



## BEMS (Battery Equalizing & Monitoring System)



Firefly International Energy, USA, has developed a real-time, novel & patented active battery management solution known as Battery Equalizing and Monitoring System (BEMS). It is designed to equalize old and new batteries connected in a series string and thus extend battery life & provide more energy by preventing premature battery failure like battery dry up. Following are the salient features of the BEMS:

- 1) Prevent battery unbalancing in string with old & new batteries after replacement.
- 2) Suitable for 24 to 48V nominal system voltage.
- 3) Auto calibration for number of batteries in string & number of cells in a battery.
- 4) Accurate balancing up to  $\pm 5\text{mV}$  per cell.
- 5) Battery voltage sense resolution of  $0.5\text{mV/VPC}$
- 6) High balancing current capacity up to 6A for faster equalization.
- 7) Parallel equalizing of low batteries in string for faster equalization of string.
- 8) Can be used for high voltage strings in sub-strings form.
- 9) Battery undervoltage & overvoltage fault indication.
- 10) External relay compatibility for enabling shutdown.
- 11) IP67 design.

BEMS Model details: These are suitable for both VRLA and Flooded batteries:

- 1) **2EM06**: Suitable for 2V batteries – Resolution up to  $\pm 5\text{mV}$  per block & balancing current up to 6A
- 2) **4EM06**: Suitable for 4V & 6V batteries – Resolution up to  $\pm 10\text{mV}$  per block & balancing current up to 6A
- 3) **8EM02**: Suitable for 8V & 12V batteries – Resolution up to  $\pm 20\text{mV}$  per block & balancing current up to 2A

**Importance of Battery balancing:** Differences in cell chemistries and temperature gradients across the string can lead to imbalances between individual batteries. Within a string, the batteries are charged in series, and it is unlikely that all batteries will receive an equal and proper charge. This improper charge leads to some batteries receiving a full



charge while others receive an insufficient charge (undercharged). During subsequent discharge cycles, the undercharged batteries may be driven to very low voltages and the batteries could be forced into cell reversal, leading to permanently damaged batteries. If undercharged batteries are not maintained properly, battery string capacity and longevity is greatly compromised. Many battery manufacturers recommend battery string equalization to circumvent the negative impacts of improper charging. String equalization of batteries is generally accomplished by periodically providing a boost charge to the string, in which a low level charging current is maintained for enough time to ensure that the weakest battery (most undercharged) within the string is brought to a full charge. Unfortunately, this will also lead to overcharging the fully charged batteries resulting in gassing and heat buildup, which will potentially damage the battery. In fact, many recent studies have shown that improper string equalization schemes significantly reduce the life cycle of the battery string.

**Advantages:** By equalizing individual batteries within the string, batteries are properly maintained and kept at the same state of charge. During charging, all batteries will receive a full charge, thus preventing under/overcharging.

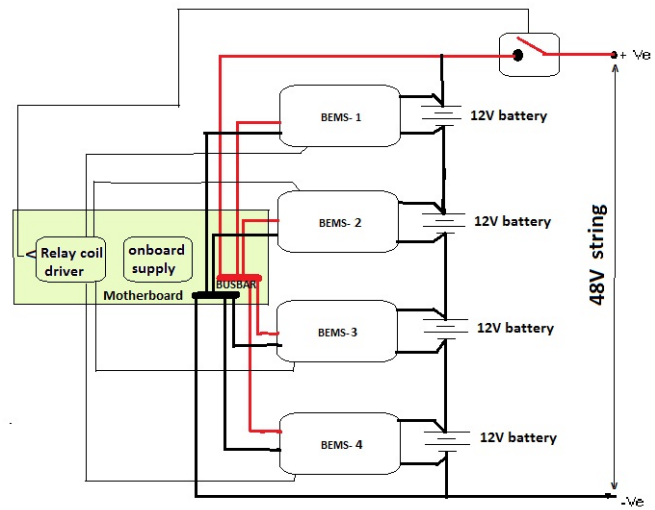
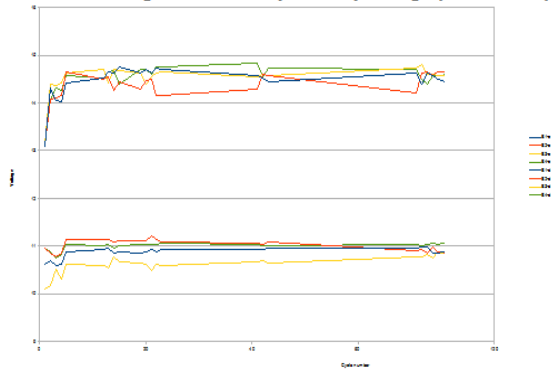
- BEMS is a real time equalization system that equalizes and maintains batteries during charge, discharge, and idle modes. With BEMS, the life cycle cost of motive and stationary batteries is greatly reduced.
- BEMS for safety purpose incorporates reverse polarity protection, transient voltage protection and resettable protection fuses.
- Its high resolution ADC enables a battery voltage sense resolution of 0.5mV/ VPC, and high speed processor enables immediate balancing response from BEMS.
- Conventional active BMS balances between two batteries and hence a charged battery of the pair is discharged to charge adjacent one, i.e. slow sequential energy transfer. While in Firefly BEMS enables fast Parallel energy transfers balancing.
- Being parallel Firefly BEMS enables efficient & direct energy transfer and balancing in lesser number of cycles with unmatched resolution.
- With Firefly BEMS, other batteries in string are not loaded individually for balancing low battery in string.



## Technical Specifications

<b>Nominal String Voltage</b>	24V - 48V
<b>Nominal Battery Voltage</b>	2V,4V,6V,12V
<b>Max. Equalization Current</b>	Up to 6A*
<b>Standby Current Draw</b>	≤ 5mA
<b>Operating Temperature</b>	-25°C – 50°C
<b>Operating Environment</b>	Up to 90% humidity
<b>Typical Efficiency</b>	85%
<b>Voltage Sense Resolution</b>	0.5mV / VPC
<b>Equalization Accuracy</b>	<ul style="list-style-type: none"> <li>▪ Up to ± 5mV/ cell</li> </ul>
<b>Operating Modes</b>	Equalizes during charge, discharge, and idle modes
<b>Safety</b>	<ul style="list-style-type: none"> <li>➤ Under voltage shutdown^</li> <li>➤ Over voltage shutdown^</li> <li>➤ Reverse polarity protection</li> <li>➤ Transient voltage protection</li> <li>➤ Resettable fuses</li> <li>➤ IP67 enclosure</li> </ul>
<b>Dimensions</b>	5.4"x3.0" x 0.87"
(LxWxH)	(137mmx78mm x22mm)
<b>Weight</b>	0.35 lb. (160 g)
<b>Design &amp; Patent</b>	Designed in USA

BEMS balancing in two Firefly battery strings (old & new)



Line diagram for a 48V string with 12V batteries

