Operating Instruction & Manual
Perseus drive unit

Document date: 2020-05-04
Version 1.2

Contents

1 - Concept overview

Perseus is a servo-motor driver and the associated servo motor designed for operation of a variety of Single-Use-Bioreactor, Single-use-Fermenter, Single-Use-Mixers and Stirred-Tank-Reactors. The 3 servo motor options offer different spec ranging 0-4,000 RPM (Revolution-Per-Minute) and 0-1 Nm torque.

What makes Perseus unique is its ability to give detailed online information about the WATT lost to the agitated liquid and hereby in real-time calculate the actual Power Number with reference to RPM.

1.1 – Product purpose

Perseus have several purposes:

1. Agitate Single-Use-Bioreactor (SUB), Single-use-Fermenter (SUF), Single-Use-Mixers (SUM) and Stirred-Tank-Reactors (STR) ranging from 0.5 to 50 liter Vessel Volume (VV)
2. Deliver from 90 up to 180 WATT and up to 4,000 RPM
3. Gives scientific data, information about Power Number – otherwise very hard to establish
4. Be part of the configurable Process-Control-System (PCS) from www.cronus-pcs.com
5. Stand-alone servo motor driver for Single-Use-Bioreactor's (SUBs), Single-Use-Fermenter's (SUFs), Single-Use-Mixer's (SUMs)

2 - Device Overview

The Perseus drive unit is a product manufactured by www.cronus-pcs.com and housed in a Hephaestus U2 cabinet manufactured from AISI 304 stainless steel.

2.1 Specification

When connection to a suitable supply of power the spec is:

External sensor	Integrated encoder in servo motor
Power breaker	Integrated SSR 5 amp
GUI	5" TFT display
Computer power	900 MHz quad-core ARM Cortex-A7 CPU running Linux with Code-Sys PLC software
USB socket	for Wi-Fi and data download
RJ45socket	for IP/TCP via LAN – ModBus and OPC
Power supply	24 VDC, 6 amp
Noise level, dBa	<45
Duty cycle	100%
Orientation	any

Operating conditions	10°C to 50°C, <80% relative humidity, non condensing
Drive unit life-time, estimated, hours	>50,000
MTBM (mean time before maintenance)	10,000
Servo motor life-time – full load, hours	10,000
Cabinet size and material	U2 – AISI304
Weight, kilo	3.5

2.2 – Servo motor

The triple-phase DC servo motors used are:

A - one German quality ECI 42 brush-less 24 VDC, 90 watt servo motor with 1:3.2 planetary gear rated at 0 - 1,200 RPM and 0,7 Nm torque.

B - one German quality ECI 42 brush-less 24 VDC, 90 watt servo motor rated at 0 - 4,000 RPM and 0,2 Nm torque.

C - one German quality ECI 63 brush-less 24 VDC, 150 watt servo motor rated at 0 - 4,000 RPM and 0,4 Nm torque.
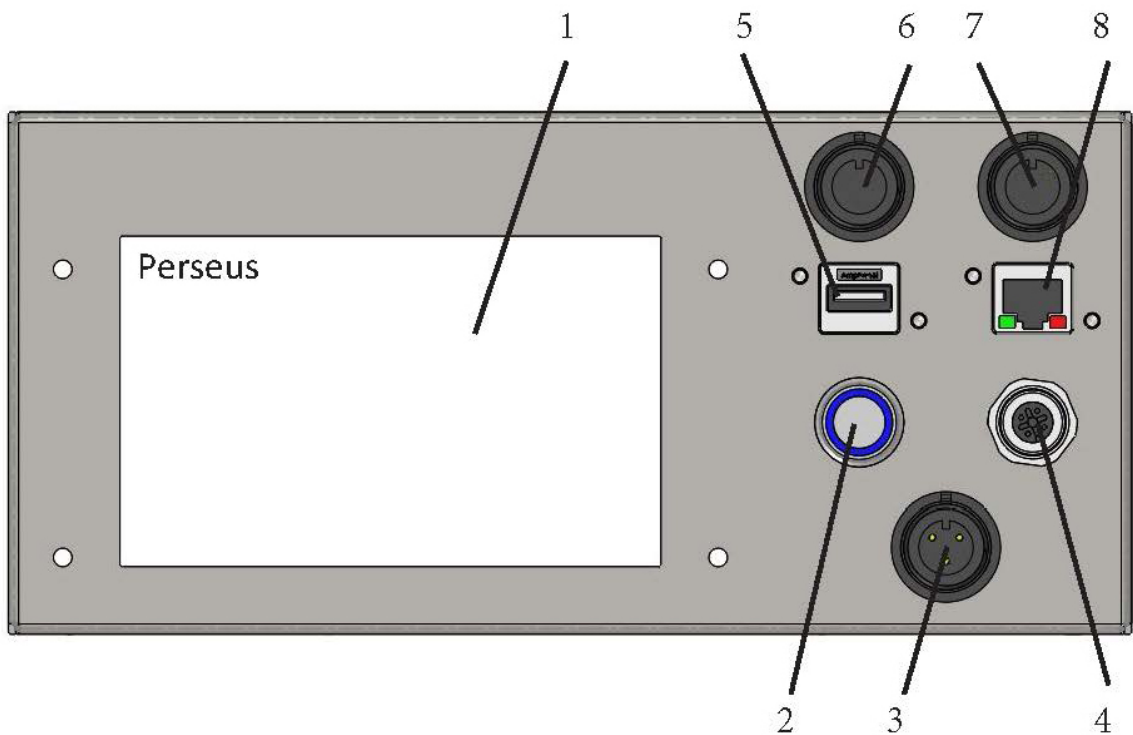

Cable connection from Perseus to servo motor is by 2 individual cables with Buccaneer connectors in both ends. 2 servo motors shown.
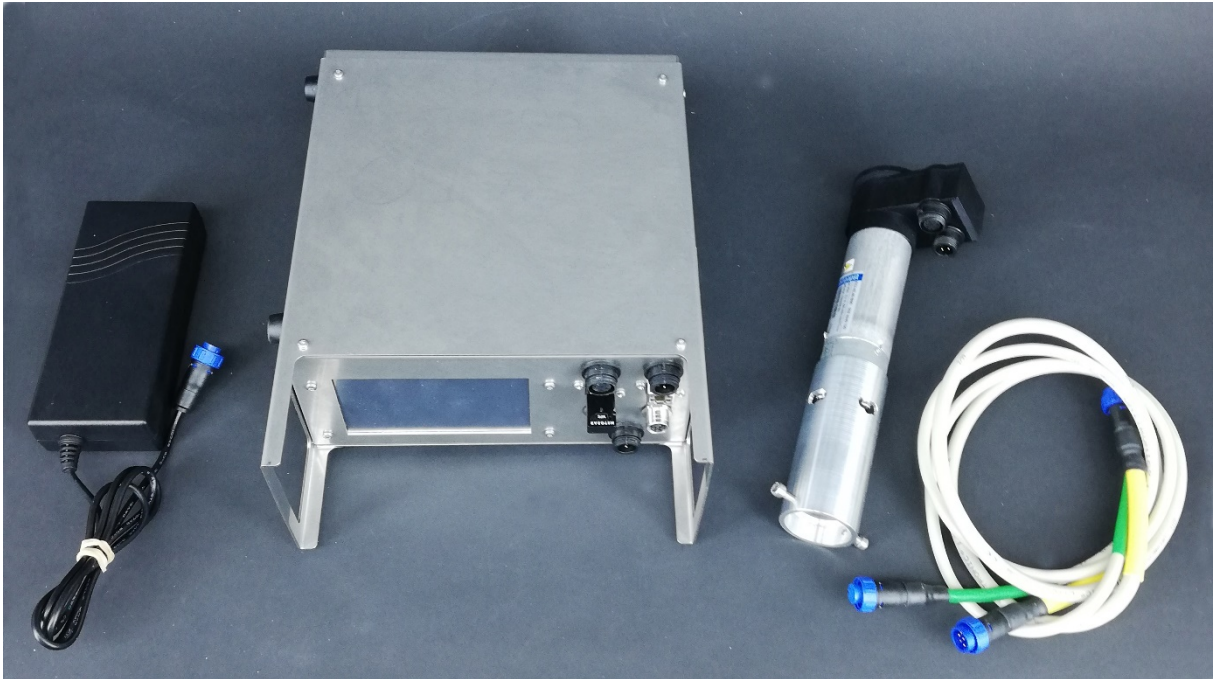
The kit as delivered.

The servo motor's has been 3D mapped on a dynamometer and the entire performance characteristics stored in Perseus memory.

2.3 – Perseus drive unit

Perseus front panel is equipped with:
1. 5" touch sensitive TFT display
2. Main power breaker
3. Buccaneer 3 pin 24 VDC power input
4. M12 RKF 5 pin sockets for external 4-20 mAmp RPM control
5. USB socket for Wi-Fi access and software upgrade
6. Buccaneer 8 pin signal socket for motor connection Yellow cable
7. Buccaneer 4 pin power socket for motor connection Green cable
8. RJ45 socket for Local-Area-Network (LAN) connection

There are two fan openings on the rear panel of Perseus. One opening comply a fan. Avoid pushing the cabinet close to a wall prohibiting ventilation and internal cooling.

3 - Operation Manual

At activation of power button Perseus (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 GUI 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. Perseus is pre-programmed from the manufacturer with simple routines. If there are no faults found by the Perseus software is ready to operate.

3.1 – How to setup and connect Perseus unit to the servo motor

3.1.1 – How-to plug-in cables correctly and in the right places

Perseus drive unit dual motor cables are colour coded.

Yellow power cable has 8 contact pins. Green encoder cable has 4 contact pins.

3.1.2 – How to mount the motor with the right adaptor

The motor can fit many types of mounting as long because we can make an adaptor that fist almost everything.

For now we will concentrate on MST (Magnetic Stirrer Table) and HPD (Head Plate Drive) mounting. **Make sure everything is in the right place.**

MST drive:
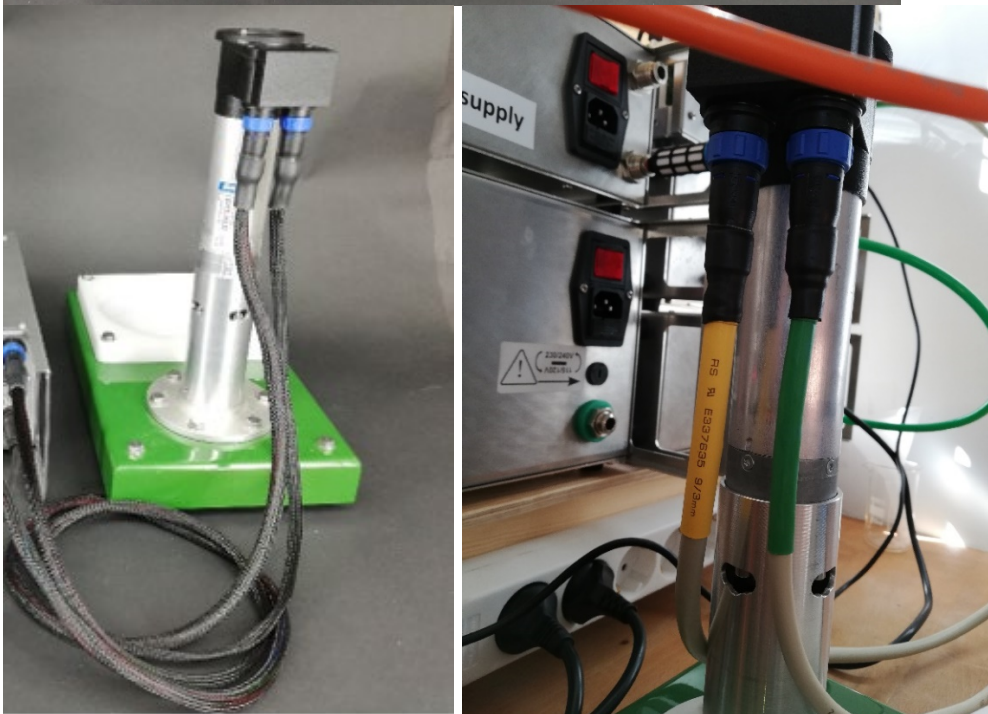
Illustrated how the DC motor is mounted with the adapter on an MST with coloured cables in the right places.

HPD drive:
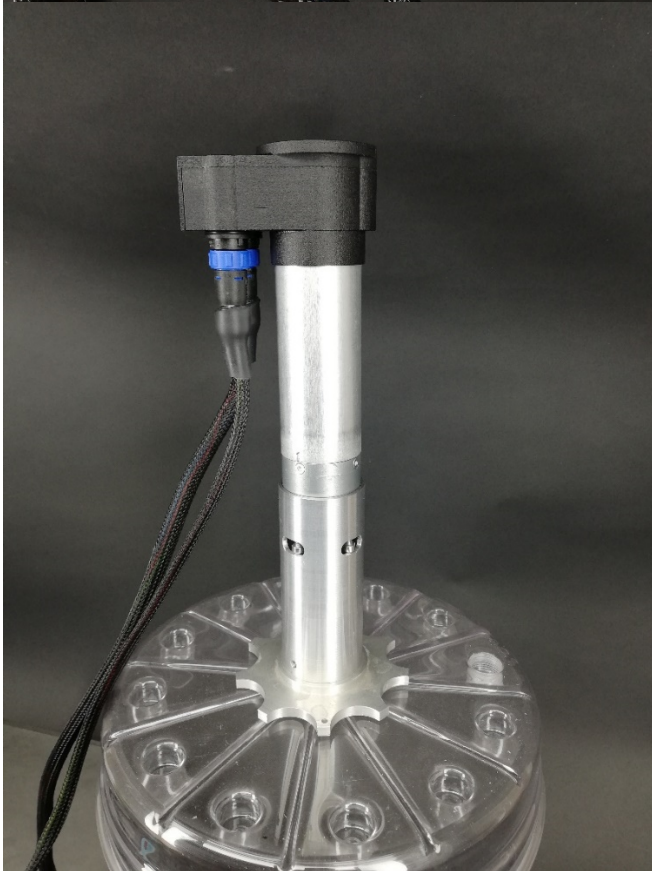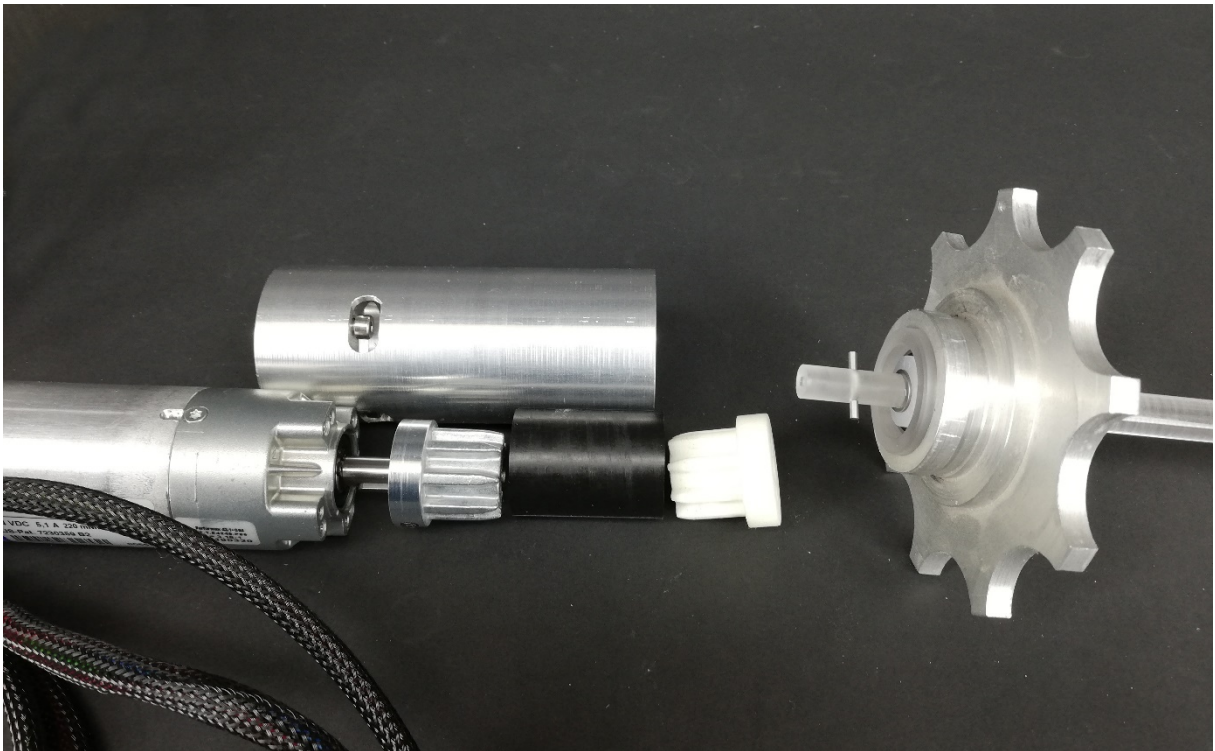
Illustrated how the DC motor is mounted with the adapter on an head plate (HPD).

3.1.3 – How to control RPM extern with analogue input

The Perseus drive unit optionally may control the servo motor RPM from an external device via analogue 4-20 mAmp input. Like from a Process-Control-System (PCS) or a controller able to offer the analogue 4-20 mAmp output.

Perseus software include the option to select external RPM control.

Photo show a testing "milli amp generator" able to simulate the external controller with a 4-20 mAmp signal. Not part of the kit !

3.2 - Perseus GUI explanation
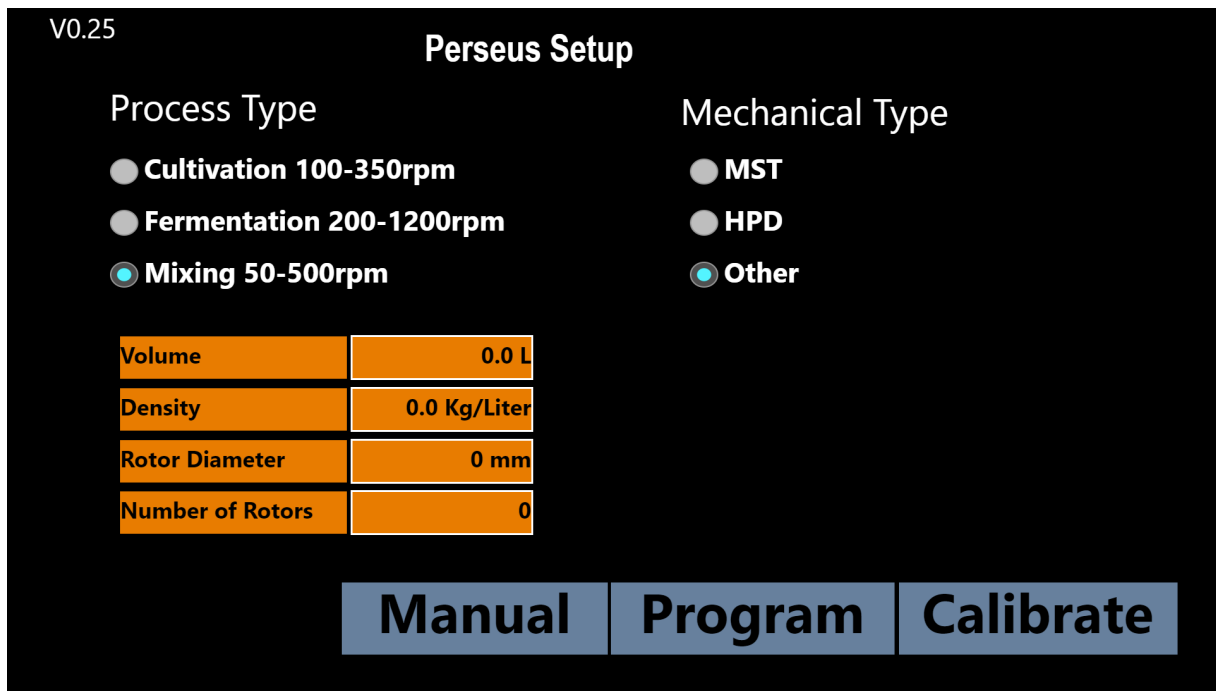
Perseus has a black background / Graphic-User-Interface (GUI) design.

Being the first user interface, you will see after power up. This is also here you setup the main details of your process by following the 4 steps below.

1 select - What **Process Type** you plan to run? Your choice has impact of the RPM you can choose.
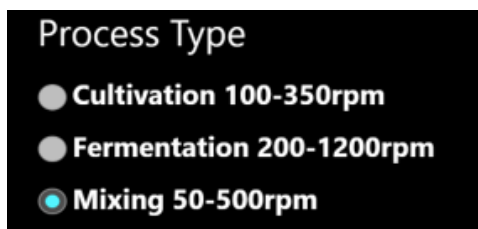
Perseus Process Type selection.

2 select - Which **Mechanical Type** drive you plan?
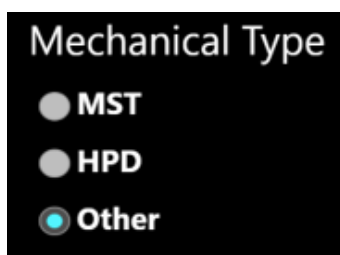
Perseus Mechanical Type selection.

3 select - Which **Volume**, **Density**, **Rotor Diameter** and **Number of Rotors**. Click on the areas surrounded by white and a numpad will appear.

Vessel setup selection.

The numpad will show minimum and maximum value. You must be in the shown range to set a new value. The **Back** button will erase one character, the **Clear** button will clear all the characters, the **ESC** (Escape) button will close the numpad without any changes. The **OK** button will set the new values and close the numpad if the new values is between the minimum and maximum.
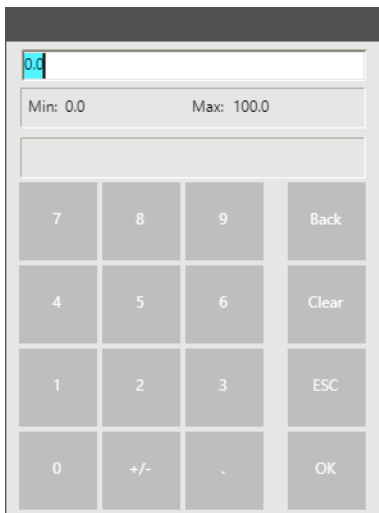
Numpad that will occur several times during setup of Perseus.

4 select - The last section of the setup/start GUI of Perseus will send you to another GUI, either the **Manual**, **Program** or **Calibrate**.
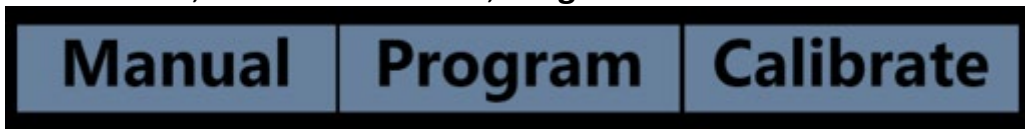
GUI selection bar in Perseus Setup GUI.

Perseus Setup

Process Type
- ⚪ **Cultivation 100-350rpm**
- ⚪ **Fermentation 200-1200rpm**
- 🔵 **Mixing 50-500rpm**

Mechanical Type
- ⚪ **MST**
- 🔵 **HPD**
- ⚪ **Other**

Volume	20.0 L
Density	1.5 Kg/Liter
Rotor Diameter	30 mm
Number of Rotors	3

Manual	**Program**	**Calibrate**
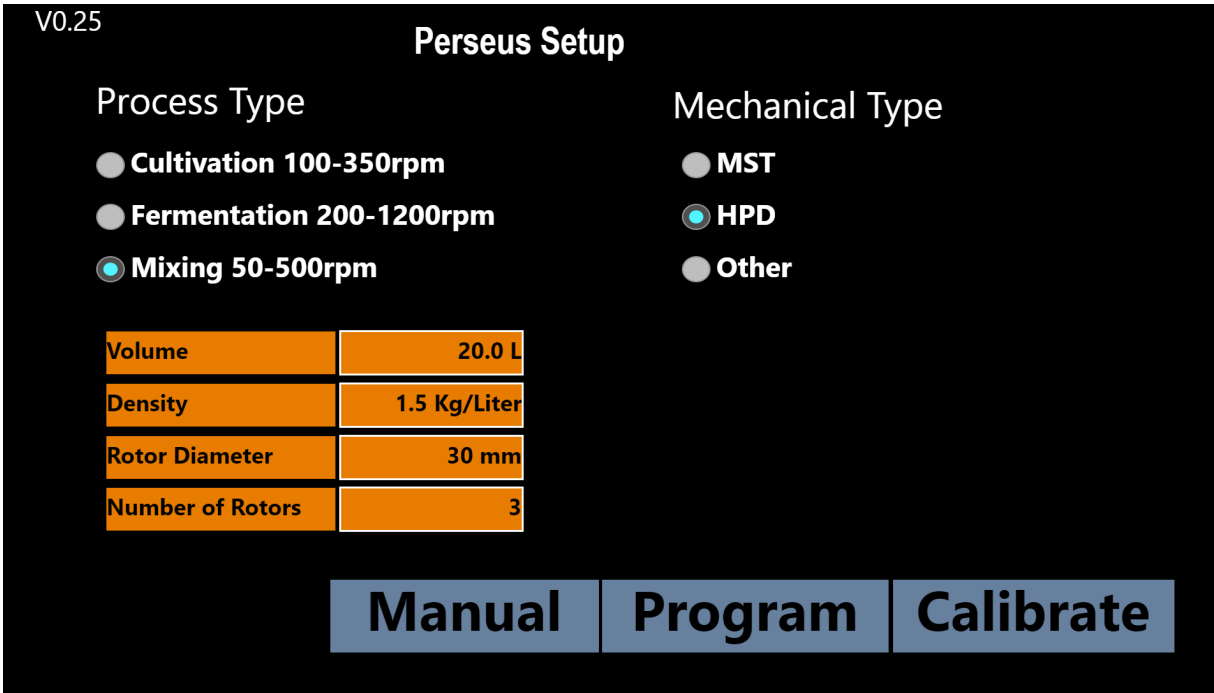
Ready with all the basics for a perfect run. Example shown!

3.2.1 – Perseus Manual GUI

Perseus Manual

Mechanical Type	MST	Desired Value	0rpm
Volume	0.0 L	Velocity	0 rpm
Density	0.0 Kg/Liter	Torque	-2 mNm
Rotor Diameter	0 mm	Mechanical Power	0.0 W
Number of Rotors	0	Power Number	0.0

Running	**0 hour**	**0 min**	**0 sec**

Clockwise	**Start**	**Intern**	
Counter clockwise	**Stop**	**Ext/4-20ma**	**Setup**
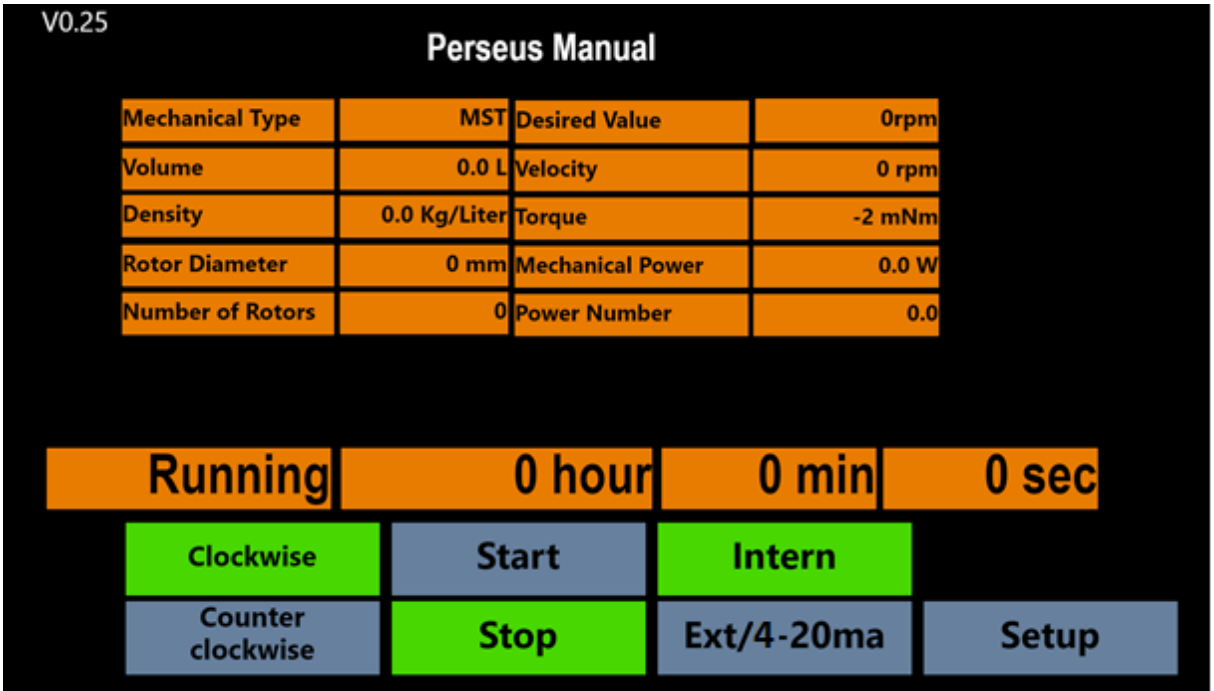
Perseus Manual *GUI is where you decide if you want to manually control the RPM of the servo motor.*

1 - The table below show what you typed in at the Setup GUI.

Mechanical Type	MST
Volume	0.0 L
Density	0.0 Kg/Liter
Rotor Diameter	0 mm
Number of Rotors	0

Vessel information non editable.

2 - This table below is where you want to put in the desired **Velocity Value** by clicking inside the green area as shown at right in the top line, The only variable you can change in this table - by a numpad that shows up.

Necessary to get the motor to start rotating. The remaining lines 2-5 of the table shows on-line data:

1. Choose **Desired Value**
2. **Velocity**: the actual RPM
3. **Torque**: the torque the motor is delivering in milli Newton meter
4. **Mechanical Power**: the power the motor is consuming in Watt
5. **Power Number**: Power Number is a dimension less information used to compare with other rotor systems

Desired Value	0rpm
Velocity	0 rpm
Torque	-2 mNm
Mechanical Power	0.0 W
Power Number	0.0

Desired value (RPM) editable and motor information non editable.

3 - This bar below shows the running time since the motor was started.

Running	0 hour	0 min	0 sec

Information about running time for motor.

4 - At the last element of the Manual GUI you can choose: direction of rotation, **Start** and **Stop** the motor. If you want to use **Intern** or **Extern** (4-20 mAmp) control of the motor. The button lights up in green showing what is enabled.

Clockwise	Start	Intern	
Counter clockwise	Stop	Ext/4-20ma	Setup

Motor control bar and change of GUI (Setup).

You can return to **Setup** only when the motor is not running otherwise the setup button will fade a little out and be unavailable. Like sown on next picture.

V0.25

Perseus Manual

Mechanical Type	HPD	Desired Value	100rpm
Volume	20.0 L	Velocity	100 rpm
Density	1.5 Kg/Liter	Torque	56 mNm
Rotor Diameter	30 mm	Mechanical Power	0.0 W
Number of Rotors	3	Power Number	54.3

Running	0 hour	5 min	2 sec
Clockwise	Start	Intern	
Counter clockwise	Stop	Ext/4-20ma	Setup
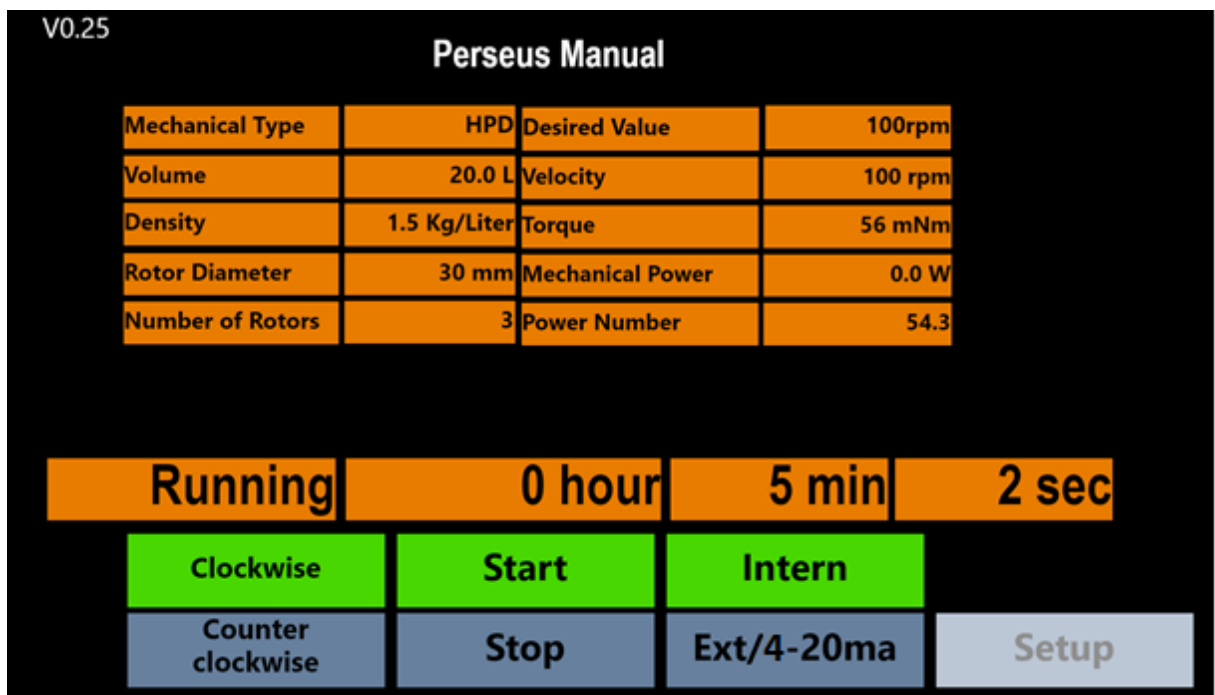
Ready with the RPM inserted and START pressed. Example shown!

V0.25						
Perseus Program						
Velocity	0 rpm	**No**	**Velocity**	**Hours**	**Min**	**Dir.**
Torque	-1 mNm	1	0rpm	0	0	
Mechanical Power	0.0 W	2	0rpm	0	0	
Power Number	0.0	3	0rpm	0	0	
Mechanical Type	Unknown					
Volume	0.0 L					
Density	0.0 Kg/Liter					
Rotor Diameter	0 mm	Set Sequence				
Number of Rotors	0	Continous				
Time left		0 hour	0 min	0 sec		
Start/ Continue	**Stop**	**Reset**	**Setup**			
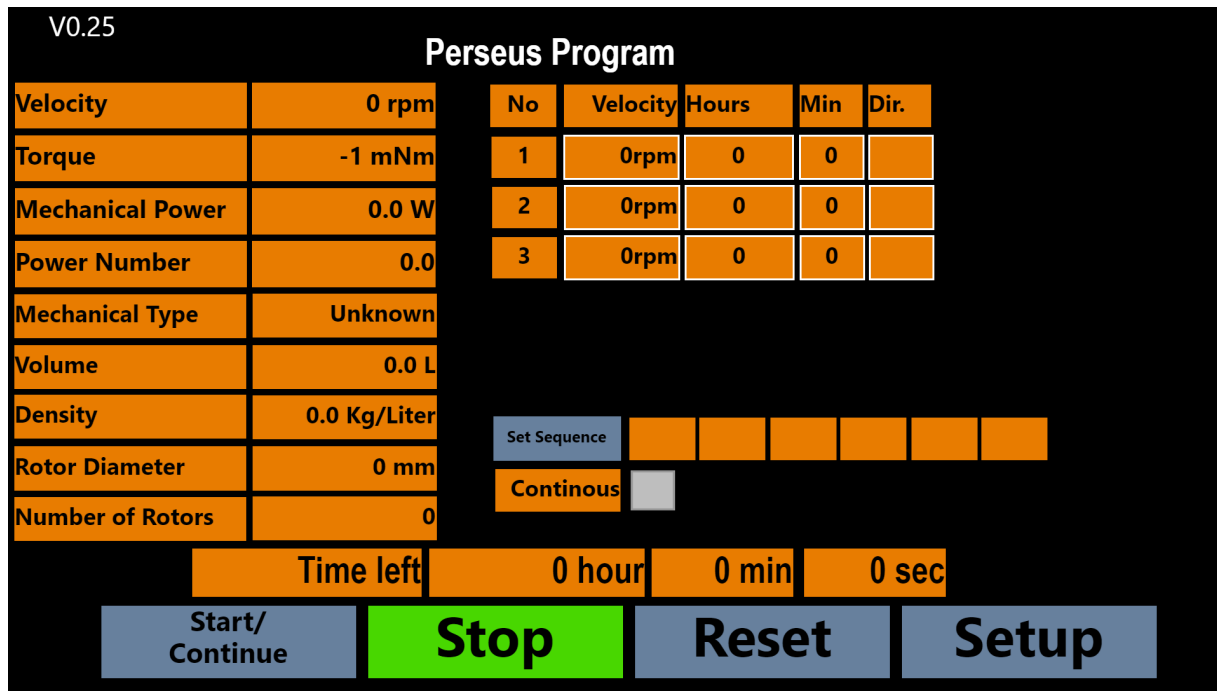
Perseus Program GUI before any manual changes.

If you want different RPMs during your run, you can choose **Perseus Program** instead of the manual solution. This program option will allow you to create sequences of your own design. You can decide to run the program once or loop it (continuous).

During Program or Manual mode the shown Mechanical Power (Watt) is the total Watt consumed subtracted the Watt lost to total mechanical friction measured in Calibration mode. To calibrate and measure the mechanical friction loss the vessel must be empty!

If one wants to remove Calibration then press "Factory Settings" and the mechanical power will be the total mechanical power induced to the system including total mechanical losses.

Entering Calibrate, Program or Manual mode automatically start an initialization of the motor controller which will disable some user interactions for a while. It is seen by some of the buttons turns grey.

1 - The first table shows all the variables as selected in the Setup GUI and all the motor numbers/explained in the 3.1.2 - **Perseus Manual** GUI section.

Velocity	0 rpm
Torque	-1 mNm
Mechanical Power	0.0 W
Power Number	0.0
Mechanical Type	Unknown
Volume	0.0 L
Density	0.0 Kg/Liter
Rotor Diameter	0 mm
Number of Rotors	0

Vessel and motor information, non editable.

1 – In the table below you can design 3 types of runs the motor can execute during the sequence. For all 3 of them you must choose the velocity (RPM), runtime (**Hours and Min**) and **DIR**ection being **CW** (clockwise) or **CCW** (counter clockwise). All boxes which values can be changed are surrounded with a white frame.

No	Velocity	Hours	Min	Dir.
1	0rpm	0	0	
2	0rpm	0	0	
3	0rpm	0	0	

Run design table, editable.

2 - Now you can set the sequence you may like in the order of 1 to 6 runs. By clicking the grey **Set Sequence** it will activate a pop-up window that will let you use the combination of the 1-3 runs you have designed. All you need to do is to press the No 1-3 in the order you wish to go.

Set sequence bare show the picked sequence once selected.

If you want the sequence to loop (run continuously), then tick the little grey box to the right side of Continuous.

Sequence selection table.

By pressing button No 1 - 3 you can select your sequence.
C button: will erase the numbers in the white area.

CANCEL button: will close the pop-up window without any changes.
OK button: will let you set the selected sequence.

3 - The **Time left** bar will show how much time the enabled run has left.
Example No 1 run have 1 hour left before entering run No 2.
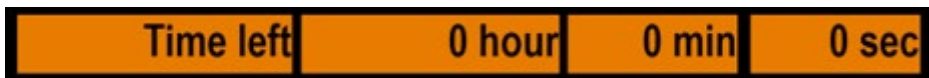
Time bar for current run in the sequence.

4 - The last bar let you **Start**, **Stop**, **Continue** or **Reset** the sequence, and let you go back to the Setup GUI if the motor is stopped.

Perseus Program control bar and change of GUI (Setup).

The picture below shows how the Perseus GUI will look like when the motor sequence is started and are in run No 1 highlighted with a green light.

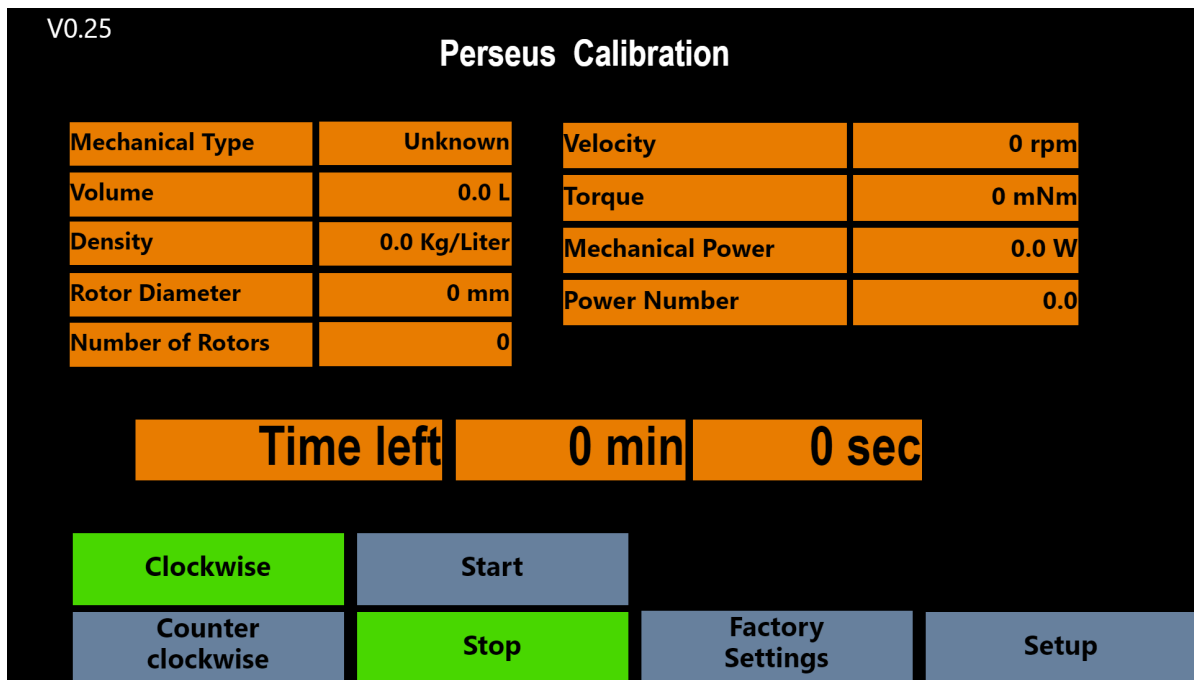|			No	Velocity	Hours	Min	Dir.
Velocity		50 rpm	1	50rpm	2	0	CW
Torque		49 mNm	2	100rpm	0	30	CCW
Mechanical Power		0.0 W	3	150rpm	1	14	CW
Power Number		392.2					
Mechanical Type		HPD					
Volume		20.0 L					
Density		1.5 Kg/Liter		Set Sequence	1 2 3 2		
Rotor Diameter		30 mm		Continous	✓		
Number of Rotors		3					

Time left — 1 hour — 58 min — 58 sec

| Start/ Continue | Stop | Reset | Setup |

Ready with the sequense inserted and START pressed. Example shown!

The **Perseus Program** table above show in left column selected vessel and motor values. If they needed to be changed - go back to start - cannot be change in this window.

3.2.3 – Perseus Calibrate GUI

V0.25	**Perseus Calibration**

Mechanical Type	Unknown		Velocity	0 rpm
Volume	0.0 L		Torque	0 mNm
Density	0.0 Kg/Liter		Mechanical Power	0.0 W
Rotor Diameter	0 mm		Power Number	0.0
Number of Rotors	0			

Time left   0 min   0 sec

Clockwise	Start		
Counter clockwise	Stop	Factory Settings	Setup

Perseus Calibration GUI before any manual changes.

Quite unique you can obtain **Torque**, **Mechanical Power** and **Power Number** as real-time data, information for the selected / specific drive system, rotor system in a specific vessel.

You need to mount the servo motor on the drive system (HPD, MST) before you can calibrate Perseus. Allowing the software to measure losses, consumption for a short period. Hereby able to calculate the numbers continuously.

1 - The time bar shows how long time left for the calibration to be finished.

Time left   0 min   0 sec

Time bar for current calibration.

2 – In the **Perseus Calibration** window you must choose direction of rotation. Then press start and the motor will calibrate itself to whatever it is mounted too, make sure to do it before putting any liquid into the vessel.
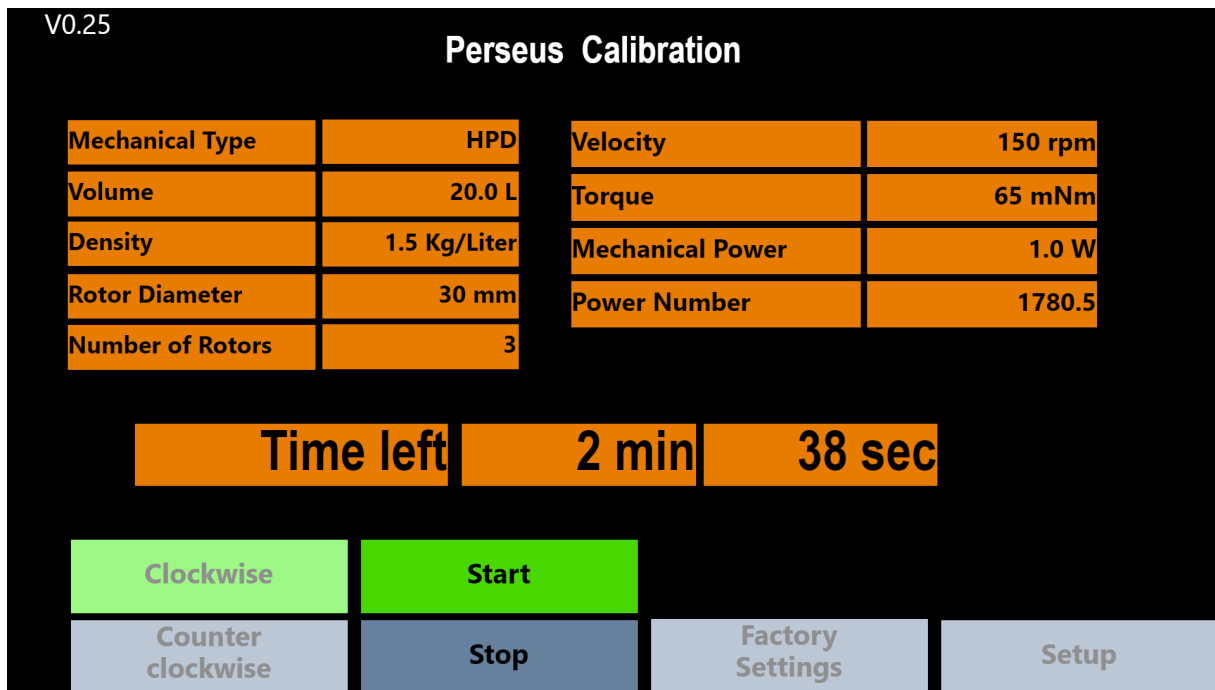
If anything should go wrong or the vessel/mounting setup was wrong just stop the process and reset the calibration.

To reset press the button **Factory Settings** and start the calibration again when the setup is correct.

Clockwise	Start		
Counter clockwise	Stop	Factory Settings	Setup

Perseus Calibration control bar and change of GUI (Setup).

The picture below shows how the Perseus Calibration GUI will look like when its running.

	Perseus Calibration		
V0.25			

Mechanical Type	HPD	Velocity	150 rpm
Volume	20.0 L	Torque	65 mNm
Density	1.5 Kg/Liter	Mechanical Power	1.0 W
Rotor Diameter	30 mm	Power Number	1780.5
Number of Rotors	3		

Time left	2 min	38 sec

Clockwise	Start		
Counter clockwise	Stop	Factory Settings	Setup

Ready with the calibration inserted and START pressed. Example shown!

After calibrating you need to go back to setup and choose Manual or Program to make the motor running.

3.3 – User example

A short (not so detailed) summery of the route diagram of the Perseus software is:

Start in the Setup GUI where vessel and liquid info are set, go to either:
- Manual GUI
  - Start motor with desired RPM or go back to Setup GUI.

- Program GUI
  - Start sequence with desired runs or go back to Setup GUI.

- Calibration GUI
  - Start calibration, reset to factory settings or go back to Setup GUI.

4 - Operation principles

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

4.1 – Wi-Fi connection

When Perseus is equipped with the NetGear Wi-Fi access point the Apache webhost will be accessible from a browser.

Go into "Settings"/ Wi-FI NETWORKS" and check if you can see Perseus and select. Return to a browser and write anything in the address line for access to Apollon.

Perseus can be controlled via an USB Wi-Fi dongle:

SSID: perseusXX-cronus

Phrase: cronus-perseus

4.2 – LAN IP/TCP connection

Check present development status on https://cronus-pcs.com/support/

4.3 – Software upgrade

Check out www.cronus-pcs.com/support/communication/software-upgrade

4.4 – Power supply

CE and UL marked **MeanWell GSM160A24** power supply with EIC C13 inlet which fit any wall power with ground. Delivered without the power cable. Be sure to use cabling with ground and wall power ground.

More info here - https://cronus-pcs.com/products/eos-power-supplies/

5 - Safety precautions

Various component requires individual attention. Operator must also have gained familiarity with the Safety Instructions to be found separately on https://cronus-pcs.com/support/

5.1 – Documentation

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

5.2 – CE Declaration of Conformity

CE Declaration of Conformity	
Company: Cronus-PCS	
Company address: Malmmosevej 19C DK-2840 Holte Denmark www.cronus-pcs.com	

We hereby declare that based on the design, construction and product placed on the market, the product designated below fulfils the relevant fundamental safety requirements and health regulations specified by the pertinent EC Directive.

The declaration shall become legally invalid if any modifications are made to the product, which have not been approved and certified by Cronus-PCS.

Designation of the pump product: Perseus - p/n 8410

Relevant directives of the EC:
- 2006/42/EC Machinery
- Electromagnetic Compatibility - DIN EN 61000-3-2:2014
- Electrical equipment designed for use within certain voltage limits – EIC 61010-1:2010

Date of signature: 2019-11-15

Function of Signature
Per Stobbe
CEO and Director of R&D