



USER MANUAL

Maxwell Technologies® **BOOSTCAP® 56V UPS Energy Storage Modules**

Models:

- BMOD0130 P056 B02
- BMOD0130 P056 B03

Bt4486kkk #1017025

Notice: The products described herein are covered by one or more of the following patents: 7307830, 7203056, 7027290, 7352558, 7295423, 7090946, 7508651, 7492571, 7342770, 6643119, 7384433, 7147674, 7317609, 7495349, 7102877

1. Introduction

The 56 Volt UPS energy storage modules are self-contained energy storage devices comprised of twenty-three individual ultracapacitor cells. The module includes bus bar connections and integrated cell voltage management circuitry. Units may be connected in series to obtain higher operating voltage, in parallel to provide higher current or longer run time, or a combination of series/parallel arrangements as needed. The module is intended for installation in a standard 19" equipment rack or a 23" UPS rack.

The module is designed to provide short term backup power (module power ratings are for 15 second discharge) for graceful shutdown of systems, for ride through of power transients (sags, spikes, dropouts), and for transition to a permanent backup solution such as a fuel cell or diesel generator. The module is intended for occasional charge/discharge (typically less than once per hour) as it contains no active cooling features.

To meet the lifetime requirements, the maximum operating temperature is 40°C/104°F and 56V per module. The absolute maximum operating conditions are 65°C/149°F and 62V. The cell voltage management provides the highest reliability for controlling overvoltage conditions. Passive circuits are always operating to help prevent overvoltage conditions. An optional alarm circuit is available which provides an open collector signal when the voltage exceeds 2.7V on any cell in the module (see section [6.2](#)).

Ultracapacitors function on electrostatic principles with no chemical reactions and no moving parts. They avoid the lifetime issues associated with chemical storage in batteries or mechanical issues associated with kinetic energy storage. The 56 Volt UPS modules are non-toxic and designed for years of maintenance-free operation.

2. Unpacking

Inspect the shipping carton for signs of damage prior to unpacking the module. Damage to the shipping carton or module should be reported to the carrier immediately.

Remove the module from the shipping carton and retain the shipping materials until the unit has been inspected and is determined to be operational.

NOTE: The original shipping materials are approved for both air and ground shipment. The module should be removed from the shipping carton by lifting it by the body of the module.

The shipping container should contain the following:

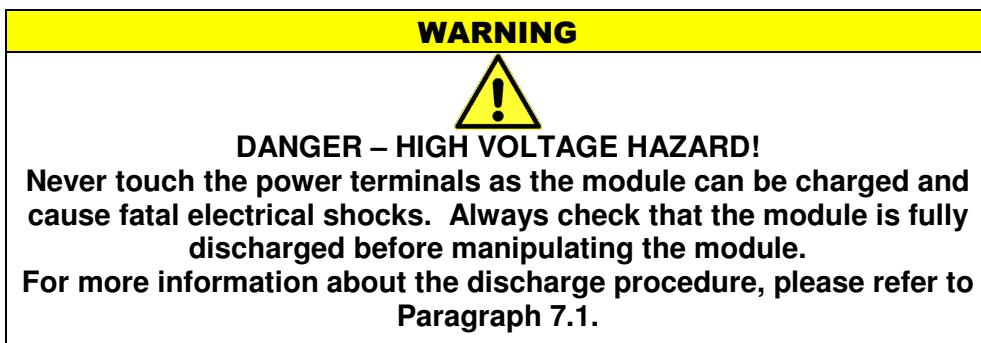
- 1 x Energy Storage Module with M8 and M10 connection bolts installed
- 1 x Accessory Kit consisting of:
 - 1 x Users Manual

The following accessories are included with the B03 option:

- 1 x Deutsch connector shell
- 2 x crimp-on receptacles
- 1 x Deutsch wedgelock

If the unit is found to be defective or any parts are missing, contact your supplier. A Return Material Authorization (RMA) number must be issued prior to returning the unit for repair or replacement.

3. Safety



Do not operate unit above specified voltage.

Do not operate unit above specified temperature rating.

Do not touch terminals with conductors while charged. Serious burns, shock, or material fusing may occur.

Protect surrounding electrical components from incidental contact.

Provide sufficient electrical isolation when working above 50 V DC.

Prior to installation on and removal from the equipment, it is mandatory to fully discharge the module.

4. Installation

4.1 Mechanical

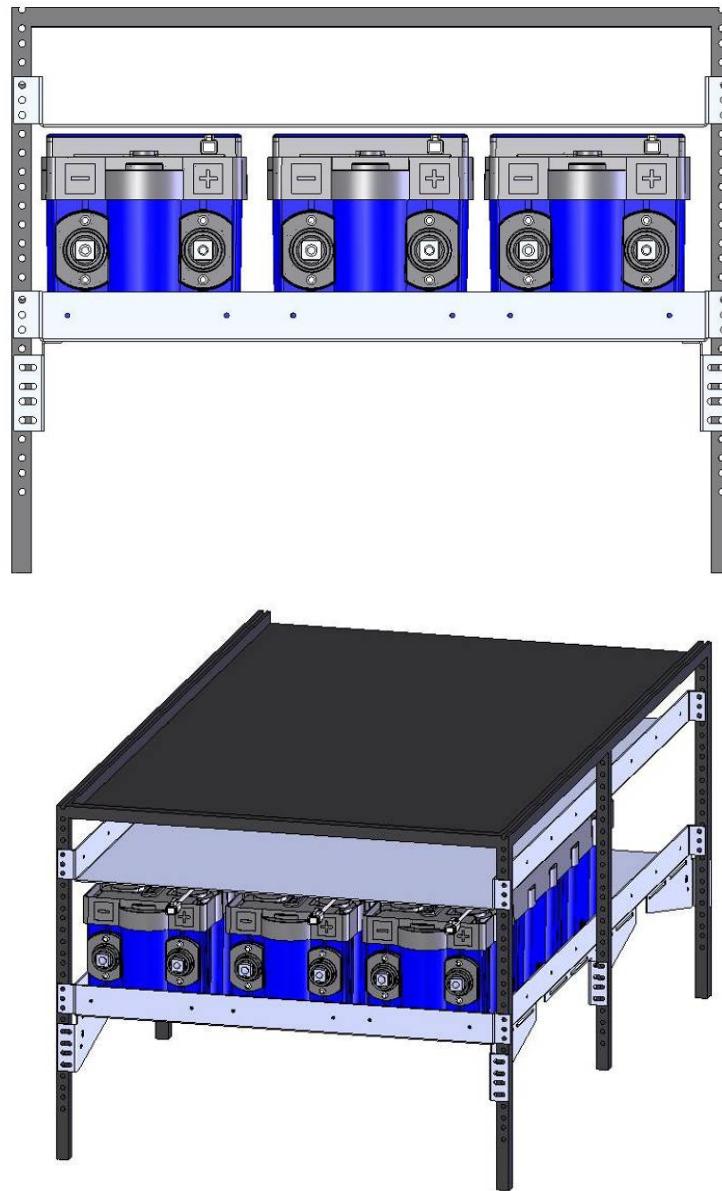


Figure 1. Three modules mounted in a 24" rack.

Modules are intended for installation horizontally as shown in Figure 1. The module should be mounted on a shelf. The modules should further be secured to the rack using the front or side mounting holes. See the data sheet for available mounting locations.

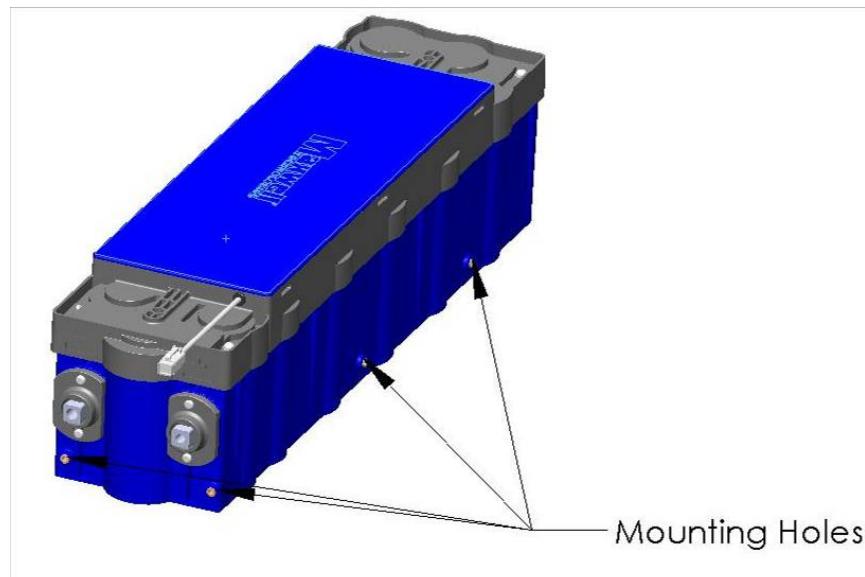


Figure 2. View of side and front mounting holes.

The 56V UPS Energy Module has eight M5 mounting holes. Four of these holes are shown in Figure 2. Refer to Figure 3 for the location of mounting holes.

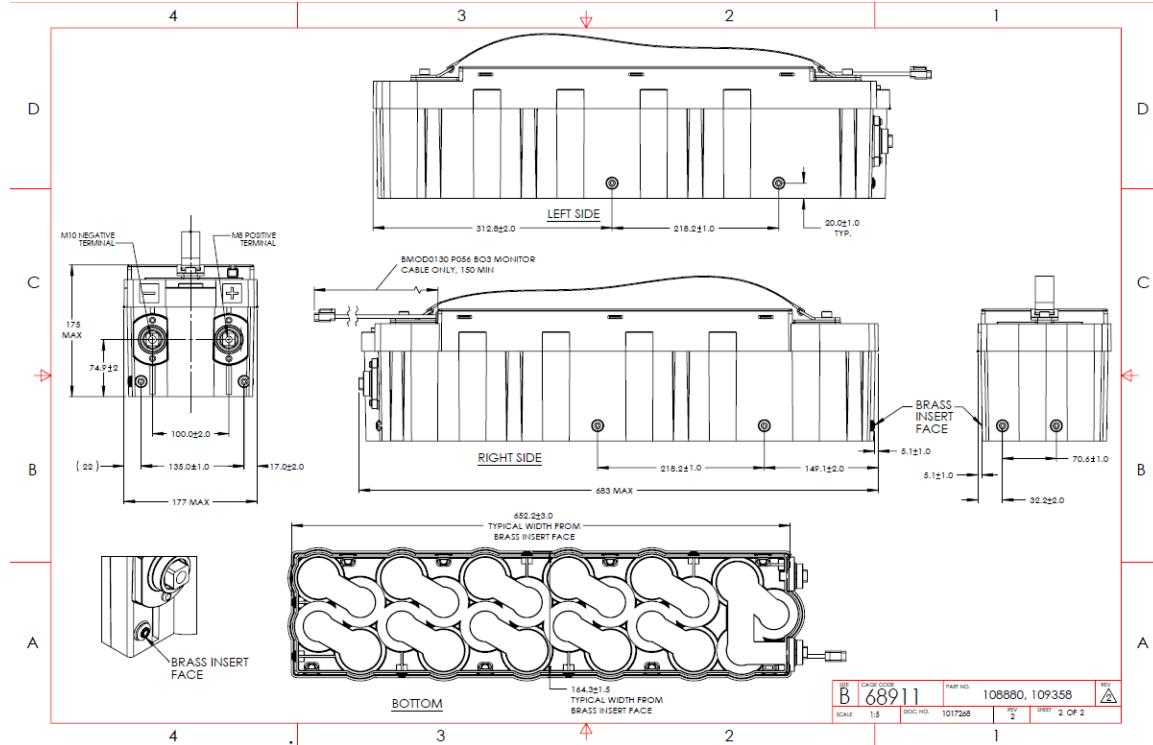


Figure 3. Drawing with locations of mounting holes.

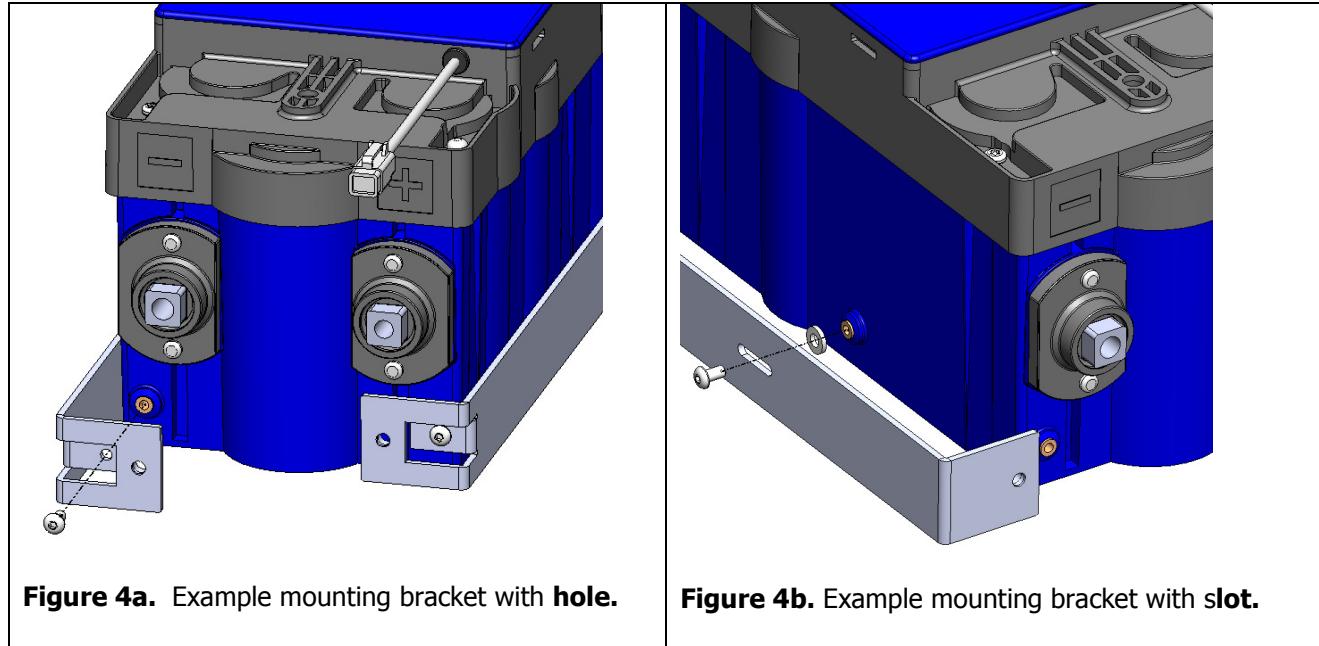


Figure 4a. Example mounting bracket with **hole**.

Figure 4b. Example mounting bracket with **slot**.

4.2 Mounting Bracket Requirements for Seismic Zone 4 Compliance

- Minimum of 4 holes must be utilized to effectively mount the 56V Module.
 - Two front **AND** two back **OR**
 - Two left **AND** two right
- Bracket must contact face of brass insert and not make contact with plastic housing.
- Maximum hole size of 6.0mm to ensure bracket tightens against face of brass insert.
- If a slot is used, a washer with a maximum hole diameter of 6.0 mm should be included, as shown in Figure 4b.
- M5 size screws with a maximum engaged thread length of 10mm must be used.
- Maximum torque is 5 N-m.

5. Electrical

WARNING



CAUTION

To avoid arcing and sparking the energy storage module should be in a discharged state and the system power disconnected during installation. The module is shipped discharged and with a shorting wire. The shorting wire should be removed prior to electrical connection.

WARNING



CAUTION

To provide the lowest possible ESR the energy storage modules are not fused. Care should be taken within the application to prevent excessive current flow as required. Excessive current and/or duty cycle will result in overheating the module which will cause irreparable damage. Please consult the specific data sheet for each module for current and duty cycle capabilities.

5.1 Output Terminal Posts

The output terminals of the module consist of internally threaded aluminum posts. Maximum thread depth is 16 mm. They are designed to connect directly to a ring lug or a bus bar. Apply a layer of high conductivity aluminum-aluminum anti-oxidant joint compound between the mating surfaces. For example, Noalox® Anti-Oxidant Compound available from IDEAL is a viable choice. There are many other vendors that supply an equivalent compound.. The positive terminal is threaded for a M8 x 1.25 steel bolt (provided). The negative terminal is threaded for a M10 x 1.5 steel bolt (provided). When applying torque to the terminals, it is recommended to use a maximum torque of 20 N-m / 14.8 ft-lbs for the M8 and 30 N-m / 22.1 ft-lbs for the M10 bolts. Anti-rotation features within the module prevent damage to the terminals when applying torque to the bolts.

Attachment to the output terminals should be made with ring lugs or bus bars of an appropriate size for the application current. The energy storage modules have low ESR. As a result, the

resistance of the cable connecting the energy storage module to the load can easily exceed the ESR of the module.

Connection of modules in series or parallel or combination thereof should utilize the same gauge wire (or equivalent bus bar) as determined for final output connections. When connecting in series, connect the positive output terminal of one module to the negative output terminal of the next module (as shown in Figure 5 and Figure 7). For parallel connections, connect positive terminals together and negative terminals together (as shown in Figure 6 and Figure 7). The maximum operating voltage of a series connected system should not exceed 750V.

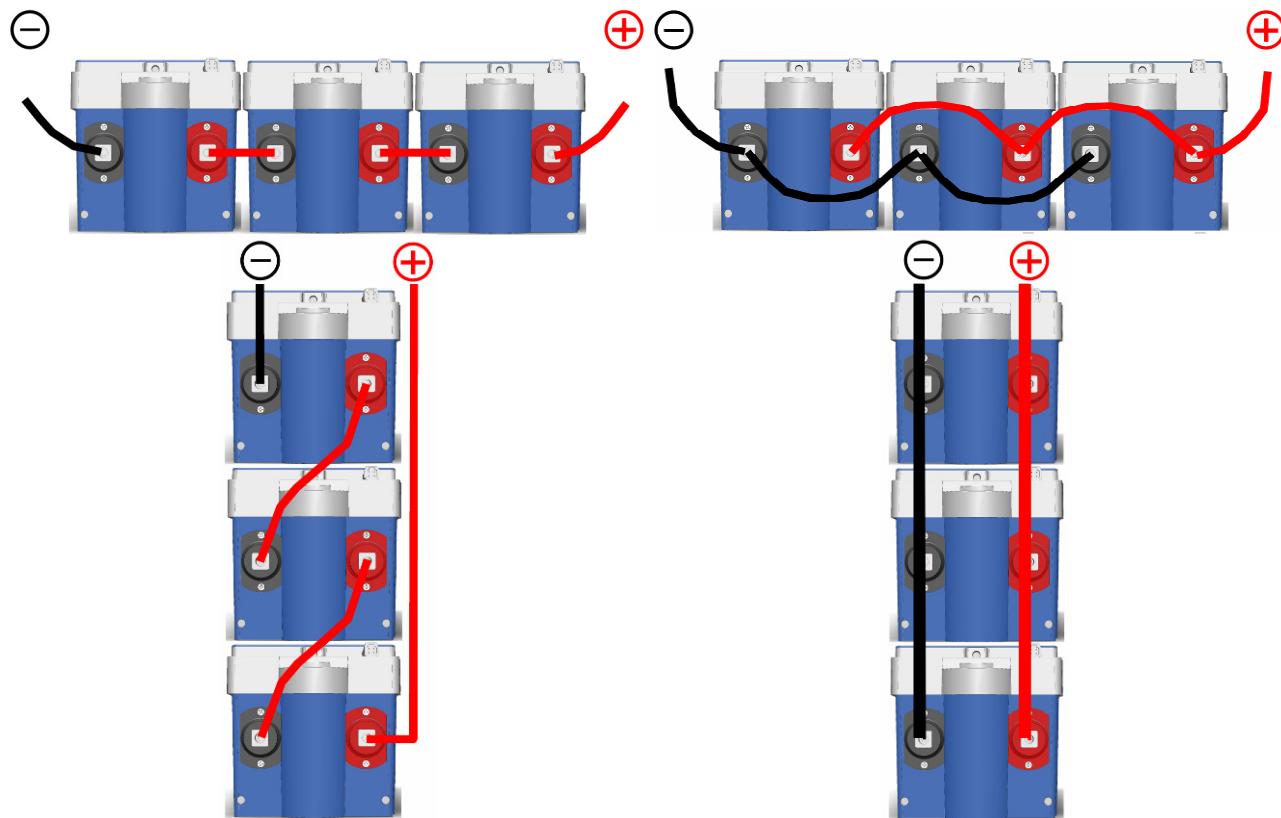


Figure 5. Series connected modules (horizontal or vertical). In this example, the system would provide 30kW for 15 seconds at 168V maximum voltage.

Figure 6. Parallel connected modules (horizontal or vertical). In this example, the system would provide 30kW for 15 seconds at 56V maximum voltage.

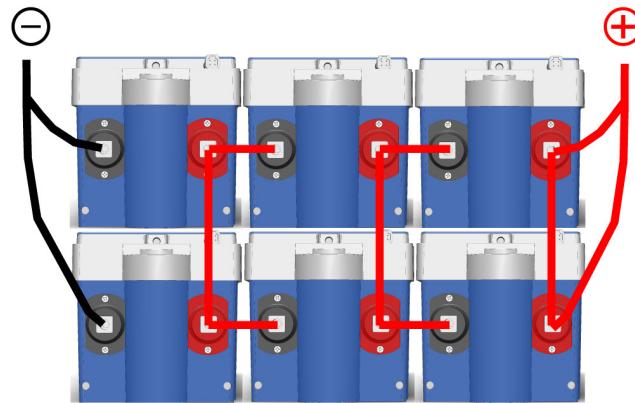


Figure 7. 3 Series x 2 Parallel connect modules. In this example, the system would provide 60KW for 15 seconds at 168V maximum voltage.

5.1.1 Module to Module Balancing

The modules are equipped with a passive voltage management circuit that protects every cell within the module. Module-to-module balancing is not required.

5.2 Thermal Performance

Low internal resistance of the energy storage modules enables low heat generation within the modules during use. As with any electronic component, the cooler the part operates the longer the service life. In most applications natural air convection should provide adequate cooling. In severe applications requiring maximum service life, forced airflow may be required.

The thermal resistance, R_{th} , of the units has been experimentally determined assuming free convection at ambient ($\sim 25^{\circ}\text{C}$). The R_{th} value provided on the data sheet is useful for determining the operating limits for the units. Using the R_{th} value a module temperature rise can be determined based upon any current and duty cycle. The temperature rise can be expressed by the following equation.

$$\Delta T = I^2 R_{esr} R_{th} d_f$$

where:

I = current RMS AC or DC (amps)

R_{esr} = resistance R_{ac} for AC current or R_{dc} for DC current (ohms)

R_{th} = thermal resistance ($^{\circ}\text{C}/\text{W}$)

d_f = duty cycle fraction

This ΔT plus ambient should remain below the specified maximum operating temperature for the module (please refer to the module datasheet).

6. Operation

6.1 General

The module should only be operated within specified voltage and temperature ratings. Determine whether current limiting is necessary on input/output based on current ratings of ancillary devices. Observe polarity indicated on module. Reverse polarity operation of the module(s) is not recommended.

Electric isolation of the module is tested to 3500 VDC for maximum operating voltage of 750 VDC.

When several modules are connected in series for operating at higher voltage, care must be taken to ensure proper creepage and clearance distances in compliance with national safety standards for electrical equipment.

6.2 Overvoltage Logic output (B03 models only)

A single open collector logic output is available for overvoltage monitoring. This output will indicate if any cell in the module has gone into an over voltage condition. The over voltage signal is available via the connector supplied on the module.

The logic output is isolated from the capacitor voltages. When multiple modules are installed, the logic outputs may be monitored individually or wire-or'd to provide a single fault line. A table indicating the pin out, indication and maximum current is provided below. The maximum open circuit voltage is 5.5 VDC.

Pin #	Name	Output	Maximum current
1	GRND		
2	Overvoltage	High – Inactive Low – Active	5 mA
3	Not used	N/A	N/A
4	No used	N/A	N/A

NOTES:

1. The Overvoltage pin will go active if any one cell goes into an over voltage condition, 2.7V nominal threshold
2. The signal "Overvoltage" (Pin 2) is an open collector output indicating when any cell voltage is above the threshold voltage. A pull-up resistor ($\geq 1\text{k}\Omega$) connected to a 5V supply should be connected to Pin 2. In this configuration, the voltage at Pin 2 will be $\sim 5\text{V}$ when the circuit is not active. When a cell in the module goes into an over-voltage condition, the output of Pin 2 goes low. This signal can be used as a signal to the system electronics to stop charging in order to allow the cell(s) to discharge to an acceptable voltage through the built-in passive balancing system. Figure 8 shows a typical connection to use this system.
3. The Overvoltage circuit can sink up to 5 mA with a V_{OL} of no more than 0.4V. The leakage current when the output is off is 50 nA. The proper value of the pull-up resistor should be calculated based upon overall system circuit design.

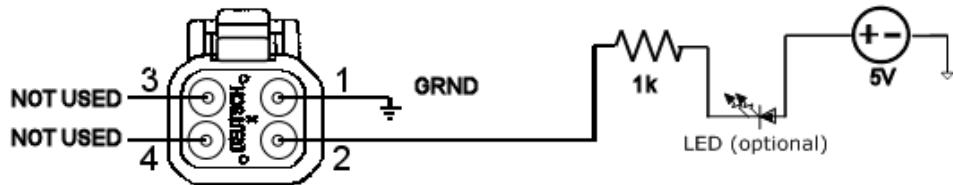


Figure 8. Typical connection to the monitor cable. (Users to verify values based on their circuit design).

The mating connector parts for the output logic are provided in the accessory kit. The connector is designed for 22 gauge wire; if the wire length required is longer than 6 feet, a shielded cable is recommended.

7. Safety

WARNING



DANGER – HIGH VOLTAGE HAZARD!

Never touch the power terminals as the module can be charged and cause fatal electrical shocks. Always check that the module is fully discharged before manipulating the module. Please refer to the step by step instructions below for the manual discharge procedure.

- Do not operate unit above specified voltage.
- Do not operate unit above specified temperature rating.
- Do not touch terminals with conductors while charged. Serious burns, shock, or material fusing may occur.
- Protect surrounding electrical components from incidental contact.
- Provide sufficient electrical isolation when working above 50 V DC.
- Prior to installation on and removal from the vehicle or equipment, it is mandatory to fully discharge the module to guarantee the safety of the personnel.

WARNING

A fully discharged module may "bounce back" if it is stored without a shorting wire connected to the + and – terminals. This bounce back can be as much as 7.5V for the 56V module.

7.1 Discharge Procedure

Proceed as follow to discharge the module:

1. Using a voltmeter, measure the voltage between the 2 terminals.
2. If the voltage is above 2V, a resistor pack (not supplied with the module) will need to be connected between the terminals. Proper care needs to be taken in the design and construction of such a dissipative pack. *e.g.* At 56V, for a 2 Ohm pack, the module will be discharged with a peak current of 28A and will take about 15 minutes to discharge. However, in this case, the heat/power dissipated in the resistor pack will be $\sim 3.9\text{kW}$. The resistor pack will need to be sized and provided with suitable cooling to handle this power dissipation. Additionally, proper enclosure or other packaging is necessary to ensure safety. In all cases, proper design of the dissipative resistor pack is necessary.
3. If the voltage is under 2V, connect the shorting wire provided by Maxwell (or similar wire) to the + and – connectors.
4. The module is now safe for handling. However, leave the shorting wire connected **at all times** until the module is installed in the system and the power cables are connected.

8. Maintenance

Prior to removal from the system, cable removal, or any other handling ensure that the energy storage module is completely discharged in a safe manner. The stored energy and the voltage levels may be lethal if mishandling occurs. Maintenance should only be conducted by trained personnel on discharged modules (Paragraph 7.1).

8.1 Routine Maintenance

- 8.1.1 Clean exterior surface of dirt/grime
 - 8.1.1.1 Reason - Improve power dissipation performance.
 - 8.1.1.2 Use a cleaning cloth dampened with a water/soap solution. Do not use high-pressure sprays or immersion
 - 8.1.1.3 Frequency
 - 8.1.1.3.1 Annually

8.1.2 Check mounting fasteners for proper torque

8.1.2.1 Reason - Avoid mechanical damage

8.1.2.2 Frequency

8.1.2.2.1 Annually

8.1.3 Inspect housing for signs of damage

8.1.3.1 Reason – allows potential internal damage to be identified

8.1.3.2 Frequency

8.1.3.2.1 Annually

8.1.4 Check signal/ground connections

8.1.4.1 Reason – avoid false signals or shock hazards

8.1.4.2 Frequency

8.1.4.2.1 Annually

9. Storage

The discharged module can be stored in the original package in a dry place. Discharge a used module prior to stock or shipment. A wire across the terminals should be used to maintain short circuit after having discharged the module.

10. Disposal

Do not dispose of module in the trash. Dispose of according to local regulations for general electronics waste.

11. Specifications

Refer to datasheets at <http://www.maxwell.com>, for specifications.

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