REHUB MPPT 48
SOLAR MPPT CHARGER FOR UPGRADING 36/48V INVERTERS

User Manual
Ver 2.0

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Amberroot Systems Private Limited
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Product Warranty

1. We warrant the original goods purchased for a period of 12 months after purchase.
2. Please register your device with the following Serial Number at www.amberroot.com for validating this Warranty certificate.

3. Warranty is invalid if the device is used other than as intended by the manufacturer.
4. Within the warranty period we will repair or replace at our option all failures which are caused by material or manufacturing faults.
5. Amberroot will not be responsible for any consequential damage.
6. A warranty repair does not extend the warranty period.

Exclusions of Warranty

No warranty claims will be accepted for damages resulting from handling, use or treatment that are not explicitly mentioned in this manual. In particular, damages arising from the following causes are excluded from the warranty

1. Voltage higher than 150V across PV or battery terminals.
2. Battery cables connected across PV input terminals.
3. Accidental presence of liquids in the equipment or oxidation due to condensation.
4. Damage resulting from falls or mechanical shocks.
5. Opening the unit/lid or modifications carried out without the explicit authorization of Amberroot Systems.
6. Damage due to atmospheric surge voltage (lightning).
7. Damage due to inappropriate transportation or packaging.

[Scan for company address and contact details.]

Company Seal:

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1 Introduction

REhubs enable adding Solar PV to existing back up solutions without the expense of replacing the UPS/Inverter and Batteries. REhub controls the charging of the batteries from from two sources – the Grid (charging by the existing UPS/Inverter) and the installed Solar PV.
Adding Solar PV is the logical way to extend the back up hours and reducing the dependence on Grid Power - but must be done the right way. REhub provides the right combination for adding Solar PV. REhub intelligently controls the charging process in a way that keeps the batteries safe and therefore extends their life. They allow the maximal use of Solar power. The unit is based on a high efficiency MPPT (Maximum Power Point Tracking) charge controller that maximizes the extraction of energy from the PV panel.

2 General information

2.1 About this User Manual

This manual contains all the necessary information and procedures to install, configure, use and troubleshoot REhub Solar MPPT chargers for use with Inverters. It does not contain information about Photovoltaic modules (PV) or Batteries or Inverters of various brands that can be connected. For information of those devices, please refer to the instructions of each specific manufacturer.

2.2 Important safety information

This manual contains important safety instructions. Read carefully the safety and operation instructions before using REhub. Take into consideration all the warnings mentioned both on the equipment & in this manual. Please follow all the instructions regarding the operation and use.
This user manual is intended to serve as a guideline for the safe and efficient use of REhub. This manual does not contain any information meant for persons other than the personnel qualified for the installation of such a product.
The installation and commissioning of REhub must be entrusted to qualified personnel. The installation and use must comply with the local safety instructions and standards in force.

2.3 Symbols used in this manual

☠	This symbol is used to indicate safety instructions which, if not followed, could result in serious personal injury or death to the operator or the user.
⚠	This symbol is used to indicate a risk of material damage and/or the cancellation of the Warranty.

2.4 WARRANTY: PRESERVE THIS DOCUMENT FOR ANY WARRANTY CLAIMS

The warranty for this equipment depends upon the strictly following the instructions in this manual. This Manual Contains The Warranty Period And Terms In The Last Page. PLEASE PRESERVE THIS DOCUMENT.

2.4.1 Limitations of Liability

We disclaim all responsibility and liability for damage, costs or losses resulting from an installation that does not comply with the instructions, a faulty operation or inadequate maintenance. The use of REhub is in any case under the responsibility of the customer.

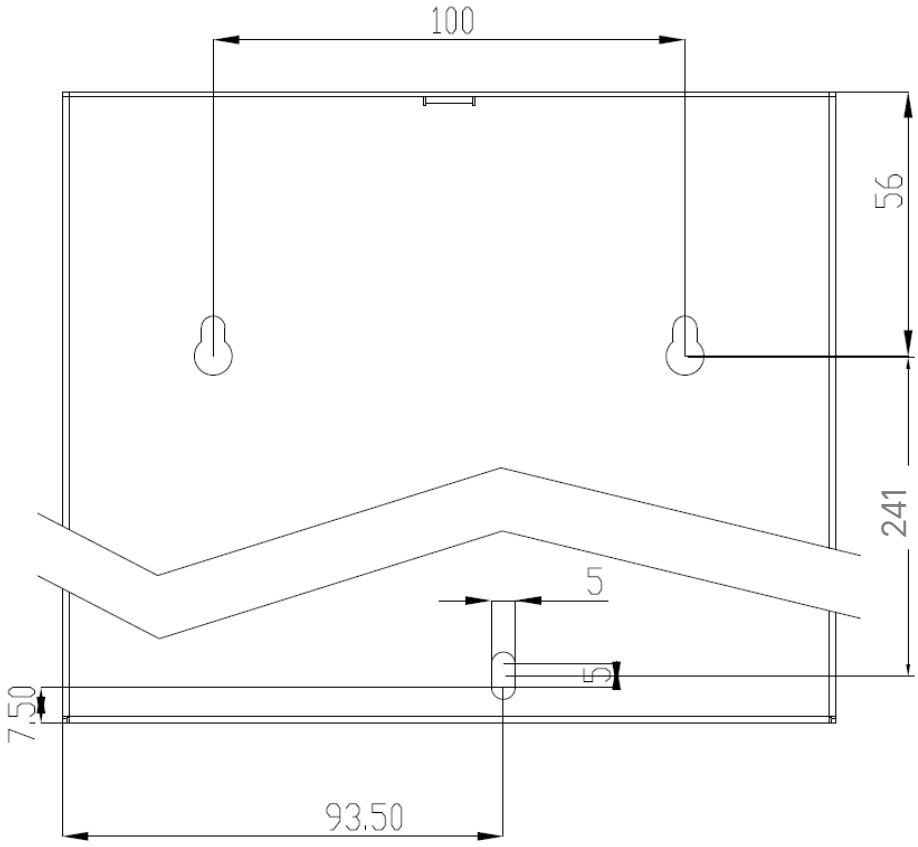
THIS EQUIPMENT IS NEITHER DESIGNED NOR GUARANTEED TO SUPPLY INSTALLATIONS USED FOR VITAL MEDICAL CARE NOR ANY OTHER CRITICAL INSTALLATION ENTAILING POTENTIAL RISKS OF DAMAGE TO PEOPLE OR TO THE ENVIRONMENT.

We assume no responsibility for the infringement of patent rights or other third parties rights resulting from the use of the Charger.

Amberroot reserves the right to make any modifications to the product without prior notification. AMBERROOT IS NOT LIABLE FOR INCIDENTAL, DIRECT OR INDIRECT DAMAGES OF ANY KIND, INCLUDING ANY PROFIT LOSS, REVENUE LOSS OR DAMAGES CAUSED TO EQUIPMENT OR GOODS DUE TO DEFECTIVE EQUIPMENT.

3 Installation

3.1 UNPACKING



When unpacking, check that the equipment has not been damaged during transportation and that all accessories listed below are present. Any fault must be immediately reported to the product distributor or the contact mentioned at the end of this manual.

Standard accessories:

Installation and operation manual. One Battery Cable, 10/16 Sqmm, Black, 1 Meter long.

3.2 Where to Install

REhub must be installed on a flat wall vertically. Keep the air vents clear of any obstruction. Leave sufficient space around the unit for air circulation.

Install in an area which is

- Protected from any unauthorized person and children
- Protected from direct solar radiation or heat sources.

The presence of a heat source may significantly reduce its rated power. Similarly, insufficient ventilation may lead to the overheating of some internal components of the equipment. In this

case, the device will automatically limit its power as long as this abnormal situation persists. Do not expose REhub to any dripping liquids.

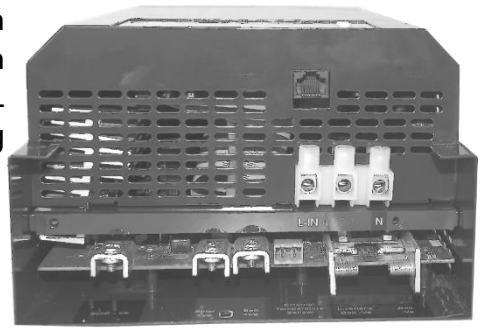
	Wiring must be done by a professional qualified for such installations. Take extra care while connecting High voltage systems, Battery terminals.
	Take care to not connect the panels to the battery input or the connection of the batteries to the PV input.
	TAKE CARE not to connect the AC line to any of the DC (PV or Battery) connections.

REhub is electronically protected against overloads, PV short-circuits, overheating, polarity reversal of the battery, polarity reversal of the PV.

Access the cable compartment after removing the L Plate.

Cable entry is through the slot in the L Plate. Close the L Plate after the terminals are sufficiently tightened and all the connections are checked for correctness.

Image on the left is with the L plate in place. On the right is with the L plate removed, exposing the various terminals.



3.3 Components of the Cable Compartment

S/no	Description	Comment
1	Terminal to connect Solar -Ve	Ensure appropriate cable size is used and ends properly crimped to avoid accidental shorts from stray strands. Ensure that the input Voltage and Current (String sizing) do not exceed name plate ratings.
2,3	Terminals to connect Battery +Ve and Solar +Ve. These are close to each other because the system uses Common +Ve	
6	External Temperature Sensor	Connect the External temperature Sensor (Part to be purchased from Amberroot) for temperature compensation of Battery charging (Optional)
4	Terminal to connect to Inverter's Battery -Ve	Disconnect the connection between the Inverter and Battery -Ve terminal, at the Battery -Ve terminal, and connect to this

		terminal. This connection carries the full current of the Loads from the batteries.
5	Terminal to connect Battery - Ve	This connection carries the full current of the Loads from the batteries and the charging current from the Solar charger.
7	Barrier Terminal to connect AC Live – Input from Mains	REhub controls the Mains input to the existing Inverter with a heavy-duty relay. This Mains input is internally connected to this relay. Use a heavy-duty cable based on the expected load.
8	Barrier Terminal to connect AC Live – Output to Inverter	The Mains Output from REhub is from the Output of the Relay – which switches off the Mains input to the Inverter based on Solar availability and the Battery state of charge. Use a heavyduty cable based on the expected load
9	Barrier Terminal to connect AC Neutral Tap to measure AC Voltage	This connection is a 'Tap' from the Neutral terminal of the Mains OR the Inverter. This is used by REhub to determine the availability of AC from Mains. If connected as a 'Tap', the wire cross section can be small because it is not carrying the Load current.
10	RJ 45 Jack for access to RS485 Data	This port is in the RJ 45 form factor but is not an Ethernet connection. Please use with Amberlink adapters (available for purchase separately) only.

3.4 Solar PV connections

REhub accepts input voltages between 0V to 150V. It can start charging the batteries when the input voltage is above the battery voltage. Keep the connection ready. Close the connections when you are ready to POWER Up.

3.4.1 Serial connection of Solar PV string

REhub can operate at a much higher PV voltage compared to the Battery system Voltage. It is therefore not necessary to match the PV panel voltage to the Battery Voltage. However, the name plate limits of the PV input must be strictly followed.

To get the optimum Voltage, the solar modules shall be connected in series to form a string having the desired voltage. The optimum operating voltage of the module string (Vmpp) must always be above the battery Voltage.

To establish the minimum number of PV modules to be connected in series in the same string, the max voltage of the battery must be multiplied by 1.1 and divided by the modules Vmpp voltage.

For example, for a 48V system with a lead-acid battery with maximum Voltage of 60V and using PV panels with 17V Vmpp. 60*1.1/17=3.88.

The result must be rounded up to the higher value (i.e. 4 modules - of 17 Vmpp - in series for the above example is the MINIMUM number of panels required for operation).

Maximum Panels in Series:

The open-circuit voltage of the string must be lower than 150V under any temperature and irradiation conditions.

To establish the maximum numbers of the PV modules connected in series in the same string, use the following formula: 135V/(Voc). (Example: 135/(22)=6.13). The result must be rounded down to the lower value (i.e. 6 modules - of 22 Voc - in series for the above example).

There can be thus 6 PV modules in series of the mentioned model for as per this example.

Table below gives an idea of the possible arrangements for common panels according to the number of cells or their type.

	Solar PV panels in a string					
	36 Cell Solar Panel with Voc<23V		60 Cell Solar Panel with Voc<38V		72 Cell Solar Panel with Voc<45V	
Battery Voltage	Min	Max	Min	Max	Min	Max
36V	4	6	3	3	2	3
48V	4	6	3	3	2	3

Note that CIS or other forms of THIN film PV modules cannot be connected to REhub unless their Voc is <135V.

3.4.2 Parallel connection of Solar PV string

To get the required charging power, 2 or more strings are usually to be connected in parallel. Each string connected in parallel must be composed by the same number of modules of the same type.

The number of strings connected in parallel depends on the Isc of each string. The Isc of the array must be <40A for REhub MPPT, 40A Version. When you need to determine the Isc of the parallel array, it is the Isc of each panel multiplied by the number of parallel strings. For example, if the Isc of the panels used in the system is 4A. The maximum number of Parallel strings → 40A/4A =10.

The total power of the array can be slightly higher than rated power of REhub. This excess capacity is designed in to get the desired charging power under all circumstances of Solar radiation. However, the output current from REhub will be limited to the maximum rated current. (This is 40A in REhub 48-40A models)

3.5 Cable Size

Based on Array arrangement, calculate INPUT current. Choose the appropriate cable size for INPUT current based on the length of the cable from the PV panels to REhub. REhub must be located close to the Batteries.

3.6 Battery Connection

REhub monitors the net current delivered to the Batteries. REhub is by default configured to allow a maximum of 18A net current into the batteries. NOTE THAT THE TOTAL OUTPUT TO THE LOADS IS STILL AS PER THE RATED OUTPUT OF THE CHARGER (40A) . What this means is that the sum of the negative currents (currents drawn by the loads) and the positive currents (currents delivered by Solar PV and Inverter) will be not more than 18A. This is ideal for Battery size of 150Ah – typical home back up Batteries. This value can be changed through Amberlink. (separately available for purchase). There are two connections to the batteries from REhub. Connections [3] and [5] deliver the Solar charge to the batteries. Connections [4] is to monitor the battery currents. The existing Inverter Battery -Ve must be disconnected from the battery and connected to REhub terminal [4]. Keep the Inverter in switched off / Away mode till you are ready with all connections. Do not close the Battery connections till you are ready for POWER UP.

Note: Do not use a washer between the Battery lugs and the terminal [4,5]. Allow direct contact of the lugs to the terminals to reduce resistance.

3.7 Inverter Connection

REhub is meant to add SAFE Solar PV to existing Inverters. The Mains input LIVE of the Inverter is controlled by REhub. Disconnect the mains to Inverter connection and connect line cable to REhub Line out socket.

The rated load current of the connected inverter MUST be less than 100A. Keep the inverter in away/off mode till you are ready for the final power UP.

3.8 Mains Relay Operation Control: Switching Between Forced ON and Auto Control.

REhub by default is in Auto control of the Mains Switch. REhub decides to switch off the AC Mains input to the Inverter based on the availability of Solar energy and the state of charge of the batteries. This forces the Inverter to use Solar energy to service the Loads. Similarly REhub auto restores the Mains connection when there is no Solar energy or the state of charge of the batteries is below a set value.

As a user you can decide to OVERRIDE the decision of REhub by forcing REhub to keep the Mains switch ON. In ONAlwas (For On Always) mode, REhub keeps the Mains ON at all times. In ON1Day (for ON One Day) mode, REhub keeps REhub ON for the next 24 Hours and goes back automatically to Auto Mode at the end of 24 Hours. These Override modes may be required in case the day is very cloudy and Inverter is toggling frequently between using Solar and using the Mains to power the load. Alternately, these modes may be required if heavy loads like Mixer-grinder is connected to the lighting circuit supported by the Inverter. When running a Mixer, switch to ONAlwas or ON1Day mode when power is available, to ensure the Inverter is not delivering power from the batteries to the Mixer. Make sure to switch back to Auto when the desired usage is completed.

Offgrid mode is a special mode in which the MAINS power is not used unless the battery voltage goes very low. In Offgrid mode, REhub does not switch on the Mains input to the Inverter even if Solar is not available. This mode is different from the Auto mode in the way REhub switches on the Mains input to the Inverter. In Offgrid mode it automatically switches on the Mains input only when the battery voltage reaches a set low value.

⚠ Check to make sure LINE& Neutral are NOT Swapped

Sometimes the LINE and Neutral is swapped between the Input wire of the Inverter and the Output Load socket. Even with the swap prior to the installation of REhub, the problem is not seen because the Inverter delivers output from the batteries only when the Mains are not available. So a Line- Neutral swap from input to output is not noticed

However when the Inverter's Mains input is connected to REhub with the LINE – Neutral interchanged between AC input and output Load and when REhub forcibly switches off the MAINS input to the Inverter (even when MAINS power is available in the daytime when Solar is available), the Output Load may get dangerously high voltage, because the Inverter is delivering output from the Batteries and the MAINS is also available.

Sometimes, the Neutral wire is connected to the Live input of REhub. REhub operates by switching off the Mains input to the Inverter. This operation will not happen if the Neutral is connected to the Live input of REhub because the relay then is switching ON or OFF the Neutral line and not the LIVE!

Always make sure that the Input to Output LIVE pins have continuity and that LIVE and Neutral are not swapped in the Inverter.

4 Powering Up

Connecting the battery terminals will energize and start the unit. Therefore connect the Battery -Ve terminal at the battery terminal side last. Keep the -Ve Battery cable from REhub open till the last when you are ready to power up. Before energizing the equipment, recheck the polarity and the connections. Keep the MAINS MCB switched off.

A. Completing the PV+ and PV - connections.

Check the voltage between PV+ and PV- wires before closing the PV -Ve. You will get a voltage approximately equal to the open circuit voltage of the array.

Note if the installation is being done in the night you will not get the Voc value but likely to get a Voltage much lesser.

B. Connecting the battery: On the BAT+Ve and BAT-Ve terminals.

Remove the cable from the Battery -Ve terminal of the Inverter from the battery terminal and connect to REhub.

Check the battery terminal voltage. Make sure you have chosen the right battery system voltage for the REhub.

A 48V battery system will have voltage between 38V to 60V. On first time power on REhub will go to Auto Detect Mode. By default this unit always charges to 48V battery system. DO NOT CONNECT TO 36V battery system unless you confirm that the unit has been configured to work with 36V battery system. This unit can be configured to work with 36V systems at the factory ONLY.

C. Connecting the AC live from Mains connection.

Switch on the AC MCB. Put the Inverter to normal mode. ***Do this after REhub MPPT recognizes the battery system voltage and starts functioning***. IF YOU GET A BATT PROTECTION TRIP ERROR – wait and the unit recovers and starts up again.

⚠ ***Take care not to swap Solar PV and Battery connections. The unit is not protected for such a swap.*** The unit will not power up if batteries are connected in reverse polarity. If PV polarity is swapped, the unit will show Solar as 'LOW'.

5 Using Circuit Breakers for Safety

We recommend that a circuit breaker is installed in the following paths in the wiring. The circuit breakers need to be purchased separately and is not supplied by default with the unit. Please use appropriately rated DC MCBs only.

- A single pole DC MCB of minimum 40A,200V rating between the Solar +Ve connection from the array and REhub.
- A single pole DC MCB of minimum 63A, 100V rating between the Battery +Ve terminal of REhub and the battery.

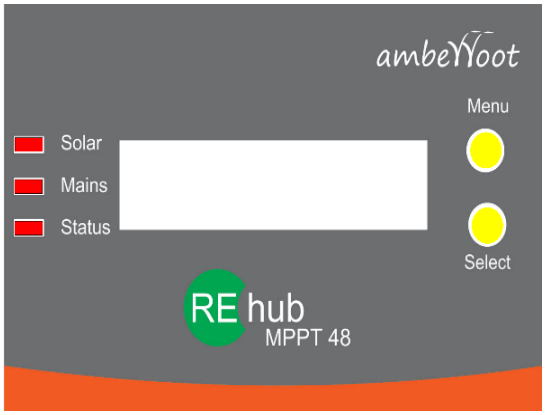
6 Screens and indications

REhub has a 16X 2 LCD screen and three LED indicators. The display scrolls through various screens and is a useful indicator for details on what is happening with the charger. The LED indicators give a quick status update.

Solar LED
Off – No Solar
Blinking fast – Solar good
Double blink – Solar available but not being used

Mains LED
Off – No Mains
Blinking – Mains available but not used. (Mains input to Inverter Off)
On – Mains available and is being used. (Mains input to Inverter On)

Status LED
Blinking slow – All ok
Blinking fast – error condition



Menu button
Press to scroll through the different Menu options

Select button
Press when you want to select a Menu option. The selection may result in further Menu options at a level lower.

6.1 Information provided on the LCD screen

6.1.1 Start-up screens

REhub MPPT Amberroot Sys	Model 141 36/48V – 40A	Ver:0x035 DB:24 SL # 14100026	Battery System Voltage 48V

Make sure that the correct battery system voltage is recognized. If the unit has been configured for 36V system, the last screen above will show the battery system voltage as 36V.

6.1.2 Display screens

Solar Y Mains Y Mains to Inv: Y +	Battery 54.35V - 13.5 A	Solar Input 93 V	Solar Output 1250W 23 A

Solar Units 12 kWhr	Int temp 36 deg C Ext temp 28 deg C

The display scrolls through the screens shown above. Solar is Y if available. Mains is Y if available. Mains to Inv is Y if the Mains input to the Inverter is ON. The + / - sign indicates that a counter is running which will change the state from Y to N .

Solar Power output is based on the following factors

- Availability of Solar Power – depends on Solar irradiance.
- Battery state of charge – When Batteries are in Bulk mode, the Solar charger limits the Current to the batteries to a maximum of 18A. In Absorb or Float mode, the batteries determine how much current is allowed.
- State of Load. If the Batteries are full and Load is limited the Solar power has nowhere to go and will therefore be limited. When loads go up, Solar power ramps up (Subject to availability) and when Solar power alone cannot service the loads, battery is discharged to service the loads along with Solar PV.

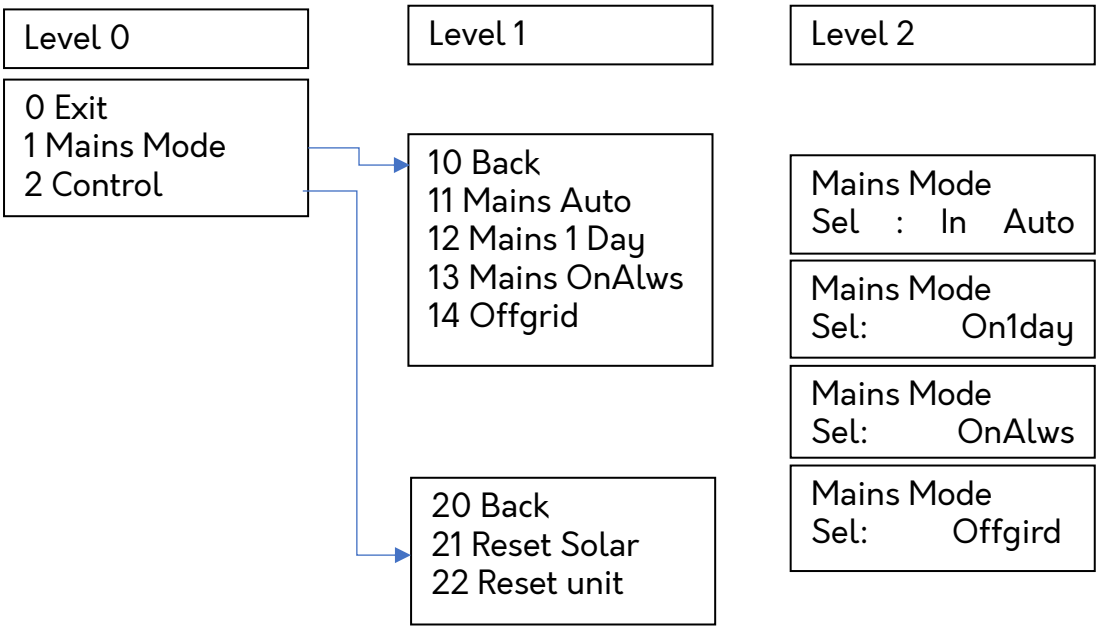
The Battery status screen shows the Net Amps delivered to the batteries and the battery Voltage. By default, the maximum +Ve current to the batteries is set to 18A. A negative value indicates that the Load is higher than Solar, and the Amps shown in being drawn from the batteries.
The Solar output screen shows the Output Amps and the instantaneous Power generated.
The external temperature value is used for Temperature compensated battery charging. This value is shown only of the external temperature sensor is connected to the unit.
The 'Energy' screen shows the Cumulative energy generated by Solar PV.
When the unit is set to a mode other than Auto, one of the following screens is additionally shown in each cycle.

Mains Mode OnAlwys	Mains Mode On1Day	Mains Mode Offgrid

When the unit is set Auto – the following screen is shown at the time of transition only.

Mains Mode Auto

The different modes can be changed using the Menu and Select buttons. The Menu has the levels as shown below. Selecting 'Exit' brings the screen back to scroll mode. Selecting 'Back' pushes the screen to one level higher.



Reset Solar forces the unit to do a complete scan of Solar and to start again. .
Reset unit forces the unit to completely reboot. The energy generated value is also reset to zero.

7 Data Port

The data port streams the data seen on screen using MODUS PROTOCOL. It uses RS485 with RJ 45 jack. IT IS NOT AN ETHERNET port.
Please use with Amberlink adapter only. Contact us for details.

8 REhub operation

REhub prioritizes keeping the batteries charged for sufficient back up. There are two sources of energy to deliver power to the batteries. Solar PV panels and the Grid Mains through the back up Inverter. REhub extracts power from the Solar Panel using a high efficiency MPPT based charger. MPPT stands for Maximum Power Point Tracking and the unit extracts power from the Solar panels at the voltage and current that delivers the maximum power (called the Maximum Power Point). Since this Maximum Power voltage and current varies, the Unit uses sophisticated algorithms to 'Track' this maximum power point. Additionally, REhub allows the conversion of existing Inverters to Solar based systems. REhub does this by controlling the Mains Input to the Inverter and monitoring the net current delivered to the batteries. At all times, REhub ensures that the batteries are kept safe and maximum Solar power is used to power the Loads. REhub is designed to work with Inverters of any make (48V). However, it is advisable to use REhub with efficient, Pure Sine Wave output Inverters.

Determine the approximate Loads (day time Load connected to the Inverters) and match the number of Solar panels installed so that the energy generated per day is approximately equal to the energy consumed by the loads for best results with your Solar addition.

REhub functions in the following manner:

- When Batteries are discharged – the batteries are charged using both the Solar PV and Grid if Mains power is available.
- When Solar is available AND Batteries are nearly completely charged (Voltage of 54V for at least 5 minutes), the GRID based charging from UPS Inverter is cut off and Loads and Charging to the batteries are supplied from Solar PV.
- When Solar Power is unavailable OR the Battery Voltage drops to 49V and remains in this state for at least 5 minutes, the Mains Input to the Inverter is switched on again
- If the Battery is seen to be discharging too fast, the Mains Input to the Inverter is switched on again

REhub ensures that the NET current delivered to the batteries at all times is 10% to 15% of the Battery Ah. The unit is by default configured to work with 150Ah batteries. Note that when Loads are being serviced from Solar and Batteries, the Solar charger could be supplying the current required by the Loads. Yet the net Current allowed into the batteries will always be lesser than or equal to 15% of Battery Ah. The battery Ah setting is a Factory setting. You can change this value through the data port by purchasing a Data cable 'Amberlink' to access the data base of the system. The configuration using Amberlink is given in a separate manual available with Amberlink.

8.1 Battery charging stages

REhub follows a three-stage charging from the Solar PV.

- Bulk mode: As much current as available and permissible for the batteries is delivered to the batteries
- Float mode: The batteries are charged. Only as much current as need to keep the batteries charged completely is delivered.
- Absorb Mode: The unit keeps the battery Voltage constant till the Current absorbed by the battery is lesser than 1A.

8.2 Connecting more than one array to a single battery bank

Sometimes it is desirable to connect a larger array to a single battery bank. For example the loads may require an installation of 5kWp Solar array. Two REhubs, each connected to 2.5kWp array (in this example) can be connected to the same battery bank. With REhub's net current monitoring feature, the output can be looped in a manner that the Loads get the desired say 80A current but the net current delivered by both the units is still restricted to the desired value. (Say to 10% of the battery Ah). The wiring for this arrangement is shown in page 10 of this manual.

9 Error conditions

When an error occurs, REhub displays the error on the screen. Some errors are self-corrected and once the error condition disappears, REhub resumes operation. Some errors may be system errors that require correction in the system for recovery. In case you need support, please capture an image of the error screen (and the next screen) for easier debugging.

Error in System Battery Prot Trip	Error in System Err 12 61V	Error in System High Temperature

Some possible errors are:

- Excess temperature
- Battery High voltage or Low Voltage error
- PV High voltage error

Bat Prot Trip: Sudden surge or voltage change is observed in the battery terminal. The next screen could indicate the error # and the Battery Voltage. Please capture the details of this screen to help us zero in on the problem faster.

High Temperature: Sustained Internal temperature beyond normal operating temperature. Could indicate the Fan is nonfunctional.

Given below are some error conditions and what to do when you get them.

Error	***Possible Reasons***	***Error Messages***	***Ways to eliminate***
No Display	Batt Not On Or not connected	None	Turn on Battery
	Battery Reverse	None	Check and connect correctly
	Battery Over Voltage	None	Check Battery Voltage
Zero Charging Current	PV Not Connected	Solar V is Less than Bat V	Connect PV
	PV Reverse/Shorted	None / Solar Low.	Check and correct PV
	Internal Error due to PV panel Overcapacity	Error in System – Prot Trip	Reduce PV Capacity / Wait
	Internal Error due to transients arising due to long battery cables	Error in System – Prot Trip / Batt Prot Trip.	Reduce battery Cable length / Wait.
	Internal Error due to transients arising due to insufficient wire gauge	Error in System – Prot Trip	Connect proper gauge wire
	Over temperature. (The unit cycles through Charging and Tripping)	Error in System – High Temperature	Wait for temperature to reduce. Make sure there is sufficient air circulation. Also check if PV panel connected is more than what is recommended.
	PV Low/ Night time	Solar – Low	Wait for Sufficient sunlight
Unit getting stuck in System Detect	Battery Voltage Very Low	None	Check the battery health. Connect proper 12V or 24V Battery.
Not cutting off Mains	Manual Override on	Mains Setting in ' Alwas On' or 1DayOn	Change to Auto Mode
No Mains	Mains not connected	Mains – N	Check and connect mains
	Power Cut	Mains – N	Wait for Power to be restored
	In Auto Mode	Mains – N	Switch to Manual Override Mode if Mains Power is required
Battery Low indication	In Off-grid mode	Inverter trips / indicates Low Battery	Solar generation + Battery back up is not enough to tide over a complete day

10 Specifications

[1]	Operating principle	High efficiency MPPT Based Solar Charger to enable addition of Solar PV to existing UPS inverters. Monitors the net battery current to ensure optimal charging rate and maximizes the usage of Solar. RS485 based interface for communication
[2]	Output Current Rating, Continuous, Max. Temp Derate beyond 65 Deg Internal	40A
[3]	Battery System Voltage	48V
[4]	Recommended Solar module STC Wp	2500Wp
[5]	PV Open Circuit Voltage (VOC) Max	150V
[6]	PV MPPT Voltage range	Battery Voltage to 140V
[7]	Input Current PV (Max)	30A
[8]	Power Conversion Efficiency (typical)	95% typ
[9]	Full load output voltage	Same as battery voltage
[10]	Float Mode Charge Voltage	54 V (Configurable)
[11]	Bulk Mode Charge Voltage	58.6V (Configurable)
[12]	Ambient temperature range	-10°C to 55°C
[13]	Ports	1 pair of PV input separate positive and negative 1 +Ve Terminal output to be connected to battery 1 -Ve terminal for current monitoring (-Ve) 1# of 3 Port barrier AC Terminal for Input and Output AC Live and Neutral 1 RS485 Port
[14]	Dimension	307 X 182 X 107mm, IP20
[15]	Weight	~ 4 Kgs
[16]	Protections	
[16a]	PV Reverse polarity	Electronically protected
[16b]	Battery Reverse	Electronically protected
[16c]	Over current protection	System shutdown, recovers with a timeout
[16d]	Over temperature protection	System shutdown, recovers with a timeout
[16e]	Battery Short Circuit	System shutdown, recovers with a timeout
[16f]	PV Short Circuit	System shutdown, recovers with a timeout
[17]	Indications	16X2 Character LCD. Displays, Battery V, Solar instantaneous Power, Cumulative energy from Solar
[18]	Relay	Dual contact, 20A AC Relay to control mains input to Inverter
[19]	Notes : Communication	EXTERNAL: Modbus RTU 19.2kbps . Used to communicate with PC / external device.

Quick reference guide for the installation of REhub MPPT

Step 1 *Prepare to connect*: Keep the cables ready. Draw the PV +Ve and -Ve wires to the battery room. Make provision to mount the REhub on a wall close to the batteries and the Inverter. Measure and cut a 10/6 Sqmm cable (RED) for connection between REhub and battery. Crimp appropriate lugs to the cable ends. Remove the Inverter's battery -Ve cable from the battery -Ve terminal

Step 2 *Make the Solar connections* : Measure Open Circuit voltage, ensure it is within REhub upper limit, make the PV -Ve connection to REhub. Connect the PV +Ve and battery +Ve cable to the terminals on REhub.

Step 3A *Make the battery connections* : Measure the battery Voltage to make sure it is within the operating limits of 48V battery system voltage. Connect the battery +Ve cable to the battery terminal. Connect the Inverter's battery -Ve cable to REhub.

Step 3B *Complete the battery connections and REhub starts up*: Now connect the black 10/16Sqmm cable provided with REhub to the battery -Ve terminal of the batteries. This will complete the battery connections and REhub will start up.

Step 4 *Make the Inverter's AC connections*: Make sure there is no LIVE and Neutral Swap in the Inverter's input and output. Connect the LIVE wire from Mains to Live-In terminal. Connect Live-out terminal to Mains Live input of the Inverter. Connect a wire from the Neutral terminal of the Inverter to the Neutral terminal in REhub. Close the L plate once the system working is verified on the display screen. WAIT till you see REhub switching off the MAINS input to the Inverter and the Inverter indicates that it is in back-up mode.

Installation mistakes

This section lists the installation mistakes that can occur. Installation mistakes can prove costly and may have repercussions to the life of the product that is not immediately obvious.

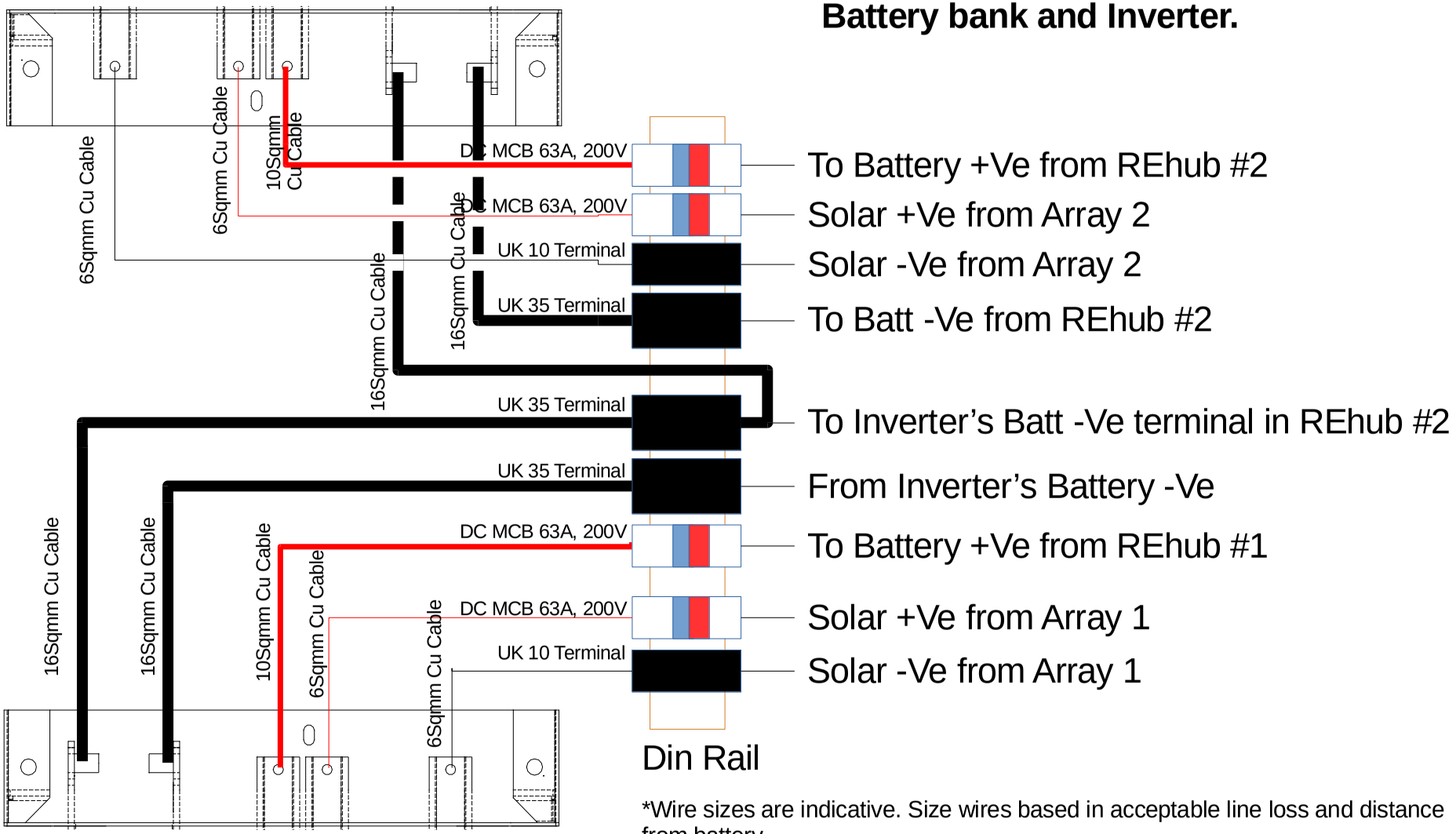
S/no	Level	Mistake	Observation	Prevention, Correction
1		PV array voltage > 150V	PV Protection trip indication on screen. If Voltage sustained MoV can blow.	CHECK with Voltmeter before connection. If MoV blows, the unit needs to be returned for repair. THIS IS NOT COVERED under Warranty.
2		PV polarity swap	Solar is shown as N.	CHECK polarity with Voltmeter before connection. Reconnect with correct polarity
3		PV short circuit	PV Protection trip indication on screen	Check connections. Reconnect after resolving the short.
4		Battery Reverse Polarity	Unit does not power up	CHECK with Voltmeter before connection. Reconnect with correct polarity
5		Battery Short circuit	Track may open up or weakest link will burnup	Take extreme care in connections. Use MCB to isolate for safety. The unit may not be repairable.
6		Wrong battery Voltage	Unit will freeze at System Voltage deduction.	CHECK battery Voltage with Voltmeter before connection.

				Make sure the battery Voltage is between 30 to 45V for 36V systems and between 40 to 60V for 48V systems.
7		Connecting 36V battery system to unit configured for 48V	Unit may start up but will be operating at 48V set points. Extremely dangerous for the Batteries.	Check name plate and make sure you are using the correct version.
8		Battery – PV Swap	Will blow the MoVs in the unit.	The terminals for Battery and PV in the unit are deliberately designed differently. Be careful to not mix the Battery negative and PV negative. If MoV blows, the unit needs to be returned for repair. THIS IS NOT COVERED under Warranty.
9		Connecting Live -In to Live-Out and Vice versa	The Relay operation may be affected	Crimp Live-In first and complete the connection before taking up Live – Out connection.
10		Stray strands of AC live -In or Live-Out touching the enclosure	Can cause a electrical shock	Use proper cylindrical lugs and crimp tightly
11		Live – Neutral swap	May cause Inverter to trip or go bad. Relay operation does not happen correctly	REhub MPPT 48 uses only the Live line to control the relay operation. Make sure the wires are not swapped.
12		Insufficiently tightened terminal screws	Heating up of the terminals – resulting in even the terminal solder giving up	Tighten the screws with enough torque If terminal Solder has melted, the unit needs to be returned for repair.
13		Under sizing of wires	Wires get heated up. Excessive Voltage drop	Size wires based on acceptable Voltage drop, Length etc.

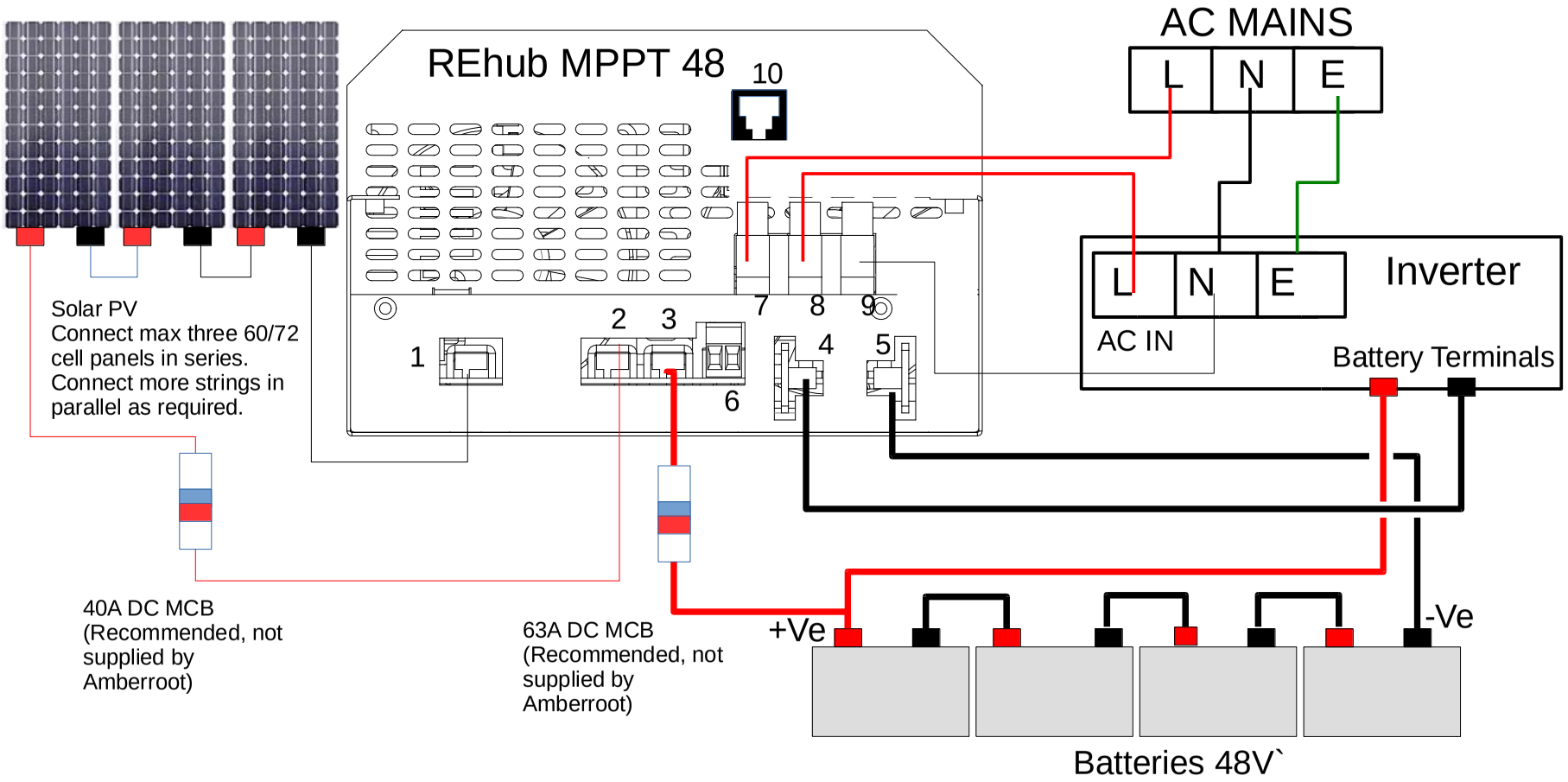
Check list for the installation of REhub MPPT

Sl no	***Description***	***Desired Valve***	***Measured value***	***Verified***
1	Check PV Voc Voltage using multimeter	Less than 150V		
2	Check Battery Voltage using multimeter	48V System (43.3 to 58V)		
3	Check the polarity of the PV wires. Connect PV -Ve Wire to PV port and check for tightness.			
4	Connect Battery and Solar positive to common +Ve terminal on REhub. Check for tightness.			
5	Connect phase of power supply into Line In of REhub. Check for tightness			
6	Connect inverter Line Input to Line Out of REhub. Check for tightness.			
7	Connect Neutral of Power supply/ Inverter to REhub's Neutral terminal.			
8	Connect Inverter/UPS to Battery negative to appropriate terminal in REhub. Check for tightness			
9	Connect Battery negative cable from REhub to Negative terminal of the battery. Check for tightness			
10	REhub starts up and does System detect. Verify if correct battery Voltage is detected.	Correct battery system Voltage		
11	Make sure that LINE and Neutral wiring in existing Inverter matches the Mains / house wiring. Connect the Inverter to REhub as described, Wait and confirm that REhub switches off the Mains input to the Inverter			

Wiring two REhubs (two PV arrays) to a single Battery bank and Inverter.



*Wire sizes are indicative. Size wires based in acceptable line loss and distance from battery.
* External terminals are optional. MCBs are recommended for safety during installation



Port #	Description	Port #	Description
1	PV -Ve	6	Ext Temperature Sensor
2,3	Common Batt +Ve, PV +Ve	7	AC Live Input
		8	AC Live Output
4	Inverter's Batt -Ve	9	AC Neutral
5	REhub Batt -Ve	10	Data Port