

# **LOOM SOLAR**

## **PURE MPPT SOLAR CHARGE CONTROLLER**

40 AMPS - 12V / 24V AUTO

### **FUSION-4024**



USER MANUAL

# SOLAR MPPT CHARGE CONTROLLER

FUSION 4024

FUSION 4024 Solar MPPT Charge Controllers are multi voltage range devices with unique features. The same device can be used for battery banks ranging from 1 Battery (12V) up to a battery bank of 2 batteries (24V) in series. The battery voltage is selected by the device itself when we connect the battery bank across its terminal. The device gives a configurable charging current up to 40A. The Max PV panel input open circuit voltage up to 160V makes it easier to group the panels conveniently. Also, sleek & stylish design of the product gives a better aesthetic view so that you can wall mount the product in a visible place inside your home or office.

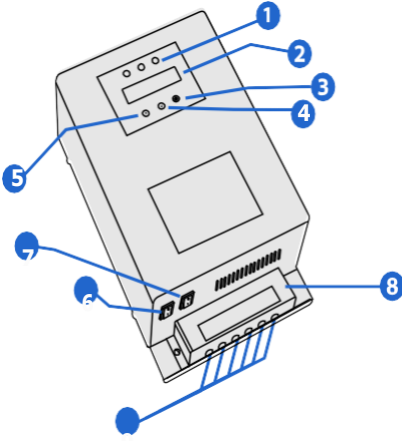
## SALIENT FEATURES

- ▲ Compatible for 12V/24V Battery bank
- ▲ Auto-Detection and setting of Battery Bank.
- ▲ 4 stage Smart charging for prolonged battery life.
- ▲ Programmable Initial limited ampere charging and periodic or voltage-controlled equalization charging facility
- ▲ Ultra-fast & efficient (98.9%) power point tracking.
- ▲ dsPIC33EP family micro controller based multi-phase interleaved switching.
- ▲ PV panel reverse polarity protection.
- ▲ Automatic disconnection of PV panels at night.
- ▲ Over voltage and overload protection from PV panels.
- ▲ Protection for battery against hardware failures.
- ▲ 13 menu custom function settings and inbuilt settings keys
- ▲ Grid power Control to the connected inverter

## SPECIFICATIONS

Max PV Array Open Circuit Voltage (Voc)	12V (100V Voc) 24V (160V Voc)
Max PV Panel Array (in Watts) Applicable	12V (700Wp) 24V (1200wp)
Nominal Battery Voltage	12V / 24V (Auto Setting)
Maximum Charging Current	40A (Configurable)
Battery charging stages	Bulk-absorption-float Equalization
Maximum Tracking Efficiency	98.9%
Standby Power Consumption	<1.5W
Overload Protection	✓
Over Charge Protection	✓
Panel Reverse Polarity Protection	✓
Battery Reverse Polarity Protection	Optional
Dimensions – L x W x H (in mm)	310x150x110
Net Weight (Kgs)	2.285 Kgs
Connector	Input / Output Terminal Block
Communication	Display/UART

## KNOW YOUR DEVICE



- |   |                         |
|---|-------------------------|
| 1 | LED INDICATORS          |
| 2 | 2x16 LCD                |
| 3 | SETTINGS BUTTON [ENTER] |
| 4 | SETTINGS BUTTON [ ▼ ]   |
| 5 | SETTINGS BUTTON [ ▲ ]   |
| 6 | MPPT ON/OFF SWITCH      |
| 7 | GRID BYPASS SWITCH      |
| 8 | TERMINAL COVER          |
| 9 | I/O POWER TERMINALS     |

<b>INDICATOR</b>	<b>ON</b>	<b>OFF</b>	<b>BLINKING</b>
<p><b>BLUE</b></p> <p>SOLAR / GRID POWER STATUS</p>	LOAD IS ON SOLAR POWER	LOAD IS ON GRID POWER	BATTERY LOW WARNING
<p><b>GREEN</b></p> <p>SOLAR PRESENCE</p>	PV PANEL VOLTAGE IS HIGHER THAN BATTERY BANK VOLTAGE / PV PANEL CONNECTION IS READY	PV PANEL VOLTAGE IS LOWER THAN BATTERY BANK VOLTAGE / PV PANEL CONNECTION NOT READY	-
<p><b>RED</b></p> <p>SOLAR CHARGING STATUS</p>	SOLAR CHARGING CURRENT IS ABOVE 2AMPS	SOLAR CHARGING CURRENT IS BELOW 2 AMPS. CHARGING IS STILL GOING ON IN LOW AMPS	<b>BULK CHARGING INDICATION</b>

## INSTALLATION & OPERATION

- 1) **PV Panel Grouping:** Using standard Solar MC4 connectors and parallel connectors group the PV panel array as to the recommended grouping example chart provided. Good quality weatherproof solar DC cables must be used.
- 2) **Battery Bank Setup:** If more than one battery is used, Connect the batteries with 16sq.mm/10 sq.mm interlinking cables and tight them well. Check each battery separately for specific gravity, same terminal volt and good backup. Do not use old and new batteries together, either in parallel or in series if they are with different terminal volt and backup as it will decrease the life of both batteries.

### 3) **MPPT Charge controller installation**

Mount the MPPT charge controller vertically on the wall using the wall mounting clamp provided

Avoid exposure to rain, dusty area, direct sun light or in area having high temperature

Use 25 sq.mm/16 Sq.mm standard electric cables below 1.5 meter length as battery wires.

Red color for positive and black for negative is better. Remove the connection terminal cover of the charger and connect the battery wires to the battery ensuring correct polarity.

#### **(Reverse polarity will spoil the charge controller)**

Three LED Indicators and cooling fan of the device starts functioning for 5 seconds and goes off.

**Display shows the voltage of the connected battery bank and applicable range of PV**

**Panel Open Circuit Voltage (Voc) limit for the connected battery bank.**

**Ensure the displayed battery bank voltage and connected battery bank voltage is same when MPPT is powered on**

Connect the cables from PV panels to the solar positive and negative terminals of the charge controller  
If the panel voltage and polarity is correct green LED indicator glows on.

Switch on the MPPT Switch (6) on the Charger. When the PV Panel voltage detected is higher than the connected battery bank voltage MPPT starts charging.

When the PV panel voltage goes below the battery bank voltage the green LED indicator goes off.

When the device detects more than 2Amp charging current to the battery, charging LED (RED) glows on.

IF the current is less than 2Amp the Red LED goes off ,but charging continuous in low amp till the solar power availability.

When the connected battery voltage reaches 14.2V (adjustable) the Blue LED glows on indicating battery is near full charge (default value14.2V) and ready to use either directly or using an inverter.

#### **Automatic Grid power/ Solar power Change Over using MPPT charge controller**

##### **(Converting a home inverter to a smart solar inverter)**

Remove the connected grid phase input wire from the the inverter and connect to the 'PHASE IN' terminal on the charge controller. Connect another wire from the 'PHASE OUT' terminal of the charger to the input phase connector of the inverter.

For automatic changeover function (grid to solar /solar to grid) keep the GRID BYPASS switch on the charger in ON position. When kept it in OFF position Inverter will always be on Grid power.

Never connect the neutral wire of the Grid power to any terminal of the charger.

(Refer examples for Connection diagram provided).

##### **How MPPT charger controls the connected Inverter:**

Charge controller is provided with a relay inside to connect and disconnect grid power to inverter monitoring the terminal volt of the battery. When the battery terminal volt rises up to 14.2V (adjustable) charger disconnects Grid power to the inverter and the load on it starts running on battery power (solar power). When the solar charging current stops load will be working from the battery bank and the battery voltage goes down. When it reaches 11.5V(adjustable) the device reconnects AC mains (grid power) to inverter and the blue LED goes off. Blinking of blue LED indicates low battery bank voltage. ie. below 11.7 V (adjustable) giving warning indication to remove heavy load on inverter

## RECOMMENDED GROUPING OF PV PANELS

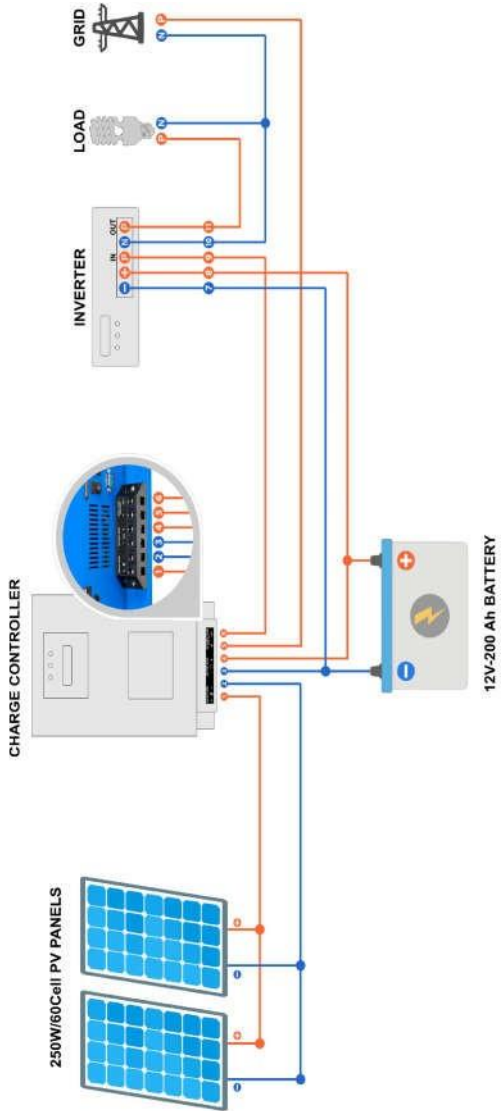
- Recommended PV Panel Input voltage for maximum MPPT performance.

Battery Bank Volt	Max.PV Panel Voltage Range (Voc)	Examples for Grouping of Panels in Series	Max. PV Panels Applicable in Watts
12V	30V-100V	1) 36 V Voc (260w panel) X 2 panel in series = 72 Voc=520W 2) 21V Voc (150w panel) X 4 panel in series=84Voc=600w 3) 47 V Voc (375 w panel) x 1 4) 51 V Voc (400 w panel) x 1	700W
24V	60V-160V	1) 47V Voc (375W panel) x 2 panel in series = 94Voc=750w 2) 36 V Voc (260w panel) X 2 panel in series = 72 Voc=520W X 2 strings in parallel=1040w	1200W

Note: Solar panels should be grouped in such a way that the Open Circuit Voltage (Voc) of the panels connected in series should not exceed the Maximum panel voltage mentioned above for each battery bank!

# CONNECTION DIAGRAM

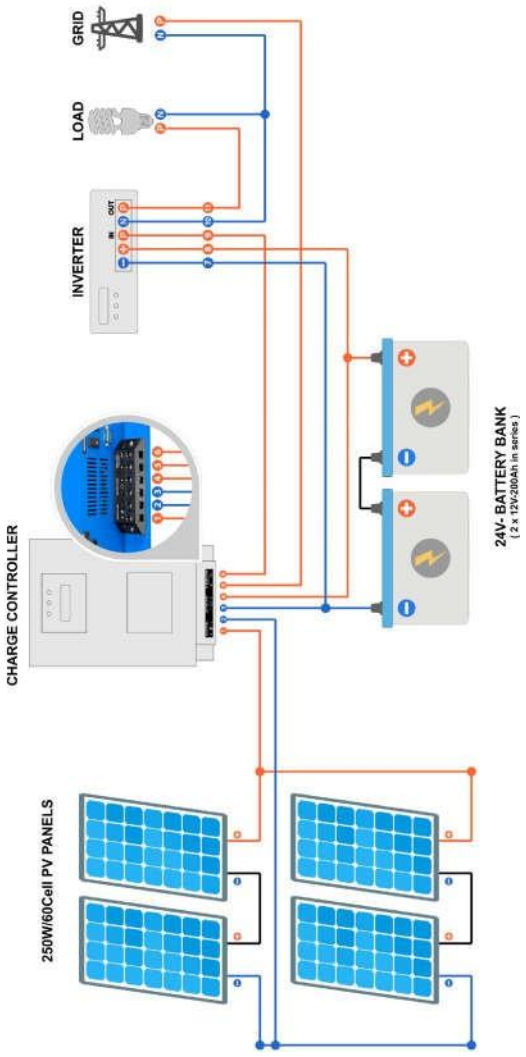
## 500W/12V OFFGRID SOLAR POWER PLANT





# CONNECTION DIAGRAM

## 1000W/24V OFFGRID SOLAR POWER PLANT



## TROUBLE SHOOTING

<b>ERROR CODE</b>	<b>DESCRIPTION</b>	<b>SOLUTION</b>
EV	PV PANEL VOLTAGE ERROR	PV PANEL VOLTAGE IS NOT IN THE SPECIFIED LIMIT. CHECK FOR PV PANEL GROUPING. REFER PV PANEL GROUPING MANUAL PROVIDED.
EB	BATTERY BANK VOLTAGE ERROR	CONNECTED BATTERY BANK VOLTAGE IS NOT IN THE SPECIFIED LIMIT. CHECK FOR DEFECTIVE BATTERIES LOOSE CONNECTION OF JUMPER WIRES AND NUMBER OF BATTERIES.
ET	HIGH TEMPERATURE	CONNECTED PV PANEL CAPACITY (WATTS) IS NOT IN THE SPECIFIED LIMIT OR CHECK FOR THE FUNCTION OF THE COOLING FAN.
E:M	HARDWARE FAILURE	LIGHTNING MAY CAUSE HARDWARE FAILURE. IF CONTINUOUS BEEP SOUND AND ERROR MESSAGE <u>EM</u> IS SEEN, CHECK FOR LOOSE CONTACT OF BATTERY CONNECTORS OR FAULTY BATTERIES. DISCONNECT AND RECONNECT THE BATTERY WIRES FROM THE DEVICE. IF THE PROBLEM PERSISTS CONTACT THE INSTALLER FOR SERVICE ASSISTANCE.

## IMPORTANT NOTE FOR ACTIVATION OF LIMITED AMPERE BATTERY CHARGING AND EQUALIZATION CHARGING

### 1. What is initial limited ampere charging in MPPT charge controller?

Maximum recommended charging current for a solar C10 inverter battery is up to 20% of the battery AH. Batteries used in solar power system is often discharged below 11.5V every day. So, it is recommended to start initial charging with limited ampere instead of charging with maximum capacity of MPPT charge controller.

Eg : Recommended maximum charging current for a 12V,150AH lead acid battery is 30 Amp. If such a battery is connected to the MPPT delivering above 30 amps the excess ampere entering the battery can be controlled in the initial charging stage by activating initial limited ampere charging feature.

MPPT delivers only 20% of the battery Ah. ie.30amps to the battery if the Ah limit is set to 150

#### 1. Ampere Limiting based on load shifting voltage: (grid to solar shifting volt)

In this mode battery charging ampere is limited in the initial stage. (if battery is 150Ah charging current will be limited to 30 amps.) When load is shifted to solar, entire ampere is shared between load and battery.

#### 2. Ampere limiting based on Charging mode:

In this mode also, battery charging ampere is limited in the initial stage and the limitation is stopped after the completion of bulk charging stage.

(When float charging starts)

ie.The entire charging current is never delivered to battery in float charging mode as the battery is already charged to float charging level.

MPPT charge controllers are sun light dependent devices and they can't deliver high ampere in the morning. They start to charge the batteries in low ampere early in the morning. As the terminal volt of the battery increases, charge controller shifts the connected inverter load to solar power and the current is shared to load and battery charging. Hence the activation of limited ampere charging is not necessary in low ampere charge controllers connected with high Ah batteries. **eg: If the charge controller delivers more than 30amp current in starting stage and the connected battery is below 150Ah it is recommended to activate limited ampere charging option.**

## 2. What is Equalization charging in MPPT charge controller?

When a lead acid battery is left in a discharged state for extended periods of time, non-removable sulphate crystals are formed on the surface of battery plates that reduce the charging and discharging capacity of the battery. Equalization charging is an over charging process of lead-acid batteries above their recommended charging voltage, to remove sulfation and bring all cells of the battery to similar levels by increasing the voltage to 2.50V/cell, or 10 percent higher than the recommended charging voltage. Equalization charging also equalize acid stratification, a condition where acid concentration is greater at the bottom of stationary batteries than at the top level. Battery experts recommend periodic equalization charging to keep the batteries healthy (once in every three month)

### **SMF, VRLA, AGM, GEL Batteries.**

**SMF** (sealed maintenance free), **SLA** (Sealed lead acid) and **VRLA** (Valve regulated lead acid) batteries are same. Its 2 types of cells are (**AGM** (Absorbed glass mat) and **GEL** cells. They are maintenance free batteries which do not require regular water filling, its composition of electrodes and electrolyte is same as flooded lead acid batteries. These batteries do not need to be kept upright as the electrolyte is in the form of gel or paste.)

**Un-attended equalization charging of battery is risky as there is chance for overheating of battery plates, overflowing of electrolyte and damaging of batteries.**

Remove all loads from the batteries before starting equalization charging.

Fill all the battery cells with distilled water in the required level.

It is better to remove the all the lids of batteries before starting equalization charging as the batteries will begin gassing and bubbling vigorously at the peak stage of boost charging.

Ensure the batteries are installed in a good, ventilated area.

Even a spark from a metal cutter, loose contact of battery wires may cause fire hazard and explosion of batteries.

During equalization charging, check the changes in the specific gravity of acid of each cells every hour and stop charging if the gravity and voltage of cells no longer rises during the gassing stage. Further improvement of the cell is not possible and continued charging will spoil batteries

## Enabling limited ampere charging in MPPT charge controller.

Enter settings menu 13. AMP-LT (Read page 12 for MPPT function settings)

1. Select option "0" to disable limited ampere charging.

2. Select option "1" for limited ampere charging up to the set value of 7th menu. (7.GRD-SOL) ( Grid to Solar shifting volt 14.2V default) When kept in this mode MPPT delivers only 30 amps of continuous charging current to the battery if the Ah is set to 150 and delivers the maximum available ampere to load and battery charging after shifting to solar power.

3. Select option "2" for limited ampere charging up to the set value of 2nd menu. (Bulk charging limit. 15V default)

MPPT delivers only 30 amps of continuous charging current to the battery if the Ah is set to 150 and release the ampere limit only after the completion of bulk charging (15V in default). In this mode, load is shifted to inverter only after starting float charging (end of bulk charging)

**Enabling equalization charging in MPPT charge controller.** Enter settings menu and configure menu 5.N-DAYS "0" to disable all modes of equalization charging.

Enter settings menu and configure following settings for enabling equalization charging:

### 3.EQLZ-V: Set the equalization voltage

As the equalization is an over charging process, ask a battery expert before setting the maximum applicable upper voltage limit. Blind settings will spoil the batteries.

4. BVLC-V: Select the battery low voltage level to enable equalization charging based on battery terminal volt.

(Configure a value slightly less than inverter low voltage cut off to avoid frequent equalization charging)

### 5.N-DAYS: Set period of Equalization charging

N-DAYS = 0 =>Disables all modes of Equalization charging

N-DAYS = 1 =>Equalization charging starts every alternate days

N-DAYS = 2 =>Equalization charging starts every 2 days

.....  
N-DAYS = 30 => Once in a month (Recommended)

N-DAYS = 90 => Once in 3 months

N-DAYS = 180 => Once in 6 months

**13. AMP-LT:** Recommended to set AMP-LT "1" or "2" for controlled (limited ampere) charging to battery in Equalization charging mode. This option is recommended because system will not shift from grid to solar till the equalization charging is completed which helps to rise battery terminal voltage gradually and attains maximum gravity of electrolyte and gets good backup from batteries.

## Changing the default settings of MPPT charge controller

**Note:** Before changing the default settings values of the device, ensure the maximum ampere and voltage ratings applicable for your battery type and brand (SMF, LEAD-ACID, GEL) This device is not designed for direct charging of lithium Phosphate battery. Blind settings may cause severe damage to the batteries and charge controller. Default values given are for lead acid C10 grade solar lead acid batteries.

**Refer battery user manual for recommended charging ampere and voltage for the connected batteries.**

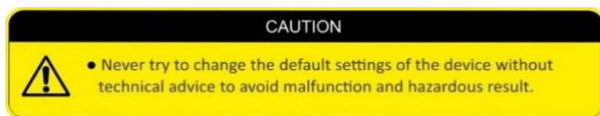
Never try to change the default settings of the device without the help of technical advice. Note down the default settings of the device before changing. Read function settings page before changing default settings of the device.

### Entering setup mode of MPPT charge controller.

Connect the charge controller to the desired battery bank. To enter Setup mode, switch off the MPPT switch ( 6 ) and AC BYPASS switch (7) on the charger.

Press and hold the ENTER button on the front panel (button 3) till the charger enters setup mode. All the LED indicators and fan start to function.

Press the enter button to scroll through the various setup menu as shown in the function settings page. Use the PLUS and MINUS button (4 and 5) to increase or decrease the default values. When kept idle for 5 seconds or gone through all settings menu new settings will be saved and the device goes to normal mode.



## MPPT FUNCTION SETTINGS

MENU	TYPE	DESCRIPTION	RANGE		
			MIN	DEFAULT	MAX
<b>1.FLOAT-V</b> Battery float charging limit	SETTINGS	Limit the float charging voltage recommended for the batteries This value varies in different types of batteries. Default value given is for C10 grade solar lead acid batteries.For SMFand Gel batteries this value is between 13.0V to 13.8V.Refer battery user manual to change the value	13.0V	14.2V	15.5V
<b>2.BULK-V</b> Battery bulk charging limit	SETTINGS	Limit the maximum bulk charging voltage recommended for the batteries. This value varies in different types of batteries. Default value given is for C10 grade solar Lead acid batteries.For SMFand Gel batteries this value is between 13.5V to 14.5V (Refer battery user manual before changing	13.5V	15.0V	16.5V
<b>3.EQLZ-V</b> Battery equalization upper volt limit	Battery equalization charging settings	(Never try to equalise sealed (SMF,SLA,GEL) batteries). Limit the maximum voltage required to boost the lead acid batteries. Equalization is an over charging of battery above their recommended bulk charging voltage to equalise terminal volt of all cells. (Read page 12,13)	14.0V	15.5V	16.5V
<b>4.BVLC-V</b> Battery equalization lower volt limit		Select the battery low volt level to activate auto equalization based on battery volt.(Select a volt limit just below the inverter low volt cutoff level to control frequent equalization)	9.0V	10.5V	13.0V
<b>5.N-DAYS</b> Select the equalization period in days		Select the number of days to activate periodic equalization	"0" day	"0" day	180 day
<b>6.MAX - AMP</b> Set the output ampere of MPPT	SETTINGS	Limit the charging current to the battery if needed.(maximum charging current is recommended as 20% of the Ah of a single 12V lead acid battery.Eg: for a 150Ah battery, 30ampere is the maximum charging current recommended.Refer bat.user manual befor changing the value.	3A	40A	40A
<b>7.GRD-SOL</b> Set grid power to solar power shifting voltage	SETTINGS	If grid power is connected to inverter through MPPT to shift the load automatically from grid power to battery power(solar power) set the changeover battery voltage preferred.	12.0V	14.2V	16.0V
<b>8.SOL-GRID</b> Set solar power to grid power shifting voltage	SETTINGS	Set the changeover battery voltage preferred to change the load automatically from solar power (battery power) to grid power	9.0V	11.5V	16.0V
<b>9.BLK-LED</b> Battery low volt warning limit	SETTINGS	Blinking of blue LED indicates low battery volt. Set this value above the vale given in the 8th menu SOL-GRID changeover	LB	11.7V	16.0V
<b>10.BAT-AH</b> Set the Ah of the connected battery	SETTINGS	Set the Ah of the connected battery bank to limit the bulk charging time Eg:if 2 150Ah battery is connected in series set the value 150Ah and if connected in parallel set as 300Ah.	10Ah	150Ah	200 Ah
<b>11.CAL-AMP</b> Ampere calibration settings of MPPT	CALIBRATION	When MPPT charging is going on connect a true RMS DC clamp meter (Fluke brand is better ) over the positive battery wire and ensure the same reading is seen on the MPPT display.Calibrate and correct if there is difference.If the reading is less in clamp meter increase 2 or 3 points using UP button and save changes.If the reading is high in the clamp meter decrease 2 or 3 points and save the changes. the Repeat the charging process till both display shows same reading	70	88	150
<b>12.CAL-VOLT</b> Volt calibration settings of MPPT	CALIBRATION	Note the battery volt reading on the MPPT display.Measure battery terminal volt using a true RMS DC volt meter.If there is difference in reading UP or down the default value till both readings are equal.	-	-	-
<b>13.AMP-LT</b> Settings for initial limited ampere charging  Initial Charging ampere is limited to 20% of the Ah of the connected battery.	SETTINGS	A) Select option "0" to stop all initial limited ampere battery charging B) Select option "1" to start initial limited ampere charging up to the set value of 7 th menu.(Grid to solar shifting volt) C) Select option "2" to start initial limited amp charging up to the set value of 2nd menu. (Bulk charging) MPPT continuous on limited amp charging till the end of bulk charging	-	"0" zero	-

## **IMPORTANT SAFETY PRECAUTIONS**

**Lead Acid batteries produce Hydrogen gas which is highly flammable**

- 1) Never use a flame or any kind of spark producing device near fully charged batteries as it may cause an explosion of the batteries and fire hazard (eg: Checking battery water level under a candle flame, spark from metal cutter or spark from loose contact of battery connecting wires )
- 2) Maintenance of the batteries and pv panel array at regular intervals make the solar power system trouble free and fresh
- 3) Solar panels should be grouped in such a way that the maximum Open Circuit Voltage (Voc) of the panels connected in series should not exceed the Maximum PVpanel voltage recommended for each BatteryBanks.
- 4) Safety precautions must be taken while grouping and connecting PV panels to the charge controller with high Voc input.(500 Volt DC current from the PV panel is highly dangerous.Never touch the terminals without safety gloves)
- 5) Extreme care should be taken while connecting High voltage solar power systems.
- 6) Earthing and wiring of high power solar system must be done under the supervision of a qualified electrical engineer
- 7) Never connect the PV panel connection to the battery input or the connection of the batteries to the PVinput.
- 8) Never connect any of the grid line to any of the DC (PV or Battery) connection terminals.
- 9) The installation and use must comply with the local safety instructions and standards in force.
- 10) 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.
- 11) The use of the charger is in any case under the responsibility of the customer.
- 12) This equipment is neither designed nor guaranteed to installations used for vital medical care nor any other critical installation entailing potential risks of damage to people or to the environment



## CONVERTING A NORMAL INVERTER TO A SMART SOLAR INVERTER USING MPPT CHARGE CONTROLLER

Before starting it is better to make a plan of your solar energy needs and ensure your existing inverter and batteries are suitable for solar application. When a battery is charged with limited charging ampere (6AMP to 10 AMP) for long hours it delivers good energy backup. Solar charging and discharging is a daily process with high current from solar panels. We get only 4 to 5 hours average sun light in a day and have to charge the batteries in this time. C10 grade solar batteries above 100Ah have the capacity to handle high current charging and discharging. Usually inverter batteries are either C20 grade or C10 grade normal batteries. An inverter battery is always connected to grid power and continuously charging the batteries in limited ampere for long hours (6 AMP to 10 AMP) and gives good backup. That is why we don't get enough backup from normal batteries when charged from solar power with high current. If we use normal batteries for solar charging with limited charging current they can't be got fully charged before evening. So always insist on C10 grade solar batteries for solar applications.

Now check your home inverter is provided with a grid charging ON/OFF switch.

Most of the branded normal type inverters are not provided with a grid charging ON/OFF switch on them. When we use this type of normal inverter in solar off-grid system it will charge batteries from grid power and we do not get actual solar benefit.

### HOW THE CHARGE CONTROLLER DRIVES INVERTER

Most of the solar MPPT charge controllers are provided with an in built relay to control grid power to inverter. Remove grid power phase wire from your inverter and connect to PHASE IN terminal of MPPT. Connect a wire from PHASE OUT terminal of MPPT to the phase in terminal of inverter. (Never connect neutral wire of grid power to any connectors of MPPT). When charging starts terminal volt of the battery rises to the preset voltage 14.2V (this value is adjustable) MPPT disconnects the AC mains to inverter and the connected load on inverter works on battery power (solar power). when the battery terminal volt goes down (in the evening or cloudy sky) and reaches 11.5V (this value is adjustable) MPPT reconnects grid power to inverter. If your inverter is a normal type without a grid charging disabling switch it will charge the batteries and we don't get solar benefit. To overcome this it is better to limit the load on inverter and keep the battery terminal volt always high. Some customers use the solar power only at day time and shift the load to AC mains by keeping the shifting to AC mains voltage 12.0V or more. Fitting an external grid changeover relay system for bypassing grid power directly to load is also applicable. If we use an inverter with grid charging ON/OFF switch we can keep the switch in off position to avoid charging from grid. Only on cloudy days we can keep the switch in on position and charge the batteries from grid power.