ferroamp

PSM 10/12/15 SERIES

INSTALLATION MANUAL

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WARNING

- Read through the instruction manual before installation.
- Electrical installation shall be done by professional such as electrician or authorized personnel in accordance with electrical standards and safety precautions.
- Simple assembly required for specific component shipping (ESO); consult your supplier for additional assembly support.
- Do not open the enclosure of the electrical components. Warranty is void if unauthorized modification is made.
- Plug in the jumper brick (for battery modules) only when the system is ready to power up.

The FerroAmp PSM 10/12/15 series high performance energy storage system is designed to be installed and operated together with the EnergyHub system with the patented ACE technology.

Abbreviations

ACE	Adaptive Current Equalization
BAT	Battery Module (batt.)
BMS	Battery Management System
CAN	Controller Area Network
CHG	Charge
COM	Communication (comm.)
ESO	Energy Storage Optimizer
LED	Light Emission Diode
PSM	Power Storage Module
SSO	Solar String Optimizer
SOC	Status of Charge

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Ferroamp Elektronik AB (FERRO.ST) is a research-driven platform company that builds smart integrated energy system for home and industry. The FerroAmp ACE technology is patented under PCT WO2012050501 (A1).

Sunwoda Energy

Sunwoda Energy Solution Co., Ltd is a professional energy storage solution provider with 20 years' know-how in battery industry. Sunwoda Energy is a subsidiary of the listed Sunwoda Electronic Co., Ltd (300207.SZ) established in 1997, a manufacture powerhouse with the headquarter in Shenzhen, China.

esol

ESOLtech AB, a Stockholm-based company focused on energy storage technology.

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1. LIST OF COMPONENTS

The PSM 10/12/15 series high performance energy storage system comes with the following components:

- Cabinet
- Battery modules
- Battery controller modules
- Energy Storage Optimizer (ESO)
- Accessories box

System components:

Component	Figure	Quantity
Battery module		4 pcs (PSM10) 5 pcs (PSM12) 6 pcs (PSM15)
Battery Controller (BMS)		1 pcs
Energy Storage Optimizer (ESO)	(showing only the metal enclosure)	1 pcs (up to 6kW) 2 pcs (up to 12kW)
The Cabinet	see picture on the cover page	
Accessories box	see the list of accessories	

List of accessories:

ltem no.	Description	quantity	note
1	Installation manual	1	This manual
2	Wall mounting expansion bolt	2	M6 x 60mm
3	Power Cable: ESO - Battery controller PG	1	UL1015 12AWG Red 1500mm
4	Power Cable: ESO - Battery controller NG	1	UL1015 12AWG Black 1500mm
5	Power Cable 230VAC - Battery controller	1	IEC53 RVV 300/500V Black (3 threads) 4000mm
6	Comm. cable: from ESO to Battery controller	1	RJ45 Grey 2000mm
7	Grounding cable (PE) for ESO	1	UL1015 10AWG Yellow-Green 320mm
8	LED Cable	1	UL1007 24AWG (6 threads) 400mm
9	Power Cable for Battery Module	5	UL1015 10AWG Blue 100mm - 590mm
10	Power Cable for Battery Module (PSM 12/15)	7	UL1015 10AWG Blue 100mm - 590mm
11	Comm. Cable for Battery Module	5	UL1007 24AWG (5 threads) 100mm - 1300mm
12	Comm. Cable for Battery Module (PSM 12/15)	7	UL1007 24AWG (5 threads) 100mm - 1300mm
13	Cable tie	30	plastic 150mm
14	Cable tie basis	10	3M (adhesive) White 28,3 *28.3mm
15	Bolts	2	M6 x 14mm

* Available online from https://github.com/PSM-support/Instruction-manual

2. CABINET ASSEMBLY

The cabinet is pre-assembled. The PSM cabinet is designed to be installed and used indoor only. Before installation, please make sure that:

- Ambient temperature is 3 45 deg. (recommended 25 deg.);
- Relative humidity ranges 0-95%;
- Adequate clearance (illustrated below) for safe installation.



Note: the measurement in the diagram is not to the scale

2.1 WALL MOUNTING

Clear the wall. Measure the distance from the floor to the spot on the wall where mounting assembly is to be fixed.

- **Figure A:** A wall mounting assembly is preinstalled at location 1. The assembly can be attached to location 1, 2 or 3 on the cabinet.
- **Figure B:** Fix the wall mounting piece to the wall.
- Figure C: Fasten the fixing bolts (M6) to secure the cabinet.

Please refer to Section 2.3 for the feet adjustment.



2.2 REMOVING THE SIDE PANELS

The cabinet has a symmetric design meaning that the panels on the left-hand-side are identical and exchangeable to the ones on the right.



The diagram shows the upper side panels and one of the lower side panels are removed. Detach the grounding cable for installation clearance. The following shows the details of removing the grounding cables.



2.3 ADJUSTING THE FEET

There are 4 adjustable feet and are accessible after removing the side panels. Using a hex key (5mm, insex) to adjust the height of the feet.



2.4 CABLE FOR LED PANEL

Connect the LED cable to the LED connector socket inside the cabinet as indicated below:



There is only one direction the cable can be inserted firmly. The following picture shows inserted LED cable connector. The other end of the cable is to be connected to the battery controller module **(See also Section 3.2)**.



3. BATTERY AND CONTROLLER MODULES

Both the battery module and the battery controller box are shipped with protection covers preinstalled.

Battery module:

Touch Protection Cover (black)



Battery controller module:



The PSM system is shipped with one battery controller module and 4 - 6 battery modules depending on system configuration.

Remove the preinstalled Black protection cover before inserting the unit into the cabinet.

3.1 TOUCH PROTECTION COVER

For battery module:



Black screw-fixed piece

The battery module with the protection covers removed:



For the battery controller module:



Black screw-fixed piece

The battery controller module with the protection covers removed.



3.2 INSERT THE BATTERY MODULES



The battery shall be inserted **one by one from the bottom** of the cabinet.

Left: PSM12/15 with 5 or 6 batt. Right: PSM10 with 4 batt.

Make sure all the bolts for the inserted module fastened before installing the next one.

Install the controller module after all the battery modules are done.

Pay special attention not to block the Cable for LED panel (Section 2.4) whose connection is to be done in Section 3.3.

The following is a side view of the system (15kWh) after insertion of the battery and controller modules. **PSM12** and **PSM 10** are illustrated respectively in **3.3**.

Make sure all the bolts (M6) fastened before proceeding.



3.3 CABLE INSTALLATION

3.3.1 Connection overview and the numbering of the cables (PSM15):



0

0

FAL v.1.07

- The power cables (solid) first, then
- The communication cables (dashed)

Note: the cable connector is labeled with the exact port to be connected and shall not be reversed.

Install the battery module touch protection covers (Section 3.1) back; the system shall then resemble the figure on right-hand side.

3.3.2 Connection overview and the numbering of the cables (PSM12.5 – 5 Batt.):



3.3.3 Connection overview and the numbering of the cables (PSM10)



Note:

For **2050 mm** cabinet installation, 2 empty slots are left at the bottom;

Zoomed in:



4. ESO MODULE

Depending on the system configuration, one or two ESO modules are shipped alongside with your PSM system. The ESO module is normally shipped in a cardboard package without pre-assembly. Each ESO module resembles a rectangular metal box.

Please skip to 4.2 if ESO is shipped pre-assembled.

4.1 ESO ASSEMBLY

4.1.1 Lay the ESO modules on a flat surface. For 2 ESO system, lay them side by side and make sure the second one (ESO2) have the bottom metal enclosure facing upward as indicated in the picture below.



Note that the weld nuts are visible from the ESO bottom metal enclosure.

4.1.2 Install the ESO adaptor:



- firmly insert the adaptor into the sockets
- fasten the screws (2 pcs per ESO)

Note: do not lift the ESO off the supporting surface during the assembly

4.1.3 Install the ESO front plate.

- Carefully align the ESO front plate
- Pay specially attention to the LED prismatic piece
- Fasten the screws (4 pcs per ESO)



4.2 ESO INSERTION



Insert the assembled ESO sideways and fasten the bolts (M6).

The ESO can be inserted from the either the left or the right side (illustrated) of the cabinet.

Make sure the ESO metal enclosure sits firmly on the rail before fastening the bolts.

Thanks to symmetric design - the left and right side panels are interchangeable.

4.3 ESO CABLES INSIDE THE CABINET

4.3.1 PE for ESO – from the back of the ESO to metal frame inside the cabinet.



4.3.2 Communication cable (RJ45)

A standard RJ45 cable (Ethernet cable) is used for the communication between ESO and the battery controller (illustrated on the right).

5. EXTERNAL CABLES

5.1 SIDE VIEW WITH UPPER

SIDE PANEL REMOVED:

- (1) DC-Link cable (DC+, DC-, PE) connecting to the DC junction box, powered from the Energy Hub
- (2) AC230 cable (L, N, PE) powering the controller module (single phase, 230V)
- (3) Cable gland To be fastened at closing up the side panel. Make sure no tension is built.

Make sure no tension is built when fastening the cable gland. Tighten the cable gland only when ready to close the side panel.





5.2 ESO POWER CABLE CONNECTION

- (1) Power Cable ESO Battery controller (Red +, Black –)
- (2) DC-link Cable from the ESO to DC junction box (not included*).



*Note: For PSM15/12kW the DC link cable shall be rated at 20A

5.4 DC LINK CABLE - PHOENIX CONTACT 5P SOCKET

To connect:

- Prepare the cable according to the following illustration. Insert one cable at a time, apply force evenly and gently in the direction towards the cable socket, make sure each cable is fully inserted.
- Once fully inserted, the cable is locked inside the socket.



To remove an installed cable:

- Firmly insert the flat-blade (2mm) into the locking-releasing hole (illustrated below)
- Pull out one cable at a time until all cables are fully detached



5.3 AC CABLE FOR BATTERY CONTROLLER

(Only for controller model H100030H-P02)

The module comes with a cable terminal block in the box. The back of the controller looks like below.



- Build the cable / peel off the insulation (approx. 1.0 cm)
- Insert the cable into the terminal block as indicated below
- Plug in the terminal block and fasten the screws (flat-blade 2mm)



Please consult electrician for the AC power cabling.

6. FINAL CHECK AND FINISHING UP

Consider using the Trouble shooting / installation checklist in Section 7.4

6.1 JUMPER BRICKS

Both the battery and the controller module come with jumper bricks for safety consideration.

6.1.1 The battery is physically cut off from the internal circuit if the jumper brick is removed.



Insert jumper bricks only when the system is ready to boot up for the first time.

6.1.2 The battery controller comes with a green jumper that needs to be installed. The power to the controller is cut off if the jumper is removed. Insert the jumper as illustrated below



The battery controller has no power output if the QS breaker is switched off. The QS switch should be switched **ON** before powering up. It is prohibited to operate the QS during charging or discharging.



Make sure all the jumpers, switches done properly.

6.2 FINISHING UP

Put back all the side panels in reverse order they were removed. Make sure all the screws are properly fastened.

Note: the PSM system does not come with any switch.

When powering up the controller module (**H100030H-P02**) from AC230, the LED lights up. You may hear click which indicates the system initiates self-diagnosis. Your PSM system is now ready.

Contact your system administrator for appropriate configuration of the PSM in your FerroAmp Portal system.

After a proper configuration, the PSM system will be displayed as a battery in your Portal. The PSM is automatically controlled from the EnergyHub.

PSM 10/12/15 Series installation manual

esoltech AB

7. MORE INFORMATION

7.1 MEANING OF CABINET LED

LED indicator interpretation

(\star is flashing, $\star \star$ is flashing quickly, • is always on and the flashing frequency is 1Hz)

	STATES DESCRIPTION	LED 1	LED 2	LED 3	LED 4	LED 5	REMARKS
Power off							Lights off
Self-inspection							LED scrolling
	SOC 0% - 20%	*					LED1-LED5 flashing
	SOC 21% - 40%	٠	*				LED2-LED5 flashing
	SOC 41% - 60%	•	•	*			LED3-LED5 flashing
	SOC 61% - 80%	٠	•	٠	*		LED4-LED5 flashing
50	SOC 81% - 100%	•	•	•	•	*	LED5 flashing
argin	Over vol. *	*	٠				Warning mode
Ċ	Over temp. **	*		•			п
	Over current	*	•	•			11
	Over vol. *	**	•				Protection mode
	Over temp. **	**		٠			п
	Over current	**	•	•			п
	SOC 0% - 20%	٠					
	SOC 21% - 40%	•	•				
	SOC 41% - 60%	•	•	٠			
	SOC 61% - 80%	•	•	•	•		
ള	SOC 81% - 100%	٠	٠	٠	٠	٠	
ıargir	Under vol. *	*			•		Warning mode
Disch	Over temp. **	*	•		٠		п
	Over current	*	•	•	•		п
	Under vol. *	**			٠		Protection mode
	Over temp. **	**	•		٠		II.
	Over current	**	•	٠	٠		п
	Error	*	*	*	*	*	Error mode

* the cell voltage is out of predefined range for nominal operation

 ** the cell temperature is out of predefined range for nominal operation

Warning mode – anomaly detected, system can recover automatically

Protection mode – prolonged warning mode, recover may require human interference (power cycle)

Error – error detected, disconnect and check up

7.2 System schematic diagram

1. One battery module.



Note: the **jumper brick** is illustrated here as a "switch"; when inserted, the single battery module is **switched ON**. Refer to **6.1 JUMPER BRICKS** for detailed description. The open circuit voltage $V_{BAT+,BAT-}$ is 102 ~ 106V.

2. Schematic diagram showing power cables



PSM 10 (4 Batt.)



PSM 12,5 (5 Batt.)



PSM 15 (6 Batt.)

3. Schematic diagram showing communication cables



Note: the **cable connector is labeled** with the exact port to be connected and shall not be reversed.

Taking **PSM10** (4 batteries) for example, 5 comm. cable are installed between:

CON_COM2	>	BATT_COM1
BATT1_COM2	>	BATT2_COM1
BATT2_COM2	>	BATT3_COM1
BATT3_COM2	>	BATT4_COM1
BATT4_COM2	>	CON_COM1

Properly installed comm. cables should resemble a "close loop"

7.3 TROUBLE SHOOTING GUIDE

Use a **CAT III** (690V or better) multimeter for measuring the total voltage of a battery string. Normally, the **Negative (COM)** probe is **black**, and the **Positive (DC V)** probe is **red**.

- 1. Measure the voltage (BAT+ and BAT-) for **each battery** module
 - Insert the jumper brick
 - The measured module voltage $V_{BAT+,BAT-}$ shall be 102 ~ 106V
- 2. Check the power cable polarity according to the system schematic diagram
 - Step by step measuring the battery voltage in series, the measurement should be done according to the following:

Negative (COM)	Positive (DC V)	Battery pcs.	Approx. Voltage (V)
BAT1-	BAT1+	1	102
BAT1-	BAT2+	2	204
BAT1-	BAT3+	3	306
BAT1-	BAT4+	4	408
BAT1-	BAT5+	5	510
BAT1-	BAT6+	6	612

if the measured voltage does not correspond to above, check the power **cable** as well as the safety **jumper brick**; repeat the measurement.

• If properly connected, the total measured voltage at the **controller module** (BATT +, BATT -) should be:

Negative (COM)	Positive (DC V)	PSM model	Approx. VBATT+, BATT-

 BATT BATT+
 PSM 10
 408 v

 BATT BATT+
 PSM 12,5
 510 v

 BATT BATT+
 PSM 15
 612 v

- 3. Check the protection earth (**PE**)
 - Note: the PE is shared by the **controller module, ESO** (casing), the **cabinet** and **PE in the main junction box.** The electric potential should be equal when measured using a multimeter.
 - It **prohibited** to connect PE with single phase neutral line (N) which will cause **isolation** fault thus result in system bootup failure.
 - At normal operation condition (bootup completed), the PE is "floating" meaning:

 $V_{BATT+, PE} = V_{PE,BATT-}$

Taking PSM 10 with 4 batteries for example, when measuring at the controller module output with a multimeter:

 $V_{BATT+, BATT-} \sim = 408 \text{ V}$, $V_{BATT+, PE} = V_{PE, BATT-} \sim = 204 \text{ V}$

- 4. Check the CAN communication cable (COM1, COM2, CAN)
 - **Proprietary cables** (UL1007 24AWG 5 threads) are used for CAN communication between adjacent modules and are always physically connecting from port **COM2** (on the first module) to **COM1** (next adjacent one).

Follow **3.3 CABLE INSTALLATION** for detailed instruction. Refer also to the **Schematic diagram** showing **communication cable** in previous section.

• Standard RJ45 cable is used for CAN communication between controller module and the ESO.

When connecting a CAN analyzer to the CAN port (RJ45) on the controller module for debugging, one will need to manually set RES dip1 to ON (CAN terminating resistor) because some CAN analyzer does NOT have internal terminating resistor thus results in CAN communication failure. It is OK to leave RES dip1 to ON even for normal operation condition.

- 5. Power on the PSM system
 - CHECK the DC junction box first: the DC junction box normally accommodates one DC breaker (MCB, 4-p 1000V) for DC-link and multiple fuse holders (1-p 1000V) for SSO (10A, solar panel) and ESO (20A, battery).

Make sure DC Link power from the Energy hub is turned off before trouble shooting. It is important to **connect only ESO** to the DC-Link when trouble shooting.

- First, power up the DC-link
 - Connect ONLY the ESO to the DC-link, it can be done by closing its fuse holders while leaving the SSO fuse holder (s) open; close the MCB breaker for DC-link, then
 - Switch on the Energy hub, it will automatically detect modules connected to DC link and power them up;
 - \circ ~ The LED on the ESO panel will light up indicating it is powered through the DC link

- $\circ~$ The fault LED on the ESO panel will light up **red** indicating no communication to the battery controller module. This fault will be cleared as long as the battery is properly connected.
- Second, switch on the battery controller module
 - Make sure the main **switch (QS)** is on and the **jumper** (green) on the front of the controller module is inserted. The controller model (H100030H-P02) will boot up immediately after powered through AC 230V.
 - The LED on the front panel will light up **one at a time from left to right** indicating selfdiagnosis, during which time the user can hear multiple "**click**" indicating relay action inside the controller module.



- The PSM boot up sequence will take about 45 seconds; when finished, the ESO will automatically recognized the connected battery, and the LED on the ESO panel will light up green.
- On the PSM cabinet front panel, the left-most LED will **stay on** indicating SOC ~ 20%.
- Note: the controller module will automatically perform multiple diagnoses before trying to precharge then close its main relays (powered on):

output shortage	short circuit between controller module output to the ESO (LOAD/CHG +, -)				
isolation	 Step-wise impedance check: Batt.+ to PE Batt to PE LOAD/CHG + to PE (briefly close pre-charge relay) LOAD/CHG - to PE (open pre-charge relay, briefly close negative relay) 				
batt. voltage	the voltage at the controller battery string input (batt.) agrees with the number of battery modules installed in the system				
communication	the CAN communication between controller module and each battery module is established				
Cell level BMU	the cell level management unit (BMU, inside the battery module) functioning normal: the cell voltage is normal				
temperature	the temperature sensors are functioning normal; the ambient temperature should be above zero				

In case any error is detected during the bootup, the controller module will abort the sequence and all LED on the cabinet front panel starts **flashing**.

Please contact customer support for further support if the guide does not resolve the issue.

7.4 TROUBLE SHOOTING / INSTALLATION CHECKLIST

Mark **"x"** if the item is checked OK

What to check	Where to check	Mark
Power cables	Batt. module	
Jumper bricks	Batt. module	
Comm. Cable	Batt. module / Ctrl. module	
Protective earth (PE)	ESO / Junction box / Ctrl. module/ Cabinet	
DC-Link cable (DC+, DC-)	ESO / Junction box	
Power output (LOAD/CHG)	Ctrl. module (LOAD +, -) / ESO (BAT+, -)	
AC 230 cable	Ctrl. module	
QS switch	Ctrl. module	
Safety jumper (green)	Ctrl. module	
RJ45 (CAN)	Ctrl. module / ESO	

Manufacture supplied information

1. Battery Module

Model No. H102025M-S (with High-voltage Control Module)

2. Battery controller module

HV control module H100030H-P01 (off-grid)

HV control module H100030H-P02 (AC powered)

3. Ferroamp support

Technical support: support@ferroamp.se

Phone +46 (0)8-684 333 90, select 2

7.5 DATASHEET

	DC coupled energy storage			
PSM System Model *	PSM 10 / 4 (8) PSM 12.5 / 5 (10) PSM 15 / 1			
Storage capacity, W _{NOM}	10 kWh	12.5 kWh	15 kWh	
Maximum power rating, P _{MAX}	4 kW (8kW)	5 kW (10kW)	12 kW	
Battery voltage, V _{NOM}	410 V	512 V	614 V	
Maximum cont. battery charge current, IBAC		20 A		
Maximum cont. battery discharge current, I _{BAD}		20 A		
Electrical roundtrip efficiency incl. DC/DC converter		93 % typical		
Cycle life	6000 cycl	es @ 80% DOD, EOL capacity	/ 70%	
Cell chemistry		LiFePO4		
Maximum battery potential to ground		1000 Vpk		
Battery fuses	20	A, 1000 V, 10x38 mm gPV		
SOC precision		≤ 5 %		
Standby consumption incl. DC/DC converters	≤ 5 W	(10 W)	≤ 10 W	
Protection functions	Over voltage, over temp prote	erature, over current, isolati ction, short-circuit protectio	ion fault, pre-charge n	
DC-nanogrid				
Number of included ESO DC/DC converters	1(2) 2		2	
DC bus voltage, V _{DC}	760 V (nominal)			
DC bus voltage range, V_{DC}		720 – 800		
Maximum DC bus current, I _{DC(max)}	10 A / 20 A	10 A / 20 A	20 A	
DC bus connection		3-wire (DC+, DC-, PE)		
DC bus communication	Narrow bar	nd power line communicatio	n (PLC)	
Physical				
Dimensions H x W x D	1550 x 630 x 250 mm	2050 x 630 x	250 mm	
Weight	140 kg	Up to 21	.0 kg	
Color		Black		
Installation				
Ambient temperature		3°C – 40°C		
Humidity	10 – 90% RH non condensing			
Degree of protection	IP 20			
BMS Power supply	230 VAC, max 40 W			
Compliance				
Battery safety		EN 62619, UN38.3		
LVD		EN 62477-1		
EMC	EN	N 61000-6-3, EN 61000-6-2		

* the data in parenthesis refers to system shipped with 2 ESOs

7.6 Upgrading guide

Please check with your supplier / distributor for upgrading options available in your region.

Table 7.6 Viable configurations for PSM system

	3 batt.*	4 batt.	5 batt.	6 batt.
1 ESO	7.5 kWh / 3kW	10kWh / 4kW	12.5 kWh / 5kW	15 kWh / 6kW
2 ESO	7.5 kWh / 6kW	10kWh / 8kW	12.5 kWh / 10kW	15 kWh / 12kW
Cabinet size	1550 mm / 2050mm	1550 mm / 2050mm	2050 mm	2050 mm

* Only offered as upgrading option for extra PSM cabinet purchase

Electric power refers to the rate of energy, in term of kilowatt (**kW**) that can be withdrawn from a power source. Higher kW means more electronic devices can be plugged in at the same time. On the other hand, taking EV charging for example, more power means faster charging.

Electrical energy refers to the total amount of energy that is available measured as kilowatt hour (**kWh**). 1 kWh is calculated as to supply electricity to a 1-kW device for 1h.

7.6.1 Adding a second ESO

For PSM unit shipped with 1 ESO, a most cost-effective option for system power upgrade is to add a second ESO.

An ESO is shipped inside canton box with screws (4 pcs M3x6mm, 2 pcs M3x30mm) for front plate and ESO adaptors assembly. Please refer to **Chap.4.1 ESO Assembly** for detailed instruction.

The ESO must be powered off before proceeding ESO upgrade.

Examine the Fuse box

Your existing DC junction box may come with pre-mounted 10A DC fuses. This is because the PSM shares the same junction box with SSO. After the upgrade make sure **20A DC fuses** are installed for the PSM.

7.6.2 ADDING MORE BATTERY MODULES

Contact ferroamp helpdesk before adding more batteries to existing system. Consider the following :

> Age of the existing PSM system

Professional analysis is needed for system older than 6 months. The cycle count of existing PSM battery modules must be controlled.

> Battery consistency

The performance of the PSM battery system will degrade if individual module does not works in sync with one another. It is most important to make sure each individual battery module is at exact same SOC, SOH before connecting them together.

Depending on what is needed, the help desk will initiate SOC calibration remotely then control the PSM so that the SOC will hold before proceeding with adding additional unit. Battery balancing is compulsory after adding in additional battery module.

> Controller upgrade

Battery controller module with firmware prior to <u>BCMU v.1.17</u> does not support automatic recognition of the number of the batteries connected.

> Replacing the entire system batteries + controller

For example, to upgrade from an existing 4-batt tall cabinet unit to a 6-batt one, it is possible to send back only the 4-batt modules + controller to the service center and replace with 6-batt modules + updated controller. By doing this, the service center will make sure that all the replaced units are in perfect sync thus spare the need for additional balancing.

7.6.3 Additional upgrade options

Multiple PSM with different configurations (kW/kWh), e.g. PSM10kWh/4kW + PSM7.5kWh/3kW can work on the same DC-nanogrid. Consider adding a second PSM unit if needed.

7.7 BALANCING BATTERY MODULE

In case of mixing new and old battery modules otherwise Ferroamp support out of reach, it is still possible to perform manual balancing. However the following described in this section shall be **performed with extreme caution**.

Use a <u>multimeter</u> to measure the voltage of each battery module. Then single out the one with the lowest voltage, as illustrated below:



Method 1: balancing using a DC power source

- Risk of short circuit: remove the jumper brick (Ch.7.2 fig-1) before connection.
- Risk of damaging power source: consider using a diode between the charger (left) and the battery (right) as illustrated below:



Manually charge the singled-out battery module with a DC power source using constant voltage (CV) mode where the charging current shall be limited to < 5A (0.2C). For example, to manually charge a new out-of-the-box module (105V@30%) to a <u>targeted 108V</u>, apply a charging voltage of <u>approx. 109V</u> (108v + ~ 1v drop cross the diode), then allow the current to gradually decrease to <u>0.05A</u> (0.02C) before disconnecting the DC charger. Note: **the purpose of the charging (balancing) is to**,

Make sure the voltage of each battery module as close as possible to one another.

After Balancing Battery modules, reassemble the PSM. Set the PSM system to **cycle mode** with SOC limit setting of **[0, 100]**. Allow the PSM to run multiple cycles to calibrate the system SOC.

Recommended power source: HSPY-400-01.

Method 2: balancing using existing batteries

• NOTE: the method is only legit when the voltage difference is less than 3V. Remove the jumper brick (Ch.7.2 fig-1) before proceeding.

The existing modules already installed in the 5-batt PSM each has a module voltage of 108V (~60%). However the new out-of-the-box module has 105V (30%). Put the battery module side by side as illustrated below and connect all **Batt+** on each module together, while all **Batt-** together as illustrated below (cable size 10 mm²):



Insert the red **jumper brick** for the module with the lowest voltage as below:



Insert the red **jumper brick** for the **one module** to enable the balancing as below:



Wait for **5 mins** before **inserting** the red **jumper brick** for **next module** to enable the balancing as below:



Insert one jumper brick every 5 mins until all are inserted like follow:



Allow the battery modules stay connected for **24h** before put them back to the PSM cabinet.