Installation and User Manual

Solar Power Control System
Type “SPCS 4(5,5)-400”

June 2015 / Rev. 01

Contents

1 Safety Information

The present manual contains important instructions for safety operation, start running into exploitation and operation with complete units type SPCS 4(5,5)-400.

This manual has to be kept together or near the equipment any time!

Used symbols and warning signs:

DANGER

DANGER means risky situation which, if it is not avoided, can lead to death or to serious injury.

ATTENTION

ATTENTION refers to cases, which are not connected with human injury. Not conforming to this warning sign can bring to material damages.

1.1 Warnings for danger and attention

DANGER

Read and understand the manual before installing or operating the SPCS 4(5,5)-400 drives. Installation, exploitation and maintenance of the unit must be performed only by qualified personnel.

DANGER

Regional standards for installation must be observed.

DANGER

DO NOT touch unshielded components or terminal strip screw connections with voltage present.

DANGER

DO NOT open the cover of the SPCS 4(5,5)-400 drive box.

DANGER

The unit operates with voltages, dangerous for human life. DC capacitors of the unit stay under voltage even, if the unit is switched OFF.

After turning OFF the SPCS 4(5,5)-400 unit and disconnecting the PV, please wait 10 minutes to allow the DC bus capacitors to discharge!

DANGER

If some information is not clear, please, contact with the service center of your distributor!

ATTENTION

Warranty void!

The unit must not be damaged, as well as it is forbidden to make holes on it. Any transport damage has to be established and reported to supplier before unit installation.

1.2 Warranty

The data and installation instructions, given in this manual, are revised regularly and all corrections are included in next issues. In case of avoiding the installation instructions, the warranty claims will not be accepted. We cannot bear any responsibility also in cases of incidents and material damages, due to improper use, as well as from actions of not authorized persons with resulting from these consequences.

2 Introduction

The **"Solar Power Control System" - SPCS 4(5,5)-400** drives are designed to be built in autonomous solar pump installations. The SPCS 4(5,5)-400 device is intended for direct supply of three phase AC induction pump motors.

The SPCS 4(5,5)-400 drive is for outdoor installation. It implements user friendly plug & play and fan less design for quick installation and low maintenance costs. After installation the drive could work in automatic mode and there is no need of additional adjustments.

The drive is compatible and easy to operate with different types of water pumps.

Typical application diagram of SPCS 4(5,5)-400 installation:

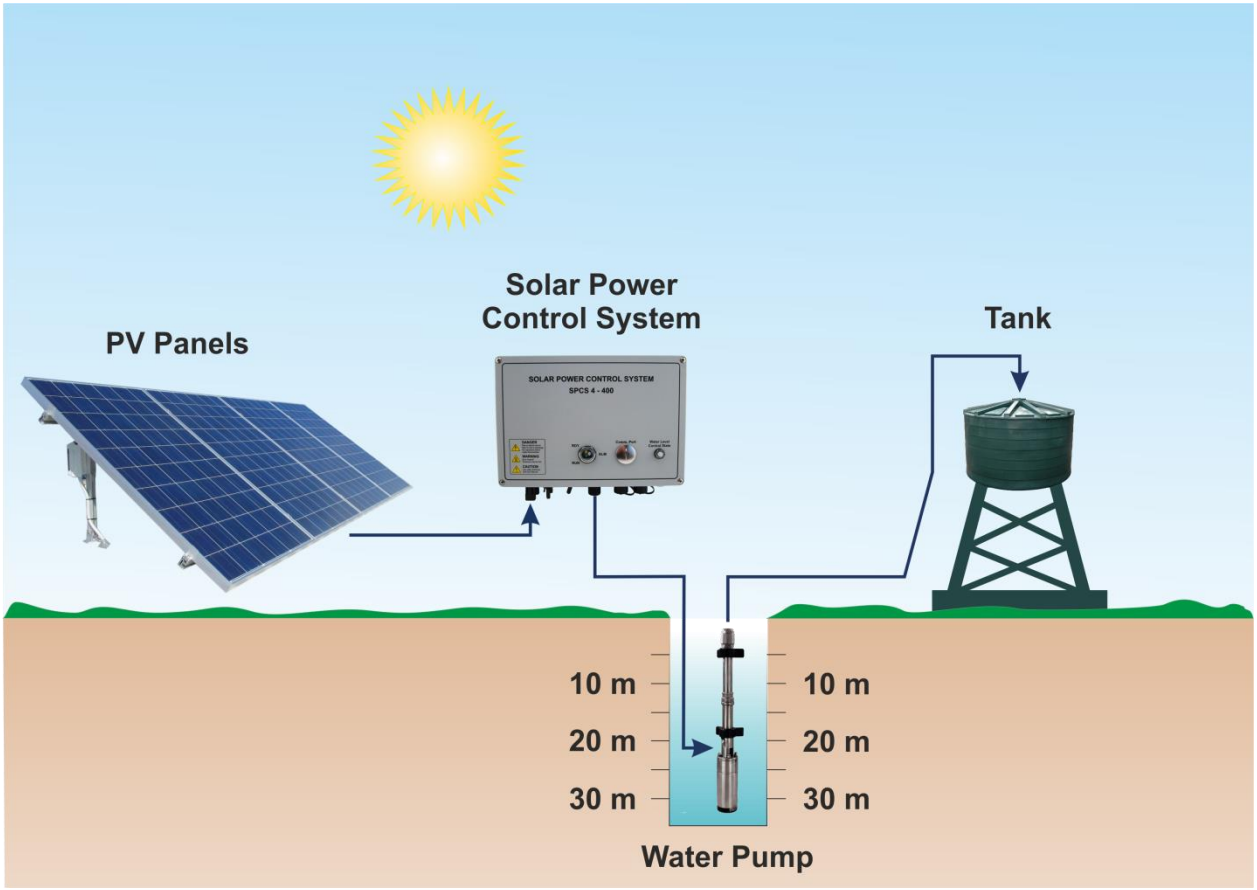


Figure 2.1. Typical application *diagram of* SPCS 4(5,5)-400 *installation*

3 Hardware Description

3.1 Technical parameters

The basic technical parameters of SPCS 4(5,5) - 400 are listed in *Table 3.1*.

Table 3.1. Technical parameters

Model	***SPCS 4-400***	***SPCS 5,5-400***
Output Ratings		
Applicable AC Induction Motor Power	4,0 kW / 5,5 HP	5,5 kW / 7,5 HP
Output Voltage (Rated Motor Voltage)	3P 380/400/415 V_{AC}	3P 380/400/415 V_{AC}
Output Frequency (min and max frequency software adjustable in service mode)	0-60 Hz, Variable Frequency Drive	0-60 Hz, Variable Frequency Drive
Output Current (Rated Motor Current)	11,0 A	14,0 A
Input Ratings		
Max Input Voltage (V_{oc})	850 V_{DC}	850 V_{DC}
MPPT Range	550 – 630 V_{DC}	550 – 630 V_{DC}
Number of String Inputs	1	2
Recommended min PV input power at STC	5,2 kWp (20 PV x 250 Wp)	10,0 kWp 2 x (20 PV x 250 Wp)
System Data		
Degree of Protection	IP 55	
Operation Temperature	-10ºC / + 50ºC	
LED Indication	Ready / Run / Alarm	
Operation Mode	Manual Run / Stop switch	
Communication	RS 232/485 / ***MODBUS RTU***	
Built-in Electronic Protections		
Over Voltage, Short Circuit, Over Load, Earth Fault, Output Phase Interruption, Overheating, Reverse Polarity, Dry Run		
Service mode trough RS port by "Drive Remote Control Panel"		
Frequency Adjustment (minimal and reference values)		
Acceleration / Deceleration Time Adjustment (ramps)		
Motor Voltage Adjustment		
System Diagnostic		
Displaying: DC Voltage / AC Voltage / Output Frequency / Motor Phase Current		
Complementary Options		
System management through digital inputs	Water (Liquid) Level Control: ➢ Water well high/low level with LED indication; ➢ Reservoir high/low level with LED indication;	

3.2 SPCS 4(5,5)-400 label with technical parameters

The label with the main technical parameters and serial number of the unit is located on the right side of the inverter module. The label is shown on *Figure 3.1.*

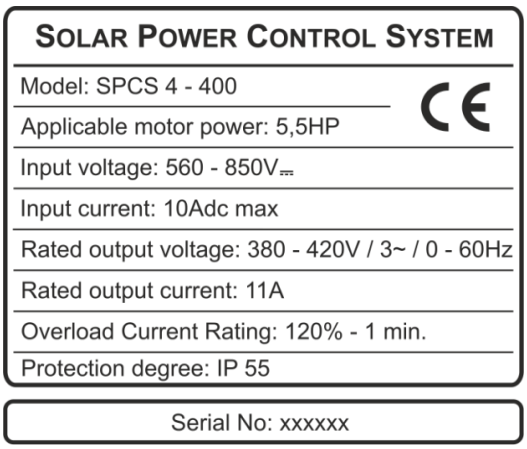


Figure 3.1. SPCS 4 - 400 label with technical parameters and serial number.

3.3 Mechanical installation

The SPCS 4 (5,5) - 400 unit has to be mounted on the wall or on the frame. The inside parts of the inverter module must be protected from water or other liquid substances, during the installation ***("Comm. Port" cap must be screwed properly and the connectors must be assembled properly).***

The mounting dimensions of the inverters are shown on the *Figure 3.2* down below.

SPCS 4-400	***SPCS 5,5-400***

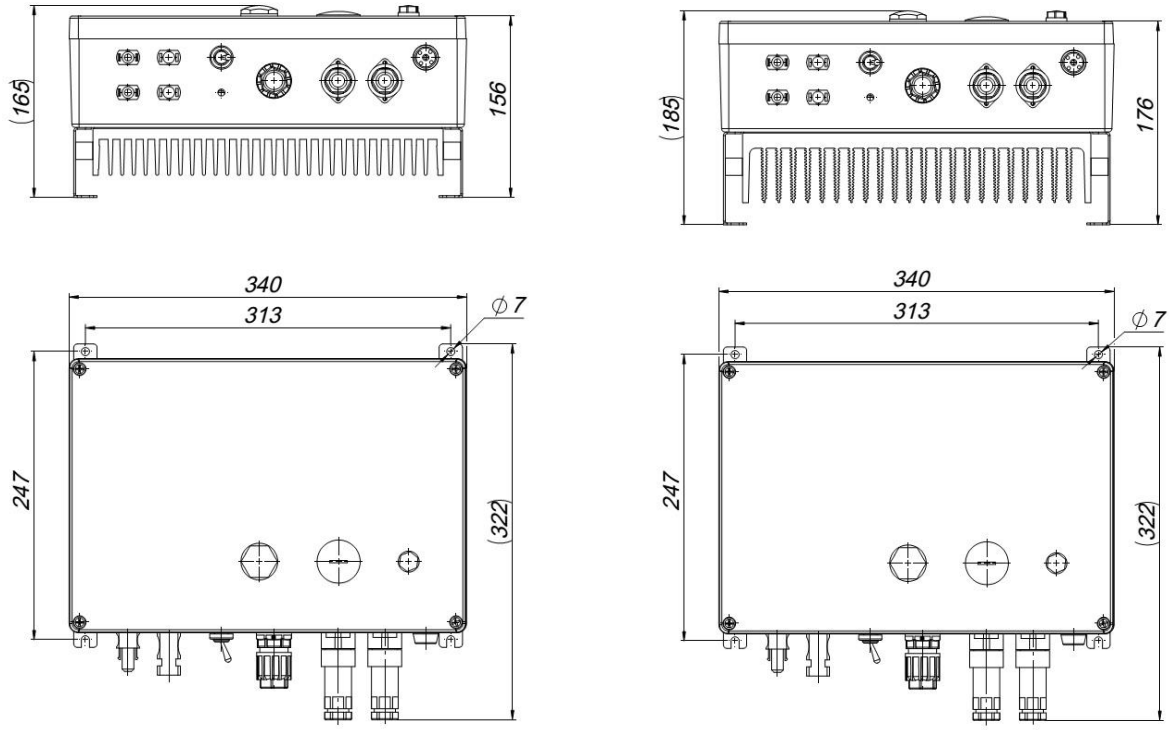


Figure 3.2. Overall and mounting dimensions

The following steps (*Figure 3.3.*) must be taken into account, when the SPCS 4(5,5)-400 drives are mounted:

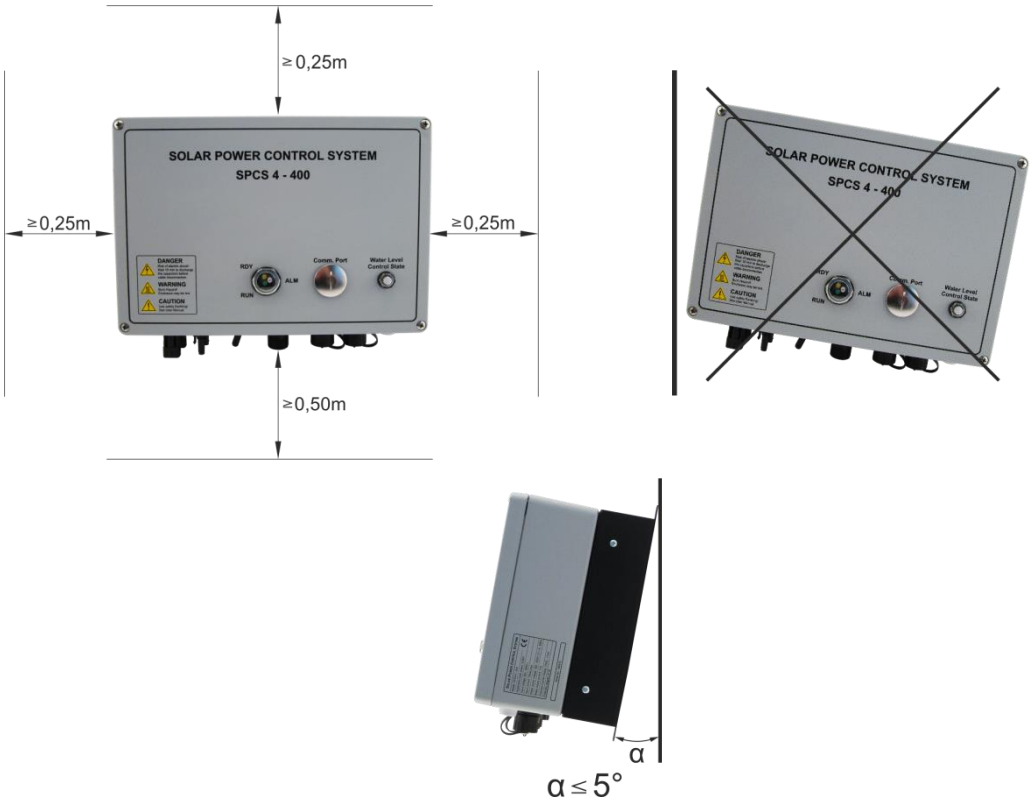


Figure 3.3. Mounting an SPCS 4(5,5) – 400 drive

3.4 SPCS 4(5,5)-400 connections

Connections of the drive are shown on *Figure 3.4, Figure 3.5.* and *Table 3.3* down below:

Table 3.3 Power connectors of SPCS 4(5,5) - 400 drive

Connector Designator	Connector Pole Name	Description	Comment
PE	PE	Protective Earth	Threaded Stud
PV+	PV+	PV Input +	550 – 850 V_{DC}(max)
PV-	PV-	PV Input -	
PV+	PV+	PV Input +	550 – 850 V_{DC}(max)
PV-	PV-	PV Input -	
MOTOR	1	Output Phase **U**	380 / 400 / 415 / 3-phase
	2	Output Phase **V**	
	3	Output Phase **W**	
	PE	Protective Earth	
SET 1	1	High Level	Water Level probe (electrode)
	2	Low Level	Water Level probe (electrode)
	3	Common	Water Level probe (electrode)
SET 2	1	High Level	Water Level probe (electrode)
	2	Low Level	Water Level probe (electrode)
	3	Common	Water Level probe (electrode)

The wiring diagram of SPCS 4(5,5) - 400 is shown on *Figure 3.4.*

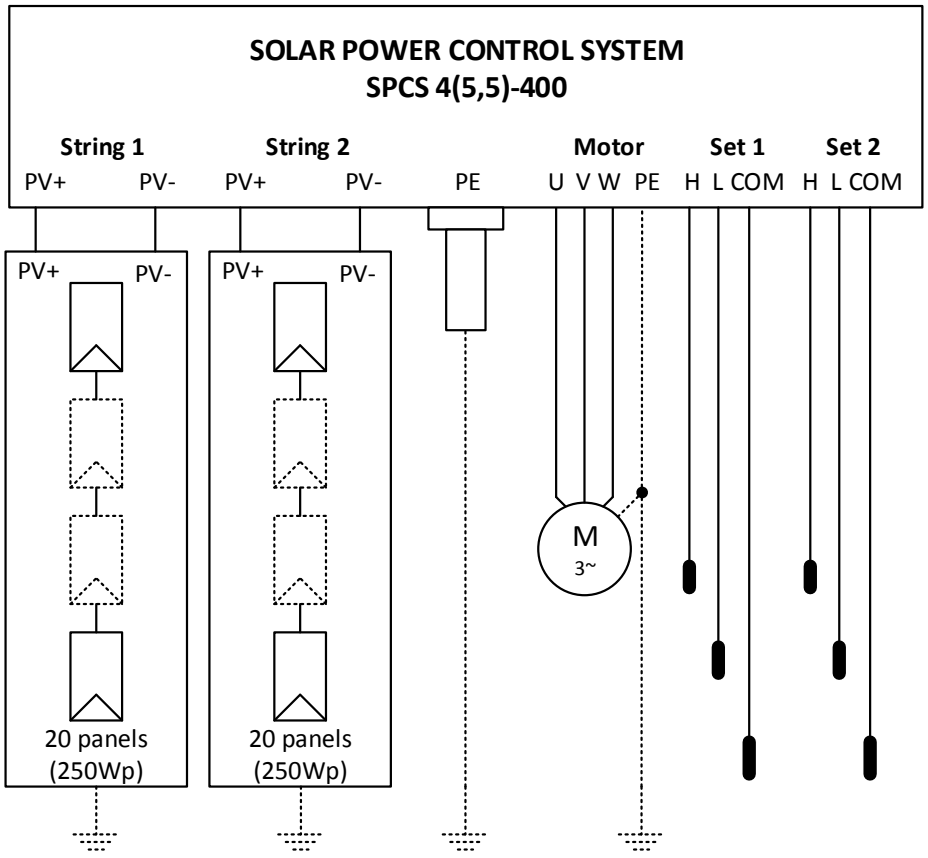


Figure 3.4. SPCS 4(5,5)-400 connections block diagram

For more detailed information regarding to positions of the drive connections and indications of the SPCS 4(5,5)-400 drive, please see *Figure 3.5* below.

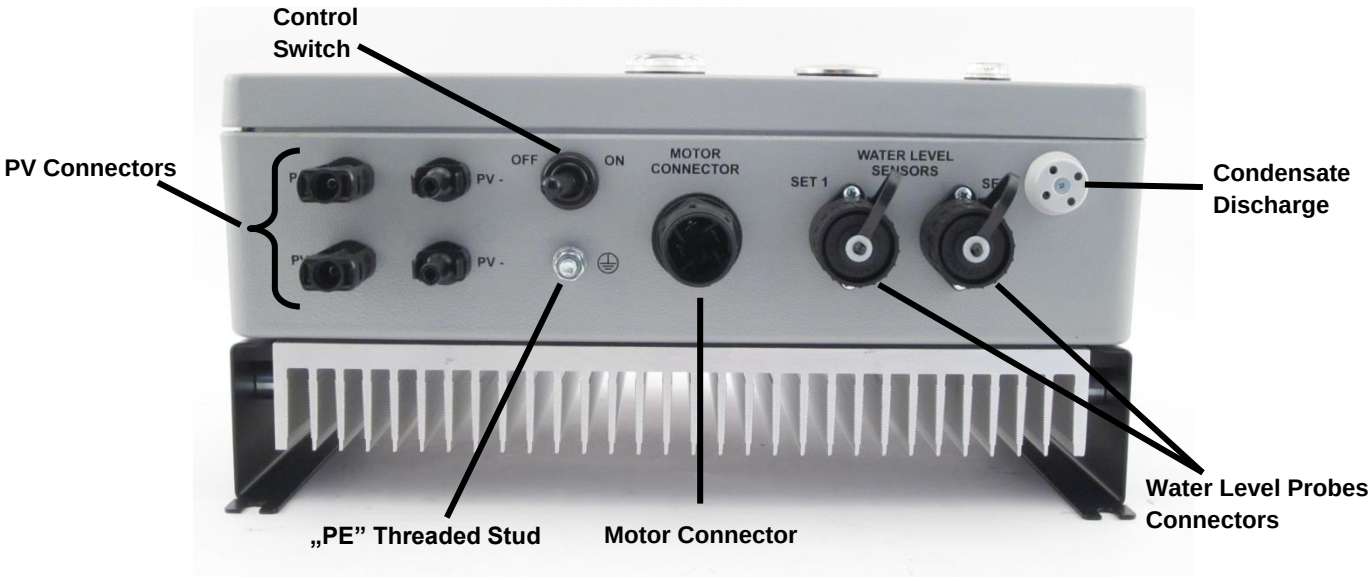


Figure 3.5. SPCS 4(5,5) – 400 bottom side.

The control switch has two positons:

- "OFF" - the drive is "OFF" and respectively, the pump motor is not runnig;
- "ON" - the device is running in automatic mode (please see pages 24-25 – "Digital Input Functions");

ATTENTION

The SPCS 4(5,5) - 400 wire connections must be implemented in the following sequence:

1. Check, that the control switch is in 'OFF' position.

2. Connect the pump motor (Figure 3.6). Check, that the inverter output phases are connected, so that the rotation of the pump motor will be according to the proper direction specified on the pump.

3. CONNECT THE SAFETY EARTH TO THE 'PE' THREADED STUD - Figure 3.5

4. Connect the 20 - panels string(s) to the device PV inputs.

5. Check, that the 'RDY' indication LED is continuously lit-on, after 15 sec of blinking.

6. The control switch could be moved to position 'ON'.

3.5 “Motor Connector” description.

On *Figure 3.6* you can see the description of the motor connection.

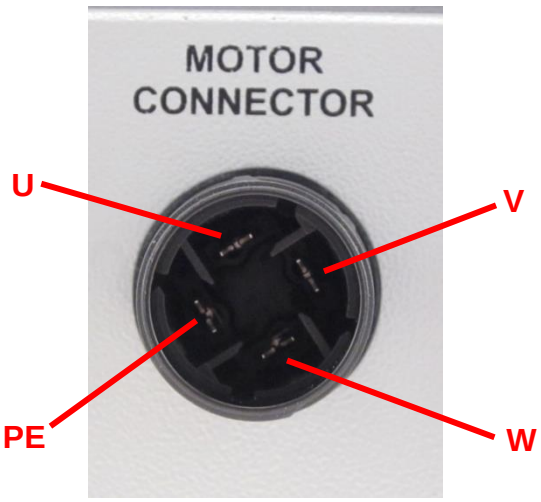


Figure 3.6. Description of the motor connection.

On *Figure 3.7* is shown the motor cable connecting procedure. Examples of the needed hand tools for these operations are shown on *Figure 3.8.*

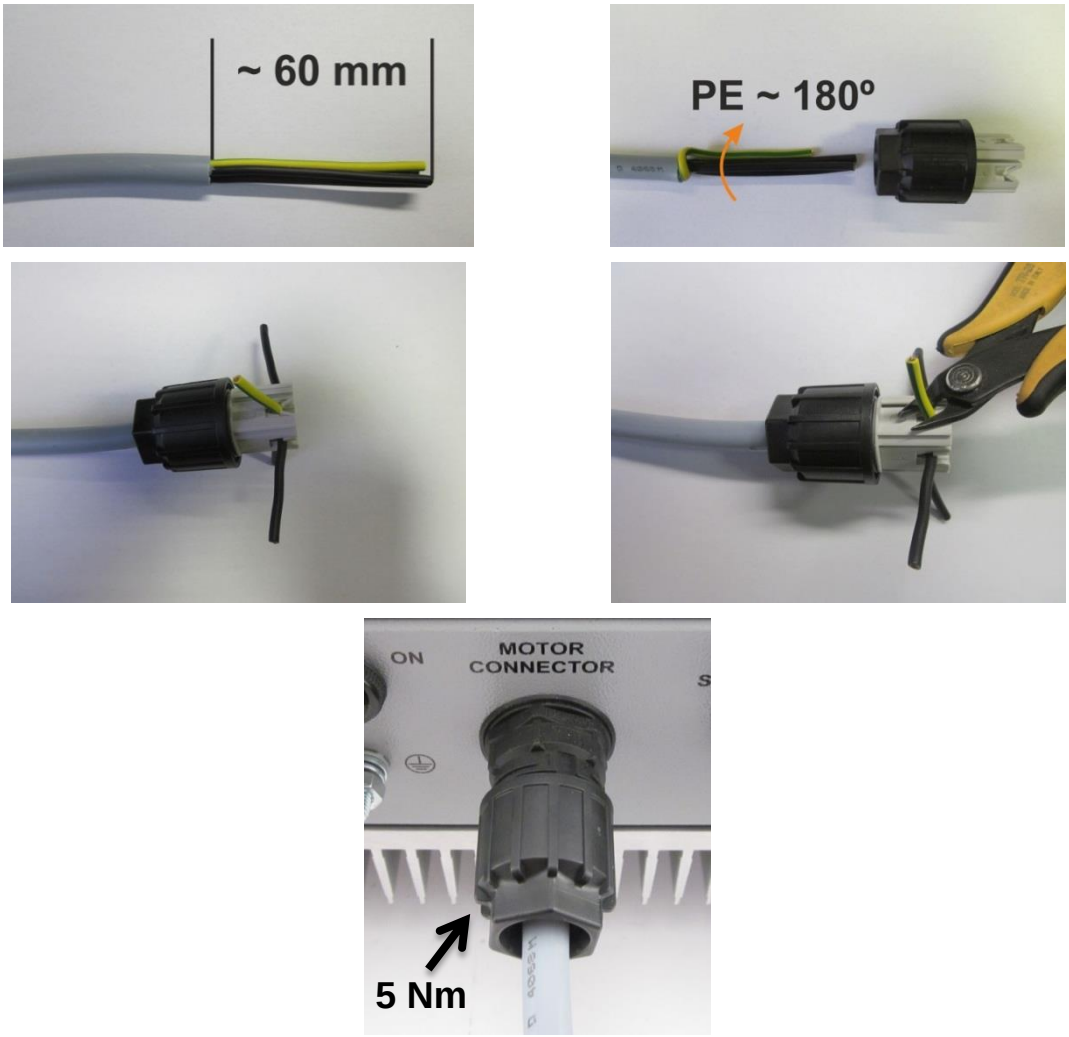


Figure 3.7. Motor cable connecting procedure.

Figure 3.8. Examples of the needed hand tools.

3.6 Water Level Probes (Electrodes) Connector description.

On *Figure 3.9* you can see the description of the water level probes connection.

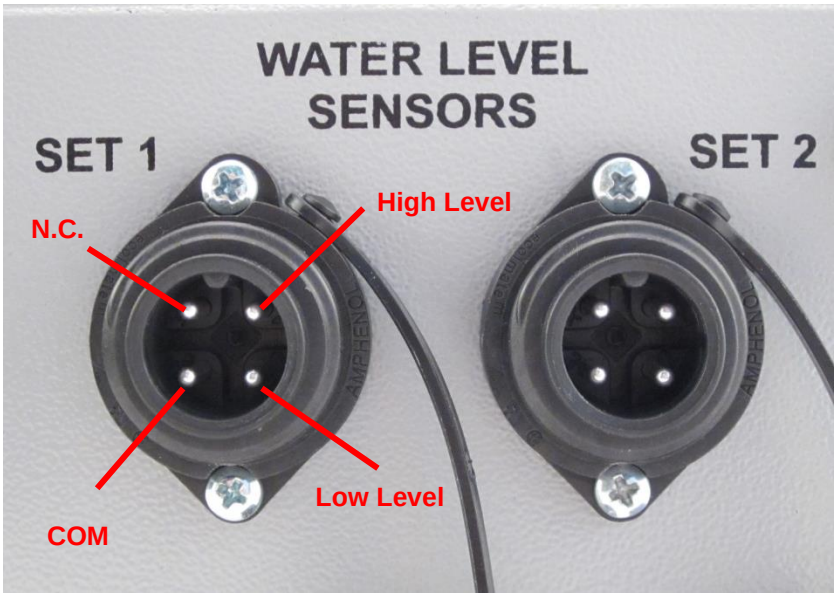


Figure 3.9. Description of the water level probes connection.

3.7 Drive LED Indication and Electronic Protections

On *Figure 3.10* are shown the positions of the LED indication and Communication Port cap. In operational mode communication port cap ***must be screwed properly***. In service mode, the communication port is used for drive monitoring and adjustment, together with the "Drive Remote Control Panel" (please refer to the control panel user manual) or with laptop (notebook) with ***"ConfigMaster"*** Software.

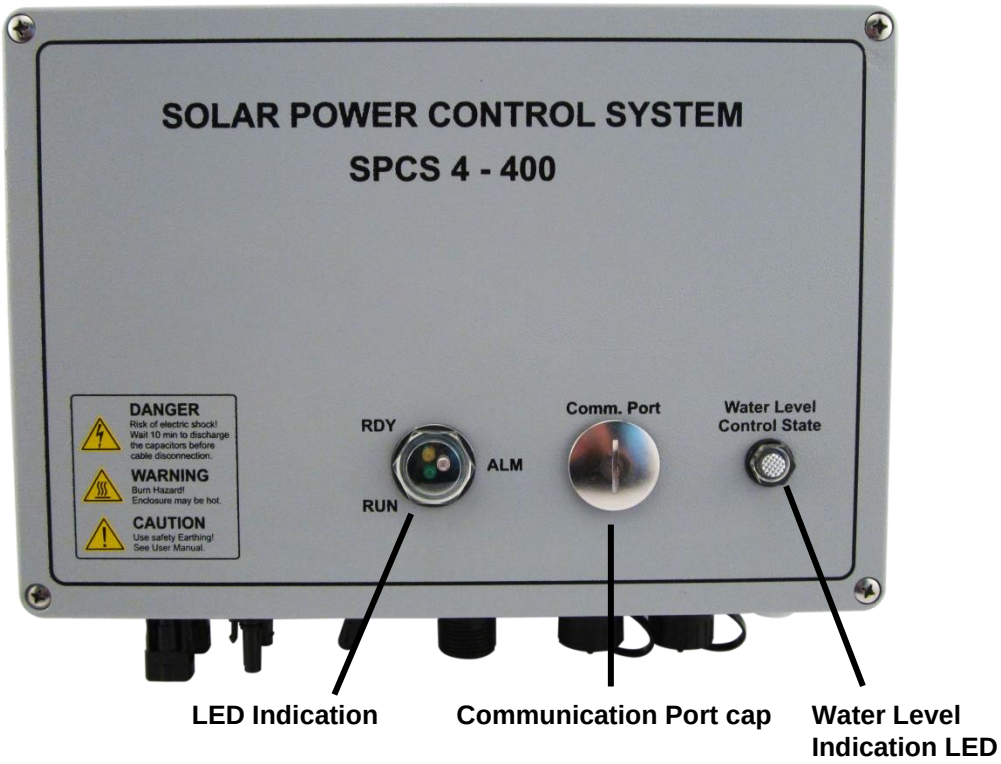


Figure 3.10. LED indication and Communication Port cap.

Indication is implemented by four Light Emitting Diodes (LEDs) – see *Table 3.4*.

Table 3.4. Drive and water level states

№	LED Designator	LED Color	Indicated Drive State
1	**RDY** (Ready)	**Yellow**	Normal drive state. It is constantly lighted unless some fault condition is detected.
2	**RUN** (Running)	**Green**	Active (running) drive state. A.C. voltage is applied to the motor.
3	**ALM** (Alarm)	**Red**	Blinking indicates presence of fault condition which has activated some electronic self-protection. Please see the description of the "Drive Electronic Protections" *Table 3.6.*
4	**Water Level Control State**	**Red**	Please see *Table 3.8.*

Drive (inverter) states indicated by the blinking patterns of "**RDY"** and **"RUN"** LEDs – *Table 3.5*.

Table 3.5. Description of indication

№	Indicating LEDs	Indicated Drive State
1	**RDY**	When power is initially applied across the inverter input terminals, it takes some seconds for the high-voltage capacitors to charge, and then the device enters the normal operating condition. The capacitors charging state is indicated by '**RDY**' LED flashing. When charging is complete the '**RDY**' LED stays permanently lit on.
2	**RDY & RUN**	If '**RDY**' LED is lit on, the '**RUN**' LED remains extinct until start command *(control switch in position "ON")* is applied. Then the '**RUN**' LED is lit too, indicating active *(running)* drive state. However, there are cases when '**RUN**' LED is not immediately lighted, instead it starts blinking for certain amount of time before being continuously lit on: **1.** There is a minimum time interval between two consecutive starts of the drive. If the control switch is turned from position "ON" to position "OFF" and then immediately switched "ON" again, the '**RUN**' LED starts blinking until this time interval expires. **2.** In **"Auto"** control mode, if the drive is disabled due to insufficient power input from the solar panels, then an automatic start is attempted on expiration of a preset restart time interval. Until this automatic start the '**RUN**' LED keeps on blinking. *In the both cases, described above the '**RUN**' LED blinking indicates, that start command (control switch in position "ON") is applied and pending, but not yet active.*
3	**RDY & RUN**	If power is applied to the drive in ***'Manual Mode'*** (please refer to pages 24-25 – "Digital Input Functions") switch turned ON, then after completion of capacitors charging (indicated by '**RDY**' flashing as described above), the '**RDY**' and '**RUN**' LEDs start blinking alternatively. This flashing pattern indicates that you need to cycle the 'Manual Start' switch in order to enable the inverter, as Manual Start Mode does not allow ***automatic start*** of the drive.
4	**RDY & RUN**	The alternative '**RDY**' and '**RUN**' LEDs flashing described above appears also in case that the 'Emergency' input (please refer to pages 24-25 – "Digital Input Functions") is activated at any time. Flashing stops when the 'Emergency' input is deactivated.
5	**RDY & RUN**	When drive unit operation is controlled by the High and Low Tank Level inputs (please refer to pages 24-25 – "Digital Input Functions"), activation of the "Water Tank High Level" input turns the drive off. This state is indicated by alternative flashing of the '**RDY**' and '**ALM**' LEDs. The state persists until "Water Tank Low Level" input gets active.

ATTENTION

A set of built-in self-protections preserves both, the inverter and the controlled motor from various harmful conditions. Activation of any protection disables the inverter output and stops the drive. In automatic control mode, drive restart is automatically attempted after expiration of a preset restart time interval. The alarm is cleared and the drive is enabled only, if the fault condition has already gone.

When a fault protection is active, the '**RUN**' and '**RDY**' LEDs are turned off and the '**ALM**' LED starts blinking. The '**ALM'** LED blinking pattern consists of series of frequent blinks, separated by longer pauses. The number of consecutive blinks in each series indicates the active fault protection. Drive electronic protections indication table is shown below:

Table 3.6. Indicated alarm states

Number of blinks	Indicated Alarm State
1 blink	**Over-Voltage**
2 blinks	**Under-Voltage**
3 blinks	**Short Circuit**
4 blinks	**Over-Current**
5 blinks	**Over-Heating**
6 blinks	**Over-Load**
7 blinks	**Encoder Fault (**not applicable for Solar pump drive systems**)**
8 blinks	**Output Phase Interruption**
9 blinks	**Earth Fault**
10 blinks	**Pump Dry Run**

ATTENTION

1. ***In case that the fault condition causing the fault indication has disappeared, this blinking pattern repeats until the restart time expiration. The next automatic start stops the alarm indication and the 'RDY' LED goes on again.***

2. ***Fault Protection #10 (Pump Dry Run) is indicated a bit differently, than the others. As 'Dry Run' is not really a drive system fault, but an external condition demanding the drive to be stopped, unlike the other faults, the Ready (RDY) LED is not extinguished, while Pump Dry Run alarm is indicated.***

3. ***Also there is another case of different indication. When there is a pump "Stop" condition, initiated by the "Water Level Control" management, then the 'RDY' and 'ALM' LEDs are blinking consecutively. The "Water Level Control" states are described on page 18.***

Drive State LED Indications – Summary:

Table 3.7. Drive state LED indications

RDY	RUN	ALM	Drive State	Comment
Flashing	Extinct	Extinct	Capacitors **Charging**	Lasts approx. 15 seconds
Lighted	Extinct	Extinct	**Ready**, 'Start' Not Activated	Control switch in position "OFF".
Lighted	Flashing	Extinct	**Ready**, 'Start' Pending	Control switch in position "ON". See *Table 3.5*.
Lighted	Lighted	Extinct	Ready, Activated - **Running**	Control switch in position "ON".
Lighted	Extinct	Flashing	Pump **Dry Run** (Drive disabled)	**10** wink series separated by pauses
Extinct	Extinct	Flashing	**Fault** (Drive Disabled)	From **1** to **9** wink series separated by pauses.
Flashing	Flashing	Extinct	**Drive Off:** "Emergency" active or Inverter powered-up with "Manual Start" active	**RDY** / **RUN** alternatively flashing. To end this state: Remove 'Emergency' input or Cycle the 'Manual Start' input
Flashing	Extinct	Flashing	'**Water Tank High Level**' on	**RDY** / **ALM** alternatively flashing until 'Water Tank Low Level' goes active
Flashing	Extinct	Flashing	**'Water Level Control"** function initiated stop	Refer to *Table 3.8 on page 18.*

3.8 Service Mode

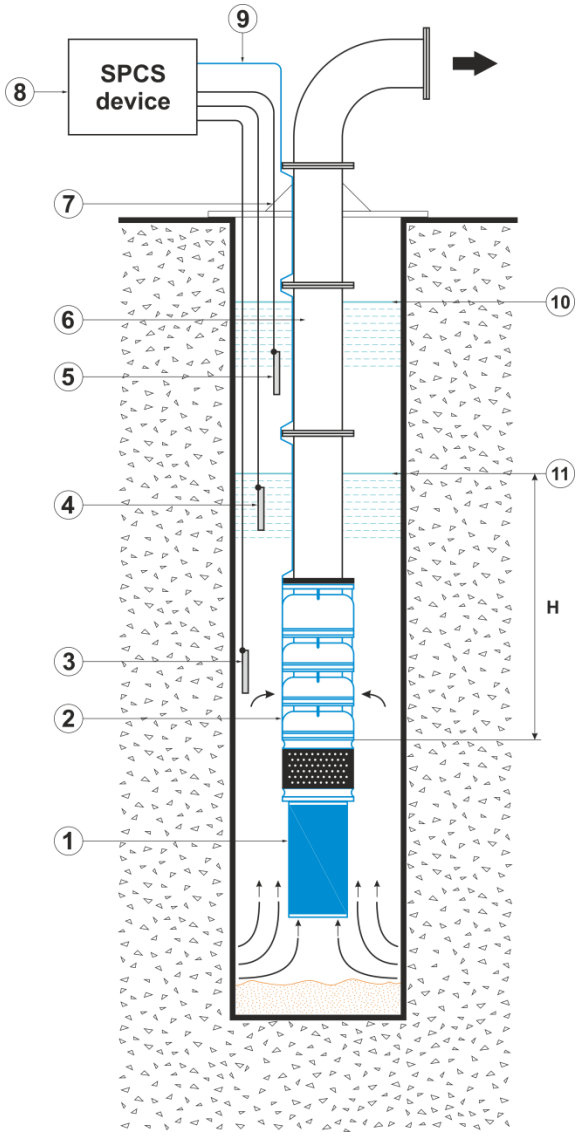
In service mode, the SPCS 4(5,5) – 400 communication port cap is removed and “Drive Remote Control Panel” is connected as shown on *Figure 3.11*.

NOTE: For more information regarding service mode of SPCS 4(5,5) -400, please see “Drive Remote Control Panel” user manual.

Figure 3.11. Service mode of SPCS 4(5,5) - 400

3.9 Water Level Control (WLC)

The “WLC” functionality is implemented for conductive liquids (water) level control in pump systems. An example diagram of a typical water level pump control system in well installation is shown on *Figure 3.12*.



1 – Submersible motor
2 – Pump
3 – Common probe (electrode)
4 – Low level probe (electrode)
5 – High level probe (electrode)
6 – Submersible pipe column
7 – Base plate
8 – Solar power drive system with “WLC” module
9 – Pump motor power supply cable
10 – High level
11 – Low level

H – Positive suction head

Figure 3.12. Typical well installation diagram with water level management by “WLC” module, using one sensors (electrodes) set

The working principle of the “WLC” management is based on the resistance between the “HIGH” to “COMMON” and “LOW” to “COMMON” electrodes. The distance between the “HIGH” and “LOW” probes, forms the level hysteresis.

Recommended sensors (electrodes) are “Lovato Electric” *11SN13 – Kit of 3 level electrodes*, or similar types.

The table with operating states of the water level management is shown down below.

Implemented “Water Level Control” management with two sets of water level sensors and corresponding water level indication states are presented in *Table 3.8* down below.

Table 3.8. – LED Indication and Water Level Management States

DO0 State (Reaction from SET1 sensors)	***DO1 State (Reaction from SET2 sensors)***	***WELL (SET1) and TANK (SET2) States***	***Pump State***	***Water Level Indication LED State***	***Comment***
1	0	WELL Full TANK Empty	RUN	*2 sec.* lit "ON" → *2 sec.* extinct;	*Winking uniformly with period 4 seconds.*
0	1	WELL Empty TANK Full	STOP	*0,2 sec.* lit "ON" → *3,8 sec.* extinct;	*1 short wink, long dark pause.*
1	1	WELL Full TANK Full	STOP	*0,2 sec.* lit "ON" → *0,2 sec.* extinct → → *0,2 sec.* lit "ON" → *3,4 sec.* extinct;	*2 short winks, long dark pause.*
0	0	WELL Empty TANK Empty	STOP	*0,2 sec.* lit "ON" → *0,2 sec.* extinct → → *0,2 sec.* lit "ON" → *0,2 sec.* extinct → → *0,2 sec.* lit "ON" → *3,0 sec.* extinct;	*3 short winks, long dark pause.*

NOTE: ***"1"*** *- digital output logic active state;* ***"0"*** *- digital output logic inactive state;*

On the figure below (*Figure 3.13*) is represented a typical solar pump installation with water level control:

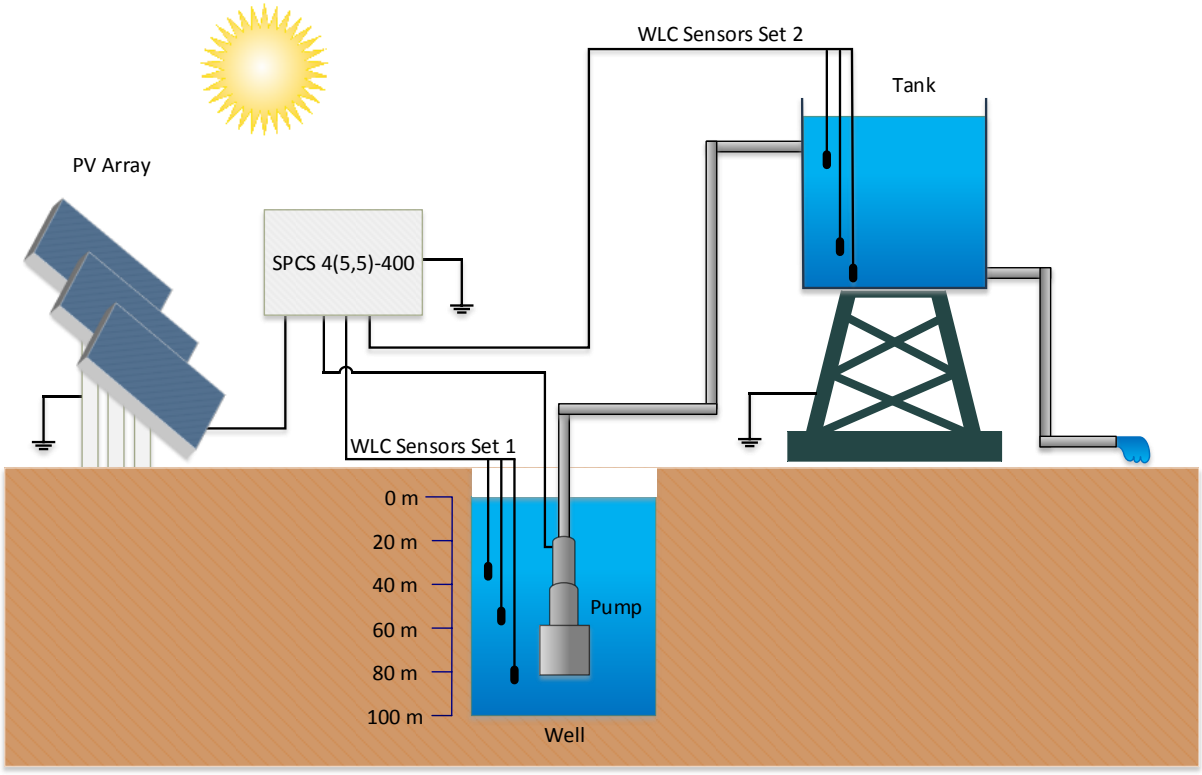


Figure 3.13. Typical pump installation with water level management functionality

On the time diagram below (*Figure 3.14*) is represented the functionality of the "WLC" management:

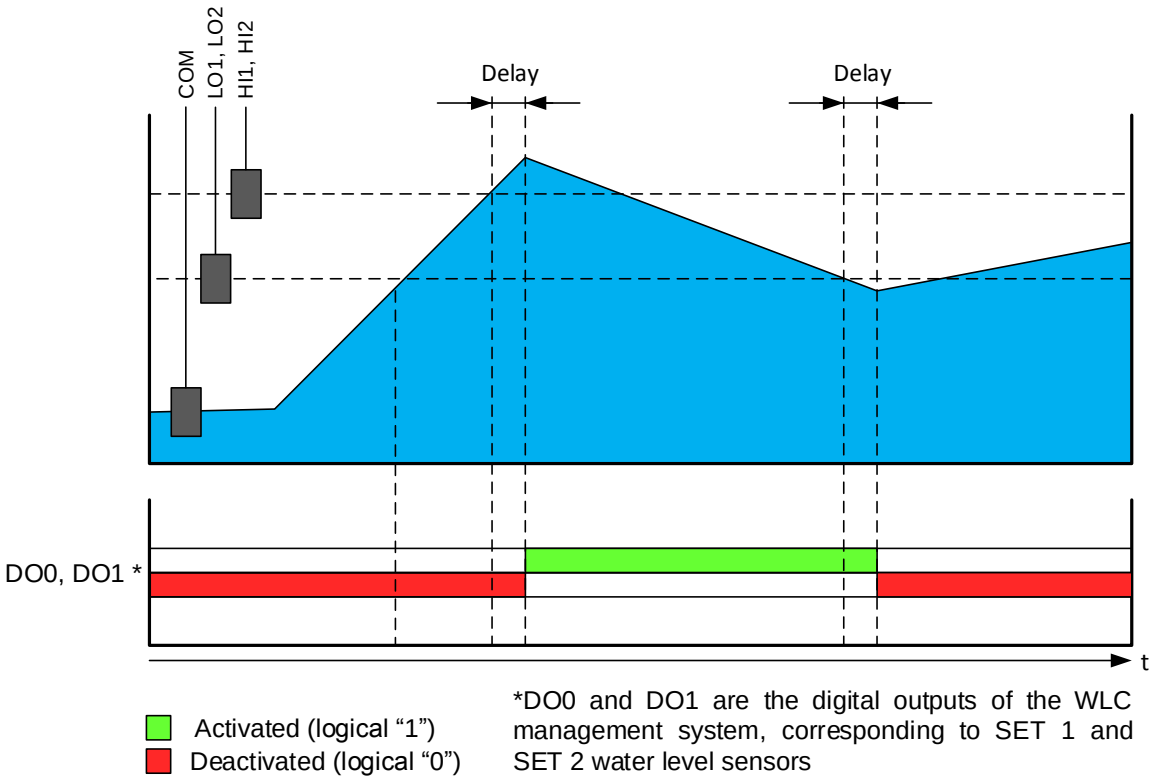


Figure 3.14. "WLC" functionality time diagram

NOTE: ***Instead of "Water Level Control" sensor connectors, there could be placed "Digital Input" connectors for implementing another pump control functions from external automation system.***

4 Software Functional Description

4.1 Parameters of frequency inverter (SPCS 4(5,5) – 400 Software Rev. 1. 39.0)

Parameters of frequency inverter are grouped in 12 functional menus, described below.

Table 4.1. – Parameters of frequency inverter

4.1.1 Menu 0 (a) - Frequency Set point

№	Parameter	Explanation	MODBUS address	Range		Factory setting
A.00	Freq.Ref Hz	Frequency Reference [Hz]	0x0000	0 - 70	Hz	50.0
A.01	Freq.Min Hz	Minimal operational Frequency [Hz]	0x0001	0 - 50	Hz	30.0

4.1.2 Menu 1 (b) - Display

№	Parameter	Explanation	MODBUS address	Range		Factory setting
b.00	Disp.Par.ID	Choice of variable for visualization: **0** : **voltage** across the capacitor battery **1** : **output phase current** of the inverter/motor **2** : **input DC current** of the inverter (***option***, not applicable in base model) **3** : **output frequency** of the inverter **4** : **drive condition** **5** : **software version** **6** : **state** of digital inputs of the inverter **7** : **state** of digital outputs of the inverter **8** : calculated **Output Line Voltage** **10** : calculated **Power Factor**	0x0100	0 - 8	V = A ~ A = Hz - - - - V~. -	-
b.01	Displ.Value	Present value of selected variable	0x0101		-	-

4.1.3 Menu 2 (c) - Motor Parameters

№	Parameter	Explanation	MODBUS address	Range		Factory setting
C.00	Unom V	Nominal line voltage	0x0200	100 - 420	V~	400
C.01	I_nom A	Nominal phase current	0x0201	0.5 - 48.0	A_{rms}	Depends on the drive power
C.02	Pole pairs	Number of pole pairs	0x0202	1 - 4	-	2
C.03	Frq Max Hz	Maximal frequency	0x0203	25 - 65	Hz	55
C.04	Frq Base Hz	Base frequency	0x0204	25 - 65	Hz	50

4.1.4 Menu 3 (d) - General Setup

№	Parameter	Explanation	MODBUS address	Range		Factory setting
d.00	MainsVtg V	Setting of grid voltage	0x0300	127 - 440	V~	400
d.01	fInvert.kHz	Setting of switching frequency	0x0301	1 - 12	kHz	2
d.02	Fan-On Levl	Cooling Fan switch-on level	0x0302	0.00 – 1.00	-	0.64
d.03	Prot.Enable	Activation/Deactivation of - Earth Fault protection (**EF**) and - Output Phase Interruption protection (**out**) 0 – both protections disabled 1 – '**EF**' disabled, '**out**' enabled 2 – '**EF**' enabled, '**out**' disabled 3 - both protections enabled	0x0303	0 - 3	-	3
d.04	Stop Mode	Inverter Stop Mode 0 – controlled stop with speed ramp 1 – free (uncontrolled) stop	0x0304	0 - 1	-	0
d.05	Defaults/Save	**1**: Loading of saved backup configuration from flash memory into operational memory **2**: Creation of backup configuration by copying the adjusted parameter values from operational memory into flash memory **3**: Forced copying of adjusted values of parameters from operational memory into "automatic" area in flash memory Refer to section **4.3.4** for more details on this topic	0x0305	0 - 3	-	0

4.1.5 Menu 4 (e) - Multifunctional inputs

№	Parameter	Explanation	MODBUS address	Range		Factory setting
E.00	DigInp1 Fnc	Multifunctional **Digital input 1**	0x0400	0 – 110	-	12
E.01	DigInp2 Fnc	Multifunctional **Digital input 2**	0x0401	0 – 110	-	11
E.02	DigInp3 Fnc	Multifunctional **Digital input 3**	0x0402	0 – 110	-	3

Refer to Chapter **2.1** for detailed explanation of Multifunctional Inputs configuration and usage.

4.1.6 Menu 5 (f) – Ramp generator

№	Parameter	Explanation	MODBUS address	Range		Factory setting
F.00	Acc x100ms	Positive acceleration from 0 to Freq.Ref	0x0500	0-9999	x 0.1s	65
F.01	Dcc x100ms	Negative acceleration from Freq. Ref to 0	0x0501	0 – 9999	x 0.1s	65
F.02	Emg x100ms	Negative acceleration for emergency stop	0x0502	10 - 1000	x 0.1s	50

4.1.7 Menu 6 (g) – Current limit

№	Parameter	Explanation	MODBUS address	Range		Factory setting
G.00	IlimLo/Inom	Current limitation – low level	0x0600	20% - 170%	-	135%
G.01	IlimHi/Inom	Current limitation – high level	0x0601	60% - 200%	-	160%
G.02	Ovrld Timer	Timer protection from overload	0x0602	500 - 32750	ms	32000
G.03	Ovrld Scale	Overload Current / Rated Current ratio	0x0603	100% - 150%	-	120%

4.1.8 Menu 7 (h) - Communication

№	Parameter	Explanation	MODBUS address	Range		Factory setting
H.00	Baud / 100	Choice of speed on RS232 serial port: 9600, 19200, 38400, 57600, 115200 (bit/sec) The value is entered without the two trailing zeroes	0x0700	96 - 1152	baud /100	192
H.01	Parity	Parity control: **0** – No parity control **1** – Odd number of "ones" in each symbol **2** – Even number of "ones" in each symbol	0x0701	0 - 2	-	0
H.02	Stop bits	Number of stop-bits	0x0702	1 - 2	-	1
H.03	Node ID	Identifier of MODBUS node	0x0703	1 - 247	-	1
H.04	Mbs.timescl	MODBUS communication timeout correction	0x0704	0.100-1.900	-	1.000

4.1.9 Menu 8 (i) - V-Hz curve

№	Parameter	Explanation	MODBUS address	Range		Factory setting
I.00	Ustart/Umax.	Output voltage at Zero Frequency	0x0800	0.0% – 20.0%	-	0.00
I.01	Uboost/Umax	Output voltage at Boost Frequency	0x0801	0.0% - 20.0%	-	0.00
I.02	Ubase/Umax	Output voltage at Motor Base Frequency	0x0802	25.0% - 100.0%	-	1.00
I.03	Fboost/Fmax	Boost Frequency	0x0803	0.0% - 50.0%	-	0.00

4.1.10 Menu 9 (j) - Solar Control

№	Parameter	Explanation	MODBUS address	Range		Factory setting
J.00	SolarPiRegP	Proportional (**P**) Gain of the **PI**-regulator which controls the inverter output frequency	0x0900	0.000–1.000	-	0.025
J.01	SolarPiRegI	Integral (**I**) Gain of the **PI**-regulator which controls the inverter output frequency	0x0901	0.000–0.100	-	0.008
J.02	SolarVtgCrt	Minimal allowable operating voltage against the voltage of solar panel in non-operational (open circuit) condition	0x0902	0.40 – 0.95	-	0.80
J.03	Restrt[sec]	Interval (in seconds) for restarting the inverter	0x0903	10 - 1800	-	240
J.04	LogInt[min]	Interval (in minutes) for logging of inverter operative data in internal non-volatile memory	0x0904	0 - 60	-	5
J.05	IrradScalar	Irradiance input scalar (not applicable)	0x0905	0.050 - 1.000	-	0.470
J.06	MPPT-To[ms]	MPPT Cycle Time in milliseconds	0x0906	500-9999	-	2000
J.07	MPPT-Step	MPPT Step	0x0907	0.000-0.010	-	0.002

NOTE: Menu **10 ("Solar Log")** contains values of the variables stored in an EEPROM log. As optional EEPROM is not present in the SPCS 4(5,5)-400, the menu description is omitted.

4.1.11 Menu 10 (l) – Solar Log

4.1.12 Menu 11 (n) - Pump Control

№	Parameter	Explanation	MODBUS address	Range		Factory setting
n.00	Min.PwrFctr	Power Factor level for “dry pump” detection	0x0B00	0.00–0.80	-	0.30
n.01	Tmeout[sec]	Number of seconds before drive is disabled after detection of “dry pump” condition	0x0B01	5 – 120	sec	13
n.02	Restrt[min]	Number of minutes before automatic drive restart is attempted after “dry pump” detection	0x0B02	1 – 1440	min	30

4.2 Configuration and activation of digital input/output functions

4.2.1 Configuration and activation of digital input functions

A set of digital inputs is provided to control the inverter. Each digital input can be assigned different function according to the characteristics of the technological process and the customer preferences. This is done by assigning any of the available set of digital input functions to some digital input. All input functions will be listed and explained in this chapter further bellow.

Assigning a function to given digital input is done in **Menu 4** - "**Multifunctional inputs**", where each of the digital inputs is presented by separate parameter. We choose the digital input to which we want to attach a function, and then we set the parameter corresponding to this input to the value corresponding to the needed function.

After a function has been configured (assigned) to a digital input, activation of the input activates also the attached function. Activating the input means to feed an active level (voltage) by closing or opening of contact connected to it. The type of active level (if activating is done by closing or opening) also can be chosen individually for each input – this will be described further below in this chapter.

Summary:
In order to activate some digital input function, you need to attach this function to some digital input, and then the input has to be activated by feeding the chosen active level.

Digital Input Functions

Table 4.2. - Digital Input Functions

№	Name	Description
0	Not configured	There is no function assigned to this input.
1	Emergency stop	By activating of this function the motor stops. Until this function is active, inverter cannot be started.
2	Run (Manual Mode)	If voltage is present at the inverter input, we activate Function **2** to start the drive. If Function **2** is permanently active (corresponding input switch permanently ON): - the inverter does not start automatically when input voltage appears. Instead, the inverter control system waits until Function **2** is deactivated, then activation of the function starts the inverter (i.e. the "Manual Run" input has to be cycled). - In case that the drive is stopped by any electronic self-protection, subsequent disappearance of the fault condition does not restore normal drive operation. Instead, the inverter control system waits for the "Manual Run" input to be cycled.
3	Run (Auto Mode)	If voltage is present at the inverter input, we activate Function **3** to start the drive. If Function **3** is permanently active (corresponding input switch permanently ON): - The inverter starts automatically when input voltage appears. - In case that the drive is disabled by any electronic self-protection, subsequent disappearance of the fault condition restores normal drive operation after expiration of a timer set in **j.3** parameter.
4	Level above upper limit	If this function is activated (by exceeding the upper limit level of the tank): the inverter stops and the pump stays switched-off until activation of function **5** („Level below lower limit")
5	Level bellow lower limit	If this function is activated (by the water level gone bellow lower limit): the inverter drives the motor on condition that **Run Manual**(**2**) or **Run Auto**(**3**) function is active and **Emergency stop** function(**1**) is not active. **Note**: if neither **5**, nor **6** functions are configured, the inverter is controlled by the **Run** and **Emergency Stop** functions only.
6	Level Enable	This function performs drive control through a single "liquid level" input. The drive is enabled when "Level Enable" input is active and is disabled when "Level Enable" goes inactive.

By configuring input functions with numbers (values) shown in above table, activation of given function is done by closing the contact, connecting the corresponding digital input to the source of operational voltage. Deactivation becomes by opening of the same contact.
In case it is necessary to implement the reverse logic (activating by contact opening) the values of functions from the table have to be modified by adding an offset of 100.

Example 1: We want to assign input function **2** (**Run Manual**) to digital input **1**, so that this function is activated by closing of a contact. In Menu 4 "**Multifunctional inputs**" we find the parameter, corresponding to digital input **1**:
This is parameter **e.01**. We give **e.01** the value of **2**. So function **2** is assigned to digital input **1**.
Function **2** is activated by closing the contact, connected to input **1**.

Example 2: We change the conditions in Example 1, so that the function **2** is activated by opening of a contact and is deactivated by closing the contact.
In accordance with the principle, shown above, we set parameter **e.01** to the value **2**+**100**, i.e. **102**.
So function **2** is assigned to digital input **1**, but it is activated by opening of a contact connected to input **1** and it is deactivated by closing the same contact.

Note: The next 6 input functions are only applicable to a hardware with dual output (3-phase / Single-phase), or when a hardware "WLC" module is present.
The first 4 functions control both the inverter outputs and the respective 3-pole/2-pole contactors. Configuring the dual output control mode is performed as follows:

- Function **7** (Pump Manual) or **8** (Pump Auto) is assigned to **e.1** parameter (**DigInp2Fnc**)
- Then Function **10** (OutContFbk) and **9** (Single Out) are automatically assigned by the inverter software to parameters **e.0** parameter (**DigInp1Fnc**) and **e.2** parameter (**DigInp3Fnc**) respectively.

Table 4.3 – Digital Input Functions

№	Name	Description
7	Pump Manual	Enable the Pump (3-phase) inverter output in Manual mode This function should be used instead of **Run Manual** (**2**) when dual output is available.
8	Pump Auto	Enable the Pump (3-phase) inverter output in Auto mode. This function should be used instead of **Run Auto** (**3**) when dual output is available.
9	Single Out	Enable the Single-phase inverter output when ***dual output option*** is available.
10	OutContFbk	This digital input function provides feedback about the state of both contactors used to route the inverter output to the 3-phase or the Single-phase output. The feedback secures safe switch-over between 3-phase and Single-phase output mode.
11	LvlCntrl1	"WLC" Module Level Control Function 1. Factory setting.
12	LvlCntrl2	"WLC" Module Level Control Function 2. Factory setting.

4.3 Description of inverter menus and parameters

4.3.1 Menu 0 (a) - "Setting of inverter output frequency"

Parameter **a.00** (**Frequency Reference**) sets the maximal output frequency, which the inverter can achieve in case of high irradiance, ensuring enough energy flow from the solar panels.
In lower irradiance conditions the output frequency set point is provided by the 'Solar' **PI**-Regulator which sustains the highest possible output frequency for given irradiance conditions.

Parameter **a.01** (**Minimal operational Frequency**) sets a lower limit for the inverter/pump operation.
In poor irradiance conditions the highest achievable output frequency/motor velocity, might be too low for the pump to ensure any water flow. So, the motor/pump would rotate at low speed to no avail.

Therefore, normal pump operation assumes that the pump motor rotation speed does not fall below some minimal value at which water flow stops. If the incoming energy flow from the PV panels is not sufficient to sustain this minimal output frequency, then the inverter control system disables the inverter output and the pump stops for certain time interval before a new attempt to accelerate the drive above the minimal frequency is tried. This retry interval is configured (in seconds) through the **n.03** – **Restrt** [sec] parameter in Menu 11.

Automatic restart is launched only in case that the **Automatic Start** input is active.

4.3.2 Menu 1 (b) - "Display"

The menu consists of two parameters.
The first (**b.00**) is index, by which can be chosen some of the liable to visualization variables.
The second (**b.01**) is "read-only" parameter (only for reading) in which the chosen for visualization variable appears.
The values, which can accept **b.00**, as well as the corresponding list of variables for visualization, are shown in paragraph 1.2.
For visualization of given variable by operation with software **ConfigMaster**, should be kept the following sequence:

- It is assigned the desired value of index **b.00** (with this it is choosing the variable for visualization)
- With right button of the mouse should "click" upon first or second column of **Menu 1** and from the open context menu should be chosen "Download Menu **1**", thus refreshing the content of parameter **b.01**, where the chosen variable in correct format appears.

Note:
The visualization cell (Parameter **b.01**), can be chosen for permanent observation by "click" with right button upon the last column on **Menu 1**/ Parameter 01.
By this the colors of the frame are changing and the software starts periodical refreshment of its content. The exit from the regime of permanent observation can be done by secondary "click" upon the same cell on the table.
By analogic way any other "read-only" parameter can be chosen for permanent observation.
It is not allowed simultaneous setting in regime for observation of two or more parameters.

4.3.3 Menu 2 (c) - "Motor Parameters"

For the motor control mode „Constant **U/f** proportion", used in this type of inverters, some of parameters in **Menu 2** are important for control of the pump motor, others are used only to calculate the values, which are visualized or are written into the log file, preserved in the internal energy-independent memory of the inverter.
The important parameters for the control of AC induction motor are:

- **c.00** – Nominal line voltage
- **c.01** – Nominal phase current
- **c.03** – Maximal frequency
- **c.04** – Base frequency

Nominal voltage and current, as well as the base frequency can be taken from the motor label or from producer documentation of the pump.
The value of **c.03** (Maximal frequency) can be specified equal or a little higher than the base frequency. This parameter specifies the upper limit, to which can be increased the frequency reference in **Menu 0**.
Parameter **c.05** – Power factor is used to calculate the active output power of the inverter and can be taken also from the label of the motor or pumps documentation.
Parameter **c.02** (Number of pole pairs) is not substantial for this mode of motor control.

4.3.4 Menu 3 (d) - "General Setup"

d.00 – "**MainsVtg**"
By supply from electrical grid, this is the nominal effective value of the line voltage.
By supply from solar panels, the value of this parameter is specified equal to their nominal voltage (depending from the type and number of in series connected panels), multiplied by coefficient, equal to **0.707** (reciprocal value of squire root of 2)

d.01 – "**fInvert.kHz**"
This parameter specifies the inverter switching (carrier) frequency.
The range for setting is 2-12(kHz).
The main considerations for the choice of switching frequency are:

- higher output frequency of inverter requires also higher switching frequency.
- but higher switching frequency causes higher commutation losses in the inverter power stage.
- lower switching frequency produces higher acoustic noise in the motor.

As the drives for water pumps operate with low output frequency (up to 60 Hz), it is preferred the carrying frequency not to exceed 5-6 kHz. Typical adjustment would be between 2 and 4 kHz. The acoustic noise from the motor is of no importance for this type of drives, and relatively low switching frequency helps against overheating of power transistor unit.

d.02 – "**Fan-On Levl**"
This parameter sets the temperature of power unit, at which the inverter cooling fan is switched-on. Lower value of this parameter secure lower temperature for fans switch-on.
By value zero, the fan will be permanently switched-on, irrespective of the temperature of the power unit. This parameter is not useable in fan less design.

d.03 – "**Prot.Enable**"
The inverter 'Earth Fault' and 'Output Phase Interruption' protections can be masked (disabled) or enabled using this parameter. Possible values of this parameter and their meaning are shown below:

Table 4.4 – Possible values of parameter

Value	*'Earth Fault'*	*'Output Phase Interruption'*
0	disabled	disabled
1	disabled	**enabled**
2	**enabled**	disabled
3	**enabled**	**enabled**

d.04 – "**Stop mode**"
Parameter **d.04** defines the drive behavior on removing the **Run** signal (setting the **Run** input to inactive state) while the pump motor is rotating.

If **d.04** is set to the value of **0**, then the inverter brings the motor to standstill by decreasing the output frequency in accordance with the Deceleration Ramp, configured by parameter **H.01** (controlled stop).

If **d.04** is set to the value of **1**, then the motor coasts freely to standstill (uncontrolled stop).

d.05 – "**Defaults/Save**"
Parameter **d.05** serves mainly to store entire configurations in permanent (flash) memory of the inverter, as well as to restore written configurations.

When the inverter is power supplied, the configuration parameters, specifying the behavior of the drive, are kept in an energy dependent operational memory (RAM).

By switch-off of the power all parameters from the running configuration are automatically saved in energy independent (non-volatile) FLASH memory.

By switching-on of the power, all parameters from energy independent memory (FLASH) are transferred into operational memory. So the inverter configuration is restored from the last switch-off. This is so-called **"automatic configuration"**, which is preserved and restored automatically, without external command.

By change of some configuration parameters it is possible to reach to unwanted behavior of the drive compared with its condition before start of the changes. In case a lot of changes are made, the restoration "by memory" of the last working configuration can be impossible. To secure taking out from such unfavorable situation, it is foreseen a possibility for saving the **"reserve configuration".** This configuration is saved in separate zone in flash-memory that is not affected by automatic writing at power-down. It is recommended after change of configuration parameters, by reaching well working configuration, this configuration to be written as a "reserve" one. This can be done as on **d.05** is assigned value of **2**: **d.05** = 2 (after writing of configuration, the value on **d.05** automatically returns in **0**).

So written reserve configuration stays unchanged until not being overwritten in already described manner. Copying of reserve configuration from flash-memory into operative memory becomes as on **d.05** is assigned value of **1**: **d.05** = 1.

The running configuration can also be written in the flash-memory not only automatically (at power-down), but also forcefully – as on **d.05** is assigned value **3**: **d.05** = 3.

Note: Each of these operations can be activated only in inactive condition of inverter – when the **Run** input is inactive.

4.3.5 Menu 4 (e) - "Multifunctional inputs"

Each of parameters **e.0** – **e.2** in this menu corresponds to one physical input of the inverter.
Digital inputs **e.01** – **e.02** are multifunctional and each of them can be assigned some of the available digital input functions, as described in **2.1** – **„Configuration and activation of digital input functions"**

4.3.6 Menu 5 (f) - "Ramp generator"

By parameters **f.00** and **f.01** can be specified positive acceleration and negative motor acceleration.
Acceleration is assigned as time for change of output frequency of the inverter

- from 0 to maximal specified frequency (Freq. Ref.) for positive acceleration
- from maximal specified frequency (Freq. Ref.) to 0 for negative acceleration.

The time is assigned in 0.1 second units.
For example adjustment 100 of the time for positive acceleration (**f.00**) corresponds to 100 x 0.1 = 10 (Sec).
This is a small acceleration, corresponding to smooth start-up of the pump and such adjustment for positive acceleration is typical for this type of drives.

Parameter **f.02** assigns negative acceleration, applied in during Emergency Stop.

4.3.7 Menu 6 (g) - "Current Limit"

g.00 specifies a 'low limitation' threshold for the motor phase current. In case of exceeding this limit, the motor acceleration is temporarily stopped (the output frequency reference is "frozen" at its present value) until the phase current drops below the low limitation threshold, then the motor acceleration is resumed.
g.01 specifies a 'high limitation' threshold for the motor phase current. In case of exceeding this limit, the output frequency reference is being gradually reduced until the phase current drops below the high limitation threshold, then the motor acceleration is resumed.
Both **g.00** and **g.01** are dimensionless values specified against the adjusted nominal motor current. If sufficiently long acceleration time is set by **f.00** parameter, the pump acceleration goes smoothly, so in practice there is rather small probability of entering any of the current limitation regimes.
g.02 is a parameter which sets a timer for drive overload protection. The overloading protection is activated in case of continuous operation at motor phase current greater than the adjusted 'overload' current of the motor (set by **g.03**). The time is assigned in milliseconds. For example, the adjustment of **g.02** = 5000 means, that the overload protection will be activated after operation longer than **5** seconds at current bigger than the 'overload' value.
g.03 sets the motor current threshold, above which overload timer is started. **g.03** is a dimensionless value: the ratio between the 'overload' current and the nominal motor current.

4.3.8 Menu 7 (h) - "Communication"

h.00, **h.01** and **h.02** parameters set the communication parameters for the **RS232/RS485** serial port.

- **h.00** sets the communication speed. Available values are 9600, 19200 and 38400, 57600 and 115200 baud. The preferred speed value is entered in **h.00** as listed above, just the trailing two zeroes are omitted.
  As an example, the 19200 baud speed is set by **h.00** = 192.
- **h.01** sets the parity control: **0** (No Parity), **1** (Odd Parity), **2** (Even Parity).
- **h.02** sets the Stop Bits number: 1 or 2. Default communication settings are: **19200**, **N**, **8**, **1**. (number of data bits in character is always 8).
- **h.03** sets the device identifier number in a MODBUS network (MODBUS Node ID). In accordance with MODBUS protocol, possible values range from 1 to 247. Default value is 1.
- **h.04** is a scalar used for modifying the MODBUS inter-frame timeouts from their standard values. This may be needed for interoperation with devices which don't strictly abide by MODBUS standard. Default setting for **h.04** is **1.00**, which ensures standard MODBUS inter-frame timeout.

4.3.9 Menu 8 (i) - "V-Hz curve"

The inverter implements the well-known 'Constant Volt per Hertz' control method. The parameters of this menu set the ratio between the amplitude and frequency values of inverter's output voltage.

i.00 and **i.01** configure voltage boost at zero frequency and at the 'boost frequency' respectively (the 'boost frequency' is set by **i.03** parameter). The voltage boost increases motor torque at very low rotation speed at the price of somewhat bigger motor power losses in the low-speed range. For pump drive systems the load at very low rotation speed is inconsiderable, so boosting of output voltage is normally redundant, so **i.00** and **i.01** parameters may keep their default zero values

i.02 sets the ratio between the voltage at the base (nominal) voltage frequency and the nominal motor Line Voltage, configured through Menu 2 ("Motor Parameters"). Ordinary setting for **i.02** is 1.00 – the voltage amplitude at the nominal frequency is equal to the configured motor line voltage.

i.03 sets the boost frequency value for the U/f curve. According to the considerations given above, Voltage Boost is hardly needed for pump drives, so normally **i.03** may preserve its default zero value.

4.3.10 Menu 9 (j) - "Solar Control"

j.00 and **j.01** parameters set respectively the **P**-component gain and **I**-component gain of a Proportionally- Integral Controller (**PI** - Controller) which produces the drive output frequency set point depending on the measured value of the DC-voltage coming from the PV panels.
"Solar" **PI**-controller prevents the drive from drawing too much power from the PV-panels in case of insufficient solar radiation. So, it reduces the output frequency set point if the measured PV voltage tends to fall below some critical threshold. This 'Critical Voltage' threshold is defined as proportion of the PV voltage under load towards the PV voltage in idle state ('Open Circuit' PV voltage, **OC**). So, setting the Critical Voltage presumes knowledge of the 'Open Circuit' PV voltage. 'Open Circuit' PV voltage can be easily measured by the inverter in idle state. But this is true only on condition that there is only one inverter connected to the PV string. If there are two or more inverters supplied by common PV string, automatic determination of the 'Open Circuit' PV voltage is not possible as there is no guarantee that when some inverter is idle, the PV panels are not being loaded by some other inverter.

j.02 parameter configures the relative value of the drive operating DC-voltage (Critical Voltage) towards the "Open Circuit" PV voltage.
Normally the value of **j.02** is about 0.80, which means that when the inverter is in operation, its control system tries to ensure maximal possible output frequency without letting the DC voltage drop below 80% of the PV panels OC voltage value.

j.03 – **Restrt** [sec] sets the time interval (in seconds) between two consecutive attempts to accelerate the pump motor above the configured minimal operational frequency.
Refer to the description of Parameter **A.01** (**Minimal operational Frequency**) for more details.

j.04 and **j.05** parameters are related to EEPROM logger operation. Since EEPROM is not available in the present hardware, these parameters are of no importance.

j.06 and **j.07** parameters configure the **MPPT** (Maximum Power Point Tracking) operation.

MPPT performs continuous automatic correction of the Critical Voltage value (configured via **j.02**) in order to achieve maximal possible frequency on the inverter output. The Critical Voltage value set by **j.02** is internally summed with a correction value which is periodically re-calculated using the well-known 'Perturb & Observe' algorithm. The intervals for calculation of the correction are set in milliseconds, through **j.06** ('MPPT-Timeout'). The perturbation step is set by **n.07** ('MPPT Step').

MPPT operation is possible only in the case of one inverter connected to a PV string.
If several inverters are supplied from common string, MPPT function on each of them should be cancelled by giving the MPPT Step (**j.06**) the value of 0.

4.3.11 Menu 10 (l) - "Solar Log"

Menu **10** (**"Solar log"**) contains values of the variables stored in an EEPROM log. As EEPROM option is not available in the present hardware, the menu description is omitted.

4.3.12 Menu 11 (n) - "Pump Control"

As continuous operation of the pumping system without water is considered an emergency, protection against it is implemented in the drive control system. Menu **11** provides parameters for customizing this protection.
There are two decisions to be made regarding the timing of the 'dry pump' protection:

a) How long to wait before turning the drive off in case that 'dry pump' condition is detected. This timeout value is set in seconds via **n**.**01** (**Tmeout** [sec]) parameter. It shouldn't be too small because transient 'dry pump' conditions normally occur during initial drive acceleration. The timeout must not be too long either as prolonged dry rotation may be harmful for the pump. By default the timeout is set to 60 seconds.

b) How long the drive should stay inactive in case it has been turned off due to 'dry pump' condition. This interval is set in minutes via **n**.**02** (**Restrt** [min]) parameter. The maximal value of **o**.**02** is 1440 minutes (24 hours). By default the restart interval is set to 60 minutes.

Besides, a 'Minimal Power Factor' threshold is set which is used for 'dry pump' condition detection. Normally you don't need to change the default value of **0.40** set for this **n**.**0** (**Min**.**PwrFctr**) parameter. But in some rare cases it might need modification, especially if the pump regime allows continuous operation at speed or load substantially smaller than the nominal ones. In such cases faulty activation of the 'dry pump protection may occur. To avoid it, you may need to slightly decrease the **n**.**0** setting.

To help you figure out the meaning of this ''Minimal Power Factor' threshold, here is a brief description of the simple principle on which the 'dry pump' protection implementation is based:
Induction motors are notorious for their poor power factor in case of idle running or when driving small loads. The power factor grows up when the motor load increases and reaches values of about 0.80 or even 0.90 and more at nominal load and nominal speed (depending on motor specifications).
So, knowing the power factor value, the 'dry pump' condition with respective power factor of the order of **0.20** is easily distinguished from the 'full load' condition with power factor around **0.80** or more.
But if the drive is operated at speed/load much smaller than the rated ones, the power factor at this smaller load may occasionally drop below the default value of **0.30**, so some decrease of **n**.**0** parameter value will prevent unwanted activation of the 'dry pump' protection.
In these unlikely cases, setting the proper value of the power factor threshold is facilitated by the Power Factor monitoring capability of the drive system – refer to the description of Menu 1(**Display**) in paragraph 3.2. Power factor value can be monitored by selecting the value of 9 for the Display Index parameter **b.0.**

4.4 MODBUS communication

4.4.1 Supported functions of MODBUS protocol

The system supports MODBUS – functions with the following functional codes:

Table 4.5 – Functional codes

03 (0x03)	Read Holding Registers
04 (0x04)	Read Input Registers
05 (0x05)	Write Single Coil
06 (0x06)	Write Single Register
16 (0x10)	Write Multiple Registers

4.4.2 Addressing of parameters and variables of the drive by MODBUS protocol

Each of described inverter configuration parameters may be read / modified by standard functions of MODBUS protocol.

4.4.3 Principle of addressing

Two-byte address for access to any configured parameter is formed this way:

- Most significant byte is the number of the menu to which the parameter belongs;
- Least significant byte is the index of the parameter within the menu;

4.4.4 Format of parameters and variables of the drive accessible through MODBUS

Presentation of parameter values inside the MODBUS Protocol Data Units is depicted below. To add clarity, some examples are included (*please, refer to the screenshot on the next page*).

Both Integer and Real configuration parameters transmitted through MODBUS frames are coded as 16-bit integer values.
Representation of any parameter sent over the serial line depends on the adopted position of the Decimal Point (**DP**) for the parameter.
A parameter value is transformed to Integer through multiplying it by a factor, equal to the **N**-th power of 10, where **N** is the **DP** position.

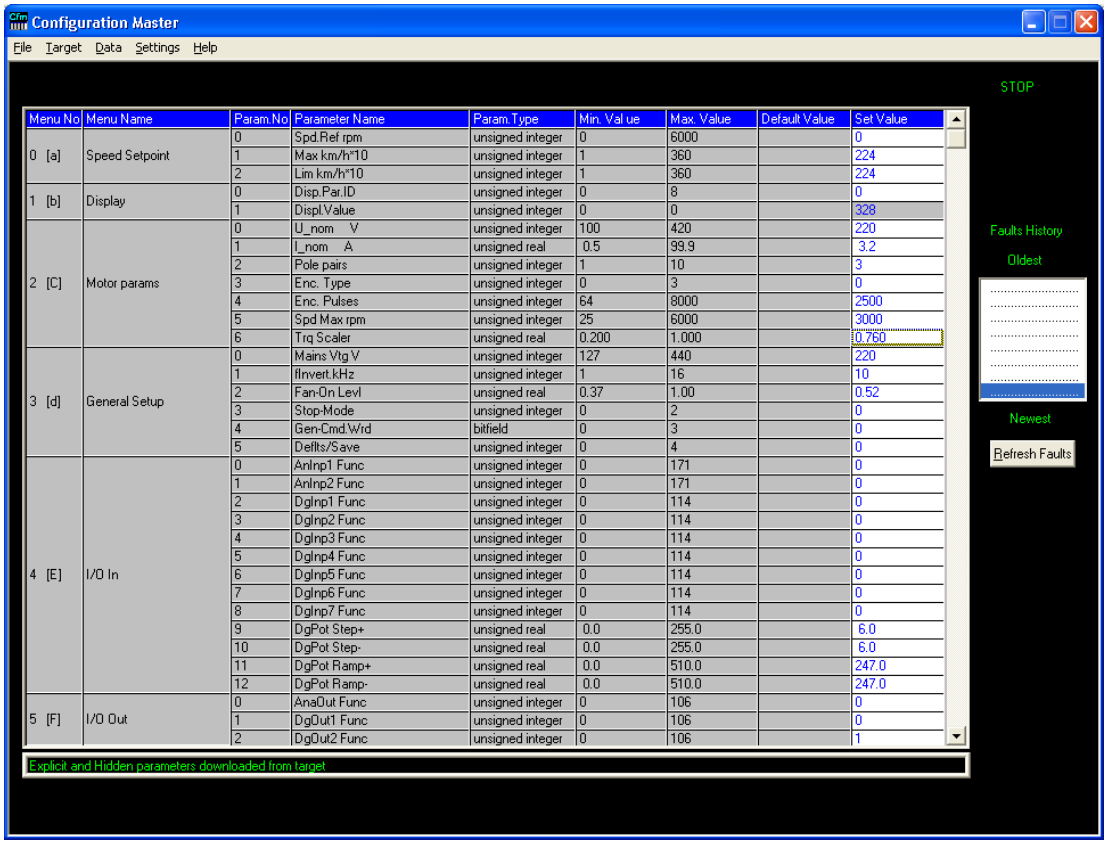
For an Integer parameter DP position is zero, so the transformation factor in this case equals 1 and the value is sent exactly as it appears in the “Set Value” field on the screen.

For a Real parameter the transformation factor, being a power of 10, is big enough to shift the decimal separator to the zero position, converting the Real value into Integer one.

Knowing the DP position for any parameter of interest, the receiving side restores the actual parameter value through dividing the integer number coded in the MODBUS frame by the same transformation factor.

The screenshot below shows part of a Drive Unit configuration downloaded through the “ConfigMaster” tool.

Conversion of Real parameter value to Integer one is illustrated with the example of Parameter 6 in Menu 2 (*Figure 4.1*). There are three digits to the right of the decimal separator there, so the DP position is equal to 3. The transformation factor should be 10^3 = 1000. Hence the value of 0.760 is transformed into 1000 x 0.760 = 760 before being inserted into the MODBUS message frame. On reception the real value is restored through dividing of 760 by 1000.



Menu No	Menu Name	Param.No	Parameter Name	Param.Type	Min. Value	Max. Value	Default Value	Set Value
0 [a]	Speed Setpoint	0	Spd.Ref rpm	unsigned integer	0	6000		0
		1	Max km/h*10	unsigned integer	1	360		224
		2	Lim km/h*10	unsigned integer	1	360		224
1 [b]	Display	0	Disp.Par.ID	unsigned integer	0	8		0
		1	Displ.Value	unsigned integer	0	0		328
2 [C]	Motor params	0	U_nom V	unsigned integer	100	420		220
		1	I_nom A	unsigned real	0.5	99.9		3.2
		2	Pole pairs	unsigned integer	1	10		3
		3	Enc. Type	unsigned integer	0	3		0
		4	Enc. Pulses	unsigned integer	64	8000		2500
		5	Spd Max rpm	unsigned integer	25	6000		3000
		6	Trq Scaler	unsigned real	0.200	1.000		0.760
3 [d]	General Setup	0	Mains Vtg V	unsigned integer	127	440		220
		1	fInvert kHz	unsigned integer	1	16		10
		2	Fan-On Levl	unsigned real	0.37	1.00		0.52
		3	Stop-Mode	unsigned integer	0	2		0
		4	Gen-Cmd.Wrd	bitfield	0	3		0
		5	Deflts/Save	unsigned integer	0	4		0
4 [E]	I/O In	0	AnInp1 Func	unsigned integer	0	171		0
		1	AnInp2 Func	unsigned integer	0	171		0
		2	DgInp1 Func	unsigned integer	0	114		0
		3	DgInp2 Func	unsigned integer	0	114		0
		4	DgInp3 Func	unsigned integer	0	114		0
		5	DgInp4 Func	unsigned integer	0	114		0
		6	DgInp5 Func	unsigned integer	0	114		0
		7	DgInp6 Func	unsigned integer	0	114		0
		8	DgInp7 Func	unsigned integer	0	114		0
		9	DgPot Step+	unsigned real	0.0	255.0		6.0
		10	DgPot Step-	unsigned real	0.0	255.0		6.0
		11	DgPot Ramp+	unsigned real	0.0	510.0		247.0
		12	DgPot Ramp-	unsigned real	0.0	510.0		247.0
5 [F]	I/O Out	0	AnaOut Func	unsigned integer	0	106		0
		1	DgOut1 Func	unsigned integer	0	106		0
		2	DgOut2 Func	unsigned integer	0	106		1

Figure 4.1. "ConfigMaster" User Interface (Parameter 6, Menu 2)

The following examples illustrate reading / modification message sequences for various parameter formats.

Read Holding Registers (MODBUS Function Code **0x03**)

Menu **2**, Parameter **4**
Reading of **Integer** parameter value **2500** (hex **09C4**)

Table 4.6 - Examples

Request			**Response**		
01 03 02 04 00 01 C4 73			**01 03 02 09 C4 BF 87**		
NodeID	**01**	Slave Address	NodeID	**01**	Slave Address
FuncCode	**03**	Function Code	FuncCode	**03**	Function Code
Menu	**02**	Starting Address	ByteCount	**02**	Byte Count
Param	**04**		RegVal_Hi	**09**	Register Value
RegCnt_Hi	**00**	Quantity of Registers	RegVal_Lo	**C4**	
RegCnt_Lo	**01**		CRC_Lo	**BF**	CRC
CRC_Lo	**C4**	CRC	CRC_Hi	**87**	
CRC_Hi	**73**				

Menu 2, Parameter 1
Reading of **Real** parameter value **3.2**, presented as **3.2** x **10** = **32** (hex **0020**)

Request			Response		
01 03 02 01 00 01 D4 72			**01 03 02 00 20 B9 9C**		
NodeID	**01**	Slave Address	NodeID	**01**	Slave Address
FuncCode	**03**	Function Code	FuncCode	**03**	Function Code
Menu	**02**	Starting Address	ByteCount	**02**	Byte Count
Param	**01**		RegVal_Hi	**00**	Register Value
RegCnt_Hi	**00**	Quantity of Registers	RegVal_Lo	**20**	
RegCnt_Lo	**01**		CRC_Lo	**B9**	CRC
CRC_Lo	**D4**	CRC	CRC_Hi	**9C**	
CRC_Hi	**72**				

Menu 2, Parameter 6
Reading of **Real** parameter value **0.760**, presented as **0.760** x **1000** = **760** (hex **02F8**)

Request			Response		
01 03 02 06 00 01 65 B3			**01 03 02 02 F8 B8 A6**		
NodeID	**01**	Slave Address	NodeID	**01**	Slave Address
FuncCode	**03**	Function Code	FuncCode	**03**	Function Code
Menu	**02**	Starting Address	ByteCount	**02**	Byte Count
Param	**06**		RegVal_Hi	**02**	Register Value
RegCnt_Hi	**00**	Quantity of Registers	RegVal_Lo	**F8**	
RegCnt_Lo	**01**		CRC_Lo	**B8**	CRC
CRC_Lo	**65**	CRC	CRC_Hi	**A6**	
CRC_Hi	**B3**				

Menu 3, Parameter 2
Reading of **Real** parameter value **0.52**, presented as **0.52** x **100** = **52** (hex **0034**)

Request			Response		
01 03 03 02 00 01 25 8E			**01 03 02 00 34 B9 93**		
NodeID	**01**	Slave Address	NodeID	**01**	Slave Address
FuncCode	**03**	Function Code	FuncCode	**03**	Function Code
Menu	**03**	Starting Address	ByteCount	**02**	Byte Count
Param	**02**		RegVal_Hi	**00**	Register Value
RegCnt_Hi	**00**	Quantity of Registers	RegVal_Lo	**34**	
RegCnt_Lo	**01**		CRC_Lo	**B9**	CRC
CRC_Lo	**25**	CRC	CRC_Hi	**93**	
CRC_Hi	**8E**				

Write Single Register (MODBUS Function Code **0x06**)

Menu 2, Parameter 4
Writing **Integer** parameter value **2500** (hex **09C4**)

Request			Response		
01 06 02 04 09 C4 CE 70			**01 06 02 04 09 C4 CE 70**		
NodeID	**01**	Slave Address	NodeID	**01**	Slave Address
FuncCode	**06**	Function Code	FuncCode	**06**	Function Code
Menu	**02**	Register Address	Menu	**02**	Register Address
Param	**04**		Param	**04**	
RegCnt_Hi	**09**	Register Value	RegVal_Hi	**09**	Register Value
RegCnt_Lo	**C4**		RegVal_Lo	**C4**	
CRC_Lo	**CE**	CRC	CRC_Lo	**CE**	CRC
CRC_Hi	**70**		CRC_Hi	**70**	

Menu 2, Parameter 1
Writing **Real** parameter value **3.2**, presented as **3.2** x **10** = **32** (hex **0020**)

Request			Response		
01 06 02 01 00 20 D8 6A			**01 06 02 01 00 20 D8 6A**		
NodeID	**01**	Slave Address	NodeID	**01**	Slave Address
FuncCode	**06**	Function Code	FuncCode	**06**	Function Code
Menu	**02**	Register Address	Menu	**02**	Register Address
Param	**01**		Param	**01**	
RegCnt_Hi	**00**	Register Value	RegVal_Hi	**00**	Register Value
RegCnt_Lo	**20**		RegVal_Lo	**20**	
CRC_Lo	**D8**	CRC	CRC_Lo	**D8**	CRC
CRC_Hi	**6A**		CRC_Hi	**6A**	

5 Cable Connector Sets

On the *Figure 5.1* to *Figure 5.4* are shown the cable connectors in the SPCS 4(5,5) - 400 packages.

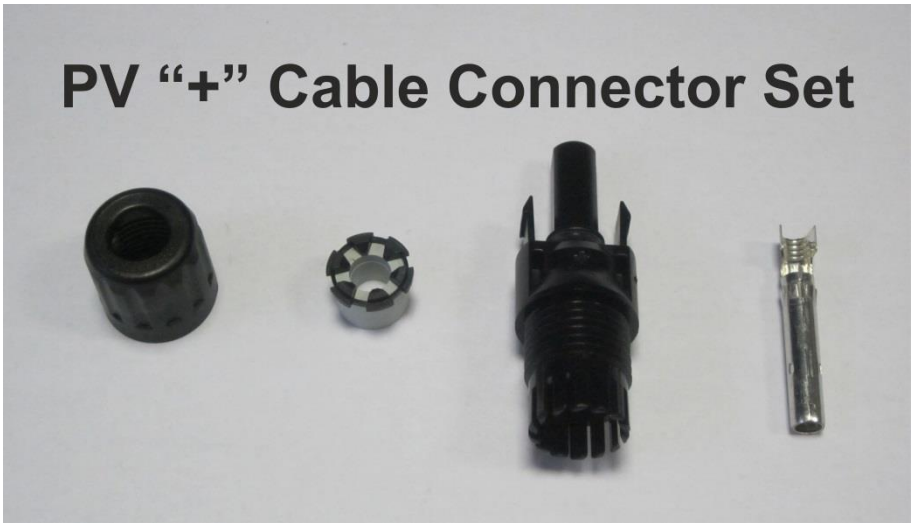


Figure 5.1. PV “+” cable set.

The PV “+” connector must be installed with PV installation cable – cross section 6mm^2 (red).

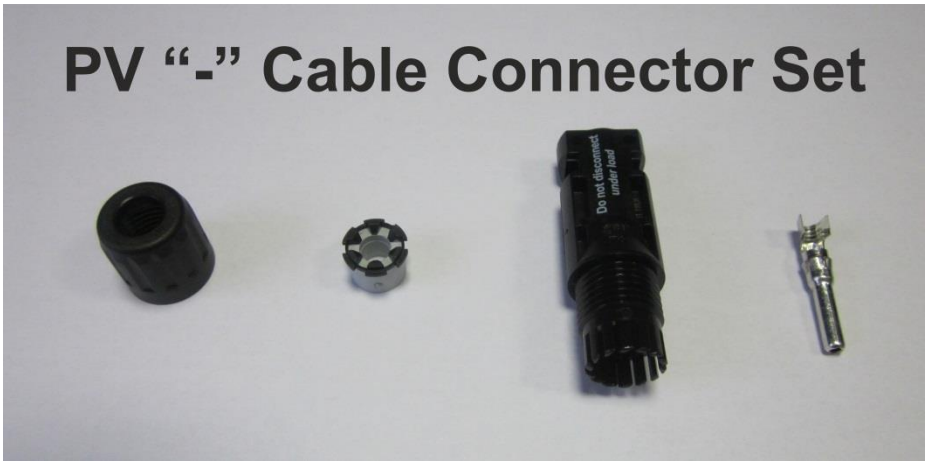


Figure 5.2. PV “–“ cable set.

The PV “-” connector must be installed with PV installation cable – cross section 6mm^2 (black).

Figure 5.3 Motor cable connector set.

The cable for motor connector must be with outer diameter, between 6÷10mm and with 4 x 2,5mm^2 (3P + PE). Please refer also to pages 11 – 12.

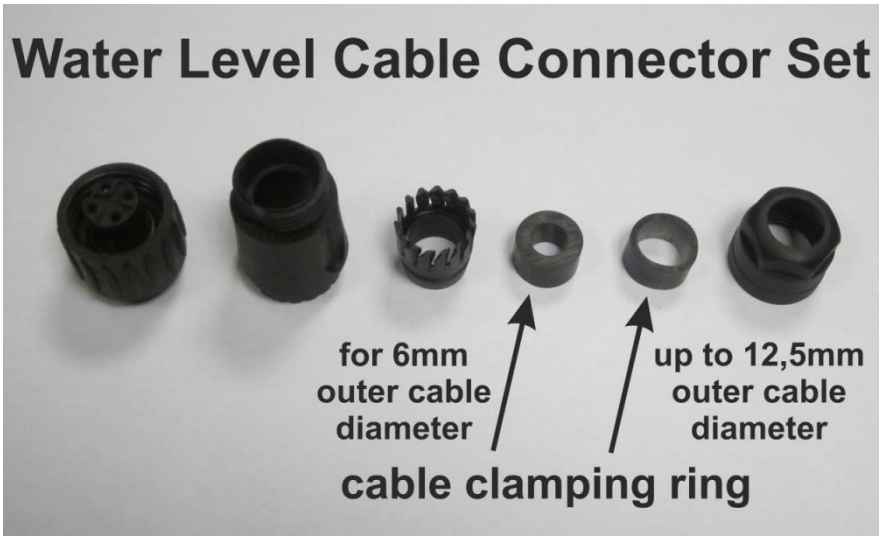


Figure 5.4. Water level cable connector set.

The cable for water level connector must be with outer diameter, between 6÷12,5mm / 3 x 1,5mm^2.

Examples of the needed tolls for assembling the PV cable connectors and water level sensors cable connectors are shown on *Figure 5.5*.

Figure 5.5. Examples of the needed hand tools for the PV cable connectors and water level sensors cable connectors.

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