



FCP

Single-phase Inverter for single or three-phase motor pump

Operation and maintenance handbook

1. SPECIFICATIONS

The aim of this handbook, we would like to give you the most important information about the correct use and maintenance of the inverter; the models of FCP, differents for the voltage output are:

FCP109: Single-phase Inverter for Single-phase motor-pump, max. 1100W (1.5 Hp) for a maximum current of 9A.

FCP111: Single-phase Inverter for Single-phase motor-pump, max. 1500W (2 Hp) for a maximum current of 11A.

FCP307: Single-phase Inverter for Three-phase motor-pump, max. 1500W (2 Hp) for a maximum current of 7A.

This Inverter is designed specifically for motor-pumps operation, all types not depending from the flow or the pressure, with a perfect feedback control of pressure (detected with a pressure transducer), a substantial energy savings (up to 40% on respect to the standard on-off system) combined with various security features for the pump that are not possible in common appliances using pressure or flow switch.

The following instructions are about the standard model only.

If you require thecnical assistance regarding specific parts at Service Sales please do specify the exact initials of the model, followed by the number of the model, on the upper-left part of the product.

2. WORKING CONDITIONS

	Symbol	Value	Meas. Unit
Ambient working temperature	T_{amb}	0..+40	°C
Maximum relative humidity		50	% (40°C)
Protection grade of the Inverter		IP65	
Protection grade of the pressure transducer		IP67	
Nominal single-phase pump power connected to FCP109	P_{2n}	1100 1.5	W Hp
Nominal single-phase pump power connected to FCP111	P_{2n}	1500 2	W Hp
Nominal three-phase pump power connected to FCP307	P_{2n}	1500 2	W Hp
Nominal voltage supply Inverter	V_{1n}	220-230	V
Range voltage supply Inverter	V_1	207..244	V
Frequency supply Inverter	f_1	50-60	Hz
Voltage single-phase Output for FCP109 – FCP111	V_2	V_1	V
Voltage three-phase Output for FCP307	V_2	$3 \times V_1$	V
Fequency Inverter Output	f_2	0..55	Hz
Nominal input current to the Inverter FCP109 – FCP111	I_{1n}	10	A
Nominal input current to the Inverter FCP307	I_{1n}	12	A
Maximum output single-phase current for FCP109 (ED100%)	I_2	9	A
Maximum output single-phase current for FCP111 (ED100%)	I_2	11	A
Maximum output three-phase current for FCP307 (ED100%)	I_2	7	A
Maximum output Inverter current for one second maximum	I_{2p}	$3 \times I_{2n}$	A
Maximum pressure gauge		0 – 10	Bar
Resolution of pressure gauge		0.5	Bar
Storage temperature	T_{stock}	-20..+60	°C

Table 1: Working conditions

- Vibrations and hits: they must be avoided by a correct assemblage;
- For different environment conditions, please contact our Sales Department.



This Inverter can not be installed in explosive environments.

3. WARNINGS AND RISKS



The following instructions give you important information for correct assembling and use of the product. Please do read terms and conditions before installing the device, these instructions should be read by people who assemble or use it; besides, these instructions should be available to all person assigned to device setting and maintenance



The inverter voltage supply is only possible with Inverter closed box, after carefully following all instructions concerning installation and electrical connections of above and after following step by step the connections described in Chapter 4 of this handbook.

Installation workers

The installation, the starting and the maintenance of the product must be done by users that have read this handbook, in order to avoid any danger of an incorrect use.

Risks due to missed respect of the safety laws

Failing to respect the safety regulations, could endangers others and damage the devices, which can lead to the loss of warranty. The results of the non-observance of the security rules can be:

- Malfunctioning of the system
- Danger to others, to electrical and mechanical events

Security for the users

All the accident-prevention laws must be respected.

Security rules for assembling and control

Assembling, controlling and servicing procedures of the device must be read on this handbook. All operations on this device must be done when the system is not in motion and with no voltage supply.

Alterations and spare parts

Every machine, equipment or system alteration must be authorized by the manufacturer. For your safety, it is important to use only original spare parts. The use of non-original components may endanger others and can lead to loss of warranty.

Misdirect working conditions

The working security is guaranteed only for the conditions described in chapter 2 of this handbook. The values shown cannot be exceeded

4. ASSEMBLING AND INSTALLING



Installation operations must be performed only by whom have carefully read this handbook and in particular as described in chapter 3 (Warnings and Risks). Please do observe the health and safety on accident prevention.

If the product shows present any damage signs, do not install it, but contact the assistant service immediately.

Install the device in a place for away from ice, water, rain et cetera. Do respect working limits and be extremely careful with the motor and inverter's cooling.

4.1 Wall Inverter fixing in vertical position

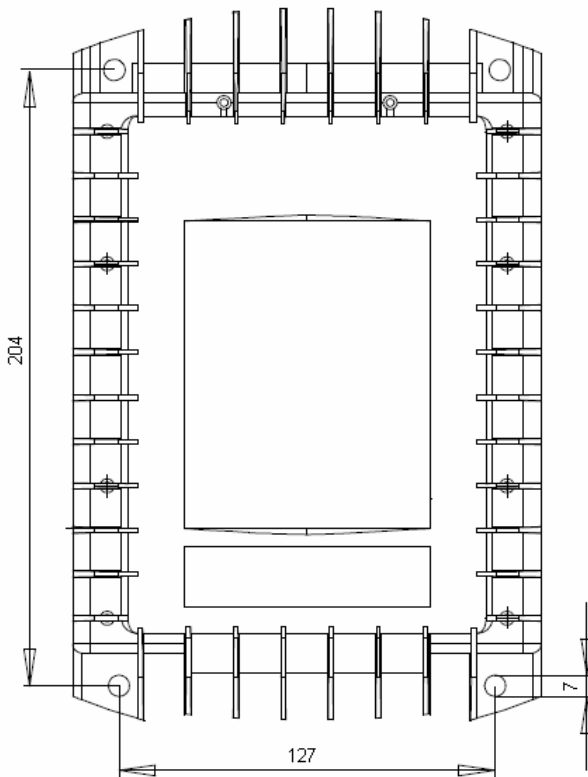
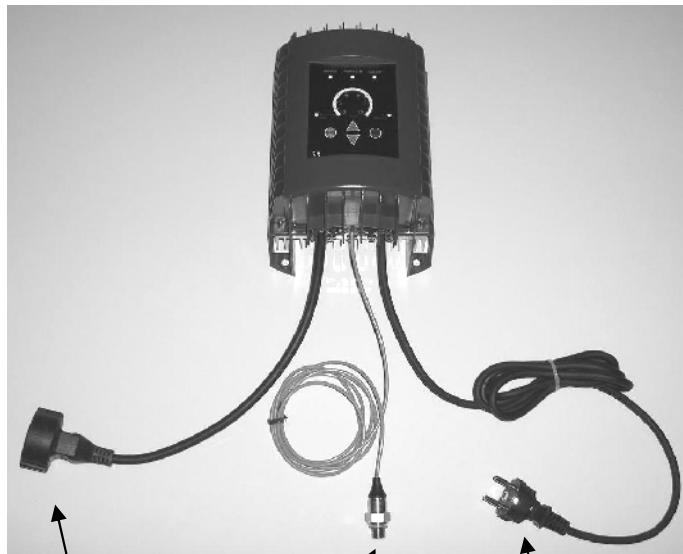


Fig. 1: Fixing holes distances (millimetres)

Install the product in place away from frost and weather conditions, mounting the unit on a wall in a *vertical position only*, leaving at least 200mm of space above and below the same so as to ensure sufficient cooling of the heat sink on the back of the inverter. The wall may also be of metal type as long as it is not a heat source and be not directly exposed to the sun.

For wall mounting the inverter using the N° 4 holes 7mm diameter arranged in the pattern of holes in Figure 1.

4.2 Connecting the hydraulic pressure transducer at the pump



2) Motor pump
voltage supply plug;
Red color for three-
phase plug

1) Pressure
transducer

3) 220-230 Vac
Inverter voltage
supply plug

Proceed to the hydraulic installing in accordance with current laws. To control pressure in feedback you need to connect to the pump outlet, the pressure transducer supplied (No. 1 fig 2), 1/4 "M, coming from the central to the inverter.

The type of transducer supplied may be a different one presented in this handbook, but maintaining the same connection and functioning.

4.2.1 Connecting the pressure transducer to New waterworks system

- Connect the pressure transducer in the hole of the filling cap $\frac{1}{4}$ "F of the pump provided to the output pressure (depending on the type of pump);

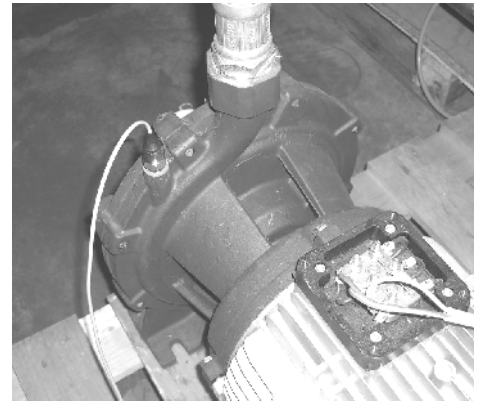


Fig 3: example of priming hole of pump delivery with transducer mounted

- On the delivery of a multistage pump, assembled with a T-fitting is possible to mount the pressure transducer in place of the pressure gauge.

Be aware that: in multi-stage pumps with the hole filling near aspiration it is not possible to mount the pressure transducer at that hole because it will not do the correct output pressure.

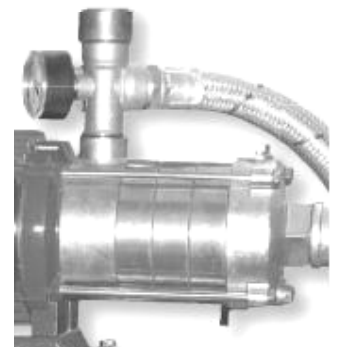


Fig 4: multistage pump outlet with manometer to replace with the transducer

- Use $\frac{1}{4}$ " F hole for the pressure gauge, which can be – in case – removed for connecting the pressure transducer;

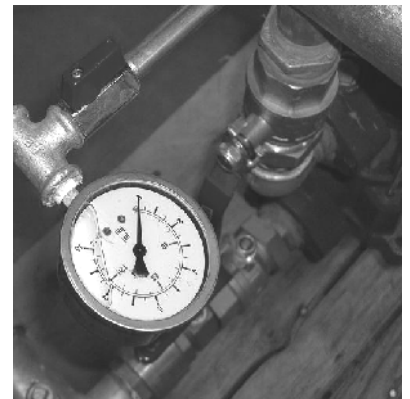


Fig. 5: Pressure gauge to replace

- Use any other $\frac{1}{4}$ "F hole on the pump hydraulics connections, possibly removing the cap (such as a hole for venting air);



Fig. 6: mounting transducer to venting air hole on the delivery pump

4.2.2 Connecting the pressure transducer to Old waterworks system

- Pump comes with PRESSURE-SWITCH with tank or with galvanized steel tank: mount the pressure transducer in place at the pressure switch, using reduction to $\frac{1}{4}$ "M. In case you need to maintain the switch for maximum pressure additional security, connect the N.C. output of the switch to ENABLE and 0V contacts (poles 2 and 5 of J5 electronic board, fig. 10)



Fig 7: pressure switch system with pressure switch to replace with transducer

- Pump comes with flow switch device: replace the flow switch with a T-fitting flow and in the central hole screwing the pressure transducer. This allows you to eliminate the problem of any blocking of the valve flow and to eliminate pressure drop, does mean eliminate all the problems inherent the flow switch systems.



Fig 8: Replace flow switch system

- It is possible to use a valve or other type of output provided at the delivery of the pump.

In case of installation of the check valve on the outlet of the pump, place the pressure transducer after the valve.

4.2.3 Membrane Tank

For an optimal pressure control is recommended to mount a small diaphragm tank (12L are usually good for a pump up to 2Hp).

For a perfect operation of the control of pressure, make sure that the tank is capable of withstanding the pressure and set the correct pressure to pre-load before connecting it to (normally 0.5-1 Bar less than the working pressure) .




Fig. 9: Membrane Tank

4.3 Inverter – Pump connection

Do connect the female schuko cable of the Inverter (No. 2 of fig. 2nd) to the power plug of the pump. Make sure the pump is in accordance with the operating conditions listed in Chapter 2 of this handbook. The pump to function with this Inverter must have the appropriate capacitor for the auxiliary winding and connected to power cable properly dimensioned, with a plug (schuko recommended).

Please do attention to following cable length table if you connect the inverter to a *sommersible* single-phase motor-pump:



220 Volt - 50 Hz - 1 -			
MOTORE MOTOR kW	2,5	4	6
	cavi - cables max m		
0,37	114		
0,55	128		
0,75	94	151	
1,1	64	103	154

Table 2: cable lengths admitted

In case of submersed motor pump with a cable length more than 20 meters be sure that the motor-pump is designed to works with inverter (may have a good phase-phase electrical insulation and not conductive rolling bearings) otherwise you need to use the specific output filter (optional – ask our sales service) connecting it between the inverter output and the motor pump voltage supply cable.

4.4 Inverter electric connection to line



The line voltage supply must match with the Inverter limits, described on chapter 3 – WORKING CONDITIONS. Do ensure proper protection from general electrical short circuit on the line.

The connection to the voltage supply is made by inserting the schuko plug (No. 3 of Fig. 3) into the socket power

The plant to which the inverter is connected must be conforms to safety regulations in use:

- Differential automatic switch: $I_n = 30\text{mA}$
- Magnetic-thermal automatic switch with intervention current proportionate to the power of the pump installed (see Table 1)
- Ground connection with total resistance less than 100
- If required by local electrical regulations in force, the installation of a differential circuit breaker, make sure it is of a type suitable for installation (see table below). The switches are suitable for those with the characteristic curve for alternating-current fault (type A).

Pump power Kw	Magneto-thermal protection (A)
0.5 (0.75 Hp)	8
0.75 (1 Hp)	12
1.1 (1.5 Hp)	16
1.5 (2 Hp)	25

Table 3: Magneto-Thermal protections



Before reopening of the inverter box to possible change cable or other components, after functioning, remove voltage and wait at least two minutes, then you can open the box (danger: contact with electric high voltage parts).

The unit is equipped with all those technical arrangements required to ensure a good functioning under normal situations installation.

The control system has a entry-filter, also have a current overload protection which guarantees absolute protection when the Inverter is combined with motors that not exceed the maximum power. For EMC is good that the power wires of control panel and motor power wires (when the motor are separated from the inverter) are shielded type (or armoured) with individual conductors of appropriate section (current density $\leq 5 \text{ A/mm}^2$). These cables must be the minimum length necessary. The screen conductor must be connected to the ground by both sides. On motor use the metal case for connection to the ground of the screen.

To avoid loops that can create mass disturbances radiated (antenna effect), the motor operated by the frequency converter must be connected on the ground individually, always with a low-impedance using the metallic box of the machine.

The wires from power supply to frequency converter and wires from frequency converter – motor (if the motor is separated to the Inverter) must be spaced as much as possible, not to create loops, not make them run parallel less than 50 cm.

Don't observe these conditions could cancel completely or partially the effect of the filter integrated.

4.5 Access to the electronic board

In case is necessary to change damaged cables, pressure transducer or to add the float switch contact, you need to open the Inverter case.



The operations of a component for the inverter must be performed only by experienced personnel qualified by the manufacturer, using only original spare parts supplied by the manufacturer.



Any action with open box of the Inverter must be made after at least 2 minutes after open line with appropriate switch or the physical separation from the power supply cable;

In case of failure to one of the cables or the pressure transducer, for the replacement of that should be opened by unscrewing the inverter cover the N° 12 screws in the back on the heat sink. For the extraction of a cable, unscrew the three screws that close the cable triangular plate. Remember to always replace the O-ring seal on the cable under the plate. To connect the cables in the appropriate terminals follow the pattern of connections in the electronic board below (fig. 10):

- Inverter Power supply cable: contact 220Vac + GND (J4)
- Single-phase Motor Power supply cable on FCP109 **and** FCP111 : contact S, T (J3);
- Three-phase Motor Power supply cable on FCP307: contact R, S,T (J3);
- Pressure transducer with 4-20 mA output: contact +Vcc, S;
- Float switch enable: contact ENABLE, 0V (J5);
- Motor ON output signal: Contact MOTOR ON, 0V (J5 - closed when the motor is ON, max. 30V, 3mA)

4.6 Connecting the float contact or other NC contact

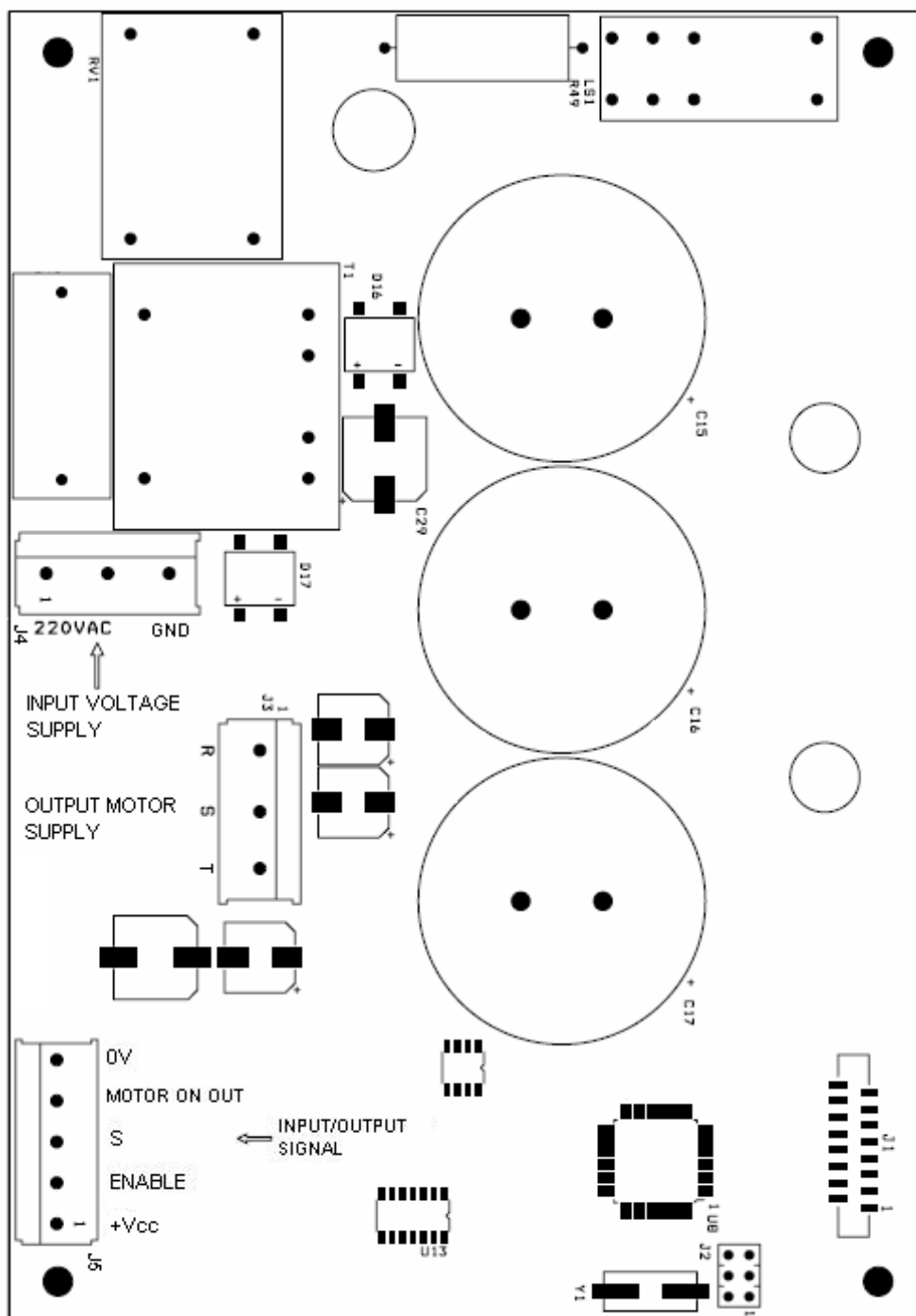
To connect an enable Normally Closed contact use the poles 2 (Enable) and 5 (common) of J5 (fig. 10). When the contact open, the Inverter stop the pump; when the contact close, the pump may restart at previous working condition.

For the connection of the float switch contact you need to change the three poles cable of the sensor with a four poles cable, passing on the same central exit of the transducer cable.



The new connections of pressure transducer and float switch contact must be done out of the Inverter box, protecting them to humidity, water and dust. Do not practice others holes to the Inverter case to avoid damages or decrease of the protection and insulation grade and interruption in anticipation of the guarantee.

4.7 Electronic Board connections:



5. STARTING AND PROGRAMMING



Fig. 11: Control panel



Button	Description
	Allow to increase the reference pressure; it allow to go up on the advanced regulation functions also
	Allow to reduce the reference pressure; it allow to go down on the advanced regulation functions also
	Starting pump; start Self-Regulation Test on the first installation or after a RESET
	Instant Stop of the motor pump

Table 4: Buttons description

LED	Description
	Power: Green fixed: Inverter voltage supply is ON
	Pump On Green fixed: Motor ON Green flashing: Enable OFF condition
	Alarm: Red fixed: Motor stop for a problem that need manual re-start (STOP then START) Red flashing: Motor stop for a problem with auto re-start
	Minimum Flow: Yellow fixed: Motor stop for minimum output flow Yellow flashing: Motor is stopping for minimum flow
	Dry Working: Red flashing: Motor stop for dry working condition of the pump, during one of four re-start of this problem, separated from 15 minuts Red fixed: final stop after 5th consecutive stop for this problem
	Circular Led Bar: Like a manometer shape of 20 Leds to indicate the instant pressure in BAR. On advanced regulation to each group of led correspond a function (see table Advanced regulations). In ALARM condition to each led correspond a different type of alarm (see Alarm table).

Table 5: Led description

5.1 Programming

- A) Make sure the pump is charged (full of water); in case the pump is not charged provide it a direct voltage supply (without Inverter) until the complete filling of water, then re-connect the pump to the Inverter;
- B) In case the pressure of the system is more than 3 BAR open the delivery to reduce it under this value, then completely close the delivery or all of the valves on the output of the pump (very important condition);
- C) Press START to start the self-regulation check. Wait roughly one minute for a completed cycle, and once the flashing Led bar is completed indicate the data saving and the pump stop for null flow condition (Minimum flow);
- D) At this point the Inverter is running; It is now possible to open the delivery of the pump and work; the reference default pressure, modifiable, is 3 BAR;
- E) If necessary, adjust the working pressure acting on keys  and  on panel; during the reference pressure setting the led bar is flashing up to one second of data saving; the measured pressure is indicated by fixed led bar;
- F) For a correct over-current motor-pump protection set the maximum current with F2 on advanced functions (chap. 5.2) reading the nominal motor data value.

The inverters generally comes to the user with the constructor data (default); if for any reason i.e. (such as inverters had been previously tested and configured for another pump) the inverter is pre-regulated, in order to RESET before self-regulation test, is necessary to perform this following:




Command	Procedure
RESET (to restore constructor data)	 &  press them simultaneously for 5 seconds
Starting SELF-REGULATION CHECK	After RESET, press 

Table 6: Reset and Self-Regulation Check starting



During self-regulation check the velocity and pressure of the pump arrive to maximum values; if is necessary, limit the maximum pressure before (F7).

We suggest to repeat the self-regulation check after any variation of parameters, in particular for variation of Maximum Velocity (F4) or Maximum pressure (F7), or in case of variations of the electrical/mechanical pump conditions, that may appear after long time of working.

5.1.1 Checking the pump stop for delivery closed



At the end of the self-regulation check, done with the delivery of the pump completely closed (all of the output valves closed) the pump shall be automatically stopping and the Inverter could show the message "MINIMUM FLOW" by the corresponding Yellow LED. The stop is preceded by a phase of flashing LED "MINIMUM FLOW". Verify that the pump stopped and after that the pump re-start working when opening any valve on pump delivery.











5.1.2 Checking the arrest of the pump dry running

After installing, if is possible, close the water input of the pump and check that, after approximately 40 seconds, the pump stop and show the message "DRY WORKING" with corresponding Red Led.

5.2 Advanced regulations and control panel visualization

Command	Procedure
Enter on Advanced Regulations	 &  press them simultaneously for 3 seconds

Press  and go up with  to enter on the advanced function request, as show on table 7 regulating the value of the selected function on a variation range indicated, on a scale from 0 to 10.

N°	Visualization	Advanced Function	Description	Range	Default
F1		Minimum flow stop	Adjustment of the minimum flow before pump stop, from the self-regulation value setted.	-10..+10 Step: 1	0
F2		Maximum motor current	Maximum RMS current setting – limit value for over-current thermal protection (A5)	3..9 (11) A for FCP109 and FCP111 1..7 A for FCP307 Step: 0.5 A	9 (11)A 7 A
F3		Minimum Motor Velocity	Minimum motor velocity adjustment.	30..70% Step: 2%	50%
F4		Maximum Motor Velocity	Maximum value of the motor velocity on respect to the nominal velocity.	90..110% Step: 1%	105% (100% for FCP109)
F5		FCP109 – FCP111: Starting velocity FCP307: Rotation	Starting velocity of the motor, before pressure control regulation. <i>Rotation direction on FCP307</i>	40..100% Step: 3% <i>0/1</i>	79% <i>0</i>
F6		Starting maximum Current FCP307: Rump	Starting Current – RMS limit value <i>Velocity ramp acceleration/deceler.</i>	18..28 A Step: 0.5 A 1000-10000 RPM/s Step: 500	26 A (28 A for FCP111) 3000 RPM/s
F7		Maximum pressure	Maximum security pressure of the system.	2..10 Bar Step: 0.5 Bar	10 Bar
F8		Pressure Hysteresis	Adjustment of the control pressure hysteresis.	0.15 ..1 Bar Step: 0.05 Bar	0.3 Bar
F9		Pressure ramp	Adjustment of the control pressure ramp on increasing-decreasing.	0.1 .. 2 Bar/s Step: 0.1 Bar/s	1 Bar/s
F10		Minimum output value of the pressure transducer	Adjustment of the minimum output value of the pressure transducer	1..5 mA Step: 0.2 mA	4 Ma










F11		Maximum output value of the pressure transducer	Adjustment of the maximum output value of the pressure transducer	10.. 20 mA Step: 0.5 mA	20 Ma
F12		Pressure transducer measure range	Adjustment of the pressure transducer range.	10..20 Bar Step: 0.5 Bar	16 Bar
F13		Proportional P.I.D. Factor	Proportional factor on the P.I.D. pressure control	0..6000 Step: 300	3000
F14		Integral P.I.D. Factor	Integral factor on the P.I.D. pressure control	0..4000 Step: 200	1000
F15		Minimum flow stop delay	Delay time on the minimum flow condition before stopping pump	2..20 sec Step: 1 sec	10 sec
F16		Dry working stop delay	Delay time on the dry working condition before stopping pump	10..100 sec Step: 5 sec	40 sec
F17		Noiseless working mode	It is possible change of the working mode type	0: Normal working 1: Noiseless working	0
F18		Check suspension	It is possible to suspend the self regulation check using a theoretical pump curve or to repeat the check on next START	0: Theoretical curve 1: Start new check 2: Checked curve	1
F19		Phisical quantity Measures	Measures of different phisical quantity on respect the pressure	0: Pressure (0..10) 1: Frequency (15..55) 2: Current (0..10) 3: Voltage (200..240) 4: T [°C] (70..90) 5: Last alarm 6: Motor T[°C](0..100)	0

Table 7: Advanced Functions



WARNING: setting an high Maximum Velocity (function F4) increase the performance of the pump but can also reduce the endurance of the same for the stress of electrical and mechanical parts.

NOTES:

Check suspension function (F18-0) eliminate the Self regulation check and regulate the pump working using a theoretical approximated curve (minimum flow stop is modifiable with F1);

Noiseless working function (F17-1) provide a more silent working power of the motor-pump (low electromagnetic acoustic noise caused by iron-core vibrations) but increase the power loss and consequently increases the Inverter temperature;

If the high value of the starting current cause problems on the magneto-thermal switch protection try reduce this current with F6 and verify that the torque remains sufficient.

6. PROTECTIONS AND ALARMS









N°	Alarm type with ALARM led ON	Protection	Description
A1		Current pick	The logic switches off the power instantaneously if this value exceeds a peak that can damage the power electronic components. Possible high starting current or short-circuit on motor.
A2		Over-voltage	The logic switches off the current if the voltage exceeds a maximum instantaneous limit beyond that can damage some electronic components of the inverter.
A3		Minimum-voltage	If the voltage goes below the minimum value of 207 Vac the power supply may provide a under-voltage to some electronic components; for this the logic switches off the current.
A4		Over-temperature IGBT	If the temperature of the power electronic components (IGBT) exceeds 85°C the inverter provide a thermal protection and stops the current. Before this stop protection the Inverter limit the current to 90% of the value imposed (F2)
A5		Motor Over-Current Thermal protection	To over-current beyond a certain time defined by an I ² t algorithm, the inverter limit the current to protect the motor from damage to the insulation. <i>For the correct functioning of this protection regulate the nominal motor current (F2).</i>
A6		Pressure transducer problem	In case of a problem or failure of the pressure transducer, the Inverter switches off the motor current. Re-start must be manually, pressing STOP followed by START.
A7		Minimum flow	This protection stop the pump when all output are closed and the flow of water is null. Do not appear "Alarm" led signalling
A8		Dry working	This protection stop the pump in absence of input flow of water. After five consecutive re-start, the stop is permanent and switch on also the "Alarm" led

Table 8: Protections and Alarms

All Alarms are showed with the corresponding Led on the circular Led bar and the red Alarm Led, that is flashing if the protection have automatic re-start otherwise is fixed if the protection need a manually re-start doing STOP then START.

Protections and Alarm details:

CURRENT PICK PROTECTION (A1): The Inverter stop immediately the current in case this value exceed a maximum value limit for the electronic components

CLOSED DELIVERY WORKING PROTECTION (A7): to prevent a closed delivery working, the control logic read the motor's working point condition; if this point is under a setting value, the system switches off the pump, and appears advise "Minimum Flow". At the end of this condition, the system restarts its normal operation. The pump curve is detected by the initial self-regulation check.

DRY WORKING PROTECTION (A8): To avoid that the pump can continue to operate after a problem in absence of input water, the system read some information of the electric motor, in a time of 30 seconds, and when they go below a minimum, turn off the pump and show the relative signal of alarm "Dry Working". The inverter tries N°5 consecutive re-start in this condition, one spaced 15 minutes of each other. After the fifth consecutive fault, switch on the led Alarm and the re-start must be manually do, pressing STOP followed by START.

ENABLE OFF: the enable contact (float contact) is open and the led MOTOR ON is flashing.

7. GUARANTEE

Under the current European law: guarantee of 2 years calculated from the date of delivery of prejudice further provisions of law or contract.

To have service in guarantee, it must submit to the company providing the guarantee certificate completed.

The guarantee is excluded or interrupted in anticipation if the damage is caused to the following: External influences, non-professional installation, non-compliance with instructions, interventions by unauthorized locations, use of not original spare parts and normal wear.

8. DECLARATION OF CONFORMITY

PENTAX SPA - declare that the products :

- FCP109
- FCP111
- FCP307

are conforms to the following European directives and to national law and at following technical standards:

- Machines 98/37/CE
- Low Voltage 73/23/CE and subsequent amendments
- EMC 89/336/CE
- EN60034, EN60335-1, EN 60335-2-41, EN 55014-1, EN 55014-2, EN 61000-3-2, EN 61000-3-3, EN 61000-3-4, EN 61000-3-12, EN292-1, EN292-2, EN50-178

Manufacturer and depositary of technical documentation:

PENTAX S.p.A.

Viale dell'industria, 1

37040 Veronella (VR) - Italia

Gianluigi Pedrollo (President)



Gianluigi Pedrollo

Veronella (Vr), 01/01/2008



Sede amministrativa e stabilimento: Viale dell'Industria, 1 - 37040 Veronella (VR) Italy
Tel. +39 0442 489500 - Fax +39 0442 489510 - www.pentax-pumps.com - E-mail: sales@pentax-pumps.it