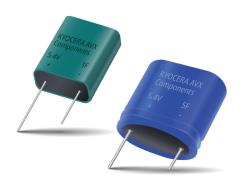
#### **Series-Connected Super Capacitor Modules**





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, pulse power applications, and battery replacement.

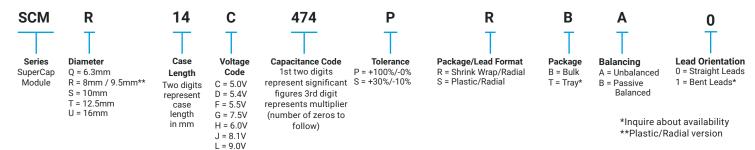
#### **FEATURES**

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

#### **APPLICATIONS**

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

#### **HOW TO ORDER**



#### **QUALITY INSPECTION**

Parts are tested for life cycle, high temperature load life, temperature characteristics, vibration resistance, and humidity characteristics. See pages 2-5 for more information.

#### **TERMINATION**

These SuperCapacitors are compatible with hand soldering and wave soldering processes, so long as appropriate precautions are followed. See 12 for more information.





For RoHS compliant products, please select correct termination style.



# 5.4V/5.0V Series-Connected SuperCapacitors Modules

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)
					Shrink W	rap / Radial Lea	ıd						
SCMQ14C474PRBA0	6.3	14	0.47	+100%/-0%	5.0/4.2*	65/85*	3	400	1000	0.80	2143	0.0016	1.17
SCMQ14C474PRTA0	6.3	14	0.47	+100%/-0%	5.0/4.2*	65/85*	3	400	1000	0.80	2143	0.0016	1.17
SCMQ14D474PRBB0	6.3	14	0.47	+100%/-0%	5.4/4.6*	65/85*	6	400	1000	0.86	2499	0.0019	1.36
SCMQ14D474PRTB0	6.3	14	0.47	+100%/-0%	5.4/4.6*	65/85*	6	400	1000	0.86	2499	0.0019	1.36
SCMR14C474PRBA0	8	14	0.47	+100%/-0%	5.0/4.2*	65/85*	5	300	1000	0.80	1429	0.0016	0.78
SCMR14D474PRBB0	8	14	0.47	+100%/-0%	5.4/4.6*	65/85*	6	300	1000	0.86	1666	0.0019	0.91
SCMR18C105PRBA0	8	18	1	+100%/-0%	5.0/4.2*	65/85*	8	200	720	1.45	1667	0.0035	1.39
SCMR18D105PRBB0	8	18	1	+100%/-0%	5.4/4.6*	65/85*	10	200	720	1.57	1944	0.0041	1.62
SCMR22C155PRBA0	8	22	1.5	+100%/-0%	5.0/4.2*	65/85*	10	190	580	2.01	1669	0.0052	1.68
SCMR22D155PRBB0	8	22	1.5	+100%/-0%	5.4/4.6*	65/85*	15	190	580	2.17	1946	0.0061	1.96
SCMS22C255PRBA0	10	22	2.5	+100%/-0%	5.0/4.2*	65/85*	20	140	360	3.29	1852	0.0087	1.93
SCMS22D255PRBB0	10	22	2.5	+100%/-0%	5.4/4.6*	65/85*	25	140	360	3.55	2113	0.0101	2.20
SCMT22C505PRBA0	12.5	22	5	+100%/-0%	5.0/4.2*	65/85*	25	100	150	7.14	2740	0.0174	2.38
SCMT22D505PRBB0	12.5	22	5	+100%/-0%	5.4/4.6*	65/85*	30	100	150	7.71	3069	0.0203	2.66
SCMT32C755SRBA0	12.5	32	7.5	+30%/-10%	5.0/4.2*	65/85*	65	70	160	8.52	1953	0.0260	2.71
SCMT32D755SRBB0	12.5	32	7.5	+30%/-10%	5.4/4.6*	65/85*	70	70	160	9.20	2209	0.0304	3.07

<sup>\*</sup>with appropriate voltage derating operating temperature can be extended to 85°C

#### **OPERATING TEMPERATURE RANGE**

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

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	≤30% of spec value ≤200% of spec value No remarkable defects
High Temperature Load Life	Temperature: +65°C Voltage: Rated Voltage Test Duration: 1,000 hours	Capacitance ESR Appearance	≤30% 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	≤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 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 ESR Appearance	≤30% of spec value ≤200% of spec value No remarkable defects



# 6.0V/5.5V Series-Connected SuperCapacitors Modules

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)
					Shrink W	rap / Radial Lea	d						
SCMQ14F474PRBA0	6.3	14	0.47	+100%/-0%	5.5/4.6*	65/85*	6	500	3000	0.54	864	0.0020	1.41
SCMQ14H474PRBB0	6.3	14	0.47	+100%/-0%	6.0/5.0*	65/85*	7	500	3000	0.59	1029	0.0024	1.68
SCMR14F474PRBA0	8	14	0.47	+100%/-0%	5.5/4.6*	65/85*	6	380	1720	0.71	1005	0.0020	0.94
SCMR14H474PRBB0	8	14	0.47	+100%/-0%	6.0/5.0*	65/85*	7	380	1720	0.78	1196	0.0024	1.12
SCMR18F105PRBA0	8	18	1	+100%/-0%	5.5/4.6*	65/85*	9	250	720	1.60	2017	0.0042	1.68
SCMR18H105PRBB0	8	18	1	+100%/-0%	6.0/5.0*	65/85*	11	250	720	1.74	2400	0.0050	2.00
SCMR22F155PRBA0	8	22	1.5	+100%/-0%	5.5/4.6*	65/85*	12	200	560	2.24	2091	0.0063	2.03
SCMR22H155PRBB0	8	22	1.5	+100%/-0%	6.0/5.0*	65/85*	18	200	560	2.45	2488	0.0075	2.42
SCMS22F255PRBA0	10	22	2.5	+100%/-0%	5.5/4.6*	65/85*	24	180	340	3.72	2373	0.0105	2.33
SCMS22H255PRBB0	10	22	2.5	+100%/-0%	6.0/5.0*	65/85*	30	180	340	4.05	2762	0.0125	2.72
SCMS32F505PRBA0	10	32	5	+100%/-0%	5.5/4.6*	65/85*	30	120	150	7.86	3580	0.0210	3.11
SCMS32H505PRBB0	10	32	5	+100%/-0%	6.0/5.0*	65/85*	36	120	150	8.57	4235	0.0250	3.68
SCMT22F505PRBA0	12.5	22	5	+100%/-0%	5.5/4.6*	65/85*	30	120	150	7.86	3176	0.0210	2.76
SCMT32F755SRBA0	12.5	32	7.5	+30%/-10%	5.5/4.6*	65/85*	78	90	120	10.86	3151	0.0315	3.28
SCMT32H755SRBB0	12.5	32	7.5	+30%/-10%	6.0/5.0*	65/85*	84	90	120	11.84	3600	0.0375	3.75
SCMU33F156SRBA0	16	33	15	+30%/-10%	5.5/4.6*	65/85*	85	35	50	23.57	4033	0.0630	3.50
SCMU33F156SRBB0	16	33	15	+30%/-10%	5.5/4.6*	65/85*	90	35	50	23.57	3946	0.0630	3.43
					Plastic	/ Radial Lead							
SCMR14F474PSBA0	9.5	16	0.47	+100%/-0%	5.5/4.6*	65/85*	6	380	1720	0.71	541	0.0020	0.51
SCMR14H474PSBB0	9.5	16	0.47	+100%/-0%	6.0/5.0*	65/85*	7	380	1720	0.78	644	0.0024	0.60
SCMR18F105PSBA0	9.5	20	1	+100%/-0%	5.5/4.6*	65/85*	9	250	720	1.60	1096	0.0042	0.91
SCMR18H105PSBB0	9.5	20	1	+100%/-0%	6.0/5.0*	65/85*	11	250	720	1.74	1304	0.0050	1.09
SCMR22F155PSBA0	9.5	24	1.5	+100%/-0%	5.5/4.6*	65/85*	12	200	560	2.24	1179	0.0063	1.15
SCMR22H155PSBB0	9.5	24	1.5	+100%/-0%	6.0/5.0*	65/85*	18	200	560	2.45	1403	0.0075	1.36

#### **OPERATING TEMPERATURE RANGE**

-40°C to +65°C @ 6.0V Balanced, 5.5V Unbalanced -40°C to +85°C @ 5.0V Balanced, 4.6V Unbalanced

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	≤30% of spec value ≤200% of spec value No remarkable defects
High Temperature Load Life	Temperature: +65°C Voltage: Rated Voltage Test Duration: 1,000 hours	Capacitance ESR Appearance	≤30% 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	≤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 ESR Appearance	≤30% of spec value ≤200% of spec value No remarkable defects
Voltage: Rated Voltage RH: 90% Temperature: +60°C Test Duration: 1,000 hours		Capacitance ESR Appearance	≤30% of spec value ≤200% of spec value No remarkable defects



# 7.5V Series-Connected Super Capacitor Modules

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)
					Shrink W	rap / Radial Lea	ıd						
SCMR14G334SRBA0	8	14	0.33	+30%/-10%	7.5/6.4*	65/85*	6	450	900	0.95	2419	0.0026	0.83
SCMR14G334SRBB0	8	14	0.33	+30%/-10%	7.5/6.4*	65/85*	7	450	900	0.95	2419	0.0026	0.83
SCMR18G604SRBA0	8	18	0.6	+30%/-10%	7.5/6.4*	65/85*	9	225	450	1.77	3947	0.0047	1.23
SCMR18G604SRBB0	8	18	0.6	+30%/-10%	7.5/6.4*	65/85*	11	225	450	1.77	3846	0.0047	1.20
SCMR22G105SRBA0	8	22	1	+30%/-10%	7.5/6.4*	65/85*	10	180	360	2.76	4076	0.0078	1.70
SCMR22G105SRBB0	8	22	1	+30%/-10%	7.5/6.4*	65/85*	15	180	360	2.76	3989	0.0078	1.66

<sup>\*</sup>with appropriate voltage derating operating temperature can be extended to  $85^{\circ}\text{C}$ 

#### **OPERATING TEMPERATURE RANGE**

-40°C to +65°C @ 7.5V

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	≤30% of spec value ≤200% of spec value No remarkable defects
High Temperature Load Life	Temperature: +65°C  Voltage: Rated Voltage  Test Duration: 1,000 hours		≤30% 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	≤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 ESR Appearance	≤30% of spec value ≤200% of spec value No remarkable defects
Humidity	Voltage: Rated Voltage RH: 90%		≤30% of spec value ≤200% of spec value No remarkable defects

<sup>-40°</sup>C to +85°C @ 6.4V



# 9.0V/8.1V Series-Connected Super Capacitor Modules

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)
Shrink Wrap / Radial Lead													
SCMR14J334SRBA0	8	14	0.33	+30%/-10%	8.1/6.9*	65/85*	6	500	2850	0.69	897	0.0030	0.98
SCMR14J334SRBB0	8	14	0.33	+30%/-10%	8.1/6.9*	65/85*	7	500	2850	0.69	869	0.0030	0.95
SCMR14L334SRBB0	8	14	0.33	+30%/-10%	9.0/7.6*	65/85*	7	500	2850	0.77	1072	0.0037	1.17
SCMR18J604SRBA0	8	18	0.6	+30%/-10%	8.1/6.9*	65/85*	9	400	1080	1.47	1934	0.0055	1.45
SCMR18J604SRBB0	8	18	0.6	+30%/-10%	8.1/6.9*	65/85*	12	400	1080	1.47	1869	0.0055	1.40
SCMR18L604SRBB0	8	18	0.6	+30%/-10%	9.0/7.6*	65/85*	12	400	1080	1.64	2308	0.0068	1.73
SCMR22J105SRBA0	8	22	1	+30%/-10%	8.1/6.9*	65/85*	12	350	840	2.20	1986	0.0091	1.93
SCMR22J105SRBB0	8	22	1	+30%/-10%	8.1/6.9*	65/85*	15	350	840	2.20	1894	0.0091	1.84
SCMR22L105SRBB0	8	22	1	+30%/-10%	9.0/7.6*	65/85*	18	350	840	2.45	2338	0.0113	2.27
					Plastic	/ Radial Lead							
SCMR14J334SSBA0	9.5	16	0.33	+30%/-10%	8.1/6.9*	65/85*	6	500	2850	0.69	498	0.0030	0.54
SCMR14L334SSBB0	9.5	16	0.33	+30%/-10%	9.0/7.6*	65/85*	7	500	2850	0.77	598	0.0037	0.65
SCMR18J604SSBA0	9.5	20	0.6	+30%/-10%	8.1/6.9*	65/85*	9	400	1080	1.47	1063	0.0055	0.80
SCMR18L604SSBB0	9.5	20	0.6	+30%/-10%	9.0/7.6*	65/85*	12	400	1080	1.64	1286	0.0068	0.96
SCMR22J105SSBA0	9.5	24	1	+30%/-10%	8.1/6.9*	65/85*	12	350	840	2.20	1129	0.0091	1.10
SCMR22L105SSBB0	9.5	24	1	+30%/-10%	9.0/7.6*	65/85*	18	350	840	2.45	1361	0.0113	1.32

#### **OPERATING TEMPERATURE RANGE**

-40°C to +65°C @ 9.0V Balanced, 8.1V Unbalanced

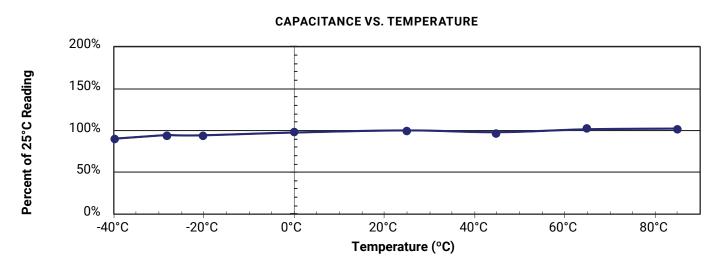
-40°C to +85°C @ 7.6V Balanced, 6.9V Unbalanced

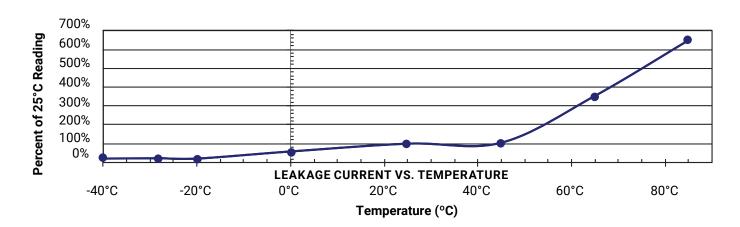
Test	Test Method	Parameter	Limits
Life Cycle	Capacitors are cycled between rated voltage and half-rated voltage under constant current at +25°C for 500,000 cycles	Capacitance ESR Appearance	≤30% of spec value ≤200% of spec value No remarkable defects
High Temperature Load Life			≤30% of spec value ≤200% of spec value No remarkable defects
Storage Temperature Characteristics	Storage Duration: 2 years No Load Temperature: +35°C	Capacitance ESR Appearance	≤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 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		≤30% of spec value ≤200% of spec value No remarkable defects

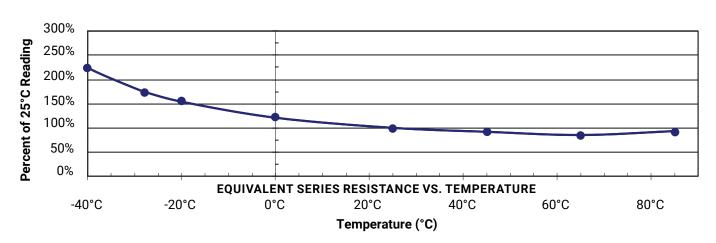




#### **QUALITY AND RELIABILITY**







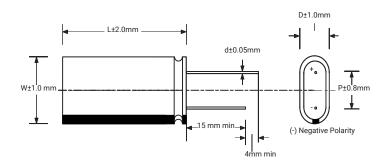


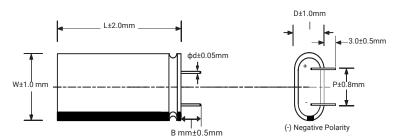


#### **MECHANICAL SPECIFICATIONS**

#### 5.4V, 6.0V SHRINK WRAP TYPE - STRAIGHT LEADS

#### 5.4V, 6.0V SHRINK WRAP TYPE - BENT LEADS



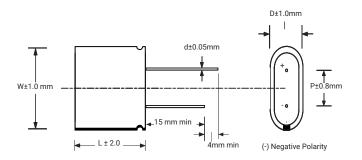


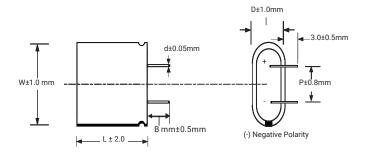
Cap (F)	D (mm)	W (mm)	L (mm)	P (mm)	d (mm)	B (mm)*
0.47	6.3	13.6	14.0	9.0	0.6	2.0
0.47	8.0	16.0	14.0	11.5	0.6	2.0
1	8.0	16.0	18.0	11.5	0.6	2.0
1.5	8.0	16.0	22.0	11.5	0.6	2.0
2.5	10.0	20.0	22.0	15.5	0.6	2.0
5	10.0	20.0	32.0	15.5	0.6	2.0
5	12.5	25.0	22.0	18.0	0.6	2.0
7.5	12.5	25.0	32.0	18.0	0.6	2.0
15	16.0	32.0	33.0	23.7	0.8	2.0

<sup>\*</sup>for version with bent leads

#### 7.5V, 9.0V SHRINK WRAP TYPE - STRAIGHT LEADS

#### 7.5V, 9.0V SHRINK WRAP TYPE - BENT LEADS





Cap (F)	D (mm)	W (mm)	L (mm)	P (mm)	d (mm)	B (mm)*
0.33	8.0	24.0	14.0	13.5	0.6	2.0
0.6	8.0	24.0	18.0	13.5	0.6	2.0
1	8.0	24.0	22.0	13.5	0.6	2.0

<sup>\*</sup>for version with bent leads



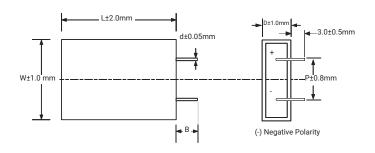


#### **MECHANICAL SPECIFICATIONS**

#### **6.0V PLASTIC TYPE - STRAIGHT LEADS**

# d±0.05mm (-) Negative Polarity 4mm min

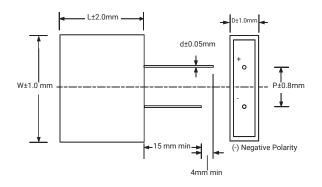
#### **6.0V PLASTIC TYPE - BENT LEADS**



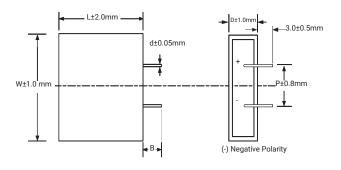
Cap (F)	D (mm)	W (mm)	L (mm)	P (mm)	d (mm)	B (mm)*
0.47	9.5	18.5	16.0	11.5	0.6	2.0
1	9.5	18.5	20.0	11.5	0.6	2.0
1.5	9.5	18.5	24.0	11.5	0.6	2.0

<sup>\*</sup>for version with bent leads

#### 9.0V PLASTIC TYPE - STRAIGHT LEADS



#### 9.0V Plastic Type - Bent Leads



Cap (F)	D (mm)	W (mm)	L (mm)	P (mm)	d (mm)	B (mm)*
0.33	9.5	26.6	16.0	13.5	0.6	2.0
0.6	9.5	26.6	20.0	13.5	0.6	2.0
1	9.5	26.6	24.0	13.5	0.6	2.0

<sup>\*</sup>for version with bent leads

# **Series-Connected Super Capacitor Modules**

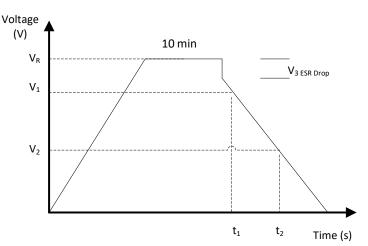
# **K**YOCERa

#### **TEST METHODS**

#### **IEC CAPACITANCE TEST METHOD**

Procedure:

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



I - Discharge Current, 4 × C × V<sub>R</sub> (mA)

V<sub>p</sub> - Rated Voltage (V)

V<sub>1</sub> - Initial Test Voltage, 80% Of V<sub>p</sub> (V)

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

t, - Initial Test Time (s)

T<sub>2</sub> - Final Test Time (s)

$$C = \frac{1 \times (t_2 - t_1)}{V1 - V2}$$

#### DC ESR MEASUREMENT

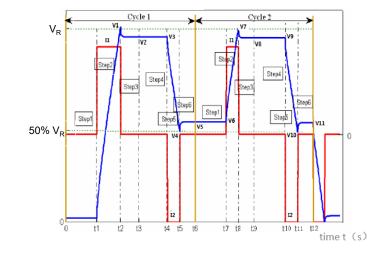
A six-step  $\mathsf{ESR}_{\mathtt{DC}}$  test method is illustrated to the right and carried out as follows:

- Rest 10 Seconds
- Charge under constant current (I<sub>1</sub>) to rated voltage (V<sub>R</sub>)
- Rest 5 seconds
- Rest 10 seconds, record V<sub>3</sub> and t<sub>4</sub>
- Discharge under constant current (I2) to half rated voltage, Record I<sub>2</sub>, V<sub>4</sub>, And t<sub>5</sub>
- Rest 2 seconds, record V<sub>5</sub> And t<sub>6</sub>

Repeat steps 1-6 recording I, V, And t accordingly, finally discharging to below 0.1V under constant current (I<sub>2</sub>).

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:  $ESR_{dch1} = \frac{(V_s V_4)}{I_2}$ ;  $ESR_{dch2} = \frac{(V_{11} V_{10})}{I_2}$ Discharge DC ESR:  $ESR_{dch} = \frac{(ESR_{dch1} + ESR_{dch2})}{2}$



Note: I<sub>1</sub> = I<sub>2</sub> = 75mA/F, the rated capacitance in the chart means discharge capacitance, and DC ESR (ESR<sub>DC</sub>) means discharge DC resistance.



#### **Series-Connected Super Capacitor Modules**

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 =  $(0.12*V^2 / R_{pc})$  / mass

#### **ENERGY DENSITY**

Energy Density = (½ CV²) / (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**

