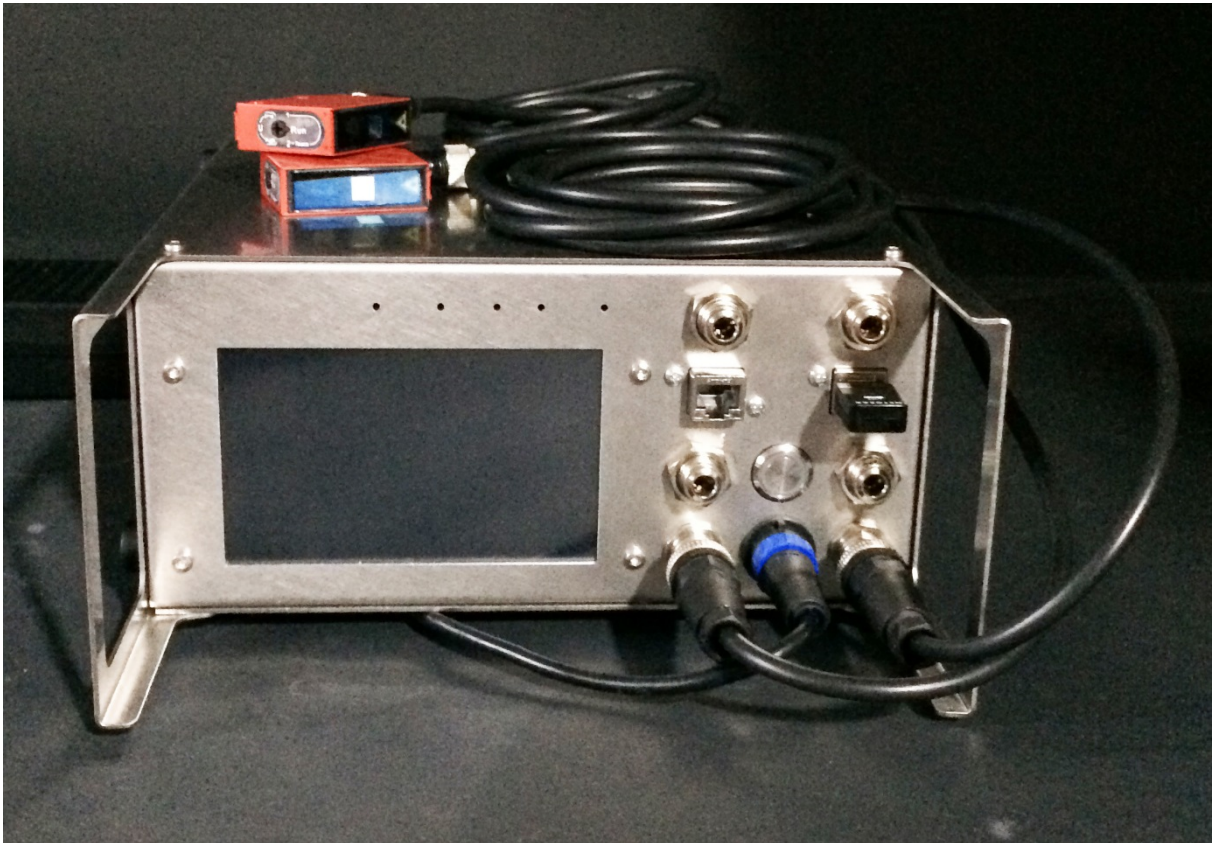


Operating Instruction & Manual

Atropos drive unit



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1. Hardware setup

Atropos is a family of drive units designed for operation of Euterpe diaphragm Single-Use-Pump (SUP). Atropos is available in:

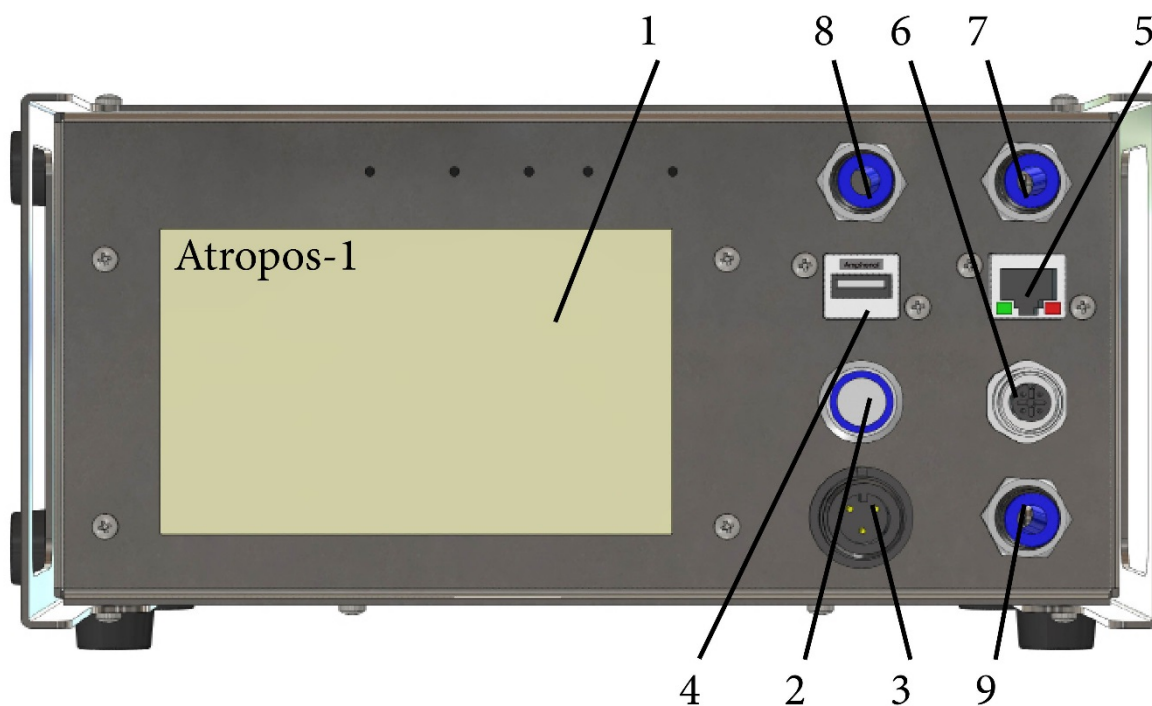
- two different sizes ranging 750 – 5.000 ml/min capacity
- two different models – single and dual channel

1.1 - Product purpose

Driving the diaphragm Euterpe SUP requires drive gas both below and above atmospheric pressure. The drive gas is constantly adjusted via a set of proportional valves inside Atropos. Control is based on input from Laser sensor's and pressure sensor's. Stroke Volume (SV) and number of strokes / Beats-per-Minute (BpM) determine the pumped volume / Cardiac Output (CO) and velocity of the liquid passing through the smallest orifice.

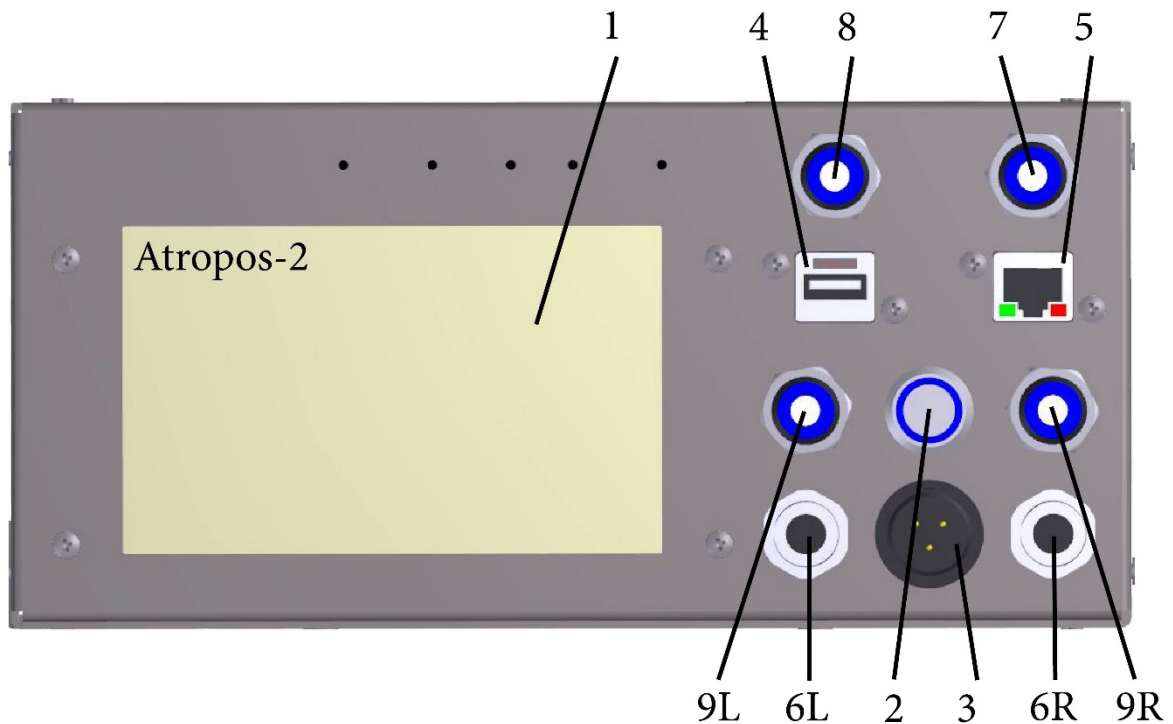
2. - Device Overview

The Atropos unit is a standard product manufactured by www.pumpcell.com housed in a Hephaestus U2 cabinet manufactured from AISI 304 stainless steel.



For single channel Atropos-1 front panel is equipped with:

1. 5" touch sensitive TFT display
2. Main power breaker
3. Buccaneer 24 VDC power input
4. USB socket for Wi-Fi access and charging
5. RJ45 socket for Local-Are-Network (LAN) connection
6. SUP laser sensor input with M12, RKF5, 5P socket
7. Supply pressure 6 mm one-touch connection
8. Supply vacuum 6 mm on-touch connection
9. SUP drive via 6 mm hose and on-touch connection



For dual channel Atropos-2 front panel is equipped with:

1. 5" touch sensitive TFT display
2. Main power breaker
3. Buccaneer 24 VDC power input
4. USB socket for Wi-Fi access and charging
5. RJ45 socket for Local-Are-Network (LAN) connection
- 6L. Left channel laser sensor input with M12, RKF5, 5P socket
- 6R. Right channel laser sensor input with M12, RKF5, 5P socket
7. Supply pressure 6 mm one-touch connection
8. Supply vacuum 6 mm on-touch connection
- 9L. Left channel SUP drive via 6 mm hose and on-touch connection
- 9R. Right channel SUP drive via 6 mm hose and on-touch connection

There are two fan openings on the rear panel of Atropos. Avoid to push the cabinet close to a wall prohibiting ventilation and internal cooling.

2.1 - Atropos internal design

Internal sensors and actuators:

- Pressure sensor for supply, >1 - <4 bar atmospheric (will tolerate up to 8 bar supply)
- Vacuum sensor for supply, <0,1 bar absolute (will tolerate up to 8 bar supply)
- First channel drive gas pressure / vacuum sensor outlet to SUP, ± 1 bar
- Second channel drive gas pressure / vacuum sensor outlet to SUP, ± 1 bar
- Proportional valve for positive drive gas pressure regulation
- Proportional valve for negative drive gas pressure regulation
- Fan for cabinet temperature control

External sensor(s):

- For each channel, a re-usable tri-angular red Leuze laser sensor mounts on the re-usable bracket, foot on the SUP for on-line measurement of the actual position of the free-floating silicone membrane / diaphragm inside the Euterpe SUP.



2.2 - Requirement

The drive unit must be properly installed according to fluid diagram and general recommendations.

2.3 - Specification

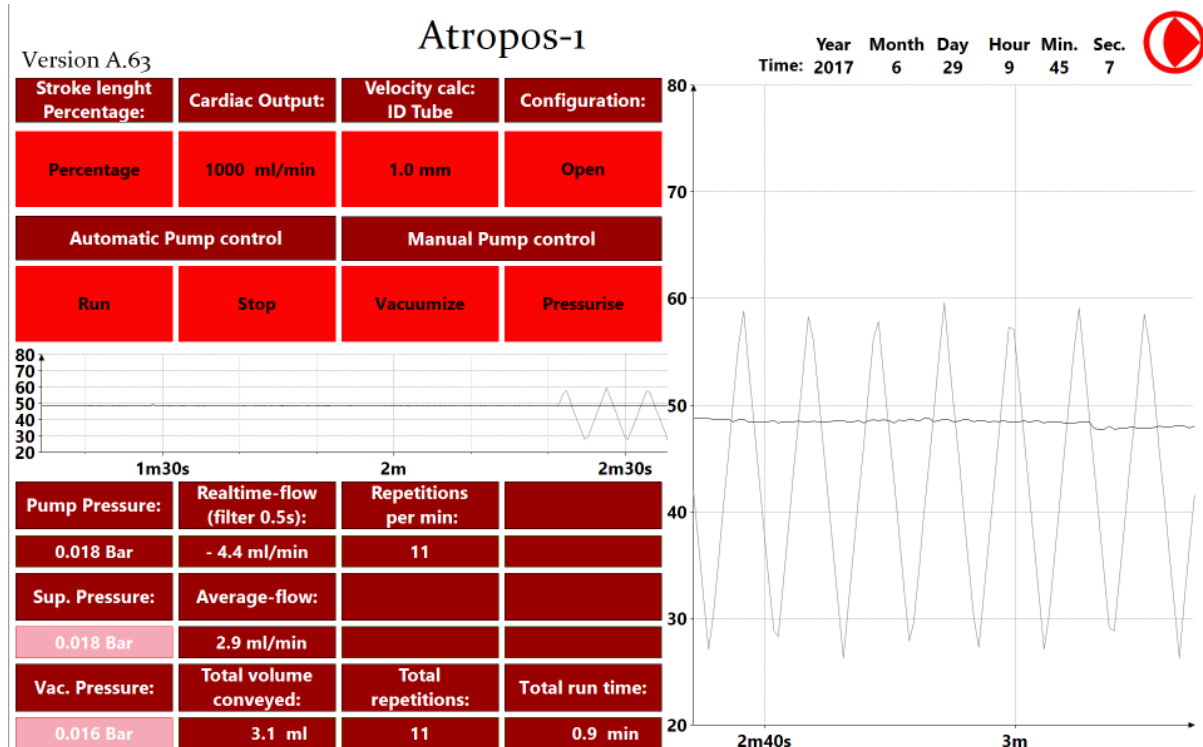
When Atropos is connected to:

- a suitable supply of pressurised air with sufficient capacity
- a suitable supply of vacuum with sufficient capacity
- Leuze Laser sensor(s) for each either one or two channels
- Euterpe Single-Use-Pump(s) for at least one channel
- 24 VDC supply

then the spec is:

Beats-per-Minute (BpM)	Check latest info on www.pumpcell.com
Stroke volume (SV)	Check latest info on www.pumpcell.com
Cardiac Output (CO)	Check latest info on www.pumpcell.com
GUI	5" touch sensitive TFT display
Computer power	900 MHz quad-core ARM Cortex-A7 CPU
USB socket	Wi-Fi like NetGear N300 Mini Adaptor
RJ45 socket	IP/TCP via LAN (ModBus protocol)
Power supply	24 VDC, >30 watt via Buccaneer socket
Build in fan, noise level, dBa	<65
Duty cycle	100%
Orientation	any
Operating conditions	10°C to 40°C, <80% relative humidity, non condensing
Life time, estimated, hours	<50,000
MTBM, battery must be changes, hours	10,000
Cabinet size and material	Hephaestus U2 – AISI304
Weight, kilo	3,5

3. Software setup



Graphical-User-Interphase (GUI) for Atropos drive unit operate with 3 different red colours. Light red is warning info from pressure sensors. Bright red is programming is possible. Dark blood red is read out windows.

3.1 – Basics is the human brain and heart

Atropos control the cardiac cycle of the Euterpe pump. The parameters we work with are:

- Cardiac Output (CO) = total pumped volume, SUP capacity, ml/min (CO = BpM x SV)
- Beats-per-Minute (BpM) = determined by the diaphragm diameter, 0-25
- Stroke Volume (SV) = programmable from 0-100%

Atropos copies the purpose of Medulla in the brain and the heart’s Sinoatrial Node and combines the features with the ability for interaction, programming, and functionality. Atropos take advantage of the build-in Apollon brain and receives real-time signals from pressure, temperature, and displacement/Laser sensors. Apollon regulate by positive feedback control a set of proportional valves for the BpM, and the driving force and movement of the elastic Myocardium wall inside the Euterpe SUP.

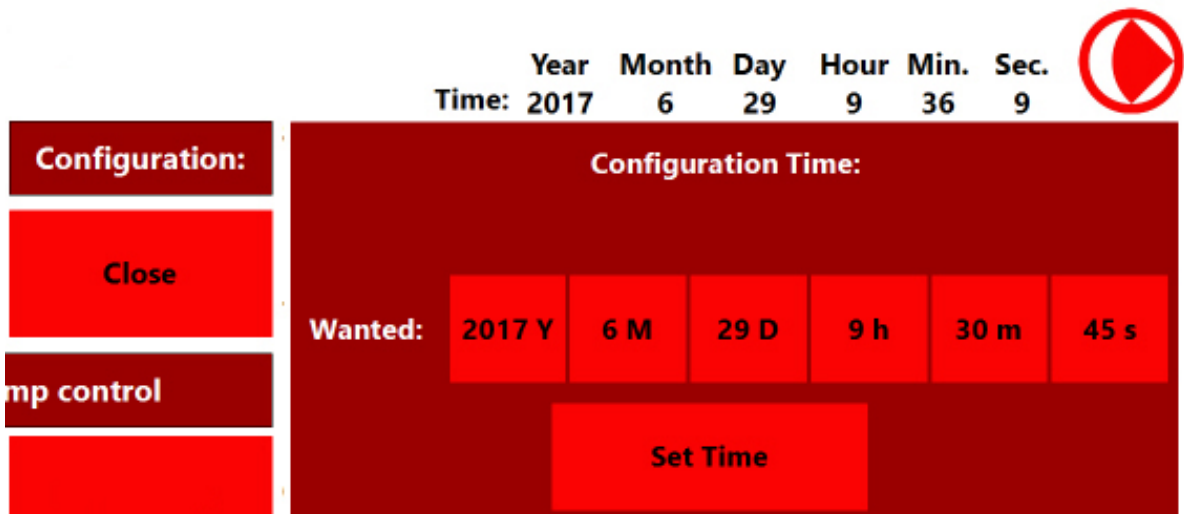
Check more info out on www.pumpcell.com/support

3.2 – You can program various parameters

First you should check if the clock is relevant for your geographic area. Atropos is equipped with a battery driving an internal crystal for accurate time measuring. The clock is set to CET, Central-European-Time. If you need another time its easy to alter. Remember to “Set” the time.

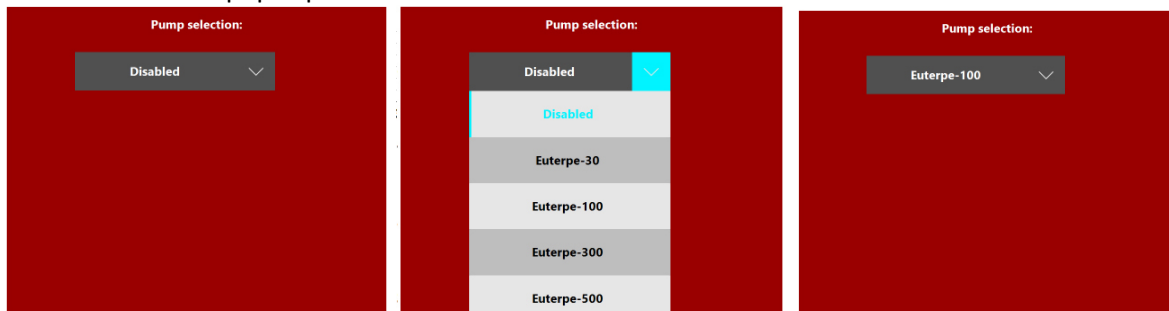


The window “Open” allow clock modification and SUP selection. If clock time is OK or you have modified and chosen the correct size SUP, you have finished - then press “Close”.



Adjusting time

Initial at start-up no SUP is chosen. Press Configuration “Open” and the window for clock adjustment and SUP selection pops up.



If the black bar shows “Disabled” no SUP is chosen. Press the “Disable” black bar and a scroll window appear. Choose the correct size SUP and the black bar show the SUP chosen. Press then “Close”.

3.3 – How to program Atropos

You can determine:

1. Cardiac Output (CO) = total pumped volume in ml/min (CO = BpM x SV)
2. Stroke Volume (SV) = programmable from 0-100%
3. Smallest orifice in the system

There is a relation between SV and BpM. If you select a low SV the maximum BpM depending on the Euterpe size determines the CO. Maximum CO occurs with SV = 100%.

Stroke length Percentage:	Cardiac Output:	Velocity calc: ID Tube
Percentage	1000 ml/min	1.0 mm

Programming and input window

Upper row you have 4 options

3.4 – How to start and stop the software

Automatic Pump control		Manual Pump control	
Run	Stop	Vacuumize	Pressurise

Run

Start up the process based on latest program.

Stop

Terminate the process based on latest program.

Vacuumize

Button for manual operation. Use for system priming and testing functionality.

Pressurize

Button for manual operation. Use for system priming and testing functionality.

3.5 – Details to how measurements is done

Pumped volume, Cardiac Output (CO mL per minute)

SUP displacement and stroke frequency determines the total volume over time. The SUP will pump double the programmed volume as the pump stroke is 50% of the time. The display shows programmed curve and the actual curves. The pumped volume, CO cannot exceed the SUP specific capacity multiplied with the SV in percent.

Stroke Volume, SV, 0-100%

Potentially shear stresses could be of interest. Find the smallest part in the fluid pass and measure the diameter to be inserted in red window under “Velocity Calc:

Orifice velocity, m/s: 0.1 – 10

If highest velocity is of interest. Insert the diameter for the smallest orifice in the system.

Pump Pressure:	Realtime-flow (filter 0.5s):	Repetitions per min:	
0.018 Bar	0.0 ml/min	0	
Sup. Pressure:	Average-flow:		
0.019 Bar	0.0 ml/min		
Vac. Pressure:	Total volume conveyed:	Total repetitions:	Total run time:
0.018 Bar	0.0 ml	0	0.0 min

Data acquisition and real-time read out windows.

Its good to know that “Real-time flow” is approximately the double of “Average-flow”. This because the SUP is a reciprocating pump and fluid is moved only at the down wards stroke.

“Total volume moved” can only be from process start after pressing Run button.

3.5 - Alarms

Data from drive gas is shown online so it the actual pressure above the Myocardium diaphragm. Jumping between vacuum and pressure.

Alarms for:

Alarm area will show if the supply hose for pressure and vacuum is not mounted correctly.

- Pump pressure range, Bar: ± 0.5 to 0.9
- Supply pressure range, Bar: 0.5 to 0.9
- Vacuum pressure range, Bar: ± 0.8 to ± 1.0

If no pressure or vacuum is available, drops out or insufficient – then an alarm as light and the process stops.

4. Hardware installation

The scope of the Atropos product is to drive the Euterpe SUP's.



Unpack and disposing the shipping material properly. Atropos unit need no preparation and is ready for installation. The unit is pre-programmed with the CET time.

Procedure to follow for model Atropos-1 and Atropos-2:

1. Connect a pressurised drive gas supply of max 1 Bar (could be Sarpedon / Alagonia) with 6 mm rigid hose.
2. Connect a vacuum source (such as Sarpedon / Alagonia) with 6 mm rigid hose.
3. Connect the 6 mm drive gas hose from the SUP to Atropos.
4. Mount the level sensor onto the SUP foot.
5. Connect 24 VDC from one of the Eos family of power supplies.
6. Start-up Atropos and watch the unit get alive
7. Spend some minutes and use the two manual buttons to remove air and fill SUP with liquid.
8. Program according to you SOP and planning
9. The Atropos is ready

Requirement

The system must be properly installed and connected in accordance with the specifications and previous information. Operator must also have gained familiarity with the Safety Instructions to be found separately on www.pumpcell.com/support/safety-instructions

4.1 - Fault information

The build-in display of Atropos will inform about possible faults whenever detected.

- If no air pressure or vacuum source is detected
- If no movement is detected by level sensor

5. Communication

Atropos contain a webserver displaying online information on the build-in display.

Each Atropos product has an IP address shown at the Manufacturer's Identification Label under the product. If you hook up via the Wi-Fi connection to a touch sensitive PC, smartphone, or PAD you should see the GUI from the actual Atropos unit.

5.1 - Programming

It is of importance

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5.2 - PID routines

Many hours have been invested in setting up the PID routines and the intelligence for auto-tuning. Atropos will initiate auto-tuning at each start-up for best possible accuracy.

6. Operation Manual

At activation of power button then Atropos (or restoration of voltage after a power outage) starts up and the display will show:

- The operating system software (Linux) is loaded
- The system configuration is loaded.
- The operating software is loaded and actual information shown on display

Any user-defined parameters from a previous process is stored in a battery-buffered memory and can be used for the next process. Atropos is pre-programmed from the manufacturer with simple routines. If there are no faults found by the software Atropos is ready to operate

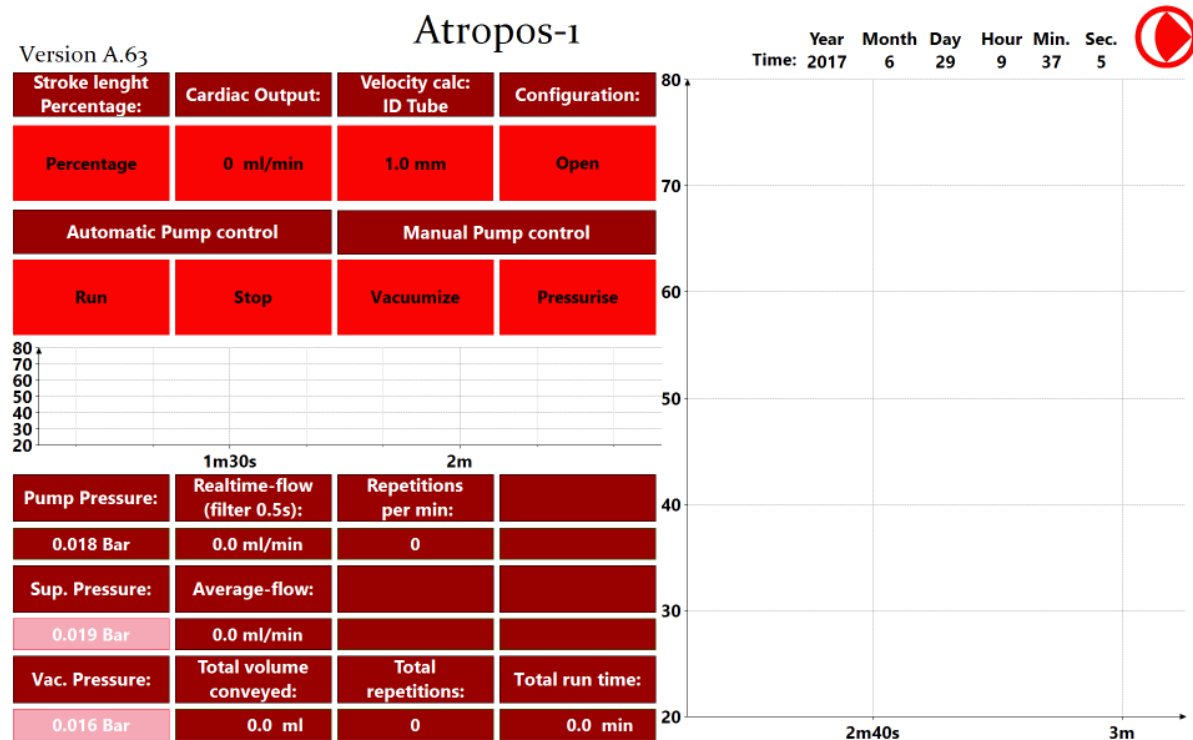


Illustration of the GUI shown on the build-in 5" display.

6.1 - Operation principles

Assuming a correct assembly of all systems, connections, etc. according to your Fluid Diagram – check all connections are tight.

6.2 - Wi-Fi connection

When Atropos is equipped with the NetGear Wi-Fi access point the Apache webhost will be accessible from a browser. Write anything in the address line for access.

6.3 – LAN IP/TCP connection

Note ready yet.

7. Safety precautions

Various component require individual attention. Operator must also have gained familiarity with the Safety Instructions to be found separately on www.pumpcell.com/support/Safety_Instruction .

7.1 - Documentation

Atropos functionality must be checked on a regular basis and data of such testing kept recorded.