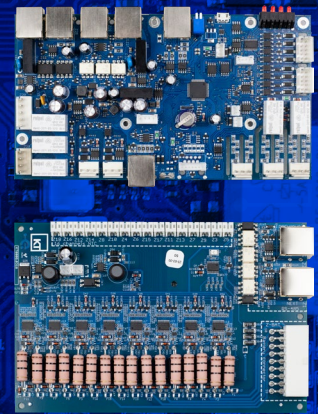


BDMS SYSTEM (BRICK DYNAMIC MANAGEMENT SYSTEM)

BMS system (Battery Management System)



1. INTRODUCTION

BMS (Battery Management System) is necessary for the proper operation of batteries based on lithium-ion cells of any type. Due to the use of BMS systems, currently used lithium-ion batteries are characterized by a high level of safety, reliability and their service life is often several thousand charge/discharge cycles. BDMS (Brick Dynamic Management System) proposed by Kon-TEC is a modular BMS system in which one master module, the Master, manages the operation of the Slave modules, to which each cell of the lithium-ion battery is connected. The following instruction is intended to familiarize the User with the functionalities of the modular BMS system and its methods for proper connection and operation.



CAUTION

Non-compliance with this documentation, by the User, may lead to damage to the BMS system, damage to batteries or individual cells, and even a fire hazard and/or an immediate health hazard of people near the battery.



NOTICE

Whenever the term battery/energy storage/energy storage battery appears in the manual, it means a series of cells connected to and managed by the BMS. These terms exist in the manual and they should be treated interchangeably anyway.

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1.A. TASKS OF THE BMS SYSTEM

- protection of the battery against unfavorable working conditions - a properly configured BMS system protects the battery, in the first place, against exceeding the nominal current-voltage operating parameters, as well as against operation in unfavorable temperature conditions,

- cell balancing - a phenomenon that, as one of the most important, negatively affects the service life and improper operation of the whole battery is unbalanced cells. Unbalance means unequal level of charge of individual cells.

The capacity of the entire battery is equal to the capacity of the weakest cell. In order to prevent unbalance, BMS systems have the function of balancing the cell voltage level in the battery,

- communication with the supervisor system - regardless of the field of application, the BMS system must most often communicate with the supervisor system. Depending on the application, it can be an EV computer, a SCADA system, a hybrid inverter of the renewable energy source installation and many others. External communication of the BMS system should be easy to configure and resistant to interference.

1.B. APPLICATION OF THE BMS SYSTEM

The BDMS system can be used with the customization of energy storage systems on request or as part of unit production. It also fulfills its role as a system that manages the operation of cells in stationary energy storage batteries of any capacity and power. Due to its features, it can be successfully used in the customization of lithium-ion batteries for electric vehicles, including electric cars. The system is universal and allows for easy scaling and customization of communication with an external management system (EV vehicle computer, SCADA system, hybrid inverter of the RES installation and many other).



QUESTIONS

Who is the Kon-TEC BMS intended for?

The Kon-TEC BMS system is intended for producers of energy storage batteries, electric and custom vehicles, solutions in the field of energy storage, manufacturers and constructors of inverters, entities integrating systems in the field of energy, including distributed and renewable energy.



BE CAREFUL

The use of the Kon-TEC BMS system requires the User's knowledge and experience in operating with batteries based on lithium-ion cells.



QUESTIONS

I assemble my own custom battery with used car cells - is the Kon-TEC BMS for me?

Used cells from electric cars can often be damaged or unbalanced. The BMS has a balancing system, but it is not a device that can reverse the process of uneven degradation of cells in a given battery (caused by differences in the internal resistance of the cells). Before connecting used cells to the BMS system, please test their internal resistance, capacity, voltage level and do the pre-balance.



BE CAREFUL

Connecting the Kon-TEC BMS system to the used cells/batteries requires the User's knowledge and experience in operating with batteries based on lithium-ion cells. You should be aware that such action, without proper precautions, may lead to damage to the BMS, damage to the battery or individual cells and even to the risk of fire and/or direct threat to health and life of people nearby batteries.

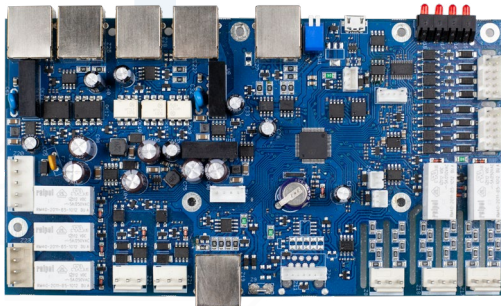


QUESTIONS

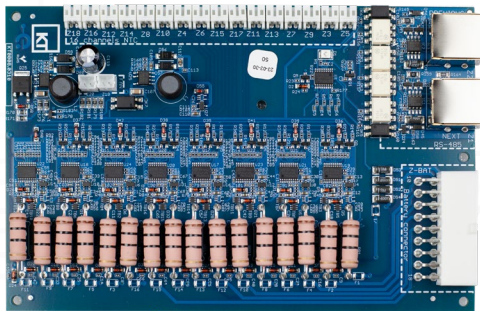
I am looking for a plug'n'play BMS system - is the Kon-TEC BMS for me?

The use of the Kon-TEC BMS system requires the User's knowledge and experience in operating with batteries based on lithium-ion cells. Proper configuration of the BMS system (including self-configuration of communication) is a prerequisite proper operation of the device. Despite the fact that the Kon-TEC BMS system has predefined communication protocols for several inverters (see Chapter 8 for more details), it is for typically professional end-user and is not a plug'n'play device.

2. TECHNICAL SPECIFICATION AND DIMENSIONS



MASTER



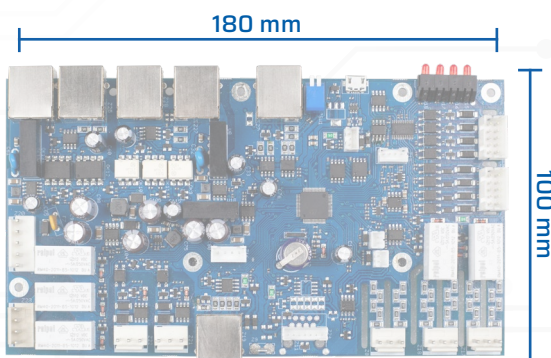
SLAVE

BMS SYSTEM TECHNICAL SPECIFICATION

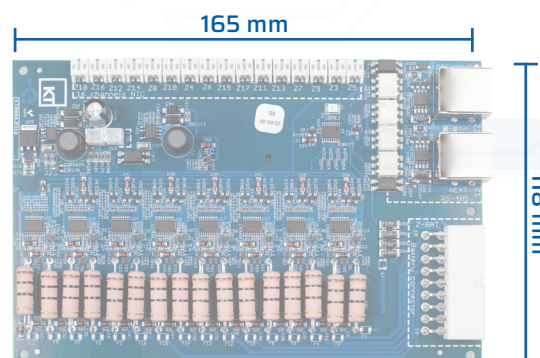
MASTER	
Supply voltage range:	11-36 VDC
Maximum battery voltage:	980VDC
Maximum number of cells: (series system):	196
Voltage measurement accuracy:	+/- 1 V
Current measurement range:	- 200 to 200 A
Working mode power consumption:	+/- 0,1 A
Working mode power consumption:	7,2W
Standby mode power consumption:	0,2 W
Operating temperature:	- 40°C to 85°C
Communication interfaces:	CAN & RS485
Communication protocols:	CAN, MODBUS RTU

SLAVE	
Single cell voltage range:	1,00 - 4,95 V
Balancing current:	< 500 mA
Single cell voltage measurement accuracy:	+/- 0,05 V
Standby mode current consumption:	100 uA
Working mode current consumption:	12mA
Operating temperature:	- 20°C to 85°C
Cell voltage sampling time:	0,1s

The user access application enables full self-configuration of the BMS system by the user, for the used battery/cell type.



MASTER



SLAVE

3. SYSTEM STRUCTURE

The BDMS system consists of a Master management module and Slave modules connected to it. Master is the module that manages the entire energy storage/battery/battery of cells, which communicates with the slave modules via a separate (opto-isolated) communication bus. The Master module also communicates with any external system (hybrid inverter, EMS, SCADA system), using the CAN or RS485 communication interface. Slave module has a cell voltage, temperature measurement and cell balancing system.

3.A. MASTER MODULE

Master is the module that manages the entire energy storage; communicates with other modules via optical separated (optoisolated) communication bus. The Master module has a battery current and voltage measurement, USB communication interface for configuration and diagnostics and configurable digital inputs and outputs, enabling control of external devices cooperating with energy storage system.

The Master module also acts as an intermediary between the energy storage system and the outside world, providing an interface and by transferring a number of diagnostic and functional data to the supervisor system (management systems fleet/control/monitoring/SCADA).

The software of the Master module analyzes the data transmitted by individual Slave modules and makes decisions about starting and completion of the balancing process. It also monitors the charge/discharge current of the entire battery, calculates the actual battery state of charge (SOC), monitors the trend of battery capacity changes with successive charging cycles (SOH), supports thermal, voltage and current protections and handles any failures reported by slave modules. This software also supports communication of the Master module to the outside world using the CAN or RS485 communication interface.



QUESTIONS

Can I view battery parameters in real time?

The Master module is equipped with a USB communication interface for configuration and diagnostics that connects to the User's Access Application. In the User's Access Application, it is possible to display any parameters of the battery (more in Chapter 8), however, this is a configuration solution, not a long-term energy storage battery monitoring solution. For the latter purpose, it is necessary to communicate with the BMS system using the shared one CAN or RS485 communication interface and any supervisor device (it can be a computer acting as server). In future versions of the BMS, it is also planned to make the operator panel/display module available.

3.B. SLAVE MODULE

Slave is a module that manages a single series of cells, which is controlled by the Master module simultaneously independently performing functions of protecting the cells, connected to it, against failures. The Slave module has a measuring system of cell voltage and temperature, and the balancing system of individual cells. The Slave module is available in the Slave Passive 16S version with passive balancing and Slave Active 7S version with active balancing.

The Slave module software measures the cell voltage and temperature. Based on the measurements, it decides whether balancing is possible and safe. The above measurements are transferred to the Master module software and a decision is made there, whether balancing of individual series is necessary. Slave module, based on Master module decision to start balancing, begins the above-mentioned process by selecting the balancing parameters to the current voltage and temperature, relative to target voltage. All balancing parameters can be defined in the User Access Application (more in Chapter 8). In case of detected failure, the Slave module informs the Master module about its occurrence and takes action steps for safe operation and problem solving.



BE CAREFUL

In the case of the Slave Passive 16S module, an even number, from 10 to 16, of lithium-ion cells of any type can be connected to the module.

4. SECURITY MEASURES

The Master module and each of the Slave modules included in the system have a number of safeguards to ensure efficient operation of the energy storage battery. The system continuously monitors the voltage and current of the main bus of battery and the voltage of each cell. Depending on the number of temperature sensors connected by the user, the BMS system also has a temperature monitoring function of each cell. If any of the user-defined thresholds is exceeded (more in Chapter 8), actions are taken to avoid failure of the device connected to the BMS. Information about exceeding operating parameters is also transferred to the superior system in the form of an alarm. Communication loss between the Slave modules and the Master module disconnects the battery from the load. The following safety parameters of the entire battery and individual cells can be configured:

- Maximum allowable voltage of the entire battery,
- Minimum allowable voltage of the entire battery,
- Maximum charging current,
- Maximum voltage of single cell,
- Minimum voltage of single cell,
- Maximum battery charging temperature,
- Minimum battery charging temperature,
- Maximum operating temperature of the battery,
- Minimum operating temperature of the battery.

The BMS system also protects the battery from the following phenomena, regardless of the set parameters:

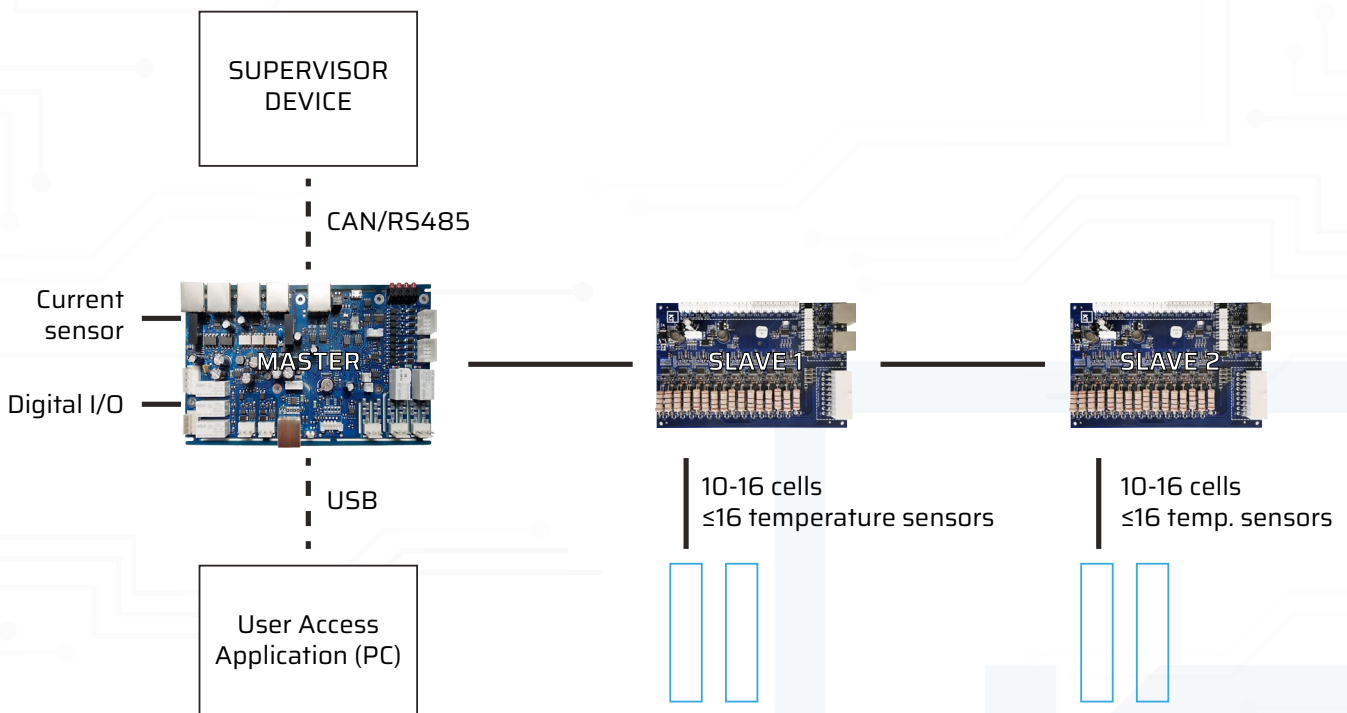
- Short-circuit current (short-circuit of the main terminals of the battery connected to the BMS),
- Deep discharge – the BMS system will always disconnect the battery in the event of a decrease in the battery charge level (SOC parameter) to zero (or appropriately earlier, depending on the User's definition).

CAUTION

Appropriate definition of safety parameters is crucial for the correct operation of the battery connected to the BMS system and has a significant impact on the life of both individual cells and the entire battery.

5. EXTERNAL AND INTERNAL CONNECTIONS

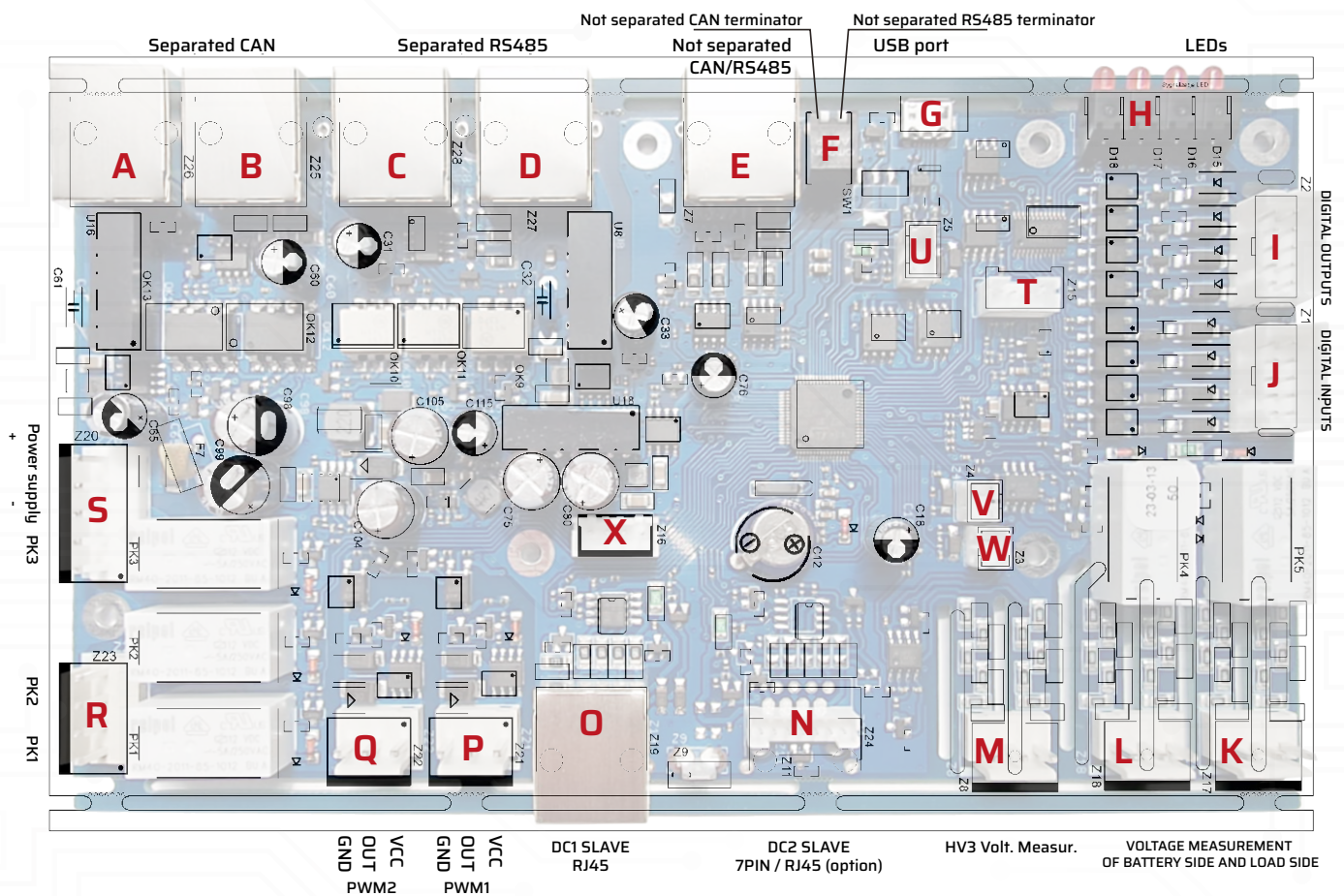
The general connection architecture of the Kon-TEC BMS system is shown in the figure below:



The Master module connects with an opto-isolated RS422 serial bus with an internal device protocol with any number of slave modules, with the first Slave module connecting to the Master module and each subsequent Slave module connecting with the preceding Slave module. The Master module connects via CAN or RS485 protocol to the supervisor device (hybrid inverter, EMS, SCADA system). The User can independently define communication protocol frames in the User Access Application. In order to configure the entire BMS system, the User connects to a PC, on which the Application is installed, via USB. The Hall current sensor and digital inputs and outputs can be connected to the Master module. Slave modules are connected to individual cells. Any number of cells (at least one) can be equipped with NTC100 temperature sensors connected to individual Slave modules.

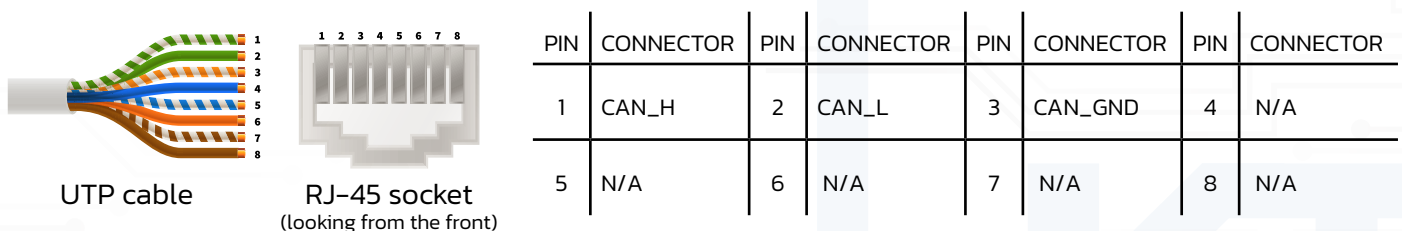
5.A. MASTER- CONNECTION INTERFACES

The connection interfaces of the Master module are shown in the figure below. In the description of each connection, the type of plug is given and in the case of non-standard plugs - the pin arrangement used in the socket connection is also given.

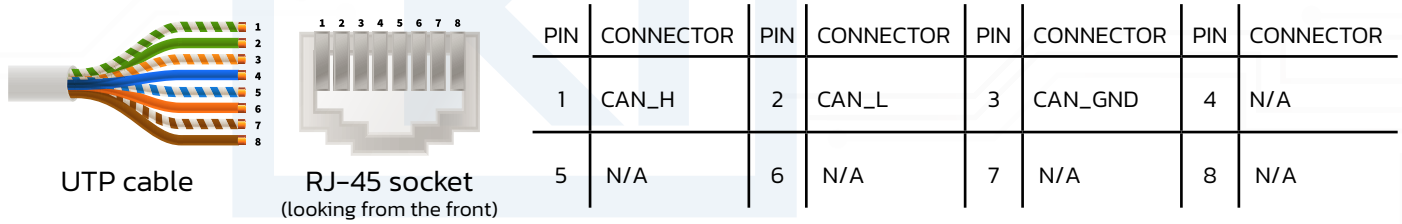


Below, the individual connection interfaces are described along with their role and the type of physical connection:

A. (Z26) CAN separated, connection in Daisy Chain option (chain input by default), RJ45 plug in Modicon standard, pins from the left, looking from the front of the connector:



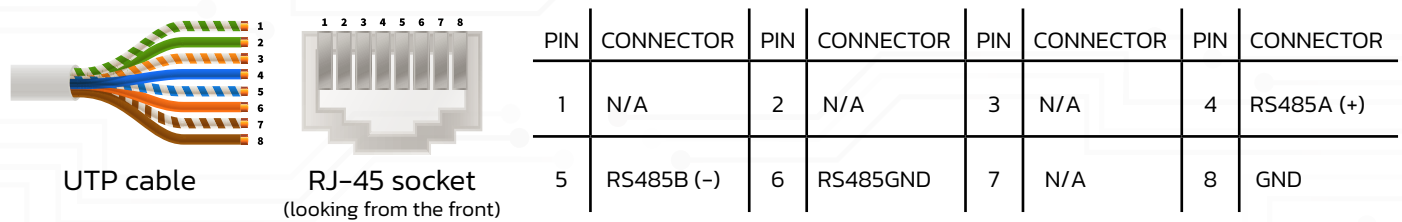
B. (Z25) CAN separated, connection in Daisy Chain option (chain output by default), RJ45 plug in Modicon standard, pins from the left, looking from the front of the connector:



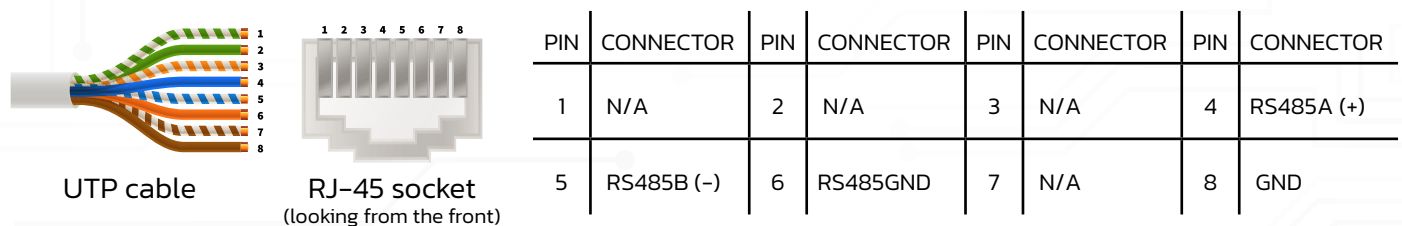
CAUTION

The last of the Daisy Chain modules should be terminated with a termination resistor (terminator) for CAN open located between pins 1 and 2. An example of commercially available terminator TCSCAR013M120

C. (Z28) MODBUS RTU/RS485 separated, Daisy Chain type connection, RJ45 plug in Modicon standard, pins from the left, looking from the front of the connector:



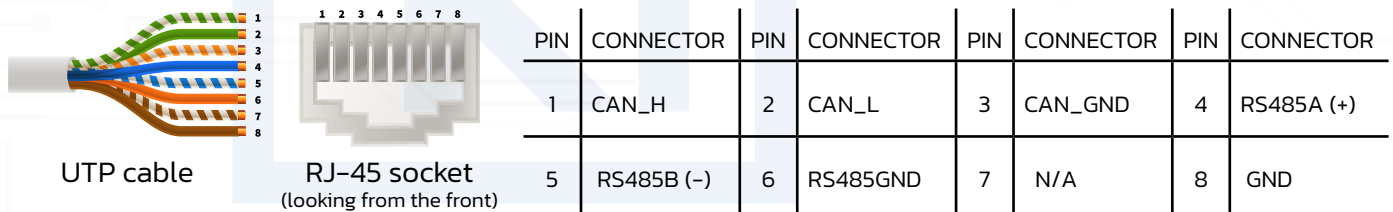
D. (Z27) MODBUS RTU/RS485 separated, Daisy Chain type connection, RJ45 plug in Modicon standard, pins from the left, looking from the front of the connector:



CAUTION

The last of the Daisy Chain modules should be terminated with a terminating resistor (terminator) to RS485 open located between pins 4 and 5. An example of a commercially available VW3A8306RC terminator.

E. (Z7) CAN/RS485 non-separated, plug for connecting CAN or RS485 communication in non-separated version, RJ45 plug in the Modicon standard, pins from the left, looking from the front of the connector:

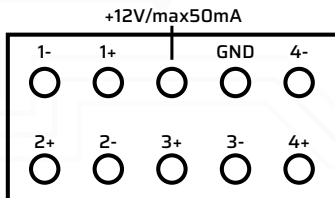


F. (SW1) DIP Switch for selecting the correct terminating resistor depending on the protocol used communication (NOT SEPARATED CAN or NOT SEPARATED RS485)

G. USB connector for connection to a computer and the User Access Application (more about UAA support in Chapter 8), microUSB plug, type A, device connector, connection creates a virtual COM port in the computer

H. (D15 .. D18) 4 service LEDs

I. (Z2) 4 digital outputs separated (from the system and between each other) + 1 non-separated power supply output OUT1 12V/50mA, HIROSE DFIBZ socket, 2.5 mm raster, 2 rows of 5 pins in a row, top view in the figure, output current max. 0.1A, output voltage 0-28V



TIP

The OUT1 power output can be used, for example, to handle the LED signaling diodes informing about the occurrence a certain state on the digital output

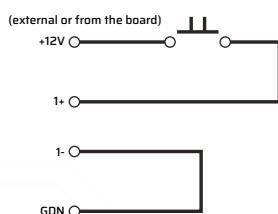
CAUTION

The current of 50mA is the maximum current that can flow simultaneously from the OUT1 power output and from the power output OUT2. If, for example, the OUT1 output is loaded with a current of 30mA, then from the OUT2 output we can supply a maximum of 20mA

CAUTION

OUT1 power output is **not separated** (unlike other digital outputs)

J. (Z1) 4 digital inputs separated (from the system and between each other) + 1 non-separated power supply output OUT2 12V/50mA, HIROSE DFIBZ socket, 2.5 mm raster, input voltage 5-28V, current consumption 5.6mA
An exemplary digital input connection diagram is presented below:



TIP

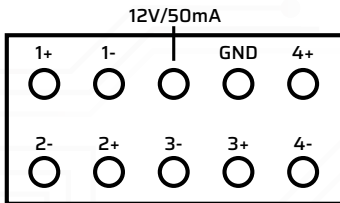
The OUT2 power output can be used, for example, to handle relays or switches that supply a specific power supply signal to the digital inputs

CAUTION

The current of 50mA is the maximum current that can flow simultaneously from the OUT1 power output and from the power output OUT2. If, for example, the OUT1 output is loaded with a current of 30mA, then from the OUT2 output we can supply a maximum of 20mA

CAUTION

OUT2 power output is **not separated** (unlike other digital outputs)



- K. (Z17)** Voltage measurement of battery side and load side, measurement relative to ground +/- 1kV, CviLux plug, CI52 series, 3.96mm raster, 3 pins (two positive voltage poles, viewed from the front from the left, 1 load side „plus” and 3 battery side „plus”, middle pin 2 not connected)
- L. (Z18)** Voltage measurement of battery side and load side, measurement relative to ground +/- 1kV, CviLux plug, CI52 series, 3.96mm raster, 3 pins (two negative voltage poles, viewed from the front from the left, 1 load side „minus” and 3 battery side „minus”, middle pin 2 not connected)
- M. (Z8)** Voltage measurement at any point, differential measurement 0-1kV, CviLux plug, CI52 series, 3.96mm raster, 3 pins (negative and positive pole of the measured voltage, looking from the front from the left 1 „plus” and 3 „minus” of the measured voltage, middle pin 2 not connected)
- N. (Z24)** In the current version, the 7-pin connector of the slave module for previous versions of the slave module, CviLux plug, CI01 series, 2mm raster, 7 pins

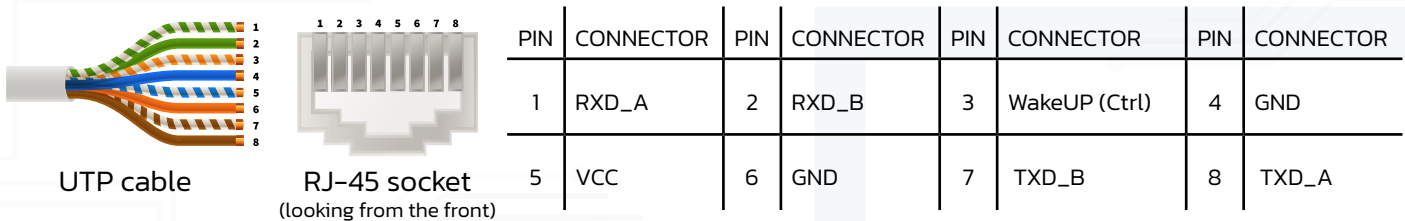
CAUTION

The connector is not intended for use by the User, it is used only as a service connector

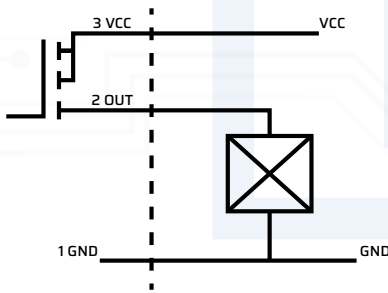
CAUTION

In future versions of the device, the connector will be replaced with an RJ45 plug, a combined patch cord, for the second (parallel) row of slave modules. The arrangement of pins in the connector is identical to the Z19 connector

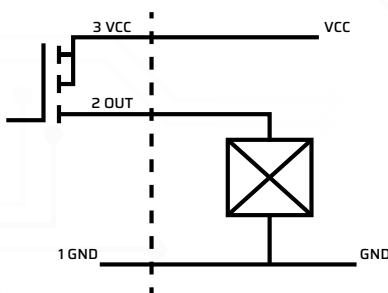
- O. (Z19)** Connector of the first series of Slave modules, RJ45 plug, connected with a patch cord, pins from the left, looking from the front of the connector:



P. (Z21) Low-frequency PWM1 output, galvanically separated, 0 – 100Hz, e.g. for fan control, 10-24V, 1A, CviLux plug, CI52 series, 3.96mm raster, 3 pins on the front from the left side 1 GND, 2, OUT, 3 VCC, PWM receiver connection diagram below:



Q. (Z22) Low-frequency PWM2 output, galvanically separated, 0 – 100Hz, e.g. for fan control, 10-24V, 1A, CviLux plug, CI52 series, 3.96mm raster, 3 pins on the front from the left side 1 GND, 2, OUT, 3 VCC, PWM receiver connection diagram below:



R. (Z23) Relay outputs, potential-free relay contact with maximum parameters 125V/4A, CviLux plug, CI52 series, 3.96 mm raster, 4 pins from the front, from the left, 1 PK2 make contact (negative pole contactor), 2 PK2 make contact (negative pole contactor), 3 PK1 make contact (precharge contactor), 4 PK1 make contact (precharge contactor)

CAUTION

More information about the wiring diagram and the role of the precharge contactor is given in Chapter 6

S. (Z20) Relay outputs, potential-free relay contact with maximum parameters 125V/4A, CviLux plug, CI52 series, 3.96 mm raster, 4 pins from the front, from the left 1 Power supply of contactors +, 2 Power supply of contactors -, 3 PK3 make contact (positive pole contactor), 4 PK3 „Neutral” contact (positive pole contactor), 5 PK3 break contact (positive pole contactor)

CAUTION

Considering the contacts of the PK3 contactor, it should be remembered that always two poles (pair 3 and 4 or 4 and 5) will be short-circuited (make contact or break contact) – always remember to properly connect the make contacts/break contacts for proper operation of the system

CAUTION

More information about the connection diagram is given in Chapter 6

T. (Z15) Connection of the Hall sensor (e.g. DHAB S/124 LEM), CviLux plug, CI01 series, 2mm raster, 4 pins, cut-out at the bottom of the plug looking from the top of the board, from the left 1 +5V, 2 high-current range, 3 GND, 4 low-current range

U. (Z5) One Wire plug, e.g. for connecting a temperature sensor (e.g. DS18B20), CviLux plug, CI01 series, 2mm raster, 3 pins, cut-out at the bottom of the plug looking from the top of the board, from the left 1 VCC (+5V), 2 data, 3 GND

V. (Z4) Optional NTC temperature sensor, (typically NTC sensors are connected to the Slave module, this connector is not supported in the application), CviLux plug, CI01 series, 2mm raster, 2 pins, cut-out at the bottom of the plug looking from the top of the board, from the left 1 NTC, 2 GND

CAUTION

In its current version, the connector is not intended for use by the User and is not supported by the User Access Application

W. (Z5) Optional NTC temperature sensor (typically NTC sensors are connected to the Slave module, this connector is not supported in the application), CviLux plug, CI01 series, 2mm raster, 2 pins, cut-out at the bottom of the plug looking from the top of the board, from the left 1 NTC, 2 GND.

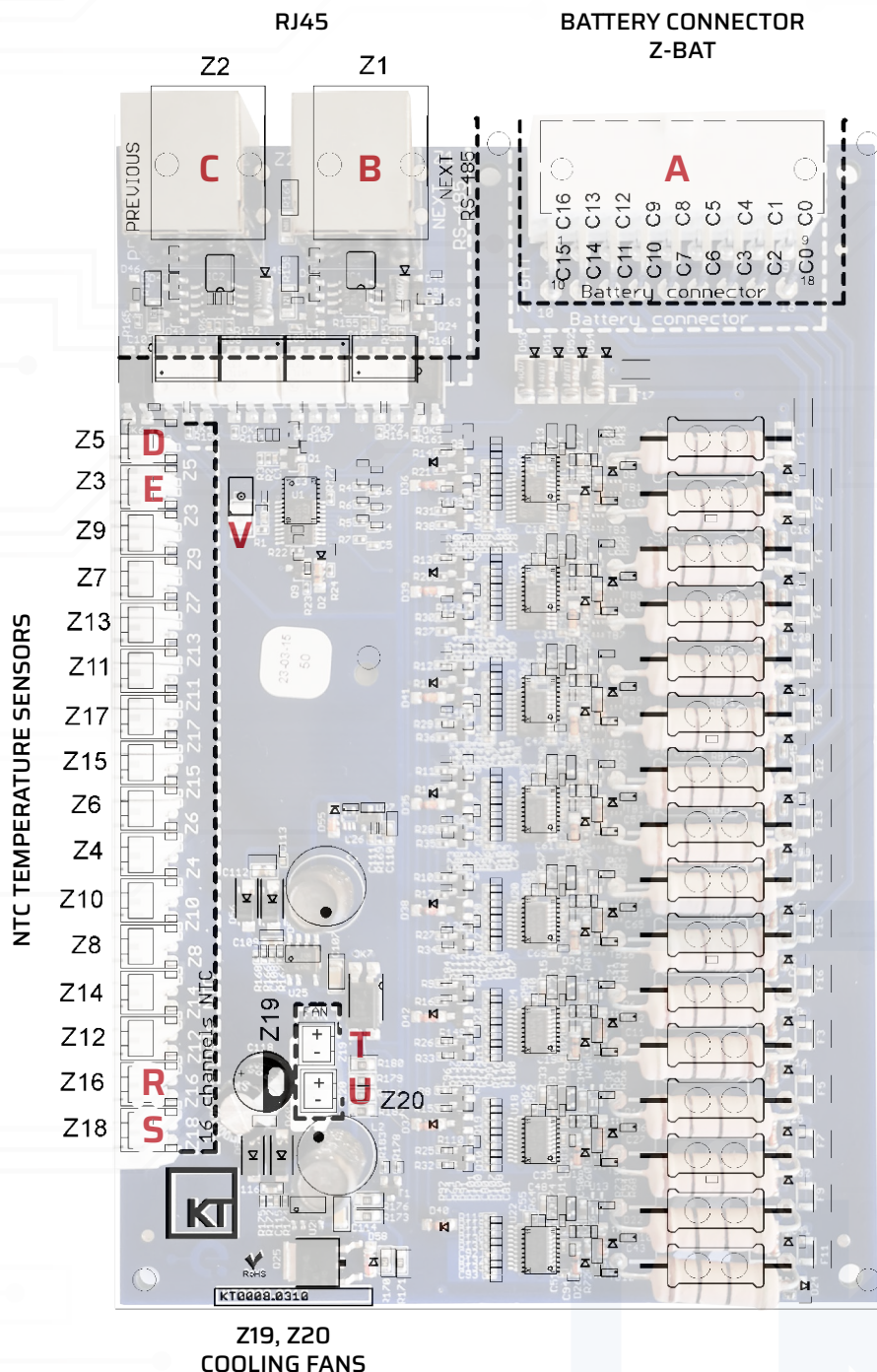
CAUTION

In its current version, the connector is not intended for use by the User and is not supported by the User Access Application

X. Current sensor connection (current transformer, for example LEM HAS 50A-600A), Joint Tech A2501H-4P plug, 2.5mm raster, 4 pins, cut-out at the bottom of the plug looking from the top of the board, from the left 1 GND, 2 Out, 3 -15V, 4 +15V

5.B. SLAVE - CONNECTION INTERFACES

Connection interfaces of the Slave module are presented in the figure below. It is given in the description of each connection type of plug and in the case of non-standard plugs - the arrangement of pins in the connection socket is also given.



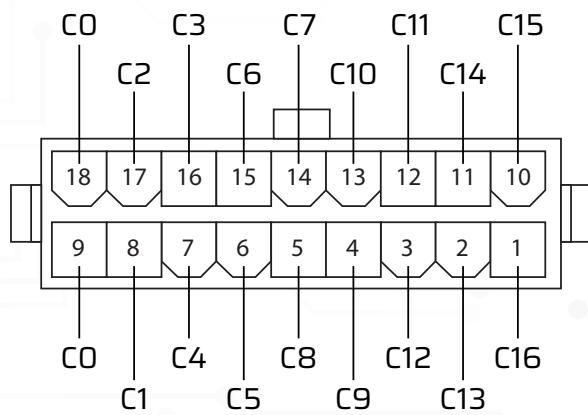
Below, the individual connection interfaces are described along with their role and the type of physical connection:

A. Angled connector for connecting individual cells, (blocking latch from above), Cvilux CP-01418150 18-pin (2 rows, 9 pins each row)

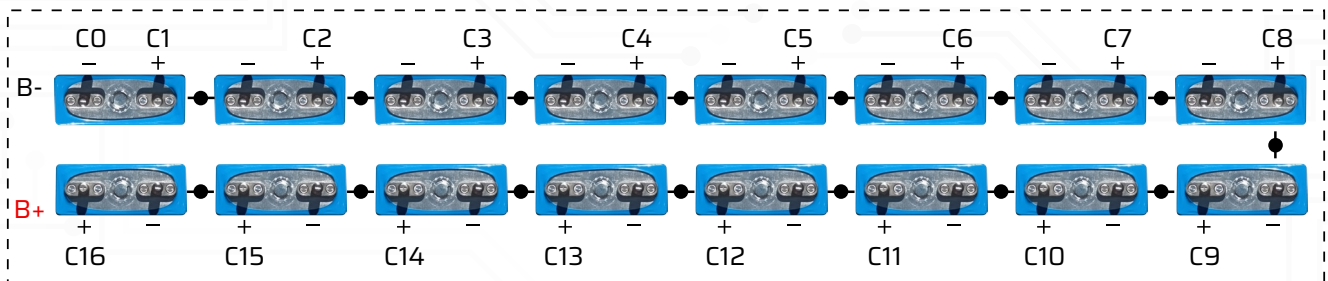
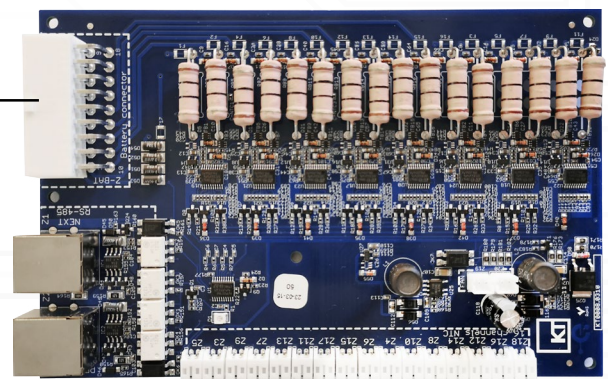
PIN	CONN.	PIN	CONN.	PIN	CONN.	PIN	CONN.	PIN	CONN.	PIN	CONN.	PIN	CONN.	PIN	CONN.	PIN	CONN.
18	(C0) cell 1-	17	(C2) cell 2+/3-	16	(C3) cell 3+/4-	15	(C6) cell 6+/7-	14	(C7) cell 7+/8-	13	(C10) cell 10+/11-	12	(C11) cell 11+/12-	11	(C14) cell 14+/15-	10	(C15) cell 15+/16-
9	(C0) cell 1-	8	(C1) cell 1+/2-	7	(C4) cell 4+/5-	6	(C5) cell 5+/6-	5	(C8) cell 8+/9-	4	(C9) cell 9+/10-	3	(C12) cell 12+/13-	2	(C13) cell 13+/14-	1	(C16) cell 16+

CONN. - CONNECTOR

SOCKET A FRONT SIDE



SLAVE



! BE CAREFUL

Pins 9 and 18 are factory-connected together, so connect C0 to one or both of them at once

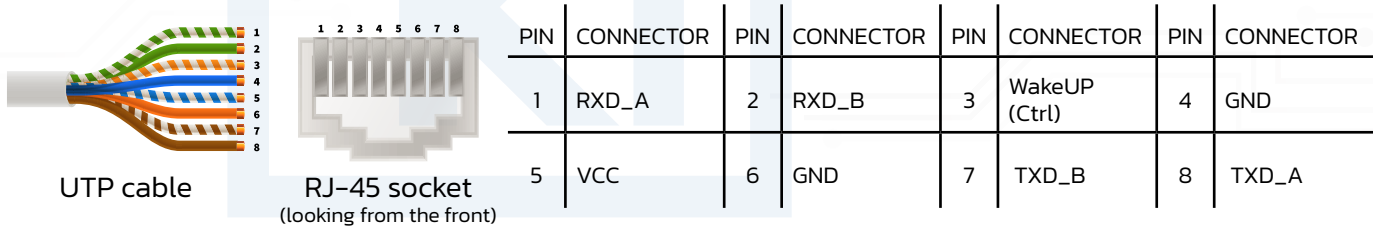
! BE CAREFUL

Connecting the wires of the cells in connector A requires User's knowledge and experience in operating with batteries based on lithium-ion cells. If any doubt about the proper connection of the cells, contact the device supplier.

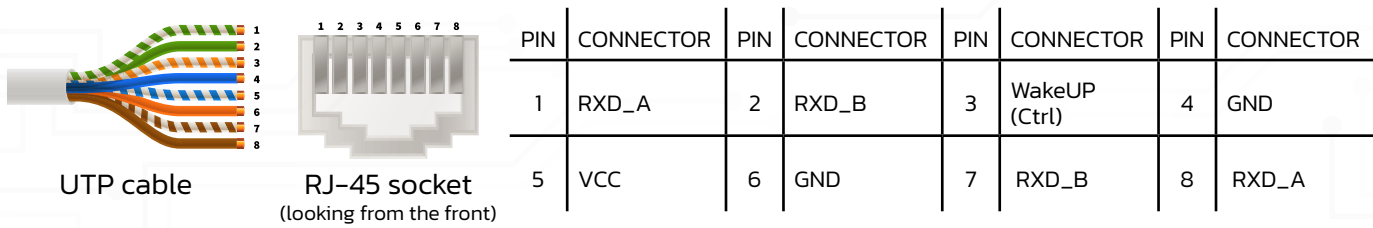
! CAUTION

Incorrect connection of the cell terminals in connector A, as well as improper insulation of the wires, can lead to short-circuits, and thus damage to the BMS system, damage to the battery or individual cells, and even to the danger of fire and/or direct threat to health and life of people nearby the battery.

B. (Z1) Slave module connector, the input port can be connected to the output of the next slave module, RJ45 plug, wired patch cord type, pins from the left, looking from the front of the connector:



C. (Z2) Slave module connector, the output port can be connected to the Master module input or to the previous Slave module input, RJ45 plug, connected with a patch cord, pins from the left, looking from the front of the connector:



D. (Z5) NTC temperature sensor, angled CviLux plug, CIO1 series, 2mm raster, 2 pins, cut-out on the top of the plug looking from the front, from left 1 NTC15(NTC+), 2 C14(NTC-)

E. (Z3) NTC temperature sensor, angled CviLux plug, CIO1 series, 2mm raster, 2 pins, cut-out on the top of the plug looking from the front, from left 1 C14(NTC-), 2 NTC16(NTC+)

F. (Z9) NTC temperature sensor, angled CviLux plug, CIO1 series, 2mm raster, 2 pins, cut-out on the top of the plug viewed from the front, from left 1 NTC13(NTC+), 2 C12(NTC-)

G. (Z7) NTC temperature sensor, angled CviLux plug, CIO1 series, 2mm raster, 2 pins, cut-out on the top of the plug looking from the front, from the left 1 C12(NTC-), 2 NTC14(NTC+)

H. (Z13) NTC temperature sensor, angled CviLux plug, CIO1 series, 2mm raster, 2 pins, cut-out on the top of the plug looking from the front, from the left 1 NTC11(NTC+), 2 C10(NTC-)

I. (Z11) NTC temperature sensor, angled CviLux plug, CIO1 series, 2mm raster, 2 pins, cut-out on the top of the plug looking from the front, from the left 1 C10(NTC-), 2 NTC12(NTC+)

J. (Z17) NTC temperature sensor, angled CviLux plug, CIO1 series, 2mm raster, 2 pins, cut-out on the top of the plug looking from the front, from left 1 NTC9(NTC+), 2 C8(NTC-)

K. (Z15) NTC temperature sensor, angled CviLux plug, CIO1 series, 2mm raster, 2 pins, cut-out on the top of the plug looking from the front, from the left 1 C8(NTC-), 2 NTC10(NTC+)+C+

L. (Z6) NTC temperature sensor, angled CviLux plug, CIO1 series, 2mm raster, 2 pins, cut-out on the top of the plug looking from the front, from left 1 NTC7(NTC+), 2 C6(NTC-)

M. (Z4) NTC temperature sensor, angled CviLux plug, CIO1 series, 2mm raster, 2 pins, cut-out on the top of the plug looking from the front, from the left 1 C6(NTC-), 2 NTC8(NTC+)

N. (Z10) NTC temperature sensor, angled CviLux plug, CIO1 series, 2mm raster, 2 pins, cut-out on the top of the plug looking from the front, from left 1 NTC5(NTC+), 2 C4(NTC-)

O. (Z8) NTC temperature sensor, angled CviLux plug, CIO1 series, 2mm raster, 2 pins, cut-out on the top of the plug looking from the front, from the left 1 C4(NTC-), 2 NTC6(NTC+)

P. (Z14) NTC temperature sensor, angled CviLux plug, CIO1 series, 2mm raster, 2 pins, cut-out on the top of the plug looking from the front, from left 1 NTC3(NTC+), 2 C2(NTC-)

Q. (Z12) NTC temperature sensor, angled CviLux plug, CIO1 series, 2mm raster, 2 pins, cut-out on the top of the plug looking from the front, from the left 1 C2(NTC-), 2 NTC4(NTC+)

R. (Z16) NTC temperature sensor, angled CviLux plug, CIO1 series, 2mm raster, 2 pins, cut-out on the top of the plug looking from the front, from left 1 NTC1(NTC+), 2 C0(NTC-)

- S. (Z18) NTC temperature sensor, angled CviLux plug, CI01 series, 2mm raster, 2 pins, cut-out on the top of the plug looking from the front, from left 1 CO(NTC-), 2 NTC2(NTC+)
- T. (Z19) Fan 1 power plug, angled CviLux plug, CI01 series, 2mm raster, 2 pins, cut-out on the top of the plug looking from the front, from the left 1 GND, 2 VCC/12V
- U. (Z20) Fan 1 power plug, angled CviLux plug, CI01 series, 2mm raster, 2 pins, cut-out on the top of the plug looking from the front, from the left 1 GND, 2 VCC/12V

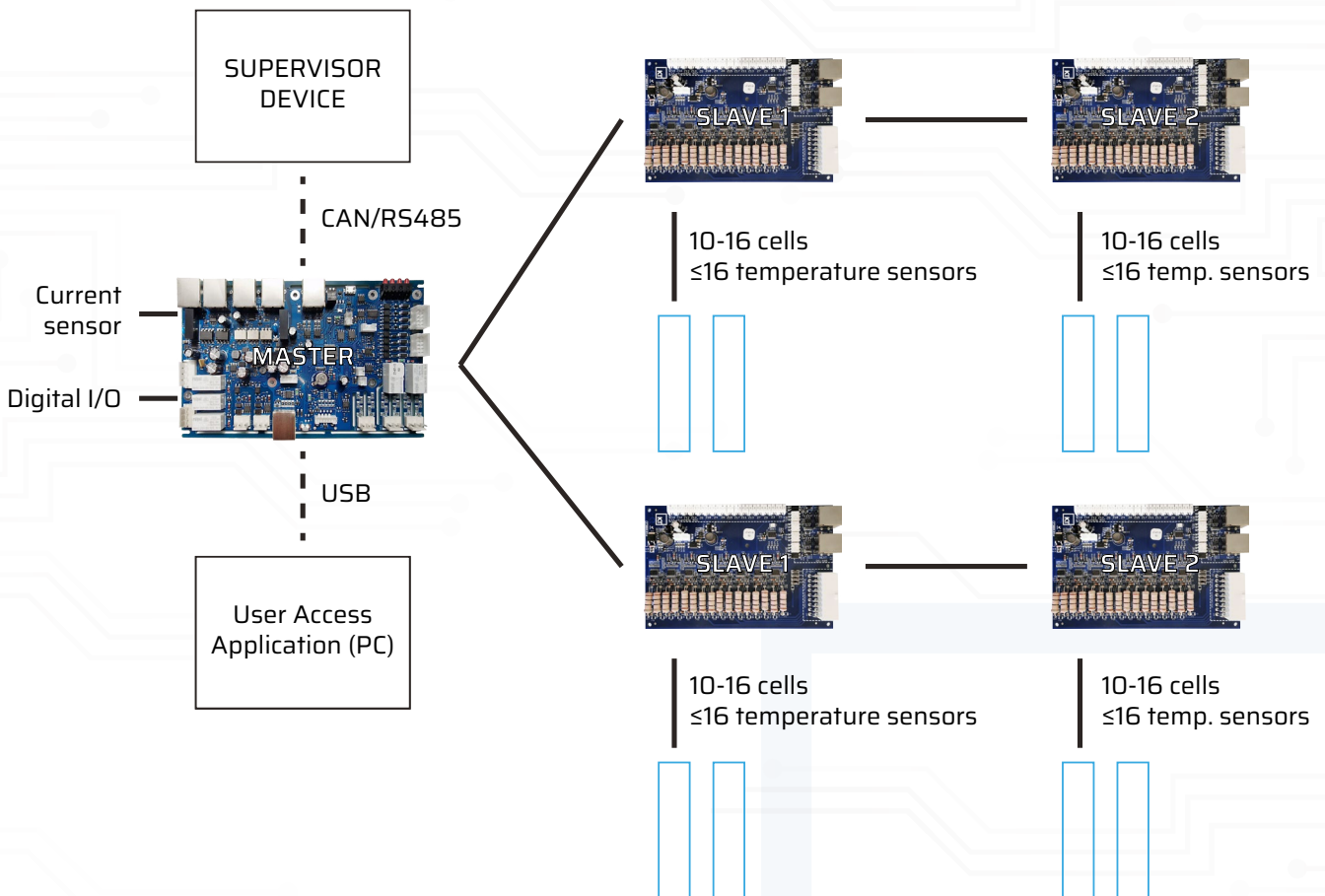
CAUTION

At least one NTC temperature sensor should be connected to the cell/battery of cells as necessary management of thermal charge/discharge curves by BMS

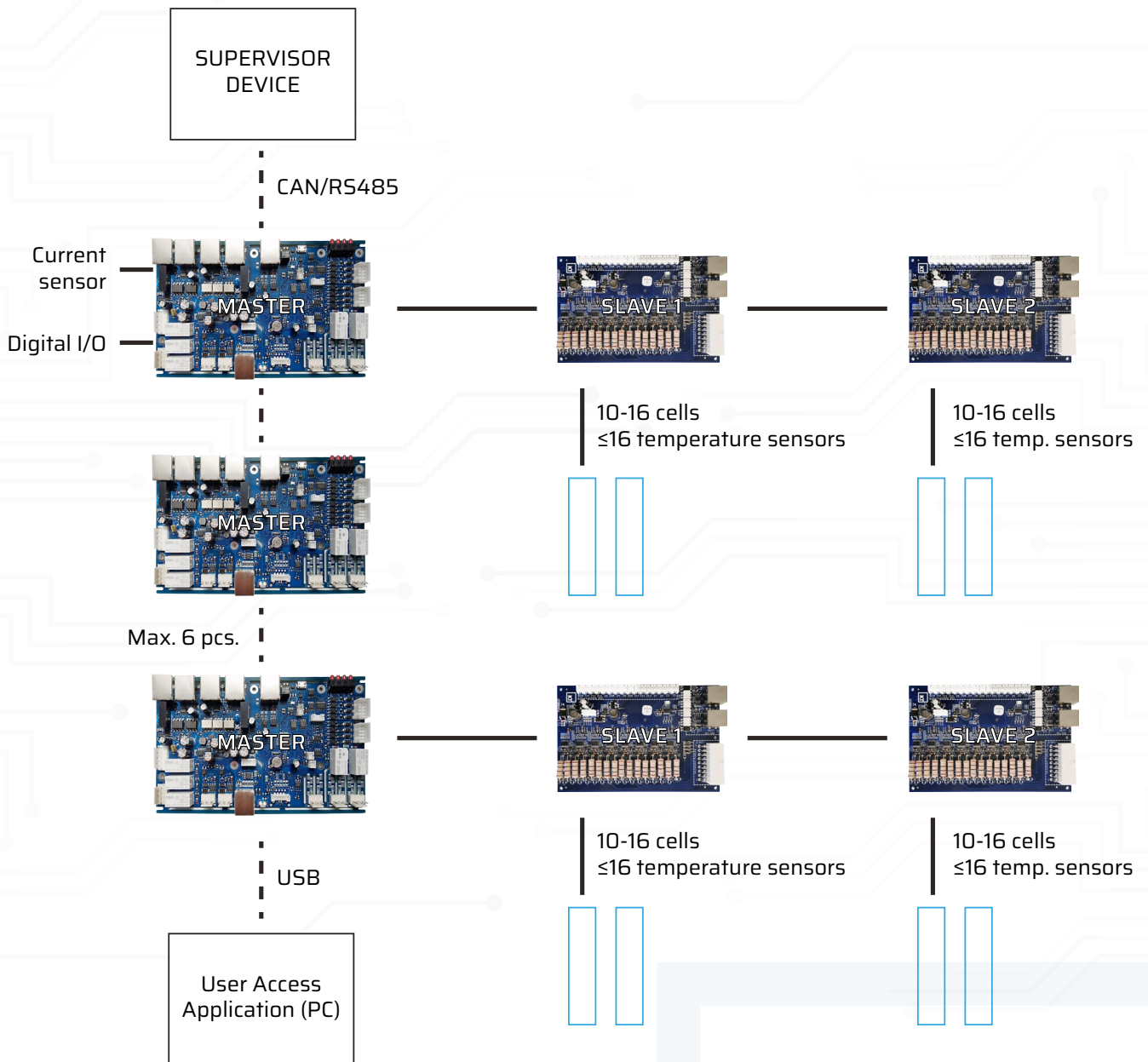
V. Communication LED

5.C. SERIES-PARALLEL CONNECTION OPTION

In addition to connecting cells in series, connecting the first Slave module to the Master module and then connecting it to it further Slave modules, it is also possible to connect several serial branches in parallel. We can do this in two ways. In the first method, you can connect two series of cells to one Master module in parallel (two inputs for Slave modules described in Chapter 5 item A). This method is currently available and is shown in the figure below



In future versions of the device, the possibility of connecting parallel series of cells, connected to Master modules, communicated with supervisor module Master, will be added. In this case, the Master modules are connected with each other using CAN/RS485 separated protocol in the Daisy Chain option, with one Master module acting as the supervisor and communicating with the superior system (hybrid inverter, EMS system, SCADA). In this way, we can connect up to six Master modules. For the reason stated above, the communication topology of the Master module is referred to as serial-parallel.



5.D. CAN/RS485 COMMUNICATION

The Master module supports two basic external communication protocols allowing for simple configuration with external systems, such as hybrid inverters in RES installations, EMS systems, SCADA systems in industrial plants. Supported communication protocols are CAN and RS485 – both in separated and non-separated versions.

In the case of the non-separated version, both for the CAN and RS485 protocols, plug into the E (Z7) connector of the RJ45 type in Modicon standard (pin list presented in point A. of this Chapter) and set in the correct position switch F (SW1) selecting the protocol by which we want to communicate.

In the case of the separated version of the CAN protocol, plug into connectors A (Z26) and B (Z25) of the RJ45 type (pin list presented in point A. of this Chapter) – it is a Daisy Chain connection.



CAUTION

Note that if the Master module is the last Daisy Chain module in a larger system communication, it should be terminated with a termination resistor (terminator) to CAN open placed in between pins 1 and 2

In the case of the separated version of the RS485 protocol, plug into the C (Z28) and D (Z27) connectors of the RJ45 type (pin list presented in point A. of this Chapter) – it is a Daisy Chain connection.



CAUTION

Note that if the Master module is the last Daisy Chain module in a larger system communication, it should be terminated with a termination resistor (terminator) to RS485 open placed in between pins 4 and 5.

After properly connecting the Master module to the communication chain, we can configure the CAN/RS485 communication using the User Access Application – more on this in Chapter 8.

5.E. DIGITAL INPUT AND OUTPUT PORTS

The Master module has the functionality of freely configurable digital input and output ports by the User. Exact the current/voltage parameters of the ports, as well as examples of their potential connections, are described in subsection A of this chapter. Due to the functionality of digital input/output ports, there is no need for additional control devices (e.g. PLC drivers), if we need to create a simple logic based on controlling several digital signals. This increases the universality and functionality of the BMS system, allows you to reduce the cost of the entire system and easy management of functions control, dependent on the battery parameters, managed by the BMS system (e.g. alarm signals, necessary signals to manage the temperature/humidity in the area where the battery is located).



NOTICE

All digital inputs and outputs are separated from each other and from the Master module



CAUTION

Please note that if we use the 12V/50mA supply voltage available in the digital input and output connectors (more in sub-section A. of this Chapter) to power the relays, which then go to the digital input, then the given input will not be galvanically separated (**supply voltage is not separated**).



CAUTION

Attention! In the current version of the software, defining the logic of digital inputs and outputs is not configurable from the level of User Access Application. In order to use this functionality, it is necessary to contact the Manufacturer.

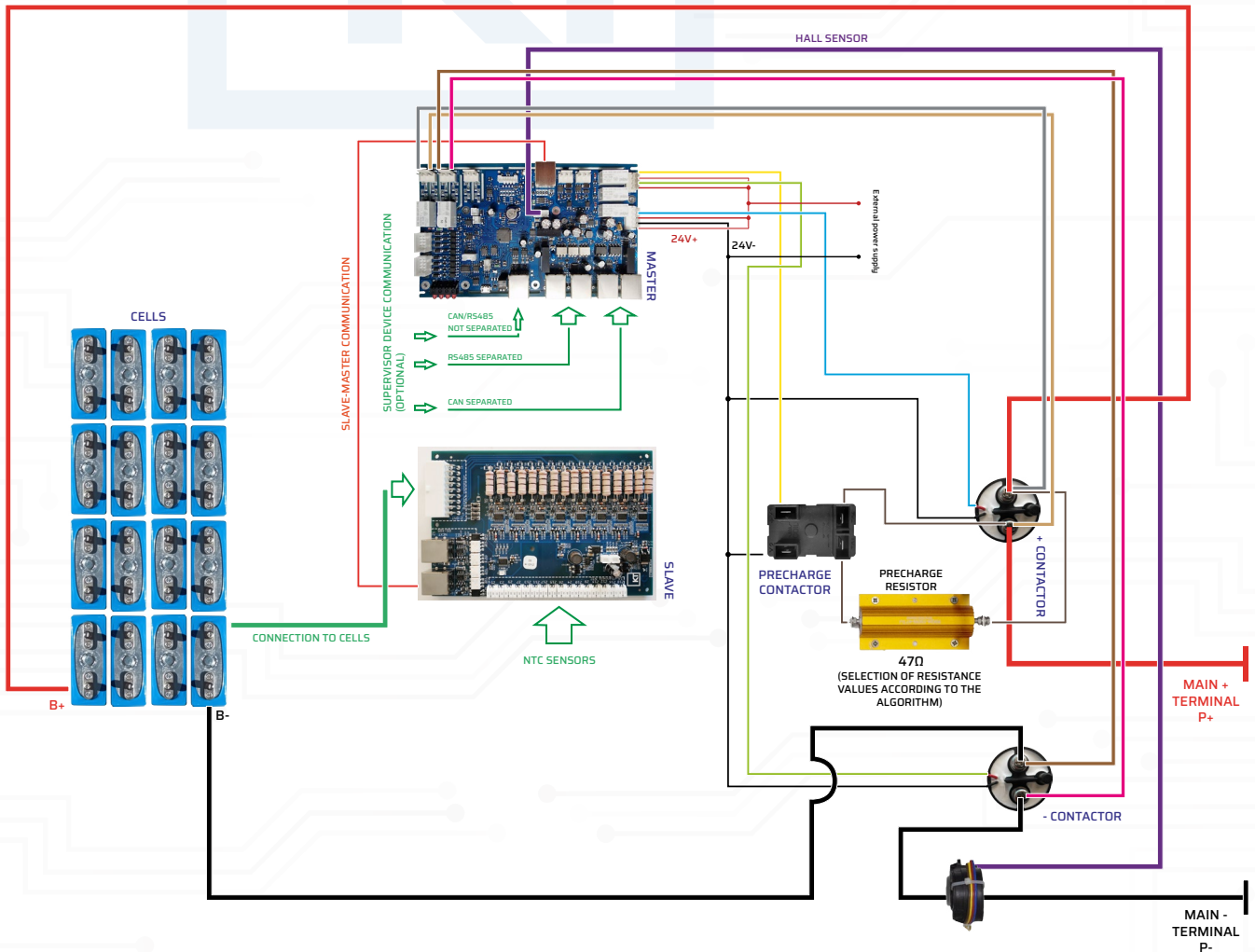
5.F. PWM OUTPUTS

Due to two PWM outputs P (Z21) and Q (Z22) we can easily control devices such as fans, making low-frequency generated signal, e.g. from the temperature conditions of the area in which the battery is located.

An exemplary PWM connection diagram, as well as the current parameters of the PWM outputs, are given in subsection A of this chapter. More information about defining the parameters of the PWM outputs in the User Access Application is given in Chapter 8.

6. CONNECTION DIAGRAMS

Below is a basic diagram of connecting the BMS system to the battery, along with a description of individual connections and their connections role



6.A. PRECHARGE CONTACTOR AND ITS ROLE

Any battery system should be connected to the load system by the main contactor. The BMS system is equipped with relay outputs that allow you to disconnect both the negative pole of the battery (PK2) and the positive pole of the battery (PK3). In both cases, the signals from the relays are transferred to the main contactor of the battery (one or two if both relay inputs are used simultaneously). Full disconnection of the battery poles (both positive and negative) is necessary for some applications, e.g. related to fire hazard.

In addition, in most battery systems connected to high-power loads, it is recommended to use a precharge contactor. The BMS has a precharge contactor relay (PK1). The reason for using a precharge contactor is:

Typically, there are capacitive elements on the load side, which we can think of as a large capacitor. At the time, when we turn on a high voltage battery (> 100V), there is a rapid charge of capacitors on the load side and due to the large potential difference between the contacts of the contactor, a dangerous spark discharge is created. In the extreme cases, this discharge may lead to melting of the contactor contacts, and thus permanent damage to the switching system, the entire battery, the load system and/or fire, and even threat to the life of people nearby the battery.



CAUTION

For the reasons described in the paragraph above, it is recommended to use a precharge contactor in most implemented battery systems. Not using the precharge contactor may lead to permanent damage to the switching system, the entire battery, the load system and/or fire, or even endanger the life of people nearby the battery.

**BE CAREFUL**

If you have doubts and are not sure whether it is worth using a precharge contactor in a given application – for safety best apply it. Resignation from its use should be supported by knowledge about the nature of the load connected to the battery.

For the reason given above, before the main battery contactor closes, the precharge contactor, after which a high power resistor is also connected, is turned on. Such a system allows for a slow increase in the voltage of the system and safe activation of main contactor a few seconds after the precharge contactor has been switched on.

**CAUTION**

The resistance value of the resistor, cooperating with the precharge contactor, depends on the power, capacitance and nature of the load system that is connected to the battery. This value should be selected in accordance with the available precharge resistor selection algorithms. Incorrect selection of the resistance value may result in damage to the device/battery or the entire system.

7. TECHNICAL FUNCTIONALITIES

The Kon-TEC BMS system has a number of technical functionalities that distinguish it from the competition and the choice of our BMS system makes it unique for User technical possibilities, previously unavailable in products offered on the market.

7.A. SOC

The BMS system allows the User to monitor trends related to charge/discharge cycles. Rated parameters SOC are defined in the User Access Application (more on this in Chapter 8). For correct measurement of parameter, it is necessary to connect a current sensor, any supported type, to the BMS. In order to increase accuracy of the SOC measurement, the SOC correction function has been implemented – more on this in Chapter 8

7.B. SOH

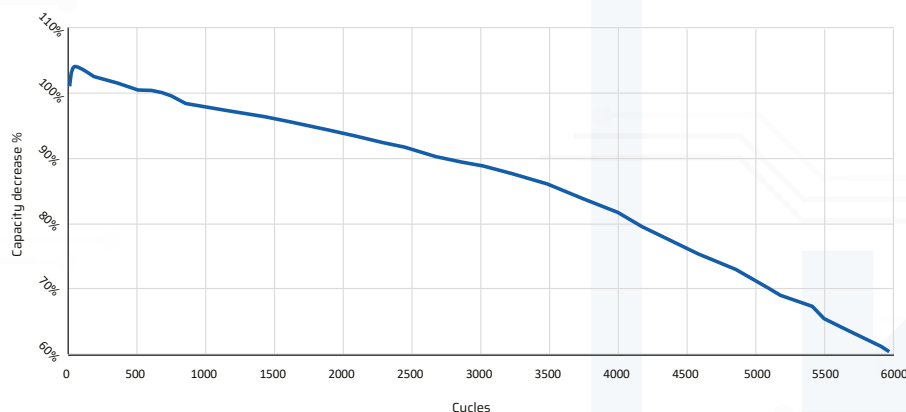
SOH is a parameter that gives user the information regarding to the degradation of the maximum battery charge level with successive charge/discharge cycles. Due to this, the User obtains accurate status information about used batteries, which facilitates the planning of possible service actions and extends the service life of batteries. In order to proper functionality of the SOH parameter monitoring function, it is necessary to define the ratings SOC parameters in the User Access Application (more on this topic in Chapter 8) and connecting the current sensor, any supported, to the BMS system.

Typically, any type of lithium-ion battery has a non-linear decrease in SOH with each cycle.

We can observe three basic areas of behavior of the SOH parameter:

- in the first phase, lasting about a dozen or so cycles, there is a relatively rapid decrease in the SOH parameter by 1%–2% of the initial value,
- in the second phase, corresponding to the rated number of cycles declared by the cell manufacturer, a slow, approximately linear decrease in the value of the SOH parameter to approx. 80% of the initial value of the parameter,
- in the third phase, after the decrease of the SOH parameter below 80% of the initial value, its faster, non-linear decrease occurs to a value of 50% or less – in this phase the cells lose their capacitive properties, and its occurrence is signaled by the need of replacing cells/battery.

LiFePO4 cycle lifetime



7.C. POWER CONSUMPTION AND SLEEP MODE

During the development work, a problem related to too high energy consumption by the Slave modules was identified. In the prototype version of the BMS system, the slave modules consumed a current of 15mA. By changing the architecture of Slave modules and microcontroller that manages their operation, in the current version Slave modules consume a current of 3-5 mA and are equipped in the Standby sleep function, during which they consume a current of 10-20uA. It should be noted that energy consumption is one of the most important parameters of the BMS system, which affects its energy efficiency as well as efficiency of the entire battery system.

7.D. PARAMETER REGISTRATION

The BMS has the function of registering the operating parameters of the system, detecting any irregularities in the battery operation, environmental alarms detection (e.g. exceeding the permissible temperatures) in the form of service logs. The logs may be read from the level of the User Access Application in order to determine the time/reasons of the irregularities. More about this in Chapter 8.

8. HOW THE APPLICATION WORKS

The main task of the User Access Application is to enable the User to define the energy storage battery parameters, such as number of series and allowable voltages and currents. The application allows simple configuration of charging/discharging curves, temperature curves (including thermal protection) and cell series options. With the application it is also possible to monitor, in real time, the voltages of individual cells or the voltage and current of the entire battery, such as also measurement of the battery capacity and the trend of changes in capacity, based on accurate measurement of the charge flow, using the coulometer functionality.

In order to start working with the Application, you must connect the Master module of the configured BMS system with a USB cable, to the USB port on the Master module (more on this in Chapter 5) with any USB port on the PC, equipped with the Windows operating system version 10 or later. To use the application, unpack the archive provided by the manufacturer named ISM_02_02_2023 anywhere on the disk and open the application marked with the „KT” logo.



CAUTION

In case of blocking the ability to unpack the .exe file by the Windows Security Firewall, add this file to security exceptions.

Functionally, the application has been divided into individual windows, between which we move by switching tabs. The connection to the BMS system is established in the first window.



CAUTION

If at any time of using the Application we want to save the current configuration to the configured BMS system, click the „Save to Controller” button in the upper right corner of the window. In case we want to read configuration data from the BMS system to the application, click the „Read from Controller” button in the upper right corner of the window.

8.A. COMMUNICATION SETTINGS

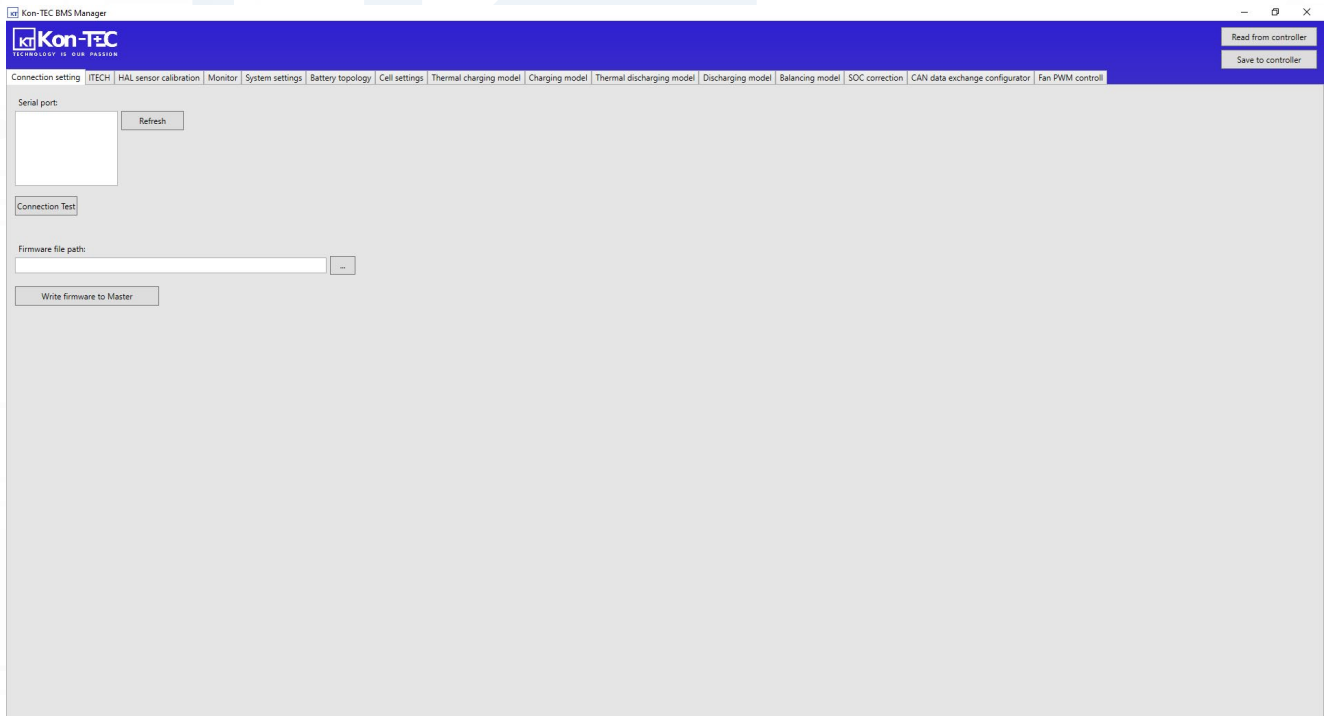
The first window concerns the choice of communication options. The user can select the communication port through which it will connect with the Master module. In addition, it is possible to perform a communication test.

In order to establish a connection with the BMS system connected to any USB port on the PC, select the button „Refresh”.

In the „Serial port” window, a virtual COM port will appear, select it and click the „Connect” button.

If you want to check whether the configured BMS system is properly connected to the application, click the „Connection test” button.

If we have new Firmware available for the Master module, we can update it to the module by indicating the access path to it, located on the disk, and then clicking the „Write firmware to Master” button.



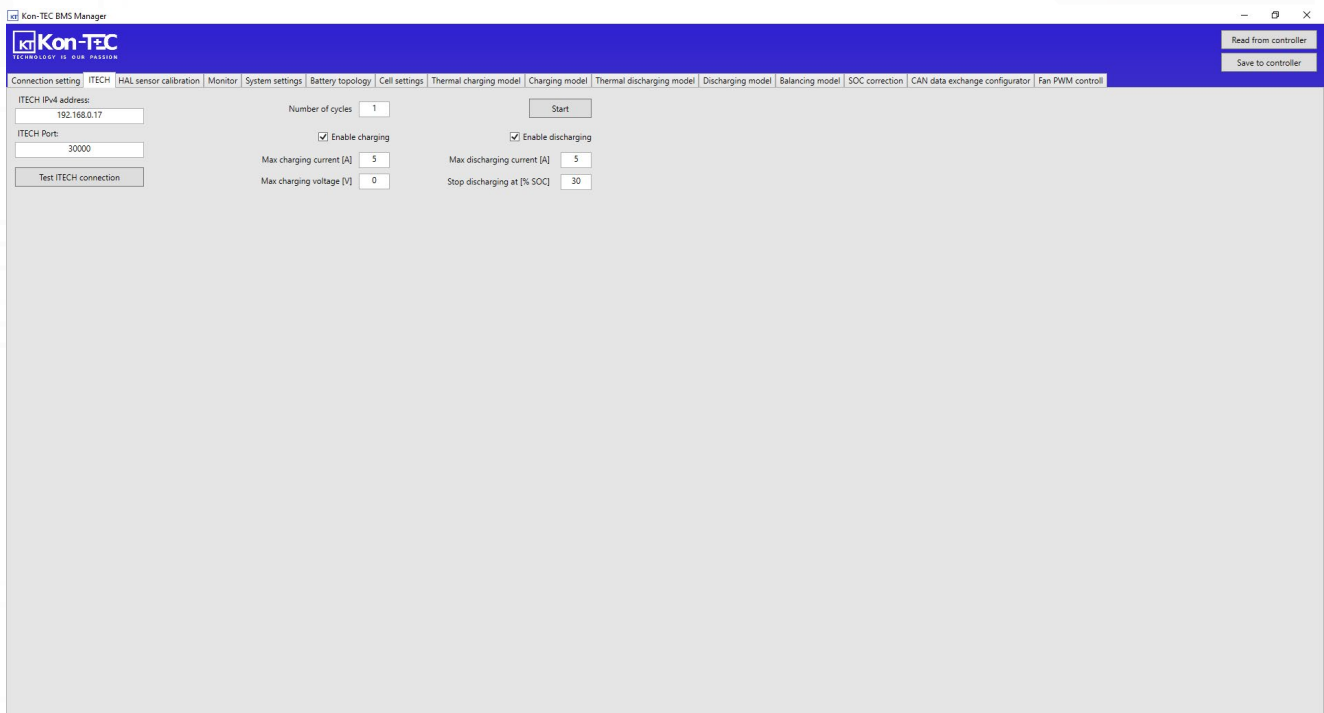
App photo 1. Communication settings window

8.B. CONNECTION WITH ITECH ELECTRONIC LOAD

In the second window, it is possible to connect to an artificial ITECH load/charger and control it from the level of application. In the window, you can define the device address, test communication and set the parameters of the charging/discharging the battery.

CAUTION

This functionality is intended only for Users who are owners of an artificial ITECH load/charger and who are experienced in its use.



App photo 2. Artificial ITECH load/charger communication window

8.C. HALL SENSOR CALIBRATION

In the third window, it is possible to calibrate the Hall sensor used to measure the flowing current (to/from the battery connected to configured BMS).

For proper calibration:

Make sure that the Hall sensor is properly connected (more in Chapter 7) and that no energy flows into/out of the battery.

Then click the „CURRENT IS SET TO 0A“ button (first from the top)

Set the charging current to 5A and start the battery charging process.

Click the „NOW CHARGING AND CURRENT IS SET TO 5A“ button

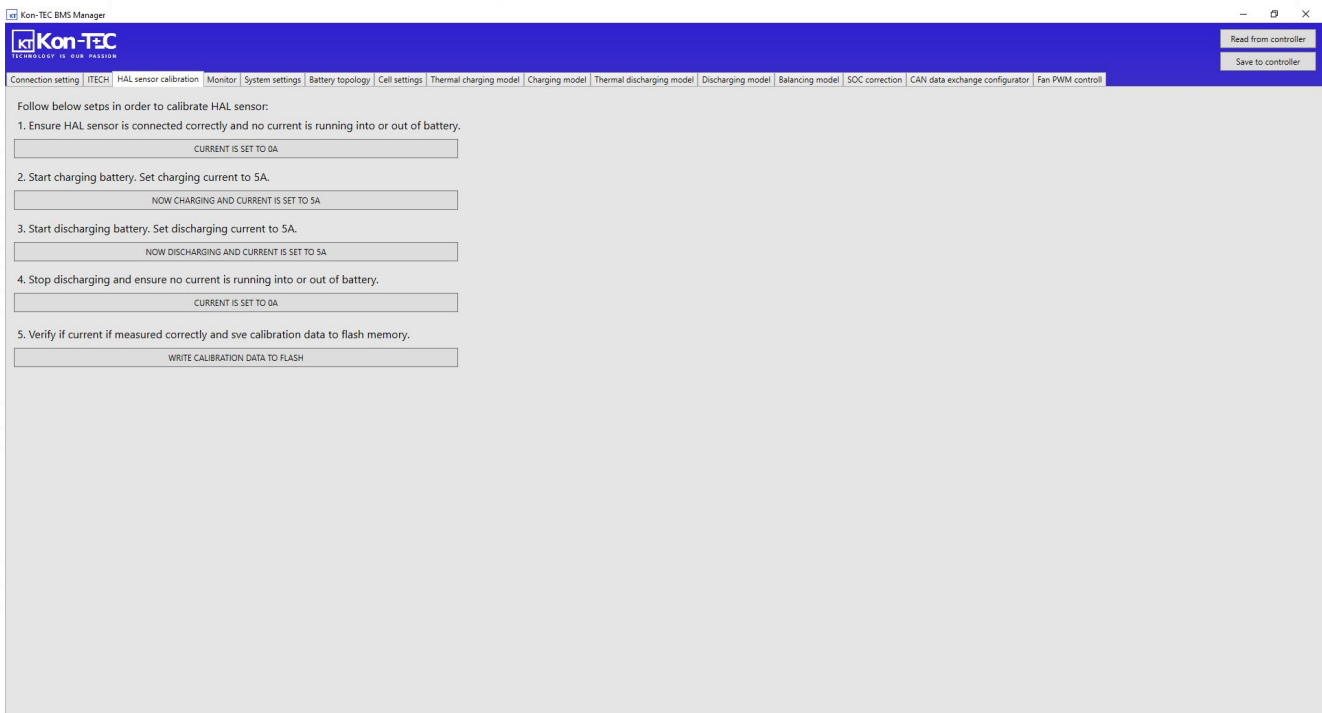
We set the discharge current to 5A and start the battery discharge process.

Click the „NOW DISCHARGING AND CURRENT IS SET TO 5A“ button

We turn off the discharge process, make sure that no charge flows into/out of the battery.

Click the „CURRENT IS SET TO 0A“ button (second from the bottom)

We check whether the current measurements were carried out correctly and save the calibration data to the device by clicking the „WRITE CALIBRATION DATA TO FLASH“ button.



App photo 3. Hall sensor parameter settings window

8.D. PARAMETERS MONITORING

In the fourth window, we can view the monitored parameters in real time. We can read the voltage/temperature on individual cells (with the option of selecting the monitored cell), as well as voltage, temperature and current of the entire battery. It is also possible to measure the battery capacity and the trend of changes in capacity based on current measurements.

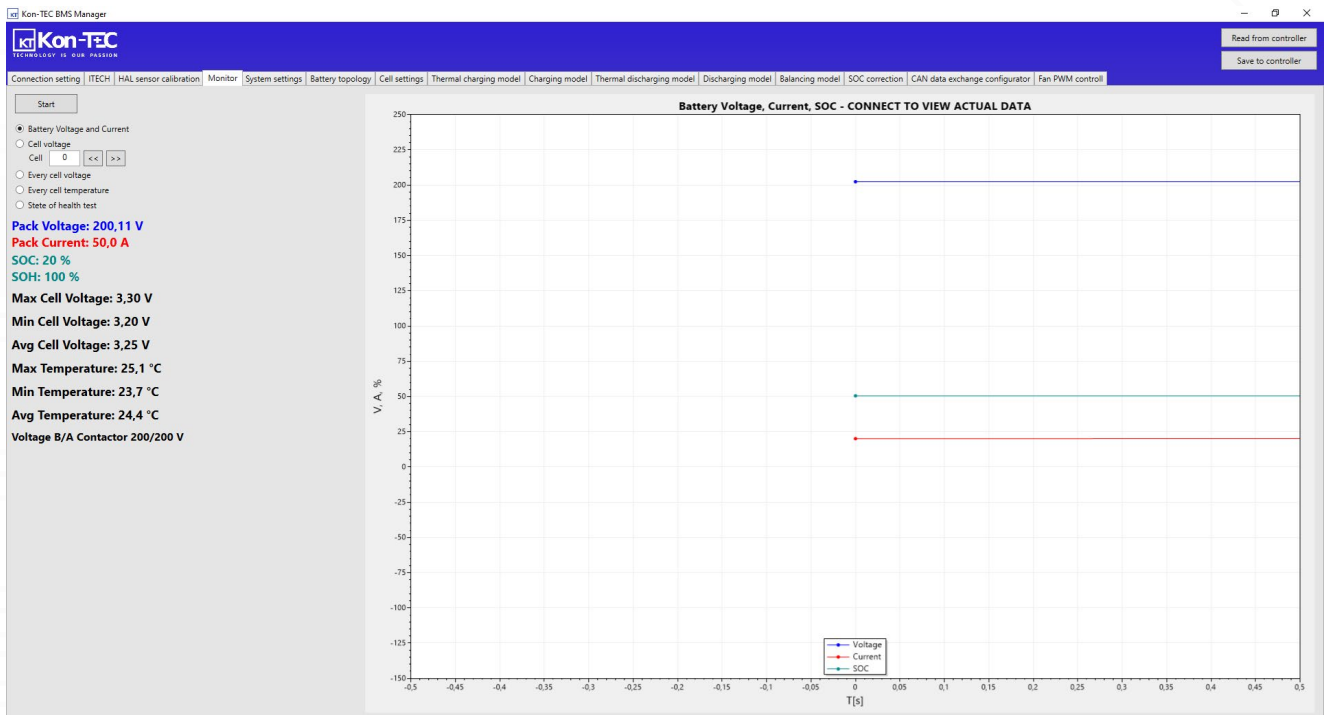
CAUTION

Measurements are disabled by default. To start continuous measurement, click the „Start“ button in the upper left corner of the window. To disable continuous measurement (e.g. in order to upload new configuration parameters to the BMS system), click the button „Stop“ in the upper left corner of the window.

We can choose to display the following parameters of the battery connected to the BMS:

- „Battery voltage and current“ – shows a historical graph of voltages and currents of the entire battery as a function of time

- „Cell voltage” – shows a historical graph of voltages and temperatures of a given cell as a function of time. We enter the cell number manually in the input window to the right of „Cell”. We can also move between successive battery cells by clicking the „<<” and „>>” buttons,
- „Every cell voltage” – shows the current voltage histogram on all cells of the battery connected to the BMS system (updated in real time),
- „SOC” – shows the graph of the SOC of the battery connected to the BMS system as a function of charge/discharge cycles (more information on SOC parameter in Chapter 7),
- „SOH” – shows the current SOH value of the battery connected to the BMS system (more information about the SOH parameter in Chapter 7).



App photo 4. Battery parameters monitoring window

8.E. SYSTEM SETTINGS

The fifth window allows the User to set the parameters of the entire battery connected to the BMS system, such as the number of cells, total capacity, maximum voltage, maximum allowable charging and discharging current.

CAUTION

Proper definition of the parameters in this window is crucial for the correct operation of the BMS system and its proper cooperation with a supported cell battery

CAUTION

The settings of individual parameters require, from the User, knowledge and experience in operating with batteries based on lithium-ion cells.

CAUTION

In the event of incorrect definition of individual parameters, the BMS system can be damaged, it also may lead to damage to the battery or individual cells, and even to the risk of fire and/or immediate danger to health and life of people nearby the battery.

Definable battery parameters:

- „Number of cells” - allows you to define the number of cells that the battery, connected to the configured BMS system, consists of,
- „Total capacity [Ah]” - allows you to define the capacity of a SINGLE cell, which the battery, connected to the configured BMS system, consists of, the value is given in [Ah],
- „Max battery voltage [V]” - allows you to define the maximum voltage of the entire battery connected to the configured BMS system, the value is given in [V],
- „Min battery voltage [V]” - allows you to define the minimum voltage (cut-off voltage) of the entire battery connected to the configured BMS system, the value is given in [V]
- „Max charge current [A]” - allows you to define the maximum current that can be charged to the battery, connected to the configured BMS system, the value is given in [A],
- „Charge overcurrent delay [s]” - allows you to define the time after which battery charging process will be disconnected, in case of exceeding the maximum allowed value, the value of the parameter is given in [s], a fractional number we separate with a comma,
- „Battery overcurrent protection [A]” - allows you to define the maximum current the battery, connected to the configured BMS system, can be charged, the value is given in [A],
- „Max startup current [A]” - allows you to define the maximum peak current (usually during start-up) that the battery, connected to the configured BMS system, can be loaded, the value is given in [A],
- „Shortcircuit current [A]” - allows you to define the value of the discharge current, which is treated as a short-circuit current for the battery, connected to the configured BMS system, the value is given in [A],
- „Shortcircuit delay [s]” - allows you to define the time after which the battery contacts/terminals will be disconnected in case of short-circuit current, the value is given in [s], the fractional number is separated by a comma.
In the next two boxes, we define the necessary parameters for proper disconnection of the charging process of the connected battery to the configured BMS system (the charging process is disconnected by the BMS system if both parameters value occur below):
- „Lowest cell voltage is at [V]” - allows you to define the lowest voltage value of the cell with the lowest voltage in the series, at which the battery charging process is disconnected by the BMS system, the value is given in [V],
- „Cell voltage delta is less than [V]” - allows you to define the value of the voltage difference between the cell with the lowest voltage and the cell with the highest voltage in the series, at which the battery charging process is disconnected by the BMS system, the value is given in [V].



CAUTION

After defining the parameters, you **MUST** remember to save them to the configured BMS system by clicking the button in the upper right corner „Save to controller”.



CAUTION

It is also possible to read the parameters from the currently configured BMS system to the Application using the button in the upper right corner „Read from controller”.

Further parameters can be defined in the column on the right:

- „Max battery voltage recovery [V]” - allows you to define the voltage at which the BMS switches on the battery contactors again in case of exceeding the maximum value of the voltage of the entire battery connected to the configured BMS, the value given in [V],
- „Min battery voltage recovery [V]” - allows you to define the voltage at which the BMS switches on the battery contactors again in case of exceeding the minimum value of the voltage of the entire battery connected to the configured BMS, the value given in [V],
- „Zero current deadband [A]” - this is the current value read by the BMS from the Hall sensor, which is to be ignored by system. Typically, in the case of a Hall effect sensor, there is always a residual induction in the conductor wire, therefore an ignored value should be defined, so that the measured current values will not be affected among others, on the number of read charge/discharge cycles.

**CAUTION**

Due to the fixed value of this parameter, the BMS may incorrectly indicate SOC when the battery is discharging with very low currents.

- „Expected battery life [cycles]” – allows you to define the expected number of battery cycles, after which the value of the SOH parameter will remain at >80%,
- CAN watchdog timer (0 = disabled) [s]” – allows you to define the WatchDog operation period for CAN communication by entering value „0” disables the WatchDog function for CAN communication,
- Selection of the inverter model connected via the CAN communication protocol – if the model is selected, there is no need to define the communication frame by yourself (subitem N of this Chapter), the available models are Victron, Goodwe, Sungrow, Solis and Deye,
- Selection of the type of precharge procedure – the following options are available: no precharge procedure, precharge management from the inverter level (via CAN or RS485 communication), self-defined parameters of the precharge procedure.

If the option of defining the precharge procedure is selected, the User may define the following procedures parameters.

**CAUTION**

Self-definition of parameters requires the User’s knowledge and experience in operating with batteries based on lithium-ion cells

- „Precharge initial delay [x 10ms]” – initial waiting time for voltage equalization (until the start of voltage difference measurements)
- „Precharge switching timeout [x 10ms]” – time of performing voltage difference measurements,
- „Max voltage difference [V]” – the voltage difference after the main contactor is switched on (precharge procedure ends),
- „Max precharge current [A]” – maximum current, after which (below) the main contactor is switched on (the initial charging procedure ends),

**CAUTION**

Two conditions must occur simultaneously to complete the precharge procedure.

- „Retry timeout [s]” – the time after which the precharge procedure will restart, if the execution time of voltage difference measurement, without reaching the required parameters for the end of the precharge procedure, has elapsed.

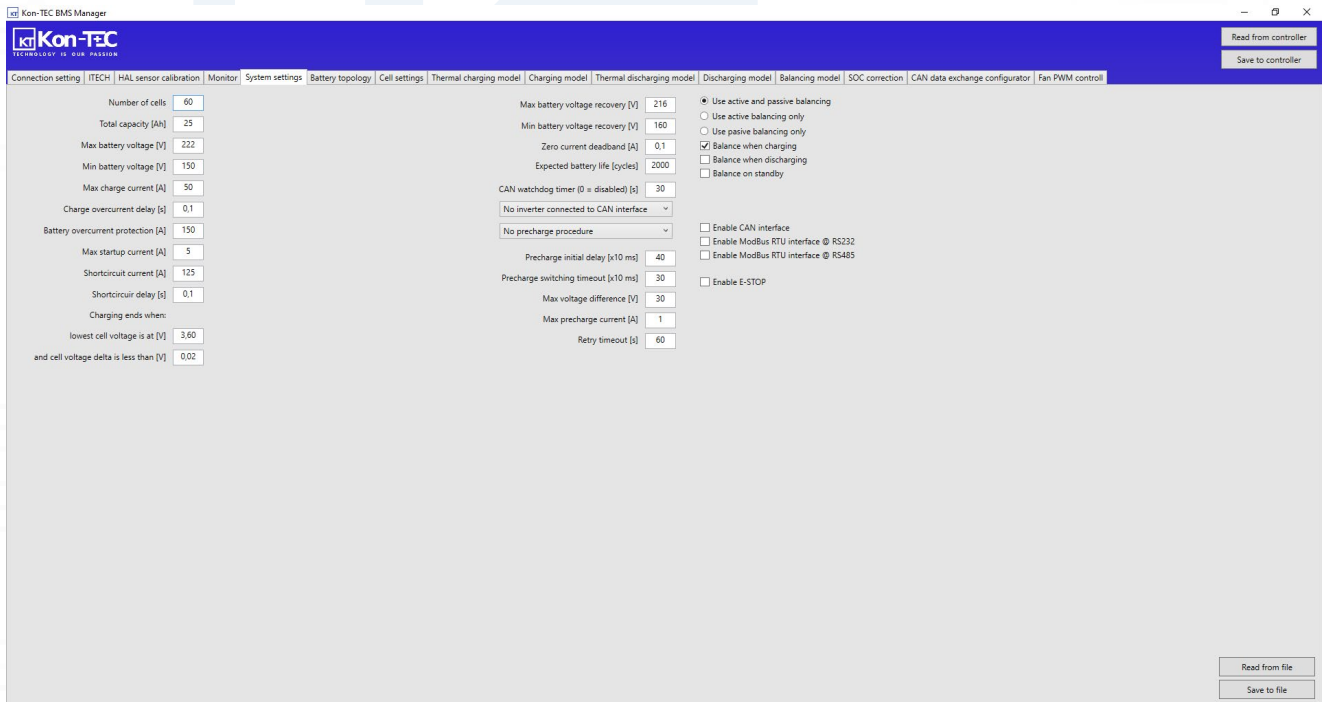
In the third column, it is possible to define balancing parameters (passive or active balancing), time of balancing (charging, discharging, standby) and communication protocols used (selection of CAN or MODBUS RTU @ RS485).

**CAUTION**

The distinction between active and passive balancing options will affect the performance of the BMS **only when** active slave modules are connected to the system.

**CAUTION**

MODBUS RTU @ RS232 and Enable E-STOP options are service options and are not supported in the current version of the Application.



App photo 5. Battery parameter settings window

8.F. SYSTEM TOPOLOGY

In the sixth window, we can define the topology of the system. We define the number of Slave modules that the Master module supports and the number of cells supported by them.

CAUTION

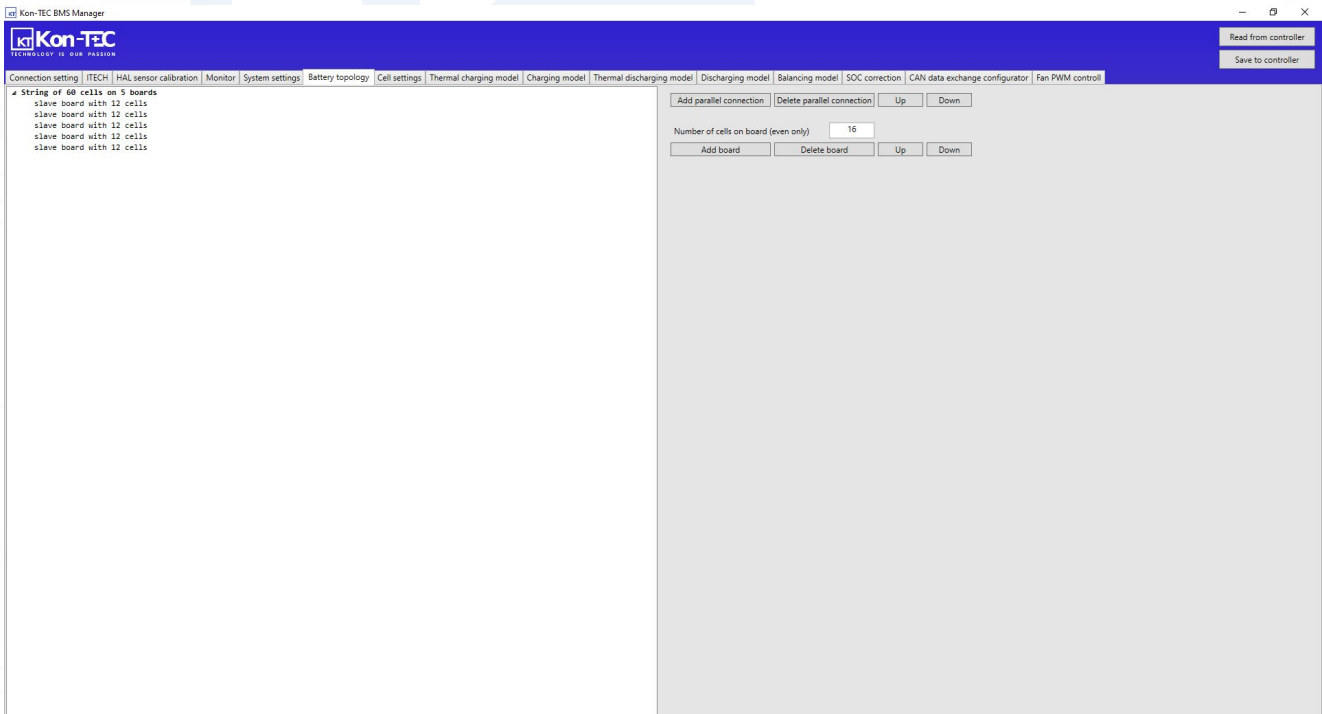
After defining the system topology, you **MUST** remember to save it to the configured BMS system by clicking „Save to controller” button in the upper right corner.

CAUTION

Proper configuration of the system topology, in accordance with the actual connection diagram, is a prerequisite for the proper operation of the BMS and the entire battery.

NOTICE

In the current version of the Application, it is possible to define two series of cells connected to the Master module in parallel (two inputs for Slave modules described in Chapter 5). In future versions of the application, the ability to define parallel series connected to Master modules connected to the superior Master module (topology described in Chapter 5, point C), will be added.



App photo 6. System topology settings window

8.G. CELL SETTINGS

The seventh window is analogous to the fifth layout settings window, except that here the user can set parameters for single cell. The Kon-TEC BMS system can work with cells of various types. Depending on the type of cell, other parameters of the maximum and minimum cut-off voltage, as well as, the reference voltage must be set.



UWAGA

Proper definition of the parameters in this window is crucial for the correct operation of the BMS system and its proper cooperation with supported cells



UWAGA

The settings of individual parameters require the User's knowledge and experience in operating with batteries based on lithium-ion cells



UWAGA

In the event of incorrect definition of individual parameters, the BMS system can be damaged, it also may lead to damage to the battery or individual cells, and even to the risk of fire and/or immediate danger to health and life of people near the battery.

- Cell reference voltage [V]" – allows you to define the value of the nominal voltage of the used cells, the value is given in [V],
- „Cell overvoltage alarm [V]" – allows you to define the alarm voltage value of the used cells, the value is given in [V],
- Cell overvoltage protection [V]" – allows you to define the cut-off voltage of the used cells, at which the battery will be disconnected, the value is given in [V],
- „Cell overvoltage recovery [V]" – allows you to define the recovery voltage of the used cells, at which the battery will be switched on again, after the overvoltage event, the value is given in [V],
- „Cell undervoltage alarm [V]" – allows you to define the threshold value of the alarm voltage drop for the used cells, the value is given in [V],

- „Cell undervoltage protection [V]” – allows you to define the threshold value of voltage drop of the used cells, at which the battery will be disconnected, the value is given in [V],
- „Cell undervoltage recovery [V]” – allows you to define the threshold value of the recovery voltage of the used cells, at which the battery will be reconnected after the occurrence of an excessive voltage drop event, the value is given in [V],
- „Active balance start [V]” – allows you to define the threshold voltage at which the active balancing process starts (only when Slave modules with the option of active balancing are connected), the value is given in [V],
- „Active balance end [V]” – allows you to define the threshold voltage, at which the active balancing process ends (only when Slave modules with the option of active balancing are connected), the value is given in [V].

CAUTION

After defining the parameters, you **MUST** remember to save them to the configured BMS system by clicking the button in the upper right corner „Save to controller



App photo 7. Single cell parameters settings window

8.H. THERMAL CHARGING MODEL

In the eighth window, the user can define the temperature charging curve. Defining curves allows you to accurate control of the behavior of the entire battery during operation. The curve should be defined in accordance with the documentation, technical specifications and recommendations of the manufacturer of the cells that are being used with the battery, connected to the BMS system.

CAUTION

The settings of individual parameters require the User’s knowledge and experience in operating with batteries based on lithium-ion cells

CAUTION

In the event of incorrect definition of individual parameters, the BMS system can be damaged, it also may lead to damage to the battery or individual cells, and even to the risk of fire and/or immediate danger to health and life of people nearby the battery.

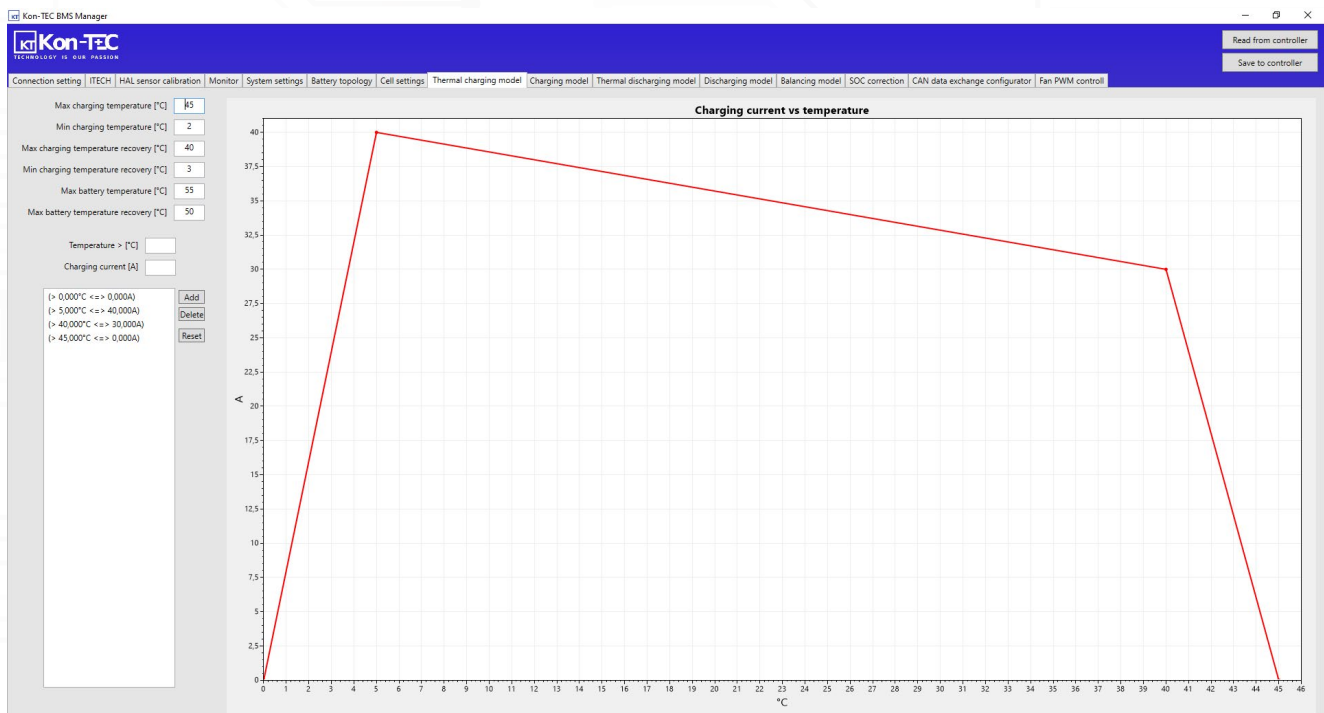
We can define the following general parameters for the entire battery:

- „Max charging temperature [oC]” - the maximum temperature, at which the battery can be charged,
- „Min charging temperature [oC]” - the minimum temperature, at which the battery can be charged
- „Max charging temperature recovery [oC]” - the temperature, at which it is possible to recharge the battery after exceeding temperature values, above the maximum value,
- „Min charging temperature recovery [oC]” - the temperature, at which the battery can be recharged after the minimum value of temperature drops.
- „Max battery temperature [oC]” - the maximum temperature of the entire battery, beyond which the battery contacts/terminals remain disconnected by BMS,
- „Max battery temperature recovery [oC]” - the temperature, at which it is possible to reconnect the battery contacts/terminals, after they are disconnected by the BMS, as a result of exceeding the maximum temperature of the entire battery.

In addition to defining general parameters for the entire battery connected to the configured BMS system, in the lower left window corner, the User can define the temperature charging curve by defining its successive points (for value pairs: temperature => maximum allowable charging current). The defined curve appears in the window on the right.

CAUTION

After defining the parameters and the temperature charging curve, you MUST remember to save them to configured BMS system by clicking the „Save to controller” button in the upper right corner.



App photo 8. Temperature charging curve settings window

8.1. CHARGING MODEL

In the ninth window, the user can define the current–voltage charging curve. Defining curves allows for precise control of the behavior of the entire battery during operation. The curve should be defined according to technical documentation and recommendations of the manufacturer of the cells that are being used with the battery connected to the configured BMS system.

CAUTION

The settings of individual parameters require the User’s knowledge and experience in operating with batteries based on lithium-ion cells



CAUTION

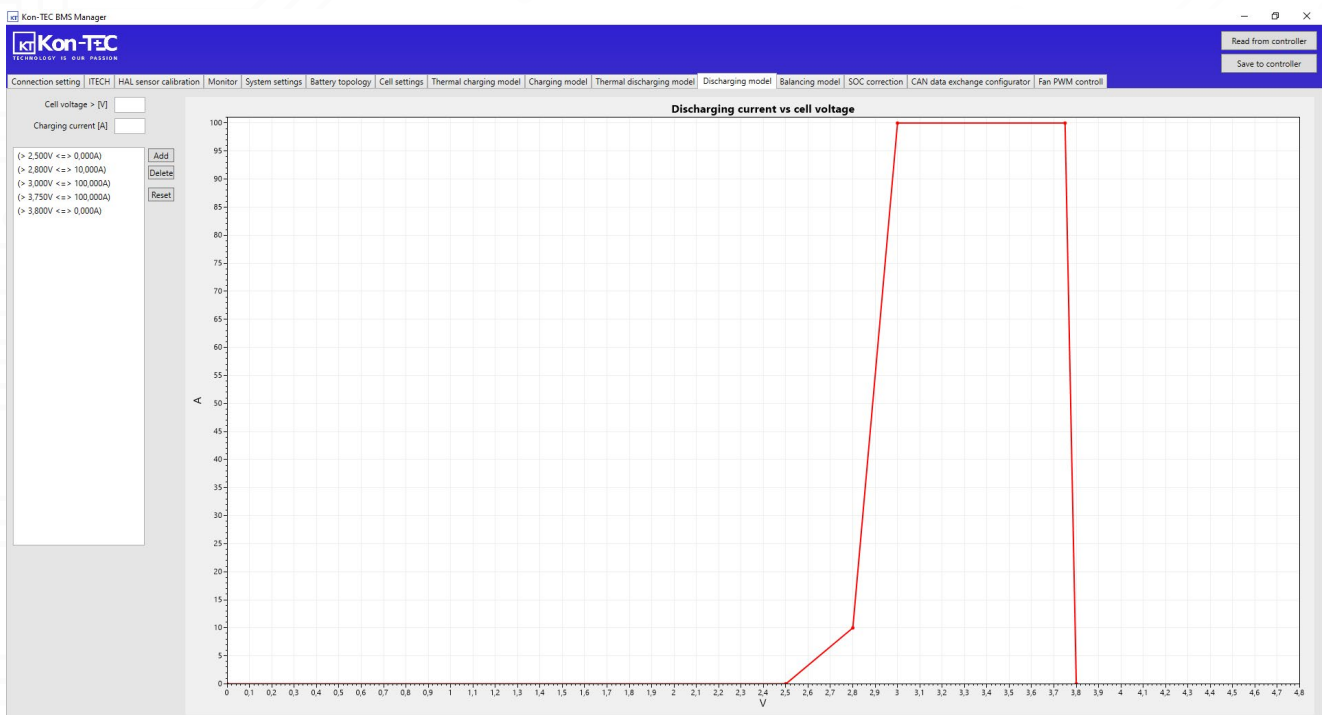
In the event of incorrect definition of individual parameters, the BMS system can be damaged, it also may lead to damage to the battery or individual cells, and even to the risk of fire and/or immediate danger to health and life of people nearby the battery.

In the window on the left, the user can define the current-voltage discharge curve by defining its successive points (for individual pairs of values: voltage => maximum allowable charging current). Defined curve appears in the window on the right.



CAUTION

After defining the current-voltage discharge curve, you MUST remember to save them to the configured BMS system by clicking „Save to controller” button in the upper right corner.



App photo 9. Current/voltage discharge curve settings window

8.J. BALANCING MODEL

In the twelfth window, the User can define the balancing curve of cells of a given type. The balancing curve is one of the most important parameters affecting the correct operation of the cells, supervised by the configured BMS system, as well as ensuring their long life. Proper definition of balancing points allows for quick and efficient charging of the cells, while maintaining a high degree of their balance. Typically, essential data to define the balancing curves can be provided by the cell manufacturers.

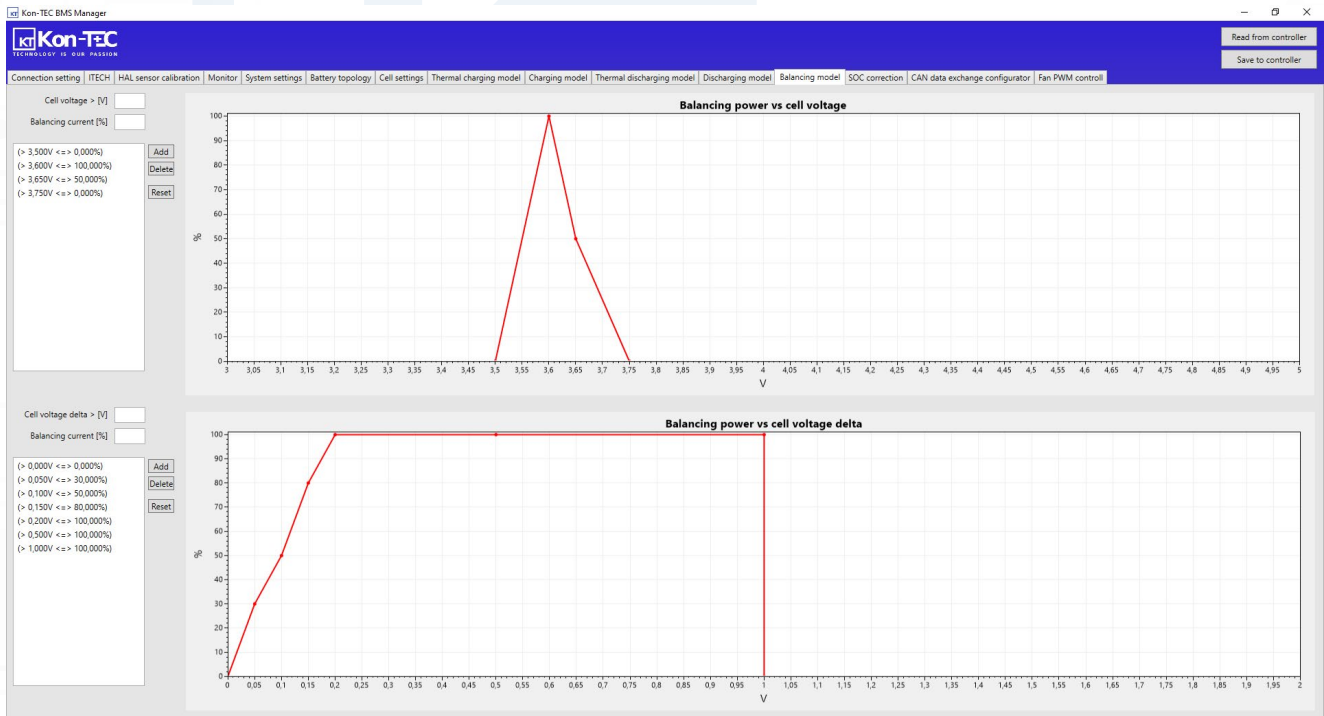
In the upper window on the left, the user can define the current-voltage balancing curve by defining its subsequent points (for individual pairs of values: voltage => balancing current defined as % of maximum balancing current). The defined curve appears in the window on the right.

In the lower left window, the user can define the current-voltage balancing curve dependent on the voltage difference between the highest cell voltage and the lowest cell voltage, by defining its subsequent points (for individual pairs of values: voltage difference => balancing current defined as % of the maximum balancing current). The defined curve appears in the window on the right.



CAUTION

After defining the current-voltage balancing curves, you MUST remember to save them to the configured BMS system by clicking „Save to controller” button in the upper right corner.



App photo 10. Cell balancing curve settings window

8.K. SOC CORRECTION

The thirteenth window contains the functionality that allows you to enter the value of SOC correction parameters (indicating the actual, current state of charge of the battery). Due to this functionality, it is possible to increase the accuracy of the actual SOC measurement, depending on the voltage value of the cell with the lowest voltage, which has a positive effect on operation of the entire battery connected to the configured BMS.



CAUTION

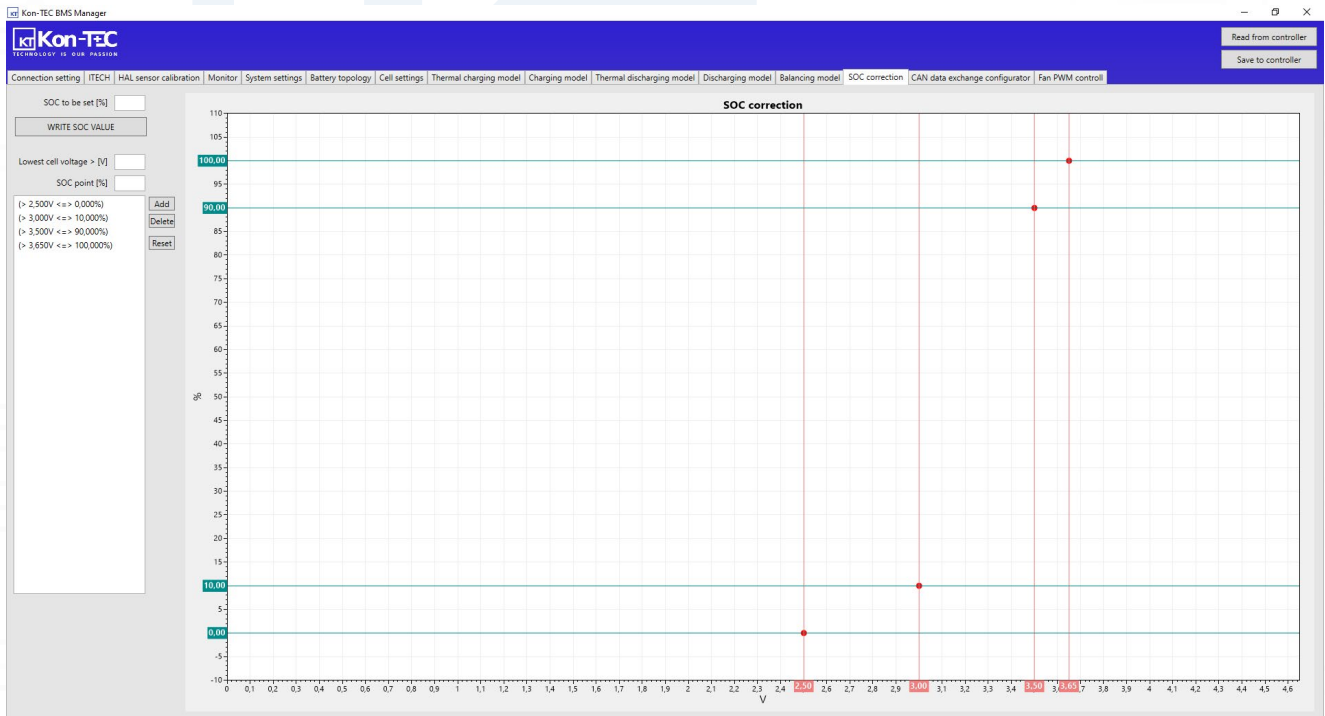
The settings of individual parameters require the User's knowledge and experience in operating with batteries based on lithium-ion cells

In the window on the left, the user can define SOC correction points (for individual pairs of values: voltage on the cell with the lowest voltage => charge level of the entire SOC storage defined in %). The defined curve appears in the window on the right.



CAUTION

After defining the current-voltage balancing curves, you MUST remember to save them to configured BMS system by clicking „Save to controller” button in the upper right corner.



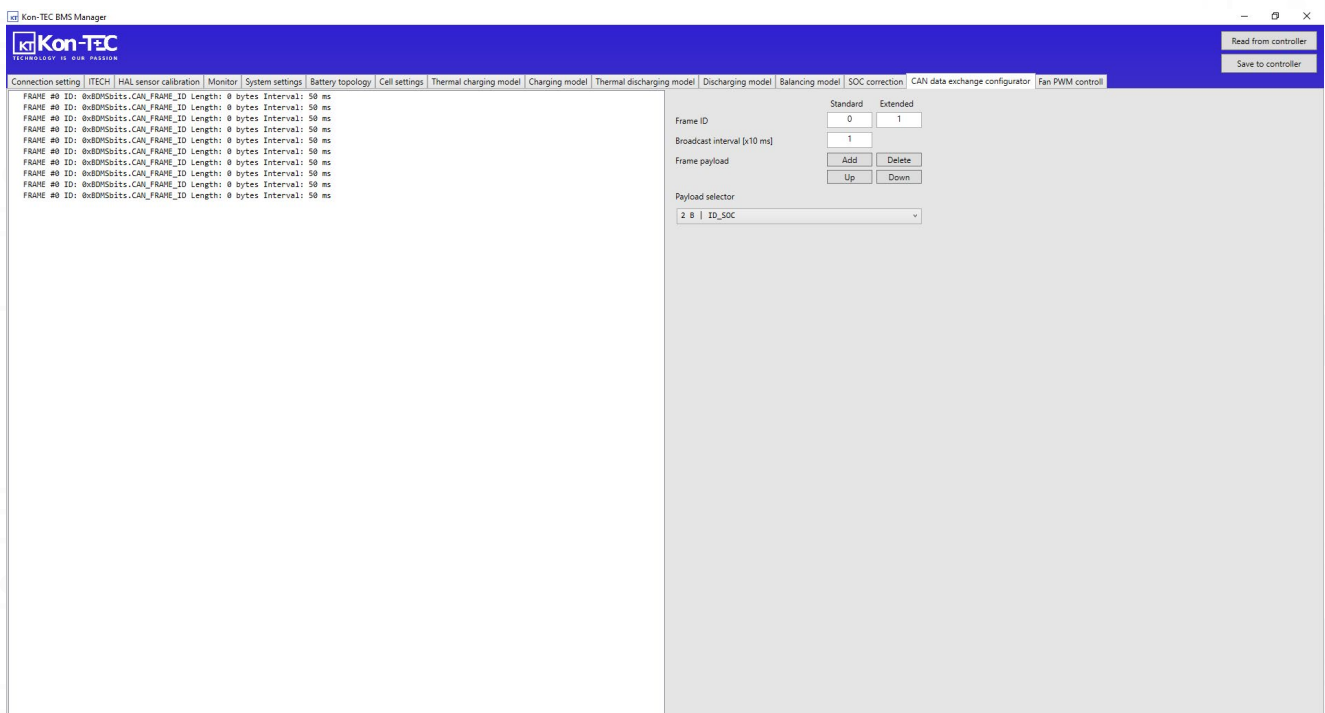
App photo 11. SOC correction parameter settings window

8.L. COMMUNICATION PROTOCOL CONFIGURATION

In the fourteenth window there is a functionality that allows you to define a communication protocol frame. Possessing communication protocol frame of the device with which the BMS is about to communicate, we can define it in this window and establish communication between this device and the BMS and the entire battery.

CAUTION

In the case of communication with a hybrid inverter for which the Application has a predefined communication protocol (subitem E of this Chapter), **there is no need** to define the communication frame by yourself. The app has predefined communication parameters for Victron, Goodwe, Sungrow, Solis and Deye inverters.



App photo 12. Communication protocol configuration window

8.M. PWM OUTPUTS CONTROL

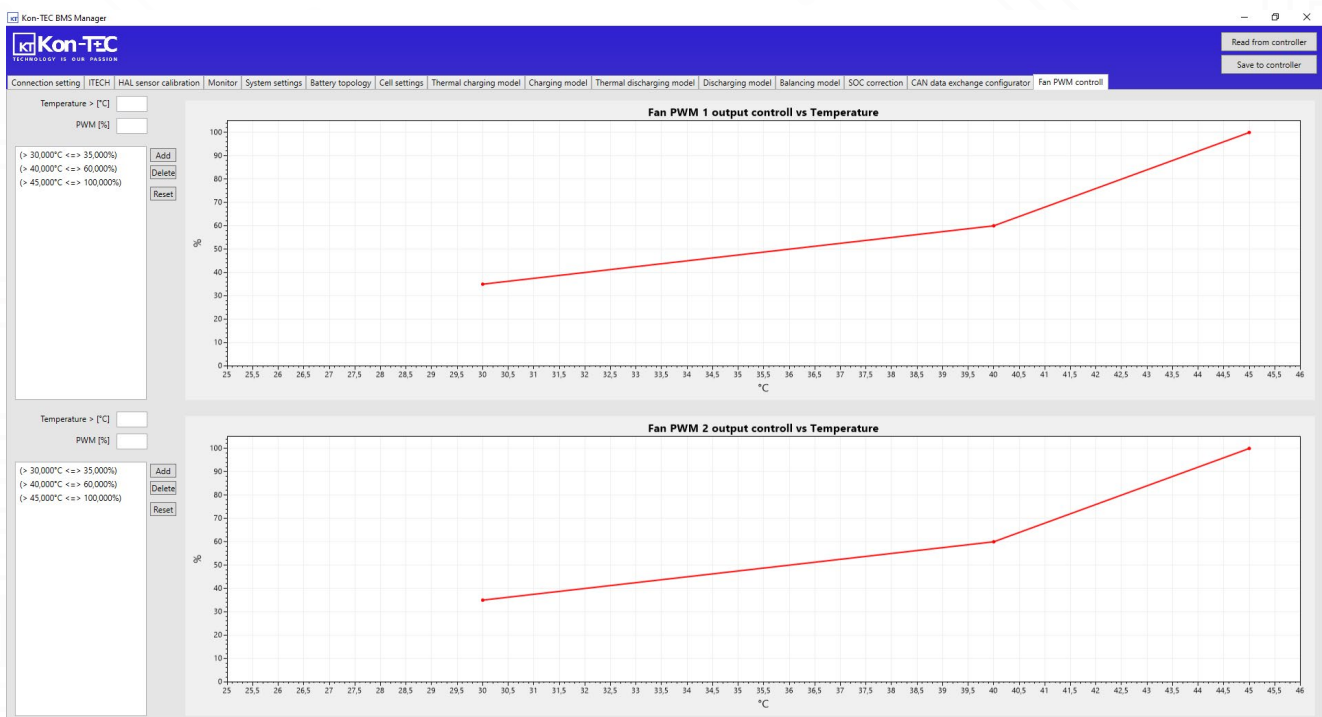
In the fifteenth window, the User can adjust the degree of PWM signal filling at the PWM output no. 1 and 2 (more about PWM outputs in Chapter 5), depending on the temperature. This functionality can be used, for example, to define a cooling fans action depending on the energy storage temperature. Defining curves allows for fine control behavior of the entire battery during operation. The curve should be defined in accordance with the technical documentation and recommended environmental parameters of the operation of the cells that are being used with the battery connected to the configured BMS system.

In the window on the left, the user can define the control curve of the PWM output 1 (above) and the PWM output 2 (below), by defining its successive points (for individual pairs of values: temperature => % of signal filling PWM). The defined curve appears in the window on the right



CAUTION

After defining the curves of the degree of filling the PWM signals depending on the temperature, it is **NECESSARY** to remember to save them to the configured BMS system by clicking „Save to controller” button in the upper right corner.



App photo 13. PWM output control window