



Orion BMS Purchasing Guide

Rev. 1.2

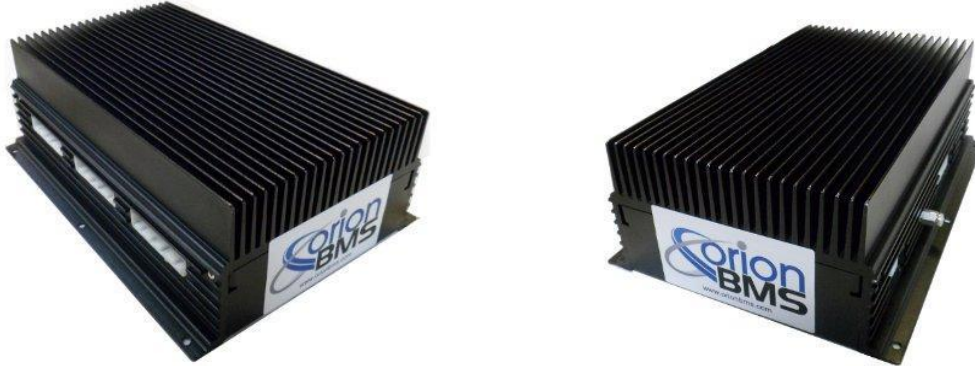
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Ewert Energy Systems is a research & development company focusing on developing solutions for plug-in hybrid and electric vehicles and other energy storage applications. Ewert Energy provides custom solutions as well as off the shelf components.

Main Components

Orion BMS Unit



In order to reduce costs, the Orion BMS is offered with various numbers of cell group locations populated. Please carefully read “Wiring the BMS” in the “Wiring and Installation Guide” before determining how many cell BMS is required. Ideally, the BMS can be ordered sized to the actual number of cells in the application, however, depending on the placement of fuses, safety disconnects or and any high resistance busbars / wires, the BMS may need to be ordered sized for substantially more cells than the pack actually has. For example, a battery that has 48 cells may require 60 or 72 cell version of the Orion BMS depending on where high impedance busbars or fuses are located. The Orion BMS is available in increments of 12 cells from 12 cells to 180 cells. Multiple units can be connected together in series to support more than 180 cells.

To allow safety disconnects and fuses in the middle of the pack and take advantage of the 2.5kV isolation barriers, some smaller sizes are also available with “-S” configurations that offer cell groups on different connectors. Custom population configurations can be made for larger volume orders.

The following table shows the standard available cell number ordering options. Additional custom configurations can be requested.

108 Cell Size Enclosure

<u>BMS Size</u>	<u>Cell Groups Populated</u>		<u>BMS Size</u>	<u>Cell Groups Populated</u>
12	1		48-S*	1, 2 and 4, 5
24	1, 2		60	1, 2, 3, 4, 5
24-S*	1 and 4		72	1, 2, 3, 4, 5, 6
36	1, 2, 3		84	1, 2, 3, 4, 5, 6, 7
36-S*	1, 2 and 4		96	1, 2, 3, 4, 5, 6, 7, 8
48	1, 2, 3, 4		108	1, 2, 3, 4, 5, 6, 7, 8, 9

* -S ordering options are designed to provide 2.5kV isolation between cell groups

180 Cell Size Enclosure

BMS Size	Cell Groups Populated
120	1, 2, 3, 4, 5, 6, 7, 8, 9, 10
132	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11
144	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
156	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
168	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
180	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15

Standard order Orion BMS units with less than 108 cells are packaged in the 108 cell size enclosure and the standard sizes 120 - 180 cell are packaged in the 180 cell size enclosure. The enclosure drawings are available on support page of the Orion BMS website (www.orionbms.com/support).

The Orion BMS is configured by default to have an internal termination resistor on the CAN1 interface and no termination resistor on the CAN2 interface. The Orion BMS can be special ordered with any configuration of termination resistors. Please request a quote for special configurations.

The Orion BMS is designed to manage one battery string very well and is not setup to manage multiple strings with one unit. If multiple strings are to be paralleled together, special care must be taken and more than one Orion BMS unit would be necessary. Please see the "Wiring and Installation Manual" for more information. Please note that this does not apply to a single string where multiple cells have been paralleled together.

Multiple Orion BMS units can be strung together in series in a master / slave configuration to allow for more than 180 cells.

Current Sensor



The current sensor should be sized to meet the highest amperage expected in an application, however should be sized as small as possible to improve accuracy. For example, if an application has an expected maximum amperage of 275 amps, a 500A current sensor should be used. Some headroom should be left between the maximum expected amperage and the size of the current sensor to allow for brief current transients that may exceed the rating of the current sensor. For example, if the application is expected to draw 190 amps maximum, a 500A current sensor should be selected even though a 200A sensor is technically large enough. While accuracy is somewhat improved by using the smallest current sensor for the application, it is best to error on the side of getting a sensor that is larger than necessary since the accuracy is not greatly improved.

The current sensors offered with the Orion BMS are dual range sensors and contain 2 sensors in each package. One sensor is smaller than the other and this is used to provide both redundancy and to improve accuracy measuring smaller currents.

The following sizes of current sensors are currently available:

+/- 200A, 500A, 750A and 1000A

The Orion BMS supports current sensors > 1000A, however those applications typically require more care to select. Please contact Ewert Energy if higher currents are necessary.

The current sensor is technically optional, however it is strongly recommended because the majority of the Orion BMS systems' features depend on having an accurate current sensor.

Without a current sensor, the Orion BMS is unable to provide any of the following calculations:

- Internal resistance calculations
- Battery health
- Over-current protection (still provides over and under voltage protection)
- Current measurements
- Open cell voltages
- Weak cell faults
- State of charge calculation or state of charge drift
- Calculation of Charge or Discharge current limits
- Simulation of virtual battery

Thermistors



The Orion BMS main unit supports up to 4 thermistors (up to 800 additional thermistors are can be connected using 80 thermal expansion modules which are separately). The thermistors are 10K thermistors with a B25/50 value of 3380K and come standard with 1 meter of wire (however they can be special ordered with longer or shorter wire lengths.)

Thermistors are optional and can be ordered wired into the wiring harness or included loose with the order.

If more thermistors are required for the specific application, a thermistor expansion module can be used.

CANdapter



The CANdapter is necessary to connect the Orion BMS unit to a computer via a USB port to upload settings to the BMS, updating firmware and logging data to a PC. One CANdapter can be used between multiple Orion BMS units and is only needed when settings need to be changed, firmware needs updating or if diagnostic data needs to be retrieved from the BMS unit.

More info on the CANdapter can be found at www.candapter.com

Wiring Harnesses

For convenience, pre-assembled wiring harnesses are available for all Orion BMS connectors. The Orion BMS uses professional automotive grade locking connectors which require special crimping tools or machine dies to assemble. These crimping tools run several hundred dollars each or are rented from the manufacture on a monthly basis. While it may be economical for larger production orders to assemble custom wiring harnesses, many of our customers benefit from purchasing pre-assembled harnesses.

The Orion BMS has 4 main harnesses:

- 1.) Cell voltage tap harnesses
- 2.) Total pack voltage tap harness
- 3.) Main I/O harness
- 4.) Current sensor & thermistor harness

Purchasing pre-assembled wiring harnesses is optional. If the Orion BMS units are ordered without the pre-assembled wiring harnesses, crimps and connectors are provided. If the pre-wired harnesses are ordered, the crimps and connectors are not included since they are not necessary.



Cell voltage tap harness - 36 cell



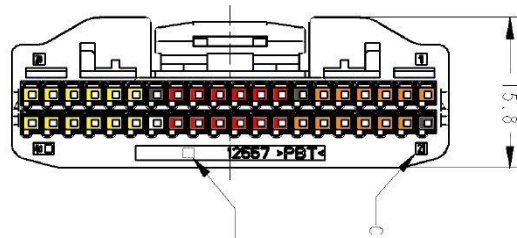
Cell voltage tap harness - 12 cell

Cell voltage tap wiring harnesses

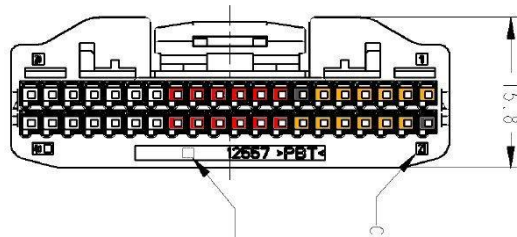
The Orion BMS is populated in increments of 12 cell groups and the wiring harness options are available to match those increments. When ordering through the website, the correct wiring harness for any model of the Orion BMS will be ordered. The wiring harnesses are available with 12 cell, 24 cell and 36 cell configuration per connector. If an 84 cell BMS is ordered, cell groups 1, 2, 3, 4, 5, 6 and 7 are populated and therefore the cell voltage tap wiring harness connectors included would be 2 of the 36 cell harnesses and one 12 cell harnesses for a total of 84 cells.

Cell voltage tap wiring harnesses come standard as 6 foot (1.8 meter) lengths and are terminated in cut wire without any terminals. The wires are 22 AWG stranded and appropriate crimps should be used with them.

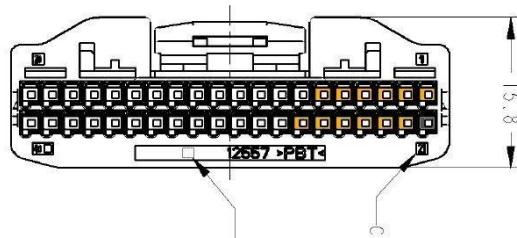
Cell voltage tap wiring harnesses are in 5 feet of $\frac{5}{8}$ " , $\frac{1}{2}$ " or $\frac{3}{8}$ " convoluted tubing. The convoluted tubing may be cut or discarded depending on the application requirements.



Standard 36 Cell Harness Configuration (3 group)



Standard 24 Cell Harness Configuration (2 group)



Standard 12 Cell Harness Configuration (1 group)

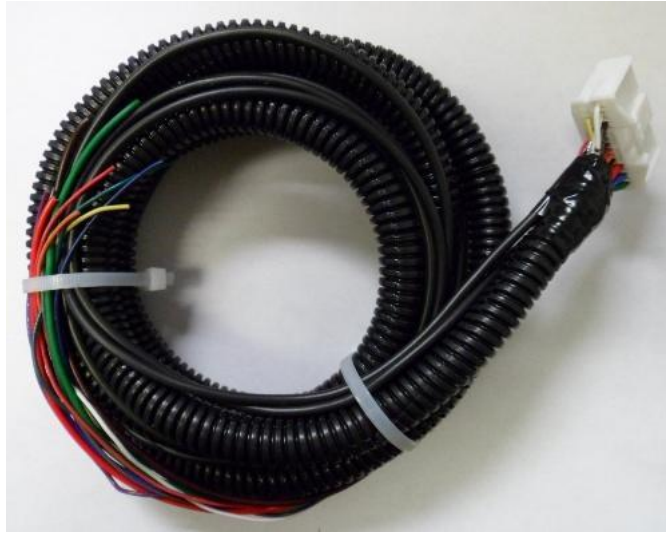
Total pack voltage tap wiring harness



The total pack voltage tap wiring harness contains only 2 wires that are terminated in cut wire (positive and negative for the total pack). The wires are 22AWG, 8 feet long and are 600V UL listed wire.

Total pack voltage tap harnesses are in 6 feet of $\frac{1}{4}$ " convoluted tubing. The convoluted tubing may be cut or discarded depending on the application requirements.

Main I/O harness



The Main I/O harness is also terminated in cut wire. All usable pins are populated including the 2 CAN interfaces. All wires are 6 feet (1.8 meters) in length except for the CAN wires. CAN1 wires are 12 feet in length (designed to reach the front of a vehicle) and CAN2 wires are 4 feet in length since CAN2 does not include a termination resistor by default and the maximum recommended physical distance from the main bus is just under 4 feet.) Both CAN wires are single shielded twisted pairs.

Thermistor / Current Sensor Harness



Current Sensor Harness with thermistors installed



Current sensor harness without thermistors installed

Current sensors and thermistors share the same connector on the Orion BMS unit. The current sensor harness is included with the current sensor and does not need to be ordered separately, however it does not come with the thermistors loaded in by default. For a small charge the thermistors can be loaded into the current sensor harness.

Installation Tools

Tap Validation Tool



The tap validation tool is used to determine if the battery tap connectors are properly wired before connecting to the Orion BMS. Improperly wired connectors can cause permanent damage to the Orion BMS unit that is not covered by warranty.

The tap validation tool is available both for weekly rentals for single use applications as well as for purchase for OEMs that need the tool for use on an assembly line.

Available Add-Ons

Thermal Expansion Module



The thermistor expansion module is used in applications where more than the 4 standard thermistors are needed for temperature monitoring. One thermal expansion module monitors up to 80 thermistors. The unit communicates with the main Orion BMS system via either two 5V analog signals (emulated thermistors) or via the CAN interface. The thermal expansion module is programmable and can be setup for the exact number of thermistors the application requires. A software utility allows for viewing the value of each individual thermistor so that thermistor errors can easily be located.

Please see the Thermistor Expansion Module Purchasing Guide for more information on ordering options.

Basic Display Module



The Basic Display module for the Orion Jr. BMS provides visual feedback of the essential information on a battery pack. This information includes State of Charge, Power Limited (reduced output power), and the Malfunction Indicator Status (error indicator).

Data Logging Display Module

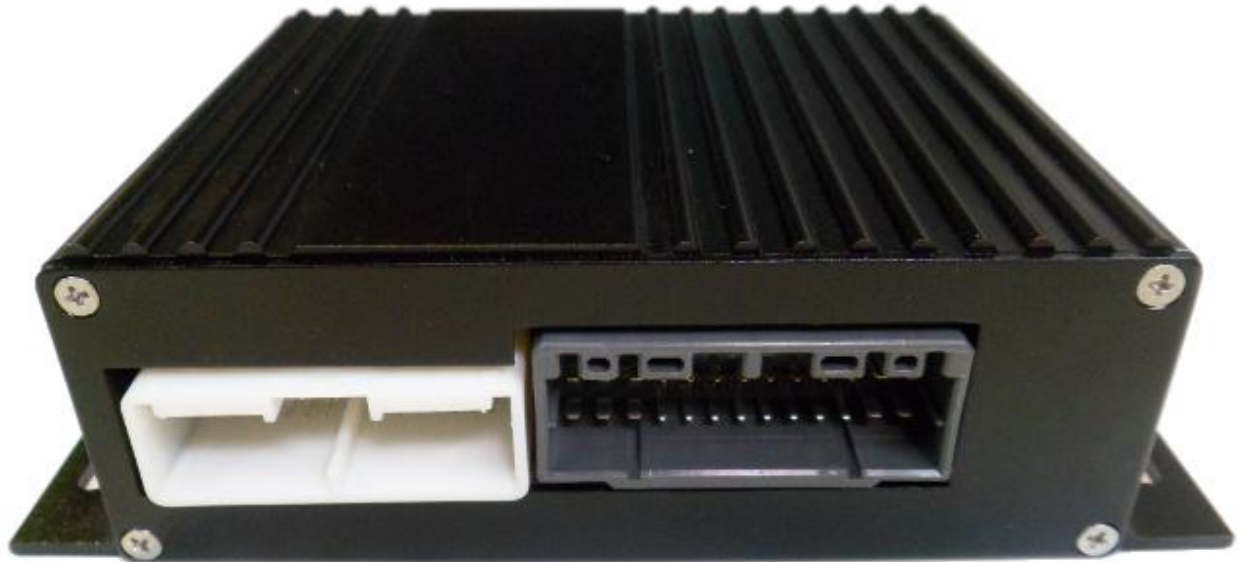


The CAN Data Logger and Display module for the Orion BMS provides visual feedback of the essential information on a battery pack as well as data logging capabilities for diagnostics. This display and logging combo connects to an Orion BMS unit via CAN (Controller Area Network) and logs user-selected data to a memory card while displaying State of Charge, Power Limited (reduced output power), and the Malfunction Indicator Status (error indicator)

Product Specifications

- Logs BMS parameters to memory card at user selectable sampling rate
- Connects to the Orion BMS via CAN (no analog connections)
- Supports brightness dimming for automotive use (via CAN)
- External “event trigger” input which can flag events for future review
- Log graphing and analysis software
- Real time clock to store data and time of each charge / discharge cycle
- Supports CAN frequencies of 125, 250, 500Kbps, and 1 Mbps
- User customizable logging frequency from 100mS to 10 seconds
- Compatible with any size “micro SD” type memory card up to 32Gb in size (required for data logging; memory card not included with purchase)

Contactor Expansion Module



The contactor expansion module is designed specifically for 2004-2009 Toyota Prius vehicles in order to add an additional plug-in hybrid battery pack to the original battery pack. The contactor expansion module is sold to qualified retailers and OEMs and includes patented technology from Ewert Energy Systems for increasing electric drive capabilities of the Prius. Please inquire for additional information on this item.

Hybrid Energy Manager

This patented breakthrough device offered by Ewert Energy allows for full electric drive of the Toyota Prius vehicle at any speed as well as an ideal blended mode that heavily favors electric drive over the gas engine while still maintaining the full power of the vehicle. The Hybrid Energy Manager is available to qualified companies and works exclusively with the Orion BMS. Please inquire about the Hybrid Energy Manager.

OEM & Reseller Sales

Prices listed on the Orion BMS website are our suggested retail prices for single quantity units. We offer a favorable pricing structure for OEMs, so please request a quote for pricing for quantities over 5 units. For larger orders, custom modifications are possible.