BT/BF SERIES

Operating Manual

Version V5.4.1

WARRANTY AND LIABILITY

Apart from glass items, consumable and spare parts, and subject to use according to standard operating conditions, our equipment is guaranteed free of any defects due to errors in manufacturing or design as acknowledged by us, for a period of 12 months as from delivery ex-shop. Parts substituted or remade under this warranty shall be guaranteed only for the remaining initial warranty period.

Warranty is under exclusion:

a. If faulty material or design comes from the buyer or third party imposed by the Customer
b. If malfunction results from servicing or changes performed by the Customer without our prior written permission
c. If malfunction arises from fair wear and tear, carelessness or defective maintenance by the Customer, unusual applications or non-observance of our instructions for use and servicing
d. If malfunction is the result of absolute necessity as import or export bans or embargo and exchange control measures shall be regarded as absolute necessity for the performance of the contract
e. If the Customer does not follow the instructions that the Supplier may have notified for installation and starting of equipment.

The Supplier liability is specifically limited to the terms above, any claims including warranty claims to impose penalties for further liability being excluded.

The Supplier guarantees that the software complies with contractual specifications. The Supplier liability is limited to delivery of licensed programs on an input medium without material or manufacturing flaws and to debugging of proven programming errors, free of charge for a period of three months following delivery. Beyond the warranty period, the Licensee may take out a specific maintenance contract (of available). This service provides the Licensee with technical support and user assistance especially on the telephone. User assistance is restricted to practical help with software functions and by no means covers the related operating system or any mass-marketed input-output software (word processor, spreadsheet, etc.).

It is expressly agreed that the Supplier shall not be liable for any Licensee compensation for any direct or indirect injury whatever the damage; particularly to information, data, files, programs or other property set apart from the software, or any loss of profit. Excluded from the warranty are floppy disks damaged by accident, misuse, improper use, servicing or alterations provided by a third party other than the Supplier.

The Supplier liability may not be presumed for any reason whatsoever outside the scope of the aforementioned warranty provisions.

The Supplier is bound by mere obligation to provide means. In particular, liability cannot be incurred if the direct Supplier advice or software messages are not implemented.

WARNING AND CAUTIONS

WARNING:
To prevent damaging the instrument or injuring yourself, it is absolutely necessary that you understand everything in English, above all, technical terms, before operating the instrument. Otherwise, it is necessary for you to receive complete instruction from someone qualified who understands both the instrument and English very well.

CAUTIONS:
Liquids associated with this instrument may be classified as carcinogenic, bio-hazardous, flammable, or radioactive. Should these liquids be used, it is highly recommended that this application be accomplished in an isolated environment designed for these types of materials, in accordance with government and local regulatory laws, and in compliance with your company's chemical/hygiene plan in the event of a spill. In all cases, when using instruments, prudence and common sense must be used.

TABLE OF CONTENTS

1 Introduction

All pumps provide continuous, pulse – free fluid flows over a wide range of pressures and temperatures. Key features of the system include the following:

• Designed for pumping fluids at high pressure with precise control.

• Sophisticated electronics provide highly accurate fluid rates and volume measurements.

• The system works with water, oil, or brine. Fluid-wetted parts are available in Hastelloy (C-276) or Titanium (TA6V) for users pumping highly corrosive fluids.

• The system is operated using either an external computer or a built-in Touch Panel Computer (TPC) using a specific software running under the Windows® (XP or later) operating system. The software accommodates the user with complete control over all operating parameters.

• The pump system can be operated in many different operating modes, including Constant Rate, Constant Pressure, Constant Net Pressure and Continuous Flow and Pressure. The system can also operate in both directions; it can either deliver or receive fluids.

• Different options are available as high temperature (200 °C) or stirring systems, which allows the user to heat and/or mix the entire pump cylinder fluid for reservoirs conditions experiments.

• Different pump models provide different maximum flow rate and pressure specifications. In general, the higher the maximum pressure specification, the lower the maximum flow rate specification.

All of our pumps offer the following advantages:

- ✓ Accurate flow rate
- ✓ Accurate pressure control
- ✓ Accurate volume measurement
- ✓ Wide range of flow rate at full load
- ✓ Continuous pulse less fluid flow
- ✓ Remote control
- ✓ Extreme long life
- ✓ Very compact design

2 Description

2.1 Basic Components

All pumps have been designed for practical space workshops and basic electrical facilities. A 2-cylinder pump is necessary for continuous flow, while a 3-cylinder system is necessary for a flow recirculating process.

A standard pump system typically includes the following components:

Table 1 – Basic Components per Pump Model

1-Cylinder Pump	2-Cylinder Pump	3-Cylinder Pump
1 cylinder 2 hand valves or 2 air driven valves 1 pressure transducer 1 controller drive 1 brushless motor 1 I/O controller Plumbing and cables	2 cylinders 4 air driven valves 2 pressure transducers 2 controller drives 2 brushless motors 1 I/O controller Plumbing and cables	3 cylinders 6 air driven valves 3 pressure transducers 3 controller drives 3 brushless motors 1 I/O controller Plumbing and cables

2.2 Technical Specification

All models has the following the specification:

- Min flow rate :0.0001 ml/min
- Flow rate accuracy: +/-0.1%
- Pressure accuracy: 0.1%FS
- Thermal Error: span coefficients ±0.015 %FS /°C
- Maximal viscosity before degradation of performance: 10cP

Model	Volume (ml)	Pressure (psi)	Max. flow rate (ml/min)
BTSP 50-30	50	30,000	20
BTSP 100-10	100	10,000	45
BTSP 125-20	125	20,000	30
BTSP 175-15	175	15,000	30
BTSP 250-10	250	10,000	60
BTSP 500- 5	500	5,000	130
BTSP 250-20	250	20,000	35
BTSP 300-15	300	15,000	40
BTSP 500-10	500	10,000	70
BTSP 1000-5	1000	5,000	130
BFSP 500-15	500	15,000	40
BFSP 1000-15	1000	15,000	80
BFSP 500-25	500	25,000	50

BTDP/BFDP are of the same specification of the BTSP/BFDP with the same model number but with 2 cylinders of equivalent volume.

2.3 Name and address of manufacturers

Information and help may be obtained from Floxlab:

FLOXLAB
23 rue du Port 92000 Nanterre (France)

Tel: +33 (0) 1 81 93 12 85
Fax: +33 (0) 1 41 37 04 76
contact@floxlab.com

2.4 Equipment ratings:

2.4.1 Electrical ratings:

The device shall be connected to the power with the requirements below:

Supply voltage:	110-230VAC +/- 10%
Frequency range:	50 – 60 Hz +/- 10%
Power requirements:	1000W

2.4.2 Range of environmental conditions:

The device is designed to be operated under the normal environmental conditions:
- Indoor use;
- Altitude up to 2 000 m;
- Temperature 5 °C to 40 °C;
- maximum relative humidity 80 % for temperatures up to 31 °C decreasing linearly to 50 %
- Relative humidity at 40 °C;
- Mains supply voltage fluctuations up to ±10 % of the nominal voltage;
- Transient overvoltage up to the levels of category II
- Pollution degree level 2

2.4.3 Degree of IP protection as per IEC 62262:

The equipment is rated IP50.

2.4.4 Origin of accessories and spare parts:

For safety reasons, use only spare parts and accessories that meets or exceeds the manufacturer's specifications shall be used.

2.5 Options or Accessories

2.5.1 Temperature Controlled System

All pumps can be equipped with a temperature-controlled system. The specific design allows the pump cylinder to be temperature controlled from -5 °C (+23 °F) to +200 °C (+392 °F), even if the standard maximum temperature is 150 °C (302 °F). Above this temperature, the thermal effects become progressively more detrimental to the components and reduce their life span.

If only heating is requested, the pump has a heating mantle, which heats the pump directly, without liquid. The temperature is controlled by the pump itself: press the **I/O** button on the control software to adjust the temperature set point and start the heating. If needed, you can adjust the temperature regulation by changing the P, I and D parameters in the **Calibration** window, even if it has been already factory programmed.

If heating and cooling are requested, the pump has a fluid jacket, which controls the temperature pump cylinder by recirculating a thermostatic liquid. In that case, a chiller is compulsory allowing external control of the temperature.

Both equipment when installed surround the pump cylinder.

For safety reasons, quitting the pump's program or shutting down the TPC automatically stop the heating.

For safety reasons, a secondary Pt100 has been implemented to avoid over heating the pump. In this particular case a switch off of the heating will be toggled, it will need to be manually validated before resuming the heating function.

In case of overheating, please open the side panel to see if there is any damage and contact us!

2.5.2 Stirring System

Some pumps can be equipped with a stirring system (BT and BF series). The stirrer is installed on top of the pump cylinder and is driven by a 24 VDC brushless motor. The pump software controls the motor RPM through the I/O Controller.

The stirrer fan is magnetically driven by the motor shaft, so there is no sealing to protect the motor. This unique design drastically increases the rotation yield and is completely independent of the cylinder pressure. However, the maximum RPM depends on the fluid viscosity: above 100 cP, you may have to reduce the maximum stirrer RPM proportionally to the fluid viscosity.

Note that the stirring system increases the cylinder dead volume of about 10 ml.

For safety reasons, quitting the pump's program or shutting down the TPC automatically stop the stirring.

2.5.3 Fast Pumping System

Some pumps can be connected to a fast pumping system(BT and BF series). It is composed of a peristaltic pump connected to the refilling circuitry. This system allows you to quickly refill the chamber connected to the process circuitry. Note that it is manual and must be activated from the peristaltic pump panel only.

Open both tank and process valves before running the peristaltic pump. The standard maximum flow rate is 3.5 L/min.

A specific manual is provided with this guide: run this system only after having carefully read the peristaltic pump manual.

2.6 Material

All pumps are made under all the relevant specifications, applicable safety norms and health requirements in accordance with the local legislation.

Standard wetted parts are made of stainless steel, fluorocarbon (FKM) elastomer for the O-rings and poly-tetra-fluoro-ethylene (PTFE) polymer for the backup rings. Titanium, Hastelloy or other metals and/or other polymers/elastomers are also available upon request.

Note that pumps are specifically adapted for cooling, heating, stirring, fast pumping and other applications as special CO_2 injection, for example.

2.7 Instruction for lifting and carrying

Lifting a carrying should be mostly done with the appropriate equipment: Crane, forklifts, lifting table.
Please lift the pump using the base of the Pump.
The weight, dimensions and center of mass are indicated in the annex 8

2.8 Control Methods

Two control methods can be implemented, either a local control with the intermediary of a Touch Panel Computer situated on the pump or a remote control via a Remote Computer.

2.8.1 Local Control – Touch Panel Computer (TPC)

The Touch Panel Computer (TPC) is already loaded with the control software. It includes factory parameters, calibration set points and all other commands to control locally the flow rate, volume and pressure of the pump during fluid transfer operations.

The intuitive interface allows access to the configuration parameters by touching the screen. The volume and pressure parameters can be set up to monitor a complete experience.

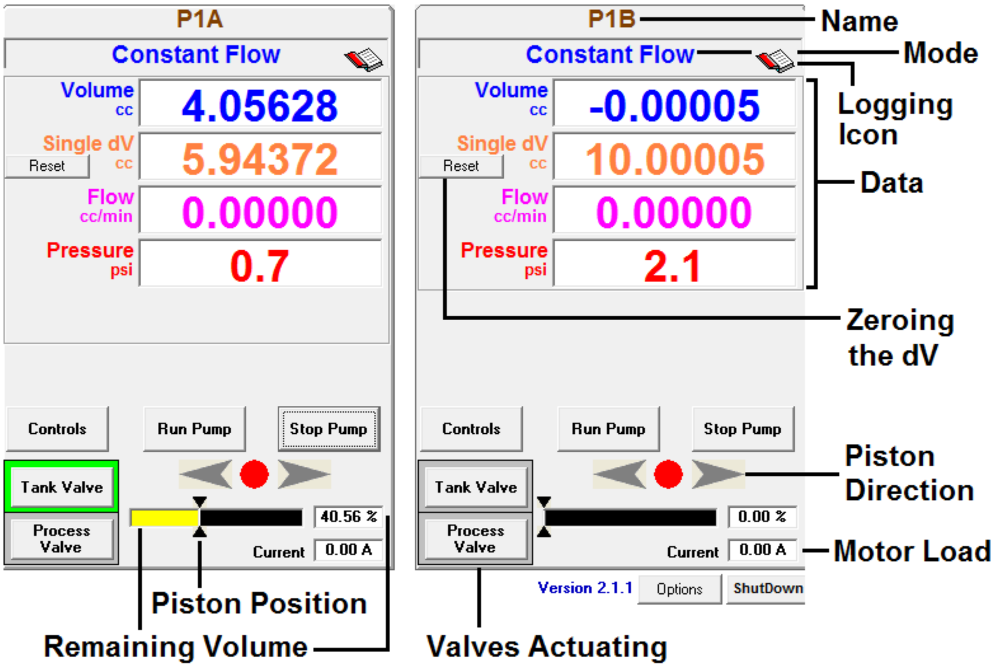


Figure 1 – Standard Display of the TPC

The user is able to:

- ✓ Start/Stop the pump.
- ✓ Control the flow direction.
- ✓ Control the pressure.
- ✓ Ramp the pumping rate.
- ✓ Displace a precise volume.
- ✓ Open/Close the automatic valves (option for single cylinder models).

3 System Setup

3.1 Plumbing

The piping between the pump chamber and the valves (manual/automatic) is completed at the factory. However, the inlet and outlet tubing, i.e. from the feeding tank and valves (inlet) and the valves to the system being pressurized (outlet), will be assembled on-site. The recommended tubing characteristic depends on the pressure rating (See Table 2).

Table 2 – Tubing characteristics

	Pressure	Outer diameter	Fitting type
BT/BF Series	≤15,000 psi	1/8’	Compression
BT/BF Series	> 15,000 psi	1/4’	Collar/gland threaded

NOTE: for installation instructions for a fluid ferrule sleeve and a fluid gland nut onto a fluid tubing, please refer to ‘How to Attach a Fitting’ section in the maintenance manual.

If you would like to purchase additional fluid ferrule sleeves or fluid gland nuts or fitting, please contact the Supplier.

3.2 Power Source

All pumps require an AC voltage input within the range of 90 to 260 volts (50/60 Hz) in order to operate. The maximum observed power consumption does not exceed 230 watts. The pumps are built to function over a universal AC voltage range, so the user does not need to set the voltage. The power cord supplied with the pump will conform to the electrical norms of its destination:

- Plug the provided AC power cord into the pump. The power receptacle is located near the bottom, left, on the pump’s back panel.
- Plug the other end of the power cord into a 90 to 260 volt (50/60 Hz) AC source.

If a computer was ordered with the pump, it is set to the country’s voltage. See the supplied computer operating manual for further information on power specifications.

3.2.1 Uninterruptable Power Supplies (UPS)

Electronic equipment, including the pump and your computer, can be affected by brief power interruptions and power line surges or spikes. Uninterruptible Power Supply (UPS) can provide back-up power to your equipment during such occurrences. This will prevent your pump from stopping when power interruptions or fluctuations occur. To prevent disruption to an experiment, it is strongly recommended that users who are interested in obtaining continuous fluid flow over extended periods of time use a UPS with their pump system. For more information about choosing a UPS for your pump, please ask the Supplier.

3.3 Air Supply (automatic valves – optional)

If automatic valves are used with the pumps, they are air-actuated. Air is taken into the system through the air inlet and distributed to the pilot solenoid manifold. The pilot solenoids then distribute and control the air flow to the valves.

IMPORTANT: Although the pump uses very little air, the air supply **MUST** meet the following conditions:

- ✓ The air must be clean and dry. Impurities and moisture could cause the pilot solenoids to rust or block, and then malfunction. The air must be between 75 to 105 psi (5 to 7 bar). Over pressure may damage the pilot solenoids.

To connect the air supply, first identify the air inlet, located on the back panel of the pump. Insert a 6 mm diameter tube into the air inlet fitting until it is tight and cannot be moved. Attach the other end of the tube into your pressurised air source. If your air supply has a switch to turn it on, turn it on now so that air can be supplied to the pump.

NOTE that PFA is the recommended material for the air tubing although other materials will work. Please ask the Supplier if you need recommendations.

3.4 Remote Computer

If you purchased a computer together with your pump, the control software has probably already been installed. It is assumed that, at this point, the user has completed the following:

- ✓ the air supply is connected.
- ✓ a fluid supply is connected.
- ✓ the pump is connected to a power source.
- ✓ a computer is connected to the pump and turned on.

3.4.1 IP configuration

Per Standard the Ip are set as follows:

- The electronic card's: 192.168.1.150
- The panel PC's: 192.168.1.101
- The remote computer's: 192.168.1.100

The IP needs to be modified if they are on the same network.

For the panel/PC, you can modify it using the computer parameters after exiting the Floxpump software (Control/Calibration/Service Commands/Quit).
For the electronic card, contact us, we will send you a software that can easily change it.

After each modification don't forget to modify appropriately the configuration file.

3.4.2 Requirements

Before installing the software on your remote computer, make sure your computer meets the minimum following hardware requirements:

- ✓ Windows operating system XP
- ✓ Pentium based
- ✓ 100 MHz minimum for UC
- ✓ USB port
- ✓ Ethernet port
- ✓ 50 MB hard disk space

3.4.3 Installation

If your computer meets the above requirements, follow the steps below to install the software:

- Insert the CD (or the USB drive) into your computer
- Run the 'Setup'. A 'Setup' window will appear. Just follow the instructions. Usually you will be asked for terminating all other programs before installing the software.
- When all other programs are closed, click on Next. The Choose Destination Location window appears. This is the location where the software will be installed. If you want to install to the default directory, click on Next. If you wish to install in a different directory, click on Browse and locate that directory. You may also type in a directory location. The Setup program will create the directory if it does not already exist. When you are finished, click on OK.
- The Program Group window appears next. Users can choose the Program Group or create a new one.
- During the software installation, you may be asked to keep your file if an older one is to be copied. Answer 'Yes' to keep your more recent file.
- Setup will display a message conveying that the installation has been successful.
- Store the CD in a safe place. Use this disk if you need to restore or re-install the software.

3.5 Installation Precautions

Make sure the connected power source is according to specification and stable.
If installed on another equipment it is best to screw the foot of the pump to the support.

For ergonomic it is best recommended for the pump panel to be place adapted to the end user.

The On/OFF switch at the bottom of the pump is to be Accessible at all time for an emergency shut down.

Make sure the plumbing is fitted and tightened enough.

If needed to check the air supply.

During installation only use the constant flow and constant pressure mode.

The pump will be considered as correctly install if they are no issue in the following procedure:
- Open the tank valve and select the constant flow mode.
- At a negative flow rate of 25% of max flow rate fill the pump with water.
- After the pump stops, inject at 75% of max flow rate, till the pump stops.
- Fill the pump at 100% of max flow rate till 75% of the pump capacity.
- Close all valves, in constant pressure mode regulate the pressure at 50% of pressure range.
- Wait for stability. Do the same for 75% and 100% of the pressure range.

Don't forget to depressurise before opening the valves.

4 Touch Panel Computer (TPC)

4.1 Introduction

Please see the dedicated manual for a complete description of the TPC Series. This Touch Panel Computer is a state-of-the-art HMI (Human Machine Interface) with a 6.5' or 12.1' display (depending on pump's model) and an x86-based platform with these key features:

- ✓ **Fan less**
  By using a low-power processor, the system does not have to rely on fans, which are often unreliable and causes dust to circulate inside the equipment.

- ✓ **Bright Display**
  The TFT LCD display suits industrial demands for clear interfaces.

- ✓ **Powerful Communication Capability**
  The TPC Series provides a powerful I/O interface facilitating communication with other devices. The I/O interface includes serial ports, Ethernet and USB 2.0 support. TPC Series also supports the expansion slot PC-104. This makes it easy to expand with the requiredPC-104 modules.

- ✓ **Windows Support**
  In addition to the OS support of Windows XP (or later), TPC series offers a platform supporting Windows CE as well. The optional Windows CE operating system specifically for the TPC Series is available for Windows CE application programmes builders.

4.2 Specifications

4.2.1 Power

- **Typical:** 24VDC @ 2.5 A (60 W)
- **Input Voltage:** - 18-32VDC (the fuse blows as input levels exceed 33 VDC)

4.2.2 Safety

- FCC Class A
- CE certified
- The front bezel is compliant with NEMA 4 and IP65

4.2.3 Environment

- **Operating Temperature: –** 0 ~ 50 °C (32 ~ 122 °F)
- **Storage Temperature: –** -20 ~ 60 °C (-4 ~ 140°F)
- **Humidity:** 40 °C @ 10~95% relative humidity (non-condensing)
- **Vibration:** 2 grms (5 ~ 500 Hz) with CF Card

4.2.4 System

6.5' TPC	12.1' TPC
CPU: Intel® Atom™ Z510 1.1GHz (512K cache) BIOS: Award BIOS System Chipset: US15WP VGA: Integrated in US15WP Memory: 1GB SO-DIMM DDR2 SDRAM Watchdog Timer: 1 ~ 255 sec (system) Storage: Compact Flash® slot	CPU: Intel Pentium M 1.4GHz BIOS: Award 4Mbit flash memory South Bridge: Intel 915GME VGA: Intel 915GME Memory: 2GB SO-DIMM DDR2 SDRAM Watchdog timer: 1.6 second timeout period Storage: Compact Flash® slot

4.2.5 I/O Ports

6.5' TPC	12.1' TPC
Serial Ports: 1x RS-232; 1xRS-422/485 RJ-45 Ethernet port: 1xLAN (10/100BaseT) USB Ports: 2xcompliant USB 2.0 and 1.1 Compact Flash Slot: 1xType II	Serial Ports: 3xRS -232; 1xRS-232/422/485 RJ-45 Ethernet port: LAN 1 (10/100BaseT); LAN 2 (10/100/1000BaseT) USB Ports: 4xcompliant USB 2.0 Compact Flash Slot: Type II

4.2.6 LCD

6.5' TPC	12.1' TPC
Display Type: TFT colour LCD Size (diagonal): 6.5' Maximum Resolution: 640x480 (VGA) Maximum Colours: 262K Viewing Angle: H160 °/V140 ° Luminance (cd/m2): 700 Contrast Ratio: 600 Operating Temperature: -30 ~ 85°C Backlight: LED	Display Type: TFT colour LCD Size (diagonal): 12.1' Maximum Resolution: 800x600 (SVGA) Maximum Colours: 262K Viewing Angle: H140 °/V120 ° Luminance (cd/m2): 350 Contrast Ratio: 500 Operating Temperature: -10 ~ 65 °C Backlight: 2 CCFL

4.2.7 Touchscreen

6.5' TPC	12.1' TPC
Touch Type: Resistive Base Glass Construction: Tempered glass Resolution: 1024 x 1024 Light Transmission: 81% ± 3% typical Controller: RS-232 Interface Durability: 1 million touches	Touch Type: Resistive Base Glass Construction: Tempered glass Resolution: 1024 x 1024 Light Transmission: 80% typical Controller: USB Interface Durability: 1 million touches

4.2.8 I/O Port Arrangement

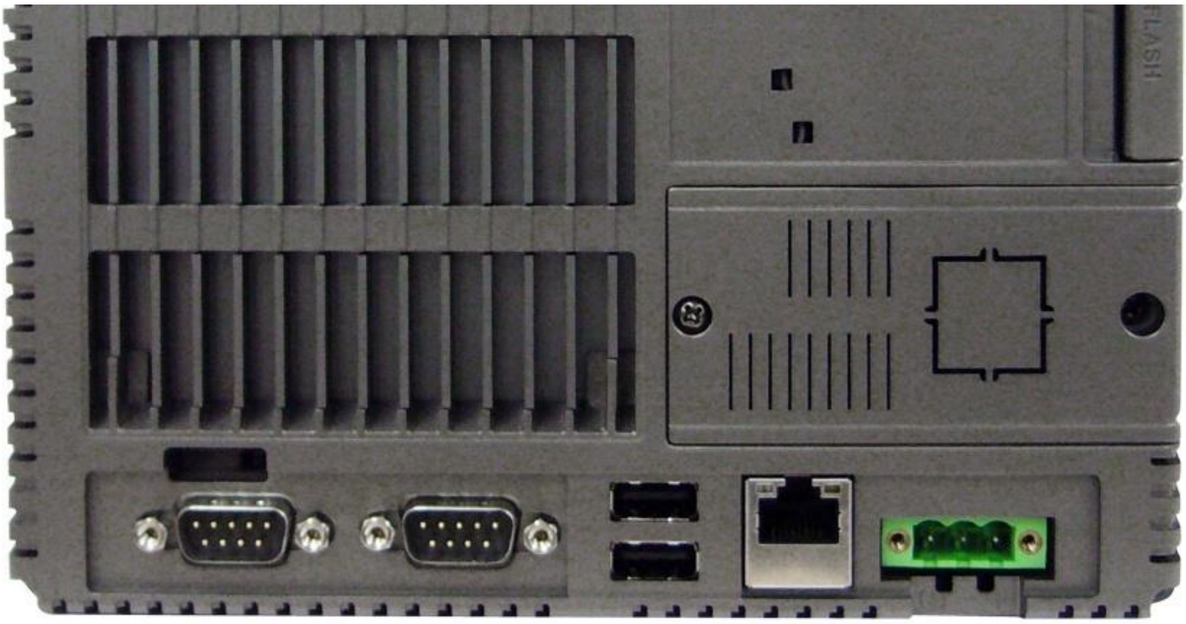


Figure 4 – I/O Port Arrangements for 6.5' TPC

Figure 5 – I/O Port Arrangements for 12.1' TPC

5 Software: Panel Pump Run

5.1 Switch On

At this point, the user has completed the following:

- The fittings are tightened.
- The pump is connected to the power supply.
- A fluid inlet and outlet supply is connected.
- If automated version, the air net is connected (5–7 bar).
- The touch panel or the remote computer is ready to be used with the software lunched.

To turn on your pump, push the ON/OFF toggle the switch to 'ON'.

5.2 Software Architecture

✓ The windows sequences of the software are summarised here:

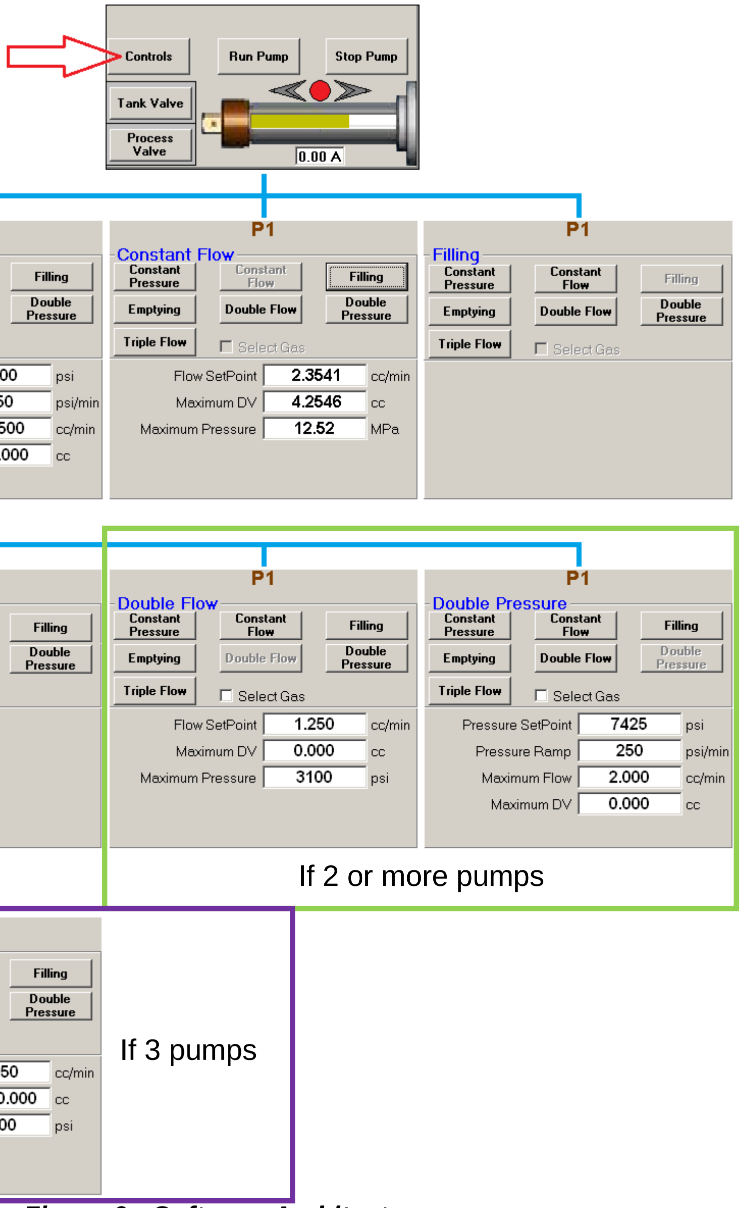


Figure 6 – Software Architecture

5.3 Welcome Window

When launching the pump control software, the following window appears for a few seconds:

Figure 7 – Welcome Window

5.4 Main Window

The software can control one, two or three pumps at the same time.

After a few seconds, the main window appears as shown:

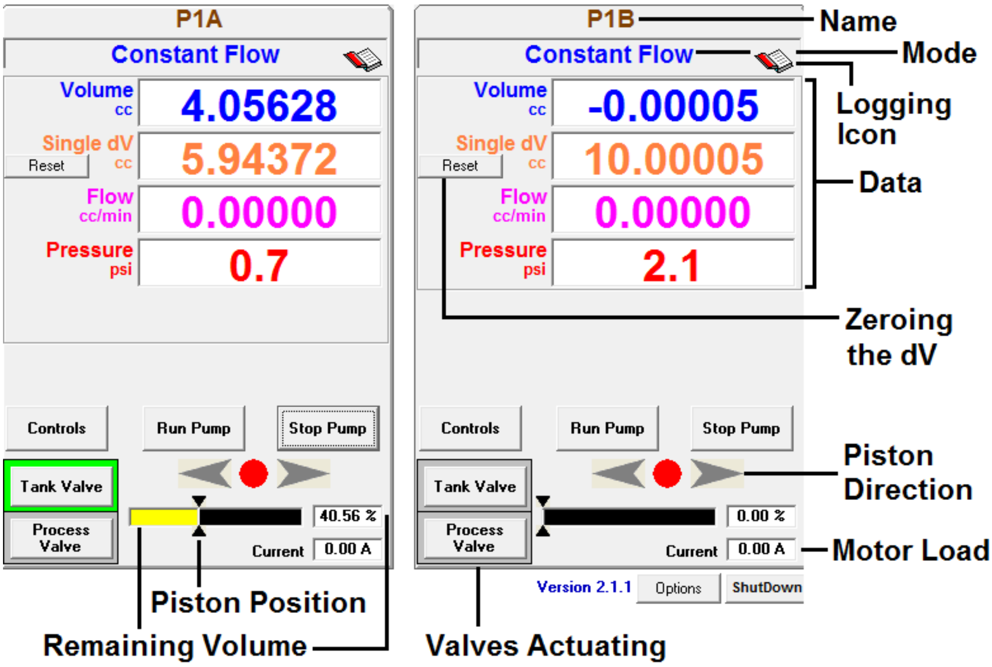


Figure 8 – Standard Main Window for a Two-Cylinder pump

5.5 Digital Outputs

5.5.1 Run/Stop Buttons

Pump cylinders can be started/stopped by using the ‘**Run Pump /Stop Pump**’ buttons on the main window. Each operating pump cylinder has its own ‘**Run Pump / Stop Pump**’ button. For independent operating modes, each pump cylinder’s ‘**Run Pump / Stop Pump**’ button will need to be pushed. For dual pump operations, only the ‘**Run Pump**’ button needs to be pushed to start the pair of pump cylinders.

You will have to confirm pump initiation:

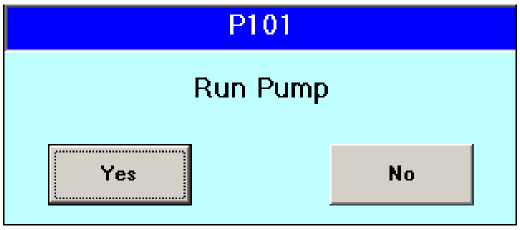


Figure 9 – Confirmation Message for Pump Starting

5.5.2 Running Pumps in Independent Mode

When a pump cylinder is set to an independent operating mode, the cylinder direction is set to either deliver or fill by entering a positive (deliver) or negative (fill) flow rate, as desired. If fluid is to be taken into the pump cylinder, the flow rate is set to negative value. If fluid is to be delivered out of the pump cylinder, the flow rate is set to positive value.

In independent operating modes, the user also needs to set the positions of the tank and process valves. These valves can be opened or closed depending on the flow direction. If the fluid is to be taken into the pump cylinder, the tank valve is opened and the process valve is closed. If fluid is to be delivered out of the pump cylinder, the tank valve is closed and the process valve is opened.

5.5.3 Running Pumps in Dual Mode

When the pump cylinders are set to a dual operating mode, all valve operations will be automatically set and controlled by the pump controller. The user does not need to preset the valves to achieve proper operations.

When operating in a dual operating mode, starting one of the pump cylinders in the pair starts the cylinder pair. One of the cylinders becomes the active pump cylinder while the other becomes the passive cylinder until the first switchover. The direction of the active pump cylinder is automatically determined by the sign of the inputted flow rate.

For positive flow rate (delivery mode), the active pump cylinder delivers first and the standby pump cylinder fills. For negative flow rate (fill mode), the active pump cylinder fills first and the standby pump cylinder delivers.

For example, if you want to start a pump cylinder in dual constant rate delivery operation and start with cylinder 1, it will be the active pump cylinder and will deliver first with its process valve open and its tank valve closed. Cylinder 2 will be the standby pump cylinder and will fill first with its tank valve open and its process valve closed. When cylinder 1 has delivered all of its fluid and is empty, it will switch with cylinder 2. Cylinder 1 becomes the standby pump cylinder and Cylinder 2 become the active pump cylinder.

Dual Constant Pressure operating mode runs at a constant pressure by switching between delivering and filling to maintain the set pressure. The valves will automatically switch as required. Please note that for constant pressure operation, the actual pressure, compared to the set point, determines the direction of the pump cylinder.

5.5.4 Tank and valves

The tank and process valves are important for the successful operation of the different operating modes. The software colour codes the tank and process valve buttons: **green** when the valve is open and **grey** when the valve is closed. The tank and process valves are opened or closed depending on the operating mode chosen and whether the pump cylinder is delivering or receiving fluid.

To fill a pump cylinder, the tank valve needs to be open and the process valve needs to be closed, so that fluid can enter the pump as the piston retracts. The opposite holds true for fluid delivery. Please refer to the fluid flow diagram shown here.

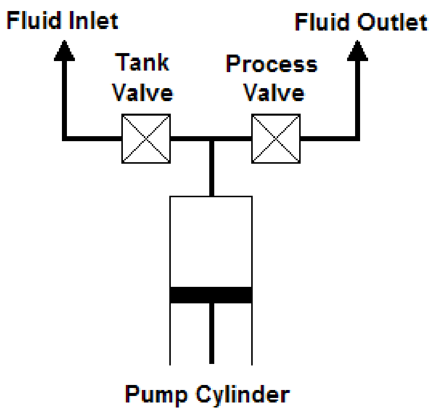


Figure 10 – Standard Pump Cylinder Piping

For single constant rate and constant pressure operating modes, the user manually sets the valves to open or close as desired. For dual constant rate/pressure and confining operating modes, the valves are automatically opened or closed, as needed, for proper pump operation.

Click on the valve button of the appropriate pump cylinder to open or close the valve. You will have to confirm by clicking **Yes** or **No**:

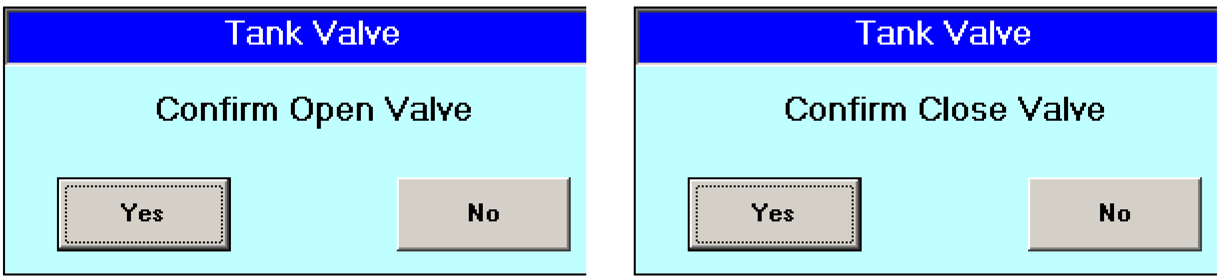


Figure 11 – Confirmation Message for Valve Actuation

Note that the software colour codes for valves button are **green** when the valve is open:

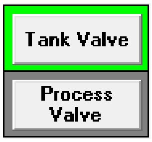


Figure 12 – Tank and valve Buttons. In this case the tank valve is open.

5.6 Piston Position

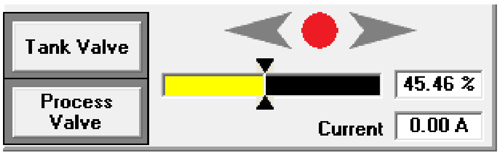


Figure 13 – Piston Position

The piston position field is a visual display of the position of the piston. The run conditions field (described in 'run Condition' section) is a written description of the action of the piston. By watching the piston position and motion status fields, a user can know each piston's location and its actions.

The piston position field is a graphic representation of each pump cylinder's piston moving in and out of the cylinder barrel. The white portion of this field represents the piston; the yellow portion represents the fluid in the cylinder barrel. As the piston extends into the cylinder barrel, it is shown moving towards the left. Thus, this display is 'read' from right to left.

The piston can be fully retracted, called pump **FULL**; fully extended, called pump **EMPTY**; or somewhere in between.

- In the empty position, the piston is fully extended into the cylinder barrel and the white portion on the piston position display extends all the way to the left side of the Piston Position field, showing a nearly solid white box.

- When at full position, the piston is fully retracted out of the cylinder barrel and the piston position box displays only a small white area on the right-hand edge.

5.7 Running Conditions

5.7.1 Emptying/Extending

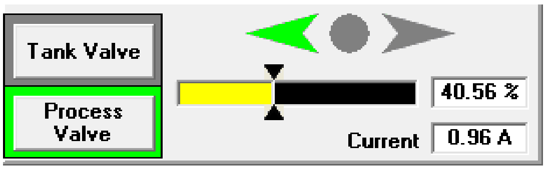


Figure 14 – Extending Condition

The piston is in the process of extending, or moving forward, into the cylinder barrel. As the piston extends, fluid is displaced out of the chamber via the outlet, i.e. fluid delivery.

5.7.2 Filling/Retracting

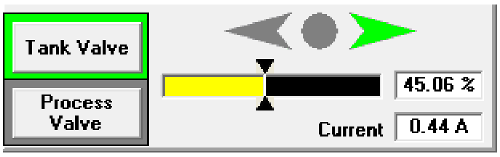


Figure 15 – Filling Condition

The piston is in the process of retracting, or moving backwards, withdrawing from the cylinder barrel. As the piston retracts, the chamber pressure decreases causing the tank fluid to be drawn in through the inlet, i.e. fluid receipt.

5.7.3 Standby

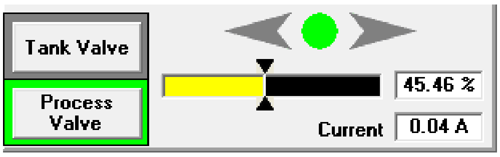


Figure 16 – Stand-by Condition

The piston is in the process of stopping and is slowing down. Usually, the duration of this sequence is relatively short.

5.8 Pump Data

5.8.1 Volume

The cylinder Volume field displays the remaining volume with respect to the piston position either when the controller was turned on or when the cylinder volume was reset. The default volume unit is the milliliter (1 ml = 1 cc). The decimal accuracy is set to 4 digits by default. Please ask for other accuracy.

5.8.2 Displaced Volume

The Displaced Volume field displays the displaced volume with respect to the piston position either when the controller was turned on or when the cylinder volume was reset. The default volume unit is the milliliter (1 ml = 1 cc). The decimal accuracy is set to 4 digits by default. Please ask for other accuracy.

Note that the Displaced Volume field displays the combined pumped volume for the pump cylinder pair. This information is valid only when pump cylinders are operating in the Dual operating mode, with one fluid continuously pumped alternatively by two pump cylinders. The unit of measure used for cumulative volume must be the same as that used for cylinder volume.

The Current Displayed Volume can be zeroed by clicking the '**Reset**' button. You will have to confirm by clicking **Yes** or **No**:

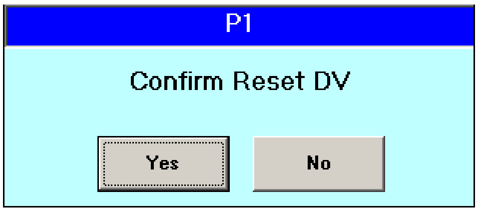


Figure 17 – Confirmation Message for DV Zeroing

5.8.3 Pressure

The current Pressure field displays the current pressure inside the cylinder barrel. This measurement is taken from a pressure transducer. Each pump cylinder has one pressure transducer connected to it. The current pressure of each pump cylinder is displayed on the main window.

The default unit for pressure is pounds per square inch (psi).

<u>The user cannot change the unit of measure displayed after ordering the pump. This must be defined BEFORE ordering the pump.</u>

5.8.4 Flow Rate

The current Flow Rate field displays the rate at which the pump cylinder is filling or delivering.

The default unit for flow rate is milliliter per minute (ml/min or cc/min).

<u>The user cannot change the unit displayed after ordering the pump. This must be defined BEFORE ordering the pump.</u>

5.8.5 Temperature (option)

The current Temperature field displays the temperature of the pump only if the pump is equipped with a heating system.

The default unit for temperature is degree Celsius.

<u>The user cannot change the unit displayed after ordering the pump. This must be defined BEFORE ordering the pump.</u>

5.8.6 Pump Mode Bar

It shows the operating mode selected for the pump (see next section for mode operation details).

5.8.7 Entering a Value

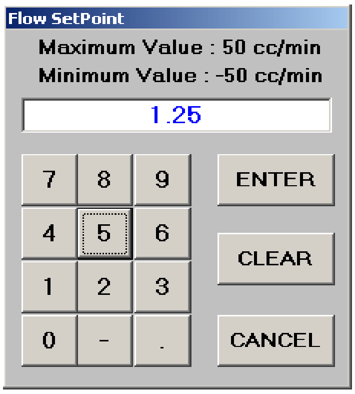


Figure 18 – Numerical Key Pad

A numerical key pad will pop up every time the software asks for an input. The value must be inside the limits. Press ‘**Enter**’ to validate.

5.9 Operating Modes

An operating mode is grayed if not available. To choose an operating mode:

- Click on the operating mode button for a particular pump cylinder. These buttons are located in the Controls window as shown on the next page. Your pump immediately switches to the selected operating mode.

The Supplier strongly recommends that you become familiar with all of the operating modes. A description of each operating mode follows. Moreover, all operating modes should be clearly understood before running any pumps.

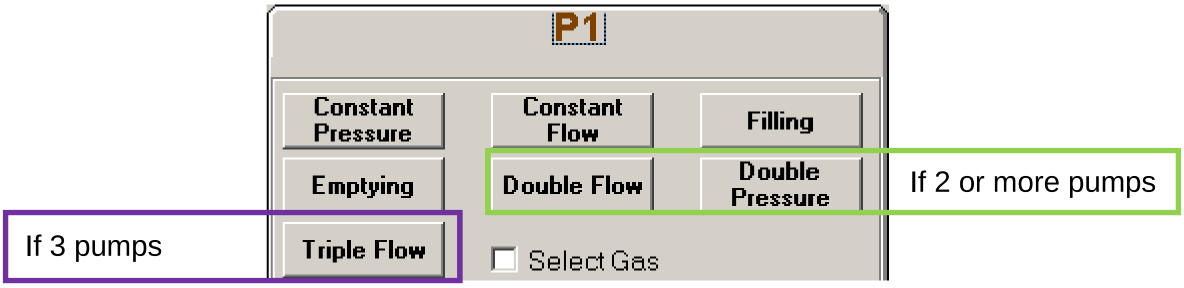


Figure 15 – Operating Modes Window

The modes for 1 or more pumps are:

- Constant Pressure
- Constant Flow
- Filling the Pump
- Emptying the Pump

In this case the pumps can be independently controlled

The modes for 2 or more pumps are:

- Double Flow
- Double Pressure

The mode for 3 pumps is the Triple Flow.

5.9.1 Single Pump – Constant Pressure

In this mode, a single pump cylinder is operated in constant pressure mode at a user-set pressure. When a pump cylinder is operated in this mode, the piston will either extend or retract for one piston stroke. The user sets the valves and restarts the pump cylinder for each piston stroke. The direction of the piston (extending or retracting) is determined by whether the pump must pressurise (piston extends) or depressurise (piston retracts) in order to achieve the specified pressure level.

The set pressure field allows a user to instantaneously change the set pressure of a pump cylinder operating at constant pressure. The pressure entered automatically becomes the set pressure. Even if it is changed during the operation, the system rapidly adjusts to the new pressure without interrupting the process.
Click on the '**Constant Pressure**' button in the '**Controls**' window:

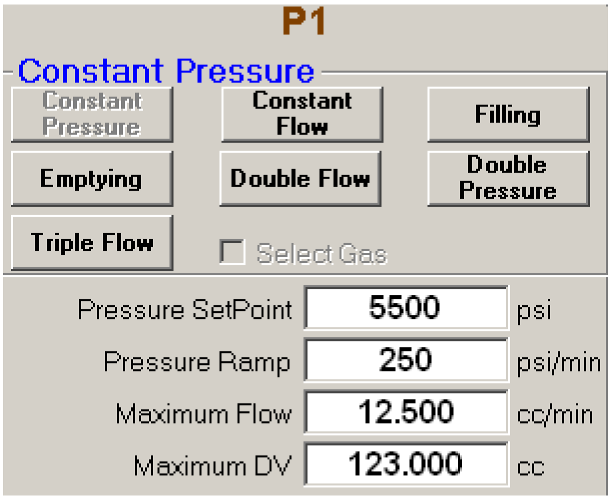


Figure 20 – Single Pump Constant Pressure Window

Pressure Set Point:	is the pressure set point at which the pump will work.
Pressure Ramp:	is the ramp pressure set point, which is the pressure variation limit (here in psi/min). Setting 0 deactivates the function: the pressure variation depends only on the PID parameters (see Parameters section).
Maximum Flow:	is the maximum flow rate set point, which is the flow limit (here in cc/min). Setting 0 deactivates the function: the flow rate depends only on the PID parameters (see Parameters section).
Maximum DV:	is the displaced volume at which the pump stops when reached. Setting 0 deactivates the function.

After entering the desired values, you can start the pump by clicking the '**Run**' button.

Note that in this mode, if the pump is pressurised, the pump will not start if its position doesn't allow displacement in each direction.
Favorite start with either ambient pressure or a middle piston position..

5.9.2 Single Pump – Constant Flow

In this mode, a single pump cylinder is operating in constant flow mode at a user-set rate. When a pump cylinder is operated in this mode, it either delivers or fills for only one piston stroke. The user sets the valves and restarts the pump cylinder for each piston stroke. The direction of the piston (extends or retracts) determined by the sign of the flow set point: positive flow means piston extending, negative flow means piston retracting.

The set flow rate field allows a user to instantaneously change the set flow rate of a pump cylinder operating at constant flow rate. The flow rate entered automatically becomes the set flow rate. Even if it is changed during operation, the system rapidly adjusts to the new flow rate without interrupting the process.
Click on the '**Constant Flow**' button in the '**Controls**' window:

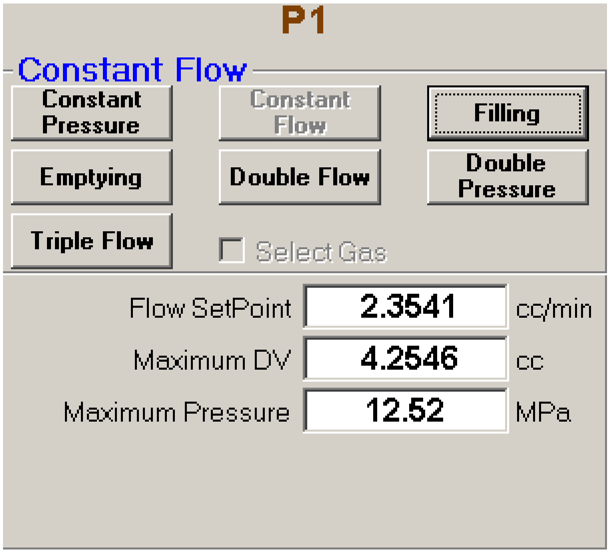


Figure 21 – Single Pump Constant Flow Window

Flow Set Point: is the flow rate set point at which the pump will work.

Maximum DV: is the displaced volume at which the pump stops when reached. Setting 0 deactivates the function.

Maximum Pressure: is the pressure limit. The pump will deliver fluid but will stop if it reaches the limit pressure. If you enter 0, the pump will not deliver. Note that the maximum pressure is always active (Factory Set).

After entering the desired values, you can start the pump by clicking the '**Run**' button.

Note that in this mode, if there is a DV, if the pump is stoped, the DV is still effective for the next start of the pump. To unlock it, enter DV=0 before modifying the DV

5.9.3 Filling the Pump

In this mode, a single pump cylinder is refilling from the tank. When a pump cylinder is operated in this mode, the piston retracts for one stroke.
Note that the tank valve is automatically operated (if present). To avoid a water hammer, the pump will decompress the fluid before opening the valve.

Click on the '**Filling**' button in the '**Controls**' window:

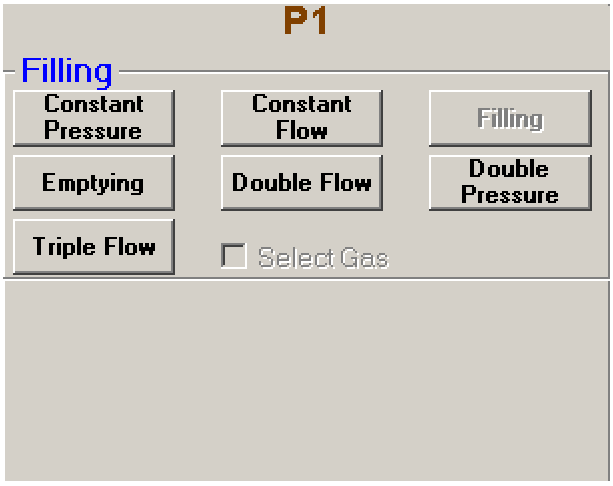


Figure 22 – Filling Window

Then, you can start the pump by clicking the '**Run**' button.

5.9.4 Emptying the Pump

In this mode, a single pump cylinder is emptying to the tank. When a pump cylinder is operated in this mode, the piston extends for one stroke.
Note that the tank valve is automatically operated (if present). To avoid a water hammer, the pump will decompress the fluid before opening the valve.

Click on the '**Emptying**' button in the '**Controls**' window:

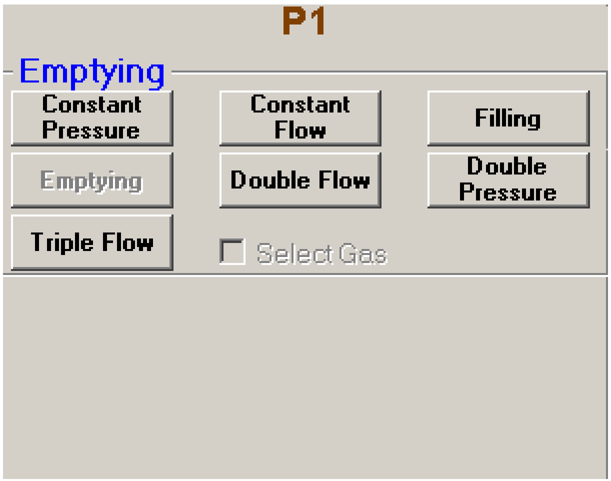


Figure 23 – Emptying Window

Then, you can start the pump by clicking the '**Run**' button.

5.9.5 Double Pump – Double Flow

In this mode, a pair of pump cylinders continuously delivers fluid at a constant rate, as set by the user. Fluid pressure is determined by the pressure drop across the experiment. The pressure in the standby pump cylinder is brought to the delivery pressure of the active pump cylinder before switchover, so to maintain a pulse less flow. The user sets a flow rate when this mode is selected. During the refill (standby) stroke, the rate is determined by the return rate factor, which cannot be higher than one – half of the maximum flow rate.

The set dual constant flow rate field allows a user to instantaneously change the set flow rate of the dual cylinders operating at constant flow rate. The flow rate entered automatically becomes the set flow rate. Even if it is changed during operation, the system rapidly adjusts to the new flow rate without interrupting the process.

Click on the '**Double Flow**' button in the '**Controls**' window:

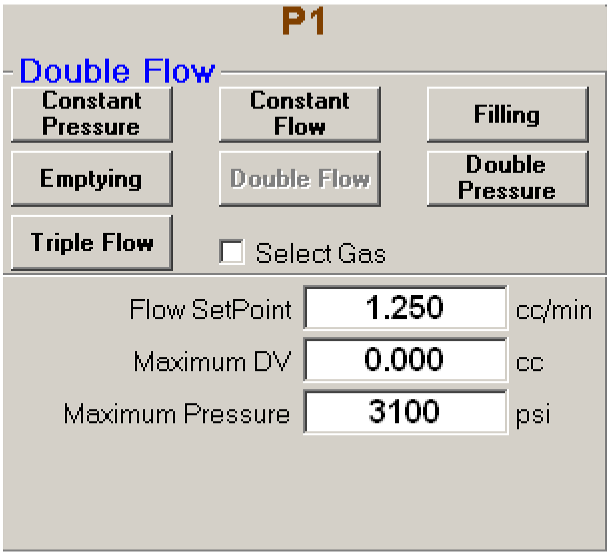


Figure 24 – Double Pump Continuous Flow Window

Flow Set Point: is the flow rate set point at which the pump will work.

Maximum DV: is the displaced volume at which the pump stops when reached. Setting 0 deactivates the function.

Maximum Pressure: is the maximum pressure set point, which is the pressure limit. The pump will deliver fluid continuously but will stop if it reaches the limit pressure (too high rate through a porous media, for instance).

Note that in this mode, it is recommended to start with both cylinder in a middle position and at ambient pressure

Note that in this mode, the maximal recommended flow rate should be 1/3 of the maximum flow rate in single mode

5.9.6 Double Pump – Double Pressure

In this mode, a pair of pump cylinders continuously delivers fluid at constant pressure, as set by the user. The flow rate varies as needed to maintain that pressure. Specify a set pressure when selecting this mode. In this mode, the piston is at the halfway point at switchover, and will either deliver or receive fluid to maintain the specified pressure level. The maximum continuous delivery or receive rate for this mode is one – half of the maximum rate because the piston has only half of the full piston stroke available.

The set dual constant pressure field allows a user to instantaneously change the set pressure of the dual cylinders operating at constant pressure. The pressure entered automatically becomes the set pressure. Even if it is changed during operation, the system rapidly adjusts to the new pressure without interrupting the process.

Click on the '**Double Pressure**' button in the '**Controls**' window:

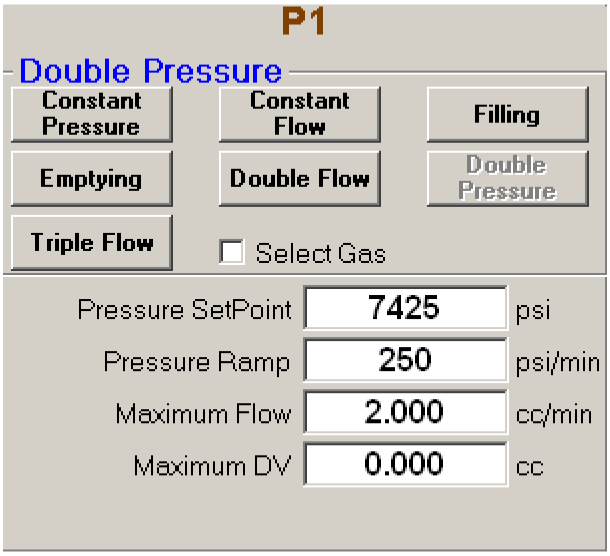


Figure 25 – Double Pump Continuous Pressure Window

Pressure Set Point: is the pressure set point at which the pump will work.

Pressure Ramp: is the ramp pressure set point, which is the pressure variation limit (here in psi/min). Setting 0 deactivates the function: the pressure variation depends only on the PID parameters (see Parameters section).

Maximum Flow: is the pressure set point at which the pump will work.

Maximum DV: is the displaced volume at which the pump stops when reached. Setting 0 deactivates the function.

> Note that in this mode, if the pump is pressurised, the pump will not start if its position doesn't allow displacement in each direction.
> Favorite start with either ambient pressure or a middle piston position.

5.9.7 Triple Flow

In this mode, three pump cylinders are operated at the same time in order to continuously recirculate fluid in a closed system at a constant rate, as set by the user. Fluid pressure is determined by the pressure drop across the experiment, or by an external pumping system. In this mode, as one piston extends, another retracts, and the third is stationary (standby).

The pressure in the standby pump cylinder is brought to the delivery (or receiving) pressure of the active pump cylinder before switchover to reinforce the pulse less aspect of the flow. The user sets a flow rate when this mode is selected.

To begin operating the three-cylinder system in this mode, place the three pump cylinders as follows (from left to right cylinder):

1st cylinder (left): 50% of maximum capacity
2nd cylinder (middle): 5% of maximum capacity (almost empty)
3rd cylinder (right): 95% of maximum capacity (almost full)

The set flow rate field allows a user to instantaneously change the set flow rate of the three-cylinder system. The flow rate entered automatically becomes the set flow rate. Even if it is changed during operations, the system rapidly adjusts to the new flow rate without interrupting the process.

Click on the '**Triple Flow**' button in the '**Controls**' window:

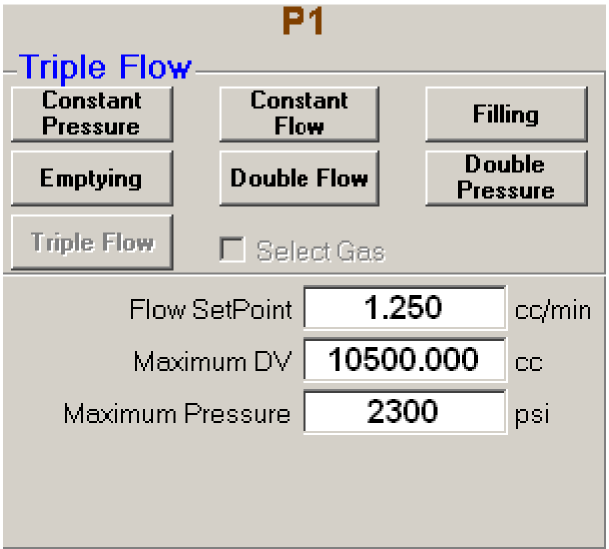


Figure 26 – Triple Pump Continuous Flow Window

Flow Set Point: is the flow rate set point at which the pump will work.

Maximum DV: is the displaced volume at which the pump stops when reached. Setting 0 deactivates the function.

Maximum Pressure: is the maximum pressure set point, which is the pressure limit. The pump will deliver fluid continuously but will stop if it reaches the limit pressure (too high rate through a porous media, for instance).

5.10 Calibration

From the main window, you can click on '**Calibration**' to access the pressure sensor, volume and temperature calibration as well as the PID pressure control parameters:

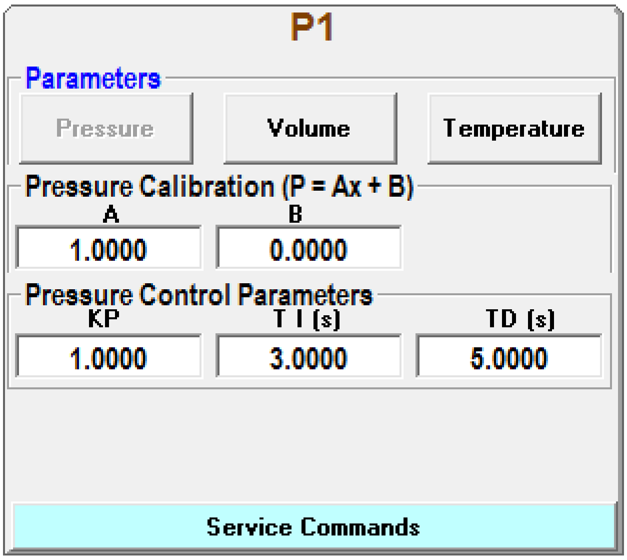


Figure 27 – Parameters Access Window

5.10.1 Pressure Sensor Calibration

All the analog inputs may be adjusted by entering the correct **Gain/A** and **Offset/B** values. Enter the correct values in the fields after calibration has been made (see 'Calibrating the Pressure Transducer' section).

The calibration is calculated as follows: Calibrated_Value = **A** x Raw_Value +**B**

Coefficients A and B may be calculated from the following graph:

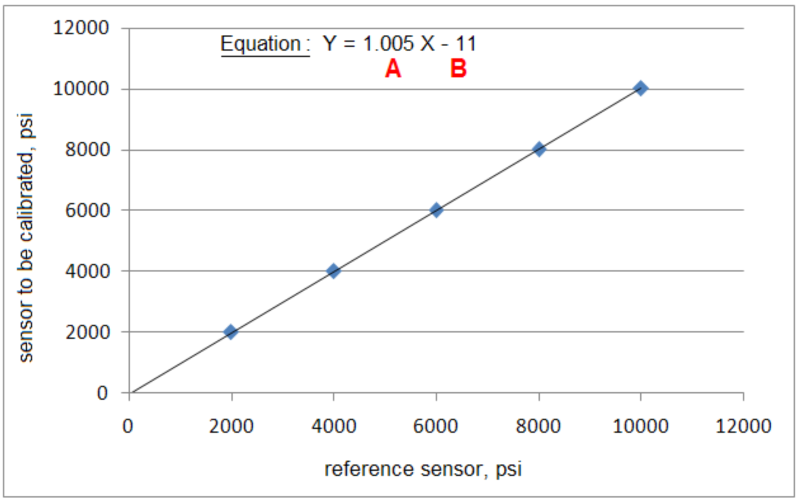


Figure 28 – Linear Regression for Calibration Procedure

5.10.2 Pressure Control Calibration

The algorithm for pressure regulation uses the following standard equation:

$$u(n) = u(n-1) + K_p [e(n) - e(n-1)] + K_i . e(n). Te + K_d/T_e [e(n) - 2e(n-1) + e(n-2)]$$

with: u = output signal
e = error (set point – measure)
T_e = sampling time
K_p, K_i, K_d = PID parameters (Proportional, Integral, Derivative)

You may adjust the pressure regulation by changing the PID parameters. The default values are P = 1, I = 0, D = 0 for a closed circuit (the most frequently met conditions) and P = 1, I = 2, D = 1 for an open circuit. These values ensure a good regulation for a large process condition.

CHANGING THE PID VALUES CAN MAKE THE PRESSURE REGULATION BECOME ERRATIC WITH LARGE OVERSHOOT. IN THAT CASE, YOU MAY BLOW OUT THE RUPTURE DISC. IT IS RECOMMENDED TO KEEP THE PID VALUES AS THEY ARE WHEN RECEIVING THE PUMP.

5.11 Service Commands

From the '**Calibration**' window, you can click on '**Service Commands**' to access the window as shown below:.

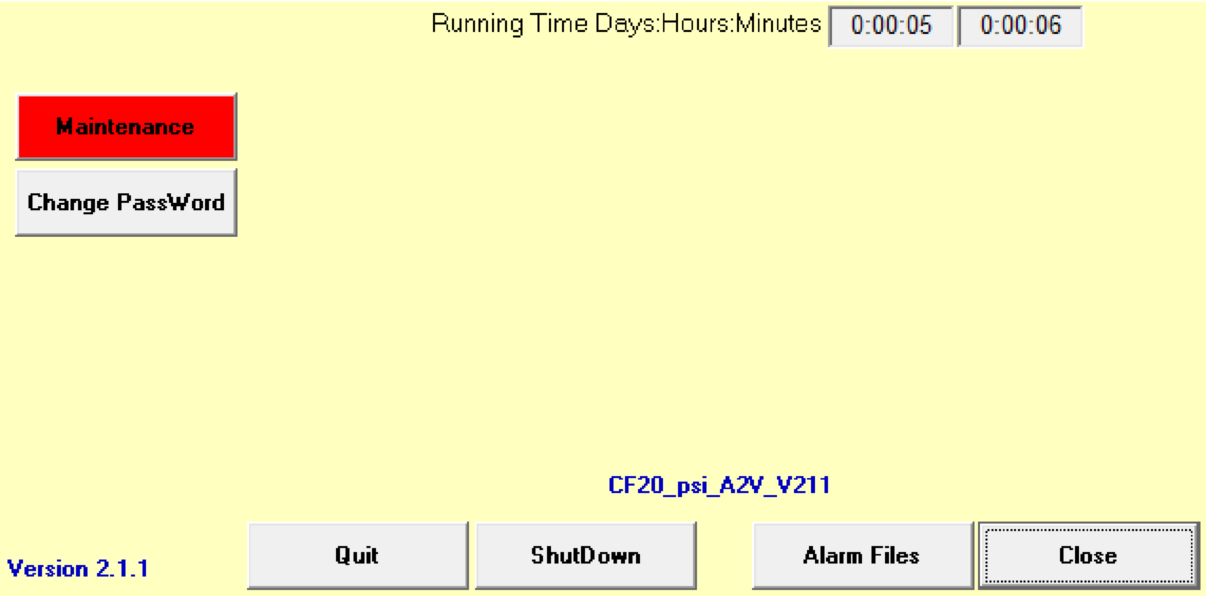


Figure 29 – Service Commands Window

5.11.1 Change Password

Use this button to change the password needed to access certain of these buttons: enter the old password, then the new one.

5.11.2 Quit

The '**Quit**' button allows you to quit the pump control software and return to the Microsoft desktop window. Do it before power off the pump.

5.11.3 Shut Down

The '**Shut Down**' button allows you to quit the pump control software and to turn off the computer. Do it before power off the pump.

5.11.4 Alarm Files

The '**Alarm Files**' button allows you to display the following window (see next page):

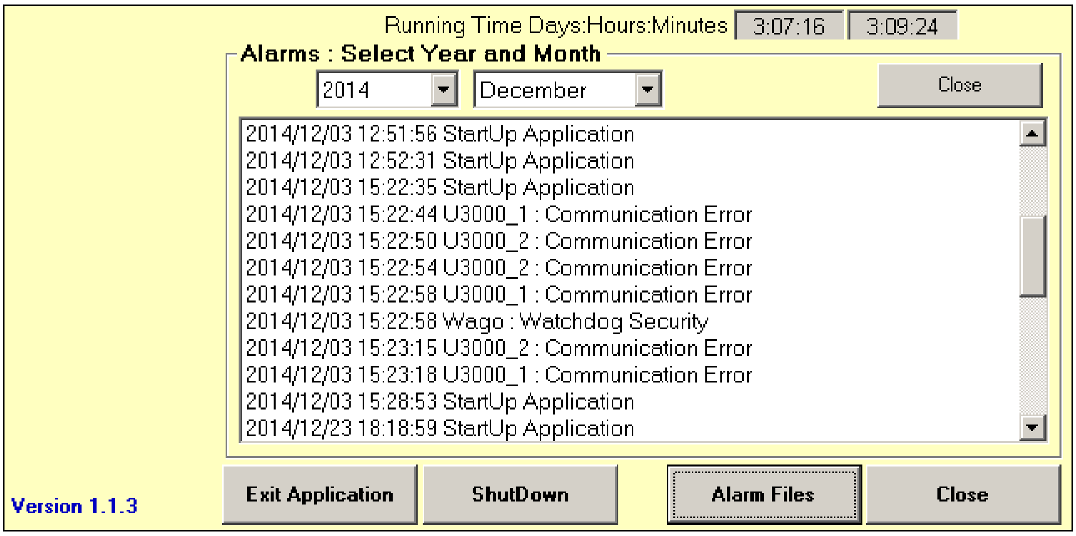


Figure 30 – Alarm Files Window

You can see all alarm files recorded since the beginning of the pump's life. Files are sorted by the **Year** and the **Month** in the scrolling menus.

Note that the running time of all pumps connected to the software is displayed in the upper right corner of the window. If the software is running but the pump is stopped, the pump's running time will not count.

5.11.5 Close

Use this button to close this window and go back to the main window.

5.11.6 Other Parameters (password protected)

Other parameters are password protected and reserved to the Supplier engineers because those parameters are critical for proper operation, e.g. PID control for pressure regulation. To access these parameters, please contact the Supplier.

6 Pump Evaluation

This chapter explains important evaluation procedures for the Pump Series. As the pumps can reach extremely high pressure, it is critical to periodically evaluate their condition. By performing the pump checkout procedures, each part of the pump is carefully examined to confirm a safe operation.

NOTE: a new pump will not contain any liquids inside. The system evaluation can be performed without adding fluid. After they are completed, instructions for fluid addition will be discussed.

If your pump has already been in use, you may do these assessments even with fluid inside, but with prudence, as pressure can build very rapidly.

6.1 When to Perform a Pump Evaluation?

You should perform the pump evaluation procedures in each of the following situations:

1. When a pump is first received. Although all pumps are carefully checked out before shipment, a system checkout is necessary to ensure that no damage has occurred during shipping.

2. After making any changes or adjustments to any part of the pump, or any of its connections. A pump checkout is required after moving or reconfiguring your pump or making any adjustments that require you to disconnect/reconnect, the cables or plumbing.

3. If the pump has not been operated for more than three months. If you have not operated your pump for three months or more, a pump checkout is required. If you are in doubt how long it has been since the pump was last operated, perform a pump checkout.

6.2 Connections

To operate the pump, all cable and plumbing connections must be correctly assembled, otherwise the system can malfunction. For example, if the pump's case has been opened and any cables disconnected, it is critical that they are properly reconnected. Typical connections are shown in Figure 3.1:

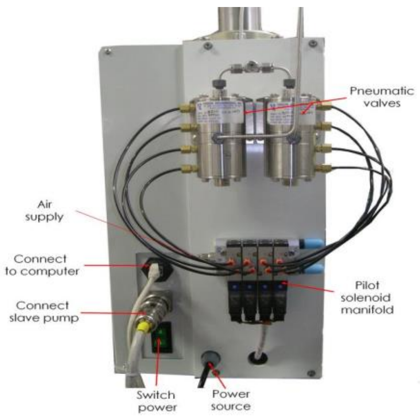


Figure 3 – Typical Pump Connections (back side)

6.2.1 Plumbing

A fluid plumbing tee is connected to the cylinder barrel and to the tank & process valves. The other side of each valve is connected to the fluid inlet or the fluid outlet tee by virtue of a fluid plumbing.

Trace all fluid plumbing connections to make sure the fittings are properly tightened. If any, make sure the screws holding the valve fluid tees to the cylinders are tightened. Check that you have a fluid source and a fluid outlet sink or container, make sure all the fittings are correctly tight.

6.2.2 Remote Computer

If you are using a remote computer to control the pump, follow the procedure below to make sure the computer is properly connected to your pump system:

- Connect an Ethernet cable between the computer and the pump.

- Check that the remote computer IP Address is 192.168.1.100 and the Sub Mask is 255.255.255.0 as all pumps have an IP Address ranging from 192.168.1.101 to 192.168.1.160.

6.3 Valves

This is only valid if the fluid valves are air-operated. The pilot solenoids control the air flow via electric signals from the TPC or computer: they are normally located on a manifold near the valves. There are two pilot solenoids for each valve. Pilot solenoids open/close the fluid inlets inside the valves. The pilot solenoid manifold takes in air from the user’s air supply and distributes it to the pilot solenoids.

At this point, it is assumed that the conditions below are true:

- ✓ The pump is turned ON.
- ✓ The user can control the valves either by the TPC or by the remote computer.
- ✓ The air supply is ON.

Open and close each valve sequentially. Listen for an ‘air escaping’ sound when the pilot solenoid opens and closes. The sound should be easy to hear. The clicking sound you may hear is simply the pilot solenoid opening or closing. The depressurisation sound is the same as when you open a can or bottle that is under pressure and you hear an immediate gust of air. It is important that you hear this sound when the pilot solenoid opens and closes.

If you do not hear the ‘air escaping’ sound when each valve is opened and closed, then the air supply pressure is inadequate. Go back and check that your air tubing has been connected properly and that it is securely attached. If your air supply has a switch to turn it on, make sure the switch is turned on.

6.4 Filling the Pump

If your pump does not have liquid in it, add it at this point. Complete the following procedure for each pump cylinder you wish to fill.

1. Connect the fluid inlet to a fluid supply and connect the fluid outlet to a drain or a container.

2. Set the '**Flow Set Point**' rate to about 30 percent of the maximum flow rate.

   NOTE: to *REFILL* the pump cylinder (retract), enter a *NEGATIVE* flow rate; to *EMPTY* the pump cylinder (deliver), enter a *POSITIVE* flow rate.

   To set the flow rate, do the following:

   - ✓ From the software, select '**Controls**' then, '**Mode Flow**'.
   - ✓ In the '**Flow Set Point**' text box, enter the flow rate at about 30% of the maximum flow rate. For example, entering '-20' will refill the pump at 20 cc/min while entering 15 will empty the pump at 15 cc/min.

3. If the pump cylinder is full, then go on to #4. If the pump cylinder is not full, then open the '**Tank Valve**', close the '**Process Valve**' and start the pump cylinder to initiate the filling process.

4. Make sure the fluid outlet plumbing is connected to a drain or a container. When the pump cylinder is full, close the '**Tank Valve**', open the '**Process Valve**' and start the pump cylinder.

5. On the first pumping stroke, mostly air is delivered out of the fluid outlet. You may start to see liquid coming out of the tubing by the end of the first piston stroke. If you put your fluid outlet into a liquid container, you will see bubbles when the air comes out of the fluid outlet. To check if fluid is coming out of the plumbing, lift the fluid plumbing slightly out of the liquid, but leaving it inside the container. Watch for fluid droplets at the tubing outlet.

6. When the pump cylinder is empty, close the '**Process Valve**', open the '**Tank Valve**' and start the pump. Wait until the pump cylinder is full and stops. The pump cylinder will be pulling in fluid. If the fill container is small enough, the user may observe the fluid level start dropping as fluid is pulled into the pump cylinder. On the next forward piston stroke, the pump cylinder should deliver fluid.

7. Repeat this procedure again until you reach a piston stroke where no air bubbles come out, only liquid. End with full cylinder stroke. The cylinder barrel is now full of fluid and all air is flushed out.

8. Repeat this procedure for each pump cylinder in your system, resulting in all pump cylinders being full of fluid.

6.5 Pressure Transducer Check

Because the Pump Series can reach extremely high pressures very quickly, it is absolutely essential that the pressure transducers be thoroughly checked. To check them, please read the note below, then follow the procedure.

NOTE: At this point both pump cylinders need to be full of fluid. Close both the '**Tank Valve**' and '**Process Valve**' for pump cylinder using the TCP or the remote computer.

> **When performing the pump cylinder check,**
> **<u>STOP THE PUMP CYLINDER</u>**
> **if pressure does not start to increase after about 10 seconds.**

To perform the Pressure Transducer Check, do the following:

1. Set the pressure to 500 psi (35 bar).

   To set the pressure, do the following:

   - ✓ From the software, select '**Controls**' then, '**Mode Pressure**'.
   - ✓ In the '**Pressure Set Point**' text box, enter the desired pressure.

2. Start the pump cylinder. Watch the current pressure reading until it reaches 500 psi (35 bar). If the pump cylinders are filled with fluid, this should occur with about 1 ml of fluid pumped otherwise there is a fluid leak.

3. Increase the pressure set point by 1000 psi increment until the maximum pressure and go on to #2.

4. Repeat this procedure for all the pump cylinders in your system.

If you had to stop the pump cylinders because the pressure did not start to increase within 10 seconds, the most likely reason is:

- <u>Insufficient Fluid in the Pump</u>. This can be caused by:

  - ☑ An Air Leak in the fluid tubing.
  - ☑ The Fluid inlet tubing is clogged, so no fluid can enter the pump.
  - ☑ Fluid is too viscous, or thick, to be pulled into the pump.

Go through the pump and check all of the air fitting connections to make sure they are tight. If the fittings are all tight, go back to 'Connection' section and 'Filling the Pump' section. When finished, try the Pressure Transducer Check again.

- <u>The Pressure Transducer has malfunctioned</u>. This can be caused by:

  - ☑ The pressure transducer is broken and not reporting the pressure.
  - ☑ The pressure transducer is cross-wired.

To check this, open the '**Tank Valve**' and listen for pressure being released. If there is pressure being released, you probably do have a pressure transducer failure or the pressure transducer is cross-wired.

NEVER operate the pump if you have any reason to believe that a pressure transducer or a pump controller is malfunctioning!

Do not proceed further until your pump system has passed all checks!

7 Safety

7.1 Requirements

BEFORE ATTEMPTING TO OPERATE THE PUMP, THE OPERATOR SHOULD READ AND UNDERSTAND THIS MANUAL.

All pumps are designed for operator safety. Any instrument that is capable of high temperatures and pressures should always be operated with **CAUTION!**

To ensure safety:

- Locate the pump in a low-traffic area.
- Post signs where the pump is being operated to warn non-operating personnel.
- Read and understand the instructions before attempting instrument operations.
- Observe caution notes!
- Observe and follow the warning labels on the instrument.
- Never exceed the instrument maximum temperature and pressure ratings.
- Always disconnect main power to the instrument before attempting any repair.
- Turn off the heater at completion of each test.
- Appropriately rated fire extinguishers should be located within close proximity.

ALL PUMPS ARE CALIBRATED AND TESTED PRIOR TO SHIPMENT.

7.2 Overpressure

All pumps are restrained from reaching excessively high pressures by a digital overpressure safety feature, which is set and monitored by the pump controller. Note that only the safety pressure at a level higher than the expected run pressure is specified. If the pump reaches the factory-set safety pressure, a digital overpressure error message is displayed on the pump controller and stops the pump cylinders. For example, if the safety pressure is set at 10,100 psi, the pump cylinder will stop if pressure reaches or exceeds 10,100 psi.

DUE TO HYSTERESIS PHENOMENA, IF THE PISTON IS MOVING FORWARD AT A FAST RATE, THE PRESSURE MAY EXCEED THE SAFETY PRESSURE BEFORE THE PISTON STOPS.

7.3 Pressure Failure

All pumps have also a safety feature which generates an error message if the pressure transducer current drops below a pre-set level. In this case, the pump controller assumes pressure transducer failure. A pressure sensor error message will be displayed on the status bar of user interface and the pump cylinders will stop pumping.

7.4 Explosion Warning

CAUTION: PUMPS ARE NOT EXPLOSION PROOF!

All pumps must be placed within a properly operating vent hood (fume cupboard), when using methane or any other flammable gas. There must absolutely be NO gas leaks present before introducing the flammable gas in the pump. In a temperature-stable, leak-free system, the flow rate, as registered by the pump, should settle to a value below 0:01 ml/min after 15 minutes during a static extraction. Ensure that all SFE tubing connections are completely free of any gas leaks by performing a leak test using N_2.

All pumps use *brushless* drive motors. Minor modifications to the pumps may render them safer, especially in the rare event of catastrophic piston seal failure. **However, these modifications will not make these pumps explosion proof.**

- Remove the front and back cylinder covers (if any present) located on the cylinder tower. This will allow any escaped gas to quickly dissipate away from the pump cylinder area and to reduce the amount entering the motor compartment.
- Seal the pump motor compartment with tape and purge it with a continuous flow of inert gas, such as nitrogen (N2) gas for example. This will also reduce the possibility of accumulating an explosive mixture around the motor and all electrical connections.
- For further information, call the Supplier and consult its Service Department.

USE THE PUMP IN THESE POTENTIALLY HAZARDOUS APPLICATIONS AT YOUR OWN RISK!

7.5 Supercritical Warning

We want our customers to be aware of the potential hazards involved with supercritical fluid extraction. Oxidizing gases, such as nitrous oxide (NO), in contact with organic matrices or flammable modifiers, can detonate under certain conditions. Likewise, flammable fluids, such as methane, under high pressure conditions can present a hazard.

With concern for the safety of our customers, we have designed our pumps to be as safe as possible. However, we do not recommend the use of our pumps with potentially explosive reactions. Because large numbers of scientists may be exposed to this hazard, we urge that carbon dioxide (CO_2) or other less reactive solvents be substituted.

8 Troubleshooting

The pump has 2 separate cylinders. To isolate the cause of a problem in a multiple cylinder system, cylinders can be compared against each other. Also, the removable parts of the pumps are interchangeable and can also be used to help isolate the cause of a problem.
The removable parts include the cylinder barrel, seal, piston, transducer and valve.
Note that the transducers can be swapped, but will require recalibration if this is done.

An example is as follows: pump cylinder A is leaking, and continues to leak after replacing the seal. The user needs to determine if the problem is the cylinder barrel or the piston. To find out, one could exchange the cylinder barrels between pump cylinders A and B. If the leak moved from pump cylinder A to pump cylinder B, then we know the problem is either the cylinder barrel or the seal that is inside it. If, however, the leak continues in pump cylinder A, then the piston is the most likely source of the leak, i.e. scratch or solid deposit.

8.1 Drive Faults (Allen-Bradley)

When the drive detects a fault, the 7-segment LED on the drive (inside the pump cabinet) displays a flashing E followed by a two-digit error code that registers one digit at a time. The software displays the same error code in the status bar. Double-click the error message to acknowledge the error. The error is continuously displayed until the problem is solved. Most common errors messages are explained in the following Table.

IN CASE OF A WATCHDOG ISSUE: LOOK FOR THE FIRST TWO LED OF THE COMMUNICATION MODULE; THEY ARE THE WATCHDOG INDICATOR LAMPS. FOR FUNCTIONING EQUIPMENT THEY SHOULD ALWAYS BE LIGHT ON (GREEN). IN THE OPPOSITE CASE, TRY TO CHECK THE WIRE INTEGRITY BETWEEN THIS MODULE AND THE DRIVE.

DC BUS CAPACITORS MAY RETAIN HAZARDOUS VOLTAGES AFTER INPUT POWER HAS BEEN REMOVED.
BEFORE WORKING ON THE DRIVE, MEASURE THE DC BUS VOLTAGE TO VERIFY IT HAS REACHED A SAFE LEVEL OR WAIT THE FULL TIME INTERVAL LISTED ON THE DRIVE WARNING LABEL.
FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

Table 1 – List of Drive Faults

Error Code	Problem or Symptom	Possible Cause(s)	Action/Solution

Table 1 – List of Drive Faults			
Error Code	Problem or Symptom	Possible Cause(s)	Action/Solution
E03	Absolute Feedback Range Exceeded	The motor position exceeds +/- 2047 revolutions from the home position (applies only to systems with absolute feedback).	□ Decrease application range of motion. □ Upgrade firmware.
E04	Motor Over Temperature	Motor thermostat trips due to: □ High motor ambient temperature and/or □ Excessive current	□ Operate within (not above) the continuous torque rating for the ambient temperature (40 °C maximum). □ Lower ambient temperature, increase motor cooling.
		Motor wiring error.	Check motor wiring.
		Incorrect motor selection.	Verify the proper motor has been selected.
E09	Bus Under voltage	Low AC line/AC power input.	□ Verify voltage level of the incoming AC power. □ Check AC power source for glitches or line drop. □ Install an uninterruptible power supply (UPS) on your AC input.
E10	Bus Overvoltage	Excessive regeneration of power. When the motor is driven by an external mechanical power source, it may regenerate too much peak energy through the Ultra3000's power supply. The system faults to save itself from an overload.	□ Change the deceleration or motion profile. □ Use a larger system (motor andUltra3000). □ Use a resistive shunt. □ If a shunt is connected, verify the wiring s correct and shunt fuse is not blown.
		Excessive AC input voltage.	Verify input is within specifications.
E18	Over speed Fault	Motor speed has exceeded 125% of maximum rated speed.	□ Check cables for noise. □ Check tuning.
E19	Excess Position Error	Position error limit was exceeded.	□ Increase the feed/forward gain. □ Increase following error limit or time. □ Check position loop tuning.

Table 1 – List of Drive Faults

Error Code	Problem or Symptom	Possible Cause(s)	Action/Solution
E20	Motor Encoder State Error	The motor encoder encountered an illegal transition.	□ Replace the motor/encoder. □ Use shielded cables with twisted pair wires. □ Route the feedback away from potential noise sources. □ Check the system grounds. □ Verify that the unbuffered encoder signals are not subjected to EMI in theCN1 cable. Remove these signals from the CN1 cable if they are not being used. □ Verify that the motor has a high-frequency bond to the drive's enclosure panel. □ Verify that any stage connected to the motor shaft (for example using a ball screw) has a high-frequency bond to the machine frame and the drive's enclosure panel.
		Bad encoder.	Replace motor/encoder.
E21	Auxiliary Encoder state error	The auxiliary encoder encountered an illegal transition.	□ Use shielded cables with twisted pair wires. □ Route the encoder cable away from potential noise sources. □ Bad encoder – replace encoder. □ Check the ground connections.
		Setup time violation for Step/Direction or CW/CCW input.	Check timing of Step/Direction or CW/CCW inputs to determine if setup time requirements are being met.
E22	Motor Thermal Protection Fault	The internal filter protecting the motor from overheating has tripped.	□ Reduce acceleration rates. □ Reduce duty cycle (ON/OFF) of commanded motion. □ Increase time permitted for motion. □ Use larger Ultra3000 and motor. □ Check tuning.
E24	Excess Velocity Error	Velocity error limit was exceeded.	□ Increase time or size of allowable error. □ Reduce acceleration. □ Check tuning.
E26	User-Specified Velocity Fault	User specified velocity level was exceeded.	Increase to a less restrictive setting.
E30	Encoder Communication Fault	Communication was not established with an intelligent encoder.	□ Verify motor selection. □ Verify the motor supports automatic identification. □ Verify motor encoder wiring.
E31	Encoder Data	Encoder data is corrupted.	Replace the motor/encoder.

8.2 Drive Faults (Flexi Pro)

The following table will help you interpret the warning and fault codes, and respond appropriately.

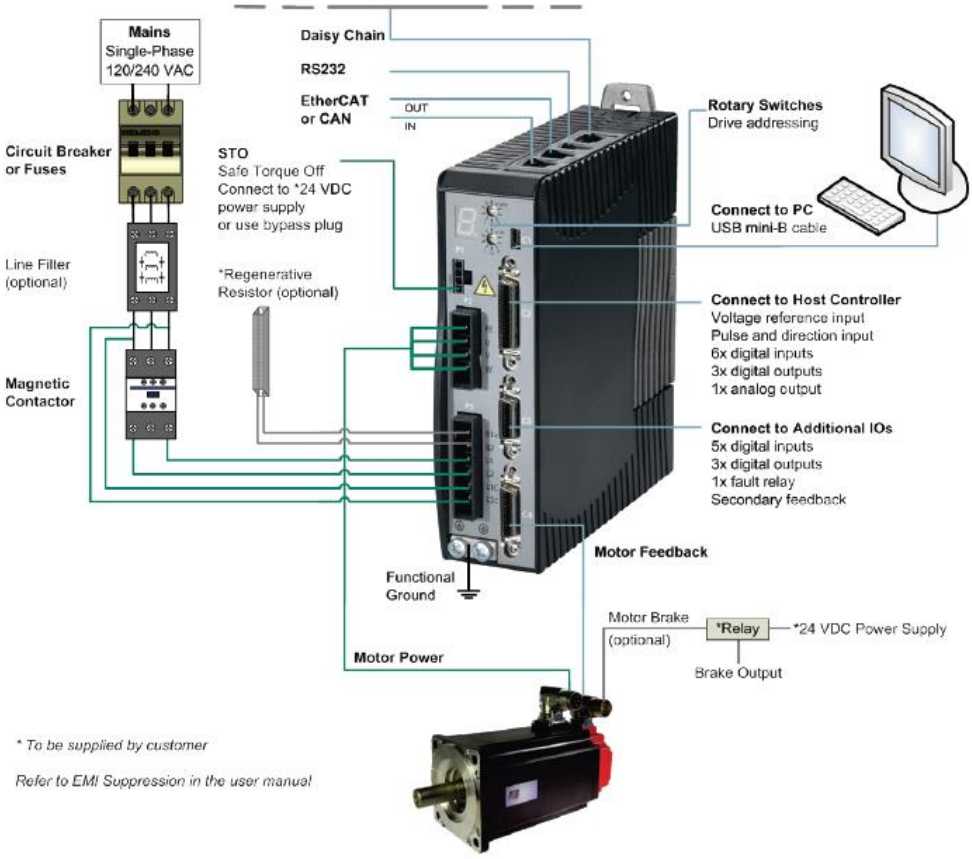
- Display is the code that appears on the drive's 7-segment display (inside the pump cabinet).
- Light distinguishes between a steadily lit character (for warnings) or **a flashing character (for faults).**

table 2 – list of drive faults

Display	Light	Type	Name	Description	Action Required
≡	Flash	Fault	Watchdog Fault	Generally occurs due to an unforeseen circumstance. The drive is inoperable until power is cycled.	Contact technical support.
A4		Fault	CAN Supply Fault	A problem with the internal voltage supply for the CAN bus.	The drive probably needs repair. Contact technical support.
C1		Fault	CAN Heartbeat Lost	Drive detected disconnection between CAN master and drive.	Reconnect master and slave, and power cycle the drive.
e	Flash	Fault	Parameter Memory Checksum Failure	The non-volatile memory used to store drive parameters is empty or the data is corrupted.	Reconfigure the drive, or download the parameter set, and save the parameters.
E	Flash	Fault	Failure Writing to Flash Memory	An internal problem accessing the flash memory. Fatal fault; drive cannot be operated.	Contact technical support.
H	Flash	Fault	Motor Over-Temperature	Either the motor has overheated, or the drive is not set up correctly for the motor temperature sensor.	Check that the drive is configured properly (using THERMODE, THERMTYPE, THERMTHRESH and THERMTIME), and that the motor temperature sensor is properly connected to the drive if needed. If the drive is configured and wired properly, check whether the motor is under-sized for the application.
H	Steady	Warning	Motor Over-Temperature	Motor is overheated.	
J	Flash	Fault	Velocity Over-Speed Exceeded	Actual velocity exceeded 1.2 times the velocity limit. The velocity limit is set using VLIM.	Check that VLIM is set to match the application requirements. Using velocity loop tuning, check for excessive overshoot.
J1		Fault	Exceeded Maximum Position Error	The position error (PE) has exceeded the position error limit (PEMAX)	Change drive tuning to improve position tracking, or increase PEMAX to allow a greater position error.

table 2 – list of drive faults					
Display	Light	Type	Name	Description	Action Required
J2		Fault	Exceeded Maximum Velocity Error	The velocity error (VE) has exceeded the velocity error limit (VEMAX)	Change drive tuning to improve velocity tracking, or increase VEMAX to allow a greater velocity error.
L1		Warning	Hardware positive limit switch is open	Positive hardware limit switch is activated.	
L2		Warning	Hardware negative limit switch is open	Negative hardware limit switch is activated.	
L3		Warning	Hardware positive and negative limit switches are open	Positive and negative hardware limit switches are both activated.	
L4		Warning	Software positive limit switch is tripped	Positive software limit switch is activated. PFB > POSLIMPOS and POSLIMMODE = 1	
L5		Warning	Software negative limit switch is tripped	Negative software limit switch is activated. PFB < POSLIMNEG and POSLIMMODE = 1	
L6		Warning	Software limit switches are tripped	Positive and negative software limit switches are activated. PFB > POSLIMPOS and PFB < POSLIMNEG and POSLIMMODE = 1	
o	Flash	Fault	Over-Voltage	The bus voltage exceeded the maximum value.	Check whether a regen resistor is required for the application.
o15		Fault	Plus 15V Out of Range	The internal +15 V supply is out of range.	The drive probably needs repair. Contact technical support.
o-15		Fault	Minus 15V Out of Range	The internal -15 V supply is out of range.	The drive probably needs repair. Contact technical support.
o5		Fault	5V Out of Range	5V is low or powering off.	May occur during power off. If occurs otherwise, contact technical support.
P		Fault	Over-Current	Over-current at the drive output has been detected. The drive allows this fault to occur up to 3 times in succession. After 3 faults, the drive forces a delay of 1 minute before it can be reenabled.	Check for a short circuit on the motor connection. Check for excessive overshoot in the current loop.
r20		Fault	Feedback Communication Error	Communication with the feedback device did not initialize correctly.	Check that the feedback device is wired correctly. Check that the correct encoder type (MENCTYPE) is selected.

table 2 – list of drive faults					
Display	Light	Type	Name	Description	Action Required
u	Flash	Fault	Under-Voltage	The bus voltage is below the minimum value.	Check that the main AC voltage supply is connected to the drive and is switched on. The under-voltage limit can be read with the UVTHRESH command.
u	Steady	Warning	Under-Voltage	The bus voltage is below the minimum value.	Check that the main AC voltage supply is connected to the drive and is switched on. Verify that the setting of UVMODE is correct.



FLEXI PRO-1D5/FLEXI PRO-003 – Servo System Wiring –120/240 VAC, 1-Phase

8.3 Error Messages

If the software encounters a fault, the user interface displays a message in the status bar. Double-click the error message to acknowledge the error. The error is continuously displayed until the problem is solved. Error messages are explained in the following Table.

Table 2 – List of Software Faults

Message	Problem or Symptom	Action/Solution
"FAULT COMMUNICATION IN/OUT"	No communication with computer	Verify the communication port at the pump backside and if all cables are properly plugged.
"FAULT SENSOR PRESSURE"	The pressure transducer is disconnected or malfunctioning.	Check the transducer cable. Check the 24Vdc power supply.
"FAULT PRESSURE HIGH LIMIT"	The pump pressure is greater than the limit pressure.	Reduce the pressure and adjust the PID values in order to avoid pressure overshoot. If the pump was stopped, check the temperature (temperature increasing build up the pressure).
"FAULT OVERTRAVEL"	The top limit switch was activated.	Run negative flow to free the top switch then, refill the pump completely
"FAULT SENSOR TEMPERATURE"	The temperature probe is disconnected or malfunctioning.	Check the temperature probe.
"FAULT OVER CURRENT"	The intensity needed to rotate the motor is greater than the intensity limit.	Turn off the pump, disconnect all power cable, and check that the free pulley is rotating freely by hand. If yes, contact the Supplier.
"FAULT SENSOR PRESSURE AUX 1"	The auxiliary pressure transducer 1 is disconnected or malfunctioning.	Check the transducer cable. Check the 24Vdc power supply.
"FAULT SENSOR PRESSURE AUX 2"	The auxiliary pressure transducer 2 is disconnected or malfunctioning.	Check the transducer cable. Check the 24Vdc power supply.
"FAULT OVERPRESSURE AUX 1"	The auxiliary pump pressure 1 is greater than the limit pressure.	Reduce the pressure and adjust the PID values in order to avoid pressure overshoot. If the pump was stopped, check the temperature (temperature increasing build up the pressure).
"FAULT OVERPRESSURE AUX 2"	The auxiliary pump pressure 2 is greater than the limit pressure.	Reduce the pressure and adjust the PID values in order to avoid pressure overshoot. If the pump was stopped, check the temperature (temperature increasing build up the pressure).
"FAULT SERVO DRIVE"	No communication with the motor controller	Check the motor status
"WATCHDOG ERROR"	Software communication error	Check RAM usage and Network overload.

8.4 Air Supply Problem

All the air driven pump valves need a CLEAN and DRY air supply between 5 and 7 bar (75 to 105 psi) to properly operate.

8.4.1 No "Air Escaping" Sound

The most likely cause of this problem is a wet air supply resulting in pilot solenoid corrosion and failure. To check this, turn off your air supply, and check if there is any water in the line. If the pilot solenoids have rusted and no longer operate, they will need to be replaced.

Another common issue is an inadequate air pressure (too low or too high) to operate the valves. Use a pressure gauge to determine the air pressure. If the air pressure is too low:

- Check that your air tubing has been connected properly,
- Check that the air supply is on, and
- Check that the air tubing is not clogged.

If the air pressure is too high (more than 7 bar or 105 psi), install an air regulator to limit the inlet pressure.

8.4.2 Constant "Air Escaping" Sound

If you hear a constant "air escaping" sound when the valves are not being operated, then it is likely there is an air leak. The pilot solenoid valves should not leak air when they are operating properly.

- Check each air fitting to see if any fitting is loose.
- Check each air tube to see if it is cracked.
- Try using "Snoop" (soap and water solution) to detect small leaks by making bubbles appear.
- Sometimes a pilot solenoid will get stuck part way open or part way closed and allow air passage. Try opening and closing the valve to get the pilot solenoid unstuck and moved to a fully open or fully closed position. Opening and closing a pilot solenoid a few times may free up a stuck solenoid. If this doesn't work, the pilot solenoid may have to be replaced to permanently fix the issue.

8.5 Fan Does Not Run

Fans are not temperature controlled but continually run. When a pump is powered on, fans come on immediately. If fans do not run when the pump is powered on, check fans through the wire cage and make sure fans blades are not obstructed by some foreign object. You can also check fans power connection - which is inside the pump case.

8.6 Fluid Leaks

Although only high grade materials and components make up the pumps, a fluid leak can still occur. The following sections explain what to do if you have a fluid leak.

8.6.1 Leakage Basics

The pump uses a piston to push fluid out of a cylinder barrel. The fluid is contained in the cylinder barrel by a seal, which is mounted around a piston. For a continuous flow system, valves, pressure transducers and interconnecting tubing and fittings are also required to control the flow of fluid. Any of these components can be the source of a fluid leak.

Detecting a leak can sometimes be difficult. Large leaks in the range of 0.01 ml/min are easy to find since these can be observed by the eye (a typical drop of liquid is about 0.05 ml) or detected with a bubble (snoop) leak detection solution for gases. Smaller leaks in the 0.01 to 0.001 ml/min range or less become more difficult since fluid can evaporate as fast as it leaks. Care and patience are needed to find leaks in this range. If you are using brine, a salt deposit residue is a clear indication of a leak. Extreme care must be used to find leaks below 0.001 ml/min, since many other factors need to be considered as temperature fluctuation for example.

8.6.2 Leak Testing

The pump system can trace volume changes very accurately. Volume measurement combined with pressure measurement can be used to detect fluid leaking.

- To detect a leak in this way, the pump can be pressurised to a set pressure and then stopped, and the pressure can be recorded as a function of time. This is a truly static leak test in that the piston is not moving with respect to the seal.
- Alternately, the pump cylinder can be operated in constant pressure mode and the volume recorded versus time. This is a quasi-static method in that the piston will be making slight motions as the pressure control algorithm operates.
- A third method uses gear mode, without valves, to push fluid from one pump cylinder into the other. This is a truly dynamic leak test of the pump cylinders.

Temperature must be precisely controlled in order to know if a small leak is real or not. Depending on the fluid and its compressibility, temperature changes cause variation in pressure in a closed fluid system. In a typical pump cylinder, pressure can change 50 to 100 psi per degree C. Therefore, if you want to detect small leaks, temperature must be held steady, and even then long tests are usually needed to get reliable data.

Not only does external temperature need to be controlled, time must be allowed for thermal equilibrium of the fluids in the pump system. When a fluid is pressurised, it heats up. This heated fluid inside the pump cylinder then starts to cool down to the cylinder barrel temperature. As it does this, the fluid contracts and the pressure falls. This fall in pressure can look like a fluid leak. Allow at least 15 minutes after pressurization for the temperature to equalize.

When looking for small leaks, there are several other considerations to be aware of. The seal (O-ring) in the system is elastic. With pressure and time it tends to creep, which increases volume in the cylinder barrel and looks like a fluid leak. This problem is most noticeable when a new seal or O-ring is installed, but can also show up in dynamic tests as the seals and rings wear deteriorate.

Other factors that can affect the results of leak tests include pressure transducer drift, fluid property changes, gas bubbles, fluid permeation and absorption into the seal.

8.6.3 Does Your Pump Have A Fluid Leak?

A pump cylinder can be checked for fluid leakage by following the steps below:

1. Fill the pump with the fluid to be tested.
2. Set the pump to constant pressure independent mode.
3. Close both the tank and process valves.
4. Select an appropriate test pressure.
5. Start the pump.

Next the pump will pressurize and hold the set pressure. After allowing for thermal effects to subside (about 15 minutes) set the volume of the pump cylinder to zero and watch for fluid volume changes. If the pump continues to move forward, then there is a leak. By logging the volume versus time, the leak rate can be determined. Any changes in temperature during this test time will also show up as changes in volume, so care must be used in analyzing this data.

8.6.4 Finding Your Leak

If you detect a leak, then the next step is to find it. The most likely place for a leak to occur is at the piston-seal interface or in the valves. Seal leaks are most often caused by particles in the fluid scratching the seal lips. If fluid is leaking from the bottom of your pump, source of the leak is probably the piston seal. Also, if a fluid leak is present but there is no evidence of it at the valve leak ports, or around any of the fluid tubing fittings, then most likely the leak is at the seal. To test more thoroughly without taking the case apart, try removing the fitting of the cylinder barrel and replacing it with a plug, then running the leak test again. If leak continues, then it is almost for sure a piston seal leak. Please refer to" Changing the Pump Cylinder Seals" section. If the leak is no longer present when this test is run, then the leak is most likely in the valves.

Seal generally will have a lifetime of about 1 year. With certain fluids or/and high temperature, seal life decreases. To increase the life of the seals, the following can be done:

- Pump clean fluids whenever possible.
- Filter the fluid being pumped so there are few, if any, solid particles in the fluid.
- If you are pumping brine or other corrosive fluids, do not let them sit in the pump for a longtime. Flush the pump with a clean fluid after each use.

8.7 No Fluid Delivered

If no fluid is being delivered during pump operation, try the following:

- Make sure the fluid inlet plumbing is connected to a fluid source. If using an inlet filter, try removing it temporarily.
- Check if the fluid inlet or fluid outlet plumbing is clogged, resulting in no fluid entering the pump. If you suspect a clog, disconnect the tubing and check that fluid can easily flow through it.
- Check for loose fittings on the fluid inlet side. Check to see if the tubing has a hole or crack which would cause air to be drawn into the tube instead of fluid.
- Check to see if the fluid is too viscous, or thick, to be pulled into the pump. This can be checked by watching the pressure of the pump cylinder as it starts to fill. If the pressure drops too much, the fluid will adhere to the tubing and not get pulled into the pump. Typically pressure drops only 1 to 2 psi when the pump cylinder is pulling in fluid. Water will adhere if the pressure during filling drops more than 6 psi.

Check the piston motion by doing the following:

1. Set the operating mode to Constant Flow.
2. Set the flow rate to 50% of maximum flow rate.
3. Set the cylinder direction (negative or positive flow rate) to either fill or deliver, whichever is appropriate.
4. Open the tank valve.
5. Start the pump cylinder and watch the physical piston position indicator for proper movement from full to empty. If there is no piston movement, check the motor and drum timing belts. Refer to “Drive Belts” section.

- Make sure the valve assembly is installed in the correct position. The fluid outlet side of the valves should be towards the pump control panel and valve cable.
- Check the valve cable. Make sure it is properly connected. The ribbon-type valve cable comes out through the top of the vertically positioned pump control panel and plugs into the pilot solenoid control board between the two valves on the fluid outlet side of the pump. Check that the tank and process valves are operating properly by performing the Pilot Solenoid Check (see "Pilot Solenoid Check" section).
- Check that the air pressure for the valves is between 75 and 105 psi. If the air pressure is too low or too high, the pilot solenoids can malfunction.
- Is the air clean and dry? The pilot solenoids are constructed of soft magnetic iron and can easily rust when exposed to moisture.
- Remove the pump case and verify the anti-rotating pin is attached to the screw. Please refer to “Removing the Pump Case” section, for instructions on removing the pump case.

8.8 Pressure Problems

The pressure transducers are essential for proper pump operation. Any problems with the transducer will mean that the pump will operate incorrectly. Several types of problems with the pressure transducers are covered below.

8.8.1 Pressure Transducer Error

If the pump reports a "Fault Sensor Pressure" error, this means that no signal is coming from the transducer. This needs to be fixed. To correct this problem, do the following:

- The transducer cable must be inserted into the connector in the correct orientation as described on the printed circuit board with the conductors out on the transducer board and away on the controller.
- Check if the cable has been worn or cut. If there is an analog overpressure reading, this can be the result of a controller failure, a transducer cable problem or a transducer failure.
- Check the transducer cable first and then try swapping transducers and transducer cables. If there is a faulty component, it will need to be replaced.

8.8.2 Pressure Does Not Increase

If the pressure does not start to increase in a pump cylinder when it is running, then the most likely cause is no fluid in the pump, which can be caused by any of the following:

- A leak in the inlet fluid tubing allowing air to be pulled into the pump cylinder instead of fluid.
- The fluid inlet tubing is clogged, preventing fluid from entering the pump cylinder.
- Fluid is too viscous, or thick, to be pulled into the pump

Other causes of this problem could be that the tank valve is leaking, the cylinder seal is leaking, the pressure transducers are cross wired or the fluid being delivered is leaking out somewhere along its path.

8.8.3 Pressure Overshoots

Pressure control in a constant pressure mode is set by the proportional, integral and differential gain constants. Adjust those parameters and check the pressure again.

This problem can also be caused by having a gas-liquid mixture. The piston will accelerate to compress the mixture and shoot past the set pressure before it can slow down. If you must use a gas-liquid mixture, you will need to carefully set the servo constants to keep the pump from exceeding the safety pressure.

8.8.4 Pressure Is Not Constant

Pressure control in constant pressure mode is set by the proportional, integral and differential gain constants. Adjust those parameters and check the pressure again.

This problem can also be caused by a leak (see Fluid Leaks section).

8.9 Valve Problems

The air actuated flow control valves are a vital part of the operation of the pump. They control the direction of the fluid flow. The valves used on the pump are highly reliable. However, as with any mechanism, problems can occur. In this section we will present some valve operation basics. Refer to the Valve User Manual, included with your pump, which has detailed maintenance and troubleshooting information regarding the valves.

8.9.1 Valve Cable Connection Check

The valve cable connects the pump controller to the pilot solenoid control board. The ribbon type valve cable comes out through the pump control panel. Make sure the valve cable is plugged into the pilot solenoid control board, which is located between the two valves on the fluid outlet side of the pump. The valve cable should be firmly seated. If it has come loose, simply slide it into the receptacle until the ejector latches swing around and lock the valve cable in place.

8.9.2 Checking Your Air Supply

The valves used with the pumps are air actuated. Air is taken into the system through the air inlet and distributed to the pilot solenoid manifolds. The pilot solenoids then distribute and control the air flow to the valves.

8.9.3 Air Supply Requirements

IMPORTANT: Although the pump uses very little air, the air supply that is used **MUST** meet the following conditions:

- The air must be clean.
- The air must be dry. Moisture in the air supply will cause the pilot solenoids to rust and malfunction.
- The air must be between 75 to 105 psi (5 to 7 bar).If air pressure exceeds this, the pilot solenoids may stop working.

8.9.4 Checking Your Air Supply Connection

To check the air supply connection, first identify the air inlet. Look for the fluid outlet tee on your pump. You will see a plastic tube coming from each valve. The two tubes join together into a fitting. The air inlet is attached to this fitting. Make sure a1/4" tube is inserted into the air inlet fitting, and that it is tight and cannot be moved.

Attached to the other end of the tube should be your pressurised air source. If your air supply has a switch to turn it on, make sure it is turned on so that air will be supplied to the pump. Note that 6 mm tubing will also work, in most cases. PFA™ or Teflon™ tubing is the recommended material for the air tubes, however, other materials will work.

8.9.5 Pilot Solenoid Check

Pilot solenoids are used to open or close the fluid pathways inside the valves. The pilot solenoid manifold takes in air from the user's air supply and distributes that air to the pilot solenoids. Please refer to "Pilot Solenoid Check" section for information on checking your pilot solenoids.

8.9.6 Obstructed Valve

It is possible for the valve inlet to become clogged with particles from the fluid being used. If a valve becomes clogged, then fluid can no longer be pulled into a pump. This can be detected by watching the pressure in the pump cylinder as the piston retracts. The pressure should not drop more than 1-2 psi. If it drops more than this, the fluid may not be getting into the pump cylinder due a clogged inlet tube or valve.

The outlet side of the valve is unlikely to clog due to the fact that the pump can generate high enough pressures to push most particles out of the valve. It may be possible to clear a clog on the inlet side by using the pump to push the particles out of the inlet. It would be advisable to clean all tubing and components thoroughly if a clog has been encountered so that this problem does not reoccur.

8.9.7 Valve Leaks

There is a possibility that the valve will not fully close and fluid can leak across the closed valve. If this occurs, the valve will not hold pressure. If you pressurize a pump and it is not holding pressure, fluid may be leaking out of a seal, or it could be leaking out across the valve. One way to check if a valve is leaking fluid is to swap tank valve and process valve. Refer to the Valve User Manual for maintenance and repair instructions.

8.10 Software Updates

The pump operation is controlled by a software programs: the remote software, which is stored on the remote computer. New versions of software are periodically released. Problems detected after a software release, are resolved in later software versions.

To make sure you have the latest software version available for your pump, check which version you have: it is displayed in the left bottom line of the Status Bar.

9 Maintenance

Thanks to their robust design, the Pump Series require little maintenance. Most of the pump parts are permanently sealed and never need to be greased or lubricated. However, the ball screw must be clean and lubricated every year or after any piston leak. Inspect and calibrate your pump every year for optimum performance. A few components of the pump will need to be replaced on an as-needed basis.

BEFORE ANY MAINTENANCE OPERATION, EMPTY THE PUMP CYLINDER!

Before performing pump maintenance, make sure the cylinder pump is empty and the piston is at the maximum retract position (bottom position). If the pump is not empty, set the operating mode to Constant Flow. Next, open either the tank or process valve, or both, so the displaced fluid has a place to go. Set a positive flow rate to deliver and start the pump cylinder. Wait for the pump to stop. Empty the fluid reservoir then, set a negative flow rate to fill and start the pump cylinder. Wait for the pump to stop. Do this for both pump cylinders.

BEFORE ANY MAINTENANCE OPERATION, REMOVE THE POWER CORD AND TURN OFF THE AIR NET!

IN CASE YOU NEED TO USE A WISE, ALWAYS USE SOFT JAWS (ALUMINIUM OR WOOD MADE) TO AVOID DAMAGING ANY OF THE PUMP PARTS!

All the drawings are in Annex, they can be used as references

9.1 Changing the Seal

The pump cylinder has one packing seal in it: 1 O-Ring encapsulated between 2 backup rings located at the cylinder bottom. The seals should be changed as needed. A sure sign that the seal needs to be changed is fluid leaking from the bottom. For more information on leakage, go to the “Fluid Leaks” section. The following step-by-step guide will show you how to change the seal:

THE PUMP CYLINDER MUST BE COMPLETELY EMPTY BEFORE REMOVING IT! EVEN WITH THE PISTON ON TOP, SOME FLUID REMAINS IN THE CYLINDER. SO, IT IS HIGHLY RECOMMENDED TO PUT AN ABSORBENT PAPER/TISSUE UNDER THE CYLINDER BEFORE REMOVING IT.

IN ANY CASES, AVOID SPILLING FLUID ON THE BALL SCREW! SPILLING FLUID ON THE BALL SCREW COULD RESULT IN IRREVERSIBLE DAMAGE TO IT IF NOT CLEAN IMMEDIATELY!

IF FLUID HAVE BEEN SPILLED ON THE BALL SCREW, CLEAN IT IMMEDIATELY! DO NOT FORGET TO RELUBRICATE THE BALL SCREW AFTER CLEANING!

EXCEPT IF IT IS ABSOLUTELY NEEDED, AVOID UNSCREWING THE PUMP CYLINDER BASE.

9.1.1 Tools You Will Need

- 3/8 inch to 3/4 inch open-end spanners.
- 3 to 10 mm ball driver Allen keys.
- Phillips-head screwdriver
-

9.1.2 Spares needed (diagram in annex)

Ref	Designation	Number per cylinder	Used in Pompe		
0022949 JT13.87x3.53Ph94	Parbak piston d21 PTFE Oring 13.87x3.53 - polyuréthane hydrolisé 94 schores	4 2	BT 30kpsi - 50cc BT 30kpsi - 50cc		
0022944 JT18.64x3.53Ph94	Parbak piston d25.4 PTFE Oring 18.64x3.53 - polyuréthane hydrolisé 94 schores	4 2	BT 20kpsi - 125cc BT 20kpsi - 125cc		
0025537 JT24.99x3.53Ph94	Parbak piston d25.4id PTFE Oring 24.99x3.53 - polyuréthane hydrolisé 94 schores	4 2	BT 30kpsi - 150cc BT 30kpsi - 150cc		
0022917 JT23.39x3.53V	Parbak piston d30 PTFE Oring 23.39x3.53 - viton 90shA	4 2	BT 10kpsi - 100cc BT 10kpsi - 100cc	BT 15kpsi - 100cc BT 15kpsi - 100cc	BT 15kpsi - 175cc BT 15kpsi - 175cc
0022938 JT29.74x3.53V	Parbak piston d36 PTFE Oring 29.74x3.53 - viton 90shA	4 2	BT 10kpsi - 250cc BT 10kpsi - 250cc	BT 15kpsi - 300cc-old BT 15kpsi - 300cc-old	
0039738 JT26.34x5.33V	Parbak piston d36x5.33 PTFE Oring 26.34x5.33 - viton 90shA	4 2	BT 15kpsi - 300cc BT 15kpsi - 300cc		
27460 JT34.29x5.33V	Parbak piston d46 PTFE Oring 34.29x5.33 - viton 90 shA	4 2	BT 10kpsi - 500cc BT 10kpsi - 500cc	BT 20kpsi - 250cc BT 20kpsi - 250cc	
27460 JT34.29x5.33V	Parbak piston d46 PTFE Oring 34.29x5.33 - viton 90 shA	4 2	BF 15kpsi - 500cc BF 15kpsi - 500cc		
0022933 JT44.04x3.53V	Parbak piston d50.8 PTFE Oring 44.04x3.53 - viton 90 shA	4 2	BT 5kpsi - 500cc BT 5kpsi - 500cc		
0030673 JT40.64x5.33V	Parbak piston d51 PTFE Oring 40.64x5.33 - viton 90ShA	4 2	BF 25kpsi - 500cc BF 25kpsi - 500cc		

9.1.3 Removing the Transducer

If The pressure transducer is directly bolted on the pump cylinder:

- Undo the screw fixing the cable connector (black plastic cap) to the pressure transducer by using the Phillips head screwdriver. If no cap, unplug the transducer cable from the I/O board inside the pump casing.
- Undo the transducer from the pump's cylinder with a 19 mm (or ¾") open-end spanner. Note that the transducer can be either: male 1/4" BSP with a sealing washer (the washer must be replaced after each transducer unmounting) or female 1/4" HP (usually models above 700 bar).
-

9.1.4 Removing the Valves Assembly

- Disconnect all the valve tubing (from tank and process ports). Do not forget to disconnect the air net plastic tubes.

Optionnal:

- Remove the 2 manifold tubing (from manifold to common valve port).
- Undo the 2 bracket attaching screws from the pump cylinders, then remove the valves assembly including the bracket.

9.1.5 Removing the Cylinder

- Undo the bolts fixing the cylinder plates for each cylinder.
- Remove the plates and pull the cylinders one by one.
- Note that removing the cylinder will be easer if the piston is at it lowest position.

DO NOT REMOVE THE BALL SCREW NUT FROM THE NUT! YOU WILL NEVER BE ABLE TO SET THE NUT BACK ON THE SCREW.

9.1.6 Changing the Seal (Plunger piston)

The sealing consists of 1 O-Ring encapsulated between 2 back-up rings, and 1 retaining ring. This assembly is inserted at the cylinder bottom and maintained by a packing nut.

- Undo the packing nut by hand. If it is necessary, you can use an Allen key by using the holes made all around the nut.
- Gently slide off the sealing assembly (O-Ring, back-up rings and retaining ring).

9.1.7 Changing the Seal (Scrapper piston)

The sealing consists of 2 O-Ring encapsulated between 4 back-up rings, and 1 retaining ring. This assembly is inserted on the top of the piston and hold with a packing nut.

- Undo the packing nut by hand. If it is necessary, you can use an Allen key.
- Gently slide off the sealing assembly (O-Ring, back-up rings and retaining ring).

9.1.8 Inspecting Piston, Cylinder and Ball Screw

It is important that you inspect your piston for scratches or deposits. Pumping fluids that contain abrasive particles can wear the piston surface.

- First take a clean, soft cloth or paper towel and wipe the piston to remove any remaining film or residue.
- Look at the piston. It should be smooth, with no scratches or indentations on it. An intermittent leak can be caused by a scratch on the piston. If your piston has been severely scratched, you may need to order a new piston. If something has become stuck to the piston, it will need to be removed.
- Look at the cylinder (inside). It should be clean. As the sealing is made on the piston, the cylinder doesn't need to be as perfect as the piston surface. However, scratches or indentations may indicate a problem of cylinder/piston misalignment.
- Look at the ball screw. It should be fully greased. If the screw is dry, add some grease on it. If you have had a leak, remove all fluid that may have spilled on the screw, particularly the water or brine. After wiping off the screw, do not forget to grease it again.

NEVER USE STEEL WOOD OR SAND PAPER TO TRY RESTORING THE PISTON OR THE CYLINDER! ASK THE SUPPLIER FIRST FOR ADVICE.

9.2 Drive Belts

There is a drive belt that links the driven pulley and the free (gear) pulley. To inspect the drive belts, the mechanical pump assembly needs to be removed.

9.2.1 Tools You Will Need

- 3/8 inch to 3/4 inch open-end spanners and 8 mm + 22mm open-end spanner
- 3 to 10 mm ball driver Allen keys.

9.2.2 Spares needed (diagram in annex)

For a BTSP you need x1 belt:
- SYN 16-AT5/455 Drive Belt

9.2.3 Removing the Mechanical Assembly

- Turn OFF the pump, remove the power cord.
- Turn OFF the air net, remove the inlet tubing from the pilot solenoid manifold.
- Remove the pump casing (10 screws – 2 casing pieces).
- Remove the transducers (see 7.1.2).
- Remove the valves assembly (see 7.1.3).
- Remove the 4 end stroke switches.
- Remove the I/O control card square support (2 screws) from the separating plate. Put the I/O control card away.
- Disconnect the 2 motor cables.
- Remove the 5 separating plate attaching screws. Do not forget the 3 attaching screws of the cylinder base.
- Put the separating plate with the end stroke switches away.
- Remove the 4 screws from the pump base plate, then remove the mechanical assembly.

9.2.4 Removing the Drive Belt

The drive belt links the driven pulley to the free (gear) pulley.

- Use the 6 mm Allen key to loosen the driven pulley hub.
- Use the 22 mm open-end spanner to loosen the free pulley.
- Pull the 2 pulley hubs at the same time to remove the belt.

9.2.5 Inspecting the Drive Belt

The drive belt needs to be inspected **every 6 months** for signs of wear and replacement requirements. Replacement drive belt must be purchased from the Supplier. A drive belt that needs replacing will show any of the following symptoms:

- Drive belt should be cleanly wrapped over each of the two pulleys.
- Drive belt should be fully on the holding post and neatly wrapped around the pulleys.
- Drive belt should have no folds, cracks or frays.
- Drive belt should be tight enough.

If you see any of the above symptoms, replace the drive belt before you run the pump again. Drive belt should be replaced every 2 years even if it looks in perfect condition. If the drive belt becomes noisy, you may apply grease on its internal surface (toothed side) after having cleaned the belt with a soft cloth.

ALWAYS REPLACE THE TWO DRIVE BELTS AT THE SAME TIME. IF ONE DRIVE BELT NEEDS TO BE REPLACED, THE SECOND DRIVE BELT WILL NEED REPLACEMENT SOON. SAVE YOUR TIME!

PUMP EVALUATION MUST BE PERFORMED AFTER DRIVE BELTS REPLACEMENT TO ENSURE ALL CABLES ARE RECONNECTED PROPERLY AND THE PUMP IS READY TO OPERATE.

Remounting procedure is the exact reverse procedure of unmounting.

9.3 Calibrating the Pressure Transducer

The pressure transducer needs to be recalibrated periodically. During normal use it should be recalibrated every 12 months. If usage is heavy, or if the pump has been subjected to unusual circumstances such as continuous pressures above 90% of its rated pressure range, then recalibration should be performed. Also, pressure transducer should be recalibrated after being taken apart and put back together.

In the case of multiple operating mode, calibration allows the two individual pressure transducers on the two pump cylinders to correctly read pressure. The control software uses these pressures to match the standby pump cylinder's pressure to the delivery pump cylinder's pressure to eliminate pressure variations at switchover. If the two pressure transducers are not synchronized, then the pressure in one pump cylinder will not be the same as the pressure in the other, even though the readings on the display will match. The easiest way to check transducer synchronization is to use one pump cylinder to pressurize both pressure transducers (connect pump cylinders together) and record the pressure of both pressure transducers over the pressure range of interest.

9.3.1 What Is a Pressure Transducer?

A pressure transducer is a device that converts a pressure to an electrical signal proportional to that pressure. The signal generated by the pressure transducer is sent directly to an A/D (analog-to-digital) converter which converts the analog electrical signal of the amplifier to a 15-bit digital signal that is displayed on the computer.

Each individual pressure transducer will have slight variations in zero pressure output voltage (zero offset) and its output voltage at full pressure (gain). These variations are taken into account by the interpretation software. The process of adjusting the offset and gain compensation values is called calibration.

-

9.3.2 Methods of Calibration

There are two basic methods of pressure calibration for the pump system. The first method is to attach a secondary calibrated gauge, such as a quartz transducer, to the system. With this method, the pressure for the calibration procedure will be generated by the pump. Then the pressure read by the system is adjusted until the system's transducer readings match the reading by the calibrated gauge (CG).

The second method is to use an external pressure source, such as a "dead-weight tester". With this method the user connects the external calibrated pressure source (PS) to the pump system. The pressure is then read by the system and adjusted until it matches the pressure being output by the pressure source.

9.3.2.1 Calibrated Gauge

- Connect a calibrated gauge (CG) to the fluid outlet (process valve). Be sure the tank valve is connected to a fill reservoir at atmospheric ("zero gauge") pressure.
- Set the system to "zero pressure" as follows: for the cylinder being calibrated, open the tank valve, so the cylinder pressure is at atmospheric or "zero" pressure. The process valve can also be opened, if desired.
- From the "**Calibration**" window (see Calibration section for more details), adjust the offset B in order to have the display read zero pressure. The range of zero offset is limited, so that a malfunctioning transducer or a transducer with significant pressure accidentally left on it, will not be able to be zeroed.

NOTE: If your system is typically operated at significantly less than the pump's maximum rating (for example, typical usage at 1000 psi for a 10,000 psi pump), then the pressure in this step may be set at the system's typical operating pressure to obtain a more accurate calibration.

- For the cylinder being calibrated, open the process valve and close the tank valve.
- Set the cylinder you are calibrating to Constant Flow mode at 1 ml/min or less depending of the pump capacity (small volume, low flow) and start the pump.
- Monitor the pressure with the calibrated gauge and stop the pump when pressure reaches 90% of the pump's maximum pressure.
- From the "**Calibration**" window (see Calibration section for more details), adjust the gain A in order to have the display read calibrated pressure.

REMEMBER TO ALWAYS ADJUST THE OFFSET PRIOR TO ADJUSTING THE GAIN.
THE RANGE OF GAIN AND OFFSET IS LIMITED TO PREVENT FAULTY AND MALFUNCTIONING TRANSDUCER FROM BEING INCORRECTLY CALIBRATED.

IMPORTANT – WHEN YOU RAISE THE SYSTEM'S PRESSURE, THE TEMPERATURE OF THE PUMP'S INTERNAL FLUID WILL TEMPORARILY RISE. AS THIS FLUID COOLS, THE SYSTEM PRESSURE WILL DROP. IN THIS SITUATION, IT IS BEST TO WAIT FIVE MINUTES AFTER REACHING YOUR HIGH PRESSURE BEFORE PROCEEDING, SO THAT THE PRESSURE REMAINS CONSTANT DURING CALIBRATION.

9.3.2.2 Calibrated Pressure Source

- Connect a calibrated pressure source (PS) to the fluid outlet (process valve). Be sure the tank valve is connected to a fill reservoir at atmospheric ("zero gauge") pressure.
- Set the system to "zero pressure" as follows: for the cylinder being calibrated, open the tank valve, so the cylinder pressure is at atmospheric or "zero" pressure. The process valve can also be opened, if desired.
- From the "**Calibration**" window (see Calibration section for more details), adjust the offset B in order to have the display read zero pressure. The range of zero offset is limited, so that a malfunctioning transducer or a transducer with significant pressure accidentally left on it, will not be able to be zeroed.

NOTE: If your system is typically operated at significantly less than the pump's maximum rating (for example, typical usage at 1000 psi for a 10,000 psi pump), then the pressure in this step may be set at the system's typical operating pressure to obtain a more accurate calibration.

- For the cylinder being calibrated, open the process valve and close the tank valve.
- Set the pressure source up to 90% of the pump's maximum pressure.
- From the "**Calibration**" window (see Calibration section for more details), adjust the gain A in order to have the display read calibrated pressure.

**REMEMBER TO ALWAYS ADJUST THE OFFSET PRIOR TO ADJUSTING THE GAIN.
THE RANGE OF GAIN AND OFFSET IS LIMITED TO PREVENT FAULTY AND MALFUNCTIONING TRANSDUCER FROM BEING INCORRECTLY CALIBRATED.**

IMPORTANT – WHEN YOU RAISE THE SYSTEM'S PRESSURE, THE TEMPERATURE OF THE PUMP'S INTERNAL FLUID WILL TEMPORARILY RISE. AS THIS FLUID COOLS, THE SYSTEM PRESSURE WILL DROP. IN THIS SITUATION, IT IS BEST TO WAIT FIVE MINUTES AFTER REACHING YOUR HIGH PRESSURE BEFORE PROCEEDING, SO THAT THE PRESSURE REMAINS CONSTANT DURING CALIBRATION.

9.4 How To Attach a Fitting?

- Cut tubing. Allow an extra 1/2 inch (or 13 mm) in length for proper fitting engagement. After cutting the tube, deburr it – remove any sharp edges or corners – before installing the gland and sleeve. Use air or fluid to clean the tubing internally and externally.
- Slip gland and sleeve onto tubing. Make sure the larger end of sleeve is toward the gland. Push tubing into valve or fitting until it firmly contacts the bottom.
- Tighten gland until sleeve begins to grip tubing.

- Note the wrench's starting position. Tighten the gland approximately 1–1/4 turns for the Autoclave® type connection.
-

THE TUBING OUTSIDE DIAMETER MUST BE EXACTLY 1/8 INCH (0.125 +/-0.001 MM) OR 1/4 INCH (0.250 +/-0.001 MM); 3 MM OR 6 MM TUBING WILL NOT WORK.

-

FOR HIGH PRESSURE FITTING SUCH AS AUTOCLAVE F250C YOU MUST USE A SPECIFIC TOOLING TO PREPARE THE TUBE (LEFT TAPPED AND CONED). ASK THE SUPPLIER FOR PART# AND PRICING.

-

9.4.1 Re-assembly

Reassemble a connection by inserting tubing, with attached sleeve and gland, into valve or fitting. Always tighten gland by hand first before using a wrench. After frequent reassembles, it may take less than 3/8 turn to generate a gas-tight seal, and as little as 1/8 of a turn may be sufficient. DO NOT OVERTIGHTEN. Over tighten will deform the sleeve and reduce the fitting's sealing ability.

-

9.5 Bearings and Motor

The bearings and motor in the pump do not require greasing or lubrication during the life of the pump. In fact, no maintenance at all is required for these robust components.

9.6 Valve Maintenance

To perform periodic valve maintenance, go to the Valve User Manual. All maintenance instructions can be found in the Valve User Manual.

-

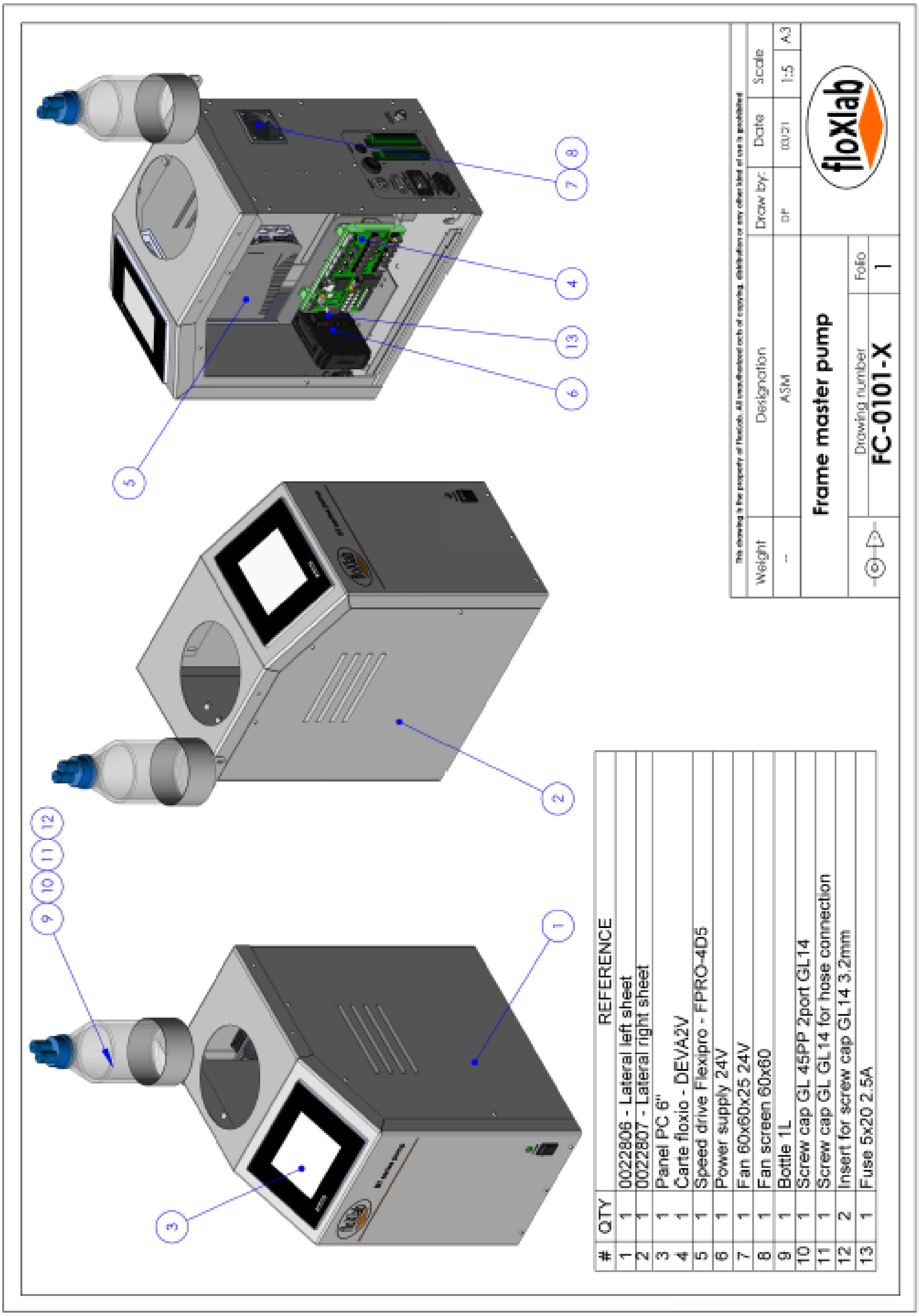
9.7 Storage

It is the customer responsibility to provide an adequate environment for the equipment. It is important to keep the equipment in a temperature and humidity controlled room, so as to preserve the sensitive electronics.

- ✓ Do not expose the equipment to chemical substances or heat sources such as ovens, steam pipes or even water leaks.
- ✓ After every operation we recommend to cut off the electrical equipment supply.
- ✓ Inspect your equipment periodically for any signs of deterioration.

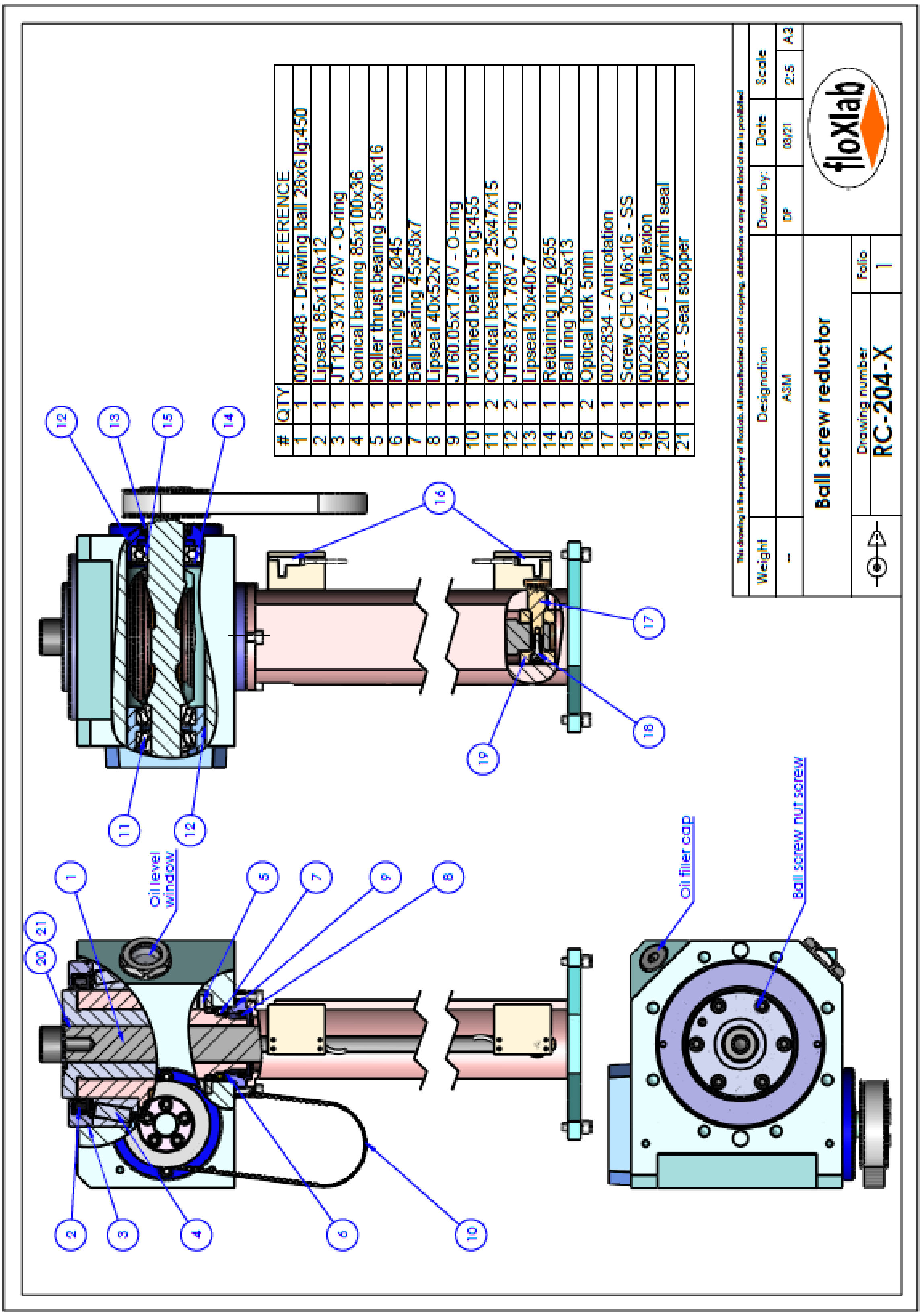
The pump must be stored, when not in service, at room temperature. The pump should be stored once partially fill the cylinder with light oil and run the piston all of the way up, when it not be used for a long period of time. Storage area must be kept dry. Apply grease generously on the ball screws before storage.

Annex 1 –Frame example drawing (BT)

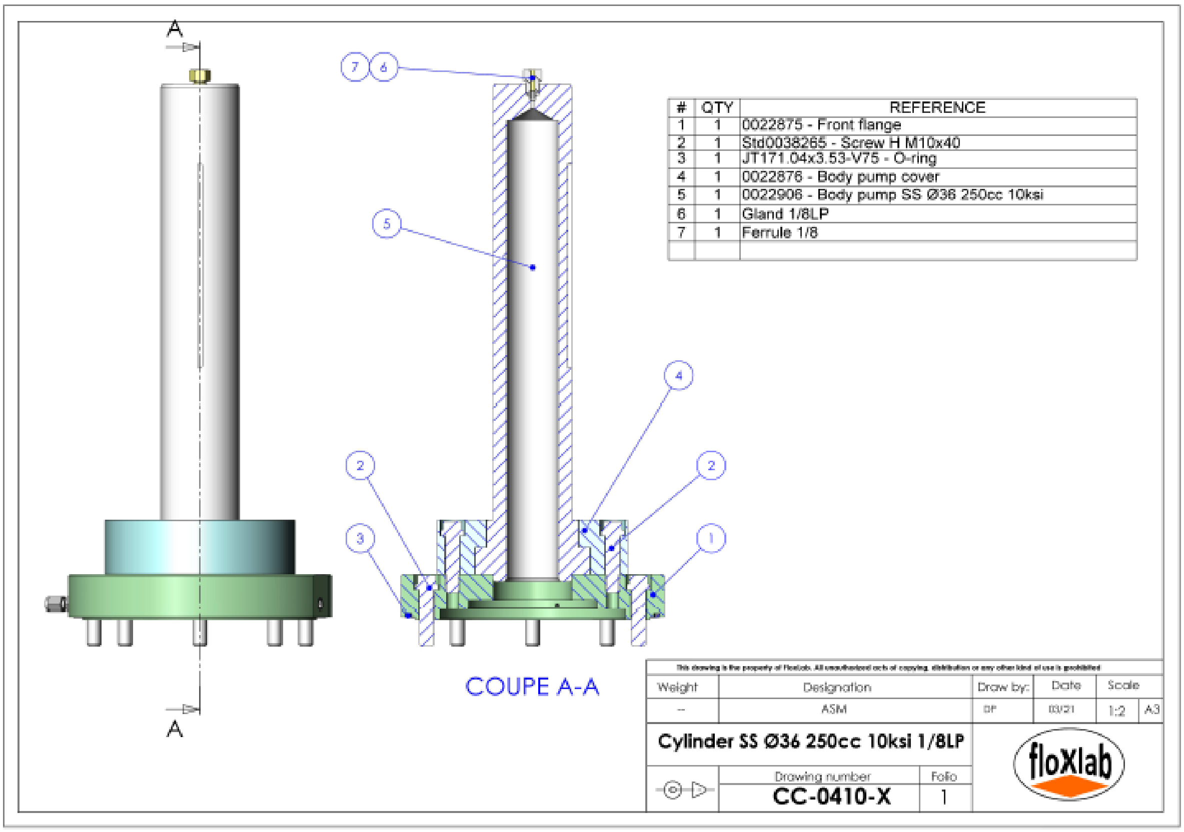


#	QTY	REFERENCE
1	1	00228806 - Lateral left sheet
2	1	00228807 - Lateral right sheet
3	1	Panel PC 6"
4	1	Carte floxio - DEVA2V
5	1	Speed drive Flexipro - FPRO-4D5
6	1	Power supply 24V
7	1	Fan 60x60x25 24V
8	1	Fan screen 60x60
9	1	Bottle 1L
10	1	Screw cap GL 45PP 2port GL14
11	1	Screw cap GL GL14 for hose connection
12	2	Insert for screw cap GL14 3.2mm
13	1	Fuse 5x20 2.5A

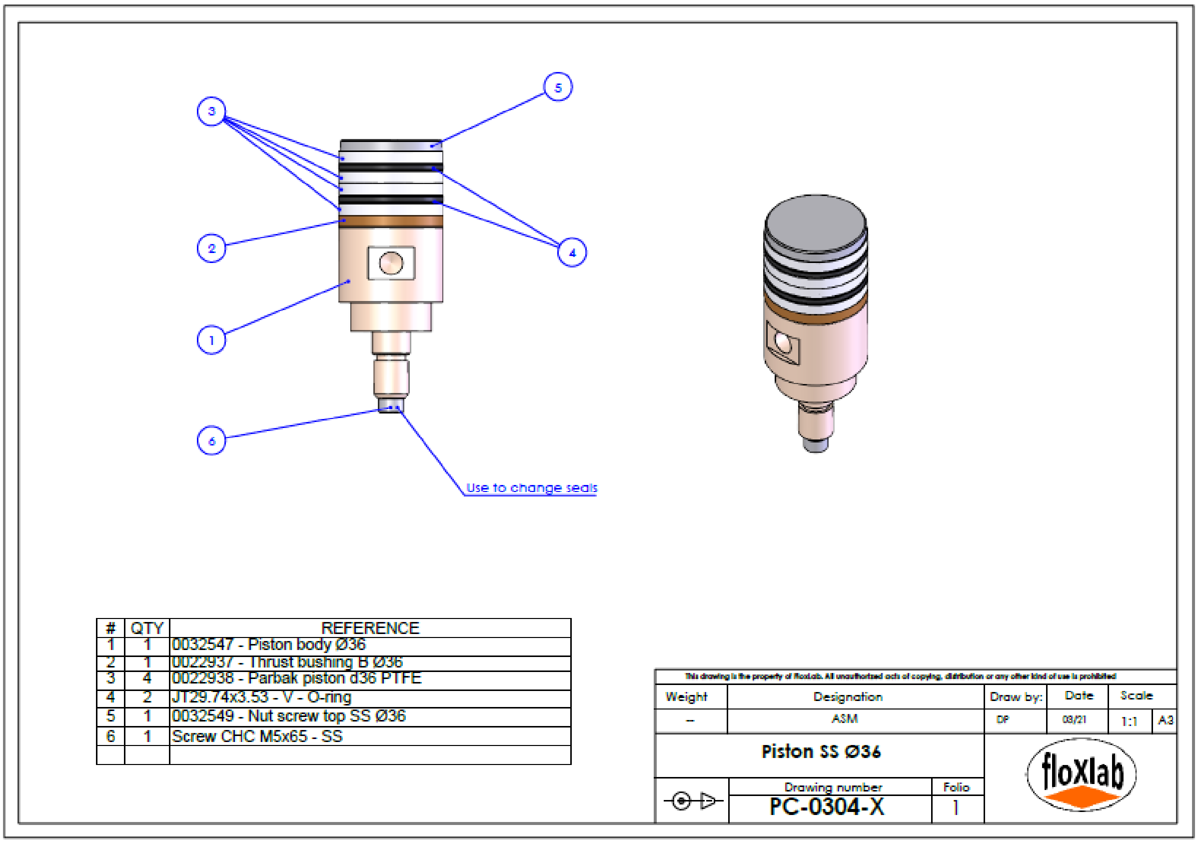
Annex 2 –Reductor example drawing (BT)



Annex 3 – Scraper Drawing exemple (250-10)

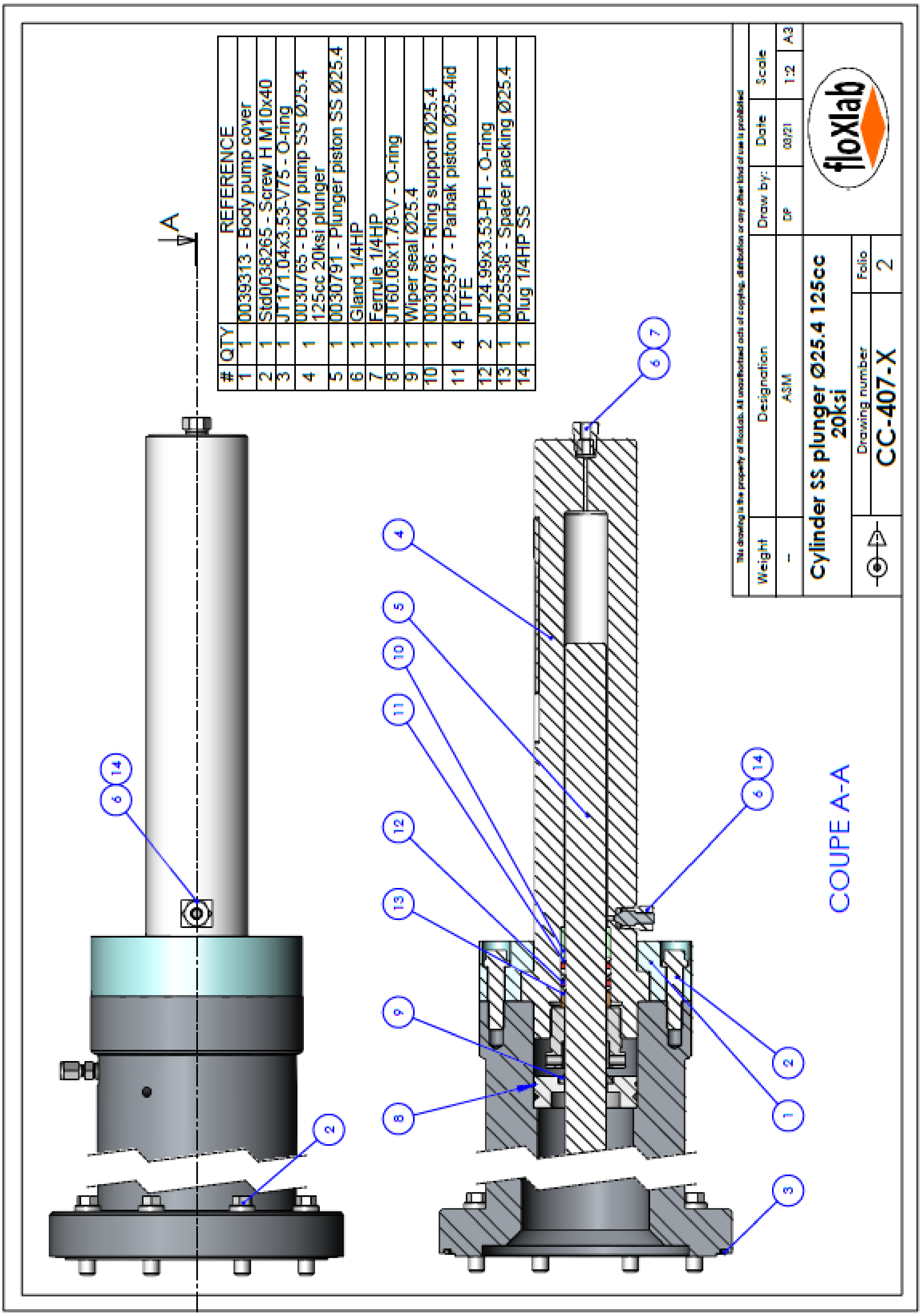


#	QTY	REFERENCE
1	1	0022875 - Front flange
2	1	Std0038265 - Screw H M10x40
3	1	JT171.04x3.53-V75 - O-ring
4	1	0022876 - Body pump cover
5	1	0022906 - Body pump SS Ø36 250cc 10ksi
6	1	Gland 1/8LP
7	1	Ferrule 1/8

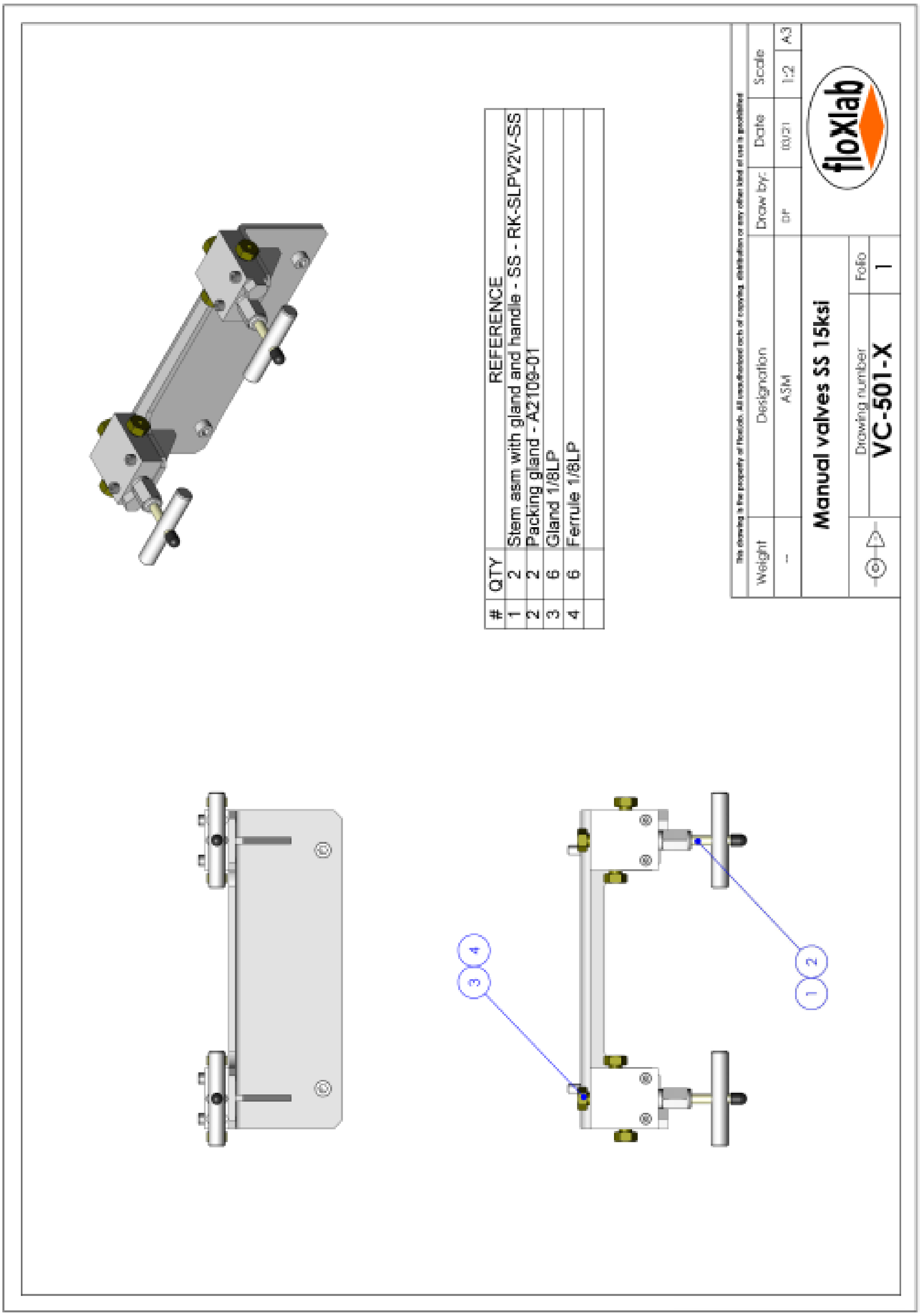


#	QTY	REFERENCE
1	1	0032547 - Piston body Ø36
2	1	0022937 - Thrust bushing B Ø36
3	4	0022938 - Parbak piston d36 PTFE
4	2	JT29.74x3.53 - V - O-ring
5	1	0032549 - Nut screw top SS Ø36
6	1	Screw CHC M5x65 - SS

Annex 4 – Plunger Drawing exemple (250-10)



Annex 5 – Manual Valves Drawing (<=15k psi)

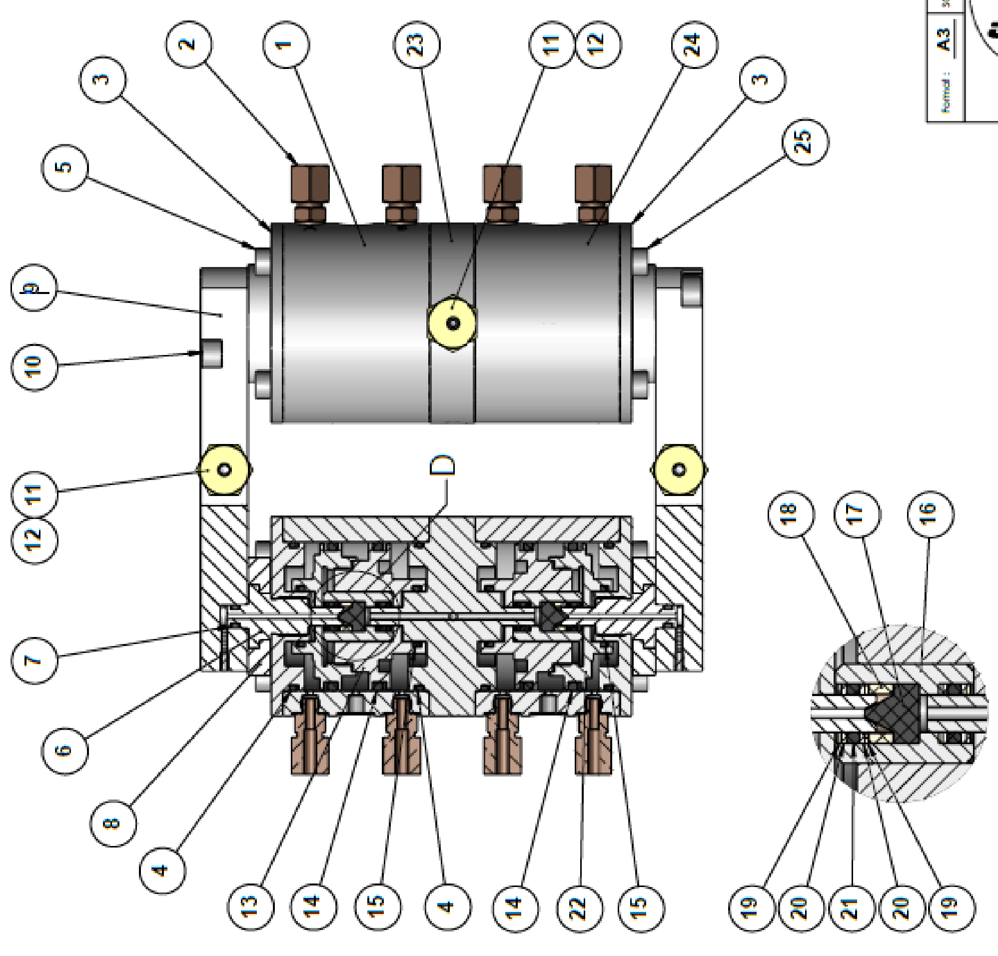


#	QTY	REFERENCE
1	2	Stem asm with gland and handle - SS - RK-SLPV2V-SS
2	2	Packing gland - A2109-01
3	6	Gland 1/8LP
4	6	Ferrule 1/8LP

Annex 6 – Valves Drawing (<=10k psi)

CFV-0402 - Valve SS 3ksi 6ksi 12ksi

REPERE	PART NUMBER	DESCRIPTION	T°C	QTY/APP	LEVEL
1	0029939	Body cylinder valve 10ksi M4		2	
2		Pneumatic connection 10-32x1/8od	A	8	
2		Union brass 1/8odx10-32 seal viton	HT	8	
3	0029942	Cover valve 10ksi		4	
4	JT34.65x1.78V	Oring 34.65x1.78 - viton 90ShA		8	2
5		Screw TH M4x12 - A4-80		8	
6	0030070	Sealing end fitting SS		4	
7	JT3.35x1.78V	Oring 3.35x1.78 - viton 90ShA		4	2
8	0030310	Flange		4	
9	0032301	Union dual valve SS		2	
10		Screw CHC M5x12 BUMAX109		8	
11	LPG2	Gland 1/8LP		4	3
12	LPF2	Ferrule 1/8LP		4	3
13	0029948	Pneumatic piston half male d38.1		4	
14	JT32.99x2.62V	Oring 32.99x2.62 - viton 90ShA		8	2
15	JT12.42x1.78V	Oring 12.42x1.78 - viton 90ShA		8	2
16	0029949	Sealing piston SS		4	
17	0029951	Sealing seat 10ksi		4	3
18	0029950	Seat spacer		4	
19	0029953	Backup ring d7.5x4.7 peek		16	3
20	0029952	Backup ring d7.5x4.7 ptfe		16	3
21	JT4.47x1.78V	Oring 4.47x1.78 - viton 90ShA		8	2
22	0029943	Pneumatic piston half female d38.1		4	
23	0029941	Middle flange valve SS 10ksi		2	
24	0029936	Body cylinder valve 10ksi d4.3		2	
25		Screw TH M4x65 - A4-80		8	



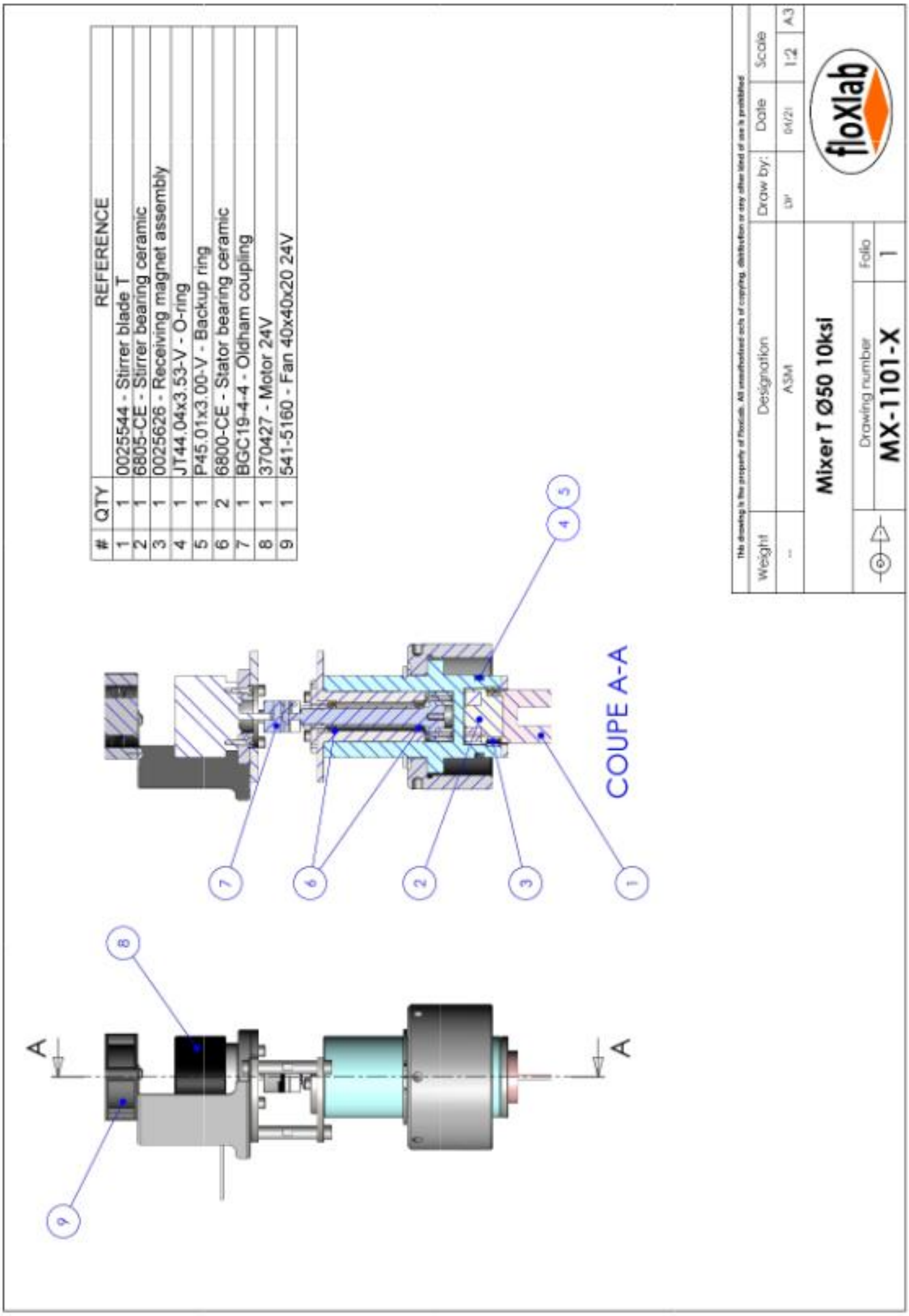
Format : A3 | SCALE : 1:1 | DRAWN BY : JCR | CHECKED BY : JCR | DATE : 05/05/2021

floXlab

DESIGNATION: Valve 3ksi 6ksi 12ksi

DRAWING NUMBER: CFV-04xx

Annex 7 – Stirrer Drawing

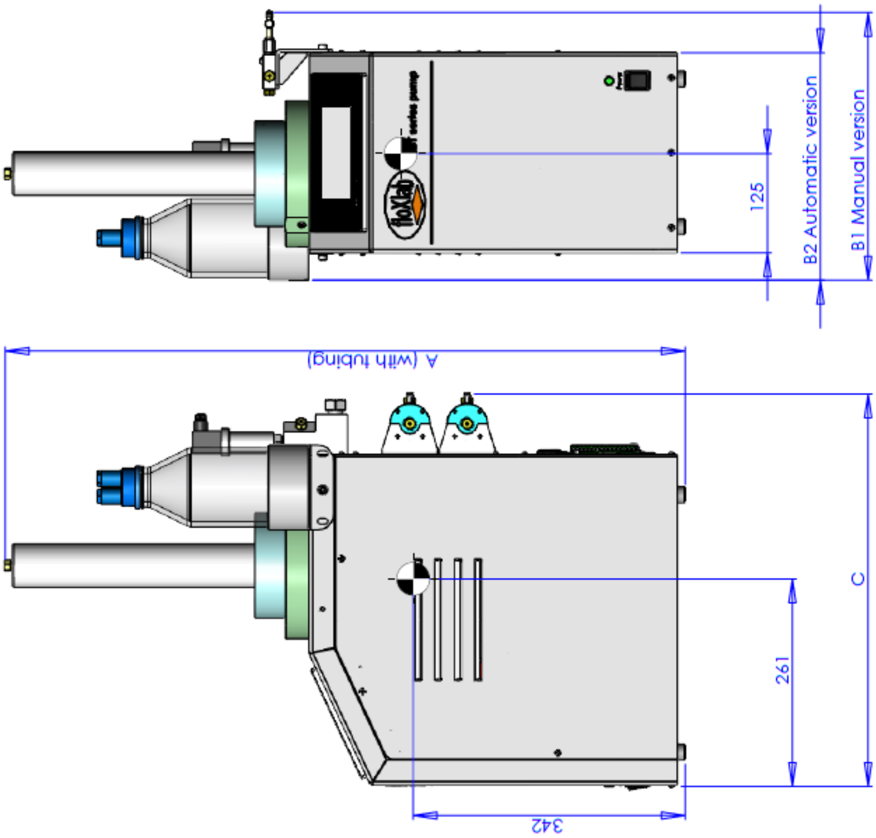


#	QTY	REFERENCE
1	1	0025544 - Stirrer blade T
2	1	6805-CE - Stirrer bearing ceramic
3	1	0025626 - Receiving magnet assembly
4	1	JT44.04x3.53-V - O-ring
5	1	P45.01x3.00-V - Backup ring
6	2	6800-CE - Stator bearing ceramic
7	1	BGC19-4-4 - Oldham coupling
8	1	370427 - Motor 24V
9	1	541-5160 - Fan 40x40x20 24V

Annex 8 – Pumps dimensions

	A	B1	B2	C
BTSP 20-40	1150	380	290	600
BTSP 125-20	1160	380	290	600
BTSP 175-15	940	380	290	600
BTSP 250-10	930	380	290	600
BTSP 100-10	820	380	290	600
BTSP 500-5	940	340	290	600
BTSP 1000-1.8	950	300	290	600
EXTENDED BTSP				
BTSP 300-15	1020	380	290	600
BTSP 500-10	1012	380	290	600
BTSP 1000-5	1035	340	290	600
BTSP WEIGHT : 70 Kg				
EXTENDED BTSP WEIGHT : 75 Kg				

All dimensions in millimeters



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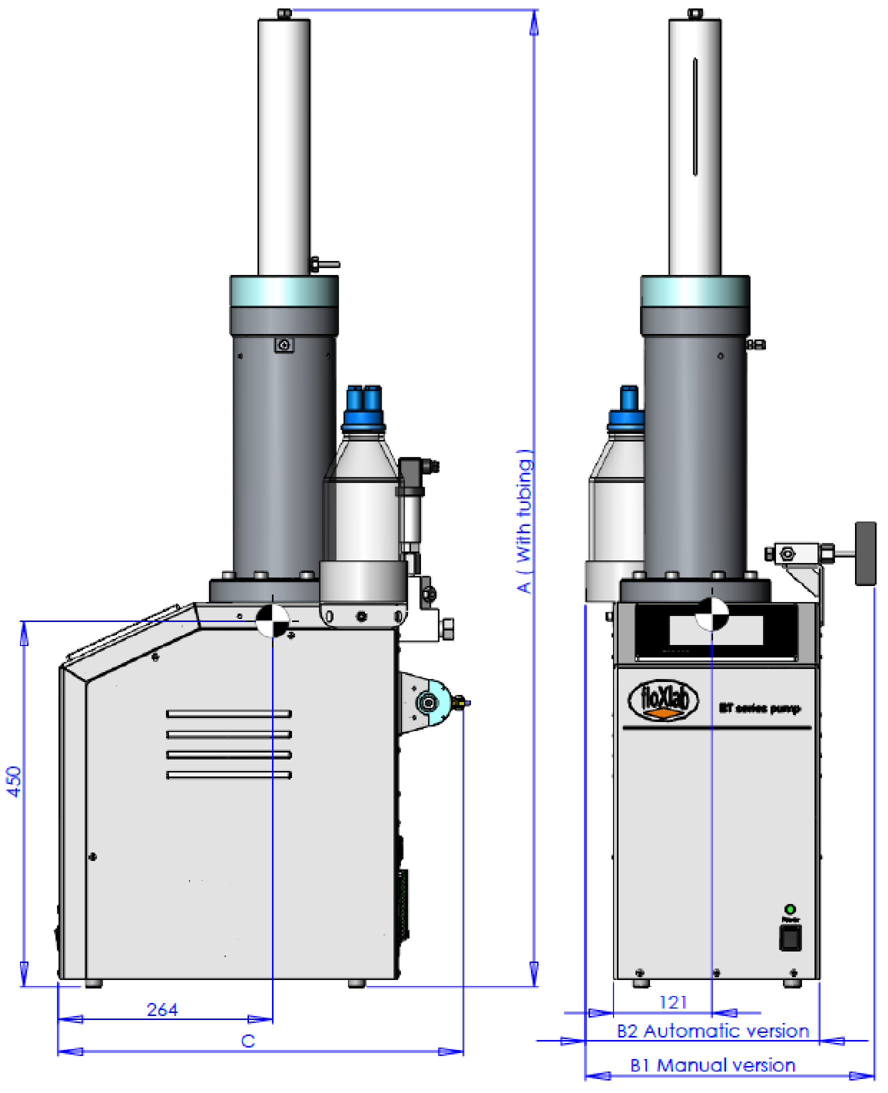
Weight	Designation	Draw by:	Date	Scale	
-	ASM	DP	03/22	1:5	A3

Layout drawing Benchtop & Extended Benchtop

Drawing number: Benchtop-Scraper

Folio: 1



	A	B1	B2	C
BTSP 50-30	1050	380	290	600
BTSP 125-20	1260	380	290	600
BTSP 175-15	1290	380	290	600
BTSP 250-10	1270	380	290	600
BTSP 1000-1.8	1270	280	290	600
EXTENDED BTSP				
BTSP 150-30	1390	380	290	600
BTSP 250-20	1420	380	290	600
BTSP WEIGHT : 75 Kg				
EXTENDED BTSP WEIGHT : 82 Kg				

All dimensions in millimeters

Weight	Designation	Draw by:	Date	Scale	
--	ASM	DP	03/22	1:5	A3

Layout drawing Benchtop & Extended Benchtop

Drawing number	Folio
Benchtop-Plunger	1

LIST of FIGURES

LIST of TABLES

List of annexes

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