

# **Battery Monitoring System**

(Battery monitoring system for larger UPS systems)

# INSTALLATION, COMMISSIONING and MAINTENANCE MANUAL

V3.1

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# Table of content

1	System	n description	4
	1.1	System and wiring diagram	5
	1.2	System Features	6
2	Modul	es description	8
	2.1	BTMS Gateway	8
	2.2	BM-SS BTMS String Master	10
	2.3	BTMS Hall Sensor	12
	2.4	BTMS Cell sensor	14
	2.5	BTMS Power Supply	16
	2.6	BTMS Battery master controller	
	2.7	BTMS IO expansion module	20
	2.8	BTMS Temperature and humidity sensor	21
	2.9	BTMS 7" HMI Touch display	23
	2.10	BTMS IOT Agregator	24
3	BTMS I	Installation	26
	3.1	Base System	27
	3.1.1	Install BM-CS	27
	3.1.2	Install BM-HS	27
	3.1.3	Install BM-SS	27
	3.1.4	Install BM-GW	28
	3.1.5	Install BM-PS-60-24	28
	3.1.6	Install BM-MC and BM-C-A1	29
	3.1.7	Install BM-HMI-BM	29
	3.1.8	Install BM-TH	
	3.2	Power ON	
4	BTMS o	commissioning	31
	4.1	General settings	
	4.1.1	Network settings	
	4.1.2	NTP settings	
	4.1.3	Time settings	
	4.1.4	Users Setting	34
	4.1.5	SMTP settings	35
	4.1.6	SMS notifications	35
	4.1.7	Modbus server	35
	4.1.8	Project settings	
	4.2	Adding string and battery sensors	



	4.2.1	Assign string sensor to string
	4.2.2	Assign string to UPS
	4.2.3	Adding BM-MC, BM-LC and BM-TH
	4.2.4	Validate Configuration41
	4.2.5	Check Settings41
	4.3 S <sup>4</sup>	tring and Battery sensors settings42
	4.3.1	Alarm settings42
	4.3.2	Resistance settings44
	4.3.3	Balancing settings44
	4.3.4	Cell settings45
	4.3.5	Hall Setting46
	4.3.6	Voltage Measurement47
	4.3.7	Configuration file48
	4.4 B	TMS Installation and Commissioning steps overview50
5	Maintena	ance52
	5.1 N	1aintenance plan
	5.2 P	reventive Maintenance Checklist52
6 Troubleshooting		hooting
	6.1 A	larms
	6.2 S	ystem malfunctions
	6.3 S	upport
7	Appendix	k: BTMS Alarm List



# **1** System description

This system comprehensively measures the battery performance and displays the real-time parameters and real-time alarm for the failed battery to realize the automation of battery detection and failure expected detection. Through real-time monitoring of the battery power parameters and operating status obtained by the Controller, the actual operating status and health status of the battery pack can be accurately grasped, and problems existing in the use of the battery pack can be found in time.

The HMI touch display displays the power data, health status and alarm reminder of each battery in real time. The cell sensors detect the condition of each battery in real time, and gives a timely alarm to the bad battery, so as to accurately grasp the actual running state and health of the battery pack in real time, and to timely find problems in the use of the battery pack.

This not only effectively extends the backup time and operating life of the battery pack, but also greatly reduces the maintenance costs such as manpower and material resources. It also improves the safety of battery use, reduces the accident rate and effectively saves energy and reduces emissions, creating for the user and create good economic and social benefits for the users.

BTMS         Battery Monitoring System         Battery monitoring system for larger UPS systems		Battery monitoring system for larger UPS systems.
battery	-	Lead-acid rechargeable battery stores electricity to operate the UPS during a power outage.
cell - Basic battery building. A battery us connected in series.		Basic battery building. A battery usually consists of several cells connected in series.
string	-	Multiple batteries connected in series.
UPSUninterruptible Power SupplyA device that provides battery backup when the electric fails or drops to an unacceptable voltage level.		A device that provides battery backup when the electrical power fails or drops to an unacceptable voltage level.
<b>BM-AG</b> BTMS Aggregator When several BM-GW's are needed at the Datacenter, aggregate all BM-GW and provide site functionality + Clour connectivity and alarming.'		When several BM-GW's are needed at the Datacenter, aggregate all BM-GW and provide site functionality + Cloud connectivity and alarming.'
BM-GW	BTMS Gateway	Visualization (browser) of batteries and installed systems connected to the GW logically grouped into strings and UPS's in real time and their historical data. Alarming, Cloud connectivity
SCADA	3rd party SCADA	Any SCADA that accesses battery, stringig and/or UPS data via Modbus TCP/IP protocol.
PC web	PC with WEB Browser	Viewing the user interface from BM-AG or BM-GW via any web browser.
BM-MC	BTMS Master Controller	It allows the connection of BM-TH sensors and configurable digital inputs for monitoring additional alarm signals and outputs for alarming or switching off strings where an error occurs.
BM-HMI	BTMS Human-Machine Interface	Local display of the state of the batteries inside the UPS, string and by battery.
CAD	BTMS HMI interface	Communication interface for connecting BM-HMI to BM-CS
BM-LC	BTMS IO Module	Expansion for MC with additional digital inputs and outputs.

### Dictionary of terms and abbreviations



BM-TH	BTMS Temperature and Humidity sensor	Ambient temperature and relative humidity sensor.
BM-SS	BTMS String Master	It monitors the string (string current), aggregates battery data (total string voltage, average SOC, Balance) and enables monitoring of data from BM-CSs.
BM-HS	BTMS Hall Sensor	It measures the string current
BM-CS	BTMS Cell / Battery Sensor	Control of each individual battery / cell. It allows monitoring the status, voltage, internal resistance, temperature of the cell and calculates SOC and SOH.
SOC	State Of Charge	Calculated battery charge; it is calculated from the actual voltage on the battery and by integrating the charge and discharge current.
SOH	State Of Health	Informative battery state calculation that takes into account internal resistance, battery temperature, rise/fall of voltage during charge/discharge and other parameters that affect battery performance.
Balance	Voltage balance within string	Calculation of voltage inequality on the batteries within the string. Battery sensors can actively equalize the voltage between the batteries within the string during the floating charge phase.

# 1.1 System and wiring diagram







# 1.2 System Features

### Highlights

- monitoring of all important battery parameters of larger UPS systems in order to ensure operational reliability
- simple and fast installation on existing or new UPS systems
- very reliable operation
- simple and intuitive WEB user interface
- automatic logging of data and storage for a period of one year
- easy download of all displayed data for further processing in standard format (csv)
- easy connectivity to 3rd party SCADA, BMS, ... systems via standard Modbus TCP/IP protocol

### System functionality

Data		Real-	History	Alarming		Range	Accuracy	Resolution
		time data	data	Low	High			
Per Battery (cell)	Voltage	$\checkmark$	√	1	~	2V battery 1.6 2.6 V 12V battery 7.5 15.6 V	±0.2 %	0.001 V
	Resistance	$\checkmark$	$\checkmark$		~	0.1 50 mΩ	±(1.5 % + 25 μΩ)	0.001 mΩ
	Temperature	$\checkmark$	$\checkmark$		$\checkmark$	-20 +85 °C	±0.5 %	0.1 °C
	SOC	$\checkmark$	$\checkmark$	$\checkmark$		0 100 %		1 %
	SOH	$\checkmark$	$\checkmark$	$\checkmark$		0 100 %		1 %



Per string	Voltage	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	20 800 V	± 0.5 %	0.01 V
	Current	$\checkmark$	$\checkmark$	~	$\checkmark$	-1000 1000 A	±2%	0.01 ADC
	State	1				floating charge, equalizing charge, discharge, idle		
	SOC	$\checkmark$	$\checkmark$	$\checkmark$		0 100 %		1 %
	Balance	$\checkmark$	$\checkmark$			0 100 %		0.01 %
	Ambient temperature	$\checkmark$				-40 +80 °C	± 0.5 °C	0.1 °C
	Ambient hmidity	$\checkmark$				0 100 % RH	±3 %RH	0.1 %RH
	Hall sensor state				<b>v</b>			
Per UPS	Voltage	~				Average of string voltages		
	Current	~				Sum of string currents		
	SOC	~				Average of string SOC		

# System limitations

	Device	Functionality	Limitations
BM- GW	BTMS IOT Agregator	Combines several BM-GW into one system	Virtually unlimited number of BM-GW
BM- GW	BTMS IOT Gateway	Combines several BM-SS into UPS WEB interface Data collection and logging	Up to 32 battery strings Strings arranged arbitrarily in up to 32 UPS-es
BM- SS	BTMS String master	Combines several BM-CS into string	Up to 120 batteries / string
BM- HS	BTMS Hall sensor	Measures string current	One per string
BM- CS	BTMS Cell sensor	Measures battery	One per battery
BM- MC	BTMS Master controller	Enables the connection of BM-LC, BM-TH and BM-HMI	One per BM-GW
BM- LC	BTMS IO expansion module	Connection of auxiliary sensors (leakage, fire, ) Connection of auxiliary alarm devices (string disconnection, warning light, siren)	Up to 32 IOs (Up to 4 per BM-MC)
BM- TH	BTMS Temperature and humidity sensor	Ambient temperature and humidity measurement	One per string
BM- HMI	BTMS Human-Machine Interfaces	Local inspection of data from UPS, strings and batteries	One per BM-MC



# 2 Modules description

# 2.1 BTMS Gateway



# **Highlights & Features**

- Local WEB UI
  - real-time data display
  - data logging
  - history data display (tables, timeplots)
  - history and real-time data download
  - e-mail, SMS alarming
- Robust and safe connection of BTMS system to BTMS cloud platform.
- Secure access and communication (TLS encryption)
- Local data buffer, no data loss
- User data safety according to GDPR
- Secure remote access to BM-C controllers

	Order code:	BM-GW-01	NO GSM modem	
		BM-GW-02	With GSM modem	
Mounting:		DIN rail, 31 mm		
	Dimensions:	86 × 114× 30	mm	

## System specifications

- Up to 32 strings arbitrarily distributed on several UPSs
- Up to 120 batteries / string (3840 batteries / system)
- Temperature and humidity sensor for each string
- Logging data for one year by automatically deleting old data
- Send e-mail and SMS alarms directly from the device



# HW Technical specification

Power supply:	12 VDC 2A max (Barrel Connector 5.5mm x 2.1mm)
Construction:	Extruded aluminum IP30
CPU:	Rockchip RK3588 Quad-core ARM Cortex-A76(up to 2.4GHz) and quad-core Cortex-A55 CPU (up to 1.8GHz)
System Memory:	4 GB LPDDR4X at 2133MHz
Storage:	eMMC Flash 32GB, 256 GB SSD
Ethernet:	2 x RJ-45 10/100/1000/2500 Mbps
LTE:	Cat 4
Working temp.:	0°C to +70°C
Humidity:	0% to 95%
Vibration Endurance:	2 Gms with storage (5 to 500Hz, X/Y/Z direction; random, operating)

Wiring



# Mounting

 On DIN Rail (35 mm) in control system cabinet



# 2.2 BM-SS BTMS String Master



## **Highlights & Features**

- Real-time monitoring of string voltage, chargedischarge current, charge-discharge state and string SOC.
- Monitor the voltage, impedance, temperature, SOC and SOH of each battery with BM-CS cell sensors and the specially designed isolated power bus.
- Advanced one-step auto-sensing for individual address. No more manual intervention and setup needed, reducing workload and setup errors.
- Advanced measurement algorithm, no need to discharge large current and measurement can be lossless.
- Balancing function: Keep voltage balanced during the floating charge process of battery pack, keeping the individual battery in the best state, extending backup time and life span of battery pack.
- Communication is based on power-isolated RS 485. Secure and stable.
- Quickly locate the alarmed or faulty battery pack in machine room.
- External open Hall Sensor, measuring chargedischarge current in different ranges.
- Isolated voltage in communication interface: AC 3750 V
- Supports up to 120 batteries (BM-CS)

Order code:	BM-SS-A1
Mounting:	DIN rail, 85 mm
Dimensions:	85×120×39 mm



# **Technical specification**

Power supply	Nominal	24 VDC
	Range	12 36 VDC
Power loss	≤ 2W	
Operating temperature	Standard	0 45 °C
	Limit	-10 55 °C
Storage temperature	-40 70 °C	
Working humidity	5 95 %RH, non-conder	sing
Dimensions:	Width	85 mm
	Height	105 mm
	Height max	120 mm
	Depth	39 mm
Voltage measurements	Range	20 800 VDC
	Accuracy	± 0.5 %
	Resolution	0.01 VDC
Current measurements	Range	-1000 1000 A
	Accuracy	±2%
	Resolution	0.01 ADC

### **LED Indicators**

Normal operation	Green LED breathing mode
Alarm / Error	Red LED

# Wiring



# Mounting

 On DIN Rail (35 mm) in control system cabinet or next to first BM-CS and next to BM-HS





# Highlights & Features

- easy installation (split core)
- wide current range of application



Order code:	BM-HS-50	50 A
	BM-HS-100	100 A
	BM-HS-200	200 A
	BM-HS-300	300 A
	BM-HS-400	400 A
	BM-HS-500	500 A
Mounting:	On the + string cable and surface	screwed to the
Dimensions:	95 × 80 × 25 mm	
Core inner diameter:	40 mm	



# **Technical specification**

Dimensions:	width	95 mm	
	height	80 mm	
	depth	25 mm	
	core inner diameter	40 mm	
Current measurements	type	rated	range
	BM-HS-100	50 A	0 ± 100 ADC
	BM-HS-200	100 A	0 ± 200 ADC
	BM-HS-400	200 A	0 ± 400 ADC
	BM-HS-800	400 A	0 ± 800 ADC
	BM-HS-1000	500 A	0 ± 1000 ADC
	Resolution	0.01 ADC	

# Wiring



# Mounting

- On positive wire between first battery / cell and UPS
- Pay attention to the direction indicated by the arrow



# 2.4 BTMS Cell sensor



# Highlights & Features

- Real-time cell voltage measurement
- Internal resistance measurement on line
- Negative pole temperature measurement
- Balancing function

Order code:	BM-CS-12	for 12 V battery
	BM-CS-02	for 2 V battery
Mounting:	On battery, 3M double sided adhesive tape	
Dimensions:	60 × 95 × 25 mm	

# **Technical specification**

Power supply	BM-SS-02	2 VDC (1.6 2.6 VDC)
	BM-SS-12	12 VDC (7.5 15.6 VDC)
Power loss	BM-SS-02	110 mW
	BM-SS-12	90 mW
Operating temperature	standard	0 45 °C
	max	-10 55 °C
Storage temperature	-40 70°C	
Operating humidity	5 95 % RH, Non condensing	
Dimensions:	width	60 mm
	height	80 mm
	height max	95 mm
	depth	25 mm
Voltage measurements	BM-SS-02	1.6 2.6 VDC
	BM-SS-12	7.5 15.6 VDC
	accuracy	±0.2 %
	resolution	0.001 V
Resistance measurements	range	0.1 50 mΩ
	consistency	±(1.5 % + 25 μΩ)
	repeatability	±(1.0 % + 25 μΩ)
	resolution	0.001 mΩ
Balancing	Current	0.2 A
	Time	1 min



# **LED Indicators**

Normal operation	Green LED breathing mode
Alarm / Error	Red LED flashing

# Battery SOC is calculated using the default battery characteristic parameters:

Battery voltage level	2 V	12 V
Float range	-0.02 C* +0.02 C*	
Float voltage	2.23 V	13.38 V
Cut-off voltage	1.75 V	10.8 V
Recovery voltage	2.12 V	12.68 V

\* C is the battery capacity





# Mounting

- Directly on the battery / cell with the included double-sided sticker
- Use supplied cable with U spade terminals directly for battery / cell wiring



# 2.5 BTMS Power Supply





# **Highlights & Features**

- Suitable for parallel operation without extra components
- Protection Class II, Double Isolation (No Earth connection is required)
- Universal AC input voltage and full power up to 55°C
- Power will not de-rate for the entire input voltage range
- Efficiency > 88.0% @ 115Vac & 230Vac
- NEC Class 2 / Limited Power Source (LPS) certified
- Over-voltage / Overcurrent / Over Temperature
   Protections

Model number:	BM-PS
Mounting:	DIN rail, 4M, 71mm
Dimensions:	91 x 71 x 55.6 mm

## Safety standards

CB Certified for worldwide use TUV to EN 60950-1, UL/cUL recognized to UL 60950-1 and CSA C22.2 No. 60950-1, CB scheme to IEC 60950-1, Limited Power Source (LPS)

## **Technical specification**

Input voltage range	85 - 264 VAC
Output voltage	24 VDC
Output current	2.5 A
Input current	< 1.50A @ 115Vac, < 1.00A @ 230Vac
Max Inrush Current (Cold Start)	< 30A @ 115Vac, < 60A @ 230Vac
Operating temperature	-25°C to +71°C
Storage temperature	-25°C to +85°C



# Wiring

# 24 VDC OUT

# Mounting

• On DIN rail (35 mm) in cabinet

# Dimensioning the power supply

When the total consumption of all modules powered by one power supply is greater than the capacity of the power supply, you need several power supplies that can be connected in parallel or you can arrange the power supplies in segments.

Module	Max consumption
BM-AG	720 mA
BM-GW	720 mA
BM-MC	280 mA
BM-LC	120 mA
BM-SS	85 mA
BM-HS	-
BM-CS	-
BM-TH	20 mA

Module	Max supply
BM-PS	3.80 A



# 2.6 BTMS Battery master controller



# **Highlights & Features**

- Communication with temperature and humidity sensors
- Additional digital inputs for connecting various sensors (leakage, gas,...)
- Additional digital outputs for disconnecting strings with an error or for alarming
- Supports up to:
- 32 strings (BM-SS)
- 4 Digital IO modules (BM-LC) with 8 DI and 8 DO each

Order code:	BM-MC-A1
Mounting:	DIN rail, 6M, 106 mm
Dimensions:	148×108×58 mm

## **Technical specification**

Power supply	Normal	24 VDC
	Range	1828 VDC
Power consumption	Typical	150 mA
	Max	250 mA
Digital outputs	Relay 8 A / 250 VAC or 8 A / 30 VDC resistive	
Operating conditions	0 50 °C / 0 85 RH non-condensing	
Mounting	DIN Rail	
Dimensions	Width	185 (110 + 2 × 37,5) mm
	Height	103 mm
	Depth	51 mm



# **LED Indicators**

PWR		Power supply OK
RUN		Run
		Stop
		Pause
		Program error
		No kernel
		Hardware error
IEX2	IEX-2 modules communication status	
COM1	BM-TP communication status	
COM2	BM-SS communication status	
Ethernet	LAN communication status	

# Wiring

# 24 VDC <sub>GND</sub> DI BM-MC BM-LC BM-LC ABD BM-TH BTMS LAN DO

# Mounting

 On DIN Rail (35 mm) in control system cabinet



# 2.7 BTMS IO expansion module



Order code:	BM-LC
Mounting:	DIN rail, 6M, 106 mm
Dimensions:	106×108×58 mm

# **Highlights & Features**

- Expansion for MC with additional digital inputs and outputs
- Additional sensors (leak, gas) can be connected to inputs
- Relay outputs can disconnect faulty string or turn on additional signaling in the event of an error on the string

# **Technical specification**

Output power per relay	
- incandescent / halogen 230V	1000 W
- halogen 12V with transformer	500 W
- LED with transformer or compact	500 W
Total power for all outputs together:	4000 W
Maximum switching voltage	250Vac
Dielectric strength output to output	400Vac
Maximum input cable length:	50 m
Power supply:	24 V / max. 120 mA
Ingress protection:	IP20
Operating temperature:	045 °C
Storage temperature:	-2075 °C
Relative humidity:	095 % n/c
Weight:	280g



# Terminals



# 2.8 BTMS Temperature and humidity sensor




- High measurement accuracy •
- Integrated use of temperature and humidity
- Superior performance, good long-term stability

Order code:	BM-TH
Mounting:	On wall
Dimensions:	135 × 150 × 45 mm

# Highlights & Features

Technical	specification

10 30 VDC	
0.4 W max	



	Long term stability	≤ 0.1 °C / year
	Response time	$\leq$ 18/s (1 m/s wind speed)
Humidity measuring	Range	0 100 % RH
	Precision	±3 %RH (5 95 %RH, 25 °C)
	Resolution	0.1 %RH
	Long term stability	≤0.1 %RH / year
	Response time	≤6 seconds (1 m/s wind speed)
Dimensions:	housing width	110 mm
	max width	135 mm
	housing height	100 mm
	max height	150 mm
	depth	45 mm

# Wiring



# Mounting

• On wall next to string



# 2.9 BTMS 7" HMI Touch display



# **Highlights & Features**

- 7" capacitive touch screen
- Supports up to:
- 32 strings (arbitrary arranged in UPS)
- 3840 batteries (8 BM-SS × 120 BM-CS)

Order code: **BM-HMI** 

# **Technical specification**

Power supply	24 VDC, 5 W max	
Size	7"	
Resolution	1024 × 600	
Colors	65 k, 16-bit RGB	
Communication	RS 485	
Dimensions	Width 184 mm	
	Height	118 mm
	Depth	15 mm
	Max depth	23 mm

# Wiring



# Mounting

- On the wall
- On the cabinet



# 2.10 BTMS IOT Agregator



# Highlights & Features

•

- It logically combines several BM-GWs into one system
- Overview of the entire Data Center via a single web interface

Order code:	BM-AG
Mounting:	DIN rail, 31 mm
Dimensions:	31 × 125 × 100 mm

# **Technical specification**

Power supply:	12 to 24 VDC, 1.39-0.72A		
Construction:	Extruded aluminum and heavy-duty steel, IP30		
CPU:	Intel® Celeron® N3350 2C @1.1 GHz, TDP: 6W		
System Memory:	1 x DDR3L-1866 SO-DIMM 4 GB		
Storage:	128 GB SSD		
System I/O Outlet:         Serial 1 x DB9 RS-232/422/485           Display 1 x VGA         Ethernet 2 x RJ-45 isolated* 10/100/1000 Mbps			
			DIO 1 x DB9 8-bit programmable DIO
			LTE Cat 4 Quectel EG25-G Mini PCIe



Working temp :	-20°C to +70°C (-1°E to +158°E	
Working temp	-20 C t0 +70 C (-4 F t0 +158 F	
Humidity:	0% to 95%	
Vibration Endurance:	2 Gms with storage (5 to 500Hz, X/Y/Z direction; random, operating)	
Mounting:	DIN rail, wall	
Weight (net/gross):	0.3 kg (0.67 lb)/0.45 kg (0.99 lb)	
Dimensions:	height	125 mm
	width 31 mm	
	depth	100 mm

Wiring

# Mounting

- DIN rail, 31 mm
- On the cabinet





# **3 BTMS Installation**

# System wiring diagram



Following steps to be done before start installation:

- Disconnect the UPS from batteries by switch off battery breaker
- Break string to small segments where total voltage doesn't reach 50 V
- Provide a place to install BTMS panel which includes below
- BM-PS in (Power supply)
- BM-GW (Gateway)
- BTMS LAN switch (Network switch)
- BM-MC (Master controller)
- BM-HMI (and communication adapter CAD-232-A2-IQ)

Provide space to install below component on the battery cabinet

- BM-SS (String sensor)
- BM-CS (Cell sensor)
- BM-HS (Hall sensor)



# 3.1 Base System

# 3.1.1 Install BM-CS

• Connect red / black wires to battery terminals (Use original cables as they are)



- Mount on battery with supplied 3M double sided stickers
- Plug in red / black battery cable connector in
- Connect the sensors with included white RJ9-RJ9 cables
- 1<sup>st</sup> OUT port (right) to 2<sup>nd</sup> IN port (left),
- 2<sup>nd</sup> OUT port (right) to 3<sup>rd</sup> IN port (left),



• Max 60 BM-CS in one line

## 3.1.2 Install BM-HS

- Unscrew split core and put around + wire from UPS to string
- Arrow is pointing from UPS to 1st battery



# 3.1.3 Install BM-SS

- Mount on DIN rail near the 1st string battery
- Connect BM-HS with included 4-pin flat cable
- Connect 1st battery BM-CS with included white RJ9-RJ9 cable



- Connect 1st battery BM-CS of second line (if needed)
- Power supply (+24 Vdc) from battery monitoring panel



## 3.1.4 Install BM-GW

- Mount in distribution cabinet on DIN rail with the included bracket
- Install BTMS LAN switch
- Mount in distribution cabinet or LAN cabinet
- Plug the power supply into the appropriate socket
- Connect LAN cables to BM-GW
- Pull the LAN cables to the BM-SS but do not connect them to the LAN switch (Properly mark which cable goes to which BM-SS)

### 3.1.5 Install BM-PS-60-24

- Check that the BM-PS capacity (3.8 A) is sufficient for all devices powered by the PS power supply
- If the consumption exceeds the capacity of the power supply divide the consumers into groups and uses several power supplies
- Make sure that circuit breaker is switched OFF
- Mount BM-PC on DIN rail in distribution cabinet
- Connect AC L & N terminals
- Connect DC + & terminals to
  - All BM-SS
  - BM-GW





# 3.1.6 Install BM-MC and BM-C-A1

- Mount in distribution cabinet on DIN rail
- Connect DC power supply +24 V & GND terminals to + & of power supply terminals
- Connect LAN cable to BTMS LAN switch



## 3.1.7 Install BM-HMI-BM

- Mount CAD-232-A2-IQ adapter on DIN rail next to BM-MC
- Ensure that the connecting cable (short RJ9 to RJ9) to the BM-MC is correctly inserted
- Connect BM-MC COM 2 port with CAD-232-A2-IQ adapter bottom port (it doesn't matter which one)
- Connect BM-HMI A & B terminals to CAD-232-A2-IQ A & B terminals
- Connect BM-HMI +24 V & GND terminals to + & BM-PS terminals





### 3.1.8 Install BM-TH

- Mount BM-TH on wall next to string
- Pull communication bus and power supply to BM-MC do not connect to BM-TH
- Communication bus must follow rules for RS-485 wiring
  - Bus line (no branching)
  - Use twisted pair shielded cable
  - Shield connected ONLY to one end of line
  - Terminate line with 120-ohm resistor on both side
  - Max length 1200 m



# 3.2 Power ON

- Visually inspect wiring
- Power on BM-PS circuit breaker
- Check that all devices that are powered by the power adapter are turned on and are working stably (the LED indicators are lit continuously)



# 4 BTMS commissioning

The initial settings of the BTMS system can only be made by a specially trained authorized person or by Robotina. To properly set up the system, it is necessary to provide the following information:

- Gateway IP address within facility LAN:
  - DHCP or fixed (IP, Subnet mask, Gateway IP)
- Gateway IP address within BTMS LAN:
  - IP, Subnet mask, Gateway IP
- Battery / Cell info (provided by the client prior to commissioning):
  - Capacity in Ah
  - Nominal voltage in V
  - Reference internal resistance in mΩ
  - Cut-off voltage in V
  - Recovery voltage in V
  - Float voltage in V
  - Float current in A
  - Internal resistance correction in mΩ
- Battery / Cell alarm and recovery info (provided by the client prior to commissioning):
  - Voltage upper limit in V
  - Voltage lower limit in V
  - Resistance upper limit in mΩ
  - SOC lower limit in %
  - SOH lower limit in %
  - Temperature upper limit in °C
- String info (provided by the client prior to commissioning):
  - Resistance measuring interval in hours
- String alarm and recovery info (provided by the client prior to commissioning):
  - Charging current limit in A
  - Discharging current limit in A
  - Voltage upper limit in V
  - Voltage lower limit in V
  - SOC lower limit in %
- Hall (current) sensor info (provided by the client prior to commissioning):
  - Type
  - Nominal current in A
- Balancing settings (provided by the client prior to commissioning):



- Balancing enabled (yes/no)
- Target balance in %
- Interval time in s
- Communication settings (determined by the commissioning engineer at commissioning):
  - RS485 address (10 ... 17)
  - RS485 baud rate (38400 bps)
  - LAN IP address (192.168.10.100 ... 192.168.10.131)
  - LAN Subnet mask (255.255.255.0)
  - LAN Gateway (192.168.10.1)

An excel table "BTMS Commissioning Table v2.0.xls" has been prepared to help with data entry.

- Connect the laptop to the BTMS LAN switch
- Set the IP on the laptop to 192.168.10.20
- Open the address 192.168.10.1 in the Internet browser
- Login with default username (admin) and default password (bmgw!admin)

← → C @ O & https://192.168.0.29/gu//login.html	D <sub>0</sub> ★ » =
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# 4.1 General settings

### 4.1.1 Network settings

- Select Settings General tab
- Set the parameters for the WAN interface



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€ → C @	08	https://192.168	.0.29/gui/data_cente					<b>a</b> ☆	
Probotina	Real-time data	History data	Discharge data	a Alarm Se	ttings		The Main Admin User		MS ng System
Data Center     UPS 1	Network setting	gs							
String 1/1									
	Adapter	Mode	IP	Subnet	Gateway	DNS			
	LAN	fixed	192.168.10.1	255.255.255.0					
	WAN	fixed	192.168.0.29	255.255.255.0	192.168.0.2	192.168.0.41, 192.168.0.71			
	Edit Syn Custom NTP Host	nc now Port	Enabled						
	Default NTP p Host ntp.ubuntu.cor 0.ubuntu.pool. 1.ubuntu.pool. 2.ubuntu.pool.	m ntp.org ntp.org	BLED)						
	Time settings								
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# 4.1.2 NTP settings

 if necessary / requested set the parameters for an additional NTP (Network Time Protocol) server

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Probotina	Real-time data	History data	Discharge dat	a Alarm Se	ttings			The Main Admin User		'MS ring System
Data Center     UPS 1     String 1/1	Network setti	ngs								
	Adapter	Mode	iP	Subnet	Gateway	DNS	ĺ			
	LAN	fixed	192.168.10.1	255.255.255.0	0					
	WAN	fixed	192.168.0.29	255.255.255.0	192.168.0.2	192.168.0.41, 192.168.0.71				
	NTD sattings									_
	NTP settings									
	Edit	Sync now								
	Custom NT	р								
	Host	Port	Enabled							
			12							
	Default NTF	P pools (ENA	ABLED)							
	Hos	ŧ								
	ntp.ubuntu.c	com								
	0.ubuntu.po	ol.ntp.org								
	1.ubuntu.po	ol.ntp.org								
	2.ubuntu.po	oi.ntp.org								
	Time settings									
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# 4.1.3 Time settings

• Set the desired time zone



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Probotina	Real-time data	History data Disch	arge data Ala	m Settings		The Main Admin User	AB Battery Monit	TMS toring Syst	5
Data Center     UPS 1     String 1/1	Time settings	s							^
	Ent Time 18:10:09	Date 06/07/2022							
	Edit Timezon Europe/Ljut	ie Dijana							
	Users								
	Add								
	User	Full name	Administrator	Phone number	E-mail				1
	admin	The Main Admin User	12		razvoj@3-port.si				
	goran	Goran Kocjancic	53	041379313	goran.kocjancic@robotina.com				
	devid	Devid Palcic	12						
	SMTP setting	IS							
	Edit								
C Robotine d.o.o all rights n	eserved.						1.0.dev / 1.0.64	.dev / 1.0.d	lev

# 4.1.4 Users Setting

- Change (and remember!) the admin password
- Add users

Data Center - Settin	gs × +						- a ×
← → C @	0	A https://192.168.0.29/gui/da					Q <sub>0</sub> ☆ ≫ ≡
Probotina	Real-time data	History data Discha	irge data Alar	m Settings		The Main Admin U	Jser Battery Monitoring System
Data Center     UPS 1     String 1/1	Time setting:	s					
	Time	Date					
	18:10:09	06/07/2022					
	E da						
	Edit						
	Europe/Ljut	bljana					
	Users						
	Add						
	User	Full name	Administrator	Phone number	E-mail		
	admin	The Main Admin User	5		razvoj@3-port.si		
	goran	Goran Kocjancic	12	041379313	goran.kocjancic@robotina.com		
	devid	Devid Palcic	12				
	SMTP setting	15					
	Edit						
C Robotina d.o.o all rights n	eserved.						1.0.dev / 1.0.64.dev / 1.0.dev



# 4.1.5 SMTP settings

• Set the parameters for the SMTP (e-mail) server

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Probotina	Real-time data         History data         Discharge data         Alarm         Settings         The	Main Admin User
Data Center     UPS 1	SMTP settings	
String 1/1	Edit	
	Host Port From E-mail Security Username	
	SMS notifications	
	Test SMS Your user does not have an associated phone number.	
	Project settings	
	Edit Delete logo	
	Project name Company URL Owner	
	Data Export	
	New data export	
	File Size Time	
	IIV vala cythylis arailand	
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# 4.1.6 SMS notifications

• Test SMS messaging

Data Center - Settin				n ×
← → ♂ @	O & https://192.168.0.29/gui/data_center/settings.html		<b>₽</b> ☆	» ≡
Probotina	Real-time data History data Discharge data Alarm Settings	The Main Admin User	Battery Monitorin	MS Ig System
Data Center     UPS 1	SMTP settings			Î
= String 1/1	Edit			
	Host Port From E-mail Security Username			
	SMS notifications			
	Test SMS Vour user does not have an associated phone number.			
	Project settings			
	Edit Delete logo			
	Project name Company URL Owner			
	Data Export			
	New data export			
	File Size Time			
	no data exports available			
				~
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# 4.1.7 Modbus server

• Edit Modbus settings



### 4.1.8 Project settings

- Set project information
- The project name is displayed as root in the tree menu
- You can also change the logo that appears above the tree menu

Data Center - Setting					
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Probotina	Real-time data History data Discharge data Alarm Settings	The Main Admin User		Ing Sys	Stem
Data Center     UPS 1	SMTP settings				Ŷ
= String 1/1	Edit				
	Host Port From E-mail Security Username				
	SMS notifications				
	Test SMS Vour user does not have an associated phone number.				
	Project settings				
	Edit Delete logo				
	Project name Company URL Owner				
	Data Export				
	New data export				
	File Size Time				
	No data exports available				
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# 4.2 Adding string and battery sensors

- Select Settings Configuration tab
- Connect a string sensor (always only one new-one at a time)
- In the New unassigned BM-SS table (below main table) OK should appear for COM Status and HALL

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Probotina	Real-time data	History data	Discharge data	Aarm 🔺 Set	ttings						The Bab	Admin User	A BTI		
ta Certer 🔺	Ceneral	Configuration	Diegnostics												
	Apply configur	ration													
		~		100					EN-MC	Naster controler	NAD. Put	v.			
							to comp rabits		EM-TH Temperature and humidity sensors						
	Index							COM Status							
	1							-		-		-			
	2							-							
	3							-							
	-				-	-		-		-		-			
	5											-			
	2														
	8							-							
	9				-			-		-		-			
	1.0				-	-		-	-	-	-	-			
	11				-	-		-		-		-			
	12											-			
												DIV-LIC ADD-480195			
					Ne			N							
					CON Status	Ratteries	Hall	COM Status	Temperature	Humidity					
					OK	ERROR	DK								
					400400 FML-22	Configure cells									



- To set the battery sensors press the Configure cells button
- In Cell sensor addressing dialog box
- Press Auto-sensing
- Wait that Address searching status change to 3
- Check whether all battery sensors have been found
- If all sensors found then confirm with the Check & Write button
- If the number of sensors found does not match the expected check sensor
- Cabling and repeat Auto-sensing

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Probotina	Real-time data	History data	Discharge data	Airm Ret	tings						The Hain	Admin User	BTMS
Data Center	Ceneral	Configuration	Diagnostics										
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	Appy comp	trator	_		_						_	_	_
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	2												
	3				Call sensor an	dressing - String D							
						a county - anning c		· ·	•			-	•
	5				Aute-sensing	Check & Write							
	7				Address searc	hing status 3							
	6				Guartity of Co	DW1 cells 2							
	9											-	
	10						close					-	•
	11								•	-		-	
	12											-	
											E	N-LC Auto-ascre	
					CON Status	Ratteries	Hall	COM Status	Temperature	Humidity			
					GK	DK	DKC						
					Assign EN-SS	Corfgure cels							
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# 4.2.1 Assign string sensor to string

- Press Assign BM-SS
- In Assign BM-SS dialog box select to which string BM-SS should be assigned



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robotina	Real-time data	History data	Discharge data	Abrm 🛦 Se	ttinge						The Hain	Admin User	
🖲 Date Certer 📐	General	▲ Configuration	Diegnostics										
	Apply config	uration											
											NAR. <b>Ful</b>	• A	
													CL IET
	Index												00
	1											-	. ^
	2												
	3												
	-				Aceign RN-RS			*	•	•		-	
	5				200	Unassioned			•	•		-	
	2				10	String 1 v							
	0												
	9				-							-	
	10						Cancel Save					-	•
	11					•			•			-	
	12												
												N-LC Auto-astro	68
					Ne								
					CON Status	Ratteries	Hal	COM Status	Temperature	Humidity			
					ак	DK	DK						
					Assign BN-SS	Configure cells							
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# 4.2.2 Assign string to UPS

- In main table select row
- Press Edit UPS
- In Edit UPS dialog
  - Select UPS ID
  - Set name for UPS
- Subsequent movement or reassignment of BM-SS sensors to another string and automatic reconfiguration of battery sensors is also possible
- Repeat the process for all string sensors



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Probotina	Real-time data	History data	Discharge data	Abrm 🛓 🖬	ettings						The Mair	Admin User	BTM
Data Certer 🛆	Conoral	▲ Configuration	Diegnostes										
	Apply config	juration											
							1				NAD: NAI	• a	
													CE IES
	Index												00
	1	String 01			ок	aк	СК	-		-	-	-	
	2	String 02											
	Э	String 03											
	-	String 0+			-					-	•	-	
	5	String 05			Edit UPS			<b>H</b>	•		•	-	
	6	String 06			ID I	1.NewLPR v		•	•			-	•
	7	String 07			hame	UPS 0)							
	0	String 08											
	9	String 09					Cancel Save					-	
	10	String 10									•	-	
	12	String 12										-	
		Eat String	6	otUPS	Move 8	NI-SS Confor	ie calis					EN-LC Auto-addres	5
									_	_			
					Ne								
					CON 519FUK	E3/1N1#6	HBI	COM SEMI.K	Temperature	Humidity	1		
	d laurant fire inc. i	d ann an Roman S											11 /m/12 0.00 /m

# 4.2.3 Adding BM-MC, BM-LC and BM-TH

- Select Settings Configuration tab
- Select BM-MC controller in main table 1st row right side
- Press BM-LC Auto-address to discover connected BM-LC IO modules
- If the modules are connected correctly, the statuses in the right 3 columns should change

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Probotina	Real-time data	History data	lischarge dat	a Aarm 🔺 🖡	Gettinge						The Main	Admin User	Battery Hanitorie g Syste
Data Center	Ceneral	A Configuration	Disgnostics										
	Apply config	juration											
											NAD. PUL	-	
								EM-TH Tem			rul 2019	.C Audiary digt	CL IST
	Index							COM Status			Status		
	1	String 01	1	UPS 01	к ок	aк	СК			-		-	. ^
	2	String 02			-							-	
	з	String 03			-			-				-	
	-	String 04			-							-	•
	5	Sting 05			-		•	-	•	•	•	-	
	6	String 06			-	-		-		-		-	
		String 07											
	9	String 09			-								
	10	501ng 10			-								
	11	String 11			-								
	12	String 12											
					Move 8				Nove BN-TH			BN-LC Auto-addres	89
					Ne	w unassigned BM	-55	N	ew unassigned BN	-тн			
					CON Status			COM Status					
					-								
					Assign BN-SS								
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• Connect BM-TH temperature and humidity sensor (only one new sensor at a time)



• The data of the connected sensor should appear in the New unassigned BM-TH table below the main table

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Probotina 🗖	ol-time data	Nietory data	Discharge dat:	a Aarm	A Sett	tings						The Main	Admin User		<b>NS</b> J Dyster
🛛 Data Certer 🛓	General	▲ Configuration	Disgnostics												
	family and														
	Apply comp	Juration	_	_	_		_	_	_	_	_	_	_	_	
										EN-M.	: Naster controller	NAD: 30829	v		
									EM-TH Tem			EN			
	Index	Nama	urs	Name		CON Status	Datteries	Hal	COM Status	Temperature	Humidity	Status	DI	00	
	1	String 01	1	UPS 01	×	ак	GК	ОК	-	-	-		-		î
	2	String 02				-			-						
	з	String 03				-			-				-		
	-	String 04				-		•	•	•	•	•	-	•	
	5	String 05						•	•	•	•	•	-		
	б	String 06				-					-		-		
	7	String 07				-			-				-		
	8	String 08				-			-		-		-		
	9	String 09				-		•	•	•		•	-		
	10	Stind 10				-		•	•	•	•	•	-	•	
	11	String 11							•				-		
	12	String 12													~
		EditString		EditUPS		Move 8	N-SS Confor	re cells					BN-LC Auto-addred	10	
															_
									N						
									COM Status						
									ок	23 <b>.1</b> °C	44.2 %				
									Assign BM-TH						
d bioding data of civits respond to a	eat for include	d name and the same h												1.1.dec/1.0.61	dec / 5.4

• Use the Assign BM-TH button to determine which string the sensor belongs to

Data Castano Cambra atom - V.	+												_ <b>л</b> v
2 Per Celes - Cirrigueion - K	-										-		
←⇒ଟଇ	08.	(11ps/) <b>192.16369.141</b> /gd)	/data_center/co	nfiguratios.html							40	유 쓰 백 🕻	-
robotina	Real-time data	Rictory data	lischarge dat	a Aaraa 🔺 🗛	ettings						The Main	Admin User	PBTMS
Data Center A	General	A Configuration	liegnostics										
	Apply config	uration											
		<b>2</b> .4							EN-MC	Master controler	NAD: 30529	•	
								EM-TH Tem	perature and humi	dity sensors	EN	-LC Auxiliary digit	CL IC
	Index							COM Status					80
	1	String 01	1	UPE D1	<b>с</b> ок	ак	ск	ак	22.2 °C	41.5 %		-	· ^
	2	String 02			-			-			-		
	э	String 00			-			-		-		-	
	4	SDIng 04			-			-	-	-		-	•
	5	String 05						-		-		-	
	6	String 06			-			-				-	
	7	String 07			-			-					
	0	String 00			-			-	-	-		-	
	9	Sting 09			-			-	-	-		-	•
	1.0	String 10			-			-		-		-	
	11	String 11			-			-		-		-	
	12	String 12											. v
		EditString		EditUPS	Move 8	N-SS Confg	ire calls		Nove BN-TH			EN-LC Auto-addres	8
											_		
					Ne			N					
					CON Status	Ratteries	Hal	COM Status	Temperature	Humidity			
								ок	23.2 °C	41.5 %			
								Assign BNI-TH					
												Sensor now Sensor 0 wa	ea a moved to 1
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• Repeat for all BM-TH sensors



### 4.2.4 Validate Configuration

- Check whether the data in the main table reflect the actual desired state
- Confirm the configuration with the Apply configuration button above the table

Probotina	Real-time data	a History data Di	ischarge data	Alarm Setting	5							The Main Admin User	Battery	BT
CAD 5 13	General	Configuration Diag	nostics											
String 02														
tring 03 14		String		IIDS		BM-SS String mast	or		BM-M	C Master controller	NAD: 20915	~		
itring 01 itring 02								BM-TH Ten	perature and humi	dity sensors	E	BM-LC Auxiliary digital	10	
itring 03	Index	Name	UPS	Name	COM Status	Batteries	Hall	COM Status	Temperature	Humidity	Status	DI	DO	
15 tring 01	1	String 01	1	UPS 13	с ок	ок	ок	ок	22.7 °C	57.5 %	ок	ON	OFF	
tring 02	2	String 02	1	UPS 13	с ок	ОК	ок	ок	22.6 °C	58.4 %	ОК	ON	OFF	
	3	String 03	1	UPS 13	с ок	ок	ок	ок	22.6 °C	57.2 %	ок	ON	OFF	
	4	String 01	2	UPS 14	с ок	ок	ок	ок	22.8 °C	57.6 %	ок	OFF	ON	
	5	String 02	2	UPS 14	с ок	ОК	ок	ок	22.6 °C	58.4 %	ОК	OFF	ON	
	6	String 03	2	UPS 14	с ок	ОК	ок	ок	22.8 °C	57.4 %	ок	OFF	ON	
	7	String 01	3	UPS 15	с ок	ок	ок	ок	23.0 °C	56.4 %	ОК	OFF	ON	
	8	String 02	3	UPS 15	с ок	ОК	ок	ок	23.0 °C	57.1 %	ок	OFF	ON	
	9	String 09			-		•	-	-	•	-	-	-	
	10	String 10				-		-	•	-	-	-	-	
	11	String 11			-			-	•	÷	-		-	
	12	String 12			-			-	-		-		-	
												BM-LC Auto-address		
					N	lew unassigned BM	·ss	N	lew unassigned BM-	тн				
					COM Status			COM Status						

• The tree menu on the left side should refresh and reflect the actual status of the UPS and strings connected to the BM-GW



## 4.2.5 Check Settings

- Switch the laptop to the facility network
- Set the IP on the laptop according to the requirements for the facility LAN



• Use the Internet browser to go to the address you set for the WAN connection

# 4.3 String and Battery sensors settings

• To set up an individual BTMS string sensor, just select it in the tree structure on the left and select the Settings view.

🗿 String - Settings 🛛 🛪	+										-	a ×
← → ♂ ພ̂	O & https://192.168.69.141/g	ui/data_center/ups/string/settings.html	lups=ups_01&string=string_01_01						<b>Q</b> ∂ <b>Q</b> ∂	£ 🖣	<b>U</b>	≡
Probotina	Real-time data History data	Discharge data Alarm Se	ttings						The Main Admi	n User		TMS pring System
Data Center	Alarm settings											Í
<ul> <li>0PS 01</li> <li>String 01</li> </ul>	Recommend Edit											
		Alarm trigger threshold	Alarm dear threshold		SMS	E-mail	DO					
	Enable alarms											
	String current charge limit	200.0 A	190.0	A								
	String current discharge limit	-200.0 A	-190.0	A								
	String voltage high limit	28.8 V	27.4	v								
	String voltage low limit	21.6 V	22.6	v								
	String SoC low limit	30 %	40	96								
	Hall alarm enable											
	Cell voltage high limit	14.40 V	13.70	v								
	Cell voltage low limit	10.80 V	11.30	v								
	Cell resistance high limit	25.00 ms	20.00	mΩ								
	Cell SoC low limit	50 %	60	96								
	Cell SoH low limit	60 %	70	96								
	Cell temperature high limit	50 °C	48	•с								
	Resistance settings											
	Resistance measurement interv	al 1h - 120h	Ý	1	h							
	Edit											
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### 4.3.1 Alarm settings

- The conditions for triggering and automatic alarm reset are set for the string and for all batteries within the string.
- Editing of the settings is enabled with the Edit button above the table.



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	String current charge limit	200.0	A	190.0	A											
	String current discharge limit	-200.0	A	-190.0	A	•										
	String voltage high limit	28.8	v	27.4	v			•								
	String voltage low limit	21.6	v	22.6	v	2										
	String SoC low limit	30	%	40	96	2										
	Hall alarm enable			2		2										
	Cell voltage high limit	14.40	v	13.70	v			2								
	Cell voltage low limit	10.80	v	11.30	v	2										
	Cell resistance high limit	25.00	mΩ	20.00	mΩ	2										
	Cell SoC low limit	50	%	60	96	2										
	Cell SoH low limit	60	96	70	96	2										
	Cell temperature high limit	50	•С	48	°C	2										
	Resistance settings															
	Edit Write															
	Resistance measurement interv	al 1h - 120h		Ý	1	h										
	Balancing settings															
	Edit Write															
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- Limit values are set in the left part of the table, and the action that the alarm triggers is set in the right part. The action can be sending an SMS or/and e-mail message or/and triggering a digital output.
- Use the Write button to use the entered changes. The "Cancel" button cancels all changes.
- The Recommend button presets some alarm parameters depending on the connected batteries and the used Hall sensor.

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• The proposed values can then be further adapted to the requirements and entered.

# 4.3.2 Resistance settings

• Here we set the battery resistance measurement frequency.

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Data Center	Cell temperature high limit. S0 12 30 48 12 0	^
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	Cel nominal voltage 12 V v Internal resistance inference 14.50 m0	
	Internal resistance correction 0.60 m2	
	Cut off voltage 10.80 V	
	Recovery voltage 12.68 V	
	Post-voltage 13.38 V	
	Plant current 2.00 A	
	Hall settings	
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## 4.3.3 Balancing settings

• Battery balancing can be enabled or disabled. If balancing is enabled, set the threshold value at whichbalancing is triggered and the balancing execution interval.



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# 4.3.4 Cell settings

• For the proper functioning of battery status monitoring, it is necessary to specify what batteries areused in the string.

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Data Center     UPS 01     O String 01	Cell settings Cancel Write		
	Cell capacity 10 Ah		
	Internal constance ofference 14.50 m0		
	Internal resistance correction 0.60 m0		
	Cut-off votage 10.00 V		
	Recovery voltage 12.68 V		
	Float voltage 13.38 V		
	Ploat current 2.00 A		
	Hall settings Eat Unite Zero calibration Hall sensor type 200 A - v		
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# 4.3.5 Hall Setting

• Select the sensor used from the values offered.

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UPS 01     O String 01	Cancel Write Of concerty 10 Ab					
	Cell nominal voltage 12 V v Internal resistance inference 14.50 m2					
	Beternal resistance correction         0.60 mQ           Cut-off voltage         10.80 V           Reconstry relition         12.66 V					
	Ploat voltage         13.38         V           Ploat current         2.09         A					
	Hall settings					
	Cancel Write Zers calibration					
	25 A Voltage measured					1
	200 A           200 A           400 A           500 A           200 A					
	Configuration file					
	Download         Save this string's configuration data to a file.           Upload         Upload other string's configuration data to this string (You can also drag and drop the file onto an individual table).					
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### The Zero calibration button is used to calibrate the Hall sensors.

# It is important to ensure that during calibration the string current is 0 A

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# 4.3.6 Voltage Measurement

• The string sensor allows 2 ways of measuring the string voltage: as the sum of the voltage of the batteries in the string or directly. Since we have to work with dangerously high voltage when measuring the voltage directly, it is recommended to use the summation of the voltage of individualbatteries where possible.

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e songer	Carcel Write					
	Cell capacity	10 Ah				
	Cell nominal voltage	12 V v				
	Internal resistance reference	14.50 mg				
	Out-off voltage	10.80 V				
	Recovery voltage	12.68 V				
	Float voltage	13.38 V				
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# 4.3.7 Configuration file

• It is possible to easily save the string sensor settings to a file.



• And reading all the instructions from this one.

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• If we drag and drop the saved file onto the settings table, only the parameters that are in the table will be entered from the file.



# 4.4 BTMS Installation and Commissioning steps overview

Step	Activity	Description	Done by	
1	Mounting & wiring	Mount all modules and wire them according wiring diagrams. It is necessary to be very careful when wiring, as there can be very high and life-threatening voltage in the string due to serial batteries / cells connections.	Installer	
2	Test wiring	Check the entire wiring carefully. Connect the power supply to all modules and check if the modules are working correctly (the LED indicators behave according to the instructions).	Installer	
3	Fill in the table: "BTMS Commissioning Table v2.0.xls"	For each string and for each gateway, all necessary data must be entered in the table. The information from the table, which must be filled in by the customer, is necessary so that the authorized system integrator can set up the BTMS system correctly.	Customer	
4	General settings	Follow the steps in 4.1 General settings	Authorized system integrator	
5	Add string, battery and other sensors	Follow the steps in "4.2 Adding string and battery sensors".	Authorized system integrator	
6	String and Battery sensors setup	Follow steps in "4.3 String and Battery sensors settings"	Authorized system integrator	
7	BM-GW setup	Set WAN, NTP, Time setting. Add Users for WEB UI app.	Authorized system integrator	



8	Function test	On all user interfaces (touch panel, WEB UI on BM-GW), check whether all displayed data are consistent with the expected values. Check Modbus TCP/IP communication with the BMMC controller.	Authorized system integrator
9	Archive relevant data	Archive Configuration file and commissioning table	Authorized system integrator



# 5 Maintenance

Regular maintenance of electrical installations has a decisive effect on reliability and safe use. Therefore, electrical installations must be periodically inspected and tested. It is mandatory that the maintenance personnel are familiarized with project documentation and electrical installation plan. All electrical installations must be safe for both people and equipment throughout their lifetime. We expect normal operation of the installations with as few interventions and repairs as possible.

# 5.1 Maintenance plan

Basically, all electrical equipment that is installed in Battery Monitoring System does not require any special maintenance. Nevertheless, periodic preventive maintenance activities performed by authorized personnel are strongly recommended.

# 5.2 Preventive Maintenance Checklist

We strongly recommend quarterly preventive maintenance checkup. We provide a checklist with recommended maintenance activities that should be performed by authorized personnel.



	BTMS Battery Monitoring System Preventive Maintenance Checklist								
	CLISTOMED DATA								
1 PLANT/BU	IILDNIG				2 LOCATION		3 (	3 CONTRACT	
4 EQUIPMEI	NT				5 CUSTOMER		6 DATE		
7 TESTED BY	(								
			BIIVIS EQUIP		DAIA				
# of UPS	# of Strings	# of	To	tal	# of Battery	# of	String	# of Hall	
		Batteries	ващ	eries	Sensors	Se	nsors	Sensors	
		perstini	<u></u>						
	١	/ISUAL AND	D ELECTRICAL/I	ИЕСН	ANICAL INSPEC	TION			
CHECK	POINT	COND*			NOT	ES			
		COND							
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damage, note and recomme	e any changes endations)								
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inspect all eq	uipment								
changes and	s, note any								
recommenda	tions)								
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appear)									
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(check if all Cell sensors									
are functionir	ng and								
provide mea	surements,								
recommenda	tions)								



8 VERIFICATION OF ALL		
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SS) (check if all String		
sensors are functioning		
and provide		
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9 VERIFICATION OF ALL		
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HS) (check if all Hall		
sensors are functioning		
and provide		
measurements, note any		
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CONTROLLERS (BM-C)		
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changes and		
recommendations)		
12 VERIFICATION OF		
ALL GATEWAYS (BM-		
GW) (check if all		
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		LOG VERIFICATION
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CHECKFOINT	COND	NOTES
13 CHECK LOG FILES		
FOR COMPLETENESS		
	SOFT	WARE/HARDWARE MAINTANANCE
CHECK POINT	COND*	NOTES
14 BACKUP ALL		
CONTROLLERS		
15 BACKUP ALL		
DATABASES		
16 INSTALL ALL		
FIRMWARE		
UPDATES/PATCHES		
L		



DOCUMENT ALL EQUIPEMENT							
CHECK POINT	COND*	NOTES					
17 PROVIDE ALL DATA LISTED IN "btms commissioning table v2.0.xlsx"							
		PHOTO DOCUMENTATION					
CHECK POINT	COND*	NOTES					
18 PHOTO DOCUMENT ALL REGULAR AS WELL AS UNUSUAL SITUATION AND EQUIPEMENT							
NOTES	NOTES						
*CONDITION: A=ACCEPTABLE; r=NEEDS REPAIR, REPLACEMENT OR ADJUSTMENT; C=CORRECTED; NA=NOT APPLICABLE ** YEARLY WITHIN MAJOR SEERVICE							



# 6 Troubleshooting

# 6.1 Alarms

If you notice any alarm check the BTMS Alarm list for further action. Alarm list is attached at the end of the document.

# 6.2 System malfunctions

If you are having problems with the system, try the appropriate solutions below. This may fix a system error that is the result of one of the most common system failures or installation mistakes.

- Check the power supply and the power supply of all components are connected correctly
- Check communication cables are properly connected (it is best to check each one step by step)
- Check that the hall sensor is facing correctly (there is an arrow on it showing the direction of the electric current)
- Check LED on Cell sensor and String master (is green breathing mode or constant red)

# 6.3 Support

In any case, our technical support will be able to help you, it is at in http://support.robotina.com. By trying the solutions listed above, our technical support will also be more effective in identifying errors and will help you more effectively.

One of the possible causes of malfunction may also be incorrect initial system configuration.

The initial configuration of the system can only be done by an authorized person!

Contact an authorized person for any problems.

Robotina Help Desk in http://support.robotina.com





# 7 Appendix: BTMS Alarm List

Alarm	Alarm trigger	Alarm clear	Action		
String current charge limit	String charging current over alarm trigger threshold	Automatically String charging current below alarm clear threshold	Turn off the UPS Check the UPS settings Verify string current		
String current discharge limit	String discharging current over alarm trigger threshold	Automatically String discharging current below alarm clear threshold	Turn off UPS Check wiring Verify UPS settings Verify string current		
String voltage high limit	String voltage over alarm trigger threshold	Automatically String voltage below alarm clear threshold	Turn off the UPS Check the UPS settings Verify string voltage		
String voltage low limit	String voltage below alarm trigger threshold	Automatically String voltage over alarm clear threshold	Turn off the UPS Check the UPS settings Check the condition of the batteries in the string Verify string voltage		
String SoC low limit	String SOC below alarm trigger threshold	Automatically String SOC above alarm clear threshold	Check the operation of the UPS Check the string breaker Check the condition of the batteries in the string		
Hall alarm enable	Hall sensor faulty or disconnected	Automatically Hall sensor is working correctly	Check the Hall sensor connection		
Cell voltage high limit	Battery voltage over alarm trigger threshold	Automatically Battery voltage below alarm clear threshold	Check the UPS settings		
Cell voltage low limit	Battery voltage below alarm trigger threshold	Automatically Battery voltage over alarm clear threshold	Check the condition of the other batteries in the string, if they are all at the limit, the problem is in the UPS settings; if the other batteries are within the expected values, the cause is most likely in the battery.		



Alarm	Alarm trigger	Alarm clear	Action
Cell resistance high limit	Battery internal resistance over alarm trigger threshold	Automatically Battery internal resistance below alarm clear threshold	Check the wiring of the battery and the battery sensor. Manually checks the battery's internal resistance. Replace the battery.
Cell SoC low limit	Battery SOC below alarm trigger threshold	Automatically Battery SOC over alarm clear threshold	Check the condition of the other batteries in the string, if they are all at the limit, the problem is in the UPS settings or operation; if the other batteries are within the expected values, the cause is most likely in the battery.
Cell SoH low limit	Battery SOH below alarm trigger threshold	Automatically Battery SOH over alarm clear threshold	Check the wiring of the battery and the battery sensor. Replace the battery.
Cell temperature high limit	Battery temperature over alarm trigger threshold	Automatically Battery temperature below alarm clear threshold	Turn off the UPS and wait for the temperature to drop to normal. Check the battery wiring (power part). If the problem persists, replace the battery.,
Cell disabled	At least 1 battery (cell) sensor is disabled.	Automatically Battery (cell) sensor enabled again	Check battery sensor wiring. Check battery voltage. Check ethernet cable. If the problem persists, replace the battery or battery sensor.



NOTES: