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Solar Pump Inverter

SKI650

SAKO, Always Online

Preface

Thank you for using SKI650 series products. This manual provides you with relevant operation instructions and detailed description of parameters. Please read this manual carefully before installation, running, maintenance or inspection.

Please make sure the wiring and the pump' s rotation direction is correct before use.

Contents

Notes for Safe Operation

Before Installation

⚠ WARNING

Do not install or operate the controller that is damaged or has missing parts. Otherwise, it may result in equipment damage or harm life.

Installation

⚠ CAUTION

◇ Hold the bottom of the controller when installing or moving the controller, can not just hold the shell to prevent the injured or broken controller.

◇ Install the controller on nonflammable material like metal. Otherwise it may cause a fire.

◇ When the controller is mounted in a protective cabinet, the cabinet need to set vents to ensure ambient temperature is below 40℃ , otherwise it may be damaged because of high temperature.

◇ When install the controller, you should avoid direct sunlight, can be installed under the PV array.

⚠ WARNING

◇ Ensure only qualified personnel to operate. Otherwise it can cause an electrical shock or damage of the controller.

◇ Make sure the controller is isolated from power supply by the circuit breaker. Otherwise it may cause a fire.

◇ Make sure that the ground terminal ⏚ is grounded correctly.

◇ Do not touch the power input terminals of the controller and the pump's terminals. Otherwise it may cause an electrical shock.

Operation

⚠ CAUTION

◇ Do not open or remove the front cover when operation. Otherwise it may cause an electrical shock.

◇ Before testing the pump must be installed; can not make the pump dry-runfor a long time. In order to test the pump, the maximum dry-runtime is not more than 15s.

◇ If the pump turning is reversed, it can change any two lines of the pump's three power lines.

◇ When the water pump is due to the light shadow, it will restart the operation after 120s.

◇ If a water level probe is installed in the well, when the water level is below the level of water shortage, the water pump will stop. If there is no water level probe, it will need to be short. If a water level probe is not used, the controller terminal must be short.

Maintenance and check

⚡ WARNING

◇ Only qualified or authorized professional personnel can maintain, replace and inspect the controller. Otherwise it may cause damage and injury.

◇ Wait at least 10 minutes after the power failure, or make sure that is no residual voltage before carry out maintenance and inspection, otherwise it may cause damage.

Others

⚡ WARNING

If failing to follow these instructions, resulting in damage to the machine, can not enjoy the warranty service.

Chapter 1　How It Works

The SKI650 solar pumping system serves to provide water in remote applications where electrical grid power is either unreliable or unavailable. The controller can convert DC from the PV array to AC, and drive kinds of pumps. In sunny days, the SKI650 solar pumping system can continuously pump water. The system without batteries and other energy storage devices, it is recommended to take water pumped to a reservoir for later use and water sources are those natural or special such as river, lake, well or waterway, etc. A float switch can be installed in the water tower to control the pump operation, And install a low-levelprobe in well to detect the well water so that when the water shortage pump is stopped. Figure 1 shows a typical diagram of a SKI650 solar pumping system. The major parts and components in the system are listed after the diagram.
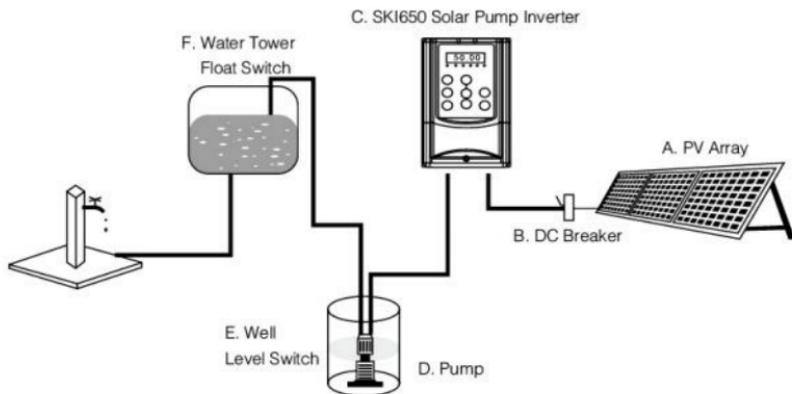

Figure 1　SKI650 solar pumping system

The SKI650 solar pumping system is designed which consists of:

A. Solar Array

B. DC Breaker or Disconnect Switch

C. SKI650 series Solar Pump Controller

D. Pump and Motor

E. Water Source Level Switches (optional)

F. Tank Level Switches (optional)

The SKI650 solar pump controller runs at variable speed while match the changing power provided by 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 lash on the motor and pumping system.

Pump Check Valve Requirements

Notice: 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.

1.1 Features

System Diagnostics

The SKI650 solar pump inverter continuously monitors system performance and detects 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 condition. 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 is available, the SKI650 solar pump inverter will be operating. Whenever the SKI650 solar pump inverter 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. Due to the controller' s soft-startfeature this will not harm the motor.

Over Temperature Foldback

The SKI650 solar pump inverter is designed for full power operation from a solar array in ambient temperatures up to 45 ℃ . In excess of 45 ℃ temperature 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

The SKI650 solar pump inverter can access two water level switch detects remotely control the pump automatically. Level switch for SKI650 solar pump inverter is optional, not mandatory.

Switching to Backup AC Power

The SKI650 solar pump inverter's input power terminal may be switched manually to a backup AC power source.

Note: Depending on the model number, SKI650 solar pump inverters support power input either 220VAC single phase, or 380VAC three phase, Please contact inverter manufacturer or 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 SKI650 solar pump inverter simultaneously! Please check if the design is in accordance with all applicable national and local electrical codes.

Chapter 2   General Information

The SKI650 solar pump inverter is a variable speed motor drive designed to run any IEC three-phase asynchronous motor. The SKI650 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 SKI650 solar pump inverter is designed to provide these features with the plug and play ease of installation.

The SKI650 solar pump inverter is designed with the high standard of reliability expected of products. 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 SKI650 solar pump controller unit. Verify that the part number is correct and that no damage has occurred during transit.

NOTE: SKI650 solar pump controller is one component of a SKI650 solar pumping system which has other two optional components, solar array and AC pump with motor.

2.2 Descriptions and Features

The SKI650 solar pump controller is based on a standard SKI650 platform controlling a standard three-phase asynchronous motor driving a pump powered by a solar array or an optional AC generator backup.

The SKI650 solar pump inverter continuously monitors system performance and incorporates a number of features for pumping system protection. In the event of a fault, the SKI650 solar pump inverter will indicate the type of fault through the LED display mounted on the front cover of controller.

The SKI650 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 - reversingtorque.

◇ 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 SKI650 Solar Pump Inverter Model Description

2.4.1 Model Description

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SKI  650 - 5D5G - 4
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Input Voltage:
1: 310VDC rating, MPPT range
280VDC ~ 360VDC (Note 1)
4: 540VDC rating, MPPT range
500VDC ~ 600VDC(Note 2)

Output Voltage:
1: 220V three phase; 4: 380V three phase

Power Code: SD5G: 5.5KW

Series ID: Solar Pump Inverter

SKI series
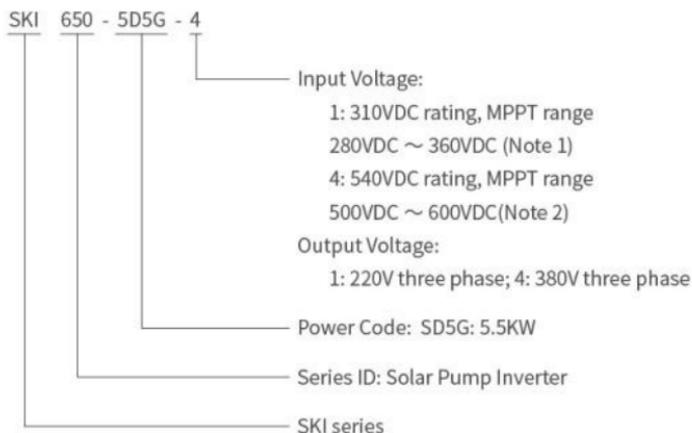
Note 1: Supporting Alternating Current input, with voltage rating of 220VAC single phase connected to terminal R&T.

Note 2: Supporting Alternating Current input, with voltage rating of 380VAC three phase connected to terminal R, S and T.

2.4.2 SKI650 Solar Controller General parameters

General Parameters			
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
Communication			
MODBUS Communication Card	Optional, RS-485 Isolated		
Others			
Ambient Temperature Range	-20℃～ 60℃ ; > 45℃ , Derating as Required		
Cooling Method	Fan Cooling		
Ambient Humidity	≤ 95%RH		
Standard Warranty(month)	18		

2.4 SKI650 Solar Pump Inverter Model Description

2.4.3 SKI650 Solar Controller Input and Output Data

SKI650-XDXG-1 Input and Output Data

Controller Model	SKI650-0D7G	SKI650-1D5G	SKI650-2D2G
Input Data			
Max Input Voltage(Voc)	DC 450V		
Recommended Voltage, at MPP	DC 280-360V		
Recommended PV Array Power [kW]	0.9 ~ 1.2	1.8 ~ 2.4	2.7 ~ 3.5
Alternate AC Generator			
Input Voltage	Single Phase AC 200-240V (±10%)		
Max Amps(RMS) [A]	8.2	14	23
Power and VA Capability [kVA]	2.0	3.1	5.1
Output Data			
Output Voltage, Rated	Three Phase AC 200-240V		
Max Amps(RMS) [A]	4.5	7	10
Output Power, Rated [kW]	0.75	1.5	2.2
Output Frequency	0 ~ 50Hz/60Hz		

SKI650-XDXG-4 Input and Output Data

Controller Model	SKI650-2D2G	SKI650-4D0G	SKI650-5D5G	SKI650-7D5G
Input Data				
Max Input Voltage(Voc)	DC 750V			
Recommended Voltage, at MPP	DC 500-600V			
Recommended PV Array Power [kW]	2.7 ~ 3.5	4.8 ~ 6.4	6.6 ~ 8.8	9 ~ 12
Alternate AC Generator				
Input Voltage	Three Phase AC 380/400/415/440V (±15%)			
Max Amps(RMS) [A]	5.8	10.0	15.0	20.0
Power and VA Capability [kVA]	5.0	6.6	9.0	13.0
Output Data				
Output Voltage, Rated	Three Phase AC 380/400/415/440V (±15%)			
Max Amps(RMS) [A]	5.0	9	13	17
Output Power, Rated [kW]	2.2	4	5.5	7.5
Output Frequency	0 ~ 50Hz/60Hz			

2.4 SKI650 Solar Pump Inverter Model Description

Controller Model	SKI650-011G	SKI650-015G	SKI650-018G	SKI650-022G
Input Data				
Max Input Voltage(Voc)	DC 750V			
Recommended Voltage, at MPP	DC 500-600V			
Recommended PV Array Power [kW]	13.2 ～ 17.6	18 ～ 24	22.2 ～ 29.6	26.4 ～ 35.2
Alternate AC Generator				
Input Voltage	Three Phase AC 380/400/415/440V (±15%)			
Max Amps(RMS) [A]	26	35	38.5	46.5
Power and VA Capability [kVA]	17	23	25	30
Output Data				
Output Voltage, Rated	Three Phase AC 380/400/415/440V (±15%)			
Max Amps(RMS) [A]	25	32	37	45
Output Power, Rated [kW]	11	15	18.5	22
Output Frequency	0 ～ 50Hz/60Hz			

Controller Model	SKI650-030G	SKI650-037G	SKI650-045G	SKI650-055G
Input Data				
Max Input Voltage(Voc)	DC 750V			
Recommended Voltage, at MPP	DC 500-600V			
Recommended PV Array Power [kW]	36 ～ 48	44 ～ 59.2	54 ～ 72	66 ～ 88
Alternate AC Generator				
Input Voltage	Three Phase AC 380/400/415/440V (±15%)			
Max Amps(RMS) [A]	76	76	90	113
Power and VA Capability [kVA]	41	50	59.2	85
Output Data				
Output Voltage, Rated	Three Phase AC 380/400/415/440V (±15%)			
Max Amps(RMS) [A]	60	75	90	112
Output Power, Rated [kW]	30	37	45	55
Output Frequency	0 ～ 50Hz/60Hz			

2.4 SKI650 Solar Pump Inverter Model Description

SKI650-XDXG-4 Input and Output Data

Controller Model	SKI650-075G	SKI650-090G	SKI650-110G	SKI650-132G
Input Data				
Max Input Voltage(Voc)	DC 750V			
Recommended Voltage, at MPP	DC 500-600V			
Recommended PV Array Power [kW]	90 ~ 120	112 ~ 149	132 ~ 176	159 ~ 211
Alternate AC Generator				
Input Voltage	Three Phase AC 380/400/415/440V (±15%)			
Max Amps(RMS) [A]	157	180	214	256
Power and VA Capability [kVA]	114	134	160	192
Output Data				
Output Voltage, Rated	Three Phase AC 380/400/415/440V (±15%)			
Max Amps(RMS) [A]	150	176	210	253
Output Power, Rated [kW]	75	93	110	132
Output Frequency	0 ~ 50Hz/60Hz			

Controller Model	SKI650-160G	SKI650-200G	SKI650-220G	SKI650-250G
Input Data				
Max Input Voltage(Voc)	DC 800V			
Recommended Voltage, at MPP	DC 500-700V			
Recommended PV Array Power [kW]	192 ~ 256	240 ~ 320	264 ~ 352	300 ~ 400
Alternate AC Generator				
Input Voltage	Three Phase AC 380/400/415/440V (±15%)			
Max Amps(RMS) [A]	307	385	430	468
Power and VA Capability [kVA]	231	250	280	355
Output Data				
Output Voltage, Rated	Three Phase AC 380/400/415/440V (±15%)			
Max Amps(RMS) [A]	304	377	426	465
Output Power, Rated [kW]	160	200	220	250
Output Frequency	0 ~ 50Hz/60Hz			

2.4 SKI650 Solar Pump Inverter Model Description

Controller Model	SKI650-280G	SKI650-315G	SKI650-355G	SKI650-400G
Input Data				
Max Input Voltage(Voc)	DC 750V			
Recommended Voltage, at MPP	DC 500-600V			
Recommended PV Array Power [kW]	336 ~ 448	378 ~ 504	426 ~ 568	480 ~ 640
Alternate AC Generator				
Input Voltage	Three Phase AC 380/400/415/440V (±15%)			
Max Amps(RMS) [A]	525	590	665	785
Power and VA Capability [kVA]	396	445	500	565
Output Data				
Output Voltage, Rated	Three Phase AC 380/400/415/440V (±15%)			
Max Amps(RMS) [A]	520	585	650	725
Output Power, Rated [kW]	280	315	355	400
Output Frequency	0 ~ 50Hz/60Hz			

Note: according to different regions, the recommended PV array power is 1.2 ~ 1.6 times the power of the controller.

2.5 Outline & Installation Dimensions

### 2.5.1 Outline & installation dimensions diagram
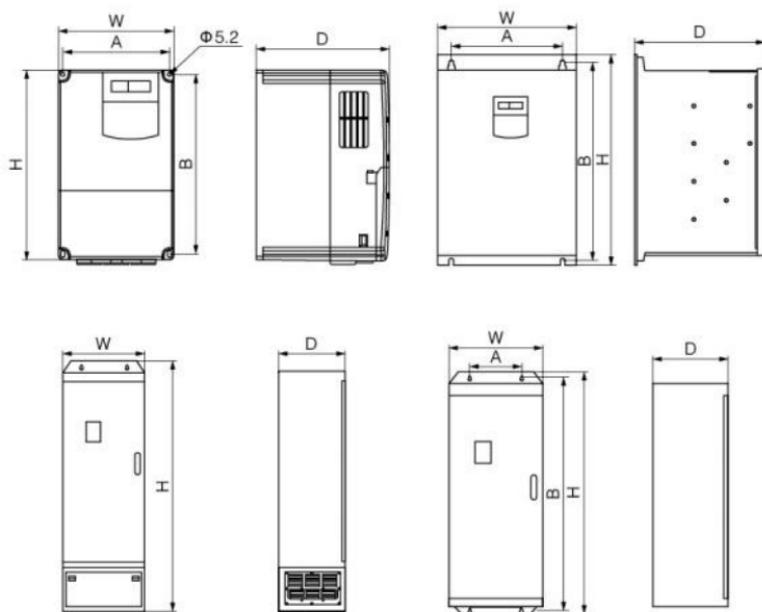
Figure 2   Outline & installation dimensions diagram

2.5 Outline & Installation Dimensions

2.5.2 Table of outline & installation dimensions

Power(kw)	Installation Dimensions		Outline Dimensions			Holes (mm)	Note
	A(mm)	B(mm)	H(mm)	W(mm)	D(mm)	Φ(mm)	
0.75 ～ 2.2	115	175	185	125	160	4	-
4.0 ～ 7.5	136	230	246	150	176	5	-
11 ～ 15	201	306	320	218	215	5	-
18.5	175	313	335	220	218	6.5	-
22	175	360	375	205	209	9	-
30 ～ 45	175	460	477	290	229	8	-
55 ～ 75	210	577	594	350	260	8	-
90 ～ 110	342	680	700	475	320	8	-
132	320	738	756	460	345	8	-
160 ～ 220	270	1233	1275	490	405	12	Without base
			1448	490	405	-	With base
250 ～ 350	500	1325	1362	750	415	12	Without base
			1670	750	415	-	With base

Chapter 3 Mechanical and Electrical Installation

3.1 Mechanical Installation

3.1.1 Overheat protection

Install the SKI650 solar pump inverter 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. Placing the control box in direct sunlight or high ambient temperatures will result in reduced performance due to temperature foldback protection of the SKI650 solar pump inverter. For optimum performance, maximize the shading of the control box.

It is recommended that use a wire tube to protect the electric wire from the destruction of wildlife and natural weathering, and bury the wire tube into the ground to strengthen protection. If you do not use a wire tube, you can use a higher quality outdoor cable.

3.1.2 Location Selection

The SKI650 solar pump inverter is intended for operation in ambient temperatures up to 60 ℃ , but in order to avoid overheating caused by the failure, it is recommended to install the controller in the shadow position.
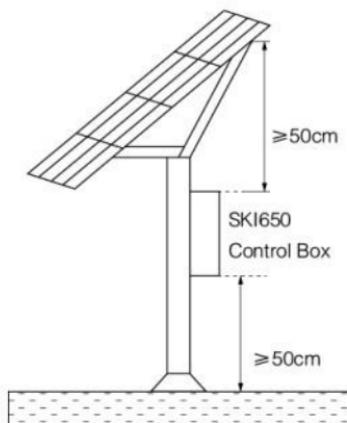

Figure 3   Control Box Location

3.1 Mechanical Installation

The SKI650 solar pump inverter 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 have a bottom gland plate for installing wire cord or conduit. To decide the size of control box, Please refer to the following Figure 4.
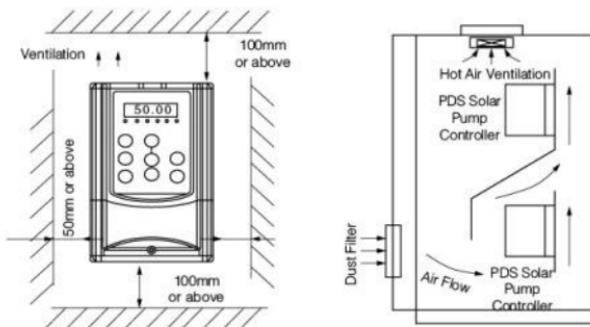

Figure 4   Ventilation Arrangement and Required Distances

3.2 Electrical Installation

3.2.1 Terminals

The following are typical figures of terminal blocks.

**Note: Terminals are different in shapes and combinations, depending on different sizes of SKI650 Solar Controllers.**
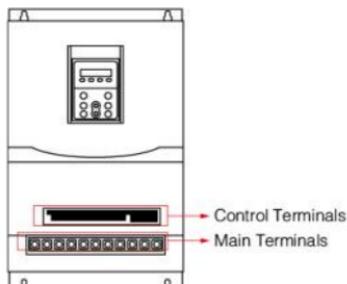
Figure 5   Terminals Arrangement of SKI650 Solar Pump Inverter

3.2 Electrical Installation

GROUND	P+	PB	R	S	T	U	V	W	GROUND
GROUND	No Function		AC/DC INPUT The DC and AC can't input at the same time.			Pump To reverse direction, reverse any two wires.			GROUND
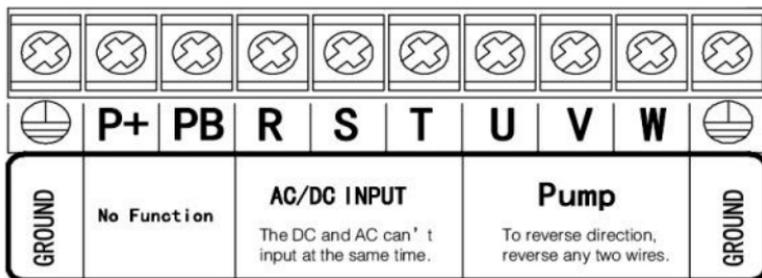
Figure 6   Main terminals (The sequence may be different from actual product)

+10V	A12	GND	COM	X3	X4	FWD	COM
No Function			Low-water sensor probe		NO / NC Remote Float Switch		
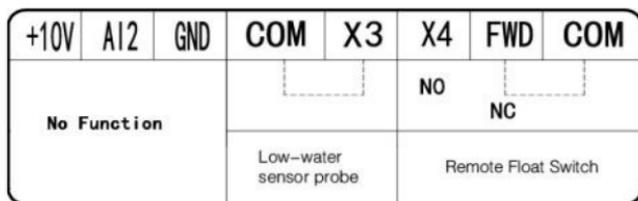
Figure 7   Control terminals (The sequence may be different from actual product)

3.2.2 Power in DC Wiring

For Solar Pumping Systems, a two-pole DC disconnect switch must be installed between the solar array and the SKI650 solar pump inverter.

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 SKI650 solar pump inverter's terminals block labeled as "R", "T".

Note: The R, S, T terminals are with anti reverse connection protection; DC power supply can be connected in the R, S, T terminals, can not consider the phase sequence.

3.2 Electrical Installation

> ⚠️ **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.
>
> ◇ To ensure that the polarity of the solar array cable must be properly connected to the controller's R, T pole, otherwise possible damage the controller.
>
> ◇ Make sure that AC power is disconnected (If AC power supply is wired as backup power, AC and DC power supply can not simultaneously put into the controller, otherwise it will damage the controller.)

3.2.3 Junction box connection

If there are a large number of solar modules, it is needed to use a junction box to converge the bus to the solar array. The junction box need to install fuses, lightning protection device and DC switch. The fuse and the DC switch can prevent the short circuit protection; the lightning protection device can play the direct current side the lightning protection function. The junction box must be sealed, and water can not enter.

3.2.4 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. Correct grounding helps to prevent shock hazard if there is a fault in the motor.

3.2.5 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 6). 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)	Brown (BRN)	Ground (GND)

Figure 8   Motors with international leads

3.2 Electrical Installation

3.2.6 Low water level probe wiring (optional)

In order to avoid dry pumping lead to pump damage can be connected a wells probe to the terminals of the SKI650 solar pump inverter, so as to detect the water level in wells and the wire maximum length can not be more than 50m. Also set F0.06 as 1, set F7.09 as 1, set F7.02 as 9. If the probe is not available or connected, please short connect X3 and COM. If there is no water level probe for the detection of the water level, the controller can also detect water through the built-in software water detection function.

3.2.7 Water tank level float wiring (optional)

Use a floating ball switch to prevent reservoir overflow is recommended. When the reservoir is full, the pump will stop; when the water level is lower than the low level, the pump will be restarted. It can prevent the overflow, limit the unnecessary pump wear. Set F0.06 as 1, set F7.09 as 1, F7.03 as 6. If the floating ball switch is not available or connected, please short connect FWD and COM.
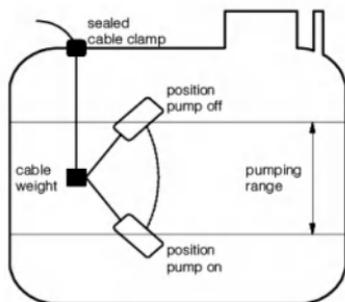
Figure 9   Floating Ball Diagram

Floating ball switch request:

◇ Three signal line

◇ The minimum requirements for 1 mm^2 line diameter, the distance up to 600m

◇ If the application is in a long distance transmission, the need to use the shielded wire. The end of the shielding layer close to the controller needs to be grounded, the end close to the floating ball switch; the end close to the float switch is not required to be grounded.

If the float switch is not used, the FWD and COM are kept short.
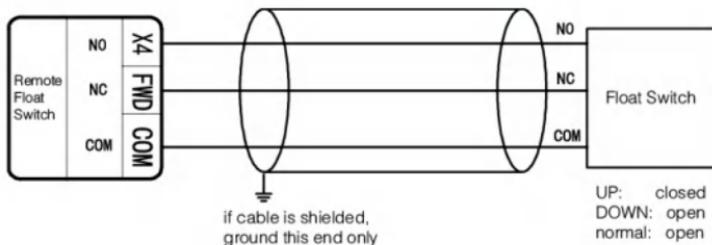
Figure 13 Float ball wiring diagram

3.2 Electrical Installation

3.2.8 Electrical conduit

When the system installed in the outdoor, electrical conduit can be used to protect the outdoor electric wires, so as to avoid the impact from the weather, human activities, chewing animals. If you do not use the electrical conduit, use the higher quality outdoor wire.

System Wiring Diagram
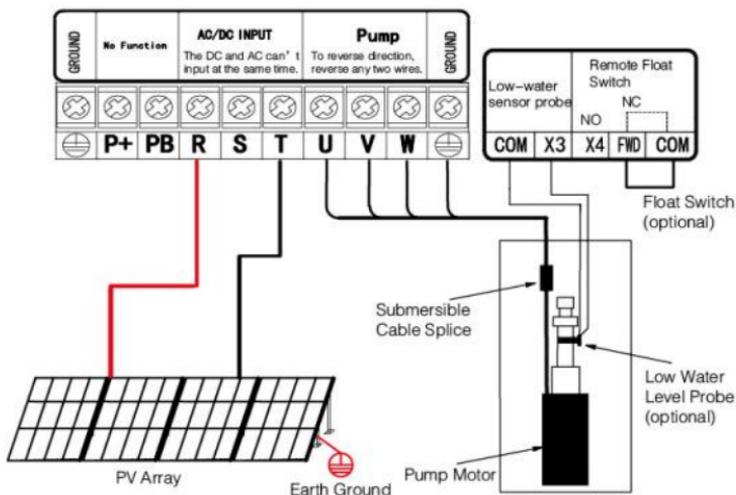
Figure14   System Wiring Diagram

NOTE

◇ The float switch is optional; if not use, please keep the terminal FWD and COM short.

◇ Low water level probe is optional; if not use, please keep the terminal X3 and COM short.

In the case of conventional 250W polycrystalline components, the peak voltage is 30.6V and the open circuit voltage is 37V. Description of the number of input components in series :

The SKI650-1 series controller is connected in series with the serial number of the input components of the 10 ～ 12 block, and the 250W 280 ～ 360VDC (MPPT) is satisfied.

The SKI650-4 series controller is connected in series with the serial number of the input components of the 18 ～ 20 block, and the 250W 500 ～ 600VDC (MPPT) is satisfied.

Chapter 4 Start-up and Operation

4.1 Keypad Description
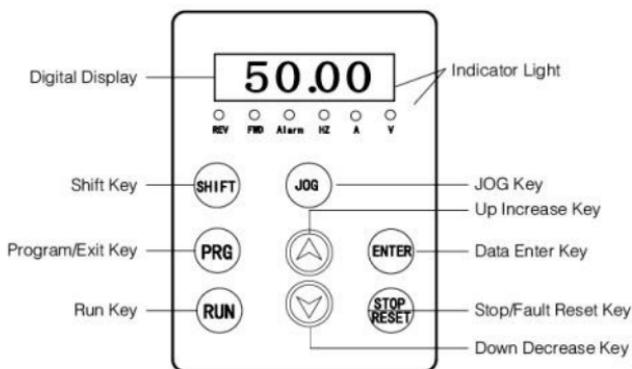
Figure 15 Keypad Schematic Diagram

Symbol	Button Name	Function Description
PRG	program/exit key	Enter or exit of menu, parameter modification
ENTER	data enter key	Progressively enter menu and confirm parameter
▲	UP increase key	Progressively increase data or function codes.
▼	DOWN decrease key	Progressively decrease data or function codes.
≫	shift key	Use it to select displayed parameters cyclically during running or stop status. In parameter setting mode, press this key to select the bit to be modified.
RUN	run key	Start to run the controller in keypad control mode.
STOP RESET	stop/reset key	In running status, use it to stop the controller. In malfunction alarm status, use it to reset the controller.

4.2 Keypad Operation Process

4.2.1 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)

In order to set up the electric automatic start function F7.09=1 as an example, the modified parameter flow chart is as follows:
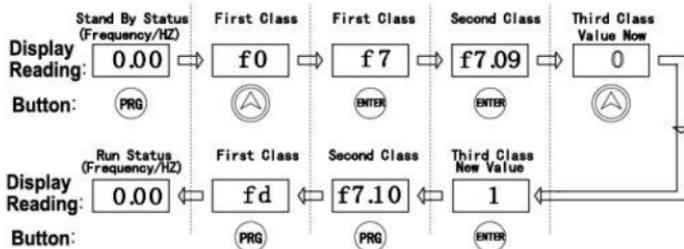
Figure 16   Schematic Diagram of Function Parameters

4.2.2 Fault Reset

After the controller has failed, the controller will display the relevant fault code information. The conventional fault code (E32) can automatically reset after 10s operation, and can also choose to reset the STOP/RESET on the keyboard. If the conventional failure persists, the controller will reset once every 10s. Special fault code requires the user through the STOP/RESET key on the keyboard to reset the fault; the controller can continue to run after the reset.

4.3 Trial operation

◇ 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 the DC switch.

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

4.3 Trial operation

For Example, if the motor which rated frequency is 60Hz, these parameters need modification:

High limit of running frequency F0.15=60, F0.16=60;

Other related parameters are: motor rated power F2.01, motor rated frequency

F2.02=60, motor rated speed F2.03 , motor rated voltage F2.04, motor rated current F2.05.

Note: default motor rated frequency setting is 50Hz.

Slowly start to check the direction

Pressing the RUN/STOP key to start the motor shortly and slowly, and check the direction of the pump.

If the pump is in dry-run state, the maximum operating time can not exceed 15s, otherwise it may cause damage to the pump.

If the pump is in dry-run, the maximum operating time can not exceed 15 seconds; otherwise it may cause damage to the pump. If the pump steering error, close the DC switch, according to the pump / motor wiring to change the wiring of the motor section of the two leads.

After the above parts are complete, you can try to run the system.

Let the system work for an hour, check the water supply capacity.

Commissioning finish

When the light is insufficient, the solar power module output power will be reduced, and the pump operation speed will be very slow until stop. The controller will attempt to start every 120s, and during the trial run, the running indicator is always on.

When a shadow suddenly passes through the solar array, the controller will lose track of the input voltage, and the pump will stop working. But the controller does not show the fault, the controller will try to restart the pump.

4.4 Running status panel display parameters

Description: press "shift" key to switch

Display code	Name	Description	Unit	Remarks
H	Operating Frequency	The Operating Frequency	Hz	◎
	Output Voltage	Controller Output Voltage	V	
A	Running Current	Controller Actual Output Current	A	◎
	Input Voltage	DC Input Voltage	V	

4.5 User Definable Parameters

○ : 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.

Group : Basic Parameters

Function Code	Function	Descriptions	Unit	Factory Setting	Modification Type
F0.16	Upper limit of running frequency	F0.17 ~ F0.15	Hz	50.00	●
F0.17	Lower limit of running frequency	0.00 ~ F0.16	Hz	0.00	●
F0.19	Acceleration time	0.1 ~ 3600	s	Model Setting	○
F0.20	Deceleration time	0.1 ~ 3600	s	Model Setting	○
F0.10/ F0.11	Default setting	LED ones digit: power down storage 0: storage 1: not storage LED tens digit: power down storage 0: hold 1: not hold LED hundred digit: up/down key, frequency 0: invalid 1: valid		000	○

Group : Motor Parameters

Function Code	Function	Descriptions	Unit	Factory Setting	Modification Type
F2.01	Motor rated power	0.4 ~ 999.9	kW	Different according to inverter model	●
F2.02	Motor rated frequency	0.01 ~ F0.15	Hz	50.00	●

4.5 User Definable Parameters

Group : Motor Parameters

Function Code	Function	Descriptions	Unit	Factory Setting	Modification Type
F2.03	Motor rated speed	0 ～ 60000	rpm	Different according to inverter model	●
F2.04	Motor rated voltage	0 ～ 999	V	Different according to inverter model	●
F2.05	Motor rated current	0.1 ～ 6553.5	A	Different according to inverter model	●

Group: Display Interface Parameters

Function Code	Function	Descriptions	Unit	Factory Setting	Modification Type
F0.00	User password	0 ～ 65535		0	○
D-33/ D-34	Radiator temperature	0 ～ 110.0	°C	0	◎
F0.01	Inverter software version	1.00 ～ 99.99		1.00	◎
D-35	Accumulative running time	0 ～ 65535	hour	0	◎

Group: Protection and Malfunction Parameters

Function Code	Function	Descriptions	Unit	Factory Setting	Modification Type
D-50	Fault record of the one before last	0: No fault 1: Inverter module protection (E-11) 2. Over-current when accelerate (E-01) 3. Over-current when decelerate (E-02) 4: Over-current atconstant speed (E-03)		0	◎

4.5 User Definable Parameters

<div align="center">Group: Protection and Malfunction Parameters</div>

Function Code	Function	Descriptions	Unit	Factory Setting	Modification Type
D-51	Last fault record	5: Over-voltage when accelerate (E-04) 6: Over-voltage when decelerate (E-05) 7: Over-voltage at constant speed (E-06) 8: Reserved 9: Under voltage (E-07) 10: Inverter overload (E-09) 11: Motor overload (E-08) 12: Phase-lack of input (E012) 13: Phase-lack of output (E013) 14: Heatsink overheating (E-15/E-16) 15: External fault (E-19) 16: Communication fault (E-17/E-18/E-27) 17: Reserved 18: Current detection fault (E-20) 20: Reserved 21: Reserved 22: EEPROM fault (E-22) 26: Water shortage fault (E-32)			◎
D-52	Running frequency when fault occurs	0 ∼ F0.16	Hz	0.00	◎
D-53	Output current when fault occurs	0.00 ∼ 6553.5	A	0.00	◎
D-54	DC bus voltage when fault occurs	0 ∼ 999	V	0	◎

4.5 User Definable Parameters

Group: Solar pumping special parameters

Function Code	Function	Descriptions	Unit	Factory Setting	Modification Type
F0.05	Control mode	0: common V/F control(manually torque boost) 1: advanced V/F control(automatically torque boost) 2: open loop current vector control (SVC) 3: closed loop current vector control (reserved) 4: separated type V/F control Note 1: choose control method 3(closed loop current vector control) input terminal X6 can only be used for ordinary terminal, not for high-speed pulse input. Note 2: this parameter can not be initialized, please modify it manually.	1	Depending on model	✕
F0.06	Run command channel selection	0: Control Panel Run Command Channel 1: Terminal Run Command Channel 2: Communication Run Command Channel		1	○
F0.07	Main frequency source A selection	10: MPPT Open		10	○
F0.15	Max output frequency	Low-frequency Stage: Max (50.00, 【F0.16】) - 300.00 High-frequency Stage: Max (50.0, 【F0.16】) - 3000.0	Hz	50	●
F1.08	Stop mode	0: Deceleration Stop 1: Free Stop		0	●
F2.10	Asynchronous motor no-load current	0.01 - 655.35A	A	Model Set	●

4.5 User Definable Parameters

Function Code	Function	Descriptions	Unit	Factory Setting	Modification Type
		Group: Solar pumping special parameters			
F7.00	Input X1 function	0: control terminal idle 1: forward run(FWD) 2: reverse run(REV)	1	1	×
F7.02	Input X3 function	9: External fault normlly- close input		Model Set	●
F7.03	Input X4 function	0: control terminal idle 43: timing triggering input	1	43	×
F7.09	Auto start when power on	0: Disable 1: Enable		1	○
F7.21	Programmable relay R2 output	0: no output 25: preset operation time out	1	0	×
F7.34	Time out processing	0: stop timing, stop output 1: stop timing, resume output 2: cycle timing, stop output 3: cycle timing, resume output	1	3	×
F7.35	Timing start condition	0: timing starts since power on 1: timing starts in operation status, and stops in stop status	1	1	×
F7.36	Timing setting	0 ~ 65535s	1s	0	○
FC.04	Restart after power failure	0: Disable 1: Start at start frequency 2: Start in speed tracking mode		1	●
FC.05	Restart delay after power failure	0.0 ~ 60.0s	0.1s	60.0	×
FC.06	Times of automatic reset for water shortage failure	0 - 100 Set as 100 Means That There Is No Limit to Times, That Is Countless Times		50	●
FC.07	Water shortage detection automatic start-up interval	0.1 - 6000.0Min	min	20.0	●

4.5 User Definable Parameters

Group: Solar pumping special parameters

Function Code	Function	Descriptions	Unit	Factory Setting	Modification Type
FC.12	Freq. decreasing point of instantaneous power failure	220V: 180~330V 250V 380V: 300~550V 450V	1V	Depending on model	✕
FC.13	Freq. decreasing factor of instantaneous power failure	0: the function of immunity to transient power failure is disabled 1 ~ 100	1	82	○
FD.00	Mode selection	0: General Use 1: Solar Use 2: Constant Pressure Water Supply Use		1	○
FD.01	MPPT max voltage	(FD.02)-1000 380V: 537V 220V: 311V	V	Model Set	○
FD.02	MPPT min voltage	0 - (FD.01) 380V: 350V 220V: 200V	V	Model Set	○
FD.03	Lowest running frequency when yielding water	0.00 ~ F0.16	Hz	0	○
FD.04	Water shortage detection current ratio corresponding to no-load current	80.0 ~ 300.0	%	150.00	○
FD.05	Water shortage detection time	0 ~ 250 (0: disabled)	s	10	○
FD.06	Power on auto start delay	0 - 65535	s	120	○

4.5 User Definable Parameters

Parameter interpretation:

FD.03, Low limit of running frequency: this parameter defaults to 20Hz, when the light becomes weak, and the controller output frequency is lower than FD.03, the controller will be in standby mode. After the light becomes strong, the controller will rerun. Can set this parameter artificially, in order to avoid pump at low speed without water, reduce the pump abrasion at low speed.

F2.01-F2.05 Motor parameter: the user can be set according to the actual pump motor nameplate parameters

F0.00 user password: the user can set a 5 digits password; after the password is set up and confirmed, the password will be valid for 3 minute.

F7.09, Automatic start when power on: the factory defaults to 0 (disabled).It can be set to 1 (enabled), then as long as the solar module power supply, the controller will automatically start and achieve automatic operation of the whole day.

FD.05 water shortage detection time: when applied to a deep well pump, not using the water level probe to detect the water shortage, the controller can use the built-in water shortage detection function to complete the water shortage detection. When this parameter is not 0, the software will start the function of water shortage.

Software shortage detection principle: If the water shortage happens, the controller will still run FD.05 time, after that it will appear the water shortage fault E-32. The fault will be reset and the controller will restart automatically after 20 minutes. If there is no water shortage but fails E-32, it may appear false; then you can simply reduce FD.04 value.

WARNING : DO NOT touch any other piece inside the SKI650 Solar pump inverter while power is applied. To service any other areas of the inverter, disconnect ALL power sources and wait 5 minutes before continuing.

For the selection of SKI650 solar pump inverter, it can be matched with the power of the pump. However, if the controller drives a submersible pump, please use a higher - rated controller; if the length of cable is more than 100m, add an output reactor. For example, to an application of 50m deep well, a 5.5kW controller should be selected to control a 4kW motor.

Chapter 5   Diagnostics and Troubleshooting

The SKI650 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.

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.

5.1 Fault Codes

Fault code	Fault description	Possible causes	Remedy
E-01	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
E-02	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
E-03	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
E-04	Over-voltage during acceleration	Abnormal input voltage	Check input power
		Restart the motor when instantaneous trip-off occurs	Avoid prompt restart when trip-off
E-05	Over-voltage during deceleration	Too-fast deceleration	Add proper braking units
		Abnormal input voltage	Check input power supply or wiring

5.1 Fault Codes

Fault code	Fault description	Possible causes	Remedy
E-06	Over-voltage at constant running speed	Abnormal input voltage	Install proper input AC reactor
E-07	Under voltage of DC bus	Too-low input voltage	Check input power supply or wiring
E-08	Motor overload	Too-low input voltage	Check input power supply or wiring
		Lower-rating controller	Replace with higher-rating controller
E-09	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
E-10	Off load	Output current lower than off-load detection	Check load
E-11	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
E-12	Input phase loss	Phase loss of power supply	Check power supply and wiring
E-13	Output phase loss or current imbalance	Broken wires in the output cable	Check the wiring and installation
		Broken wires in the motor winding	
		Loose output terminals	
E-14	Short trouble of output to ground	reserved	reserved

5.1 Fault Codes

Fault code	Fault description	Possible causes	Remedy
E-15/ E-16	Controller overheat	Instantaneous over-current 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	
E-17	Communication	Improper baud rate setting	Set proper baud rate
E-18/ E-27	fault	Receive wrong data	Push STOP/RESET to reset and ask for support
		Long-time communication interruption	Check communication devices and cables
E-19	External device fault	External device (water probe) detected no water	Ensure enough water and restart the inverter manually
		External device (water probe) is broken or short connection failed	Replace the external device or short connect X3 & COM
E-20	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	
E-21	Motor tuning fault	Wrong setting of motor parameters	Reset the motor parameter
		Mismatching of power specification between driver and motor	Seek help from manufacturer
		Tuning timeout	Check motor wiring

5.1 Fault Codes

Fault code	Fault description	Possible causes	Remedy
E-22	EEPROM fault	Read/Write fault of control parameters	Push STOP/RESET to reset
		EEPROM damaged	Ask for support
E-23	Parameter copy fault	Upload fault of the driver parameter to operation panel	Check wiring of operation panel
		Download fault of parameter from operation panel to the driver	Check wiring of operation panel
		Parameter download without upload in advance	Upload parameter first, then download
E-24	PID feedback disconnecting	PID feedback wire is loosen	Check feedback wiring
		Feedback value lower then disconnection detection value	Adjust detection input threshold
E-25	Voltage feedback disconnecting	Feedback value lower then disconnection detection value	Adjust detection input threshold
E-26	Arrival of operation limit time	Arrival of operation limit time	Seek help from agent
E-27	Co-processor communication fault	reserved	reserved
E-28	Encoder disconnecting	reserved	reserved
E-29	Large deviation of speed	reserved	reserved
E-30	Overspeed fault	reserved	reserved
E-31	reserved	reserved	reserved
E-32	Water shortage protection	Water shortage of water source	Stop the controller Repair broken wiring or replace water level switch
		Verify if the setting of FD.04 "Water shortage detection current ratio" is too high, while FD.05 "Water shortage detection time" is non-zero and the current sensing is enabled.	Reduce setting value of FD.04

5.2 Common Faults and Remedies

The SKI650 solar pump inverter may have following faults or malfunctions during operation, please refer to the following remedies.

5.2.1 Pump can not run

The main problem of the new system is that the wiring is not standardized and the controller terminal line falls, so that the pump can not run. Sometimes the RUN indicator light on the keyboard is bright, and the controller also has voltage output, but may be the solar array does not have enough power to start the pump; then the controller will attempt to start the pump every 120s. There are the following reasons for the pump can not run:

◇ If there is no enough sun light, and the controller"s input power is not enough.

◇ Motor wiring errors cause the pump to reverse, change the wiring.

◇ The motor shaft vibrates and can not rotate, it may be caused by the wiring errors; Need to recheck the motor wiring.

◇ Pumps and pipes are clogged with mud and debris, and the pump can't run

5.2.2 Controller over current, overload fault

The controller appears over current and overload failure may be due to the following reasons:

◇ The pump or pipe plug causes the pump current increase and the controller protection; Need to pull out the pump and check.

◇ Because of the increase in operating current of the pump, which is caused by the pump wire is too long, the controller will be protected, and the controller will be enlarged to use.

5.2.3 DC switch trip when power on

◇ A multimeter can be used to check the internal circuit of the controller, if there is a short circuit, the machine has been damaged

◇ Check if the machine has a burning smell; if there is a burning smell, please contact the agent to replace the controller

5.2.4 The keyboard without display after power on

◇ Use a multimeter to measure the input voltage of the controller; check the voltage is normal.

◇ Check if the machine has a burning smell; if there is a burning smell, please contact the agent to replace the controller

Chapter 6   Regular maintenance

6.1 Controller and 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.

◇ **pump**

The pump's motor is permanently sealed, no need to maintain. Pump head is a mechanical device, may be used for a period of time, due to the sand in the water, and other impurities cause a certain wear, the performance of the pump needs to be regularly detected. If the flow of the pump is less than the normal value, may need to be replaced.

6.2 Solar panels

Periodically cleaning of the surface of panels and checking wiring are required.

6.3 Cable

Need to regularly check the power cable and ground wire to make sure all the wires are reliably connected and without being corroded.

Chapter 7   Backup AC power

In order to ensure continuous water supply, solar water pump system can be manually switched to standby AC power supply when the light is insufficient or wet days. When switching, the need to ensure that the DC and AC power supply reliable mutual lock. Backup AC power source can be a local power grid, or a diesel generator (please refer to the 2.4.3 technical form).

Warning: at any time, only one power supply can be entered, otherwise it may cause the controller to damage.

Take three phase 380VAC backup AC power supply for example, the wiring is shown in the following diagram:
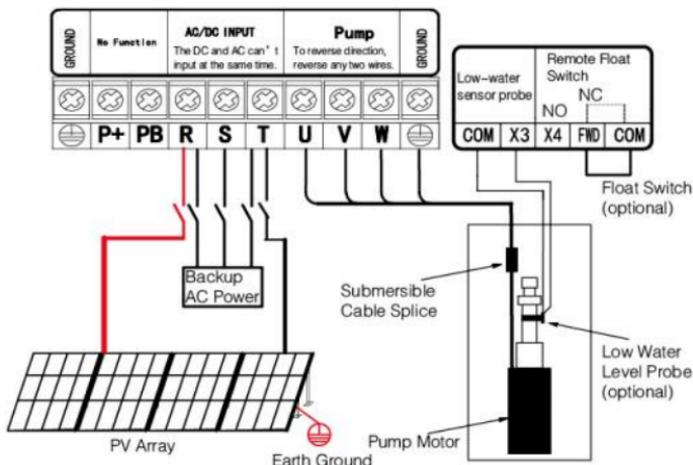
Figure 17 schematic diagram of alternate AC power supply

If the pump motor rated voltage is three-phase 220-240VAC, then the single-phase 220VAC standby power supply L/N power line, need to be connected to the main terminal R/T of the controller

System Report

System and Components	
Date of Purchase	
Distributor (Contact details)	

System				
Controller Serial Number				
Motor Serial Number or Power				
Pump Type	Submersible		Surface	

Solar Power				
Solar Module				
Manufacturers				
Type				
Peak Voltage (Vmp)				
Open Circuit Voltage (Voc)				
Quantity				
Connection		Series		Parallel

System Report

Installation	
Installation Date	
Installer (contact details)	

Submersible Pump			Surface Pump		
Well Depth		m/ft	Head (self suction)		m/ft
Pump Depth		m/ft			
Vertical Height (well mouth to the tower top)		m/ft	Suction lift		m/ft
Static Water Level		m/ft	MAX. Suction lift		m/ft
Dynamic Water Level		m/ft			

Vertical Pipe in Well (pump)			Suction Pipe		
Diameter		mm/inch	Diameter		mm/inch
Type			Type		
Length		m/ft	Length		m/ft

Additional Pipe (to water tower)			Vertical Pipe		
Diameter		mm/inch	Diameter		mm/inch
Type			Type		
Length		m/ft	Length		m/ft

Cable of Submersible Pump			Cable of Surface Pump		
Wire Diameter		mm²/AWG	Wire Diameter		mm²/AWG
Length (from the controller to pump)		m/ft	Length (from the controller to pump)		m/ft