Operating Instruction & Manual
Cilix-19 drive unit

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Version 1.2

Contents

1 - Concept overview

Cilix-19 is an 8 in parallel BLDC motor driver/controller. The associated BLDC motors designed for operation of a variety of Single-Use-Bioreactor, Single-use-Fermenter, Single-Use-Mixers and Stirred-Tank-Reactors.

What makes Cilix-19 unique is its ability to give detailed real-time information about the WATT lost to the agitated liquid and hereby in real-time calculate and show the actual Power Number with reference to RPM.

1.1 – Product purpose

Cilix-19 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 13 liter Vessel Volume (VV)
2. Deliver from 0.1 up to 50 WATT and up to 2,800 RPM with BLY-17 motor
3. Gives scientific data, information about Power Number – otherwise very hard to establish
4. Optional operate as part of the configurable Process-Control-System (PCS) from www.cronus-pcs.com under Lucullus via OPC-UA
5. Stand-alone BLDC motor driver for Single-Use-Bioreactor's (SUBs), Single-Use-Fermenter's (SUFs), Single-Use-Mixer's (SUMs) with BLY-17

2 - Device Overview

The Cilix-19 motor driver/controller is a product manufactured by www.cronus-pcs.com and housed in a 19" rack U2 cabinet.

2.1 Specification

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

External sensors	Integrated encoders in BLDC motor – Hall and Optical
Power breaker	Integrated fuse
GUI	5" TFT display
Computer power	900 MHz quad-core ARM Cortex-A7 CPU running Linux with Code-Sys PLC software
USB socket	data download and external Wi-Fi antenna adapter
RJ45 socket	for IP/TCP via LAN – ModBus and OPC
Power supply	110-230 VAC, 50-60 Hz
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
Anaheim BLY17 BLDC motor life-time – full load, hours	10,000
Weight, kilo	9 kg

2.2 – BLDC motor

Cilix-19 is designed for triple-phase DC servo motors:

- Anaheim Automation BLY171D-24V-2800-1000SI NEMA-17 size with OD 5 mm axle – a 24 VDC driven motor that deliver up to 25 WATT and up to 2800 RPM
- Teknic M-2331W-LS-04K NEMA-23 motor rated at ~150 Watt, 48 VDC with 9.5 mm axle – when driven by Cilix-19 max RPM around 400

Cable connection from Cilix-19 to BLDC motors is by one yellow Turck and one M12 grey both attached to the motor black hat. Motors shown ID30 adaptor of different length for different size bioreactor.

2.3 – Perseus drive unit
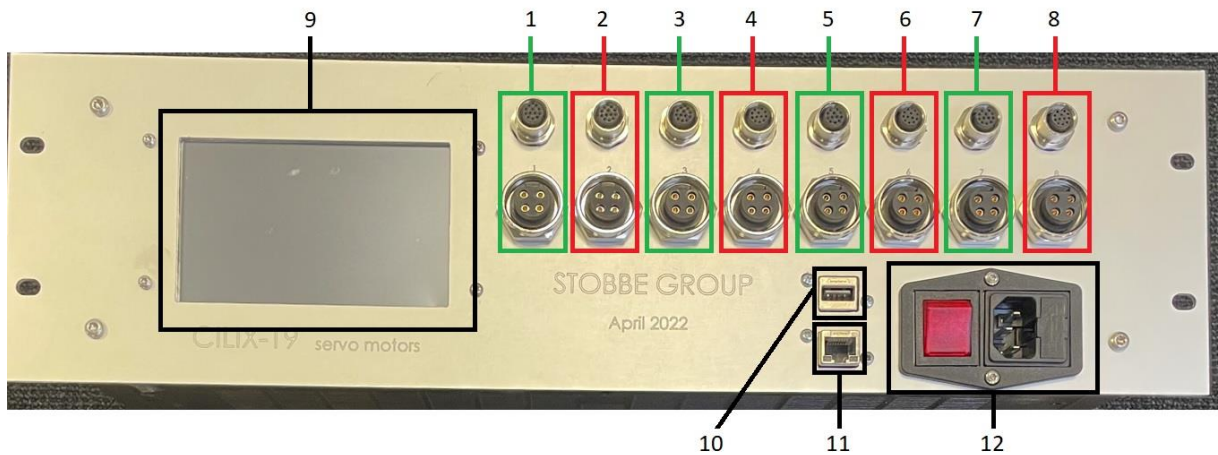
Perseus front panel is equipped with:

1. Motor connection 1
2. Motor connection 2
3. Motor connection 3
4. Motor connection 4
5. Motor connection 5
6. Motor connection 6
7. Motor connection 7
8. Motor connection 8
9. 5" touch sensitive TFT display
10. USB socket for Wi-Fi access and software upgrade
11. RJ45 socket for Local-Area-Network (LAN) connection
12. Main power breaker and 110-230 VAC power input

Illustration of where the different cables are to be connected to the Cilix-19.

3 - Operation Manual

At activation of power button Cilix-19 (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 are stored in a battery-buffered memory and can be used for the next process. Clilix-19 is pre-programmed from the manufacturer with simple routines. If there are no faults found by the Cilix-19 software - then ready to operate.

3.1 – How to setup and connect Cilix-19 unit to the BLCD motor

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

Cilix-19 drive unit dual motor cables are yellow and grey and are connected like shown to every channel 1-8: grey M12 cable connection top and yellow Turck connection at bottom.

Yellow power cable has 4 contact pins. Grey encoder cable has 12 contact pins.

3.1.2 – How to mount the motor with the right adaptor

The BLY17 motor will fit a range of adapters based on the same NEMA-17 flange layout. Photo show at left the long ID30 designed for CellVessel and to the right the short ID30 designed for DYnaSUBs.

Seen the larger WF21 sprocket and to the right the smaller WF11 sprocket.
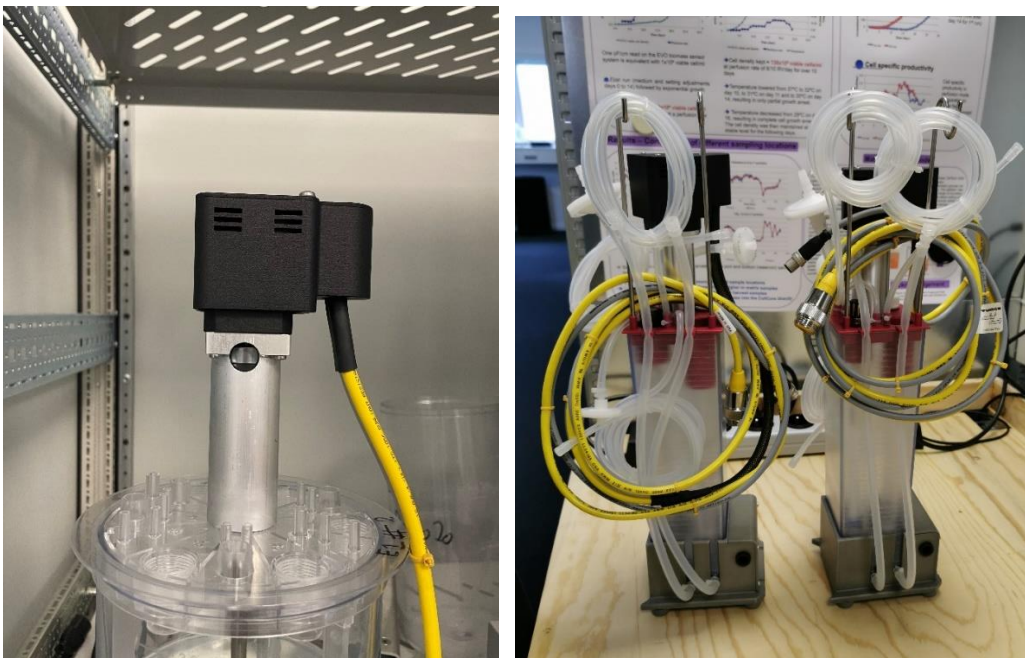
Illustrated how the BLY17 motor is mounted with the long ID30 adapter on head plate (HPD) on a 3.2 liter CellVessel. And how the short ID30 fits on the 1 liter DYnaSUB.

3.2 – Cilix-19 GUI explanation

Motor 1	None	stop	0 rpm	0 rpm	0.0	mNm ▼
Motor 2	None	stop	0 rpm	0 rpm	0.0	mNm ▼
Motor 3	None	stop	0 rpm	0 rpm	0.0	mNm ▼
Motor 4	None	stop	0 rpm	0 rpm	0.0	mNm ▼
Motor 5	None	stop	0 rpm	0 rpm	0.0	mNm ▼
Motor 6	None	stop	0 rpm	0 rpm	0.0	mNm ▼
Motor 7	None	stop	0 rpm	0 rpm	0.0	mNm ▼
Motor 8	None	stop	0 rpm	0 rpm	0.0	'mW' ▼

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Cilix-19 has a black background / Graphic-User-Interface (GUI) design.

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

1 select – Auto setup motor

The following is very important for setting up the unit.
By pressing the display field "stop" (with white surrounding) of the chosen motor, a selection window will appear and then choose "Set Auto", this will set the motor setting for the specific motor that is connected inside the driver. (If the Auto tuning have been performed and the motor is the same, it is not necessary to repeat the above, even after a shutdown of Cilix-2), but beware that the motor must:

- be load-free
- not to be touched
- be able to turn freely in any direction (not connected to anything)

Finish by pressing "OK" to confirm the changes or "CANCEL" to go back to the start screen without any changes, see pictures below:

Motor 1	Anaheim BLY17	stop	0 rpm	0 rpm	0.0	mNm	▼
Motor 2	Anaheim BLY17	stop	0 rpm	0 rpm	0.0	mNm	▼
Motor 3	Anaheim BLY17	stop	0 rpm	0 rpm	0.0	mNm	▼
Motor 4	Teknic 2331	stop	0 rpm	0 rpm	0.0	mNm	▼
Motor 5	Anaheim BLY17	stop	0 rpm	0 rpm	0.0	mNm	▼
Motor 6	Anaheim BL				0.0	mNm	▼
Motor 7	Anaheim BL				0.0	mNm	▼
Motor 8	Anaheim BL				0.0	mNm	▼

Motor Nr: 1

STOP   CW   CCW

Set Auto   CANCEL

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Cilix-2 Motor Auto Setup 1

Motor 1	Anaheim BLY17	stop	0 rpm	0 rpm	0.0	mNm	▼
Motor 2	Anaheim BLY17	stop	0 rpm	0 rpm	0.0	mNm	▼
Motor 3	Anaheim BLY17	stop	0 rpm	0 rpm	0.0	mNm	▼
Motor 4	Teknic 2331	stop	0 rpm	0 rpm	0.0	mNm	▼
Motor 5	Anaheim BLY17	stop	0 rpm	0 rpm	0.0	mNm	▼
Motor 6	Anaheim BL				0.0	mNm	▼
Motor 7	Anaheim BL				0.0	mNm	▼
Motor 8	Anaheim BL				0.0	mNm	▼

Motor Nr: 1 Auto Setup

The motor must be load-free.
The motor must not be touched.
The motor must be able to turn
 freely in any direction

OK   CANCEL

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Cilix-2 Motor Auto Setup 2

Motor 1	Anaheim BLY17	auto	0 rpm	0 rpm	0.0	mNm ▼
Motor 2	Anaheim BLY17	stop	0 rpm	0 rpm	0.0	mNm ▼
Motor 3	Anaheim BLY17	stop	0 rpm	0 rpm	0.0	mNm ▼
Motor 4	Teknic 2331	stop	0 rpm	0 rpm	0.0	mNm ▼
Motor 5	Anaheim BLY17	stop	0 rpm	0 rpm	0.0	mNm ▼
Motor 6	Anaheim BLY17	stop	0 rpm	0 rpm	0.0	mNm ▼
Motor 7	Anaheim BLY17	stop	0 rpm	0 rpm	0.0	mNm ▼
Motor 8	Anaheim BLY17	stop	0 rpm	0 rpm	0.0	mNm ▼

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Cilix-2 Motor Auto Setup 3

When the "Auto" field again shows "Stop" the setup is finished with the auto setup of the chosen motor. Which normally takes around 1-2 minutes.

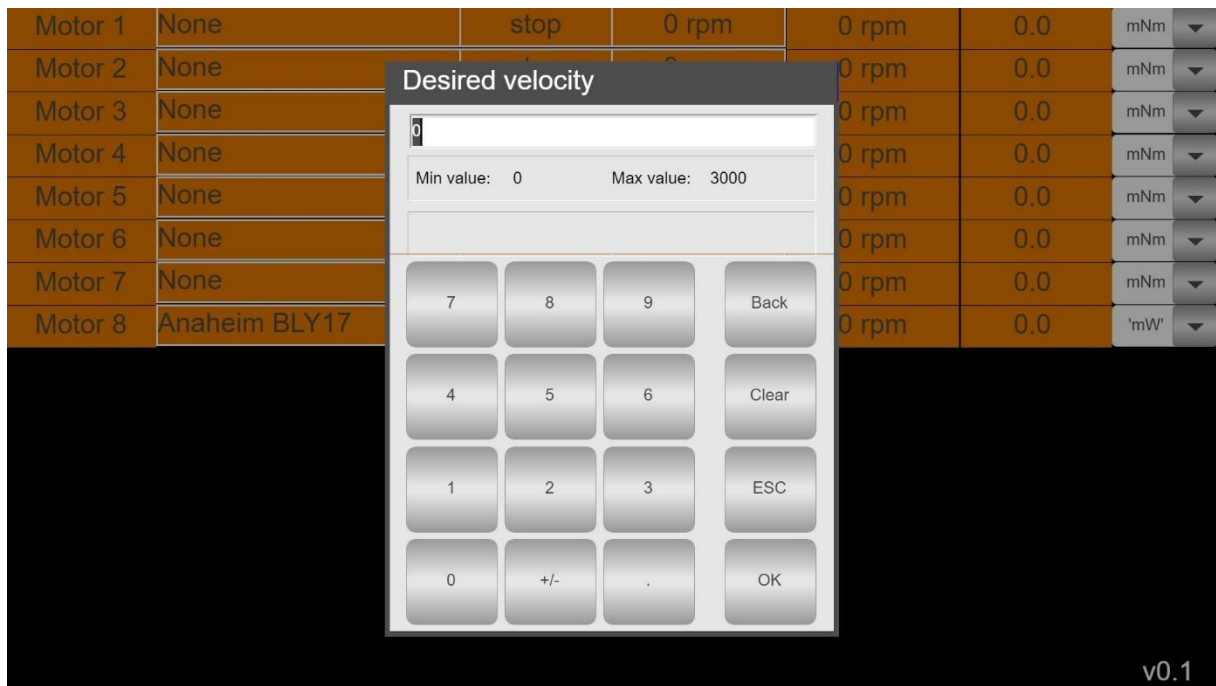## 2 select - Which RPM do you want to use

Press the field with "0 rpm" (with white surrounding), a numpad will appear where you can enter the desired value.

Back: is used for deleting only 1 character/number.
Clear: is used for deleting all characters/numbers.
ESC: is used for going back to the start screen without any changes.
OK: is used for going back to the start screen accepting the changes.

Motor 1	None		stop	0 rpm	0 rpm	0.0	mNm	▼
Motor 2	None				0 rpm	0.0	mNm	▼
Motor 3	None				0 rpm	0.0	mNm	▼
Motor 4	None				0 rpm	0.0	mNm	▼
Motor 5	None				0 rpm	0.0	mNm	▼
Motor 6	None				0 rpm	0.0	mNm	▼
Motor 7	None				0 rpm	0.0	mNm	▼
Motor 8	Anaheim BLY17				0 rpm	0.0	'mW'	▼

Desired velocity

0

Min value: 0   Max value: 3000

7	8	9	Back
4	5	6	Clear
1	2	3	ESC
0	+/-	.	OK

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Cilix-19 RPM selection numpad pop up window.

3 select - Which Direction/starting the motor

Press the field with "stop" (with white surrounding), a selection window will appear with 4 buttons, the current direction used is highlighted with green:

STOP: Can be pressed if the motor is running to stop the motor instant.
CW: Can be pressed if the motor is not running (STOP mode) or is in CCW mode and the motor will then start running towards the desired RPM on a clockwise direction.
CCW: Can be pressed if the motor is not running (STOP mode) or is in CW mode and the motor will then start running towards the desired RPM on a counter clockwise direction.
CANCEL: Can be used if no changes is needed and you just want to return to the start screen.

Motor 1	None		stop	0 rpm	0 rpm	0.0	mNm ▼
Motor 2	None		stop	0 rpm	0 rpm	0.0	mNm ▼
Motor 3	None		stop	0 rpm	0 rpm	0.0	mNm ▼
Motor 4	None					0.0	mNm ▼
Motor 5	None					0.0	mNm ▼
Motor 6	None					0.0	mNm ▼
Motor 7	None					0.0	mNm ▼
Motor 8	Anaheim					0.0	'mW' ▼

Motor Nr: 8

STOP   CW   CCW

CANCEL

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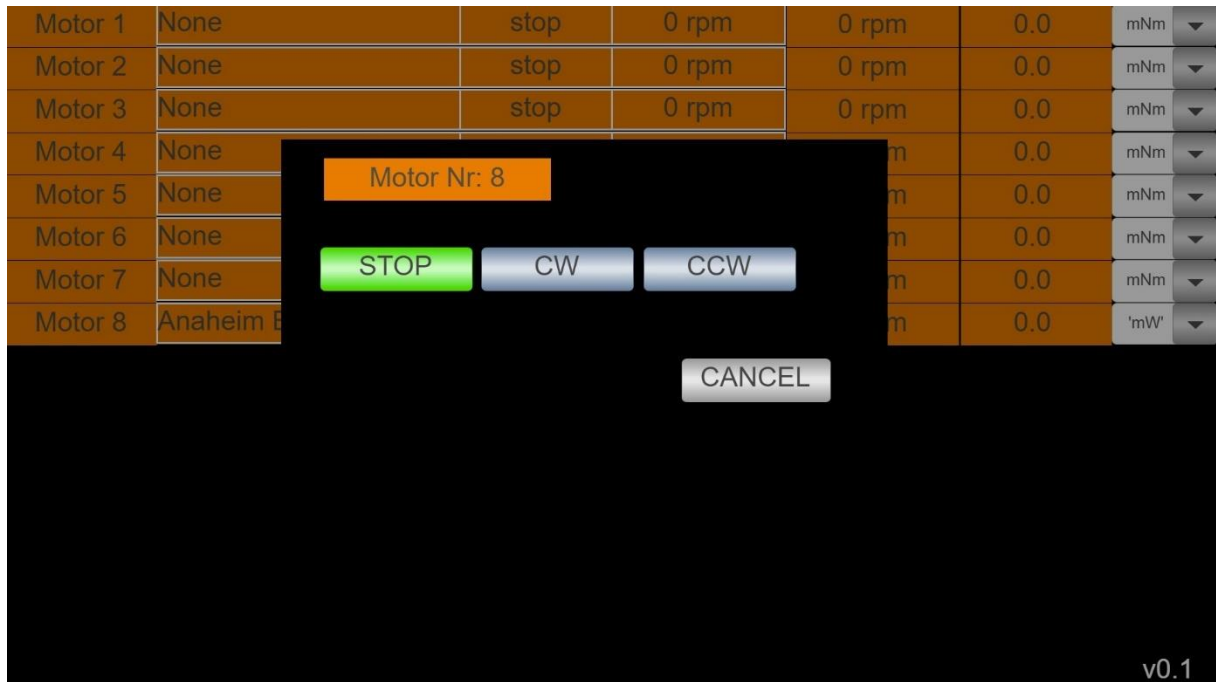
Cilix-19 motor direction selection pop up window.

4 select – Which **units** is displayed

When any of the 8 motors is running Cilix-19 show in real-time the power consumed by each of the motors, in either:

- mNm: milli Newton meter
- mW: milli Watt

PN: Power Number (is only used when the motor setup is calibrated to a given speed that is wished for measuring (see 5 select)).

Motor 1	None	stop	0 rpm	0 rpm	0.0	mNm	▼
Motor 2	None	stop	0 rpm	0 rpm	0.0	mNm	▼
Motor 3	None	stop	0 rpm	0 rpm	0.0	mNm	▼
Motor 4	None	stop	0 rpm	0 rpm	0.0	mNm	▼
Motor 5	None	stop	0 rpm	0 rpm	0.0	mNm	▼
Motor 6	None	stop	0 rpm	0 rpm	0.0	mNm	▼
Motor 7	None	stop	0 rpm	0 rpm	0.0	mNm	▼
Motor 8	Anaheim BLY17	cw	200 rpm	205 rpm	190.7	'mW'	▼

'mNm'

'mW'

PN

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*Cilix-19 unit of consumed power by the motor shown.*

5 select – Calibration for Power Number

This step is **only** needed if you want to find the Power Number (PN) of the impeller/turbine in use of the current system where the motor is used.

Cilix-19 will during calibration on an empty SUB measure friction in various bearings and seals.

When desired, make sure that the motor is not running (STOP mode), then add the motor and RPM selection as in (1 Select and 2 Select above). It is only possible to measure NP at one specific RPM at a time.

Then press the field "Motor (1-8)" depending on what motor that is to be calibrated. Then a calibration option will appear on the bottom of the screen:

Motor 8	
Density	1.0 Kg/L
Diameter	30 mm
Cali minutes	10 min
Time left	8 : 29
Start	Close
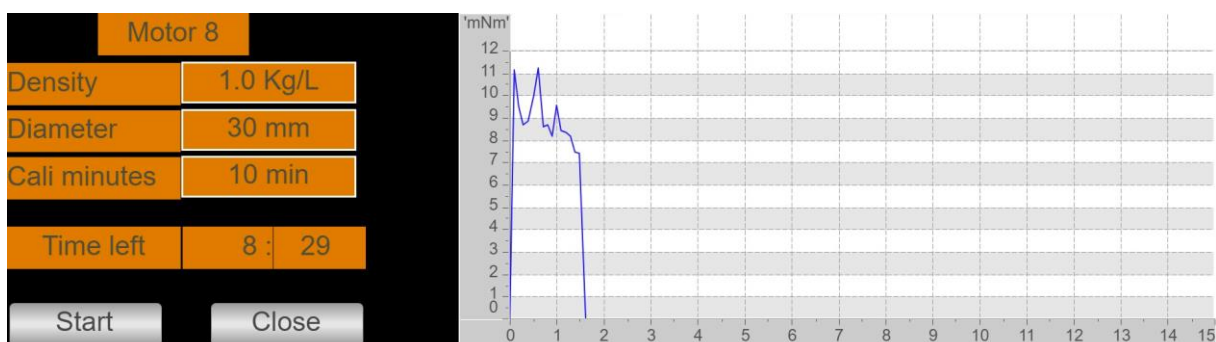
These steps and data are needed to calculate the PN.

- **Density:** The density of the liquid inside the vessel, press the "Kg/L" field, and type in the desired value like on the 2 Select.
- **Diameter:** Is the diameter of the impeller/turbine, press "mm" and type in the desired value like on the 2 Select.
- **Cali minutes:** Is the time of the calibration, we recommend 30 min or longer time for more precise measurement.
- **Start:** Starts the rotation of the motor, which will be clockwise during calibration with to no liquid inside the vessel.
- **(Stop):** For stopping the calibration before end "cali minutes" go to the same field at starting/stopping/selecting direction for the given motor. (Explained in 3 select above)
- **Close: I**f terminating the calibration part you have to close down the calibration for the particular motor (8 on the picture below) before you can calibrate another motor.

Motor 1	None	stop	0 rpm	0 rpm	0.0	mNm ▼
Motor 2	None	stop	0 rpm	0 rpm	0.0	mNm ▼
Motor 3	None	stop	0 rpm	0 rpm	0.0	mNm ▼
Motor 4	None	stop	0 rpm	0 rpm	0.0	mNm ▼
Motor 5	None	stop	0 rpm	0 rpm	0.0	mNm ▼
Motor 6	None	stop	0 rpm	0 rpm	0.0	mNm ▼
Motor 7	None	stop	0 rpm	0 rpm	0.0	mNm ▼
Motor 8	Anaheim BLY17	cw	200 rpm	207 rpm	0.0	PN ▼

Motor 8	
Density	1.0 Kg/L
Diameter	30 mm
Cali minutes	10 min
Time left	8 : 29
Start	Close
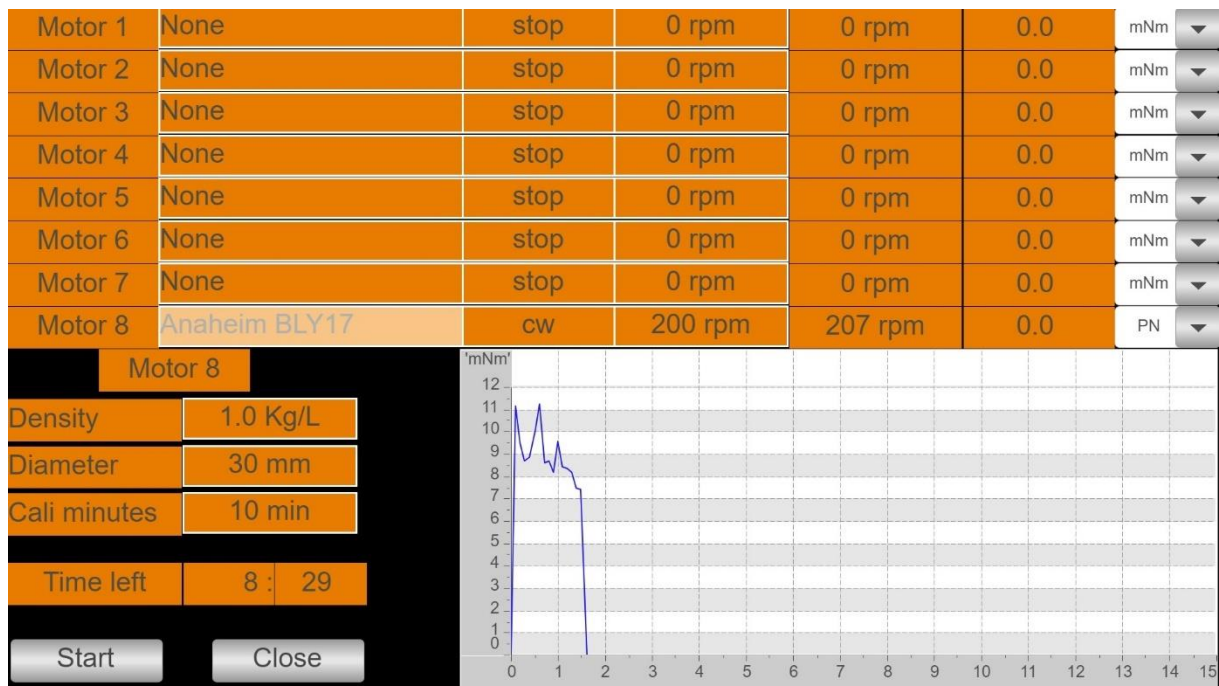
Further instruction for PN setup:

- Run the calibration on an empty vessel on the wished RPM for at least 30 minutes, for Cilix-19 to know the power consumption of the system without load on the impeller/turbine. (Remember to put in alle the variables)

- When the calibration stops, add liquid, and go at the same RPM as the calibration and start the rotation like explained in 3 select above.
  the PN is taking the average value over 5 minutes so wait at least 5-10 minutes to read out the PN.
- Never trust the value of the PN unless you have performed the calibration.

NOTES:

The calibration software tool in Cilix-19 is designed for BLY-17 motors and as to such NOT for the larger Teknic motor.

If the BLY-17 motor is calibrated while cold, the mechanical Power Number will during operation fall until the motor has reached its operating temperature at a given speed/resistance. This as the motor will use less power to overcome internal friction when it gets warmer.

Try the above out and with a new "warm" calibration and hereby secure the correct Power Number to drive the actual impeller design.

In future we may optimize PN software for the even smaller BLY-13 motor for better measurements at lower Power Numbers.

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 Cilix-19 is equipped with the Wi-Fi access point the internal webhost will be accessible from a PC, PAD, mobile phone browser.

Go into "Settings"/ Wi-FI NETWORKS" and check if you can see Cilix-19 and select. Return to a browser and write anything in the address line for access to Apollon PLC inside Cilix-19.

Cilix-19 can be controlled via an USB Wi-Fi antenna adapter:

SSID: cilix19-XX-cronus

Phrase: cronus-cilix19

After connected via WiFi go to the browser and type c.dk:8080

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 power plug with EIC C13 inlet.

Be sure to use cabling and wall socket with earth

5 - Safety precautions
Various component requires individual attention. Operator must be familiar with the Safety Instructions to be found on https://cronus-pcs.com/support/

5.1 – Documentation
Cilix-19 and BLDC motor functionality must be checked on a regular basis and data of such testing kept recorded.

5.2 – Maintenance
The instrument must be kept away from access to liquids. No SUBs or liquid containers places on top of Cilix-19.

Once every second year its advisable to remove possible dust inside cabinet in a proper way.

Its of outmost importance that power cables are checked regularly and insure they follow local instructions with proper earth, ground.

5.3 – Electrical security
Cilix-19 is equipped with an UL certified MeanWell UHP-750-24 power supply which operates from 110 to 240 VAC and rated at 24 VDC/22 amp on the 110 VAC.

The 19" cabinet is earth secured on each surface – never to be removed.

5.2 – CE Declaration of Conformity

CE Declaration of Conformity	
Company: Cronus-PCS A/S	
Company address: Nørrelundvej 10 DK-2730 Herlev 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 product: Cilix-19

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: 2022-09-13

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