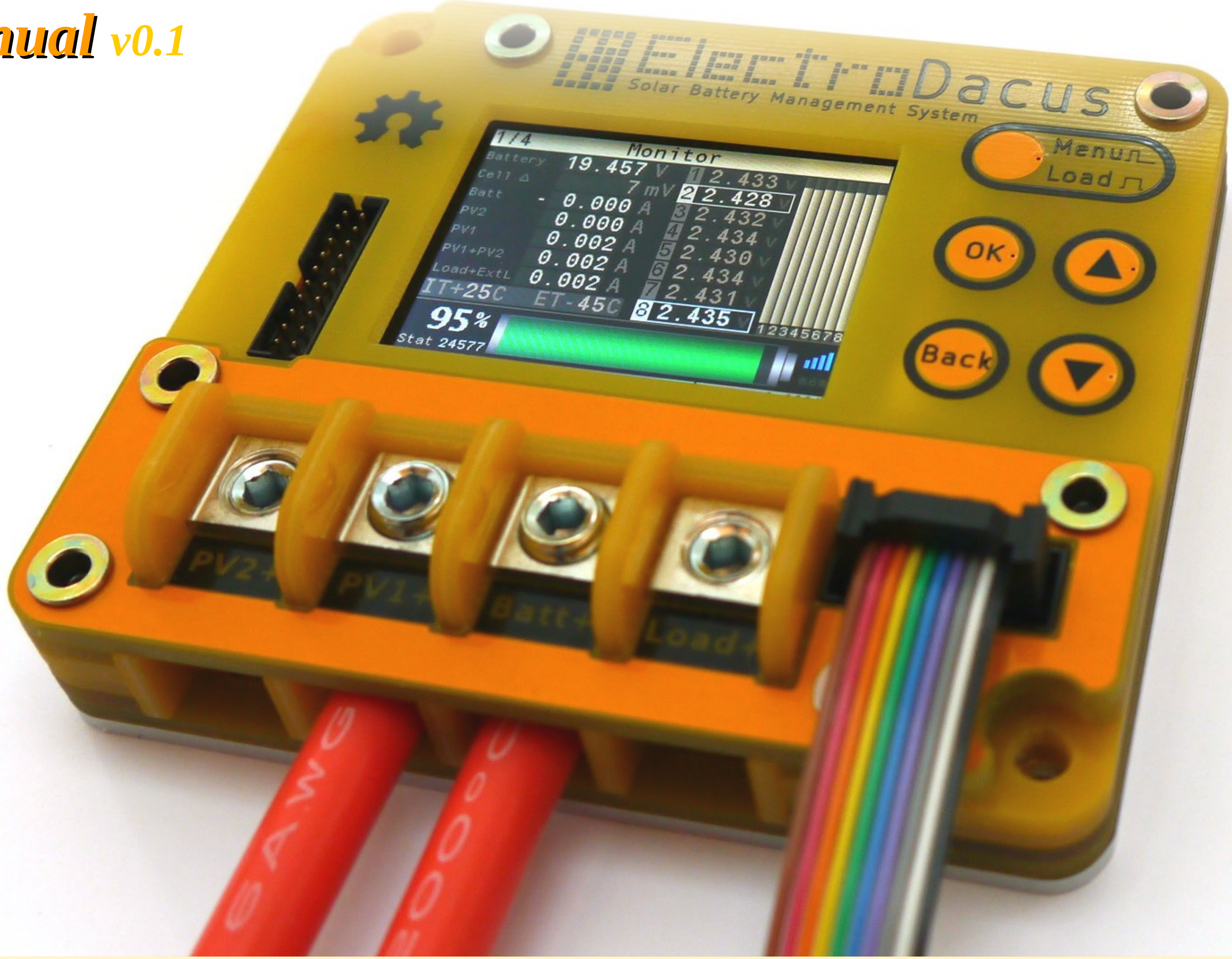
user manual v0.1



SBMS100 / SBMS60

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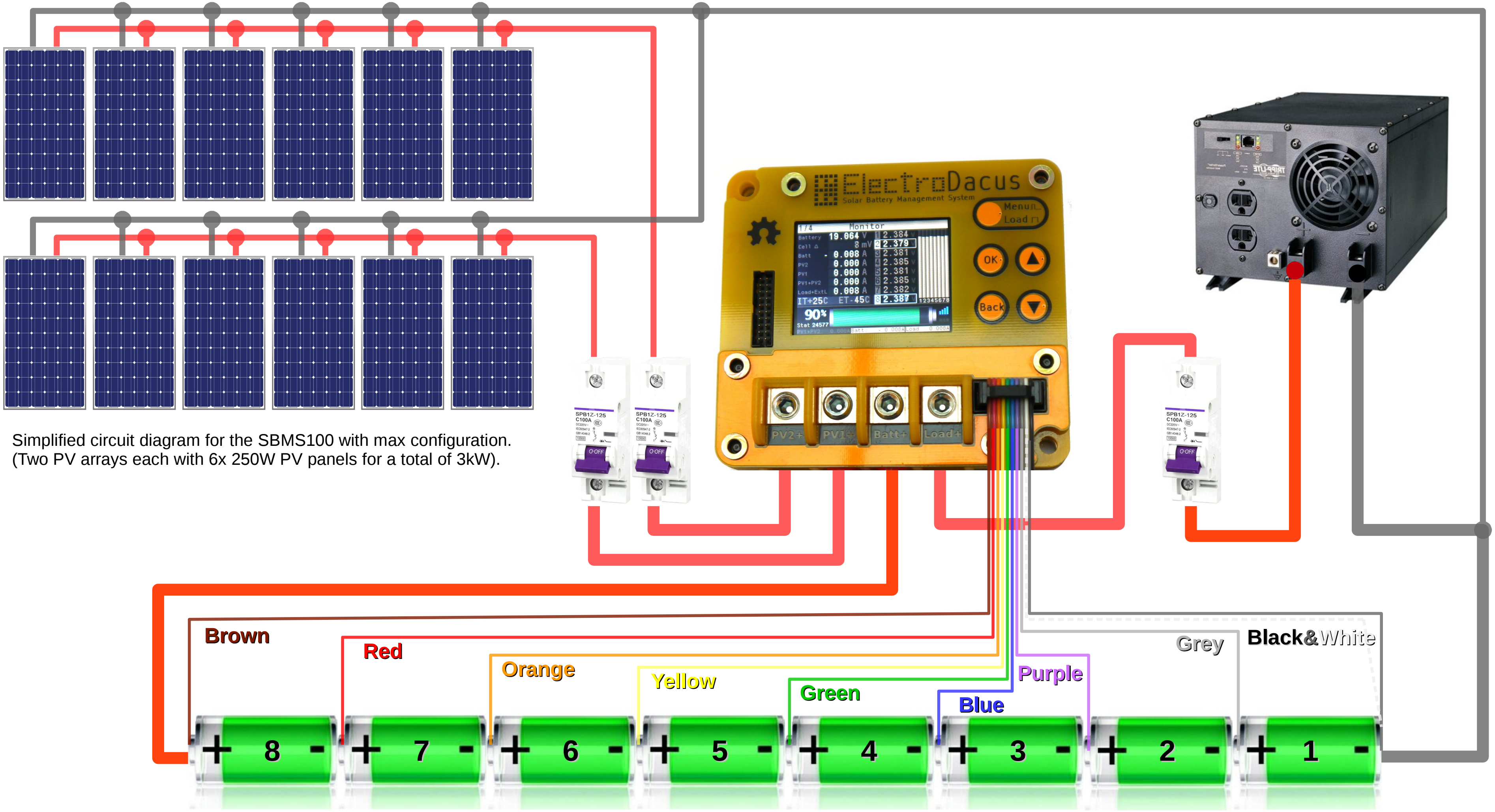


Simplified circuit diagram for the SBMS100 with max configuration.
(Two PV arrays each with 6x 250W PV panels for a total of 3kW).

SBMS100 / SBMS60

Specification

Battery type	any type of Lithium cells and Supercapacitors
Number of cells	3 to 8 cells
Battery voltage limits (min/max)	8V to 32V
Battery/PV recommandation 12V	4 cell LiFePO4 / 32 or 36 cells PV panel
Battery/PV recommandation 24V	8 cell LiFePO4 / 60 cells PV panels
Max PV Open Circuit voltage	47V (mono or polycristaline panels with up to 72 cells)
Dual PV input	PV1+ and PV2+ with separate current measurement and ideal diode
PV1 or PV2 max current	SBMS60 (72A) / SBMS100 (72A)
PV1 + PV2 max current	SBMS60 (72A) / SBMS100 (120A)
Load+ overcurrent limit	SBMS60 (72A) / SBMS100 (120A)
Cell balancing current	max 200mA
Power terminal max wire size / recommended	35mm2 (#2 AWG) / 16mm2 (#6 AWG) 200C silicone
Battery temperature sensor	Thermistor (optional)
20pin connector	Includes Ext IO, 16bit ADC, external current shunt input 500A max
Data logging to internal Flash memory	128Mbit (16Mbyte) 2 minute interval for one year of data
WiFi	WiFi used for remote monitoring SBMS as AP
Display	2.2” Color LCD 320x240
Weight	255g
Dimensions	100mm x 90mm x 26mm
Self consumption	250mW to 700mW (WiFi and Backlight ON)
Max TDP	SBMS100 (22W) / SBMS60 (14W)

1 Install Instructions

Step 1

Connect the Batt+ power connector to battery positive terminal with a max 2m of 16mm2 (#6AWG) flexible copper wire with 200°C silicone insulation (check pageX for more details about the recommended cable).
<u>Make sure this is the first connected and last to be removed.</u>

Step 2

Connect the 10pin monitor and balancing cable. Make sure this is the second one to be connected after Batt+ and never disconnect while anything else is connected except for Batt+. (see details on pageX or Parameter Settings on how this has to be connected to individual cells).

Step 3

Go to Parameter Settings menu and select the type of cell, number of cells and battery capacity then push Store Parameters button to save data to SBMS.
Then remove the 10pin connector and reconnect for the new stored parameters to be accepted.

Step 4

Go to monitoring menu page 3 and push ok button then a small sub menu will be displayed in the top left corner. Use down key to select Load OFF and then push OK to enable this.
You should see CFET and DFET flags change state from highlighted to not being highlighted meaning that load+, PV1 and PV2 are disconnected internally.

Step 5

Connect Load+ using the same type of cable mentioned in step1 to a 125A circuit breaker in OFF position and from there to your load.

Step 6

Connect the PV1 and or PV2 to your PV array to appropriate size circuit breaker in OFF position.
See the pageX for the type of PV panels recommended based on the number of cells and battery voltage.

Step 7

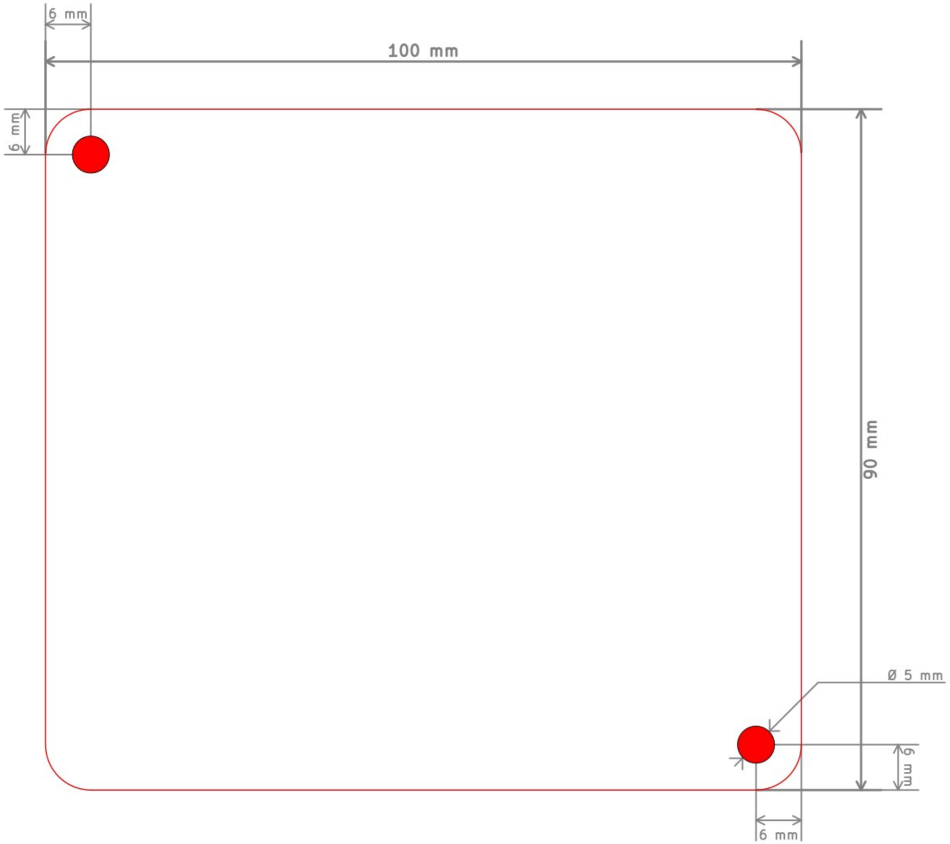
Switch the Load and PV breakers in ON position and then go again to page 3 of the monitoring menu and select Load ON this time. The CFET and DFET should be highlighted and the Load should now have power also the PV1 and PV2 should provide charging current.

Step 8

Check the first page of the Monitoring Menu to see if all works correctly. You are done. Make sure you follow the install procedure in reverse when you want to remove the SBMS. Make sure you never remove the Batt+ or 10pin cell monitoring connector while PV1, PV2 or Load+ is connected.

2 Thermal Management

The SBMS60 and SBMS100 will need to be mounted on an appropriate size heatsink able to dissipate the max TDP (Total Dissipated Power) that is as high as 22W for SBMS100 and 14W for the SBMS60 at full load (charge and discharge at the same time).
The SBMS has two mounting holes as you see in the below drawing you can use to prepare the heatsink.



If size and weight is of great concern a fan can be used to cool the back of the SBMS.
If SBMS is not used with full configuration then a smaller heatsink can be used or even no heatsink at all.

You can use the simple formula below to calculate the TDP.

TDP[W] = I[A] x I[A] x R[Ω]

For example you need to know the R for Load+ and PV1/PV2. Load+ resistance path on SBMS100 is 1mΩ and SBMS60 is 1,5mΩ where PVx input on SBMS100 is 2,4mΩ and on SBMS60 is 3mΩ.
For max configuration on SBMS100 you have:
on Load+ TDP = 100A x 100A x 0,001Ω = 10W
on PVx TDP = 50A x 50A x 0,0024Ω = 6W
So total 10W + 6W + 6W = 22W on full load SBMS100

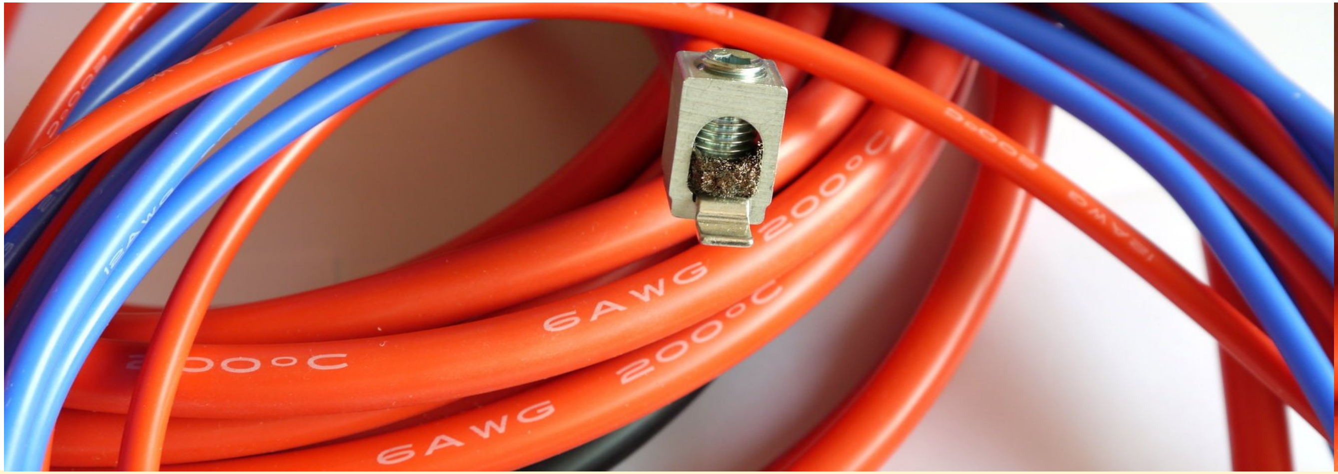
The SBMS100 without any heatsink or fan can at most dissipate 4W to 5W so below is an example with lower power to allow this.
Example SBMS100 with max 40A load and 24A on each PV

on Load+ TDP = 40A x 40A x 0,001Ω = 1,6W
on PVx TDP = 24A x 24A x 0,0024Ω = 1,38W
Total 1,6W + 1,38W + 1,38W = 4,36W

So 40A load and 48A charging is around max supported by SBMS100 without a heatsink.
The SBMS has an internal 10k thermistor installed on the power board and will measure and display the temperature of that board. If temperature exceeds +60°C the charging and discharging will be turned off and only turn on the charging and discharging when temperature drops below +50°C.

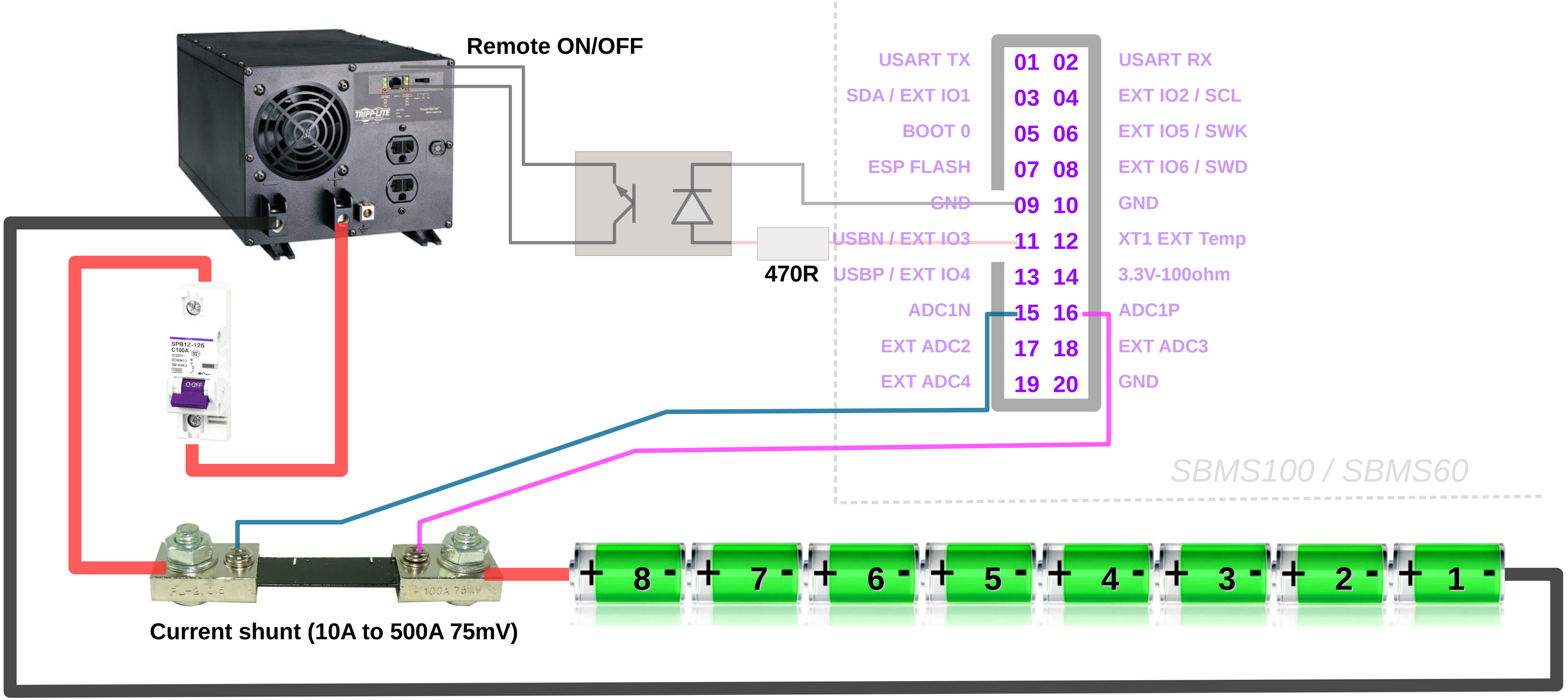
3 Cable Selection

SBMS requires flexible copper cables. *For full load configuration I recommend using high quality 16mm2 (sold as #6 AWG) flexible tinned copper cable with 3200 strands of 0,08mm and 200°C silicone insulation.*
I measured 1,125mΩ/m for this cable and you will want to keep the resistance of cable between battery positive terminal and SBMS Batt+ connector below 2,5 mΩ so around 2m max is recommended for this particular cable.
No fuse or breaker is allowed between Batt+ and battery positive terminal. *Use the same cable between Load+ and a DC circuit breaker.*
The same cable can be also used between PVx and a DC circuit breaker.
The circuit breakers on PVx and Load+ will allow for a way to manually disconnect the circuit and offer redundant overcurrent protection.
When you connect the cable to the SBMS power connectors please do not use to much torque. Since you will probably using a 4mm hex allen key the force pushing on the cable will be multiplied 628 times even with just a 10cm long key.
Excessive force can break the connectors from the PCB.



4 External Load

On both SBMS60 and SBMS100 an External Load can be connected allowing large loads of up to 500A to be connected.



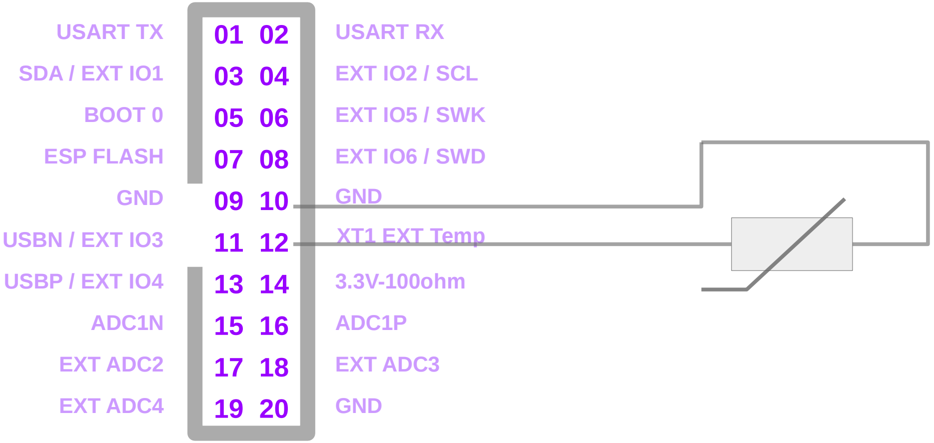
All you need for an external load connection is a 75mV current shunt. Can be 10A up to 500A and the load needs to support remote ON/OFF and optoisolation is required between EXT IO x pin and inverter remote ON/OFF port.
Most large power inverters have a digital remote ON/OFF input signal. The example inverter in the above diagram is the TRIPP-Lite PV2400FC (is a modified sine inverter that I happen to own) that has a 15V signal that if pulled to GND will power the inverter and the amount of current when that 15V signal is pulled to GND is around 13mA so most optoisolators will be able to handle that.
The EXT IO pins supply 3.3V and up to 20mA can be draw from them. With normal optoisilator with infrared LED the voltage drop on that LED is around 1.2 to 1.3V so about 2V will drop on external resistor you need to add for current limiting (in the above example a 470Ohm resistor was used that will limit the LED current to 2V / 470Ohm = 4.25mA more than sufficient for the optoisolator).
An appropriate circuit breaker or fuse is also needed for overcurrent protection.

The current sense output from the current shunt gets connected on pins 15 and 16 on the 20pin connector.
The pin16 (ADC1P) will be on the battery positive side of the current shunt resistor and pin15 (ADC1N) on the side going to your external load presumably a DC to AC power inverter as in the above diagram.

The external load will need to support remote ON/OFF capabilities and that will be connected to one of the 4 EXT IO pins.
The EXT IO pin you decide to use (EXT IO3 used in the above example) will need to be programmed in the EXT IO x submenu as type 2 (Low Voltage Disconnect) or as type 4 if you want the load (inverter) to be disconnected when battery gets below a certain SOC level (user programmable).
Another setting you will need to do is in the ADC (ExtLoad settings) submenu where you will be turning the ExtLoad ON and providing the ExtLoad shunt resistance value in [mΩ] so that SBMS is able to calculate and display current correctly.
Example 1) 500A 75mV shunt will have a resistance value of 75mV / 500A = 0.1500mΩ.
Example 2) 75mV / 200A = 0.3750mΩ
Example 3) 75mV / 10A = 7.5000mΩ.

5 Battery Temperature

It is possible to add external temperature sensor but in most cases not needed and so is optional.
All Lithium batteries require temperature above freezing (> +5°C) during charging otherwise they will be damaged.
Best way when possible is to have the battery inside the living space where temperature is ideal for battery operation.
The SBMS is designed to accept a thermistor as temperature sensor connected between pin 12 and one of the GND pins (like pin 10 on the 20 pins connector).



The SBMS is calibrated for a particular 10kOhm thermistor made by Murata NCP21XV103J03RA (this same thermistor type is used internally to measure the power board temperature).
The low and high temperature limits for this external temperature sensor can be set from the Advanced Parameter Setting submenu parameter 29 and 30.
Value is a 12bit binary number and if you use the recommended thermistor the 0°C=3144b,+5°C=3000b, +50°C=1338b, +55°C=1182b, +60°C=1040b.
You can see the actual temperature in Monitoring menu and the raw binary value in Diagnostic menu.

6 The 20pin connector

There is a 20pin connector on the left side of the LCD on SBMS and it is used for different functionality described below.

USART TX	01	02	USART RX
SDA / EXT IO1	03	04	EXT IO2 / SCL
BOOT 0	05	06	EXT IO5 / SWK
ESP FLASH	07	08	EXT IO6 / SWD
GND	09	10	GND
USBN / EXT IO3	11	12	XT1 EXT Temp
USBP / EXT IO4	13	14	3.3V-100ohm
ADC1N	15	16	ADC1P
EXT ADC2	17	18	EXT ADC3
EXT ADC4	19	20	GND

01 & 02 *UART TX and RX pins are used for the WiFi module so if you want to use the USART for something else then WiFi will be disabled (voltage levels 0 to 3.3V).*
03 & 04 *This two pins are reserved as I2C port for a future addon to SBMS (Digital MPPT heat controller) and maybe some other future addons.*
05 *Boot 0 connected to pin* **14** *will put the STM32F373 microcontroller in programing mode.*
06 & 08 *This pins have dual function as programmable EXT IO5 and IO6 (0 to 3.3V 20mA max) and as SWK and SWD programing interface for the STM32F373.*
05 *ESP Flash connected to GND will put the ESP8266 WiFi module in programing mode.*
11 & 13 *This pins have dual function as programmable EXT IO3 and IO4 (0 to 3.3V 20mA max) and as USB or CAN port not used in the software as of now. USB can probably be used in firmware upload mode for the STM32F373 (not tested).*
14 *This is a 3.3V supply from the internal DC-DC converter trough a 100ohm series resistor mostly to be used to pull up BOOT 0 pin to enter programing mode.*

15 & 16 *External current shunt input with a 0 to 90mV input range see page 11 for more details.*
17, 18 & 19 *Ext ADC inputs 2,3,4 with analog input range of 0 to 1.8V that will be logged in the internal SBMS memory at 2 minute intervals but not used in any automation with the latest firmware version. This are good if you want to log some other analog signals.*