SOLAR PUMP DRIVE CFW700

Application Manual

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Application Manual
Solar Pump Drive

Series: CFW700

Language: English

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CONTENTS

ABOUT THE MANUAL

This manual provides the necessary information for the configuration of Solar Pump Drive application developed with the CFW700 inverter SoftPLC function. This application manual must be used together with the CFW700 user's manual, the SoftPLC function manual and the WLP software manual.

ABBREVIATIONS AND DEFINITIONS

PLC	Programmable Logic Controller
CRC	Cycling Redundancy Check
RAM	Random Access Memory
USB	Universal Serial Bus
WLP	Ladder Language Programming Software

NUMERICAL REPRESENTATION

Decimal numbers are represented by means of digits without suffix. Hexadecimal numbers are represented with the letter 'h' after the number.

QUICK PARAMETER REFERENCE

Parameter	Description	Adjustable Range	Application Default 60 Hz (50 Hz)	User Setting	Prop.	Groups	Page
P0100	Acceleration Time	0.1 to 999.0 s	20.0 s			BASIC	-
P0101	Deceleration Time	0.1 to 999.0 s	20.0 s			BASIC	-
P0133	Minimum Speed	0 to 18000 rpm	2400 (2000) rpm			BASIC	-
P0134	Maximum Speed	0 to 18000 rpm	3600 (3000) rpm			BASIC	-
P0136	Manual Torque Boost	0.0 to 30.0 %	According to inverter model		V/F	MOTOR, BASIC	-
P0142	Maximum Output Voltage	0.0 to 100.0 %	100.0 %		cfg V/F		-
P0143	Intermediate Output Voltage	0.0 to 100.0 %	60.0 %		cfg V/F		-
P0144	Minimum Output Voltage	0.0 to 100.0 %	28.0 %		cfg V/F		-
P0202	Control Type	0 to 5	0 (1) = V/F		cfg	STARTUP	-
P0205	Main Display Parameter	2 = Speed in rpm 5 = Frequency in Hz	5 = Output Freq.			HMI	29
P0206	Secondary Display Parameter	0 to 1500	4 = DC Link Voltage			HMI	29
P0207	Parameter for Bar	0 to 1500	3 = Motor Current			HMI	29
P0208	Ref. Eng. Scale Main Display	0 to 65535	600			HMI	29
P0209	Main Display Eng. Unit	3 = rpm 13 = Hz	13 = Hz			HMI	29
P0210	Main Display Decimal Place	0 to 7	1 = wxy.z			HMI	29
P0220	LOC/REM Selection Source	0 to 11	1 = Always Remote		cfg	I/O	-
P0222	REM Reference Sel.	0 to 17	7 = SoftPLC		cfg	I/O	-
P0226	REM Rotation Selection	0 to 12	0 = Clockwise		cfg	I/O	-
P0227	REM Run/Stop Selection	0 to 5	1 = DIx		cfg	I/O	-
P0228	REM JOG Selection	0 to 6	0 = Disable		cfg	I/O	-
P0230	Dead Zone (AIs)	0 to 1	1 = Active		cfg	I/O	-
P0231	AI1 Signal Function	5 = Pressure PID Feedback	3 = Not Used			I/O	23
P0233	AI1 Input Signal	0 = 0 to 10 V 1 = 4 to 20 mA	0 = 0 to 10 V			I/O	-
P0235	AI1 Input Filter	0.00 to 16,00	0,30 s			I/O	-
P0236	AI2 Signal Function	6 = Solar Sensor Detector 7 = Control Setpoint	3 = Not Used		cfg	I/O	22
P0238	AI2 Input Signal	0 to 3	0 = 0 to 10 V		cfg	I/O	-
P0251	AO1 Signal Function	11 = Repeat AI1	2 = Real Speed		cfg	I/O	23
P0263	DI1 Input Function	0 to 31	1 = Run / Stop		cfg	I/O	-
P0264	DI2 Input Function	25 = Pressure PID Man/Auto 27 = Power by Group or Network	27 = Power by Group or Network		cfg	I/O	23/ 43
P0265	DI3 Input Function	26 = 1st DI for Control Setpoint Selection 27 = Power by Group or Network	26 = 1st DI for Control Setpoint Selection		cfg	I/O	23/ 29
P0266	DI4 Input Function	26 = 2nd DI for Control Setpoint Selection 27 = Power by Group or Network	26 = 2nd DI for Control Setpoint Selection		cfg	I/O	23/ 29
P0275	DO1 Output Function	34 = Triggers External Power	11 = Run			I/O	23
P0276	DO2 Output Function		2 = N > Nx			I/O	23
P0277	DO3 Output Function		1 = N* > Nx			I/O	23
P0296	Inverter Rated Voltage	0 to 7	According to inverter model		cfg		-
P0320	FlyStart/Ride-Through	0 to 3	3 = Ride-Through		cfg		-
P0331	Voltage Ramp	0.2 to 60.0 s	10.0 s		V/f		-
P0339	Output Voltage Compensation	0 to 1	1 = Active		cfg V/f		-
P0340	Auto-Reset Time	0 to 255 s	255 s				26
P0400	Motor Rated Voltage	200 to 600 V	According to inverter model		cfg	MOTOR, STARTUP	-
P0401	Motor Rated Current	0.0 to 200.0 A	According to inverter model		cfg	MOTOR, STARTUP	-
P0402	Motor Rated Speed	0 to 30000 rpm	According to inverter model		cfg	MOTOR, STARTUP	-
P0403	Motor Rated Frequency	0 to 500.0 Hz	60.0 (50.0) Hz		cfg	MOTOR, STARTUP	-

Parameter	Description	Adjustable Range	Application Default 60 Hz (50 Hz)	User Setting	Prop.	Groups	Page
P1001	Command for SoftPLC	0 to 2	1 = Run Program			SPLC	-
P1010	Solar Pump Drive Application Version	0.00 to 10.00	-		ro	SPLC	29
P1011	Current Tracking Setpoint	0 to 1000 V	-		ro	SPLC	29
P1012	Actual Pressure Setpoint / Speed	0.0 to 4000.0 [Eng. Un.1]	-		ro	SPLC	29
P1013	Pressure Reading	0.0 to 300.0	-		ro	SPLC	29
P1014	Running Time	0 to 65535 h	-		ro	SPLC	30
P1015	Total Energy	0 to 65535 kWh	-		ro	SPLC	30
P1016	Remaining Time to a new Start Attempt	0 to 3600 s	-		ro	SPLC	30
P1017	Deviation Stopping Value of AI2	0.0 to 100.0 %	0.0 %			SPLC	22
P1019	Increment Rate MPPT	10 to 40	20			SPLC	18
P1022	Minimum Setpoint Vdc	0 to 1000 V	440 V			SPLC	18
P1023	Maximum Setpoint Vdc	0 to 1000 V	750 V			SPLC	18
P1024	PID Proportional Gain Vdc	0.000 to 32.000	1.000			SPLC	19
P1025	PID Integral Gain Vdc	0.00 to 32.00	20.00			SPLC	19
P1026	PID Integral Gain Vdc	0.000 to 32.000	0.00			SPLC	19
P1027	Time Between Starts	0 to 3600 s	60 s			SPLC	21
P1028	Enable Starting Value of AI2	0.0 to 100.0 %	0.0 %			SPLC	21
P1029	Actuation Value DOx AI2 Value to Start an External Power Source (Network / Group)	0.0 to 100.0 %	0.0 %			SPLC	22
P1030	Pressure Control	0 = Manual 1 = Automatic 2 = DIx Selection 3 = Disabled	3 = Disable			SPLC	23
P1031	Pressure Sensor Scale	0.0 to 300.0	10.0			SPLC	24
P1032	PID Proportional Gain Pressure	0.000 to 32.000	1.000			SPLC	23
P1033	PID Integral Gain Pressure	0.00 to 320.00	10.00			SPLC	24
P1034	PID Integral Gain Pressure	0.000 to 32.000	0.000			SPLC	24
P1035	Motor Speed below which Solar Pump Drive goes to Sleep Mode	0 to 4000 [P0209]	0 [P0209]			SPLC	25
P1036	Time Delay for Solar Pump Drive goes to Sleep Mode	1 to 65000 s	10 s			SPLC	25
P1037	Control Process Variable Deviation for Solar Pump Drive to Wake Up	0.0 to 300.0	0.0			SPLC	25
P1038	Cloud/Load Controller Activation Level	0.0 a 100.0 %	1.0 %			SPLC	20
P1039	Cloud/Load Controller Gain	0.00 a 10.00	1.00			SPLC	20
P1040	Time Delay for Dry Pump Fault (F765)	0 to 65000 s	0 s			SPLC	26
P1041	Motor Speed for Dry Pump	0.0 to 4000.0 [P0209]	54.0 (45.0) [P0209]			SPLC	26
P1042	Motor Current for Dry Pump	0.1 to 100.0 %	45.0 %			SPLC	23
P1043	Time Reset Fault for Dry Pump	0 to 6500 min	0 min			SPLC	26
P1044	Minimum Output Pressure	0.0 to 300.0	0.0			SPLC	26
P1045	Minimum Fault Pressure Time	0 to 65000 s	0 s			SPLC	27
P1046	Maximum Output Pressure	0.0 to 300.0	10.0			SPLC	27
P1047	Maximum Fault Pressure Time	0 to 65000 s	0 s			SPLC	27
P1049	Actuation Time DOx	0 to 65000 s	0 s			SPLC	22
P1051	Control Setpoint 1	0.0 to 4000.0 [Eng. Un.1]	60.0 (50.0)			SPLC	28
P1052	Control Setpoint 2	0.0 to 4000.0 [Eng. Un.1]	1.5			SPLC	28
P1053	Control Setpoint 3	0.0 to 4000.0 [Eng. Un.1]	1.5			SPLC	28
P1054	Control Setpoint 4	0.0 to 4000.0 [Eng. Un.1]	1.5			SPLC	28
P1059	Running time ((P1014) and Total Energy kWh (P1015) Reset	0 = Not Used 1 = Reset Running Time 2 = Reset Total Energy	0 = Not Used			SPLC	28

FAULTS AND ALARMS

Fault / Alarm	Description	Possible Causes
F021: Undervoltage on the DC Link	Undervoltage fault on the intermediate circuit.	The input voltage is too low and the DC link voltage dropped below the minimum permitted value (monitor the P0004 parameter value): Ud < 223V - 200 / 240V three-phase input voltage (P0296=0); Ud < 170V - 200 / 240V single-phase input voltage (P0296=0); Ud < 385V - 380 V input voltage (P0296 = 1); Ud < 405V - 400 / 415V input voltage (P0296=2); Ud < 446V - 440 / 460V input voltage (P0296= 3); Ud < 487V - 480V input voltage (P0296=4); Ud < 530V - input voltage 500 / 525V (P0296=5); Ud < 580V - input voltage 550 / 575V (P0296=6); Ud < 605V - input voltage 600V (P0296=7); Phase loss at the inverter input; Pre-charge circuit failure; Parameter P0296 was set to a value higher than the power supply rated voltage.
A163: Signal Fault AIx 4..20 mA	Analog input signal AIx at 4 to 20 mA or 20 to 4 mA is below 2 mA.	Current signal on the analog input AIx interrupted or null. Error in the parameterization of analog input Aix.
A750: Sleep Mode Active	It indicates that the Solar Pump Drive is in the sleep mode.	Value of the pump motor speed is below the threshold programmed in P1035 during the time programmed in P1036.
A752: Starting Time	It indicates that the time between start attempts has started, the remaining time to the new start attempt can be followed in P1016.	Starting Time was due to lack of Solar Drive power (low power on solar panels)
A754: DC Checking Routine	It indicates that the drive is trying to accelerate to minimum speed and checking the DC bus behavior.	DC Bus checking alarm occurs at each start attempt when there is no measurement of a Solar Detection Sensor (AI2).
A756: Low Level Solar Detection	It indicates that there is Low Solar radiation (AI2).	The system is attempting to start with a low-level measurement of a Solar Detection Sensor (AI2).
F761: Minimum Pressure	Minimum system pressure failure.	The system pressure is below the value of P1044 for the time programmed in P1045.
F763: Maximum Pressure	Maximum system pressure failure.	The system pressure is above the value of P1046 for the time programmed in P1047.
F765: Dry Pump	It indicates that the pump was stopped due to dry pump protection.	During a time (P1040) the value of the pump motor speed remains above of the threshold programmed in P1041 and motor torque remains below the threshold programmed in P1042.
F799 Incompatible Firmware Version	It indicates that the Firmware is incompatible with the Solar Pump Application.	The firmware of the product (P0023) is incompatible with the Solar Pump Application version.

1 SAFETY INSTRUCTIONS

This manual contains the information necessary for the correct use of the frequency inverter CFW700 applied to photovoltaic systems for water pumping.

It was developed to be operated by people with proper technical training or qualification to handle this kind of equipment.

1.1 SAFETY WARNINGS IN THIS MANUAL

DANGER!
The procedures recommended in this warning aim at protecting the user against death, serious injuries and considerable material damages.

ATTENTION!
The procedures recommended in this warning aim at preventing material damages.

NOTE!
The information mentioned in this warning is important for the proper understanding and good operation of the product.

ATTENTION!
The voltage Voc should not be higher than 400 V for equipment with nominal voltage 200-240 Vac and 800 V for equipment with nominal voltage 380–480 Vac to avoid damaging the frequency inverter.

1.2 SAFETY WARNINGS IN THIS PRODUCT

The following symbols are attached to the products as a safety warning:

High voltages presente

Components sensitive to electrostatic discharges. Do not touch them.

Connection of the shield to the grounding.

1.3 PRELIMINARY RECOMMENDATIONS

DANGER!
Only persons with adequate technical training or qualification to operate this type of equipment. These people should follow the safety instructions defined by a local regulation. Failure to follow the safety instructions could result in death and/or equipment damage.

NOTE!
For the purposes of this manual, qualified persons are those trained and are therefore suitable for:
1. Install, ground, energize and operate the CFW700 in accordance with these manual and legal safety procedures.
2. Wear protective equipment in accordance with established local standards.
3. Provide first aid.

DANGER!
Always open switch Q1 (according to figure 3.2 and 3.3 on section 3.2 Connections) to disconnect the DC side of photovoltaic modules, before touching any electrical components connected to the product. Wait for at least ten minutes in order to guarantee the full discharge of the capacitors. Always connect the grounding point of the inverter to the protection grounding.

ATTENTION!
The electronic cards have components sensitive to electrostatic discharges. Do not touch the components or connectors directly. If necessary, first touch the grounding point of the inverter which must be connected to the protection ground or use a proper grounding strap

NOTE!
Read this manual thoroughly before installing or connecting the CFW700.

2 PHOTOVOLTAIC WATER PUMPING SYSTEM

This document presents information necessary to configure all the functions of the frequency inverter CFW700 applied to photovoltaic water pumping systems. For more detailed information on the function of expansion and communications accessories, refer to the following manuals:

- CFW700 Frequency Inverter Documentation;
- Solar Pump Drive Installation Guide;
- CFW700 SoftPLC Manual;
- CFW700 Programming Manual;

These files are available on the WEG's website - www.weg.net.

2.1 OVERVIEW OF THE CFW700 IN PHOTOVOLTAIC SYSTEMS

The frequency inverter CFW700 is a high-performance converter AC/DC and AC/DC that allows a speed and torque control of induction three-phase motors. The frequency inverter CFW700 also features PLC (Programmable Logic Controller) through the SoftPLC feature (integrated).

The function of the CFW700 in photovoltaic water pumping systems is to convert energy generated by photovoltaic modules into alternating form, and to apply this energy in the activation of water pumps, according to Figure 2.1.

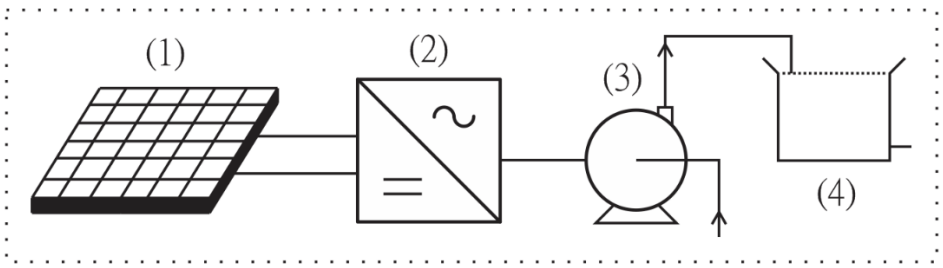

Figure 2.1 *– Block Diagram of a photovoltaic pumping system*

Where:

(1) Solar photovoltaic plant
(2) Frequency Inverter CFW700 WEG
(3) Water pump
(4) Water tank

2.2 GENERAL CHARACTERISTICS OF THE SOLAR PUMP

The main characteristic of the Solar Pump Drive developed for the CFW700 inverter SoftPLC function is the control of one pump using for this a frequency inverter using the power supply by a photovoltaic system, thus allowing control of the speed of the pump.

Each is notable for the following characteristics:

- Acceleration and deceleration ramps for the pump driven by inverter;
- Maximum and minimum speed limits for the pump driven by inverter;
- Selection the manual control mode or automatic. If the control is in manual mode the control setpoint will be speed, if it is in automatic the control setpoint will be pressure;
- Selection of the control setpoint via logical combination of the two digital inputs (maximum of 4 setpoints);
- Selection of the control process variable via analog input AI1;
- Selection of the engineering unit and range of the control process variable sensor via CFW700 parameters;
- Selection of the engineering unit (Hz or rpm) for the application speed parameters;
- Voltage setpoint Vdc minimum and maximum;
- Gain, offset and filter adjustments for the control signals via analog inputs;
- PID controller gains setting of the pressure control;
- PID controller gains setting of the voltage control;

- Enable or not of the sleep mode with the PID controller enabled;
- Wake up/Start level mode to activate the pump;
- Minimum output pressure protection;
- Maximum output pressure protection;
- Dry pump protection through evaluation of motor torque and pump speed;
- Counter hours of operation and energy produced by the solar modules and consumed by the pump.

NOTE!
For applications where the cable between motor and inverter is greater than 100 meters, consult the WEG for sizing.

3 INSTALLATION

3.1 SIZING OF PHOTOVOLTAICS SOLAR MODULES

To install/dimension solar photovoltaic modules must accomplish its 3 main characteristics:

■ **Peak Power (W_p)** Is the maximum measured power that the solar photovoltaic module establishes for the STC condition.
■ **Open Circuit Voltage (V_{oc})** is the voltage measured at the terminals of the module when it is uncharged, for the STC condition.
■ **Maximum Power Voltage (V_{mpp})** is a specific value of the voltage which it is multiplied by the output current, it will give the maximum output power, for the STC condition.

The Standard Test Conditions (STC) is the values presented were measured by standard tests under radiation conditions of 1000 W/m² with an air mass (PM) of 1,5 and a cell temperature of 25 ºC.

In the plant where such modules are installed, the climatic conditions may be different, it being necessary to calculate a new open circuit voltage value for the scaling of the photovoltaic water pumping system. The main factor that will affect the operation of the system will be the temperature, since the low temperatures will raise the voltage of the open circuit (V_{oc}).

The equation that considers all variables is complex, as well as knowing the exact values of these variables, for this reason is presented below a simple equation that approaches the value to reality:

$$V_{oc} = N_p \cdot V_{oc(STC)} \cdot \left(1 + \left(T_{minimum} - T_{(STC)}\right) \cdot \frac{\beta}{100}\right)$$

Where:

■ **V_{oc}:** Open circuit voltage of the photovoltaic solar module at the installation local (V);
■ **N_p:** Number of photovoltaic solar modules connected in series;
■ $V_{oc\ (STC)}$**:** Open circuit voltage of photovoltaic solar module in STC condition;
■ **$T_{minimum}$:** Minimum operating temperature of the module at the operating local (ºC);
■ **$T_{(STC)}$:** Standard panel test temperature, 25 °C;
■ **β:** Temperature Coefficient specified by the photovoltaic solar module data.

With this information calculates the number of solar modules that must be connected in series to operate in the operating voltage range of the inverter. This serial connection, in turn, shall be replicated in parallel as many times as necessary to meet the operating power of the system.

The operating voltage of the inverter varies according to the model, being 250-380 Vdc for 220 Vac single phase and three phase, and 440-750 Vdc for 380-480 Vac models. Particular attention should be paid to the open-circuit voltage (V_{oc}), which should not exceed the inverter's overvoltage protection voltage. In case of higher voltage, this will end up damaging the equipment.

The frequency inverters operate with undervoltage and overvoltage protection, so that if the voltage reaches these limit values, the inverter will interrupt its operation. Table 3.1 shows the inverter operating voltage information, as well as the overvoltage and undervoltage limits.

Table 3.1 *– Voltage levels of the CFW700*

P0296	200-240 Vac		380 Vac	400-415 Vac	440-460 Vac	480 Vac	500-525 Vac	550-575 Vac	600 Vac
Number of power phases	1	3	3	3	3	3	3	3	3
Operating Voltage (Vdc)	250~380	250~380	440~750	440~750	440~750	440~750	610~940	610~940	610~940
Undervoltage Protection (Vdc)	170	223	385	406	446	487	532	583	608
Overvoltage Protection (Vdc)	400	400	800	800	800	800	1000	1000	1000
Power Supply Voltage (Vdc)	310		540				710		

To facilitate the understanding of sizing, we use the following system as an example:

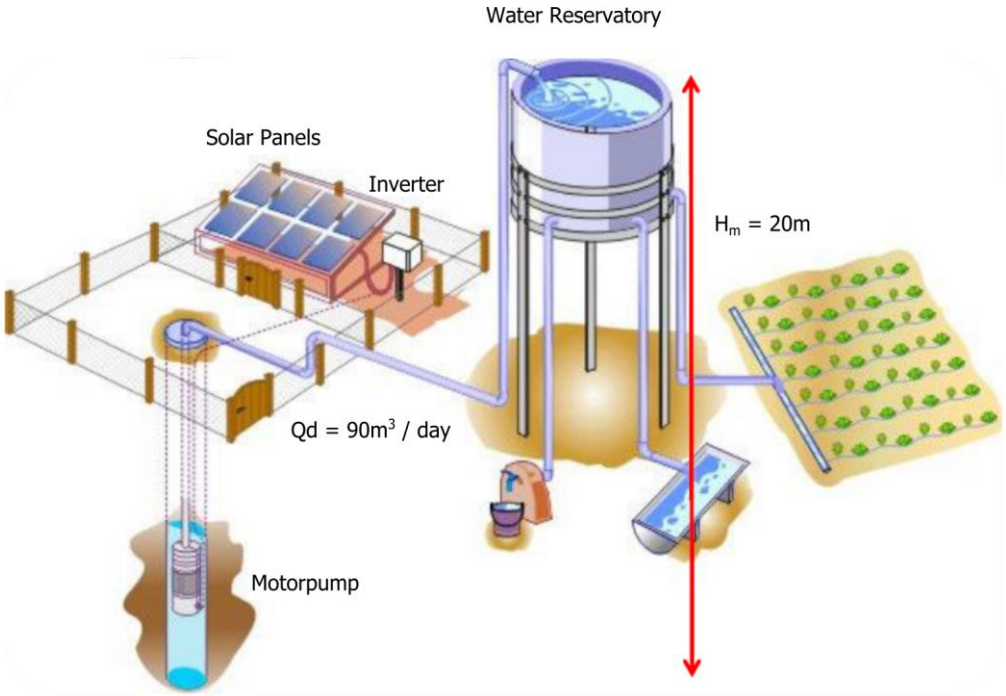

Figure 3.1 *– Example of a photovoltaic pumping system*

For this example, based on desired flow a motor pump of 3 CV was selected as a reference, the sizing of the system's number of modules follows the equations:

MOTORPUMP SIZING

CALCULATION OF DAILY HYDRAULIC ENERGY

$$Daily\ Hidraulic\ Energy\ (E_H) = g * H_m * \frac{Q_d}{3600}$$

Where:

E_H : Daily hydraulic energy (Wh/day).
g : Acceleration due to gravity (9.81 m/s²) – has a constant value.
H_m : Manometric height (20 m) – value varies according to project layout.
ρ_a : Water density (1,000 kg/m³) – has a constant value.
Q_d : Pumped volume (90 m³/day) - value varies according to pumped volume need
$(HSP)_\beta$: Hours of Sun Peak (3.9 kWh/m²) – value varies according to location, use the lowest seasonal irradiation value.

CALCULATION OF THE FINAL ENERGY REQUIRED

$$L = \frac{Daily\ Hidraulic\ Energy}{n_{motorpump}}$$

Where:

L : Final energy required (W/h).
$n_{motorpump}$: Pump Efficiency (0.3) – average of the pumps for this application.

POWER CALCULATION

$$Power\ (W_p)\ = 1{,}25 * \frac{L}{(HSP)_\beta}$$

The power (W_p) obtained results in 5.24 kW_p, and for the proposed example this power is enough for the 3 CV pump selected. The equations presented are analogous for the other designs and their respective powers.

- CFW700 Three-Phase 220 V;
- 3 CV Three-Phase Pump;
- Solar modules model TSM-PEG15H 345 W from the manufacturer TRINA SOLAR.

The photovoltaic solar panel model TSM-PEG15H has the following characteristics (NMOT):

Table 3.2 – *Technical characteristics of the Photovoltaic Solar Module Polycrystalline*

Electrical Characteristics	
Nominal Power Output (P_{mpp})	345 W_p
Voltage at Pm Point (V_{mpp})	35,7 V
Current at Pm Point (I_{mpp})	7,31 A
Open Circuit Voltage (V_{oc})	43,7 V
Short Circuit Current (I_{sc})	7,76 A
Module Efficiency	16,8 %

From the power (W_p) needed (5.24kW_p) and the power of the chosen solar panel (345W_p), it is possible to calculate the number of modules needed (5240 W_p / 345 W_p), which would be 16 modules. By opting for a series connection of eight photovoltaic solar modules, a maximum power voltage of 285.6 Vdc will be generated, with an open circuit voltage (Voc) of 349.6 Vdc.

Considering as operating limits the temperatures between 0 °C and 70 °C, it is possible to calculate the lowest maximum power voltage for the temperature of 70 °C ($\boldsymbol{Vmp_{MIN}}$ = 236.7 Vdc) and the highest open circuit voltage for the temperature of 0°C ($\boldsymbol{Voc_{MAX}}$= 376.7 Vdc).

NOTE!
The dimensioning values are according to the table 3.1 (within the limits of CFW700).

By associating eight solar modules in series, we are inserting steps of 2760 W_p. To meet the application needs 5.24kW_p, another set of eight modules will be associated in parallel, totaling 5.52kW_p. Thus, it meets the voltage dimensioning criterion (inverter operating range) and the power required to control the pump. The set of 16 TSM-PEG15H solar modules have the technical characteristics shown in table 3.3.

Table 3.3 – *Technical information for the set of 16 modules (2x Strings of 8x modules TSM-PEG15H)*

Specific Information PV Installation (NMOT) x PV Quantity	
Nominal Power Output (P_{mpp})	5520 W_p
Voltage at Pm Point (V_{mpp})	285,6 V
Current at Pm Point (I_{mpp})	14,62 A
Open Circuit Voltage (V_{oc})	349,6 V
Short Circuit Current (I_{sc})	15,52 A

The connection of the eight solar modules must be carried out according to the diagram in figure 3.2.

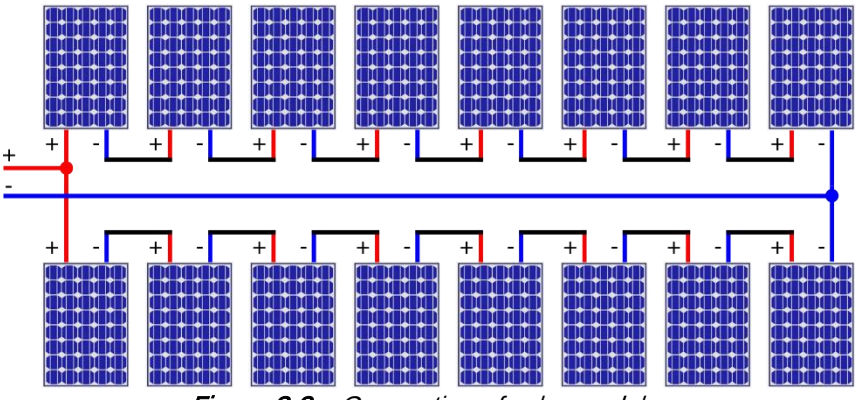

Figure 3.2 – *Connection of solar modules*

3.2 CONNECTIONS

The type of connection to be used will be determined by the voltage of the equipment, below are presented the typical connections for each CFW700 Frame, for more details about the connections of the solar panels consult the “Solar Pump Drive Installation Guide”

3.2.1 T4 Model

For CFW700 frequency inverters from 380 to 480 V, model T4, the following connection is recommended:

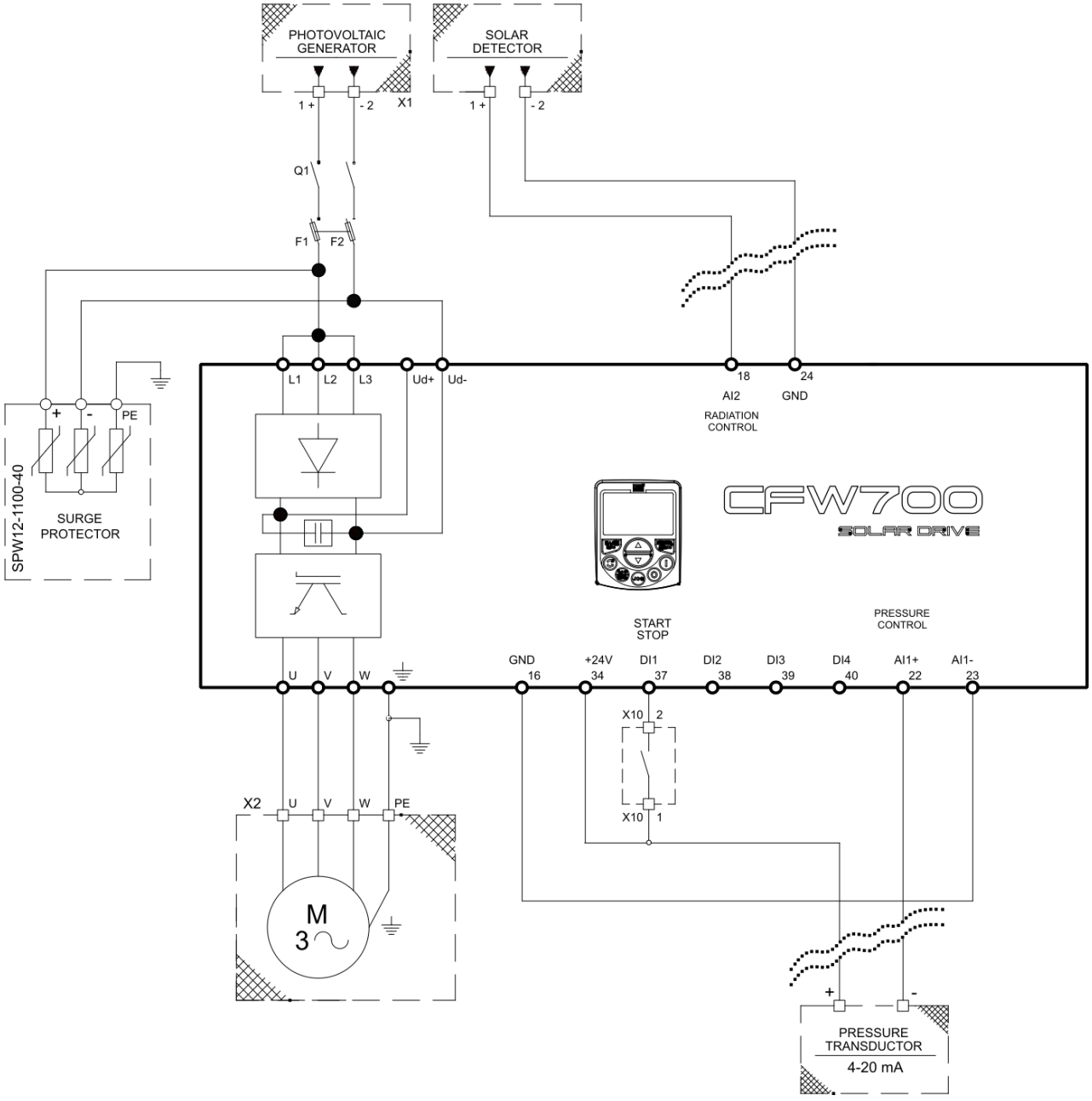

Figure 3.3 – Connection diagram of the photovoltaic water pumping system for CFW700 T4

NOTE!
Take care to don't reverse the positive and negative voltage connections from the solar modules.

NOTE!
The inputs/outputs connections may be different from what is indicated in this diagram, depending on the needs of the application.

3.2.2 T4 Model with Hybrid Power

For CFW700 frequency inverters from 380 to 480 V, models T4, and that require hybrid power (photovoltaic panels + generator set) the following connection is recommended:

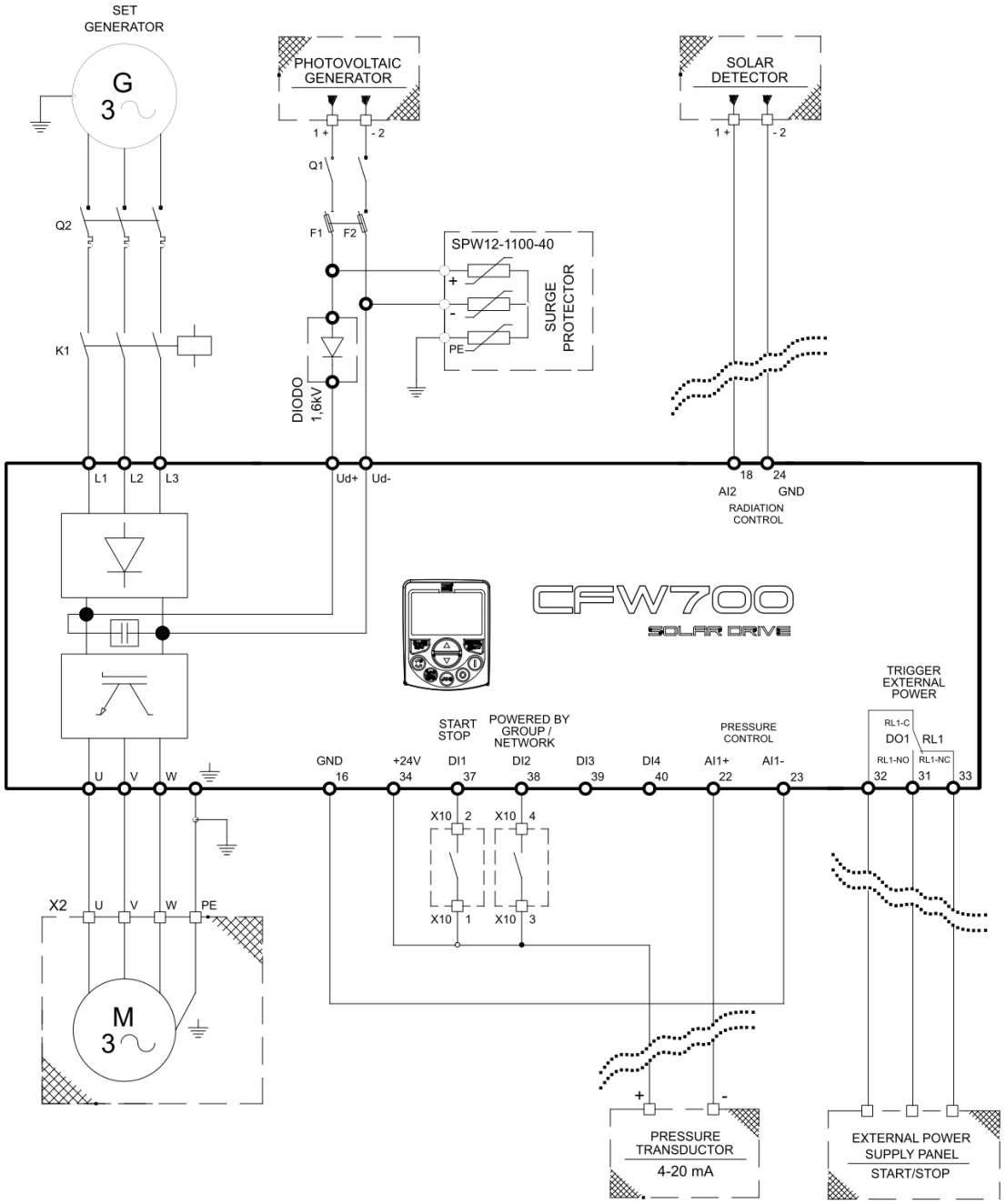

Figure 3.4 – Connection diagram of the photovoltaic water pumping system for CFW700 T4 with Hybrid Power

NOTE!
Take care to don't reverse the positive and negative voltage connections from the solar modules.

NOTE!
When closing the contactor K1 it must be timed to avoid that the starting peak of the generator reaches the voltage input of the frequency inverter.

NOTE!
The inputs/outputs connections may be different from what is indicated in this diagram, depending on the needs of the application.

4 CONTROL METHOD BY MAXIMUM POWER POINT TRACKING

The strategy of control method of variable reference is constantly tracking the maximum power point of the system (MPPT).

The maximum power point of a solar module changes according to the solar radiance incident on the solar cell, as well as the temperature, wind velocity, inclination of the solar photovoltaic module, passing of clouds, thus generating the need of the constant search for maximum power of the system. Compared to the fixed-point method, MPPT provides a higher system efficiency, which can reach 20 %.

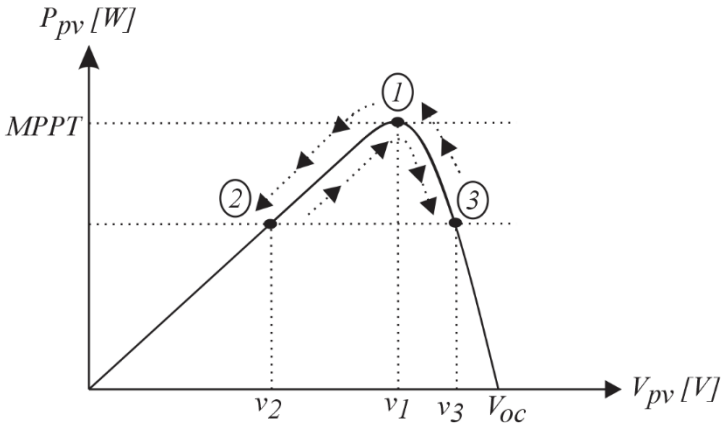

Figure 4.1 – *Maximum Power Point Tracking*

Where:

(1) Automatic Proportional Voltage Value at Maximum System Power
(2) Minimum Control Setpoint Level per MPPT (P1022)
(3) Maximum Control Setpoint Level per MPPT (P1023)
(🡐 🡒) Increment Rate MPPT (P1019)

The maximum and minimum setpoint levels of the MPPT control must be adjusted according to the characteristics of the photovoltaic panels and be within the protection limits of the frequency inverter. Figure 4.2 shows the behavior of the system with the default parameterization of voltage levels.

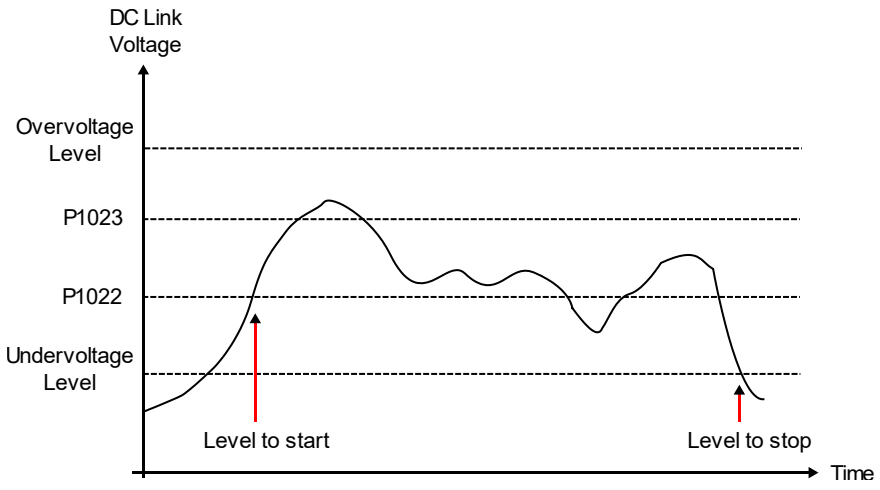

Figure 4.2 – Range adjust of minimum and maximum MPPT tracking values.

5 PARAMETERS DESCRIPTION

The CFW700 inverter parameters (P0000 to P0999) and the SoftPLC function parameters (P1000 to P1059) for the Solar Pump Drive application will be presented next.

NOTE!
The Solar Pump Drive application only works on CFW700 inverter with **firmware version over V2.30**
So, upgrading the CFW700 inverter firmware to the working of this application is required.

NOTE!
The adjustable range of the CFW700 parameters has been customized for Solar Pump Drive application. Refer to the CFW700 programming manual for more details on the parameters.

Symbols for property description:

CFG	Configuration parameter, value can be programmed only with motor stopped
RO	Read-only parameter
RW	Read and write parameter

5.1 VOLTAGE REGULATOR

This group of parameters allows the user to configure the operating conditions of the voltage regulator for operation by the photovoltaic modules, both for direct pumping and pressure regulation.

P1019 – Increment Rate MPPT

Adjustable Range:	10 to 40	Application Default Setting:	20
Properties:			
Access groups via HMI:	SPLC		

Description:
This parameter defines the variation rate of voltage setpoint for maximum power point tracking. Initially leave this parameter with the defect value and in case of Setpoint variation it is not fast enough to gradually increase until the optimum operating result is achieved.

5.1.1 Voltage Setpoint Limits

P1022 – Minimum Setpoint Vdc

Adjustable Range:	0 to 1000 V	Application Default Setting:	440 V
Properties:			
Access groups via HMI:	SPLC		

Description:
This parameter defines the minimum value of the voltage setpoint that the system must use during the process of maximum power point search.

P1023 – Maximum Setpoint Vdc

Adjustable Range:	0 to 1000 V	Application Default Setting:	750 V
Properties:			
Access groups via HMI:	SPLC		

Description:
This parameter defines the maximum value of the voltage setpoint that the system must use during the process of maximum power point search.

5.1.2 Voltage PID Controller

This group of parameters allows the user to configure the PID controller gains for the DC voltage control supplied by the photovoltaic modules. The PID controller always will attempt to search the work point defined by Tracking Setpoint and for this will act on the output frequency of the motor.

P1024 – Voltage PID Proportional Gain

Adjustable Range:	0.000 to 32.000	Application Default Setting:	1.000
Properties:			
Access groups via HMI:	SPLC		

Description:
This parameter defines the proportional gain value of the PID controller for the DC voltage control.

P1025 – Voltage PID Integral Gain

Adjustable Range:	0.00 a 320.00	Application Default Setting:	20.00
Properties:			
Access groups via HMI:	SPLC		

Description:
This parameter defines the integral gain value of the PID controller for the DC voltage control.

P1026 – Voltage PID Derivative Gain

Adjustable Range:	0.000 to 32.000	Application Default Setting:	0.000
Properties:			
Access groups via HMI:	SPLC		

Description:
This parameter defines the derivative gain value of the PID controller for the DC voltage control.

5.1.2.1 PID Controller Gain Adjustment

In controlling pumping systems, a Proportional-Integral (PI) velocity regulator is sufficient to achieve good control performance. The proportional gain K_P (P1024) and integral K_I (P1025) must be changed if the controller response is not satisfactory, i.e. if there are oscillations in the DC Bus Voltage (P0004) around the setpoint, very slow response time or constant error in relation to the setpoint. Here are some suggestions for regulator adjustment:

■ DC Bus oscillation: In most cases this is due to excessive gain of the PID controller, reduce the K_P and K_I gains gradually and observe the response;

■ Very slow response time: Increasing the K_P gain the system must respond faster, however from a limit the system may have surges;

■ Constant error in the output: In this case, increasing the gain K_I eliminates the constant error of the output, ie when the output cannot reach the setpoint. Excessive K_I gain can generate oscillations at the output, then decrease the gain K_P so that the total gain is reduced while maintaining gain K_I.

5.1.3 Cloud/Load Controller

This group of parameters allows the programmer to enable and adjust the gain of the cloud/load controller. The controller acts together with the DC Voltage PID controller, when the error between the SP voltage and the DC Link voltage are above a threshold (P1038), the controller is enabled and will contribute the DC Voltage PID, adding a value to its output according to a gain setting (P1039).

P1038 – Cloud/Load Controller Activation Level

Adjustable Range:	0.0 to 100.0	**Application Default Setting:**	1.0 %
Properties:			
Access groups via HMI:	SPLC		

Description:
This parameter defines the threshold percentage error value between the voltage SP and the DC Link voltage for activating the Cloud/Load Controller.

P1038 – Cloud/Load Controller Gain

Adjustable Range:	0.00 to 10.00	**Application Default Setting:**	1.00
Properties:			
Access groups via HMI:	SPLC		

Description:
This parameter defines the value of the Cloud/Load Controller gain that will be added to the DC Voltage PID Controller actuation.

Adjust the level to enable the cloud/load effect controller (P1038) and the controller gain (P1039), gradually increase the controller gain to a faster response.

NOTE!
A setting of “0.00” disables the Cloud/Load Controller.

5.1.4 System Start Configuration

This group of parameters allows the user to configure system start options.

P1027 – Time Between Starts

Adjustable Range:	0 to 3200 s	Application Default Setting:	60 s
Properties:			
Access groups via HMI:	SPLC		

Description:
This parameter defines the time base between starts, when the system is stopped by power failure or the DC Link reaches the minimum voltage limit (P1022).

During the starting process the system monitors the energy available on DC Bus, in case of insufficient energy to accelerate the motor pump to the minimum speed, the system automatically recalculated the time between starts, using the time base (P1027) as reference to a new start attempt (Figure 5.1). The remaining time to a new start attempt can be monitored by P1016.

This delay is to avoid continuous starts and stops, and in the case of submersible pumps, preventing the restart of the pump before emptying the pipe.

NOTE!
If the run command is removed from the system, the time will be reset and once go back to operate the run command the start will be realized immediately without consider any time.

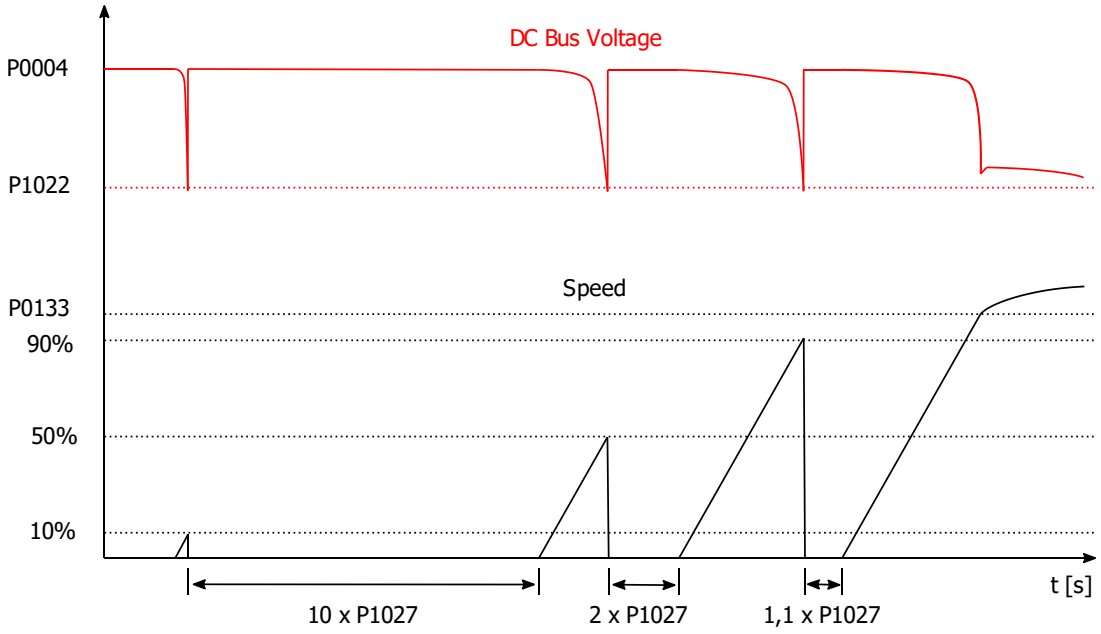

Figure 5.1 *– Example: Auto Adjustment for Time Between Starts*

5.1.5 Solar Detector

The Solar irradiation detection consists of a photovoltaic module with a small solar panel properly dimensioned (Pmax=5W, Vmp=16.8V, Imp=0.3A, Voc=21V, Isc=0.39A) to be connected to the analog input 2 (AI2) of the CFW11 using a signal conditioning device (Solar Detector), the objective is to inform the instantaneous solar irradiation.

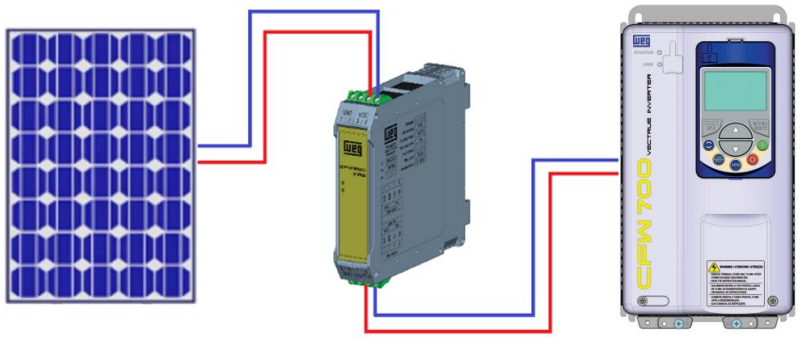

Figure 5.2 *– Solar irradiation detection using the Solar Detector.*

Figure 5.2 – Solar irradiation detection using the Solar Detector.
The use of this device is optional but will increase the efficiency of solar pumping by allowing system starts to occur only when available solar radiation is sufficient to drive the pump at a predetermined minimum speed.

The settings of these parameters must be carried out at the first or last hour of the day, when the solar radiation is lower, to verify in which radiation conditions the pump operates at the lowest permissible speed. Under these conditions you should check the value of parameter P0019 to determine the available radiation value. Once this value is known, it must be set equal to or slightly higher in parameter P1028.

The Solar Detector can also be used to automate the external power supply. The parameter P1029 is used to drive the digital output DOx (P0275/P0276/P0277) configured in 34 that can connect an external power supply.

NOTE!
The use of the Solar Detector is optional, but its use is recommended if a more autonomous system is desired.

P0236 – AI2 Signal Function

Adjustable Range:	0 to 12	-> 3 = SoftPLC (No Function) -> 6 = Function 2 Application (Solar Detection) -> 7 = Function 3 Application (Pressure SP)	Application Default Setting: 3
Properties:	CFG		
Access groups via HMI:	I/O		

Description:
This parameter defines the function of the analogic Input AI2. To enable the Solar Detection Function, select the corresponding value.

P1028 - Enable Starting Value of AI2

Adjustable Range:	0.00 to 100.0 %	Application Default Setting: 0.0 %
Properties:	CFG	
Access groups via HMI:	SPLC	

Description:
This parameter defines the radiation value in % of analogic input AI2, which will allow the system to start.

P1017 – Deviation Stopping Value of AI2

Adjustable Range:	0.00 to 100.0 %	Application Default Setting: 0.0 %
Properties:	CFG	
Access groups via HMI:	SPLC	

Description:
This parameter defines the deviation value from the starting value (P1028), which the system will be commanded to stop. i.e.: A value of 20.0% in P1028 and 5.0% in P1017, it means that the system will be allowed to start with values of AI2 above 20.0%, and the system will be commanded to stop with values of AI2 below 15.0%.

P1029 – Solar Detector Value for Digital Output Actuation (External Power)

Adjustable Range:	0.00 to 100.0 %	Application Default Setting: 0.0 %
Properties:	CFG	
Access groups via HMI:	SPLC	

Description:
This parameter defines the value of the radiation, in% of the analogic input AI2, which will allow the activation of the digital output configured with value 34 for the activation of an external power supply that will complement the photovoltaic generator.

P1049 – DO Actuation Time

Adjustable Range:	0 to 3200 s	Application Default Setting: 0 s
Properties:		
Access groups via HMI:	SPLC	

Description:
This parameter defines the DO actuation time (delay) for the digital output to be trigged.

Table 5.1 – Digital Input and Output for External Power Supply

DOx / Dix Function	Description
P0275 = 34 P0276 = 34 P0277 = 34	The output DOx will switch when the solar radiation shown at P0019 is less than the value set at P1029, during the time set at P1049. The output DOx will return to its idle state when the radiation read in P0019 exceeds de deviation value at P1017 from the value set in P1029 during the time set in P1049. In this option, the actuation of

	the external power supply requires the presence of minimum solar radiation that allows the energization of the equipment.
P0264 = 27 P0265 = 27 P0266 = 27	With the input DIx configured to 27 when the input is TRUE it means that the external source is supplying the inverter, and it's expected that the power supply is enough to run the system in nominal conditions. When the input is FALSE it means that the external source is not connected, and the system is been supplied by the Solar Panels.

5.2 PRESSURE CONTROLLER

This group of parameters allows the user to configure the conditions of operation of the pressure controller. The pressure controller should receive the pressure return of the system by connecting a pressure transducer to the analogic input (AI1) and perform the pump speed control, when the user defined pressure is reached and the solar radiation conditions allow it.

P0231 – AI1 Signal Function

Adjustable Range:	0 to 12	-> 3 = SoftPLC (No Function) -> 5 = Function 1 Application (Read Pressure)	Application Default Setting:	3
Properties:	CFG			
Access groups via HMI:		I/O		

Description:
This parameter defines the function of the analogic Input AI1. To enable Read the Pressure, select the corresponding value.

P0251 – AO1 Signal Function

Adjustable Range:	0 to 24	-> 2 = Real Speed -> 11 = Function 1 Application (Repeat AI1)	Application Default Setting:	2
Properties:	CFG			
Access groups via HMI:		I/O		

Description:
This parameter defines the function of the analogic Output AO1. To enable repeat the AI1 value on the AO1, select the corresponding value.

P0254 – AO2 Signal Function

Adjustable Range:	0 to 23	-> 0 = Speed Reference -> 12 = Function 2 Application (Repeat AI2)	**Application Default Setting:**	0
Properties:	CFG			
Access groups via HMI:		I/O		

Description:
This parameter defines the function of the analogic Output AO2. To enable repeat the AI2 value on the AO2, select the corresponding value.

P1030 – Pressure Control

Adjustable Range:	0 = Manual 1 = Automatic 2 = Select Man/Auto by DIx 3 = Disabled		Application Default Setting:	3
Properties:	CFG			
Access groups via HMI:		SPLC		

Description:
This parameter defines the pressure control mode.

Table 5.2 – Pressure Control Mode Options

P1030	Description
0	The system tries to control the motor speed accordingly to the Manual Speed Setpoint (P1051 or AI2). With limited radiation, the system controls the DC bus voltage, causing the pump to run at maximum speed possible to reach the Manual Speed Setpoint.
1	The system operates through the DC voltage control and when the solar radiation allows controlling the Output Pressure. With limited radiation, the system controls the DC bus voltage, causing the pump to run at maximum speed possible to reach the Pressure Setpoint.
2	The selection of Manual or Automatic Mode is made by Dix (0=Manual / 1=Automatic). The DIx must also be programmed for this function, check the parameter P0264.
3	Disable the Pressure Control. The system controls the DC bus voltage, causing the pump to run at maximum speed possible, limited to the maximum speed (P0134).

P1031 – Pressure Sensor Scale

Adjustable Range:	0.0 to 300.0	Application Default Setting:	10.0
Properties:	CFG		
Access groups via HMI:	SPLC		

Description:
This parameter defines the full-scale value of the pressure sensor connected to the analog input 1 (AI1).

5.2.1 Pressure PID Controller

This group of parameters allows the user to configure the PID controller gains for the pressure control.

P1032 – Pressure PID Proportional Gain

Adjustable Range:	0.000 to 32.000	Application Default Setting:	1.000
Properties:			
Access groups via HMI:	SPLC		

Description:
This parameter defines the proportional gain value of the PID controller for the pressure control.

P1033 – Pressure PID Integral Gain

Adjustable Range:	0.00 to 320.00	Application Default Setting:	10.00
Properties:			
Access groups via HMI:	SPLC		

Description:
This parameter defines the integral gain value of the PID controller for the pressure control.

P1034 – Pressure PID Derivative Gain

Adjustable Range:	0.000 to 32.000	Application Default Setting:	0.000
Properties:			
Access groups via HMI:	SPLC		

Description:
This parameter defines the derivative gain value of the PID controller for the pressure control.

5.2.2 Sleep Mode

This group of parameters allows the user to configure the system to stop the pump when the pump motor speed drops below a programmed threshold (low control demand). Even though apparently the pumping control is off, the output pressure (control process variable) is still monitored for wake up and/or start level conditions by the minimum voltage level (P1022).

P1035 – Pump Motor Speed below which Solar Pump Drive goes to Sleep Mode

Adjustable Range:	0.0 to 4000.0 [P0209]	Application Default Setting:	0.0 [P0209]
Properties:			
Access groups via HMI:	SPLC		

Description:
This parameter defines the value of the pump motor speed below which the system will stop the pump keeping the control active, i.e., will sleep.

NOTE!
A setting of "0" disables the sleep mode, it means that the pump will be started or stopped according to the status of the command "Run/Stop".

P1036 – Time Delay for Solar Pump Drive goes to Sleep Mode

Adjustable Range:	1 to 65000 s	Application Default Setting:	10 s
Properties:			
Access groups via HMI:	SPLC		

Description:

This parameter defines the waiting time with the value of the pump motor speed shall remain below the value set in P1035 in order for sleep mode to be activated and the pump to be stopped.

NOTE!
The alarm message "A750: Sleep Mode Active" will be generated on the HMI of the CFW700 inverter to alert that the Solar Pump Drive is in sleep mode.

P1037 – Control Process Variable Deviation for Solar Pump Drive to Wake Up

Adjustable Range:	0.0 to 300.0	Application Default Setting:	0.0
Properties:			
Access groups via HMI:	SPLC		

Description:
This parameter defines the value to be reduced (direct PID) from the control setpoint for starting the pump and resuming control of the pumping. Becoming this value, it is compared with the control process variable and, if the value of the control process variable is less than this value, the condition to wake up is enabled.

5.3 PROTECTIONS

This group of parameters allows the user to configure the protections as dry pump, maximum pressure and minimum pressure as dry pump protections, maximum pressure and minimum pressure. If the system activates pumping without pressure control, the time parameter P1045 and P1047 must be set to "0" so that as pipe pressure protection functions remain disabled.

5.3.1 Dry Pump

This group of parameters allows the user to configure dry pump detection, to protect the inverter driven pump.

P1040 – Time Delay for Dry Pump Fault (F765)

Adjustable Range:	0 to 65000 s	Application Default Setting:	0 s
Properties:			
Access groups via HMI:	SPLC		

Description:
This parameter defines the waiting time with the dry pump condition active, before the dry pump fault “F765: Dry Pump” is generated.

P1041 – Motor Speed for Dry Pump

Adjustable Range:	0.0 to 4000.0 [P0209]	Application Default Setting:	54.0 [P0209]
Properties:			
Access groups via HMI:	SPLC		

Description:
This parameter defines the pump motor speed threshold value, above which evaluation of actual motor current to detect the dry pump condition (P1042) is enabled.

NOTE!
A setting of “0” disables the Dry Pump Protection.

P1042 – Motor Current Percentage for Dry Pump

Adjustable Range:	0.0 to 100.0 %	Application Default Setting:	45.0 %
Properties:			
Access groups via HMI:	SPLC		

Description:
This parameter defines the pump motor current percentage threshold value, below which the dry pump condition is detected.

P1043 – Reset Dry Pump Time

Adjustable Range:	0 to 720 min	Application Default Setting:	0 min
Properties:			
Access groups via HMI:	SPLC		

Description:
This parameter defines the time in minutes the reset time of the drive time when the dry pump was detected to the time the drive is reset.
If this parameter is set to "0", the automatic reset of the Dry Pump condition is disabled.

NOTE!
This parameter may interfere with the automatic auto-reset programmed in parameter P0340, so if it is necessary to activate the fault reset by Dry Pump, you must deactivate auto-reset by setting P0340 to "0".

5.3.2 Minimum Output Pressure

This parameter group allows the user to configure the minimum output pressure detection for pump protection activated by the CFW700 frequency inverter.

P1044 – Minimum Output Pressure

Adjustable Range:	0.0 to 300.0	Application Default Setting:	0.0
Properties:	CFG		
Access groups via HMI:	SPLC		

Description:
This parameter defines the minimum pressure value of the system to enter the minimum pressure condition. In addition to the pressure, to enter a minimum pressure condition, the pump speed must be equal the maximum speed. This condition is to avoid the interference of the voltage control, which can cause the system pressure not to reach the minimum value, the solar radiation can be not enough to reach this value, without involving a fault.

P1045 – Minimum Fault Pressure Time (F761)

Adjustable Range:	0 to 3200 s	Application Default Setting:	0 s
Properties:	CFG		
Access groups via HMI:	SPLC		

Description:
This parameter defines the time with the active minimum pressure condition, to generate the minimum pressure fault (F761).

NOTE!
The system will stop if a fault message is generated. The value of this parameter at "0" disables the fault.

5.3.3 Maximum Output Pressure

This parameter group allows the user to configure the maximum output pressure detection for pump protection activated by the CFW700 frequency inverter.

P1046 – Maximum Output Pressure

Adjustable Range:	0.0 to 300.0	Application Default Setting:	10.0
Properties:	CFG		
Access groups via HMI:	SPLC		

Description:
This parameter defines the minimum pressure value of the system to enter the maximum pressure condition.

P1047 – Maximum Fault Pressure Time (F763)

Adjustable Range:	0 to 3200 s	Application Default Setting:	0 s
Properties:	CFG		
Access groups via HMI:	SPLC		

Description:
This parameter defines the time with the active maximum pressure condition, to generate the maximum pressure fault (F763).

NOTE!
The system will stop if a fault message is generated. The value of this parameter at "0" disables the fault.

5.4 CONTROL SETPOINT

This group of parameters allows the user to adjust the speed or pressure setpoint required for the system to function. The setpoints will have the speed reference function when the pressure control is disabled/manual mode, and will have the pressure setpoint function when the pressure control is in automatic control mode.

The communication between a Setpoint or another will be via digital inputs configured for the function.

P1051 – Control Setpoint 1

P1052 – Control Setpoint 2

P1053 – Control Setpoint 3

P1054 – Control Setpoint 4

Adjustable Range:	0.0 to 4000.0 [Eng. Un. 1]	Application Default Setting:	P1051 = 60.0 P1052 = 1.5 P1053 = 1.5 P1054 = 1.5
Properties:			
Access groups via HMI:	SPLC		

Description:
These parameters define the value of the setpoint in pressure mode active (bar) when control setpoint source was programmed to be via logical combination of digital inputs DI3 and DI4 according the table 5.3.

Table 5.3 *– Truth table for control setpoint via logical combination of the digital inputs DI3 and DI4*

Digital Input	P1051 – Control Setpoint 1	P1052 – Control Setpoint 2	P1053 – Control Setpoint 3	P1054 – Control Setpoint 4
Digital Input DI3	0	1	0	1
Digital Input DI4	0	0	1	1

NOTE!
This parameter will be displayed according to the parameter selection for engineering unit 1 (P0510) without unit, Hz or rpm. This selection is made automatically by the application accordingly to the Pressure Control Mode (P1030) and Main Display Engineering Unit (P0209).

NOTE!
The Control Setpoint function operated by digital inputs is configured by setting the parameters P0265 and P0266 to 26.

5.4.1 Reset of P1014 and P1015

P1059 – Reset P1014 and P1015

Adjustable Range:	0 = No function 1 = Reset Running Time (P1014) 2 = Reset Total Energy (P1015)	Application Default Setting:	0
Properties:	CFG		
Access groups via HMI:	SPLC		

Description:
This parameter allows to reset the parameters P1014 (Running Time of the CFW700) and P1015 (Total Energy kWh counter).

These parameters can be useful for counting the number of monthly or weekly hours that the system is operating and the kWh generated. Once parameter P1014 or P1015 is reset, parameter P1059 returns to value "0" automatically.

5.5 HMI MONITORING

This parameter group allows the user to configure which parameters will be shown on the HMI display in the monitoring mode.

P0205 – Main Display Parameter Selection

P0206 – Secondary Display Parameter Selection

P0207 – Bar Graph Parameter Selection

P0208 – Main Display Ref. Scale

P0209 – Main Display Engineering Unit

P0210 – Main Display Decimal Place

NOTE!
Refer to the CFW700 frequency inverter programming manual for further information about the HMI parameters.

5.6 READING PARAMETERS

P1010 – Solar Pump Drive Application Version

Adjustable Range:	0.00 to 10.00	Application Default Setting:	-
Properties:	RO		
Access groups via HMI:	SPLC		

Description:
This parameter indicates the version of the ladder application software developed for the Solar Pump Drive.

P1011 – Current Tracking Setpoint

Adjustable Range:	0 to 1000 V	Application Default Setting:	-
Properties:	RO		
Access groups via HMI:	SPLC		

Description:
This parameter shows the current value of the DC voltage setpoint that will be modified by the system in search of the maximum reference point.

P1012 – Actual Pressure Setpoint / Speed

Adjustable Range:	0.0 to 4000.0 [Eng. Un. 1]	Application Default Setting:	-
Properties:	RO		
Access groups via HMI:	SPLC		

Description:
This parameter displays the current value of the control setpoint in function of the system configuration:

■ Pressure control in Automatic: the value shown here will correspond to the system pressure setpoint that the pressure controller will attempt to maintain;

■ Pressure control in Manual/Disabled: the value shown here will correspond to the system speed reference setpoint that the system will attempt to maintain;

NOTE!
For more details about the pressure control refer to parameter P1030.

NOTE!
This parameter will be displayed according to the parameter selection for engineering unit 1 (P0510). This selection is made automatically by the application accordingly to the Pressure Control Mode (P1030) and Main Display Engineering Unit (P0209).

P1013 – Output Pressure

Adjustable Range:	0.0 to 300.0	Application Default Setting:	-
Properties:	RO		
Access groups via HMI:	SPLC		

Description:
This parameter displays the value of the system output pressure read via the connection of a pressure transducer in the analog input 1.

P1014 – Running Time

Adjustable Range:	0 to 65000 h	Application Default Setting:	-
Properties:	RO		
Access groups via HMI:	SPLC		

Description:
This parameter displays the operating time of the pump powered by the CFW700.

P1015 – Total Energy

Adjustable Range:	0 to 65000 kWh	Application Default Setting:	-
Properties:	RO		
Access groups via HMI:	SPLC		

Description:
This parameter displays the kWh value produced by the CFW700 and consumed by the pump. Until it reaches the value of 1000 kWh, the data will be presented with three, two, or one decimal point automatically. From 1000 kWh, the parameter format will be without decimal point, XXXX kWh. The Actual Decimal Point can be read at P0513.

P1016 – Remaining Time to a New Start Attempt

Adjustable Range:	0 to 3200 s	Application Default Setting:	-
Properties:	RO		
Access groups via HMI:	SPLC		

Description:
This parameter displays the remaining time to a new Start Attempt, this reading is related to the adjust made on the Time Between Starts (P1027).

6 POWER UP AND START UP

Shown below is a step-by-step guide for the commissioning of a water pumping photovoltaic system using a WEG CFW700 frequency inverter:

1. Verify that the connections of power, ground, and control are correct and secure;
2. Measure the voltage from the solar modules, and check that it is within the allowed range;
3. Mechanically disengage the load motor. If the engine cannot be uncoupled, make sure that turning in either direction (clockwise or counter-clockwise) will not cause damage to the machine or risk of accidents;
4. Energize input;
5. Enter the general parameters in the CFW700 (**Erro! Fonte de referência não encontrada.**, pag. 5), r eport according to the technical characteristics of the water pump and the inverter;
6. Switch to remote mode, and restart the CFW700;
7. If using a solar detector, adjust the values according to irradiation percentage to start the system (P1028) and percentage to stop the system (P1017). If not using a solar detector, check if the time between starts (P1027) is suitable for your application.
8. With the system running, configure the Proportional (P1024) and Integral (P1025) gains of the controller, can be done by the HMI, or WLP;
9. In steady state (after acceleration), if the MPPT tracking is too slow, the MPPT increment rate can be gradually increased through (P1019) via HMI;
10. If the system is being turned off with passing clouds or an added load into the pump, adjust the level to enable the cloud/load effect controller (P1038) and the controller gain (P1039), gradually increase the controller gain to a faster response.

NOTE!
The inverter performs some routines related to loading or downloading data (parameter settings and/or SoftPLC). The indication of these routines is displayed in the bar for variable monitoring. After these routines, if there is no problem, the display will show the monitoring mode

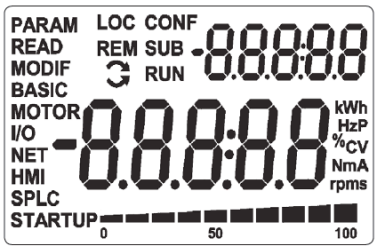

Figure 6.1 – HMI display when powering the drive