# Applications

* Electric vehicles
* Drones
* Energy storage
* Research programs

# Product summary:

ENNOID-BMS is a configurable battery management system consisting of a Master board based on an STM32 microcontroller connected through an ISOSPI interface to several modular slave boards. ENNOID-BMS can monitor the specifics temperatures, currents & voltages that are critical for any lithium-ion battery packs. Based on the monitored inputs & the configured parameters, the master board can allow or interrupt the flow of energy from the battery pack by switching the state of external heavy-duty contactors. ENNOID-BMS can measure each cell voltage level & can trigger the passive balancing function during charging for cells above the configured limit to ensure that all cells have a similar State-Of-Charge (SOC). Parameters can be configured through the ENNOID-BMS-Tool software running on a USB connected host computer.

# Features

* Up to 400V operation
* Up to 500A continuous operation
* Modular with master/slave topology
* Isolation between battery pack & components
* Communication between slaves & master through a two-wire daisy chained ISOSPI interface
* Isolated CAN bus interface
* Isolated charger detection circuit
* Isolated voltage measurement for battery & load
* Isolated bi-directional current monitoring via external delta-sigma current sensor
* 12V contactor coil outputs for charge, discharge & pre-charge circuits
* USB interface for programming and firmware upgrades through an easy to use graphical user interface
* OLED Display & power button
* 2.5V to 4.5V cell voltage operation

# Block diagram

A screenshot of a cell phone

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Figure 1: Simplified block diagram

# Pinout information

## Master board

The master board is equipped with an STM32F3 microcontroller which enables all functionalities of the battery management system.

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A circuit board

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Figure 2 : Master board

|  |  |  |  |
| --- | --- | --- | --- |
| # | Name | Description | |
| 1 | ExtPower | + | 12V DC power input |
| - | ISOGND |
| 2 | Discharge | + | 12V DC output for discharge contactor |
| - | ISOGND |
| 3 | Precharge | + | 12V DC output for precharge contactor |
| - | ISOGND |
| 4 | Charge | + | 12V DC output for charge contactor |
| - | ISOGND |
| 5 | - Discharge + | + | 0-400V isolated DC input for load voltage measurement |
| - | BATGND |
| 6 | - BAT + | + | 0-400V isolated DC input for battery voltage measurement |
| - | BATGND |
| 7 | - Charge + | + | 0-400V isolated DC input for charger detection |
| - | BATGND |
| 8 | Current | 3.3V | +3.3V |
| I+ | Delta-sigma signal from isolated current sensor |
| I- | Not connected |
| GND | ISOGND |
| 9 | Shunt1\* | 3.3V | +3.3V |
| I+ | Differential input + from isolated differential current sensor |
| I- | Differential input - from isolated differential current sensor |
| GND | ISOGND |
| 10 | Master | PA | Isolated ISOSPI communication 2 wire interfaces with slave boards |
| MA | Isolated ISOSPI communication 2 wire interfaces with slave boards |
| 11 | USB | Micro-USB interface with ENNOID-BMS-tool software on a computer | |
| 12 | CAN | EN | External enable signal |
| 5V | External 5V for CAN |
| H | CANH |
| L | CANL |
| GND | CANGND |
| 13 | OLED | 3.3V | +3.3V |
| RST | No connect |
| SDA | SDA signal output for OLED display |
| SCL | SCL signal output for OLED display |
| GND | ISOGND |
| 14 | Power Button | GND | ISOGND |
| N.O. | Normally open pin for power button |
| 3.3V | No connect +3.3V |
| LED | +3.3V for LED (optional) |
| GND | ISOGND |
|  | Debug\*\* | +3.3V | |
| SWCLK | |
| ISOGND | |
| SWDIO | |
| NRST | |

\* Current & shunt1 ports requires different components for operating. User must choose which one is appropriate.

\*\*Debug port is not required for operation

## Slave board LTC6811

The slave board is using an LTC6811 IC. It can monitor up to 12 cells in series. The slave board is powered directly by the lithium-ion cells it monitors.

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A circuit board

Description automatically generated

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Figure 3: Slave board

|  |  |  |  |
| --- | --- | --- | --- |
| # | Name | Description | |
| 1 | Master | Isolated ISOSPI communication 2 wire interfaces towards previous slave board or master board | |
| 2 | Slave | Isolated ISOSPI communication 2 wire interfaces towards next slave board | |
| 3 | LAST? | Leave pins unconnected for the last slave board in the battery pack. Otherwise, those pins must be shorted. | |
| 4 | Cells | BAT- | Connect to negative voltage of the battery module |
| 1 to 12 | Connect all subsequent pins to the next cells positive voltage levels. |
| 5 | Analog\* | Analog input that can be accessed & sampled if needed (temperature sensor) | |
| 6 | I2C\* | I2C communication channel for 8 additional temperature sensors through external ADC128 IC | |
| 7 | GPIO\* | GPIO for external signal if needed | |

\* Not mandatory for operation

# Other related hardware

## Current sensor

We recommend using ENNOID dedicated Delta-Sigma Current sensor board

## Power supply

ENNOID-BMS require a 12V power supply which can supply power for the Master-BMS board. A peak current of 3A is required for a few milliseconds for closing most type of high current external contactors. Only a few milliamps are required afterward closing. The power supply must be able to handle contactors peak loads.

We recommend using our ENNOID-BMS 12V DC output power supply board which is fed and isolated from the battery pack itself. We offer two versions with different voltage inputs:

1. 24V to 150V
2. 75V to 400V

## OLED display

SSD1306 compatible OLED display is not mandatory for operating ENNOID-BMS but is recommended.

## Power button

Power button N.O. type toggle switch is required for turning ON/OFF ENNOID-BMS. External activation of ENNOID-BMS is possible through CAN bus or with USB.

## Contactor

Contactor with economizer is recommended. Some contactors with high coil resistance don’t require economizer. ENNOID-BMS does not actually support PWM outputs for contactors without build-in economizer. LEV200, EV200, EVC250 or EVC500 contactors with economizer are recommended

# Software

Download ENNOID-BMS-Tool software for windows:

<https://github.com/EnnoidMe/ENNOID-BMS-Tool/releases>

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# ENNOID-BMS configuration

1. Connect at minimum a 12V power supply to ENNOID-BMS Master board.
2. Connect a host computer running the ENNOID-BMS-Tool to the ENNOID-BMS master board with a micro USB cable. (Warning: some cheap USB cables cannot carry data and won’t work with ENNOID-BMS) Power LED indicator should light up. Click connect on the connection page. The app should now shows “connected” in the right side bottom corner.
3. Go into firmware tab and upload latest firmware (this step is needed only for initial setup or uploading a new firmware version)
4. Under *“Master Settings”* tab, user can define all parameters of the BMS (Tabs under *“Slave Settings”* are not required for configuring ENNOID-BMS). Modified parameters can be read, applied & saved by clicking on the associated buttons on the right-side panel.
5. For real-time data logging & testing the BMS, the “*Data Analysis*” tab shows in real time the measured pack voltage, load voltage, current, Temperatures, BMS status & all cells voltages. You need to click on the “RT” button on the left side of the screen to activate real time communication.
6. Once properly configured, you can operate the ENNOID-BMS with the ON/OFF power button, & the OLED display will show your battery status.

Enjoy!