

SIMP BMS

Manual V0.23

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Disclaimer

Please read this manual and understand it, questions are allowed. You the purchaser of this product are responsible for installing this system yourself. You NEED knowledge of battery systems, automotive wiring and general computer knowledge.

THIS IS NOT A PLUG AND PLAY SYSTEM, USER CONFIGURATION AND WIRING REQUIRED

The device is provided "as is". Simp Eco Engineering makes no warranties, expressed or implied, and hereby disclaims and negates all other warranties, including without limitation, implied warranties or conditions of merchantability, fitness for a particular purpose, or non-infringement of intellectual property or other violation of rights. Further, Simp Eco Engineering does not warrant or make any representations concerning the accuracy, likely results, or reliability of the use of the materials in this manual or otherwise relating to such materials.

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SimpBMS Purchase Overview

The standard items included in the purchase of a SimpBMS are:

- The SimpBMS board
- Teensy 3.2 flashed with requested Firmware



Optional available hardware at extra cost:

- Mating Connectors to the SimpBMS board with terminals



- Nextion 3.2 Inch Display with flylead, loaded with software to work with SimpBMS



Basics of the SIMP BMS

The starting point for this BMS is to keep it simple, the BMS will not prevent you from harming your battery if you do not set it up properly or ignore the limits it sends out.

Currently supported slaves:

- Tesla Model S/X
- Tesla battery modules used in other OEM cars
- VW E-Golf and GTE (no balancing currently)
- Mitsubishi Outlander
- BMW I3

Features:

Teensy 3.2 based

4 - 5-16V isolated inputs

4 - 12V outputs

4 - Low side switching outputs

2 - analogue current inputs (for dual range sensor)

1 - Serial bus for Tesla modules

1 - Canbus for communication with other modules, current sensors or vehicle

1- Spare serial bus for expansion

Current working features:

- Canbus communication formatted for Victron Systems
- Full Control of Slaves, reading temperatures and voltages plus controlling balancing
- Precharge control, timer and current based
- Can based current sensor (CAB300)
- AH Counter Based SOC calculation
- Voltage based SOC correction
- Watchdog timer to reset BMS in event of software error
- Canbus Chargers (Brusa NLG5xx, Chevy Volt, Elcon)
- Display support (Nextion)

Working Modes

Normal Operation (EV)

This mode will function as you would expect from a 'key' operated pack, such as found in vehicles. Precharge will happen with key on ect.

ESS Mode (stationary)

Specifically developed to cater to the needs of stationary or large packs
(dual purpose packs on boats for example)

When powered up Precharge occurs (no key in used) then contactors/relays used to control charge and discharge allowed. Also a Shunt trip or Main contactor output to disconnect packs when issues occur.

All features beyond output and input control are identical.

Work in Progress

EVSE controls

An interface circuit is being developed to allow the SimpBMS to directly interface with an EVSE via the Control Pilot line.

This will use the following pins (you can use more than one source of signal if needed)

1. AC present, 12V high when EVSE active and plugged in
2. Input 4 to sense duty cycle of the CP signal
3. Charge enable to request power from the EVSE

Functionality currently looking at supporting:

1. Enabling EVSE and charger if values allow
2. Managing the DC current limit based on AC current and Battery limits

Detailed Workings

Balancing

There is a small difference between *ESS Mode* and *Normal Operation*;

- ESS Mode* always allows balancing based on balancing settings

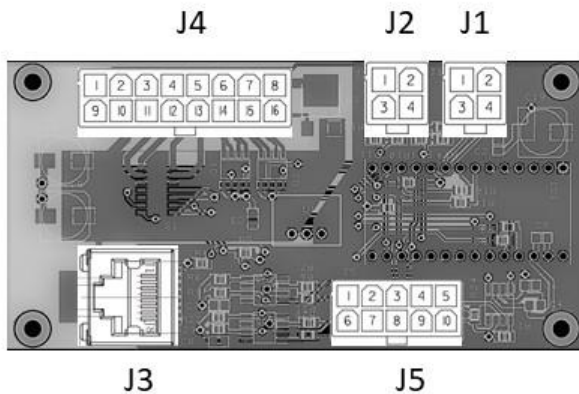
- Normal Operation* does not balance while in 'driving' operation state, this is due to the possibility of large voltage fluctuations due to high variation of loads.

For the working of balancing please see the setup page with the relevant parameters;
Serial Interface / 'b' Battery Settings Menu

Wiring Basics

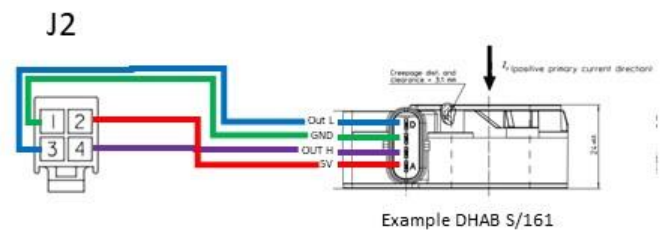
SIMP-BMS V2.1 – Wiring Basics

By T de Bree
18/08/18



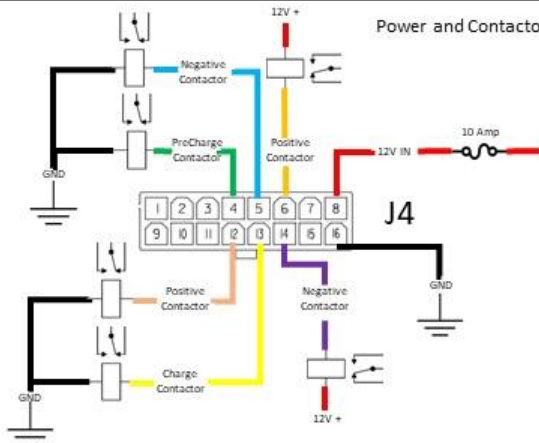
BMS Slaves : see pages below

Analogue Current Sensor



Example DHAB S/161

Power and Contactors

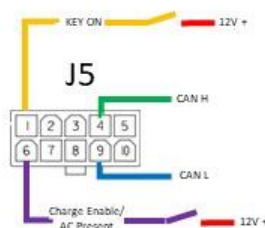


Input and Comms

KEY ON or CHARGE ENABLE, can be fed with 5-16V.
Need to be constant signal not a pulse

No CAN termination resistor present on SIMP-BMS

CAN H and L shared with J3

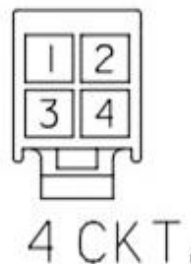
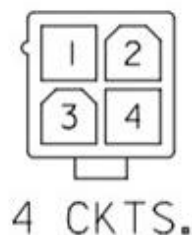


Connector 2 Current Sensor
Supplier Molex
Family Mini fit 4
Part no 39-28-x04x
Harness Part 39-01-x04x

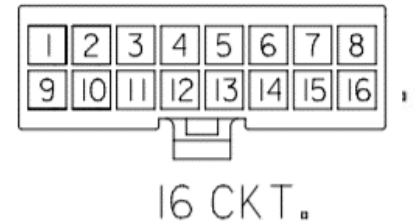
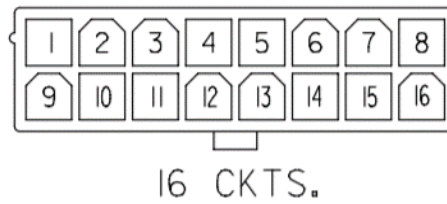
| Pin | Function |
|-----|-----------|
| 1 | GND |
| 2 | 5V |
| 3 | Current 1 |
| 4 | Current 2 |

Connector 1 Tesla BMS
Supplier Molex
Family Mini fit 4 way
Part no 39-28-x04x
Harness Part 39-01-x04x

| Pin | Function |
|-----|----------|
| 1 | GND |
| 2 | 5V |
| 3 | RXbms |
| 4 | TXbms |



Connector4 IO
 Supplier Molex
 Family Mini fit 10 way
 Part no 39-28-x16x
 Harness Part 39-01-x16x

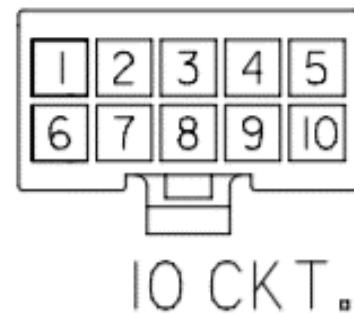
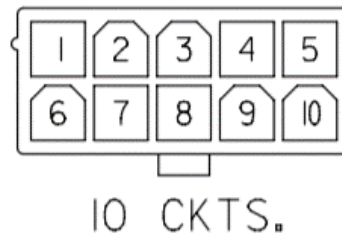


| Pin | Function | Switching | Type | V2 Normal usage | ESS Mode |
|-----|----------|-----------|--------|-----------------|------------------------------|
| 1 | 15V Out | - | Supply | - | - |
| 2 | GND | - | Ground | - | - |
| 3 | GND | - | Ground | - | - |
| 4 | Out 2 | High | Output | Precharge Cont | <i>Shunt Trip/ Main Cont</i> |
| 5 | Out 4 | High | Output | Negative Cont | <i>Not USED/PreCharge</i> |
| 6 | Out 6 | Low | Output | Positive Cont | <i>Not USED/Main Cont</i> |
| 7 | Out 7 | Low | Output | - | Negative Cont |
| 8 | 12V IN | - | Power | Fused 12V IN | Fused 12V IN |
| 9 | 12V | - | Supply | - | - |
| 10 | 12V | - | Supply | - | - |
| 11 | 12V | - | Supply | - | - |
| 12 | Out 1 | High | Output | Positive Cont | Discharge Enable |
| 13 | Out 3 | High | Output | Charge Cont | Charge Enable |
| 14 | Out 5 | Low | Output | Negative Cont | |
| 15 | Out 8 | Low | Output | Gauge Out | Gauge Out |
| 16 | GND | - | Ground | | |

| Function | Pin | Pin | Function |
|----------|-----|-----|----------|
| 12V IN | 8 | 16 | GND |
| Out 7 | 7 | 15 | Out 8 |
| Out 6 | 6 | 14 | Out 5 |
| Out 4 | 5 | 13 | Out 3 |
| Out 2 | 4 | 12 | Out 1 |
| GND | 3 | 11 | 12V |
| GND | 2 | 10 | 12V |
| 5V | 1 | 9 | 12V |

*to be implemented

Connector 5 Comms
 Supplier Molex
 Family Mini fit 8 way
 Part no 39-28-x10x
 Harness Part 39-01-x10x



| Pin | Function | Switching | Type | V2 Normal usage | ESS Mode |
|-----|----------|-----------|--------|---------------------------|--------------|
| 1 | In 1 | High | Input | Key on | Storage Mode |
| 2 | In 2 | High | Input | <i>Alt Charge Current</i> | - |
| 3 | Txspare | - | Comms | - | - |
| 4 | CanH | - | Comms | Can | Can |
| 5 | 5V Out | - | Supply | - | - |
| 6 | In 3 | High | Input | AC present | - |
| 7 | In 4 | High | Input | <i>CP cond signal</i> | - |
| 8 | Rxspare | - | Comms | - | - |
| 9 | CanL | - | Comms | Can | Can |
| 10 | GND | - | Ground | | |

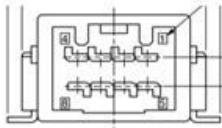
| Function | Pin | Pin | Function |
|----------|-----|-----|----------|
| In 3 | 6 | 1 | In 1 |
| In 4 | 7 | 2 | In 2 |
| Rxspare | 8 | 3 | Txspare |
| CanL | 9 | 4 | CanH |
| GND | 10 | 5 | 5V |

SIMP-BMS V2.1 – Wiring Basics

By T de Bree
19/11/11

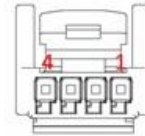
Can Bus Devices

| Outlander CMU connecetor | |
|--------------------------|------------|
| Supplier | JST |
| Part No | 08CPT-B-2A |



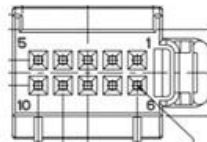
| Function | Outlander Slave | | SimpBMS | |
|----------|-----------------|-----|-----------|-----|
| | Connector | Pin | Connector | Pin |
| GND | X1 | 6 | X4 | 2 |
| 12V | X1 | 4 | X4 | 9 |
| CAN L | X1 | 1 | X5 | 9 |
| CAN H | X1 | 5 | X5 | 4 |

| CAB 300 | |
|----------|-----------|
| Supplier | TE |
| Part No | 1473672-1 |



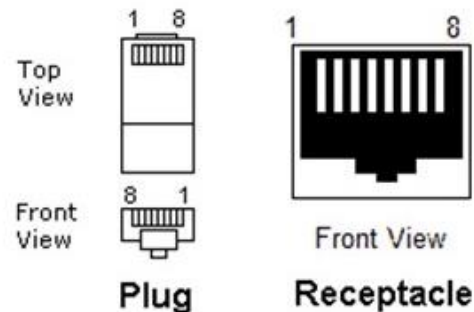
| Function | CAB 300 | | SimpBMS | |
|----------|-----------|-----|-----------|-----|
| | Connector | Pin | Connector | Pin |
| GND | X1 | 3 | X4 | 2 |
| 12V | X1 | 4 | X4 | 9 |
| CAN L | X1 | 1 | X5 | 9 |
| CAN H | X1 | 2 | X5 | 4 |

| VW Slave connecetor | |
|---------------------|-------------|
| Supplier | TE |
| Part No | 1-1670990-1 |



| Function | VW Slave | | SimpBMS | |
|----------|-----------|-----|-----------|-----|
| | Connector | Pin | Connector | Pin |
| GND | X1 | 1 | X4 | 2 |
| 12V | X1 | 5 | X4 | 9 |
| CAN H | X1 | 6 | X5 | 9 |
| CAN L | X1 | 7 | X5 | 4 |
| Enable | X1 | 3 | X4 | 9 |

Connector 3 is compatible with Victron CAN RJ45



Connector 3 Comms
 Supplier -
 Family RJ45
 Part no -
 Harness Part -

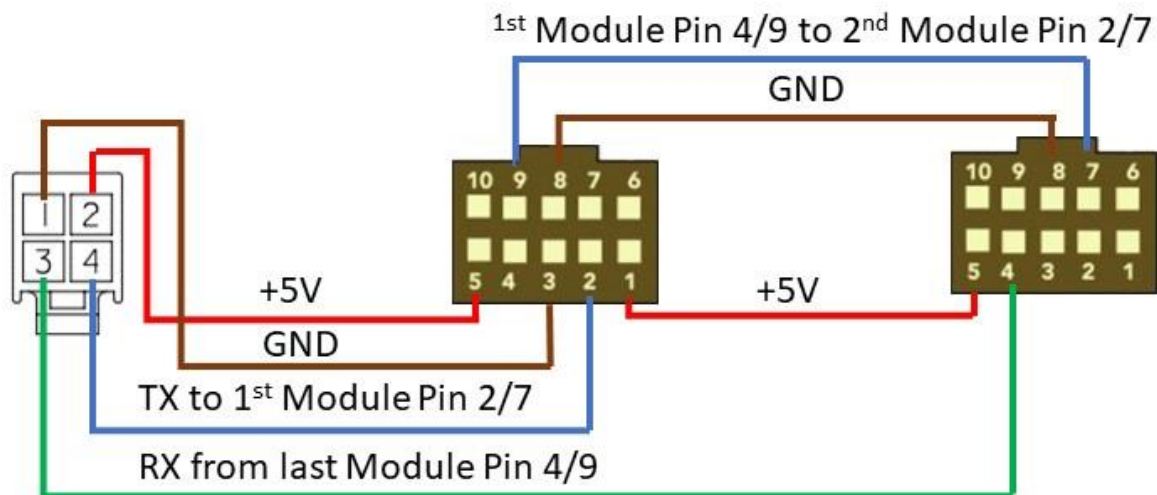
| Pin | Function |
|-----|----------|
| 1 | GND |
| 2 | 12V |
| 3 | |
| 4 | 12V |
| 5 | GND |
| 6 | |
| 7 | CanH |
| 8 | CanL |

Tesla Slave Wiring

SIMP-BMS V2.1 – Wiring Basics

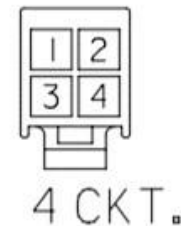
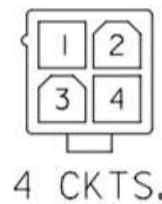
By T de Bree
18/08/18

Tesla Slaves



Connector 1 Tesla BMS
Supplier Molex
Family Mini fit4 way
Part no 39-28-x04x
Harness Part 39-01-x04x

| Pin | Function |
|-----|----------|
| 1 | GND |
| 2 | 5V |
| 3 | RXbms |
| 4 | TXbms |



Chevy Volt Gen1 Slaves

The battery master, located in front of the Chevy Volt Gen 1 pack is connected to the internal network with the slaves and current sensor.

Connector looks as below:



BMS Slaves

| Pin | Function | Color | SimpBMS connection |
|-----|-----------|-------------------|--------------------|
| 9 | 5V supply | Grey/Red | J5-5 |
| 10 | Ground | Black/Purple | J5-10 |
| 11 | Can Low | White Yellow | J5-9 |
| 12 | Can High | Light Blue/Yellow | J5-4 |
| 13 | - | Light Blue | - |

Current Sensor - dhab s44

| Pin | Function | Color | SimpBMS connection |
|-----|------------|-------------------|--------------------|
| 1 | 5V supply | Purple/Red | J2-2 |
| 2 | Ground | Black/Grey | J2-1 |
| 3 | High Range | Light Blue/Yellow | J2-3 |
| 4 | Low Range | Light Green/Brown | J2-4 |

Configuration:

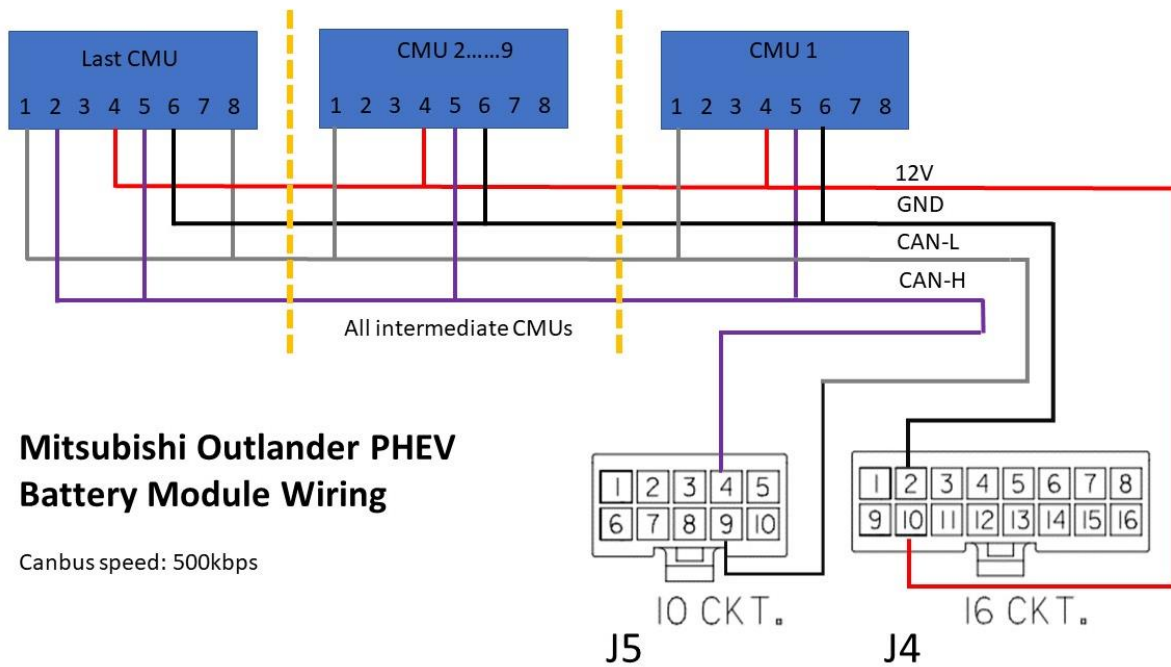
Current Sensor Type: Dual Range

Low Range : 100 mV/A

High Range : 6.15 mV/A

Mitsubishi Outlander CMUs

Up to a full pack can be used, it is not possible to use more because of the assigned Can Bus Ids per module.



Mitsubishi Outlander PHEV Battery Module Wiring

Canbus speed: 500kbps

BMW I3 CSC modules

Up to a full pack can be used, it is not possible to use more because of the assigned Can Bus Ids per module.

Designed to be Daisy chained from one module to the next, remember to close the end canbus by having a 120 ohm resistor between canH and canL.

| | BMW i3 Slave Connector | | | | | |
|-----------------|-------------------------------|----|------|--------------|------------|-------------|
| Function | 5V Power | | ? | CanL | CanH | GND |
| Wire | Red/White | NC | Blue | Yellow/Brown | Yellow/Red | White/Brown |
| Pin | 1 | 2 | 3 | 4 | 5 | 6 |
| Pin | 7 | 8 | 9 | 10 | 11 | 12 |
| Wire | Red/White | NC | Blue | Yellow/Brown | Yellow/Red | White/Brown |
| Function | 5V Power | | ? | CanL | CanH | GND |

| BMW I3 Pin | Function | Color | SimpBMS connection |
|-------------------|-----------------|-------------------|---------------------------|
| 1 | 5V supply | Grey/Red | J5-5 |
| 6 | Ground | Black/Purple | J5-10 |
| 4 | Can Low | White Yellow | J5-9 |
| 5 | Can High | Light Blue/Yellow | J5-4 |

If using more then one module you can just do the following:

| First BMW I3 Pin | Function | Next BMW I3 |
|-------------------------|-----------------|--------------------|
| 7 | 5V supply | 1 |
| 12 | Ground | 6 |
| 10 | Can Low | 4 |
| 11 | Can High | 5 |

Outputs and Inputs

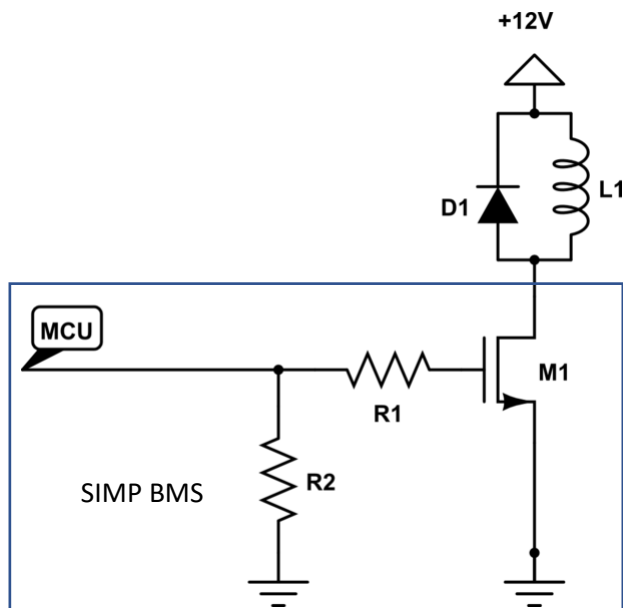
Contactors

It is possible to use both contactors with built in economizers or without.

Contactors **with** built in economizers **MUST** be used on the **12V switched** outputs

Contactors **without** built in economizers **MUST** be used on the **ground switched** PWM outputs

See for the circuit below, a diode must be used in parallel with the contactor.



Contactor behavior

ESS Mode:

Delay on the Low switching contactor outputs can be set via precharge delay

| Function | Switching | Pin | ESS switching behaviour |
|-----------|-----------|-----|-------------------------|
| Charge | High | 13 | Instant |
| DisCharge | High | 12 | Instant |

These outputs are meant to control dumb loads and chargers/sources.

The other outputs to 'Trip Shunt' or 'Main Contactor' mode

Trip Shunt

In ESS mode OUT2 can be used to trip DC breakers with a shunt trip device. This output goes high when an over or under voltage or over temperature situation occurs.

Make sure the shunt is rated for the activation signal of 12V.

| Function | Switching | Pin | ESS switching behaviour |
|------------|-----------|-----|-------------------------|
| Shunt Trip | High | 4 | Instant |
| Not Used | High | 5 | NOT USED |

Main Contactor

In ESS mode you can choose to have a single contactor to connect and disconnect the battery.

When an over or under voltage or over temperature situation occurs the battery gets disconnected. If these faults are not present the battery is allowed to connect.

| Function | Switching | Pin | ESS switching behaviour |
|----------------|-----------|-----|---|
| Main Contactor | High | 4 | Switches on after precharge |
| Main Contactor | Low | 6 | Switches on after precharge |
| Precharge | High | 5 | Switched on for duration of precharge delay |

Inputs

Inputs are triggered by giving them anywhere from 5-16V, the inputs are isolated from the micro controller but must share the same ground as 12V in.

EV Mode:

| Pin | Name | Function |
|-----|-----------------------|--|
| 1 | Key-on | Request BMS to close contactors and go into 'Drive' mode via precharge |
| 6 | AC-present | Request BMS to go into charge mode and command charger |
| 2 | Charge Current | Not connected – standard limit / HIGH is alternate limit |
| 7 | <i>CP conditioned</i> | <i>Control Pilot signal monitoring (future implementation)</i> |

ESS Mode:

| Pin | Name | Function |
|-----|--------------|--|
| 1 | Storage Mode | Charge Voltage now reduced to parameter 'Storage Setpoint' |

Wiring contactors into BMS or Not

Depending on your setup you can decide to have the contactors controlled by the BMS or by the Inverter/Drive unit.

Please keep in mind:

- Tripping contactors with rotating motors can/will damage the inverter
- The BMS is meant to protect the batteries and not other items
- Wiring items directly to the battery can cause drain that can irreversibly damage the batteries.

If your motor controller/inverter can control the contactors use this. Wire the BMS positive contactor 12V output to control a relay that can cut the enable signal to the motor controller/inverter to protect the batteries. This signal can also be used for a 'Ready' light on the dash for a visual indication.

Depending on the charger you can wire it directly to the battery or via a single contactor depending on the type of charger used, some require pre-charging.

Wiring up BMS Slaves

When reusing existing vehicle battery modules might not be possible to parallel them at cell level.

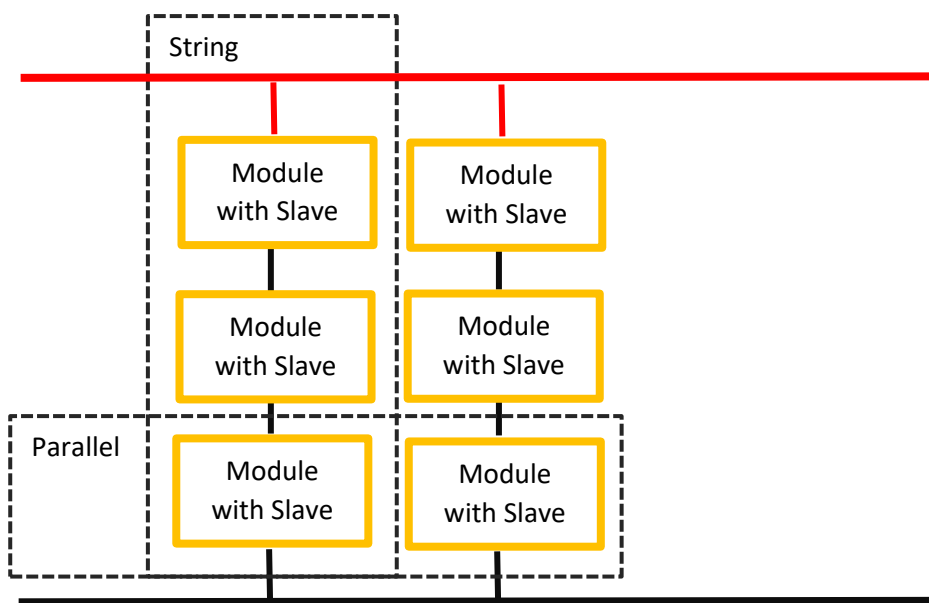
The approach that thus can be taken is to wire all the modules in series and then parallel the strings to create the complete pack.

Values to determine for your setup:

Battery Capacity – Capacity of parallel cells monitored by BMS Slave

slaves in parallel – How many battery strings are connected in parallel

Cells in Series – total amount of cells that are in series in a string



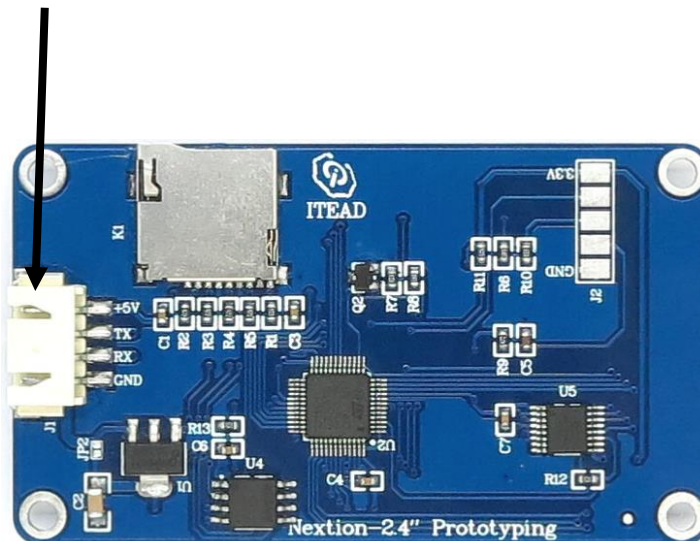
Wiring up Nextion Display

A Nextion Display programmed with the appropriate software will allow the displaying of information provided by the SimpBMS.

The required connections are on connector 5.

| Connector 5 | Signal BMS | Connection Display |
|-------------|------------|--------------------|
| 5 | 5V supply | 5V |
| 10 | Ground | Ground |
| 8 | RXspare | TX |
| 3 | TXspare | RX |

Nextion Display Connection



Wiring up Chargers

SimpBMS can control chargers in various ways:

- Simple on/off control with a relay
- Can bus controlled with a relay as back up (Can Bus info in the Can Bus Chapter)

Depending on how your charger is connected to your pack you can enable the HV contactors closing if required.

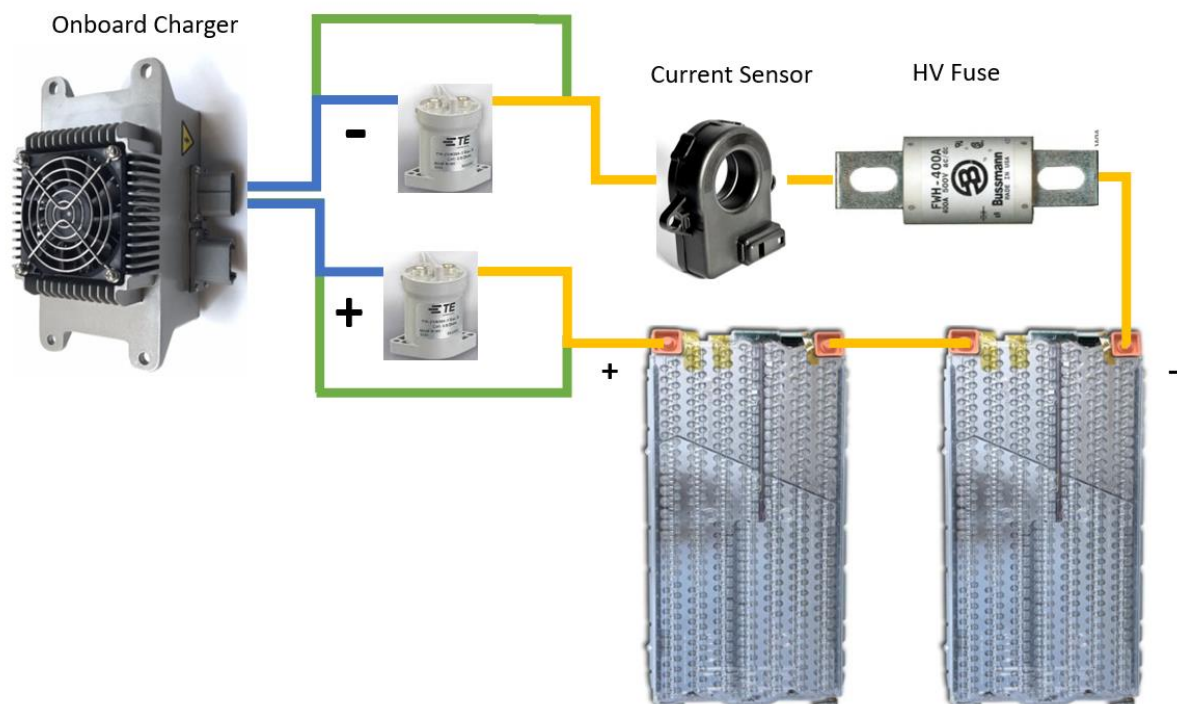
Below is an simplified diagram, this is for illustration only.

If the charger is directly connected to the battery, like the green lines show, the contactors do not need to close in order to charge.

The variable ; *Charger HV Connection* would be set to **Direct To Battery HV**

If the charger is connected to the HV bus after the contactors, the blue lines;

The variable ; *Charger HV Connection* would be set to **Behind Contactors**



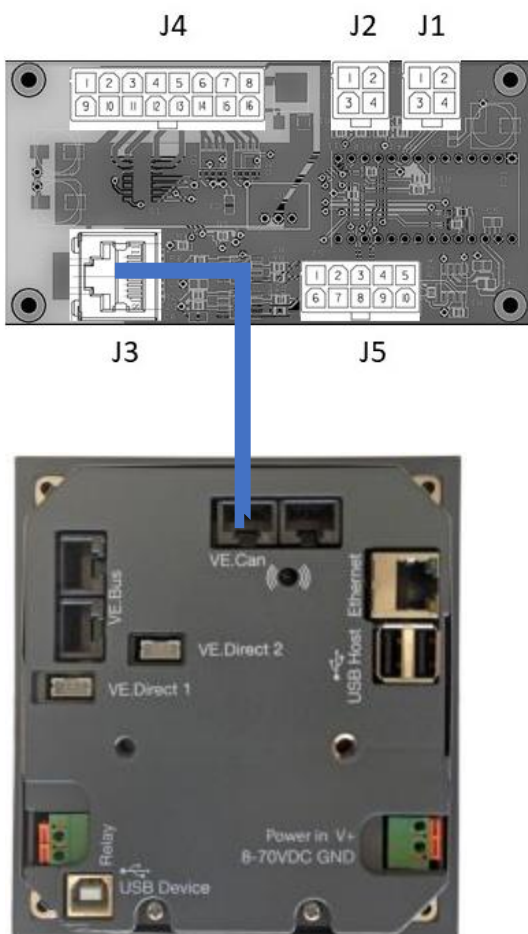
Connection to Victron Color Control

Connector 3 on the SimpBMS is compatible with the VE.Can rj45, this means that you can use a standard ethernet cable to join the two. Please bear in mind that for VE.Can to work it requires a termination resistor to be added on the second VE.Can port on a color control.

Victron VE.Can terminator: <https://www.victronenergy.com/accessories/ve-can-rj45-terminator>

The SimpBMS will still require to be powered by an external 12V source.

Example connection to a Color Control GX (all GX devices supported)



The GX control needs to be configured to 500kbps so it can receive the data from the SimpBMS.

The SimpBMS should show up as an available Battery monitor on the GX.

A good start for further workings of a Can based BMS in the Victron system :

<https://www.victronenergy.com/live/ccgx:start>

Serial Interface

How to connect to SIMP BMS.

1. Connect the Micro-B USB port on the teensy to your computer with appropriate cable
2. Computer should identify new usb/serial device
3. Open your preferred Serial Terminal Program. Example :
https://www.compuphase.com/software_termite.htm
4. Connected to the Simp BMS via the serial port (115200 BAUD)
5. Now you should see the 'Debug' screen info scrolling

Any issues with connecting please check the Teensy Microcontroller troubleshooting guide:

<https://www.pjrc.com/teensy/troubleshoot.html>

If the Teensy does not show up as serial port please run the Teensy Serial installer

https://www.pjrc.com/teensy/serial_install.exe

Diagnostic Info Screen

BMS Status : 1 Ready 12

Modules: 2 Cells: 12 Strings: 1 Voltage: 43.551V Avg Cell Voltage: 3.651V Low Cell Voltage: 3.607V High Cell Voltage: 3.772V Avg Temp: 21.423C

Module #1 21.99V Cell0: 3.67V Cell1: 3.70V Cell2: 3.71V Cell3: 3.67V Cell4: 3.61V Cell5: 3.77V Neg Term Temp: -82.27C Pos Term Temp: -89.26C
 Module #2 21.56V Cell6: 3.62V Cell7: 3.61V Cell8: 3.61V Cell9: 3.61V Cell10: 3.62V Cell11: 3.62V Neg Term Temp: 21.64C Pos Term Temp: 21.21C
 CANbus 4.81mA 54% SOC 54000.00mAh

BMS Status : this is what state the bms is in.

Ready : BMS is good and communicating normally, waiting for a drive or charge digital input
 Mode that is suggested for a fixed storage solution

Error : A fault is present in the read out from the modules. Possible issues:

Overvoltage

Under voltage

Overtemperature

Under temperature

Precharge : when Key on is high this is initiated, drives the negative contactor and then the precharge contactor. Once Precharge Timer (5000mS) has ran out AND the current drops below 1000mA it will close the contactor.* This initiates transition into drive.

Drive : Monitors voltages and temperatures with negative and positive contactor closed.

If key on signal goes low both contactors turn off immediately and BMS goes into Ready state.

Transition to error state if : under voltage is detected

Temperature currently only derates the transmitted current limits

Charge: When AC present in is high the charger enable output gets turned on until end of charge is reached or error occurs.

When one cell hits the overvoltage it will stop charging and go to ready.

Rest of displayed information is shown per module, both voltage and temperatures reported

Plus a summary of totals and averages based on pack settings

To open setup send the command: s

Simp BMS Setup Menu

Not all variants have the same parameters or menus.

```
MENU
Debugging Paused
Firmware Version : 310320
b - Battery Settings
a - Alarm and Warning Settings
e - Charging Settings
c - Current Sensor Calibration
k - Contactor and Gauge Settings
i - Ignore Value Settings
d - Debug Settings
x - Experimental Settings
R - Restart BMS
q - exit menu
```

This stops the scrolling of the diagnostics info.

This shows the Firmware Version Number, please indicate this when ever requesting support.

And displays the following options:

- b - Battery Settings
- a - Alarm and Warning Settings
- e - Charging Settings
- c - Current Sensor Calibration
- k – Contactor settings and Gauge Settings
- i – Ignore Value Settings
- d - Debug Settings
- x-Experimental Settings
- R – Restart BMS
- q - exit menu

'q' Quit

Exit the setup menu and resume diagnostics display info

'd' Debug Settings

```
Debug Settings Menu
Toggle on/off
1 - Can Debug :0
2 - Current Debug :0
3 - Output Check :0
4 - Input Check :0
5 - ESS mode :0
6 - Cells Present Reset :0
7 - Gauge Debug :0
8 - CSV Output :0
9 - Decimal Places to Show :2
q - Go back to menu
```

Inputting a number of the shown options toggles the modes, *to stop* send the same number.

- 1 – Can Debug = show can messages
- 2 – Current Debug = show all the current calculation information
- 3 – Output Check = cycle outputs **!!! DO NOT TURN ON WITH HV CONNECTED TO CONTACTORS**
- 4 – Input Check = show level of all inputs
- 5 – ESS Mode = turn on and off ESS Mode, ON is 1
- 6 – Cells Present Reset = recalibrate the cells to check if they are present
- 7 – Gauge Debug = cycle the gauge output up and down for testing pwm settings for gauge
- 8 – CSV Debug = Data is now displayed in a Comma Separated Values makes logging it easier
- 9 – Decimal Places to Show = how many decimals to show for cell voltage debug

- q – go back a menu

'b' Battery Settings Menu

Settings modified by sending " 'ID' 'New Value' " via the serial terminal, will refresh values in terminal

```

Battery Settings Menu
r - Reset AH counter
f - Reset to Coded Settings
q - Go back to menu

1 - Cell Over Voltage Setpoint: 4200mV
2 - Cell Under Voltage Setpoint: 3000mV
3 - Over Temperature Setpoint: 65.00C
4 - Under Temperature Setpoint: -10.00C
5 - Cell Balance Voltage Setpoint: 3900mV
6 - Balance Voltage Hysteresis: 40mV
7 - Ah Battery Capacity: 100Ah
8 - Pack Max Discharge: 30.00A
9 - Cell Discharge Voltage Limit Setpoint: 3200mV
0 - Slave strings in parallel: 1
a - Cells in Series per String: 12
b - setpoint 1: 3100mV
c - SOC setpoint 1: 10%
d - setpoint 2: 4100mV
e - SOC setpoint 2: 90%
g - Storage Setpoint: 3800mV
h - Discharge Current Taper Offset: 300mV
j - Discharge Current Temperature Derate : 40.00C
k - Cell Discharge Voltage Hysteresis: 200mV
  
```

r – Reset AH Counter = Use voltage to determine SOC, best used with open circuit voltage

f – Reset to coded settings, the settings that were written when the code was compiled

1 – Over Voltage Setpoint = Over voltage limit per cell in mV

2 – Under Voltage Setpoint = Under voltage limit per cell in mV

3 – Over Temperature Setpoint = Setpoint at which allowed discharge and charge current is reduced to zero

4 - Under Temperature Setpoint = Setpoint at which allowed discharge and charge current is reduced to zero

5 – Balance Voltage Setpoint = Setpoint of cell voltage in mV at which during charging cells will start balancing.

6 – Balance Voltage Hysteresis = Voltage required to be above the lowest cell to allow balancing of cell in mV

7 – Battery Capacity = each group of parallel cells monitored per slave capacity in Ah

8 – Max Discharge = maximum discharge current in A, transmitted current limit will taper from max current starting at discharge temp to zero at over temperature.

9 – discharge voltage limit = used to calculate max discharge setpoint, voltage per cell will get converted to pack level by BMS

0 – slaves in parallel = amount of slave strings in pack (will multiply total pack capacity)

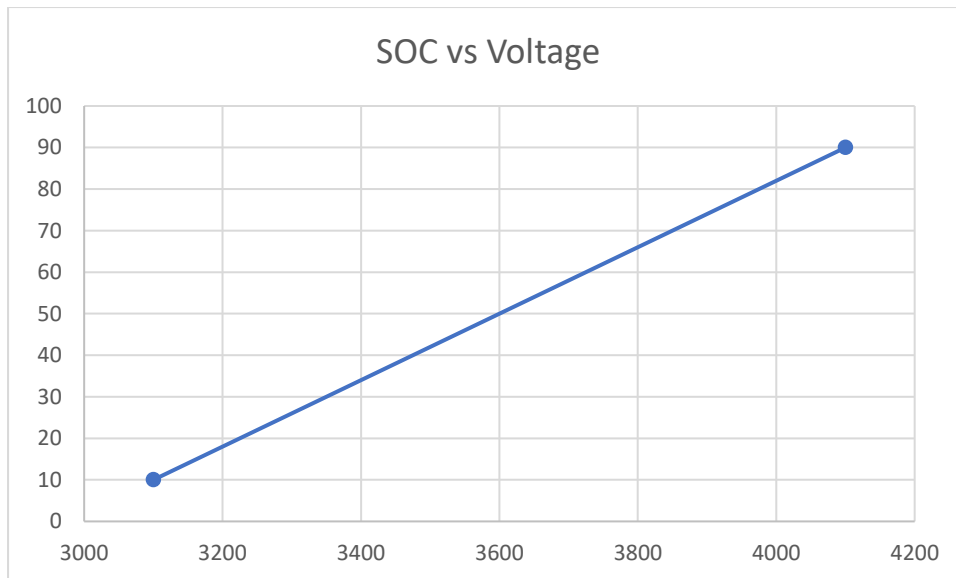
a – cells in series = amount of cells in series (per string if wired in parallel)

b - mV setpoint 1 = cell voltage setpoint 1 for voltage based SOC calc

c - SOC setpoint 1 = SOC for corresponding cell voltage

c- mV setpoint 2 = cell voltage setpoint 2 for voltage based SOC calc

e- SOC setpoint 2 = SOC for corresponding cell voltage



g – Storage Charge Voltage setpoint = when in Storage mode in ESS this is used instead of Charge Voltage Limit

h – Discharge Current Taper Offset = the voltage offset from Discharge Voltage Limit at which the discharge current Max will start to taper down.

j – Discharge Current Temperature Derate = Temperature above which discharge current starts to taper to 0 Amps at Over Temperature

k – Cell Discharge Voltage Hysteresis = cell voltage needs to rise this amount above the Discharge Voltage Limit before discharge is allowed again in ESS mode

'e' Charging Settings

Settings modified by sending " 'ID' 'New Value' " via the serial terminal, will refresh values in terminal

```

Charging Settings
1 - Cell Charge Voltage Limit Setpoint: 4100mV
2 - Charge Hysteresis: 200mV
3 - Pack Max Charge Current: 30.00A
4 - Pack End of Charge Current: 5.00A
5 - Charger Type: Volt Charger
6 - Charger Can Msg Spd: 100mS
7 - Can Baudrate: 500kbps
8 - Charger HV Connection:
9 - Charge Current derate Low: 0.00 C
a - Alternate Pack Max Charge Current: 15.00A
q - Go back to menu
  
```

1 – Cell Charge Voltage Limit = End of charge voltage target for cells

2 – Charge Hysteresis = Drop in cell voltage required to restart charging

3 – Pack Max Charge Current = Max allowed charge current into pack

4 – Pack End of Charge Current = Current when reaching target voltage, tapers based on hysteresis

5- Charger Type = Switch can bus controlled charge output messages (Cyclic)

Relay Control – Turn output on and off

Brusa NLG533 – On standard Control Ids

Volt Charger

Eltek Charger – Volvo versions also supported

Victron Charger

6- Charger Can Msg Spd = Interval target between sent can messages

ONLY FOR TESLA FIRMWARE 7 – Can Baudrate = Can network speed, to be changed to match other items on Can network, see for information the chapter on Can. Will only take effect after exiting the menu's fully and then doing a powercycle.

8 – Charger HV Connection = How does the charger connect to the pack

Direct To Battery HV – connected directly to the battery pack (through a fuse ofcourse)

Behind Contactors – connected onto the main HV bus after the contactors, so during charging contactors need to be closed.

9 – Charge Current derate Low = Temperature under which the Charge Current will derate, it will reach zero at Under Temperature

a – Alternate Pack Max Charge Current = when pin is toggled high this is the newly enforced Max Charge Current

'c' Current Sensor

Settings modified by sending " 'ID' 'New Value' " via the serial terminal, will refresh values in terminal

```
Current Sensor Calibration Menu
c - To calibrate sensor offset
s - Current Sensor Type : Canbus Current Sensor
1 - invert current :0
2 - Pure Voltage based SOC :0
3 - Current Multiplication :1
q - Go back to menu
```

c - To calibrate sensor offset = for calibrating analogue sensor offsets*

s - To switch between Current Sensors = switches between sensors types

Undefined = OFF

Analogue Dual Sensor = dual range 5V output sensors

CanBus Sensor = CAB300 or CAB500 supported over CAN

Analogue Single Sensor = single range 5V output sensors

- 1- Invert current = if current sensor is reading the wrong direction toggle value
- 2- Pure Voltage SOC = do not use coulomb counting and rely on using cell voltage to do SOC

Recommend for large packs with low discharge and charge currents

- 3 – Current Multiplication = 1 if all current goes through the sensor , 2 if only one cable (identical required) passes through the sensor and two are used on one pole.

q - Go back to menu

```
Current Sensor Calibration Menu
c - To calibrate sensor offset
s - Current Sensor Type : Analogue Dual Current Sensor
1 - invert current :0
2 - Pure Voltage based SOC :0
3 - Current Multiplication :1
4 - Analogue Low Range Conv:64.30 mV/A
5 - Analogue High Range Conv:5.80 mV/A
6 - Current Sensor Deadband:5 mV
8 - Current Channel ChangeOver:20.00 A
q - Go back to menu
```

4 – Analogue Low Range Conv = value for conversion mV/A, enter 10x.

5 – Analogue High Range Conv = value for conversion mV/A, enter 10x.

6 – Current Sensor Deadband = voltage around the zero point which the measurement will be ignored

8 – Current Channel ChargeOver = at which current level will the alternate channel be selected

Configuring an Analogue Current Sensor

When configuring an Analogue Current Sensor it must be kept in mind that analogue sensors all will have drift and variation due to their implementations/wire runs/emc influences.

Data required from manufacturer:

1. Single or Dual Channel
2. Resolution of each channel in mV/A on a 5V reference
3. If a dual channel limit of lowest channel

Select the variant of Analogue Current Sensor you are using, single or dual channel by cycling through the types using 's'.

When the system is powered on but no current is flowing through the sensor you are required to run the command 'c' to calibrate current sensor.

This will now report back some values which are written to the memory logging where the middle point is thus zero current point.

You now need to input each channels resolution in parameter 4 and 5.

You can leave the current sensor dead band at 5mV to start, you can later tweak this value to suit your system and sensor.

If you are using a dual channel sensor please input the current limit of the lower range in parameter 8.

Now completely exit the Setup menu using the command 'q' twice, this saves the parameters.

Go back into the setup menu and enter the debug screen and use the current debug option to view the reported values against a known current, keep in mind that a device you are using to determine what the current should be might have a different way of filtering the values.

Try a few points to get an indication of the deviation.

A current value lower than expect decrease the value for the resolution.

A current value higher than expected increase the value for the resolution.

'k' Contactor Control

Settings modified by sending " 'ID' 'New Value' " via the serial terminal, will refresh values in terminal

Contactor and Gauge Settings Menu

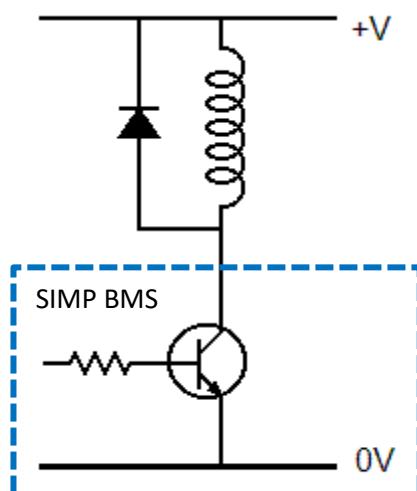
- 1 - PreCharge Timer: 5000mS
- 2 - PreCharge Finish Current: 1000 mA
- 3 - PWM contactor Hold 0-255 :50
- 4 - PWM for Gauge Low 0-255 :50
- 5 - PWM for Gauge High 0-255 :255
- 6 - ESS Main Contactor or Trip :Main Contactor and Precharge

1 – Precharge Timer = mS of minimum precharge time

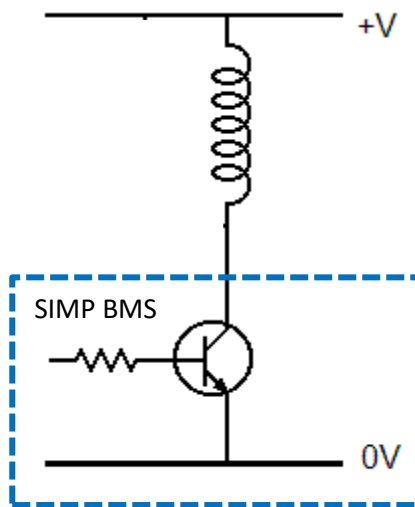
2 – Precharge Finish Current = mA of allowed current before switching in the main contactor

3 – Pwm contactor Hold = PWM duty cycle (values 0-255), lower the value the lower the 'voltage' at the contactor. This only works on the PWM pull low outputs.

Contactors without an internal coil require an diode placed across their ground and 12V feed, as depicted below, the coil is the contactor.



Settings up an Analogue Gauge



The principle of the gauges driver is identical to that of the grounding contactor control.

Please make sure that your gauge works with a grounding signal, usually indicated by the original sensor having a signal connection and a ground connection.

This output can also be used with a setup that expects a voltage signal, all that needs to be done then is to have a 1K ohm pull up resistor to 12V so that the grounding output can put it to ground at varying duty cycles to generate an average voltage.

When a parameter is entered for a gauge value the gauge will snap to this position until the setup menu has been exited.

4 – PWM for Gauge Low = PWM duty cycle of Gauge Output to reflect 0% SOC

5 – PWM for Gauge High = PWM duty cycle of Gauge Output to reflect 100% SOC

6 - ESS Main Contactor or Trip = utilize a precharge and main contactor or a shunt trip setup only available in ESSmode

'a' Alarms and Warnings Settings Menu

Settings modified by sending " 'ID' 'New Value' " via the serial terminal, will refresh values in terminal

```
Alarm and Warning Settings Menu
1 - Voltage Warning Offset: 100mV
2 - Cell Voltage Difference Alarm: 200mV
3 - Temp Warning Offset: 5.00 C
4 - Over and Under Voltage Delay: 500 mS
```

1 – Voltage Warning Offset = Offset from Under and Over Voltage limits when an Alarm Flag gets set

2 – Cell Voltage Difference Alarm = Difference below low and high cell to trigger Alarm Flag

3 – Temp Warning Offset = Offset from Over Temperature limit when an Alarm Flag gets set

4 – Over and Under Voltage Delay = the time allowed for cells to be exceeding limits, Overvoltage and Undervoltage, this is used to allow sag exceeding these limits for heavy discharges or inrush currents during turn on. Set in mS, please keep in mind that slaves might not be read at a very high frequency thus you should allow enough time for reading to be done.

'i' Ignore Value Settings

Settings modified by sending " 'ID' 'New Value' " via the serial terminal, will refresh values in terminal

Ignore Value Settings

1 - Temp Sensor Setting:0

2 - Voltage Under Which To Ignore Cells:500mV

q - Go back to menu

1 – Temp Sensor Setting = Sensor to use, 0 is use all

2 – Voltage Under Which to Ignore Cells = to allow missing cells and then mask false readings

Common Setup Issues and Errors

Series Cells Fault

When the errors “series cells fault” is shown it means that the BMS is expecting more or less cells to be present.

Fix: check your settings for parallel strings and Cells in series with your actual connected setup, correct these numbers to make the error disappear.

If not resolved please check that all slave modules are recognized and communicating, if not please troubleshoot communications first.

CANBUS

SIMP BMS will communicate on the canbus at the following speeds (baudrates)

| Firmware | Baudrate [kbps] |
|------------------|-----------------|
| Tesla | Programmable |
| Outlander | 500 |
| Imiev | 500 |
| Volt/Ampera gen1 | 125 |
| VW | 500 |
| BMW | 500 |

This is used to communicate with the following devices:

- Outlander BMS slaves
- Panasonic BMS slaves
- Volt Gen 1 BMS Slaves
- Can Current sensor
- Victron VE-CAN
- Can Bus based Chargers
- Other devices

Termination Resistor

SIMP BMS does not come with a termination resistor as standard does come with a location for a 0805 resistor to add one.

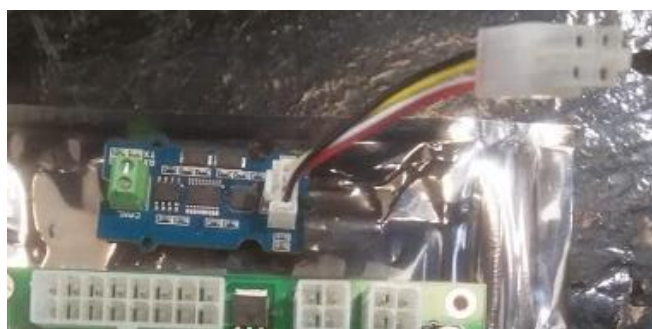
If you measure the resistance across CanH and CanL if it is not 60 Ohm add a 120 Ohm resistor at the SIMP BMS connector. If the resistance is still too high add a 120 Ohm resistor at the other end of the can bus.

Canbus Expansion

The canbus expansion module currently only works with the Chevy Volt / Opel Ampera software.

This allows you to run chargers and DCDC on a bus that is not locked at 125kbps for the slaves.

The Expansion Module plugs into J1, then wire the canbus High and Low into the screw terminal on the module.



Outlanders BMS SLAVES

It is only possible to use slaves with unique IDS, so maximum of 10 slaves before a trick is required.

Each slave can monitor 8 (10 possibly) parallel cell groups

CAN Current Sensor

Only one current sensor per SIMP BMS

CAB 300

Bi-directional 350A max

Canspeed : 500kbps

VW/Panasonic BMS Slaves

It is only possible to use slaves with unique IDS, so maximum of 8 slaves before a trick is required.

Each slave can monitor 12 parallel cell groups

Chevy Volt BMS Slaves

Can only talk to a complete pack at most, cannot add any more slaves.

Victron VE-CAN

Communicate using the simple protocol as REC BMS, will share all required information from the batteries.

You can set the Victron GX systems up to accept 500 or 250 kbps.

Can Bus Controlled Charger

Currently the following chargers are supported, please note the associated **can speeds these need to match everything** else on the network.

| Charger | Baudrate [kbps] |
|-------------------------|--|
| Eltek | 500 (possibly changeable) |
| Brusa NLG5xx | 500 default (configuration possible) |
| Chevy Volt/ Opel Ampera | 500 |
| TCcharger /Elcon | 250 default (500 available from factory) |
| Coda | 500 |

Other CAN Devices

Other devices can be connected, these can be setup to display and react to messages from the SIMP BMS.

CAN Messages

Message Limits
 Message ID 0X351

| Byte | Bit | Signal | Scale | unit |
|------|-----|-----------------------|-------|------|
| 0 | | Discharge Current LSB | 0.1 | A |
| 1 | | Discharge Current MSB | 0.1 | A |
| 2 | | Discharge Voltage LSB | 0.1 | V |
| 3 | | Discharge Voltage MSB | 0.1 | V |
| 4 | | Charge Current LSB | 0.1 | A |
| 5 | | Charge Current MSB | 0.1 | A |
| 6 | | Charge Voltage LSB | 0.1 | V |
| 7 | | Charge Voltage MSB | 0.1 | V |

Message SOC
 Message ID 0X355

| Byte | Bit | Signal | Scale | unit |
|------|-----|---------|-------|------|
| 0 | | SOC LSB | 1 | % |
| 1 | | SOC MSB | 1 | % |
| 2 | | SOH LSB | 1 | % |
| 3 | | SOH MSB | 1 | % |
| 4 | | SOC LSB | 0.01 | % |
| 5 | | SOC MSB | 0.01 | % |
| 6 | | - | | |
| 7 | | - | | |

Message Status
 Message ID 0X356

| Byte | Bit | Signal | Scale | unit |
|------|-----|-----------------|-------|------|
| 0 | | Voltage LSB | 0.01 | V |
| 1 | | Voltage MSB | 0.01 | V |
| 2 | | Current LSB | 0.1 | A |
| 3 | | Current MSB | 0.1 | A |
| 4 | | Temperature LSB | 0.1 | C |
| 5 | | Temperature MSB | 0.1 | C |
| 6 | | - | | |
| 7 | | - | | |

Message Warnings
 Message ID 0X35A

| Byte | Bit | Signal |
|------|-----|--------------|
| 0 | 3 | Undervoltage |
| | 4 | Overvoltage |
| 1 | 7 | Overtemp |
| 2 | 12 | Undertemp |
| 3 | | - |
| 4 | | - |
| 5 | | - |
| 6 | | - |
| 7 | | - |

Message Low and High
 Message ID 0X373

| Byte | Bit | Signal | Scale | unit |
|------|-----|----------------------|-------|--------|
| 0 | | Min Cell Voltage LSB | 1 | V |
| 1 | | Min Cell Voltage MSB | 1 | V |
| 2 | | Max Cell Voltage LSB | 1 | V |
| 3 | | Max Cell Voltage MSB | 1 | V |
| 4 | | Min Temperature LSB | 1 | Kelvin |
| 5 | | Min Temperature MSB | 1 | Kelvin |
| 6 | | Max Temperature LSB | 1 | Kelvin |
| 7 | | Max Temperature MSB | 1 | Kelvin |

Firmware Updating

Updating firmware can be done with the simple process explained below, CHECK SETTINGS once you flash the new firmware. The process can alter memory locations and thus corrupt settings.

Links

Latest files available on Github, including uncompiled code.

Tesla Github :

<https://github.com/tomdebree/TeslaBMSV2>

Outlander Github :

<https://github.com/tomdebree/OutlanderPHEVBMS/tree/master/OutlanderBMSV2>

VW Github:

<https://github.com/tomdebree/VW-bms/tree/master/VWBMSV2>

Flashing the HEX

The easiest way to get new firmware onto the SIMP BMS is by uploading the latest 'ino.hex' file

Example file name: [TeslaBMSV2.ino.TEENSYS31.hex](#)

In order to get the hex onto the Teensy (microcontroller of the SIMP BMS) it is required to have Teensy Loader installed.

Please follow instructions on the PJRC website : <https://www.pjrc.com/teensy/loader.html>

Once installed and having downloaded the latest hex onto your computer follow the following steps to update the firmware:

6. Power down the system SIMP BMS is part of
 - a. This means turning off all chargers and loads attached if these are controlled by the SIMP BMS
7. Connect the Micro-B USB port on the teensy to your computer with appropriate cable
8. Open Teensy Loader "teensy.exe"
9. Go 'file' , 'Open HEX File' and select the just obtained firmware HEX
10. Program your SIMP BMS by clicking the arrow curved down ('Program' button)
 - a. If buttons not available hit press the reset on button on the Teensy on the SIMP BMS
11. Use the Teensy loader to reboot the SIMP BMS once Programmed, arrow pointing right
12. Using a Terminal program check all settings on the SIMP BMS, and correct as required

Changelog

| Version | Changes |
|---------|---|
| V0.12 | Added info on Can Speeds information in Can chapter Possibility to change them in the Tesla settings charging menu |
| V0.13 | Connector 5 pinout updated IN3 is charge and not IN2 |
| V0.14 | Shunt Trip output in ESSmode |
| V0.15 | Chevy Volt battery wiring |
| V0.16 | Mistubishi wiring info, output functions, common troubleshooting |
| V0.17 | Mistubishi wiring correction |
| V0.18 | Volt/Ampera wiring correction and General user Warning |
| V0.19 | -Updated Canbus -Added info on canbus expansion -Added info on wiring contactors or not |
| V0.20 | Updated Parameter Menu section |
| V0.21 | Updated ESS contactor Pinout AND BMW I3 connection info |
| V0.22 | Added more info on outputs and functions under ESS mode |
| V0.23 | Charges to ESS mode outputs, now also Low Switching Main contactor |