

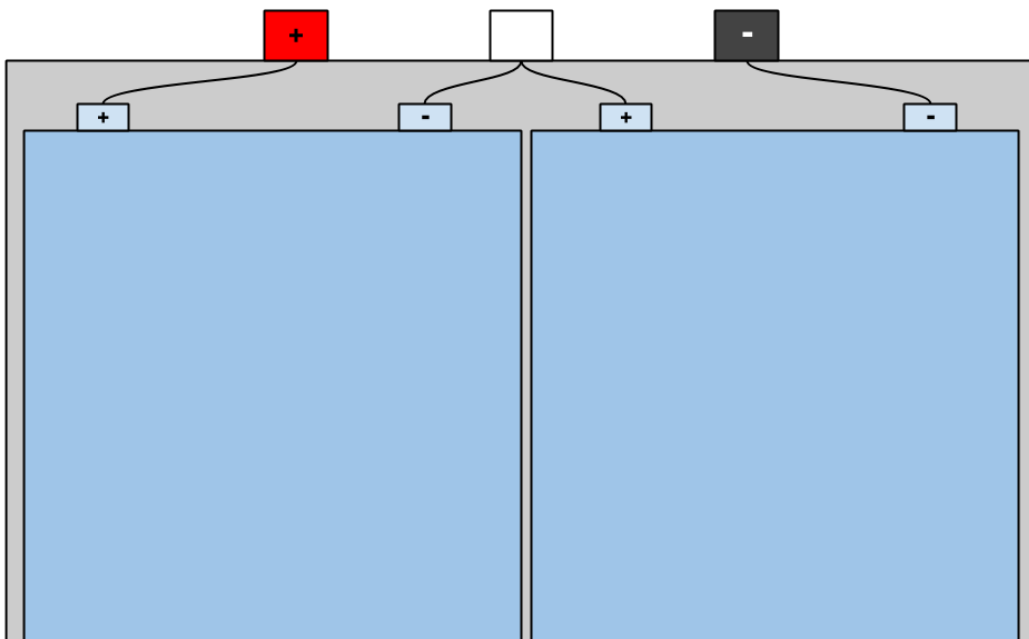


Using the Orion BMS with Nissan Leaf Modules

IMPORTANT SAFETY NOTE: Reclaimed cells always carry risk. Cells may have been involved in an accident or exposed to other physical stress which may have caused internal damage. This can lead to premature failure or risk of internal shorts within the modules. **Appropriate precautions must be taken to account for these risks.**

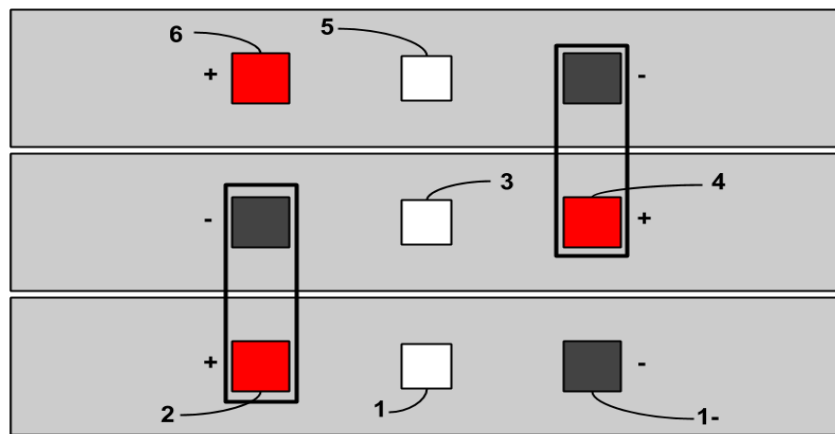
The Orion 2 BMS and Orion Jr BMS products are compatible with the popular Nissan Leaf cells manufactured by AESC Corporation. The Leaf modules are configured with 4 cells in each module - 2 cells paralleled together and 2 of these cell pairs together in series (2S2P). This leaves the module with a nominal voltage of 7.4v for a module and around 66 amp hours.

Below is a depiction of 2 cells in series inside a Leaf module:



Nissan provides a center tap on each module to allow the BMS to discretely measure each of the 2 internal cells in series. This allows the Orion BMS to be easily used to monitor these types of modules without any modifications to the module itself.

The Leaf modules technically contain 2 cells in parallel and then two of those blocks of paralleled cells in series (2S2P), however the Orion BMS treats blocks of cells which are paralleled directly together as a single cell. Because of this, the Orion BMS will see a single leaf module as 2 cells in series. The Orion BMS can easily be used with these by simply utilizing the center tap for monitoring the individual cells. This is shown below with cell tap locations for a sample configuration of 3 Leaf modules in series (this pattern continues for more cells until reaching module 7 (13th and 14th cells) where the pattern starts over with the next cell group).



Cell tap 1- (the negative) is placed on the negative most terminal of the negative most cell. Then tap 1 is placed on the center tap of the first module which is actually the positive terminal of cell #1. Then tap 2 is placed on the positive most terminal of the first module which is actually the positive terminal of cell #2.

IMPORTANT NOTE: It is very important that 2 cell tap inputs are used per Leaf module as shown in the diagram above (one tap going to the first cell in series and the second tap going to the second cell in series). **DO NOT CONNECT THE ENTIRE 7.4v MODULE TO A SINGLE CELL TAP INPUT ON THE BMS.** This will result in over 5v being applied to a single cell tap input and cause damage to the BMS which is not covered under warranty.

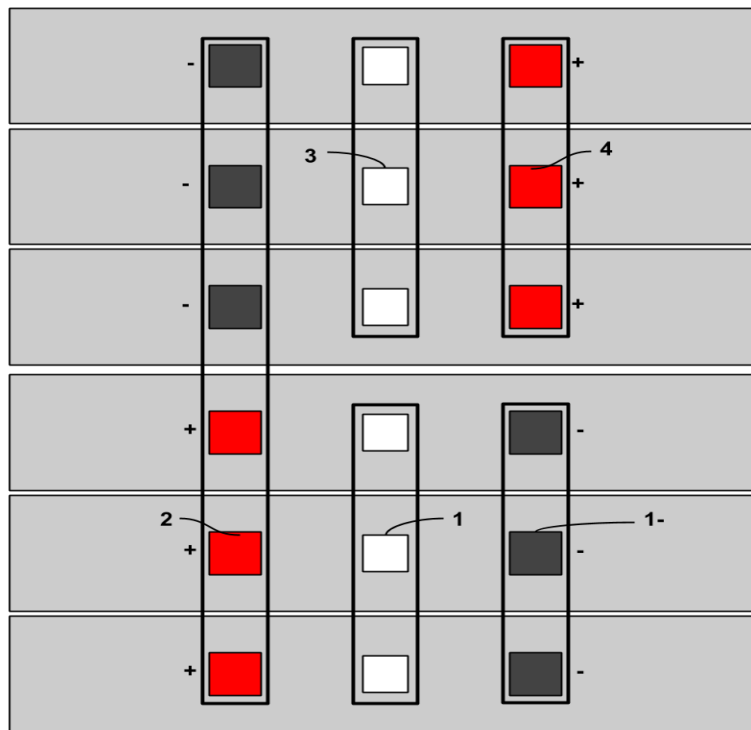
Additional Note: Mechanical compression may be necessary to maintain normal lifespan

Paralleling Multiple Leaf Modules

IMPORTANT NOTE: Paralleling multiple cells directly together and then placing those blocks of paralleled cells in series for a single string (as depicted below) is different than forming multiple parallel sets of individual strings. Paralleling cells as depicted below is far more simple than parallel strings. Please see our documentation on parallel strings for important information if considering parallel strings.

The Orion BMS treats multiple cells directly paralleled as a single cell. When cells are directly connected together, they are always electrically the same voltage and they will self balance between the various smaller cells while increasing the overall capacity. If any one individual cell went bad, the other remaining paralleled cells would take over the load and help prop up the bad cell. This means that in a worst case scenario, the connection between the group of paralleled cells must be capable of handling the full stack current. For this reason, any busbars or connections linking multiple paralleled cells must be able to handle the full stack current (even though in most cases they will not be doing so regularly).

Paralleling Leaf modules is electrically possible by connecting all of the negative terminals together, all of the center taps together and all of the positive terminals together of the block of modules being paralleled. It is usually necessary to receive the cell manufacturer's authorization to do so as in this case the center taps on the modules may not be rated to handle the full pack current. Since most cells are recovered from crashed or salvage vehicles, the official manufacturer's specifications are not always available. This means that it is necessary for the integrator to determine the suitability of paralleling modules in this manner. If it is found to be suitable, the diagram below shows how the BMS taps would be connected, as well as where the busbar interconnection locations.



Example showing how 3x Leaf modules could be connected together in parallel