

INSTRUCTIONS FOR INSTALLATION

AND

OPERATING MANUAL

FOR SOLAR PHOTOVOLTAIC

HYBRID

WATER PUMP CONTROLLER

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**INSTRUCTIONS FOR INSTALLATION AND PUTTING INTO OPERATION-
SOLAR HYBRID PHOTOVOLTAIC WATER PUMP CONTROLLER. (SHPWC)**

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1. INTRODUCTION:

The Solar Hybrid Photovoltaic water Pump controller (**SHWPC-xxx-xx-xx**) powers a standard 3 ph 230/380/400 V AC 50 hz surface or submersible centrifugal pump-site specific design.

Grid electricity outages, non availability of power of adequate quality at desired working times and durations, for water pumping “essential use such as drinking water, agriculture” pose serious challenges

Specifically designed water pump systems for use with solar Photovoltaic have been in satisfactory operation for a long time. However due to constraints like, higher initial cost, deployment of a new pumping system-by replacing existing system in a bore well installation, a hybrid controller that uses either available solar energy or available Utility energy for serving the purpose of water pumping when required.

The Solar Hybrid water Pump controller meets the above requirements, by using solar energy in day time, and / or when required, and available, the utility energy (within power quality requirements) is used to provide water pumping operation. And is able to operate the existing submersible Pump.

The controller is suitable to power only 3 ph motors, between 1 to 10 HP. Higher ratings can be designed on request.. The said controller cannot power a 1 ph AC existing motor operated device or a pump. In any case, it is found that 1 ph AC motors have very poor efficiency, are having difficulties for starting unless aided by some start aid method, and often require a source that is capable of delivering high inrush power/watt second energy for a successful start of the 1 ph AC motor driven load at every time of start.

2.0 SPECIFICATIONS OF SHWPC-380-02-01

s/n	Parameter	From Solar PV array	From AC mains	Remarks
1	Input Voltage	540-550 V DC Nominal 540-550 V DC Nominal Max Voc < 700V DC Array MPP V-operating range: 470 V to 550 V DC	3 ph 500V 50hz 3 ph 380-500 V AC, 50 hz. (Nom)	Only one of the source (PV ARRAY DC/ Utility grade AC) shall be connected at any given time of use.
2	Input power source	As per specified design rated capacity. This is based on the specified Pump, Total dynamic pumping head, expected water qty in m3/d, Pump model, make and type, efficiency at duty point;. Place of installation to estimate expected solar resource availability.	Sufficient source capacity to provide within: 1. I/P Voltage:+10% - 15% of Nominal 380-500V 2. Capacity Kva : 3.1 kva (for 1kw)	Input Voltage tolerance is +/-10% when inverter is used continuously. (load of 100%)
3	Applicable Motor	1.5kw 3 ph	1.5kw 3 ph	Suitably rated for centrifugal pump operation.
4	Rated Output Voltage	3 ph 380-400V (for Nominal Array Input voltage is ~544 V DC, array rated amps ~ 4.2 amps.	380-400V. Maximum output voltage is same as the input Voltage.	As per DC Link voltage and the load on the Motor.
5	Rated output current.	4.1 A, at peak array power of approx. 2.35 kwp	4.1 A	By source capacity
6	Overload current rating	150% for 60 sec, 200% for 0.5 sec	150% for 60 sec, 200% for 0.5 sec	Limited by source capacity.
7	Protection	IP 21	IP 21	To be installed away from sunlight direct falling rain. Install in an Indoor Ventilated area.
8	Enclosure Dimensions	CONTROLLER 500X500X250MM MOUNTING 550X360		DC ISOLATOR ENCLOSURE 200X200X200, MOUNTING 241X116
9	Controls	DC isolator 800 V 10A, with Blocking diode 1200V 20A. START, STOP: Push buttons. On the Front panel	3 pole MCB- accessible after front door opening. ON the Inverter Module: Run Stop, up, down, mode, Potentiometer	Manual Change over switch 3 ph Utility ON/Off by user.
10	Indications	VFD Run Trip, Utility supply R-Y-B phase indicator.	Display on the Inverter module- visible from front	Refer user manual CD of Inverter
11	Control supply	12 V DC Nominal Fed by 12 V 18/20Wp solar panel,		12 V 7Ah battery inside the control panel.

2,1 COMMON SPECIFICATIONS FOR SOLAR/AC POWER SOURCE

s/n		Item	Specification
1	Principal control Functions	Control system	PWM sinusoidal
2		Output Frequency range	0-500Hz, default 55Hz.
3		Voltage/frequency control	V/f constant, automatic torque boost, vector control, automatic energy saving, .suitable for PM motor.
4		Frequency setting signal	Pot/ external signal.
5		PWM carrier frequency	Typical 2 khz
6		PID control	
7	Operational functions	Jog run	Available
8		Retry operation	Yes. Auto re-start-after checking of main circuit elements. If Protection is activated.
9		Auto re-start	Yes. after momentary power failure.
10		Protections	Stall prevention, current limitation, over current, over voltage, under voltage.
11	Alarms and Display	Alarms	Stall prevention, over voltage, under voltage
12		LED display	Programmable to read locally, in % o/p current, voltage. torque, inverter load factor, inverter i/p power, operating frequency.

3. BRIEF SYSTEM DESCRIPTION

- i) Refer block diagram:
- ii) Refer Instructions for Operation and service:

A] Solar Operation:

Solar array receives the solar energy and generates the required voltage and power depending on the instantaneous solar insolation available at site.

Upon initiating a Start command, (day time with display ON and V_{pv} is in excess of 520 V) the Inverter starts by gradually increasing the output frequency and hence speed until the set point frequency/speed is reached.

Initially, the pump may start and stop after some time; this is possible when the actual array power is less than the losses and required power to overcome load.

Once the adequate voltage is built up the pump shall attempt to start. When the array power is sufficient to overcome the minimum losses and energy required for pumping, the pump starts and keeps running. As the day extends, the increasing solar insolation and increasing water output, operation continues.

The run operation continues through the day hours and as the solar insolation reduces in afternoon hours, the water output decreases. When the solar insolation is inadequate to overcome the losses and minimum required power for pumping the pump stops.

B] Utility power operation.

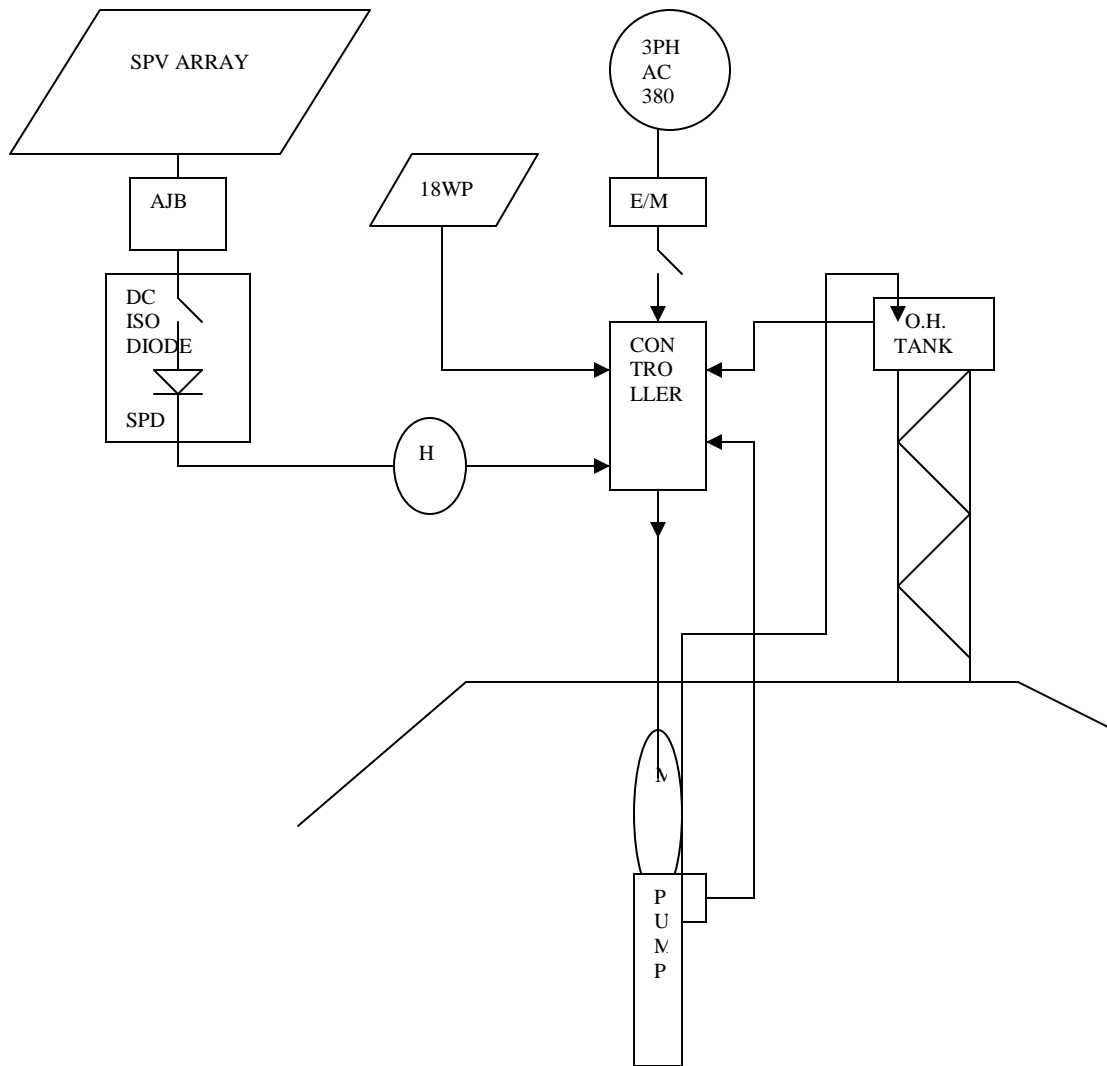
During night hours/cloudy days, when AC mains / Utility power is available, and the mode is selected the Pump is able to start on Grid supply.

After the I/P MCB is switched ON; the pump starts automatically till the power is available.

IMPORTANT: THE CONTROLLER IS NOT DESIGNED TO OPERATE AND WORK WITH BOTH SOLAR POWER AND AC MAINS/UTILITY POWER IS ON.

USER IS STRICTLY REQUIRING DTO ENSURE THAT AT A GIVEN TIME ONLY ONE OF THE TWO SOURCES IS ON

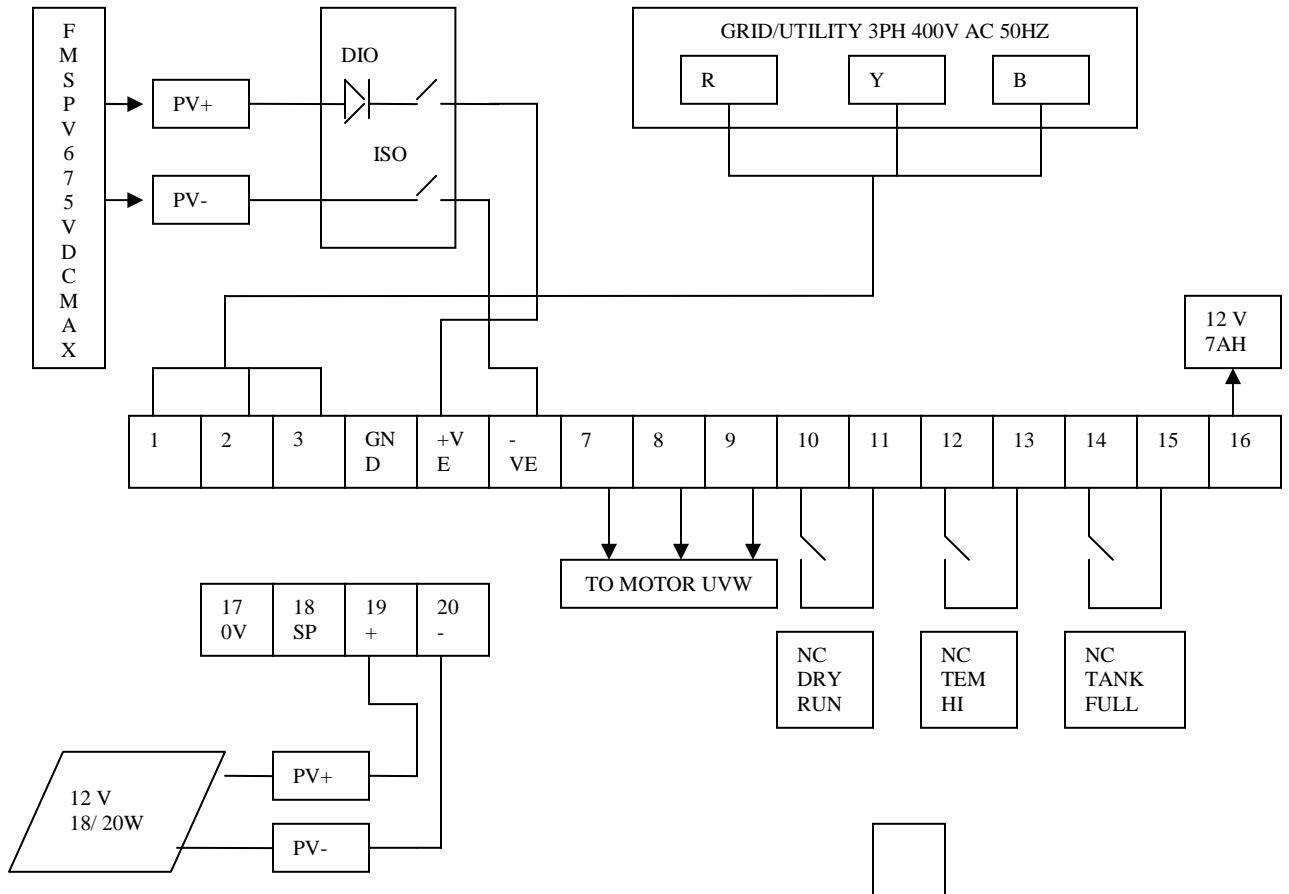
4. BLOCK DIAGRAM



Notes:

1. Array capacity shall be as per Design data.-for specified user parameters.
2. Controller Installed indoors, protected from falling water and direct sunlight.
3. Controller shall log daily kwh of Solar Array for water Pumping use.
4. When run on AC mains/utility source-local display shows DC Voltage.
5. E/M at Input of Utility source: optional by user.
6. Standard protections of Dry run and tank full can be connected to the controller.
7. Auto start and stop operation.

5. EXTERNAL WIRING AND CONNECTIONS



NOTES:

1. TB 1 TO 21 REFERS TO INSIDE TB OF CONTROL PANEL.
2. EXTERNAL 12 V 18/20WP TO BE INSTALLED FACING DUE SOUTH TILTED TO HORIZONTAL AT SITE LATITUDE.
3. MOTOR CABLE SHALL BE OF SUITABLE CROSS SECTION TO IS
4. ALL CABLES COPPER CONDUCTOR 650/1100V GRADE TO I.S.. 694
5. Rev01-09.02.12 (PV 12 V 18W panel I/P 19+, 20-) spare terminal reduced.

6. PHYSICAL INSTALATION

Installation of solar array. DC Isolator & Controller Unit.

- i) Array face must be pointed to true local south. magnetic south be considered , if locating true south is difficult at site location.-locating pole start to locate local south is advised.
- ii) Array must be tilted at an angle approx equal to site latitude. for fixed tilt arrays.
- iii) Ensure to lift bottom of the solar panel above ground to prevent submersing in water the solar panel.
- iv) Making Interconnections: Refer interconnection diagram for array connections.
- v) Install DC isolator nearest to the controller Unit. (indoor)
- vi) Install controller in indoor-away from direct sun light, protected by falling water, in a well ventilated area. Mounting height 1.5 meter above ground for easy viewing indicators.
- vii) Install 12 V 18Wp solar panel suitably near the main array. (for Controller control supply)

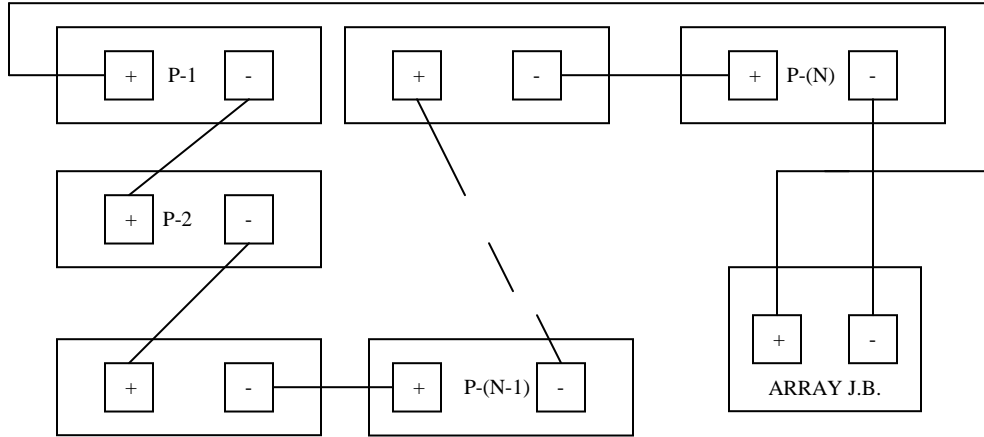
Grounding:

- i) Ground the array frames to local ground.
- ii) Ground the Controller Unit to local ground.
- iii) Install Danger plates/stickers on DC isolator & controller unit suitably.

Cable connections:

- i) Refer interconnection drawing.
- ii) Use 650/1100 V grade copper cables to IS.

7. ARRAY WIRING



Notes:

1. Shows series string connection. (Similar series Strings wiring for parallel String connections, applies) Strings in parallel are used to increase array capacity required.
2. For the total Numbers of panels-refer design work sheet
3. All wiring by 650/1100V Grade PVC outdoor type cable to IS/TUV.. as applicable.
4. Where required MC-4 compatible connectors are used.
5. Array Frame shall be grounded by 4 sq.mm Insulated copper flexible wires at least at two points. and connected to local grid.

8 CONNECTION CHECKS

s/n	Between	Condition	Expected	Remarks
1	Each array string + ve & - ve terminals	Array Open circuit	N x 32 or N x 16 DC V – (max must not exceed 720V)	36/72 cell Solar Crystalline Modules-Day time
2	String Short circuit current.-connect 0-10 Am DC ammeter across String + & - wires.	Short circuit the string-measure DC amps in series.	At least 40-60% of rated I-sc.	Depends on sunshine conditions.
3	Repeat for each of the strings installed	i) Open circuit ii) String short circuit	As above	Ac above
4	Check ground wire continuity-(PANEL FRAME.)	Visual, Multimeter	Continuity	No breaks
5	Check input electric supply	3 ph 400V 50hz	+10%-15%	Back up fuse , and switch rating to be 2x I/P Power rating
6	Auxiliary devices	Check dry run and tank full float switch	Contact closed when OK	Can check manually by dipping in and out of a small bucket with water

9. INSTRUCTIONS FOR OPERATION (PUTTING IN OPERATION)

Before start up ensure to install solar panel 12 V 18/20W , connect solar panel cables and fix terminal pins to the battery terminals.. Check Green LED glow on Charge controller.

A.1] Solar Operation: (MANUAL MODE) (ENSURE THE 3 PH 400V 50 HZ.ELECTRIC SUPPLY TO THE CONTROLLER IS OFF.)

- i) Open front door and keep Pot on the Inverter module to minimum position. Ensure that the 3 Pole MCB for AC/Grid supply is OFF. (MUST BE OFF DURING SOLAR OPERATION)
- ii) Check power wiring connections. Make Array-DC isolator ON and check LCD display on the front panel is showing the Vpv voltage, date time etc. in scroll Mode.
- ii) When Vpv is > 525 V; Press Start Push Button.(ON FRONT DOOR)
- iii) Observe LED display glow on the Inverter module.
- iv) Rotate gradually the Potentiometer on the Inverter module, to read the O/P frequency on the inverter display module.
When this is done, Vpv voltage shall fall. If the voltage falls below 520V, reduce the Potentiometer and wait till Vpv-voltage is around 520 V DC or higher
- v) Continue increasing the potentiometer till approx 30-35 hz frequency is reached.
- vi) At this setting, the water pumping is expected to start. Check the operation.
- vii) Continue increasing the frequency to 45 hz. At this set point check the Vpv voltage and after an hours check the kwh stored data appearing on the display.
- viii) Continue to increase gradually the frequency to rated frequency of 50Hz. and check pump performance. [The performance is Depending on the actual solar insolation and load demand on the Inverter (imposed by the total dynamic pumping head and the expected speed of Pump-which determines the flow rate) and may vary during an operation.]
- ix) Press STOP command. Pump shall gradually stop.
- x) After the pump has stopped, Press Start command again. and observe pump operation. If the pump stalls/ is unable to reach the set frequency/speed; then reduce the set frequency from 50 hz to a lower value say 45 Hz.
- xi) Re-check satisfactory start operation.

A.2] SOLAR OPERATION: AUTO MODE. (ENSURE THE 3 PH 400V 50 HZ.ELECTRIC SUPPLY TO THE CONTROLLER IS OFF.)

- i) After satisfactory manual operation, leave the set frequency set point to a reduced value of say 43-45 Hz. or higher value about 50 Hz.
- ii) Observe automatic start –run- stop operation the next day-when No “STOP” command was pressed in the previous day’s operation.

B] AC MAINS/UTILITY SUPPLY OPERATION. (ENSURE THE SOLAR PV DC ISOLATOR IS OFF AND PAD LOCKED)

- i) Press Stop command on Front panel and Switch DC isolator from Array to OFF position. Use lockable devices to lock the switch. in Off Position.. Open front door.
- ii) After the DC isolator is OFF, turn ON 3 pole MCB (inside the panel)to turn On AC mains supply.
- iii) Check all phase indicators are glowing.
- iv) Press Start Command to run the Pump.
- v) LED display on inverter Module starts showing frequency.

10.1 READING THE MAIN DISPLAY UNIT ON THE CONTROLLER FRONT DOOR.

The front door display is a 2 x 16 character LCD display and reads Voltage and current of the Solar PV array,

The display runs in scroll mode.

Display scroll Mode	Shows	Remarks
Vpv....., Ipv.....,	Voltage & current Solar Array	Connected array parameters
Vbat....., I load...	Voltage and discharge current of battery	When connected and configured with a suitable solar charge controller
Vsrc2....., Isrc2.....	Voltage & current second souce (when connected) such as wind/Grid rectifier Dc source	When required and configured with current sensor provided.
Total Ah Rem Ah	Total battery Ah if installed, remaining battery Ah if installed and configured	Only when battery is installed and controller is configured to read these parameters.
Kwh PV Kwh src2	Shows daily kwh energy generated by Array, and second source	Increments each hour. accumulates, day's data. (Past 30 day data can be read on the display in Manual mode.) Or can be down loaded to a Local PC via RS 232 Interface when provided and connected to a hyper terminal-
Date... time...	Date, time set values- incremented by real time clock	Set during 1 st Installation.

Buttons on this unit:

There are 2 Buttons Up, Dn.

One Disp Button. (Mode key)

One set/Enter Button (set value /enter input)

There are 04 LEDs on the controller: (active and relevant when Battery is connected and charge controller is configured.)

Green: Ch. ON

Bat Lo

Amber Ch. Disconn

Bat Lo Pre-alarm

10.2 READING THE MAIN DISPLAY UNIT ON THE VFD THROUGH THE TRANSPARENT COVER ON THE FRONT DOOR

Display readings on VFD Unit

The VFD Unit's display is behind the acrylic sheet on front door. The default reading displayed in O/P Frequency.

When the VFD is running, user can read the Various parameters on the VFD unit of the Controller.(accessed by front door opening to operate (Mode, up,dn keys on the VFD unit)

Key Operation	Shows	Remarks
Press Mode key twice	Fr - F	Direction of rotation
Pres Up key once	F....	Reads o/p frequency
Increment Up key	C...	Shows % output current
“	y...	Inverter I/P V %
“	P	Inverter O/P V %
“	q	% torque to Motor
“	c	% torque current
“	L	% load on Inverter
“	r	% over load of braking resistor
“	h	Inverter I/P Power Kw
“	H	Inverter O/P Power kw
“	o	Operating Frequency

Notes: Only most common required values are displayed. (Refer complete manual, CD document)

Note:

The status of the Control supply status derived from a 12 V 20W solar panel-is displayed by 3 LEDES just above the VFD Unit.

Green: Charge ON.. Normal operation in day time. Check panel polarity connections-if this light does not glow in day time

Red: Battery low..When glowing means the supply at L1+L2- is cut off. User must take action to resore this supply. Check if green LED glows in day time.

Clean the small solar panel.

Check the battery voltage is rising.

Red light is reset/off when Battery voltage recovers above 12.8 V +/- 0.2V

Amber: Battery over charge disconnect. Usually amber and Green LEDs turn on alternately. This is normal operation in day time when the control supply battery is fully charged.

11. DO's & DON'T's

DO'S

- 1. Ensure the panel surface is clean**
- 2. Ensure panels are facing due local south in a shadow free area.**
- 3. Ensure the connection checks are performed and found OK.**
- 4. Ensure all electric input power supply voltages and power are in specified limits.**
- 5. Ensure Pump is installed correctly and all protecting devices such as dry run switch, Tank full etc are working.**
- 6. Ensure to follow instruction for putting in operation.**
- 7. Ensure all safety instructions are followed and danger boards are in place and Grounding is connected.**
- 8. Ensure DC isolator is padlocked in Off condition when powering the controller with 3 ph electric power. (Keeping both solar Array power ON and AC electric supply ON "SIMLAUTANEOUSLY" can cause over voltages to the system and can cause controller mal function.**

DONT'S

- 1. Allow shadowing on solar panels. Shadow can cause virtual open circuit of electrical continuity and can result in loss of power from solar array.**
- 2. Don't run the Pump with water with foreign objects that can clog the Pump and over load the Motor .**
- 3. Don't touch live parts in the controller Unit with door open. Dangerous working voltages are present during operation.**
- 4. Don't open front door unless a trained experienced person is present and when the controller is working.**

12. ROUTINE MAINTENANCE INSTRUCTIONS

- 1. Visually inspect panel face for bird droppings, excessive dust/suit other foreign objects on the panel surface. A dirty panel surface prevents available solar radiation from reaching the cell surface below glass that can drastically cause reduction in power.**
- 2. Periodically clean panel surface by soft cloth and water.**
- 3. Periodically inspect panel surface for any hot spots.**
- 4. Periodically inspect array junction box, cable terminations for any discoloration due to overheat by loose connections.**

13. HOW TO REPORT FAILURE

- 1. Note and write down the date of receipt of Material.**
- 2. Note and write down the date of installation.**
- 3. Note and write down the Sl. No. of controller, Array capacity, Number of panels, their rating.**
- 4. Keep the below mentioned data at hand before you make a call/raise a call.**
 - 4.1. Array V, Array /String's short circuit current.**
 - 4.2 Indications present on:
Front panel display Unit.
Indicators on the front door.
Indicators through the front door transparent cover-VFD display**
 - 4.3 Pump is running but tripping soon after starting?**
 - 4.4 Pump unable to start.**
 - 4.5 Red LED (Bat-lo) glowing behind the transparent cover? Note which of the LEDs glowing [GREEN AMBER RED]**
- 5. Raise a call on e-mail giving the above information.**

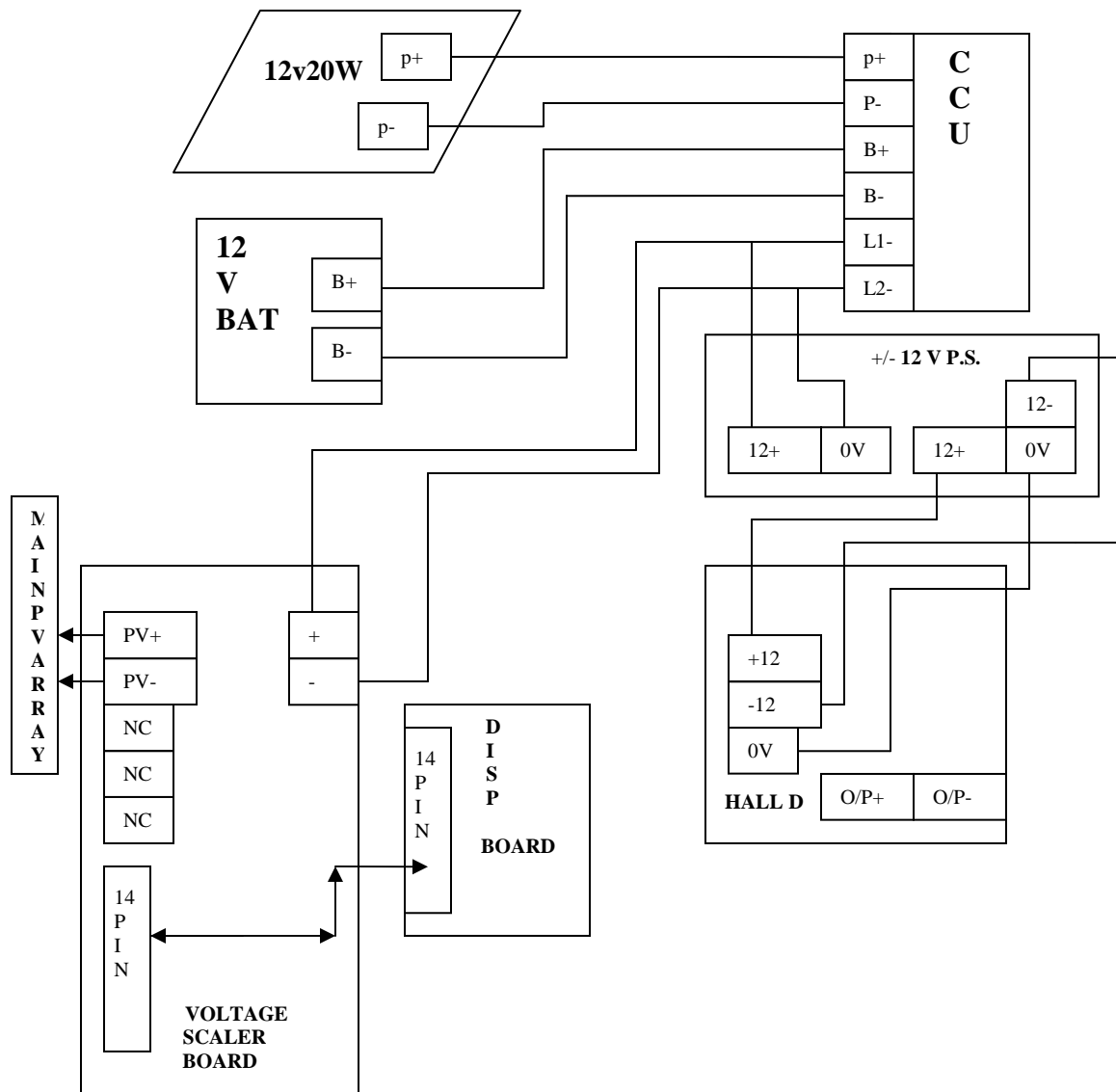
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14. Internal Wiring Interconnection Drawing for PCBS for Solar Hybrid Pump Controller



Notes:

1. For Interconnections in control panel-refer drawing.
2. Hall device Mounting for current direction shown on PCB
3. Observe Polarity while making connections.