Novaplus

User Manual

Solar Pumping Controller

RPS Series

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Safety Information

⚠ NOTICE

Important information for installers of this equipment!

This equipment is intended for installation by technically qualified personnel. Failure to install it in compliance with national and local electrical codes,and within manufacturer recommendations, may result in electrical shock or fire hazard, unsatisfactory performance, and equipment failure.

The installation information is available from pump manufacturers and distributors, and directly from the solar pump controller manufacturers.

⚠ WARNING

Serious or fatal electrical shock may result from failure to connect the motor,control enclosures, metal plumbing, and all other metal near the motor or cable to a proper earth ground in accordance with local codes, using wire no smaller than motor cable wires. To reduce risk of electrical shock, disconnect power before working on or around the water system. Do not use motor in swimming areas.

⚠ WARNING

High voltages (both AC and DC) capable of causing severe injury or death by electrical shock are present in this unit. More than one disconnect switch may be required to de-energize the equipment before servicing. This unit should only be installed or serviced by technically qualified professionals.

Anytime working on or near the solar pump controller, or system:

• Turn OFF the external DC rated disconnect from the solar array to the solar pump controller.

• Ensure AC power has been disconnected from the solar pump controller (if used).

• Wait a minimum of 5 minutes after removing power from the solar pump controller before servicing.

⚠ WARNING

Solar panels that have been exposed to full solar insolation for an extended period of time can achieve high temperatures and could be a potential source of burns to exposed skin if contacted. Use caution when working around solar arrays.

1. How it Works

1.1 General Introduction

The solar pumping system serves to provide water in remote applications where electrical grid power is either unreliable or unavailable. The system pumps water using a high-voltage DC power source such as an photovoltaic array of solar panels(Which is abbreviated as solar array in this manual). Since the sun is only available during certain hours of a day and only in good weather conditions, the water is generally pumped into a storage pool or tank for further usage, and water sources are those natural or special such as river, lake, well or waterway, etc. Two level switches, one is High Level Switch, the other is Low Level Switch, should be installed inside the pool or tank to regulate the water level. If the water comes from a well, another two level switches should be installed inside the well. The Low Level Switch of the well serves as an indication that the well has run dry. The system will shut down to protect the pump and motor until the well has recovered as the High Level Switch are reached by water. Figure 1 shows a typical diagram of the solar pumping system. The major parts and components in the system are listed after the diagram.

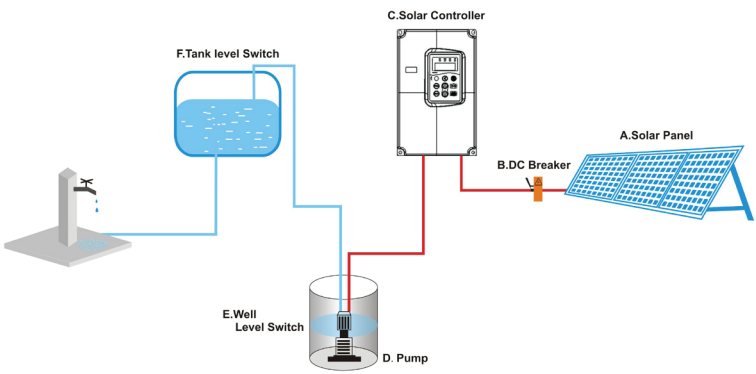

Figure 1 solar pumping system

To be part of a water supply, the solar pumping system is designed which consists of:

A. Solar Array

B. DC Breaker or Disconnect Switch

C. Solar Pump Controller

D. Pump and Motor

E. Water Source Level Switches (optional)

F. Tank Level Switches (optional)

The solar pump controller runs at variable speed to match the changing power available from the solar array. Variable speed operation means there is no in-rush or surge of energy during the pump/motor start-up, helping to eliminate wear on the motor and pumping system. A leading cause of pump motor failure is the stress applied to the motor during a full voltage start-up. The solar variable speed operation ramps up the speed smoothly, which eliminates starting stress. This feature enhances long-term motor reliability.

1.2 Pump Check Valve Requirements

In order to ensure maximum system reliability and water delivery, check valves must be installed in the drop pipe. The first check valve must be installed at the pump and additional check valves should be installed every 30m (100 ft) of vertical pipe after the pump. See the pump owner's manual for additional information.

1.3 Features

System Diagnostics

The solar pump controller continuously monitors system performance and can detect a variety of abnormal conditions. In many cases, the controller will compensate as needed to maintain continuous system operation; however, if there is high risk of equipment damage, the controller will protect the system and display the fault code. If possible, the controller will try to restart itself when the fault condition subsides. See Diagnostics and Troubleshooting section for a list of Fault Codes and corrective actions.

Motor Soft-Start

Normally, when there is a demand for water and power, the solar pump controller will be operating. Whenever the solar pump controller detects a need for water, the controller always “ramps up” the motor speed while gradually increasing motor voltage, resulting in a cooler motor and lower start-up current compared to conventional water systems. In cases where the demand for water is low, the system may cycle on and off. Due to the controller’s soft-start feature this will not harm the motor.

Over Temperature Foldback

The solar pump controller is designed for full power operation from a solar array in ambient temperatures up to 60 °C. Under extreme thermal conditions, the controller will reduce output power in an attempt to avoid shutdown. Full pump output is restored when the controller temperature cools to a safe level.

Level Control Switch

Up to four level control switches can be wired into the solar pump controller for water level control. This is optional and is not very necessarily required to run the solar pump controller. The solar pump controller can be used with one to four control switches, or none at all. This provides the user maximum adjustability when using the solar pump controller. See INSTALLATION section for more information on installing and using control switches.

Switching to Backup AC Power

The solar pump controller’s input power terminal may be switched manually to a backup AC power source. If there is sufficient voltage measured from the primary source (solar array), the controller draws from it to run the pump. The solar pump controller can be manually switched to the alternate backup supply input if:

• The solar array input cannot provide at least 180 VDC(220VAC motor output) or 350VDC (380VAC motor output) to successfully start the motor; AND

• Generator backup power is available at the AC backup terminals.

Note: Depending on the model number, solar pump controllers support power input either 220VAC single phase, or 380VAC three phase, Please contact the authorized agencies for details.

When the system is running on back-up AC power, please check for sufficient DC primary source power every 30 minutes. If the primary DC power is available, shut down the controller, switch back to primary power and attempt to run on DC power supply.

⚠ NOTICE
A DC circuit switch and a generator power switch must be installed, and these two switches must be mechanically interlocked each other to prevent switching on together resulting the solar PV and the generator being connected to the solar pump controller simultaneously! Please check if the design is in accordance with all applicable national and local electrical codes.

2. Solar Pump Controller General Information

The solar pump controller is a variable speed motor drive designed to run any IEC three-phase asynchronous motor. The solar pumping system provides water to remote locations by converting high voltage, direct current from a solar array into alternating current to run a standard three-phase asynchronous motor. When solar power is not available, the controller can be switched manually to an alternate single-phase or three-phase AC input such as a generator or inverter from battery, if available. The controller provides fault detection, motor soft start, and speed control. The solar pump controller is designed to provide these features with the plug and play ease of installation.

The solar pump controller is designed with the high standard of reliability. The controller attempts to drive the pump and motor to deliver water even under adverse conditions, reducing output as necessary to protect the system components from damage, and only shutting down in extreme cases. Full operation is restored automatically whenever abnormal conditions subside.

2.1 Inspection

Before you begin, receive and inspect the solar pump controller unit. Verify that the part number is correct and that no damage has occurred during transportation.

Note: solar pump controller is one component of the solar pumping system which has other two optional components, solar array and AC pump with motor.

2.2 Descriptions and Features

The solar pump controller is based on a standard platform controlling a standard three-phase asynchronous motor driving a pump powered by a solar array or an optional AC generator backup.

The solar pump controller continuously monitors system performance and incorporates a number of features for pumping system protection. In the event of a fault, the solar pump controller will indicate the type of fault through the LED display mounted on the front cover of controller.

The solar pumping system is optimized for pumping under adverse input power conditions unique to solar arrays.

• Internal diagnostics will tolerate a lower input voltage.

• Whenever possible, the controller attempts to drive the pump load by maximizing power output from the solar array.

An easy–to–use interface is provided to enhance configurability and enable remote system monitoring.

• A LED display provides a detailed indication of system status.

• A small keypad offers flexibility for selection of user options.

2.3 Protection Features

Electronic monitoring gives the controller the capability to monitor the system and automatically shut down in the event of:

• Dry well conditions – with low level switch

• Bound pump – with auto-reversing torque

• High Voltage Surge

• Low Input Voltage

• Open motor circuit

• Short circuit

• Over heat

NOTE: This controller provides motor overload protection by preventing motor current from exceeding rating current and by limiting the duty cycle in the event of low water level. This controller does not provide over temperature sensing of the motor.

2.4 Solar Pump Controller Model Description

RPC 10 - 4 T 5 R 5
① ② ③ ④ ⑤

Segment	Desctription	Options
①	RPC series	Renesola SolarPump Controller series
②	Series ID+Version	10:Standard type ID, Basic version
③	Motor Voltage Rating	2:220VAC 3 phase; 4:380VAC 3 phase
④	Solar Panel Voltage range	S: 310VDC rating, MPPT range 280VDC-360VDC(Note 1) T: 540VDC rating, MPPT range 500VDC-600VDC(Note 2)
⑤	Motor Power Rating	004:4kW; 5R5:5.5kW; R: decimal point
Note 1: Supporting Alternating Current input, with voltage rating of 220VAC single phase connecting to terminal R&T. Note 2: Supporting Alternating Current input, with voltage rating of 380VAC three phase connecting to terminal R, S and T.		

Table 1 Solar Pump Controller Model Description

2.5 Solar Pump Controller Specifications

Controller Model	RPC10-2SR75	RPC10-2S1R5	RPC10-2S2R2
Input Data			
PV Source			
Max Input Voltage(Voc)[V]	450V		
Min Input Voltage, at mpp[V]	180V		
Recommended voltage, at mppt	280VDC~360VDC		
Max Amps Input[A]	4.3	8.6	12.5
Recommended Max Power at mppt[kW]	1.2	2.4	3.5
Alternate AC Generator			
Input voltage	220/230/240V AC(±15%), Single Phase		
Max Amps(RMS)[A]	8.2	14.0	23.0
Power and VA capability[kVA]	2.0	5.0	7.5
Output Data			
Output Power,rated[kW]	0.75	1.5	2.2
Output Voltage, rated	220/230/240V AC, Three Phase		
Max Amps(RMS)[A]	4.5	7.0	10
Output Frequency	0-50Hz/60Hz		
Protection			
Surge protection	Integrated		
Overvoltage protection	Integrated		
Undervoltage protection	Integrated		
Locked pump protection	Integrated		
Open circuit protection	Integrated		
Short circuit protection	Integrated		
Overheated protection	Integrated		
Dry run protection	Integrated		
General Data			
Ambient Temperature Range	-20°C~60°C; >45°C, Derating as required		
Cooling Method	Fan Cooling		
Ambient Humidity	≤ 95%RH		
Dimensions(H*W*D)[mm]	151.7*101*126.8		
Gross Weight[kg]	1.4		
Standard Warranty[month]	18		
Certificates	IEC/EN 61800-5-1,IEC/EN 61800-2:2004, IEC/EN 61800-3:2004,CE		

Table 2.1 Solar Pump Controller 0.75-2.2kW 220VAC 3 phase output Specifications

Controller Model	RPC10-4TR75	RPC10-4T1R5	RPC10-4T2R2
Input Data			
PV Source			
Max Input Voltage(Voc)[V]	750V		
Min Input Voltage, at mpp[V]	350V		
Recommended voltage, at mpp	500VDC~600VDC		
Max Amps Input[A]	2.4	4.8	7.0
Recommended Max Power at mpp[kW]	1.2	2.4	3.5
Alternate AC Generator			
Input voltage	380V AC(±15%), Three Phase		
Max Amps(RMS)[A]	3.4	5.0	5.8
Power and VA capability[kVA]	2.2	3.3	5.0
Output Data			
Output Power,rated[kW]	0.75	1.5	2.2
Output Voltage, rated	380V AC , Three Phase		
Max Amps(RMS)[A]	2.5	3.7	5.0
Output Frequency	0-50Hz/60Hz		
Protection			
Surge protection	Integrated		
Overvoltage protection	Integrated		
Undervoltage protection	Integrated		
Locked pump protection	Integrated		
Open circuit protection	Integrated		
Short circuit protection	Integrated		
Overheated protection	Integrated		
Dry run protection	Integrated		
General Data			
Ambient Temperature Range	-20°C~60°C; >45°C, Derating as required		
Cooling Method	Fan Cooling		
Ambient Humidity	≤ 95%RH		
Dimensions(H*W*D)[mm]	151.7*101*126.8		
Gross Weight[kg]	1.4	1.4	1.5
Standard Warranty[month]	18		
Certificates	IEC/EN 61800-5-1,IEC/EN 61800-2:2004, IEC/EN 61800-3:2004,CE		

Table 2.2 Solar Pump Controller 0.75-2.2kW 380VAC 3 phase output Specifications

Controller Model	RPC10-4T004	RPC10-4T5R5	RPC10-4T7R5
Input Data			
PV Source			
Max Input Voltage(Voc)[V]	750V		
Min Input Voltage, at mpp[V]	350V		
Recommended voltage, at mpp	500VDC~600VDC		
Max Amps Input[A]	12.8	17.6	24.0
Recommended Max Power at mpp[kW]	6.4	8.8	12.0
Alternate AC Generator			
Input voltage	380V AC(±15%), Three Phase		
Max Amps(RMS)[A]	10.0	15.0	20.0
Power and VA capability[kVA]	6.6	9.0	13.0
Output Data			
Output Power,rated[kW]	4.0	5.5	7.5
Output Voltage, rated	380V AC , Three Phase		
Max Amps(RMS)[A]	9.0	13.0	17.0
Output Frequency	0-50Hz/60Hz		
Protection			
Surge protection	Integrated		
Overvoltage protection	Integrated		
Undervoltage protection	Integrated		
Locked pump protection	Integrated		
Open circuit protection	Integrated		
Short circuit protection	Integrated		
Overheated protection	Integrated		
Dry run protection	Integrated		
General Data			
Ambient Temperature Range	-20°C~60°C; >45°C, Derating as required		
Cooling Method	Fan Cooling		
Ambient Humidity	≤ 95%RH		
Dimensions(H*W*D)[mm]	249.5*155.5*159.5		
Gross Weight[kg]	3.4	3.5	3.6
Standard Warranty[month]	18		
Certificates	IEC/EN 61800-5-1,IEC/EN 61800-2:2004, IEC/EN 61800-3:2004,CE		

Table 2.3 Solar Pump Controller 4-7.5kW 380VAC 3 phase output Specifications

Controller Model	RPC10-4T011	RPC10-4T015	RPC10-T18R5
Input Data			
PV Source			
Max Input Voltage(Voc)[V]	750V		
Min Input Voltage, at mpp[V]	350V		
Recommended voltage, at mpp	500VDC~600VDC		
Max Amps Input[A]	35.2	48.0	57.6
Recommended Max Power at mpp[kW]	17.6	24.0	29.6
Alternate AC Generator			
Input voltage	380V AC(±15%), Three Phase		
Max Amps(RMS)[A]	26.0	35.0	38.0
Power and VA capability[kVA]	17.0	23.0	25.0
Output Data			
Output Power,rated[kW]	11.0	15.0	18.5
Output Voltage, rated	380V AC, Three Phase		
Max Amps(RMS)[A]	25.0	32.0	37.0
Output Frequency	0-50Hz/60Hz		
Protection			
Surge protection	Integrated		
Overvoltage protection	Integrated		
Undervoltage protection	Integrated		
Locked pump protection	Integrated		
Open circuit protection	Integrated		
Short circuit protection	Integrated		
Overheated protection	Integrated		
Dry run protection	Integrated		
General Data			
Ambient Temperature Range	-20°C~60°C; >45°C, Derating as required		
Cooling Method	Fan Cooling		
Ambient Humidity	≤ 95%RH		
Dimensions(H*W*D)[mm]	364*214*190.5		
Gross Weight[kg]	9.8	9.8	10.0
Standard Warranty[month]	18		
Certificates	IEC/EN 61800-5-1,IEC/EN 61800-2:2004, IEC/EN 61800-3:2004,CE		

Table 2.4 Solar Pump Controller 11-18.5kW 380VAC 3 phase Specifications

Controller Model	RPC10-4T022	RPC10-4T030	RPC10-4T037
Input Data			
PV Source			
Max Input Voltage(Voc)[V]	750V		
Min Input Voltage, at mpp[V]	350V		
Recommended voltage, at mpp	500VDC~600VDC		
Max Amps Input[A]	70.4	96.0	118.4
Recommended Max Power at mpp[kW]	35.2	48.0	59.2
Alternate AC Generator			
Input voltage	380V AC(±15%), Three Phase		
Max Amps(RMS)[A]	46.0	62.0	76.0
Power and VA capability[kVA]	30.0	41.0	50.0
Output Data			
Output Power,rated[kW]	22.0	30.0	37.0
Output Voltage, rated	380V AC, Three Phase		
Max Amps(RMS)[A]	45.0	60.0	75.0
Output Frequency	0-50Hz/60Hz		
Protection			
Surge protection	Integrated		
Overvoltage protection	Integrated		
Undervoltage protection	Integrated		
Locked pump protection	Integrated		
Open circuit protection	Integrated		
Short circuit protection	Integrated		
Overheated protection	Integrated		
Dry run protection	Integrated		
General Data			
Ambient Temperature Range	-20°C~60°C; >45°C, Derating as required		
Cooling Method	Fan Cooling		
Ambient Humidity	≤ 95%RH		
Dimensions(H*W*D)[mm]	424*285*210.3		
Gross Weight[kg]	17.2	17.2	17.6
Standard Warranty[month]	18		
Certificates	IEC/EN 61800-5-1,IEC/EN 61800-2:2004, IEC/EN 61800-3:2004,CE		

Table 2.5 Solar Pump Controller 22-37kW 380VAC 3 phase Specifications

Controller Model	RPC10-4T045	RPC10-4T055	RPC10-4T075
Input Data			
PV Source			
Max Input Voltage(Voc)[V]	750		
Min Input Voltage, at mpp[V]	350		
Recommended voltage, at mpp	500VDC~600VDC		
Max Amps Input[A]	144.0	176.0	240.0
Recommended Max Power at mpp[kW]	72.0	88.0	120.0
Alternate AC Generator			
Input voltage	380V AC(±15%), Three Phase		
Max Amps(RMS)[A]	90.0	110.0	140.0
Power and VA capability[kVA]	59.2	72.4	92.0
Output Data			
Output Power,rated[kW]	45.0	55.0	75.0
Output Voltage, rated	380V AC, Three Phase		
Max Amps(RMS)[A]	90.0	105.0	150.0
Output Frequency	0-50Hz/60Hz		
Protection			
Surge protection	Integrated		
Overvoltage protection	Integrated		
Undervoltage protection	Integrated		
Locked pump protection	Integrated		
Open circuit protection	Integrated		
Short circuit protection	Integrated		
Overheated protection	Integrated		
Dry run protection	Integrated		
General Data			
Ambient Temperature Range	-20°C~60°C; >45°C, Derating as required		
Cooling Method	Fan Cooling		
Ambient Humidity	≤ 95%RH		
Dimensions(H*W*D)[mm]	544*380*284.8		650*473*318
Gross Weight[kg]	42.2	42.6	71.0
Standard Warranty[month]	18		
Certificates	IEC/EN 61800-5-1,IEC/EN 61800-2:2004, IEC/EN 61800-3:2004,CE		

Table 2.6 Solar Pump Controller 45-75kW 380VAC 3 phase Specifications

2.6 Solar Pump Controller Dimensions

There are three types of solar pump controller dimensions, as following Figure2~4 showing. Table 3 lists all the frame sizes and mounting dimensions.

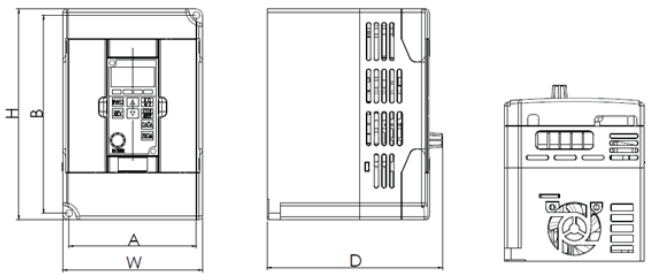

Figure 2. 0.75~2.2kW Controller Dimensions

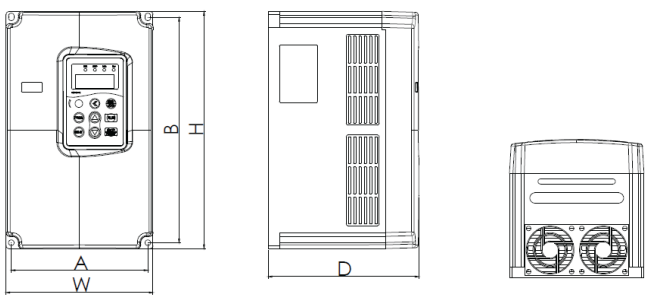

Figure 3. 4~7.5kW Controller Dimensions

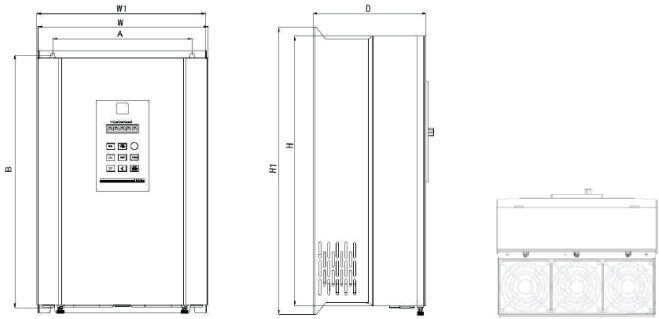

Figure 4. 11~75kW Controller Dimensions

Controller Model	Mounting Dimension (mm)		Outline Dimension(mm)					Mounting Hole Diameter (mm)
	A	B	H	H1	W	W1	D	
RPC10-2SR75	92	142.7	151.7		101		126.8	Φ5
RPC10-2S1R5								
RPC10-2S2R2								
RPC10-4TR75	92	142.7	151.7		101		126.8	Φ5
RPC10-4T1R5								
RPC10-4T2R2								
RPC10-4T004	144.4	237	249.5		155.5		159.5	Φ5.9
RPC10-4T5R5								
RPC10-4T7R5								
RPC10-4T011	156.6	378.3	364	396	214	221.7	190.5	Φ6
RPC10-4T015								
RPC10-4T18R5								
RPC10-4T022	235	447	424	463	285	289.6	210.3	Φ7
RPC10-4T030								
RPC10-4T037								
RPC10-4T045	260	580	544	595.5	380	390	284.8	Φ10
RPC10-4T055								
RPC10-4T075	343	674	650	701.5	473	485	318	Φ10

Table 3 Solar Pump Controller Dimensions

3. Installation

⚠ WARNING
High voltages (both AC and DC) capable of causing severe injury or death by electrical shock are present in this unit. This unit should only be installed or serviced by technically qualified professionals.

Anytime working on or near the solar pump controller, or system:

• Turn OFF the external DC rated disconnect from the solar array to the solar pump controller.

• Ensure AC power has been disconnected from the solar pump controller (if used).

• Wait a minimum of 5 minutes after removing power from the solar pump controller before servicing.

READ THESE INSTRUCTIONS COMPLETELY BEFORE INSTALLATION.

Note: During installation, if a conflict arises between this manual and local or national electrical codes, the applicable local or national electrical codes should prevail.

• The longevity and performance of the solar pumping package may be adversely affected by improper installation.

• The solar array structure, modules, and wiring harness must be properly assembled according to the manufacturer's installation instructions before installing the solar pump controller.

• Wiring Requirements: Use 75 °C rated wire sized for a maximum voltage drop of 3% per local electric codes.

3.1 Installation Preparation & Requirements

When installing the solar pump controller, be aware that:

• High voltage is present in the controller when powered on; use caution when live DC power is on.

• Do not allow any unauthorized persons near the solar array and connection sites while power is applied.

• It is strongly recommended that a DC rated disconnect box be used to disconnect the incoming DC power from the solar pump controller during installation and maintenance. Use a Volt Meter to confirm the absence of voltage in the line before proceeding with installation or maintenance.

• The DC disconnect should be sized to be capable of adequately disconnecting the output open circuit voltage (Voc) and short circuit current (Isc) of the solar array.

• Keep all flammable materials away from the assembly site, including dry brush and vegetation.

• For optimal performance, avoid placing the solar array around any objects that can cast shadows or reduce sunlight to the array.

• Install the solar pump controller in a control box with control terminals and power wiring. Install the control box out of direct sunlight to prevent overheating and reduced performance. The optimum location is on the mounting pole for the solar array underneath the array for protection from the sun, heat, and weather elements.

• Keep the surrounding area clear of vegetation.

• Do not block airflow around the solar pump controller heat sink.

• Limit access of animals to the system.

• Protect wires from damage from wildlife and weathering by using conduit. For additional protection, bury the conduit in the ground.

3.2 Control Box and Controller Location Selection

The solar pump controller is intended for operation in ambient temperatures up to 60 °C. The following recommendations will help in the selection of the proper location for the solar pump controller .

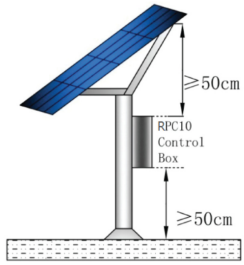

Figure 5 Control Box and Controller Location

⚠ CAUTION
When using an alternate AC power source, the ambient temperature is limited to 40 °C for full power delivery.

• The solar pump controller must be installed into a control box which has a tight enclosure to avoid direct sunshine , rain, dust, moisture, animals, plants, etc. The control box should has a bottom gland plate for installing wire cord or conduit. To decide the size of control box, Please refer to the following Figure 6.

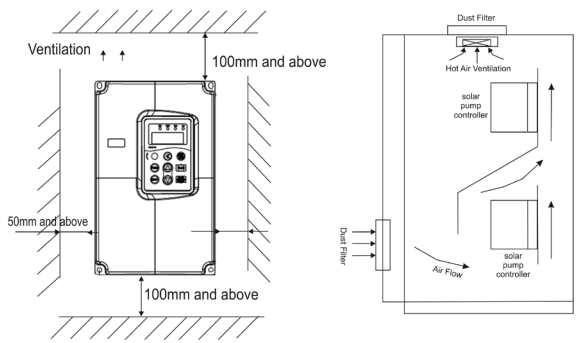

Figure 6 Ventilation Arrangement and Required Distances

• The control box should be mounted on a sturdy supporting structure such as a wall or supporting post. Please take into account the weight of the unit.

• The electronics inside the solar pump controller are air-cooled. As a result, there should be at least 50 cm both above and below to allow for air flow and proper cooling. If the control box is mounted under the PV, make sure that it is at least 50 cm beneath the array.

• The solar pump controller should be mounted with the wiring end oriented downward. The control box should not be placed in direct sunlight or other locations subject to extreme temperatures or humidity (mounting location should not be subjected to freezing conditions). Placing the control box in direct sunlight or high ambient temperatures will result in reduced performance due to temperature foldback protection of the solar pump controller. For optimum performance, maximize the shading of the control box.

3.3 Mounting Procedure

• Disconnect all electrical power supply.

• Install the control box with solar pump controller inside to a secure post using mounting screws (not included). The top mounting holes are slotted in order to hang the controller in place, while the bottom fasteners are inserted to secure the unit from ever sliding up.

• If the mounting surface is narrower than the outer mounting slots, use the top center and bottom center mounting holes and secure mounting screws (not included).

4. Electrical Wiring

4.1 Terminals

The following are typical figures of terminal blocks.

Note: Terminals are different in shapes and combinations, depending on different sizes of solar pump controller.

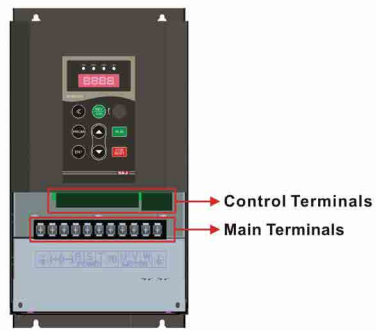

Figure 7 Terminals Arrangement of solar pump controller
(11kW size, with lower part of front cover been cut away.)

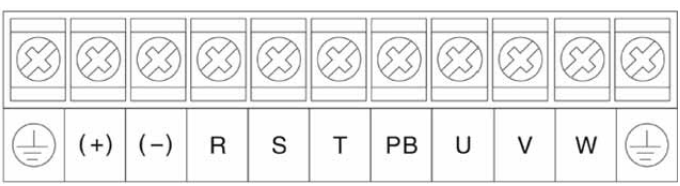

Figure 8. Main terminals (11kW)

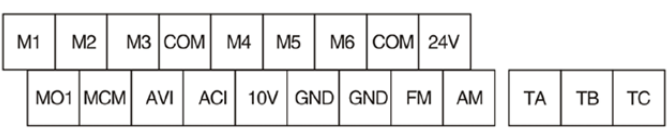

Figure 9. Control terminals (11kW)

⚠ WARNING
Capacitors inside the solar pump controller can still hold lethal voltage even after power has been disconnected. Allow 5 minutes for dangerous internal voltage to discharge before removing solar pump controller cover to access the terminals.

4.2 Power In DC Wiring

For Solar Pumping Systems, a two-pole DC disconnect switch must be installed between the solar array and the solar pump controller.

Connect the cables which comes from the two-pole DC disconnect Switch downstream terminals marked with “+” and “-”(positive and negative poles of Solar panel output), to solar pump controller ’s terminals block labeled as “R”, “T” . (Do not over-tighten the screws.).

See Figure 11.

⚠ WARNING
Before connect DC wiring, following the steps below to prevent hazardous electric shock resulting in serious injury or device burning. • Make sure that the external DC disconnect switch is off. • Make sure that AC power is disconnected (if AC power supply is wired as backup power) • Make sure that all wires are properly identified and marked: (a) the cable from the PV to the external DC disconnect switch (b) the cable from the external DC disconnect to the solar pump controller

⚠ CAUTION
Do not connect a solar array directly to the DC input of the solar pump controller without protection such as DC disconnect switch. In this controller, the integral solid state short circuit protection of motor wiring does not provide circuit protection of wiring for input power. Input wiring protection must be provided in accordance with all applicable national and local electrical codes. In addition, follow any manufacturer's recommendations for protection of a photovoltaic (PV) array and protection of a generator, if used.

4.3 Ground Wiring

Ground terminal(GND) is labeled as this icon ⏚ . Please refer to the instruction to this icon, or other equivalent icon or sign by local electrical codes or international standard.

Connect the ground wire to the ground terminal of solar pump controller. Correct Grounding helps to prevent shock hazard if there is a fault in the motor .

See Figure 11.

⚠ WARNING
Serious or fatal electrical shock may result from failure to connect the ground terminal to the motor, the solar pump controller, metal plumbing and all other metal near the motor, or cable to a proper earth ground in accordance with local codes, using wire no smaller than motor cable wires. To minimize risk of electrical shock, disconnect power before working on or around the solar pumping system. Do not use motor in swimming areas.

4.4 Motor Wiring

Connect the cable with four wires from the Motor to the controller terminal block to terminals U, V, W, and GND (See Figure 11). (Do not over-tighten the screws.).Motors with international leads are as shown in the table in Figure 10. Check motor lead color to ensure correct installation.

Note: To reverse direction of motor rotation, reverse any two wires.

US	Black(BLK)	Red (RED)	Yellow (YEL)	Ground (GND)
International	Gray (GRY)	Black (BLK)	Browm(BRN)	Ground (GND)

Figure 10. Motors with international leads

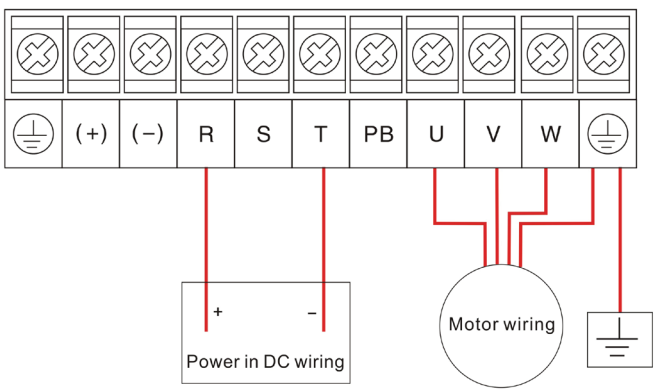

Figure 11. Main Terminals Wiring

4.5 Control Circuit Wiring (Optional)

The solar pump controller can be operated with control switches to control the controller ON/OFF, and water level switch sensing and control High/Low pumping range. Use a normally closed low-voltage control switch with a contact rating suitable for instrumentation use (i.e. Max: 24 V 15mA)

4.5.1 ON/OFF Control Switch Operation(Optinaltion)

• Solar pump controllers can be turned ON/OFF by a control terminal input. See Figure 12 for details. **Note:** F0.01 must be changed to 1 while the ON/OFF Control Switch is needed.

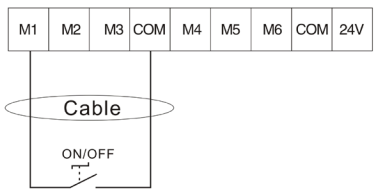

Figure 12. ON/OFF Control Switch Circuit Wiring Connections

4.5.2 Well Level Switch Operation

The solar pump controller is designed to utilize 2 level switches for well water level control. One is HIGH level, the other is LOW level. See Figure 13 for wiring connection.

Both HIGH and LOW level switch can be set to NO or NC contact type from the USER DEFINABLE PARAMETER F5.27.

When the LOW level switch acts as the water falls below LOW level threshold, the solar pump controller stops the pump, thus prevents the well water from exhausting, in some case also protect the well.

When the HIGH level switch acts as the water rises higher than HIGH level threshold, the solar pump controller starts the pump. Set the HIGH and LOW level switch threshold to appropriate value, thus prevent the pump from switching on and off frequently.

See USER DEFINABLE PARAMETER F5.27 in operation section of manual for instructions .

4.5.3 Tank Level Switch Operation

The solar pump controller is designed to utilize 2 level switches for Tank or pool water level control. One is HIGH level, the other is LOW level. See Figure 13 for wiring connection.

Both HIGH and LOW level switch can be set to NO or NC contact type from the USER DEFINABLE PARAMETER F5.27.

When the LOW level switch acts as the water falls below LOW level threshold, the solar pump controller starts the pump, thus supply water to the tank or pool.

When the HIGH level switch acts as the water rises higher than HIGH level threshold, the solar pump controller stops the pump, to prevents water overflow. Set the HIGH and LOW level switch threshold to appropriate value, thus prevent the pump from switching on and off frequently.

See USER DEFINABLE PARAMETER F5.27 in operation section of manual for instructions.

Once it shuts off, the solar pump controller then waits to run again until the switch reads “CLOSED”.

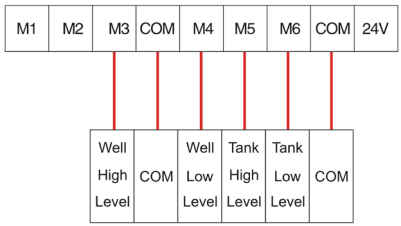

Figure 13. Well/Tank Water Level Switch Wiring Connections

4.5.4 Well & Tank Level Switches Position

Figure 14 shows the demo of four level Switches installation position .

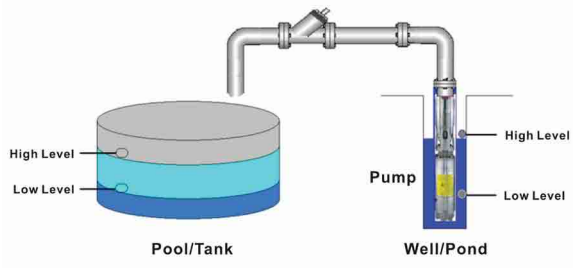

Figure 14. Demo of Well & Tank Level Switches Installation

> **⚠ CAUTION**
>
> Tank level switch configurations are superseded by the Well level switch. If the well switch detects low flow it will “OPEN” and override the run signals sent by the tank level switches to protect the well, motor and controller.

4.5.5 System Wiring Diagram

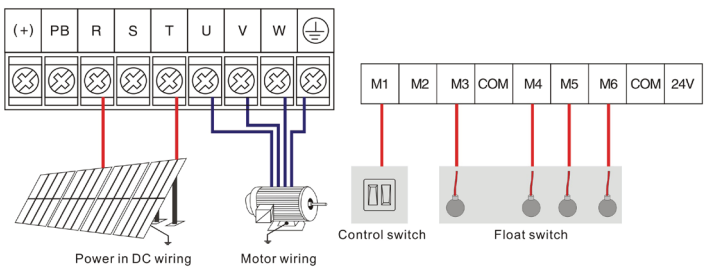

Figure 15. System Wiring Diagram

5. Start-up and Operation

5.1 Keypad Description

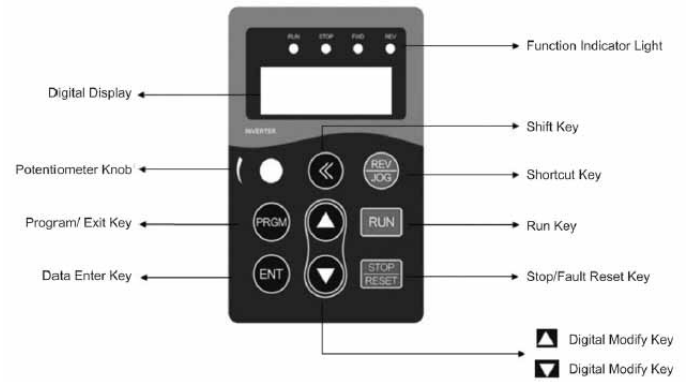

Figure 16 Keypad Schematic Diagram

5.1.1 Button Function Description

Symbol	Button Name	Function Description
PRGM	Program/ Exit	Enter or exit of menu, parameter setting
ENT	Data enter	Progressively enter menu and confirm parameter.
▲	UP/ increase	Progressively increase setting value or function codes.
▼	DOWN/ decrease	Progressively decrease setting value or function codes.
≤	Shift	Use it to select displayed parameters cyclically during running or stop status. In parameter setting mode, press this button to select the bit to be modified.
RUN	Run	Start to run the controller in keypad control mode.
STOP/ RESET	Stop/reset	In running status, restricted by function code F7.04, it can be used to stop the controller, In malfunction alarm status, not restricted by function code F7.04, it can be used to reset the controller.
REV/JOG	Shortcut	Determined by function code F7.03.

5.1.2 Functional LED indicator description

Indicator Name	Description
RUN	Light on: controller running status.
STOP	Light on: controller stops or fault status.
FWD	Lights of FWD and RUN are on at the same time: controller forward running status.
REV	Lights of REV and RUN are on at the same time: controller reversely running status.

5.2 Keypad Operation Process

5.2.1 Parameter Setting

Three levels of menu are as following:

• Function code group (first-class)

• Function code (second-class)

• Setting parameter of function code (third-class)

5.2.2 Remarks

Pressing PRGM or ENT can return to the second-class menu from the third-class menu. The difference is: Pressing ENT will save the setting parameters into control board, and return to the second-class menu with shifting to the next function code automatically. While pressing PRGM will directly return to the second-class menu without saving the parameters, and keep staying at the current function code.

For example: change the parameter 00.50Hz of function code F1.01 into 05.00Hz as the following Figure 14 flow chart shows.

Under the third-class menu, if the parameter has no flickering bit, it means that the function code cannot be modified. The possible reasons include:

(1) The parameter of this function code can't be modified, such as actually detected parameter, operation records and so on.

(2) This function code can't be modified during running status, but can be modified during stop status.

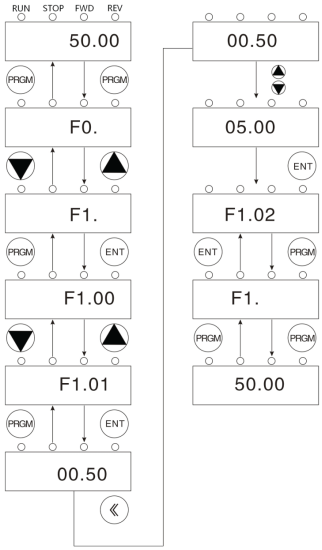

Figure 17 Flow Chart of Parameter Setting

5.2.3 Fault Reset

When controller malfunction occurs, it will display the relative fault information. Use the STOP/ RESET key or terminals (determined by F5 group) to reset the fault. After fault reset, controller is at stand-by status. If no fault reset when controller is at fault status, it will keep operation protection status and cannot run.

5.3 Commissioning Procedure

• Check and make sure wiring are correct. If needed, take a megger to test the insulation of motor, cable, etc.

• Use a multimeter to test the PV output voltage at the DC switch.

• Power on the controller by switch on the DC switch.

• If necessary, modify and set the parameters of motor to the controller.

With the pump ready, Jog the motor shortly by ON/OFF control switch with F0.01 set to 1 ,or RUN/STOP on keypad with F0.01 set to 0, to see if the running direction of pump are correct. If the direction is wrong, change the motor wiring connections by shifting two leads according to Pump/Motor Wiring Connections section, or you can change Parameter F0.09 according to User defined Parameters section to let the controller drive the motor in another direction.

• Make sure the level switches' contact type is compatible with the settings of Parameter F5.27. If not, change the settings.

• With every parts mentioned above fixed, you can try to run the system.

• Check if the tank and well level switches are functioning well.

• Let the system work an hour, test the water supply capacity.

• Commissioning finished.

5.4 User Definable Parameters

The following explains the menu structure and User Definable Parameters that is effective on solar pump controllers.

"○": The parameters can be modified at stop or running status.

" ◎ ": The parameters cannot be modified at running status.

"●": The parameters which are actual-detecting record value and cannot be modified.

Function Code	Function	Descriptions	Minimum Unit	Factory Setting	Modification Type
F0 Group: Basic Parameters					
F0.01	Run command source	0:Keypad 1:Terminals		0	●
F0.03	Main Frequency Source X Selection	0: Digital Setting Modified by Up/down key 1: Potentiometer of panel 2: AVI terminal 3: ACI terminal 4: Automatically adjusted by Light intensity 5: Reserved 6: Multi-function digital input terminals 7: PLC 8: PID 9: Communication interface		4	●
F0.09	Running direction selection	0: Forward 1: Reverse 2: Reverse running prohibited		0	●
F0.10	Max. output frequency	10.00~ 600.0Hz	0.01Hz	60.00Hz	●
F0.14	Low limit of running frequency	0.00Hz~ F0.12	0.01Hz	20.00Hz	○
F0.15	Options at low limit frequency	0: Running at low limit frequency 1: Stop 2: Sleep at 0Hz		2	○
F0.19	Deceleration time 1	0.1 ~ 3600s	0.1s	10.0s	○

F0.20	Default setting	0:Not restore to default setting 1: Restore to factory setting 2:Fault record clearing		0	●
F0.21	Parameter lock setting	0: Unlock parameter 1: Lock parameter		1	○
F2 Group: Motor Parameters					
F2.01	Motor rated power	0.4~700.0kW	0.1kW	Different according to controller model	●
F2.02	Motor rated frequency	10.00Hz~ F0.10	0.01Hz	50.00Hz	●
F2.04	Motor rated voltage	0~480V	1V	Different according to controller model	●
F2.05	Motor rated current	0.8~2000A	0.1A	Different according to controller model	●
F5 Group: Digital Input Terminal Functions					
F5.00~ F5.05	M1~M6 terminal function	0:Invalid 1:Forward 2:Reverse 39:Well High Level Limit 40:Well Low Level Limit 41:Tank High Level Limit 42:Tank Low Level Limit		F5.00 = 1 F5.01 = 2 F5.02 = 39 F5.03 = 40 F5.04 = 41 F5.05 = 42	○
F5.27	M1~M6 Normally Open/Normally Close Options	BIT0 for M1 0:N0:NO 1:NC O 1:NC BIT1 for M2 0:NO 1:NC BIT2 for M3 0:NO 1:NC BIT3 for M4 0:NO 1:NC BIT4 for M5 0:NO 1:NC BIT5 for M6 0:NO 1:NC		0C	○
F6 Group: Output Terminal Parameters					
F6.02	Relay 1 output selection	12:Input Over Voltage Fault		12	○

F7 Group: Display Interface Parameters					
F7.00	User password	0~9999		0	○
F7.10	controller firmware version				◎
FA Group: Protection and Malfunction Parameters					
FA.14	Fault Record of the one before last	0: No fault 1: Inverter module protection (E001) 2. Over-current when accelerate (E002) 3: Over-current when decelerate (E003) 4: Over-current at constant speed (E004) 5: Over-voltage when accelerate (E005) 6: Over-voltage when decelerate (E006) 7: Over-voltage at constant speed (E007) 8:Hardware overvoltage (E008) 9:Under voltage (E009) 10:controller overload (E010) 11:Motor overload (E011) 12:Phase-lack of input (E012) 13:Phase-lack of output (E013) 14:Heatsink overheating (E014) 15:External fault (E015) 16:Communication fault (E016) 17:Reserved 18:Current detection fault (E018) 19:Motor autotuning fault (E019) 20:Well Level Fault(E020) 21:Tank Level Fault(E021) 22:EEPROM fault (E022)			◎
FA.15	Last Fault Record				◎
FA.16	Current Fault Record				◎

FA.17	Running frequency when fault occurs		Hz		◎
FA.18	Output current when fault occurs		A		◎
FA.19	DC bus voltage when fault occurs		V		◎
FD Group: Solar pumping special parameters					
FD.05	Max power point voltage	0-700	Volt	220VAC motor controller: 360VDC 380VAC motor controller: 600VDC	○
FD.06	Photovoltaic open circuit voltage	0-800	Volt	220VAC motor controller: 450V 380VAC motor controller: 750VAC	○
FD.07	Power on auto start	0:Disable 1:Enable		1	○
FD.08	Delay before auto start	0.0-900.0	0.1s	5.0	○

⚠ WARNING

Do NOT touch any other piece inside the solar pump controller while power is applied. To service any other areas of the controller, disconnect ALL power sources and wait 5 minutes before continuing.

6. Three-Phase Motor Requirements

Normally, considering about the selection of solar pump controller, the motor's power rating should be equal to controller's power rating.

But if the length of cable for motor wiring is more than 50m to 100m(depends on motor power rating, the smaller the motor power rating is, the short length are required), the controller's power rating should be larger than the motor. For example, to an application of 100m deep well , a 5.5kW controller should be selected to control 4kW motor.

7. Diagnostics and Troubleshooting

The solar pump controller will attempt to drive the pump to deliver water even under adverse conditions. To ensure years of reliable service, it must also protect the system components from conditions that might result in equipment damage. When adverse conditions arise, the controller will continue to deliver as much water as possible at reduced output if necessary, and will shut down only in extreme cases. Full operation will resume automatically whenever abnormal conditions subside.

Error conditions may suspend certain features, reduce output, or shut down operation of the controller for varying amounts of time depending on the nature and severity of the error. Problems that merely reduce features or performance generally restore full operation when the trouble condition subsides without stopping the pump or flashing an error code. An severe error such as short circuit or over current requires stopping the motor immediately. An overload error stops the controller with a delay by time-load curves defined internally. The error code is shown on the LED display.

If the controller has stopped to indicate a fault code on the display, the associated time-out delay will vary depending on the nature of the fault. The number following the “E” symbol corresponds to the error code for the offending condition.

7.1 Fault Codes

Fault code	Fault description	Possible causes	Remedy
E001	IGBT module fault	Too short acceleration time	Increase acceleration time
		Damaged IGBT module	Ask for support
		Malfunction caused by interference	Inspect external equipment and eliminate interference
		Improperly grounding	Check grounding wire
E002	Over-current during acceleration	Too fast acceleration	Increase acceleration time
		Too low input voltage	Check the input power supply or wiring
		lower-rating controller	Replace with higher-rating controller
E003	Over-current during deceleration	Too-fast deceleration	Increase deceleration time
		Too-heavy and large-inertia load	Add proper braking units
		lower-rating controller	Replace with higher-rating controller
E004	Over-current at constant running speed	Sudden change of load	Check the load
		Too low input voltage	Check the input power supply or wiring
		lower-rating controller	Replace with higher-rating controller
E005	Over-voltage during acceleration	Abnormal input voltage	Check input power
		Restart the motor when instantaneous trip-off occurs	Avoid prompt restart when trip-off
E006	Over-voltage during deceleration	Too-fast deceleration	Increase deceleration time
		Too-heavy and large-inertia load	Add proper braking units
		Abnormal input voltage	Check input power supply or wiring
E007	Over-voltage at constant running speed	Abnormal input voltage	Install proper input AC reactor
		Large-inertia load	Add proper braking units

Fault code	Fault description	Possible causes	Remedy
E008	Hardware over-voltage	Abnormal input voltage	Check input power supply or wiring
		Too-fast deceleration	Increase deceleration time
		Large-inertia load	Add proper braking units
E009	Under voltage of DC bus	Too-low input voltage	Check input power supply or wiring
E010	Controller overload	Too fast acceleration	Increase acceleration time
		Restart the motor when instantaneous trip-off occurs	Avoid prompt restart when trip-off
		Too-low input voltage	Check input power supply or wiring
		Too-heavy load	Replace with higher-rating controller
E011	Motor overload	Too-low input voltage	Check input power supply or wiring
		Improper setting of motor rated current	Properly setting of motor rated current
		Improper motor's overload protection threshold	Check load and boost the torque
		lower-rating controller	Replace with higher-rating controller
E012	Input phase loss	Phase-loss of R, S, T	Check input power supply or wiring
E013	Output phase loss	broken wires in the output cable	Check the wiring and installation
		broken wires in the motor winding	
		Loose output terminals	

Fault code	Fault description	Possible causes	Remedy
E014	Controller overheat	Instantaneous overcurrent of controller	Refer to over current remedy
		Output short circuit	Re-wiring of output
		Cooling fans of controller stopped or damaged. Obstruction of ventilation channel	Replace cooling fan and clear the ventilation channel
		Too-high ambient temperature	Decrease the ambient temperature if possible
		loose cables or terminals	Inspect and tighten the wire and terminals
		Abnormal power circuit	Ask for support
		Abnormal control PCB board	
E015	External fault	Faults tripped by external fault input terminals	Inspect external equipment
E016	Communication fault	Improper baud rate setting	Set proper baud rate
		Receive wrong data	Push STOP/RESET to reset and ask for support
		Long-time communication interruption	Check communication devices and cables
E017	Reserved		
E018	Current detection fault	Loose wires or connectors of control board	Check the wiring and connectors
		Amplifying circuit abnormal	Ask for support
		Hall sensor is damaged	
		Power circuit abnormal	
E019	Auto-tuning fault	Inconsistence between controller and motor	Replace with the proper-rating controller
		Improper setting of motor rated parameters	Set rated parameters according to motor nameplate

Fault code	Fault description	Possible causes	Remedy
E019	Auto-tuning fault	Bigger tolerance of parameters against standard parameters after auto tuning.	Make motor uncoupled with load and auto-tune again
		Overtime of auto tuning	Check motor wiring and parameters setting
E020	Well Level Fault(E020)	Dry well or slow water recovery	Waiting water recovery, or re-install the pump.
E021	Tank Level Fault(E021) before auto start	High level limit is reached.	Wait until water level comes below the low level limit, and then the solar pump controller will start the pump again.
E022	EEPROM fault	Read/ Write fault of control parameters	Push STOP/RESET to reset
		EEPROM damaged	Ask for support

7.2 Common Faults and Remedies

Controller may have following faults or malfunctions during operation, please refer to the following remedies.

7.2.1 No display after power on:

(1) Inspect whether the voltage of power supply is the same as the controller rated voltage or not with multi-meter. If the power supply has problem, inspect and solve it.

(2) Inspect whether the three-phase rectify bridge is in good condition or not. If the rectification bridge is burst out, ask for support.

7.2.2 Power supply switch trips off when power on:

(1) Inspect whether the input power supply is grounded or short circuit. Solve this problem.

(2) Inspect whether the rectify bridge has been burnt or not. If it is damaged, ask for support.

7.2.3 Motor doesn't run after controller works:

(1) Inspect if there is balanced three-phase output among U, V, W. If yes, then motor could be damaged, or mechanically locked.

(2) If the output is unbalanced or lost, the controller drive board or the output module may be damaged, ask for support..

7.2.4 Controller displays normally when power on, but switch at the input side trips when running:

(1) Inspect whether the output side of controller is short circuit. If yes, ask for support.

(2) Inspect whether ground fault exists. If yes, solve it.

(3) If trip happens occasionally and the distance between motor and controller is too far, it is recommended to install output AC reactor.

(4) Inspect whether the output module is burnt or not. If yes, ask for support.

8. Periodic Maintenance

• Solar pump controller:

Periodically checking of Status display, error code display and fault record, long term verification of cooling fan and cleaning of heat sink are needed.

• Solar panels:

Periodically cleaning of the surface of panels and checking wiring are required. Please refer to manufacturer's instruction.

• Solar motor and pump:

Long term periodic maintenance and verification are required. Please refer to manufacturer's instruction.

9. Solar Array

9.1 Example: 255W Monocrystalline Solar Array Curves Displaying Diminishing Solar Light Intensity

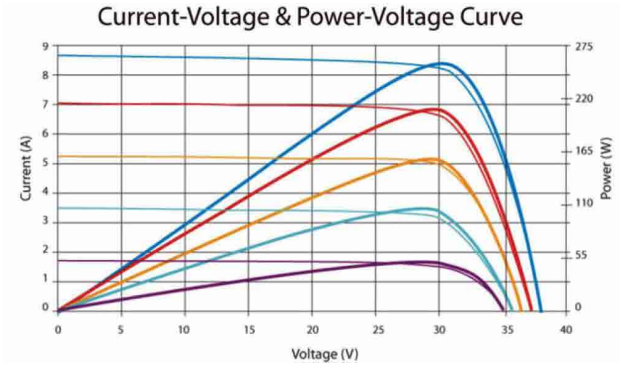

Figure 18. example solar array Curves

Each panel having the following values at standard test conditions (STC of 1000 W/m^2, 25 deg C panel temp): Isc = 8.63A, Voc =36.6 Vdc, Imp = 7.92 A, Vmp = 31.18 Vdc

Curves calculated for five different light levels: 200 to 1000 W/m^2 in 200 W/m^2 steps, at constant 25 deg. C panel temperature.

9.2 Solar Panel Wiring Configurations

Solar Panels Wired in Series When solar panels are wired in series, the positive terminal of one solar panel is wired in to the negative terminal of the next solar panel. When panels are connected in series:

- Voltage accumulates (adds) for each panel in series
- Wattage accumulates (adds) for each panel in series
- Current (Amps) remains the same as a single panel in the series

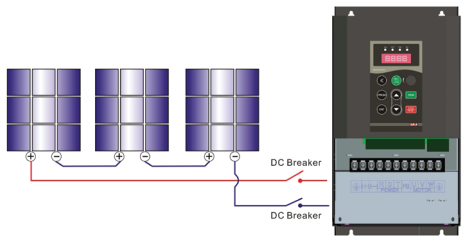

Figure 19. Solar Panels Wired in Series

Solar Panels Wired in Parallel When solar panels are wired in parallel, the positive terminal of one solar panel is wired in to the positive terminal of the next solar panels. Likewise, the negative terminals are connected together to the negative terminals of the next solar panels. When panels are connected in parallel:

- Voltage remains the same as a single panel in the parallel connection
- Wattage accumulates (adds) for each panel added
- Current (Amps) accumulates (adds) for each panel wired in parallel

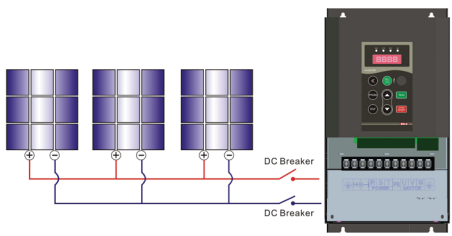

Figure 20 Solar Panels Wired in Parallel

Solar Panels Wired in Combination Series/parallel combination wiring requires that at least two sets (or strings) or panels wired in series are connected in parallel. When panels are connection in combination:

• Voltage accumulates (adds) for each panel in a single series circuit, but does not accumulate for additional strings wired in parallel

• Wattage accumulates (adds) for each panel in a single series string AND each string in parallel circuit (all panels in the array contribute additively to the total Wattage)

• Current (Amps) remains the same for single panels in a series, but accumulates (adds) for additional strings connected in parallel

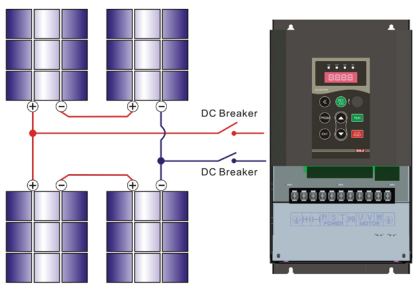

Figure 21. Solar Panels Wired in Combination Series/Parallel

Appendix
Generator Selection Information (Optional)

General Information

Not all AC generators will perform sufficiently with the solar pump controller. Always consult the generator manufacturer for application specific information.

In a solar pump controller, AC input current flows directly through an input rectifier into a storage capacitor, with no active power-factor-correction (PFC) circuitry. Because of variation of generator performance when connected to an input circuit like this, it is recommended that a suggested minimum kVA rating be obtained from the generator supplier for this type of application (input rectifier to capacitor, no PFC).

The AC input of a solar pump controller draws current only near the peaks of the sine-wave generator voltage. This pattern of current peaks may distort an input sine-wave voltage, limiting the generator's ability to maintain a voltage level required by the controller. This behavior is typical for equipment without dedicated power-factor-correction circuits. A generator's ability to provide low-distortion voltage during such operation is limited by a generator parameter called "sub-transient output reactance". The lower the sub-transient output reactance, the better the generator can maintain a low-distortion sine wave output voltage.

Generators with greater to or at least equal to the solar pump controller's kVA ratings are expected to be capable of providing adequate voltage to solar pump controller at rated power of the controllers. Please refer to the solar pump controller's specifications for details.

The above information is a guideline for selecting a generator based on best known practice. Not all AC generators will perform satisfactorily with the solar pump controller and can result in, but not limited to, nuisance tripping, unsatisfactory performance, or controller damage. Always consult the generator manufacturer for best use practices.

Line reactors are typically available as three-phase line reactors. Follow the manufacturer's instructions for use in single-phase application. The reactors can be mounted at the generator, using the proper enclosure rating determined to be adequate for the generator.

AC Power Wiring Connections

The solar pump controller has AC Power wiring options such as a generator when Solar DC power is not available.

Connect the cables from the AC power or generator to solar pump controllerto terminals R, S, and T. (Figure 8) (Do not over-tighten the screws.). There are three cases of wiring connections showing in Figure 8.

⚠ NOTICE

Depends on the given solar pump controller, some has only single phase AC input(mostly as power rating from 0.75kW to 2.2kW), and some has three phase AC input(mostly as power rating from 4kW to 55kW). Please check the controller's model label according to solar pump controller Model Description section and make sure which case of connection you should follow.

⚠ WARNING

Connecting single phase generator to three phase solar pump controller with different voltage rating will result in controller malfunction or being destroyed!

Before connecting AC power or generator to main terminal R,S,T, following steps must be carried out first, otherwise touching the conductor or parts would lead to sever injury or even death while they are energized!

• Make sure the generator is powered off.

• Make sure the external DC disconnect switch is off.

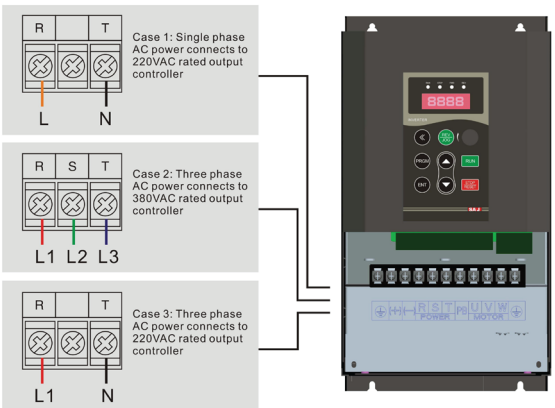

Figure 22. AC Wiring Connections