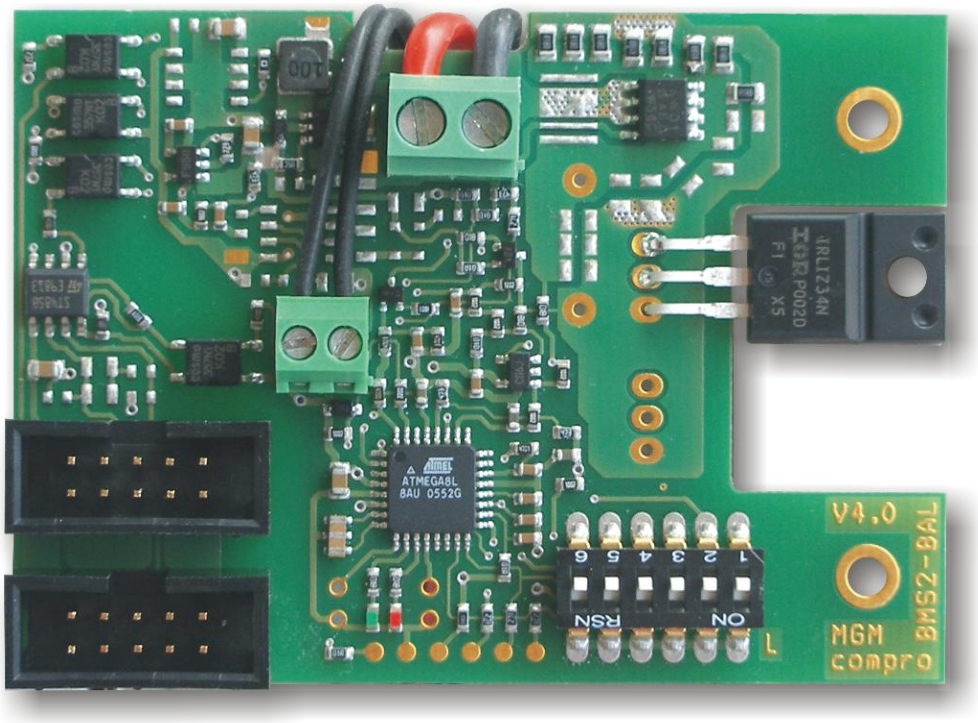
Balancing BMS type 2, version 5.x



Battery Management System

Operating Manual

Table of content:

Note:

Content…….. all items are available quickly by ***CTRL+ left mouse button***.

blue underlined ….. all like this marking texts in manual quickly jump, by ***CTRL+ left mouse button,*** to corresponding content (cross reference).

In the Manual in „**pdf**“ format on these marking texts standard cursor changed to hand symbol ( ) . In this case only click to ***left mouse button,*** (without ***CTRL***), caused jump to corresponding content (cross reference).

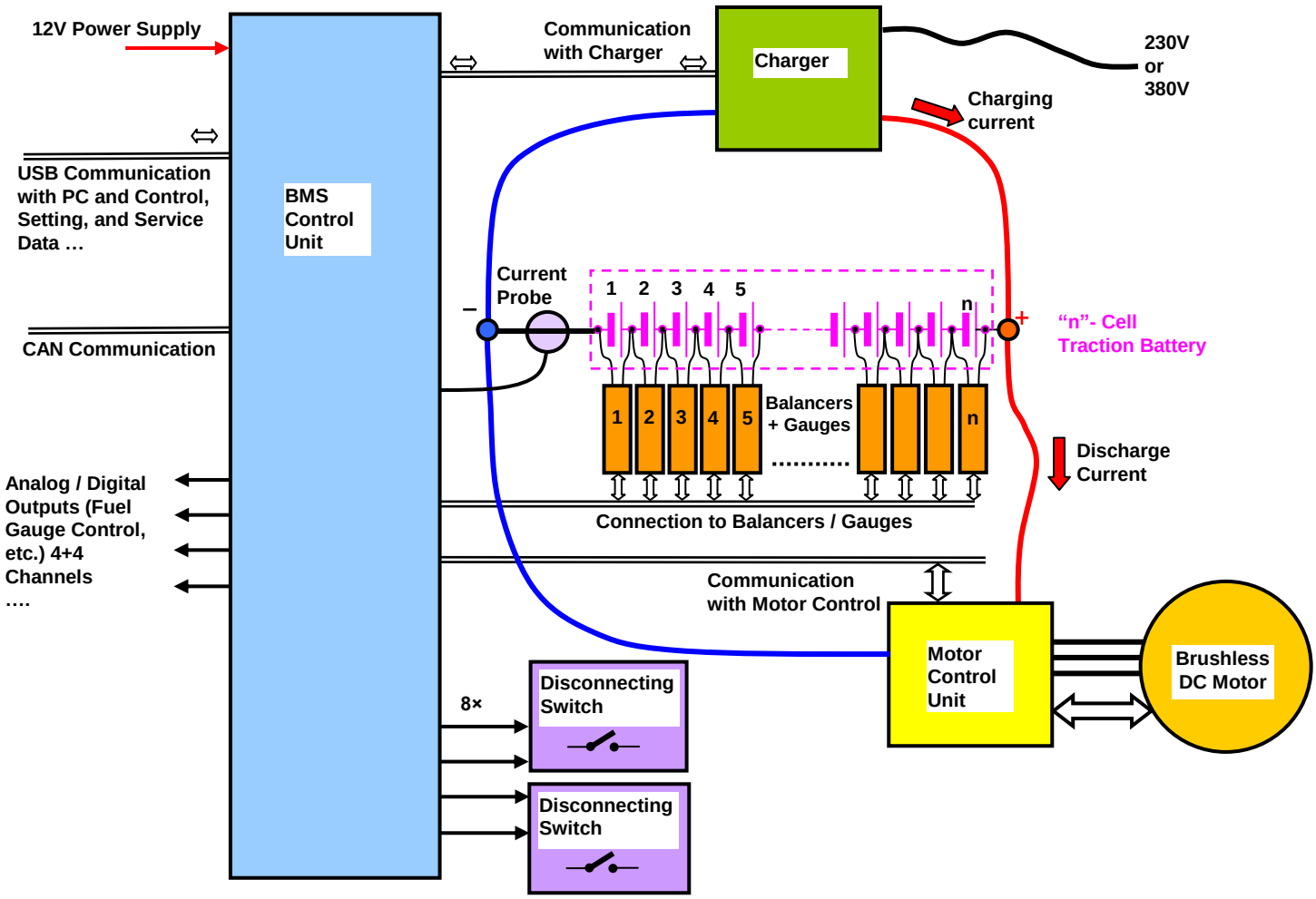
Concept behind the real-time balancing BMS Type 2

CHARGING:
Unlike “equilibrium chargers” that charge and balance each individual battery cell separately, this system uses a single charger for the entire voltage / current, each cell having its own intelligent balancing circuit.

If we consider a 100Ah traction battery with a cell capacity variance of ±2.5% charging at 100A for 1 hour, a balancing current of up to 5A is needed, provided balancing is enabled throughout the duration of the charge. Leaving balancing for the end of the charge cycle requires either a higher balancing current or a longer charge time – both of which are disadvantageous. A 200Ah battery, for example, would need either a 10A balancing current when charging at 200A, or a 2-hour charge time charging at 100A. In other words, it is possible to charge a battery of up to 800Ah overnight (within 8 hours) at a current of 100A, with a balancing current of only ~5A.
Units for balancing current 10A and units for balancing 12V battery are also available.

The worst-case scenario for energy balancing, i.e. in which there is the most power (heat) to dissipate, is a system consisting of one large-capacity cell paired with a group of smaller-capacity cells. For example, 1 large-capacity LiPol cell and 32 smaller-capacity cells with a total voltage of 125V would require dissipating ~660W (= 5A × ~4V × 33 cells). Although this is quite a large amount, a circuit balancing the cells individually at 5A would only require each cell to dissipate ~20W, which is then feasible.

This leads to the concept of individual real-time balancers balancing throughout the duration of the charge, thus enabling a BMS for any number (*n)* of cells connected in series by ***n*** balancers to one control unit.
The **BMS Type 2** is just that—individual stand-alone balancing/gauging units (balancing at currents by the used unit), are connected to the individual cells of a battery and controlled by the central Control Unit.
Control unit, except for balancer control, enables also measurement of voltage, currents, safe disconnecting, communication with charger, communication with controller(s) of motor(s), communication with operation personnel (user).



Best results can be achieved if the control unit of a BMS can actually communicate with not only the charger, but also the motor controller, allowing for smoothest operation possible even in marginal situations, e.g. – if there is insufficient time for balancing, if it is necessary to limit the charging current, if the battery is heavily discharged, if it is necessary to limit motor performance, etc. When such communication is not provided, nothing else remains in such extreme situations but for the BMS to disconnect the charger or motor, which is certainly less than ideal. The disconnecting switch should be employed only in the most critical of situations, i.e. the charger is acting abnormally, the motor is on fire, etc.

Besides controlling the balancers, the Control Unit of the **BMS Type 2** handles such communication with the charger, motor controller, and other services, as well as transmitting read-outs of voltage, heat, current, and disconnection safety status for display.

DISCHARGING:

The individual balancing units are also used for measuring during battery discharges. Similarly as while charging, the Control Unit monitors the state of each individual cell (temperature, voltage, internal resistance, total current, status in relation to other cells, etc.). If user-defined limits are exceeded, the load is disconnected. The Unit can also provide advance warnings of approaching conditions, such as a near-fully discharge, or the like.

BASIC INFORMATION:

The **BMS Type 2** is compatible with all current types of traction cells (Pb, A123, LiPol, LiFe, etc.), except NiXX cells, i.e. all rechargeable cells with an operating current between 1.8V and 5.0 Volts, respectively 9 ÷ 18V for “12V” versions, depend on the balancing / measuring unit.
Specific ranges of voltages and balancing currents depends on the type of balancing / measuring unit.

The BMS Control Unit is able to communicate with a PC for parameter settings, transfer of actual or saved values, etc. via USB. A module galvanic separated from the USBCOM 4i BMS connection is required.

BMS control unit may indicate the operating status of the monitored variables and 4 digital open collector output for currents up to 1A and 12V (on-board voltage), i.e, control LEDs or 12V bulbs and 3 analog outputs 0 ÷ 3.3V or 0 ÷ 10V and one analog or frequency output for control analog meters on the dashboard.
If this information is transmitted to the cooperating system using the CAN or RS-485 bus (i.e, also indicate the other display) - remain digital and analog outputs available and can be used for other purposes.

BMS control unit stores the long-term measurement data for later analysis, it can transfer to a connected PC via USB. It can draw attention to the damaged or defective cells and help prevent accidents completely destroyed by the type of article and unmoved to the finish.

Basic modules and Technical data of the BMS-2 system.

Control Unit BMS-2 MASTER V5.x

(for balancers BMS-2-xxx BAL-V4.xx)

Master unit firmware, as well as firmware of balancing modules, **is possible update** via internet, **USBCOM_4i BMS** module and a USB port on your PC by program „***Controller 2***“. This provides a significant advantage of the possibility to have current software (i.e. ease of repairs and modifications, access to new features and capabilities BMS, ...).

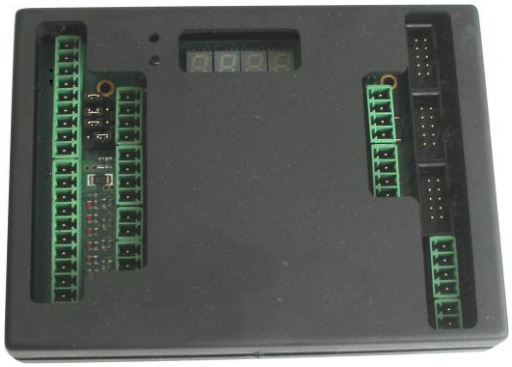
Driving unit settings as well as data reading is realized by program „***Controller 2***“, see bellow.

Driving unit provide communication with balancing/measuring modules (BMS-2-xxx BAL V4.0). Communicate with other systems via CAN bus or RS-485 bus. This unit also control power contactors for correct connection of the power or disconnect power for critical situation (emergency switch-off battery).
This unit monitored state of each cell during charging and discharging, as well as in special situation as for example charging fully charged battery during recuperation (run down from hill) – activate signal recuperation-off for motor controller. Etc.

Unit is the same for all types of balancing modules version 4.xx, only firmware is changed.

For all type of balancing/measuring units are used the same driving unit – differences are only in used firmware. Necessary specify, in order, which FW you need (depend on your application and/or substandard demands). When you need, for your application, another functions or features, than is not available in standard FW, is possible modify standard FW by your requested functions.

Dimension (include box)		130 × 95 × 25 mm
Weight (include box)		~140 gr
Supply voltage		+12 V
Unit current consumption:		
	by the operating state and number of connected balancing units	
Unit current consumption in sleep mode		cca 5 mA
Number of joinable balancing modules (max.)		64 + 64 + 64
Disconnecting Switches outputs	8 ×	max. 8 A / 12 V
Indication outputs digital (open collector)	4 ×	max.1A / 12 V
Indication outputs digital / analog ***)**	3 ×	3.3V / 10V
Indication outputs digital / analog / frequency ***)**	1 ×	3.3V / 10V
Output impedance for 2, 3 and 4 outputs		470Ω for 3.3V / 100Ω for 10V
Output impedance for 1 output		100Ω for 3.3V analog / 100Ω for 10V fervency

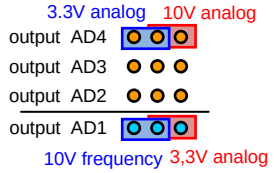


***) Note 1:** : Output indication signals (connector A, pins 6 ÷ 9) are in the default version analog (connection of analog displays). For outputs AD2, 3 and 4 it is possible to set by jumpers U3 the output voltage (either 0 up to 3.3V or 0 up to 10V) by jumper between connectors "A“ and „C“.
For output AD1 it is possible to switch between analog output (0 up to 3.3V) or a frequency output (internal converter U/f with output signal 10V). It is possible to change all of these outputs 1 ÷ 4 (or just some of them) upon a request to digital (ON-OFF or PWM)

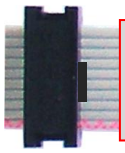
By default, pins for AD1 ÷ AD4 port select (U3 area), are assembled to enable choice of the output and customer may set the type of output by himself/herself. It is possible to set (by soldering) the type of output upon request already in the manufacture

BMS-2 MASTER 192 Control Unit
(ver. 3.3, removed from box, max. configuration)

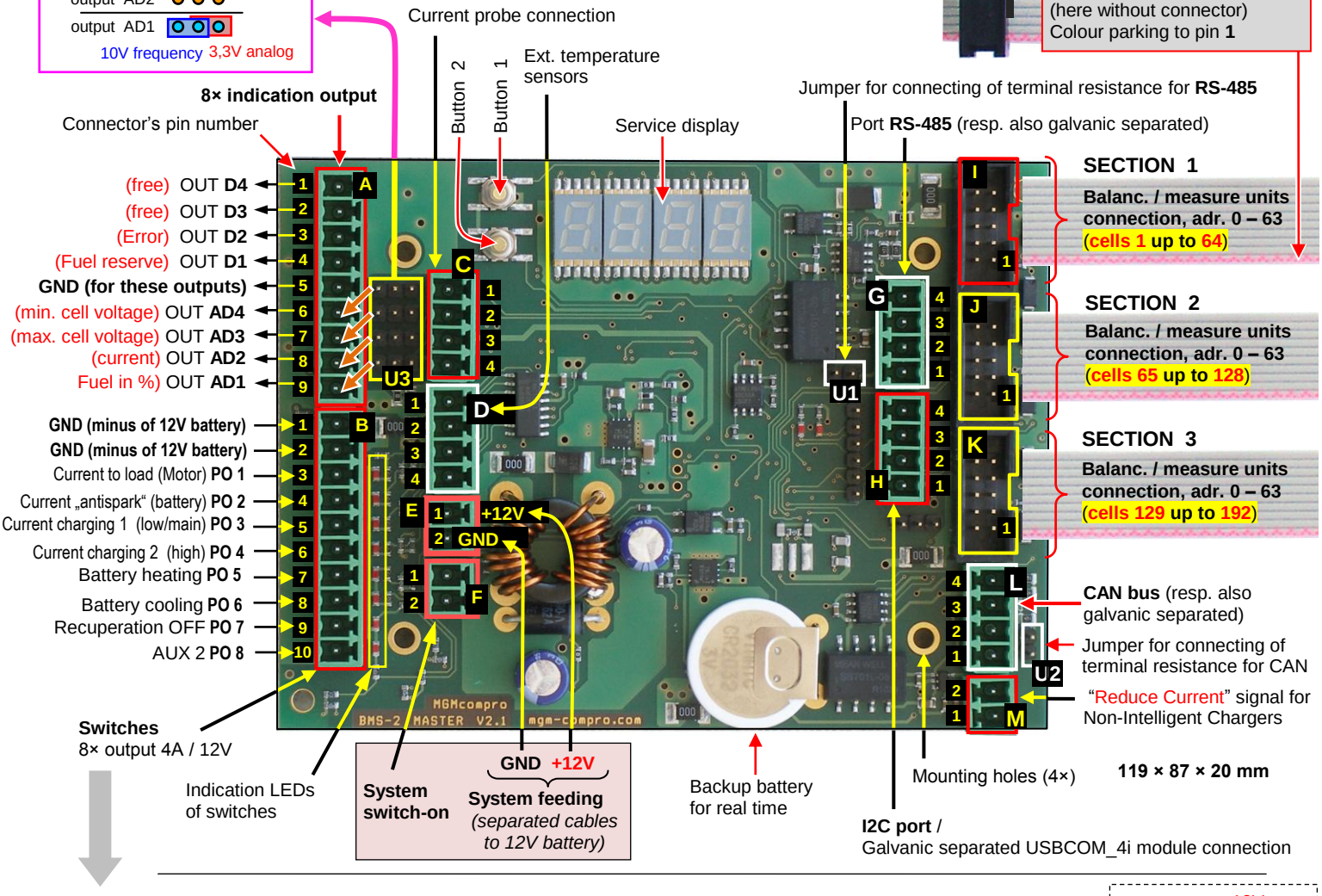
Jumpers for indication outputs specification:



The default is to select the type of output AD1 - AD4 mounted pins (field U3) and the customer himself can determine the output type by jumper. On request, the output type can be "hard connected" (by soldering) according to customer requirements already in production.



Connection flat cable with correct orientation
(here without connector)
Colour parking to pin **1**

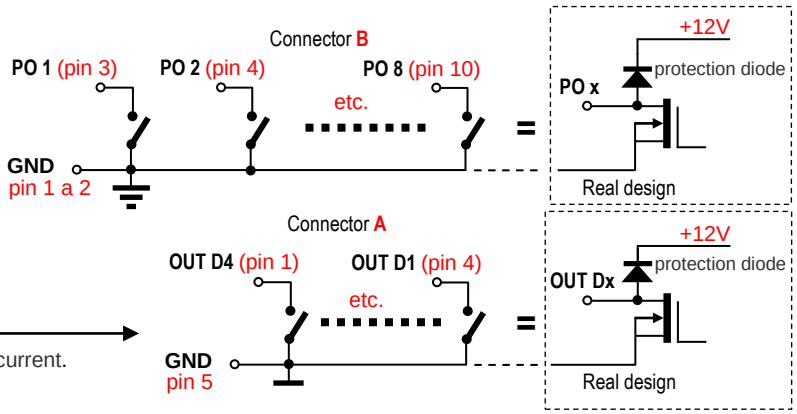


Switches connection
(connector „**B**" + part of connector "**A**"):

In active state is switch connected to „ground", to GND. Currently corresponding LED is lights (connector B only). In inactive state is switch "open". Switches are used for driving power contactors (see to last page) or as driving signal for disconnect for example recuperation.

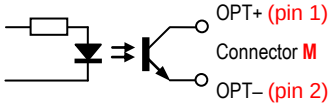
For better clearness are switches draw as mechanical contacts, in real design are used power MOSFETs.

An identical circuit is used for outputs OUT D1 to OUT D4 (1 to 4 pin of connector "A"), but the used components are for smaller current.



Output wiring for easy control the charger (connector „**M**"):

This is a classic optocoupler which provides electrical isolation of the output. When activated, the output transistor is closed (switch-on).



Standard vision haven´t following connectors:

- connector „**D**" and corresponding circuits of measuring external temperatures
- connector „**G**" and corresponding circuits of RS-232 / RS-485
- connector „**L**" and corresponding circuits of CAN

These demands, include possibility of galvanic separation, necessary specify in options in order.

Note:

- connector „**I**" is present always (for cells 1 – 64)
- connector „**J**" and „**K**" and corresponding circuits are assembled only for „128" and „192" versions.

Connector description

Connector A (indication):

- Pin 1: Digital output open collector 4 (1A / 12V) – free
- Pin 2: Digital output open collector 3 (1A / 12V) – free
- Pin 3: Digital output open collector 2 (1A / 12V) – Error
- Pin 4: Digital output open collector 1 (1A / 12V) – Fuel reserve
- Pin 5: GND
- Pin 6: Analog. / digital. output 4 (range 0 / +3.3V / 10V) – min. voltage of the cell [V]
- Pin 7: Analog. / digital. output 3 (range 0 / +3.3V / 10V) – max. voltage of the cell [V]
- Pin 8: Analog. / digital. output 2 (range 0 / +3.3V / 10V) – Current from/to battery[A]
- Pin 9: A / D / frequency output 1 (range 0 / +3.3V / 10V) – Battery charge [%]

Note: by default, outputs 2 to 4, possibly also 1 are analog
– it is possible to modify these to digital upon customer request (must be stated when ordering)

Connector C (current probe):

- Pin 1: current probe supply (+5V or +12V)
- Pin 2: Sense +
- Pin 3: current range of probe
- Pin 4: GND

Connector B (power disconnecting switches, O.C.):

- Pin 1: minus pole of battery 12V (power GND) – separate cable !
- Pin 2: minus pole of battery 12V (power GND) – separate cable !
- Pin 3: **PO 1**, Main Current (to load / for motor controller)
- Pin 4: **PO 2,** Antispark Current (for motor controller or capacitive load)
- Pin 5: **PO 3**, Charging Current 1 (main or small power – finishing)
- Pin 6: **PO 4**, Charging Current 2 (not or high power)
- Pin 7: **PO 5**, Battery Warming
- Pin 8: **PO 6**, Battery Cooling
- Pin 9: **PO 7**, AUX 1 (recuperation OFF)
- Pin 10: **PO 8**, AUX 2 (reserve)

Connector E (System supply):

- Pin 1: supply (+12V)
- Pin 2: minus pole of battery 12V (system GND)

Connector F (BMS switch-on):

- Pin 1: (system GND) minus pole of battery 12V – separately cable
- Pin 2: internal switch-on supply (+12V)

Connector M (auxiliary charger controlling):

- Pin 1: OPT +
- Pin 2: OPT –

Connector H (I2C bus, connection of USBCOM_4i):

- Pin 1: +5V / +12V output
- Pin 2: SCL
- Pin 3: SDA
- Pin 4: GND

Connector D (Ext. temperature sensors), option:

- Pin 1: sensor 1: KTY 81-210
- Pin 2: GND of sensor 1
- Pin 3: sensor 2: KTY 81-210
- Pin 4: GND of sensor 2

Connector G (port RS-232/485), option:

- Pin 1: feeding (internal or external)
- Pin 2: RxD (232) / B line (485)
- Pin 3: TXD (232) / A line (485)
- Pin 4: GND

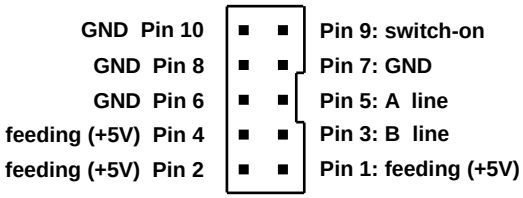
Connector L (CAN BUS), option:

- Pin 1: +5V oputput
- Pin 2: CAN L
- Pin 3: GND
- Pin 4: CAN H

Connector I, J, K (connection bus for modules):

I = section 1, cells 1 - 64,
J = section 2, cells 65 - 128,
K= section 3, cells 129 - 192

- Pin 1: feeding (+5V)
- Pin 2: feeding (+5V)
- Pin 3: line A
- Pin 4: feeding (+5V)
- Pin 5: line B
- Pin 6: GND
- Pin 7: GND
- Pin 8: GND
- Pin 9: switch-on modules
- Pin 10: GND



IMPORTANT:

1) First, must always be connected to lines **I, J, K**, followed by **E** connector (12V power supply system) and then any other connector.
In other words, before inserting the connectors into the sockets in the driving unit (except I, J, K), the system must be powered by 12V !!!
It is not permitted to disconnect the power supply system (connector E) before being disconnected all other connectors (again, except for lines I, J, K).
Do not forget for example also for the "update firmware" (when it is necessary to disconnect the 12V power supply, connector E).

   All activation and deactivation already connected the system is done via connector **F** (switching by system "key"), not by disconnecting the power supply 12V. The only exception is the firmware update.

2) Antispark (output **PO 2**) is switched by switching system ("key") for 3 sec. (capacitor load charge by limited current). Limiting resistor must be external and suitably sized (current and power).

3) If have cooperating motor controller the input for safe disconnection (e.g. controllers 256063 HBC, HBC 50063 ***MGM COMPRO*** etc.) can be output **PO 1** of **B** connector connected directly into the appropriate input of the controller - see the controllers **HBC-series** manual: http://mgm-compro.com/industrial/index.php?cat=speed-controllers-for-industry-high-power-hbc .

4) The current (common) push both buttons when power turned on invokes the default settings !!!

Programming of the parameters

Parameters setting by user:

parameter		range		step	Default settings / note
P1	**Switching-off voltage**	1.5 V	15 V	1 mV	2,5V
P2	**Low voltage**	1.5 V	15 V	1 mV	3,3V
P3	**Balancing (Nominal) voltage**	1.5 V	15 V	1 mV	3,6V
P4	**Charging voltage**	1.5 V	15 V	1 mV	4,2V
P5	**Automatic detection of balancers**			Y-N	A
P6	**Number of connected balancers**	1	192	1	**1**
P7	**Battery capacity *)**	0	655 Ah	0.01 Ah	**0 !!!**
P8	**Charging efficiency**	50 %	100 %	1 %	100%
P9	**Cooling switching**	0	100 °C	1 °C	50°C
P10	**Hysteresis of cooling switching**	0	10 °C	1 °C	5°C
P11	**Heating switching**	0	100 °C	1 °C	5°C
P12	**Hysteresis of Heating switching**	0	100 °C	1 °C	2°C
P13	**Charging current fuse**	0	655 A	1 A	**0**
P14	**Discharging current fuse**	0	655 A	1 A	**0**
P15	**Balancer constant U**	0	65 536	1	6300
P16	**System constant I**	0	65 536	1	200
P17	**Voltage Measuring device - ZERO**	0	100 %	0.1 %	0%
P18	**Voltage Measuring device - RANGE**	0	100 %	0.1 %	100%
P19	**Current Measuring device - ZERO**	0	100 %	0.1 %	50%
P20	**Current Measuring device - RANGE**	0	100 %	0.1 %	100%
P21	**Capacity Measuring device - ZERO**	0	100 %	0.1 %	0%
P22	**Capacity Measuring device - RANGE**	0	100 %	0.1 %	100%
P23	**Re-Charging switch-ON**			Y-N	N
P24	**Powerful charger 2 connected**			Y-N	N
P25	**--**	--	--	--	
P26	**Balancing mode**			H	„delayed“
P27	**Blocking of bal. module update**			Y-N	N
P28	**Output signals inverting**			Y-N	N
P29	**External temperature sensors**			Y-N	N
P30	**Battery overvoltage → traction off**			Y-N	N
P31	**Toleration of balancers dropouts switch-off**			Y-N	N
P32	**--**	--	--	--	
P33	**Low battery indication**	0	100%	1%	10%
P34	**Cell's internal resistance measuring**	--	--	Y-N	Y
P35	**Cell's voltage recording into log**	--	--	Y-N	N
P36	**Current probe multiplier**	0,25	10	0,25	1
P37	**CAN speed**	--	--	H	250 kbit/s
P38	**CAN address displacement**	0	65535	1	257
P39	**CAN mode**				B
P40	**Module search**				Uninterrupted sequence
	--	--	--	--	

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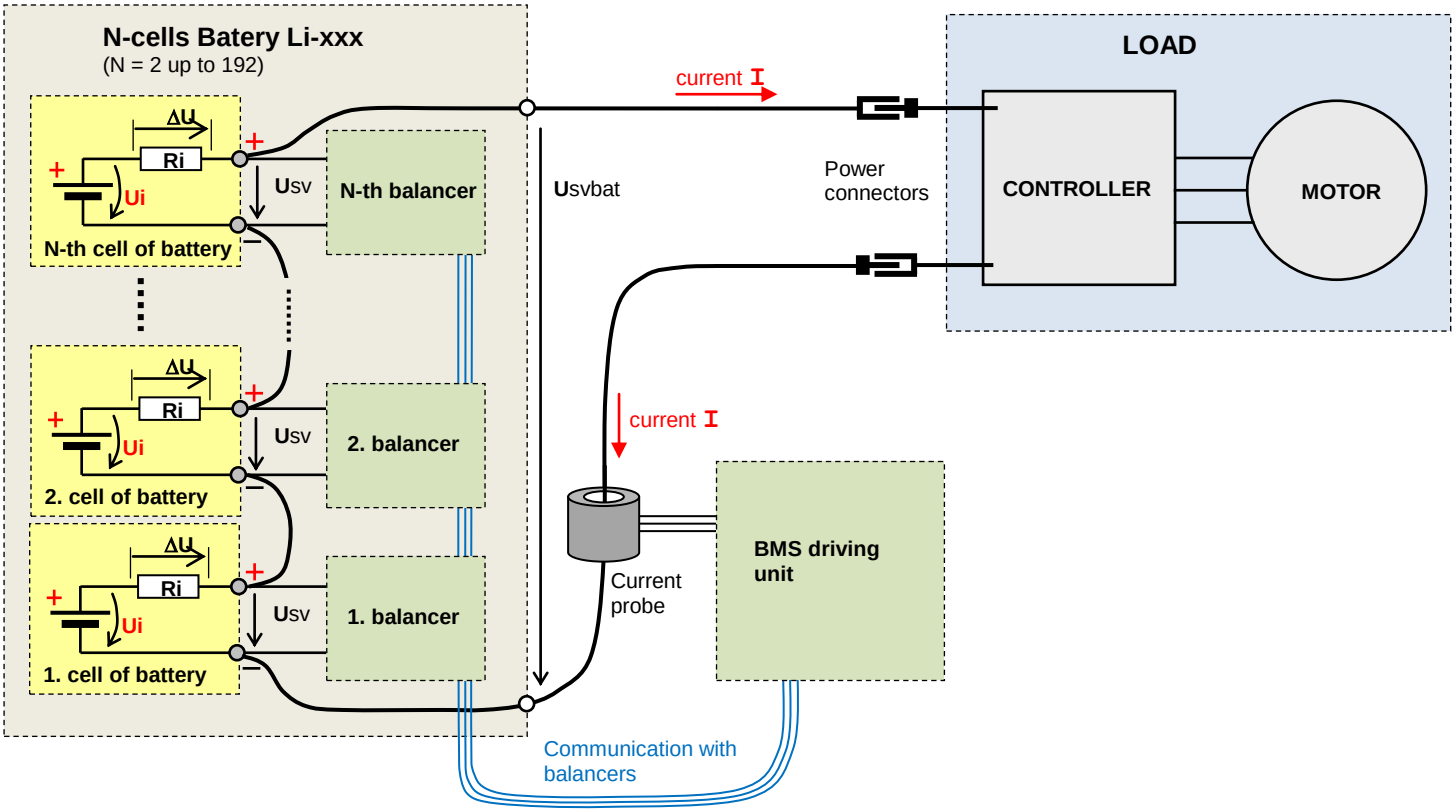
Legend: **H** - choice from discrete values

***) Note 1:** if necessary higher battery capacity value (parameter P7) can increase the capacity in exchange for a smaller resolution (6550 Ah and 0.1 Ah resolution) - in this case, please contact us

Note 2: At least red value must be set according to the actual situation before you use the system.

Parameters description

f the following description uses the term "**battery voltage**" or "**cell voltage**", we mean ALWAYS **internal voltages Ui**, not the terminal voltage **Usv** – i.e. voltage independent of the size of the current and internal resistance of the battery. The system continuously monitors the terminal voltage and current and calculates the actual internal resistance of the battery (each cell). The system uses this method for both discharge and charge the battery.
In case a terminal voltage of the cell (battery), it is always highlighted.



The minimum operating voltage of the balancing / measuring units (abbreviated balancers) is 1.8 V / cell. In this case, **the terminal voltage of the cells it means**, not the internal voltage. If the terminal voltage of cells drops for any reason under this limit, the corresponding balancer stops to measure and communicate with driving unit until the terminal voltage of the cell increases above 1.8 V.

P1: **Switching-off voltage**
If the cell voltage drops below this threshold for more than 30 seconds, occurs an emergency disconnecting of the load (**PO 1**). Status is indicated by flashing indicator is used to output **D1** (it is advisable to reduce power consumption - "reducing throttle"). To cancel the countdown occurs when the cell voltage will back (the during count down 30 second interval.) to the level set in parameter P2. But if has is disconnected, the system is on / off by key again. This is the most voltage discharged cell, i.e. cell with the smallest voltage across the battery.

P2: **Low voltage**
Is the voltage at which the system is allowed to start and / or cancellation of during countdown emergency disconnecting of the load (see P1).

P3: **Balancing voltage**
Specify the border, which begins balancing of the cells during charging. For different types of cells that line varies. Lipol cells is advantageous balance of the smallest voltage (3.2V) for LiFePO4 cells does not make sense to balance the so low voltage because most of the charging cycle is nearly constant voltage (around 3.3V). In this type of the cells is recommended to balance the values of about 3,5 ÷ 3,6V.

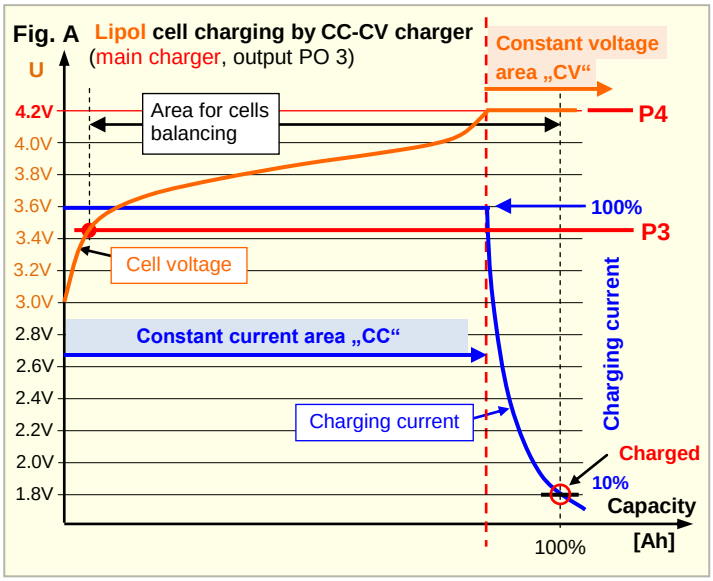
P4: **Charging voltage**
It is permissible maximum cell voltage during charging - from achieving this voltage should change the charging characteristic from the "***constant current***" to "***constant voltage***" (standard ***CC-CV*** charging). By achieving this voltage should current, thanks to this characteristic, decline. After a progressive reduction current (by charger) under 5 to 10% of nominal charging current when the battery is 100% charged. See **Figure A** + **Figure B** on the next page, where you see the basic characteristics of charging **Lipol** and **LiFePo4** cells. This type of charger is connected as main charger to the output **PO 3**.

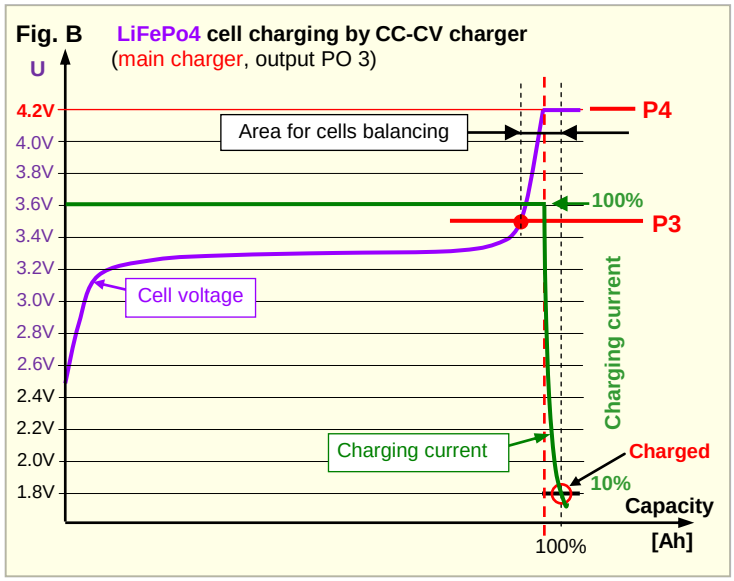
If used charger does not automatically reduce current smoothly, these scenarios are possible for charging:

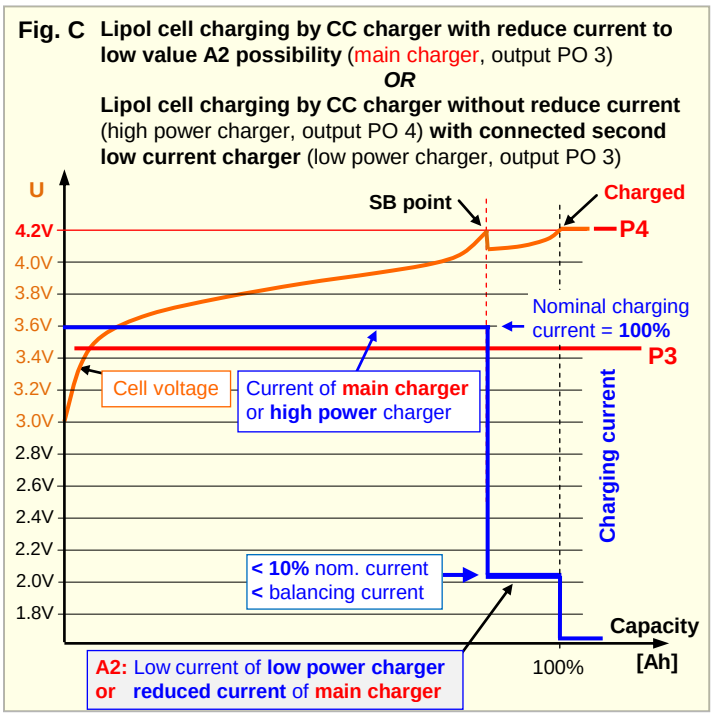
a) Charger can reduce (on the external signal) the current below 5 to 10% of the nominal charge current and simultaneously below the current level of balancing current, so after reaching voltage level P4 (**SB** point) reduces the current and the battery is recharge subsequently by this reduced current while balancing, **Figure C**. The charger is connected as main charger to output **PO 3.**

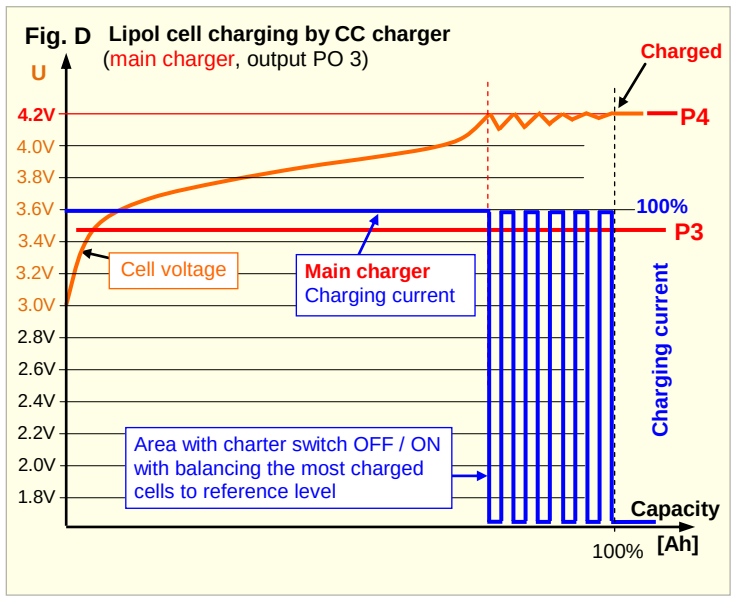
b) The charger cannot reduce the current. Charger is connected as a **powerful charger** to output **PO 4**. After reaching the voltage level P4 (SB point) is the output **PO 4** disconnected. Charging provides **low power charger** with a low current output connected to the output **PA 3** up to full charge and full balancing, **Fig C.**

c) If **powerful charger** can not reduce current and is not used second **low power charger**, the system after achieve voltage of P4 levels switch-off charger. After balancing the most charged cells to the lowest level charger turns on so the cycle repeats turning on and off until the balancing of all cells, see **Figure D.** Charger is connected as main charger to the output **PO 3.**



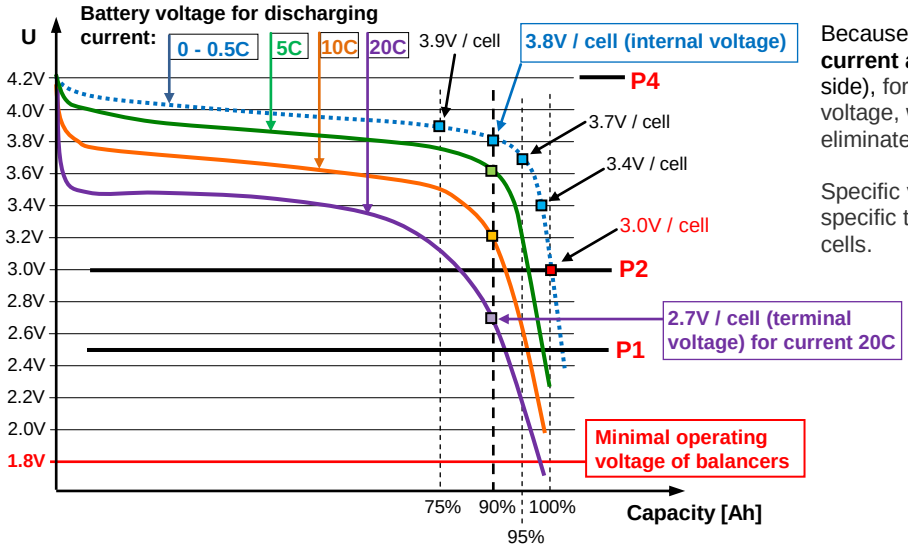






Pozn.: When using only one charger, the **main** (if one is the intelligent, CC-CV or ordinary CC, etc.), it is necessary to connect to the output **PO 3**. If you use two chargers, the small current charger is controlled by output **PO 3**, high power by output **PO 4**.
Two chargers makes sense only if the charger has not powerful characteristic of the **CC-CV** or **has no possibility reduce the current** (by external command) to the level of balancing currents of individual balancers.
Low power charger should have a charging current such that it balancers were able absorb it with reserve and at the same time should be less than 5 to 10% of the nominal charge current.

Fig. E **Lipol cells discharging**



Because terminal voltage of the cell is **strongly depend on the current and internal cell resistance** (see picture on the left side), for evaluating the state of cells is used internal cell voltage, which are independent of the above variables and so eliminate their negative influence.

Specific values and discharge curves are dependent on the specific type cells - see the manufacturer's datasheets of used cells.

P5: Automatic detection of balancers

- **NO –** BMS works only if the system found that the number of balancers is equal to the number specified in the P6
- **YES –** BMS works with any number of balancers (2 - 192). This setting is potentially dangerous, the system fails to identify the missing balancer - suitable only for testing

P6: Number of connected balancers

It is the sum of all balancers on all lines.

P7: Battery capacity

The nominal battery capacity in Ah.

P8: Charging efficiency

Specifies how efficiently for charging cells for the system can calculate (about 90%) - the value can be gradually fine-tune.

P9: Cooling switching

Specify switching borders of cooling. If the temperature of any cells is higher than temperature set here, BMS switch-on power output **PO 6.**

P10: Hysteresis of cooling switching

If the temperature of all cells drops below a set here **P9** hysteresis, BMS turns off power output **PO 6.**

P11: Heating switching

Specify switching borders of heating. If the temperature of any cells is lower than here set temperature, the BMS activates power output **PO 5.**

P12: Hysteresis of Heating switching

If the temperature of all cells increases over a set here **P11** hysteresis, BMS turns off power output **PO 5.**

P13: Charging current fuse

If the current from the charger exceeds the limit set here, the BMS disconnects power outputs **PO 3, PO 4.**
A value of zero (= 0) means the fuse is TURNED OFF.

P14: Discharging current fuse

If the current from the battery exceeds the limit set here, the BMS disconnects power outputs **PO 1.**
A value of zero (= 0) means the fuse is TURNED OFF.

P15: Balancer constant U

The value is determined for a given system from the production. When assemble the system yourself from the *MGM COMPRO* components, contact ***MGM COMPRO***.

P16: System constant I

The value is determined for a given system from the production according to the current probe. When assemble the system yourself and you need to use a probe with a different range or another probe, contact ***MGM COMPRO***.

Calibration output for external measuring instrument showing the basic variables (outputs AD1 to AD 4):

P17: Voltage measuring device - ZERO

Calibration of the analog zero voltage indicators (output **AD3** and **AD4**)

P18: Voltage measuring device - RANGE

The calibration range of the analog voltage indicators (output **AD3** and **AD4**)

P19: Current measuring device - ZERO

Calibration of the analog zero current indicator (output **AD2**), zero in the middle of scales

P20: Current measuring device - RANGE

The calibration range of the analog current indicator (output **AD2**), ± full range

P21: Capacity measuring device - ZERO

Calibration of the analog zero of the capacity indicator (output **AD1**), % of charging

P22: Capacity measuring device - RANGE

The calibration range of the analog capacity indicator (output **AD1**), % of charging

P23: Re-Charging switch-ON

- **NO –** charging is terminated by voltage **P4** achievement on the all cells. To start a new (next) charging is necessary to disconnect and reconnect the control voltage to the triggering input for activation (**F** connector)
- **YES –** Charger is periodically switched after the voltage drop on the cells below **P4** at all times activation of BMS

P24: Powerful charger 2 connected (output PO 4)

Select **YES** if connected to a **powerful high-current charger**. In this case **MUST** be connected to the low power charger to output **PO 3 !!! (if it is connected to only one charger must be connected to PO 3 !!!)**

P25: *hidden parameter*

P26: Balancing mode

- CONTINUOUS – system begins balancing to achieve of voltage parameter defined **P3**
- DELAYED – system begins balancing to reach the voltage parameter **P4** (**SB point** in Fig. **C**)
- LIMITED – system only limiting cells of voltage **P4**
- OFF – balancing is off (but the system monitors and disconnects as needed)

P27: Blocking of balancing module (balancers) update

- **NO –** BMS updates the balancers firmware where necessary
- **YES –** BMS is prohibited updated balancers - balancers with an outdated or incompatible firmware will behave as not present **- only for testing recommend**

P28: Output signals inverting (PO 1 up to PO 8)

- **NO –** Power outputs are switched on, when connected devices **to be active**
- **YES –** Power outputs are switched, when connected **to be deactivated** (disconnected)

P29: External temperature sensors

- **SWITCH-OFF –** connected sensors (**D** connector) is not taken into account
- **SWITCH-ON –** connected to an external temperature sensors (KTY 81-210) are assigned to monitor temperatures for cooling / heating (**D** connector). Both sensors must be connected physically correct behavior !!!

P30: Battery overvoltage → traction off (controlling traction / recuperation)

- **SWITCH-OFF –** battery overvoltage turns off chargers (**PO 3** / **PO 4**) and activates the output **PO 7** "recuperation off ".
- **SWITCH-ON –** battery overvoltage turns off chargers (**PO 3** / **PO 4**) and activates the output **PO 7** "recuperation off " and disconnects the load (motor) output **PO 1.**

P31: Toleration of balancers dropouts switch-off

- **SWITCH-OFF –** BMS continuously tolerates 5% balancers out of order - only the error signals output **Error** (**D2**) is activated.
- **SWITCH-ON –** BMS does not tolerate any failure balancer exceeding 5 attempts to communication.

P32: *hidden parameter*

P33: Low battery indication

Battery discharge level (remaining charge, remaining energy), which activates the light of "reserve fuel" indicator (Output **D1**). Similar as warning light in your car that you are approaching an empty fuel tank.

P34: Cell's internal resistance measuring

- deactivate
- active

P35: Cell's voltage recording into log

- switch-off
- switch-on

P36: Current probe multiplier

Parameter allows you to change the basic sensitivity of the current probe, see "Changing the sensitivity of the current probe", in proportion:
0,25× up to 10×
Values 0,25 / 0,5 decreases sensitivity 4× / 2× (increase the current range 4× / 2×), values above 1 increases, the contrary, sensitivity.

P37: CAN speed

- 1 Mbit/s
- 500 kbit/s
- 250 kbit/s
- 125 kbit/s

P38: CAN address displacement

0 up to 65335

P39: CAN mode

- A
- B

P40: Module search

- Uninterrupted sequence
- Whole address space

When you choice „ Uninterrupted sequence ",addresses of each balancer must be one after the other, without spaces.
Example: battery with 70 cells
Section 1: **0, 1, 2, 3, 4, ….. 62, 63** (total 64),
Section 2: **0, 1, 2, 3, 4, 5** (total 6),

When you choice „ Whole address space ",you may any address of balancing modules, including spaces. The only condition is that one address must not be used in the same section more than **1× !**
Example: battery with 70 cells
Section 1: **0, 1, 2, 8, 10, ….. 61** (total 30),
Section 2: **5, 6, 15, 22, 23, … 50** (total 25),
Section 3: **1, 20, 21, 22, .. …. 48** (total 15),

Installation and run program Controller 2

Are very simply and intuitive. Details are described in manual „***Installation and controlling of program Controller 2***“, follow instructions in this manual please.

Update of program *Controller 2*

Update SW version of your program ***Controller 2*** is possible make by two ways.

1. After start program automatically advice to new version in left upper corner – start update by this way.

Choice “**Download updates**”

and push **Update**

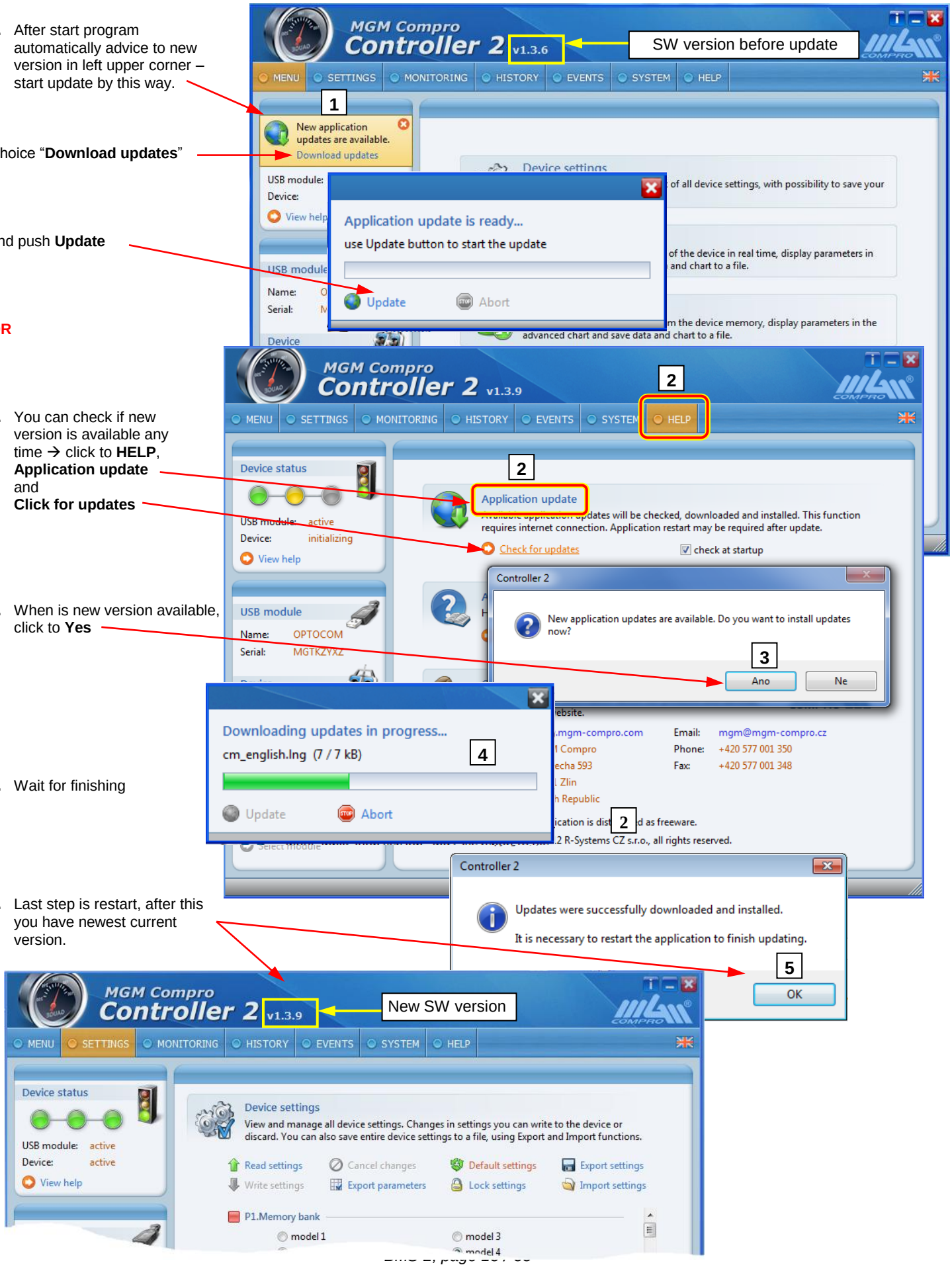
OR

2. You can check if new version is available any time → click to **HELP**, **Application update** and **Click for updates**

3. When is new version available, click to **Yes**

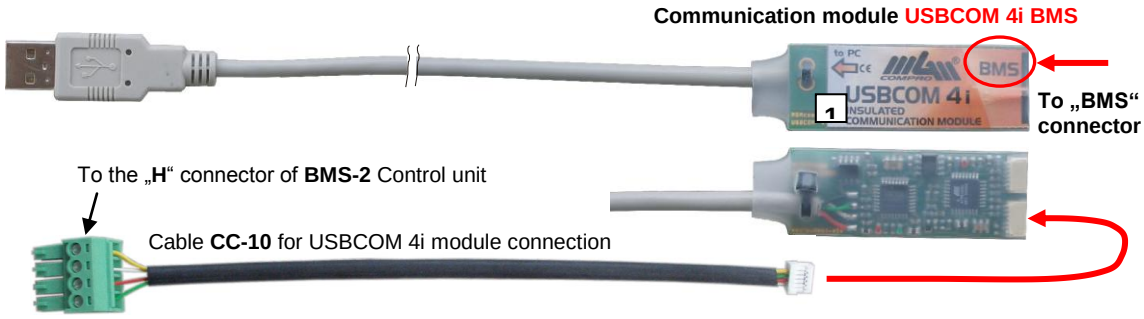
4. Wait for finishing

5. Last step is restart, after this you have newest current version.



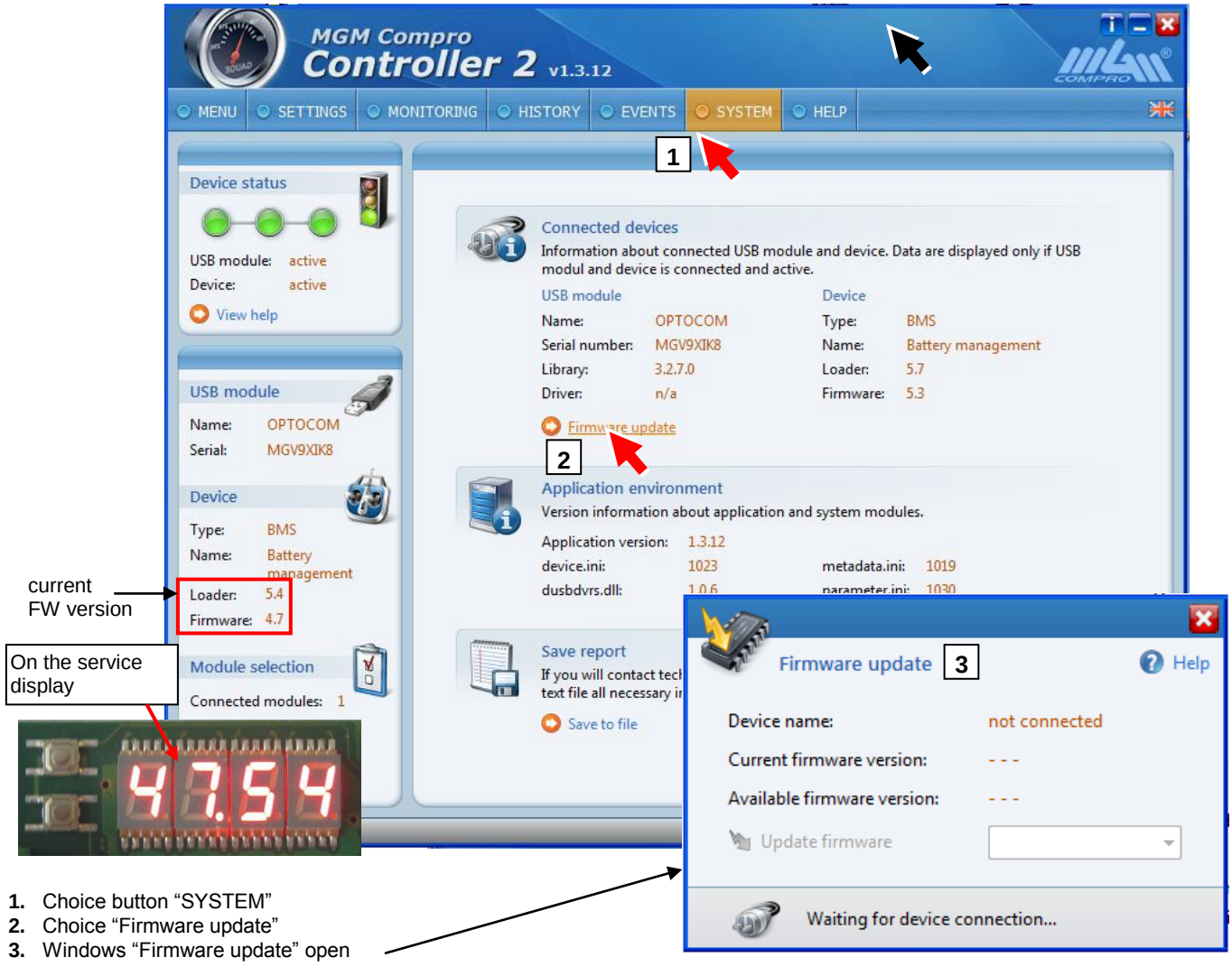
Update SW inside the controller (FW, firmware)

When you want make update firmware in you controller to newest available version, you need **USBCOM 4i BMS** module and **CC_10** cable (the same as for standard programming of parameters). **Controller must be connected to internet.**



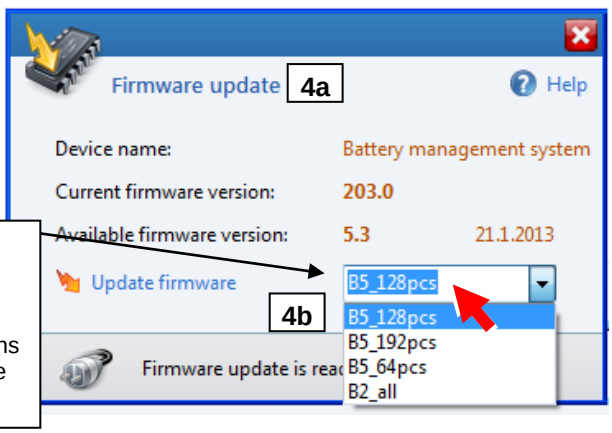
Starting sequence for firmware updating:

0. Connect **USBCOM 4i BMS** module to **PC** and to **BMS**, connector “**H**” by **CC_10** cable and Start program ***Controller 2*** first. When connect USBCOM module first time, wait for installation finish. Connect BMS, but no turn-on yet.



1. Choice button “SYSTEM”
2. Choice “Firmware update”
3. Windows “Firmware update” open

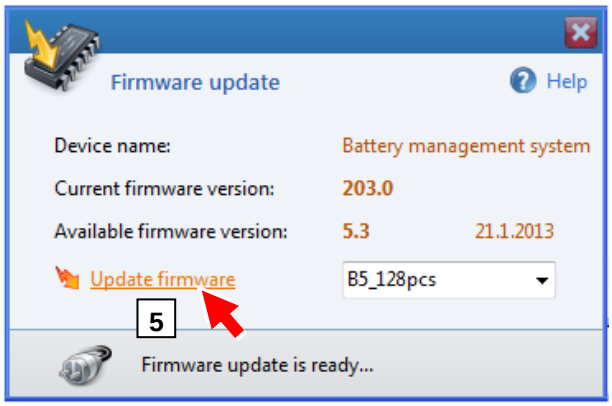
4a. Turn the BMS-2 on by connect System feeding 12V (connector “**E**”).
If is your BMS turn-on, it is necessary turn- off the BMS-2 now and turn-on once again.
Now is available window with the available firmware versions, ***4b.***



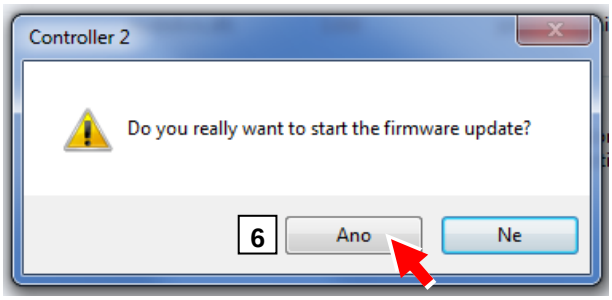
4b. Choice version corresponds with your system.

Choice vision for your BMS:
B2 – older versions
B5 – balancers V4 line
====
Number 64, 128 or 192 means type of the control unit for the number of balancers

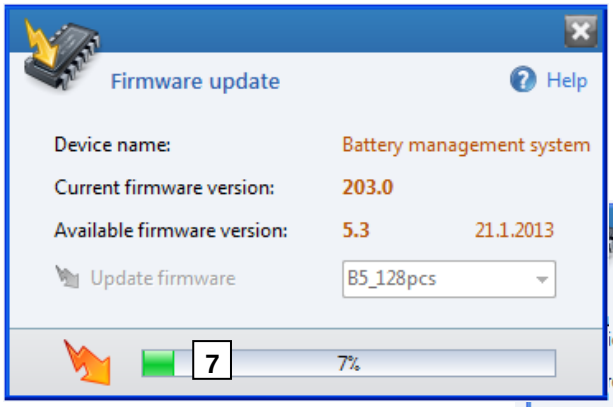
5. Push buttpn “Update firmware”.

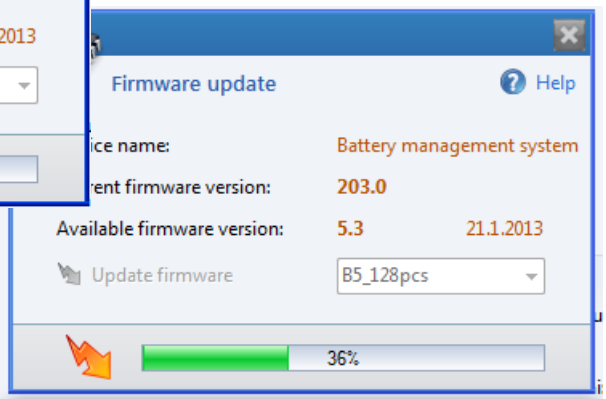


6. Confirm firmware updating.



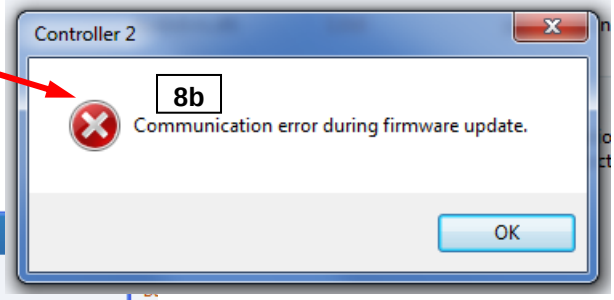
7. Updating procedure start.

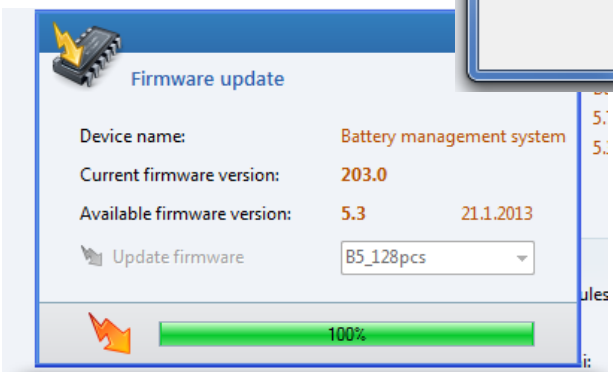




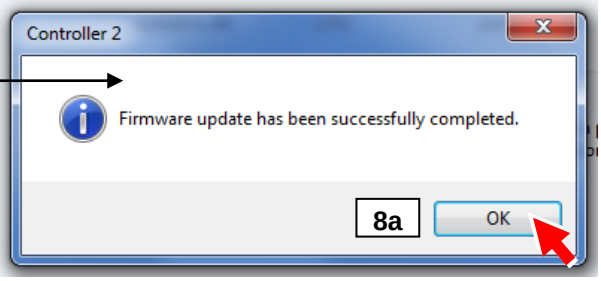
.

8b. when procedure corrupt (communication error etc.), is displayed this message Necessary start this update again **!**



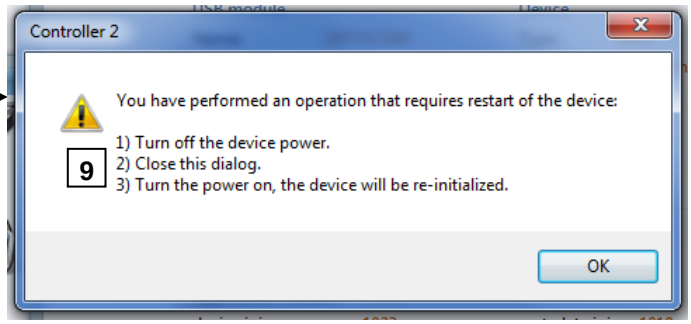


8a. When procedure correctly finished, this message will appear. Push OK



9. Follow next instruction.

Push OK.



10. After restart device (= your BMS), newest version of its firmware is displayed. Update procedure is complete.

Note:

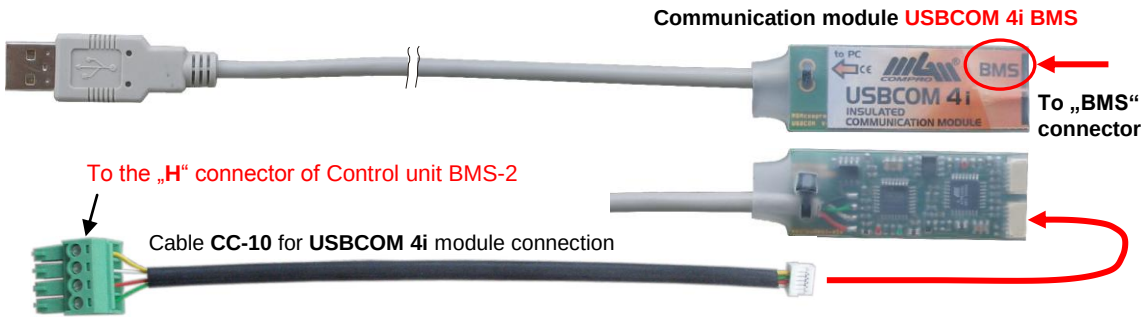
You can start updating procedure for unlimited amount of tries, the BMS cannot be broken down by failed update, but you have to finish the update procedure without errors **[8a]** before using your system or you set the parameters, etc.

When procedure don´t finished correctly **[point 8b]**, BMS (device) after next turn-on **don´t work, not possible set parameters, etc. In this case is necessary this updating procedure repeat !**

Note: Please, check also, if newest version of program „***Controller 2***“ isn't available. Newest parameters or other changes, which correspond with new version of the firmware, can be added. Without a corresponding version of program ***"Controller 2"*** settings will not work correctly!

Parameters settings / Reading data from BMS-2

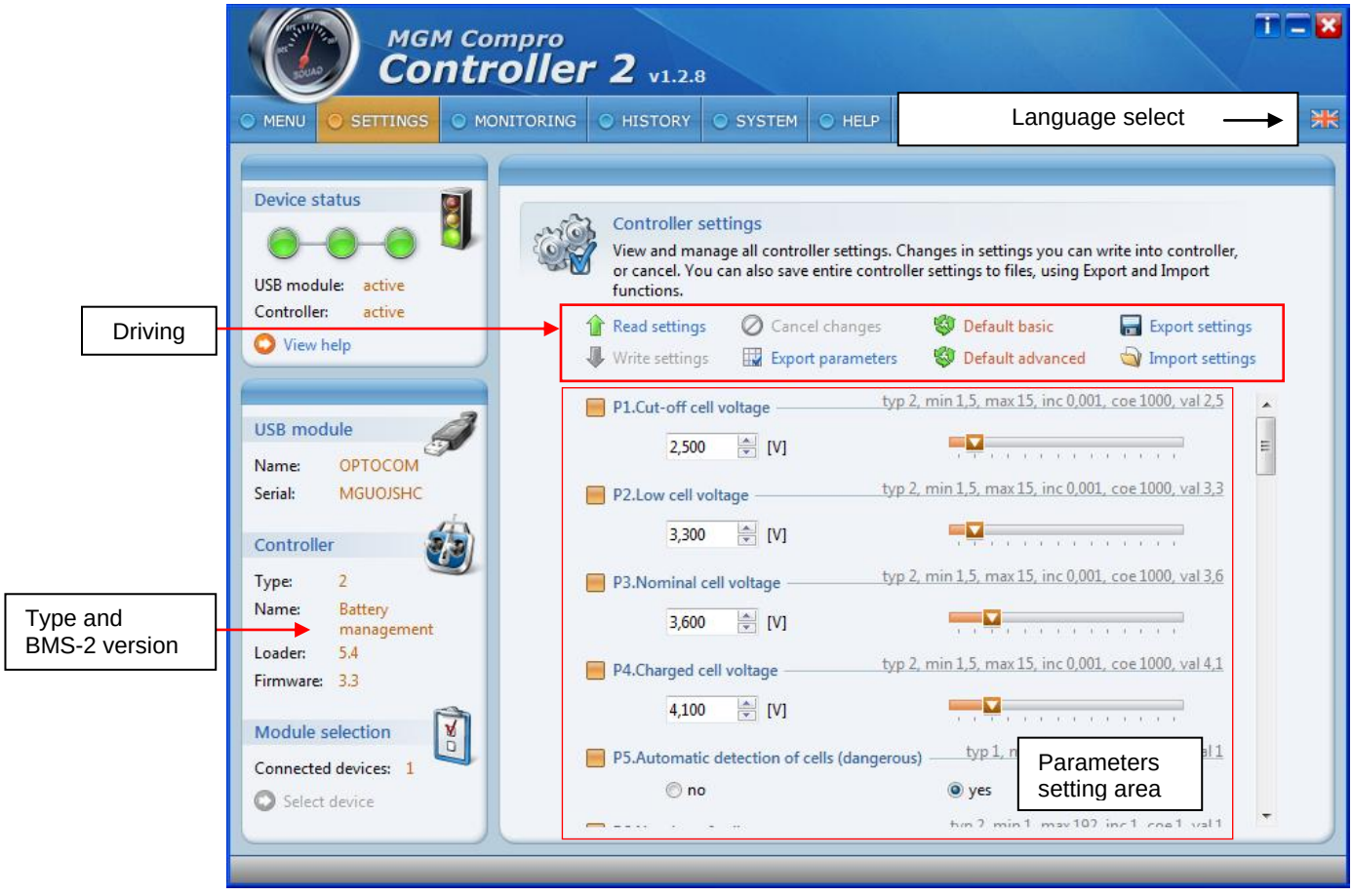
To set parameters or reading data from your BMS-2 need to connect to your PC, the module **USBCOM 4i BMS**, the control software "***Controller 2***", this is free to download on our web and on CD and connection cable **CC_10**.



1) If your BMS is already turned on and running, you can skip this point.
If BMS is off, turn on the BMS by connection 12V „System feeding“ (connector „**E**“) and "Switch-on system" (connector “**F**”).
2) start program ***Controller 2***
3) connect **USBCOM 4i BMS** to USB port of your PC and connect, by cable **CC_10,** USBCOM 4i module to BMS-2 driving unit (cable CC_10 is connected to plug **H** of driving unit BMS)
4) Now is possible communicate with BMS, read data, change and write requested parameters etc.

If BMS goes into sleep mode (i.e. is not activated by "key", F connector) cannot communicate !

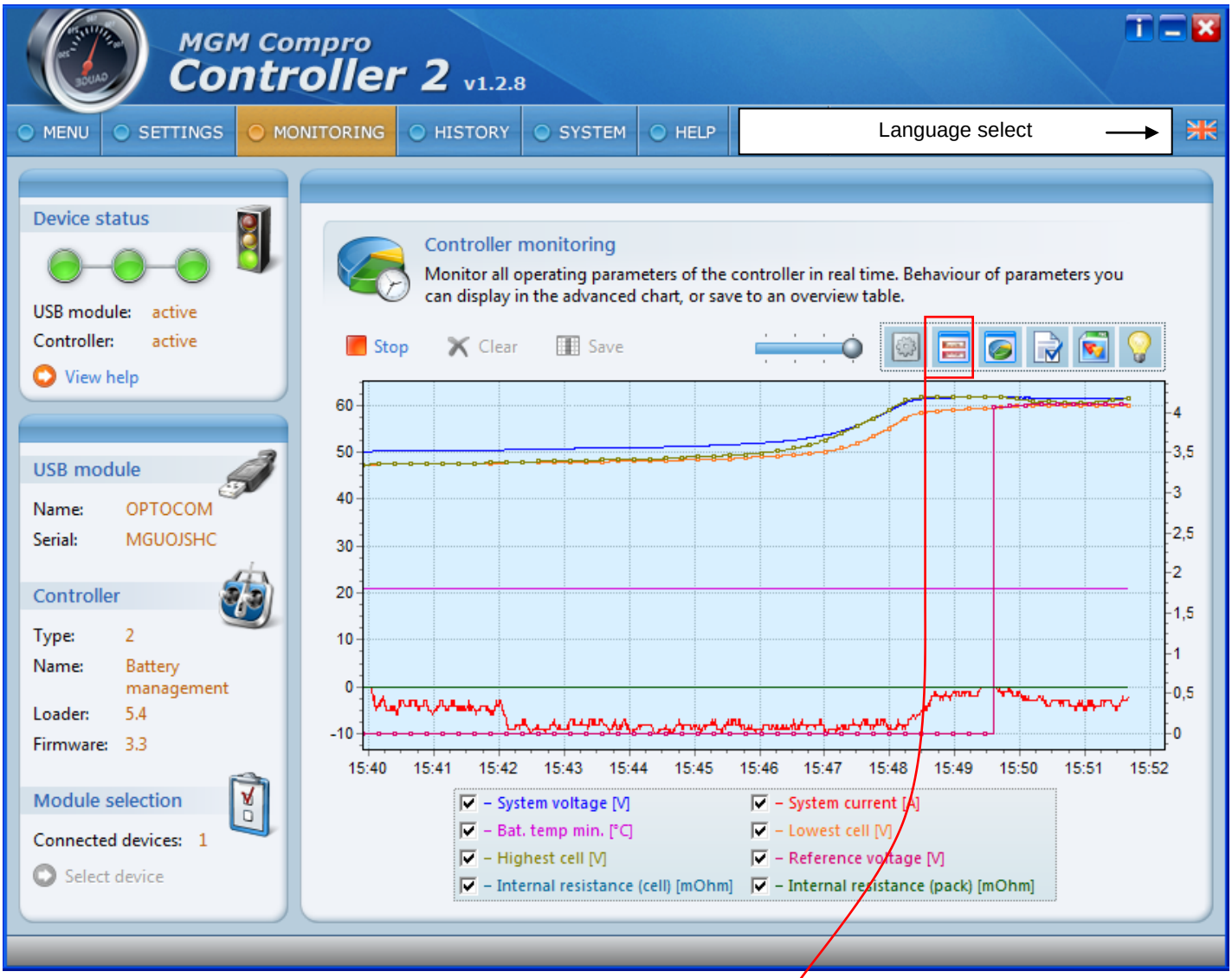
The control window in the PC:

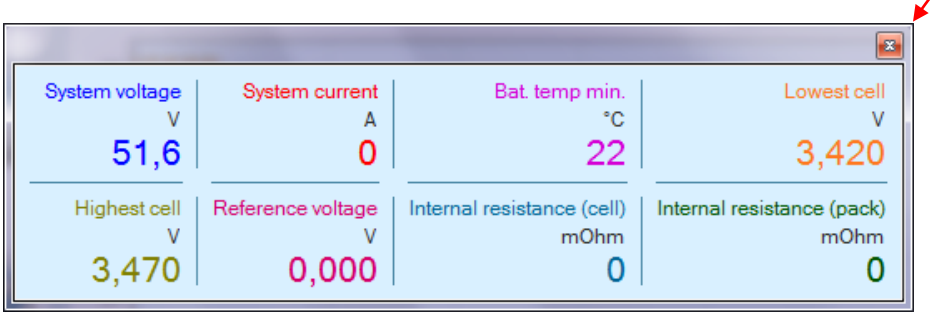


Parameters that can be set are clearly listed in the table. Their detailed description follows the table.

Monitoring the system in real time

During operation of the BMS-2 can monitor all operating parameters of the system in real time. Besides graphical presentation in the form of a graph can be in a separate window to run a numerical display of monitored values. Colors and labeling of individual variables correspond to displayable curves in the graph.
At any time during operation of the BMS-2, you can connect to a PC (via USBCOM 4i) and run a monitoring system.





Current values of variables are displayed in a separate window.

Parameters that can be monitored:

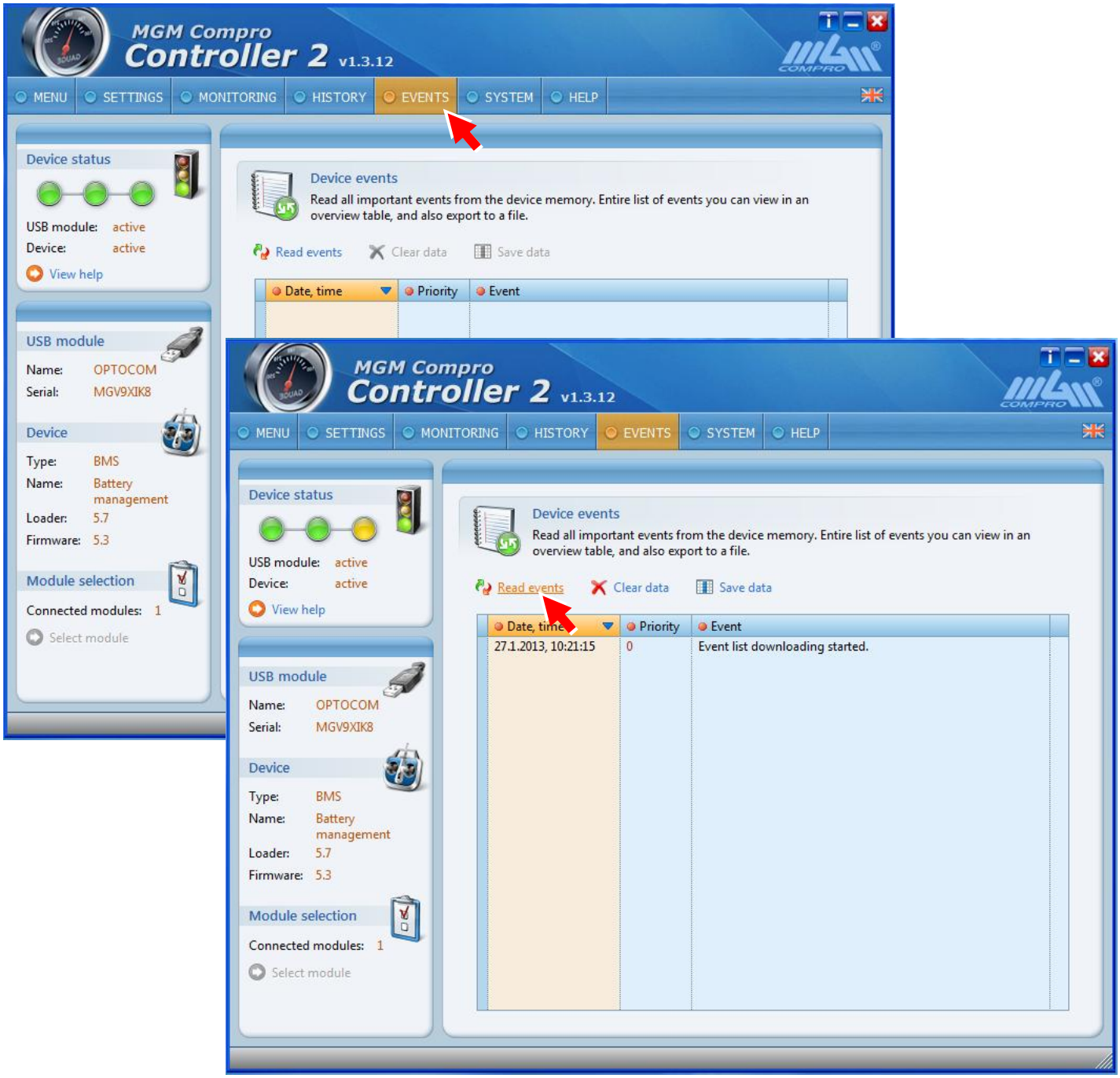
a) - traction battery voltage
b) - traction battery current
c) - traction battery capacity
d) - minimum battery temperature
e) - maximum temperature of the battery
f) - the minimum cell voltage (cell voltage with the lowest value)
g) - the maximum cell voltage (cell voltage with the highest value)
h) - references
i) - the worst internal resistance of the cell (cell with the highest Ri)
j) - internal resistance of all the battery
k) - address the smallest voltage with cells
l) - address of the cells with the highest internal resistance

History - reading data stored in the BMS-2

Function is not supported in this application.

Data log - reading events stored in the BMS-2

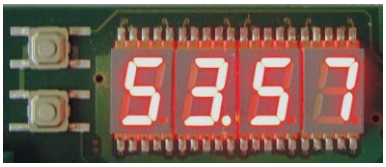
Allows you can read all important events, including the voltage of each cell in during BMS activities. It also save unit's parameter settings. This data can be saved to a file. The format of the saved file type is Excel, „xls".



Displayed values

Immediately after switch-on unit displayed SW versions on the service display:

MM.BB where MM is FW version of driving unit, dot separate second number, this is FW version of balancing units
Example:
53.57 FW of driving unit is 5.3, FW of balancing units is 5.7



Control unit displayed, over and over:

Cx.xx cell voltage with the highest value
dx.xx cell voltage with the lowest value
X.xxx difference between highest and lowest cell voltage

Sample:
C3.14 means cell with highest voltage has 3,14V
d3.02 means cell with lowest voltage has 3,02V
0.127 means difference is 0,127V

Control unit next displayed messages:

FXXX measuring / balancing unit address, which signalize some problem, and follow
XXXX error number
AXXX address of the balancing unit is not followed by an error because there is a problem with the connection.

Error messages:
BMS error indicates which balancing/measuring unit is faulty (its address, e.g. **F041** = cell number 42), the list of error of balancing units is as follows:

0000 : communication error
0001 : damaged EEPROM with calibration data
0002 : damaged balancing FET – balancing current not flows and cell is not balancing
0003 : damaged balancing FET – balancing current flows all the time and discharge cell !!!
0004 : damaged internal DC/DC converter
0005 : balancer overheating > 130 °C
0006 : damaged temperature sensor
0007 : damaged battery temperature sensor

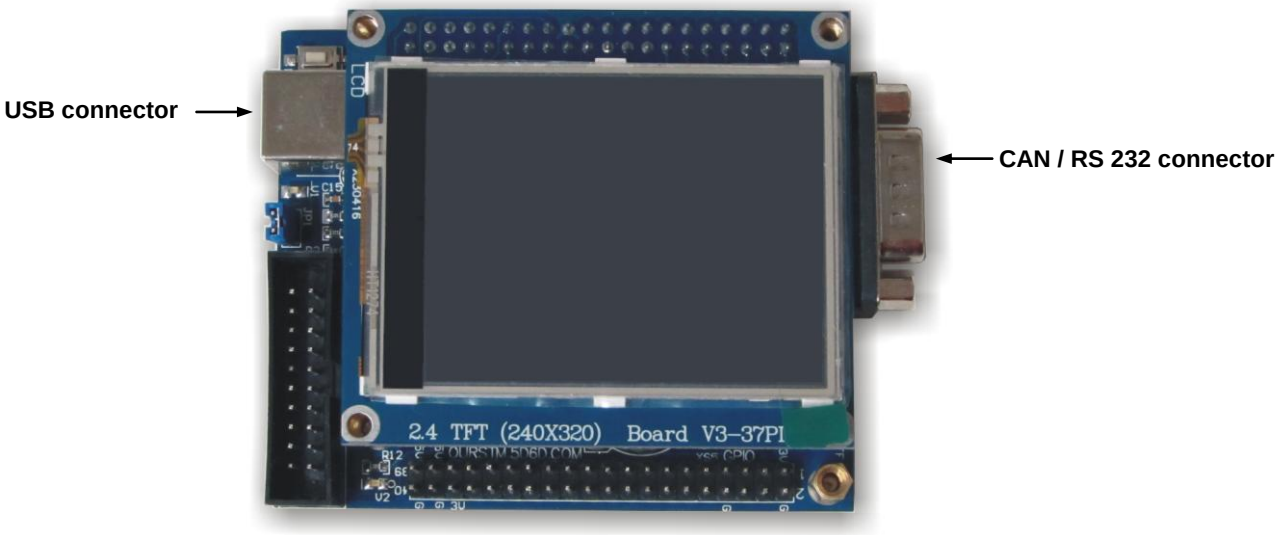
In all cases is service mission necessary !!!

0255 : BMS without set parameters (from factory)
This is the default status of the new BMS - some parameters, the user must first set up according to their specific situation with a PC, by the program "*Controller 2*", see table "**Programming parameters**"

External display

External display is possible Conner to main unit. Display GWL 320 x 240 dots is available in two versions, RS232 and CAN. RS232 type is possible Conner to H connector via cable with I2C to RS232 converter. CAN vision is possible Conner directly to L connector
In view of the function or display options are both version equivalent.

Display GWL 320 x 240 (marking **DISP1_i4_BMS**):



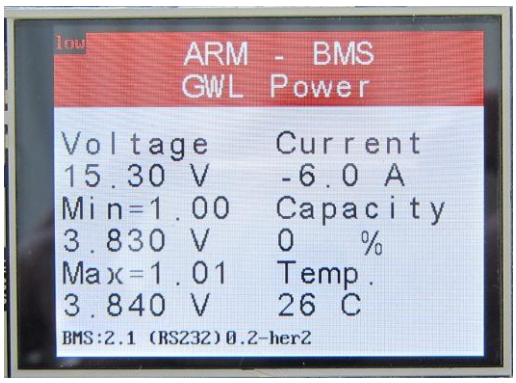
Display GWL 320 x 240 need external feeding 5V / 250mA. This is possible connect to “USB” connector or via communication connector. Using this connector and PC is possible change some display characteristics.

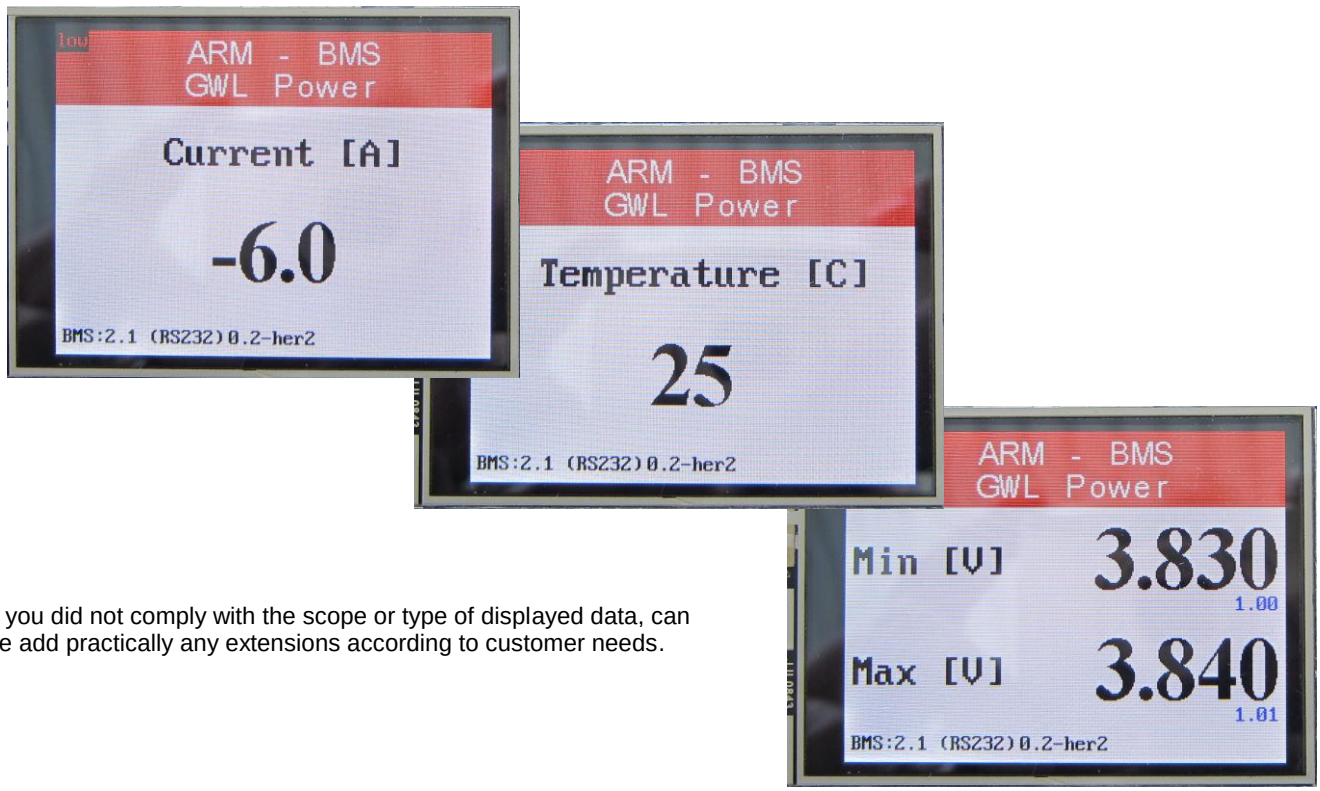
Conductors CAN_H, CAN_L and GND join a communication CAN channel of the BMS-2
Supply from ext. source 5V.

To „**L**“ connector (CAN)

Screens (data) are switched by tapping on the screen

Examples of other information displayed on the screen:





If you did not comply with the scope or type of displayed data, can be add practically any extensions according to customer needs.

Balancing / Measuring module BMS-2-xxx BAL V4.0

These modules are used for measuring voltage and temperature and balancing during battery charging and also for measuring voltage and temperature during battery discharging. For each battery cells is necessary one module. Max. number of balancing/measuring modules in one system is 192.
You can connect Pb, A123, LiPol, LiFe… cells, i.e. all types of the charging cells which operating voltage is in the range 1,8 – 5V or 9 – 18V for "12V" type. Concrete range of voltage and current depend on type of balancing/measuring unit.

These modules in all versions (5A version, 10A version and 12V version) have unique measuring of the temperature of power element (one or two pcs) **PC_x"**. Measured is directly chip temperature and therefore this eliminate all errors or measuring mistakes caused by cooling air flow or caused by bad contact to cooler.
Also is significantly increase isolation voltage between communication line (driving unit) and each battery cells (and connected balancing units) – up to 3 kV.
Dimensions of all modules are the same, differences are only in assembling components and number of power elements.

Modules have 3 modifications – standard type, type with termination impedance (marking ZR) and with additional connector (for easy connection between more small packs), marking ACC.
Mechanically last module on the bus (for each branch) must be type "**ZR**" with termination impedance. Not depend on the module address, important is only which module is on the end of each bus (flat cable).
When is battery divided to some mechanical parts (in one section) is advantageous that outer modules have additional connectors (**ACC**). Each packs are easy connected just thanks these additioanl connectors.

Dimension ……74 × 53 mm
Weight …… xx gram
Mounting to cooler …… (2+1+1) × screw M3
(power element **PC_x** is mounted to cooler by silicone paste only)

Module current consumption in sleep mode …….. cca 100 µA
Module current consumption in run mode ……... cca 30 mA
Isolation voltage between bus and cel (electronics) …….. > 3kV

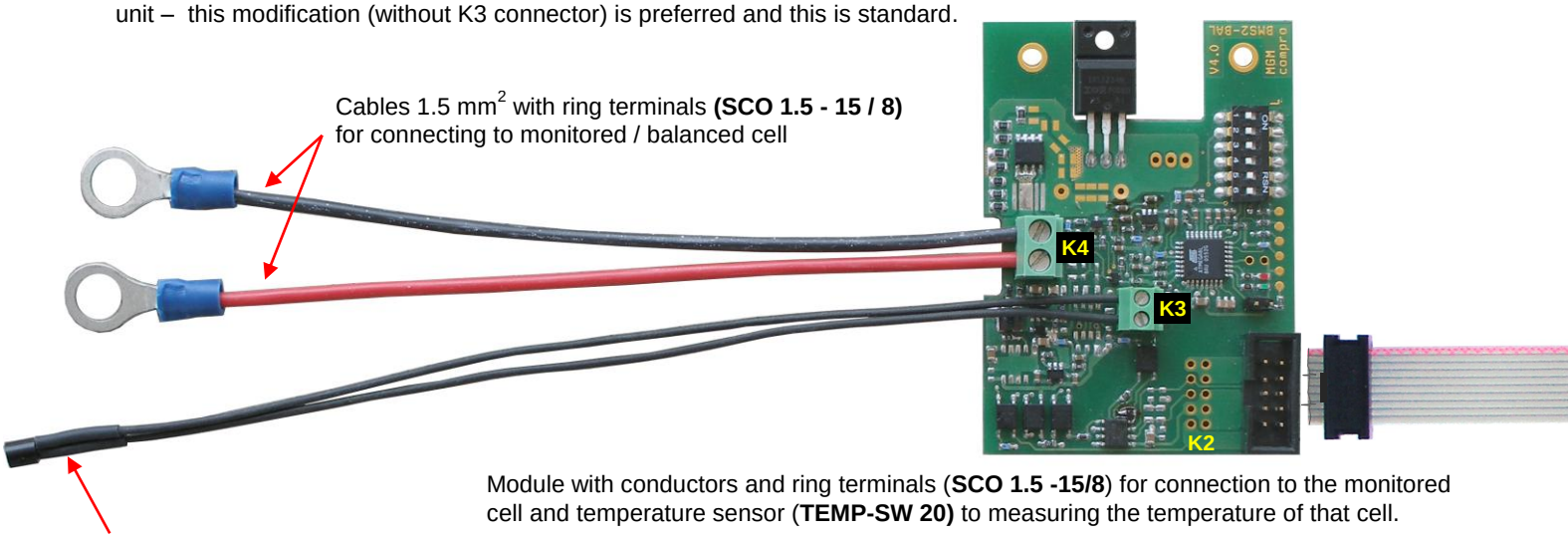
BMS-2-5A BAL V4.0
Voltage of monitored / balanced cell …….. 1.8V up to 5.0 V
Balancing current / cell …… 0 up to 5 A

BMS-2-10A BAL V4.0
Voltage of monitored / balanced cell …….. 1.8V up to 5.0 V
Balancing current / cell …… 0 up to 10 A

BMS-2-12V BAL V4.0
Voltage of monitored / balanced cell …….. 9V up to 18V
Balancing current / cell …… 0 up to 3 A

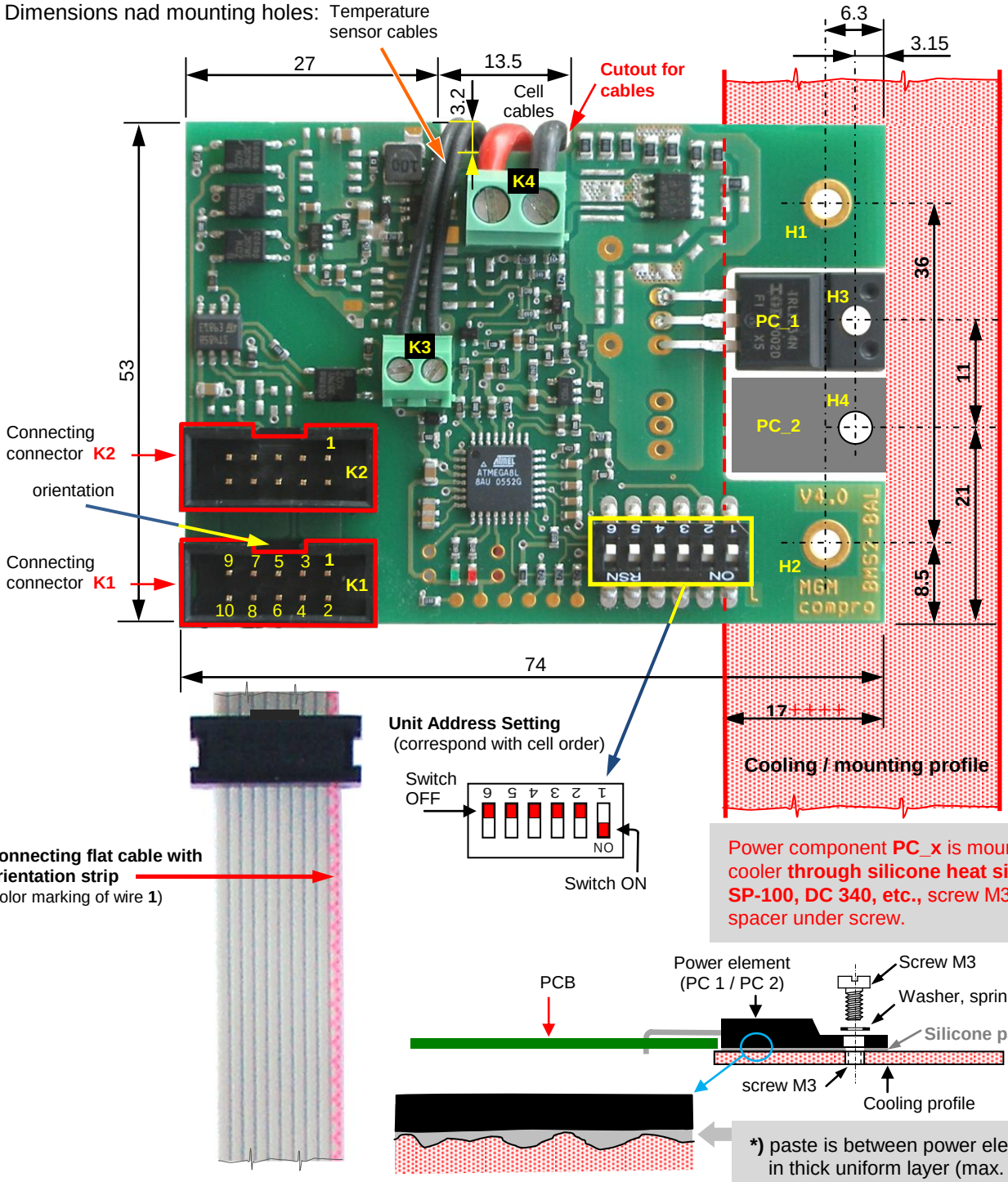
Note:

- Connector K2 is assembled in modification „**ACC**" of unit V4.0
- Instead of using connector **K3**, the sensor with conductors may be directly soldered to the unit – this modification (without K3 connector) is preferred and this is standard.



Module with conductors and ring terminals (**SCO 1.5 -15/8**) for connection to the monitored cell and temperature sensor (**TEMP-SW 20)** to measuring the temperature of that cell.

Dimensions nad mounting holes:



Connecting flat cable with orientation strip
(color marking of wire **1**)

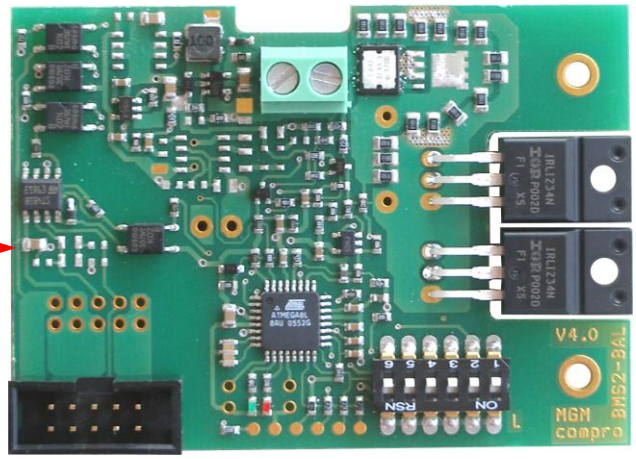
Power component **PC_x** is mounted on to the cooler **through silicone heat sink compound SP-100, DC 340, etc.,** screw M3×6 (M3×8) and spacer under screw.

***)** paste is between power element and cooler in thick uniform layer (max. ~0,05 mm).
Only to fill surface imperfections

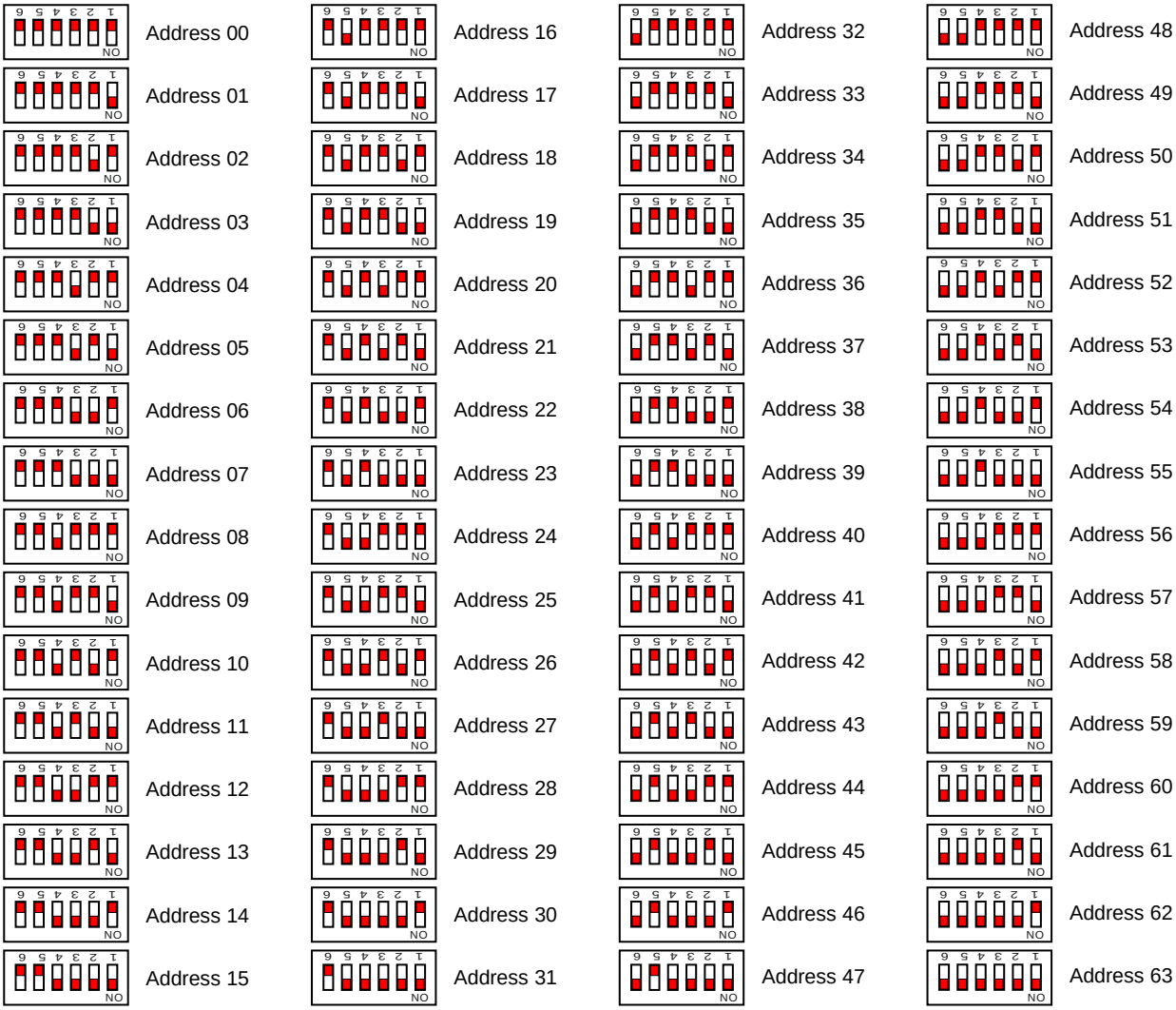
H1, H2 - mounting holes
H3, H4 - holes for cooler connection

Note.: cables for cell temperature sensor can be soldered directly to PCB without connector **K3** – this version (without K3 connector) is preferred and this is standard modification.

BMS-2-10A BAL V4.0
BMS-2-12V BAL V4.0



Module addressing



Essentially it does not matter which module, i.e. having which specific address, each cell has assigned to it. The easiest arrangement when, for example, identifying a faulty cell or a cell in poor condition, it is best to assign the lowest cell number 1 (the closest to the battery pole) the address ”00“ and assign the rest of the cells in order from there, i.e. ”01“, ”02“, and so on.

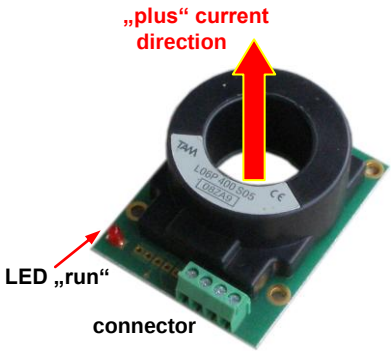
The last module on the connecting bus of each branch must be one with terminal resistors (BMS-2 BAL Vx.x ZR).
The address of the module is irrelevant; the key is to have the proper module connected to the bus in the last position (mechanically, on the end of the flat cable).

Provided the battery is mechanically separated into several elements, it is best to have modules on the end cells with auxiliary connectors (BMS-2 BAL Vx.x ACC) and connect the individual physical units via independent flat conductors with terminal connectors directly to the auxiliary connectors of the module.

Important: Within any one section may be used multiple times no address !!!

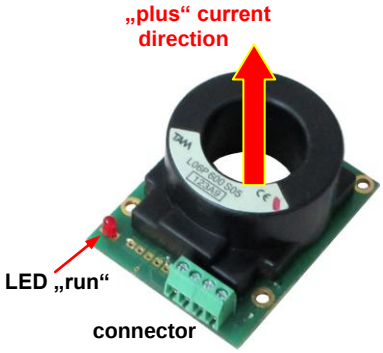
Current sensor HALL 400 B

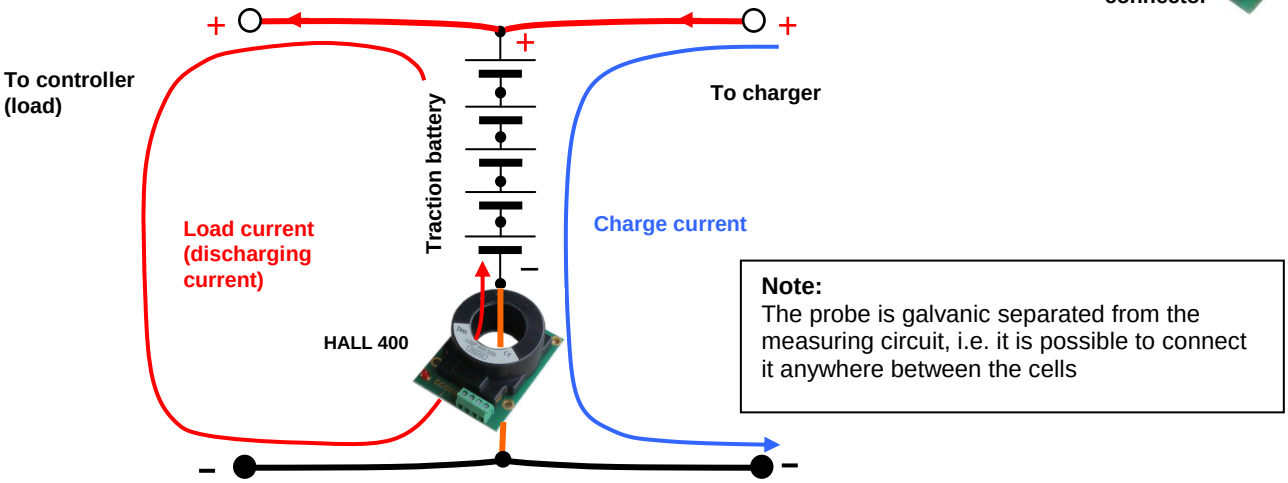
Box dimension	55 × 43 × 23 mm
Hole for current cable	Ø 22 mm
Sensing current	± 400 A
Insulating voltage	2500 VAC
supply	from control unit BMS-MAIN-xxx
Connection to current circuit	current cable through sensor hole
Orientation	Discharge current must flow through the probe as arrow direction



Current sensor HALL 600 B

Box dimension	55 × 43 × 23 mm
Hole for current cable	Ø 22 mm
Sensing current	± 600 A
Insulating voltage	2500 VAC
supply	from control unit BMS-MAIN-xxx
Connection to current circuit	current cable through sensor hole
Orientation	Discharge current must flow through the probe as arrow direction





Note:
The probe is galvanic separated from the measuring circuit, i.e. it is possible to connect it anywhere between the cells

Current probe details:

HALL 400 B / SC

(brown) **GND**
(white) **current range**
(green) **+SENSE**
(yellow) **+12V**

HALL 400 B / JST

+12V
+SENSE
Current range
GND
GND

Note: colors are relate to wires of the cable HSC-2

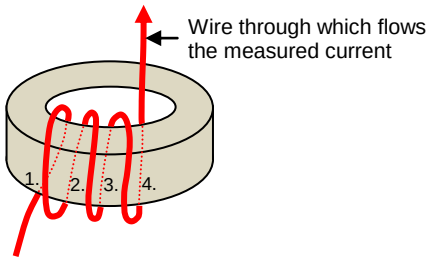
Changing the sensitivity of current probe

Standard delivery probe system has a basic sensitivity ±400A or ±600A.
If you need to change the current sensitivity of the probe (or if you prefer, so probe "current range"), it can be easily implemented as follows:

a) increase in sensitivity (decrease the current range)

Sensitivity of the probe to increase the number of times the probe (sensor hole) stretched wire, through which flows the measured current.
I.e., in other words, how many turns the sensor wires slipped so many times you increase the sensitivity of the probe.

In the example in Figure, 4 × sensor hole stretched wire, sensitivity will be increased 4 times, i.e., the resulting current range of the probe decreases from ±400A to ±100A.

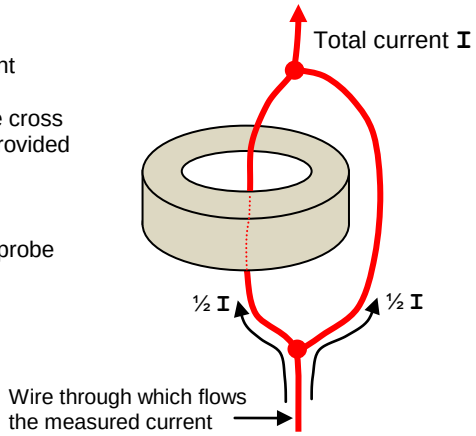


Atention ! In some applications, can be problem the increased inductance by this method (winding it around turns around the coil you create higher inductance of this wire).

b) reducing the sensitivity (increase the current range)

Sensitivity of the probe you can decrease the rate at which they divide the current flowing through the probe and the current flowing out of the probe.
The two parts of the split lines must be created equal length wires with the same cross section, of the same material and of course the joint must be precise – then is provided uniform current distribution.
Can be used the distribution ½ **:** ½ or ¼ **:** ¾

In the example shown, the current is divided into two equal parts, thus resulting probe current range is increased two times, from ±400A to ± 800A.



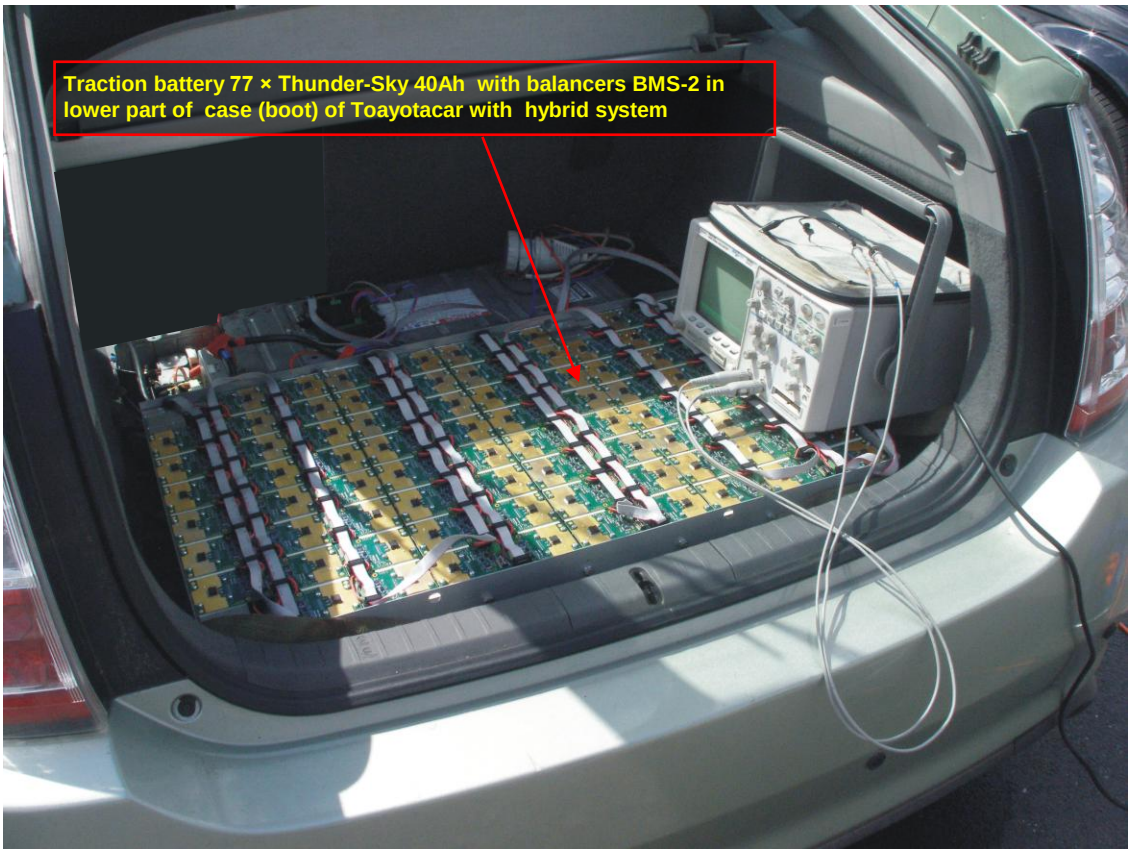
At the same time, you must set the parameter P36 corresponding to the changed range ("multiplier"), this modified probe!

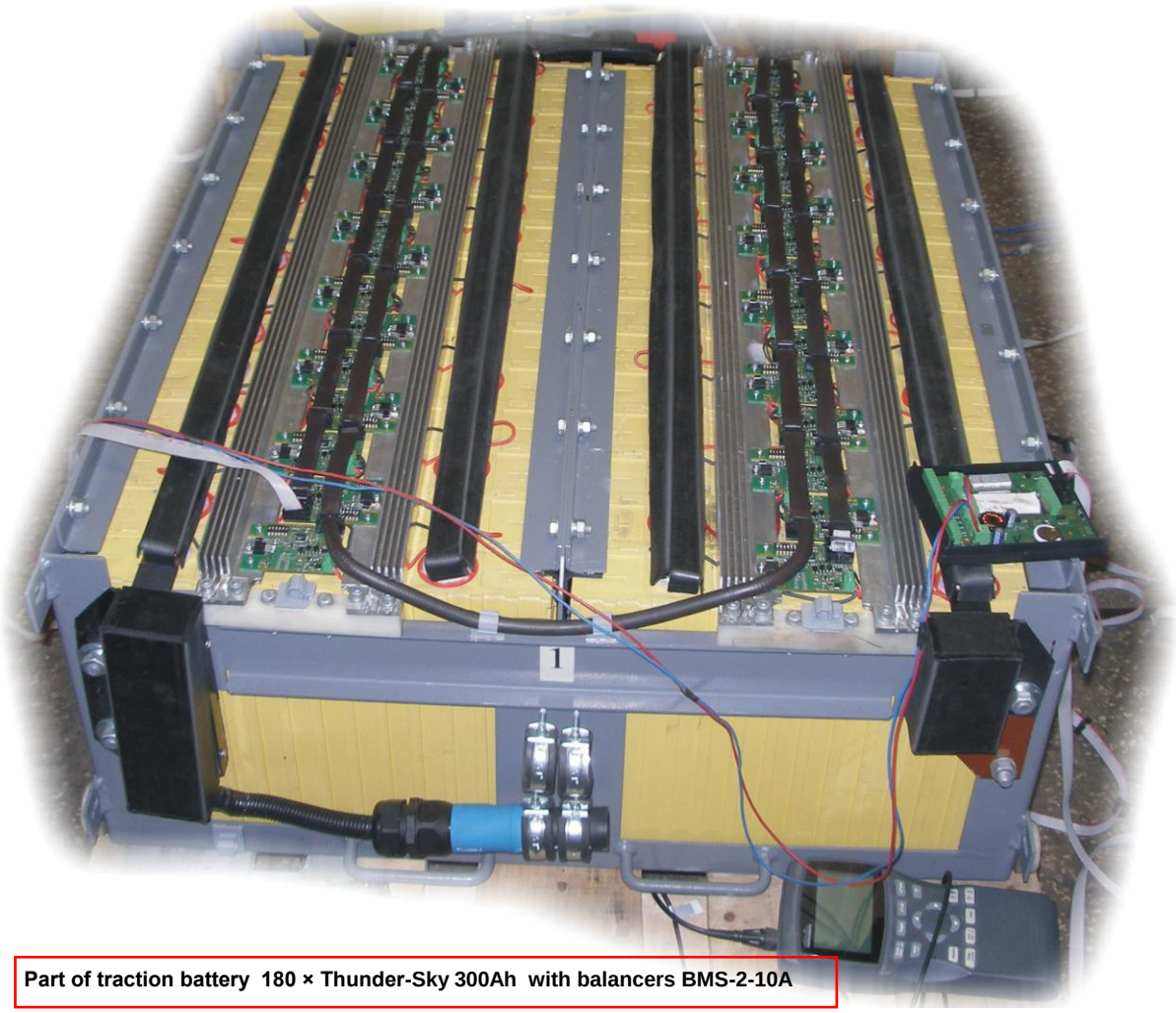
This is for 400A probe and 4 turn in case a) 100A (P36=4), in cace b) 800A (P4=0,5).

This mean with ±600A probe and dividing of cables by case **b)** distribution ¼ of the current flow through probe, ¾ outside probe, i.e. one cable go through probe, 3 the same cables go outside probe, (P36=0,25) **You can increase the current range of the ±2400A.**
On the other hand, it is possible with ±400A probe and 10 turns (P36=10) increase sensitivity 10×, i.e.. **decrease the current range of the system to ±40A**

Suitable choice probe and engaging you can change the current system sensitivity across this range, i.e. from **±40A** up to **±2400A.**

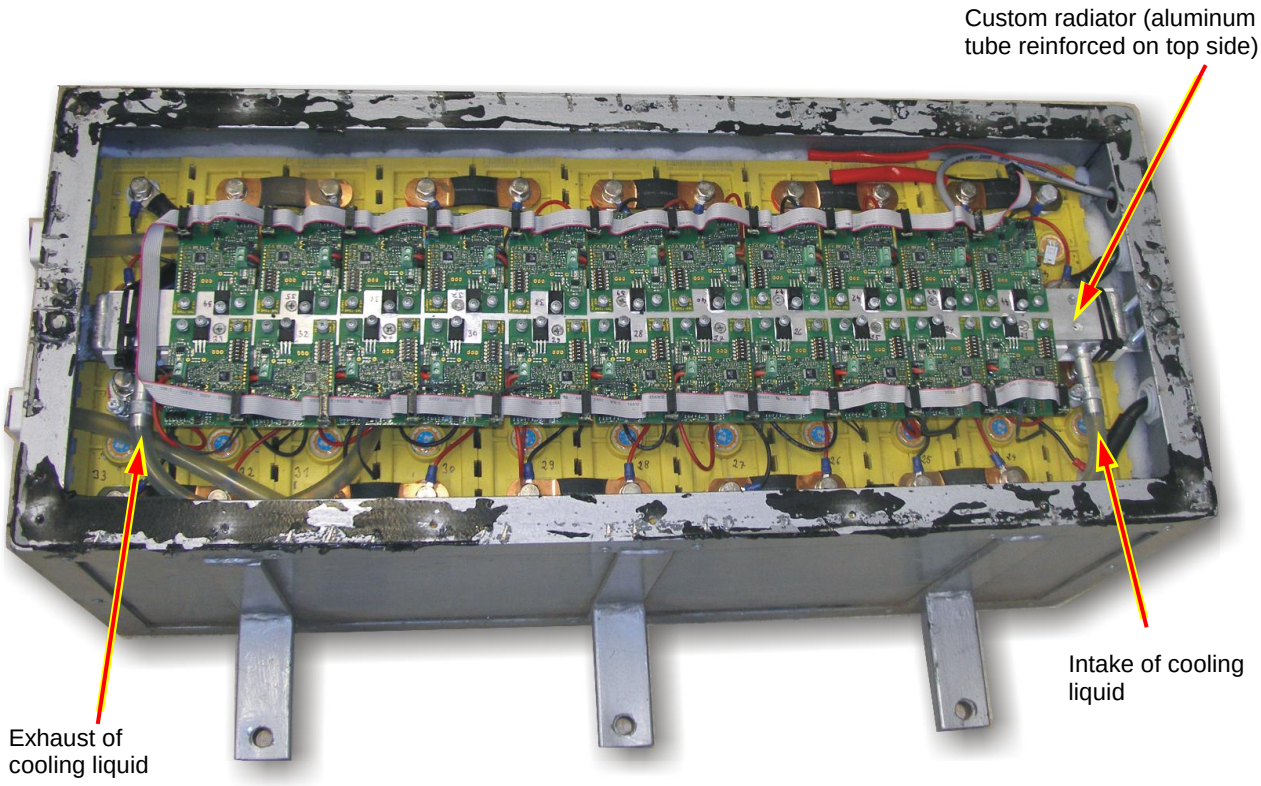
Samples.





Part of traction battery 180 × Thunder-Sky 300Ah with balancers BMS-2-10A

Half of traction battery with 44 × Thunder-Sky 100Ah cells with balancers BMS-2-5A and water cooling



Very elegant, efficient and simple method for balancers cooling by liquid, especially in fully enclosed boxes, is shown here. This is especially advantageous in devices and systems, where the liquid cooling as such no longer used for cooling the electric motor and controller. The intensity balancing is practically free limitation due to insufficient cooling, even in the worst case.
There are no problems with good cooling air distribution and use massive heatsinks with whom you can meet in air-cooled systems.
The picture is part of the sealed battery cover removed (for reasons of state inspection system) after some traveled ca 50.000 km.
Without any problems. At the edge of the box are remnants of black sealant under the cover.

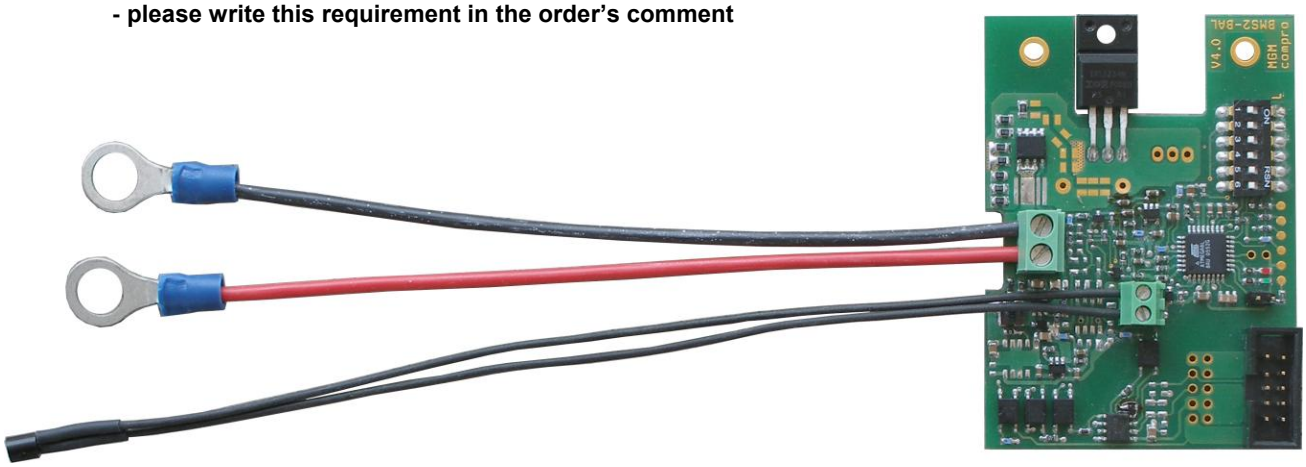
Available items.

Product	Product Code
BMS-2 MASTER-V3.3 Main Control Unit **for 64 cells**	BMS-2 MAST-64
BMS-2 MASTER-V3.3 Main Control Unit **for 128 cells**	BMS-2 MAST-128
BMS-2 MASTER-V3.3 Main Control Unit **for 192 cells**	BMS-2 MAST-192
Possibility to add 2 external temperature sensors	EXTS-2
Galvanic separated CAN	GI-CAN
Galvanic separated RS-232 or:	GI-232
Galvanic separated RS-485	GI-485
Increase humidity nad wet resistivity	WRM
Connector Phoenix Contact 2 pins, for cable	PCC-2
Connector Phoenix Contact 4 pins, for cable	PCC-4
Connector Phoenix Contact 9 pins, for cable	PCC-9
Connector Phoenix Contact 10 pins, for cable	PCC-10
Current sensor +/- 400A with 2m cable	HALL 400 B / SC / JST
Current sensor +/- 600A with 2m cable	HALL 600 B / SC / JST
Connection cable for HALL 400 B / SC, 2m	HSC-2
Module for USB connection, galvanic isolated	USBCOM 4i BMS
Connection cable (between USBCOM 4i BMS and Control unit)	CC_10
Driving SW for PC	xxxx
update SW	
BMS-2-5A BAL-V4.0 external measuring / balancing unit (**1.8V – 5.0V**)	BMS-2L BAL
BMS-2-5A BAL-V4.0 external measuring / balancing unit **with terminators**	BMS-2L BAL-ZR
BMS-2-5A BAL-V4.0 external measuring / balancing unit **with aux. connector**	BMS-2L BAL-ACC
BMS-2-10A BAL-V4.0 external measuring / balancing unit (**1.8V – 5.0V**)	BMS-2-10A BAL
BMS-2-10A BAL-V4.0 external measuring / balancing unit **with terminators**	BMS-2-10A BAL-ZR
BMS-2-10A BAL-V4.0 external measuring / balancing unit **with aux. connector**	BMS-2-10A BAL-ACC
BMS-2-12V BAL-V4.0 external measuring / balancing unit (**9V – 18V**)	BMS-2-12V BAL
BMS-2-12V BAL-V4.0 external measuring / balancing unit **with terminators**	BMS-2-12V BAL-ZR
BMS-2-12V BAL-V4.0 external measuring / balancing unit **with aux. connector**	BMS-2-12V BAL-ACC
Temperature Sensor KTY 81-210	TEMP-S
Temp. Sensor KTY 81-210 with cable RADOX (up to 30 cm)	TEMP - SW xx
Extra flexible cables (pair) 1.0 mm^2 with silicon insulation (up to 30 cm)	SC 1.0 - xx
Extra flexible cables (pair) 1.0 mm^2 with silicon insulation (up to 30 cm) (with cable lugs with hole 6, 8, 12 or16 mm)	SCO 1.0 - xx / 6 / 8 / 12 / 16
Only for BMS-2-10A BAL-V4.0:	
Extra flexible cables (pair) 1.5 mm^2 with silicon insulation (up to 30 cm)	SC 1.5 - xx
Extra flexible cables (pair) 1.5 mm^2 with silicon insulation (up to 30 cm) (with cable lugs with hole 6, 8, 12 or16 mm)	SCO 1.5 - xx / 6 / 8 / 12 / 16

(Parameter xx specify requested cables length in cm – when no specify, delivery is 15 cm length)

Flat connecting cable (module connecting)	FC-10 (delivery in footage)
Connector 10 pin for flat cable (module connecting)CON-10	CON-10
Auxiliary 10 pin connector for BMS-2 BAL-V24 module (sets connecting)	ACC-10

Note: Modules BMS-2(L) BAL xxx can be delivered with mounting temperature sensor and with cables and cable lugs **- please write this requirement in the order's comment**



Parts and Accessories

ACC-10 connector for PCB of module BMS-2 BAL V4.0

CON-10 connector for flat cable

Flat cable FC-10 for module connecting

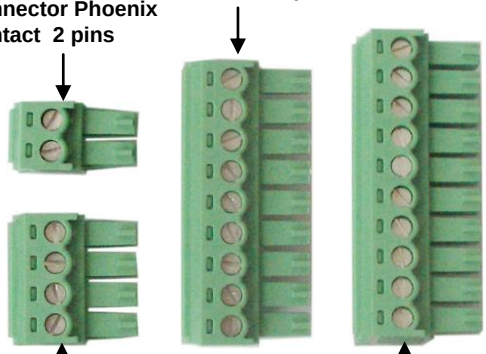
Flat cable with force on connectors CON-10

Pink marking of wire No. 1 (connection with connector's pin 1)

Extra flexible cable (pair) „SCO 1.0 - xx / D" resp. „SCO 1.5 - xx / D" with cross section 1.0 mm^2 or 1.5 mm^2 with silicone insulation and a cable lugs 6, 8, 12 or 16mm, with lenth specify by "xx" parameter (<30 cm).

Connector Phoenix Contact 2 pins

Connector Phoenix Contact 9 pins



Temperature sensor with Radox cables, TEMP-SW30
(length < 30 cm specification by customer request)

Connector Phoenix Contact 4 pins

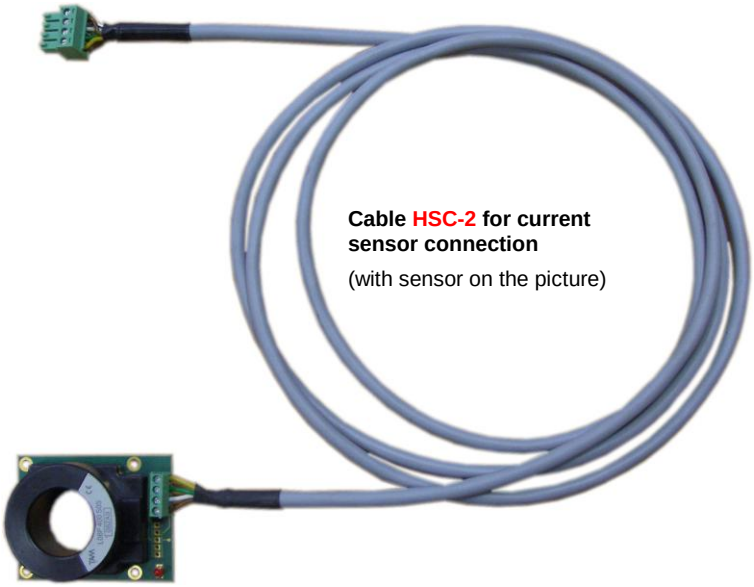
Connector Phoenix Contact 10 pins

To the „C" connector of Control unit

Current sensor HALL 400 B / xxx:
(different connectors)

HALL 400 B / SC

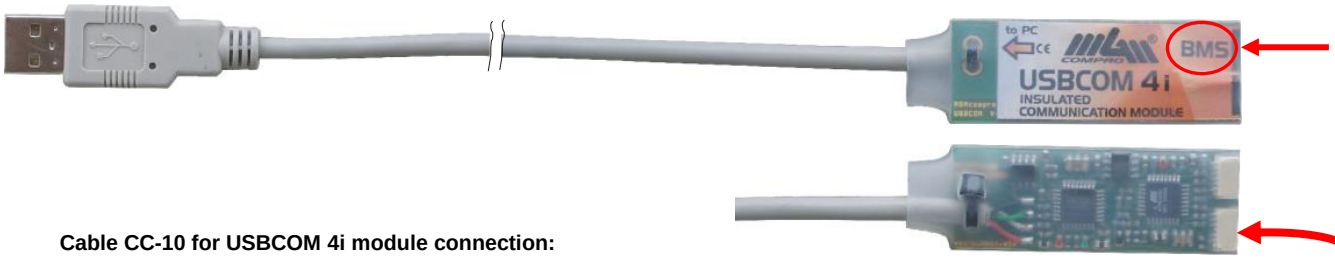
HALL 400 B / JST



Cable HSC-2 for current sensor connection
(with sensor on the picture)

Proudový snímač HALL 600 B / SC:

Communication module modul USBCOM 4i BMS:



Cable CC-10 for USBCOM 4i module connection:

To „BMS“ connector

To the „H“ connector of Control unit

Product Warranty

MGM COMPRO guarantees, this product to be free from factory defects in material and workmanship. Warranty period is of 24 months from date of purchase and purchase within the EU. Warranty for purchases made outside the EU is inline with the respective legal regulations. Warranty liability shall be limited to repairing or replacing the unit to our original specifications.

The warranty may be claimed under the following conditions:
The product has been used in the coherence with the instructions for use and only for purposes stated in the instructions and provided that none of the conditions for which the warranty cannot be claimed (see below) occurred.

It is necessary to provide together with the product for repair:

- a copy of sales receipt (if a warranty repair is claimed)
- detailed description of the problem – how it occurred and what is the problem
- description of the problem, as manifested and under what conditions it happened (number of cells, type cells, capacity, …. etc.)
- your phone number and/or email address in order to allow further consultations regarding the problem

.

The warranty does not cover and therefore cannot be claimed for damages/destroys cause by:

- forced mechanical damage, crash, etc.
- chemical substances
- unqualified manipulation, incorrect installation
- any interference with the equipment (soldering, change of wires, change components, exposed circuit board etc.)
- reversal of poles
- overloading with a higher number of cells than specified
- feeding from unspecified source (e.g. mains source instead of the specified cells)
- shortcut on the output
- overload
- water or any other substances
- salt water
- operations with not recommended (not suitable) connectors
- not following the instruction in the manual or operating in conflict with recommendations or manual

The warranty also does not apply when:

- the controller or its parts are warn by regular use
- acts of God (e.g. strike by lightening)

We do reserve the right to change our product warranty at any time without prior notice.

Service and Technical Support.

Send product for service to address: **MGM COMPRO, Sv. Čecha 593, 760 01 Zlín, Czech republic, EU**

Call your questions and requests to: **+420 577 001 350** or write on: mgm@mgm-compro.cz .

Information about products, technical notes, news, recommendation: www.mgm-compro.cz

Update firmware and SW on: www.mgm-compro.cz

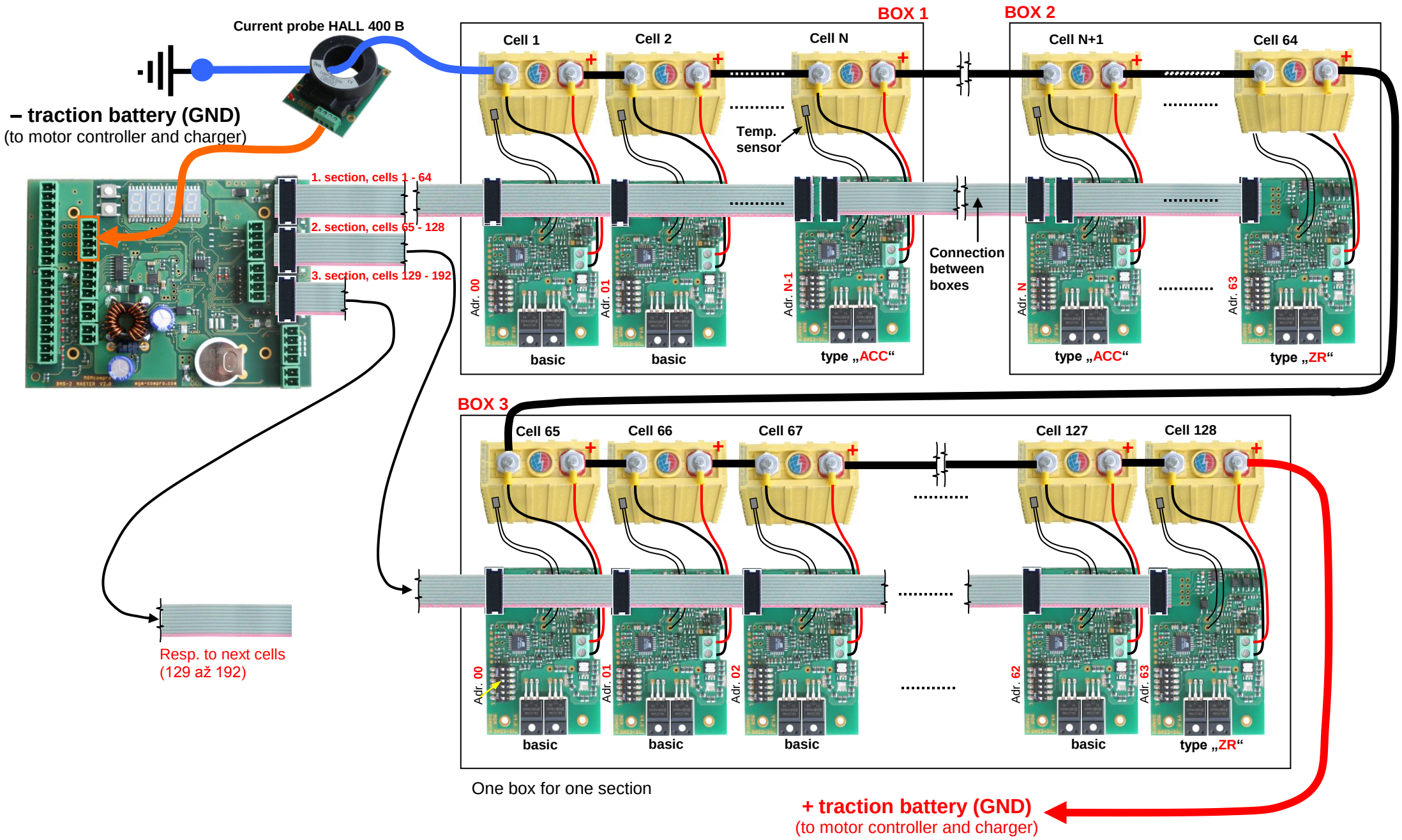
Recycling

This symbol on the product and / or accompanying documents mean that used electrical and electronic products should not be mixed with general household waste.
For proper treatment, recovery and recycling, please take these products to designated collection points, where they will be accepted on a free of charge basis.

Electromagnetic Conformity declaration CE

For these products of the BMS family we confirm that the electromagnetic compatibility directives are met.

System connection, part A



System connection, part B

*) value is depend on the battery voltage, count with initial current 5A