OPERATING INSTRUCTIONS

EDEMA BALANCE MODULE EBM TYPE 713

VERSION: 11.09.2013 ZI

Not for human use

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Contents

1. Introduction, manufacturer's details

These Operating Instructions describe the function and use of the Edema Balance Module Type 713 with sensor for the IPL2 system for isolated ventilated and perfused rat or guinea pig lung).

All the information in these Instructions have been drawn up after careful examination but does not represent a warranty of product properties. Alterations in line with technical progress are reserved.

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1.1 Copyright

2. Safety notes

Warning:

- Be careful in working with aerosols, gases and gas mixtures. DANGER !
- The EBM System is designed for use in general laboratories, light industrial and office environments.

3. General description, application

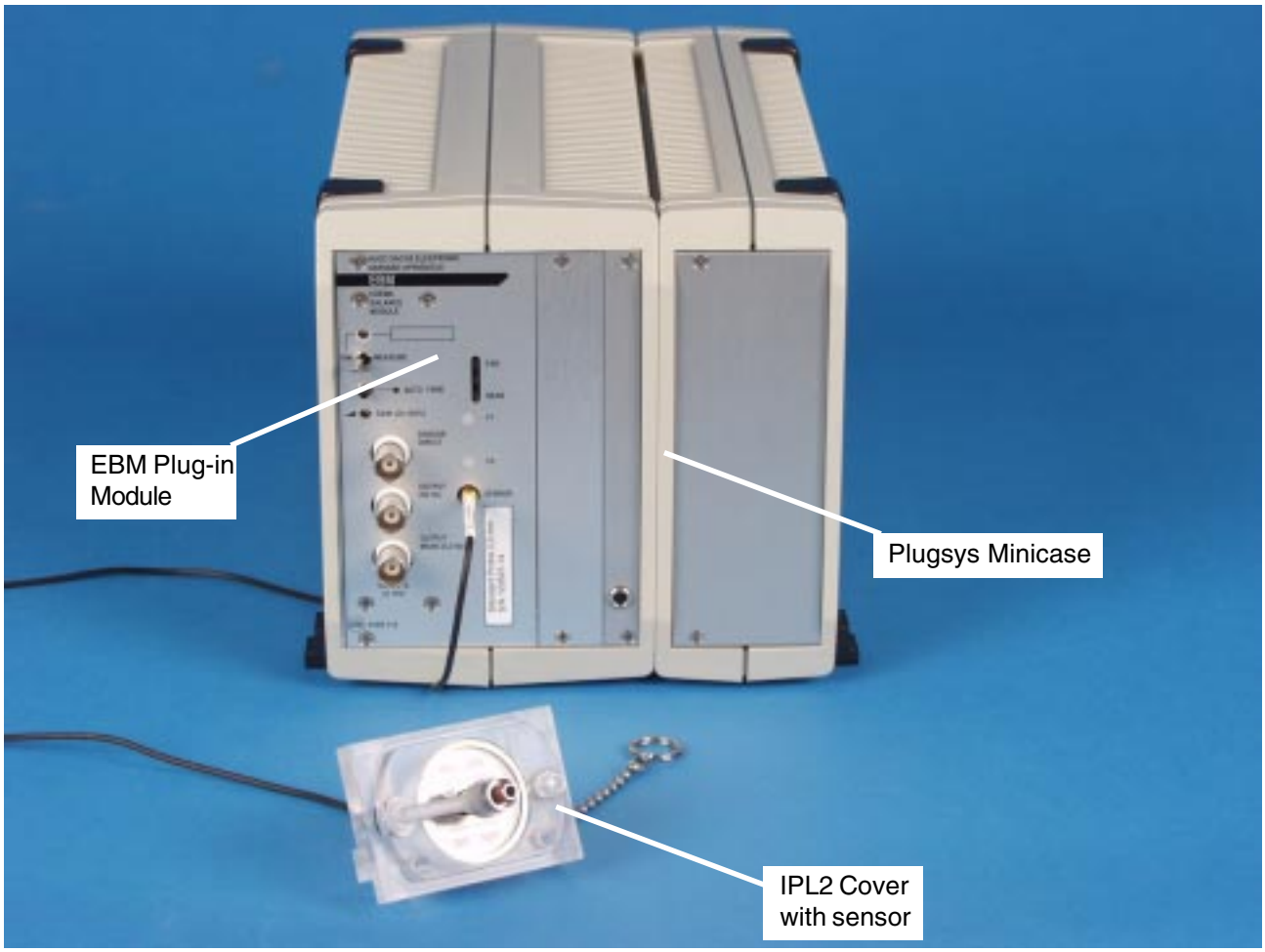
The Edema Balance module with transducer, named EBM later in that manual has been developed for continuous measurement of lung weight changed during experiments on isolated ventilated and perfused rat or guinea pig lungs in the IPL2 system of HSE-HA. In the IPL2 system the lung is ventilated by generating a negative pressure inside a thoracic chamber. That requires a weight sensor being located inside the sealed negative pressure ventilated volume.
The EBM has specially been constructed to be located inside the movable chamber cover and to receive the tracheal cannula as attachment.

4. Deliverables

The delivery consists of:
- The EBM Plugsys module
- The transducer mounted into the IPL2 cover
- One BNC-BNC output cable (length 2 m)
- The Operating instructions

5. Technical description

The system consists of the amplifier module which is a Plugsys plug-in module and the weight sensor mounted into the IPL2 cover.

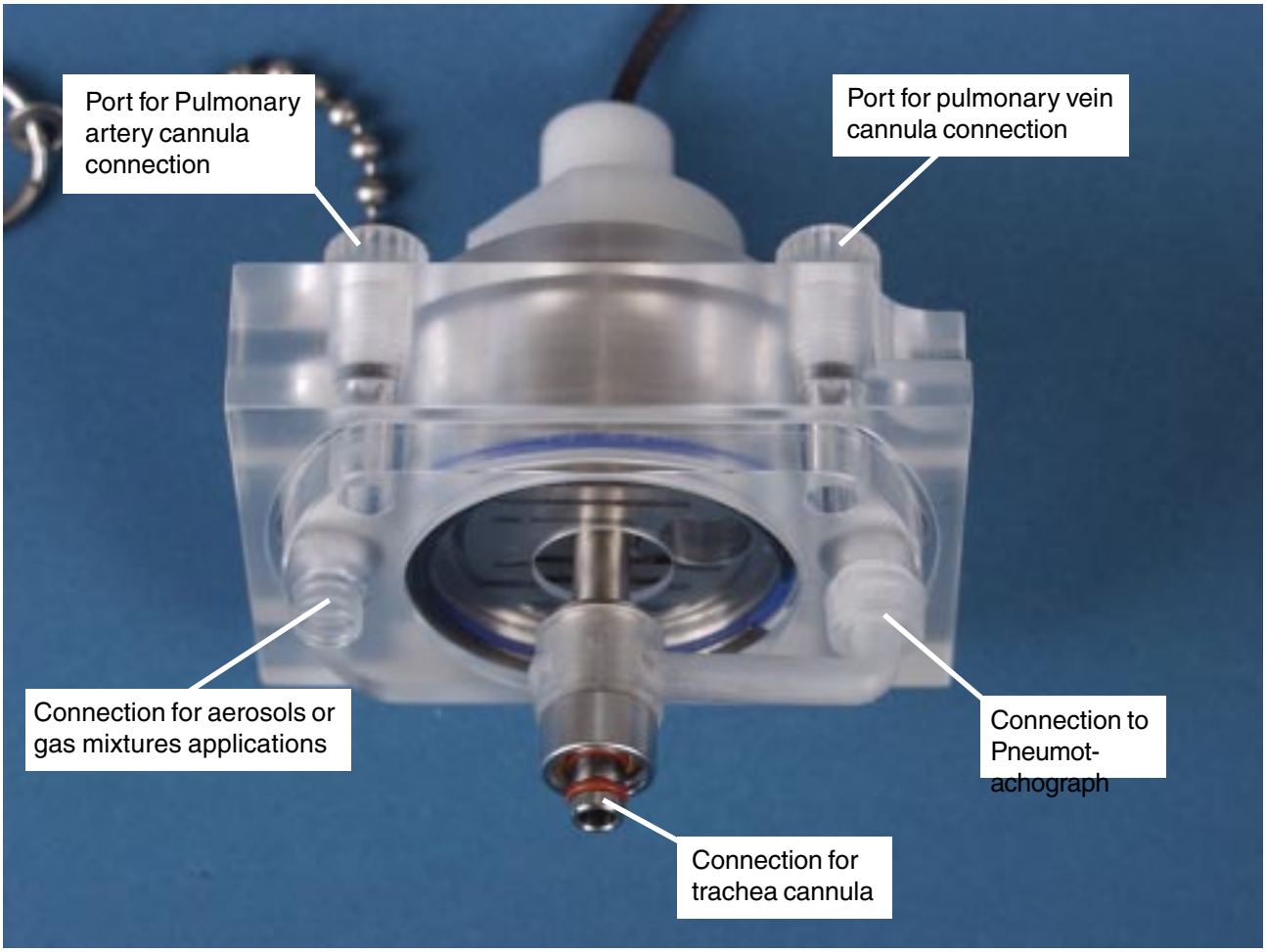


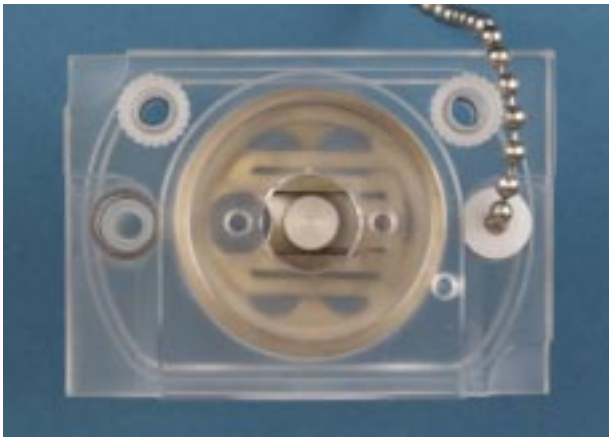
EBM module in a Plugsys Minicase and IPL2 Cover

5.1 IPL2 Cover with sensor

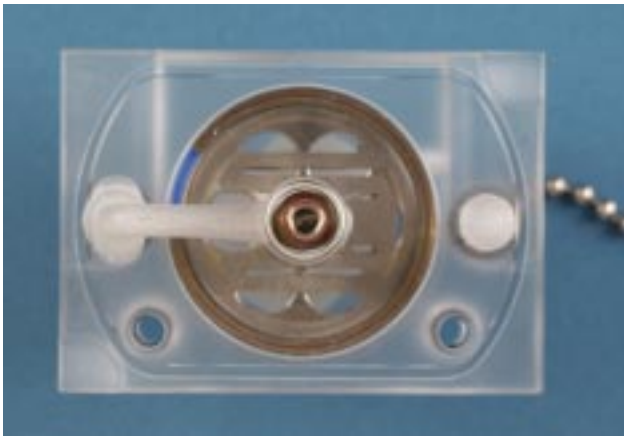
The IPL2 cover with weight sensor replaces the standard cover delivered originally with the unit. The cover present the same ports for the cannulae connection as well as for the pneumotachograph for measuring the respiratory flow. It allows also the supply of aerosols or gas mixture as bypass.

5.1.1 Ports and Connections





Top view with sensor removed, stopper on the aerosol or gas mixture port



Bottom view with stopper on the aerosol or gas mixture port

5.2 The EBM Plugsys module

5.2.1 Installing the module in a housing

The EBM module is designed as a PLUGSYS module and has a width of 10E corresponding to three slots. It can be installed directly in any housing with a system bus. An exception is the PLUGSYS MiniCase Type 609, the EBM can also be operated in this housing but installation requires some soldered connections and it is therefore only supplied completely installed from the factory.
If you bought your module installed in a housing these adjustments already have been made in the factory prior to shipping.

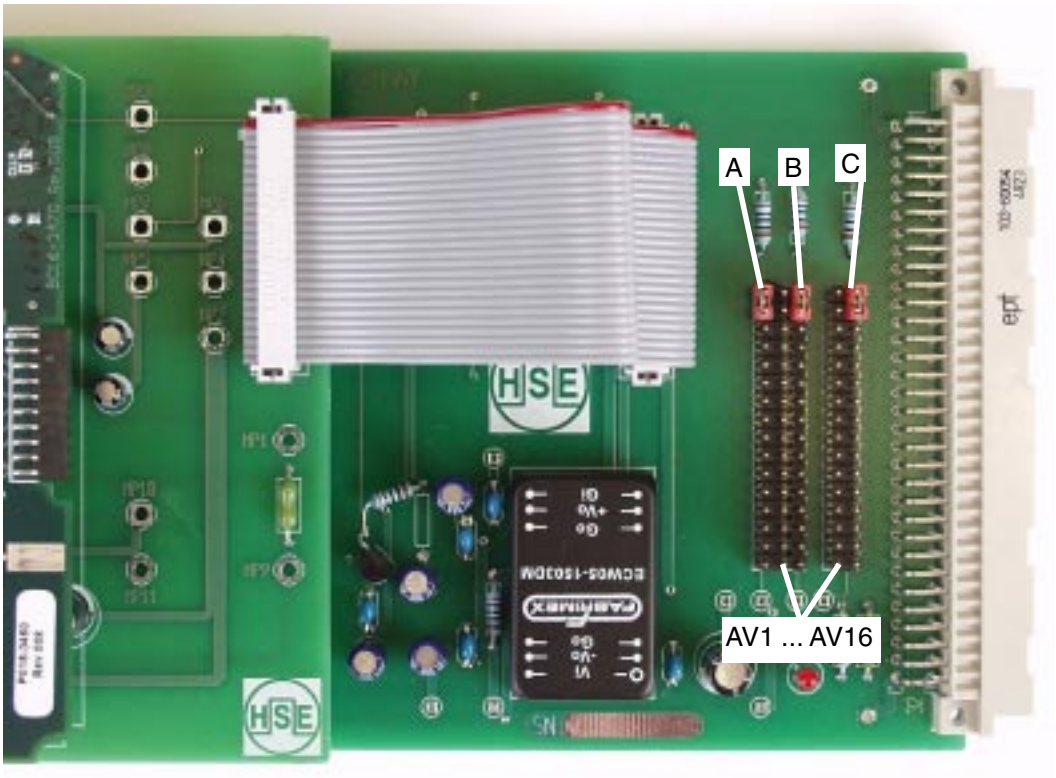
5.2.2 Protection against electrostatic discharges (ESD)

Modern electronic components are very sensitive to electrostatic discharges. Even the smallest electrostatic charge may damage the electronics or lead to faults. Therefore follow the steps described below in order to discharge any possible static electricity on your body.

- Equilibrate potentials by touching earthed metal objects, e.g. housing of some electrical equipment connected to the supply, central heating radiator etc.
- In order to avoid fresh electrostatic charges, do not move unnecessarily backwards and forwards on your working area. Where available, it is best to wear an antistatic wristband for continuous discharge of static electricity.
- When you remove the EBM from its antistatic packaging, touch first the front panel of the module to equilibrate the potentials.
- For the Jumpers adjustments (see 5.2.3) place the module flat on the foil of the antistatic packaging.
- Take care in handling the module, avoid bending the circuit board and unnecessary touching of its components.
- Before inserting the module in the housing, ensure potential equilibration between the module, yourself and the housing. First touch the metal housing before inserting the EBM.

Recommendations:
When handling the module during use it is equally important to ensure that no electrostatic discharges take place through the inner pins of the input or output sockets. For this reason you should always first provide potential equilibration between yourself, the PLUGSYS and the sensor or recording system.

5.2.3 Location of the jumpers for the internal instrument adjustments



The three output signals Sensor Direct, 80 Hz and Mean (0.2 Hz) are on 3 coulums of pins. The other pin coulumns are connected to the bus lines AV1 ... AV16. When the board is positioned in front of you as in the image, the top pin is AV1 and the bottom Pin is AV16.
The image shows the jumpers in park position if the rear analog output is not used like in a Minicase or if the data acquisition system is connected on the front panel BNC sockets.
To connect one of the signals to the signal bus remove the jumper from the park position rotate it by 90° and connect the pin on the signal column to the AV line corresponding pin. Take care that there is no other signal in the system being connected on the same AV line.

5.2.4 Installation procedure

Before the module is installed in a Plugsys housing 601 or 603 be sure you have made the internal adjustment for the connection of the analog outputs to the Plugsys signal bus. Note the precautions described in Section 5.2.4 which are absolutely essential in order to avoid electrostatic discharges.

Brief procedure (for full details see the Operating Manual of the housing):

- Switch off the housing and pull out the mains plug.
- Remove the blank panel at the housing slot position intended for the EBM module.
- Make the internal adjustments according to Section 4.2.
- Insert the EBM module, note the guide rails.
- Firmly push in the module, it must clearly engage with the bus connector.
- Screw on the front panel, reconnect the mains cable to the housing, and plug in the transducer.

5.2.4 Front panel

Adjust Trimmer for Simulate

Mode switch Simulate - Off - Measure

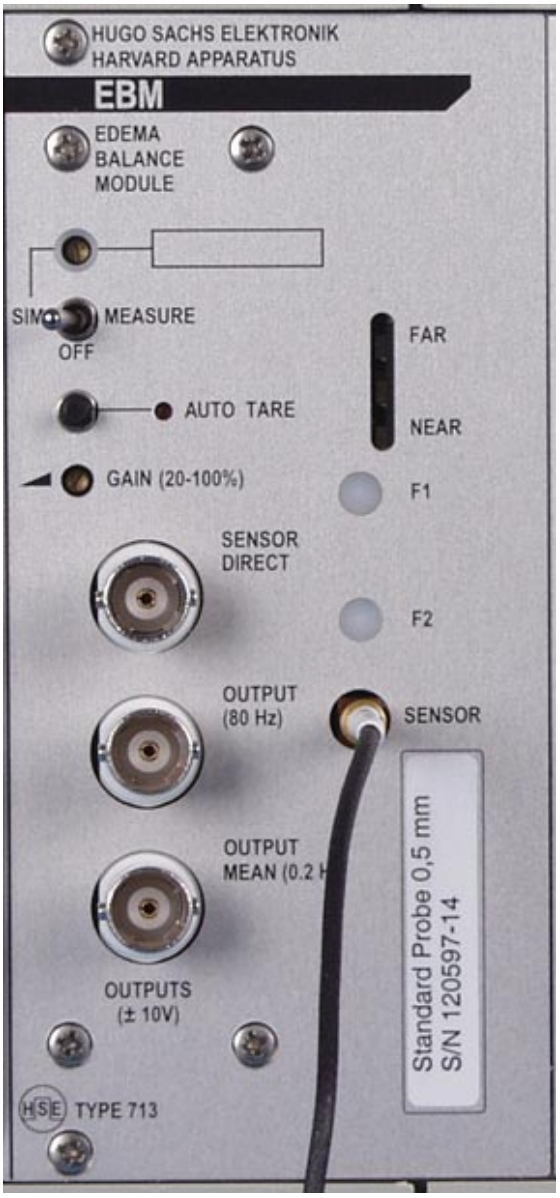
Tara Button and signaling LED

Gain adjust trimmer

BNC output for sensor signal

BNC output, tara compensated with 80 Hz filter

BNC output, tara compensated with very low pass filter 0.2 Hz



Label field for simulation value

3 LED status display for range control

Input for Sensor connection

Label field for adapted sensor

Controls description

Adjust Trimmer for Simulate

For calibrating a connected recording device e.g. data acquisition software it is convenient to simulate a calibration signal. The mode switch explained below allows to simulate at the output a BNC connectors and the internal Plugsys bus connector such a signal. The amplitude of the simulated signal and therefore the simulated weight change is adjusted with this trimmer (See the adjustment procedure later in this manual).

Label field for simulation value

The equivalent weight change value set with the trimmer described above is reported in the label field on the right of the trimmer.

Mode switch, Simulate - Off - Measure

This switch allows to select three function modes of the module. In the central off position a voltage of 0 Volt is present on all analog outputs. (BNC on front panel and internal Plugsys connector)
In the position SIM, a voltage is generated at all analog outputs equivalent to the value set with the trimmer SIMULATE and simulates a known weight change (see the label on the right of the trimmer). The position measure is the normal function position for lung weight change measurement.

Tara Button and signaling LED
When the lung is attached on the sensor, the output voltage shows the absolute lung weight with the cannulae. As the lung weight changes we want to measure are very small compared to the absolute lung weight it is essential to compensate for the absolute lung weight. This is realized by an electronic compensation circuit. To do so the button TARA is pressed until the LED on the right of the button lights up. When the LED goes off the tare is compensated (see later description on faults if the LED is blinking)

Gain adjust trimmer
The sensor presents a sensitivity of about 2 Volt at the BNC output sensor signal for 1 g weight change. For a better adaptation on the data acquisition system resolution it my be required to increase the gain for a better resolution. With this trimmer the gain can be set in the range of 20 to 100 or (about 2 Volt to 10 Volt per 1.0 g weight change)

BNC output for sensor signal
This is the direct analog output of the sensor amplifier without any compensation of TARA and with no low pass filter. The gain adjustment has also no influence on that output. The absolute range for that output is about xxx to yyy g (0 - 10 Volt)

BNC output, tara compensated with 80 Hz filter
This output is tara compensated, the gain is applied, the frequency response is 80 Hz. It is recommended to use it if fast weight changes are to be recorded by having in mind that it is more sensitive to artifacts.

BNC output, tara compensated with very low pass filter 0.2 Hz
Same as above except the very strong low pass filter of 0.2 Hz. This is the recommended output to use for recording. As the weight changes by edema are very slow processes tis output can easily follow the weight changes by reducing the effect of most of the artifacts due to vibrations of pumps and others.
Marker field for simulation value

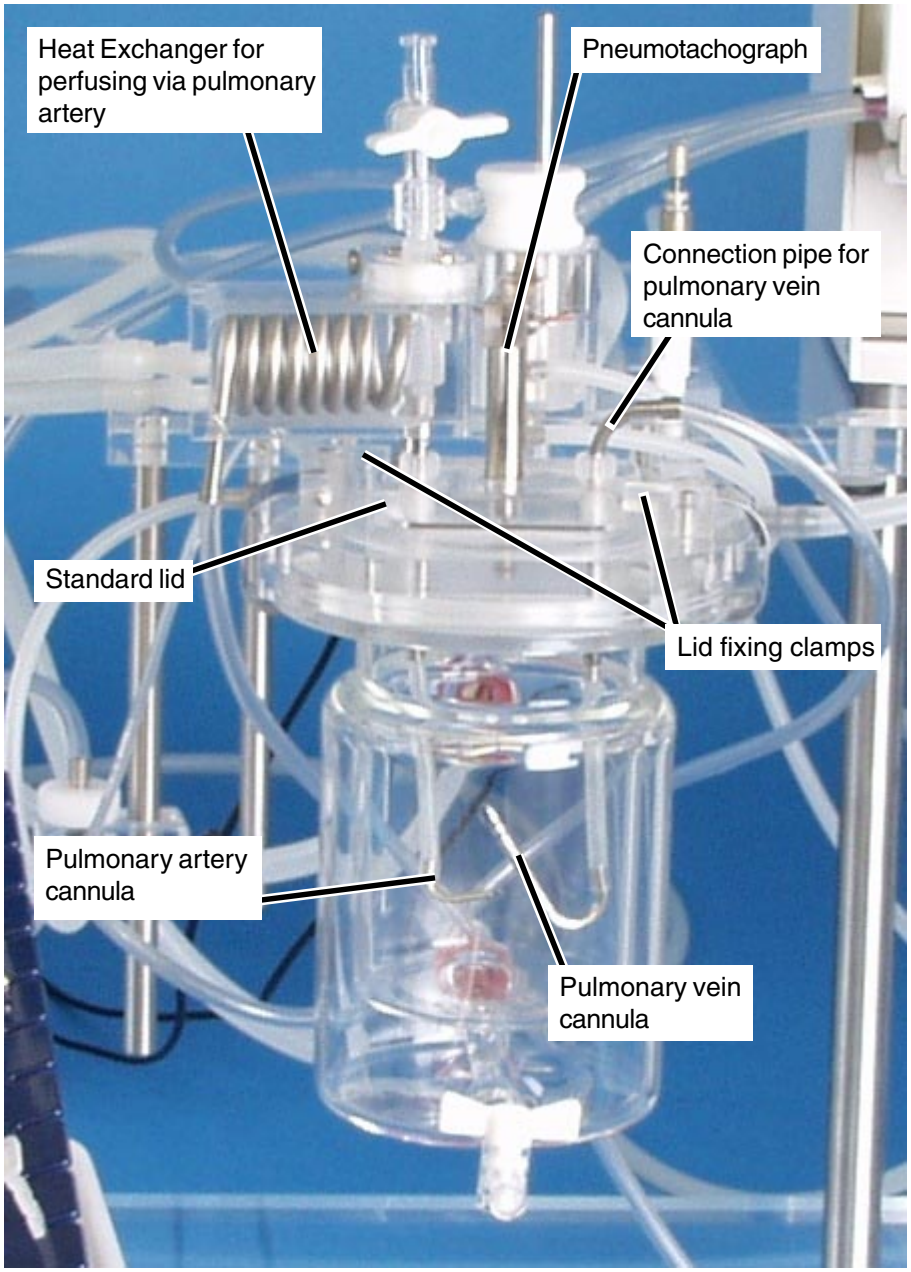
3 LED display for range control
The 3 LED display is an indicator of the sensor. It gives the information if the measurement system is off range, close to the range limits, or in the range.
The LED near can be red or blue, red means the sensor is off limit (too little weight on the sensor) or close to the limit (just enough weight)
The central LED lights green when the weight is in the measurement range
The LED far can also be red or blue. Blue means that we are coming close to the maximum weight possible, Red means that the weight is too high and we are out of the measurement range of the sensor.

Input for Sensor connection
Connector for the Sensor, the cable is flexible and must not be shorted in any way, the sensor adaptation would go wrong. To connect the sensor just plug in the connector, there is no lock feature on. To disconnect, pull the plug.

Label field for adapted sensor
As the sensor and the amplifier are adapted, the sensor can not just be exchanged. To be sure you use the right sensor, the sensor serial number is reported in that label field

6. Assembling the measurement system

6.1 Installing the sensor head on the IPL2 Sytem



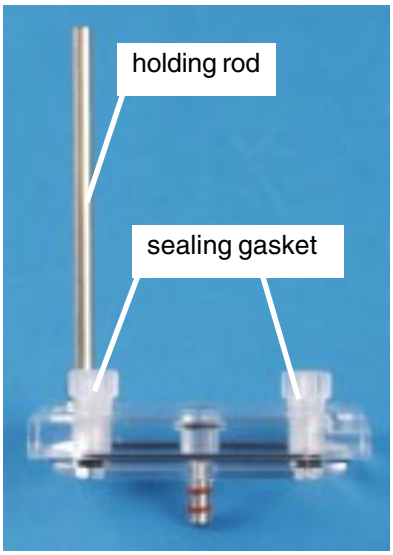
IPL2 with standard Cover

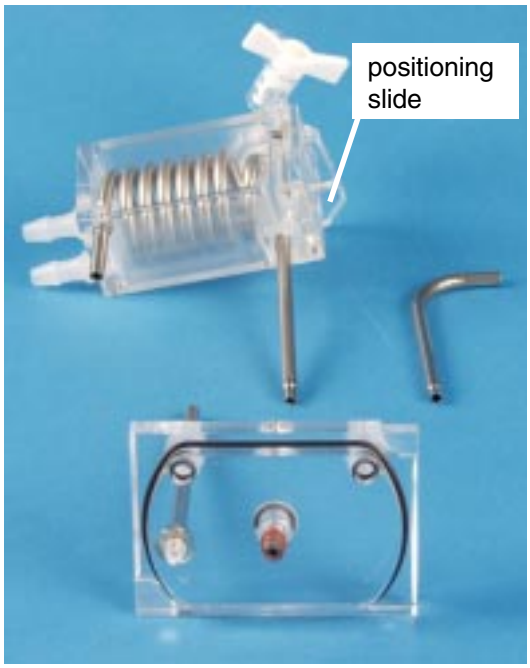
The EBM sensor is part of the lid which replaces the standard lid. There are several parts mounted on the standard lid which must be transferred to the lid with weight sensor. To do so the standard lid is removed from the IPL2 by opening the two lid fixing clamps and moving the cannulae and their fixation out of the cover. Don't forget to remove first of all the Pneumotachograph. The procedure to remove the lid is the same as for the surgical preparation.

For exchanging the different parts from standard lid to the lid with weight sensor, follow the procedure described below.

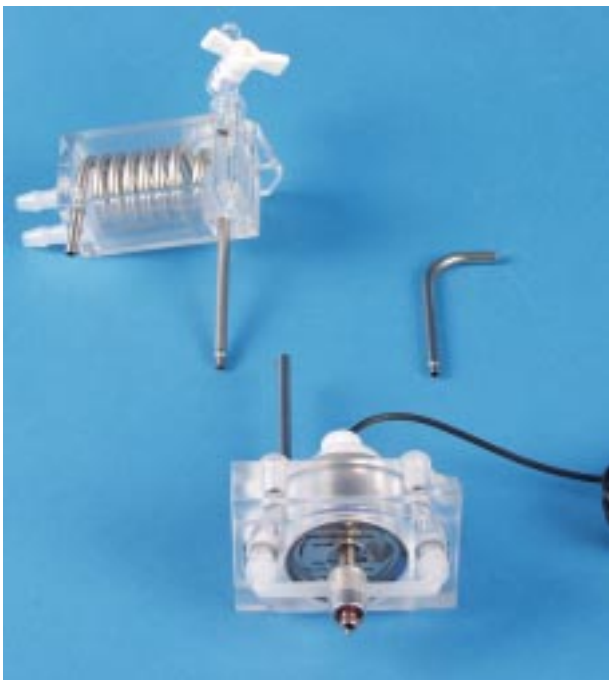
Standard Lid as removed from the IPL2

First remove the perfusion cannulae

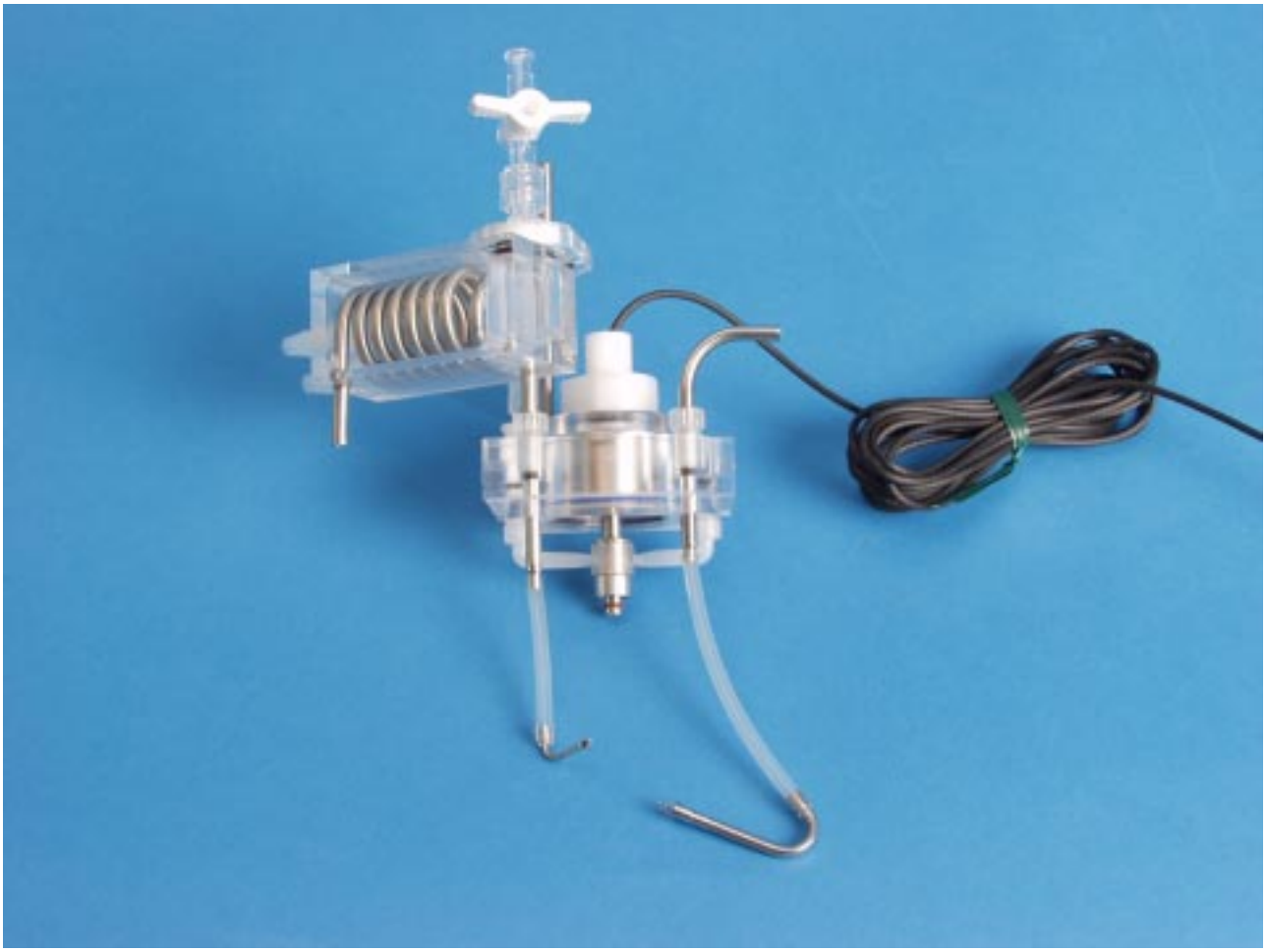




The heat exchanger with the connection tube for the pulmonary artery perfusion cannula as well as the connection pipe for the venous outflow pass through the lid and are sealed and maintained in place by two sealing gaskets. Rotate both counterclockwise to release and pull out the heat exchanger and the connecting pipe as seen above.
By removing the heat exchanger see how the positioning slide fits on the holding rod.



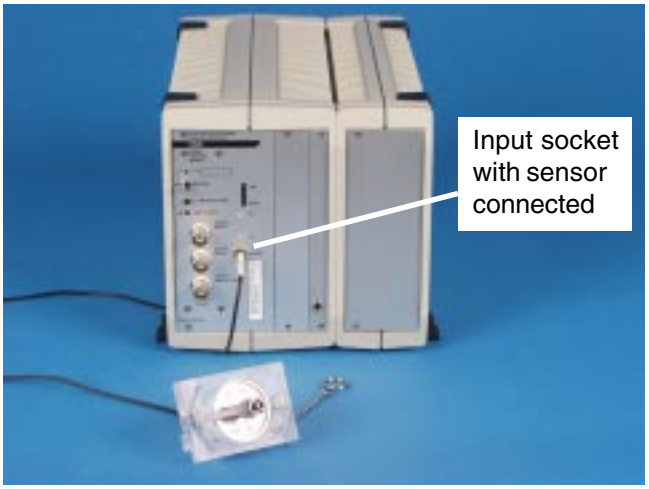
Now mount the parts on the lid with the weight sensor. First open the sealing gaskets by rotating them counter-clockwise. Place the heat exchanger by passing the connection tube through the sealing gasket and be sure the positioning rod is place in the positioning slide. Install the venous outflow pipe also passing through the sealing gasket. Thigh the sealing gaskets and attach the perfusion cannulae. The finished mounted lid should look like the picture below.



6.2 Connecting the Sensor and the DAQ system

6.2.1 Sensor connection to the module

The connecting cable is fix mounted on the sensor side. It is equipped with a special connector fitting to the dedicated socket labeled "SENSOR" on the front panel.



To connect just firmly press the connector into the socket. There is no securing system. To disconnect pull on the connector to move the connector out of the socket. Take care to pull on the connector and not on the cable, that may injure the connection of the cable inside the connector.

6.2.2 Signal output connection for DAQ

There are three signals available fro recording.
- the sensor signal
- the tare compensated with 80 Hz filter
- the tare compensated with very low pass filter 0.2 Hz

All three signals are available on the Plugsys bus if the jumpers have been installed properly on the module during installation.
They are also available on BNC sockets on the front panel to be connected to any DAQ hardware. These hardware mainly have a BNC input for the Analog digital converter.

6.2.3 Signal output description

Output "Sensor Signal"
This output signal is of the sensor measurement unit without any corrections for tare or filtering. This output is also not affected by the gain adjustment. It is in the range of 0 to 10 V. It is combined with the 3 LED display giving basic information on the status. For a good measurement, this output signal should be during measurement in the range of 2 - 8 V. It is the case when the status LED is on green. For regular use of the sensor in combination with an IPL2, there is no need to record that signal continuously as the LED status normally gives enough information on the validity of the measurement.

Output "OUTPUT (80 Hz)"
This output signal is affected by the gain setting as well as by the tare and has a low pass filter of 80 Hz. It is the sensor signal corrected by the tare (weight when the TARA button was pressed) and multiplied by the gain set on the gain trimmer. This signal should be recorded if fast weight changes are expected e.g. by dual occlusion application. The voltage range is -10 to +10 V

Output "OUTPUT MEAN (0.2 Hz)"
This output signal is affected by the gain setting as well as by the tare and has a strong low pass filter of 0.2 Hz. It is the sensor signal corrected by the tare (weight when the TARA button was pressed) and multiplied by the gain set on the gain trimmer. This signal should be recorded if only slow long term weight changes are expected e.g. to follow edema formation. The voltage range is -10 to +10 V

7. How to use it

After the lid is prepared and all connections are realized, the Plugsys case is switched on. The transducer does not require time to warm up and get stable but we would still recommend to wait about 5 minutes before using the unit and calibrating the system.

7.1 Calibration of the recording system

The EBM system is delivered factory calibrated. The calibration value can be read from the label on the front panel next to the trimmer "SIMULATE". We assume that either "OUTPUT (80 Hz)" or / and "OUTPUT MEAN (0.2 Hz) is used for recording
The recording system can be either a standard measurement unit like an oscilloscope, a digital voltmeter or a data acquisition system.
Most of the data acquisition systems require to read in two calibration values. By having the mode switch in position "OFF" the output voltage is 0 V which is identical to a weight of 0 g that signal is read in as the first calibration point. Following that the mode switch is set in position "SIM", here we simulate a weight change of the value mentioned on the label (mainly 1000 mg). The output voltage is depending on the gain set and can be read in to be the equivalent signal for the second calibration point.

7.2 Setting the gain

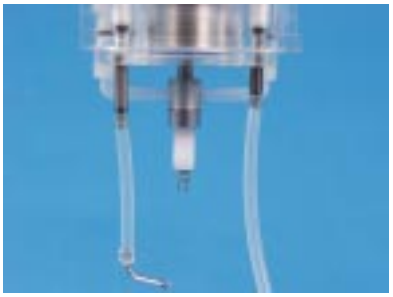
The gain setting is used to optimize the resolution of the recording. To adjust the gain you must have connect to one of the outputs (80 Hz) or (0.2 Hz) a Voltmeter or a DAQ system allowing to measure voltage. You must also know the input voltage range of you DAQ system and the weight changes you expect to record.
To get the best resolution of a measurement system with DAQ it is important to use a maximum the input range.

Procedure to set the gain:
Example 1: rat lung with a weight change of less than 5 g maximum. The DAQ input range is -10 to +10 V
- Set the mode switch on "OFF"
- Check that the voltmeter or DAQ read 0 V
- Set the mode switch on "SIM" if factory set it is 1 g
- Set the trimmer "GAIN" using the provided screwdriver so you read a voltage of 2 V
- Your measurement range is now -5 to +5 g

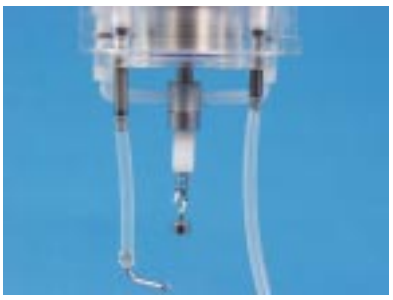
Example 2: mouse lung with a weight change of less than 1 g maximum. The DAQ input range is 0 to 5 V
- Set the mode switch on "OFF"
- Check that the voltmeter or DAQ read 0 V
- Set the mode switch on "SIM" if factory set it is 1 g
- Set the trimmer "GAIN" using the provided screwdriver so you read a voltage of 5 V
- Your measurement range is now 0 to +1 g

7.3 Changing the calibration or recalibrating

It may make sense to verify the calibration from time to time and correct it if necessary. Before recalibrate it, it must be clear that only small differences should appear. The sensor is very stable and there should not be any larger drifts, if that is the case it makes sense to send the sensor and the module back to factory for verification. The factory calibration is 1000 mg. You may want to change it to a larger or smaller weight depending on the lung weight changes you expect, to make the calibration closer to the measurement value.



Make sure you have connected on the output (80 Hz) or (0.2 Hz) a voltmeter or a DAQ system showing voltage and the mode switch is in position "MEASURE".
For changing the calibration or recalibrating, we supply a special tracheal cannula dummy with hook.
- Attach that part is placed in place of the trachea cannula. The green status LED should be on
- Hit the "TARA" button (maintain it pressed until the red LED lights up and release the button and wait until the LED is off)
- The voltmeter or DAQ system should read 0 V +/- 10 mV

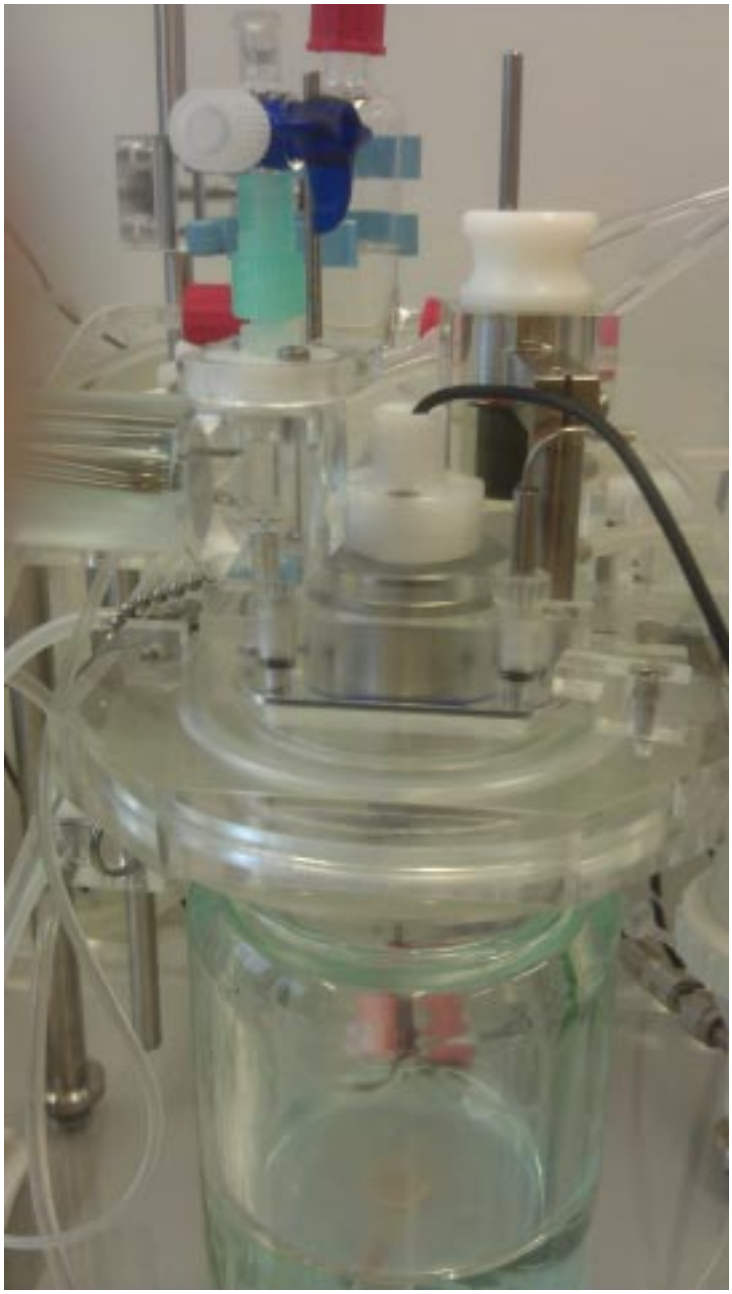


- Attach now a known weight on the hook (we deliver a 1 g weight with the system)
- Check the voltage on the voltmeter or the DAQ system. It must be less than 10 V
- Remember the voltage value
- Move the mode switch in position "SIM", adjust the trimmer on top of the mode switch using the screwdriver to read the same voltage as before
- If required changes the value shown on the label window for the weight used for this procedure

Attention:
If with the weight on the voltage is more than 10 V, the gain must be reduced

7.4 Starting an experiment

The lung is attached using the same procedure as with the standard lid and transferred to the IPL2 system. See an example below.



- Ventilation and perfusion are on at experimental baseline settings.
- Verify that the lung and the venous outflow cannula are not touching the thoracic chamber, if it is the case try to lift the lung by inserting the tracheal cannula deeper into the trachea. Move the venous outflow cannula up or down, rotate it until it does no longer touch the thoracic chamber. Remember that in case of Edema formation the lung gains weight and may be stretched and get longer. Be sure to have enough space between the lung and the bottom of the thoracic chamber.
- Be sure the status LED is green
- After a few minutes press the button "TARA" until the LED on the right of the button goes on. Release the button. The LED should go off after a few seconds, the initial weight of the lung has been compensated and the weight should show 0 g. If the LED is flashing see in section 10
- If during the experiment the status LED gets red, the sensor is out of his range and the measured values are no longer valid.
- If there is a leak and perfusate slowly runs out into the thoracic chamber during the experiment, continuously verify that the lung is not touching the liquid in the bottom of the thoracic chamber. If so at the beginning, the surface tension mimics a lung weight increase and after a while the lung is floating what mimics a lung weight loss. Always remove liquid from the thoracic chamber before it touches the lung.

7.5 Aerosol applications

Later.....

8. Cleaning the system

8.1 EBM Sensor

The sensor housing is made of Plexiglas, never use ethanol or any ehtanol containing agent for cleaning. We recommend to use a moist towel. Take care on the connector it should remain dry

8.2 EBM Plugsys module

To clean the EBM module we recommend to use a moist towel. Take care on all connectors and switches. All these parts should remain dry. Do not use any corrosive agent.

9. Maintenance and servicing

There is no special maintenance or service required. The EBM may be returned to the factory if a special transducer requires adaptation.

10. Faults, causes and remedies

Status LED NEAR lights red
The weight you want to measure is out of the available sensor range, too light

Check for:
Attach the special tracheal cannula dummy with hook in place of the lung, what is the LED color ?

- *Still red, your sensor is defective. Contact the manufacturer*
- *Green, your lung is definitely too light and can not be used with the system. Contact the manufacturer*

Status LED FAR lights red
The weight you want to measure is out of the available sensor range, too heavy

Check for:
Change to positive pressure ventilation and remove the thoracic chamber, what is the LED color ?

- *Still red, your lung is definitely too heavy and can not be used with the system. Contact the manufacturer*
- *Blue, your lung was touching the bottom of the thoracic chamber or the venous cannula was touching the chamber wall, try to correct. But if corrected you must be aware that you are measuring in the upper 80% of the measurement range*
- *Green, your lung was touching the bottom of the thoracic chamber or the venous cannula was touching the chamber wall, try to correct.*

Be sure that by mounting the thoracic chamber, the color does not change

Status LED FAR lights blue
The weight you want to measure is near the boundary of the available sensor range, may be too heavy

Check for:
Change to positive pressure ventilation and remove the thoracic chamber, what is the LED color ?

- *Still blue, you must be aware that you are measuring in the upper 80% of the measurement range*
- *Green, your lung was touching the bottom of the thoracic chamber or the venous cannula was touching the chamber wall, try to correct.*

Be sure that by mounting the thoracic chamber, the color does not change

LED "AUTO TARA" is blinking

By pressing the "Auto Tara" button, the LED lights is blinking

Check for:

The mode switch must be in position "MEASURE"

By pressing the "Auto Tara" button, the LED goes on but is blinking after a few seconds. The auto tara system can not compensate for the initial lung weight.

Check for:

The status LED NEAR or FAR is blue or red, the lung weight is too light (near) or too heavy (far). Contact the manufacturer

11. Technical caracteristics

- Transducer measurement range 0 to 30 g
- Mechanical zero set at 2 g
- Frequency response of the sensor system, output Sensor direct 1000 Hz
- Auto tara compensation 20 - 80 % of the measurement range (6 to 24 g)
- Gain x2 to x100.
- Power consumption ????

12. Reply Form

Please take a few minutes of your time in order to write to us on any difficulties in understanding the Operating Instructions or in the use of the apparatus. With your feedback you will help to improve our products and the system documentation and make them more user-friendly.

Please tell us

- where you have found mistakes,
- where the arrangement was not clear and what you did not understand,
- and where you would like to see improvements.

Many thanks for your *kind assistance.*
Yours HUGO SACHS ELEKTRONIK-
HARVARD APPARATUS GmbH.

Your name _____

Organisation _____

Street _____

Town _____

Phone / Fax _____

eMail _____

Please send this sheet or a copy to:

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