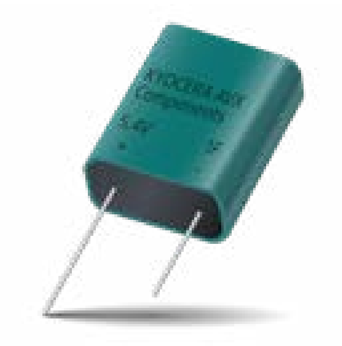
High Reliability SCM Series

Series-Connected SuperCapacitor Modules



This new series of plastic, epoxy-filled SuperCapacitor modules feature high reliability when used in elevated temperatures and/or high humidity conditions. In addition to moisture resistance features, these SuperCapacitor modules offer excellent pulse power handling characteristics based on the combination of very high capacitance and very low ESR. Degradation of electrical characteristics under normal conditions are lengthened in large part to the special plastic, epoxy-filled packaging technology of these SuperCapacitor modules. 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. These modules offer great solutions to hold up, energy harvesting, pulse power applications, and battery replacement.

FEATURES

- High Pulse Power Capability
- Low ESR
- Low Leakage Current
- Plastic, Moisture Resistant
- High Reliability

APPLICATIONS

- Smart/Remote Metering
- Telemetry
- Hybrid Battery Packs
- Scanners
- Environmental Controls
- Network Power Hold-Up
- Pulse Power Handling
- Solid State Drives
- UPS/Industrial
- Energy Harvesting

HOW TO ORDER

SCM	R	14	C	474	S	S	B	A	-	H
Series SuperCap Module	**Diameter** R = 9.5mm	**Case Length** Two digits Represent case Length in mm	**Voltage Code** C = 5.0V D = 5.4V	**Capacitance Code** 1st two digits represent significant figures 3rd digit represents multiplier (number of zeros to follow)	**Tolerance** S = +30%/-10% **	**Package/Lead Format** S = Plastic/Radial	**Package** B = Bulk T = Tray	**Balancing** A = Unbalanced B = Passive Balanced	**Lead Orientation** XX**	**Series Code** H = High Reliability

*Inquire about availability
**Inquire about availability for other tolerances
***Inquire about availability for Bend and Trimming

QUALITY INSPECTION

Parts are tested for life cycle, high temperature load life, temperature characteristics, vibration resistance, and humidity characteristics. See page 2 for more information.

TERMINATION

These SuperCapacitors are compatible with hand soldering and wave soldering processes, so long as appropriate precautions are followed. See page 4 for more information.

LEAD-FREE
LEAD-FREE COMPATIBLE COMPONENT

RoHS COMPLIANT

For RoHS compliant products, please select correct termination style.

High Reliability SCM Series

Series-Connected SuperCapacitor Modules

RATINGS & PART NUMBER REFERENCE

Part Number	Diameter (mm)	Length (mm)	Rated Capacitance (F)	Capacitance Tolerance	Rated Voltage (V)	Rated Temperature (°C)	DCL Max @ 72 Hrs (μA)	ESR Max @ 1000 Hz (mΩ)	ESR Max @ DC (mΩ)	Peak Current (A)	Power Density (W/kg)	Max Energy (Wh)	Energy Density (Wh/kg)
Plastic / Radial Lead													
SCMR14C474SSBA0H	9.5	16	0.47	+30%/-10%	5.0/4.2*	65/85*	5	375	1720	0.65	447	0.0016	0.42
SCMR14D474SSBB0H	9.5	16	0.47	+30%/-10%	5.4/4.6*	65/85*	6	375	1720	0.70	522	0.0019	0.49
SCMR18C105SSBA0H	9.5	20	1	+30%/-10%	5.0/4.2*	65/85*	6	250	730	1.45	906	0.0035	0.75
SCMR18D105SSBB0H	9.5	20	1	+30%/-10%	5.4/4.6*	65/85*	10	250	730	1.57	1057	0.0041	0.88
SCMR22C155SSBA0H	9.5	24	1.5	+30%/-10%	5.0/4.2*	65/85*	10	200	590	2.04	974	0.0052	0.95
SCMR22D155SSBB0H	9.5	24	1.5	+30%/-10%	5.4/4.6*	65/85*	15	200	590	2.20	1136	0.0061	1.10

*with appropriate voltage derating operating temperature can be extended to 85°C

OPERATING TEMPERATURE

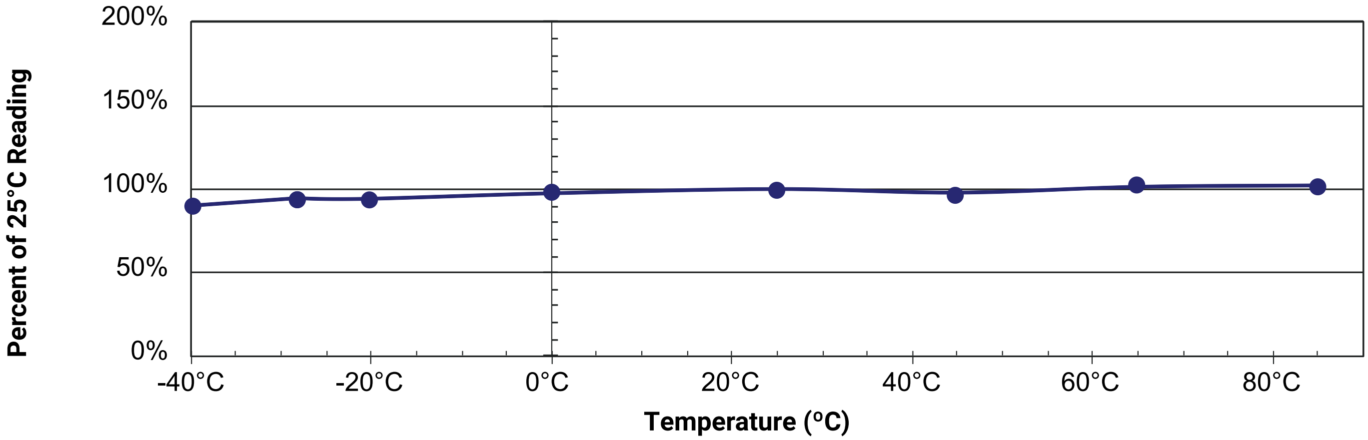
-40°C to +65°C @ 5.4V Balanced, 5.0V Unbalanced
-40°C to +85°C @ 4.6V Balanced, 4.2V Unbalanced

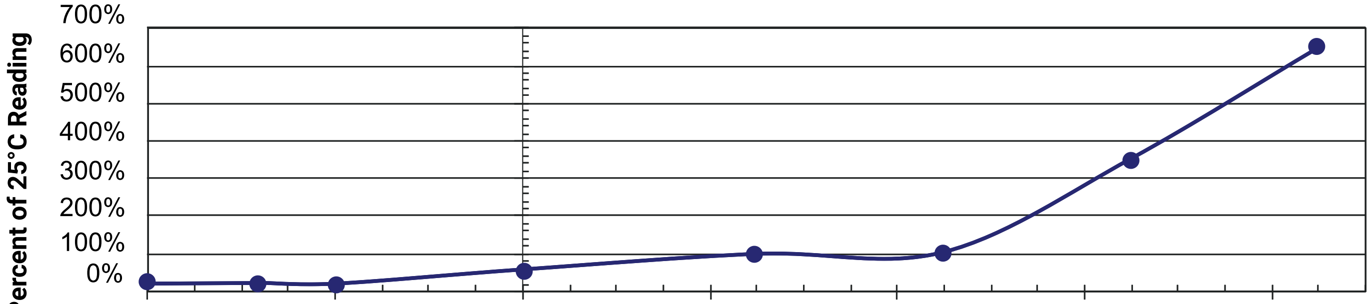
QUALIFICATION TEST SUMMARY

Test	Test Method	Parameter	Limits
Life Cycle	Capacitors are cycled between rated voltage and half-rated voltage under constant current at +25°C for 500,000 cycles	Capacitance ESR Appearance	≥70% of spec value ≤200% of spec value No remarkable defects
High Temperature Load Life	Temperature: 70°C Voltage: Rated Voltage Test Duration: 1,500 hours	Capacitance ESR Appearance	≥70% of spec value ≤200% of spec value No remarkable defects
Storage Temperature Characteristics	Storage Duration: 2 years No Load Temperature: +35°C	Capacitance ESR Appearance	≥70% of spec value ≤200% of spec value No remarkable defects
Vibration Resistance	Amplitude: 1.5mm Frequency: 10 ~ 55Hz Direction: X, Y, Z for 2 hours each	Capacitance ESR Appearance	≥70% of spec value ≤200% of spec value No remarkable defects
Humidity	Voltage: Rated Voltage RH: 90% Temperature: 60°C Test Duration: 2,000 hours	Capacitance ESR Appearance	≥70% of spec value ≤200% of spec value No remarkable defects

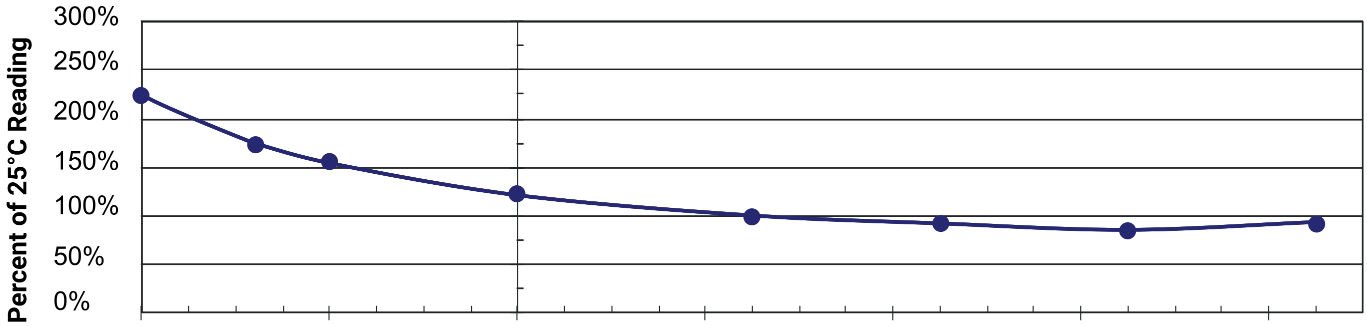
QUALITY AND RELIABILITY

CAPACITANCE VS. TEMPERATURE





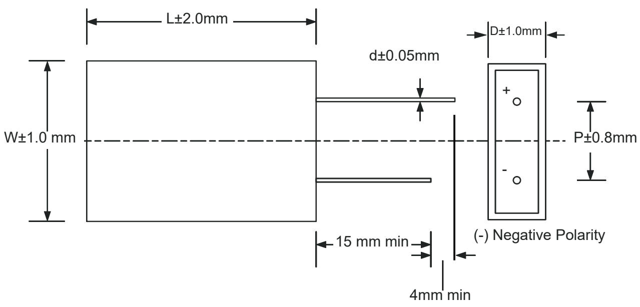
LEAKAGE CURRENT VS. TEMPERATURE



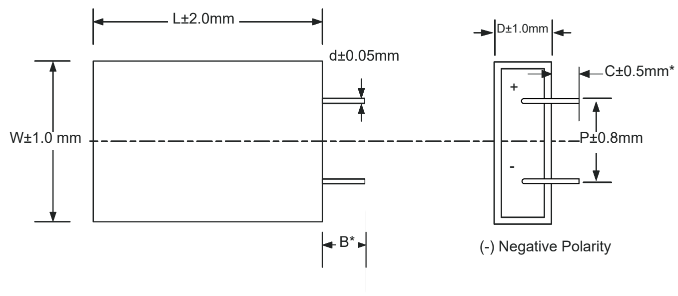
EQUIVALENT SERIES RESISTANCE VS. TEMPERATURE

MECHANICAL SPECIFICATIONS

PLASTIC TYPE - STRAIGHT LEADS



PLASTIC TYPE - BENT LEADS[1]



Cap (F)	D (mm)	W (mm)	L (mm)	P (mm)	d (mm)
0.47	9.5	18.5	16.0	11.5	0.6
1	9.5	18.5	20.0	11.5	0.6
1.5	9.5	18.5	24.0	11.5	0.6

*Request availability on custom B and C dimensions
[1] Bent Leads only available in Tray packaging

SOLDERING RECOMMENDATIONS

When soldering SuperCapacitors to a PCB, the temperature & time that the body of the SuperCapacitor sees during soldering can have a negative effect on performance. We advise following these guidelines:

- Do not immerse the SuperCapacitors in solder. Only the leads should come in contact with the solder.
- Ensure that the body of the SuperCapacitor is never in contact with the molten solder, the PCB or other components during soldering.
- Excessive temperatures or excessive temperature cycling during soldering may cause the safety vent to burst or the case to shrink or crack, potentially damaging the PCB or other components, and significantly reduce the life of the capacitor.
-

PRECAUTION: For all products with shrink wrap sleeves, washing in any type of cleaning agent is prohibited. During all soldering processes, it's recommended to protect the shrink wrap from any kind of liquid (including but not limited to: water, strong acid, strong alkali, strong oxidizing solutions, and strong solvents) to avoid the risk of damage, cracking, and fading of the outer shrink wrap.

HAND SOLDERING

Keep some distance between the SuperCapacitor body and the tip of the soldering iron; contact between SuperCapacitor body and soldering iron will cause extensive damage to the SuperCapacitor. It is recommended that the soldering iron temperature should be less than 350°C, and contact time should be limited to no more than 4 seconds. Too much exposure to terminal heat during soldering can cause heat to transfer to the body of the SuperCapacitor, potentially damaging the SuperCapacitor.

WAVE SOLDERING

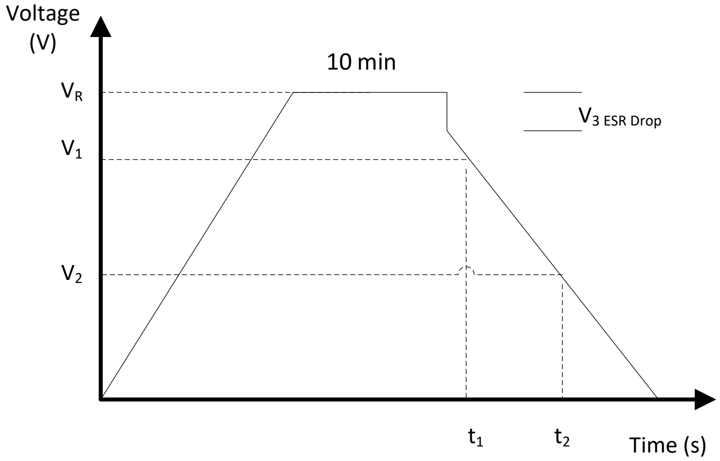
Only use wave soldering on Radial type SuperCapacitors. The PCB should be preheated only from the bottom and for less than 60 seconds, with temperature at, or below, 100°C on the top side of the board for PCBs equal to or greater than 0.8 mm thick.

Solder Temperature (°C)	Suggested Solder Time (s)	Maximum Solder Time (s)
220	7	9
240	7	9
250	5	7
260	3	5

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 V_1, V_2, and time intervals at t_1 and t_2. Use the capacitance formula to determine cap value.



I – Discharge Current, $4 \times C \times V_R$ (mA)

V_R – Rated Voltage (V)

V_1 – Initial Test Voltage, 80% Of V_R (V)

V_2 – Final Test Voltage, 40% Of V_R (V)

t_1 – Initial Test Time (s)

T_2 – Final Test Time (s)

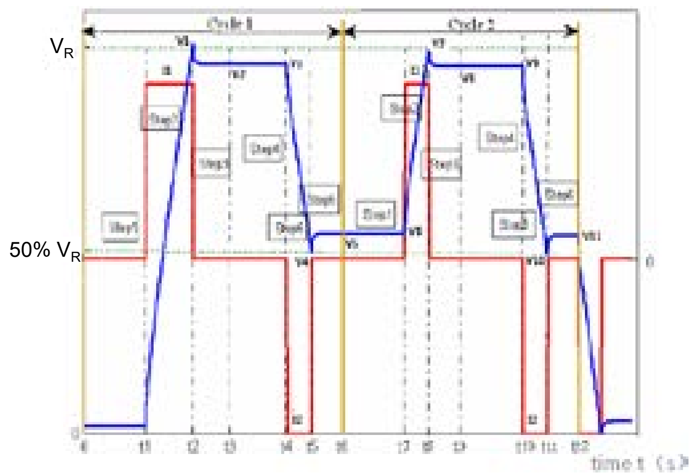
$$C = \frac{I \times (t_2 - t_1)}{V1 - V2}$$

DC ESR MEASUREMENT

A six-step ESR_{DC} test method is illustrated to the right and carried out as follows:

- Rest 10 Seconds
- Charge under constant current (I_1) to rated voltage (V_R)
- Rest 5 seconds
- Rest 10 seconds, record V_3 and t_4
- Discharge under constant current (I_2) to half rated voltage, Record I_2, V_4, And t_5
- Rest 2 seconds, record V_5 And t_6

Repeat steps 1-6 recording I, V, And t accordingly, finally discharging to below 0.1V under constant current (I_2).



Formulas to calculate:

- Two cycle discharge capacitances: $C_{dch1} = I_2 \times \frac{(t_5 - t_4)}{V_3 - V_4}$; $C_{dch2} = I_2 \times \frac{(t_{11} - t_{10})}{(V_9 - V_{10})}$
- Discharge capacitance: $C_{dch} = \frac{(C_{dch1} + C_{dch2})}{2}$
- 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: $I_1 = I_2$ = 75mA/F, the rated capacitance in the chart means discharge capacitance, and DC ESR (ESR_{DC}) 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 = (½ 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.

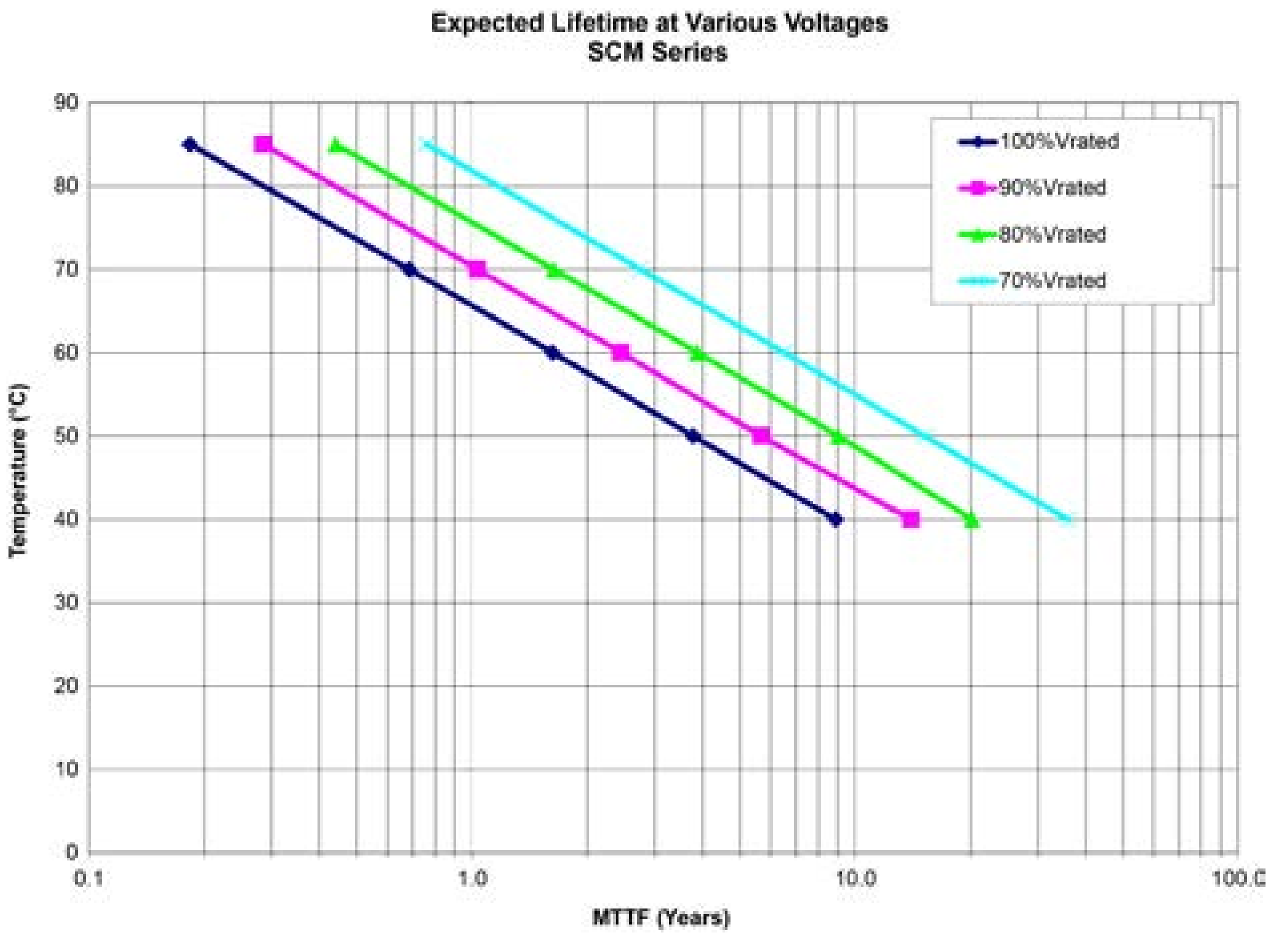
LIFE TIME AND TEMPERATURE PERFORMANCE

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.


Expected Lifetime at Various Voltages
SCM Series
Temperature (°C)
MTTF (Years)
0
10
20
30
40
50
60
70
80
90
0.1
1.0
10.0
100.0
100%Vrated
90%Vrated
80%Vrated
70%Vrated

SAFETY RECOMMENDATIONS

WARNINGS

- To avoid short circuit, after usage or test, SuperCapacitor voltage needs to discharge to ≤ 0.1V
- Do not apply over-voltage, reverse charge, burn or heat higher than 150°C, explosion-proof valve may break open
- Do not press, damage or disassemble the SuperCapacitor, 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

- UL 810A
- RoHS Compliant
- REACH Compliant
- Halogen free according to IEC 61249-2-21: 2003 and IPC/JEDEC-J-STD-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

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

SCM	A	63	K	586	S	P	P	B	2
Series SuperCap Module	**Single Cell Diameter** A = 33mm	**Single Cell Case Length** Two digits represent case length in mm	**Voltage Code** K = 16V	**Capacitance Code** 586 = 58F	**Tolerance** S = +30% / -10%	**Lead Format** P = Lead Out of Wiring Base	**Package** P = Plastic Case	**Balancing** B = Balanced	**Lead Orientation** 2 = Bolt Lead Out

QUALITY INSPECTION

Parts are tested for life cycle, high temperature load life, temperature characteristics, vibration resistance, and humidity characteristics. See next page for more information.

TERMINATION

This module has terminal screws located off the base of the part. See page 12 for more information.

OPERATING TEMPERATURE

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

LEAD-FREE
LEAD-FREE COMPATIBLE COMPONENT

RoHS COMPLIANT

For RoHScompliant products, please select correct termination style

SCM Series

Series-Connected SuperCapacitor Modules

RATINGS & PART NUMBER REFERENCES

Part Number	Case Width (mm)	Case Length (mm)	Capacitance (F)	Capacitance Tolerance	Rated Voltage (V)	Rated Temperature (°C)	DCL Max @ 72 Hrs (mA)	ESR Max @ 1000 Hz (mΩ)	ESR Max @ DC (mΩ)	Max Surge (V)	Peak Current (A)	Max Op. Current @ 15°C (A)	Max Energy (Wh)
SuperCap Module													
SCMA63K586SPPB2	48.6	226.2	58	+30% / -10%	16	65	5	-	15	17	249	21.1	2.07

Additional Information

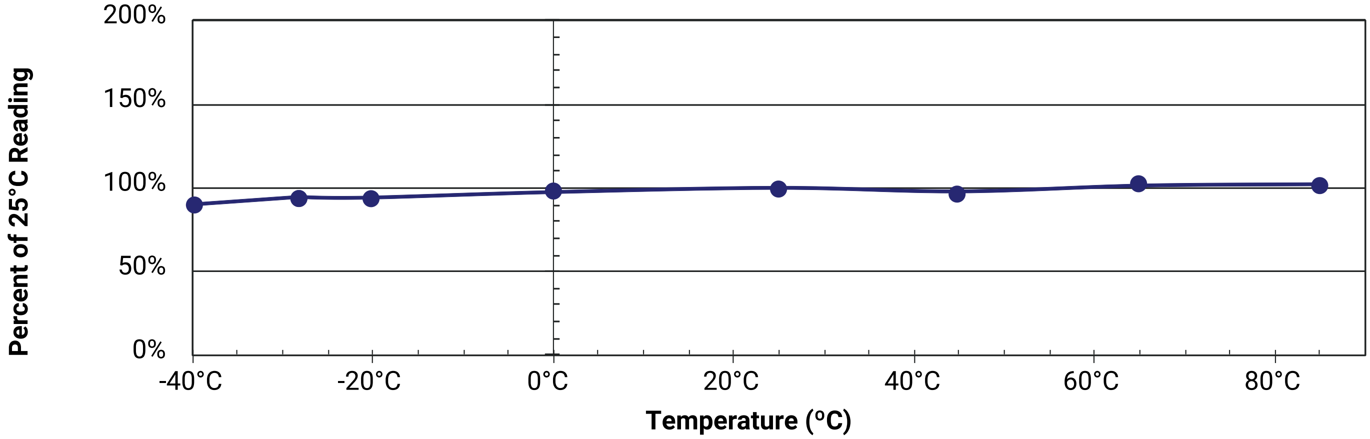
- Typical Weight: 0.68kg (±0.05)
- Insulation Resistance: ≥ 200MΩ
- High-Pot Capability: 5000 V_{DC}
- Recommended Torque for Power Terminals: M4 - 2Nm
- Overvoltage Monitoring: 52.2V (±1.35V)
- Passive Cell Voltage Management
- Cell Component – 33mm x 63mm , 2.7V 350F x 6pcs
- 6S1P Balanced PCB Board

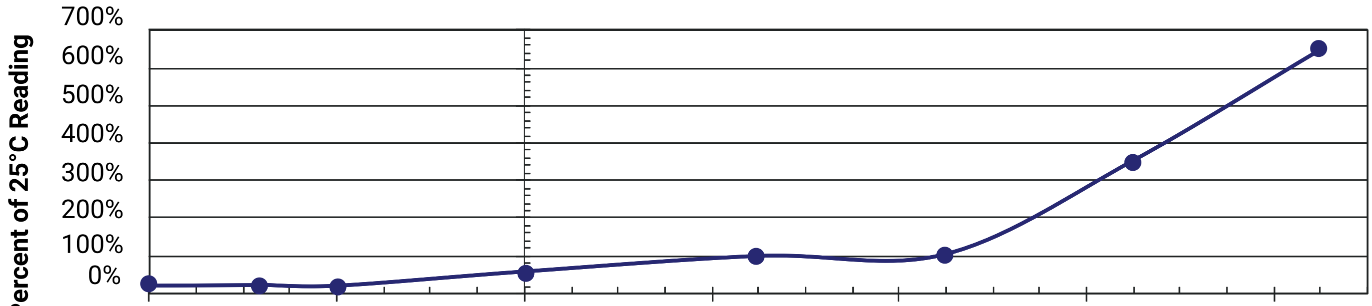
QUALIFICATION TEST SUMMARY

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

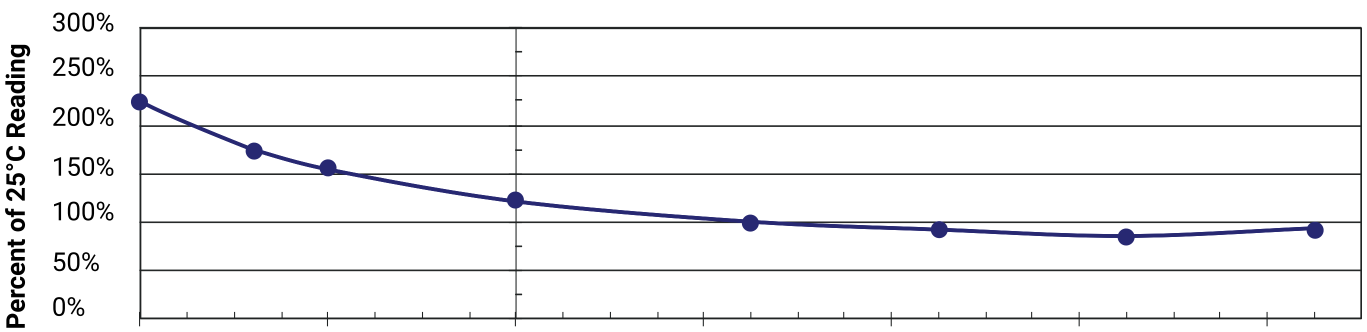
QUALITY AND RELIABILITY

CAPACITANCE VS. TEMPERATURE





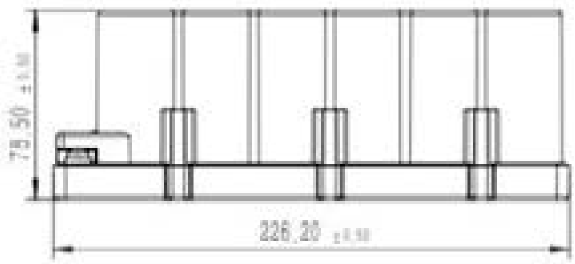
LEAKAGE CURRENT VS. TEMPERATURE

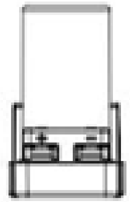


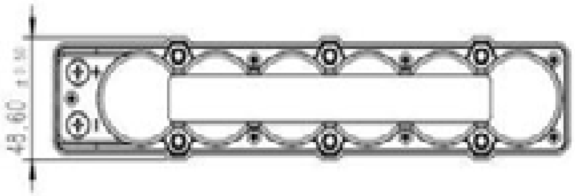
EQUIVALENT SERIES RESISTANCE VS. TEMPERATURE

MECHANICAL SPECIFICATIONS

(All dimensions in mm)

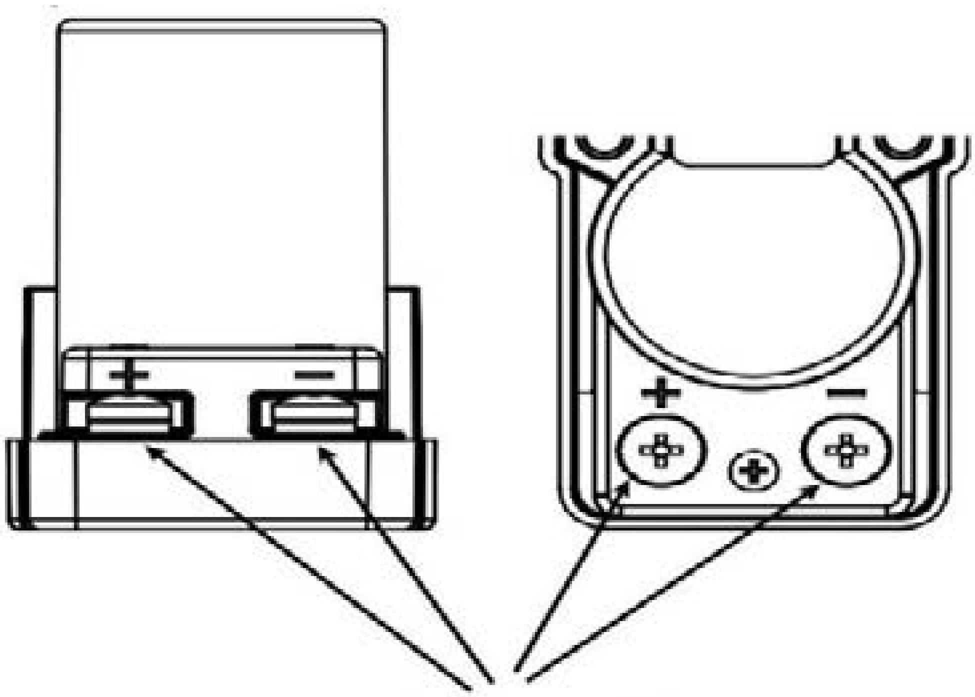






L (±0.5)	W (±0.5)	H (±0.5)	d (±0.05)	P (±0.8)
226.2	48.6	78.5	-	-

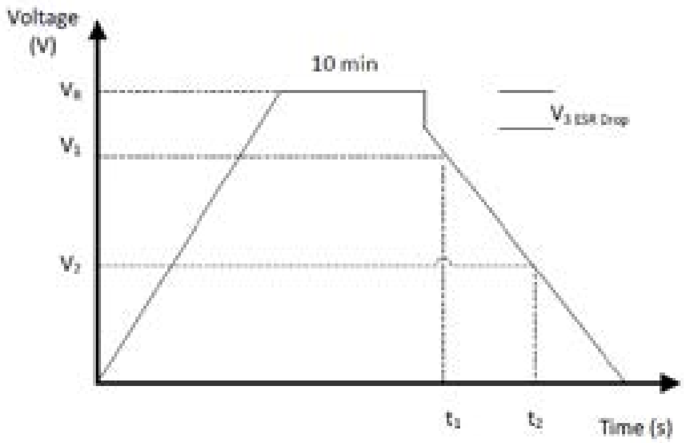
PIN INFORMATION



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 V_1, V_2, and time intervals at t_1 and t_2. Use the capacitance formula to determine cap value.



I – Discharge Current, $4 \times C \times V_R$ (mA)
V_R – Rated Voltage (V)
V_1 – Initial Test Voltage, 80% Of V_R (V)
V_2 – Final Test Voltage, 40% Of V_R (V)
t_1 – Initial Test Time (s)
T_2 – Final Test Time (s)

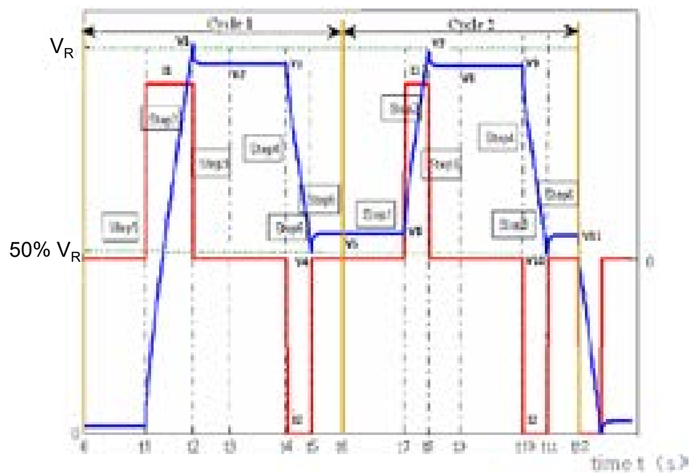
$$C = \frac{I \times (t_2 - t_1)}{V1 - V2}$$

DC ESR MEASUREMENT

A six-step ESR_{DC} test method is illustrated to the right and carried out as follows:

- Rest 10 Seconds
- Charge under constant current (I_1) to rated voltage (V_R)
- Rest 5 seconds
- Rest 10 seconds, record V_3 and t_4
- Discharge under constant current (I_2) to half rated voltage, Record I_2, V_4, And t_5
- Rest 2 seconds, record V_5 And t_6

Repeat steps 1-6 recording I, V, And t accordingly, finally discharging to below 0.1V under constant current (I_2).



Formulas to calculate:

- Two cycle discharge capacitances: $C_{dch1} = I_2 \times \frac{(t_5 - t_4)}{V_3 - V_4}$; $C_{dch2} = I_2 \times \frac{(t_{11} - t_{10})}{(V_9 - V_{10})}$
- Discharge capacitance: $C_{dch} = \frac{(C_{dch1} + C_{dch2})}{2}$
- 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: $I_1 = I_2$ = 75mA/F, the rated capacitance in the chart means discharge capacitance, and DC ESR (ESR_{DC}) 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 = (½ 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.

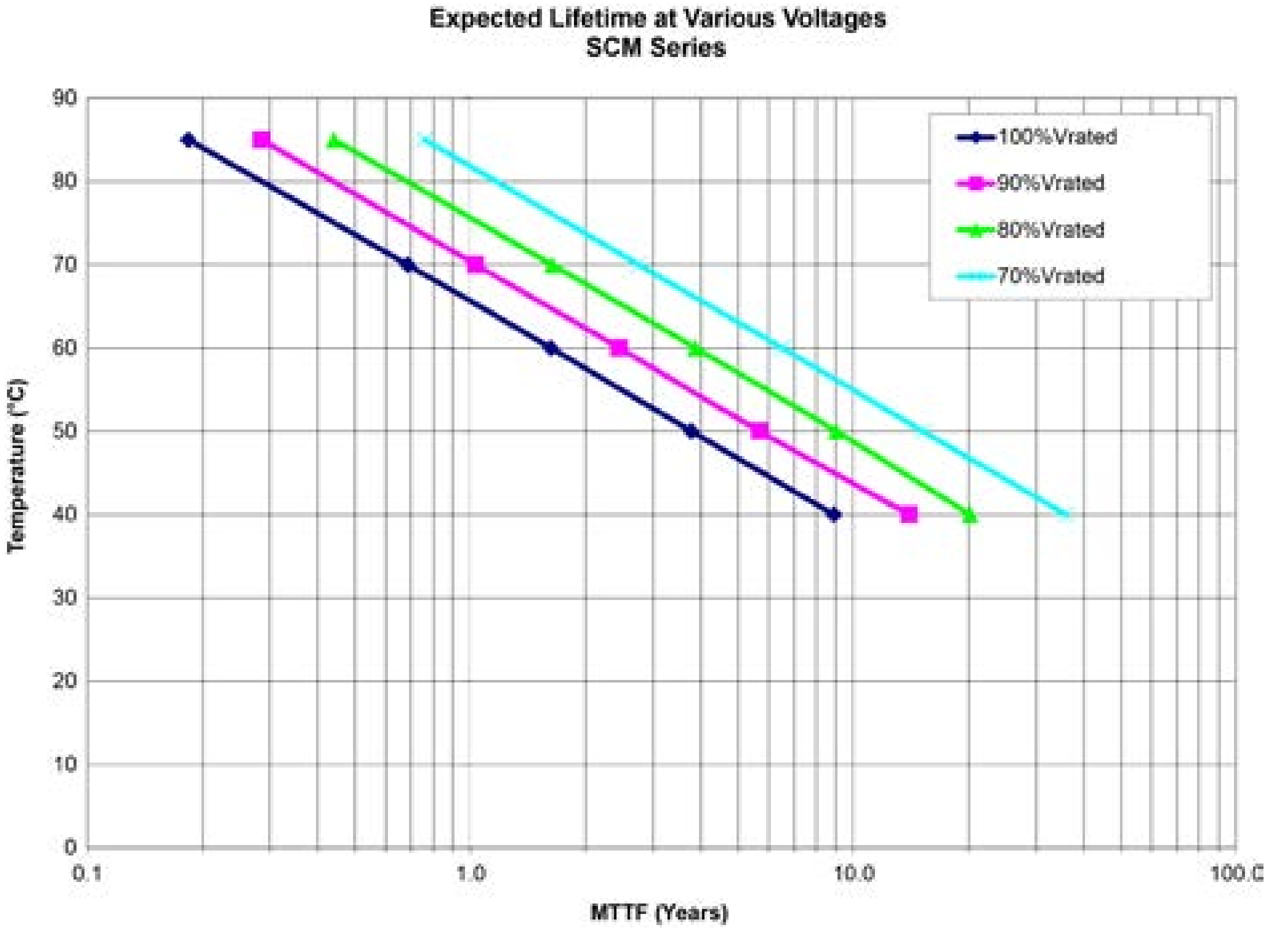
LIFE TIME AND TEMPERATURE PERFORMANCE

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.



Expected Lifetime at Various Voltages
SCM Series
Temperature (°C)
MTTF (Years)
0.1
1.0
10.0
100.0
0
10
20
30
40
50
60
70
80
90
100%Vrated
90%Vrated
80%Vrated
70%Vrated

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:

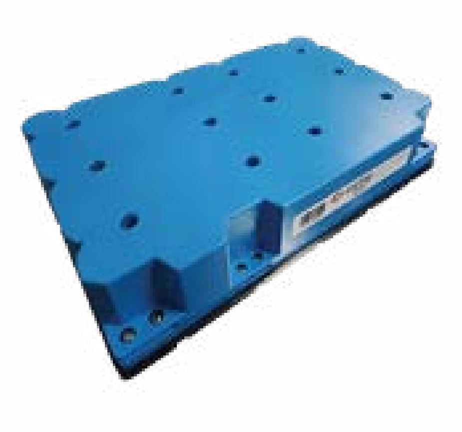
- 25°C and RH ≤ 60% without voltage applied
- Not in direct sunlight
- Not in direct contact with water, salt oil or other chemicals
- Not in direct contact with corrosive materials, acids, alkalis, or toxic gases
- Not in dusty environments
- Not in environments with shock and vibration conditions

PRODUCT PROTECTION

For any product with sleeves, washing in any type of cleaning agent is prohibited and during all processes, please protect the shrinking wrap from any kind of liquid (including but not limited to water, strong acids, strong alkali, strong oxidizing solutions, and strong solvents) to avoid the risk of damage, cracking and fading the outer shrinking wraps

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

SCM	A	63	S	585	S	P	P	B	2
Series SuperCap Module	**Single Cell Diameter** A = 33mm	**Single Cell Case Length** Two digits represent case length in mm	**Voltage Code** S = 160V	**Capacitance Code** 585 = 5.8F	**Tolerance** S = +30% / -10%	**Lead Format** P = Lead Out of Wiring Base	**Package** P = Plastic Case	**Balancing** B = Balanced	**Lead Orientation** 2 = Bolt Lead Out

QUALITY INSPECTION

Parts are tested for life cycle, high temperature load life, temperature characteristics, vibration resistance, and humidity characteristics. See next page for more information.

TERMINATION

This module has terminal screws located off the base of the part. See page 20 for more information.

OPERATING TEMPERATURE

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

LEAD-FREE
LEAD-FREE COMPATIBLE COMPONENT

RoHS COMPLIANT

For RoHScompliant products, please select correct termination style

RATINGS & PART NUMBER REFERENCES

Part Number	Case Width (mm)	Case Length (mm)	Capacitance (F)	Capacitance Tolerance	Rated Voltage (V)	Rated Temperature (°C)	DCL Max @ 72 Hrs (mA)	ESR Max @ 1000 Hz (mΩ)	ESR Max @ DC (mΩ)	Max Surge (V)	Peak Current (A)	Max Op. Current @ 15°C (A)	Max Energy (Wh)
SuperCap Module													
SCMA63S586SPPB2	234	364.5	5.8	+30% / -10%	160	65	25	-	150	170	249	21.1	20.7

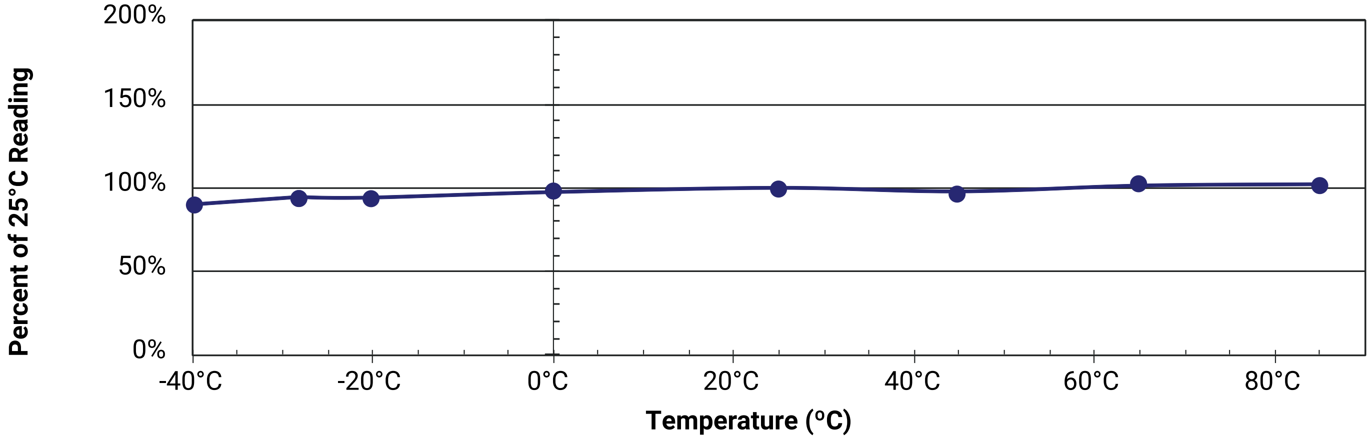
Additional Information
- Typical Weight: 5.3kg (±0.05)
- Insulation Resistance: ≥ 200MΩ
- High-Pot Capability: 5000 V_{DC}
- Recommended Torque for Power Terminals:
  M4 - 2Nm
  M5 - 4Nm
- Passive Cell Voltage Management
- Cell Component: 60pcs of 2.7V 350F, 33mm x 63mm

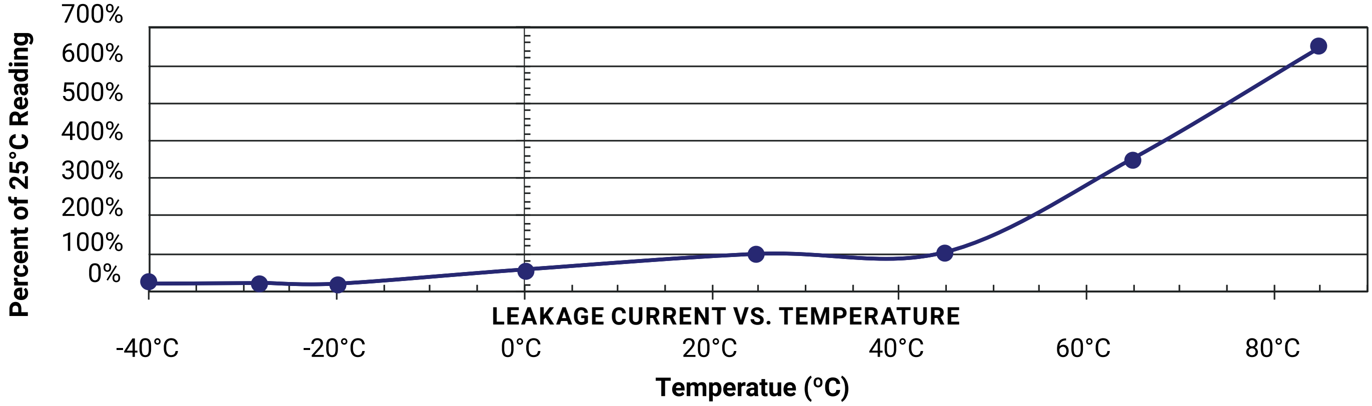
QUALIFICATION TEST SUMMARY

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

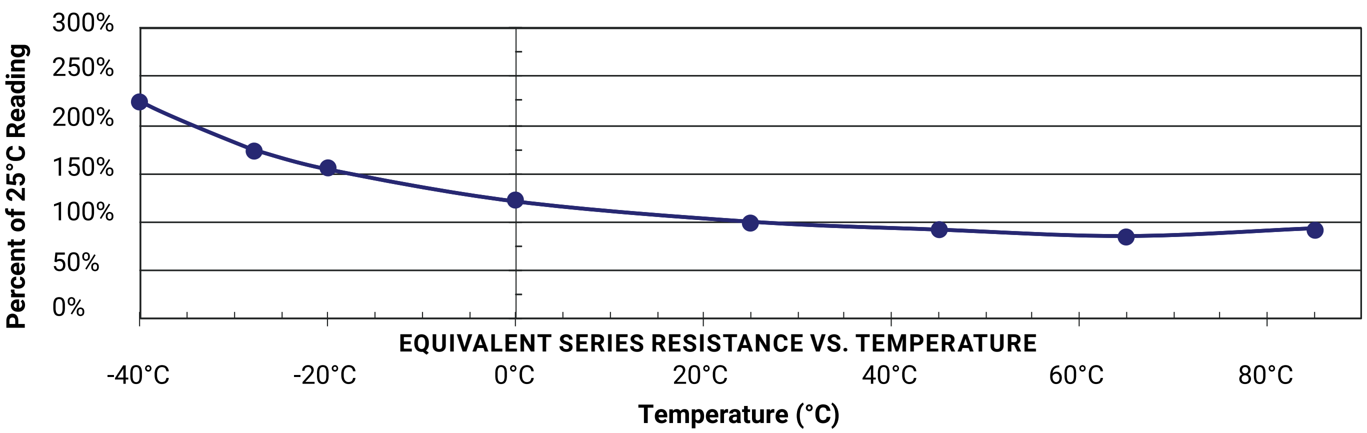
QUALITY AND RELIABILITY

CAPACITANCE VS. TEMPERATURE





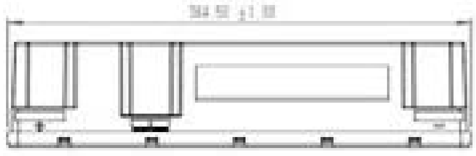
LEAKAGE CURRENT VS. TEMPERATURE

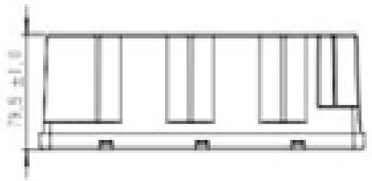


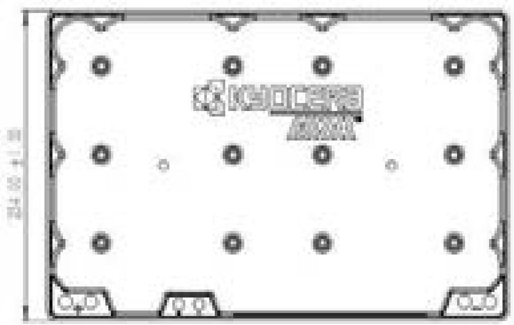
EQUIVALENT SERIES RESISTANCE VS. TEMPERATURE

MECHANICAL SPECIFICATIONS

(All dimensions in mm)

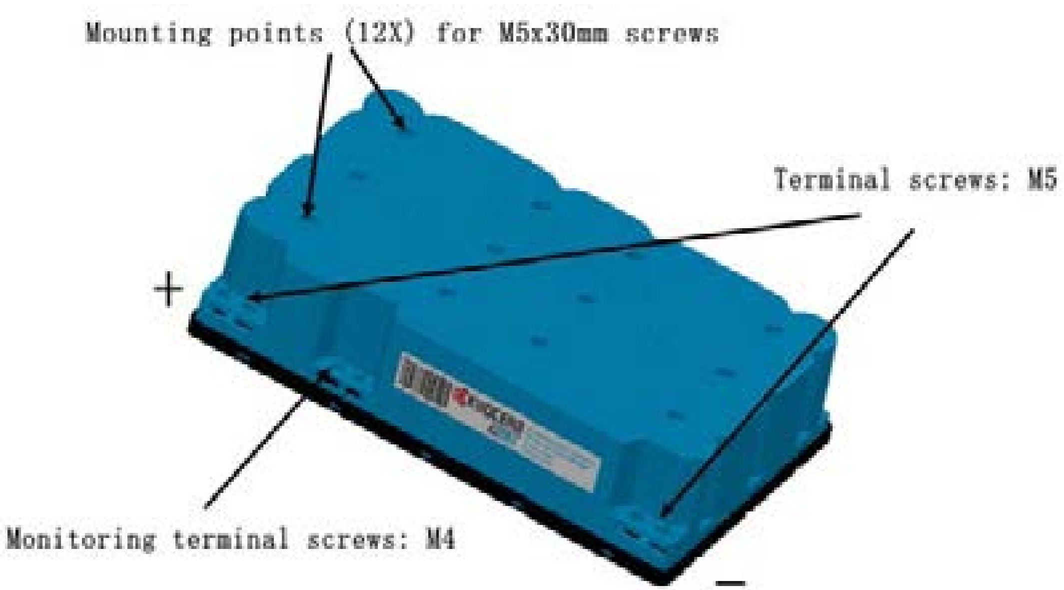






L (±0.5)	W (±0.5)	H (±0.5)	d (±0.05)	P (±0.8)
364.5	234	79.5	-	-

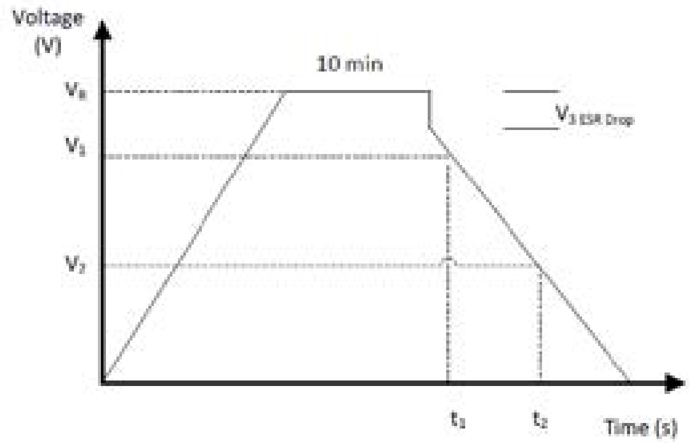
PIN INFORMATION



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 V_1, V_2, and time intervals at t_1 and t_2. Use the capacitance formula to determine cap value.



I – Discharge Current, $4 \times C \times V_R$ (mA)

V_R – Rated Voltage (V)

V_1 – Initial Test Voltage, 80% Of V_R (V)

V_2 – Final Test Voltage, 40% Of V_R (V)

t_1 – Initial Test Time (s)

T_2 – Final Test Time (s)

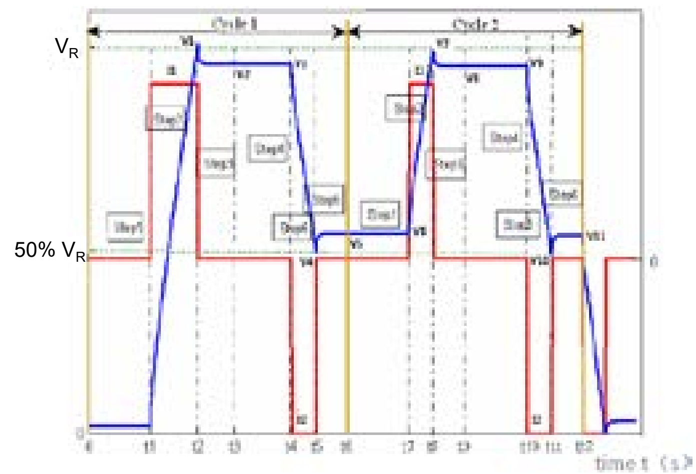
$$C = \frac{I \times (t_2 - t_1)}{V1 - V2}$$

DC ESR MEASUREMENT

A six-step ESR_{DC} test method is illustrated to the right and carried out as follows:

- Rest 10 Seconds
- Charge under constant current (I_1) to rated voltage (V_R)
- Rest 5 seconds
- Rest 10 seconds, record V_3 and t_4
- Discharge under constant current (I_2) to half rated voltage, Record I_2, V_4, And t_5
- Rest 2 seconds, record V_5 And t_6

Repeat steps 1-6 recording I, V, And t accordingly, finally discharging to below 0.1V under constant current (I_2).



Formulas to calculate:

- Two cycle discharge capacitances: $C_{dch1} = I_2 \times \frac{(t_5 - t_4)}{V_3 - V_4}$; $C_{dch2} = I_2 \times \frac{(t_{11} - t_{10})}{(V_9 - V_{10})}$
- Discharge capacitance: $C_{dch} = \frac{(C_{dch1} + C_{dch2})}{2}$
- 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: $I_1 = I_2$ = 75mA/F, the rated capacitance in the chart means discharge capacitance, and DC ESR (ESR_{DC}) 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 = $(½\ CV^2)$ / (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.

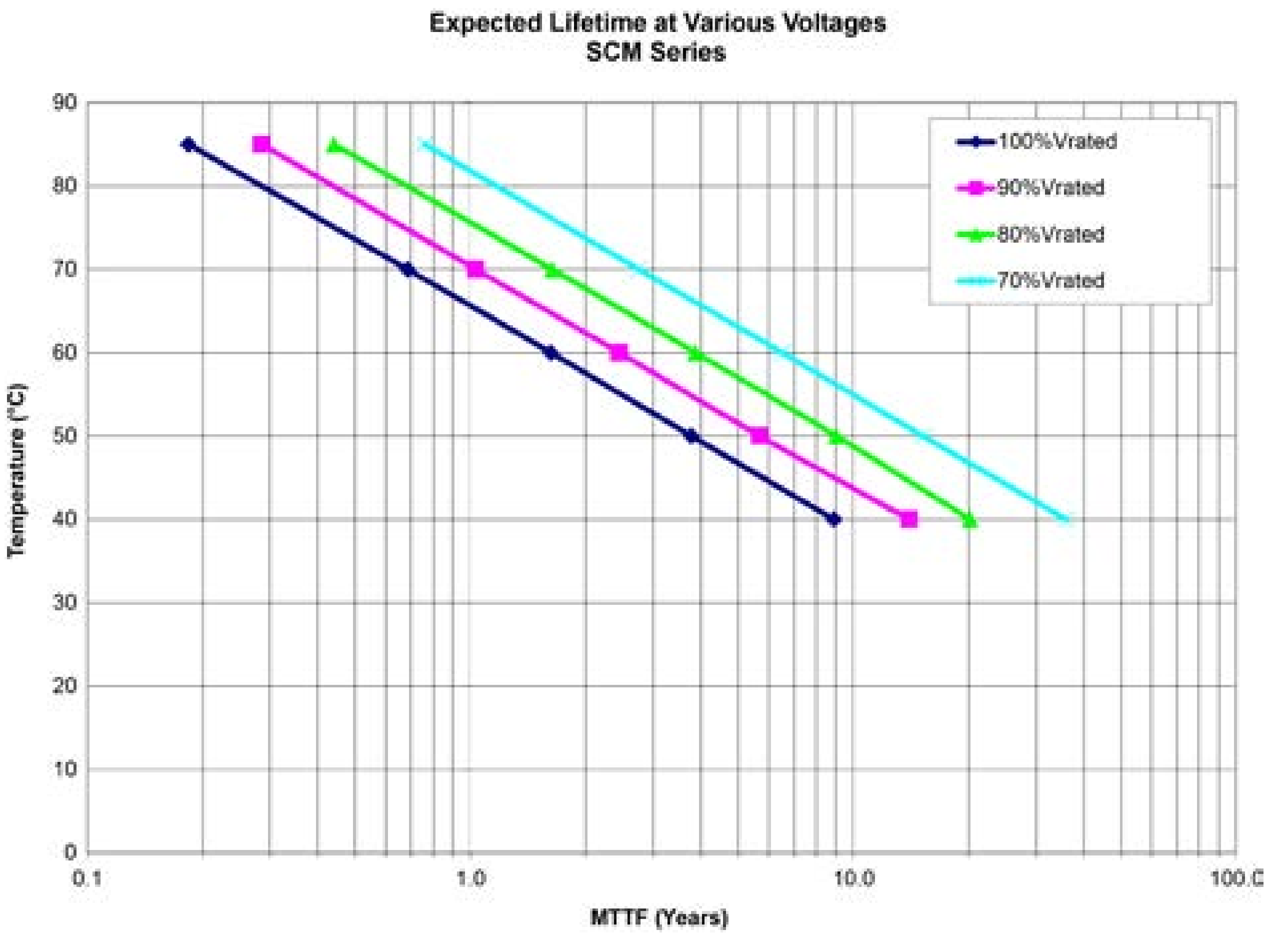
LIFE TIME AND TEMPERATURE PERFORMANCE

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.



Expected Lifetime at Various Voltages
SCM Series
Temperature (°C)
90
80
70
60
50
40
30
20
10
0
0.1
1.0
10.0
100.0
MTTF (Years)
100%Vrated
90%Vrated
80%Vrated
70%Vrated

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

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

SCM	Z	1E	K	507	S	T	A	B	2
Series SuperCap Module	**Single Cell Diameter** Z = 60mm	**Single Cell Case Length** Two digits represent case length in mm	**Voltage Code** K = 16V	**Capacitance Code** 507 = 500F	**Tolerance** S = +30% / -10%	**Lead Format** T = Line Post Lead Out	**Package** A = Aluminum Case	**Balancing** B = Balanced	**Lead Orientation** 2 = Bolt Lead Out

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)

LEAD-FREE
LEAD-FREE COMPATIBLE COMPONENT

RoHS COMPLIANT

For RoHScompliant products, please select correct termination style

SCM Series

Series-Connected SuperCapacitor Modules

RATINGS & PART NUMBER REFERENCES

Part Number	Case Width (mm)	Case Length (mm)	Capacitance (F)	Capacitance Tolerance	Rated Voltage (V)	Rated Temperature (°C)	DCL Max @ 72 Hrs (mA)	ESR Max @ 1000 Hz (mΩ)	ESR Max @ DC (mΩ)	Max Surge (V)	Peak Current (A)	Max Op. Current @ 40°C (A)	Max Energy (Wh)
SuperCap Module													
SCMZ1EK507STAB2	68	418	500	+30% / -10%	16	65	6	-	2.5	17.1	1778	199	17.8

Additional Information

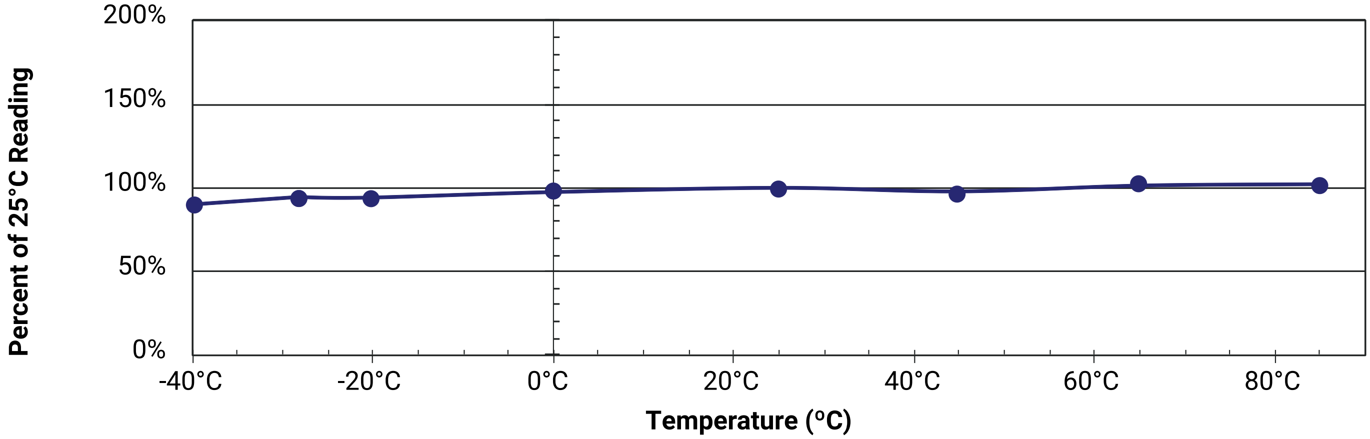
- Typical Weight: 6.2kg (±0.3)
- Insulation Resistance: ≥ 20MΩ
- Insulation Strength: ≤ 5.5mA
- Recommended Torque for Power Terminals:
  M8 - 20Nm
  M10 - 30Nm
- Overvoltage Monitoring: 16.8 ± 0.3V
- Passive Cell Voltage Management
  6S1P Balance Board
- Cell Component – 6pcs of 2.7V 3000F, 60mm x 138mm

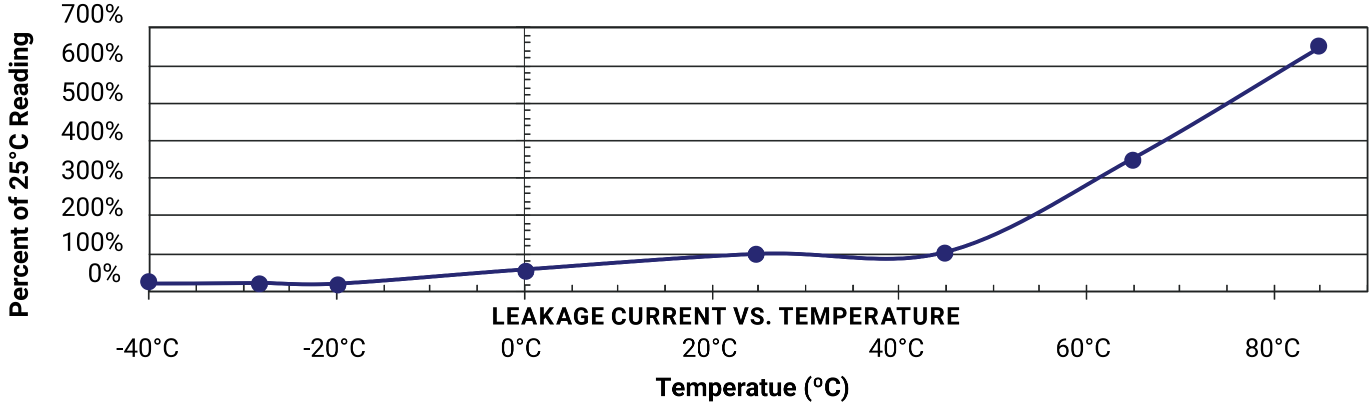
QUALIFICATION TEST SUMMARY

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

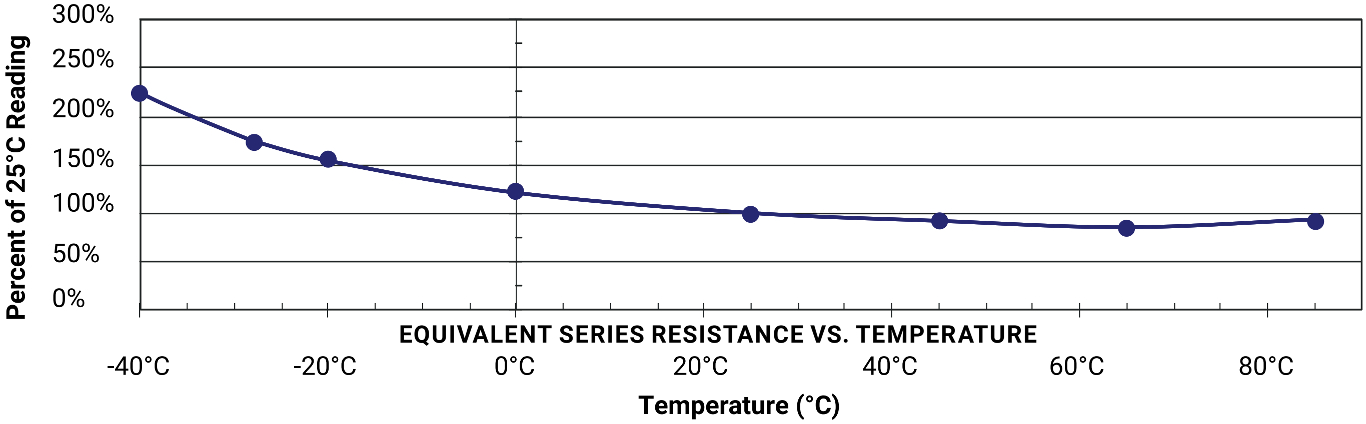
QUALITY AND RELIABILITY

CAPACITANCE VS. TEMPERATURE





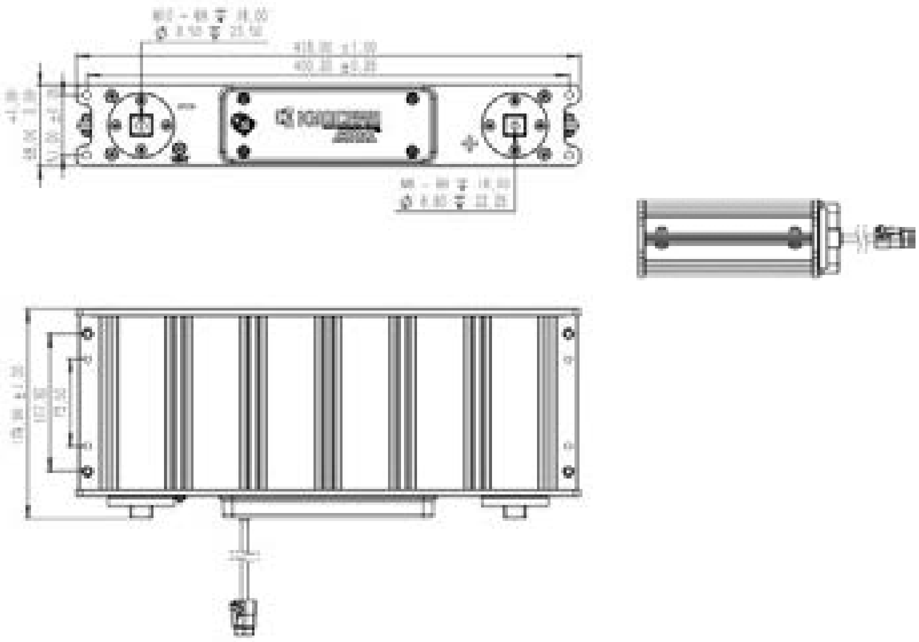
LEAKAGE CURRENT VS. TEMPERATURE



EQUIVALENT SERIES RESISTANCE VS. TEMPERATURE

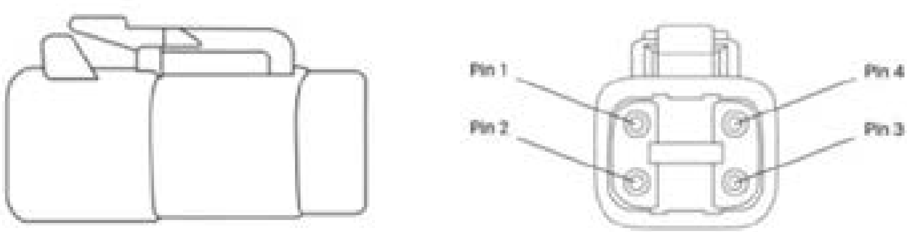
MECHANICAL SPECIFICATIONS

(All dimensions in mm)



L (±1)	W (±1)	H (±1)	d (±0.05)	P (±0.8)
418	68.0	179	-	-

PIN INFORMATION



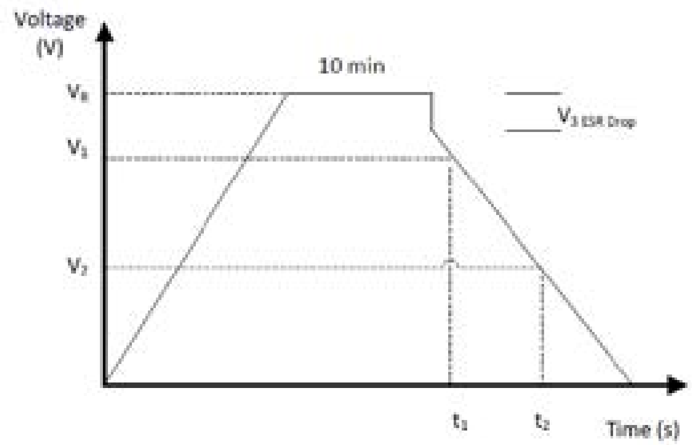
Pin	Color	Designation
1	White	Ground
2	Red	Overvoltage
3	Green	Not used
4	Yellow	Temperature

Temp (°C)	RT (Ω)
-40	332094
-25	129287
0	32554
25	10000
45	4372
65	2084
85	1070
100	677.3
125	338.7
150	182.6

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 V_1, V_2, and time intervals at t_1 and t_2. Use the capacitance formula to determine cap value.



I – Discharge Current, $4 \times C \times V_R$ (mA)
V_R – Rated Voltage (V)
V_1 – Initial Test Voltage, 80% Of V_R (V)
V_2 – Final Test Voltage, 40% Of V_R (V)
t_1 – Initial Test Time (s)
T_2 – Final Test Time (s)

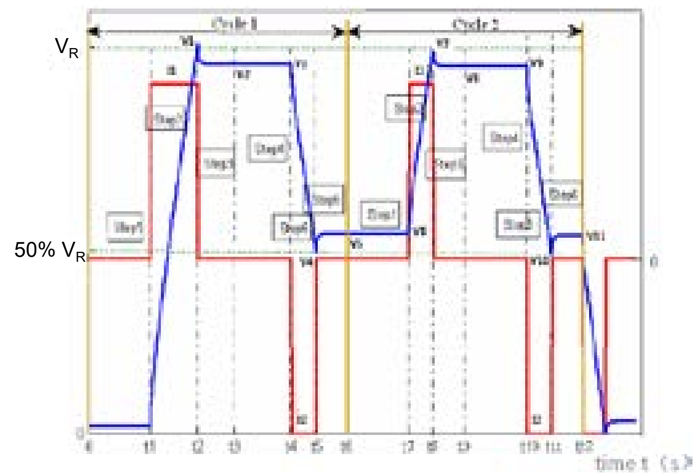
$$C = \frac{I \times (t_2 - t_1)}{V1 - V2}$$

DC ESR MEASUREMENT

A six-step ESR_{DC} test method is illustrated to the right and carried out as follows:

- Rest 10 Seconds
- Charge under constant current (I_1) to rated voltage (V_R)
- Rest 5 seconds
- Rest 10 seconds, record V_3 and t_4
- Discharge under constant current (I_2) to half rated voltage, Record I_2, V_4, And t_5
- Rest 2 seconds, record V_5 And t_6

Repeat steps 1-6 recording I, V, And t accordingly, finally discharging to below 0.1V under constant current (I_2).



Formulas to calculate:

- Two cycle discharge capacitances: $C_{dch1} = I_2 \times \frac{(t_5 - t_4)}{V_3 - V_4}$; $C_{dch2} = I_2 \times \frac{(t_{11} - t_{10})}{(V_9 - V_{10})}$
- Discharge capacitance: $C_{dch} = \frac{(C_{dch1} + C_{dch2})}{2}$
- 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: $I_1 = I_2$ = 75mA/F, the rated capacitance in the chart means discharge capacitance, and DC ESR (ESR_{DC}) 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 = (½ CV^2) / (3600*mass)

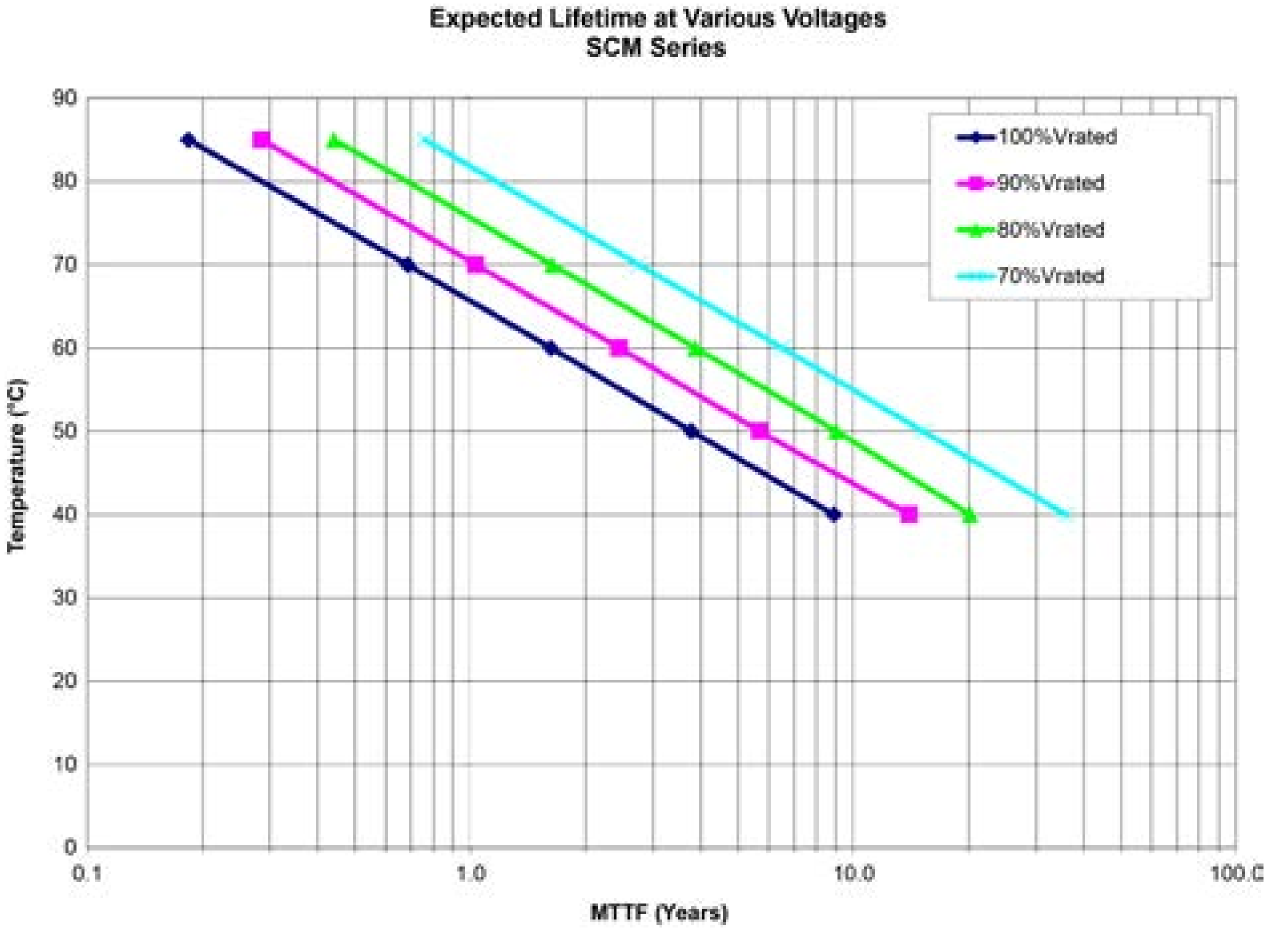
POLARITY AND REVERSE VOLTAGE
For product consistency and optimum performance, it is recommended that the capacitor be connected with polarity indicated. Reversing polarity could result in permanent damage to the circuit including much higher leakage current for a short duration of time and the life time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



Expected Lifetime at Various Voltages
SCM Series
Temperature (°C)
MTTF (Years)
0
10
20
30
40
50
60
70
80
90
0.1
1.0
10.0
100.0
100%Vrated
90%Vrated
80%Vrated
70%Vrated

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

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

SCM	Z	1E	P	1F6	S	T	A	B	2
Series SuperCap Module	**Single Cell Diameter** Z = 60mm	**Single Cell Case Length** Two digits represent case length in mm 1E = 138mm	**Voltage Code** P = 48V	**Capacitance Code** 1F6 = 165F	**Tolerance** S = +30% / -10%	**Lead Format** T = Line Post Lead Out	**Package** A = Aluminum Case	**Balancing** B = Balanced	**Lead Orientation** 2 = Bolt Lead Out

QUALITY INSPECTION

Parts are qualified for life cycle, high temperature load life, and storage temperature characteristics. See page 35 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 36 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)

LEAD-FREE COMPATIBLE COMPONENT

RoHS COMPLIANT

For RoHScompliant products, please select correct termination style

SCM Series

Series-Connected SuperCapacitor Modules

RATINGS & PART NUMBER REFERENCES

Part Number	Case Width (mm)	Case Length (mm)	Capacitance (F)	Capacitance Tolerance	Rated Voltage (V)	Rated Temperature (°C)	DCL Max @ 72 Hrs (mA)	ESR Max @ 1000 Hz (mΩ)	ESR Max @ DC (mΩ)	Max Surge (V)	Peak Current (A)	Max Op. Current @ 40°C (A)	Max Energy (Wh)
SuperCap Module													
SCMZ1EP1F6STAB2	194	418	165	+30% / -10%	48	65	6	-	5.22	51	2128	199	52.8

Additional Information

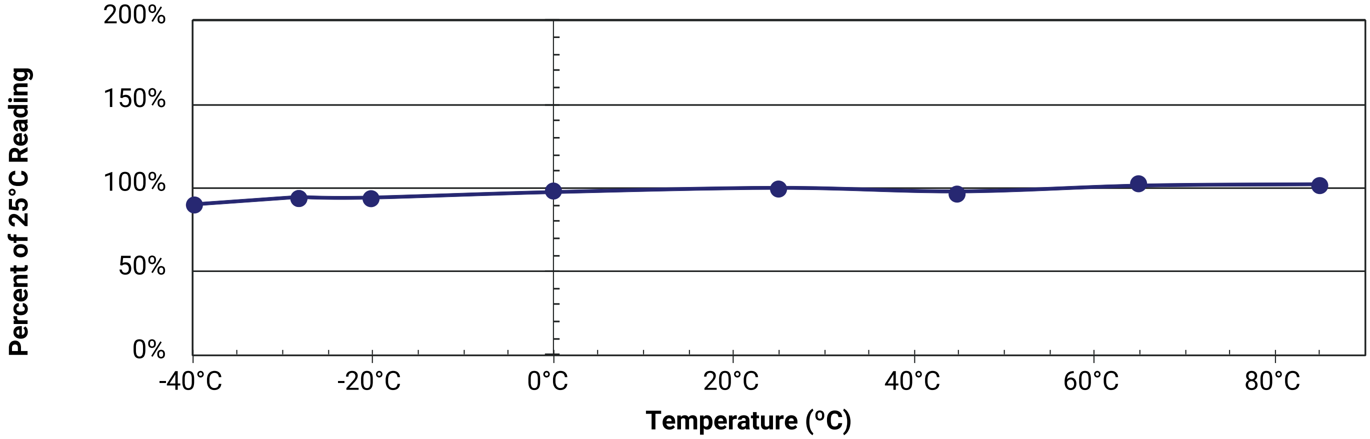
- Typical Weight: 15.5kg (±0.5)
- Insulation Resistance: ≥ 20MΩ
- Insulation Strength: ≤ 5.5mA
- Recommended Torque for Power Terminals:
  M8 - 20Nm
  M10 - 30Nm
- Overvoltage Monitoring: 52.2 ± 1.35V
- Passive Cell Voltage Management
- Cell Components – 18pcs of 2.7V 3000F, 60mm x 138mm

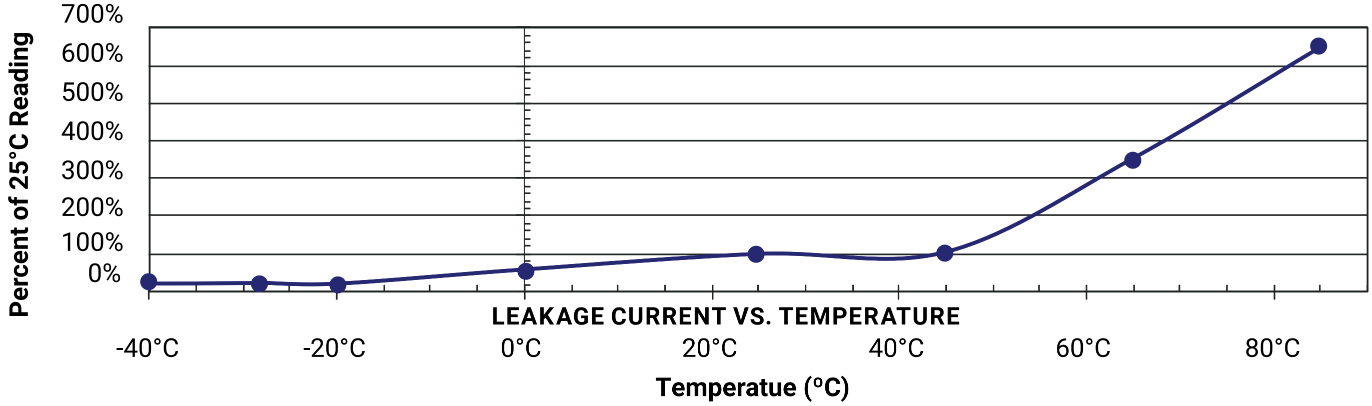
QUALIFICATION TEST SUMMARY

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

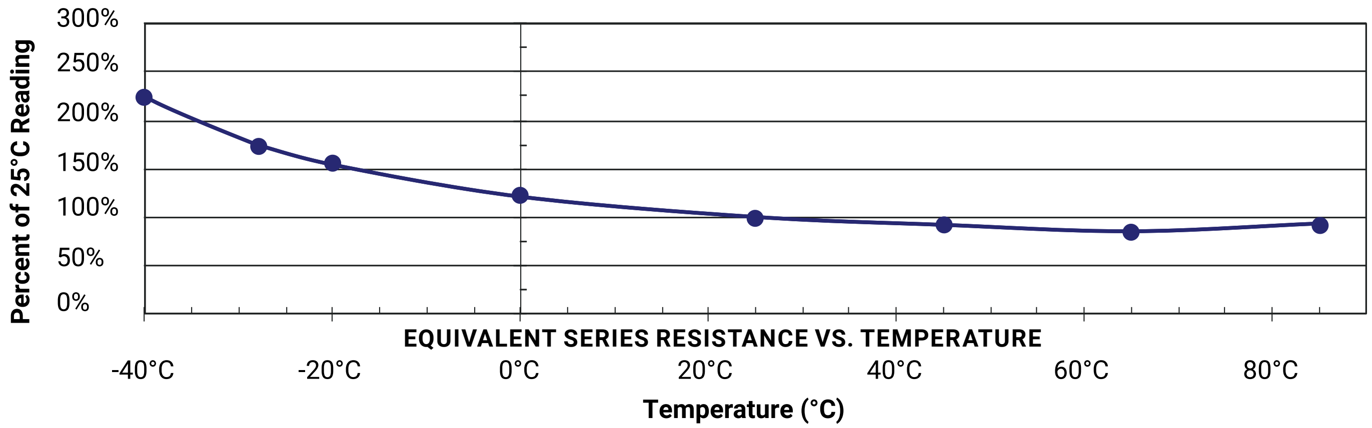
QUALITY AND RELIABILITY

CAPACITANCE VS. TEMPERATURE





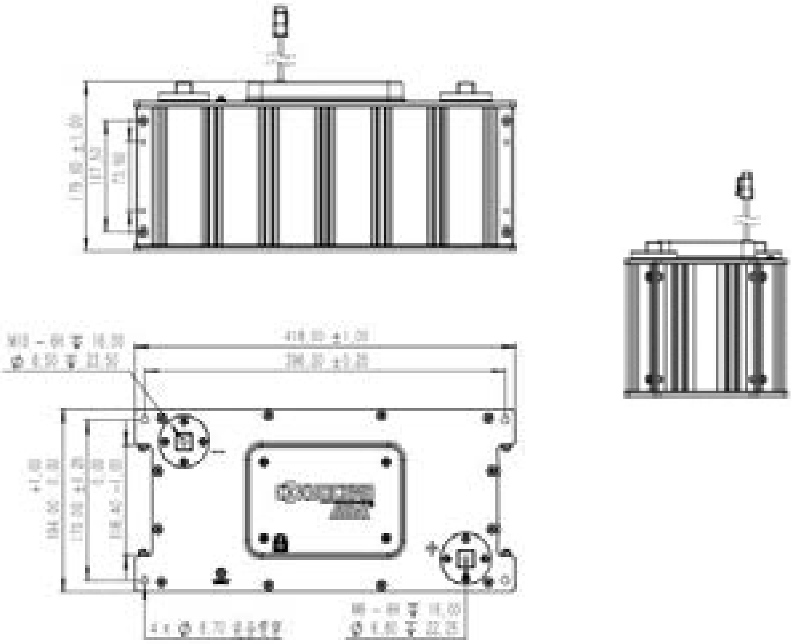
LEAKAGE CURRENT VS. TEMPERATURE



EQUIVALENT SERIES RESISTANCE VS. TEMPERATURE

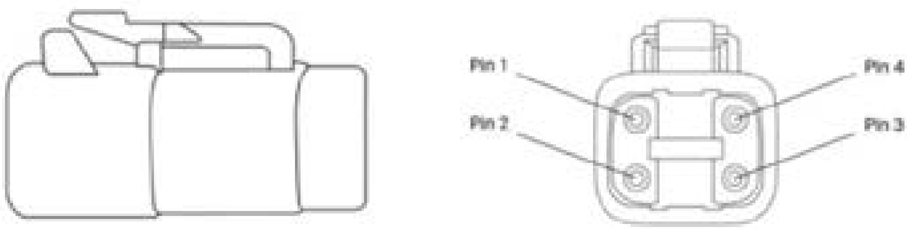
MECHANICAL SPECIFICATIONS

(All dimensions in mm)



L (±1)	W (±1)	H (±1)	d (±0.05)	P (±0.8)
418	194	179	-	-

PIN INFORMATION



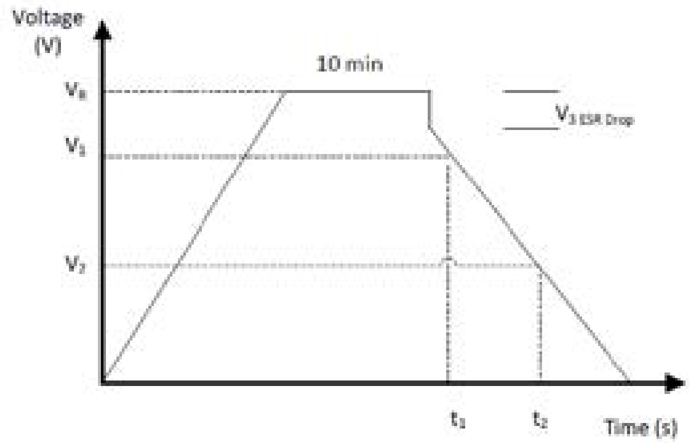
Pin	Color	Designation
1	White	Ground
2	Red	Overvoltage
3	Green	Not used
4	Yellow	Temperature

Temp (°C)	RT (Ω)
-40	332094
-25	129287
0	32554
25	10000
45	4372
65	2084
85	1070
100	677.3
125	338.7
150	182.6

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 V_1, V_2, and time intervals at t_1 and t_2. Use the capacitance formula to determine cap value.



I – Discharge Current, $4 \times C \times V_R$ (mA)

V_R – Rated Voltage (V)

V_1 – Initial Test Voltage, 80% Of V_R (V)

V_2 – Final Test Voltage, 40% Of V_R (V)

t_1 – Initial Test Time (s)

T_2 – Final Test Time (s)

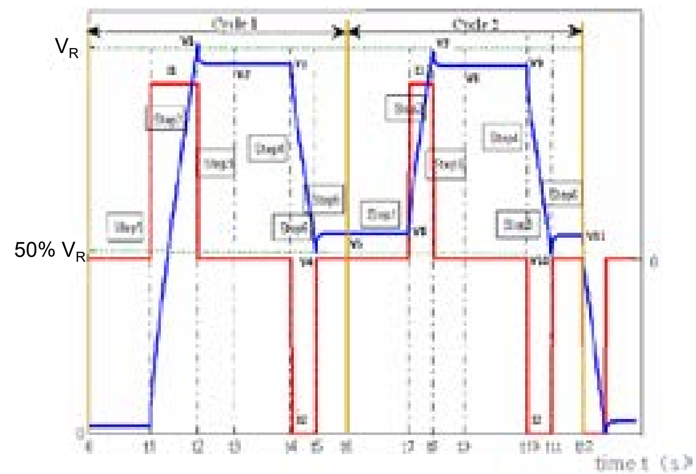
$$C = \frac{I \times (t_2 - t_1)}{V1 - V2}$$

DC ESR MEASUREMENT

A six-step ESR_{DC} test method is illustrated to the right and carried out as follows:

- Rest 10 Seconds
- Charge under constant current (I_1) to rated voltage (V_R)
- Rest 5 seconds
- Rest 10 seconds, record V_3 and t_4
- Discharge under constant current (I_2) to half rated voltage, Record I_2, V_4, And t_5
- Rest 2 seconds, record V_5 And t_6

Repeat steps 1-6 recording I, V, And t accordingly, finally discharging to below 0.1V under constant current (I_2).



Formulas to calculate:

- Two cycle discharge capacitances: $C_{dch1} = I_2 \times \frac{(t_5 - t_4)}{V_3 - V_4}$; $C_{dch2} = I_2 \times \frac{(t_{11} - t_{10})}{(V_9 - V_{10})}$
- Discharge capacitance: $C_{dch} = \frac{(C_{dch1} + C_{dch2})}{2}$
- 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: $I_1 = I_2$ = 75mA/F, the rated capacitance in the chart means discharge capacitance, and DC ESR (ESR_{DC}) 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 = (½ 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.

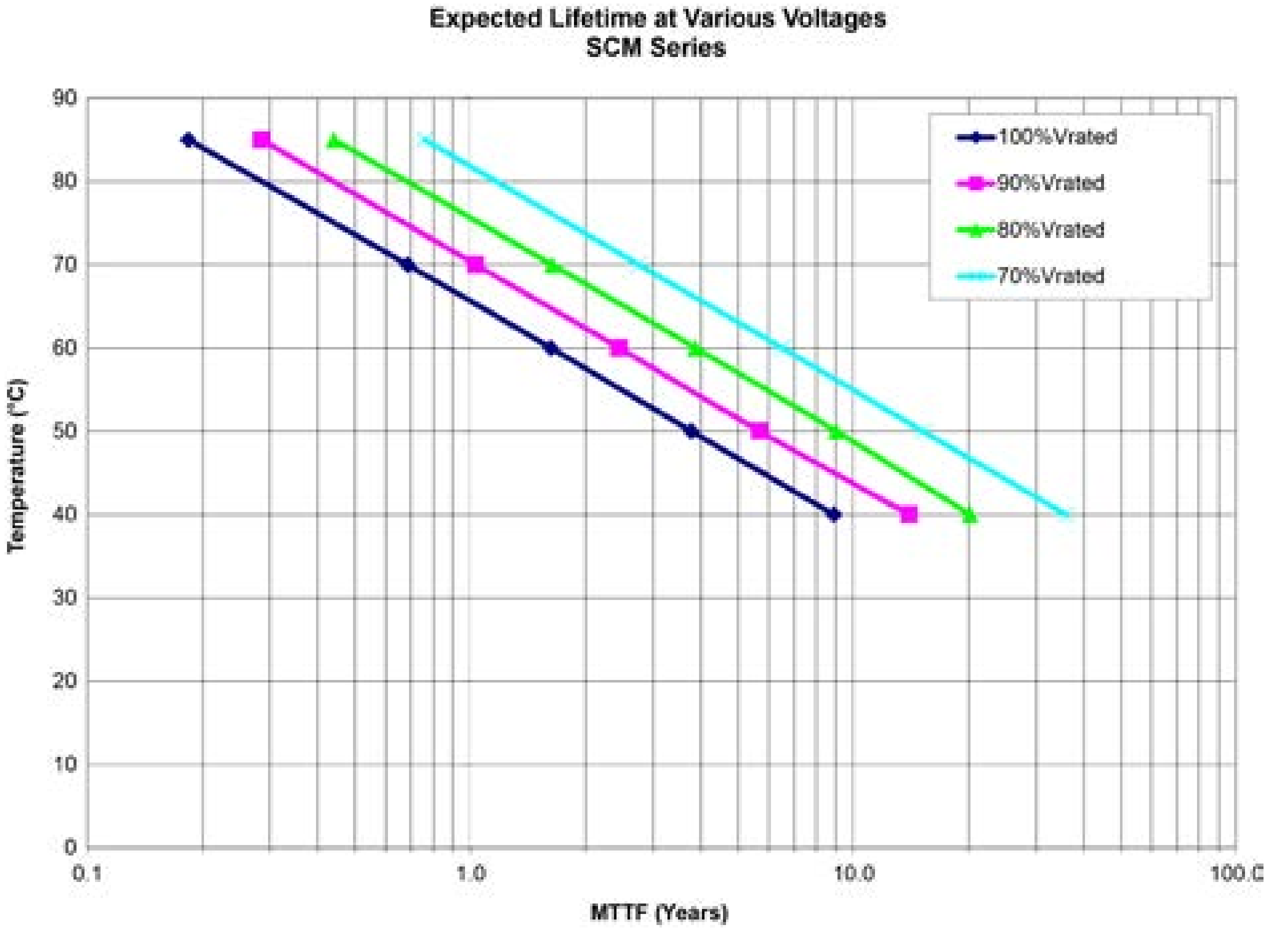
LIFE TIME AND TEMPERATURE PERFORMANCE

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.


Expected Lifetime at Various Voltages
SCM Series
Temperature (°C)
90
80
70
60
50
40
30
20
10
0
0.1
1.0
10.0
100.0
MTTF (Years)
100%Vrated
90%Vrated
80%Vrated
70%Vrated

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

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

SCM	Z	85	P	836	S	T	A	B	2
Series SuperCap Module	**Single Cell Diameter** Z = 60mm	**Single Cell Case Length** Two digits represent case length in mm	**Voltage Code** P = 48V	**Capacitance Code** 836 = 83F	**Tolerance** S = +30% / -10%	**Lead Format** T = Line Post Lead Out	**Package** A = Aluminum Case	**Balancing** B = Balanced	**Lead Orientation** 2 = Bolt Lead Out

QUALITY INSPECTION

Parts are qualified for life cycle, high temperature load life, and storage temperature characteristics. See page 43 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 44 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)

LEAD-FREE
LEAD-FREE COMPATIBLE COMPONENT

RoHS COMPLIANT

For RoHScompliant products, please select correct termination style

SCM Series

Series-Connected SuperCapacitor Modules

RATINGS & PART NUMBER REFERENCES

Part Number	Case Width (mm)	Case Length (mm)	Capacitance (F)	Capacitance Tolerance	Rated Voltage (V)	Rated Temperature (°C)	DCL Max @ 72 Hrs (mA)	ESR Max @ 1000 Hz (mΩ)	ESR Max @ DC (mΩ)	Max Surge (V)	Peak Current (A)	Max Op. Current @ 40°C (A)	Max Energy (Wh)
SuperCap Module													
SCMZ85P836STAB2	194	418	83	+30% / -10%	48	65	3	-	9	51	1140	127	26.6

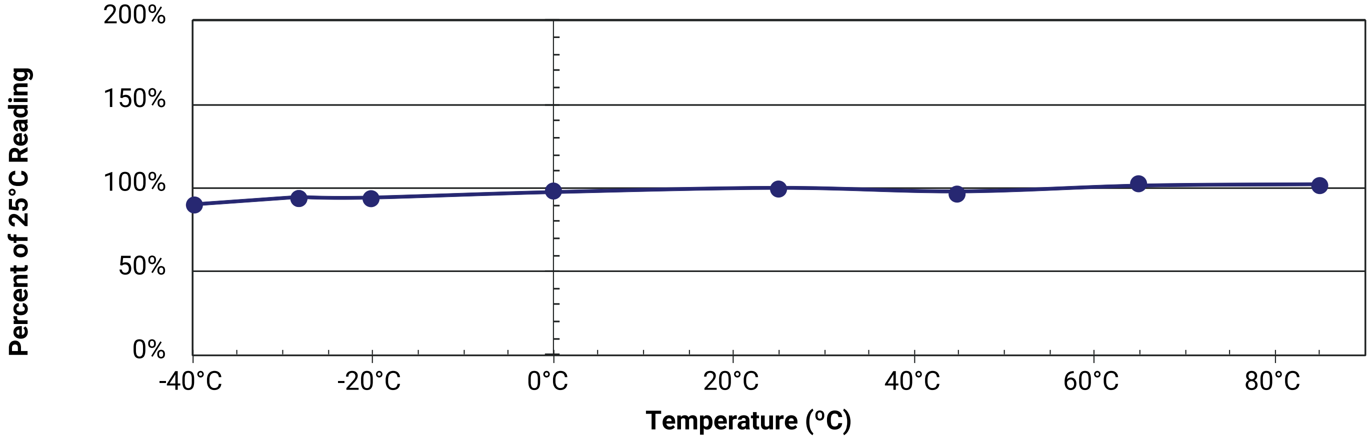
Additional Information
- Typical Weight: 9.5kg (±0.5)
- Insulation Resistance: ≥ 20MΩ
- Insulation Strength: ≤ 5.5mA
- Recommended Torque for Power Terminals:
  M8 - 20Nm
  M10 - 30Nm
- Overvoltage Monitoring: 52.2 ± 1.35V
- Passive Cell Voltage Management
- Cell Components – 18pcs of 2.7V 1500F, 60mm x 85mm

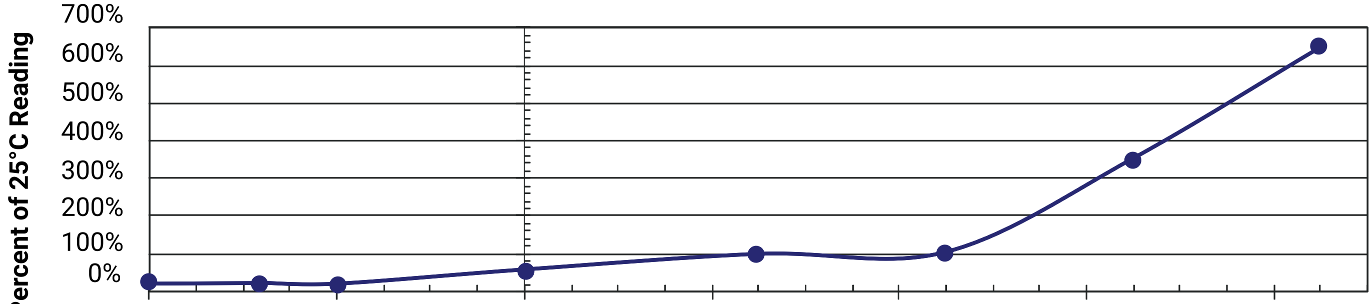
QUALIFICATION TEST SUMMARY

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

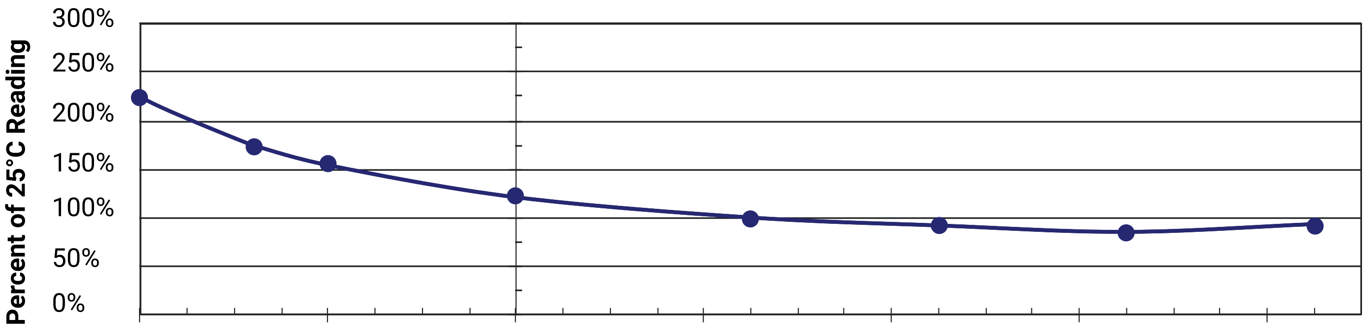
QUALITY AND RELIABILITY

CAPACITANCE VS. TEMPERATURE





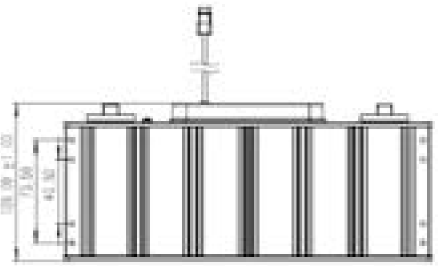
LEAKAGE CURRENT VS. TEMPERATURE

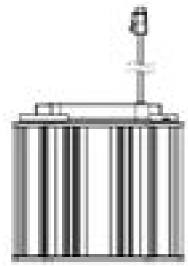


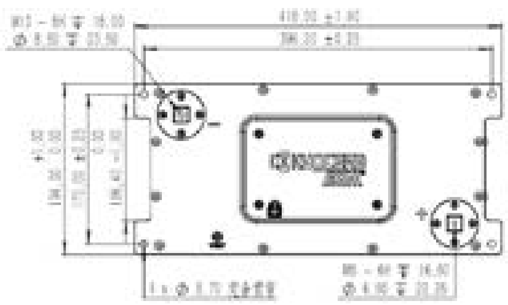
EQUIVALENT SERIES RESISTANCE VS. TEMPERATURE

MECHANICAL SPECIFICATIONS

(All dimensions in mm)

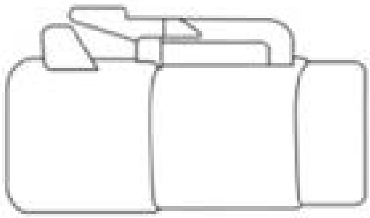


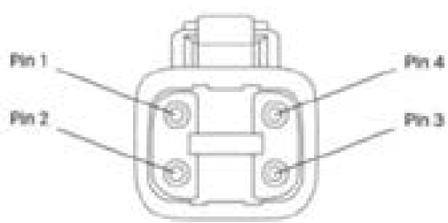




L (±1)	W (±1)	H (±1)	d (±0.05)	P (±0.8)
418	194	126	-	-

PIN INFORMATION





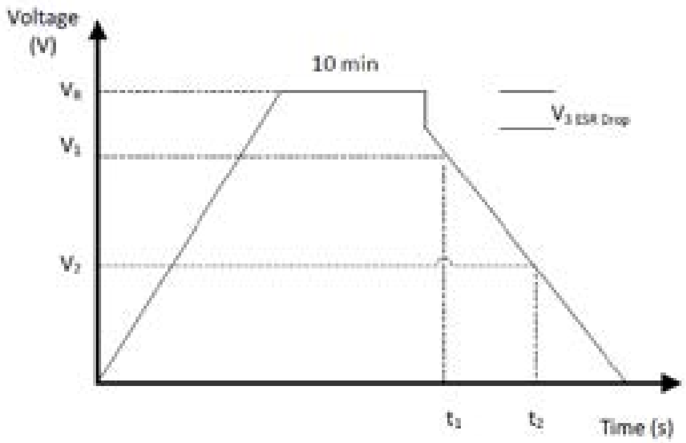
Pin	Color	Designation
1	White	Ground
2	Red	Overvoltage
3	Green	Not used
4	Yellow	Temperature

Temp (°C)	RT (Ω)
-40	332094
-25	129287
0	32554
25	10000
45	4372
65	2084
85	1070
100	677.3
125	338.7
150	182.6

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 V_1, V_2, and time intervals at t_1 and t_2. Use the capacitance formula to determine cap value.



I – Discharge Current, $4 \times C \times V_R$ (mA)

V_R – Rated Voltage (V)

V_1 – Initial Test Voltage, 80% Of V_R (V)

V_2 – Final Test Voltage, 40% Of V_R (V)

t_1 – Initial Test Time (s)

T_2 – Final Test Time (s)

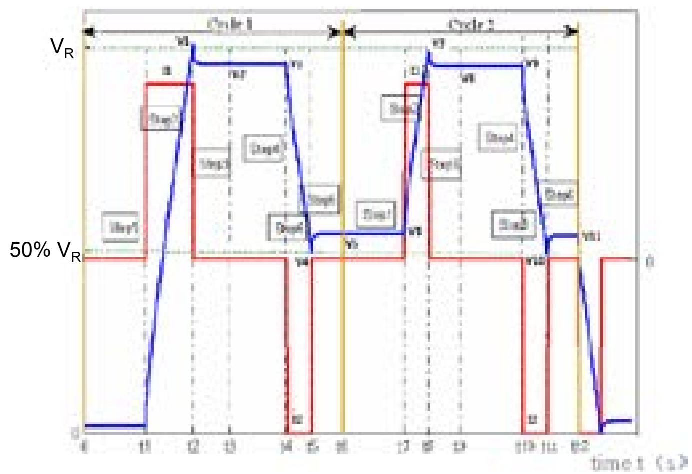
$$C = \frac{I \times (t_2 - t_1)}{V1 - V2}$$

DC ESR MEASUREMENT

A six-step ESR_{DC} test method is illustrated to the right and carried out as follows:

- Rest 10 Seconds
- Charge under constant current (I_1) to rated voltage (V_R)
- Rest 5 seconds
- Rest 10 seconds, record V_3 and t_4
- Discharge under constant current (I_2) to half rated voltage, Record I_2, V_4, And t_5
- Rest 2 seconds, record V_5 And t_6

Repeat steps 1-6 recording I, V, And t accordingly, finally discharging to below 0.1V under constant current (I_2).



Formulas to calculate:

- Two cycle discharge capacitances: $C_{dch1} = I_2 \times \frac{(t_5 - t_4)}{V_3 - V_4}$; $C_{dch2} = I_2 \times \frac{(t_{11} - t_{10})}{(V_9 - V_{10})}$
- Discharge capacitance: $C_{dch} = \frac{(C_{dch1} + C_{dch2})}{2}$
- 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: $I_1 = I_2$ = 75mA/F, the rated capacitance in the chart means discharge capacitance, and DC ESR (ESR_{DC}) 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.

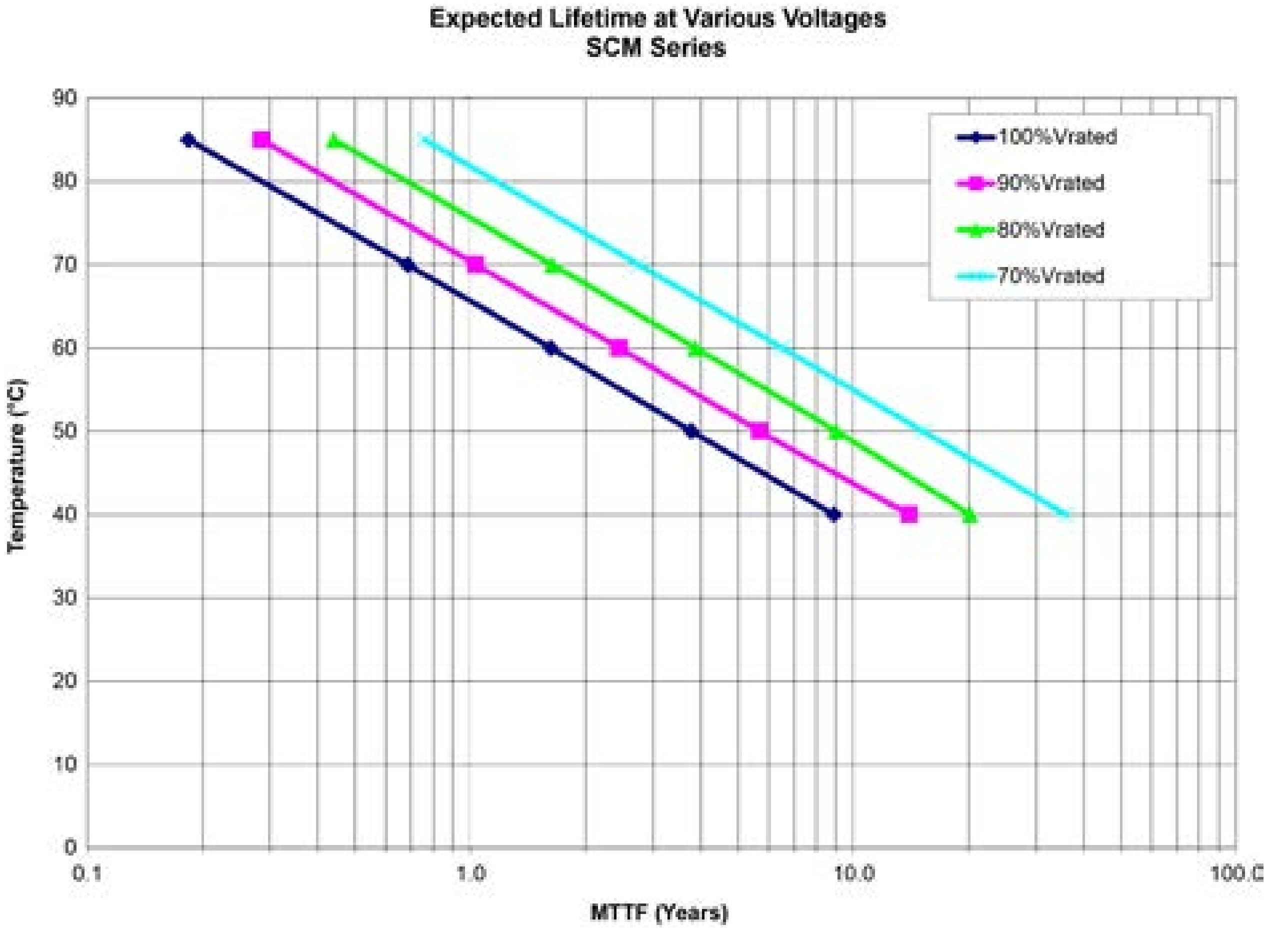
LIFE TIME AND TEMPERATURE PERFORMANCE

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.



Expected Lifetime at Various Voltages
SCM Series
Temperature (°C)
90
80
70
60
50
40
30
20
10
0
0.1
1.0
10.0
100.0
MTTF (Years)
100%Vrated
90%Vrated
80%Vrated
70%Vrated

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

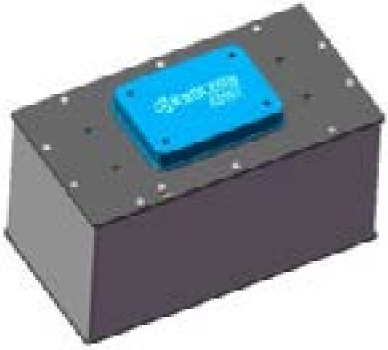
Capacitors may be stored within the temperature range of -40°C to +70°C with humidity < 60%. Lower storage temperature is preferred as it extends the shelf life of the capacitor. Product over one year and within two years of the date code, we recommend recharging the product at the beginning of use for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

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

- High Pulse Power Capability
- Low ESR
- Low Leakage Current

APPLICATIONS

- Camera Flash Systems
- Energy Harvesting
- GSM/GPRS Pulse Applications
- **UPS/Industrial**
- Wireless Alarms
- Remote Metering
- Scanners
- Toys and Games

HOW TO ORDER

SCM	Z	1E	P	1M6	R	T	M	B	2	ST
Series SuperCap Module	**Single Cell Diameter** Z = 60mm	**Single Cell Case Length** Two digits represent case length in mm 1E = 138mm	**Voltage Code** P = 48V	**Capacitance Code** 1M6 = 166F	**Tolerance** R = +20%/-0%	**Lead Format** T = Line Post Lead Out	**Case Type** M = Metal Sheet	**Balancing** B = Balanced	**Lead Orientation** 2 = Bolt Lead Out	**Special Code** ST – Lead Same Side of Terminal

QUALITY INSPECTION

Parts are qualified for life cycle, high temperature load life, and storage temperature characteristics. See page 3 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 44 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)

LEAD-FREE

LEAD-FREE COMPATIBLE COMPONENT

RoHS COMPLIANT

For RoHScompliant products, please select correct termination style

RATINGS & PART NUMBER REFERENCES

Part Number	Case Width (mm)	Case Length (mm)	Capacitance (F)	Capacitance Tolerance	Rated Voltage (V)	Rated Temperature (°C)	DCL Max @ 72 Hrs (mA)	ESR Max @ 1000 Hz (mΩ)	ESR Max @ DC (mΩ)	Max Surge (V)	Peak Current (A)	Max Op. Current @ 40°C (A)	Max Energy (Wh)
SuperCap Module													
SCMZ1EP1M6RTMB2ST	195.9	406	166	+20% / -0%	48	65	5.2	-	5.5	51	2083	199.4	53.2

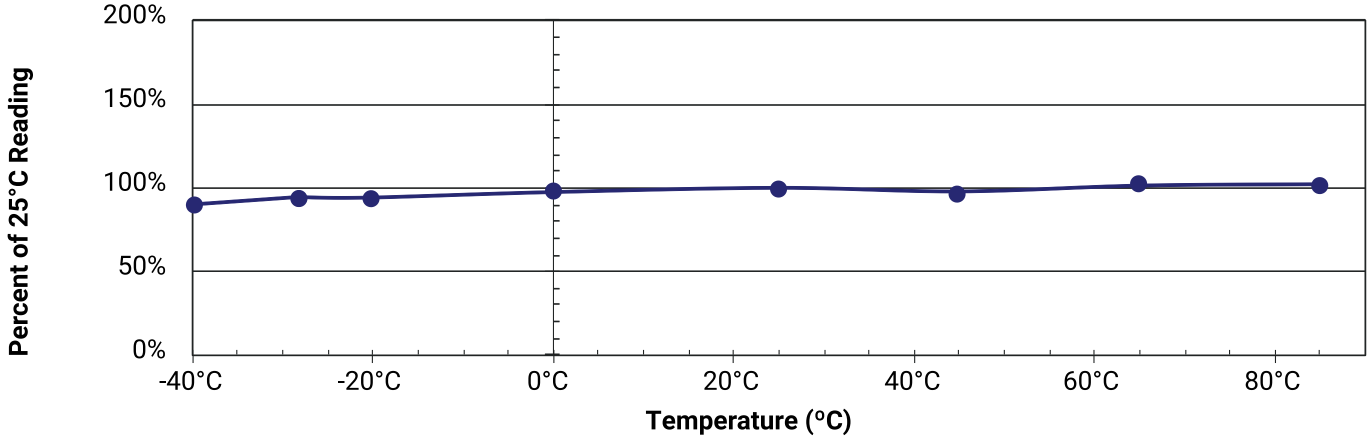
Additional Information
- Typical Weight: 16.5kg (± 1.0)
- Insulation Resistance: ≥ 20MΩ
- Insulation Strength: ≤ 5.5mA
- Recommended Torque for Power Terminals:
  M8 - 20Nm
  M10 - 30Nm
- Overvoltage Monitoring: 52.2 ± 1.35V
- Passive Cell Voltage Management

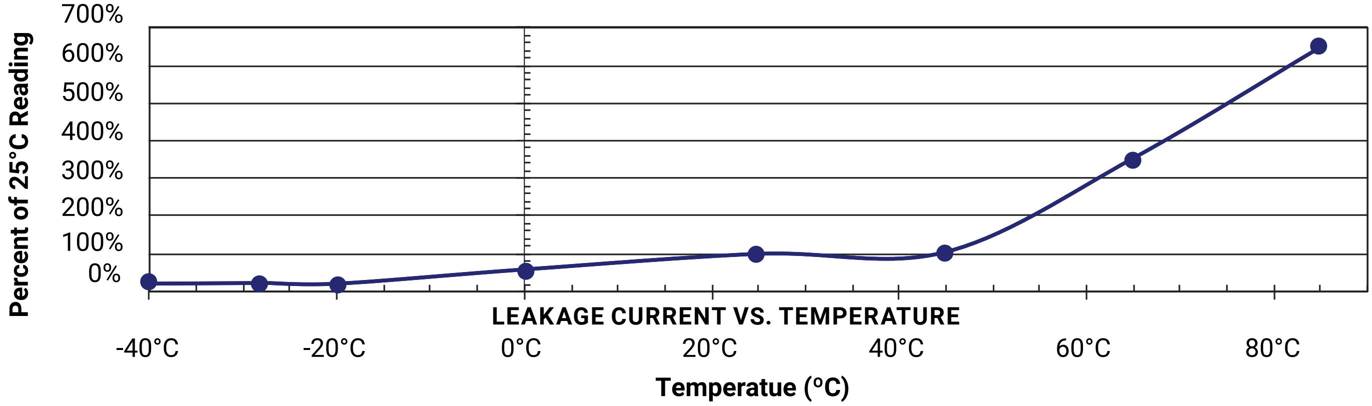
QUALIFICATION TEST SUMMARY

Test	Test Method	Parameter	Limits
Life Cycle	Capacitors are cycled between rated voltage and half-rated voltage under constant current at +25°C for 500,000 cycles and for 1,000,000 under 70% constant current	Capacitance ESR Appearance	≥70% of spec value ≤100% of spec value No remarkable defects
Temperature Characteristics	Temperature: -40°C to +65°C Voltage: Rated Voltage	Capacitance ESR Appearance	≥70% of spec value ≤100% of spec value No remarkable defects
Humidity	IEC60068-2-30	Appearance	No remarkable defects
Storage Temperature Characteristics	Storage Duration: 2 years No Load Temperature: +25°C ± 10°C	Capacitance ESR Appearance	≤10% of spec value ≤100% of spec value No remarkable defects
Shock and Vibration	IEC60068-2-6 ; IEC60068-2-27, 29	Capacitance ESR Appearance	≥70% of spec value ≤100% of spec value No remarkable defects

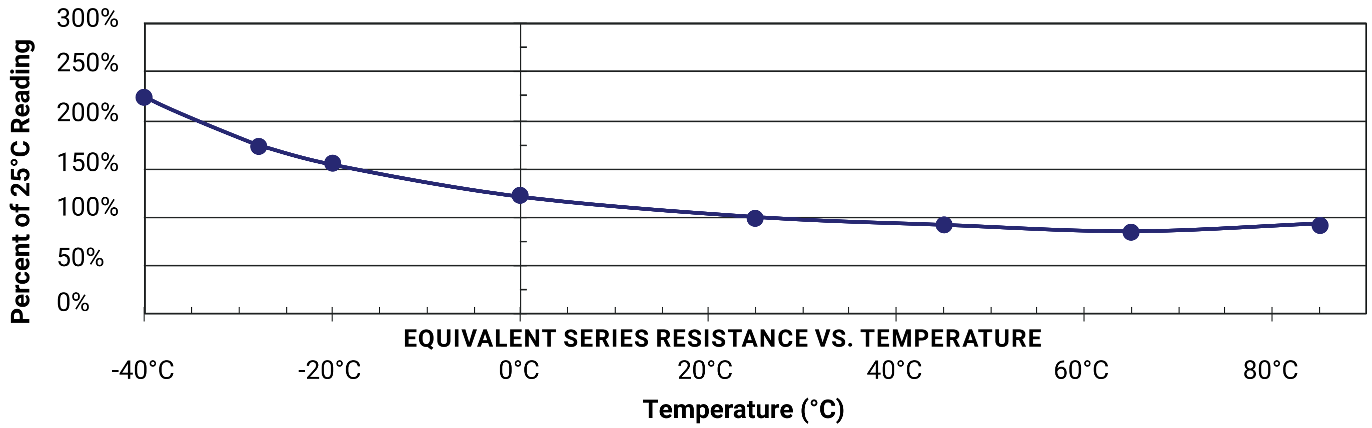
QUALITY AND RELIABILITY

CAPACITANCE VS. TEMPERATURE





LEAKAGE CURRENT VS. TEMPERATURE



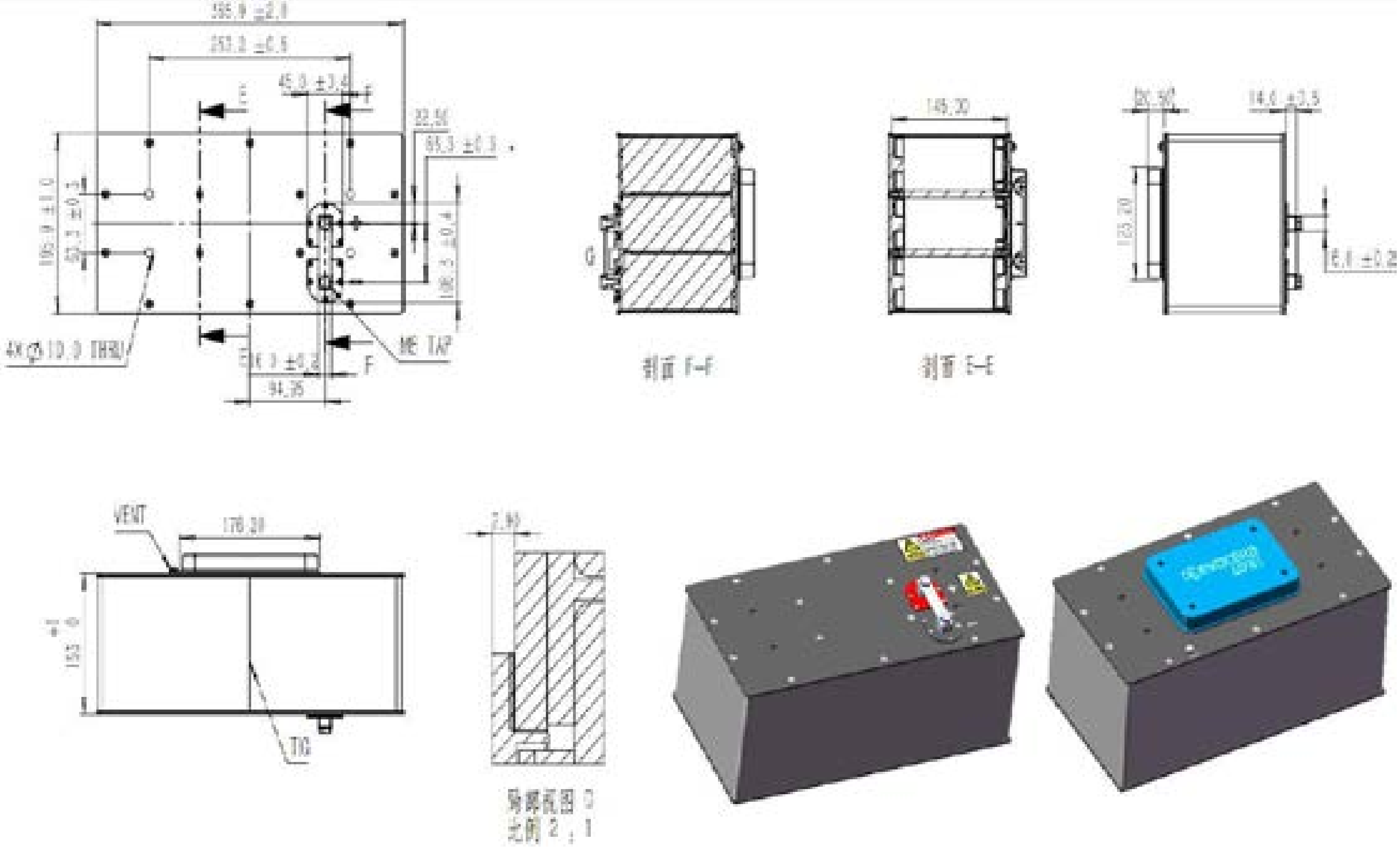
EQUIVALENT SERIES RESISTANCE VS. TEMPERATURE

SCM Series

Series-Connected SuperCapacitor Modules

MECHANICAL SPECIFICATIONS

(All dimensions in mm)

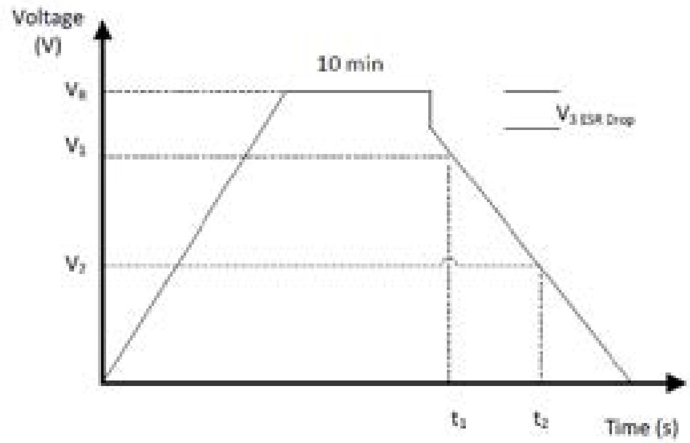


L (±2)	W (±1)	H (±1)	d (±0.05)	P (±0.25)
385.9	195.9	153	-	63.3

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 V_1, V_2, and time intervals at t_1 and t_2. Use the capacitance formula to determine cap value.



I – Discharge Current, $4 \times C \times V_R$ (mA)

V_R – Rated Voltage (V)

V_1 – Initial Test Voltage, 80% Of V_R (V)

V_2 – Final Test Voltage, 40% Of V_R (V)

t_1 – Initial Test Time (s)

T_2 – Final Test Time (s)

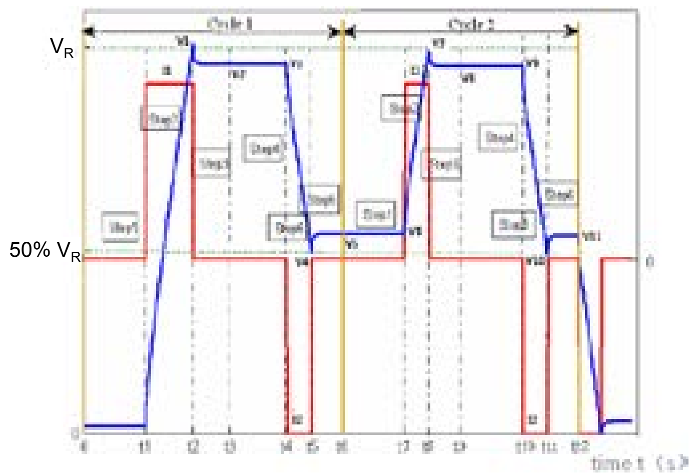
$$C = \frac{I \times (t_2 - t_1)}{V1 - V2}$$

DC ESR MEASUREMENT

A six-step ESR_{DC} test method is illustrated to the right and carried out as follows:

- Rest 10 Seconds
- Charge under constant current (I_1) to rated voltage (V_R)
- Rest 5 seconds
- Rest 10 seconds, record V_3 and t_4
- Discharge under constant current (I_2) to half rated voltage, Record I_2, V_4, And t_5
- Rest 2 seconds, record V_5 And t_6

Repeat steps 1-6 recording I, V, And t accordingly, finally discharging to below 0.1V under constant current (I_2).



Formulas to calculate:

- Two cycle discharge capacitances: $C_{dch1} = I_2 \times \frac{(t_5 - t_4)}{V_3 - V_4}$; $C_{dch2} = I_2 \times \frac{(t_{11} - t_{10})}{(V_9 - V_{10})}$
- Discharge capacitance: $C_{dch} = \frac{(C_{dch1} + C_{dch2})}{2}$
- 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: $I_1 = I_2$ = 75mA/F, the rated capacitance in the chart means discharge capacitance, and DC ESR (ESR_{DC}) 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 = (½ 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.

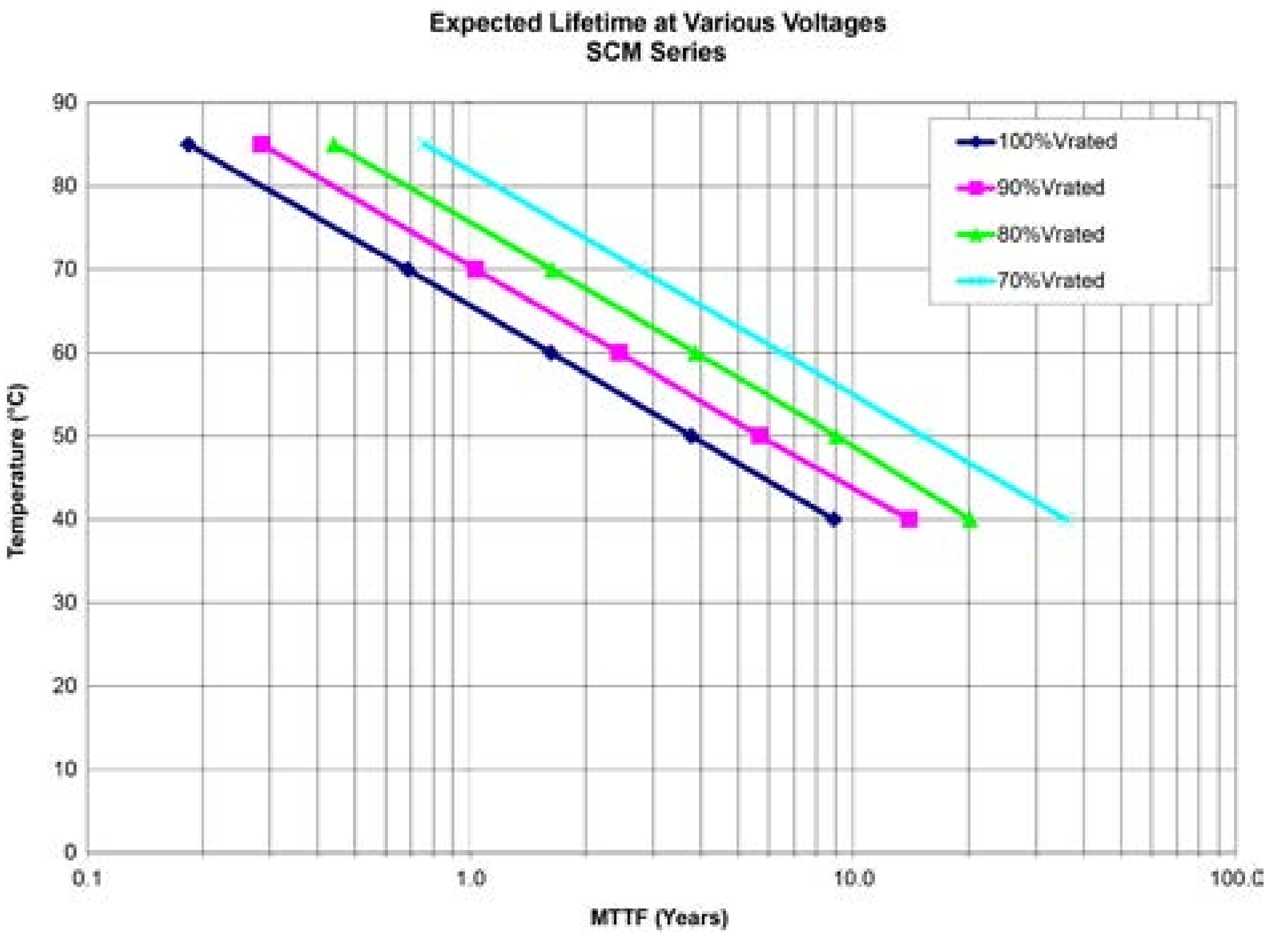
LIFE TIME AND TEMPERATURE PERFORMANCE

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.



Expected Lifetime at Various Voltages
SCM Series
Temperature (°C)
MTTF (Years)
100%Vrated
90%Vrated
80%Vrated
70%Vrated
0
10
20
30
40
50
60
70
80
90
0.1
1.0
10.0
100.0

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

- UL 810A Certified
- 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

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

- High Pulse Power Capability
- Low ESR
- Low Leakage Current
- Advanced Voltage Balance

APPLICATIONS

- Heavy Idustrial Equipment
- UPS/Industrial Systems
- Energy Harvesting
- Regenerative Energy Capture
- Peak Power Assist

HOW TO ORDER

SCM	056	S	130	P	T	B	G	0
Series SuperCap Module	**Voltage Code** 056 = 56V	**Initial Capacitance Tolerance** S = +30%/-10%	**Capacitance** 130 = 130F	**Housing** P = Plastic Casing	**Terminals** T = M8 (+) / M10 (-)	**Packaging** B = Bulk (Standard)	**Balancing** G = Advanced Voltage Balancing	**Special Code** 0 = Not Used (Standard)

QUALITY INSPECTION

Parts are qualified for life cycle, high temperature load life, and storage temperature characteristics. See page 2 for more information.

TERMINATION

This module has M8 (+) and M10 (-) power terminals, and recommended torque is 20 Nm (+) and 30 Nm (-). Module is equipped with advanced voltage balancing and overvoltage alarm. See page 4 for more information.

OPERATING TEMPERATURE

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

LEAD-FREE
LEAD-FREE COMPATIBLE COMPONENT

RoHS COMPLIANT

For RoHScompliant products, please select correct termination style

SCM Series

Series-Connected SuperCapacitor Modules

RATINGS & PART NUMBER REFERENCES

Part Number	Rated Voltage (V)	Max Surge Voltage	Nominal Capacitance	Initial Capacitance Tolerance	DCL Max @ 72 Hrs, 25°C	ESR_{DC} Max	Max Peak Curent	Power Density	Max Energy	Energy Density
SuperCap Module										
SCM056S130PTBG0	56V	62V	130F	+30%/-10%	120mA	8.1mΩ	1900A	2581 W/kg	57 Wh	3.15 Wh/kg

Additional Information

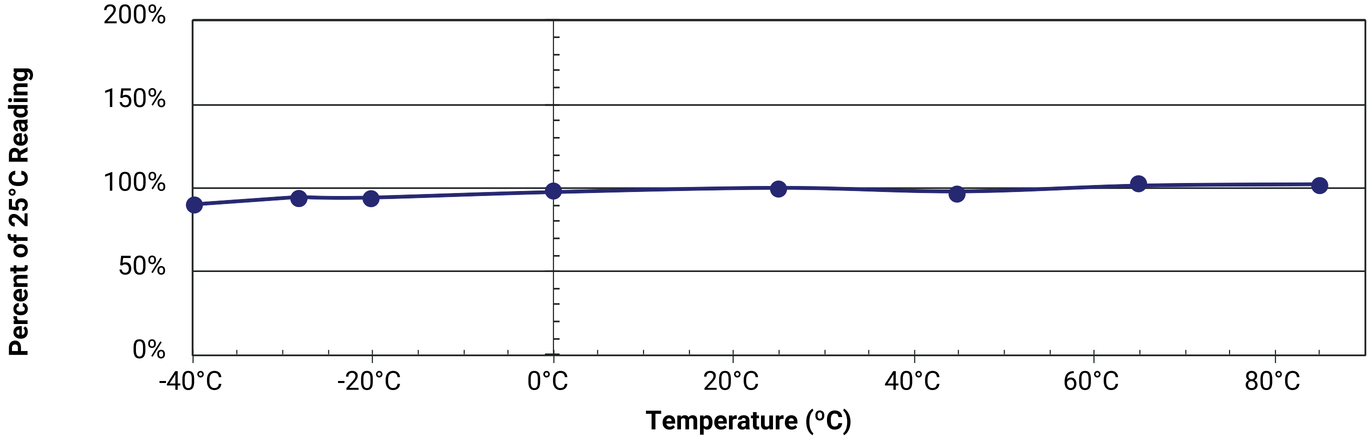
- Maximum Continuous Current (ΔT=15°C) = 61A
- Maximum Continuous Current (ΔT=40°C) = 99A
- Nominal Module Dimensions: 683mm X 177mm X 175mm
- Typical Mass: 18 kg
- Individual Cells & Configuration: 2.7V 3000F, 23s1p

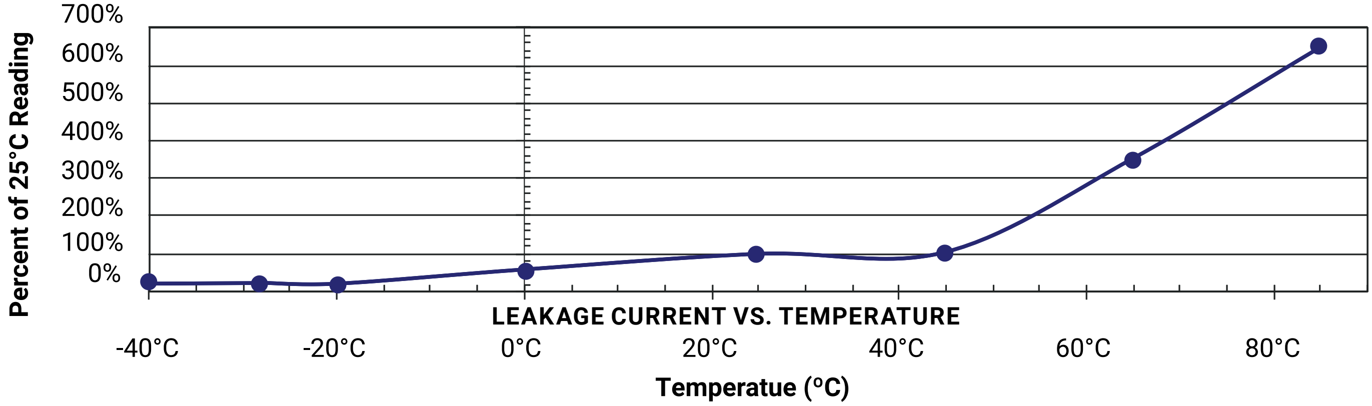
QUALIFICATION TEST SUMMARY

Test	Test Method	Parameter	Limits
Life Cycle	Capacitors are cycled between rated voltage and half-rated voltage under constant current at +25°C for 500,000 cycles	Capacitance Change ESR Appearance	≥70% of spec value ≤200% of spec value No remarkable defects
High Temperature Load Life	Temperature: +40°C Voltage: Rated Voltage Duration: 8 years	Capacitance Change ESR Appearance	≥70% of spec value ≤200% of spec value No remarkable defects
Storage Temperature Characteristics	Storage Duration: 4 years No Load Temperature: +25°C	Capacitance Change ESR Appearance	≥70% of spec value ≤200% of spec value No remarkable defects

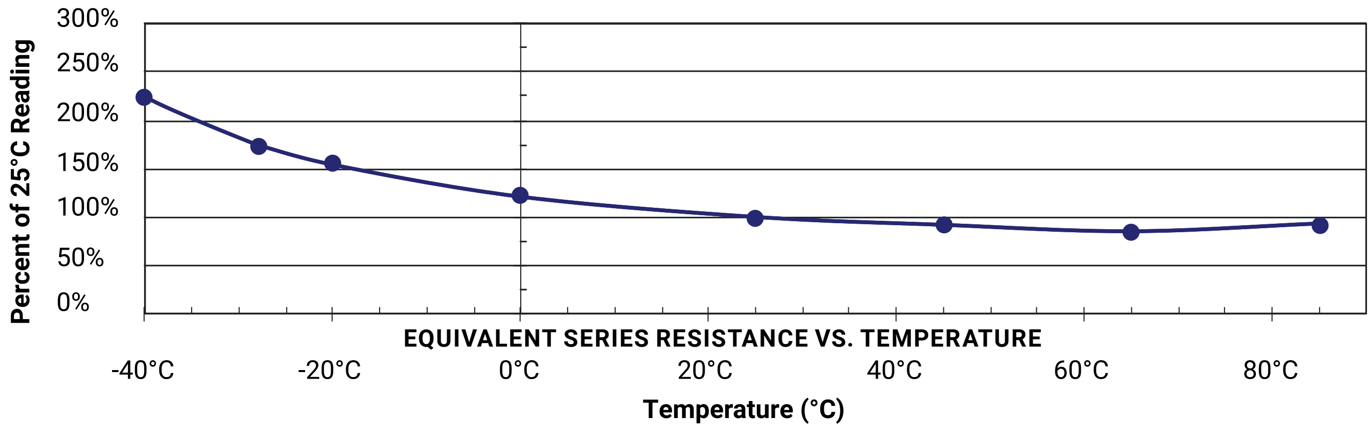
QUALITY AND RELIABILITY

CAPACITANCE VS. TEMPERATURE





LEAKAGE CURRENT VS. TEMPERATURE



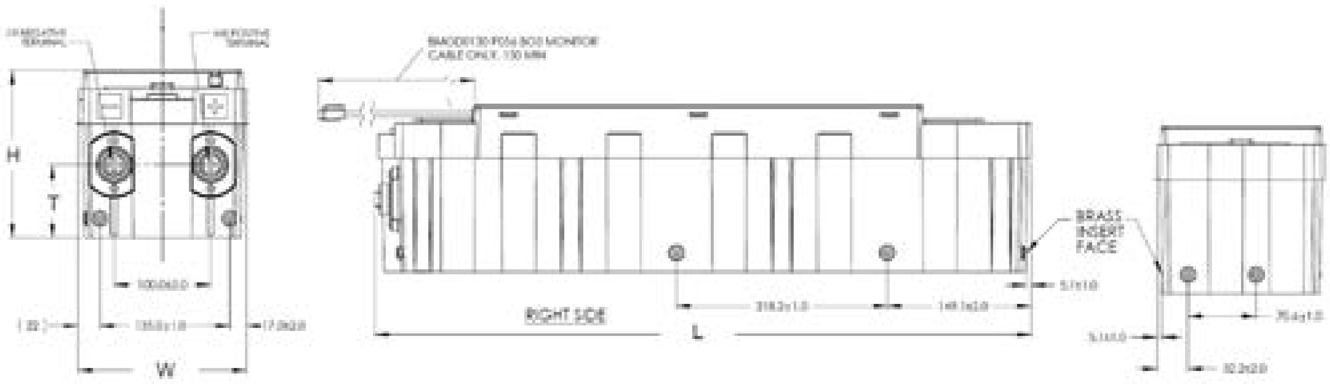
EQUIVALENT SERIES RESISTANCE VS. TEMPERATURE

SCM Series

Series-Connected SuperCapacitor Modules

MECHANICAL SPECIFICATIONS

(All dimensions in mm)

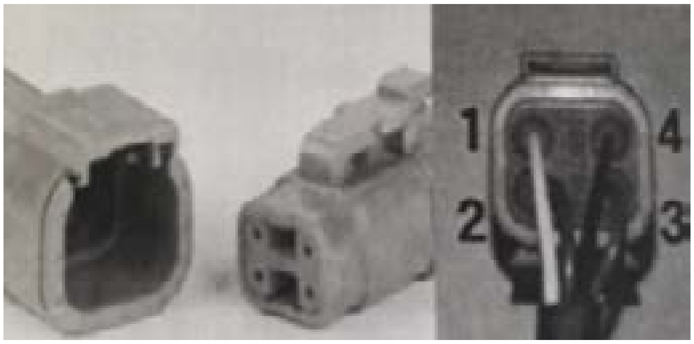


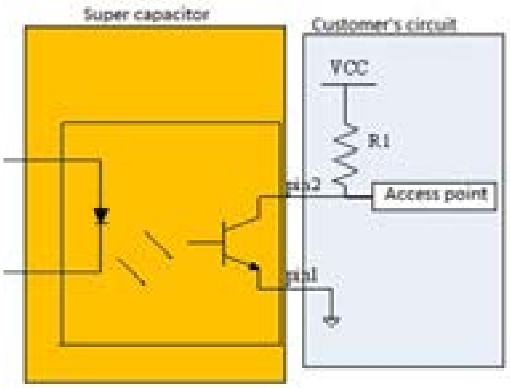
Dimensions			
L (Max)	W (Max)	H (Max)	T (±0.05)
693	177	175	74.9

Item	Spec	Notes
Single Cell	Cell size: Φ60×138 Model: 2.7V 3000F Cell ESR_{DC}: ≤0.3mΩ	
PCB Board	Advanced voltage management	
Outer Case	Plastic case	
Connector	Amphenol_ATM04-4P, ATM06-4S	Shipment includes male and female terminals

MONITORING

Connector: Deutsch DTM DT06-4S, DT04-4P
Overvoltage alarm is triggered when total voltage ≥ 60V.





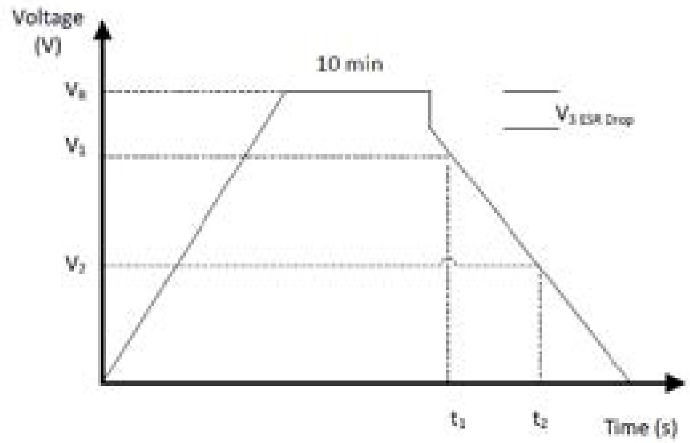
Pin	Color	Designation
1	White	Ground
2	Red	Overvoltage
3	Green	Not used
4	Black	Not used

Vcc Voltage (V)	R1 (Ω)
24	4.7K
12	2.4K

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 V_1, V_2, and time intervals at t_1 and t_2. Use the capacitance formula to determine cap value.



I – Discharge Current, $4 \times C \times V_R$ (mA)

V_R – Rated Voltage (V)

V_1 – Initial Test Voltage, 80% Of V_R (V)

V_2 – Final Test Voltage, 40% Of V_R (V)

t_1 – Initial Test Time (s)

T_2 – Final Test Time (s)

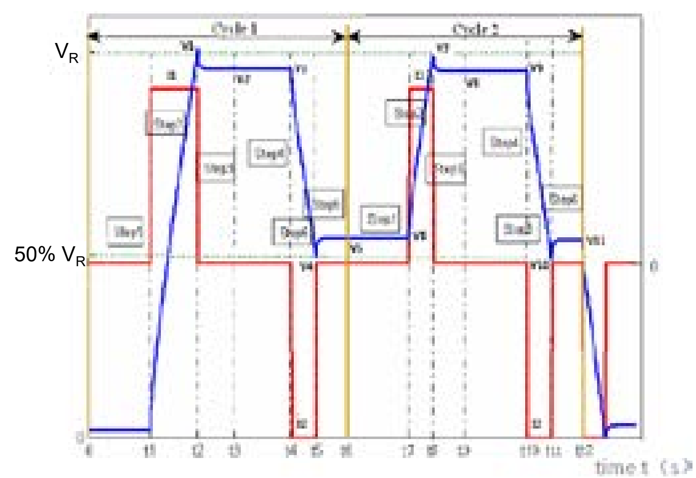
$$C = \frac{I \times (t_2 - t_1)}{V1 - V2}$$

DC ESR MEASUREMENT

A six-step ESR_{DC} test method is illustrated to the right and carried out as follows:

- Rest 10 Seconds
- Charge under constant current (I_1) to rated voltage (V_R)
- Rest 5 seconds
- Rest 10 seconds, record V_3 and t_4
- Discharge under constant current (I_2) to half rated voltage, Record I_2, V_4, And t_5
- Rest 2 seconds, record V_5 And t_6

Repeat steps 1-6 recording I, V, And t accordingly, finally discharging to below 0.1V under constant current (I_2).



Formulas to calculate:

- Two cycle discharge capacitances: $C_{dch1} = I_2 \times \frac{(t_5 - t_4)}{V_3 - V_4}$; $C_{dch2} = I_2 \times \frac{(t_{11} - t_{10})}{(V_9 - V_{10})}$
- Discharge capacitance: $C_{dch} = \frac{(C_{dch1} + C_{dch2})}{2}$
- 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: $I_1 = I_2$ = 75mA/F, the rated capacitance in the chart means discharge capacitance, and DC ESR (ESR_{DC}) 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 = ($0.12 \cdot V^2 / R_{DC}$) / mass

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

CHARGE / DISCHARGE / POLARITY
Charge voltage should not exceed rated voltage. Charge and discharge current should not exceed max rated current. Always maintain charge and discharge within the operating temperature range. Failure to follow these recommendations could cause performance & safety issues, overheating, and/or increased capacitance and ESR degradation. For product consistency and optimum performance, it is recommended that the module be connected with polarity indicated. Reversing polarity will result in reduced module performance and permanent damage to the circuit.

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.

SAFETY RECOMMENDATIONS

WARNINGS

- 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

REGULATORY / ENVIRONMENTAL

- RoHS Compliant
- Individual 3000F cells are UL 810A certified
- IP30 rated
- Vibration Spec: Telcordia GR-63-CORE Zone 4
- HIPOT Capability: 4000V DC; Test time = 60 seconds*
- Short Circuit Current: 6900A*

*Note: Not to be used as operating current

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

SCP Series

PrizmaCap™

GENERAL DESCRIPTION

KYOCERA AVX's new PrizmaCap capacitors, or SCP Series, are prismatic EDLCs (supercapacitors). The SCP Series provides the lowest profile & widest operating temperature available in KYOCERA AVX SuperCapacitors. Used by themselves or in conjunction with primary or secondary batteries, they provide extended backup time, longer battery life, and provide instantaneous power pulses as needed. They are best used in applications requiring pulse power handling, energy storage, energy/power holdup, and battery assist.

FEATURES

- Widest Temperature Rating
- Larger Capacitance in Prismatic Form Factor
- Low Profile & Light Weight
- Custom Design Capabilities

APPLICATIONS

- Wearables
- Tablet/E-Reader
- Handhelds
- High Temp. Industrial
- Bluetooth Keyboard
- Battery Assist
- Power Peripherals
- Space Constrained Designs
- High Reliability

HOW TO ORDER

SCP B 13 A 855 S N A XXXX

Style
PrizmaCap™

Size (mm)
B = 48 L X 45 W

Max Thickness
Two digits represent maximum thickness in #.#mm format
(Ex: 13 = 1.3mm)

Voltage Code
A = 2.1V

Capacitance Code
The first two digits express the significant figures, and the last digit is the number of zeroes to follow. This value would be µF.
(Ex: 855 = 85×10^5 µF = 8.5F)

Tolerance
S = +30%/-10%

Lead Format
N = SMT with fixed position terminals extending from same end

Package Code
A = Label printed on the part with double-sided adhesive tape, and in tray packaging

Custom Code
Available for custom designators

For RoHS compliant products, please select correct termination style.

QUALITY INSPECTION

Parts are tested for life cycle, high temperature load life, temperature characteristics, vibration resistance, and humidity characteristics. See page 10 for more information.

TERMINATION

These supercapacitors are compatible with hand soldering as recommended on page 12.

OPERATING TEMPERATURE

-55°C to +65°C @ 2.1V

-55°C to +90°C @ 1.1V

SCP Series

PrizmaCap™

RATINGS & PART NUMBER REFERENCE

KYOCERA AVX Part Number	Length (mm)	Width (mm)	Max Thickness (mm)	Rated Capacitance (F)	Capacitance Tolerance	Rated Voltage (V)	Rated Temp. (°C)	DCL Max @ 72 Hrs (µA)	ESR Max @ 1 kHz (mΩ)	ESR Max @ DC (mΩ)	Peak Current (A)	Power Density (W/kg)	Max Energy (Wh)	Energy Density (Wh/kg)
SCPB08A355SNA	48	45	0.8	3.5	+30%/-10%	2.1/1.1*	65/90*	50	110	200	2.16	1413	0.0021	1.14
SCPB13A855SNA	48	45	1.3	8.5	+30%/-10%	2.1/1.1*	65/90*	80	50	80	5.31	2380	0.0052	1.87
SCPB20A156SNA	48	45	2.0	15	+30%/-10%	2.1/1.1*	65/90*	110	30	55	8.63	2582	0.0092	2.43

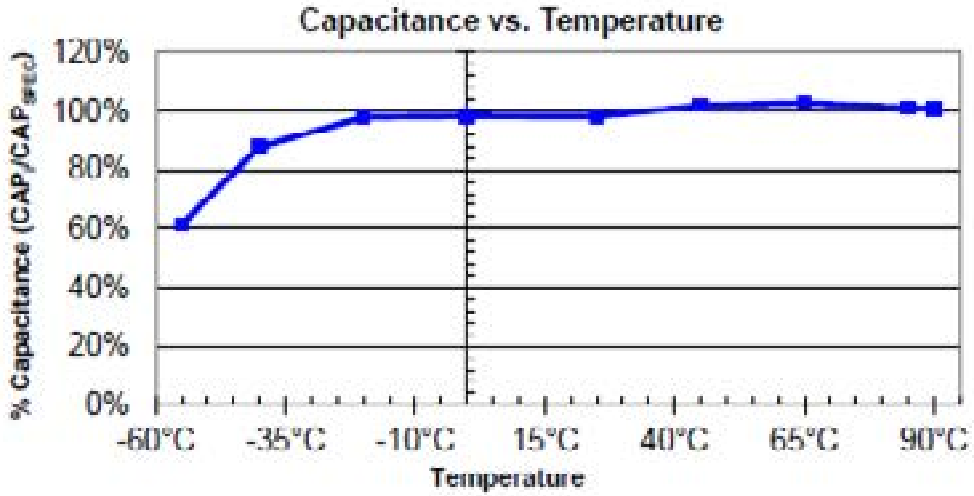
*with appropriate voltage derating operating temperature can be extended to 85°C

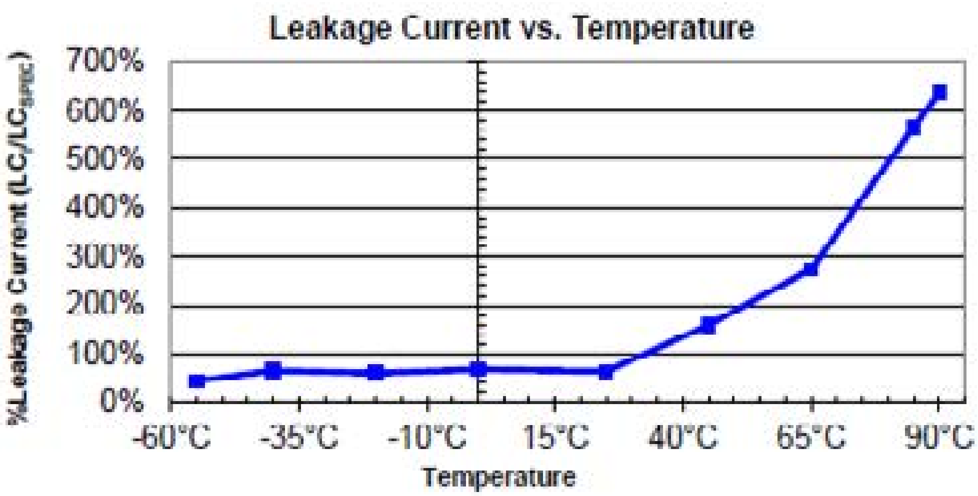
All values measured at room temperature

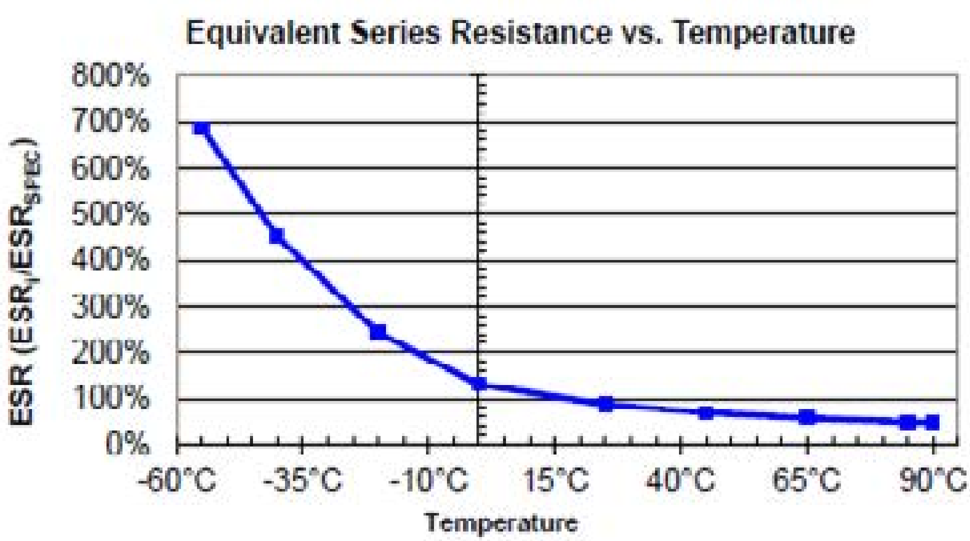
QUALIFICATION TEST SUMMARY

Test	Test Conditions	Parameter	Limits
Life Cycle	Capacitors are cycled between rated voltage and halfrated at +25°C for 500,000 cycles	Capacitance Change ESR Appearance	≤30% of spec value ≤200% of spec value No remarkable defects
High Temperature Load Life	Temperature: +65°C Voltage: Rated Voltage Test Duration: 2,000 hours	Capacitance Change ESR Appearance	≤30% of spec value ≤200% of spec value No remarkable defects
Storage Temperature Characteristics	Storage Duration: 1 year No Load Temperature: +25°C	Capacitance Change ESR Appearance	≤30% of spec value ≤200% of spec value No remarkable defects
Vibration Resistance	Amplitude: 1.5mm Frequency: 10 ~ 55Hz Direction: X, Y, Z for 2 hours each	Capacitance Change ESR Appearance	≤30% of spec value ≤200% of spec value No remarkable defects
Humidity	Voltage: Rated Voltage RH: 90% Temperature: +60°C Test Duration: 1,000 hours	Capacitance Change ESR Appearance	≤30% of spec value ≤200% of spec value No remarkable defects

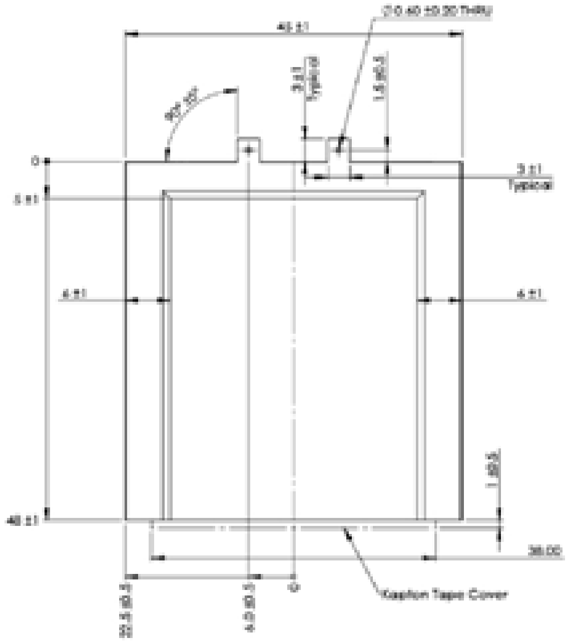
ELECTRICAL PROPERTIES VS. TEMPERATURE

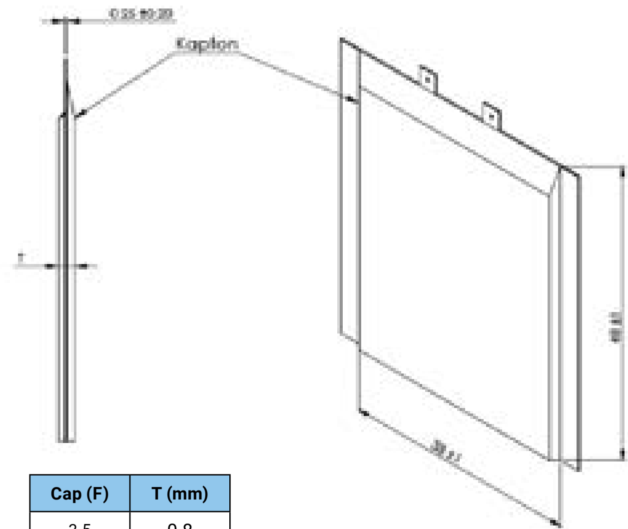






MECHANICAL SPECIFICATIONS





Cap (F)	T (mm)
3.5	0.8
8.5	1.3
15	2.0

Note: When the supercapacitor is used under stressed conditions, it is expected to see some expansion of the supercapacitor. Expansion of the supercapacitor will not affect lifetime or performance.

SOLDERING RECOMMENDATIONS

PrizmaCap products can be mounted on PCBs either by hand soldering or use of a solder iron robot which selectively heats only the capacitor terminals. IR reflow or wave soldering may not be used. The soldering iron must never come in contact with the body of the capacitor. Temperatures and times above those recommended can cause damage to the body of the capacitor and potentially damaging the electrical properties.

HAND SOLDERING

Keep some distance between the supercapacitor body and the tip of the soldering iron; contact between supercapacitor body and soldering iron will cause extensive damage to the supercapacitor. It is recommended that the soldering iron temperature should be less than 350°C, and contact time should be limited to no more than 4 seconds. Too much exposure to terminal heat during soldering can cause heat to transfer to the body of the supercapacitor, potentially damaging the supercapacitor.

Equipment:	Temperature controlled 100W general purpose soldering iron
Lead Containing Solder	
Solder Type:	Sn63/Pb37 (MP~183°C)
Temperature:	260°C (+50°C / - 50°C)
Time:	2 seconds to 5 seconds maximum
Lead Free Solder	
Solder Type:	Sn96.5/Ag3.5 or Sn96.5/Ag3/Cu0.5 or Sn95.5/Ag3.8/Cu0.7 (MP~220°C)
Temperature:	300°C (+50°C / - 50°C)
Time:	2 seconds to 5 seconds maximum

Note: Use shortest possible time to minimize heat transfer into the PrizmaCap.

TEST METHODS

IEC CAPACITANCE TEST METHOD 62391-1

Capacitance is measured using a sourcemeter (Keithley 2400 for example). Alternately, a power supply and load may be used, but accuracy can be compromised.

Procedure:

- Charge capacitor to Rated Voltage at room temperature
- Continue charging at Constant Voltage for 30 minutes
- Remove the charge and allow 10 seconds for the capacitor to stabilize
- Discharge cells with a constant current, I (mA) determined by 4 x CR x VR
- At 80%VR record (V1, t1) and at 40% VR record (V2, t2)

I	4 x CR x VR (mA)
V1	Start Voltage, 80% VR (Volts)
V2	End Voltage, 40% VR (Volts)
t1	Start Time (sec.)
t2	End Time (sec.)

Calculate Capacitance in Farads (using I in Amps.).

Capacitance – C = I x (t1 – t2)/(V1 – V2) (Farads)

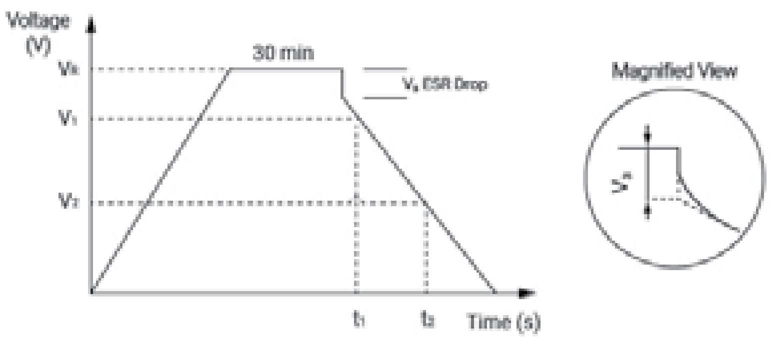


Figure 1; Constant current discharge method for capacitance, and V3 voltage drop for DCESR.

AC ESR MEASUREMENT

ACESR is measured using an LCR Meter and a Kelvin connection

Procedure:

- Measure at frequency of 1000 Hz
- Signal level of 1,000mV
- Record series resistance, Rs (Ohms)

DC ESR MEASUREMENT

DCESR can be calculated from figure 1, where RDC = V3/I

Procedure:

- To determine V3, use a straight-line approximation of the two voltage versus time curves and determine the intersection of the lines (shown in the magnified figure).

Accuracy can be increased by using a high data acquisition rate.

Alternately, DCESR is measured using an LCR Meter and a Kelvin connection.

Procedure:

- Measure at frequency of 20 Hz
- Signal level of 1,000mV
- Record DC series resistance, RDC (Ohms)

TEST METHODS

MAXIMUM OPERATING CURRENT

- This is the maximum current when capacitor temperature rise of the capacitor during its operation is less than 15°C

MAXIMUM PEAK CURRENT

- This is the maximum current in less than 1 sec

POWER DENSITY

- Power Density = (0.12*V^2 / RDC) / mass

ENERGY DENSITY

- Energy density = (½ CV^2) / (3600*mass)

POLARITY / 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

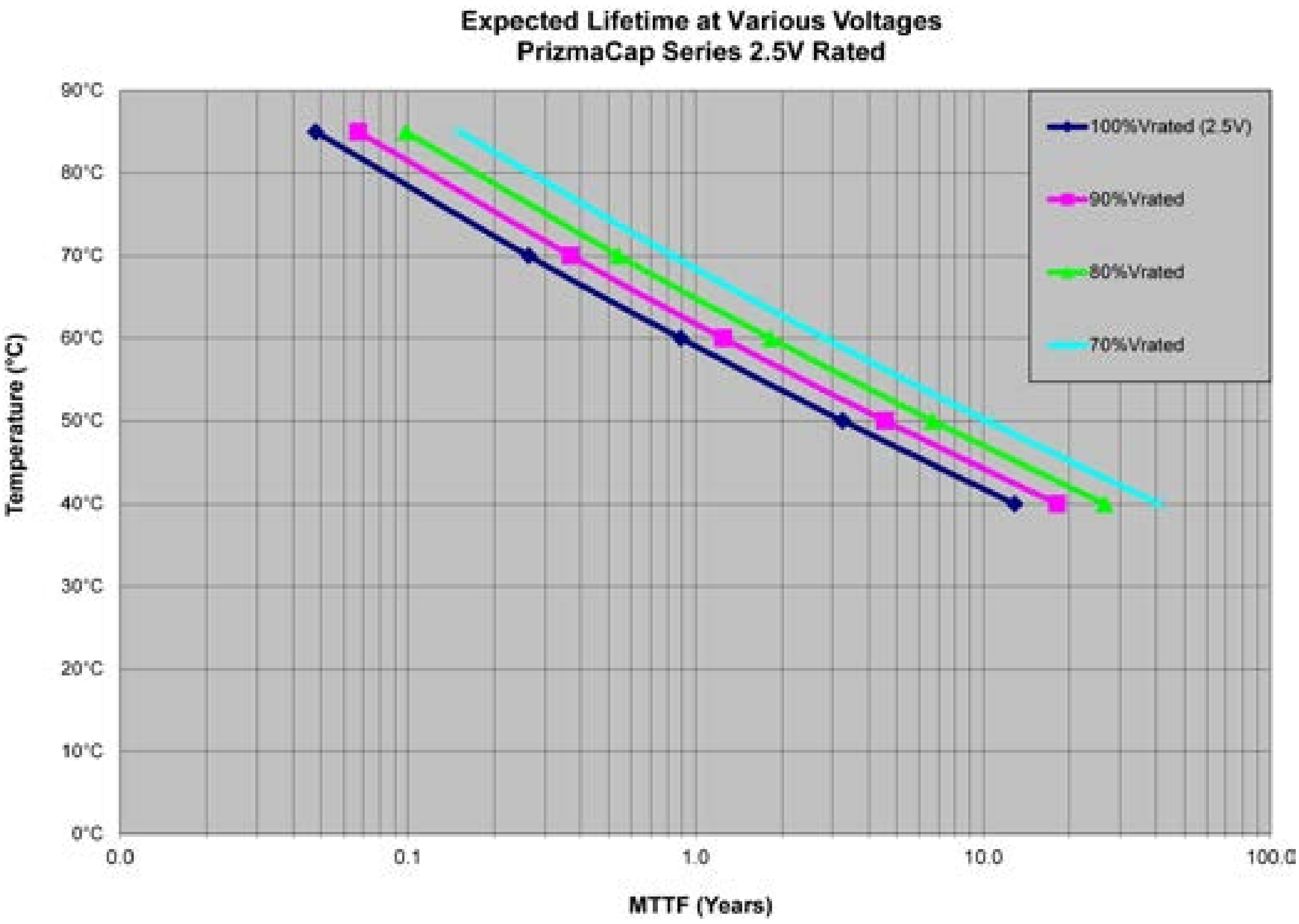
The life of a supercapacitor is impacted by a combination of operating voltage and the operating temperature according to the following Time to Failure equation:

$t \propto V^n \times e^{(-Q/kT)}$

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.

LIFE TIME AND TEMPERATURE PERFORMANCE



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 120°C, heat seal may break open
- Do not Press, Damage or disassemble the Super Capacitor, packaging 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

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