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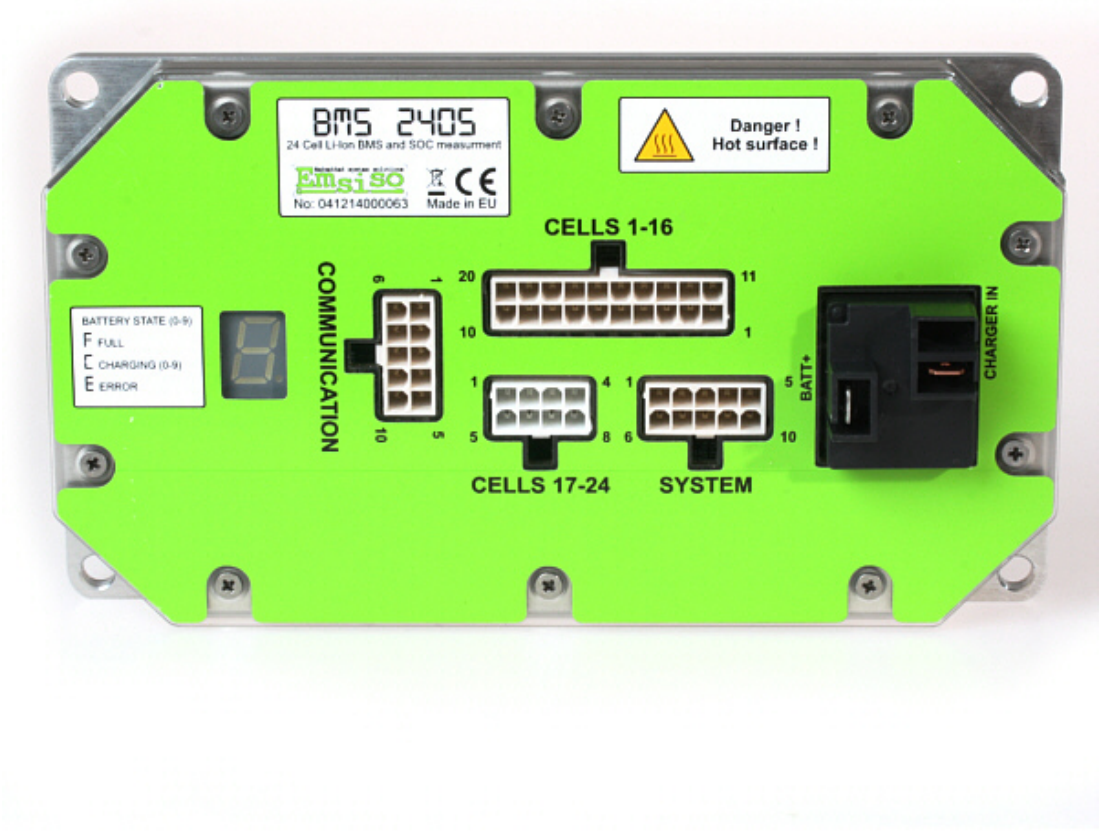

BMS2405

User manual

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1 Introduction

Battery balancer is an advanced battery management solution:

- for Li based battery cell,
- that is measuring and monitoring battery cells during the complete charge and discharge cycle,
- that protect cells against under-voltage or over-voltage,
- that is balancing during the whole duration of the charging cycle,
- that is capable of measuring charge in/out from battery (state of charge – SOC). For SOC measuring is required current sensor.
- That is capable calculating State of health of cells

For complete understanding and usage of BMS use also datasheet and other resources available at Faktor.de web sites.

2 BMS system connector

On BMS front side there is 10 pin connector that is signed as “SYSTEM”.

Pin No.	Pin Name	Voltage range[V]	Max. current[A]
1	Ignition input	15…90	-
2	Ignition output	15…90	5A
3	Charger detect input	15…90 This is only for special chargers. Look at the chapter detect input.	-
4	Charge relay output	12	0.3A
5	Ground(connected to –BAT1)	-	-
6	Analog output	Look at the chapter analog output.	0.02A
7	Optional input	12…90	-
	Optional output	12V or ignition input voltage	0.25A
8	Current sensor input	0…5	-
9	Ground of current sensor	-	-
10	Current sensor supply	5	0.3A

2.1 ON / OFF control

Power ON is triggered with:

- Ignition input = 1 (Voltage between 15 and 90V) or
- Charger is connected

Power OFF is triggered when:

- Ignition = 0 . (Voltage 0)
  - If charger is connected then BMS **stays turned on**.
- Charger is disconnected
  - when BMS doesn't recognize charger for 30 s
- Minimum cell voltage is below value of parameter Shut down voltage .
  - If BMS on power up detects that voltage cell is too low, then BMS will be turned off after 10 s. In this 10 s period user has an option to delay turning off for 10 min with sending any valid command to it. This give user opportunity to check which cell is too low .

2.2 Ignition output

Ignition output is used for connecting controller, DC/DC converter or other smaller loads.
Ignition output logic:

- Ignition output is always disabled, if BMS is turned off.
- Ignition output is enabled if:
  - Ignition input = 1 and
  - If parameter Turn on controller during charging is 1 during charging .

Maximum allowed current on ignition output is 5A. Voltage on ignition output is always equal to ignition input.

2.3 Analog output

Analog output range:

- For BMS HW version 1.2 [5V to battery voltage] and
- For BMS HW **version above 1.2 [0-10V]**

Analog output is active only if ignition output is enabled. Analog output shows value of SOC.

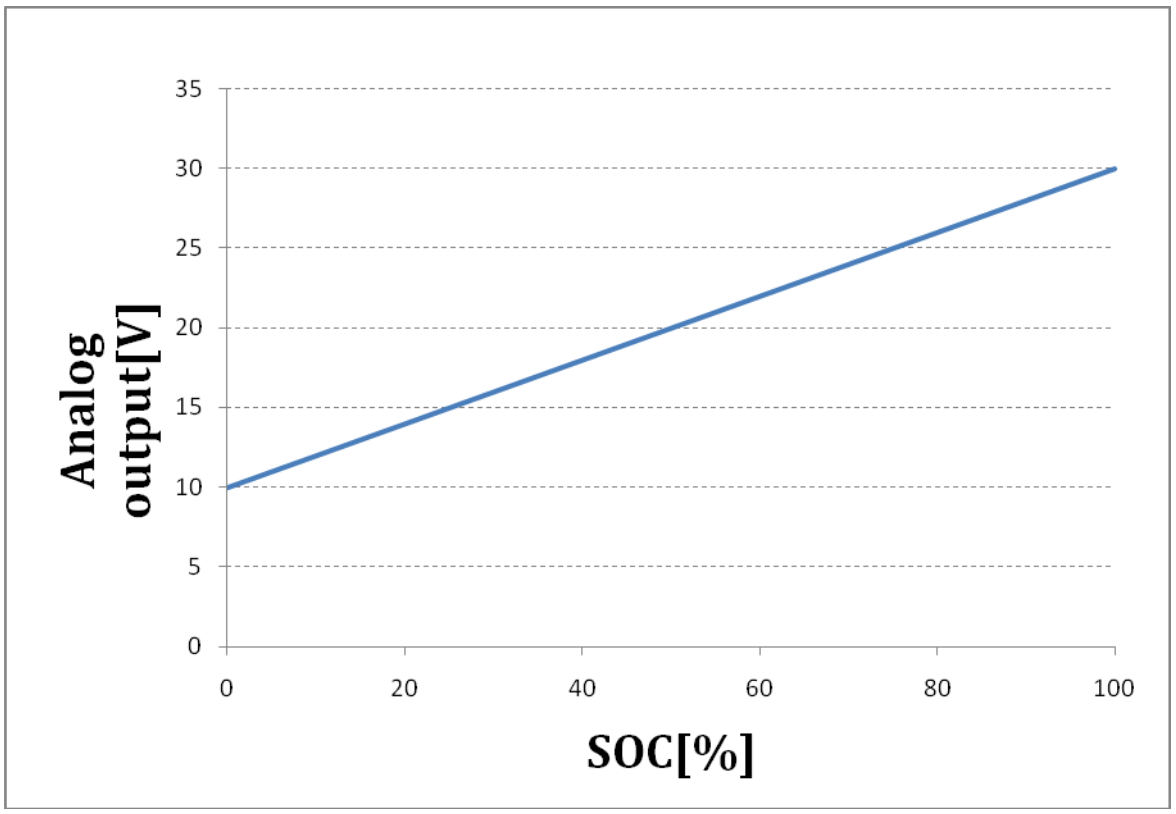


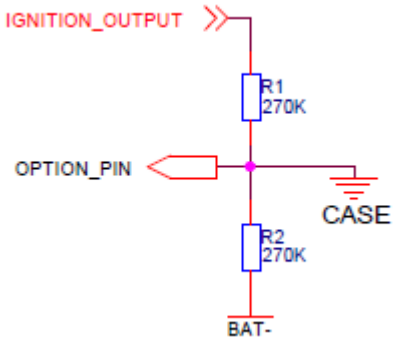
Figure 1: Analog output vs. SOC

In example above, parameter Analog voltage at S0C=0 is set to 10V. Parameter Analog voltage at SOC=100 is set to 30V.

2.4 Optional input / output

Pin 7 can be used configured in three different modes:

- Output
  - Output set when SOC > 20. Output voltage is selected with jumper on PSB between 12V or BAT+.
  - Output reset when SOC < 20
- Input (function is not implemented)
- Analog input
  - If optional pin is configured as analog input, then pin is used to measure voltage between case and BAT±. Pin must be connected to case of BMS or electric car (look picture below). If voltage is not on middle of ignition output voltage, then BMS goes to error mode.



2.5 Charge relay output

Pin 4 can be used for connecting external charging relay.

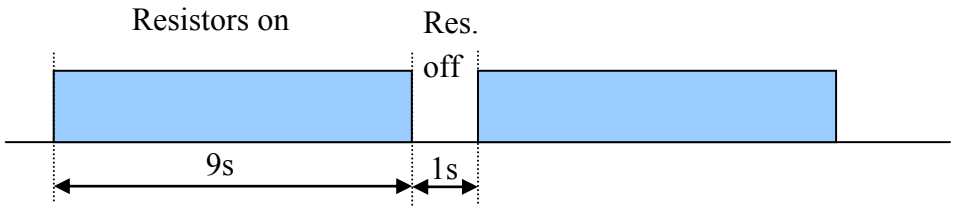
2.6 Charge detect input

Pin 3 can be used only for charger that has special output to signal charging on or off.

2.7 Charge relay

Charge relay allows charging currents up to 30A. Connect charger minus directly to -Bat1, not to the BMS. Charger plus connect to charger relay pin CHARGER IN.

2.8 Battery balancing algorithm



Battery balancer functionality:

- Balancing algorithm is enabled during charging cycle
- Balancing algorithm is enabled when battery is full.

- Each battery cell resistor is enabled if cell voltage is higher than minimum voltage for voltage that is presented with parameter Cell voltage difference
- Balancing current is 500mA.

3 Cells connections

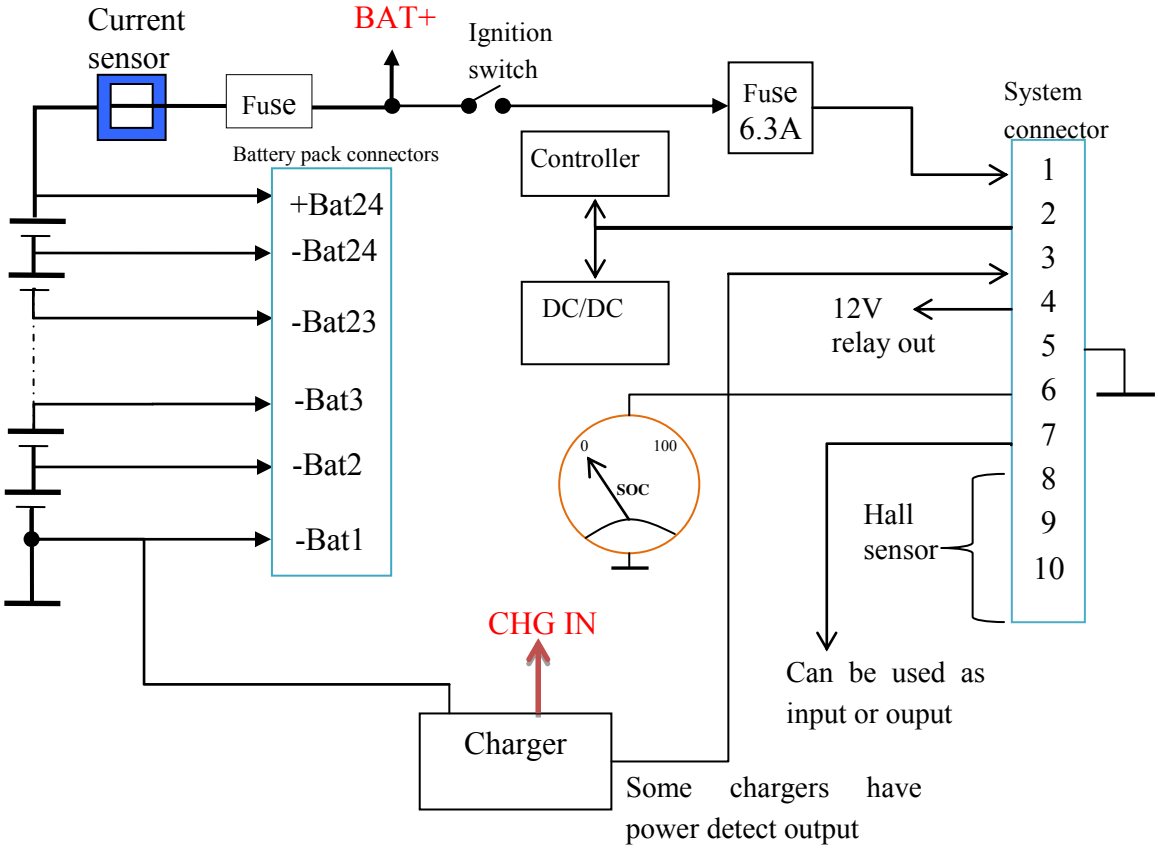


Figure 2: 24 cells schematic

3.1 Connection order for complete BMS

Connect in next order:

- Connect 20 pins cell connector,
- Connect 8 pins cell connector,
- Connect system connector,
- Connect BAT+ and
- Connect charger
- Connect serial cable if you want to communicate with device (PROGRAM connector)
- Connect control cable if you want connect other devices to BMS (BMS sending status to PC or eDrive controller) (CTRL. connector)

When disconnect the connectors use reverse order.

3.2 Cells configuration

Always first connect these two connectors to BMS.

Battery pack configuration	20 pin connector - below see which CONNECTOR PIN connect to which CELL POLE																				8 pin connector							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	1	2	3	4	5	6	7	8
6 cells	NC	NC	NC	NC	NC	NC	NC	*1	*2	*3	NC	NC	NC	+6	-6	-5	-4	-3	-2	-1	NC	NC	NC	NC	NC	NC	NC	NC
7 cells	+7	+7	+7	NC	NC	NC	NC	*1	*2	*3	+7	-7	-6	-5	-5	-5	-4	-3	-2	-1	NC	NC	NC	NC	NC	NC	NC	NC
8 cells	+8	+8	+8	NC	NC	NC	NC	*1	*2	*3	+8	-8	-7	-6	-6	-5	-4	-3	-2	-1	NC	NC	NC	NC	NC	NC	NC	NC
9 cells	+9	+9	+9	NC	NC	NC	NC	*1	*2	*3	+9	-9	-8	-7	-6	-5	-4	-3	-2	-1	NC	NC	NC	NC	NC	NC	NC	NC
10 cells	+10	+10	+10	NC	NC	NC	NC	*1	*2	*3	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	NC	NC	NC	NC	NC	NC	NC	NC
11 cells	-11	+11	+11	NC	NC	NC	NC	*1	*2	*3	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	NC	NC	NC	NC	NC	NC	NC	NC
12 cells	-11	-12	+12	NC	NC	NC	NC	*1	*2	*3	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	NC	NC	NC	NC	NC	NC	NC	NC
13 cells	-11	-11	-11	-12	-13	+13	+13	*1	*2	*3	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	NC	NC	NC	NC	NC	NC	+13	+13
14 cells	-11	-12	-12	-13	-14	+14	+14	*1	*2	*3	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	NC	NC	NC	NC	NC	NC	+14	+14
15 cells	-11	-12	-13	-14	-15	+15	+15	*1	*2	*3	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	NC	NC	NC	NC	NC	NC	+15	+15
16 cells	-11	-12	-13	-14	-15	-16	+16	*1	*2	*3	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	NC	NC	NC	NC	NC	NC	+16	+16
17 cells	-11	-12	-13	-14	-15	-16	-17	*1	*2	*3	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	NC	NC	NC	NC	NC	NC	+17	+17
18 cells	-11	-12	-13	-14	-15	-16	-17	*1	*2	*3	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	NC	NC	NC	NC	NC	NC	+18	-18
19 cells	-11	-12	-13	-14	-15	-16	-17	*1	*2	*3	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	+19	+19	+19	+19	-19	-18	-17	-17
20 cells	-11	-12	-13	-14	-15	-16	-17	*1	*2	*3	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	+20	+20	+20	+20	-20	-19	-18	-18
21 cells	-11	-12	-13	-14	-15	-16	-17	*1	*2	*3	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	+21	+21	+21	+21	-21	-20	-19	-18
22 cells	-11	-12	-13	-14	-15	-16	-17	*1	*2	*3	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	+22	+22	+22	-22	-21	-20	-19	-18
23 cells	-11	-12	-13	-14	-15	-16	-17	*1	*2	*3	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	+23	+23	-23	-22	-21	-20	-19	-18
24 cells	-11	-12	-13	-14	-15	-16	-17	*1	*2	*3	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	+24	-24	-23	-22	-21	-20	-19	-18

Notes:				
	*1	GND for NTC (not connected if NTC not used)	-1	Negative (minus) terminal of cell number 1
	*2	Temp sensor 2 (not connected if not used)	+7	Positive (plus) terminal of cell number 7
	*3	Temp sensor 1 (not connected if not used)	NC	- Not Connected

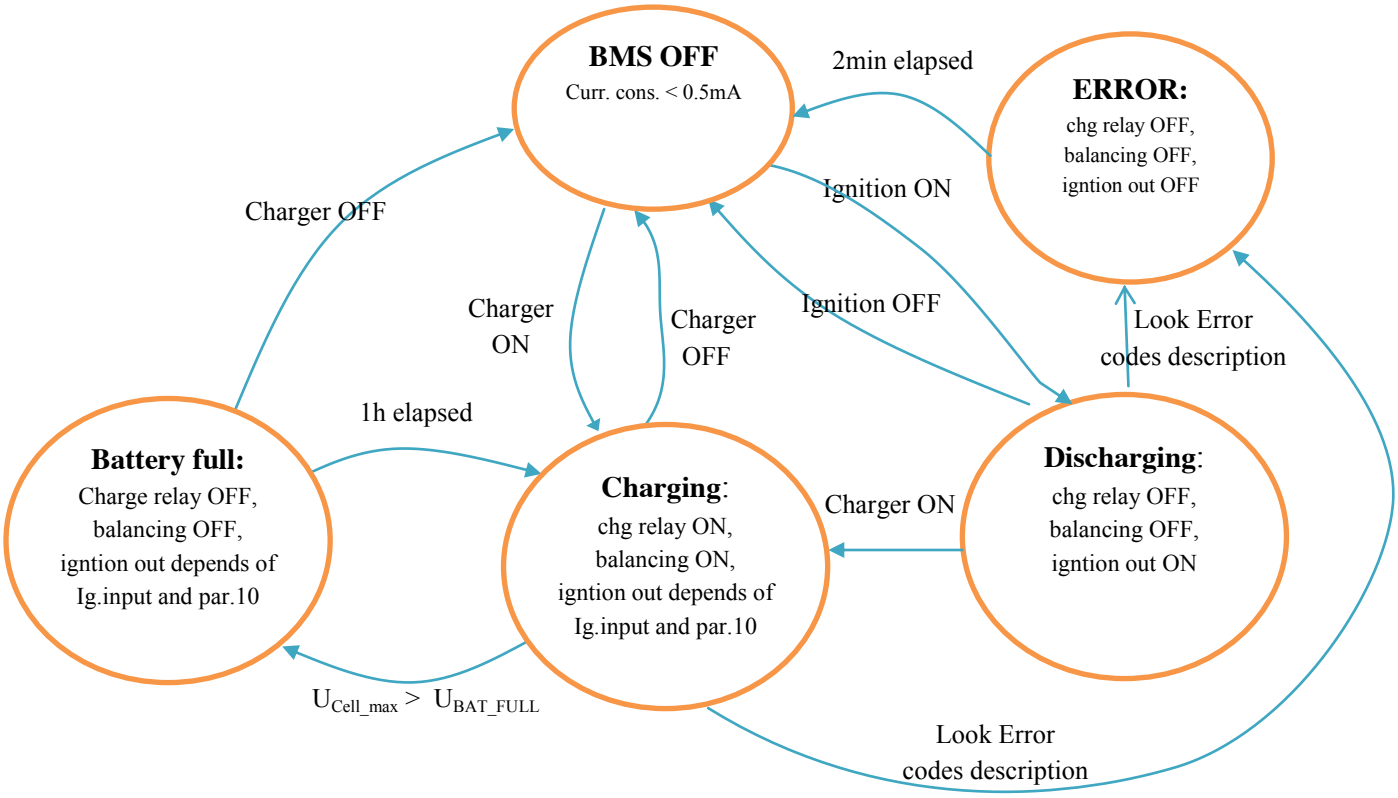
4 Procedure after BMS connection

1. Connect the BMS to PC with provided serial cable.
2. Open device configuration tool or other terminal (hyperterminal, teraterm..)
3. Ignition to 1.
4. By default cell number is 24. If you use different cell number, the BMS goes into error. In 10s after power up you have to send any valid command so that BMS stays alive. Otherwise the BMS is turned off, because of cell undervoltage.
5. Set number of cells (parameter Number_of_cells) and set date (command SET DATE).
6. Restart (ignition to 0 and back to 1) the BMS.
7. If cells are correct connected and all cells have voltage higher as 2.5(default Shut_down_voltage) then BMS shows number between 0..9. If the BMS is still in error, then send command BMS_INFO (inside 10s after power up). In first line, the BMS return description of error. Possible errors:
   - One of cell is not connected or bad connected
   - Cell voltage bellows 2.5V(check this cell also with V-meter)
   - HW internal error(contact the salesmen)
8. If current sensor is not used, skip next point.
9. Enable current sensor (parameter Current_sensor_enable) and set current sensitivity (look chapter Current sensitivity). Restart the BMS.
10. If the BMS goes into error state, check reason with command BMS INFO:
    - Current sensor is wrong connected or
    - Voltage at zero current is not correct – parameter Sensor voltage at zero current (could be in case that you use different sensor as recommended HASS 50-S).
11. Compare cells voltages with values measured of BMS INFO (command)
    - Set date (command SET_DATE).
      - Example: set_date day,month,year,hour,min,seconds
        - set_date 8,12,2011,21,35,54
    - Connect charger (SOC value will be wrong at this point, until battery is not filled to full, then BMS will set SOC = 100)

      Command BMS_INFO return values of next counters:
      - Number of charging cycles,
        - Counter is incremented when max. cell voltage is above value of par. Battery full voltage
      - Number of deep discharge cycles,

- Counter is incremented when min. cell voltage is bellow value of par. Shut Down voltage and BMS is also turned off
- Total battery charge out and
- Charge out from last charging

5 BMS states



5.1 Discharge

- This state will occur when charger is disconnected and user starts ignition
  - Ignition output is enabled, analog output shows SOC.
- Depending the events that occurs later in this state, BMS reacts differently:
  - Ignition to 0
    - BMS turns off
  - Charger is connected
    - BMS goes to charge state
  - Error occurred
    - BMS goes to error state

5.2 Charging

- This state will occur when charger is connected
  - Balancing algorithm is enabled;
  - Ignition output is enabled if parameter Turn_on_controller_during_charging is 1.
- Depending the events that occurs later in this state, BMS reacts differently:
  - Charger is disconnected
    - BMS turns off
  - Battery is full
    - BMS is still balancing, but charger relay is disconnected. After 1 hour charger relay is once more connected.
  - Error occurred
    - BMS goes to error state
  - Cells temperatures higher as parameter `Range of ext.temp. - max.value` or bellow parameter `Range of ext.temp. - min.value`
    - Charging is disabled until temperature of external sensors is out of range
    - When external temp. sensors are not connected is charging disabled until minimum BMS internal temperature is bellow `Range of ext.temp. - min.value`

5.3 Error codes

- If error code occurs, then BMS will be turned off after 2min. This give user opportunity to check what went wrong BMS_INFO.
  - Current offset
    - Wrong value of parameter Current sensor offset
    - Wrong use of hall sensor
  - Wrong current sensor orientation
    - Change sensor orientation
  - Cell under voltage
    - Turn off BMS and then connect charger
  - Communication with balancers
    - If this error occurs during charging, then the reason can be noise of charger. In this case on charger output connect splitting ferrite (farnell code: 74271222). Charger outputs (plus and minus) have to passed through ferrite.
  - Charger detect input
    - Charger detect input is active but no voltage detect on charger input

5.4 LCD

On power up all segments are showing for 1second.

LCD shows	Explanation
0-9	SOC value (9: SOC value between 90-100)
C ↔(0-9)	C:charging 0-9: SOC value
F ↔(0-9)	F:battery full 0-9: balancing voltage (difference between maximum cell and minimum cell voltage subtracted for value of parameter Cell voltage difference)
.	Battery is full and BMS doesn't recognize charger any more(Ucell < (Ucharger +0.6)). BMS goes into sleep mode. BMS turns off when charger is disconnected.
E	E: error
t	Character 't' blinking. Inhibit charging until cells temperatures are out of range.

Dot on 7-segment LCD is blinking if date is not set.

6 Montage of current sensor

Current sensor has to be montage so that it returns positive value in case of charging battery (current flows into battery). We recommended to us HASS 50-S which is included in supply. Use only current sensors with next properties:

- Supply voltage = 5V and
- Output voltage is not higher as 3.3V.

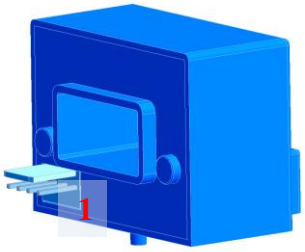


Figure 3: Current sensor HASS 50-S

Current sensor is connected to 10 pin system connector. Pin 1 of current sensor HASS 50-S is not connected.

Tabela 1:Current sensor HASS 50-S pinout

Current sensor	System connector
2 (output)	8
3 (GND)	9
4 (5V)	10

This current sensor is able to measure up to 200A DC current. Increase accuracy of current measurement with more loops of wire through current sensor.

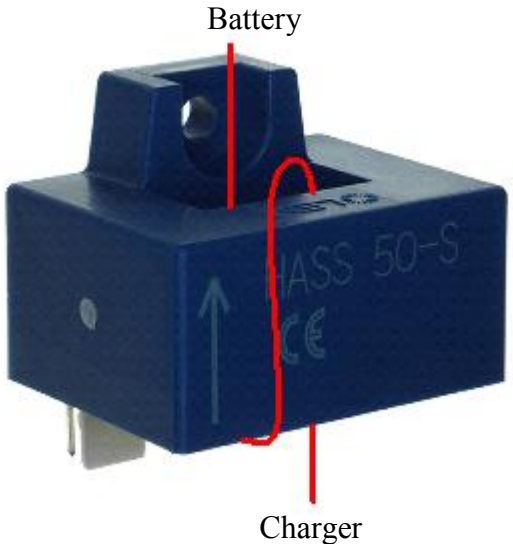


Figure 4: Two loop of wire through current sensor

Max. DC current[A]	Number of turns
200	1
100	2
50 (only if charger current is lower as 15A)	3

For HASS-50S is needed Molex connector 22-01-2045 and Molex pins 08-50-0032.

6.1 Current sensitivity

Parameter `Current sensor sensitivity` depends of number of turns:

`Current sensor sensitivity[uV/A] = 12500uV/A *` number of turns

7 State of health

State of health (SOH) is relationship between measured (actual) capacity and nominal capacity. An SOH of 100% means that the actual capacity matches nominal capacity (parameter Battery capacity). Read value of SOH with command BMS_INFO or read parameter SOH.

Actual capacity is stored in SOC logs when:

- SOC jump occurs or
- U_{min_cell} is bellow shutdown voltage

If parameter Use SOH by SOC calculation is enabled then value of SOH is used for battery capacity calculation:

$$Q_B = Q_{Nom} * SOH / 100$$

;wher

Q_B [Ah] = battery capacity used in SOC measurement

Q_{Nom}[Ah] = parameter Battery capacity

SOH[%] = value is 100 % if parameter Use SOH by SOC calculation is disabled

7.1 SOH calculation

SOH calculation is always executed on power up and is stored as parameter SOH.

- SOH calculation from logs when U_{min_cell} was bellow shutdown voltage (at least 3 logs are needed):

$$SOH[\%] = Q_{meas} / Q_{Nom} * 100$$

;wher

Q_{meas} = used charge until U_{min_cell} was above shutdown voltage

Q_{Nom} = parameter Battery capacity

- SOH calculation from SOC jumps (at least 3 logs are needed):

SOH[%] = Q_{meas}/ Q_{Nom} * 100 + SOC value after jump

;wher
Q_{meas} = used charge until SOC jump was occurred
Q_{Nom} = parameter Battery capacity

7.2 SOH to default value

To set back SOH value back to default is needed:

- Erase SOC history logs with command Erase SOC history
- Set parameter SOH to 100%

8 LOGS

Log type	Maximum number of logs	
History logs	300	
SOC history logs	10	
Status logs(optional)	HW 1.2	3000
	HW above 1.2	6000

History and SOC history logs are stored into EEPROM. Status logs are stored into flash. When no more space for log is, then oldest log is replaced with new log.

8.1 History logs

Log is stored before BMS is shutting down. Logs can be read over configuration serial interface. Command HISTORY START starts printing history logs from newest to oldest log. To stop printing send HISTORY STOP. Command HISTORY DES print history log syntax:

***Date*,U_{TOTAL},U_{MIN_VOLT},$U_{INX\_MIN\_VOLT}$,U_{MAX_VOLT},$U_{INX\_MAX\_VOLT}$,*T*,*SOC*,Q_{BAT}**

Table 2: History log syntax

Label	Description	Unit
Date	Day.motnh.year hour:minute:seconds	
U_{TOTAL}	Total battery voltage	mV
U_{MIN_VOLT},	Minimum cell voltage	mV
$U_{INX\_MIN\_VOLT}$	Index of minimum cell voltage	-
U_{MAX_VOLT}	Maximum cell voltage	mV
$U_{INX\_MAX\_VOLT}$	Index of maximum cell voltage	-
Tc	Temperature of external sensor. The BMS return -273 if temperature sensor is not found.	C
SOC	Battery capacity in percent. This value is set to 0 when U_{MIN_VOLT} is lower as value of parameter Shut down voltage. SOC is equal 100 when battery is full. SOC is decreased to value of parameter Decrease SOC if min. cell voltage is lower as value of parameter Decrease SOC because min. cell is low. **SOC is always 100% if current sensor is not present.**	%
Q_{BAT}	Actual battery capacity [0: battery full, 40000: battery is total empty (for 40Ah battery)]. This counter is reset battery is full.	mAh

8.2 SOC history

Log is stored when:

- SOC jumps to value of parameter *Decrease SOC* if min. cell voltage is lower as value of parameter *Decrease SOC when min. cell is lower as* and actually SOC value if higher as value of parameter *Decrease SOC*.
- U_{min_cell} is bellow shutdown voltage

Command SOC_HISTORY sends all SOC history logs.
SOC history syntax: ***Date,Q_B,Type***

Table 3: SOC history

Label	Description	Unit
Date	Date when jump SOC jump is occurred. (Day.motnh.year hour:minute:seconds)	
Q_B	Used charge until SOC jump.	mAh
Type	**S:** log is stored when U_{min_cell} was bellow shutdown voltage **J:** log is stored at SOC jump	

8.3 Status logs (optional)

For status logs must be flash soldered, otherwise the BMS return error on all 3 status log commands. Log is stored each second if BMS is in discharge mode. If charger is connected is streaming interval defined by parameter Data streaming interval. Command *LOG_START* starts printing logs from newest to oldest log. Stop printing with LOG_STOP. Command LOG_STOP sends log syntax.

U_{TOTAL},U_{MIN_VOLT},$U_{INX\_MIN\_VOLT}$,U_{MAX_VOLT},$U_{INX\_MAX\_VOLT}$,I_B,T_B, T_C, SOC,Q_{BAT},Power,Uc[0], Uc[1]…Uc[Number of cells]

Table 4:Status logs syntax

Label	Description	Unit
U_{TOTAL}	Total battery voltage	mV
U_{MIN_VOLT},	Minimum cell voltage	mV
$U_{INX\_MIN\_VOLT}$	Index of minimum cell voltage	-
U_{MAX_VOLT}	Maximum cell voltage	mV
$U_{INX\_MAX\_VOLT}$	Index of maximum cell voltage	-
I_B	Battery current. Positive value when current flows into battery.	A
T_B	Temperature of BMS.	C
T_C	Look table history log	C
SOC		%
Q_{BAT}		mAh
Power	Look table Contol data	%
Uc[0]	Cell 1 voltage	mV
Uc[1]	Cell 2 voltage	mV
..	..	..
Uc [Number of cells - 1]	Voltage of top cell in the stack	mV

9 Serial interfaces

The BMS has two serial interfaces: control and configuration interface. Over control interface the device sends data to PC or the controller. Configuration interface is used for adjusted of parameter, streaming data and read logs.

9.1 Control interface

Control interface is galvanic isolated RS232 interface. Over control interface the BMS sends data to PC or the controller. The data are sent each second. The BMS does not accept any command over this interface. Control interface serial settings:

- Baud Rate: 115200
- Parity: None
- Data Bits: 8
- Stop Bits: 1
- Flow Control: None

DATA SYNTAX

- String when ignition goes to 1 = **BMS2405\r\n**
- Each line is terminated with \r\n:

U_{TOTAL},U_{MIN_VOLT},$U_{INX\_MIN\_VOLT}$,U_{MAX_VOLT},$U_{INX\_MAX\_VOLT}$,I_{BAT},T,SOC,CHG,Q_{BAT}

Table 5:Control data syntax

Label	Description	Unit
U_{TOTAL}	Total battery voltage	mV
U_{MIN_VOLT},	Minimum cell voltage	mV
$U_{INX\_MIN\_VOLT}$	Index of minimum cell voltage	-
U_{MAX_VOLT}	Maximum cell voltage	mV
$U_{INX\_MAX\_VOLT}$	Index of maximum cell voltage	-
I_{BAT}	Battery current. Positive value when current flows into battery.	mA
T	Temperature	C
SOC	Look table History log	%
CHG	Charge present 1..charge is connected 0..charger is not connected (always send 0 if par. Turn on controller during charging is set to 2)	-
Q_{BAT}	Actual battery capacity [0: battery full, 40000: battery is total empty (for 40Ah battery)]. This counter is reset when U_{MAX_VOLT} is higher as parameter Battery full voltage.	mAh
Propose Power	Propose power is calculated from parameters Ucell power decreasing and Ucell power decreasing gain Propose is decreased also if temperature of external sensor is out of range(parameter Temp.range min value and Temp. range-max value)	%

9.2 Propose Power

Propose power is calculated from minimum cell voltage of battery stack and external temperature. If minimum cell voltage below value of parameter Ucell power decreasing then the BMS starts decreasing of power. Also if temperature is out of range the BMS decreasing propose power.

In example are used next settings of parameters (temperatures are in range):

- `Ucell min[mV] power decreasing = 2900`
- `Power decreasing gain[%/V] = 90`

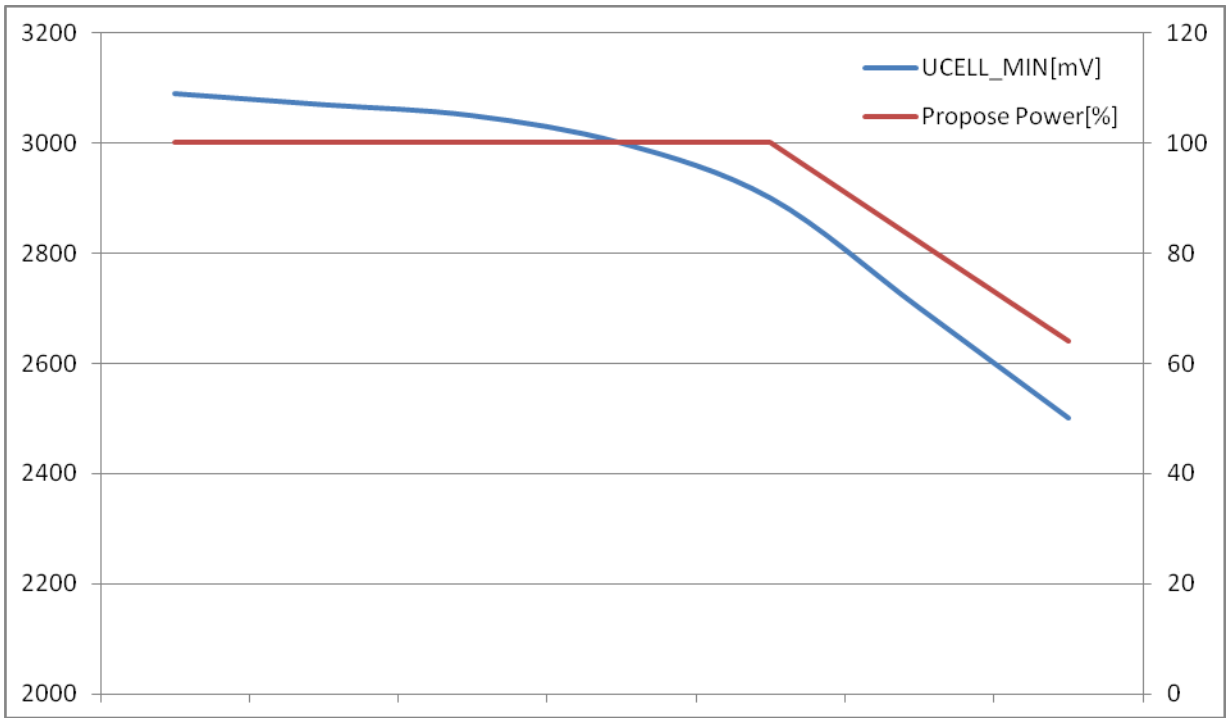


Figure 5: Power decreasing because cell voltage

9.3 Configuration (program) interface

Configuration interface is used for setting of parameters, reading of logs, monitoring of battery and FW upgrade. Use next settings of serial port on your terminal program (HyperTerminal, TeraTerm...):

- Baud Rate: 115200
- Parity: None
- Data Bits: 8
- Stop Bits: 1
- Flow Control: None

The device accepts text commands, which are terminated with CR (hex code 0D). Optional LF characters are ignored.

The device accepts one command at time. All responses begins with “OK,” or “ERROR,”

The device does not distinguish between lower and uppercase characters. All input data is converted to lowercase characters before command parsing.

10 Parameters

Parameters are stored in EEPROM. All parameters are 32 bit numbers (integer). Set parameter with command *par_set* and get parameter value with command *par_get*.

10.1 List of parameters

Print table below with command *par_print*.

Table 6: List of parameters

Par. ID	Parameter Name	Parameter description	Def. value	Min. value	Max. value
0	Number of cells	Number of connected cells	24	6	24
1	Battery full voltage[mV]	When max. cell reach this voltage then BMS goes to battery full state	3600	3000	4000
2	Range of ext.temp. - min.value	If external temperature in range between min. and max. temperature then propose power = 100%	5	-20	30
3	Range of ext.temp. - max.value	If external temperature in range between min. and max. temperature then propose power = 100%	60	0	80
4	Power decr. because ext.temp[%/C]	Decrease proposes power is temperature is out of range.	5	0	100
5	Charge detect	Enable / disable	0	0	1

	input active	charger input. Only for chargers with charger detect output.			
6	Charge detect input inverted	Inverted / non-inverted charger input. Only for chargers with charger detect output.	0	0	1
7	Current sensor enable	Enable / disable current sensor	0	0	1
8	Current sensor sensitivity[uV/A]	Current sensor sensitivity	12500	0	100000
9	Sensor voltage at zero current[mV]	Current sensor voltage at zero current	2500	0	5000
10	Turn on controller during charging	0…the controller is turned on only if ignition is on 1…the controller is always turned on during charging(drive is not possible for the controllers) 2...the controller is always turned on during charging and also drive is possible for the controller	0	0	2
11	Shut down voltage[mV]	If min. cell voltage is under this value then BMS is turned off	2500	2000	3200
12	Data streaming interval[s]	Interval for streaming to PC and store data into flash. For values bigger as 10 accept only values that are divided by 10.	2	1	600
13	Temperature limit while balancing[C]	This parameter is set by the manufacturer	50	30	70
14	Cell voltage difference[mV]	If cell voltage is bigger of min. cell voltage for value of this parameter, then enable	5	5	500

		discharge resistor on this cell. Used only in charging mode.			
15	Battery capacity[mAh]	Battery capacity.	40000	100	100000
16	Decrease SOC when min. cell is lower as	Decrease SOC to value of par. 17 if min. cell voltage is lower as this value and SOC value is higher as par. 17	2850	2400	3600
17	Decrease SOC to	Look description of parameter 16.	15	0	100
18	Analog display voltage[mV](SOC=0)	Analog display voltage when SOC is zero.	0	0	90000
19	Analog display voltage[mV] (SOC=100)	Analog display voltage when SOC is 100%.	0	0	90000
20	Ucell min[mV] power decreasing	When Ucell_min is lower as this value then BMS starts decreasing of propose power.	3000	2000	3600
21	Power decreasing gain[%/V]	Power decreasing gain[%/V]	100	0	300
22	Cell internal resistance[mΩ]	Cell internal resistance. $U_{CELL} = U_{MEASURED} - R_{CELL} * I_B$	3	0	100
23	Use SOH by SOC calculation	Enable / disable use of state of battery health by SOC calculation	1	0	1
24	State of health(SOH) value[%]	State of health according to nominal capacity	100	0	100
25	Option pin definition	0-used as output 1-input 2-analog input	0	0	2