WP Series For
Wind Power Applications

Inventing Green Solutions

www.capacitorsite.com
Email: spel@supercapacitor.in

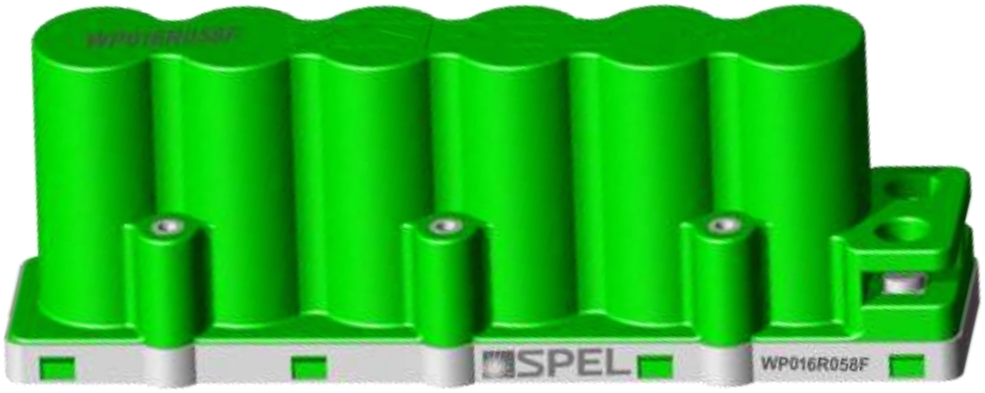
Introduction: Wind Pitch Control systems dynamically adjust blade position relative to wind speed in order to maximize the efficiency for power generation and to minimize the effect of tower shadow. This pitch control also acts as safety feature for when wind speeds are too high or grid connection to the wind turbine is lost. In either case, the pitch control adjusts the blade position to neutral, acting as a break for the turbine system. The pitch control system in a wind turbine is located in the rotor hub and controls the rotor blades. Typically, at least two functioning systems are required to bring a wind turbine to rest. Generally power supply is located stationary inside the hub, and the energy storage for is located in the rotating assembly. For reliability and safety: turbine manufacturers rely on either hydraulic or electrical based pitch control systems. In recent years there has been a trend toward electrical pitch control systems due to environmental and maintenance concerns.

To ensure reliable and safe operation of the electrical pitch control systems, SPEL ***WP Series Supercapacitors*** provide the necessary backup power to orient the rotor blades in a fail-safe position in the event of a power loss.

Advantage of Using Supercapacitor for Wind Pitch Control: Reliability and Safety, requirement limits energy storage options, batteries require a significant structure to support them in rotation as well as insulation to stave off the effects of cold. Battery assisted system requires venting provision to remove hydrogen gas build-up from cycling, also moisture protection and Battery management systems for better service life.

Supercapacitors scores over battery for this critical application as they are lightweight and nearly solid state devices. In cold weather the higher power capability of supercapacitors compared to batteries translates to faster response time for similarly designed systems. The transition from battery to supercapacitor based designs improves economics for wind farm operation. Due to longer life span (more than 10years) and practically no maintenance required, the economics become more significant for offshore wind installations.

SPEL ***Wind Power Series*** **WP016R058F** *for Wind Turbine pitch Control*



Dimensions: L *226.5* mm x W *49.5* mm x H *76.0* mm (*Tol. +/- 0.5mm***)**

Basic Specifications

Capacitance	Capacitance Tolerance	Working Voltage DC	Surge Voltage DC	Termination	Balancing	Typical Mass	Operating Temperature Range	Typical Cycle Life (25 °C)
58.0 F	0% to 20%	16.0V	18.4	Screw M5	Resistor	0.65 Kg	-40~ 65 °C	500,000 cycles

Inventing Green Solutions

Electrical Specifications

Rated Capacitance [1]	58.0 Farads
Initial Minimum Capacitance	58.0 Farads
Initial Maximum Capacitance	70.0 Farads
Rated Voltage	16.0 VDC
Absolute Maximum Voltage [2]	18.4 VDC
Absolute Maximum Current	170.0 Amps
Initial Maximum ESR (DC) [3]	21.0 milli-ohms
Test Current for Capacitance and ESR (DC) [3]	35.0 Amps
Maximum Leakage Current [4]	23.0 mA
Maximum Continuous Current	20 A
Usable Specific Power [5]	2250 W/Kg
Stored Energy (E_{stored}) [5]	2.1 Wh
Impedance Match Specific Power [5]	4689 W/kg.
Gravimetric Specific Energy (E_{max}) [5]	3.23 Wh/kg
Number of Individual Cells	6
Capacitance of Individual Cells	350.0 Farads
Maximum Stored Energy per Cell (E_{stored}) [5]	0.35 Wh
Operating Temperature Range	-40°C to 65°C
Storage Temperature Range	-40°C to 70°C

Note: *Capacitance, ESR and Leakage current are all measured according to IEC 62391-1*

* *If required then Leakage current can be altered/changed by Balancing Method.*

\+ *Results may vary. Additional terms & Conditions including limited warranty apply at the time of purchase.*

++ *Product dimensions are for reference only unless otherwise identified, Product dimensions & Specifications may change without Notice.*

Inventing Green Solutions

Physical Specifications

Physical Dimension (L x W x H) in mm +/- 0.5mm	226.5 x 49.5 x 76.0
Approximate Mass of Module	0.65 Kg.
Connection Terminals	Screw M5 Thread
Recommended Torque - Terminal	4 Nm
Environmental Protection	IP54
Vibration Specification	IEC60068-2-6
Shock Specification	IEC60068-2-2,-29
Cooling	Natural Convection
Standard Package Quantity	10 Nos.

Monitoring/Cell Management

Internal Temperature Sensor	N/A
Temperature Interface	N/A
Cell Voltage Management	Passive
Cell Voltage Monitoring	N/A
Connector	N/A

Safety

Maximum Current, Non-repetitive (I_{max}) [6]	465 Amps
Short Circuit Current (Typical)	730 Amps**
High Potential Capability	5600VDC for 60 seconds
Max Stored Energy [5]	2.44 Wh****

CAUTION: *Please do not discharge Capacitor directly.* *Please do not Reverse Polarity*

Note:

** *Current possible with short circuit from rated voltage. It should not be mistaken for operating current.*

**** *As per United Nations material classification UN3499 device should have less than 10Wh capacity to meet the Requirement of Special Provisions 361 for transporting without being treated as dangerous goods (hazardous material) Under Transport Regulations.*

Life

Endurance (at V_R and 65 °C) [7] [8]	1500 Hrs.
Room Temperature (at V_R and 25 °C) [7]	10 Years
Cycle Life (at 25 °C) [7]	1,000,000 cycles (Estimated value when cycled from V_R to ½ V_R using constant current of 12 Amps with 10 second rest between charge and discharge steps)
Shelf Life	4 Years (Stored Uncharged at 25°C) 2 Years (Stored Uncharged at 70°C & under 40% RH)

Thermal Characteristics

Typical Thermal Resistance, R_{th} (Housing)	4.8 °C/W
Typical Thermal Capacitance, C_{th}	420 J/°C
Maximum Continuous Current ΔT = 15 °C [9]	12 A
Maximum Continuous Current ΔT = 40 °C [9]	20A

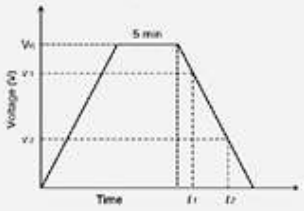
Inventing Green Solutions

www.capacitorsite.com
Email: spel@supercapacitor.in

Notes

1 **Rated Capacitance**

> Constant Current charge with 10mA/F to VR
> Constant Voltage charge at VR for 5 minutes.
> Constant Current discharge with 10mA/F to 0.1V



$$C = \frac{I \times (t_2 - t_1)}{v_1 - v_2}$$

Where

v_1 is the measurement starting voltage 0.8 x VR (V);
v_2 is the measurement end voltage 0.4 x VR (V);
t_1 is the time from discharge start to reach v_1 (s);
t_2 is the time from discharge start to reach v_2 (s);
I is the absolute value of the discharging current (A);

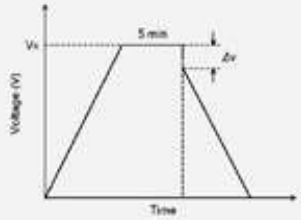
2 **Surge Voltage / Absolute Maximum Voltage**

> Absolute maximum voltage, not repeated and for no longer than 1 second.

3 **ESR** *(Equivalent Series Resistance)*

. > ESRDC

- Constant current charge to VR
- Constant voltage charge at VR for 5min
- Constant current discharge to 0.1V



$$R_d = \frac{\Delta v}{I}$$

Where

R_d is the ESRDC (Ω);
Δv is the voltage drop for 10ms (V);
I is the discharge current (A).

4 **Leakage Current**

> The capacitor is charged to the rated voltage at 25°C.
> Leakage current is the current at 72 hours that is required to keep the capacitor charged at the rated voltage

5 **Energy & Power**

> Max. Stored Energy at V_R = $\frac{½CV_R^2}{3600}$

Where C is the Capacitance (F);
V_R is the rated voltage (V).

> Usable Specific Power, IEC 62391-2 (W/kg) = $\frac{0.12 \cdot V^2}{ESR_{DC} \cdot Mass}$

> Impedance Match Specific Power (W/kg) = $\frac{0.25 \cdot V^2}{ESR_{DC} \cdot Mass}$

> Gravimetric Specific Energy (Wh/kg) = $\frac{E_{Max.}}{Weight}$

6 **Max. Current**

> Current for 1sec discharging from rated voltage to half Rated voltage under constant current discharging mode.

$$I_{Max.}\,(A) = \frac{½V_R}{\Delta t / C + R_d}$$

Where

Δt is the discharge time (sec) and Δt is 1 sec in this case;
C is the capacitance (F);
R_d is the ESR_{DC} (Ω);
VR is the rated voltage (V)

7 **Lifetime**

> End-of-Life Conditions

- Capacitance: -30% from rated min. value
- ESR: +100% from max. ESR value

8 **Endurance**

> Conditions

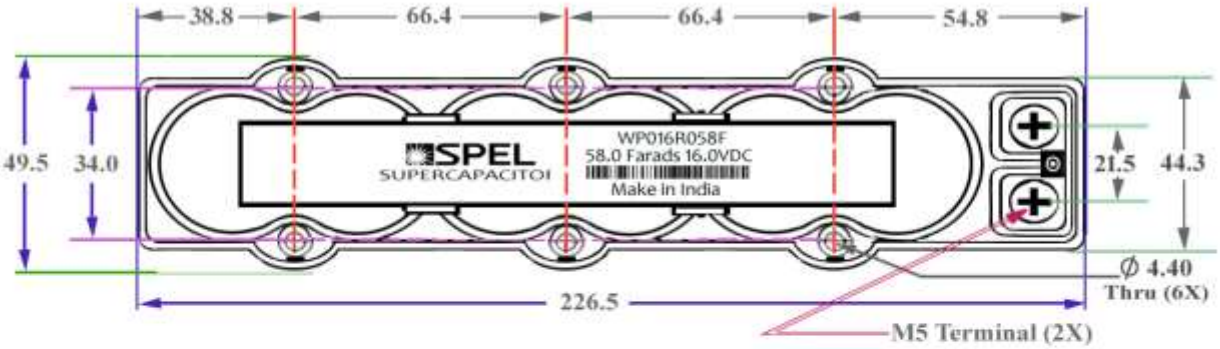
- Temperature: 65 ± 2°C
- Test duration : 1500 (+48/-0) h
- Applied voltage: V_R ± 0.02V
- Capacitance and ESR measurement are made at 25°C

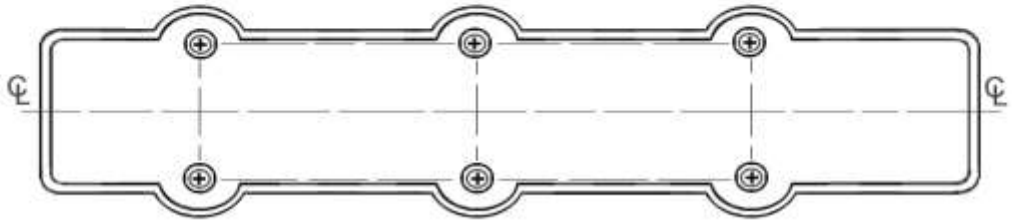
9 $\Delta T = I_{RMS}.I_{RMS}.ESR.R_{th}$

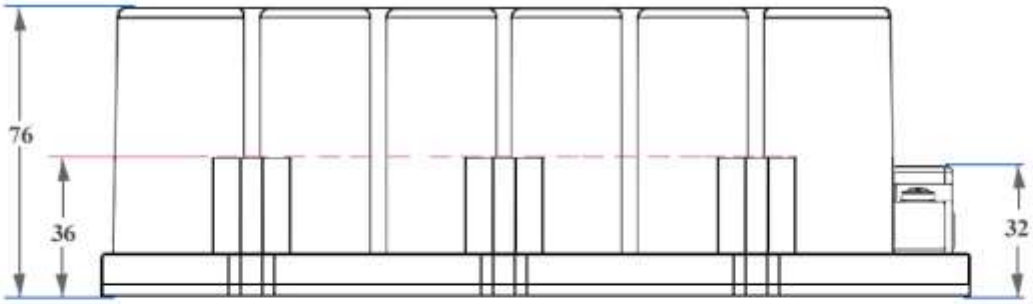
Inventing Green Solutions

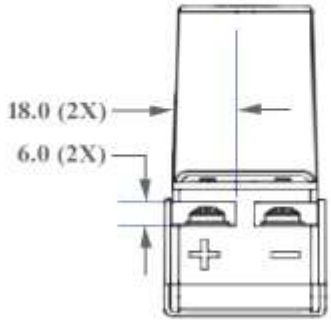
www.capacitorsite.com
Email: spel@supercapacitor.in

Product Dimensions/Drawing





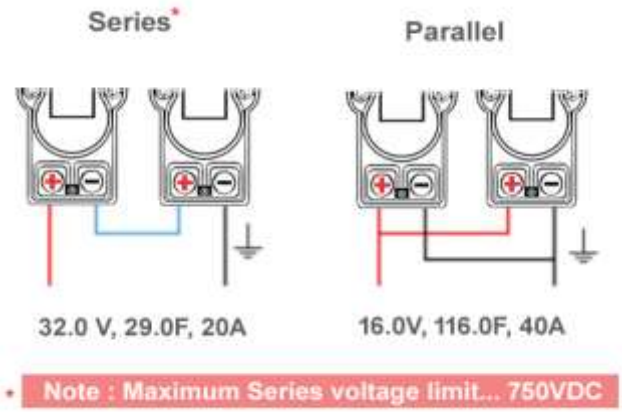


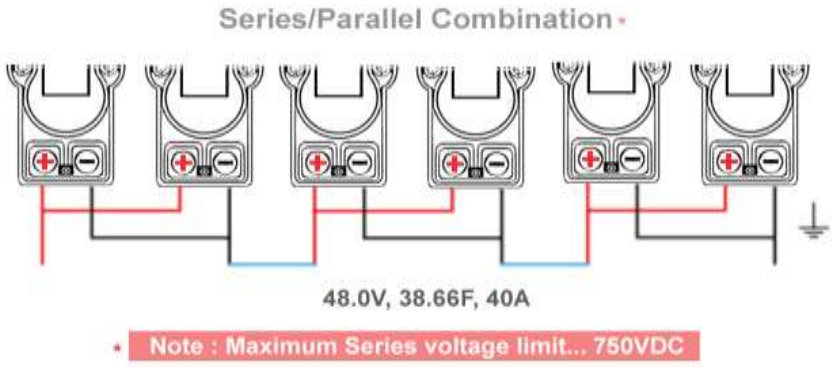


Part Description : WP016R058F
Product : Supercapacitor Module
Capacity : 58.0Farads /16.0 VDC
Dimensions are in " mm" *(Tol.+/- 0.5mm)*

Note : Product dimensions are for reference only unless otherwise identified. Product dimensions and specifictions may change without notice.. Please contact Surya Powerfarad Energies Limited directly for any technical assistance.

Wiring Configuration Examples/Caution





Mounting Recommendations

Use mounting Screw M4. Maximum allowable torque on Mounting Screws not to exceed 4Nm. All the 6 mounting locations should be utilized to meet vibration specifications.

Markings

Products are marked with the following information : Capacitance (F), Nominal Working Voltage (V), Series Code (or part No.), Polarity, Serial Number and name of Manufacturer.

Packaging information

Each Modules are packed individually in a box. These boxed modules are packed 10 to a carton as standard Packing.

Spel Technologies Private Limited
Pune, INDIA
Contact : +91--9326781092 ,+91-20-26876541

Inventing Green Solutions