USER MANUAL

CONTROLVIT CV30-PV VARIABLE FREQUENCY DRIVE FOR SOLAR-POWERED WATER PUMPING

salicru

Contents

1 Introduction

Thank you for purchasing the CV30-PV drive from SALICRU. In this manual, you will find the necessary basic information to put into operation the CV30-PV variable frequency drive for solar-powered water pumping and its attachments.
If you need additional advanced information, contact your technical service.

2 Safety precautions

Please read this manual carefully and follow all safety precautions before moving, installing, operating and maintaining the drive. Failure to follow the precautions can cause damage to devices or lead to physical injury or even death.
In the event of damage to the devices, physical injury or death as a result of disregarding the safety precautions in this manual, SALICRU will accept no liability and will not be legally bound in any way.

2.1 Safety instructions

	✧ Only qualified electricians may operate the variable frequency drive. ✧ Do not work on the wiring, carry out checks or change components when the device is live. Make sure that the power input voltage is disconnected before working on the wiring or carrying out checks, and always wait at the very least for the time indicated on the variable frequency drive to elapse or until the DC voltage of the DC bus is **below 36V**.
	✧ Do not repair the variable frequency drive in an unauthorised manner, as this could cause a fire, electric shock, or other injury.
	✧ The electrical parts and components inside the drive are electrostatic. Take measures to prevent electrostatic discharge and work accordingly.

2.2 Delivery and installation

	✧ Install the drive on fire retardant material and keep it away from combustible materials. ✧ Do not operate the drive if it is damaged or any of its components are missing. ✧ Do not touch the drive with any part of the body or wet objects, as this can cause electric shock.

Note:

- ✧ Select appropriate device installation and movement tools to ensure safe and normal operation of the drive, and prevent physical injury or death. For reasons of physical safety, the installer must take mechanical protective measures, such as the use of safety shoes and work clothes.
- ✧ Ensure that the device is not subjected to knocks or vibration during transportation or installation.
- ✧ Do not hold the drive by its cover. This could detach.
- ✧ The drive cannot meet the low voltage protection requirements of the IEC 61800-5-1 standard if the facility is more than 2000m above sea level.
- ✧ The drive's current leakage can be more than 3.5mA during operation. Earth the device using the appropriate methods and make sure that earth resistance is less than 10Ω.
- ✧ (+) and (-) are the terminals for the photovoltaic panels. R, S and T (L, N) are the input terminals for the alternating current supply. U, V and W are the output terminals to the pump. Connect the input power cables and the pump cables in the appropriate manner, otherwise the drive may become damaged.

2.3 Start-up and operation

- ✧ **The drive starts up by itself when it has sufficient input voltage, either by direct current (solar panels) or alternating current (mains or power generator).**
- ✧ **Disconnect all voltage sources applied to the drive before connecting any cable to its terminals and wait at the very least for the time indicated on it to elapse after disconnecting the power supply.**
- ✧ **During operation of the drive, it has high voltage inside. Do not perform any operation, except setting parameters with the console. Cover the terminals with the device cover before operation.**
- ✧ **Check that the working conditions specified by the pump manufacturer are met, especially with regard to minimum work frequency and acceleration time (parameters P15.05 and P00.11). Otherwise, the pump may become damaged.**

3 Product description

3.1 General description

CV30-PV series drives have been specially designed to control submersible pumps, and can be powered directly by direct current through solar panels, or, in the event of insufficient solar energy, by alternating current through the electrical mains or a power generator.

The solar light energy obtained is captured through the solar panels and transformed into electricity. This powers the drive, which, in turn, powers the submersible pump, enabling water to be extracted from the ground. The extracted water can be stored at height (tank or reservoir) for subsequent use, or it can be used for direct irrigation, depending on the needs of the facility.

This system is highly useful for any facilities that require a reliable and economically viable water supply either continuously or at certain times of the year.

The CV30-PV series is specifically designed to work in a system like the one described above (it has a specific control panel and firmware). It incorporates an MPPT (maximum power point tracker) algorithm with an efficiency of 99%, which ensures that the drive continuously takes advantage of all available energy from the solar panels.

The family is completed by the BOOST MOD-320-PV booster module for facilities with a reduced number of panels in low power systems (up to 2.2 kW) and external ATS MOD-…-4-PV cards, which enable automatic switching to the mains or a power generator at times when the energy from the solar panels is insufficient.
Possible applications are as follows:
- Accumulation of water at height for later use in irrigation.
- Water supply for livestock.
- Water supply for consumption in isolated areas.
- Irrigation from wells (depending on the needs of the facility)

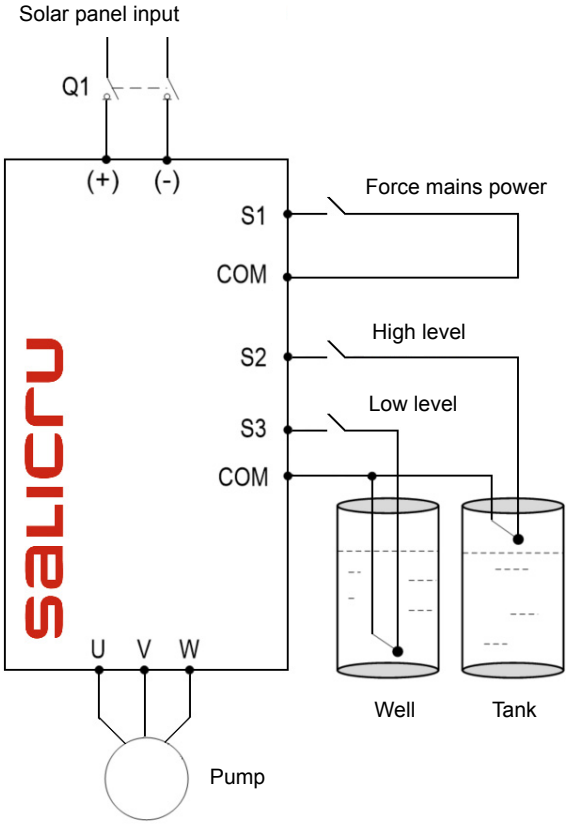
3.2 Specifications

Model	-S2	-4 / -4F
Recommended DC input range (V)	200~400	300~750
Recommended MPPT voltage (V)	330	550
AC input voltage (V)	220(-15%)~240(+10%) (single-phase)	380(-15%)~440 (+10%) (three-phase)
AC output voltage (V)	0~V input (three-phase)	0~V input (three-phase)
Max. DC voltage (V)	440	800
Start-up voltage (V)	200	300
Min. operating voltage (V)	150	250

Important note: It is possible to control 230Vac single-phase pumps by using a -S2 or -4/-4F drive, and 230Vac three-phase pumps by means of a -4/-4F drive.
To do so, parameter P15.39 needs to be set to the appropriate value to enable conversion between models.
Please contact your technical service if you wish to make a model conversion.

3.3 Basic general wiring

The following figure shows the standard wiring of the drive.



Note: The polarity of inputs S1, S2 and S3 can be changed using parameter P05.10. Refer to section 6 (Function codes).

- ✧ DC switch Q1 must be installed as a protection switch for the photovoltaic input.
- ✧ To connect the BOOST MOD-320-PV booster module, refer to section 7.1.
- ✧ When the distance between the solar panels and the drive exceeds 10 metres, Type 2 overvoltage protectors should be installed (refer to the table in section 9).
- ✧ When the distance between the drive and the pump exceeds 50 metres, output filters should be used. The distance determines which solution should be configured. Refer to section 7.3 for how to select the filter model.
- ✧ The drive works automatically after being switched on. To adjust the parameters, follow the instructions for start-up and parameter-setting in Chapters 4, 5 and 6.

3.3.1 Power circuit terminals

Terminal	Description	Function
R, S, T (L, N)	AC input	Alternating current input terminals (R, S, T for three-phase power supply, L and N for single-phase power supply) connected to the mains or a power generator. **Note: Use the screws supplied with the drive in a separate bag.**
(+), (-)	Photovoltaic input	Solar panel input terminals.
U, V, W	Drive output	AC output terminals, connected to the submersible pump motor.
⏚	Earth connection	Safety protection earthing terminal. The drive must be connected to earth.

3.3.2 Control circuit terminals

Type	Terminal	Description	Technical specifications
24V power supply	24V	24V power	24V power supply ± 10%, with maximum output current of 200mA. Generally used as an operating power source for digital inputs and outputs.
	COM	Common terminal	
Digital inputs	S1	Force AC input	Characteristics of the terminals: - Internal impedance: 3.3kΩ - Acceptable voltage input: 12 ~ 24V **Terminal S1**: - Enabled: Forces switching to mains. - Disabled: The drive will be powered in the mode indicated by the control of the drive at that moment, either by solar energy or mains. **Terminal S2**: Connected to the maximum tank level switch. Contact is set as **normally open (NO), but can be changed using parameter P05.10**. **Terminal S3**: Connected to the minimum well water level switch. Contact is set as **normally open (NO), but can be changed using parameter P05.10**.
	S2	Full tank alarm.	

Type	Terminal	Description	Technical specifications
	S3	Empty well alarm.	P05.10=2 Changes input S2 to NC. P05.10=4 Changes input S3 to NC. P05.10=6 Changes inputs S2 and S3 to NC.
Communication	RS485+ RS485-	Communication RS485	RS485 communication interface
	422TX+ 422TX- 422RX+ 422RX-	Communication RS422	Communication terminals for the connection of the optional BOOST MOD-320-PV booster module
Relay output	RO1A	NO contact of relay 1	Relay output RO1: RO1A is NO, RO1B is NC, RO1C is the common terminal. Relay output RO2 (only drives ≥ 4 kW): RO2A is NO, RO2B is NC, RO2C is the common terminal. Contact capacity: 3A/AC250V, 1A/DC30V. In the section 7.2 diagram, the coil of the AC input contactor is controlled by the **normally closed contact** of the drive's output relay.
	RO1B	NC contact of relay 1	
	RO1C	Common contact of relay 1	
	RO2A	NO contact of relay 2	
	RO2B	NC contact of relay 2	
	RO2C	Common contact of relay 2	

3.3.3 Cable sections and tightening torques

Model	Recommended cable section (mm^2)		Terminal screw size	Tightening torque (Nm)
	(+)/(-), R/S/T, U/V/W	Earth		
CV30-004-S2 PV	1.5	1.5	M4	0.8
CV30-008-S2 PV	1.5	1.5	M4	0.8
CV30-008-4 PV	1.5	1.5	M4	0.8
CV30-015-4 PV	1.5	1.5	M4	0.8
CV30-022-4 PV	1.5	1.5	M4	0.8
CV30-015-S2 PV	2.5	2.5	M4	0.8
CV30-022-S2 PV	2.5	2.5	M4	0.8
CV30-040-4F PV	2.5	2.5	M4	1.2~1.5
CV30-055-4F PV	2.5	2.5	M4	1.2~1.5
CV30-075-4F PV	4	4	M5	2~2.5
CV30-110-4F PV	6	6	M5	2~2.5
CV30-150-4F PV	10	10	M5	2~2.5
CV30-185-4F PV	16	16	M5	2~2.5
CV30-220-4F PV	25	16	M5	2~2.5
CV30-300-4F PV	25	16	M6	4~6
CV30-370-4F PV	35	16	M6	4~6
CV30-450-4F PV	35	16	M8	10
CV30-550-4F PV	50	25	M8	10
CV30-750-4F PV	70	35	M8	10

4 Console operation procedure

How to enter settings mode

The drive automatically starts up once it has voltage. To set the parameters, press QUICK/JOG during the first 10 seconds after switching on the drive to change to console control mode (the LOCAL/REMOT LED will go out). At this point, it is possible to change the parameters programmed in the device.

If the drive is already running (RUN/TUNE illuminated), press the STOP/RST key to stop it, followed by PROG/ESC to enter settings mode. After setting the parameters, disconnect and connect the drive's power supply. The drive will keep the changes made.

How to change the parameters with the console

Once the drive is in settings mode, 'P00,' which refers to parameter group number 00, will flash on the display.

To select the desired group, scroll with the *UP* and *DOWN* keys until it is visible on the display.

When the desired group appears on the display, press *DATA/ENT* to enter into the group.

If, for example, you are in group 'P02,' 'P02.01' will appear, which is parameter 01 of group 02.

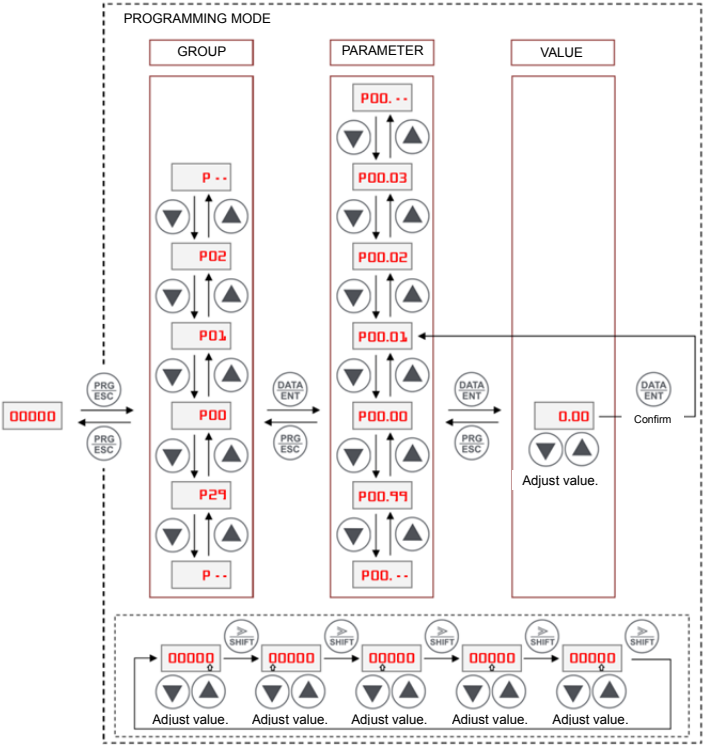
Scroll with the *UP* and *DOWN* keys to change the parameter (always within the same group).

To enter a parameter and change its value, press *DATA/ENT* again. Adjust using the *UP* and *DOWN* keys.

To jump from one digit to another, press the *»/SHIFT* key. The selected digit flashes.

If, for example, you want to enter the parameter '1000,' you can press and hold down the *UP* button or press the *»/SHIFT* button until the digit for units of a thousand flashes and then make the adjustment.

To save the entered value, press *DATA/ENT*. It will automatically jump to the next parameter. To exit without saving, press *PROG/ESC*.


PROGRAMMING MODE
GROUP
PARAMETER
VALUE
00000
PRG ESC
P --
P02
P01
P00
P29
P --
DATA ENT
P00. --
P00.03
P00.02
P00.01
P00.00
P00.99
P00. --
0.00
Confirm
Adjust value.
SHIFT
Adjust value.
Adjust value.
Adjust value.
Adjust value.
Adjust value.

5 Instructions for start-up

Step 1 - Connection of the submersible pump

Connect the three phases of the pump directly to the U, V and W terminals of the drive, as well as the earth to the earth terminal.
If you need to install a ferrite or sine-wave filter, insert these elements, ensuring that they are mounted as close as possible to the drive (refer to section 7.3 Sine-wave filter and ferrite).

Step 2 - Connection of the solar panels

Refer to section 8 (Recommended solar panels) for the recommended solar panel configuration.
Terminal (+) of the drive must be connected to the positive pole of the solar panels, and terminal (-) to the negative pole.
If you wish to have a switched system, connect the mains or a power generator to R, S and T (L, N).
Insert a direct current switch between the drive and the solar panels, and an alternating current switch between the AC input and drive, according to the table in section 9 (Selection of protections).

Step 3 - Enter settings mode

Connect switch Q1 to power the drive.

Attention! The pump will start automatically within 10 seconds. 
To enter settings mode, press the QUICK/JOG key before this time elapses (refer to section 4), or press the STOP/RESET button if it has already started.

Step 4 - Pump motor data

Enter the motor data of the submersible pump (parameters P02.00~P02.05). Refer to section 6 (Function codes).

Step 5 - Selection of acceleration

Check that the acceleration time set (parameter P00.11) meets the requirements of the pump manufacturer.
Remember that the acceleration time is the time it takes the drive to reach maximum frequency (P00.03=50Hz).
If, for example, we select P00.11=5 s, the drive will take 5 seconds to reach 50Hz, but 4 seconds to reach 40Hz, 3 seconds to reach 30Hz, etc.

Step 6 - Selection of power input

Adjust parameter P15.32 according to the power supply that you want to have.
P15.32=0 → Automatic switching between photovoltaic input and AC input.
P15.32=1 → Work only with AC input (mains or power generator).
P15.32=2 → Work only with photovoltaic input (default option).

If you want to perform automatic switching (P15.32=0), adjust parameters P15.33 and P15.34, and make sure that there is a minimum difference of 60V between them. Refer to section 6 Function codes.

Step 7 - Checking pump rotation

Press the RUN key. The drive will immediately enter its operating state. If the flow of water leaving the well is not sufficient for the designed system, it can be assumed that the pump is turning in the opposite direction. If so, press the STOP/RST key, disconnect switch Q1 and wait for the safety time indicated on the front of the drive to elapse.
Swap two of the three output phases of the drive, for example, U and V, and connect Q1 again.

Step 8 - Adjusting the lower frequency

In order to protect the submersible pump, it must always work above a minimum frequency.
The minimum frequency is obtained by multiplying parameter P15.05 (lower output frequency of the PI setting) with P00.03 (maximum output frequency).
Parameter P00.03 is normally 50Hz, so we only need to change parameter P15.05.

⚠ This adjustment is very important because, if it is not done correctly, there is a danger of damaging the pump.

When the pump is working at the minimum frequency for the time defined in P15.23 (default value of 100 s), the drive will indicate alarm A-LS and stop, or switch to the AC input.

Perform the following procedure to adjust the value of P15.05:

1. Press the STOP/RST key.
2. Set parameter P15.00=0.
3. Press the RUN key.
4. Reduce the frequency little by little by pressing the ▼ key until you see that only a trickle of water comes out of the pipe.
   Note down the frequency that appears on the display at that moment.
5. Press the STOP/RST key.
6. Adjust P15.05 according to the following formula:
   P15.05 = (value noted down + 1Hz)*100/50Hz
   If, for example, the frequency noted down is 28 Hz, we would have:
   P15.05= (28+1)*100/50= 58%
7. Set the parameter P15.00=1
8. Press the RUN key.

Step 9 - Tuning the system

When the system is in a situation of low solar radiation (weak sunlight), it may cause the drive to makes frequent starts. To avoid this, increase the time defined in P15.24 (delay for triggering low solar radiation alarm A-LS). For example, increase the value to 900 seconds.

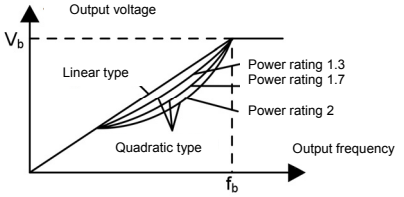
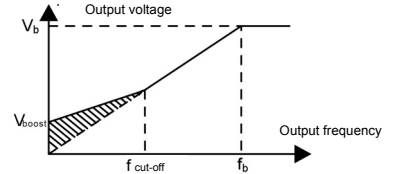
If you encounter any other problem, refer to section 11 (Frequently asked questions), or consult your technical service.

6 Function codes

'○': This means that the parameter can be changed in stopped state and in operating/running state
'◎': This means that the parameter cannot be changed in operating/running state
'●': This means that the value of the parameter is an actual detection of a quantity (for example, the output current of the drive) and it cannot be changed
In the following table, the parameters that need to be adjusted more frequently are shaded.

Function code	Name	Detailed explanation of the parameter	Default value	Modifiable
Group P00 Basic functions				
P00.03	Max. output frequency	This parameter is used to adjust the maximum output frequency of the drive. Users should pay attention to this parameter because it is the basis of the frequency and speed of acceleration and deceleration settings. Adjustment range: P00.04~400.00Hz	50.00Hz	◎
P00.04	Upper frequency limit	The upper limit of the operating frequency is the upper limit of the drive output frequency, which is less than or equal to maximum frequency. Adjustment range: 0.00Hz~P00.03 (max. output frequency)	50.00Hz	◎
P00.11	Acceleration time	The acceleration time is the time required if the drive accelerates from 0Hz to maximum output frequency (P00.03). In order to have good cooling, submersible pumps usually need acceleration times of no more than 6 seconds. Check the pump manufacturer's requirement. Adjustment range: 0.0~3600.0s	Depending on model	○
P00.18	Restoring default values	**0: No operation** **1: Restores default values** **2: Cleans fault records** **Note:** The function code will be restored to 0 after finishing the selected operation. Restoring default values (P00.18=1) will cancel the user password; please use this function with care.	0	◎
Group P02 - Pump motor data				
P02.01	Rated motor power	0.1~75.0kW	Depending on model	◎
P02.02	Rated motor frequency	0.01Hz~P00.03 (maximum frequency)	50.00Hz	◎
P02.03	Rated motor speed	1~36000 rpm	Depending on model	◎
P02.04	Rated motor voltage	0~480V	Depending on model	◎
P02.05	Rated motor current	0.8~150.0A	Depending on model	◎

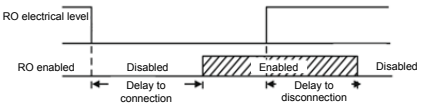
Group P04 - SVPWM control (V/f)

P04.00	V/F curve setting	This function code defines the V/F curve of the CV30-PV drive to meet the needs of different types of pump. **0: Linear V/F curve** **2: Low torque curve and power rating 1.3** **3: Low torque curve and power rating 1.7** **4: Low torque curve and power rating 2** Curves 2~4 are those indicated for pump type loads. The user can adjust this parameter according to the characteristics of the pump in order to achieve better performance. **Note:** In the following image, V_b is the rated motor voltage and f_b is the rated motor frequency. 	4	◎
P04.01	Torque boost	This boosts the torque produced by increasing output voltage. It is used to improve output torque at low frequencies.	0.0%	○
P04.02	Torque boost closing frequency	P04.02 defines the closing frequency, which is specified as a percentage of frequency fb (frequency at maximum output voltage Vb). Torque boost should be selected depending on the type of load. The larger the load, the larger the torque. Excessive torque boost is inappropriate because the motor will be over magnetised, and the current of the drive will increase, raising the temperature of the drive and decreasing its efficiency. When the torque boost is set to 0.0%, the drive is in automatic torque boost mode. Torque boost closing frequency: below this frequency point, torque boost is enabled, and above this frequency point, torque boost is disabled.  Adjustment range for P04.01: 0.0%:(automatic) 0.1%~10.0% Adjustment range for P04.02: 0.0%~50.0%	20.0%	○

Group P05 - Input terminals

P05.01	Function selection for terminal S1	**0**: No function assigned **6**: Stop by inertia (emergency stop) **7**: Fault reset **9**: External fault input **42**: Force the power supply with AC input (when the input is activated, the drive will be powered by the AC terminals. When the input is deactivated, the power input mode will be defined by the control of the drive, which can be DC or AC) **43**: Full tank signal **44**: Empty well signal **45**: Control mode for single-phase motors without condenser. **46**: Automatic function for switching from photovoltaic (PV) power mode to AC power mode, and vice versa. It is used in drives that work without a booster module. When the input is deactivated, the drive will switch to being powered in AC mode.	42	◎
P05.02	Function selection for terminal S2		43	◎
P05.03	Function selection for terminal S3		44	◎
P05.04	Function selection for terminal S4		45	◎
P05.09	Function selection for terminal HDI		46	◎
P05.10	Polarity selection for input terminals	By default, terminals S2 and S3 of the drive are normally open (NO), but can be changed to normally closed (NC) using this parameter. Adjust the following values depending on the desired state: **000**: S2 and S3 are NO **002**: S2 is NC; S3 is NO **004**: S2 is NO; S3 is NC **006**: S2 and S3 are NC	0x000	○

Group P06 - Output terminals

P06.03	Function selection for relay output RO1	**0**: Disabled **2**: Rotation forward **5**: Drive fault **20**: External fault **27:** Low solar radiation fault (A-LS) **30**: Work in photovoltaic mode. If the system is operating in photovoltaic mode, the relay output is activated (the NO contact closes and NC opens.)	30	○
P06.04	Function selection for relay output RO2 (only drives ≥ 4kW)		5	○
P06.10	Time delay to connection of relay output (RO1)	Adjustment range: 0,000~50,000 s 	10.000s	○
P06.11	Time delay to disconnection of relay output (RO1)		10.000s	○
P06.12	Time delay to connection of relay output (RO2)		0.000s	○
P06.13	Time delay to disconnection of relay output (RO2)		0.000s	○

Group P07 - Human-machine interface

Adjust value.		0~65535		
P07.00	User password	Password protection will be enabled when a non-zero value is set. **00000:** Eliminates the previous user password and disables password protection. After the password is validated, if the entered password is incorrect, the user will not be able to enter the parameters menu. Only the correct password allows the user to review or change the parameters. Please remember your user passwords. Password protection will be enabled 1 minute after exiting the parameter editing state. If the password is available, press the PRG/ESC key to enter the function code editing state; then '0.0.0.0.0' will appear on the display. Unless the correct password is provided, the user cannot enter. Note: restoring the drive to factory settings clears and disables the password (leaving it at 00000). Please keep this in mind.	0	○

P07.11	Booster or rectifier module temperature	If the drive is working with a booster module, this parameter shows its temperature, but only when the system is working in AC mode. If the drive is working without a booster module, this parameter shows the temperature of the drive rectifier. Range: -20.0~120.0°C		•
P07.12	Inverter module temperature	Range: -20.0~120.0°C		•
P07.15	High bit of energy meter	Shows the accumulated energy consumed by the drive. Drive power consumption (kWh) = P07.15*1000+P07.16		•
P07.16	Low bit of energy meter	Adjustment range for P07.15: 0~65535 (x1000 kWh) Adjustment range for P07.16: 0.0~999.9 kWh		•
P07.27	Current fault type	**0**: No fault **1**: OUt1 (U-phase IGBT fault) **2**: OUt2 (V-phase IGBT fault) **3**: OUt3 (W-phase IGBT fault) **4**: OC1 (overcurrent during acceleration) **5**: OC2 (overcurrent during deceleration) **6**: OC3 (overcurrent during constant speed operation) **7**: OV1 (overvoltage during acceleration) **8**: OV2 (overvoltage during deceleration) **9**: OV3 (overvoltage during constant speed operation) **10**: UV (undervoltage in DC bus) **11**: OL1 (motor overload) **12**: OL2 (drive overload) **13**: SPI (input phase fault) **14**: SPO (output phase fault) **15**: OH1 (overheating of booster module / rectifier) **16**: OH2 (overheating of inverter module) **17**: EF (external fault) **18**: CE (RS485 communication error) **19**: ItE (current detection fault) **21**: EEP (EEPROM operation fault) **24**: END (adjusted operating time fulfilled) **25**: OL3 (overload prealarm) **32**: ETH1 (earth leakage fault 1) **33**: ETH2 (earth leakage fault 2) **34**: dEu (speed deviation fault) **35**: STo (maladjustment) **38**: Reverse connection of solar panels (PINV) **39**: Photovoltaic overcurrent (PVOC)		•
P07.28	Type of previous fault			•
P07.29	Type of previous fault 2			•
P07.30	Type of previous fault 3			•
P07.31	Type of previous fault 4			•
P07.32	Type of previous fault 5			•
P07.57	Type of previous fault 6			•
P07.58	Type of previous fault 7			•
P07.59	Type of previous fault 8			•
P07.60	Type of previous fault 9			•
P07.61	Type of previous fault 10			•
P07.62	Type of previous fault 11			•
P07.63	Type of previous fault 12			•
P07.64	Type of previous fault 13			•
P07.65	Type of previous fault 14			•
P07.66	Type of previous fault 15			•
P07.67	Type of previous fault 16			•
P07.68	Type of previous fault 17			•

P07.69	Type of previous fault 18	**40**: Photovoltaic overvoltage (PVOV) **41**: Photovoltaic undervoltage (PVLV) **42**: Communication with booster module (E-422) fault **43**: Overvoltage of DC bus detected in booster module (OV) **ALARMS** **A-LS**: Low solar radiation alarm. **A-tF**: Full tank alarm. **A-tL**: Empty well alarm.		•
P07.70	Type of previous fault 19			•
P07.71	Type of previous fault 20			•
Group P08 - Automatic reconnection				
P08.28	No. of reconnection attempts after fault	**Number of reconnection attempts after a fault**: set the number of reconnection attempts after a fault using this function. If the attempts made exceed the set value, the drive will stop due to the fault and wait to be reset manually.	5	○
P08.29	Time interval between fault and reconnection attempt	**Time interval between fault and reconnection attempt**: Allows you to adjust the time interval from when the fault occurs until the reconnection attempt is made. **Note**: Faults OL1, OL2, OH1 and OH2 cannot be reset automatically. Adjustment range for P08.28: 0~10 Adjustment range for P08.29: 0.1~100.0s	10.0s	○
Group P15 - Special functions for solar-powered pumping				
P15.00	Enabling solar-powered pumping functions	**0: Disabled:** The specific parameters for solar-powered pumping are disabled. **1: Enabled**	1	◎
P15.01	Solar-powered pumping control mode	**0: Control by fixed reference voltage**: The reference is a fixed value and is specified by the value of parameter P15.02. **1: MPPT control**: The reference changes according to the MPPT algorithm until the system is stable	1	◎
P15.02	Fixed reference voltage	If P15.01 is selected at value 0, the reference voltage is given by this parameter. The reference voltage must be less than the voltage of the photovoltaic input, otherwise, the system will operate at the lower frequency limit defined by P15.05. The following value is recommended: P15.02 = Total Voc x 0.8 Where 'total Voc' is the open-circuit voltage of the solar panel array, which is obtained by adding the Voc value of each of the panels connected in series. Adjustment range: 0.0~750Vdc	Depending on model	○

P15.03	PI control deviation	The system will make an adjustment through the PI control as long as the value obtained through the following formula is greater than the value set in this parameter: (DC bus voltage - reference voltage) * 100% / reference voltage If the previous value is less than the parameter set, no PI setting will occur. Adjustment range: 0.0~100% (100% corresponds to the reference voltage)	0.0%	○
P15.04	Output frequency higher than the PI setting	Used to limit the maximum value of the target frequency, and 100% corresponds to the value of P00.03. After adjusting the PI control, the target frequency cannot exceed this limit. Adjustment range: P15.05~100% (100% corresponds to P00.03)	100%	○
P15.05	Output frequency lower than the PI setting	Used to limit the minimum value of the target frequency, and 100% corresponds to the value of P00.03. After adjusting the PI control, the target frequency cannot be lower than this limit. **This parameter is very important**, and it is advisable to pay special attention to its adjustment. It must be adjusted to a value that allows the pump to expel water. You are recommended to follow the instructions in section 5 (Instructions for start-up) for adjustment. Adjustment range: 0.0%~P15.04 (100% corresponds to P00.03)	20.0%	○
P15.06	Proportional gain of slow PI control (KP1)	The drive has two types of PI control, one slow and one fast. When the device is working in MPPT control mode, fast PI quickly situates the reference voltage below the voltage of the solar panels, and slow PI fine-tunes the performance.	5.00	○
P15.07	Integral gain of slow PI control (KI1)		5.00	○
P15.08	Proportional gain of fast PI control (KP2)	The higher the value of the parameter, the stronger the effect and the faster the adjustment. Adjustment range: P15.06~P15.09: 0.00~100.00	35.00	○
P15.09	Integral gain of fast PI control (KI2)		35.00	○
P15.10	Switching point between slow and fast PI	By performing the following operation, we obtain an X value: X = Absolute value (DC bus value - Reference value) If X>P15.10 → Fast PI works If X≤P15.10 → Slow PI works	20.0V	◎
P15.14	Full tank alarm delay (A-tF)	When the tank level sensor is activated (input S2), and this situation is prolonged for a longer time than that specified in P15.14, the drive will stop and display alarm A-tF. Adjustment range: 0~10000 s	5s	○

P15.15	Delay to trigger full tank alarm (A-tF)	After the time specified in P15.15 elapses, two situations can occur: - The tank level sensor is still activated, so the drive will remain shut down and continue to indicate A-tF. - The sensor has been deactivated, so alarm A-tF will be deactivated and the drive will enter operating mode again. Adjustment range: 0~10000 s	20s	○
P15.16	Empty well alarm delay (A-tL)	When the well level sensor is activated (input S3), and this situation is prolonged for a longer time than that specified in P15.16, the drive will stop and display alarm A-tL. Adjustment range: 0~10000 s	5s	○
P15.17	Delay to trigger empty well alarm (A-tL)	After the time specified in P15.17 elapses, two situations can occur: - The well level sensor is still activated, so the drive will remain shut down and continue to indicate A-tL. - The sensor has been deactivated, so alarm A-tL will be deactivated and the drive will enter operating mode again. Adjustment range: 0~10000 s	20s	○
P15.23	Low solar radiation alarm delay (A-LS)	A-LS corresponds to the low solar radiation alarm. When this alarm is activated, it means that the current solar radiation is not enough to control the pump. The two conditions that can cause the activation of alarm A-LS are: 1. The operating frequency is less than or equal to P15.05*P00.03 (output frequency lower than the PID setting), and this situation is maintained for a longer time than that specified in P15.23. 2. The current photovoltaic voltage (which can be seen in parameter P18.01) is lower than the value specified in parameter P15.37 (photovoltaic undervoltage point). Adjustment range: 0.0~3600.0 s	100.0s	○
P15.24	Delay to trigger low solar radiation alarm (A-LS)	Once the photovoltaic voltage exceeds the value specified in P15.34 (threshold to switch to photovoltaic input), and the time delay specified in P15.24 has elapsed, the drive will enter operating state again. Adjustment range: 0.0~3600.0 s	300.0s	○
P15.25	Initial reference voltage display	Displays the initial reference voltage set by the drive. This voltage is determined by the value of the first photovoltaic voltage read by the drive, minus the value of P15.28 (initial reference voltage setting). Range: 0.0~2000.0V	0	●
P15.26	Coefficient for minimum MPPT reference voltage	This parameter defines the minimum reference voltage that the drive will use during MPPT. Thus, the minimum MPPT reference voltage is obtained by multiplying the value of P15.26 by the open circuit voltage of the solar panels. The open circuit voltage is the first photovoltaic voltage read by the drive, and can be obtained by adding the value of P15.25 (initial reference voltage) and P15.28 (initial reference voltage setting). The MPPT working range goes from the minimum reference voltage to the value of P15.27 (maximum MPPT reference voltage). Keep in mind that the value of P15.27 must be greater than the minimum MPPT reference voltage. The smaller the difference between the two values, the faster the MPPT.	0.70	○

<table>
<tr><td>P15.27</td><td>Maximum MPPT reference voltage</td><td>This parameter defines the maximum reference voltage that the drive will use during MPPT.
The default value depends on the drive model:<table><tr><th>Model</th><th>Maximum MPPT reference voltage (V)</th><th>Maximum MPPT voltage (V) (P15.31)</th></tr><tr><td>-S2</td><td>400</td><td>400</td></tr><tr><td>-4</td><td>750</td><td>750</td></tr></table>Adjustment range: Minimum MPPT reference voltage~P15.31</td><td>400.0V</td><td>○</td></tr>
<tr><td>P15.28</td><td>Initial reference voltage setting</td><td>Defines where the MPPT reference voltage is initially situated with respect to the voltage that the drive receives from the solar panels.
Initial MPPT reference voltage=Photovoltaic voltage - P15.28</td><td>5.0V</td><td>○</td></tr>
<tr><td>P15.29</td><td>Refresh time for upper and lower limit of MPPT reference voltage</td><td>After the time defined in this parameter elapses, the drive will adjust the upper and lower limit of the MPPT reference voltage.
The adjustment will be as follows:
Max./min. reference voltage=Current photovoltaic voltage ± P15.30 (adjustment of upper and lower limits of MPPT reference voltage)
Every time the time defined in P15.29 elapses, new values will be obtained, and these will replace those set in P15.26 and P15.27.
This operation is performed to make MPPT control more dynamic, as the closer the upper and lower limits are, the faster the response will be.
If we set P15.29=0, the upper and lower limits set in P15.26 and P15.27 will not change with time.
Example:
Suppose that P15.29=1s and photovoltaic voltage is 400Vdc. In the first second, we will have:
- Photovoltaic voltage: 400Vdc (can be seen in P18.01).
- P15.30=30V.
- Lower limit of MPPT reference voltage: 400V-30V=370V (can be seen in P18.02).
- Upper limit of MPPT reference voltage: 400V+30V=430V.
- MPPT reference voltage: Photovoltaic voltage - P15.28 (5V)= 400V-5V=395V (can be seen in P18.00).
Adjustment range: 0.0~10.0s</td><td>1.0s</td><td>○</td></tr>
<tr><td>P15.30</td><td>Sets the upper and lower limits of the MPPT reference voltage</td><td>This value will be added to or subtracted from the current photovoltaic value in order to define the upper and lower limits of the MPPT reference voltage.
Adjustment range: 5.0~100.0V</td><td>30.0V</td><td>○</td></tr>
<tr><td>P15.31</td><td>Maximum value of the MPPT reference voltage</td><td>During MPPT, the upper limit of the reference voltage may not exceed the value set in P15.31.
The default value depends on the model:
- S2 drives: 400V.
- -4/-4F drives: 750V.
Adjustment range: P15.27~6553.5V</td><td>Depending on model</td><td>○</td></tr>
<tr><td>P15.32</td><td>Selection of photovoltaic/mains input</td><td>0: Auto switch
1: Force mains input
2: Force photovoltaic input
If the value is 0, the system will switch between photovoltaic and mains</td><td>2</td><td>◎</td></tr>
</table>

		input according to the voltage and photovoltaic threshold detected. If the value is 1, the system will force mains input. If the value is 2, the system will force photovoltaic input. **Note:** When using a digital input, option 42 (force mains power) is activated, this function code will have no effect.		
P15.33	Threshold for switching to mains input	The drive will switch to mains input when the photovoltaic voltage is lower than the value of P15.33, or when the low solar radiation alarm (A-LS) is triggered. For drives without a booster module, the value of P15.33 is determined by the ATS automatic switching module. For drives with booster module, the value of P15.33 is 70V. Adjustment range: 0.0V~P15.34	Depending on model	○
P15.34	Threshold for switching to photovoltaic input	The drive will return to working in photovoltaic mode when the photovoltaic voltage is higher than the value of P15.34, and the time delay specified in P15.24 (delay to trigger low solar radiation alarm) has elapsed. In order to avoid frequent switching, this threshold should be greater than P15.33. It is recommended that P15.34 be about 60V greater than P15.33. The default value depends on the model. Adjustment range: P15.33~400.0V	Depending on model	○
P15.35	Rated flow of the pump	If the user indicates the rated flow of the pump, an estimate of current flow can be seen in parameter P18.11. The rated flow rate (Qn) is what is obtained from working at the rated frequency and rated height (Hn). Unit: m^3/h	0.0	○
P15.36	Rated height of the pump	If the user indicates the rated height of the pump, an estimate of current height can be seen in parameter P18.12. The rated height (Hn) is what is obtained from working at the rated frequency and rated current. Units: metres	0.0	○
P15.37	Photovoltaic undervoltage point	If the photovoltaic voltage is lower than the value of P15.37, the drive will indicate PVLV (low photovoltaic voltage) fault. The default value depends on the type of drive: **Model** / **Value P15.37** -S2 / 140V -4 / 240V Drive with booster module / 70V Adjustment range: 0.0~400.0V	Depending on model	○
P15.39	Model conversion	This parameter enables model conversion. For example, if the user wishes to use a -4 drive (mains input and three-phase 400Vac output) and convert it to -2 (mains input and three-phase 230Vac output), the value of this parameter should be set to 2. It is also possible to convert the drive to power single-phase pumps. Please contact your technical service if you wish to make this conversion. **0:** Single-phase 230Vac input; single-phase 230Vac output **1:** Single-phase 230Vac input; three-phase 230Vac output (-S2) **2:** Three-phase 230Vac input; three-phase 230Vac output **3:** Three-phase 400Vac input, three-phase 400Vac output (-4/-4F)	0	◎

Group P18 - Monitoring of solar-powered pumping

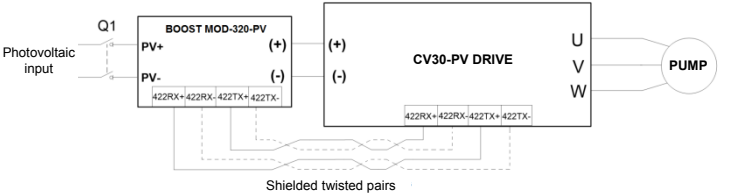
P18.00	MPPT reference voltage	As a result of the MPPT control, the drive determines a reference voltage at all times. This parameter shows its value. Units: V		•
P18.01	Current photovoltaic voltage	Displays the voltage provided by the solar panels or the booster module, and is equal to the DC bus voltage. Units: V		•
P18.02	Minimum MPPT reference voltage	Displays the minimum reference voltage during MPPT. It is obtained by multiplying the first photovoltaic voltage read by the drive on each refresh by the value of P15.26. Units: V		•
P18.04	Current transferred by the booster	Displays the current transferred from the booster module. This parameter is only enabled when the system is working in AC mode, and not when working in photovoltaic mode.		•
P18.07	Photovoltaic input power	Displays the power delivered by the solar panels at all times. Units: kW		•
P18.10	Display of work mode and settings	Shows whether the drive is working in photovoltaic mode or AC mode, and indicates whether or not the drive is connected to a booster module. _____Units digit_____ **0:** The drive is powered in photovoltaic mode. **1:** The drive is powered in AC mains mode. _____Tens digit_____ **0:** The system includes a booster module. **1:** The system **does not** include a booster module. Range: 0x00~0x11		•
P18.11	Current pump flow rate	Shows the current flow rate of the pump. The rated pump flow rate and height values should be preset in parameters P15.35 and P15.36. Unit: m^3/h	0.0	•
P18.12	Current pump height	Shows the current pump height. The rated pump flow rate and height values should be preset in parameters P15.35 and P15.36. Units: metres	0.0	•
P18.13	Volume extracted by the pump (most significant bits)	Displays the 16 most significant bits of volume extracted by the pump. Unit: m^3	0	•
P18.14	Volume extracted by the pump (least significant bits)	Displays the 16 least significant bits of volume extracted by the pump. Total volume extracted by the pump = P18.13*65535+P18.14 Unit: m^3	0.0	•
P18.15	Reset of count of volume extracted by the pump	If this parameter is set to 1, the values of P18.13 and P18.14 will be reset.	0	◎

Group P19 - Monitoring of the booster module				
P19.00	Proportional gain of the **fast** PI control of the booster	When the drive is connected to a booster module, it performs a PI control of its output voltage, which is what it delivers to the drive. There are two types of PI control, one slow and one fast. The higher the value of the parameter, the stronger the effect and the faster the adjustment. Adjustment range: P19.00~P19.03: 0,000~65535	0,500	○
P19.01	Integral gain of **fast** PI control of the booster		0,080	○
P19.02	Proportional gain of **slow** PI control of the booster		0,010	○
P19.03	Integral gain of **slow** PI control of the booster		0,010	○
P19.04	Upper limit of the output current of the booster for PI control	Sets the upper limit of the reference current of the booster module. Adjustment range: 0.00~15.0A	12.0A	○
P19.06	DC bus reference voltage	This parameter is automatically adjusted to the reference voltage of the DC bus when the system works with the booster module. The value is 350V for -2 models and 570V for -4/-4F models. Range: 300.0V~600.0V	Depending on model	◎
P19.10	Booster software version	Once switched on, the booster module sends its version number to the drive.	0.00	•

7 optional devices

7.1 BOOST MOD-320-PV booster module

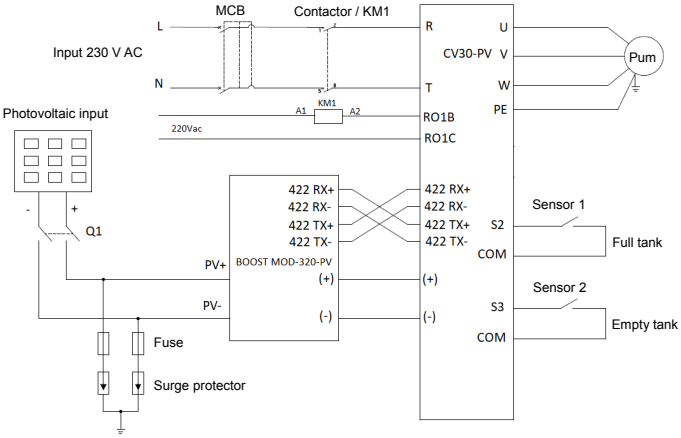
The ≤ 2.2 kW solar-powered water pumping drives support the installation of a booster module (model BOOST MOD-320-PV), which enables the number of solar panels required to be reduced and the performance of the system to be improved. It also allows automatic switching to the mains or a power generator.
The following figure shows the wiring method.



1. Connect terminals PV+ and PV- of the booster module to the positive and negative input terminals of the solar panels, respectively.
2. Connect output terminals (+) and (-) of the booster module to input terminals (+) and (-) of the drive.
3. Connect communication reception terminal 422 RX of the booster module to TX communication sending terminal 422 of the drive. Connect TX communication sending terminal 422 of the booster module to communication reception terminal 422 RX of the drive. Use twisted pairs for wiring.
3. Once the wiring has been completed, connect switch Q1 to power the system (see section 9 for the selection of protections).

The booster module allows the system to work in both MPPT control mode and fixed reference control mode (refer to parameter P15.01 of section 6), although it is recommended to work in fixed reference control mode because performance is usually better when solar radiation is low.

The booster module also allows automatic switching to the mains or a power generator, with it not being necessary in this case to install an optional ATS switching module (refer to section 7.2).
Below is a connection diagram:



Technical specifications of the booster module

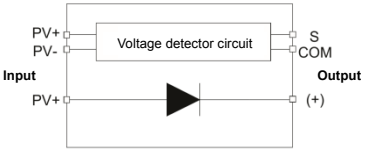
Model	BOOST MOD-320-PV
INPUT	
Max. input power (W)	3200
Max. DC voltage (V)	600
Start-up voltage (V)	80
Min. working voltage (V)	70
Max. input current (A)	12
OUTPUT	
Output voltage (V)	350/570 (depending on model). Selection is made automatically by the drive.

Meaning of the LEDs

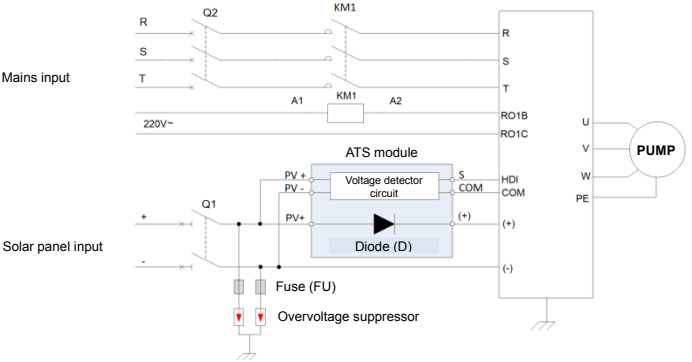
State	Description
Green LED flashing	Booster module initialising.
Green LED on	Voltage boost activated.
Red LED on	Booster module in fault state. Voltage boost deactivated. Possible faults: - Drive communication error: Check RS422 wiring between both devices. - Insufficient power supply voltage: This error is automatically reset when solar radiation is restored.

7.2 ATS switching module (autoswitch)

If you wish to have an automatic switching facility (with the option of connecting to the mains or a power generator when the available energy in the solar panels is not sufficient), it is necessary to use an optional external control circuit (ATS MOD-...-4-PV switching module).
Below is a block diagram showing its operation.



The voltage circuit activates/deactivates the S,COM signal according to a predetermined threshold. This signal is connected later to the HDI and COM terminals of the drive, allowing the selection of the type of power (photovoltaic or mains) at all times.
The ATS module works with a very low supply voltage, with which it is activated even if it has very low solar radiation.
The following figure shows the electrical diagram of the system when the ATS module is incorporated (refer to section 9 for the selection of protections):



7.2.1 ATS switching module terminals

Terminal	Description	Function
PV +	Positive photovoltaic input	Connected to the input of the voltage detection circuit and to the positive pole of the diode module.
PV –	Negative photovoltaic input	Connected to the input of the voltage detection circuit.
(+)	Switching module output	Connected to the negative pole of the diodes.
S, COM	Voltage detection signal	Changes the state of the HDI input of the drive (activates or deactivates it), depending on whether the photovoltaic voltage is higher or lower than a defined threshold. If the HDI input is deactivated, it works in AC mode.

7.2.3 Available ATS models

Model	Power and voltage range	Rated current (A)	Threshold for switching to AC input
ATS MOD-550-4-PV	0.75 kW~15 kW / 400Vac	55 A	260V
ATS MOD-1100-4-PV	18.5 kW~37 kW / 400Vac	110 A	
ATS MOD-1600-4-PV	45 kW~55 kW / 400Vac	160 A	
ATS MOD-3200-4-PV	75 kW / 400Vac	320 A	

7.2.4 Drive settings in switched systems

- Connect the photovoltaic voltage detection signal of the ATS module (terminals S and COM) to the HDI and COM terminals of the drive.
- Make sure that parameter P15.34 (threshold for switching to photovoltaic input) is set to 300V for -4/-4F models and 200V for -S2 models.

In order to avoid frequent switching, it is recommended that the value of P15.33 (threshold for switching to mains input) is about 60V lower than parameter P15.34. If switching is still too frequent, slightly increase the value of P15.34.

- Set P15.32 to value 0 (automatic switching between photovoltaic input and AC input).
- Connect the coil of the external contactor to relay output terminals RO1B and RO1C of the drive. This contactor will be the one that connects and disconnects the AC mains.

If your system includes a booster module, it is not necessary to include an ATS switching module because the booster module incorporates automatic switching. Refer to section 7.1 for more information.

7.3 Sine-wave filter and ferrite

If the distance between the drive and the pump is greater than 50 metres, it is possible for the drive to activate its overcurrent protection due to a high leakage current caused by the parasitic capacity effect of the cables with respect to earth. In addition, the insulation of the pump will be damaged as major voltage peaks, short in time but of great magnitude, will occur, with the possibility of reaching 1300V. In order to avoid the above, it is necessary to add a ferrite (or several) or a sine-wave filter to the output of the drive. If the distance between the drive and the motor is between 50 m and 100 m approximately, install a ferrite; if it exceeds 100 m, install a sine-wave filter (also called an LC filter). SALICRU has both solutions available.

7.4 EMC filters

EMC input filters reduce interference caused by the drive, which affects nearby devices. For the CV30-PV ≤2.2kW drives, external C3 category filters are available as an option. The ≥4kWdrives have an integrated category EMC filter, which can be disconnected if necessary by means of a jumper.
SALICRU has two EMC filter models available which are easy to mount and connect, and are positioned at the bottom of the drive:

Drive	EMC input filter
CV30-004-S2 PV	IPF-EMC-CV30-022-S2
CV30-008-S2 PV	
CV30-015-S2 PV	
CV30-022-S2 PV	
CV30-008-4 PV	IPF-EMC-CV30-022-2/4
CV30-015-4 PV	
CV30-022-4 PV	

8 Recommended solar panels

8.1 Recommended settings for -S2 models

DC power supply voltage: 200…400Vdc
Mains supply voltage: Single-phase 230Vac

MODELO	POTENCIA (Kw)	In SALIDA (A)	CONFIGURACIÓN DE PANELES SOLARES (MÓDULOS POR STRING * Nº DE STRINGS)			
			Potencia: 270 ± 5Wp Voc: 38,5 V		Potencia: 320 ± 5Wp Voc: 45,8 V	
			SIN BOOSTER	CON BOOSTER	SIN BOOSTER	CON BOOSTER
CV30-004-S2 PV	0,4	2,5	11*1	**4*1**	9*1	**3*1**
CV30-008-S2 PV	0,75	4,2	11*1	**5*1**	9*1	**4*1**
CV30-015-S2 PV	1,5	7,5	11*1	**8*1**	9*1	**7*1**
CV30-022-S2 PV	2,2	10	11*1	No disponible	9*1	No disponible

MODEL	POWER (Kw)	OUTPUT CURRENT (A)	SOLAR PANEL CONFIGURATION (MODULES PER STRING * NUMBER OF STRINGS)			
			Power: 270 ± 5Wp Voc: 38.5 V		Power: 320 ± 5Wp Voc: 45.8 V	
			WITHOUT BOOSTER	WITH BOOSTER	WITHOUT BOOSTER	WITH BOOSTER
				Not available		Not available

8.2 Recommended settings for -4 and -4F models

DC power supply voltage: 300…750Vdc
Mains supply voltage: Three-phase 400Vac

MODELO	POTENCIA (Kw)	In SALIDA (A)	CONFIGURACIÓN DE PANELES SOLARES (MÓDULOS POR STRING * Nº DE STRINGS)			
			Potencia: 270 ± 5Wp Voc: 38,5 V		Potencia: 320 ± 5Wp Voc: 45,8 V	
			SIN BOOSTER	CON BOOSTER	SIN BOOSTER	CON BOOSTER
CV30-008-4 PV	0,75	2,5	18*1	**5*1**	15*1	**4*1**
CV30-015-4 PV	1,5	4,2	18*1	**8*1**	15*1	**7*1**
CV30-022-4 PV	2,2	5,5	18*1	**12*1**	15*1	**10*1**
CV30-040-4F PV	4	9,5	19*1	N/D	16*1	N/D
CV30-055-4F PV	5,5	14	18*2		15*2	
CV30-075-4F PV	7,5	18,5	18*2		15*2	
CV30-110-4F PV	11	25	18*3		15*3	
CV30-150-4F PV	15	32	18*4		15*4	
CV30-185-4F PV	18,5	38	18*5		15*5	
CV30-220-4F PV	22	45	18*6		15*6	
CV30-300-4F PV	30	60	18*8		15*8	
CV30-370-4F PV	37	75	18*9		15*9	
CV30-450-4F PV	45	92	18*11		15*12	
CV30-550-4F PV	55	115	18*13		15*13	
CV30-750-4F PV	75	150	18*18		15*18	

8.2 How to calculate the necessary number of solar panels

To calculate the necessary number of solar panels in the system, the following three rules need to be taken into account:

1. **Power criterion:** The total power of the solar panel array must be greater than the power of the pump, divided by the efficiency of the pump. That is to say:
   Power of the solar panels > (pump power / pump efficiency).
   To perform this calculation quickly, the following table of approximate efficiencies of submersible pumps can be used:

Pump power	Pump efficiency (η)
≤0.75 kW	0.65
≤2.2 kW	0.7
≤5.5 kW	0.75
≤18.5 kW	0.8
≤55 kW	0.85

2. **Voltage criterion:** The voltage at maximum power (Vmp) of the solar panels (obtained by adding the Vmp values of each of the panels in series) should approximate the values in the following table, depending on the type of drive:

Drive type	Total Vmp (V)
-S2	330V
-4/-4F	550V
Drives with booster module	Only the power criterion applies

3. **Important verification:** The open-circuit voltage (Voc) of the solar panels connected in series cannot be higher than a certain voltage, which depends on the drive model used. The total open-circuit voltage of the solar panels in series is obtained by adding together the open-circuit voltages (Voc) of each of the panels.

Drive type	Total maximum Voc (V)
-S2	440
-4/-4F	800
Drives with booster module	600

Below are two examples, one for a system without a booster module and the other with:

2.2 kW 400Vac submersible pump with 270Wp solar panels (Voc=38.6V; Vmp=31.2V)
Mounting without booster

- Applying the power criterion, we calculate the necessary power of the panels by dividing the power of the pump by its efficiency (0.7 in this case).
  Necessary power of the panels = 2,200 W / 0.7 ≈ 3,142 W
  We divide the necessary power of the panels by the power of each panel (270W).
  Necessary number of panels = 3,142 / 270 ≈ 12 panels
- Applying the voltage criterion, we divide the voltage value that we want to have in the DC bus (550V in this case) by the Vmp of each panel (31.2V in this case):
  Necessary number of panels = 550 / 31.2 ≈ 18 panels
- At this point, we need to select the criterion that provides most panels. In our case, the voltage criterion provides the system with most panels, **18 units** in total.
- We check that the Voc does not exceed 800V
  Total Voc = 18 panels x Voc of each panel = 18 x 38.6V ≈ 695V < 800V (correct)

Three-phase 0.75 kW 230Vac submersible pump with 270Wp solar panels (Voc=38.6V; Vmp=31.2V)
Mounting with booster

- Applying the power criterion, we calculate the necessary power of the panels by dividing the power of the pump by its efficiency (0.65 in this case).
  Necessary power of the panels = 750 W / 0.65 ≈ 1,154 W
  We divide the necessary power of the panels by the power of each panel (270W).
  Necessary number of panels = 1,154 / 270 ≈ 4 panels
- As we are working with a booster, the voltage criterion does not apply. In this case, therefore, **4 panels** will be necessary.
- We check that the Voc does not exceed 600V
  Total Voc = 4 panels x Voc of each panel = 4 x 38.6V ≈ 154V < 600V (correct)

9 Selection of protections

Model	AC circuit breaker (A)	DC circuit breaker (A)	AC contactor (A)	Overvoltage protector	Fuse
CV30-004-S2 PV	16	16A/ 1000VDC	16	Type II, 1000VDC	30A
CV30-008-S2 PV	16		16		
CV30-015-S2 PV	25		25		
CV30-022-S2 PV	40		40		
CV30-008-4 PV	10		12		
CV30-015-4 PV	10		12		
CV30-022-4 PV	10		12		
CV30-040-4F PV	25		25		
CV30-055-4F PV	25	25A/ 1000VDC	25		
CV30-075-4F PV	40		40		
CV30-110-4F PV	50	63A/ 1000VDC	50		
CV30-150-4F PV	63		63		
CV30-185-4F PV	63	100A/ 1000VDC	63		
CV30-220-4F PV	100		95		
CV30-300-4F PV	100		95		
CV30-370-4F PV	125	125A/ 1000VDC	115		
CV30-450-4F PV	200	160A/ 1000VDC	170		
CV30-550-4F PV	200		170		
CV30-750-4F PV	250	250A/ 1000VDC	205		

10 Troubleshooting guide

Fault code	Type of fault	Possible cause	What to do
OUt1	U-phase IGBT fault	1. Acceleration too fast. 2. IGBT broken. 3. Malfunction due to interference. 4. Connection of cables to pump not correct. 5. Drive earthing not correct.	1. Increase acceleration time. 2. Change power panel. 3. Inspect surrounding devices and eliminate interference. 4. Check output cables to pump. 5. Check earth connections.
OUt2	V-phase IGBT fault		
OUt3	W-phase IGBT fault		
OC1	Overcurrent during acceleration	1. Acceleration or deceleration too fast. 2. Supply voltage too low. 3. Drive power too low. 4. Load transients or rotation abnormal. 5. Earth connection short-circuited or loss of output phase. 6. Excessive external interference.	1. Increase acceleration or deceleration time. 2. Check power supply of drive. 3. Change drive for one with more power. 4. Check whether pump short-circuited (phases or earth connection) or pump rotation not smooth. 5. Check output wiring. 6. Check for strong external interference.
OC2	Overcurrent during deceleration.		
OC3	Overcurrent during constant speed operation.		
OV1	Overvoltage during acceleration.	1. Input voltage abnormal.	1. Check power input.
OV2	Overvoltage during deceleration.		
OV3	Overvoltage during constant speed operation.		
UV	Undervoltage in DC bus.	1. Power mains voltage very low.	1. Check power input.
OL1	Motor overload.	1. Supply voltage of drive very low. 2. Rated current of motor not correctly set in drive. 3. Motor overload or load transients too strong.	1. Check power input. 2. Correctly set rated current of motor P02.05. 3. Check load or reduce its torque.
OL2	Drive overload	1. Acceleration too fast. 2. A restart after a shutdown has occurred. 3. Supply voltage very low. 4. Load too heavy. 5. Pump power too low.	1. Increase acceleration time. 2. Check power input. 3. Check power input. 4. Change drive for one with more power. 5. Select appropriate pump.
SPI	Input phase fault	Loss of phase or fluctuation in input L, N or R, S, T.	1. Check input power supply mains. 2. Check facility distribution.

Fault code	Type of fault	Possible cause	What to do
SPO	Output phase fault.	U, V, W phase fault (or significant load imbalance).	1. Check output distribution. 2. Check pump and output wiring.
OH1	Rectifier overheating	1. Dirt in the air duct or broken fan. 2. Ambient temperature too high. 3. Operating time in overload too long.	1. Clean air duct or replace fan. 2. Decrease ambient temperature. 3. Change drive for one with more power.
OH2	IGBT overheating		
EF	External fault	External fault detected through inputs S1...S4 configured for it.	Check external device that gives signal to drive.
CE	Communication error	1. Transmission speed setting not correct. 2. Communication wiring faulty. 3. Communication address wrong. 4. Strong interferences affecting communication.	1. Set transmission speed to appropriate value. 2. Check communication wiring. 3. Set communication address to appropriate value. 4. Change communication wiring distribution or improve its interference immunity.
ItE	Current detection fault	1. Control card connection not good. 2. Control panel component broken. 3. Electronic circuit of console not working properly.	1. Check control card connector and connect correctly if moved. 2. Change control panel. 3. Change console.
EEP	EEPROM fault	1. Error controlling reading and writing of parameters. 2. EEPROM damaged.	1. Press STOP/RST to reset. 2. Change control panel.
PCE	Console communication error	1. Console connection not good. 2. Extension cord of console too long or very strong interference. 3. Console communication circuits or control panel faulty.	1. Check condition of console cable. 2. Reduce distance between console and drive; check adjacent devices and eliminate source of interference. 3. Change console or control panel.
ETH1	Earth leakage fault 1.	1. Drive output short-circuited with earth. 2. Current detection circuit fault. 3. Actual power of pump differs greatly from power specified in drive.	1. Check if pump connection correct. 2. Change control panel. 3. Set motor parameters correctly.
ETH2	Earth leakage fault 2.		
dEu	Speed deviation fault.	Load too heavy or pump jammed.	Check condition of pump and motor data of function group P02.

Fault code	Type of fault	Possible cause	What to do
PINV	Solar panel connection error.	DC power supply wiring incorrect.	Switch connection of positive and negative terminals.
PVOC	Photovoltaic overcurrent	1. Acceleration or deceleration too fast. 2. Drive power too low. 3. Load temporarily abnormal. 4. Pump phases or earthing short-circuited.	1. Increase acceleration or deceleration time. 2. Select drive with higher power. 3. Check if rotation not uniform. 4. Check if load short-circuited (phases or earthing).
PVOV	Photovoltaic overvoltage	1. Solar panel input voltage too high.	1. Reduce number of solar panels wired in series.
PVLV	Low photovoltaic voltage	1. Power supplied by solar panels insufficient or cloudy conditions. 2. Pump start-up current too high.	1. Increase number of solar panels or perform test with higher incident radiation. 2. Change pump.
E-422	Communication with booster module fault.	Bad contact in communication cables.	Check four RS422 communication cables and ensure correct connection.
OV	Overvoltage of DC bus detected in booster module.	Sudden change in sunlight.	Set PI control parameters of booster module. Broaden P19.07 and P19.08 values.
A-LS	Low solar radiation	1. Sunlight weak 2. Solar panel configuration insufficient.	1. Device starts up automatically when radiation sufficient. 2. Check if solar panel configuration correct.
A-tF	Full tank alarm.	Tank full.	If tank level detector connected between terminals S2 and COM, device automatically stops when tank full. In this situation, the user need not perform any operation. If tank not full, check if terminals wired correctly.
A-tL	Empty well alarm.	Well empty.	If well level detector connected between terminals S3 and COM, device automatically stops when well level low. In this situation, the user need not perform any operation. If well level not low, check if terminals wired correctly.
END	Factory set time reached.	Operating time of drive above this factory setting.	Contact supplier and set operating time again.

11 Frequently asked questions

11.1 Questions about start-up

11.1.1 The drive console does not indicate anything

If the drive console does not indicate anything, check if the photovoltaic voltage is sufficient. The -S2 drives need a start-up voltage of 200V and the -4/-4F models 300V.
Systems that work with a booster module have a start-up voltage of 80V.

11.1.2 After switching on the drive, it starts automatically. How can I stop it so that I can change the parameters?

After the CV30-PV drive is switched on, there is a delay of 10 seconds before it starts up. Press the QUICK/JOG key before these 10 seconds elapse and the device will switch to keypad control. In this state, it is possible to change the parameters.
In any state, the user can stop the drive by pressing the STOP/RESET key, and then change the parameters.

11.1.3 The display indicates A-LS and the system stops

A-LS corresponds to the low solar radiation alarm. When this alarm is activated, it means that the current solar radiation is not enough to power the pump.
There are two conditions that can cause the activation of the A-LS alarm:

1. The operating frequency is less than or equal to P15.05*P00.03 (output frequency lower than the PID setting), and this situation is maintained for a longer time than that specified in P15.23 (low solar radiation alarm delay).
2. The current photovoltaic voltage (which can be seen in parameter P18.01) is lower than the value specified in parameter P15.37 (photovoltaic undervoltage point).

11.1.4 The drive makes too frequent start-up attempts

Once the photovoltaic voltage exceeds the value specified in P15.34 (threshold for switching to photovoltaic input), and the time delay specified in P15.24 has elapsed (delay to trigger low solar radiation alarm), the drive will enter operating state again.
If too frequent start-up attempts occur, both values can be increased. We recommend increasing P15.24 to 900 seconds.

11.1.5 The drive cannot start up automatically in the morning

Check the following points:

1. Check that P15.32 is not set to value 1 (photovoltaic/mains input selection).
2. Check that the value specified in P15.34 (threshold for switching to photovoltaic input) is not too high (carry out this check especially when using the booster module).
3. Make sure that the current photovoltaic voltage (which can be seen in P18.01) is greater than 200V (-S2 models), 300V (-4/-4F models), or 80V (systems with booster module).

11.1.6 The display indicates A-tF or A-tL and the system stops

A-tF corresponds to the full tank alarm and A-tL to the empty well alarm.
The tank level sensor is connected between control terminals S2 and COM, while the well level sensor is connected between S3 and COM.
By default, both terminals are normally open (NO), but we can change their state to NC using parameter P05.10:

- P05.10=2 Changes input S2 to NC
- P05.10=4 Changes input S3 to NC
- P05.10=6 Changes inputs S2 and S3 to NC

Check that the state of inputs S2 and S3 (NO/NC) matches that of the sensors, and that they can work correctly.

Also note how alarms A-tF and A-tL are activated and deactivated:

Activation/Deactivation of A-tF

When the drive is in operating state and the tank level sensor is activated (input S2), and this situation is prolonged for a longer time than that specified in P15.14 (full tank alarm delay, with a value of 5s by default), the drive will stop and display alarm A-tF.

After the time specified in P15.15 (delay to trigger the full tank alarm, with a value of 20s by default) elapses, two situations can occur:

- The sensor is still activated, so the drive will remain shut down and continue to indicate A-tF.
- The sensor has been deactivated, so alarm A-tF will be deactivated and the drive will enter operating mode again.

Activation/Deactivation of A-tL

When the drive is in operating state and the well level sensor is activated (input S3), and this situation is prolonged for a longer time than that specified in P15.16 (empty well alarm delay, with a value of 5s by default), the drive will stop and display alarm A-tL.

After the time specified in P15.17 (delay to trigger empty well alarm, with a value of 20s by default) elapses, two situations can occur:

- The sensor is still activated, so the drive will remain shut down and continue to indicate A-tL.
- The sensor has been deactivated, so alarm A-tL will be deactivated and the drive will enter operating mode again.

11.1.7 The display indicates OL2 or OC1 when the drive starts up

Perform the following checks:

1. Check that the direction of rotation of the pump is correct. If the pump rotates in the opposite direction, disconnect the power supply to the device, wait for the time indicated on the front of the pump, and swap two of the drive's output phases.
2. Make sure that the values specified in P02.01~P02.05 correspond to the nameplate of the pump.
3. Consider changing the drive to one of a larger size.

11.1.8 The pump is running, but there is no water in the pipe

Perform the following checks:

1. Check that the direction of rotation of the pump is correct. If the pump rotates in the opposite direction, disconnect the power supply to the device, wait for the time indicated on the front of the pump, and swap two of the drive's output phases.
2. Note that the height of the pump (H) is proportional to the square of the frequency.
   If the rated pump height is set in parameter P15.36, it is possible to see the current pump height in parameter P18.12.

11.1.9 I cannot switch between mains (AC) and photovoltaic (PV) inputs

Make sure that parameter P15.32=0.

The logic of automatic AC/PV switching is as follows:

Systems without booster:

Switching from PV to AC: One of the following two conditions must be met:

- The operating frequency is less than or equal to P15.05*P00.03 (output frequency lower than the PID setting), and this situation is maintained for a longer time than that specified in P15.23 (low solar radiation alarm delay).
- The HDI input is activated, which causes the output relay to change state after the time delay specified in P06.10 (10s by default).

Switching from AC to PV: After the time specified in P15.24 (delay to trigger the low solar radiation alarm) elapses, if the HDI input is deactivated, switching will occur after the time delay specified in P06.11 (default 10s).

Systems with booster:

Switching from PV to AC: One of the following two conditions must be met:

- The operating frequency is less than or equal to P15.05*P00.03 (output frequency lower than the PID setting), and this situation is maintained for a longer time than that specified in P15.23 (low solar radiation alarm delay).
- The photovoltaic voltage is lower than P15.33 (70V in systems with booster), which causes the output relay to change state after the time delay specified in P06.10 (10s by default).

Switching from AC to PV: After the time specified in P15.24 (delay to trigger the low solar radiation alarm) elapses, if the photovoltaic voltage is greater than P15.34 (threshold for switching to photovoltaic input), switching will occur after the specified time delay in P06.11 (10s by default).

11.1.10 The system frequently switches between AC and photovoltaic input

Check the value of parameters P15.33 (threshold for switching to mains input) and P15.34 (threshold for switching to photovoltaic input). If possible, it is recommended that P15.34 be at least 60V higher than P15.33. If switching is still too frequent, slightly increase the value of P15.34.

11.2 Questions about checks

11.2.1 How can I check the voltage delivered by the solar panels?

The voltage delivered by the solar panels can be checked using parameter P18.01.

11.2.2 How can I check the power delivered by the solar panels?

The power delivered by the solar panels can be checked using parameter P18.07. The value is expressed in kW.

11.2.3 The power that appears in P18.07 exceeds the rated power of the pump, but the operating frequency is less than 50Hz.

The efficiency of the pump should be taken into account. For the drive to work at 50Hz, the following is necessary:

Power of solar panels ≥ (Pump power / efficiency)

11.2.4 How can I check if the drive is working in AC or photovoltaic mode? With booster module or without it?

This information can be found in parameter P18.10:

Value P18.10	Booster?	Current powering mode
00	Yes	Photovoltaic
01	Yes	AC
10	No	Photovoltaic
11	No	AC

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