Maxwell TECHNOLOGIES

Enabling Energy's Future™

USER MANUAL

Notes on Using Ultracapacitor Modules

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Maxwell Technologies offers multi-cell ultracapacitor modules to fulfill the voltage requirements of many integrated systems. These standardized multi-cell modules are connected in series to achieve higher voltages. Maxwell's 5V module, built with two 2.7V small cells connected in series, is typically used in applications which require "pulse power" but low energy (e.g. AMR, RTC, etc.). Modules with higher voltages (≥24V) are targeted for industrial application such as UPS, DVR, and wind turbine pitch control system.

Environmental Considerations

Although usable under a wide range of operating conditions, Maxwell recommends avoiding use of ultracapacitor modules under the following environmental conditions:

- in direct contact with water, salt water/brine or oil,
- under direct sunlight,
- in high temperature, especially exceeding the specified maximum operating temperature in the product datasheet,
- in high humidity with the likelihood of moisture ingress,
- in direct contact with chemically active gas(es),
- stored or used in acidic or alkaline conditions,
- undergoing vibration that is more severe than the specified vibration standard in the product datasheet.

Please contact Maxwell for appropriate recommendations before operating under the listed conditions.

Electrical Considerations

1. Please review the datasheet for detailed product specification limits prior to use. Prior to storage, the module shall be shorted by connecting a shorting wire between the positive (+) and the negative (-) terminals of the module. Modules must be stored shorted, at room temperature and in a low humidity environment.

2. Before connecting a module to a system, shorting wire placed on the terminals of the module must be removed. Operation of the system with the shorting wire still connected to the terminals of the module can lead to failure of the system and system components.

3. The module must **NOT** be operated at voltages higher than the rated

voltage. Exposure to over-voltage conditions can result in accelerated leakage current, capacitance loss, ESR rise, and heating of the module, which will decrease the effective lifetime of the module significantly.

4. The module shall be operated under conditions specified on the datasheet. Excessive current must not be used at any time as it can result in heat build-up leading to module malfunction and potentially damaging the module. Please contact Maxwell for guidance on effective use of ultracapacitor modules for your application.

5. When multiple modules are connected in series, capacitance variation in the modules can create voltage imbalance amongst the modules. Maxwell recommends minimizing the capacitance variation of modules used in one system and the implementation of robust cell balancing strategies for safe operation of the module. Please contact Maxwell for integration guidelines for your application.

6. When connecting multiple modules together, thermal aspects of module use must be considered. Heat accumulation in modules can cause accelerated performance degradation. Cooling may be required for applications with aggressive duty cycles. Adequate cooling of the modules must be designed as required for the application. Please contact Maxwell for thermal management guidelines for your application.

7. Ensure that the modules are securely mounted for the application. The module has multiple mounting points which can be used to secure the module to a base structure or rack.

8. Lifetime of ultracapacitor modules is governed by ambient temperature and operational voltage. To maximize lifetime performance, the temperature of the module must be maintained well below maximum operating temperature stated in the product datasheet. It may be necessary to de-rate the operating voltage when operating the module at higher temperatures. Please contact Maxwell for voltage/temperature operating guidelines for your application.

9. Ensure modules are disconnected from the power mains before connecting power lines to module(s).

10. The voltage of the module must be checked before connecting the power lines. The module shall be fully discharged before connecting. When the shorting wire is removed from the module, the module voltage may recover

up to a certain point depending on the number of cells connected in series inside the module. The shorting wire placed on the module should ideally be removed right before connecting the modules to form the final system configuration. Maxwell recommends that module voltage is always checked prior to any electrical connection being made.

11. Applying reverse voltage on ultracapacitor module(s) may result in malfunctioning, rapid performance degradation, and/or catastrophic failure of the module. The polarity of the module terminals must be checked in advance for the correct connection of the power lines.

12. Conductive wire in the power line must not come in contact with the case of the module. If the conductive wire is exposed due to damage to the insulation sheath and touches the case, it can cause malfunctioning of the module and/or the system.

13. During assembly or mounting of the module, the terminal bolt must be tightened to the specified torque value, as specified in the product datasheet or user manual. Excessive torque may damage the module terminals.

14. When connecting the power, ensure that the area around the module is clear off any metallic materials (such as tools or measurement devices) to prevent accidental shorting between terminals.

15. Properly discharge the module using appropriate discharge equipment and/or resistors. Measure the module voltage before placing a shorting wire/strap. Shorting wire should only be placed when the module voltage is lower than 1V. Even at under 1V, expect the wire to heat up. Wear proper insulating gloves to avoid burns.

16. Do not disassemble the module package as it can potentially compromise the integrity of the product.

Module Troubleshooting

Once modules are installed, check functionality. If modules and/or systems fail to operate, please use the guidelines listed below to troubleshoot the module/system. If one or more of the below problems persist, please disconnect the power to the modules and contact Maxwell for further guidance.

1. The module is not charging:
   - Ensure that the connection between the module and the charging equipment is OK.
   - Ensure that the charging equipment is properly working.
   - Some chargers may detect ultracapacitor modules as a short due to the low impedance of the modules. Contact Maxwell engineering for information for safely charging the ultracapacitor modules.

2. There is a noticeable odor generated from the module during charging or during normal operation.
   - Stop charging or using the module/system immediately. Discharge the module to a low voltage and disconnect the module from the system.

3. There is an electric spark generated from the module during charging or during normal operation.
   - Stop charging or using the module/system immediately. Discharge the module to a low voltage and disconnect the module from the system.

Storage

1. Do not store ultracapacitor modules at high temperature and/or high humidity environment. Maxwell recommends modules to be stored at temperature between 5 and 30°C and at less than 50% RH (Relative Humidity). Avoid abrupt temperature changes, which may cause water condensation and deterioration of the product. Avoid exposure to direct sunlight for extended period as it may cause deterioration and discoloration of the exterior parts.

2. For longer-term storage, Maxwell recommends fully discharging the module and shorting the terminals.

3. Do not store the module in an atmosphere containing water-droplets or toxic gases.

4. Avoid exposure to acidic or alkaline liquids/vapor.

Disposal

For disposal of the module, comply with all local, regional, federal, and national requirements for disposal of ultracapacitor modules. In most jurisdictions, ultracapacitor product disposal can be handled by industrial waste handling organizations.

Download

"Notes on Using Maxwell Ultracapacitor Modules" is also available on Maxwell's website **www.maxwell.com** for download.