Maxwell TECHNOLOGIES
Enabling Energy's Future™

PRELIMINARY DATASHEET

This document contains confidential information on a product under development and is subject to further review. Maxwell Technologies reserves the right to change or discontinue this product without notice.

16V 58F MEDIUM CELL MODULE

Lighter-Duty Industrial Energy Storage

Maxwell Technologies' 16V medium cell ultracapacitor module provides energy storage and power delivery in a compact, cost-effective module. The modules are specifically engineered to provide cost-effective solutions for wind turbine pitch control of 1.5MW and smaller, small UPS systems, telecommunications and other lighter-duty industrial electronics applications.

The updated 16V module is based upon new and improved 350F snap-in cells. In addition to meeting or exceeding demanding industrial application requirements for both watt-hours of energy storage and watts of power delivery per kilogram, all of these products will perform reliably for more than 500,000 discharge-recharge cycles.

The modules can be series connected up to 750V and/or parallel connected for higher energy requirements. The easy-to-connect, standard module allows system designers to focus upon use of the power and energy, rather than on how to assemble cells.

FEATURES & BENEFITS

- 16V DC working voltage
- Resistive cell balancing
- Compact and lightweight package
- Screw terminals
- Improved high temp lifetime

ORDERING INFORMATION

Model Number	BMOD0058 E016 C02
Part Number	**135808**
Package Quantity	**15**

TYPICAL APPLICATIONS*

- Wind turbine pitch control
- Small UPS systems
- Industrial applications (AGV, drones, robots)
- Lighter-duty machinery

*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.

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PRODUCT SPECIFICATIONS & CHARACTERISTICS

Values are referenced at T_A = room temperature and V_R = 16V 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	Typ	Max	Unit
ELECTRICAL						
C_R	Initial Rated Capacitance	Note 1	58	61	70	F
R_S	Initial Equivalent Series Resistance (ESR)	Note 1	-	18	22	mΩ
V_R	Maximum Rated Voltage		-	-	16	V
V_{MAX}	Absolute Maximum Voltage	Non-repeated. Not to exceed 1 second.	-	-	17	V
V_{STRING}	Maximum String Voltage	For series of modules	-	-	750	V
I_{DCMAX}	Maximum Continuous Current	$\Delta T_{CELL} = I_{RMS}^2 \times R_S \times R_{th}$ - ΔT = 15°C - ΔT = 40°C	 - -	 - -	 15 24	A_{RMS}
I_{PEAK}	Maximum Peak Current		-	-	200	A
I_{LEAK}	Leakage Current	After 72 hours at 25°C	-	-	25	mA
LIFE						
t_{AGING}	Accelerated Aging	At V_R = 16V 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 = 16V 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 = 16V 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, $P_d = \frac{0.12 \times V_R^2}{R_S \times m}$	-	2,500	-	W/kg
P_{MAX}	Impedance Match Specific Power	$P_{MAX} = \frac{V_R^2}{4 \times R_S \times m}$	-	5,300	-	W/kg
E_d	Gravimetric Specific Energy	$E_d = \frac{E_{MAX}}{m}$	-	3.1	-	Wh/kg
E_{MAX}	Stored Energy	$E_{MAX} = \frac{0.5 \times C \times V_R^2}{3{,}600}$ (Note 2)	-	2.1	-	Wh
TEMPERATURE & THERMAL						
T_A	Operating Temperature	Cell case temperature	-40	25	65	°C
R_{th}	Thermal Resistance	All cell cases to ambient (with convection)	-	3.0	-	°C/W
C_{th}	Thermal Capacitance		-	470	-	J/°C
-	Cooling		Natural Convection			-

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Symbol	Parameter	Conditions	Min	Typ	Max	Unit
PHYSICAL						
m	Mass		-	0.66	-	kg
F_{M5}	Recommended Torque on Power Terminals	M5 thread	-	-	4.0	Nm
-	Vibration		IEC 60068-2-6			-
-	Shock		IEC60068-2-27, -29			-
-	Environmental Protection		IP20			-
CELL VOLTAGE MANAGEMENT						
-	Cell Voltage Monitoring		N/A			-
-	Cell Voltage Management		Passive			-
SAFETY						
-	Certifications		RoHS, UL810a (640 Volts)			
V_{HP}	High-Pot Capability	Duration = 60 seconds. Not intended as an operating condition.	-	5,600	-	VDC

TEST PROCEDURES

Notes:

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

$V1 = V_R$ $V2 = 0.8 \times V_R$ $V3 = 0.4 \times V_R$ $t2 – t1 = 5$ min **$C_R = I \times (t4 – t3) / (V2 – V3)$**

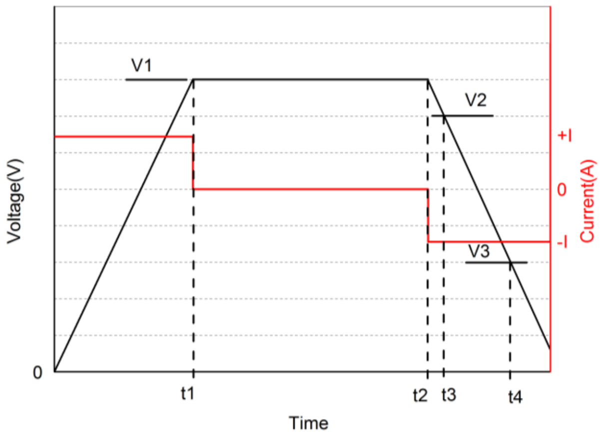

Figure 1: Capacitance & Resistance Measurement Waveform

$V1 = V_R$ $V2 = 0.5 \times V_R$ $t2 – t1 = 15$ sec $t4 – t3 = 100$ msec **$R_S = (V3 – V2) / I$**

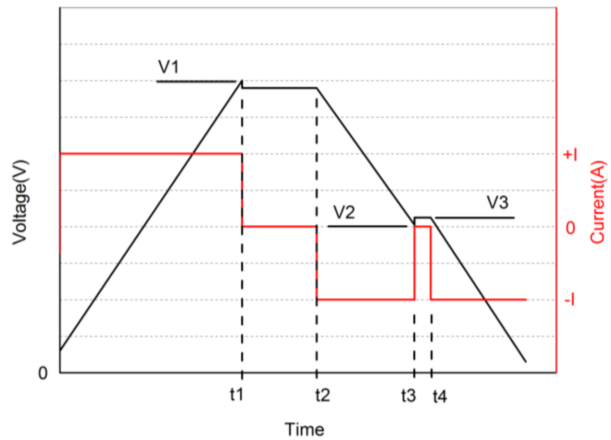

Figure 2: Cycle Life Test Waveform

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.

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TYPICAL PERFORMANCE

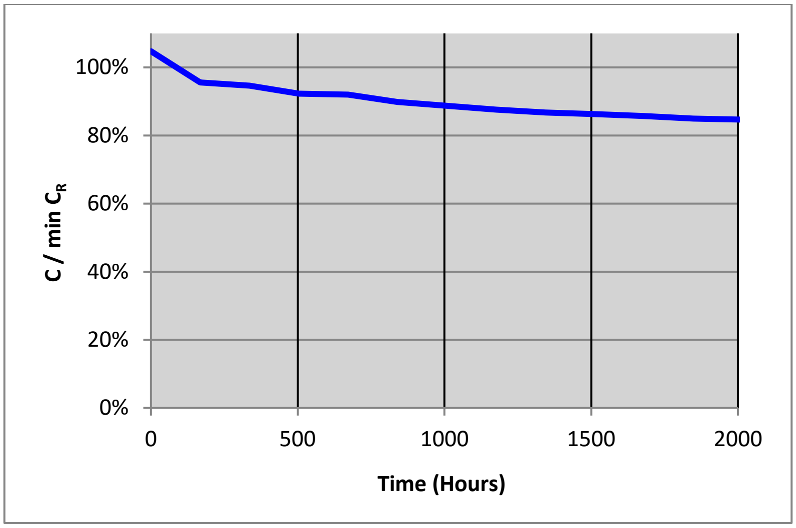


Figure 3: Accelerated Aging Capacitance Performance

V_R= 16V, T_A = 65°C

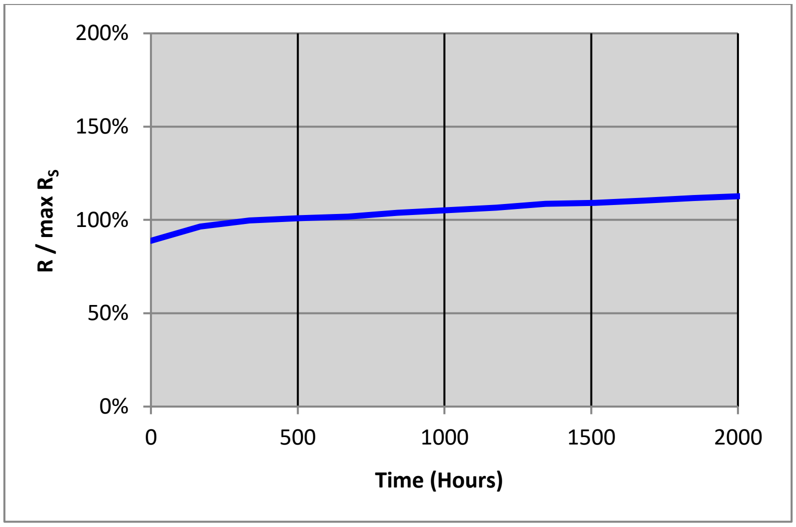


Figure 4: Accelerated Aging ESR Performance

V_R = 16V, T_A = 65°C

DETAILED PRODUCT DESCRIPTION

Introduction

The BMOD0058 E016 C02 energy storage module is built with six (6) 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 >1500m^2 /g) with extremely small charge separation (Angstroms) that results in high capacitance.

Ultracapacitor Energy= $\frac{1}{2} CV^2$

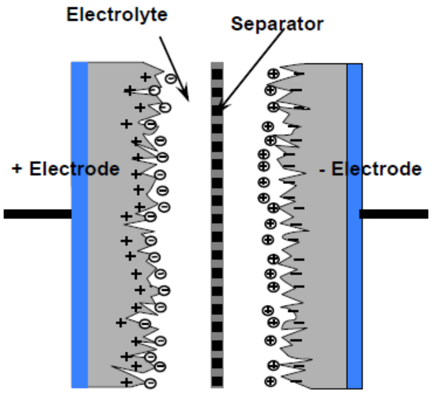


Figure 5: Ultracapacitor Structure Diagram

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 350F, 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 BMOD0058 E016 C02 module integrates a total of six ultracapacitor cells rated at 2.7V 350F connected in series to achieve the desired electrical characteristics of the module. This can be calculated using the following formulas:

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

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

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 = 6

Cell Balancing

To provide an equal voltage distribution amongst all internal sixty ultracapacitor cells, the BMOD0058 E016 C02 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 BMOD0058 E016 C02 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

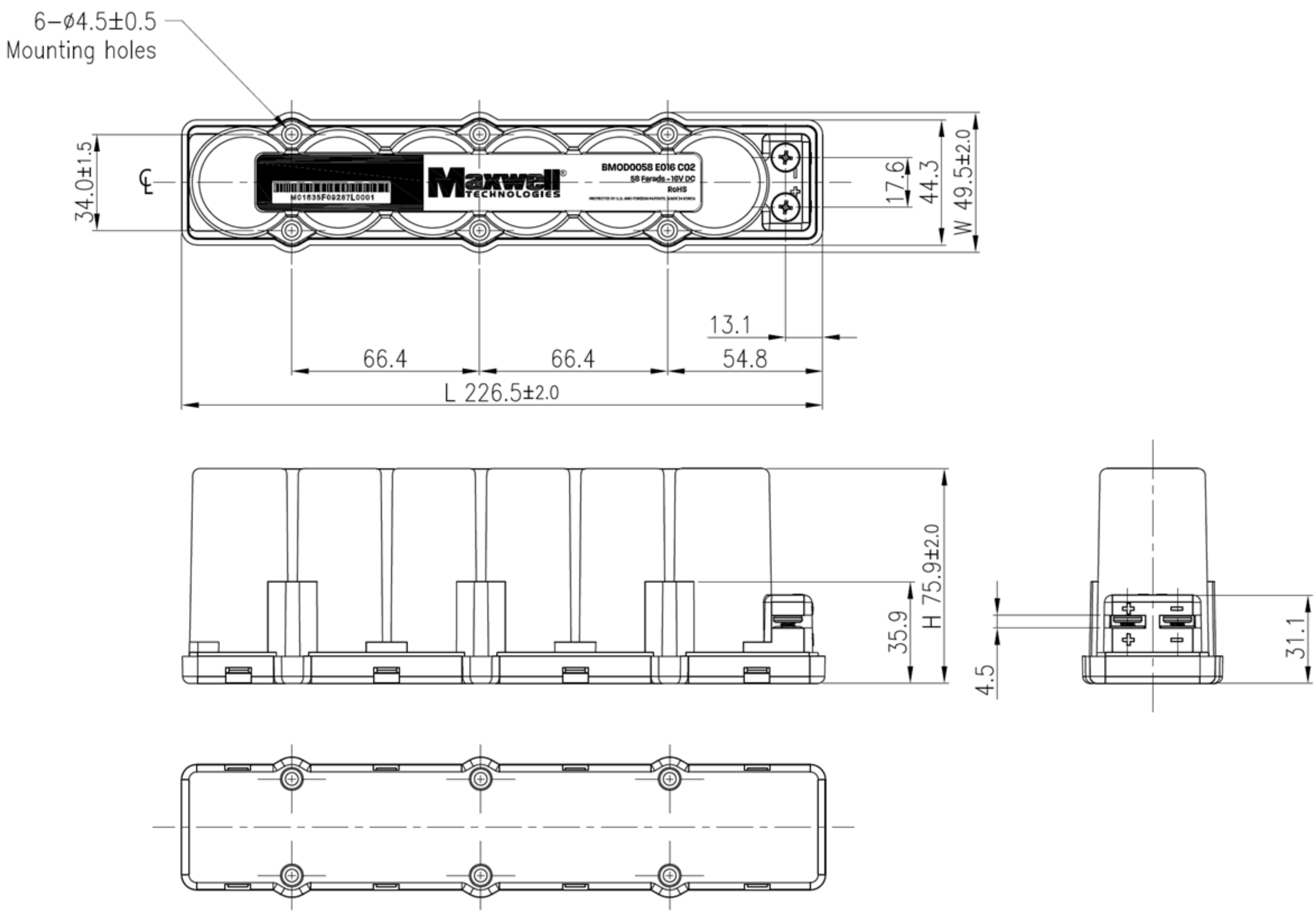
Electrical Terminals

The BMOD0058 E016 C02 module offers two power terminals (one positive, one negative).

Mounting Points

The BMOD0058 E016 C02 module offers six mounting points for securing the module in any application.

MECHANICAL DRAWINGS



DIMENSIONS	MIN	TYP	MAX	UNIT
Length (L)	224.5	226.5	228.5	mm
Width (B)	47.5	49.5	51.5	mm
Height (C)	73.9	75.9	77.9	mm

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Products and related processes may be covered by one or more U.S. or international patents and pending applications. Please see www.maxwell.com/patents for more information. Product dimensions are for reference only unless otherwise identified. Maxwell Technologies reserves the right to make changes without further notice to any products herein. “Typical” parameters which may be provided in Maxwell Technologies datasheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including “Typicals” must be validated for each customer application by customer’s technical experts. Please contact Maxwell Technologies directly for any technical specifications critical to application.

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