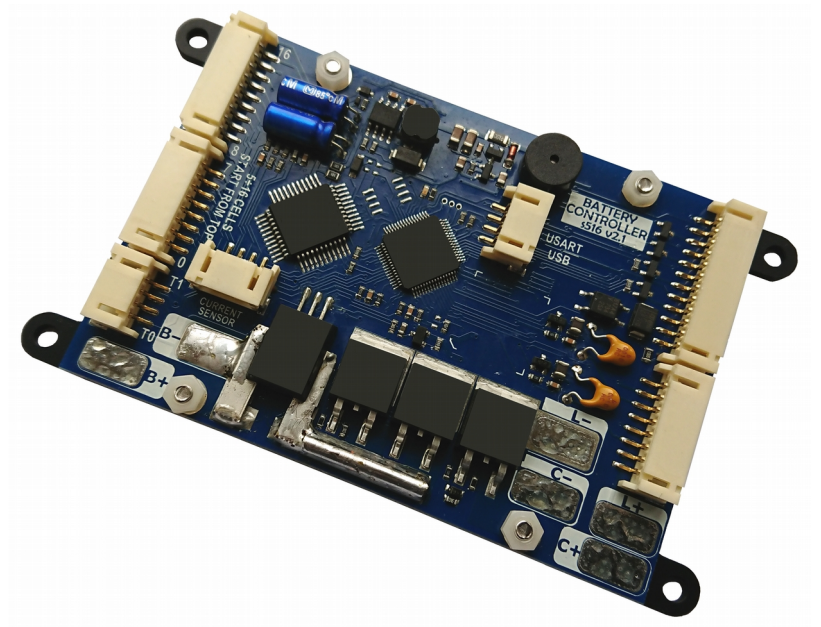




Energus Power Solutions Ltd.

Quick Start Guide

Tiny BMS s516 – 30A / 150A / 750A



Revision A, 2018-07-30

SAFETY

To ensure the security of you and your surroundings, please read these rules and follow all the guidelines contained installation instructions:

- DO NOT use the system where it may cause interference (eg. medical equipment);
- DO NOT use the system in an explosive environment;
- The system is NOT resistant to the chemical environment and mechanical stress;
- All electrical equipment MUST be rated for the voltage of the battery and battery management system;
- Use double-insulated tools;
- DO NOT short-circuit the battery or battery management system terminals, this could cause the damage to the product or the personal property;
- DO NOT lay tools or metal parts on top of the batteries or near the battery management system cable lugs;
- Before establishing connections, make sure to verify polarity.



This list is not exhaustive, and it is the responsibility of the system designer / installer to conduct their own failure mode analysis and determine what is required.



Working around batteries is DANGEROUS. Risk associated with improper use of the battery with the *Tiny BMS* device includes: short-circuit, fire or explosion.



Read the ENTIRE documentation to become familiar with the *Tiny BMS* device and its features before operating. Failure to operate the product correctly and safely may result in damage to the product, personal property and cause serious injury.



Throughout the literature the term “Note:” will be used to indicate procedures which, if not properly followed, create a possibility of physical property damage.



Using *Tiny BMS* device requires at least basic knowledge in electronics and electrical engineering. *Energus Power Solutions* will not be held responsible for damage to the battery or any consequence, if the *Tiny BMS* device is used improperly and no warranty is provided in such case.

TINY BMS POWER UP

Step 1: Prepare cells connections: connect the assembly(-ies) of balancing connector to battery cells first. Double and triple-check voltages are in sequence on the connector(s). If there are less than 16 cells, lower contacts should be unused.

Step 2: Connect main power lines of the battery to *B-* and *B+* solder-pads. Make sure connections are strong and contain no fuses or switches. *BMS* will boot up and beep several times.

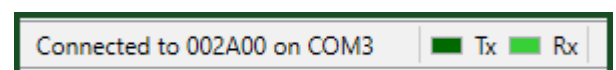
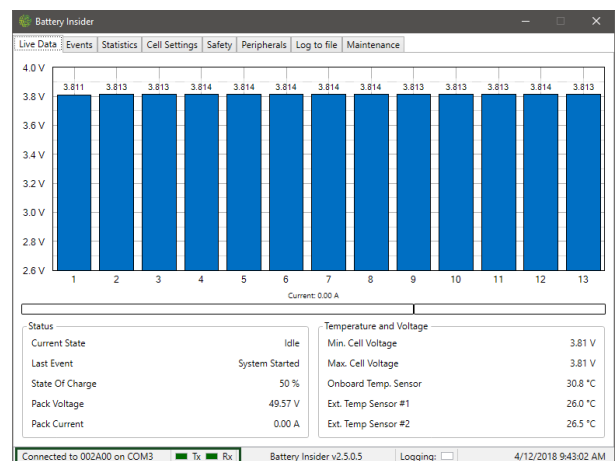
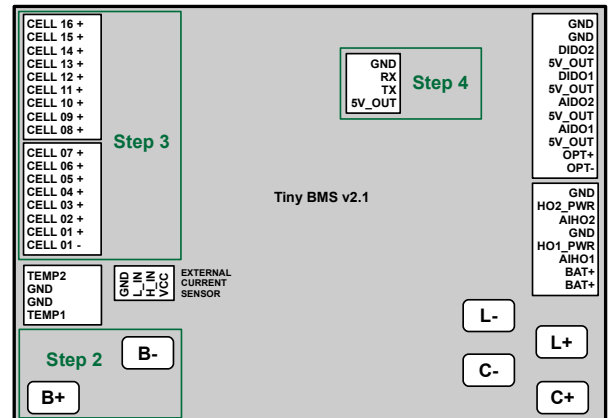
Step 3: Connect balancing connector(s) to *BMS* ports *CELL01-CELL16*.

Note: Incorrect wiring may damage the *Tiny BMS* device. Verify proper wiring before inserting the harness into the connector. Remove the harness from the connector before altering any battery connections. Damage caused by wiring errors are not covered by warranty.

Note: Connection sequence is important. *Tiny BMS* is supplied from *B-* and *B+* solder-pads and incorrect connection can lead to permanent damage of the board. Main rule is to avoid balancing wire connection without *B-* and *B+* being connected. When disconnecting from battery, disconnect balancing wires first, only then followed by *B+* and *B-* solder-pads.

Step 4: Connect *USB* cable to *Windows PC* and *BMS* device, launch *Energus PS Battery Insider* configuration utility. When connected, it will appear as a virtual *COM* port and the *Battery Insider* will connect to it automatically. While communication is ongoing, *BMS* stays in *Idle* state (activity *LED* indicator blinks)

Note: The cable is not galvanically-isolated. Take spacial care and give your full attention to avoid ground loops. Alternatively, use *USB* isolator.



BATTERY CELLS SETTINGS CONFIGURATION

Step 1: Configure battery parameters under the *Cell Settings* tab *Balancing* and *State of Charge* group boxes:

- *Number of Series Cells* value;
- *Allowed Disbalance* value;
- *Early Balancing Threshold* value;
- *Battery Capacity* value;
- Initial battery *SOC* value (Set *SOC* manually). *SOC* value is set to 100 % automatically on *Fully Charged* event.

The screenshot shows the 'Balancing' and 'State of Charge' settings in the Battery Insider software. Under 'Balancing', the 'Early Balancing Threshold' is set to 3.20 V, 'Allowed Disbalance' is 15 mV, and 'Number of Series Cells' is 13. Under 'State of Charge', the 'Battery Capacity' is set to 10.0 Ah and 'Set SOC manually' is set to 50 %.

Step 2: Upload settings to *BMS*.

Step 3: Configure battery parameters under the *Safety* tab *Critical Events* group box:

- *Over-Voltage Cutoff* threshold;
- *Under-Voltage Cutoff* threshold.


Step 4: Upload settings to *BMS*.

Step 5-6: Go back to *Cell Settings* tab and adjust cell charging and discharging characteristics:

- *Fully Charged Voltage* threshold;
- *Fully Discharged Voltage* threshold.

Step 7: Upload settings to *BMS*.


Note: These settings has a relationship *Under-Voltage Cutoff* < *Fully Discharged Voltage* < *Fully Charged Voltage* < *Over-Voltage Cutoff* and the *Battery Insider* will not allow the user to set these values in any other way.

Step 2  Upload To BMS

Critical Events


Over-Voltage Cutoff **Step 3** V

Under-Voltage Cutoff V

Step 4  Upload To BMS

Fully Charged Voltage V **Step 5**

Fully Discharged Voltage V **Step 6**

Step 7  Upload To BMS

PERIPHERALS AND SAFETY CONFIGURATION FOR LOW POWER APPLICATIONS

Step 1: Select *BMS* mode (*Dual Port* or *Single Port*) under the *Peripherals* tab.

Step 2: Upload settings to *BMS*.

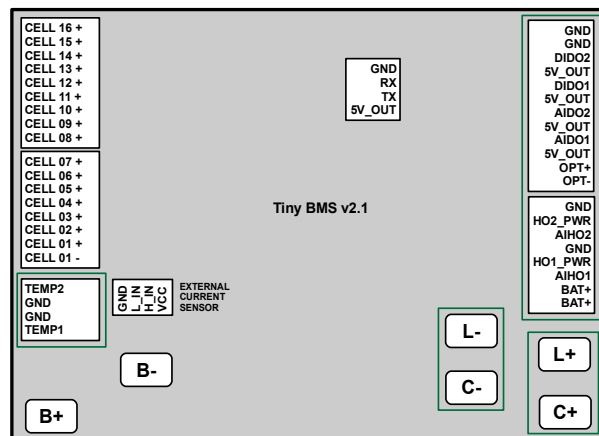
Note: When *BMS* mode has been changed and settings successfully uploaded to *BMS*, it automatically restarts itself and automatically reconnects with the *Battery Insider* again.

Step 3: Configure load parameters under the *Peripherals* tab *Load* group box:

- Set *Load Switch Type* to *Discharge FET*. Alternatively, Set *Single Port Switch Type* to *Internal FET*, if *BMS Mode* parameter is configured to *Single Port*.
- Select *Ignition* pin (*Ignition* feature is recommended when manual load control, bluetooth, CAN bus communication is required or to enter lowest possible current consumption sleep mode);
- Set load *Precharge* to *Disabled* (*Precharge* is not allowed when internal *FETs* are used);
- Leave *Precharge Duration* configured to 0.1 s default value.

Step 4: Configure charger parameters under the *Peripherals* tab *Charger* group box:


- Set *Charger Type* to *Generic CC/CV*;
- Set *Charger Detection* to *Internal*;
- Set *Charger Switch Type* to *Charge FET* (If *BMS Mode* parameter is configured to *Dual Port*).



Mode

BMS Mode **Step 1**

Single Port Switch Type

Step 2  Upload To BMS

Load

Switch Type **Step 3**

Ignition

Precharge

Precharge Duration

Step 5: Upload settings to BMS.

Step 6: Configure peripherals dependent *Tiny BMS* safety parameters under the *Safety* tab *Critical Events* group box:

- *Discharge Over-Current Cutoff* value;
- *Charge Over-Current Cutoff* value;
- *Over-Heat Cutoff* value;
- *Low Temperature Charger Cutoff* value;
- *Automatic Recovery* value.

Step 7: Adjust peripherals dependent *Tiny BMS* *Charge Finished Current* parameter under the *Cell Settings* tab.

Step 8: Upload settings to BMS.

Charger

Charger Type Generic CC/CV

Detection Step 4 Internal

Switch Type Charge FET

Step 5 Upload To BMS

Discharge Over-Current Cutoff 60 A

Charge Over-Current Cutoff 20 A

Over-Heat Cutoff Step 6 60 °C

Low Temperature Charger Cutoff 1 °C

Automatic Recovery 5 s

Charge Finished Current 1.00 A **Step 7**

Step 8 Upload To BMS

PERIPHERALS AND SAFETY CONFIGURATION FOR HIGH POWER APPLICATIONS

Step 1: Select *BMS* mode (*Dual Port* or *Single Port*) under the *Peripherals* tab.

Step 2: Upload settings to BMS.

Note: When *BMS* mode has been changed and settings successfully uploaded to *BMS*, it automatically restarts itself and automatically reconnects with the *Battery Insider*.

Step 3: Configure load parameters under the *Peripherals* tab *Load* group box:

- Set *Load Switch Type* to one of the external output pins (*AIDO*, *DIDO*, *AIHO*). Alternatively, Set *Single Port Switch Type*, if *BMS Mode* parameter is configured to *Single Port*.
- Select *Ignition* pin (*Ignition* feature is recommended when manual load control, bluetooth, *CAN* bus communication is required or to enter lowest possible current consumption sleep mode);
- Set load *Precharge* to one of the available external output pins (*AIDO*, *DIDO*, *AIHO*), if necessary. Load *Precharge* can be controlled with internal *FETs*, if both load and charger are controlled by relays / contactors;
- Set *Precharge Duration* to appropriate value, if the load *Precharge* feature is enabled before.

Step 4: Configure charger parameters under the *Peripherals* tab *Charger* group box:

- Set *Charger Type* to *Generic CC/CV*;

Tiny BMS v2.1

CELL 16 +
CELL 15 +
CELL 14 +
CELL 13 +
CELL 12 +
CELL 11 +
CELL 10 +
CELL 09 +
CELL 08 +

CELL 07 +
CELL 06 +
CELL 05 +
CELL 04 +
CELL 03 +
CELL 02 +
CELL 01 +
CELL 01 -

TEMP2
GND
TEMP1

EXTERNAL CURRENT SENSOR

GND
RX
TX
5V_OUT

GND
DIDO2
5V_OUT
DIDO1
5V_OUT
AIDO2
5V_OUT
AIDO1
5V_OUT
OPT+
OPT-

GND
HO2_PWR
AIHO2
GND
HO1_PWR
AIHO1
BAT+
BAT+

B+

B-

L-

C-

L+

C+

Mode

BMS Mode Step 1 Dual Port

Single Port Switch Type Internal FET

Step 2 Upload To BMS

Load

Switch Type AIDO1

Ignition Step 3 DIDO1

Precharge Disabled

Precharge Duration 0.1 s

- Set *Charger Detection* to one of the available external input pins;
- Set *Charger Switch Type* to one of the available external output pins (AIDO, DIDO, AIHO) (If *BMS Mode* parameter is configured to *Dual Port*).

Step 5: Upload settings to *BMS*.

Step 6: Connect external *LEM* current sensor to the *Tiny BMS* external current sensor connector.

Step 7: Manually restart the *BMS*. After the *BMS* device will be restarted, the external current sensor will be in use, and a high over-current thresholds unlocked.

Step 8: Configure peripherals dependent *Tiny BMS* safety parameters under the *Safety* tab *Critical Events* group box:

- *Discharge Over-Current Cutoff* value;
- *Charge Over-Current Cutoff* value;
- *Over-Heat Cutoff* value;
- *Low Temperature Charger Cutoff* value;
- *Automatic Recovery* value.

Step 9: Adjust peripherals dependent *Tiny BMS* *Charge Finished Current* parameter under the *Cell Settings* tab.

Step 10: Upload settings to *BMS*.


Charger


Charger Type Generic CC/CV

Detection **Step 4** DIDO2


Switch Type AIDO2

Step 5

 Upload To BMS

	Step 6	Message	Event Code
		External Current Sensor Connected (BMS restart required)	0x0F

Step 7

 Restart BMS

Discharge Over-Current Cutoff 600 A

Charge Over-Current Cutoff 20 A

Over-Heat Cutoff **Step 8** 60 °C


Low Temperature Charger Cutoff 1 °C

Automatic Recovery 5 s

Charge Finished Current 1.00 A

Step 9

Step 10

 Upload To BMS


FINAL CONFIGURATION STEPS

Finally, configure other additional features like external *Temperature Sensor Type*, *Speed Sensor Input* or *Broadcast* features, if necessary. After all the configuration is done, it is strongly recommended to restart the *Tiny BMS* device to recover all the incorrect *BMS Fault* states, which occurred during initial cells connection and configuration. After the *BMS* device was restarted, clear all *Faults* and *Statistics* values to start record and monitor the battery parameters from the beginning.

Maintenance

Required BMS restart:

- After an external current sensor was connected or disconnected
- To recover from incorrect BMS state (e.g. Under-Voltage fault after the initial connection of the cells)
- After BMS firmware malfunction occurred

Step 2  Restart BMS

TINY BMS BLUETOOTH CONNECTION WITH BATTERY INSIDER

Energus PS bluetooth adapter, connected to *Tiny BMS* device only works when *BMS* is in active state. This means, that charger or load should be connected to wake up the device from sleep mode, or alternatively, *Ignition* feature must be enabled before, using *USB-UART* cable and *Ignition* signal (high logic level voltage) should be applied to the configured *Ignition* pin. Once the *BMS* is in active state and bluetooth module is connected, the *Tiny BMS* bluetooth module should be paired on the *PC* side (*Energus PS* bluetooth module pin code is always 0516). After the *PC* and *Tiny BMS* is successfully paired, the *Battery Insider* application can be launched and it will automatically connects to *Tiny BMS* device.

Note: *Battery Insider* may require much more time to find the correct virtual COM port and connect to *Tiny BMS* device.

Note: When *Ignition* feature is enabled, *Ignition* can be activated (high logic level) by connecting configured *Ignition* pin to battery pack positive terminal *B+*. For safety reasons it is highly recommended to use about a $1\text{ k}\Omega$ resistor in series between configured *Ignition* pin and *B+*.

Note: *BMS* firmware update feature using *Bluetooth* communication is not possible.

TINY BMS BLUETOOTH CONNECTION WITH EBIKE ANALIZER ANDROID APP

Step 1: Connect *USB-UART* cable to *Windows PC* and *BMS* device, launch *Energus PS Battery Insider* configuration utility.

Step 2: Enable *Ignition* feature under *Peripherals* tab.

Step 3: Configure, if necessary, *Speed Sensor Input* feature under *Peripherals* tab *Display* group box:

- *Speed Sensor Input* channel;
- *Distance Unit*;
- *Pulses Per Unit* value.

Step 4: Configure *Broadcast* feature under *Peripherals* tab *Display* group box:

- Set *Protocol* to *CA V3*;
- Adjust *Broadcast* duration.

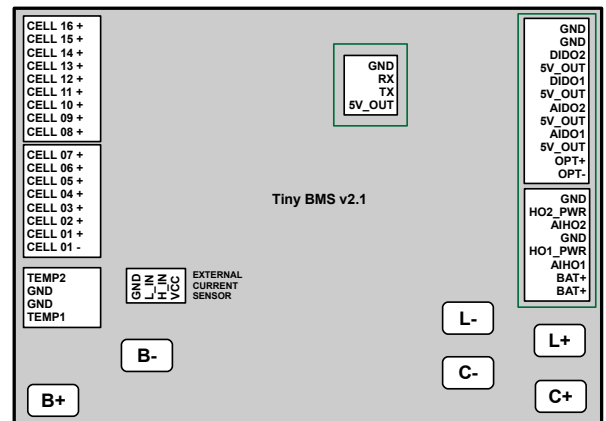
Step 5: Upload settings to *BMS*.

Step 6: Disconnect *USB-UART* cable from *Tiny BMS* device, instead connect bluetooth module. Activate *Ignition* by connecting configured *Ignition* pin to *B+* (high logic level voltage).

Note: For safety reasons it is highly recommended to use about a $1\text{ k}\Omega$ resistor in series between configured *Ignition* pin and *B+*.

Step 7: On the android device side, before launching *Ebike Analyzer* application for the first time, pair the android device with the *Tiny BMS* (*Energus PS* bluetooth module pin code is always 0516).

Step 8: Once bluetooth connection is established, launch *Ebike Analyzer* application. The connection status on the top left of the screen should be *Connected* and all battery parameters should be displayed on the dashboard.



Load

Switch Type: Discharge FET

Ignition: Step 1 DIDO1

Precharge: Disabled

Precharge Duration: 0.1 s

Display

Speed Sensor Input: Step 2 DIDO2

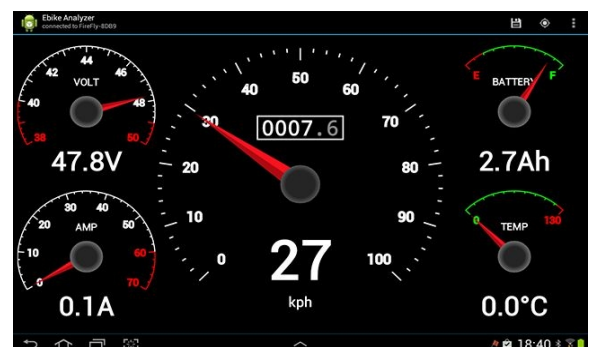
Distance Unit: Kilometers

Pulses Per Unit: 1000

Protocol: Step 3 CA V3

Broadcast: Step 4 0.2 s

Step 5 Upload To BMS



TINY BMS SOC-BAR LED INDICATOR CONFIGURATION

Step 1: Configure *Broadcast* feature under *Peripherals* tab *Display* group box:

- Set *Protocol* to *SOC BAR*;
- Adjust *Broadcast* duration (at least 1.0 s should be selected).

Step 2: Upload settings to *BMS*.

Step 3: Disconnect *USB-UART* cable from *Tiny BMS* device, instead connect *SOC-BAR LED* indicator.

Note: *SOC-BAR LED* indicator is turned off when *BMS* device is in sleep mode or the *BMS* estimated *SOC* value reached 0 %.

Display

Speed Sensor Input

DIDO2

Distance Unit

Kilometers

Pulses Per Unit

1000

Protocol

SOC BAR

Broadcast

1.0 s

Step 1

Step 2

Upload To BMS

Document revision history

Revision	Date	Description
A	2018-07-30	Initial release.