

# Solar Pumps

## User Manual



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**TheSunPays**  
co.za



# WARNING

The controller will be burned out when the open circuit voltage is higher than our settings.

Controller and Pump Matching						
Controller Model	Pump Model	Max Input Current (A)	Max Open Circuit Voltage (V)	MPPT Voltage Range (V)	Working Temperature (°C)	
DF-12	Rated 12V Pump	15	<50	30 to 48	-15 to 60	
DF-24	Rated 24V Pump	15	<50	30 to 48	15 to 60	
DF-36	Rated 36V Pump	15	<50	30 to 48	15 to 60	
DF-48	Rated 48V Pump	15	<100	60 to 90	15 to 60	
DF-72	Rated 72V Pump	15	<150	90 to 120	15 to 60	
DF-110	Rated 110V Pump	15	<200	110 to 150	15 to 60	
DF-220	Rated 220V Pump		<450	300 to 400	15 to 60	
DF-380	Rated 380V Pump		<800	480 to 750	15 to 60	

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## 2. 12V to 110V DC pumps

### 2.1. Solar Panels information

Solar panels can be divided into 3 categories mono-crystalline silicon solar cell, poly-crystalline silicon solar cell and thin-film photocell. Mono-crystalline is the most efficient one but are priced the highest; the thin-film photocell is priced the lowest. Normally, the power of a solar cell is 150W per square meter.

The open-circuit voltage ( $V_{oc}$ ) marked on a solar cell means the max electromotive force before it starts working. The voltage will then decrease when it starts working; this is called its working voltage ( $V_{mp}$ ).

Common open-circuit voltage is 21 V, 36V, 44V etc., this however is subject to area and temperature changes, the lower the temperature, the higher the voltage. Another important index is power. It is proportional to the panel area. There needs to be some solar cells to connect in series if the voltage is not enough, total voltage equals to adding each panel's voltage.

The working voltage of solar cells needs to be selected according to the controller's working voltage, and then the open-circuit voltage of solar panel needs to be confirmed. After the voltage has been confirmed, the solar power can then be selected according to the pump power. The power of the solar water pump can then be seen as the input power and the generating efficiency of solar panel is usually under 70%. To ensure the rated working time of 4 hours a day, the solar panel power equals to input power multiply by 1.5 which is also the minimum power. If the solar panel power is smaller than this value, the pump cannot reach its rated flow and head even though it can still work normally. Using more panels for the pump is better if the condition permits it, because the pump is then granted more running time and enables it to reach the rated flow and head.

## 2.2. Controller layout



1. Name plate & information
2. Operating panel
3. DC cable input port
4. Water level switch input port
5. Pump cable port
6. Earth wire (for 4-core submersible cables)

### 2.3. Solar Panel Configurations for 24V to 110V DC pumps

Controller model	Pump Model	Panel Configuration
24V	PUSC56 56m	1x 330W in series 1x 300W in series 1x 280W in series
36V	PUSC77 77m	1x 330W in series 1x 300W in series, 2x in parallel (i.e. 2 panels) 1x 280W in series, 2x in parallel (i.e. 2 panels)
48V	PUBO40 40m	2x 330W in series
	PUBO47 47m	2x 300W in series, 2x in parallel (i.e. 4 panels) 2x 280W in series, 2x in parallel (i.e. 4 panels)
	PUBO78 78m	2x 330W in series, 2x in parallel (i.e. 4 panels) 2x 300W in series, 2x in parallel (i.e. 4 panels) 2x 280W in series, 3x in parallel (i.e. 6 panels)
	PUSC10 110m	2x 330W in series, 2x in parallel (i.e. 4 panels) 2x 300W in series, 2x in parallel (i.e. 4 panels) 2x 280W in series, 2x in parallel (i.e. 4 panels)
72V	PUBO95 95m	2x 330W in series, 2x in parallel (i.e. 4 panels) 2x 300W in series, 2x in parallel (i.e. 4 panels) 2x 280W in series, 3x in parallel (i.e. 6 panels)
	PUBO120 120m	2x 330W in series, 3x in parallel (i.e. 6 panels) 2x 300W in series, 3x in parallel (i.e. 6 panels) 2x 280W in series, 3x in parallel (i.e. 6 panels)
110V	PUBO123 123m	3x 330W in series, 2x in parallel (i.e. 6 panels) 3x 300W in series, 2x in parallel (i.e. 6 panels) 3x 280W in series, 2x in parallel (i.e. 6 panels)
	PUBO140 140m	3x 330W in series, 3x in parallel (i.e. 9 panels) 3x 300W in series, 3x in parallel (i.e. 9 panels) 3x 280W in series, 3x in parallel (i.e. 9 panels)
	PUBO203 203m	3x 330W in series, 3x in parallel (i.e. 9 panels) 3x 300W in series, 3x in parallel (i.e. 9 panels) 3x 280W in series, 3x in parallel (i.e. 9 panels)

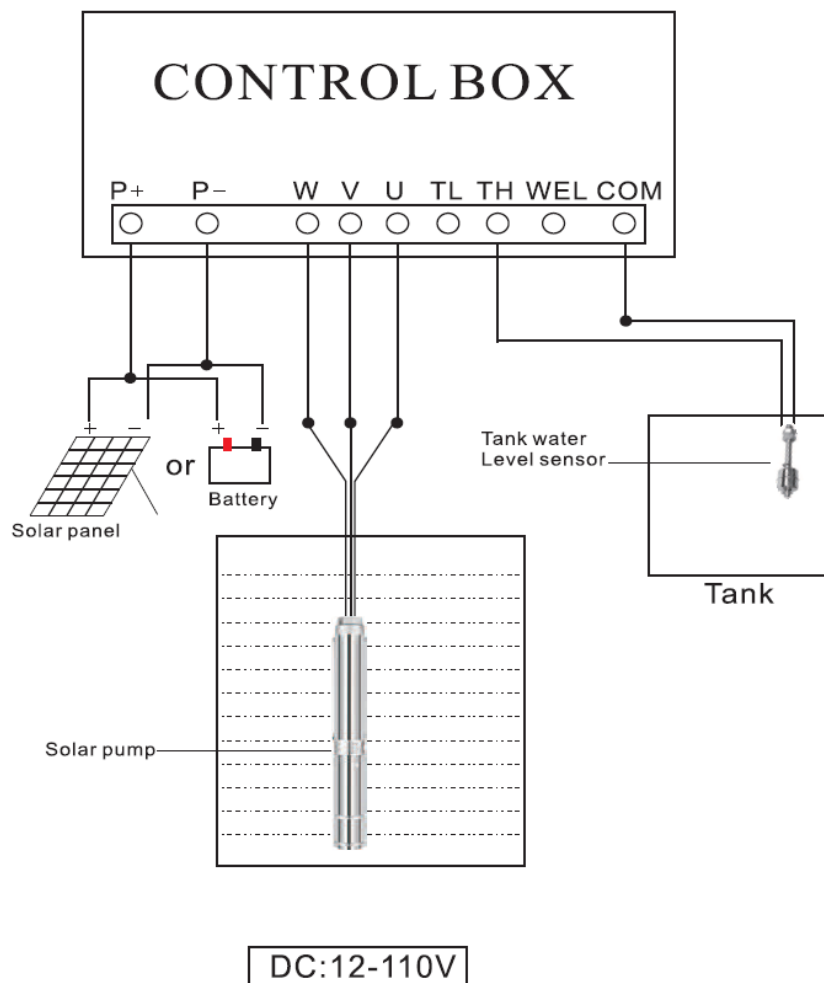
The above panel configurations are based on the 330W, 300W and 280W *The Sun Pays* solar panels. If other panels are used, please consider the following:

- Panels in series: voltages are added
- Panels in parallel: power is added
- Ensure the total Voc is below the controller max voltage
- Ensure the total Vmp is below the controller max voltage
- Ensure the total Voc is above the controller min voltage
- Ensure the total Vmp is above the controller min voltage
- Ensure the total power is more than the pump rated motor power. Ideally, about 20% to 40% more.

**WARNING:** Before connecting the solar panel wires to the controller, ensure that the voltage is not exceeded for the controller. Exceeding the maximum voltage can cause permanent damage to the controller.

## 2.4. Installation and wiring

- Set up the solar panel array as per section 2.3.
- Ensure the controller box switch is off.
- Using the wiring diagram below, connect the wires for the tank level sensor (if required)
- Connect the pump wires correctly taking care of the color coding. If the pump motor runs in the reverse direction, swop two of the three motor wires.
- For 4-core submersible cables, connect the earth wire to the connection point "PE".
- Connect the solar array wires taking care not to short the wires. Good solar installation practice is to have a circuit breaker, fuse or trip switch on these wires. Check that the polarity is correct (positive solar wire to the "P+" terminal, negative solar wire to the "P-" terminal).
- Ensure the pump is placed in the borehole/water service before starting on the pump.
- For swimming pool pumps, fill the pump with water before connecting the pipes and switching on.



## 2.5. Cable sizes

To ensure proper operation of a solar pump, the cable sizes for the solar array and the pump power cables should be properly chosen. The voltage drop is much higher for low DC voltages than a typical 230V AC power supply.

**For solar arrays:** A 6mm<sup>2</sup> cable will be sufficient for majority of setups where the total distance between the control box and solar array is less than 30m. For distances above 30m, please contact us for a specific solution.

**For submersible cables:** Depending on the pump type, the submersible cable will either be 3-core (screw pumps) or 4-core (centrifugal pumps). Please select the cable thickness from the table below. The cable length should consist of the depth at which the pump is located PLUS the distance from the borehole to the control box. The cable length will therefore determine what minimum thickness of cable is required to operate the pump at its rated conditions.

				Cable size in mm <sup>2</sup>										
Cable length (m)				20m	40m	60m	80m	100m	120m	140m	160m	180m	200m	220m
Pump Model	Controller (V)	Power (W)	Cable Type											
Screw Pumps														
PUSC56 (56m)	24	120	3-Core	2.5	4	6	10	10	16	16	16	16	25	25
PUSC77 (77m)	36	210	3-Core	4	10	10	16	16	25	25	25	35	35	35
PUSC10 (110m)	48	500	3-Core	2.5	4	6	10	10	10	16	16	16	25	25
Centrifugal Pumps														
PUBO40 (40m)	48	400	4-core	2.5	4	4	6	10	10	10	16	16	16	16
PUBO47 (47m)	48	400	4-core	2.5	4	4	6	10	10	10	16	16	16	16
PUBO78 (78m)	48	750	4-core	2.5	6	10	10	16	16	25	25	25	25	35
PUIN (90m)	550	3000	4-core	2.5	2.5	4	4	4	4	4	4	4	4	4
PUBO95 (95m)	72	750	4-core	2.5	2.5	4	6	6	10	10	10	10	16	16
PUBO120 (120m)	72	1100	4-core	2.5	4	6	10	10	10	16	16	16	25	25
PUBO123 (123m)	110	1100	4-core	2.5	2.5	4	4	6	6	10	10	10	10	10
PUBO140 (140m)	110	1500	4-core	2.5	2.5	4	6	10	10	10	10	16	16	16
PUIM203 (203m)	110	1500	4-core	2.5	2.5	4	6	10	10	10	10	16	16	16
				= Recommended minimum size				= Less performance				= Consult with electrician		

= Recommended minimum size

= Less performance

= Consult with electrician

### Example:

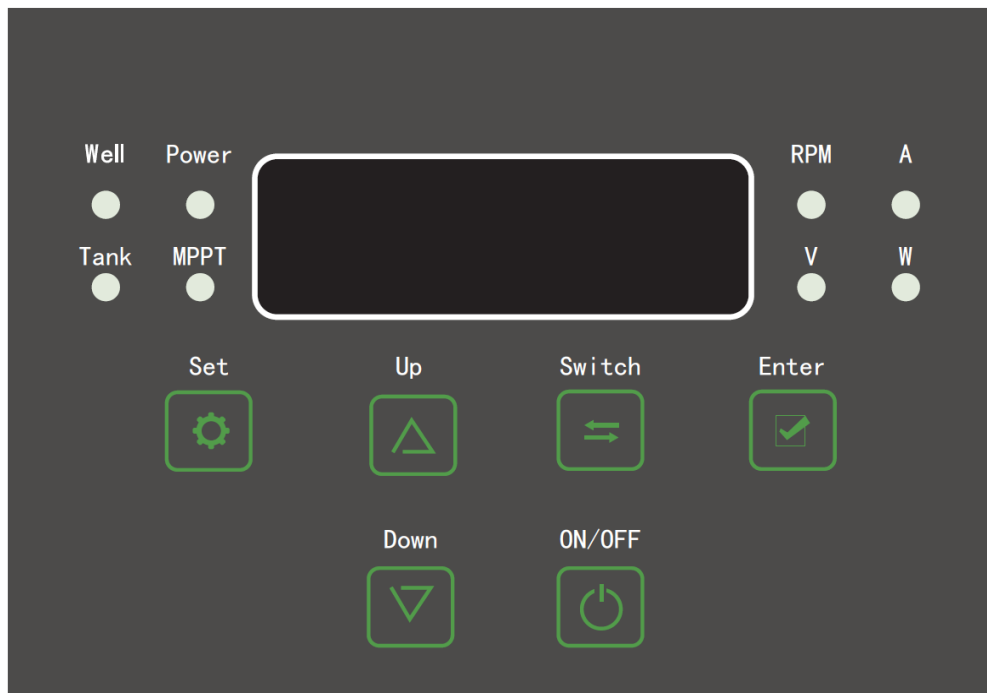
*PUBO78 pump located at a depth of 38m with the control box 12m away from the borehole.*

*Cable length = 48 + 12 = 60m*

*From the table, a 6mm<sup>2</sup> 4 core cable is required.*






## 2.6. Operating Panel






### LED lights:

- **Well:** Water in borehole is low. Pump dry run protection active.
- **Power:** Power indication, control box receives power.
- **Tank:** Water level in tank is reached
- **MPPT:** Solar MPPT controller is active
- **RPM:** Motor speed display mode selected. Indication in RPM.
- **A:** Motor current display mode selected. Indication in Amps.
- **V:** Motor voltage display mode selected. Indication in Volts.
- **W:** Motor power display mode selected. Indication in Watts.

### Keys:

Key	Function
Set 	Set Key – To change settings on the controller.
Enter 	Enter Key – To store setting values.
Up 	Up Key – To increase the pump RPM value.  In a fault state, the up key toggles the fault code.

Key	Function
Down 	Down Key – To decrease the pump RPM value.
Switch 	Switch Key – Change the display mode between Voltage / Speed / Current / Power
ON/OFF 	Power Key – Switch the control box/pump ON/OFF

## 2.7. Commissioning the pump

When the pump, control box, solar array and all wires is properly connected and checked, the system can be commissioned as follows:

- Ensure the control box is switched off.
- Lower the pump into the borehole with the ski-rope & pipe. Do not put tension on the submersible cable.
- Ensure the pump is placed in the borehole below the water level. The pump bearings need to be wetted for at least 15 minutes to properly lubricate it. For swimming pool pumps, ensure the pump is primed by adding water to the casing. DO NOT START A PUMP WHEN IT IS DRY. IT WILL CAUSE PERMANENT DAMAGE.
- Switch on the control box by pressing the power key.
- The controller will switch on and start the pump at low speed and ramp it up to the maximum speed that can be achieved with the solar array.
- If a level switch is installed on a tank, confirm that the level switch triggers the control box to stop the pump when the level switch is activated. Activate the level switch by manually lifting it by hand.
- Confirm that the pump can continuously run and supply water for at least 5 minutes.

## 2.8. Pump protection modes

### **Pump dry run protection:**

- The control box will monitor the absorbed power by the pump and compare it to a pre-set value for a given pump speed.
- If the absorbed power is less than the set value for more than 20s, the controller will switch off the pump and display fault code P48.
- The controller will wait for 30 minutes and then clear the fault code.

### **Power source protection (Battery mode):**

- When the controller is switched on, it will determine if batteries is connected (instead of solar panels).
- If battery mode is active, the default pump speed will be 4000 RPM. It can be adjusted if required between 1000 RPM and 4000 RPM.
- As power is drawn from the batteries, the supply voltage will start to drop. To protect the battery, the pump will be switched off if the battery voltage drops below the following values:

<b>Controller Model</b>	<b>Protection Voltage (V)</b>
DF-12	20
DF-24	20
DF-36	20
DF-48	40
DF-72	60
DF-110	80

### **Power source protection (PV mode):**

- When the controller is switched on, it will determine if solar panels is connected (instead of batteries).
- If PV mode is active, the maximum pump speed will be 4000 RPM.
- The pump speed will be determined by the MPPT controller which will track the maximum power available from the solar array.
- If the solar power decrease, the controller will ramp down the pump speed.
- When the pump speed drops to below 600 RPM, the controller will switch of the pump and report fault code P46.
- The controller will monitor the solar array voltage. When the pump is started, it will determine the drop is voltage. If the voltage drop is more than the set value and is active for 10 s, the controller will report fault code PL.
- The controller will retry 5 times to restart the pump after fault code PL was received. After the 5<sup>th</sup> attempt, it will pause for 30 minutes.

**Reverse polarity protection:**

- If the power supply terminals are incorrect, the controller will continuously display an alarm.

## 2.9. Service and Maintenance

The service interval for the pumps is every 3000 hours run time. The wetted parts will need to be checked and the following items replaced:

- Bearings
- Mechanical seal
- Seal ring

Check list:

- Check that the electrical connections is still fine and not corroded.
- If possible, measure the resistance between all the 3 wires. It should all be the same.
- Check the submersible cable epoxy connection
- Check the integrity of the ski rope and tension.
- Confirm that the pipe is still properly connected to the pump discharge
- Check for dirt, leaved or plastic bags at the pump inlet strainer (in the middle of the pump, metal mesh section).

If the pump will not be used for an extended time, clean it properly with a soft cloth and mild soap water. Let it dry properly and store it in a dry, ventilated area.

## 2.10. Troubleshooting

Fault Code	Description	Potential Cause and Solutions	Recovery Procedure
P0	Hardware Over Current	<ul style="list-style-type: none"> <li>- Incorrect electrical motor for pump controller.</li> <li>- UVW three-phase short circuit. Check wiring of motor cable.</li> </ul>	Automatic reset after 30 s.
P43	Phase Protection	UVW three-phase open circuit detected. Check wiring and continuity.	Automatic reset after 30 s.
P46	Stall Protection	<ul style="list-style-type: none"> <li>- Incorrect electrical motor for pump controller.</li> <li>- Submersible cable resistance too high. Choose proper cable thickness or reduce cable length.</li> <li>- Not enough power from the source (solar panels or battery). Increase the power capacity.</li> <li>- Pump bearing is seized or dirty.</li> </ul>	Automatic reset after 30 s.
P49	Software Over Current	<ul style="list-style-type: none"> <li>- UVW three-phase short circuit. Check wiring of motor cable.</li> <li>- Pump bearing is seized or dirty.</li> </ul>	Automatic reset after 30 s.
P50	Low Voltage Protection	Input voltage too low. Confirm proper power supply for the pump and controller is within operating range.	Voltage in normal range.
P51	High Voltage Protection	Input voltage too high. Confirm the power supply for the pump and controller is within operating range.	Voltage in normal range.
P48	Dry Run Protection	<ul style="list-style-type: none"> <li>- Possible air pockets. Restart the pump.</li> <li>- Borehole level is below pump. Wait for water level to rise again.</li> </ul>	Automatic reset after 30 minutes.
P60	High Temperature Protection	The MCU temperature in the controller is above 90°C.	Automatic reset if temperature is below 90°C on MCU.
E8	Current Sampling Failure	Isolate the power source to the controller. Wait 30 seconds before re-connecting power to the controller.	Switch controller on after power source cycle.
PL	Low Power from supply	<ul style="list-style-type: none"> <li>- PV mode: No sunlight. Wait for sufficient sunlight.</li> <li>- Battery mode: Charge battery</li> <li>- Check power source to be within operating range.</li> </ul>	Automatic reset for 5 times, 30 second intervals. Thereafter, pause for 30 minutes.
ALARM	Reverse polarity protection	Change the positive and negative wires on the power supply.	Restart the controller.

### 3. 220V – 380V AC / 300V – 550V DC pumps

The AC / DC pump controller allows the user to use either AC or DC power supply. When using the pump and controller, only one power source must be active. Either AC or DC. Not both at the same time. Circuit breakers should be used to isolate the AC and DC supply from the controller to allow only one of the two to be operational.

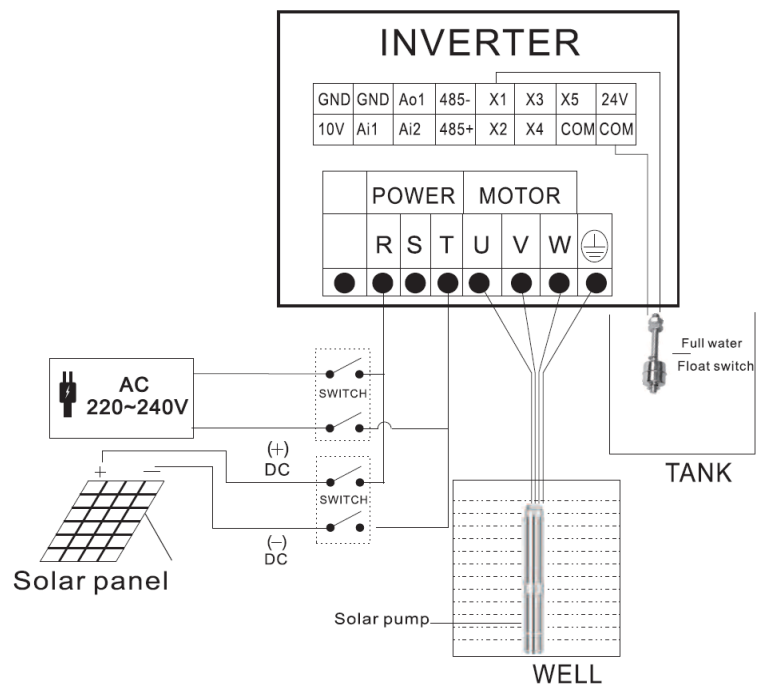
**WARNING: Only one source can be used at a time. If both AC and DC is connected, the controller and solar panels will be damaged.**

#### 3.1. Controller Layout

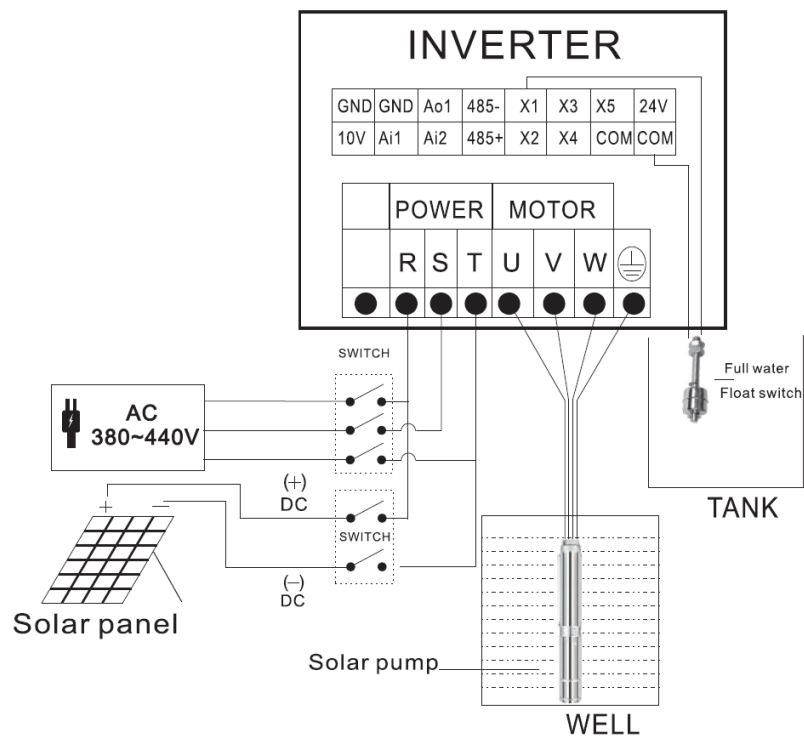


1. Name plate & information
2. Operating panel
3. AC and DC cable input port
4. Water level switch input port
5. Pump cable port

### 3.2. Wiring Diagram for 220 V AC / 300 V DC pump



### 3.3. Wiring Diagram for 380 V AC / 550 V DC pump



### 3.4. Solar Panel Configurations

- 14x 330W in series or
- 16x 300W in series.

The above panel configurations are based on the 330W and 300W *The Sun Pays* solar panels. If other panels are used, please consider the following:

- Panels in series: voltages are added
- Panels in parallel: power is added
- Ensure the total Voc is below the controller max voltage
- Ensure the total Vmp is below the controller max voltage
- Ensure the total Voc is above the controller min voltage
- Ensure the total Vmp is above the controller min voltage
- Ensure the total power is more than the pump rated motor power. Ideally, about 20% to 40% more.

**WARNING:** Before connecting the solar panel wires to the controller, ensure that the voltage is not exceeded for the controller. Exceeding the maximum voltage can cause permanent damage to the controller.