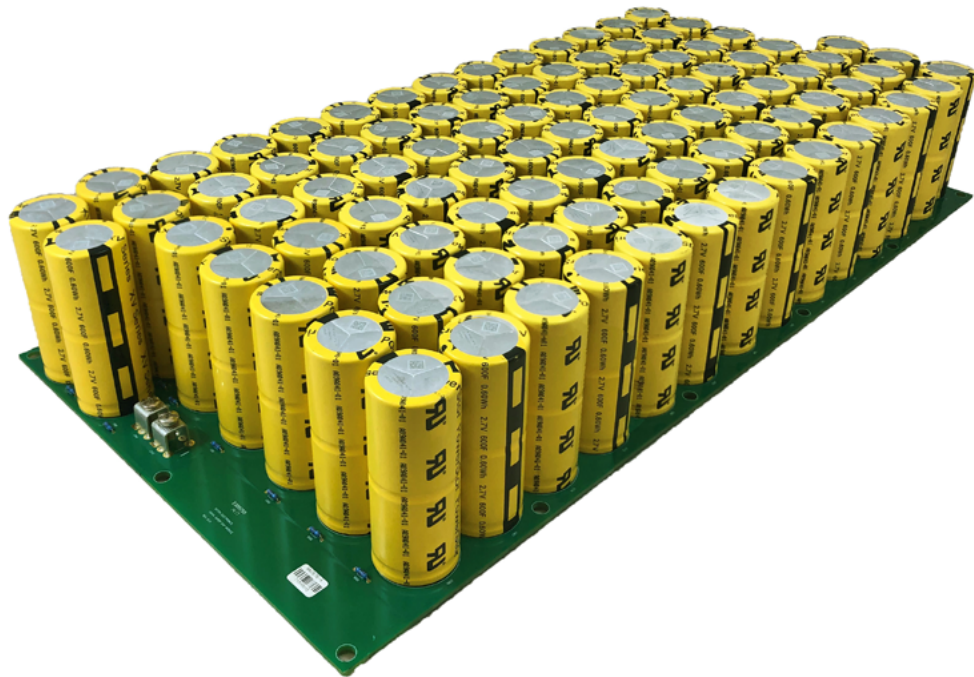


XVM PCBA Modules Instruction Manual



Powering Business Worldwide

Contents

INTRODUCTION	3
SAFETY	3
THEORY OF OPERATION	3
INSTALLATION	4
OPERATION	7
MAINTENANCE	7
STORAGE	7
DISPOSAL	7

Introduction

The XVM PCBA family of supercapacitor modules are self-contained energy storage devices comprised of ninety-six or one hundred-seventeen individual supercapacitor cells. The module includes the printed circuit board with cells soldered in place and integrated cell voltage management circuitry. Units may be connected in series to obtain higher operating voltage (maximum 1,500 V), in parallel to provide higher current or longer run time, or a combination of series/parallel arrangements as needed. The modules are intended for installation in UPS enclosure systems that could then be integrated into standard 19" or 23" equipment racks but may be installed in custom racks as well. As is, each module should be secured to a shelf to ensure integrity of the printed circuit board.

The modules are designed to provide backup power 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 cooling features. The modules are not intended for installation on vehicles or in high vibration environments. The integrated passive cell voltage management provides the highest reliability for optimizing product lifetime.

Safety

The XVM modules contains stored energy between 38.9 and 71.1 watt-hours and can discharge up to 1035 amps if short circuited. Only personnel trained in high power electrical systems should work on such systems. Modules are typically connected in series to increase the operating voltage and in parallel for increasing the potential discharge current. Before working on a system with modules installed, the module(s) should be discharged and the voltage on each module verified prior to conducting any work.



WARNING

Danger High Voltage Hazard

Never touch the power terminals as the module may be charged and cause fatal electrical shocks. Always check that the module is fully discharged before manipulating the module. For more information about the discharge procedure, please refer to page 7.

Do not operate unit above 259.2 V for XVM-259 and 315.9 V for XVM-315.

- 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 Vdc.
- Prior to installation or removal from the equipment, it is mandatory to fully discharge the module.

Theory of operation

Supercapacitors function on electrostatic principles with no chemical reactions and no moving parts. They avoid the lifetime issues associated with chemical storage of batteries or mechanical issues associated with kinetic storage such as flywheels. The XVM modules are non-toxic and designed for years of maintenance-free operation.

Supercapacitors are intended as energy storage with a DC discharge. The module should not be used for AC charging or discharging. Discharges may be constant current or constant power. Example discharges are shown in Figure 1a and 1b. The voltage of the module decreases while the current increases in a constant power load while voltage drops linearly under a constant current load.

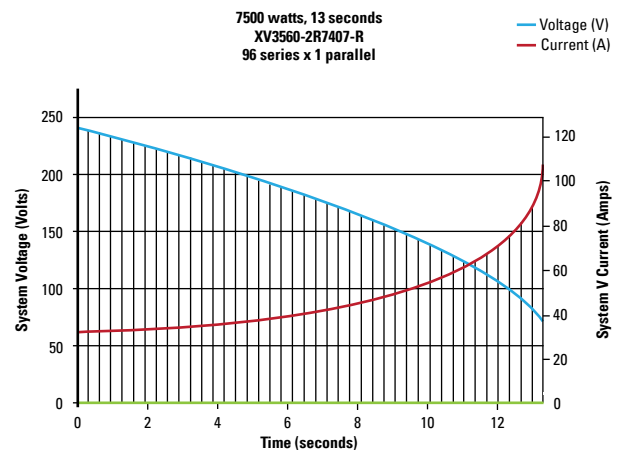


Figure 1a. Example voltage and current discharge curves for 7.5 kW discharge from one XVM-259R2425-R module with a 250 V float voltage

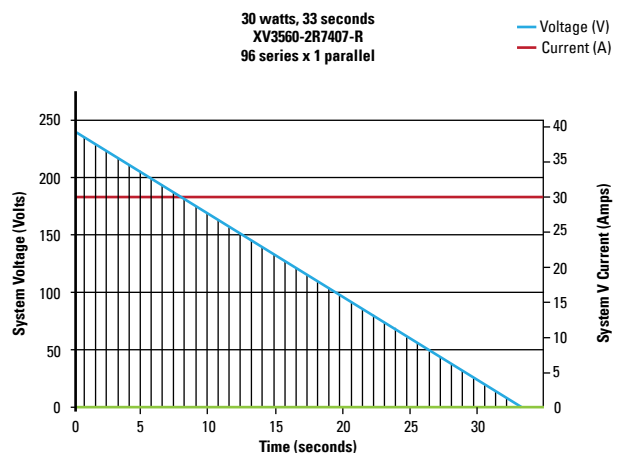


Figure 1b. Example voltage and current discharge curves for 30 A discharge from one XVM-259R2425-R module with a 250 V float voltage

Due to the very low equivalent series resistance (ESR) of the supercapacitors, minimal heat is generated during operation. However, as supercapacitors can handle very high currents, a significant heat rise can occur if the discharges and re-charging is frequent (duty cycle >1.5%) and above 40 A continuous current.

XVM PCBs Instruction manual

Many systems require multiple modules connected in series to reach higher operating voltages. The XVM modules can be series connected for operation up to 750 V. This operating voltage can be extended up to 1500 V with proper isolation with respect to voltage creepage and clearance to adjacent components and/or grounded components.

Due to manufacturing variations in capacitance and leakage current, cells in a module can differ in voltage. This voltage difference affects the capacitance and equivalent series resistance over time and results in a shortening of the life of the system.

The passive balance system uses voltage dividing resistors in parallel with each of the XV cells that are assembled in series within the XVM PCBAs. This allows current to flow naturally from higher voltage cells to adjacent lower voltage cells, providing natural balancing. This method also ensures that cell balancing is always occurring during all operation states and cell voltage levels. The balancing resistor values are sized to ensure current flow during operation is much higher than the cell leakage current.

Installation

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.

Carefully remove the module from the shipping carton and retain the shipping materials until the unit has been inspected and is determined to be operational. The XV cells are through hole soldered and special care should be taken during unpackaging to ensure that no terminal damage occurs as well as personnel safety due to the relatively sharp ends and weight of the module.

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.

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

Mechanical

Modules are intended for installation horizontally as shown in Figure 3. The module is required to be mounted on a shelf to help provide support of the weight contained on the printed circuit board. There should be no board flex in order to maintain the integrity throughout the design life of the supercapacitor modules. The modules should further be secured to the rack using the mounting holes located throughout the PCB and shown in Figure 4 and Figure 5 for XVM-259 and XVM-315 respectively. See the respective data sheets for available mounting locations [click here](#).

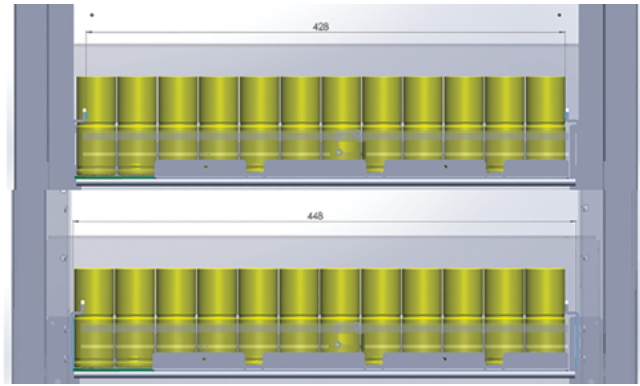


Figure 3: XVM PCBA shown mounted horizontally in UPS or cabinet

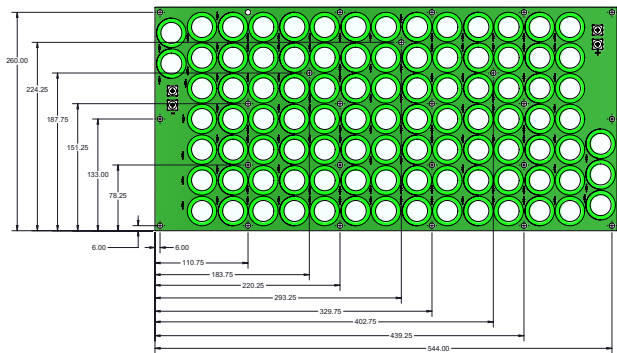


Figure 4: XVM-259 top view dimensions, including mounting holes

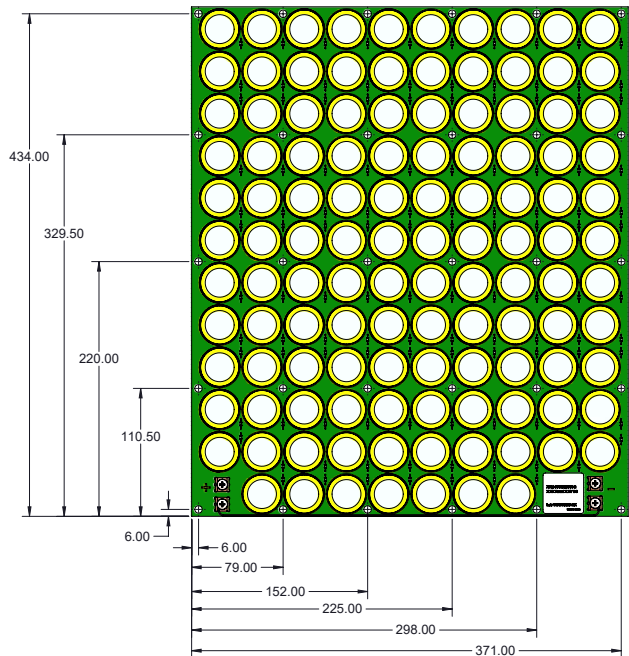


Figure 5: XVM-315V top view dimensions, including mounting holes

Electrical

⚠ 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.

⚠ 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. 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.

Positive and negative terminals

The terminals of the module consist of wire-to-board terminals using M5 nickel-plated brass screws to connect cables to terminal surface. These terminals offer a 11 x 11 mm surface area for mechanical connection. They are designed to connect via bare wire, ring lugs or fork terminals. Each terminal can accept single #8 - 16 AWG copper solid or stranded wire or appropriate ring and fork terminals. The terminals are rated up to 20 in-lb/ 2.2 N-m of torque. Applying torque above 20 in-lb/ 2.2 N-m may result in damage to the terminals.

Attachment to the terminals should be made using wiring and connections of an appropriate size for the application current. Also, it is recommended to consult the end-product assembly standard for any further definition of wire sizes. There are two redundant wire-to-board connectors for both the positive and negative terminals. It is acceptable to only wire one of the terminals. The redundancy of an additional terminal is provided in case one becomes stripped during assembly or to provide power to two different loads.

Connection of modules in series or parallel or combination thereof should utilize the same gauge wire (and ring/fork terminals) 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 6 and Figure 7). For parallel connections, connect positive terminals together and negative terminals together (as shown in Figure 8 and Figure 9). Figure 10 and Figure 11 show series-parallel wire configurations.

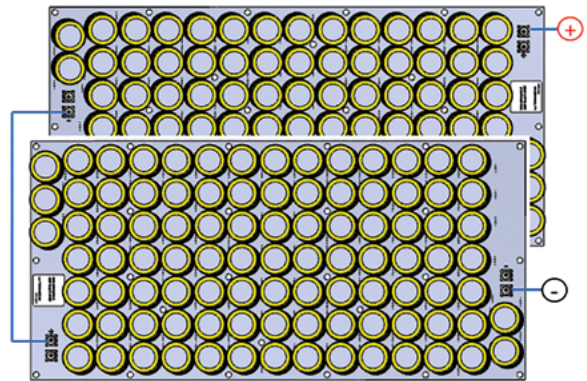


Figure 6: Series connected XVM-259 modules

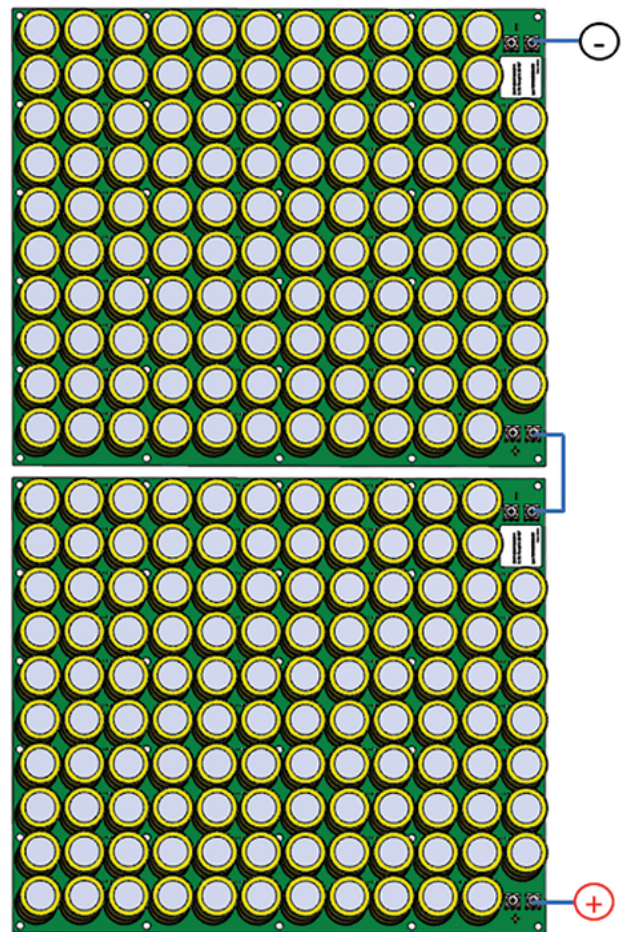


Figure 7: Series connected XVM-315 modules

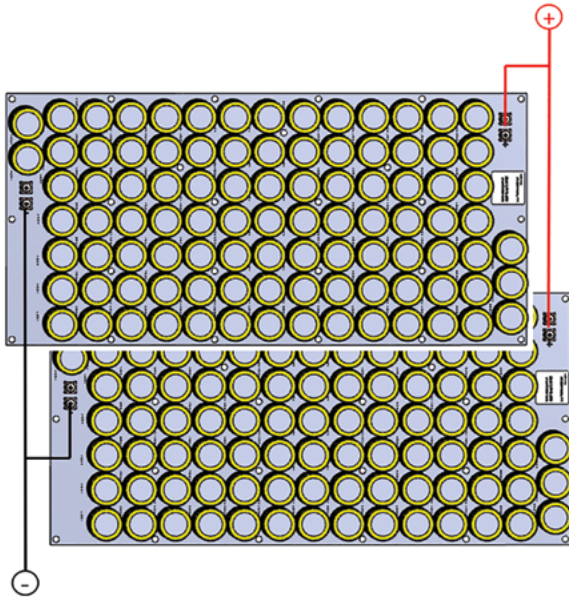


Figure 8: Parallel connected XVM-259 modules

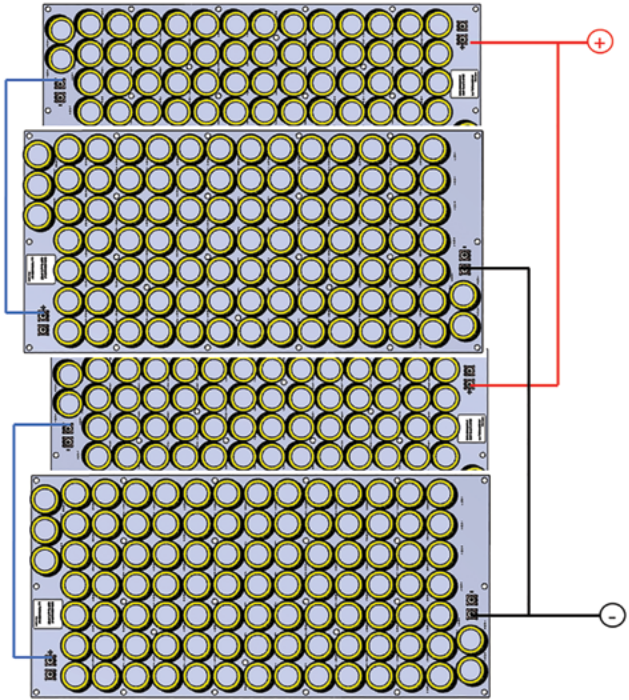


Figure 10: Series and parallel XVM-259 wiring configuration

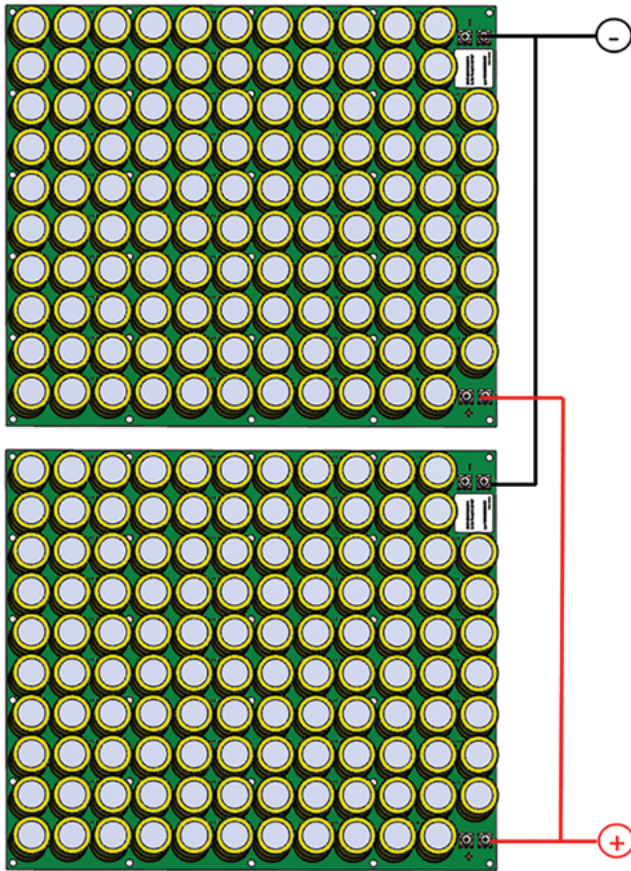


Figure 9: Parallel connected XVM-315 modules

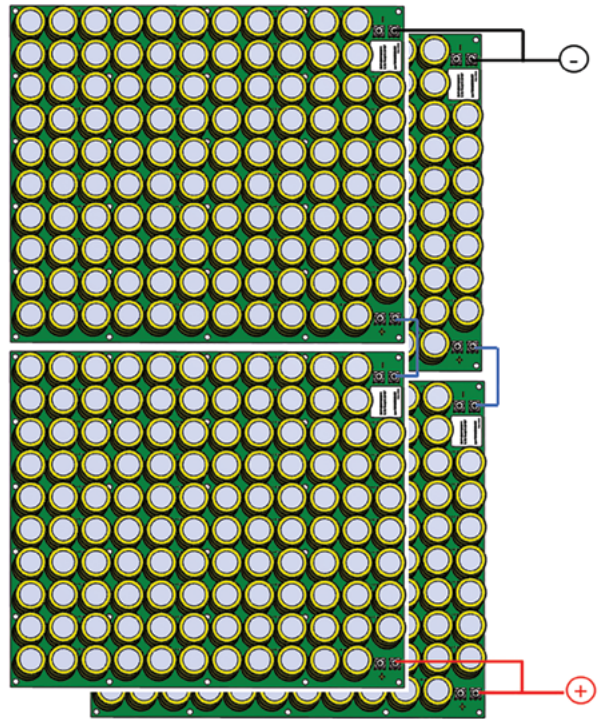


Figure 11: Series and parallel XVM-315 wiring configuration

Voltage balancing

The modules are equipped with passive voltage management circuitry that balances the voltage between cells. The voltage management functions over hours to minimize the voltage differential between cells.

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, such as backup power for UPS, natural air convection should provide adequate cooling. In higher duty cycle applications requiring maximum service life, forced airflow may be required. The XVM PCBA modules are designed as open frame modules which also helps both natural air convection or forced airflow for cooling.

Operation

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.

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 relevant end-product safety codes and standards for electrical equipment.

Overvoltage

As with any energy storage device, it is strongly recommended that the applied voltage does not exceed the rated voltage to ensure long design lifetimes. Although there is no integrated overvoltage circuitry, voltage monitoring is recommended per string to remove charging power. The balancing circuitry can help discharge to recommended limits if the overvoltage condition is very short-term.

Maintenance

Prior to removal from the system, cable removal, or any other direct 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. Maintenance for supercapacitors is intended to continue the intended performance and ensure there is no damage internally or externally.

Discharge Procedure

Proceed as follow to discharge the module:

1. Using a voltmeter, measure the voltage between the positive and negative terminals.

2. If the module voltage is above 1 V, a resistor pack (not supplied) 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 250 V charge voltage, for a 10 Ohm pack, the module will be discharged with a peak current of 25 A and will take about 23 seconds to discharge. However, in this case, the heat/power dissipated in the resistor pack will be 6.25 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 1 V, connect the shorting wire (minimum 18 AWG) to the positive and negative terminals. Due to the extremely low module ESR, there may be a spark and warming of the wire when first connecting the shorting wire.
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.

Routine Maintenance

- If any dirt or grime, use a cleaning cloth dampened with a water/soap solution. Do not use high-pressure sprays or immersion
 - Frequency - Annually
- Check mounting fasteners for proper torque
 - Frequency – Annually
- Inspect housing for signs of damage
 - Frequency - Annually
- Check signal/ground connections
 - Frequency – Annually

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 per the prescribed procedure.

Disposal

Do not dispose of module in the trash. Dispose of according to local regulations for general electronics waste. The disposal method should be compatible with aceontrile.



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