PYLONTECH

Li-ion (LFP)
Energy Storage System
PowerCube-M1-C

Operation Manual

TM024 Rev.002

This manual introduces PowerCube-M1-C from Pylontech.

PowerCube-M1-C is a high voltage DC Lithium-Ion Phosphate Battery storage system.

Please read this manual before you install the battery and follow the instruction carefully during the installation process.

Any confusion, please contact the supplier immediately for advice and clarification.

Content

1.0 SAFETY

PowerCube-M1-C is a high voltage DC system, operated by skilled/qualified personnel only. Read all safety instructions carefully prior to any work and observe them at all times when working on with the system

Incorrect operation or work may cause:

- injury or death to the operator or a third party;
- damage to the system hardware and other properties belonging to the operator or a third party.

1.1 Skills of Qualified Personnel

Qualified personnel must have the following skills:

- training in the installation and commissioning of the electrical system, as well as the dealing with hazards;
- knowledge of this manual and other related documents;
- knowledge of the local regulations and directives.

1.2 Symbols

	**DANGER** **Lethal voltage!** **Battery strings will produce HIGH DC power and can cause a lethal voltage and an electric shock.** **Only qualified person can perform the wiring of the battery strings.**
	**Warning** **Risk of battery system damage or personal injury.** **Do not pull out the connectors while the system is working!** **De-energize from all multiple power sources and verify that there is no voltage.**
	**Caution** **Risk of battery system failure or life cycle reduces.**
	**Read the product and operation manual before operating the battery system!**
	**Danger! Safety!**
	**Warning electric shock!**
	**Do not place near flammable material**
	**Do not install the system in an outdoor area**

	Do not reverse connection the positive and negative.
	Do not place near open flame.
	Do not place at the children and pet touchable area.
	Recycle label.
	Label for Waste Electrical and Electronic Equipment (WEEE) Directive (2012/19/EU)
	L'etichetta del certificato per EMC.
	The certificate label for EMC.
	The certificate label for Safety by TÜV SÜD.
	The certificate label for Safety by TÜV Rheinland.

Danger.
Batteries deliver electric power, resulting in burns or a fire hazard when they are short circuited, or wrongly installed.

Danger. Lethal voltages are present in the battery terminals and cables. Severe injuries or death may occur if touch the cables and terminals.

Warning. Do not open or deform the battery module, otherwise the product will be out of warranty scope.

Warning. Whenever working on the battery, wear suitable personal protective equipment (PPE) such as rubber gloves, rubber boots and goggles.

Warning. For battery installation, the installer shall refer to NFPA70 or similar local installation standard for operation.

Caution.
Improper settings or maintenance can permanently damage the battery.

Caution. Incorrect inverter parameters will lead to a further faulty/damage to battery.

Caution. It is very important and necessary to read the user manual carefully (in the accessories) before installing or using battery. Failure to do so or to follow any of the instructions or warnings in this document can result in electrical shock, serious injury, or death, or can damage battery, potentially rendering it inoperable.

- If the battery is stored for long time, it is required to charge them every six months, and the SOC should be no less than 90%.
- Battery needs to be recharged within 12 hours, after fully discharged.
- Do not install the product in outdoor environment, or an environment out of the operation temperature or humidity range listed in manual.
- Do not expose cable outside.
- Do not connect power terminal reversely.
- All the battery terminals must be disconnected for maintenance.
- Any foreign object is prohibited to insert into any part of battery.
- Do not use cleaning solvents to clean battery.
- Do not expose battery to flammable or harsh chemicals or vapors.
- Do not paint any part of battery, include any internal or external components.
- Do not connect battery with PV solar wiring directly.
- Please contact the supplier within 24 hours if there is something abnormal.
- The warranty claims are excluded for direct or indirect damage due to items above.

1.3 Reference standards

DESCRIPTION	CODE
Safety standard for secondary lithium batteries	IEC62619 IEC63056 IEC62477-1 IEC62040-1
UN38.3 Safe transport standard	UN38.3
CE EMC Standard CE EMC Directive 2014/30/UE	EN IEC 61000-6-1:2019 EN IEC 61000-6-2:2019 EN 61000-6-3:2007+A1 EN 61000-6-4:2007+A1 IEC 61000-6-1:2016 IEC 61000-6-2:2016 IEC 61000-6-3:2006+A1 IEC 61000-6-4:2018
UKCA EMC Standard	BS EN IEC 61000-6-2:2019 BS EN 61000-6-2:2005 BS EN 61000-6-4:2007+ A1
Battery Cell safety standard	UL1642 UL1973 JIS C 8715-2 UL9540A
Safety standard for electrical devices CE LVD Directive 2014/35/EU	IEC62477-1
Safety Standard for Lithium Battery (US)	UL1973
Safety Standard for Lithium Battery (Germany)	VDE-AR-E 2510-50:2017

1.4 Before Connecting

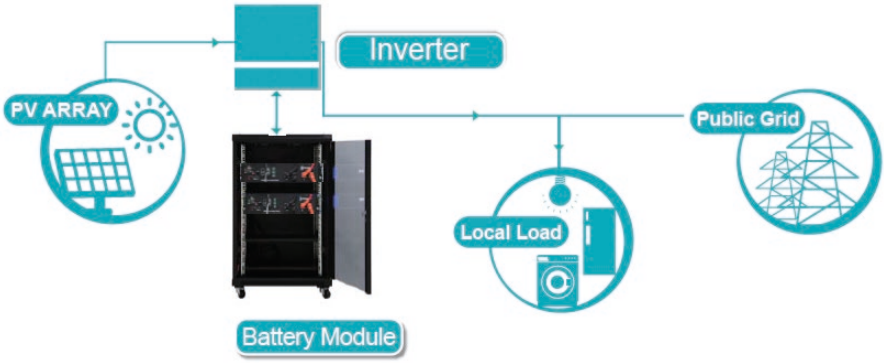
- After unpacking, please check product and packing list first, if product is damaged or lack of parts, please contact with the local retailer.
- Before installation, be sure to cut off the grid power and make sure the battery is in the switched-off mode.
- Wiring must be correct, do not mistake the positive and negative cables, and ensure no short circuit with the external device.
- It is prohibited to connect the battery and AC power directly.
- The BMS is designed for 1000V DC, please DO NOT connect battery in series.
- Battery system must be well ground and the resistance must be less than 100mΩ.
- Please ensured the electrical parameters of battery system are compatible to related equipment.
- Keep the battery away from water and fire.

1.5 In using

- If the battery system needs to be moved or repaired, the power must be cut off and the battery is completely shut down.
- It is prohibited to connect the battery with different type of battery.
- It is prohibited to put the batteries working with faulty or incompatible inverter.
- It is prohibited to disassemble the battery (QC tab removed or damaged).
- In case of fire, only dry powder fire extinguisher can be used, liquid fire extinguishers are prohibited.
- Please do not open, repair or disassemble the battery except staffs from Pylontech or authorized by Pylontech. We do not undertake any consequences or related responsibility which because of violation of safety operation or violating of design, production and equipment safety standards.

1.6 Safe handling of lithium batteries guide

1.6.1 Schematic diagram of solution



2.0 SYSTEM INTRODUCE

2.1 Product Introduction

PowerCube-M1-C is a high voltage battery storage system based on lithium iron phosphate battery, which is one of the new energy storage products developed and produced by Pylontech. It can be used to support reliable power for various types of equipment and systems. PowerCube-M1-C is especially suitable for those application scenes which required high power output, limited installation space, restricted load-bearing and long cycle life.

Fig. 2.1 - Internal power supply battery system

2.2 System parameters

Model	PowerCube-M1-C
Cell tecnology	Li-ion (LFP)
Nominal Voltage (Vdc)	<1000
Nominal capacity [kWh / Ah]	118.4 / 148
Nominal current [A]	74
Dimension [mm]	818x2178x753 (rack for 1~23pcs)
Weight [kg]	114+ (43×n)
Battery system charge voltage min~max [V]	690 ~ 828
Max Battery system charge/discharge current [A]	148
Battery Module Type	H32148-C
Module nominal voltage [V]	32
Module nominal capacity [kWh/Ah]	4.736 / 148
Depth of Discharge [%]	90% (8 - 98% SOC)
Efficiency [%]	95
Controller Name	SC1000-200J-C (Internal Power Supply Version)
Communication	CANBUS/Modbus RTU/TCP/IP
Operation Temperature [°C]	0~50
Storage Temperature [°C]	-20~60
Humidity [RH %]	5%~95%
Altitude [m]	<4000
Protection Class	IP00
Operation Life [years]	15+
Transfer Certificate	UN38.3

2.3 Battery Module

Model	H32148-C
Cell Technology	Li-ion (LFP)
Nominal voltage [V]	32
Nominal capacity [kWh/Ah]	4.736/148
Depth of Discharge [%]	90 (8-98%)
Nominal current [A]	74
Dimension WxHxD [mm]	330x150.5x628
Weight [kg]	43
Battery module charge voltage [min~max, V]	30 ~ 36
Battery system charge current [A, max.]	148
Communication Bus	RS485\CAN
Operation temperature [°C]	0 ~ 50
Storage temperature [°C]	-20 ~ 60
Protection class	IP20
Operation life [years]	10+

2.4 Battery Module Front Interface

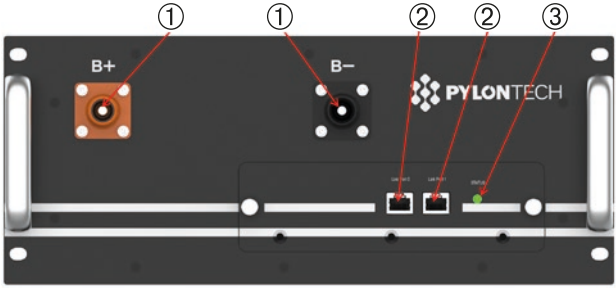


Fig. 2.2 - H32148-C

1. **Power Terminal +/-**
   To connect battery series power cables.
2. **Link Port 0,1**
   Link Port 0, 1 Communication Terminal: (RJ45 port), CAN communication, between multiple serial battery modules and control module.
3. **Status**
   Status light: to show the battery module's status:
   verde = normal, **rosso** = abnormal

Power Terminal.

Power cable terminals: there are two pair of terminals with same function, one connecting to equipment, the other one paralleling to other battery module for capacity expanding. For each single module, each terminal can achieve charging and discharging function.
AS power cables uses water-proofed connectors, it must keep pressing this Lock Button (1) during pulling out the power plug.

2.5 Control Module

PowerCube-M1-C's Control Module internal power supply (SC1000-200J-C) version.

Model	SC1000-200J-C
Related Product	PowerCube-M1-C
AC Supply for BMS [V,Hz,A]	n.d.
System Operation Voltage [Vdc]	200~1000
Max Operation Current [A]	148
Self-consumption Power-Relay Off [W]	6
Self-consumption Power-Relay On [W]	15
Dimension WxHxD [mm]	330x150.5x628
Communication	Modbus RTU/CAN/LAN
Protection Class	IP20
Weight [kg]	13
Operation Life [years]	15+
Operation Temperature [°C]	-20~65
Storage Temperature [°C]	-40~80

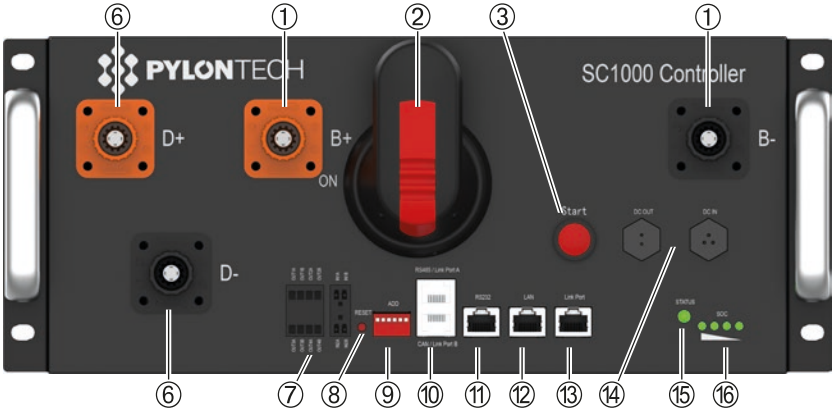


Fig. 2.3 - Control Module front interface SC1000-200J-C

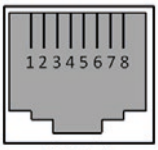
1. **Power terminal +/-**
   To connect battery power cables in series.
2. **Isolating Switch**
   To control the BMS power supply and high voltage DC power output.
3. **Start button**
   Start function: press more than 5" until the buzzer rings, to turn on controller.

Black Start function: If long press(>10") the start button 30" AFTER controller power on. The “STATUS” lamp will become green which means black start function is enabled. and relay will close and output for 10'.

6. **External power terminal +/-**
   Connect battery system with Inverter.
7. **Dry Contact Terminal**
   Provided 2 input and 4 output dry contact signal.
8. **Reset button.** Long press this button to restart the battery system.
9. **ADD.**
   6 bit dial switches to manually distribute the communication address of the battery system. Nether position is OFF, means “0”. Upper position is ON, means “1”. 1st bit to 5th bit is for address, and the 6th bit dial switch support a 120Ω resistance
10. **CAN/RS485 Communication Terminal.**
    (RJ45 port) follow CAN protocol, for communication between battery system and inverter.
    RS485 Communication Terminal: (RJ45 port) follow Modbus RTU/TCP/IP protocol, for communication between battery system and inverter.
11. **RS232 Console Communication Terminal**.
    (RJ45 port) follow RS232 protocol, for manufacturer or professional engineer to debug or service.
12. **LAN Terminal.**
    Console Communication Terminal: (RJ45 port) follow Modbus protocol, used for communication between MBMS, switches or upper controller.
13. **Link Port Communication Terminal**.
    (RJ45 port) follow RS485 protocol, for communication between multiple serial battery modules and control module..

No.	CAN	RS485	RS232 Pin
1	---	---	---
2	GND	---	---
3	---	---	TX
4	CANH	---	---
5	CANL	---	---
6	---	GND	RX
7	---	RS485A	---
8	---	RS485B	GND

Tab. 2.1 - RJ45 Pin



RJ45 Port

RJ45 Plug

14. **12V DC OUT/IN**
    DC Out: Power supply for MBMS, to connect with MBMS’ 12VDC IN
    DC In: Back-up 12VDC power supply port

15. **STATUS.** Status light: to show the battery module's status:
    green=run, **red**=alarm and protection
16. **SOC.** Battery capacity indicator: 4 green lamps, each light represents 25% capacity.

Battery status	Mode	Status		Capacity SOC				Descriptions
		●	●	●	●	●	●	
shut down		off	off	off	off	off	off	all off
sleep	normal	L2	off	off	off	off	off	Indicates sleep mode, to save the power
idle	normal	●	off	off	off	off	off	Indicates save power mode
	alarm	off	●	off	off	off	off	battery voltage or temperature is high or low
	protec.	on	●	off	off	off	off	battery voltage or temperature is over or under
charge	normal	●	off	The highest capacity indicator LED flashes (L2), others lighting				The highest capacity indicator LED flashes (L2), others lighting, horse race lamp when SOC ≥ DODH
	alarm	off	●					
	protec.	off	●	off	off	off	off	Stop charging, STATUS (red) lighting
discharge	normal	L2	off	Indicate based on capacity				Indicate based on capacity
	alarm	off	L2					
	protec.	off	●					Stop discharging, STATUS (red) lighting
abnormal	power on fault	off	L4	off	off	off	off	Stop charging/discharging, STATUS (red) lighting
	other fault	off	●	off	off	off	off	
	STL fault	off	L2	L2				MCU self-check problem

Tab. 2.2 - LED indicators instructions

Note: The flashing instructions, L2 - 0.5" light / 0.5" off; L4 - 1" light / 1" off

2.6 System Diagram

2.6.1 CAN communication between MBMS and BMS

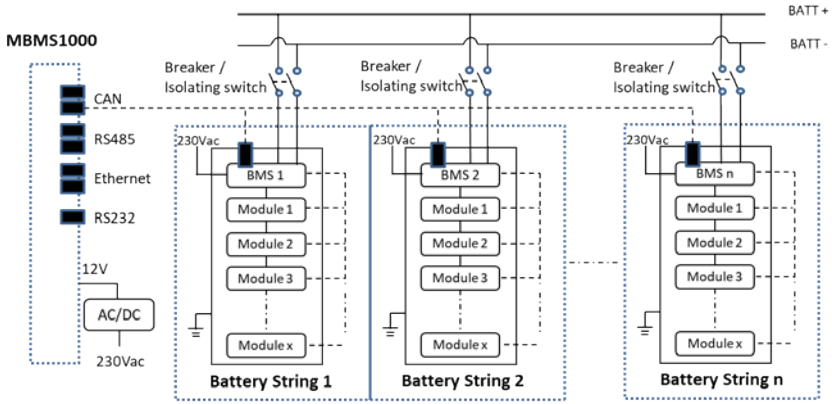


Fig. 2.4 - Multiple battery string in parallel connection by CAN communication between MBMS and BMS diagram (battery string qty. ≤6)

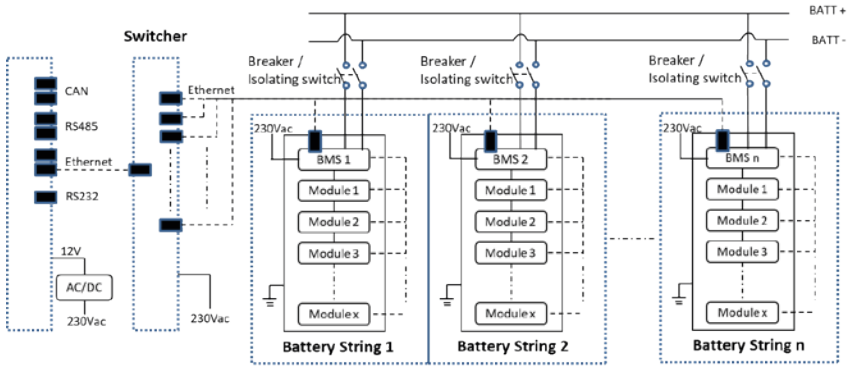


Fig. 2.5 - Multi battery string in parallel connection by Ethernet communication between MBMS and BMS diagram (battery string qty. ≤32 set)

2.6.2 Diagram between BMS and battery modules

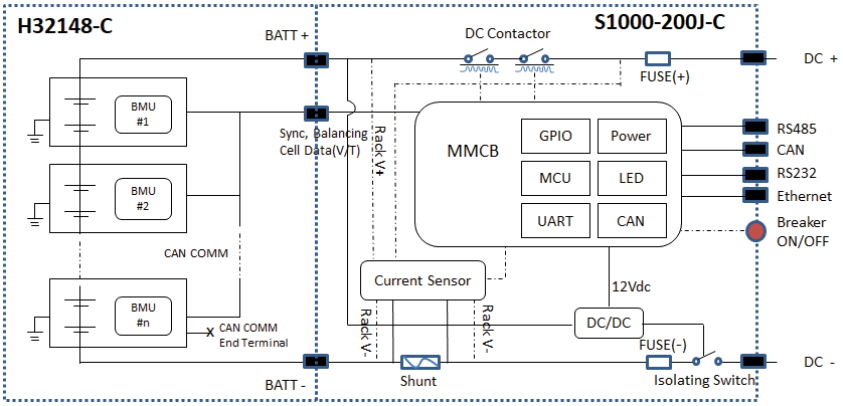


Fig. 2.6 - Diagram between BMS and battery modules (internal power supply)

3.0 INSTALLATION

3.1 Tools

			
Wire Cutter	Crimping Modular Plier	Cable Ties	Screw Driver
			
Electric Screw Driver	Adjustable Wrench	Isolating nut drivers	Multimeter

Table 3.1 - Tools needed to install battery pack

Danger. Use properly insulated tools to prevent accidental electric shock or short circuits.
If insulated tools are not available, cover the entire exposed metal surfaces of the available tools, except their tips, with electrical tape.

3.2 Safety Gear

It is recommended to wear the following safety gear when dealing with the battery pack.

		
Insulating gloves	Safety goggles	Safety shoes

3.3 System Working Environments Checking

3.3.1 Cleaning

Warning! The battery system has high voltage connectors. The clean condition will cause the isolation characteristic of the system.
Before installation and system working, the dust and iron scurf must be clean to ensure the environments cleaning. And the environment must have certain anti-dust ability.

The system after long term running must check if the humidity and dust cover or not. If heavy dust cover with high humidity on the system, stop the system running and make clean especially the ventilation channels.

Warning! The power cables and plugs still have high voltage DC power from serial connected battery modules (battery module can't be turned off), be careful to handle the Power Plugs.

3.3.2 Temperature

Caution. PowerCube-M1-C: system working temperature range 0° - 50°C;
Optimum temperature: 10°C - 40°C.
There are no mandatory ventilation requirements for the battery module, but please avoid installation in confined areas. Avoid high salinity, humidity or high temperature conditions.

Caution. The installation areas shall avoid of direct sunlight.
Out of the working temperature range may cause the battery reduces the cycle of life even trigger the battery system over / low temperature alarm or protection.
The room should be equipped with cooling/heating system. If the environment is lower than 0°C, the heating system at first must be turned on.

3.3.3 Fire-extinguisher System

Warning. The room must be equipped with fire-extinguisher system for lithium-ion battery. The fire system needs to be regularly checked to be in normal condition. Refer to the using and maintenance requirements of local fire equipment relevant.

3.3.4 Grounding System

Warning. Before the battery installation be sure the grounding point of the basement is stable and reliable. If the battery system is installed in an independent equipment cabin (e.g. container), make sure the grounding of the cabin is stable and reliable. The resistance of the grounding system must be ≤100 mΩ**.**

3.3.5 Safety area

The distance from heat source is more than 2 meters.
The distance from air outlet of inverter is more than 0.5 meters.

3.4 Handling and placement

Caution. BESS has high voltage connectors and must be operated by qualified and authorized personnel only. It must be installed in a restricted access area.

Warning. Single battery module is 43 kg. If without handling tools must have more than 2 man to handling with it.

- The base's weight capacity should support the weight of whole battery system.
- PowerCube-M1-C system bust be installed on fixed ground.

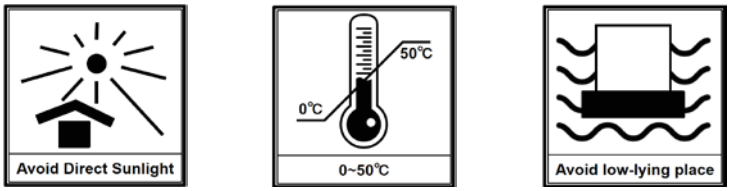


Fig. 3.1 - Avoid direct sunlight and low-lying place

3.5 Package Items

3.5.1 Accessories

The type and quantity of the accessories are subject to the battery packing list

Note. Power cable uses water-proofed connectors.
It must keep pressing this Lock Button (1) during pulling out the power plug.

3.5.2 Unpack and check the Packing List

- **Internal Cable Kits for wiring connection up to Battery Controller:**

Fig. 3.2	Power Cable + (Battery Module and Main Controller Serial Connection). Orange/190mm/1/0AWG/ 2 Orange Terminal.
Fig. 3.3	Power Cable - (Battery Module and Main Controller Serial Connection). Black/2000mm/1/0AWG /2 Black Terminal.

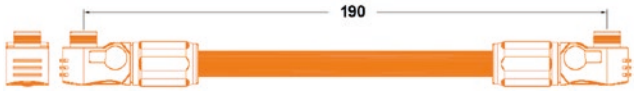


Fig. 3.2 - Power Cable +

Fig. 3.3 - Power Cable -

Fig. 3.4	Power Cable (Battery Module Left and Right rack Serial Connection). Orange/350mm/1/0AWG /1Orange & 1 Black Terminal.
Fig. 3.5	Power Cable (23 pcs, Battery Module Upper and Lower Serial Connection). Orange/240mm/1/0AWG /Orange & 1 Black Terminal.

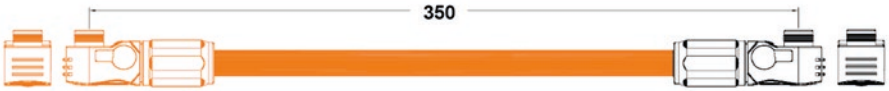


Fig. 3.4 - Power Cable.

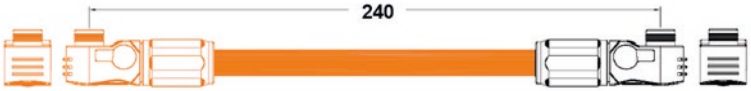


Fig. 3.5 - Power Cable.

Fig. 3.6	Battery Cascade Communication Cable (25pcs, 0.18m). Black/0.18m/8 Core Super 5th Class Twisted-pair Wire/RJ45.
Fig. 3.7	Battery Cascade Communication Cable (0.5m). Black/0.5m/8 Core Super 5th Class Twisted-pair Wire/RJ45.

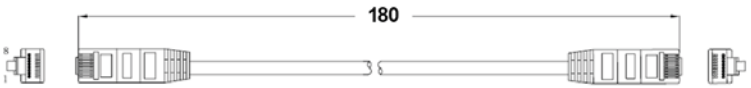


Fig. 3.6 - RJ45.

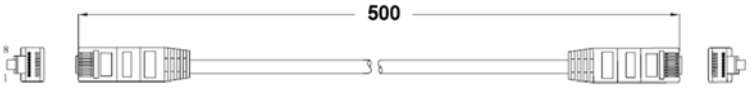


Fig. 3.7 - RJ45.

- **External Cable Kits for wiring connection from Battery Controller to PCS/EMS/ Power Supply**
  External Cable Kits for wiring connection are available in 5m lengths.
  Contact the supplier for alternative measures.

Fig. 3.8	External Battery CAN Communication Cable (direct). Black/5m/Super 5th Class Twisted-pair Wire/2 RJ45 terminal.
Fig. 3.9	External Power Cable +. Orange/5m/1/0AWG/ Phoenix Terminal/50-8 Terminal.
Fig. 3.10	External Power Cable -. Black/5m/1/0AWG /Phoenix Terminal/50-8 Terminal.

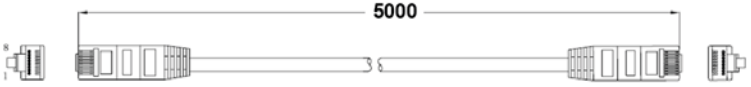


Fig. 3.8 - RJ45.

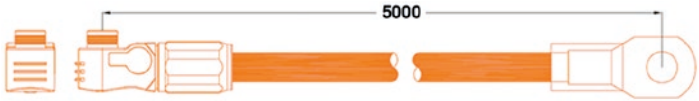


Fig. 3.9 - External Power Cable +

Fig. 3.10 - External Power Cable -

3.5.3 Handling and placement of the rack

Warning: The battery rack must be installed in a restricted access area.
If without handling tools, it must be handled by 4 persons.

Refer to the dedicated datasheets and installation manuals.

3.5.4 Control Module (BMS) and battery modules installation

- Two people are required to move a BMS module or a battery module. Each person must keep one hand on the appropriate front handle and the other hand on the bottom part of the module.
- Before fixing the BMS and battery modules, place the cage nuts in the correct hole.
- The BMS must be installed in the first free slot at the top of the rack. Feel free to choice left or right column positioning.
- Rest the rear part of the module on the appropriate lateral guides.
- Insert the module and place it in position, bringing the front panel up against the uprights of the rack.
- Fix the module with 4 M6 screws.
- If all 23 slots of the rack are not occupied, it is recommended to occupy the same number of slots between the left column and the right column so that the length of the cables is still sufficient to guarantee the connection.

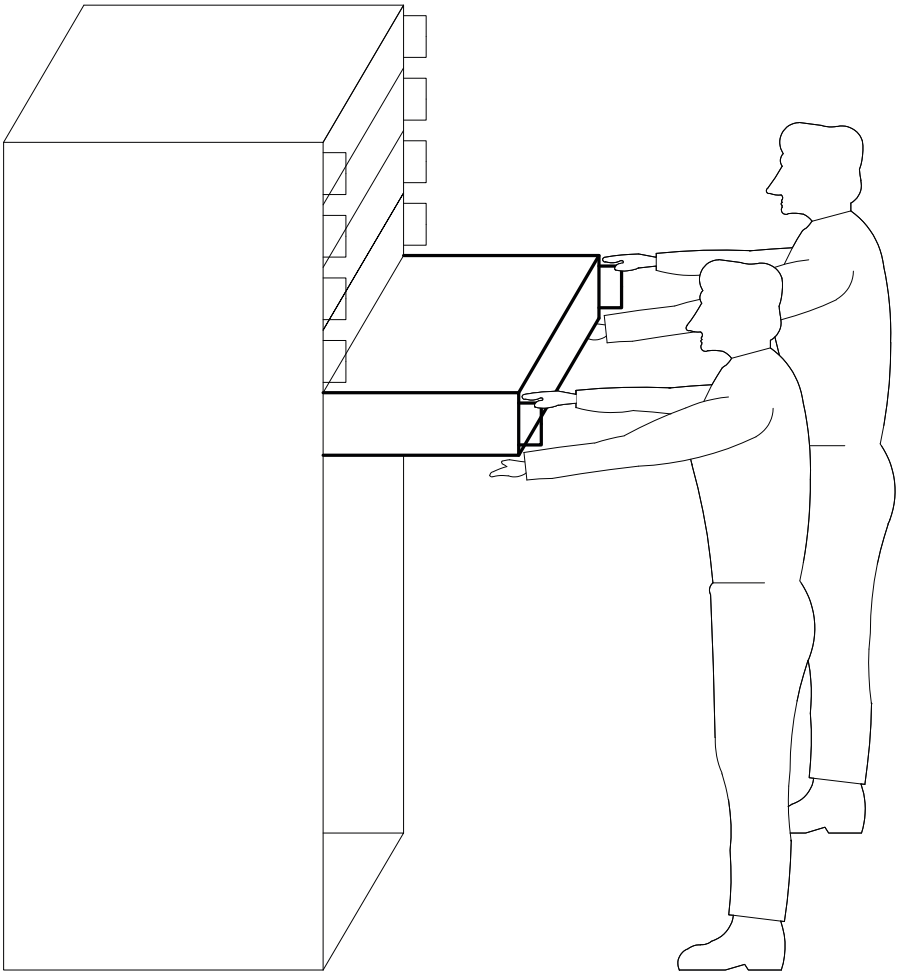


Fig. 3.11 - Modules handling

3.5.5 MBMS installation

Fig. 3.12 - MBMS Controller (If configured)

- Install the buckle nuts. The position of nuts must meet the position of the MBMS.
- Install the MBMS in. Uses 4 screws to fix it.

3.5.6 Switch Ethernet installation (If configured)

- Install the buckle nuts. The position of nuts must meet the position of the Ethernet Switch.
- Install the Ethernet Switch in. Uses 4 screws to fix it.

3.6 Cables Connection

Danger: All the plugs and sockets of the power cables must be orange to orange and black to black. Otherwise it will cause personal injury.

Danger:
Do not short circuit positive and negative poles of the battery system.

Danger: Isolation breakers or switches for each battery string must be installed for maintenance.

Caution: Wrong communication cables connection will cause the battery system failure

3.6.1 CAN Communication Mode between MBMS and BMS

When system configured PowerCube-M1-C ≤6 set. The communication between PowerCube-M1-C uses CAN communication mode. The communication between the MBMS and the BMS of 1st PowerCube-M1-C uses CAN communication mode.

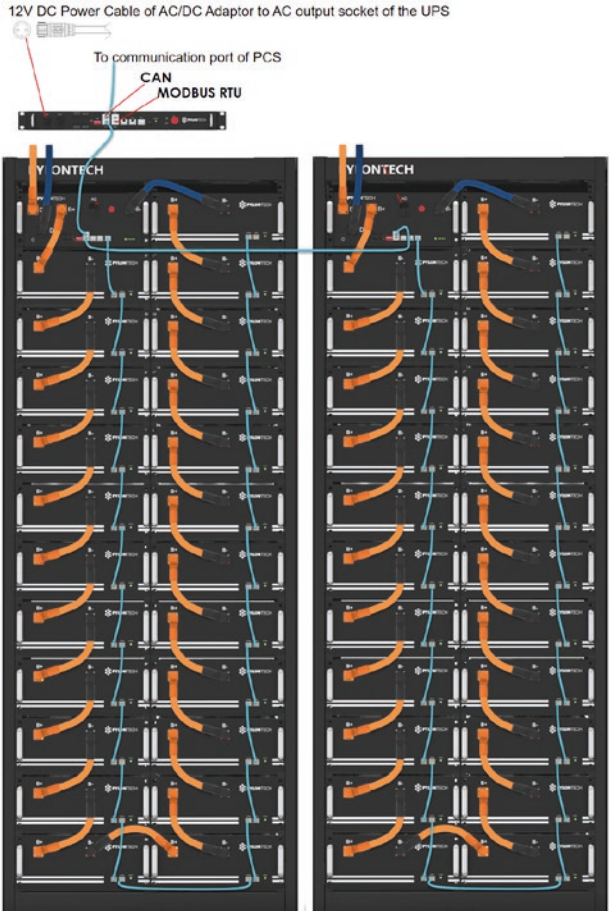


Fig. 3.13 - The 1st PowerCube-M1-C should be installed nearest by the MBMS

3.6.2 Ethernet communication between MBMS and BMS

When system configured PowerCube-M1-C ≤32set. The communication between PowerCube-M1-Cs and MBMS uses Ethernet Switch by LAN communication. Relation of MBMS and battery strings (PowerCube-M1-Cs) in the ports of Ethernet Switch

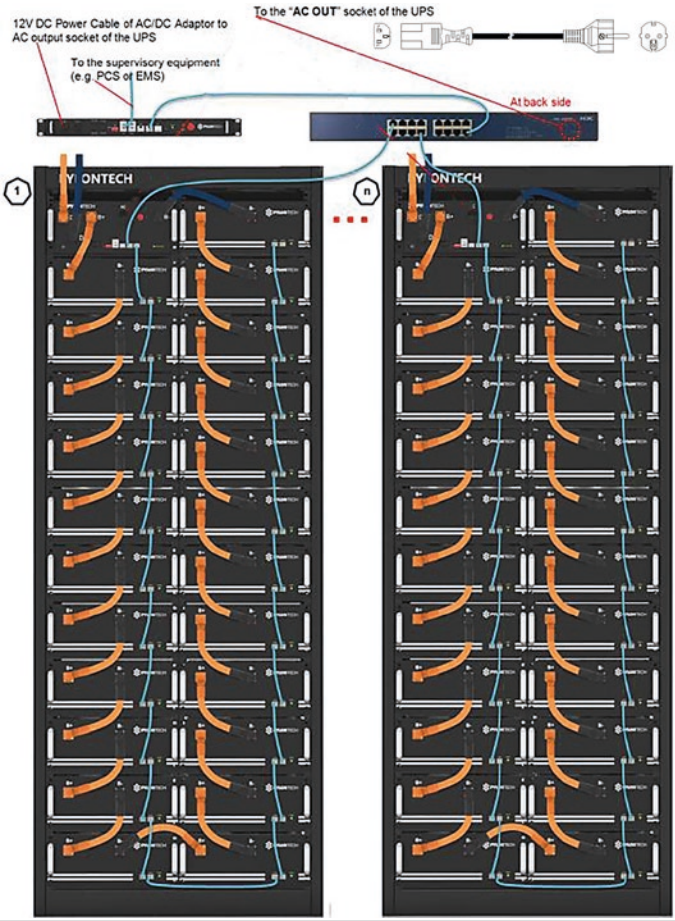


Fig. 3.14 - The both side of BMS to MBMS communication cable must be marked with labels.

Caution: The last port of Ethernet Switch is for the MBMS. From the 1st port to the nth port are for the corresponding battery string (PowerCube-M1-C). So we can fastest find out the corresponding battery string on the Ethernet Switch.

3.6.3 Switch Setting (Address Assignment)

ADD Switch - Battery Controller is a 6 bit dial switches to manually distribute the communication address of the battery system. Down position is OFF, means “0”. Up position is ON, means “1”. 1st bit to 5th bit is for address, and the 6th bit dial switch support a 120Ω resistance (Terminal Resistance).

ADD Switch - MBMS is a 6 bit dial switches to manually distribute the communication address of the battery system. Down position is OFF, means “0”. Up position is ON, means “1”. 1st bit to 4th bit is for address, the 5th and the 6th bit dial switch support a 120Ω resistance (Terminal Resistance).

- **Under communication for single BMS (battery string qty. 1 set)**
  The BMS’s first five bits must set in below BMS’s Address Configure Table 3.2.
  The last BMS’s terminal resistance must set in “1” (X=1);
  The address is configured following ASCII code: (“X” is terminal resistance).

CAN	Modbus	Setting
0	1	00000X
1	1	10000X
2	2	01000X
3	3	11000X
4	4	00100X
5	5	10100X
6	6	01100X

Table 3.2 - BMS’s Address Configure Table

- **Under CAN Communication Mode between MBMS and BMS (battery string qty. s6 set)**
  The BMS’s first five bits must set in below BMS’s Address Configure Table 3.3. The last BMS’s terminal resistance must set in “1” (X=1), and other BMS’s terminal resistance must set in “0”.
  The address is configured following ASCII code: (“X” is terminal resistance).

  The MBMS’s ADD Switch set with “000011”. The last 2 bits are terminal resistances.
  Note: the 1st to 4th bit dial for MBMS refer to “3.6.4 MBMS Communication Mode” at page 31.

String	Setting
1	10000X
2	01000X
3	11000X
4	00100X
5	10100X
6	01100X

Table 3.3 - BMS’s Address Configure Table

- **Under Ethernet communication between MBMS and BMS (battery string qty. 1~32 set)**
  The BMS's first five bits must set in above BMS's Address Configure Table 3.4.
  The BMS' terminal resistance must set in "0".
  The address is configured following ASCII code: ("X" is terminal resistance).

Battery String	Address Bit	Battery String	Address Bit	Battery String	Address Bit	Battery String	Address Bit
1	10000X	9	10010X	17	10001X	25	10011X
2	01000X	10	01010X	18	01001X	26	01011X
3	11000X	11	11010X	19	11001X	27	11011X
4	00100X	12	00110X	20	00101X	28	00111X
5	10100X	13	10110X	21	10101X	29	10111X
6	01100X	14	01110X	22	01101X	30	01111X
7	11100X	15	11110X	23	11101X	31	11111X
8	00010X	16	00001X	24	00011X	32	00000X

Table 3.4 - BMS's Address Configure Table

The MBMS's ADD Switch set with "000011". The last 2 bits are terminal resistances.
Note: the 1st to 4th bit dial for MBMS refer to next chapter.

3.6.4 MBMS Communication Mode

In some project it configures multi Energy Storage Systems. In this case will have multi MBMS. The address of MBMS must follow MBMS's Address Configure Table 3.5.

CAN	Modbus	primi 4 bit	CAN	Modbus	primi 4 bit
0	1	0000	8	8	0001
1	1	1000	9	9	1001
2	2	0100	10	10	0101
3	3	1100	11	11	1101
4	4	0010	12	12	0011
5	5	1010	13	13	1011
6	6	0110	14	14	0111
7	7	1110	15	15	1111

Table 3.5 - MBMS's Address Configure Table

3.6.5 System turns on

Warning.
Double check all the power cables and communication cables. Make sure the voltage of the PCS is same level with the battery system. Check all the power switch of every battery system is OFF.

Warning:
MBMS must be turned on AFTER all battery strings self-check finish.
The external switch or breaker between PCS and battery string must be off before the battery system power on.

System turns on step:

1. Check the UPS (if has) is turned on. And the UPS is power supplying.
2. Switch the external power or PCS on, make sure all the power equipment can work normally.
3. Confirm the MBMS is off.
4. Turn on all the BMS (Battery Control Modules) as following step:
   - Turn on the “Isolating Switch” (2, Fig. 3.15) and press an hold the “Start Button” (3, Fig. 3.15) for more than 5sec until the buzzer rings, the LED indicator on front panel will light on if the start-up is successful. Caution: do not press the start button more than 10" continuously, or it will go into “BLACK-START” mode.

The battery string’s system will check itself, if power on successfully the battery string system will entering into self-check mode automatically.
If the BMS and all battery modules are working normally, every status LED will be lighting green, that’s mean self-check are passed. Self-check will be finished within 10".

Note: If the BMS can’t receive communication from upper equipment because of the communication is off, the “STATUS” lamp will light red after 30". That doesn’t mean failure existed, it means this battery string is OK while the external communication is off.

Warning: If there is failure during the self-check, must debug the failure then can start next step

- The second BMS must be operated after success the first battery string’s self-check.
- From 1st BMS to the last BMS turn on the battery strings on one by one.

Nota: If the “STATUS” lamp shows red from beginning, it means there is failure in the battery string, the Power Relays in BMS will switch ON, must debug at first.

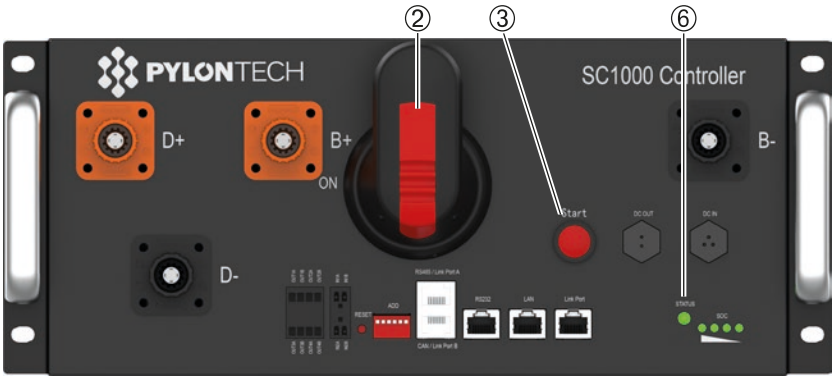


Fig. 3.15 - Control module.
Isolating Switch (2), Start Button (3), Status (6).

Black-Start (SC1000-200J-C).
If long press(>10sec) the start button 30s AFTER power on. The “STATUS” lamp will become green if the black start function is enabled. If “STATUS” lamp remain red, the black start function is failed to active, it needs long press start button again. System will close relay and output for 10mins.

Warning (SC1000-200J-C). If the black-start function is enabled, the terminal of D+ and D- will be electricity dangerous with high DC voltage output.

5. Turn on the external switches or breakers all after all the BMS turn on successful. Switch the MBMS on: And check MBMS is working. The “STATUS” lamp will light green.

Fig. 3.16 - MBMS Controller

The Power Relays in BMS will switch ON after 30 seconds, when the MBMS was turned ON. The “STATUS” lamp of the BMS will light green;

When the voltage distance is smaller than the parameter, the battery string will do the parallel operation.
When the MBMS was turned ON, the “STATUS” lamp of the BMS will light red, but it is normal;

Note: If the MBMS can’t build communication with other equipment, the system can’t work normally. External Power should communicate with battery system through LAN, CAN or RS485. Otherwise maybe cause battery system work abnormal.

Caution: The whole Battery Energy Storage System (BESS), after installation or restart the system when long time not in using, should be charged to full at first.

3.6.6 System turns off

During maintenance or long-term storage, be sure to turn off the battery system.

1. Turn off the power switch of PCS, to make sure no current through this battery string.
2. Turn off all the external switches or breaker between PCS and each battery strings.
3. Turn off the “Isolating Switch” of the BMS.
4. Turn off the “Power Switch” of the MBMS. If the ESS configures only single battery without MBMS, so needn’t this operation step.
5. Turn off the UPS (if has). The UPS can turn on if have equipment must keep running can’t turn off. Otherwise must turn off the UPS to save its power.

Fig. 3.17 - Control module.
Isolating Switch (2), Start Button (3), Status (6).

Caution. Before changing the battery module for service, be sure charge/discharge the replaced battery same voltage to the other in system battery modules. Otherwise the system need long time to do the balance for this replaced battery module.

Warning. Do not turn off the “Isolating Switch” during normal running condition. Otherwise will cause this battery string current surge by another battery strings. If the “Isolating Switch” is turned off in normal running condition, the PCS must be turned off firstly

Note: **After installation, do not forget to register online for full warranty:** www.pylontech.com.cn/service/support

4.0 MAINTENANCE

4.1 System Debug

This system debug is for BESS system (Battery Energy Storage System). BESS system can't debug alone. It must operate with configured UPS, PCS and EMS system together.

Debug Step	Content
Preparation for debug.	Turn on the BESS system, referring to chapter 3. Before turning on the whole BESS system, starting up of the load is not allowed! Remark: Besides the BESS, if other equipment has its own system starting up step, be sure to follow its own system operation menu.
System function test.	Each component system debug: Power supply from the External Power Suppler (e.g. UPS) is working normally. Communication Test: Check if the communication between the BESS system and communicated devices normal or not, alarm equipped or not. Power Conversion System Test: Before conjoint test be sure test the Inverter System starting up progress at first. And check if the parameters meet BESS requirement or not. BESS Test: Charge/Discharge test; Stop test when charging, stop discharging, current limiting functions, etc. Caution: Before turning on the BESS system, be sure setup all the parameters of the PCS and EMS at first.
Monitor function test. (If configured.)	Check if the data of the BESS system is showing on the monitor system normally.
EMS monitoring test (If configured.)	If the EMS system has been configured, check the information uniformity and command functionality following the BMS protocol.
Trial operation test.	After the system debugged, run the system a period as test (testing with low load), to test if the high voltage DC system is fit for the contract.

4.2 Trouble Shooting

Danger: The PowerCube-M1-C is a high voltage DC system, operated by qualified and authorized person only.

Danger: Before checking the failure, be sure check all the cables connection and the BESS system can turn on normally or not.

- **Section A Before start up** (For Internal Power Supply BMS)

Failure Mode	Possible Reason	Solution
Battery system do not start up after correct wiring connection and start up procedure	Power cable issue	Check the wiring connection and connectivity of the power cables.
	Other error	If problem remain, contact service engineer.

- **Section B During operation**

Failure Type	Failure Definition	Possible Reason	Solution
External	Input RV Err (Bit4)	D+ D- reversely connected	Check the external power cables of the polarity and connection
External	DC OV Err input over voltage error (Bit3)	D+ D- voltage extremely higher than battery system voltage	Check external inverter`s voltage whether match with the battery system or not.
External	Emergency stop (Bit13)	Command by external device via dry contactor	Command by external device, not an error actively report by Battery system.
Current Leakage	Current Leakage Error (Bit21)	Current Leakage >25mA	With insulation glove, disconnect the battery system and contact Pylontech service engineer.
Self-test	Self-test module Initial Error (Bit16)	Self-test failed	Restart. If problem remain, contact Pylontech service engineer.
Self-test	Self-test module coulomb error (Bit15)	Self-test failed	Contact Pylontech service engineer.
Self-test	Self-test module detecting amount error (Bit14)	Self-test failed	Contact Pylontech service engineer.
Self-test	Safety check failure (Bit11)	Chip self-test failed	Restart. If problem remain, contact Pylontech service engineer.
Self-test	Self-test volt error (Bit10)	Battery cell voltage measurement mismatch with DCBUS voltage measurement	Restart. Check the connectivity and reliability of the power and comm. cable by reconnection. Replace the BMS. If problem remain, contact Pylontech service engineer.
Battery cell	Battery damage error (Bit6)	Battery cell voltage measured at <2.0V	Restart. If problem remain, contact Pylontech service engineer.
Comm e HW	BMIC error (Bit8)	Sensor chip error	Restart. If problem remain, contact Pylontech service engineer.
Comm e HW	Internal Comm. ERR (Bit2)	Communication offline between module and BMS	Check the connectivity and reliability of he comm. cable between BMS and battery modules. Restart. If problem remain, contact Pylontech service engineer.
Comm e HW	BMU Internal bus error (Bit18)	BMU internal error	Contact Pylontech service engineer.

Tab. 4.1 - **Error Code checked from BMS (Modbus protocol Appendix IV or CAN ID 0*4250&0*4290):** *The 'Failure Definition' and 'Failure Mode' column is reference from Pylontech Modbus protocol Appendix IV Error code 1 bit to present.

Failure Type	Failure Definition	Possible Reason	Solution
Comm e HW	BMS Internal bus error (Bit9)	CMU internal error or I2C issue	Restart Replace the BMS. If problem remain, contact Pylontech service engineer.
HW	Shutdown circuit error (Bit7)	Cannot completely switch off the system during self-protection	Change PMU If problem remain, contact Pylontech service engineer.
HW	Relay Error (Bit5)	1.Start-up procedure problem 2. Relay adhesion 3. Relay damage	Completely switch off inverter and battery system. Make sure DCBUS has no voltage. Switch on each BMS first before switch on the MBMS. After the battery system finish self-test (require ~3mins), switch on the inverter. If problem remain, contact Pylontech service engineer.
HW	Temperature sensor error (Bit1)	Sensor cable / connection issue	Contact Pylontech service engineer
HW	Voltage sensor error (Bit0)	Sensor cable issue Sensor connection issue BMU issue	Contact Pylontech service engineer

Tab. 4.1 - **Error Code checked from BMS (Modbus protocol Appendix IV or CAN ID 0*4250&0*4290):** *The 'Failure Definition' and 'Failure Mode' column is reference from Pylontech Modbus protocol Appendix IV Error code 1 bit to present.

Failure Mode	Possible reason	Solution
All BMS offline error (Bit20)	Battery system over discharged Comm. cable issue Ethernet switch issue MBMS CMU issue Firmware issue	Check whether the batter system has been over-discharged or not via multimeter. Check the comm. cables between BMS and MBMS, make sure the cable is 8PIN pin – pin CAT5 ethernet cable. If BMS and MBMS is communication via CANBUS (no Ethernet switch), make sure the CANBUS physical length is less than 15m. Restart the system. Check the Ethernet switch condition, completely restart the system. Reverse sequence connect the comm. cable between the BMSs and change the ADD address settings. Restart the system. 5. Change the MBMS CMU. If problem remain, contact Pylontech service engineer.
Emergency stop (Bit13)	Command by external device via dry contactor	Command by external device, not an error actively report by Battery system.

Tab. 4.2 - **Error Code checked from MBMS (Modbus protocol Appendix IV or CAN ID 0*4250&0*4290)**

Failure Mode	Possible reason	Solution
Communication error between MBMS and BMS (Bit17)	Battery string(s) over-discharged BMS CMU error	Check whether the battery string(s) has been over-discharged or not via multimeter. Check the comm. cables between BMS and MBMS, make sure the cable is 8PIN pin – pin CAT5 Ethernet cable. If BMS and MBMS is communication via CANBUS (no Ethernet switch), make sure the CANBUS physical length is less than 12m. Restart the system. Reverse sequence connect the comm. cable between the BMSs and change the ADD address settings. Restart the system. Change the BMS CMU or BMS. If problem remain, contact Pylontech service engineer.
Insulation fault (Bit12)	External insulation detection device reports a failure	Check the external insulation detection device.

Tab. 4.2 - **Error Code checked from MBMS (Modbus protocol Appendix IV or CAN ID 0*4250&0*4290)**

Alarm	Possible reason	Solution
BMS disconnect alarm (Alarm status 2 Bit3)	BMS disconnect due to comm. offline.	If the alarm is not continuously or frequently, the system can continuous working without issue.
	BMS disconnect due to voltage difference between multiple racks.	Restart the system and make a fully discharge of the system followed by a fully charge, in order to align the voltage of multiple racks.
	BMS disconnect due to BMS error.	Reference from Section B (Tab. 4.1) to troubleshoot the BMS. Restart the system and make a fully discharge of the system followed by a fully charge, in order to align the voltage of multiple racks.
BMS communication lost alarm (Alarm status 2 Bit2)	Exist BMS offline but system can continuous operation.	Reference from Section B (Tab. 4.2) Bit 17 to troubleshoot the BMS and MBMS. Restart the system and make a fully discharge of the system followed by a fully charge, in order to align the voltage of multiple racks.

Tab. 4.3 - **Alarm Code checked on MBMS (Modbus protocol Appendix I-4 or CAN ID 0*4290)**

4.3 Replacement of main component

Danger: The PowerCube-M1-C is a high voltage DC system, operated by qualified and authorized person only.

Danger: Before replacing the main component, shut off the maintenance battery string's power. Confirm the D+ and D- terminal are without power. The turn off progress refer to chapter 3.6.7.

4.3.1 Replacement of Battery Module

A new battery module can be added onto an existing system at any time. In a serial connection system, the new module, even with a higher SOH, will follow the system worst SOH condition module to perform.

- Make sure the new battery module has an equivalent voltage level (OCV) compared to existing modules.
- Shut off the whole battery string's power. Be sure to confirm the D+ and D- terminal are without power. The turning off progress refer to chapter 3.6.7.
- Pull out the Plug (1, 2) of Power Cable +/-. Pull out the plug (3, 4) of communication cable.

Danger. The power cables and plugs still have high voltage DC power from serial connected battery modules (battery module can't be turned off), be careful to handle the Power plugs.

- Dismantle the 4 screws (6) of the battery module's front face.

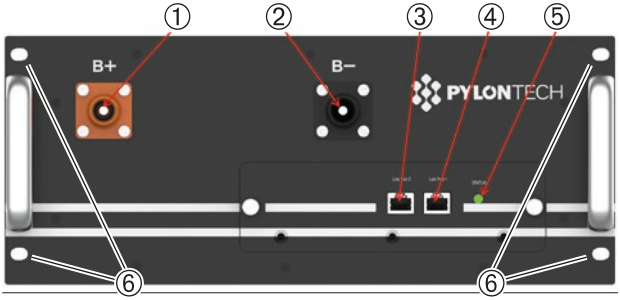


Fig. 4.1 - H32148-C

- Handle the battery module out of the rack, and put it to the appoint place.

Warning: Single battery module weights 43 kg. If without handling tools it must be handled by more than 2 personnel.

Caution: Please contact service before battery module replacement. Before change the battery module for service, be sure to charge/discharge the replaced battery same voltage to the other in system battery modules. Otherwise the system need long time to do the balance for this replaced battery module.

- Install the new battery module (see the above). And connect the normal cables. Refer to chapter 3.6.
- Turn on this battery string. Refer to chapter 3.6.6.

4.3.2 Replacement of Control Module (BMS)

- Shut off the whole battery string's power. Be sure to confirm the D+ and D- terminal without power. Operate turning off progress referring to chapter 3.6.8.

Caution: Before pulling out the communication cables be sure to mark the cable number, avoiding cable wrong sequence.

- Pull out the plugs of Power Cables (1 and 6) and the communication plugs (10 and 13).

Danger: The power cables still have high voltage DC power from another battery module, be careful to handle the Power plugs.

- Dismantle the 4 screws (3) of the battery module's front face.

Fig. 4.2 - Control module

- Handle the control module out of the rack, and put it to the appoint place
- Install the new control module (BMS). Reconnect all the cables. Refer to chapter 3.
- Turn on this battery string. Refer to chapter 3.6.6.

4.3.3 Replacement of 3rd level Control Module (MBMS)

- Turn off the Power Switch. Refer to chapter 3.6.7.

Fig. 4.3 - Module MBMS

Caution: Turn off this MBMS will stop the power output of belonging whole Battery Energy Storage System.

Caution: Before pulling out the communication cables be sure to mark the cable number, to avoid cable wrong sequence.

- Pull out the plugs of power cables (3), the communication cables (2) and dismantle the 4 screws (1).
- Handle the MBMS out of the rack, and put it to the appoint place
- Install the new MBMS inside and reconnect the cables. Refer to chapter 3.6.
- Turn on this MBMS. Refer to chapter 3.6.6.

4.4 Battery Maintenance

Danger. The maintenance of battery must be done by qualified and authorized personnel only.
Some maintenance items must turn off at first.

4.4.1 Voltage Inspection:

[**Periodical Maintenance**] Check the voltage of battery system through the monitor system. Check the system whether exist abnormal voltage or not. For example: Single cell's voltage is abnormal high or low.

4.4.2 SOC Inspection

[**Periodical Maintenance**] Check the SOC of battery system through the monitor system. Check the battery string whether exist abnormal SOC or not.

4.4.3 Cables Inspection

[**Periodical Maintenance**] Visual inspect all the cables of battery system. Check the cables has broken, aging, getting loose or not.

4.4.4 Balancing

[**Periodical Maintenance**] The battery strings will become unbalance if long time not be full charged. Solution: every 3 months should do the balancing maintenance (charge to full), normally it will been done automatically by the communication between system and external device.

4.4.5 Output Relay Inspection

[**Periodical Maintenance**] Under low load condition (low current), control the output relay OFF and ON to hear the relay has click voice, that's mean this relay can off and on normally.

4.4.6 History Inspection

[**Periodical Maintenance**] Analysis the history record to check has accident (alarm and protection) or not, and analysis its reason.

4.4.7 Shutdown and Maintenance

[**Periodical Maintenance**]
Some system function must be maintenance during the EMS restart, it is recommended to maintenance the system every six months.

4.4.8 Recycle

NOTE. Damaged batteries may leak electrolyte or produce flammable gas.
In case a damaged battery needs recycling, it shall follow the local recycling regulation (e.g. Regulation (EC) Nº 1013/2006 among European Union) to process, and using the best available techniques to achieve a relevant recycling efficiency.

5.0 REMARKS

5.1 Storage recommendation

For long-term storage (more than 3 months), the battery cells should be stored in dry (relative humidity <65%), clean and well ventilated, temperature range of -20°C ~ 60°C, no corrosive gas environment.

Before storage the battery should be charged to 50~55% SoC;

It is recommended to active the chemical (discharge and charge) of the battery every 3 months, and the longest discharge and charge interval shall not exceed 6 months.

Caution. If not follow the above instructions for long term store the battery, The cycle life will have relative heavily reduction.

5.2 Capacity expansion

A new battery module can be add onto an existing system at any time. Please make sure the existing system is being fully charged before add on a new module. In a serial connection system, the new module, even has a higher SOH, will follow the system worst SOH condition module to perform.

6.0 SHIPMENT

Battery module will pre-charged to 100% SOC or according to customer requirement before shipment. The remaining capacity of battery cell, after shipment and before charge, is determined by the storage time and condition.

- The battery modules meet the UN38.3 certificate standard.
- In particular, special rules for the carriage of goods on the road and the current dangerous goods law, specifically ADR (European Convention on the International Carriage of Dangerous Goods by Road), as amended, must be observed.

Contact the supplier for more information.

Please note that the product and this manual are subject to change without notice.

INSTALLATION AND SYSTEM TURN ON PROGRESS LIST

	ITEM	REMARK
☐	The environment is meeting all technical requirements. Cleaning, Temperature, Radiating System, Heating System, Fire-extinguisher System, Grounding System	Refer to chapter 3
☐	Battery rack is installed following the technical requirements.	Chapter 3.5.3 at page 24
☐	Control Module (BMS) and Battery Module are installed well. And install the rack metal strip.	Chapter 3.5.4 at page 24
☐	The MBMS are installed well. (If configured.)	Chapter 3.5.5 at page 26
☐	The Ethernet Switch is installed well. (If configured.)	Chapter 3.5.6 at page 26
☐	Connect the AC power cables from BMS, MBMS and Ethernet Switch to the AC “OUT PUT” socket of the UPS (If configured.).	Chapter 3.6.2 at page 27 and 3.6.3 at page 28
☐	Connect External Power Cable +/- between each BMS to the PCS or confluence cabinet.	Chapter 3.6.2 at page 27 and 3.6.3 at page 28
☐	Connect power cables of each battery string.	Chapter 3.6.2 at page 27 and 3.6.3 at page 28
☐	Connect communication cables of each battery string.	Chapter 3.6.2 at page 27 and 3.6.3 at page 28
☐	Set up ADD switch of every BMS and the MBMS (Address Assignment).	Chapter 3.6.4 at page 29
☐	Connect external communication cables from BMS to Ethernet Switch, MBMS or another	Chapter 3.6.2 at page 27 and 3.6.3 at page 28
☐	Connect the communication cable from MBMS to the PCS.	Chapter 3.6.2 at page 27 and 3.6.3 at page 28
☐	Double check every power cables, communication cables installed well. And ADD Switches are setting right.	Chapter 3.6.2 at page 27, 3.6.3 at page 28, 3.6.4 at page 29
☐	Check whether the UPS is turned on. And the UPS is power supplying.	Chapter 3.6.6 at page 32
☐	Switch the external power or PCS on, be sure all the power equipments working normally.	Chapter 3.6.6 at page 32

☐	Turn the BMS (Battery Control Modules) of each battery string on (from 1st BMS to the last, one by one) Turn on the “POWER OUTPUT SWITCH”: Turn on the “Power Switch”: The battery string’s system will check itself, if work normal the battery string system will go into self-check mode. If has failure during the self-check, be sure to debug the failure then can start next step.	Chapter 3.6.6 at page 32
☐	If every battery string is working normally. Then switch the MBMS on. The MBMS will self-check and check each battery string one by one.	Chapter 3.6.6 at page 32
☐	The first installation should do full charging progress. After MBMS communicating with each BMS, it will run parallel operation. It will start up from lowest voltage battery string to do the parallel operation during the charging. If the status LED of BMS turns to green, it means this battery string is in parallel operation.	

SYSTEM TURN OFF PROGRESS LIST

	ITEM	REMARK
☐	Turn off the switch between PCS and this battery string (PowerCube-M1-C), or turn off the power switch of PCS, to make sure no current through this battery string.	Chapter 3.6.7 at page 32
☐	Turn off the “Power Output Switch” of the BMS.	Chapter 3.6.7 at page 32
☐	Turn off the “Power Switch” of the BMS.	Chapter 3.6.7 at page 32
☐	Turn off the “Power Switch” of the MBMS.	Chapter 3.6.7 at page 32
☐	Turn off the UPS. The UPS can be turned on to check the equipment (PCS or battery system etc.). Otherwise be sure to turn off the UPS to save its power.	Chapter 3.6.7 at page 32

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