SIMP BMS

Manual V0.11

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Contents

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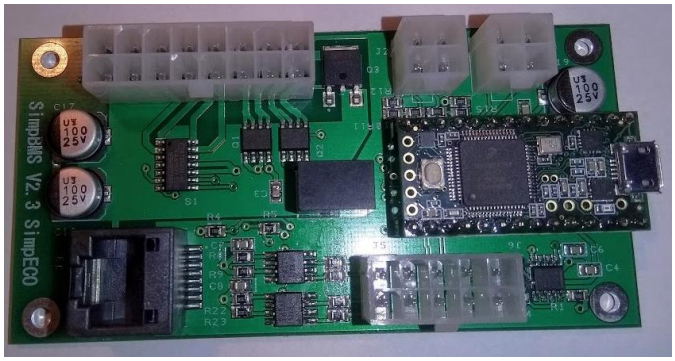
SimpBMS Purchase Overview

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

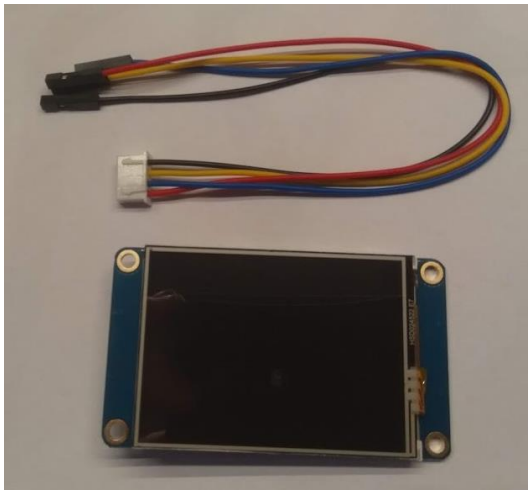
- The SimpBMS board
- Teensy 3.2 flashed with requested Firmware



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 (no temperature or balancing currently)

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 senors 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.

All features beyond output and input control are identical.

Detailed Workings

Balancing

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

-*ESS Mode* always allows balancing based on balancing settings

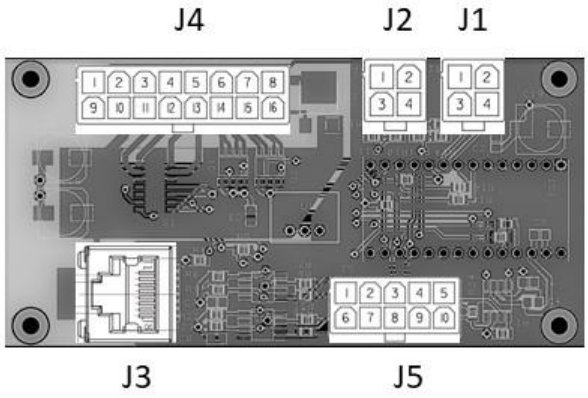
-*Normal Operation* does not balance while in 'driving' operation state, this is due to the possibility of large voltage fluctuations due to high variation of loads.

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

Wiring Basics

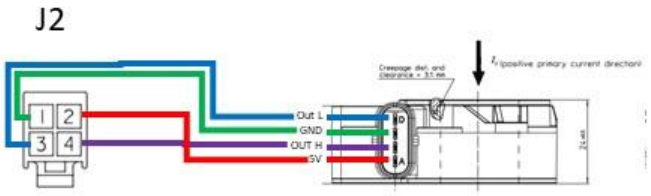
SIMP-BMS V2.1 – Wiring Basics

By T de Bree
18/08/18

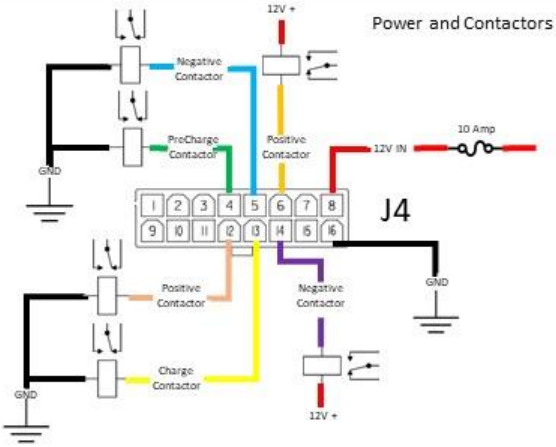


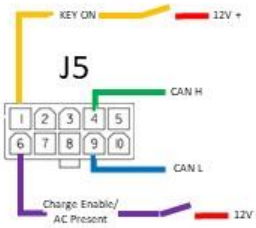
BMS Slaves : see pages below

Analogue Current Sensor



Example DHAB S/161





Input and Comms

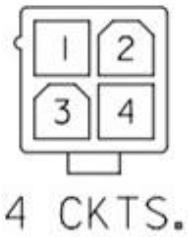
KEY ON or CHARGE ENABLE, can be fed with 5-16V. Need to be constant signal not a pulse

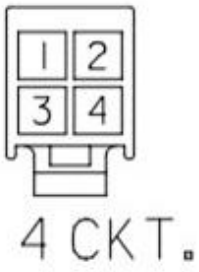
No CAN termination resistor present on SIMP-BMS

CAN H and L shared with J3

Connector 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





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

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

SIMP-BMS V2.1 – Wiring Basics

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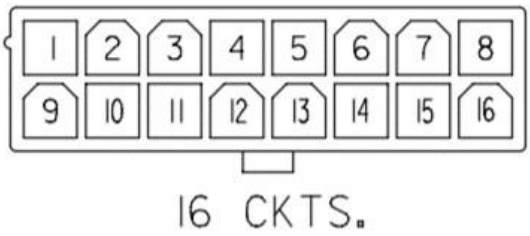
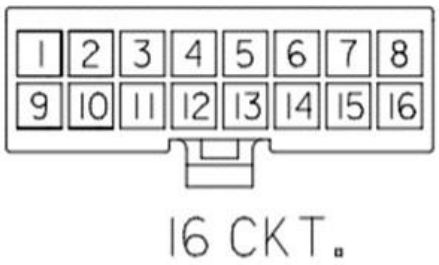
18/08/18



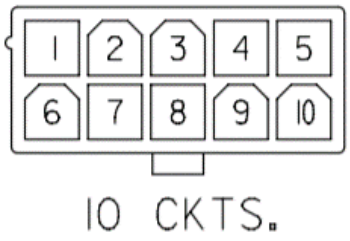


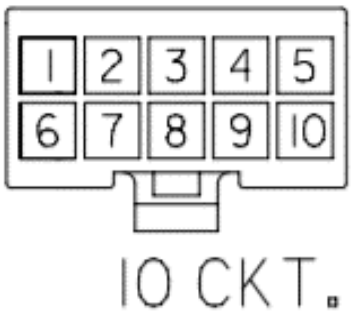
Connector 4	IO
Supplier	Molex
Family	Mini fit 10 way
Part no	39-28-x16x
Harness Part	39-01-x16x

Pin	Function	Switching	Type	V2 Normal usage	ESS Mode
1	5V Out	-	Supply	-	-
2	GND	-	Ground	-	-
3	GND	-	Ground	-	-
4	Out 2	High	Output	Precharge Cont	*Cooling Demand**
5	Out 4	High	Output	Negative Cont	*Heating Demand**
6	Out 6	Low	Output	Positive Cont	Charge Enable
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	Discharge Enable
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	AC present	-
3	Txspare	-	Comms	-	-
4	CanH	-	Comms	Can	Can
5	5V Out	-	Supply	-	-
6	In 3	High	Input	-	-
7	In 4	High	Input	-	-
8	Rxspare	-	Comms	-	-
9	CanL	-	Comms	Can	Can
10	GND	-	Ground		

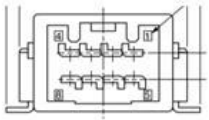
Function	Pin	Pin	Function
In 3	6	1	In 1
In 4	7	2	In 2
Rxspare	8	3	Txspare
CanL	9	4	CanH
GND	10	5	5V

SIMP-BMS V2.1 – Wiring Basics

By T de Bree
18/08/18

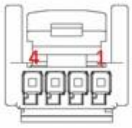
Can Bus Devices

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



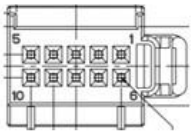
Function	Outlander Slave		SimpBMS	
	Connector	Pin	Connector	Pin
GND	X1	7	X4	2
12V	X1	1	X4	9
CAN L	X1	4	X5	9
CAN H	X1	8	X5	4

CAB 300	
Supplier	TE
Part No	1473672-1



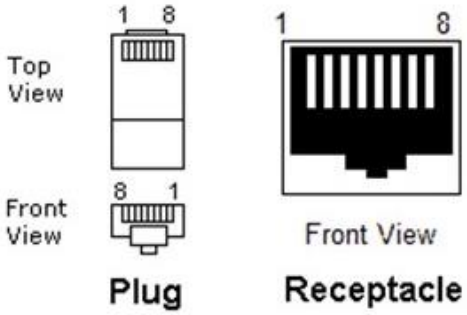
Function	CAB 300		SimpBMS	
	Connector	Pin	Connector	Pin
GND	X1	3	X4	2
12V	X1	4	X4	9
CAN L	X1	1	X5	9
CAN H	X1	2	X5	4

VW Slave conncetor	
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



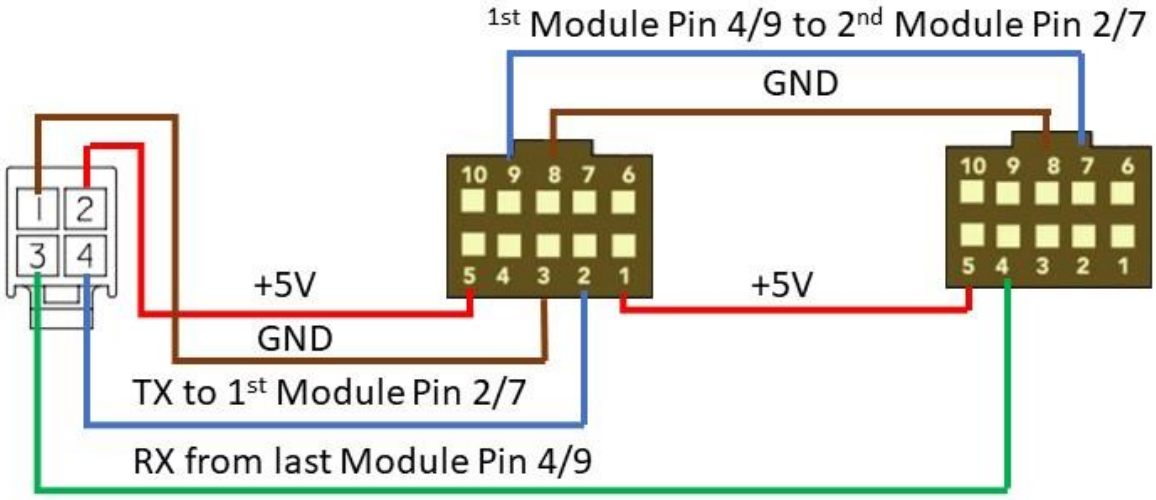
Connector 3 Comms
Supplier -
Family RJ45
Part no -
Harness Part -

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

SIMP-BMS V2.1 – Wiring Basics

By T de Bree
18/08/18

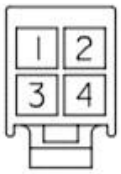
Tesla Slaves



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

4 CKTS.



4 CKT.

Outputs and Inputs

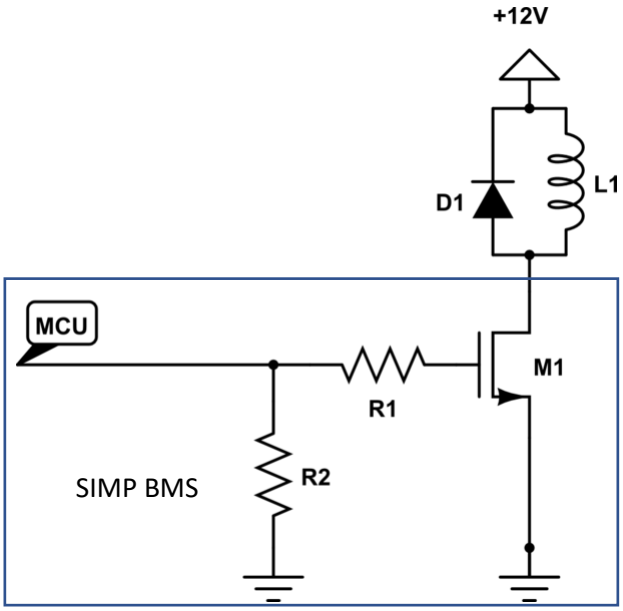
Contactors

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.



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.

Wiring up BMS Slaves

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

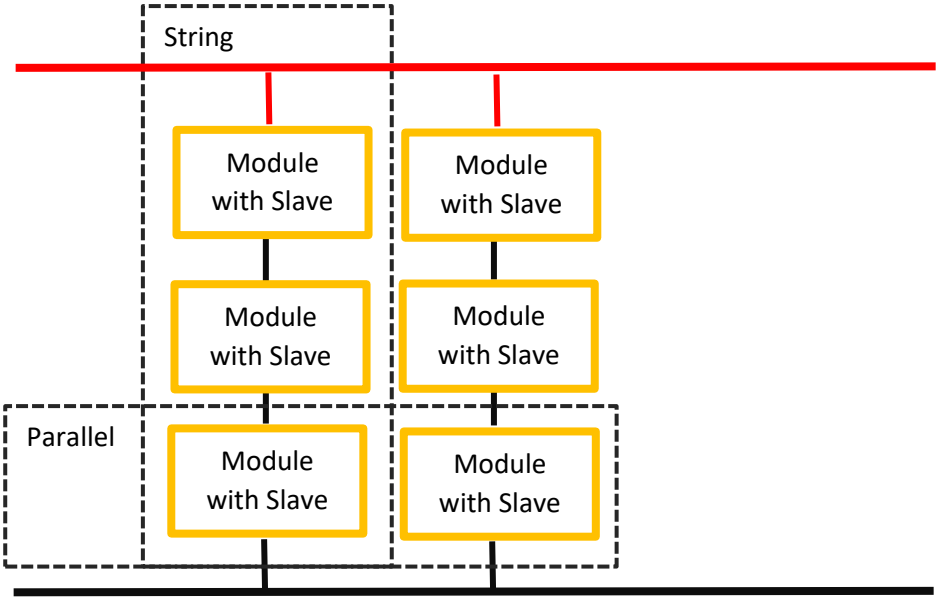
The approach that thus can be taken is to wire all the modules in series and then parallel the strings to create the complete pack.

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



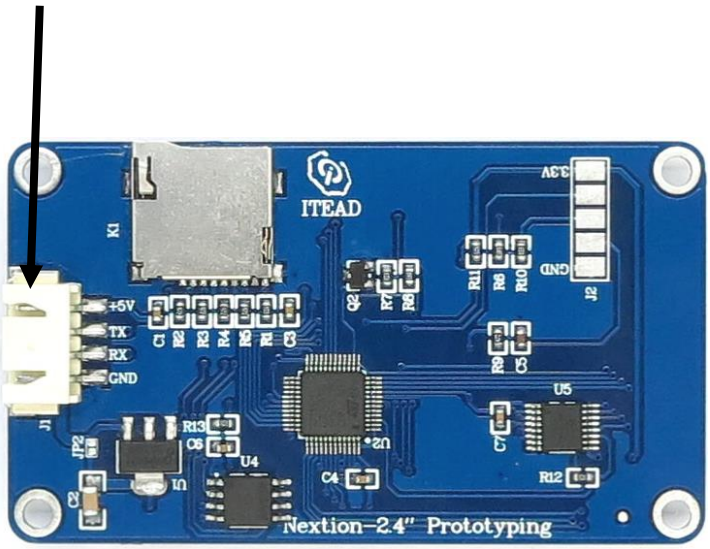
Wiring up Nextion Display

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

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

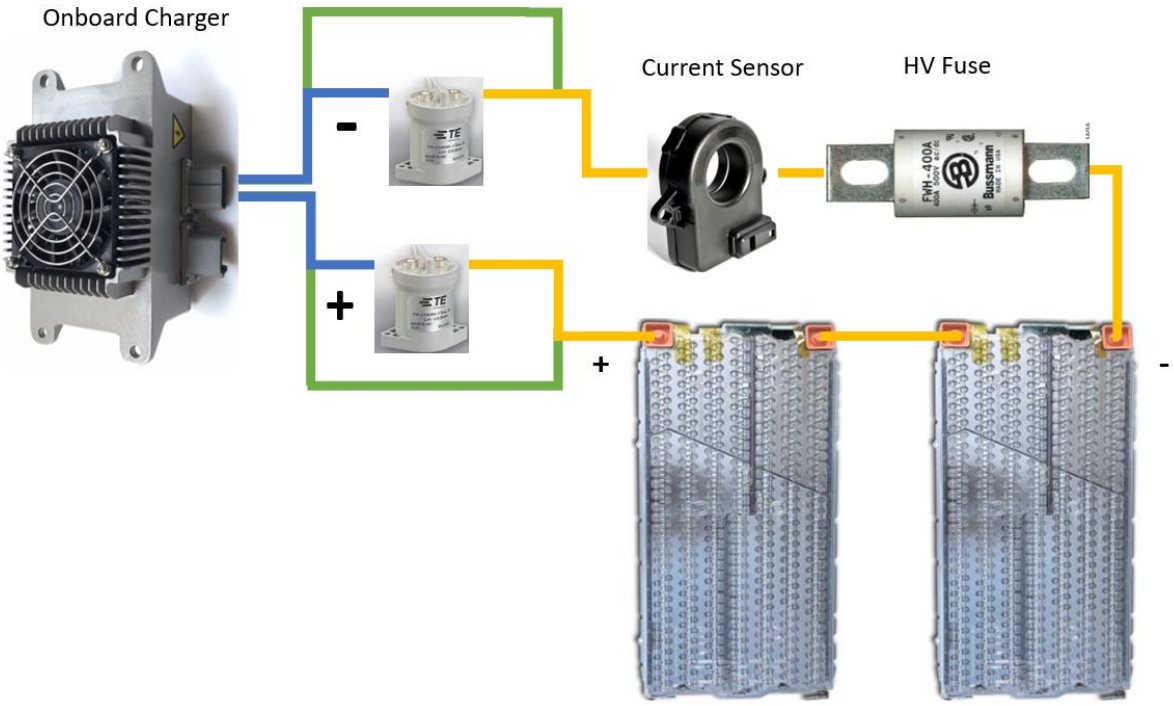
Below is an simplified diagram, this is for illustration only.

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



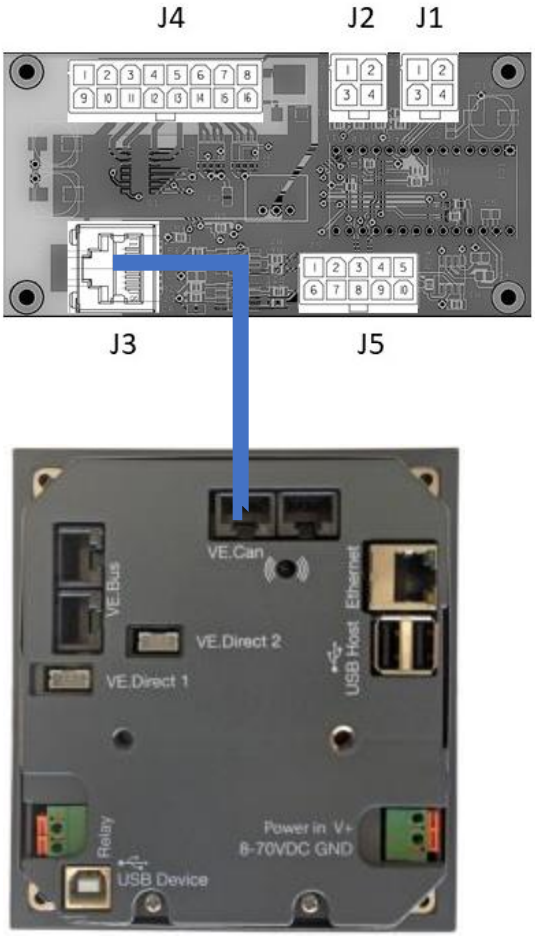
Connection to Victron Color Control

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

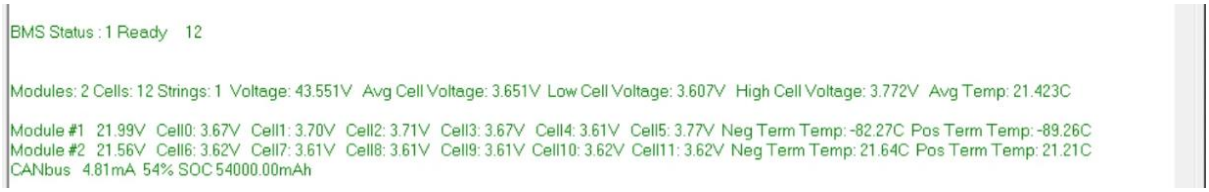
How to connect to SIMP BMS.

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

Diagnostic Info Screen



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.

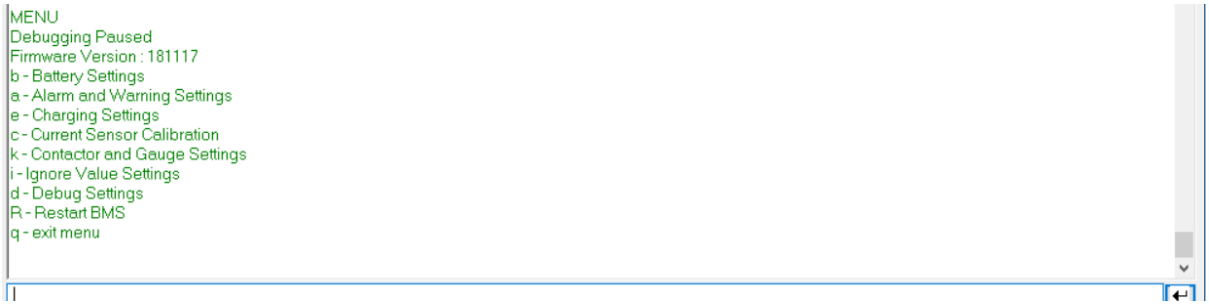
When one cell hits the overvoltage it will stop charging and go to ready.

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



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

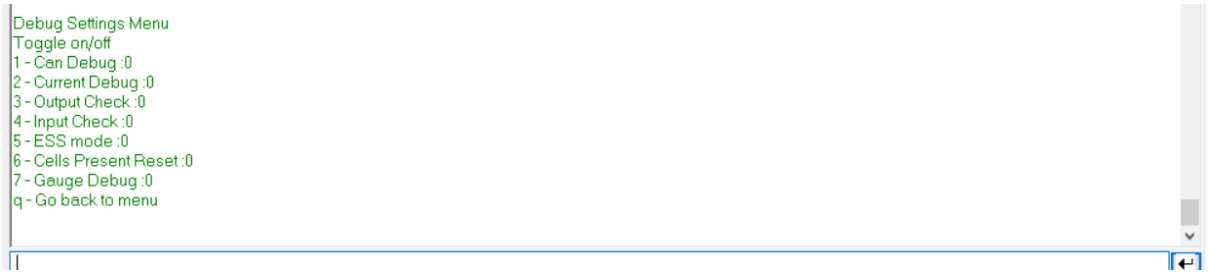
R – Restart BMS

q - exit menu

‘q’ Quit

Exit the setup menu and resume diagnostics display info

‘d’ Debug Settings



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

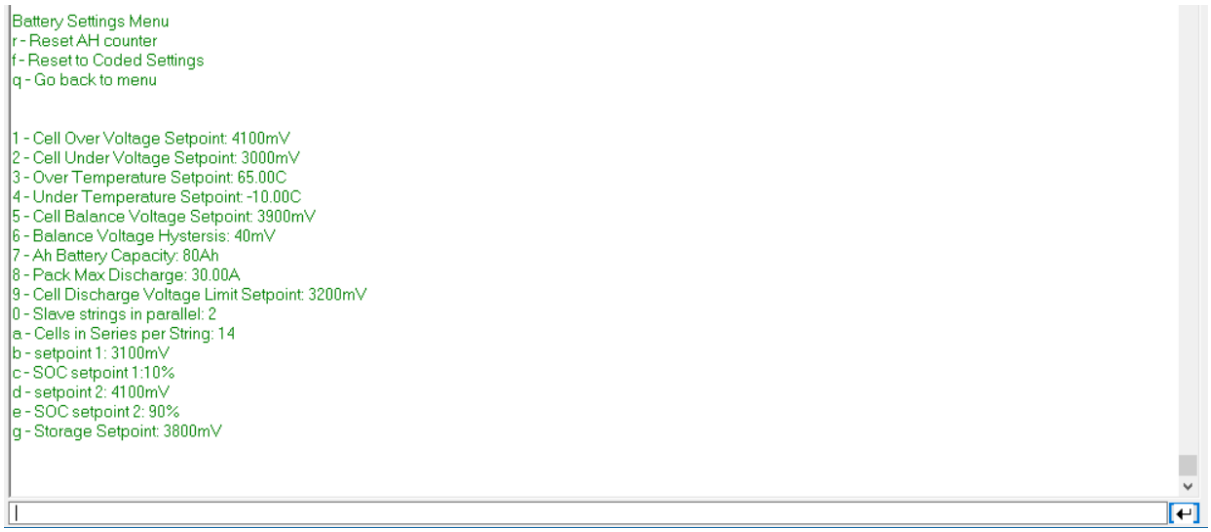
6 – Cells Present Reset = recalibrate the cells to check if they are present

7 – Gauge Debug = cycle the gauge output up and down for testing pwm settings for gauge

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



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)

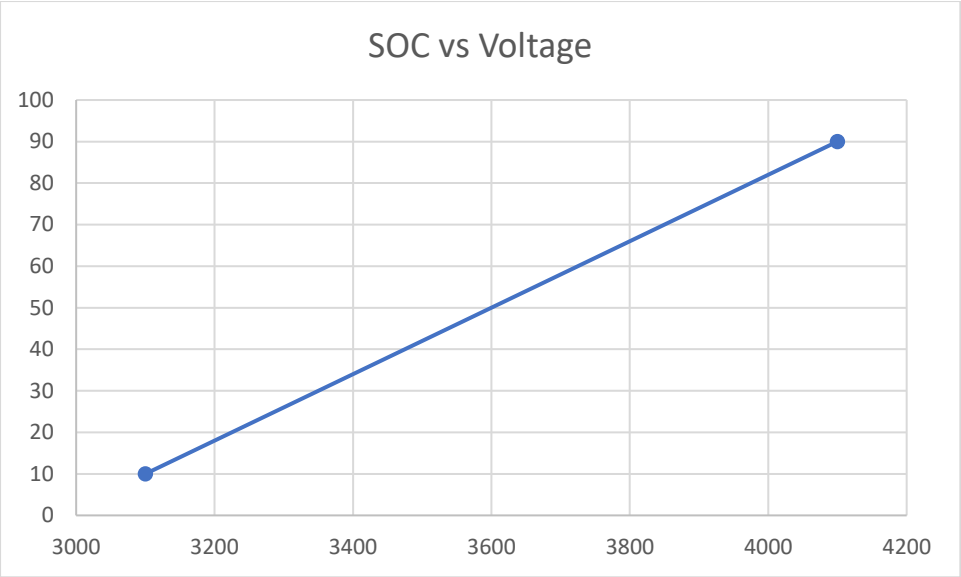
a – cells in series = amount of cells in series (per string if wired in parallel)

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

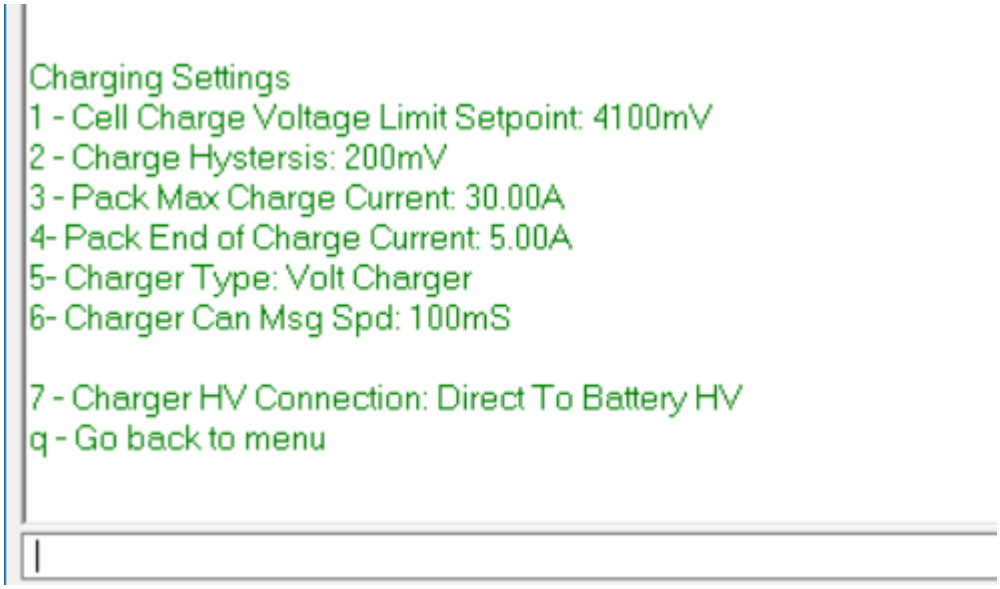
e- SOC setpoint 2 = SOC for corresponding cell voltage



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

‘e’ Charging Settings

Settings modified by sending “ ‘ID’ ‘New Value’ ” via the serial terminal, will refresh values in terminal



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

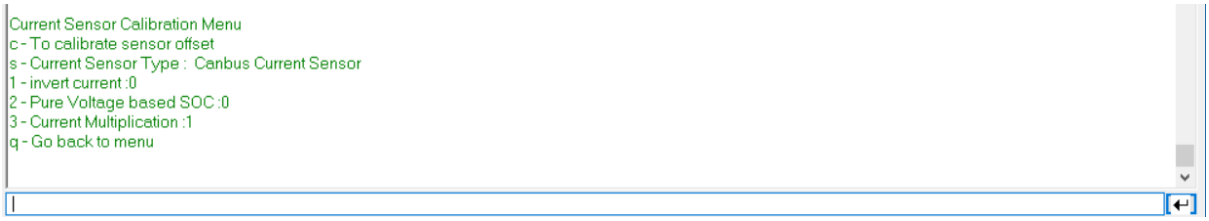
6- Charger Can Msg Spd = Interval target between sent can messages

7 – 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.

‘c’ Current Sensor

Settings modified by sending “ ‘ID’ ‘New Value’ ” via the serial terminal, will refresh values in terminal



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 supported over CAN

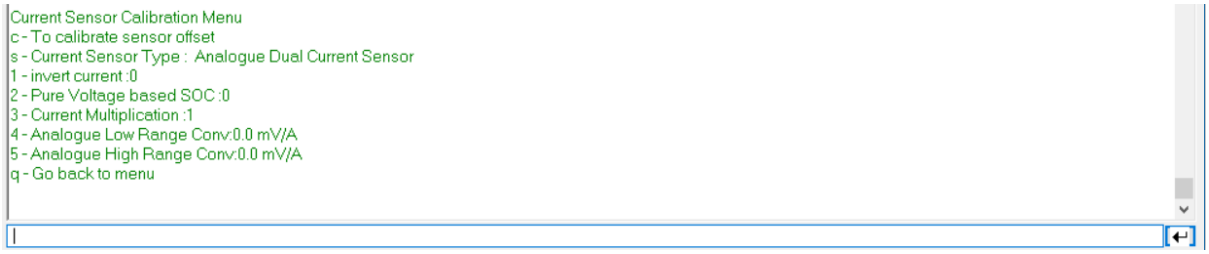
Analogue Single Sensor = single range 5V output sensors

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

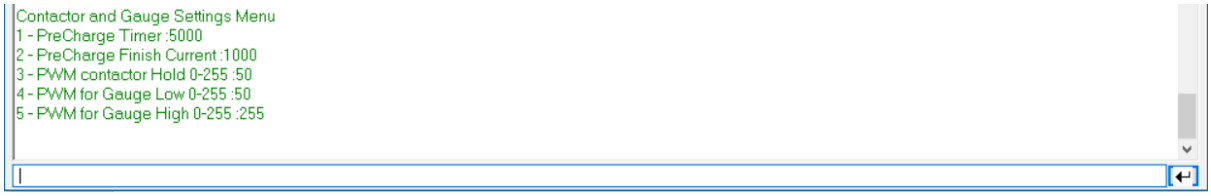


4 – Analogue Low Range Conv = value for conversion mV/A, enter 10x.

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

‘k’ Contactor Control

Settings modified by sending “ ‘ID’ ‘New Value’ ” via the serial terminal, will refresh values in terminal

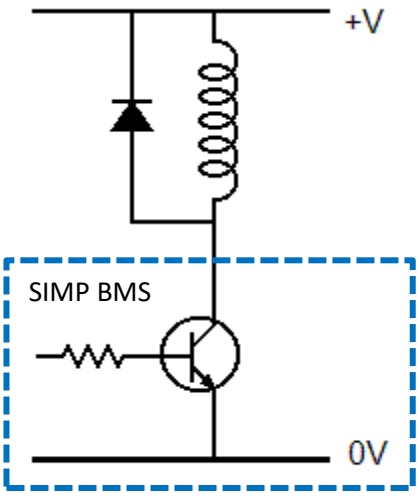


1 – Precharge Timer = mS of minimum precharge time

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.

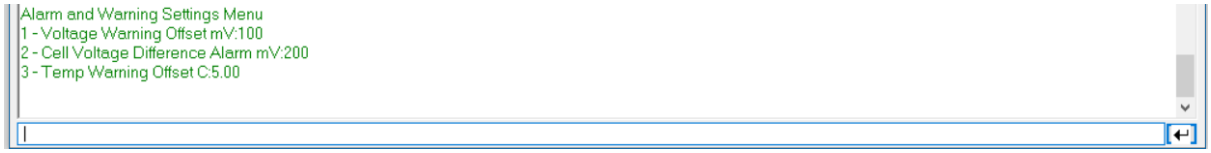


4 – PWM for Gauge Low = PWM duty cycle of Gauge Output to reflect 0% SOC

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

‘a’ Alarms and Warnings Settings Menu

Settings modified by sending “ ‘ID’ ‘New Value’ ” via the serial terminal, will refresh values in terminal



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

CANBUS

SIMP BMS will communicate on the canbus at 500kbp/s

This is used to communicate with the following devices:

- Outlander BMS slaves
- Panasonic 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.

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

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

Victron VE-CAN

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

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		-

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.TEENSY31.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