusty environments
• Not in environments with shock and vibration conditions