DMI BATTERY MANAGER
DMI1701

Digital Microgrid Open-Source Battery Management

FEATURES

- Open Source Hardware under an MIT License
- Isolated design for series batteries to 800 Vdc
- Published API for isoSPI™ communication via daisy chained RJ45 connectors to maintain history and control the balancing algorithms
- Designed particularly for isolated 48 volt battery packs for standardized connection in parallel or series high voltage batteries.
- Small size and low power consumption(10µA sleep mode) for incorporation in standardized 48 volt battery pack
- Capable of balancing and monitoring $LiFePO_4$ (LFP), Li_2TiO_3 (LTO), VRLA/AGM 2 and 4 volt cells and other chemistries.
- With DMI DC-DC converter, multiple chemistries and pack sizes may be mixed in a single system
- Balances large battery packs in reasonable time; full re-balance (10%) of 8 kWh in less than six hours.
- Fast accurate measurements; 290µs to measure all cells in system; 1.2 mV maximum total measurement error
- Synchronized voltage and current measurements for dynamic systems with continuous charge/discharge, such as residential and commercial energy storage

DESCRIPTION

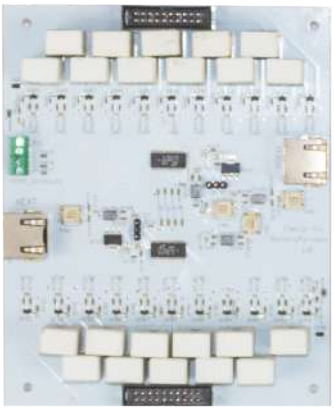
The DMI battery manager is a multi-cell monitor and balancer that measures a maximum of 5V per cell, 22 cells per battery pack, in two strings of five to eleven cells.

It will handle most battery chemistries including lithium iron phosphate (LFP), 2-4 volt lead-acid, and lithium titanate (LTO).

The BMS PCB has two RJ45 ports with isoSPI™ interface for daisy-chained high speed, RF-immune, 100m communication at 1Mb. Over the isoSPI™ link, each BMS card provides raw cell current and voltage measurements to an external, shared controller card (such as the DMI MicrogridLink) to determine State of Charge (SOC), State of Health (SOH), capacity etc. The card independently balances cells in the battery according to parameters set by the external controller.

Each cell of the battery is paired with a 5W bleed resistor for balancing the battery pack with up to 4kW of dissipation.

The BMS is designed for implementing standardized, interchangeable 48 volt battery packs which can be interconnected either in parallel for low voltage (48 volt) applications with up to three packs in parallel, or may be connected in series, to create a single battery pack of up to 1000 volts. A single pack can provide up to 80 kWH depending on the power connectors and wiring.



The BMS is intended for operation with DMI bidirectional DC-DC converters to provide controlled charge and discharge on each individual pack. This allows virtually unlimited connection of batteries to a shared high voltage bus. Other DC-DC converters and chargers can be accommodated by custom controllers.

OPERATION

Regardless of battery chemistry, more than a few cells charged together in series need to have all cells balanced to the same state of charge (SOC).

Even with lead acid batteries, cycle life can be dramatically extended with proper balancing of the cells.

The DMI BMS is designed to balance at the individual cell level, although it can treat a 2 or 4 volt wet cell battery as a single cell for balancing if required. Balancing 12 volt or 6 volt batteries at the battery level in a high voltage string offers some limited improvement in battery life but we strongly recommend cell level balancing for maximum life expectancy.

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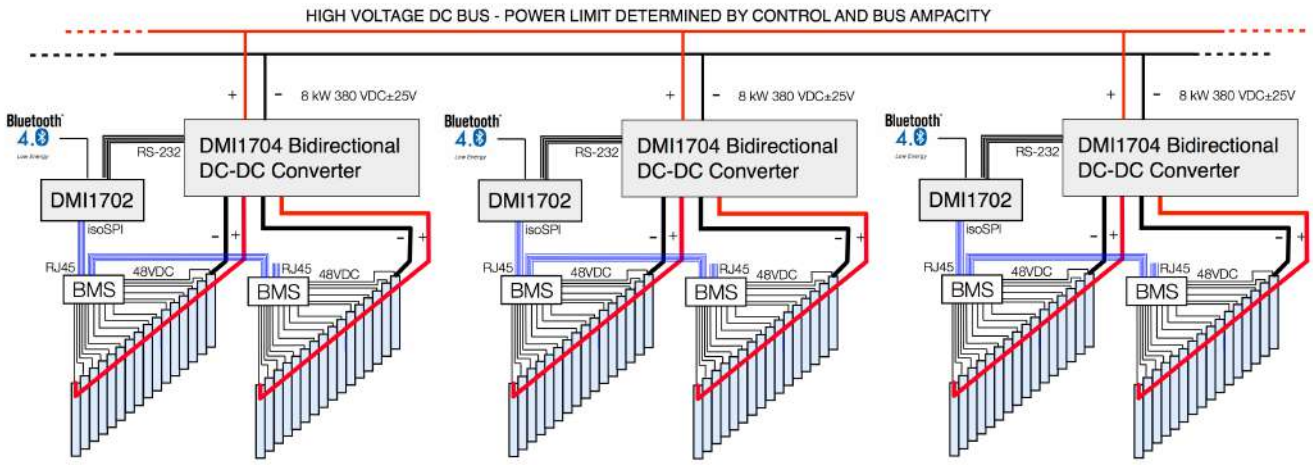

Figure 1: 380 Vdc parallel microgrid configuration with bidirectional DC-DC converters

Balancing lead-acid is quite a bit different from lithium cells because of the slower reaction time and more gradual “end points”. It’s also more difficult to balance a dynamic bank which is in a constant state of partial charge and discharge. Unlike the DMI BMS, most commercial battery balancing systems are designed for a “static” state such as recharging the batteries in an electric vehicle while the vehicle is stationary.

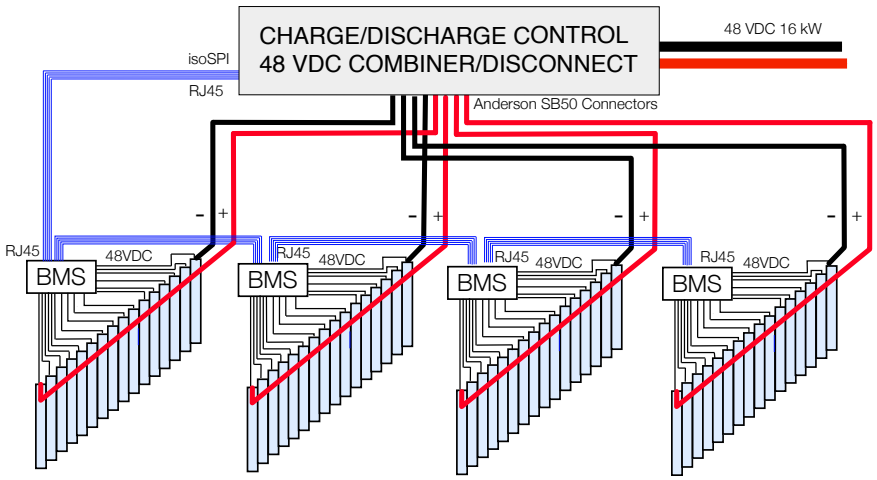

Figure 2: 48Vdc bus battery configuration

CONTROL

The Battery Manager is controlled via commands on the isoSPI™ bus. The Battery Manager will remain in 10 µA sleep mode and does not balance cells until it is awakened via commands on the bus. A series of commands on the bus will waken the BMS cards and initiate balancing and communication. Two RJ45 ports on the BMS card provide for a daisy chain of up to four BMS cards to be controlled by a single controller.

The BMS is designed to control and monitor parallel banks or large, high voltage series banks of batteries. The balancing strategy and monitoring frequency is determined by a controller communicating over the isoSPI™ bus.

The controller is application dependent. DMI produces the MicrogridLink controller and DMI1704 and DMI1703 bidirectional DC-DC converters to connect a virtually unlimited number of 48 volt batteries to a 380 Vdc bus.

For 48 volt applications, either a DC-DC converter or 48 volt charge source with external current control can be used. The controller must provide monitoring of all the batteries to assure that, when any battery is fully charged or depleted, that the appropriate action is taken and that the charge current is reduced as required.

Alternatively, a central shut-off can be provided to shut off all charging or discharging to the batteries as required if any single battery is fully charged or depleted.

SPECIFICATIONS

- Total supply voltage of each connector: 75 Vdc
- BMS card is powered by the cells it is measuring
- Cell voltage: -3 to 8 Vdc
- Storage temperature range: -65°C to 150°C
- Operating temperature range: -40 °C to 80 °C
- Three temperature ports for external NTC thermistors
- 1 Mb isolated communication to 100 meters
- Low EMI susceptibility and emissions
- 5W/cell passive cell balancing with programmable timer
- 75 mm x 100 mm x 25 mm

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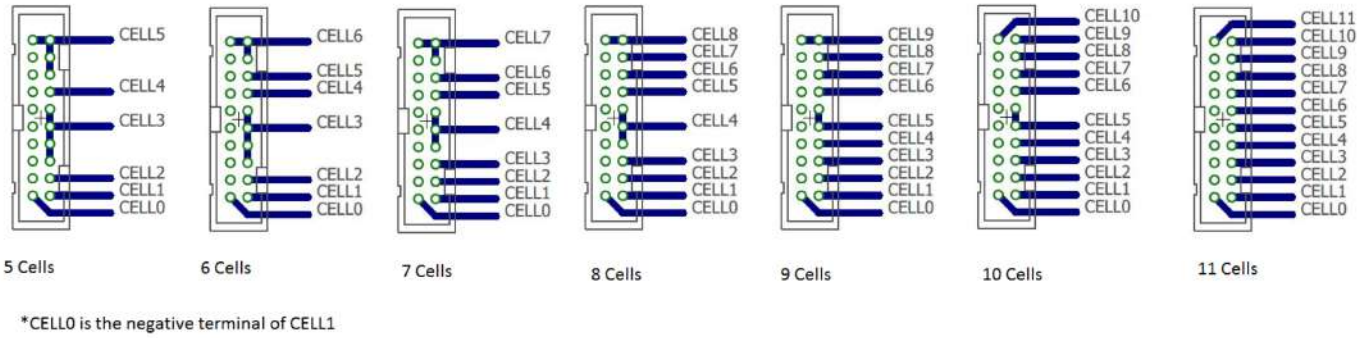
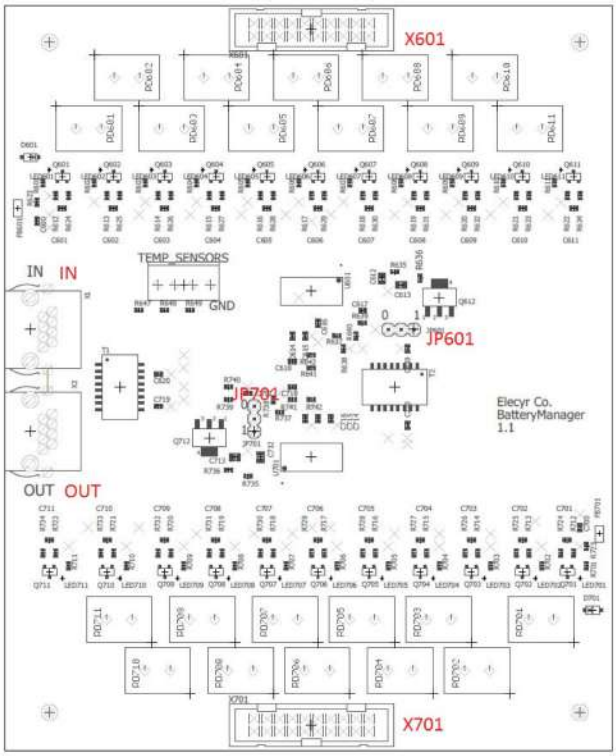


Figure 3: Cell balancing pinout for various cell configurations, one wire directly connected to each cell

OPERATION

The DMI battery manager system (BMS) is a multi-cell monitor and balancer that measures up 5V per cell, 22 cells per battery pack for most battery chemistries. Each cell is paired with a



5W bleeding resistor which is sufficient for balancing multi-kWh packs. The BMS also has 3 ports for external NTC thermistors for measuring battery temperature.

Each of the DMI BMS cards uses two programmable monitoring ICs with isolated communication. Each card is capable to manage two strings of 5-11 cells and these strings of battery cells can be connected either in parallel or in series.

The BMS has two RJ45 ports (IN and OUT) with isoSPI™ interface for high speed, RF-immune, long distance communication. It needs to be connected to a controller such as the DMI MicrogridLink in order to function and extract the cell voltage data. Up to 5 BMS cards can be daisy chained per controller. Communication protocol, schematics, and PC layout are available on request from DMI.

PIN CONFIGURATION

IN and OUT: isoSPI communication ports

JP601 and JP701: Discharger timer enable

X601, X701: Battery cell signal inputs

Temp_sensors: 3 Temperature sensors inputs and reference ground

The BMS is powered by both connector X601 and X701. Both battery strings need to provide at least 18V with 5 cells in series each. The pin configurations of X601 and X701 for different number of battery cells. Those two string of cells can be connected either in parallel or in series.

JP601 and JP701 set to 0.

After the BMS is powered up, it enters an idle mode until there is a command signal received via the IN port. This signal can be sent by either a controller or OUT port of another daisy chained BMB. The signals received will set the configuration of the BMB, including dissipation on/off as well as minimum dissipation voltage level, and request monitoring data of cells voltage and temperature sensors if available. The BMS operates only when there is communication.

The dissipation resistors turn on when the cell voltage exceeds the programmable dissipation voltage level. The monitoring ICs automatically turns dissipation off before measuring cell voltage, so dissipation will not affect the measurements.

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