

CP-3000 Centrifugal Pump drive for AP40 centrifugal pump heads

User's manual



Ordering number:

735371 CP-3000 PUMP DRIVE FOR CENTRIFUGAL PUMP HEAD AP40, 115-230VAC

735173 CENTRIFUGAL PUMP HEAD AP40



CAUTION: FOR RESEARCH USE ONLY. NOT FOR CLINICAL USE ON PATIENTS !



CAUTION: This device contains strong permanent magnets!!

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1.0 Warranty



Research Use Only !!!

Manufacturer of the CP-3000 pump drive for AP40 pump heads:

Hugo Sachs Elektronik-Harvard Apparatus GmbH
Gruenstrasse 1
D-79232 March-Hugstetten Germany
Phone: +49(0)7665/9200-0
Fax: +49(0)7665/9200-90
email: info@hugo-sachs.de

Hugo Sachs Elektronik (HSE) warrants the CP-3000 PUMP DRIVE FOR CENTRIFUGAL PUMP HEAD for a period of one year from the date of purchase. At its option, HSE will repair or replace the unit if it is found to be defective as to workmanship or materials. This warranty does not extend to any instrumentation which has been (a) subjected to misuse, neglect, accident or abuse, (b) repaired or altered by anyone other than HSE without HSE express and prior approval, (c) used in violation of instructions furnished by HSE. This warranty extends only to the original customer purchaser. IN NO EVENT SHALL HSE ELEKTRONIK BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES. Some states and regions do not allow exclusion or limitation of incidental or consequential damages so the above limitation or exclusion may not apply to you. THERE ARE NO IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR USE, OR OF ANY OTHER NATURE. Some states or regions do not allow this limitation on an implied warranty, so the above limitation may not apply to you. Without limiting the generality of the foregoing, HSE shall not be liable for any claims of any kind whatsoever as to the equipment delivered or for non-delivery of equipment, and whether or not based on negligence. Warranty is void if the device is changed in any way from its original factory design or if repairs are attempted without written authorization by HSE. Warranty is void if parts or connections not manufactured by HSE are used with the equipment. If a defect arises within the warranty period, promptly contact Hugo Sachs Elektronik, Gruenstrasse 1, D-79232 March-Hugstetten Germany by phone at +49(0)7665/9200-0 or email sales@hugo-sachs.de. In the USA, call 800-272-2775 or 508-893-8999 or email: support@hbiosci.com. Goods will not be accepted for return unless an RMA (Returned Materials Authorization) number has been issued by our customer service department. The customer is responsible for shipping charges. Please allow a reasonable period of time for completion of repairs, replacement and return. If the unit is replaced, the replacement unit is covered only for the remainder of the original warranty period dating from the purchase of the original device. This warranty gives you specific rights, and you may also have other rights, which vary from state to state.

Warranty

pump head: according to pump head manufacturer's information
In case of any doubt please contact your supplier.

1.1 Out of Warranty Service

Proceed exactly as for Warranty Service on previous page. If our service department can assist you by phone or other correspondence, we will be glad to help at no charge. Repair service will be billed on the basis of labor and materials. A complete statement of items spent, and materials used will be supplied. Shipment should be prepaid. Your bill will include return shipment freight charges. Disassembly by the user is prohibited. Service should only be carried out by experienced HSE technicians.

1.2 Repair Facilities and Parts

HSE stocks replacement and repair parts. When ordering, please describe parts as completely as possible, preferably using our part numbers. If practical, enclose a sample photo or drawing.

1.3 Safety Information

Please read the following safety precautions to ensure proper use of your amplifier. If the equipment is used in a manner not specified, the protection provided by the equipment may be impaired.

1.5 Make Proper Connections

Make sure to use the appropriate connection for your country. Attach the connector of the amplifier power supply always correctly to the input socket at the rear side of the amplifier and the power socket. Never increase the connection cable length longer than 3 meters.

1.6 Observe All Terminal Ratings

Review the operating manual to learn the ratings on all connections.

1.7 Avoid Exposed Circuitry

Do not touch any electronic circuitry inside of the product.

1.8 Do Not Operate with Suspected Failures

If damage is suspected on or to the product do not operate the product. Contact qualified service personnel to perform inspection.

1.9 Orient the Equipment Properly

Do not orient the equipment so that it is difficult to manage the connection and disconnection of devices.

1.10 Place Product in Proper Environment

Review the operating manual for guidelines for proper operating environments.

1.11 Observe all Warning Labels on Product



CAUTION Refer to manual. Read all labels on product to ensure proper usage.

1.12 Caution Notice



CAUTION: FOR RESEARCH USE ONLY. NOT FOR CLINICAL USE ON PATIENTS.

The unit itself does not generate waste but may be used with samples that are hazardous. Please use appropriate PPE and ensure disposal in accordance with local regulations and practices. This product should not be used in the presence of a flammable atmosphere such as an anesthetic mixture with air, oxygen, or nitrous oxide.

1.13 Compliance

These systems have been designed to meet the standards for electromagnetic compatibility (EMC) intended for laboratory equipment applications as well as the applicable safety requirements for electrical equipment for measurement, control, and laboratory use.

1.14 Copyright

This product and the corresponding documentation are protected by copyright. All rights reserved. This document must not be copied, photocopied, reproduced or translated, either as a whole or in parts, without prior written agreement by Hugo Sachs Elektronik - HARVARD APPARATUS GmbH, March-Hugstetten, Germany.

1.15 Magnetic Fields



On top of the unit a magnetic clutch for the centrifugal pump head is installed. Therefore, the device contains strong permanent magnets.

Hazards:

- Risk to life for persons with **pacemakers, implantable cardioverter defibrillators (ICDs), or other implanted medical devices**
- Risk of **crush or impact injuries** due to strong magnetic attraction forces
- Damage or destruction of **magnetically sensitive items** (e.g. watches, credit cards, data storage media, electronic devices)

Safety precautions:

- Persons with implanted medical devices must **not approach the device**
- Keep magnetically sensitive objects **away from the device**
- Do not bring loose metallic parts into the magnetic field
- Installation, operation, and maintenance **only in accordance with this operating manual**

Failure to observe these warnings may result in serious injury or property damage.

2.0 Introduction

These Operating Instructions describe the function and the use of the CP-3000 pump drive with coupling to a centrifugal AP40 pump head. This manual is just an addition to the pump drive manual which describes the functions and the handling of the AP40 pump head.

This manual represents an essential part of the pump and must be kept close to the pump, accessible to all users. All the information in these Instructions has been assembled after careful examination but does not represent any warranty of product properties. Alterations in line with technical progress are reserved.

Carefully read the operating instructions as well as other materials in this manual.

This manual is not a warranty for product performance. If you need help or have questions, please contact us and we will assist you. We want you to be completely satisfied with this product.

2.1 Preliminary notes on the pump system

The complete pump system consists of the pump drive and a centrifugal pump head AP40 (Medtronic). The action of the pump heads ensures very gentle pumping of blood. Also, other media can be pumped. The head forms a completely enclosed unit without any moving parts to the outside. Pump head and drive are linked by a magnetic coupling. The driving motor turns a magnet disk which transmits the rotation to another magnet located inside the pump head.

The pump heads have a limited life. The pump head mounting is therefore so arranged that the heads can be replaced without the use of tools. Read these Operating Instructions!

We recommend that you carefully read this Instruction Manual and adhere fully to the information contained in it. We accept no responsibility for any damage caused by inappropriate handling.



The pump heads should never run dry. Always fill the heads with fluid before starting the pump. Due to the centrifugal construction, these heads are not self-filling when you start the pump.

More see 3.3. Filling the pump head bubble free

2.2 Range of application and safety precautions

The pumps are intended for liquid handling in laboratories and industry. We assume that all laboratory guidelines are observed as well as the recommendations given below:

- The pump must only be operated within the given operating and ambient conditions
- Do not position the pump closer than 10 cm from a wall and ensure that the ventilation apertures are not obstructed. The ventilation apertures on the bottom of the pump drive should also not be obstructed.
- During operation the pump drive housing must not be opened or removed
- Any repairs must only be carried out by a qualified person fully aware of the potential hazards
- Any work carried out on and inside the unit by customers or third persons is undertaken on their own responsibility

The pump must not be used:

- **for medical applications on humans**
- **in hazardous (Ex) areas and in the presence of flammable gases and vapors**

Warning note

In the operation of pump drive, it is not possible to exclude certain risks. The manufacturer does not accept any responsibility for any resulting damage.



WARNING: powerful magnetic fields!

Both the pump drive (magnet box) and the centrifugal pump head incorporate permanent magnets which produce a powerful magnetic field. Any magnetically sensitive objects such as credit cards, magnetic data storage media or watches should be kept away, to avoid damage! Users with pacemakers should be careful and not come too near to the magnetic coupling.

2.3 Residual risks

- The handling of chemicals is not within the responsibility of the manufacturer
- The pump head must only be changed while the pump is switched off
- Tubing has a certain permeability to gases depending on material and pressure conditions; it can also acquire static charges. We are warning of possible dangers if any tubing is run in hazardous areas.
- Where damage may be caused by leakage of liquid following a tubing burst, the necessary safety precautions must be taken before starting
- Do not carry out any manipulation on the pump head before the pump has been switched off
- The pump head must be filled with the pumped liquid before starting up

IMPORTANT:



Pump heads must never run dry! Danger of bearing damage!

2.4 List of items supplied

- digital pump drive with mounted magnetic coupling for AP40 head
- 24 DC power supply
- Operating Instructions

Accessory if ordered:

- AP40 pump head (73-5173)

Please check the packaging and the contents for transport damage. If you find any signs of a damage, please contact the supplier immediately. Any claims can only be entertained within 8 days from receipt of the goods.

Digital pump drive with magnetic coupling for AP40 heads



Fig. 1 Pump drive without installed AP40 head

3.0 Operating panel



Start/Stop button switch for Internal/External control Priming key (maximal speed knob)

Speed Control knob

Fig. 2 Front panel, control keys

Rear side of the unit

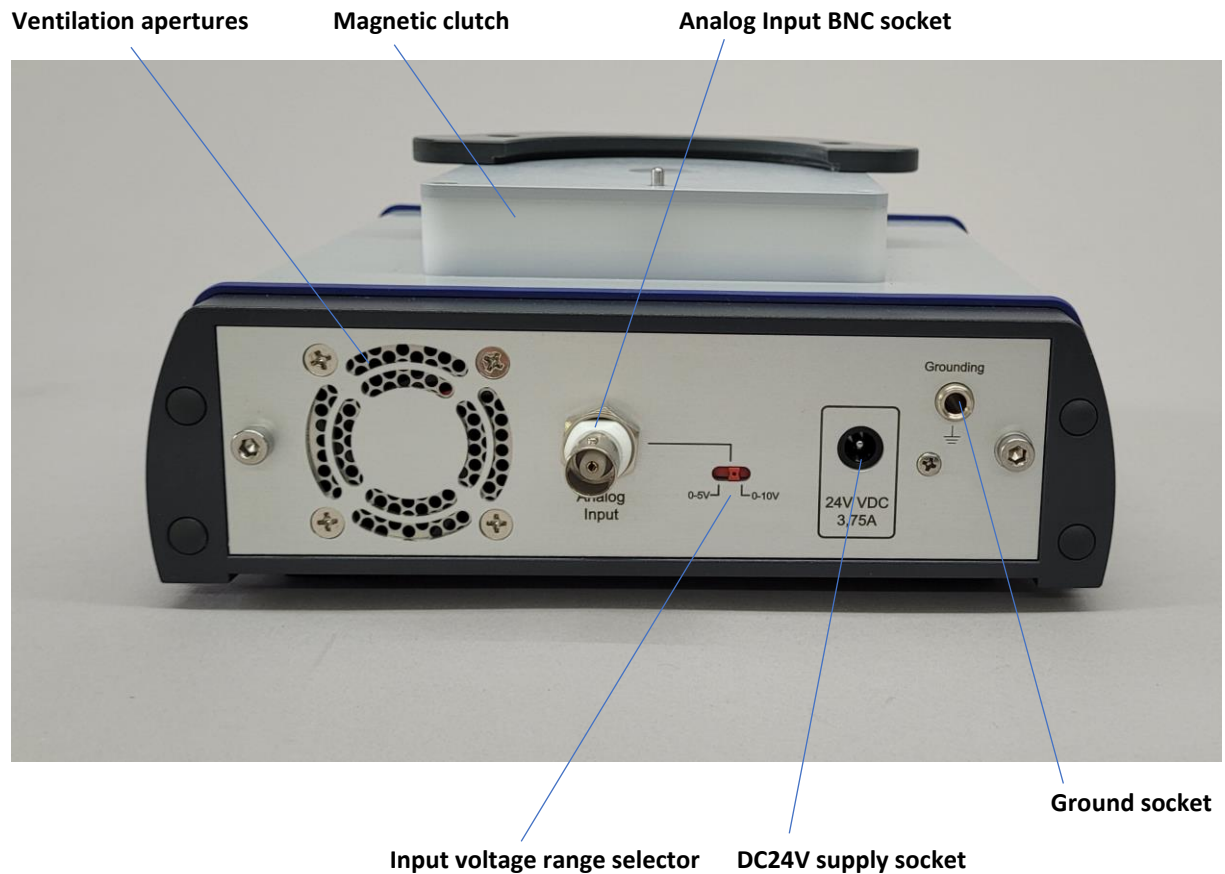


Fig. 3 Rear side of centrifugal pump drive

Supply voltage

24V DC 3.75A via power supply



Fig. 4 24V DC, 3.75 A power supply

3.1 Starting up

Before starting up, set up the pump according to the description below

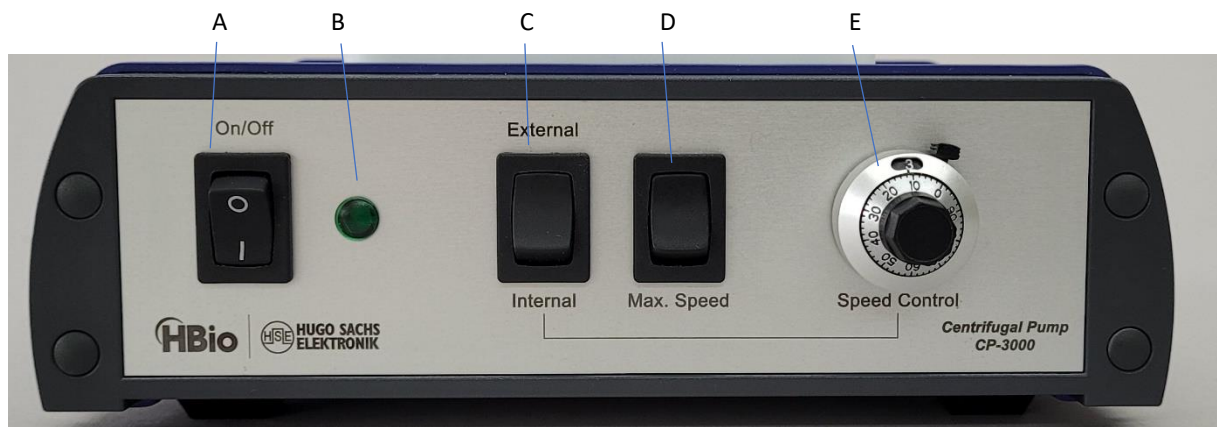


Fig. 4 Front panel control keys

A

ON/OFF switch. Starts and stops pump drive

B

ON/Off LED, if it lights green the drive is running

C

Switch External / Internal.

This switch defines if the pump speed is controlled External or Internal.

Internal means you have manual control with the “Speed Control” knob.

External means you can control the pump by an external voltage.

This would allow you to control the pump speed with an external controller, e.g. from a PC with a DAC or via a PID controller or via a function generator. By use of our transducer amplifier module and SCP controller module a constant pressure system can be set up. You would define a target pressure, and the pump would speed up and hold the pressure at the target PID controlled. Furthermore, a function generator could be used to generate a pulsatile pressure and flow curve to simulate pulsatile waveform like an aortic pressure in vivo.

More see later in this manual

D

Max. Speed knob.

Pressing and holding this key brings the pump to maximal speed.

This key can be used to prime the tubing for a fast filling of the connected tube circuit.

It can also be used for removing the perfusate from the perfusion circuit and clean the circuit.

Also it is also very useful to remove air bubbles from the tubing.

E.

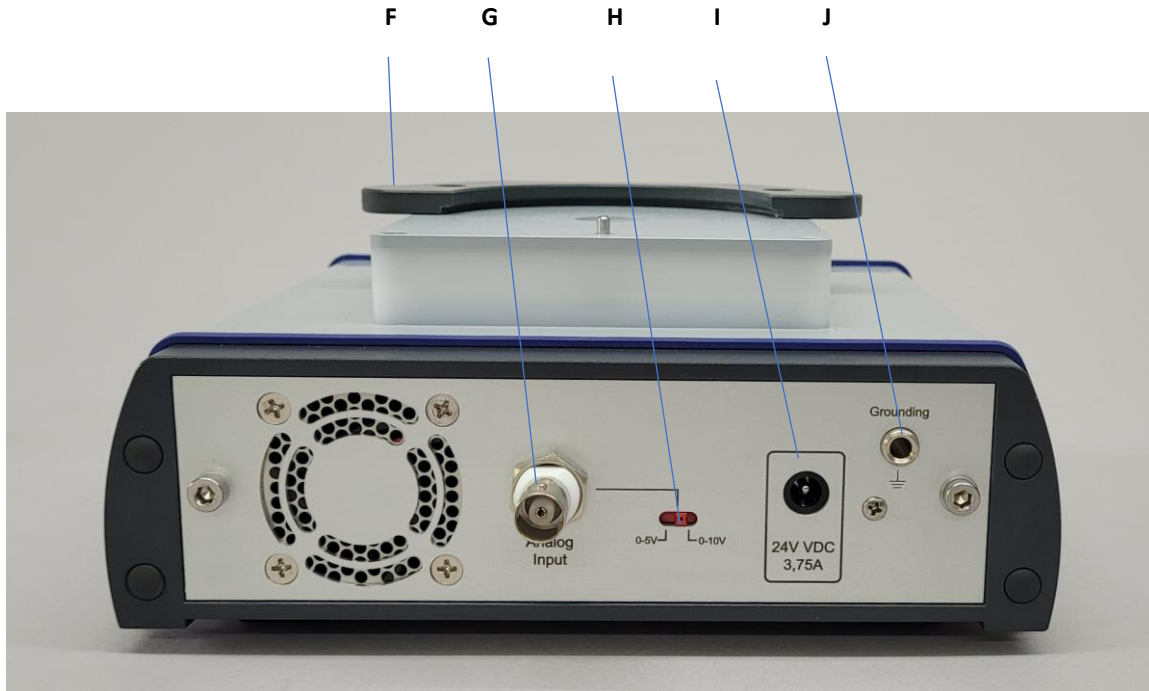
Speed knob, with scale and lock for manual pump speed control.

With this knob you set the pump speed manually.

This knob is only in function if the External / Internal switch (C) is set to Internal.

If the External / Internal switch (C) is set to External the Speed knob has no function.

Rear side



F

Magneti clutch, holder for AP-40 centrifugal pump head
 By lifting the black bracket you can install the AP-40 pump head.



Lift here and on the right side.
 Install the AP-40 pump head.
 The bracket is spring loaded and
 will fix the head in position.

G

BNC socket for analog voltage control.

H

Input voltage selector. Depending on your control voltage range select 0...5 or 0...10V input voltage.
 The SCP module always has 0...10V output voltage.

In 0..5V range the pump would run with full speed (3000rpm) when 5V is attached

In 0..10V range the pump would run with full speed (3000rpm) when 10V is attached

At 0V the pump stops.

I

Input for power supply. Use only the power supply which comes with the pump drive

J

Ground socket. In case the pump would create some electrical noise, ground the housing using this socket.

3.2 Filling Pump Head bubble free

Add the delivered T-piece with the tube set and 3-way stop cock as shown below.
 Outlet tube to this port Inlet tube to this port



Pump drive with AP40 head and tube setup ready for use

Fig. 10

To fill the pump head bubble free run the pump with the max. Speed button and stop the pump. Air bubbles will be trapped on the top of the head. Connect the syringe and open the stopcock (see stopcock position above). Remove the air from the pump head with the 50ml syringe. You may have to repeat the steps a few times until the head is filled with fluid bubble free.

3.3 Starting the Pump

It is assumed that at this point you have already connected the tubing and set the pump to External or Internal control.

If you do it the first time, and if you want to familiarize yourself with the pump, it's best to use the Internal mode and turn the Speed Control knob to 0.0 (fully counterclockwise).



Switch the On/Off to On, the green LED lights up and the pump remains stopped.

Turn the Speed Control knob clockwise, the pump will start to run.

The physical principle of the centrifugal pump will show that the pump only begins to pump the fluid at a certain speed. This is also the reason that you cannot get a linear speed to flow relation with centrifugal pumps.

Turn the Speed Control knob more clockwise until the pump starts turning and pumping.

Go a bit higher to be sure that the pump really ejects. If you measure the pressure and you intend to reach a specific pressure value speed up the pump until you reach the pressure you intend to see.

While the pump is running, always the Max. Speed button can be used for rapid filling.



Always remember: **The pump head must not be running dry.**

Warning note



WARNING: powerful magnetic fields!

Both the pump drive (magnet box) and the centrifugal pump head incorporate permanent magnets which produce a powerful magnetic field. Any magnetically sensitive objects such as credit cards, magnetic data storage media or watches should be kept away, to avoid damage! Users with pacemakers should be careful and not come too near to the magnetic coupling.

4.0 Application example: Controlling the Centrifugal Pump by a PLUGSYS SCP module to perform constant pressure perfusion

In this application the Centrifugal Pump is used to perform constant pressure perfusion to perfuse an isolated organ under constant pressure conditions.

The perfusion pressure is measured by using an APT300 pressure transducer connected to a TAM-D amplifier. The TAM-D is in the housing connected to an SCP Controller module. The SCP module is a PID controller which controls the pump speed. On the SCP module you set the target perfusion pressure e.g. 80mmHg.

When you start the SCP in CONTROLLER MODE it adjusts the pump speed so that finally a pressure of 80mmHg is reached and kept constant. In this setup the reservoir is in the heated organ chamber. The perfusion fluid enters the pump head of the CP-3000 pump and is transported through the ECMO oxygenator into the chamber, directly to the artery of the organ. From the organ the perfusate can be cannulated or just dripping off down back into the reservoir.

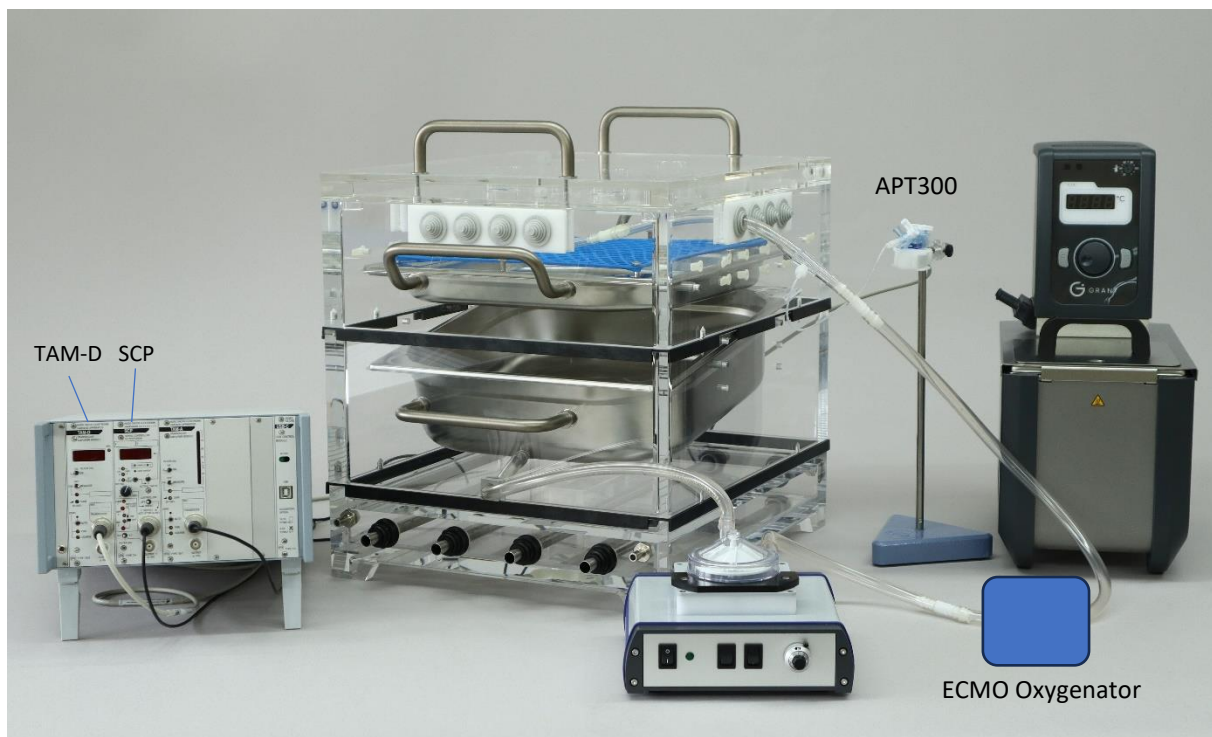
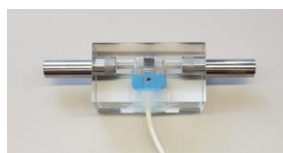


Fig. 12 Example setup with a large organ chamber for ex-vivo abdominal organ perfusion (e.g. pig kidney)

In order to measure flow in such a setup we also can provide flow probes and a TTFM-2 flow meter module. The flow probe must be installed in the tubing between the ECMO oxygenator and the organ.



4.1 Application example: Controlling the CP-3000 pump drive with a function generator to perform a pulsatile pressure like an arterial pressure

Below you see a recording example:

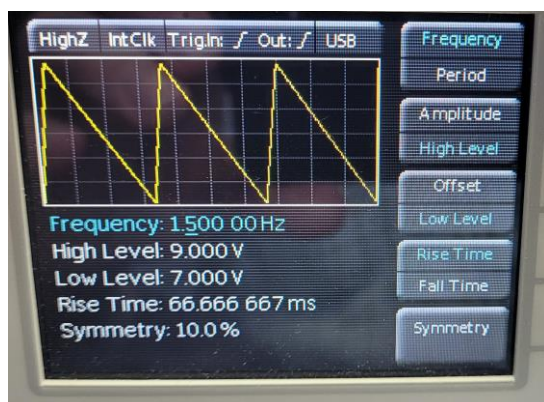
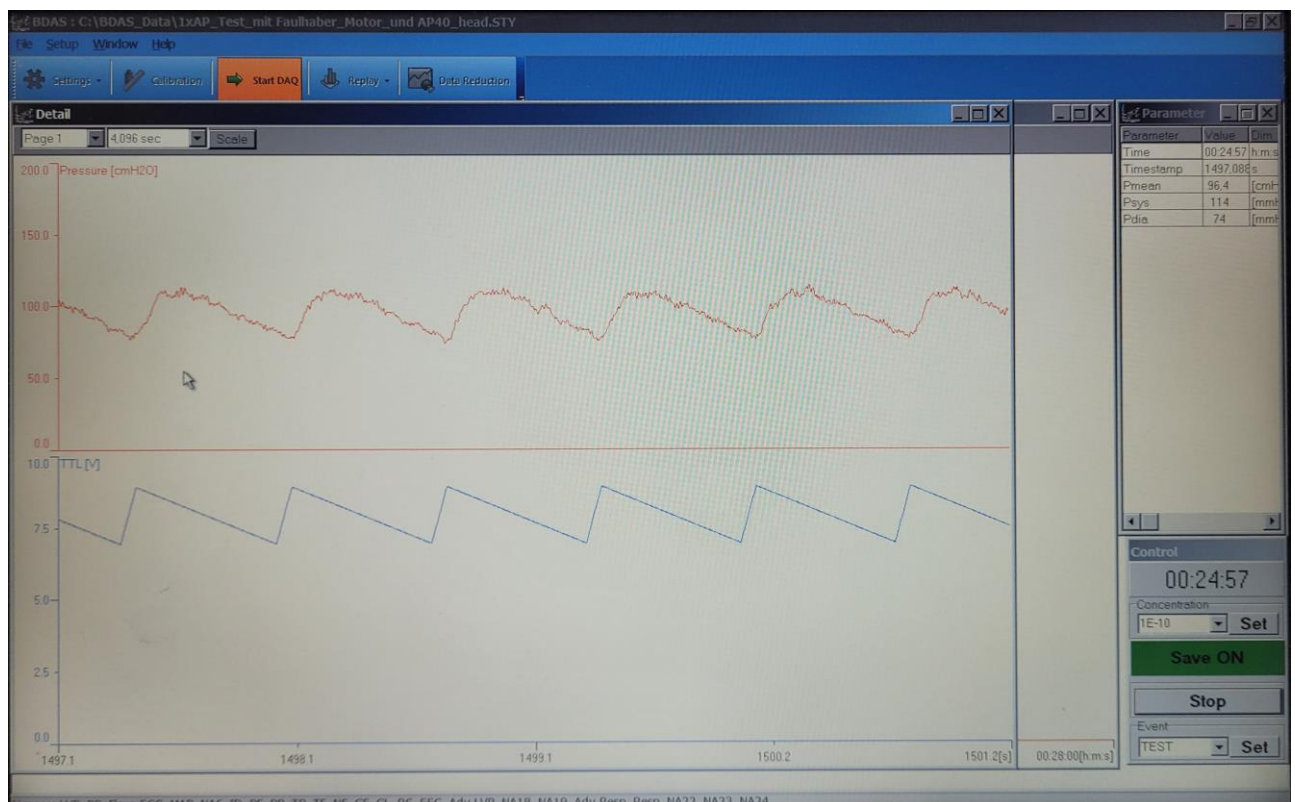
Here the CP-3000 was controlled by a External sawtooth like voltage signal, in order to get a pulsatile pressure waveform similar to an Aortic pressure in the ascending aorta.

Red curve pressure waveform

Systolic pressure: 114mmHg

Diastolic pressure: 74 mmg

Heart rate: 60 bpm



5.0 Analog control BNC connector

The analog interface connector is a BNC socket. Any BNC cable can be used to adapt.

The pump can be driven with voltages 0...5V or 0...10V. The switch to select the voltage range is right of the BNC socket.

6.0 Centrifugal pump head

The pump head described below is especially designed for pumping blood or erythrocyte suspensions. The AP40 (Medtronic) head can be directly clipped into the holder of the pump drive.

NOTE: The information given below refers only to the special application of the heads in conjunction with the CP-3000 pump drive. It does not replace the Operating Instructions supplied with these heads.

The pump heads are hermetically sealed; there is no drive shaft taken to the outside. The drive is transmitted through a magnetic coupling. A ring-shaped permanent magnet is located inside the head which is coupled to a similar magnet of the pump drive. Rotation of the drive is transmitted to the pump rotor through the attraction force of the magnets.

Pump head AP40

The pump head AP40 (manufacturer: Medtronic) is specially designed for pumping blood or erythrocyte suspensions. The AP40 has a filling volume of 40 ml. The diameter of the connections is chosen suitable for the flow rate. The INPUT and OUTPUT connections are 9.5 mm OD. See Fig. 13

A pump head AP40 is shown below. Flow rates can be seen on the next page. The drive fitted with the pump head was already illustrated on page 1.

The cone-shaped white part rotates about a central bearing and is mechanically coupled to the magnet ring. Rotation of the rotor counterclockwise causes the liquid inside the head to rotate through surface friction and to be forced outward by the resulting centrifugal force towards the outlet connection. The resulting pressure-flow diagram is shown in Diagram 1, chapter 6.1 plotted against rotational speed.

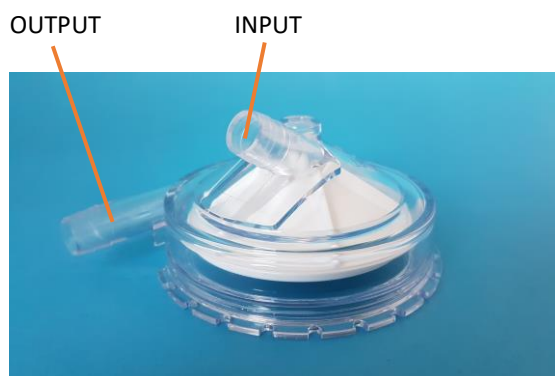


Fig. 13 AP40 pump head

Ordering number:

735173 CENTRIFUGAL PUMP HEAD AP40

6.1 Output characteristic of an AP40 pump head

Diagram 1 shows the flow-pressure characteristics of the CP-3000 pump drive with pump head AP40 at varying speed settings. At each speed a particular pressure was produced by squeezing the tubing and the flow was measured. Normal deionized water was used as liquid for these measurements.

The pressure-flow diagram shows that there is no exact linear relationship between pump speed and flow or pressure.

NOTE: the pressure/flow values which can be read from Diagram 1 must be taken only as average values and cannot not be guaranteed!

Pulsation: The pump head AP40 does not produce pulsations in the flow of the liquid output!
 If pulsation is requested, we can provide a signal generator which can modulate the pump speed so that you get a pulsatile pump e.g. to simulate an aortic pressure waveform.

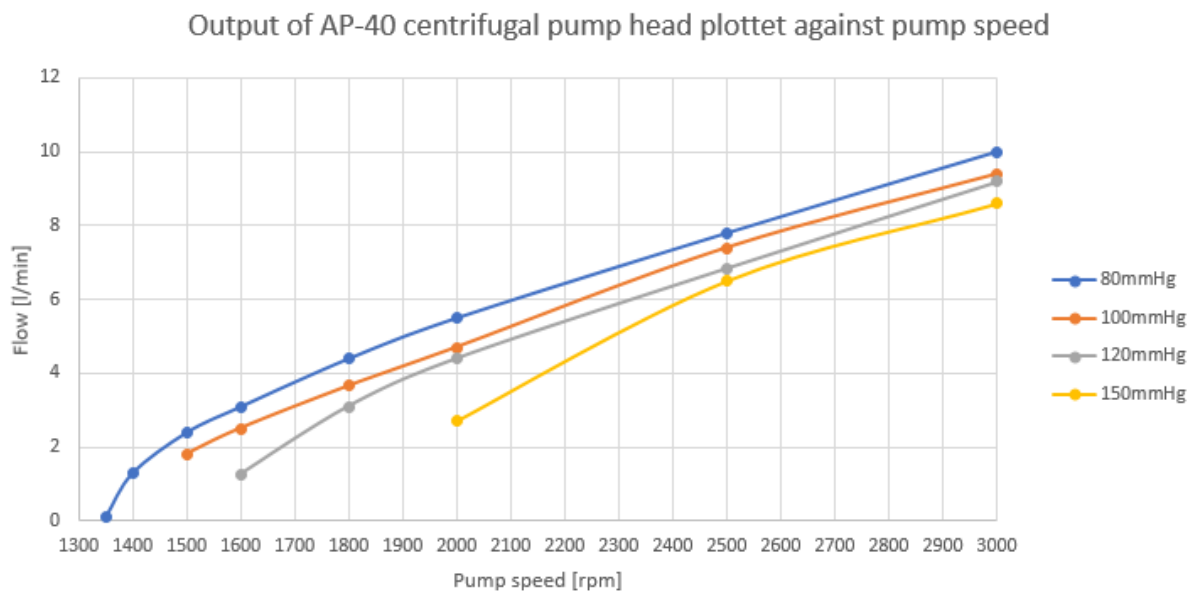


Diagram 1

All graphs don't start from 0 rpm. Depending on the back pressure and the physical nature of a centrifugal pump you need a certain speed until you receive a flow.

6.2 Fitting and removing the AP40 pump head

For installing or removing the pump head, the pump drive must be switched off!

The baseplate of the pump head is inserted from above into the slot between magnet box and the black fixing plate and pushed down up to the stop. The head must then be rotated so that the locking pin engages with one of the recesses in the rim.

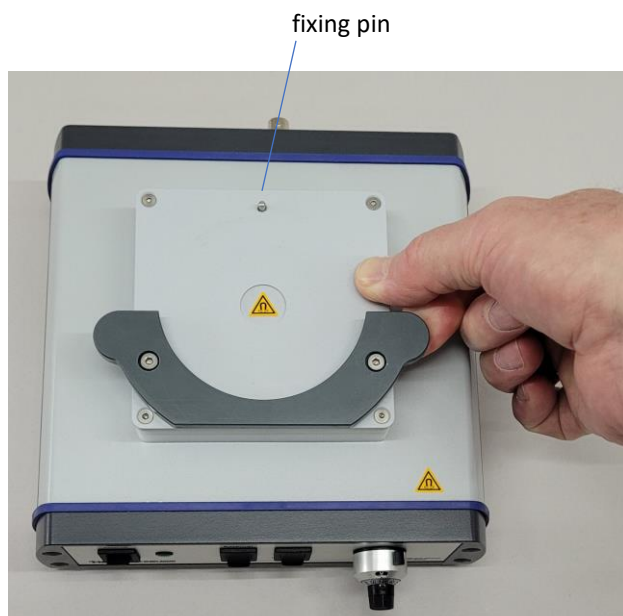


Fig. 14 Lift the black fixing plate slightly upwards to install the head

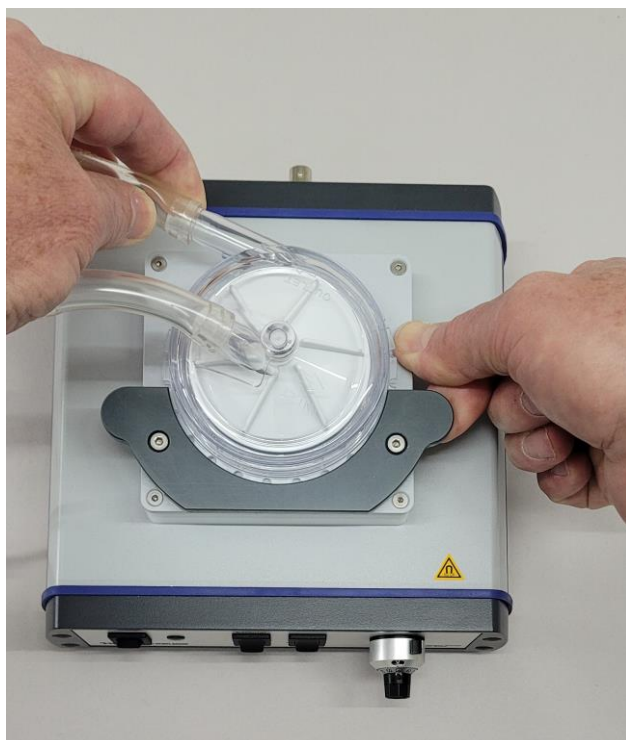


Fig. 15 Insert pump head into the open slot and push it down

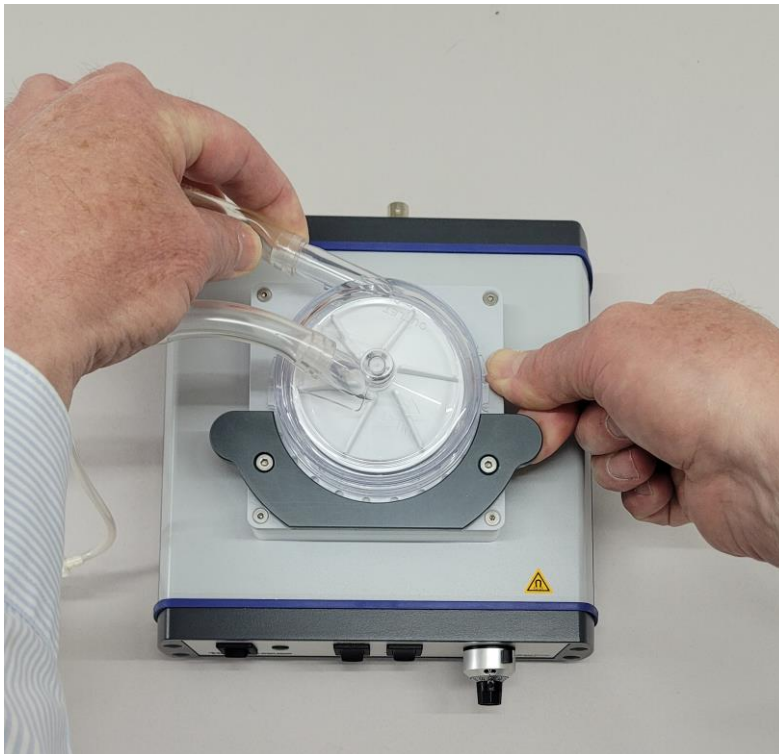


Fig. 16 Rotate the head so that the fixing pin engages with one of the recesses

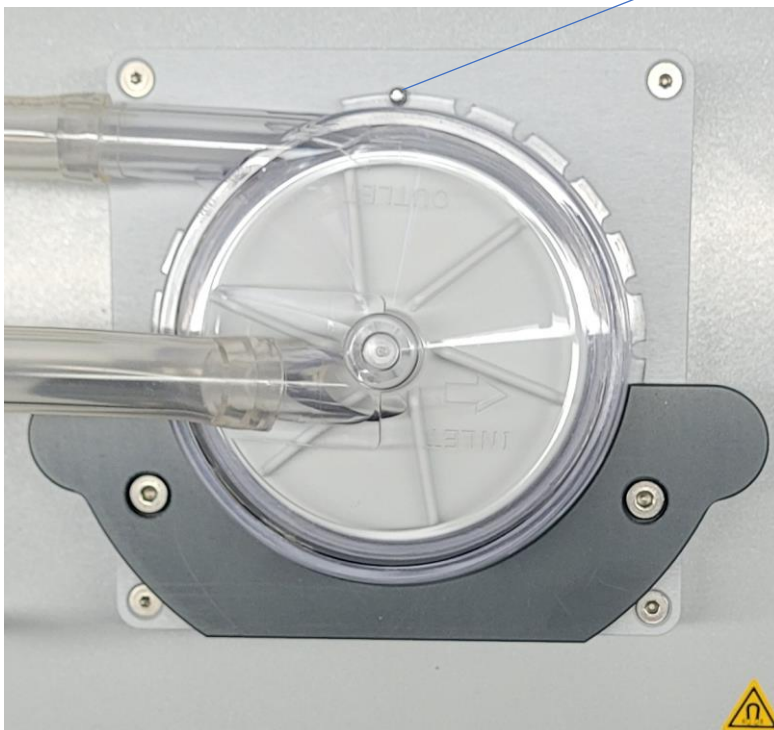


Fig.17 Head fixed, pin in the recess

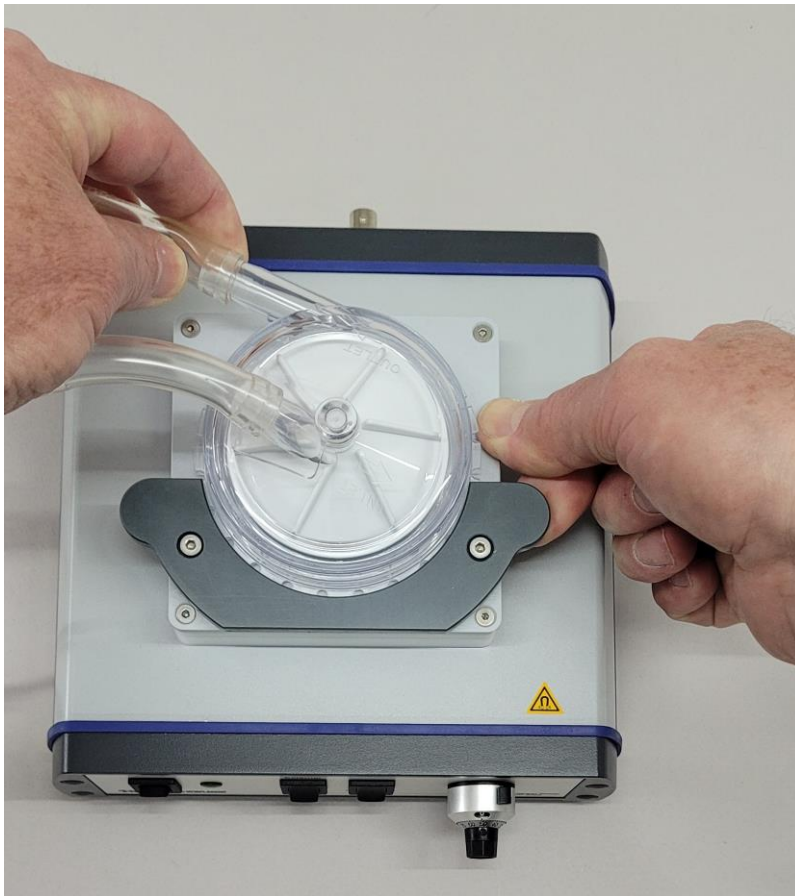


Fig. 18 To remove the head, lift the black fixing plate then pull the head upwards out of the holder.

7.0 Operating notes

Before switch-on

Ensure that the pump head is filled with the liquid to be pumped before you switch it on. Operating the pump head dry may damage the rotor bearing.

Pumping against pressure

The maximum flow rate depends on the back pressure (see Diagram 1, chapter 6.1).

Speed setting

To keep hemolysis low you should not set a higher speed than necessary. Do not artificially increase the flow resistance (squeezing the tubing) to achieve a certain flow rate.

Faulty operation

As described above, the coupling of the drive to the pump rotor takes place through the attraction between the magnets. The coupling force is sufficient for all normal operations if the coupling does not become „disengaged“. The pump has a soft start function which should avoid that effect.

The coupling can also become disengaged by careless handling of the tubing so that the pump head briefly does not lie properly against the magnet box of the drive. If drive and pump head have become „out of step“, this becomes evident by a loud rattling or whirring noise. In such a case switch off the pump drive, allow it to come to rest, and switch it on carefully again. Never start the pump at full speed.

Before switching off the pump

When stopping the pump drive it is possible that the liquid flows back.

Stopping the pump

If the pump will be out of use for some time it is essential to clean the pump head thoroughly (see section „Cleaning“ chapter 8.0).



Fig. 19 Pump drive with AP40 head and tube setup ready for use

8.0 Maintenance and cleaning

The pump drive does not require any special maintenance. Any dirt on the housing should be removed immediately. A moistened cloth with water should be used for cleaning. With strongly adhering dirt you can add a little cleaning solution (domestic detergent) to the water.



WARNING:

- Before starting any cleaning operation pull out the power supply plug
- Do not allow any liquid to pass into the pump drive housing

We recommend thorough cleaning of the pump head after each application:

- first wash out with normal tap water
- with proteins in the liquid, wash again with acetic acid (3%) or “MUCASOL” or “Cidex OPA” cleaning solutions
- use distilled water for a final rinse.

The pump heads must be considered as consumable items with a limited life. In original use (heart-lung machine or ECMO machine) they are disposables where in isolated organ experiments these units can be used multiple times when handled with care and cleaned well after each experiment.

The pump head may be damaged when:

- the pump head is operated dry
- unsuitable cleaning agents are used
- the cleaning agent is left inside the head for too long time

If the pump is being used as intended and with the necessary care, only the moving parts are subjected to a certain amount of wear.

9.0 Technical data

Speed range:	0 - 3000 rpm
Flow rate and pressure:	See diagram chapter 6.1
External control:	via analogue voltage 0...10V or 0...5V
Supply:	wide range power supply 115 V - 230 V (50/60 Hz) 3.75A
Operating conditions:	normal laboratory environment temperature +5 to +40°C rel. humidity 80% max.
Dimensions: (pump drive without head)	190mm x 235mm x 90mm height (5.5 in x 9,3 in x 3.5 in height)
Dimensions: (pump drive with head)	190mm x 235mm x 140mm height (5.5 in x 9,3 in x 5.5 in height)
Weight:	2.3 kg (5 lbs)

This system is CE conform according to the following regulations:

2014/35/EU: Low Voltage Directive (LVD)

2014/30/EU: Electromagnetic Compatibility Directive (EMCD)

2011/65/EU: Restriction on the use of certain hazardous substances directive (RoHS)

This product conforms in terms of LVD and EMCD to the following relevant standards and carries therefore the CE marking:

EN61010-1:2010 Safety requirements for electrical equipment for measurement, control and laboratory use, General Requirements.

EN61326-1:2013 Electrical equipment for measurement, control and laboratory use regarding EMC requirements.

9.1 Technical support

For technical questions contact:

techsupport@harvardapparatus.com

or

support@hugo-sachs.de