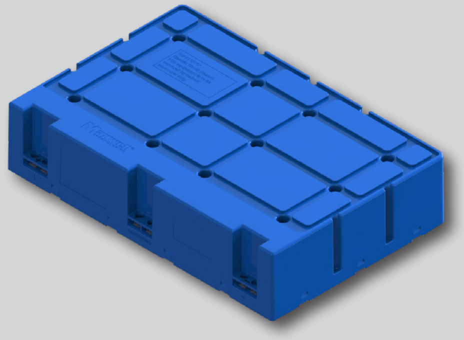
DATASHEET

160V 8F MODULE

Wind Pitch Control Energy Storage



Maxwell Technologies' 160V module is designed to provide energy storage for emergency pitch control and maximize the energy generation of a wind turbine. Based on ultracapacitor technology, the 160V module can considerably reduce turbine maintenance and life cycle costs, improve reliability and lower the overall cost of energy. Scalable in series and parallel configuration, the product can meet majority of the new and existing pitch power delivery requirements.

Ultracapacitor is the technology of choice into electric pitch control systems because of their longer operating lifetime, low maintenance requirements and superior cold weather performance when compared to batteries.

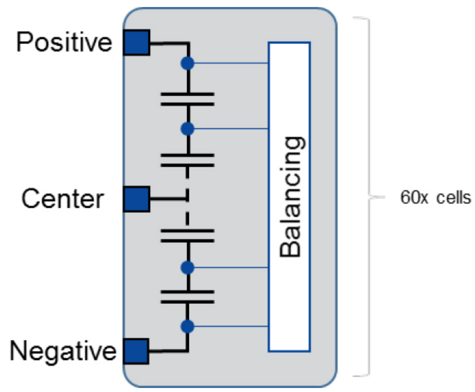
FEATURES AND BENEFITS

- Rated at 160V, 7.5F
- 2,000 hours DC life at maximum operating temperature and voltage
- Designed for up to 500,000 cycles*
- Turnkey solution with passive cell balancing
- Compact and lightweight package
- Screw terminals and center voltage tap

TYPICAL APPLICATIONS

- Wind turbine pitch control
- Small UPS systems
- Industrial applications
- Heavy duty machinery

PRODUCT BLOCK DIAGRAM



ORDERING INFORMATION

Model Number	BMOD0008 E160 B02
Part Number	**135401**
Package Quantity	2

*Typical results may vary. Additional terms and conditions, including the limited warranty, apply at the time of purchase. See the warranty details for applicable operating use and requirements.

PRODUCT SPECIFICATIONS & CHARACTERISTICS

Values are referenced at T_A = room temperature and V_R = 160V rated voltage (unless otherwise noted). Min and Max values indicate product specifications. Typical results will vary and are provided for reference. Additional terms and conditions, including the limited warranty, apply at the time of purchase.

Symbol	Parameter	Conditions	Min	Typical	Max	Unit
		ELECTRICAL				
C_R	Initial Rated Capacitance	Note 1	7.5	7.9	9.0	F
R_S	Initial Equivalent Series Resistance (ESR)	Note 1	–	200	230	mΩ
V_R	Maximum Rated Voltage		–	–	160	V
V_{MAX}	Absolute Maximum Voltage	Non-repeated. Not to exceed 1 second.	–	–	170	V
V_{STRING}	Maximum String Voltage	For series of modules	–	–	800	V
I_{DCMAX}	Maximum Continuous Current	$\Delta T_{CELL} = I_{RMS}^2 \times R_S \times R_{th}$ - ΔT = 15°C - ΔT = 40°C	 – –	 – –	 7 11	A_{RMS}
I_{PEAK}	Maximum Peak Current		–	–	200	A
I_{LEAK}	Leakage Current	After 72 hours at 25°C	–	–	30	mA
		LIFE				
t_{AGING}	Accelerated Aging	At V_R = 160V and T_A = 65°C - Capacitance change ΔC from min C_R - Resistance change ΔR from max R_S	– – –	2,000 -20 +100	– – –	hours % %
t_{LIFE}	Projected Life Time	At V_R = 160V and T_A = 25°C - Capacitance change ΔC from min C_R - Resistance change ΔR from max R_S	– – –	10 -20 +100	– – –	years % %
n_{LIFE}	Projected Cycle Life	At V_R = 160V and T_A = 25°C - Capacitance change ΔC from min C_R - Resistance change ΔR from max R_S	– – –	500,000 -20 +100	– – –	cycles % %
t_{SHELF}	Shelf Life	Stored uncharged, T_A = 25°C and RH < 50%	–	4	–	years
		POWER & ENERGY				
P_d	Usable Specific Power	Per IEC 62576, $P_d = \frac{0.12 \times V_R^2}{R_S \times m}$	–	2,200	–	W/kg
P_{MAX}	Impedance Match Specific Power	$P_{MAX} = \frac{V_R^2}{4 \times R_S \times m}$	–	4,600	–	W/kg
E_d	Gravimetric Specific Energy	$E_d = \frac{E_{MAX}}{m}$	–	4.4	–	Wh/kg
E_{MAX}	Stored Energy	$E_{MAX} = \frac{0.5 \times C \times V_R^2}{3{,}600}$ (Note 2)	–	26.6	–	Wh
		TEMPERATURE & THERMAL				
T_A	Operating Temperature	Cell case temperature	-40	25	65	°C
R_{th}	Thermal Resistance	All cell cases to ambient	–	1.3	–	°C/W
C_{th}	Thermal Capacitance		–	5,500	–	J/°C
–	Cooling			Natural Convection		–

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PRODUCT SPECIFICATIONS & CHARACTERISTICS (Cont'd)

Values are referenced at T_A = room temperature and V_R = 160V rated voltage (unless otherwise noted). Min and Max values indicate product specifications. Typical results will vary and are provided for reference. Additional terms and conditions, including the limited warranty, apply at the time of purchase.

Symbol	Parameter	Conditions	Min	Typical	Max	Unit
PHYSICAL						
m	Mass		–	6.0	–	kg
F_{M5}	Recommended Torque on Power and Monitoring Terminals	M5 thread	–	4.0	6.0	Nm
–	Vibration		IEC 60068-2-6			–
–	Shock		IEC 60068-2-27			–
–	Insulation Resistance	Per IEC60068-2-78 At T_A=40°C, 90% RH	–	400	–	mΩ
CELL VOLTAGE MANAGEMENT						
–	Cell Voltage Monitoring		At Voltage Center Tap – 2 Monitoring Terminals			–
–	Cell Voltage Management		Passive			–
SAFETY						
–	Certifications		RoHS			
V_{HP}	High-Pot Capability	Duration = 60 seconds. Not intended as an operating condition.	–	4,000	–	VDC

TEST PROCEDURES

Notes:

1. Measured at 25°C using specified test current waveform below:

$V1 = V_R$ $V3 = 0.4 \times V_R$ $\mathbf{C_R = I \times (t4 - t3) / (V2 - V3)}$
$V2 = 0.8 \times V_R$ $t2 - t1 = 5$ min

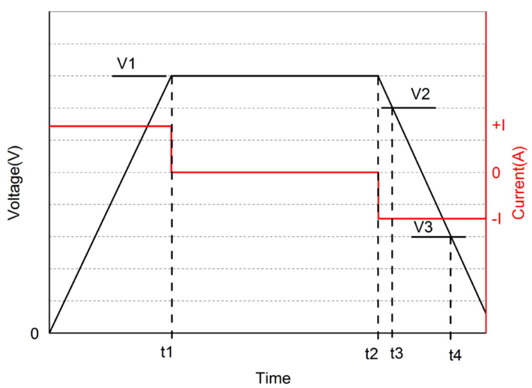


Figure 1: Capacitance Measurement Waveform

$V1 = V_R$ $t2 - t1 = 15$ sec $\mathbf{R_S = (V3 - V2) / I}$
$V2 = 0.5 \times V_R$ $t4 - t3 = 100$ msec

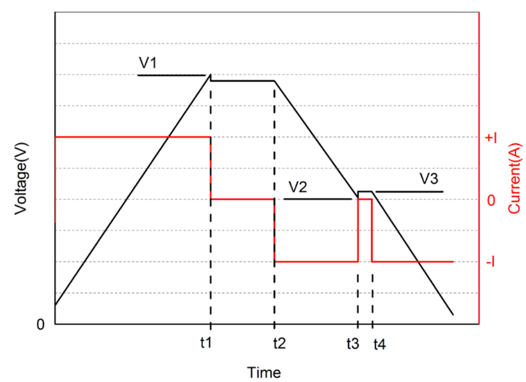


Figure 2: DC-ESR Measurement Waveform

2. Per United Nations material classification UN3499, all Maxwell ultracapacitors have less than 10 Wh capacity to meet the requirements of Special Provisions 361. Both individual ultracapacitors and modules composed of those ultracapacitors shipped by Maxwell can be transported without being treated as dangerous goods (hazardous materials) under transportation regulations.

TYPICAL PERFORMANCE

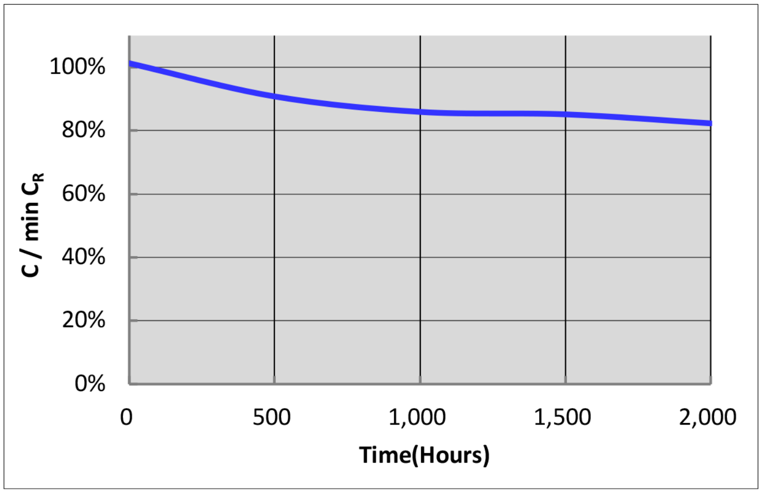


Figure 3: Accelerated Aging Capacitance Performance

V_R= 160V, T_A = 65°C

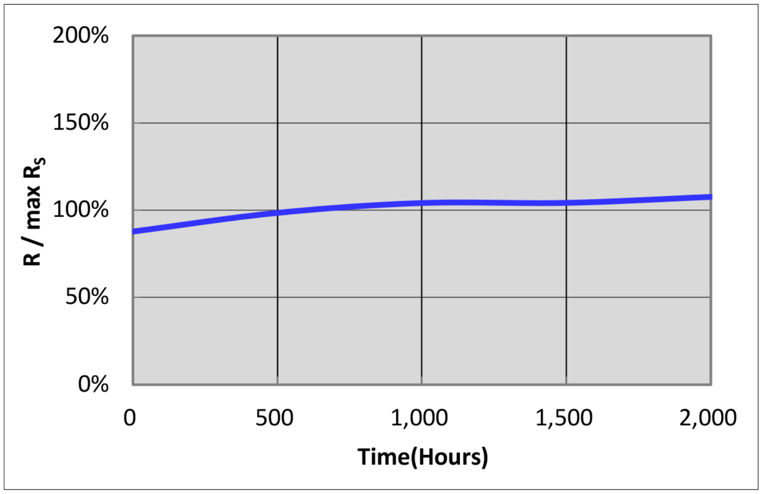


Figure 4: Accelerated Aging ESR Performance

V_R = 160V, T_A = 65°C

DETAILED PRODUCT DESCRIPTION

Introduction

The BMOD0008 E160 B02 energy storage module is built with sixty (60) ultracapacitor cells in series; these board mounted cells are passively balanced and the entire assembly is packaged into a rigid plastic enclosure.

Technology Overview

Electrochemical double layer capacitors (EDLCs) also known as electric double layer capacitor, supercapacitors or ultracapacitors deliver energy at relatively high rates (beyond those accessible with batteries) because the mechanism of energy storage is by charge-separation. Ultracapacitors store charge electrostatically (non-Faradaic) by reversible adsorption of the electrolyte onto electrochemically stable high surface area carbon electrodes. Charge separation occurs on polarization at the electrode/electrolyte interface, producing a double layer. This mechanism is highly reversible, allowing the ultracapacitor to be charged and discharged hundreds of thousands to even millions of times.*

Ultracapacitor Construction

An ultracapacitor is constructed with symmetric carbon positive and negative electrodes separated by an insulating ion-permeable separator, packaged into a container then filled with organic electrolyte (salt/solvent) designed to maximize ionic conductivity and electrode wetting. It is the combination of high surface-area activated carbon electrodes (typically >1500m²/g) with extremely small charge separation (Angstroms) that results in high capacitance.

Ultracapacitor Energy = ½ CV²

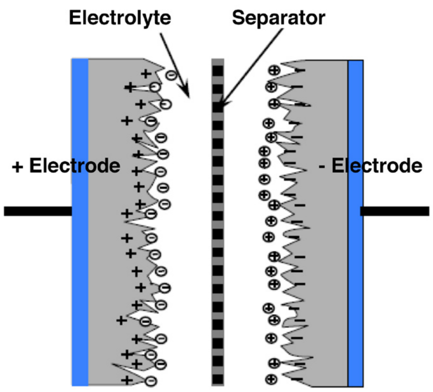


Figure 5: Ultracapacitor Structure Diagram

*Results may vary. Additional terms and conditions, including the limited warranty, apply at the time of purchase. See the warranty details for applicable operating and use requirements.

Ultracapacitors can be packaged in different mechanical packages: Prismatic Design, where the positive/separator/negative electroactive assembly can be wound on a paddle, stacked or Z-folded, then sealed in either a soft pouch cell or a hard shell prismatic can. For products with round or cylindrical packaging, the electrodes and separator are wound into a jellyroll configuration and sealed into cylindrical aluminum cans.

Ultracapacitor Cell Description

Rated at 2.7V 450F, the ultracapacitor cell in the module integrates Maxwell's most advanced electrode formulation in a compact and reliable cylindrical form factor, with outstanding electrical parameters and life performance. This ultracapacitor cell, with 4-axial, through-hole snap-in terminals is board mountable to achieve reliable and robust electrical and mechanical connectivity which maintains its integrity in high vibration applications.

Module Configuration

The BMOD0008 E160 B02 module integrates a total of sixty ultracapacitor cells rated at 2.7V 450F connected in series to achieve the desired electrical characteristics of the module. This can be calculated using the following formulas:

$$C_R = C_{CELL} \times \frac{\#\ parallel}{\#\ series}$$

$$R_S = R_{CELL} \times \frac{\#\ series}{\#\ parallel} + R_{ACCESS}$$

Where:

- C_R = module rated capacitance (F)
- C_{CELL} = cell capacitance
- R_S = module serial resistance (mΩ)
- R_{CELL} = cell equivalent series resistance
- R_{ACCESS} = module access resistance
- # parallel = number of parallel string = 1
- # series = number of cells in series = 60

Cell Balancing

To provide an equal voltage distribution amongst all internal sixty ultracapacitor cells, the BMOD0008 E160 B02 features an integrated passive balancing circuitry. Sized to accommodate the slight tolerance in capacitance and leakage current of each individual ultracapacitor cell in the design, the integrated passive balancing circuit ensures that each cell will operate within its normal operating conditions and therefore ensure the longest lifetime of the product.

The passive balancing circuit of the BMOD0008 E160 B02 is optimized for stationary, low duty cycle applications. Should there be an interest in higher cycling applications, please consult Maxwell Technologies Applications Engineering.

Mechanical Housing

The module packaging is a rigid plastic enclosure rated for the following stress and environmental conditions:

- Vibration per IEC60068-2-6
- Shock per IEC60068-2-27

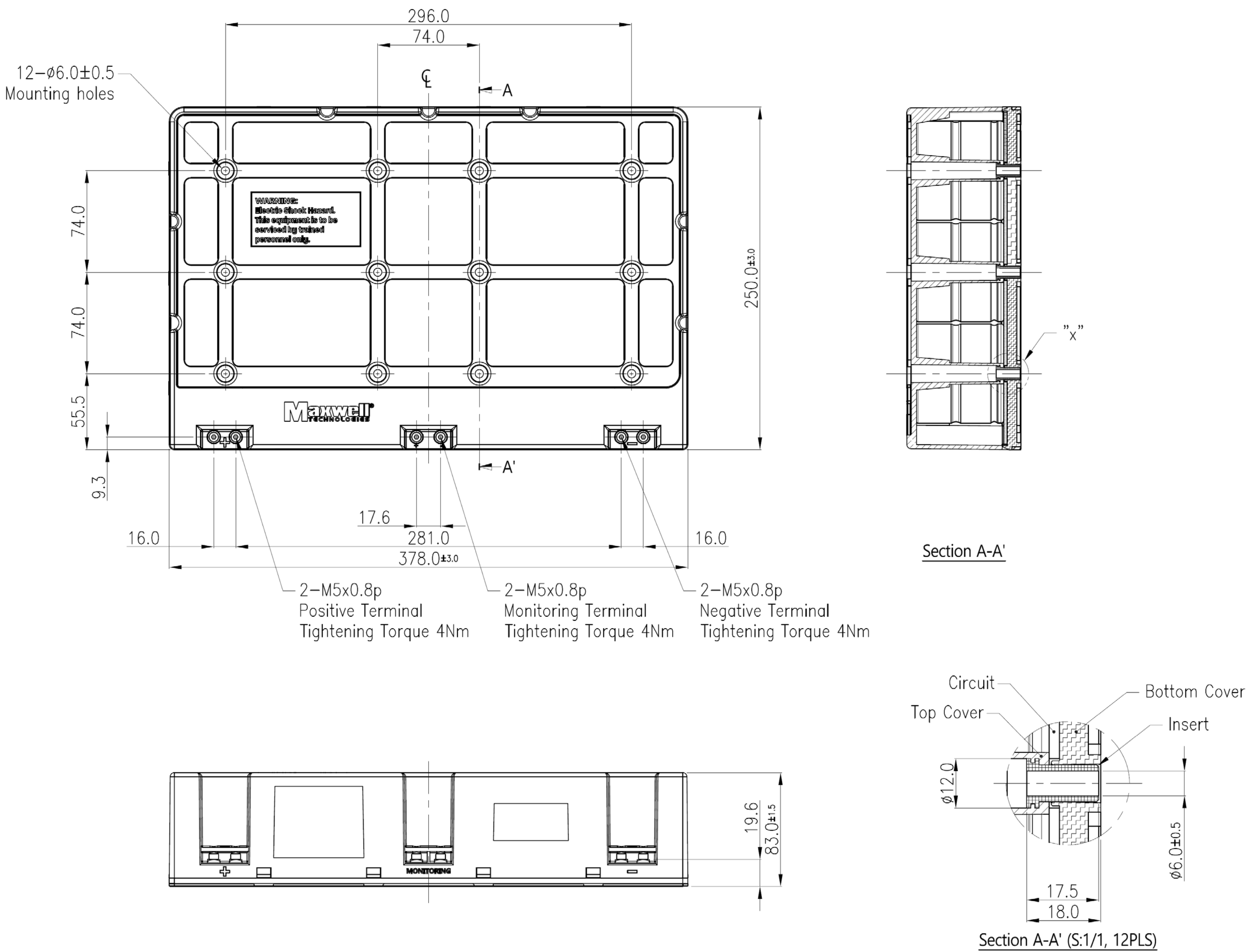
Electrical Terminals

The BMOD0008 E160 B02 module offers two positive terminals and two negative terminals as well as two monitoring terminals at the center tap.

Mounting Points

The BMOD0008 E160 B02 module offers twelve mounting points for securing the module in the application.

MECHANICAL DRAWINGS



DIMENSIONS	MIN	TYP	MAX	UNIT
Length (L)	375.0	378.0	381.0	mm
Width (W)	247.0	250.0	253.0	mm
Height (H)	81.5	83.0	84.5	mm

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