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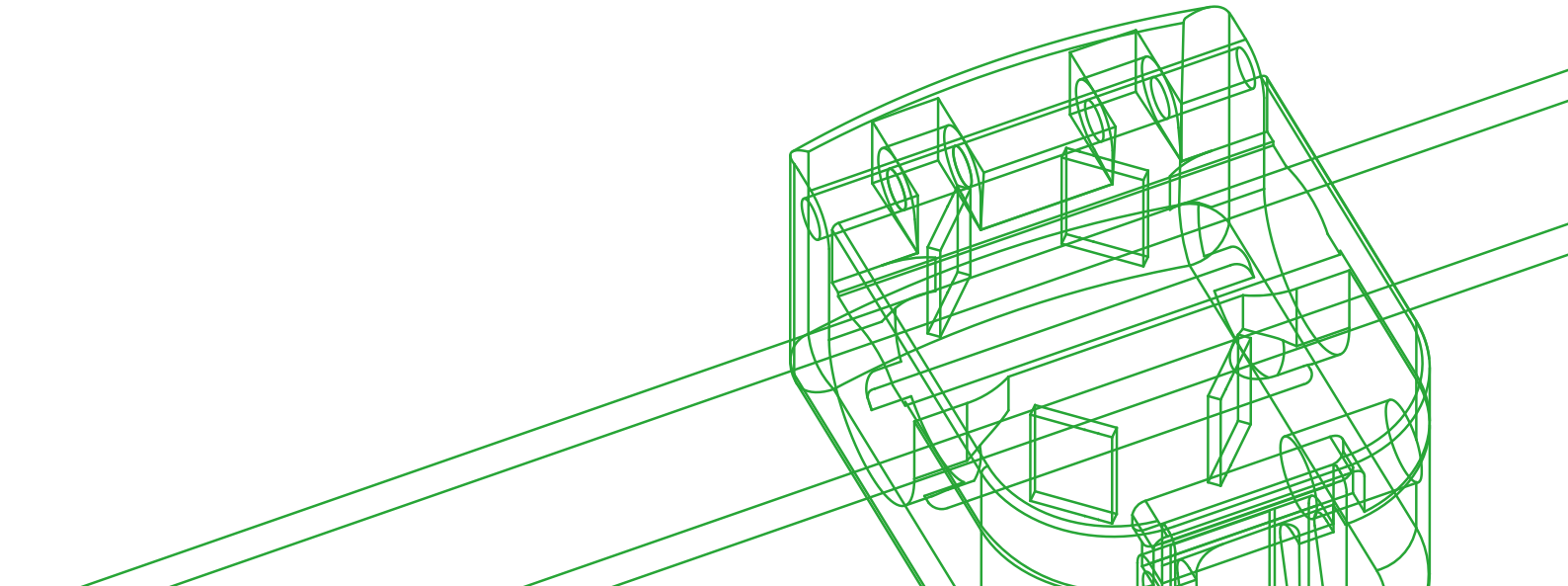
em·tec
BIOPROCESSING

BioProTT™ Clamp-On SL

User Manual



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Subject to Technical Changes

Owing to our policy of continuous product development, the illustrations and technical data contained in this document may differ slightly from the current version of the device.

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1 System Description

em-tec's sensors, which are used in combination with, and powered by, one of the evaluation devices within the BioProTT™ Product Range, carry out measurements based on the ultrasonic transit time method. They enclose flexible tubes via a simple click-fastening and operate non-invasively, i.e., without physical contact to the medium, allowing them to meet even strict hygienic requirements.

Established fields of application on tubing circuits for the sensors are, for example:

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- chromatographies
- monitoring and control of the upstream feed
- monitoring and control of the downstream feed
- filtration
- fill and finish processes
- process evaluation
- upscaling processes
- research

The "SL" at the end of the product name stands for "**S**ky**L**ark", and refers to the flow measurement board which the sensors of the BioProTT™ Clamp-On SL range are adjusted and calibrated for.

The BioProTT™ Clamp-On SLs are fully compatible with all evaluation devices of the BioProTT™ Product Range, i.e. the BioProTT™ FlowTrack SL as well as all devices within the BioProTT™ FlowMCP Series.

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2 Description of the Measurement Principle

The function of the BioProTT™ Clamp-On SL is based on an acoustic measurement principle and utilizes the transit time method to determine the flow. A typical transit time flow measurement system incorporates two piezo ceramics that act as both ultrasonic transmitter and receiver. The measurement system, consisting of an evaluation device and a BioProTT™ Clamp-On SL, operates by alternately transmitting and receiving an ultrasonic pulse between the piezo ceramics and measuring the transit time difference that it takes for the pulse to travel between them.

This method determines the transit time difference of ultrasonic signals through a measuring section and is used to estimate volumetric flow rates. There are at least two transducers, i.e. ceramics, required in order to send and receive ultrasonic pulses both with and against the flow direction. For a higher accuracy, our BioProTT™ Clamp-On SLs incorporate two pairs of transducers, i.e. four piezo ceramics in total, which are arranged in an X-configuration around the tube containing the measured flow.

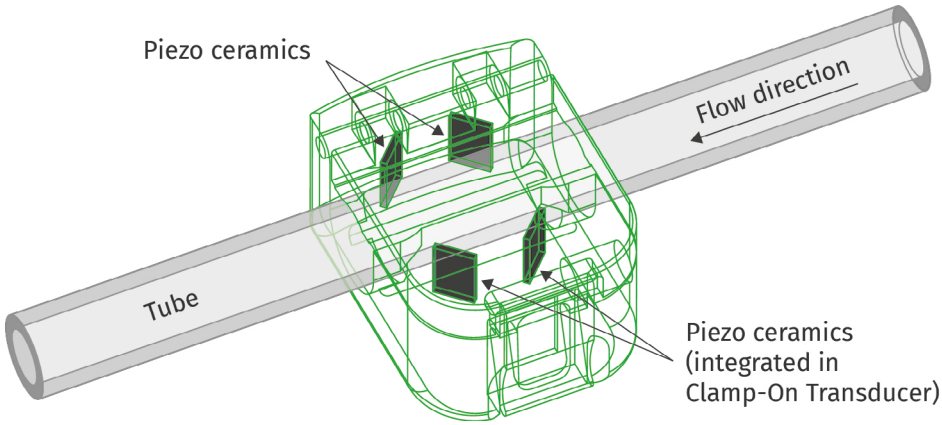

Figure 1: Sensor Structure

When sending ultrasonic signals through the measuring section, the transit time difference depends on the flow direction of the medium:

- The ultrasonic sound signals that are sent along the flow direction and volume flow of the medium, i.e. downstream, need less time to travel the measuring section
  than
- the ultrasonic sound signals that are sent against the flow direction, i.e. upstream.

The transit time difference is measured for every pulse. The difference between upstream and downstream measurements is proportional to the volumetric flow rate of the liquid in the tube. Therefore, by accurately measuring the difference between upstream and downstream transit time T_{up} and T_{down}, we are able to determine the flow velocity. The calculation as such is carried out by the evaluation device.

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3 General Safety Information, Symbols, Units and Abbreviations

3.1 Symbols Used in these Operating Instructions

Symbol	Meaning
	Warning! This safety symbol precedes critical information that must be strictly observed in order to prevent injuries and fatal hazards. This warning symbol is the most important safety symbol.
	Caution! Important information regarding correct handling. Must be observed and strictly adhered to. If this information is not observed, malfunction or damage of the product and its surroundings may occur.

3.2 Symbols on the BioProTT™ Clamp-On SL and on Packaging

Symbol	Meaning
	Do not dispose of this device together with domestic waste! The device as a whole as well as any parts must be disposed of in accordance with WEEE Directive and national legislation.
	Manufacturer: em-tec GmbH · Lerchenberg 20 · 86923 Finning · Germany
	Year of manufacture
	Serial number
	Order number
	Temperature limit during storage and transport.
	Moisture limit during storage and transport. (Non-condensing)
	Air pressure limit
	CE Mark, the device meets the Essential Requirements of the Directive 93/42/EEC.
	UKCA Mark, from January 1, 2022 onwards, this symbol will replace the CE Mark in Great Britain.
IP67	IP (=Ingress Protection) Classification

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4 General Information Concerning this User Manual

- Read this user manual carefully before starting the system!
- This document is intended for the BioProTT™ Clamp-On SL and it describes the use of the BioProTT™ Clamp-On SL.
- The user (= the person who connects the BioProTT™ Clamp-On SL to the tubing circuit and measurement system) is responsible for any risk if the BioProTT™ Clamp-On SL is not connected correctly.
- The customer must ensure that the persons involved in the integration and use of the BioProTT™ Clamp-On SL and the systems it is part of are adequately qualified. In addition, the information in this user manual must be followed.

  Please note:

  As the BioProTT™ Clamp-On SL is part of a system, the user manual of the evaluation device must also be taken into account and adhered to.

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This user manual contains important information concerning the safe and correct handling of the BioProTT™ Clamp-On SL. Keep it in an easily accessible location and familiarize yourself with all warning and safety information and observe them. It is the responsibility of the operator (= the person running and operating the system the BioProTT™ Clamp-On SL is part of) to ensure that the BioProTT™ Clamp-On SL is used, inspected and maintained in accordance with the user manual. This also applies for all subsequent revisions or instructions from the manufacturer. The manufacturer reserves the right to modify technical data without prior notice.

5 Intended Purpose, Restrictions and Limitations

5.1 Intended Purpose

The BioProTT™ Clamp-On SL is indicated for the non-invasive and contactless bi-directional volumetric measurement of the liquid flowing through tubing systems (in combination with an evaluation device of the BioProTT™ Product Range). The measurement principle is the ultrasonic transit time method.

The BioProTT™ Clamp-On SL can be used in applications such as:

- chromatographies
- adding media to bioreactors
- filtration
- fill and finish processes
- filling processes
- process evaluation
- upscaling
- feed control
- research

Additionally, the BioProTT™ Clamp-On SL can be used in any processes where liquid flows through a flexible tubing system at flow rates that lie within the relevant sensor's specification.

For more information regarding applications the BioProTT™ Clamp-On SL can be used in, please contact em-tec GmbH.

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5.2 Usage Restrictions and Limitations

The BioProTT™ Clamp-On SL is constructed and sold for the above-mentioned intended purpose only. The BioProTT™ Clamp-On SL **is not intended** to be used:

- for legal metrology.
- for measuring gaseous media.
- for measurements in explosive areas.
- as medical device.

5.3 Liabilities and Responsibilities

The user is responsible to use, check and maintain the BioProTT™ Clamp-On SL according to this user manual.

em-tec GmbH is neither liable nor responsible for any consequences arising from the use of the BioProTT™ Clamp-On SL that does not comply with the user manual or specifications in this document.

5.4 Safety Instructions

If the BioProTT™ Clamp-On SL is part of an industrial system, the user and operator have to observe the following:

- The measured values of the the BioProTT™ FlowMeasurement System report the volumetric flow rate via the available interfaces of the respective evaluation device.
- If the unit is used to control the liquid volume flow, the user must analyze the risk of the application and, if necessary, take actions independent of the BioProTT™ FlowMeasurement System to minimize said risk.
- In case of an error, refer to chapter 8 "Troubleshooting" as well as to the user manual of the evaluation device respectively.

5.5 Electrical Safety and Electromagnetic Compatibility

The BioProTT™ FlowMeasurement System (i.e. the BioProTT™ Clamp-On SL in combination with a BioProTT™ evaluation device) represents a state-of-the-art technology. It was tested according to **IEC 61326-1: 2013** (Emission: Class A, Group 1) and **IEC 61010-1: 2010** .

Although the requirements of **IEC 61326-1: 2013** and **IEC 61010-1: 2010** were taken into account during the development and manufacturing, the user may be at risk if the system and/or any part thereof is used improperly.

Electrical Installation Requirements

Please follow the general safety information when installing the BioProTT™ FlowMeasurement System. Please also observe any separate relevant safety and technical information of other electrical components used.

Electromagnetic Compatibility Requirements

The customer has to ensure that the relevant emission and immunity requirements of the device configuration are ensured in accordance with the required standards.

Interference of ultrasonic flow measurements by electromagnetic fields could be possibly identified by compromised measured data, which are not related to the real flow.

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Please note:

The BioProTT™ Clamp-On SL is not galvanically isolated.

The BioProTT™ Clamp-On SLs perform without producing either unintended or excessive ultrasound output or unintended or excessive surface temperatures according to **IEC 61326-1:2012.** Electromagnetic fields and electrostatic discharge cannot lead to unintended changes of the electronics causing hazardous ultrasonic output.

It is important to ensure that the BioProTT™ Clamp-On SL and the respective evaluation device are not placed near any disturbance source that is not compliant with the applicable standards since this could

- influence and negatively affect the measurement.
- impact the data stored on the sensor plug and permanently corrupt it.

Crossed lines and the use of extension cables might impact the data transfer and EMC compatibility and/or negatively affet the measurement.

5.6 Maintenance and Service

The service for the BioProTT™ Clamp-On SL may be carried out by em-tec GmbH only. If these instructions are not followed, em-tec GmbH shall accept no liability for the component and the warranty will be void.

If you experience any trouble with the measurement despite following the user manual, or if your BioProTT™ Clamp-On SL is damaged in any way, please contact our service department. Make a note of the serial number of the BioProTT™ Clamp-On SL and the evaluation device before you contact our staff.

If you need to return the BioProTT™ Clamp-On SL or the evaluation device for servicing, please follow the steps below:

1. Contact our service department at:

   em-tec GmbH
   Service Department
   Am Graben 6-8
   86923 Finning
   Germany

   em-tec-service@psgdover.com

2. Our service department will send you a RMA form (=Return Merchandise Authorization).
3. Fill out the form and include it in the shipment.
4. Send your shipment to the address stated above.

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6 Use of the BioProTT™ Clamp-On SL

6.1 General Safety Information

- Inspect your BioProTT™ Clamp-On SL for completeness and damage when unpacking it for the first time.
- If the BioProTT™ Clamp-On SL is not used as intended, the user may be exposed to risks that were not taken into account during its development.
- If the BioProTT™ FlowMeasurement System is used to control the liquid volume flow, the user must analyze the risk of the application and, if necessary, take actions independent of the BioProTT™ FlowMeasurement System to minimize the risk.
- For the installation, and later the operation, all ambient conditions must meet the prescribed specifications (see chapter 10 “Technical Specifications”).
- The user (= the person who connects the BioProTT™ Clamp-On SL to the tubing circuit and measurement system) is responsible for any risk if the BioProTT™ Clamp-On SL is not connected correctly.
- Do not drop the BioProTT™ Clamp-On SL. It might break or get damaged, which could impair the measurement.

6.2 Connecting the BioProTT™ Clamp-On SL to the Evaluation Device

Lab Applications using the BioProTT™ FlowTrack SL

To connect the BioProTT™ Clamp-On SL to the BioProTT™ FlowTrack SL, follow the steps listed below: :

- Carefully attach the round sensor plug to the sensor connection of the evalution device. For the BioProTT™ FlowTrack SL, this is located at the back of the device.
- If it is possible and necessary to use an extension cable, connect the sensor to one end of the extension cable and the other end of the extension cable to the evaluation device.
- Once this is done, the sensor can be attached to the tube.

Industrial Applications using a device of the BioProTT™ FlowMCP Series:

To connect the BioProTT™ Clamp-On SL to one of the evaluation devices of the BioProTT™ FlowMCP Series, follow the steps listed below:

- Carefully attach the extension cable to the respective BioProTT™ FlowMCP (D-Sub). For the BioProTT™ FlowMCP Series, this is located at the bottom of the respective device
- Connect the sensor to other end of the extension cable (round plug).
- Once this is done, the sensor can be attached to the tube.

Please note:

The total cable length between the respective evaluation device and the BioProTT™ Clamp-On SL shall not exceed 4 m.

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For more information concerning the installation of the BioProTT™ FlowMeasurement System and how to connect the BioProTT™ Clamp-On SL to the evaluation device, refer to the user manual of the respective device.

- Check and make sure that the used connector fits and is actually compatible with the measurement system.
- The connector of the BioProTT™ Clamp-On SL must be dry when plugged in.
- While installing the BioProTT™ Clamp-On SL, be sure not to impair the function of the tubing system.
- Make sure to check the plug and the pins for damage before connecting the BioProTT™ Clamp-On SL.
- Do not use the BioProTT™ Clamp-On SL if any part of it is damaged.

6.3 Attaching the BioProTT™ Clamp-On SL to the Tube

In order to be able to measure the flow inside the tube, the BioProTT™ Clamp-On SL must be clamped onto the tube.

- Before you clamp on the sensor, make sure that the tube is not deformed, damaged, or dirty.
- Ensure that the tube size and the tube material used corresponds with the size of the BioProTT™ Clamp-On SL.
- Air in the tube can lead to errors in the measurement or interrupt the ultrasound coupling.
- Ensure that there is no dirt or residue in the flow channel.
  → If necessary, clean the BioProTT™ Clamp-On SL before inserting the tube into the flow channel.

First, make sure that the arrow on the sensor lid is aligned with the flow direction (positive flow display). Then, to clamp on the BioProTT™ Clamp-On SL, follow the steps illustrated below:

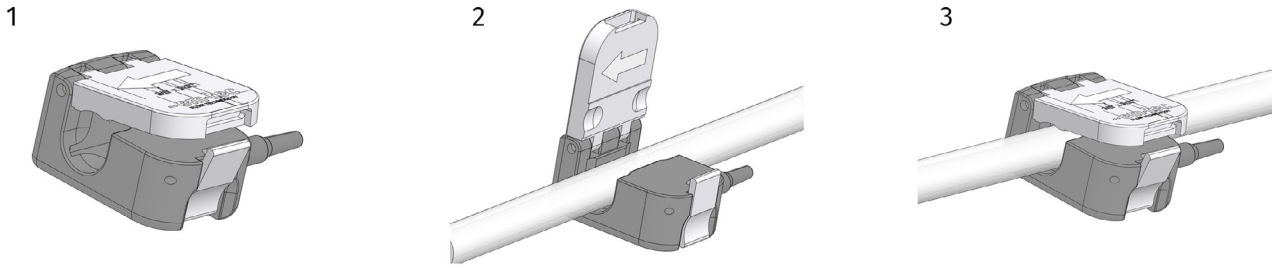

Figure 2: Attaching the Sensor

1. Open the spring-loaded lock and swing back the lid.
2. Insert the tube into the channel.
3. Close the lid and secure it with the help of the spring-loaded lock.

For more information regarding the setup and handling of sensor and tube, refer to our TechNote Issue #1 "How to Optimize the Accuracy in Your Flow Measurement Application".

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- Do not use any excessive force when closing the sensor lid; while the tube should be fixed within the channel, it must not be crammed into it as this might affect the measurement values or damage the sensor.
- Try not to pull the tube into position as this might deform the tube and/or create cracks in the material which, in turn might impact the ultrasonic signal.
- Ensure that the lid is fully closed to avoid fluctuating coupling and flow values.

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Please note:

- To avoid flow turbulences and associated measurement inaccuracies, it is necessary for the tube to be straight in the area near the BioProTT™ Clamp-On SL.
  → Ideally, the tube should be straight for a distance of at least 15 x the inner diameter (ID) of the tube on either side of the sensor.

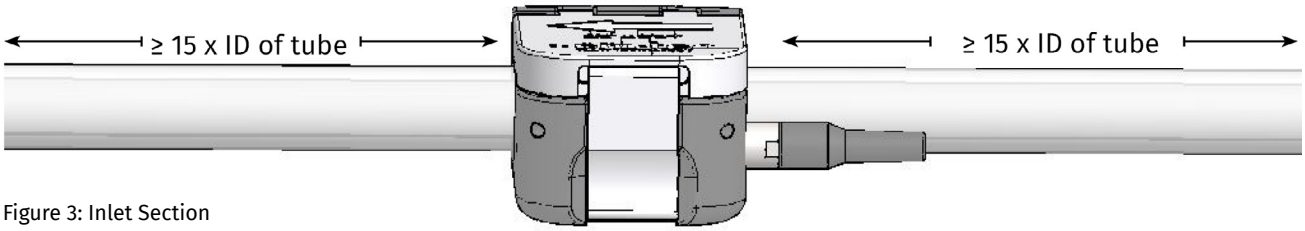

Figure 3: Inlet Section

For more information regarding sensor positioning and other possible measures to optimize and maintain the accuracy of the BioProTT™ FlowMeasurement System, see our TechNote titled "Optimizing Accuracy".

6.4 Use of the BioProTT™ Clamp-On SL

For further details concerning the use of the BioProTT™ Clamp-On SL and how to carry out flow measurements, please refer to the user manual of the respective BioProTT™ evaluation device.

Make sure to follow the steps described below and to heed the warnings included in them in order to ensure the highest possible accuracy of measurement values.

In addition, always ensure that:

- the medium temperature is the temperature the sensor was adjusted and calibrated for.
- **a zero flow adjustment is carried out before each measurement** and whenever possible without disturbing your process.

Before starting the flow measurement:

1. Make sure that only tubes specified for the BioProTT™ Clamp-On SL are used as this is the tube type the BioProTT™ Clamp-On SL is adjusted and calibrated for.
   → The tube that is used during the measurement must be the one indicated in the set calibration table.
   → The tube type(s) the sensor was adjusted and calibrated for can be found in the Calibration Information Sheet, which is part of every sensor order.
2. Before each measurement, the cables, connectors and pins must be checked for breaks or damages as this could result in wrong measurements. Do not use the BioProTT™ Clamp-On SL if you detect any damages.

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3. After inserting the tube, wait for about 5 minutes before proceeding with the setup to allow the tube enough time to regain its original structure.
4. Ensure that the temperature of the medium you use for your application is the same as the one the BioProTT™ Clamp-On SL was adjusted and calibrated for.
5. Carry out a zero flow adjustment. For this,
   - allow sufficient time for the system to adapt to ambient conditions.
   - ensure that the sensor is clamped on at the correct position.
   - ensure that there are no air bubbles inside the tube.
   - the tube must be completely filled with liquid, but the liquid **must not** move.
   - the acoustic coupling rate must be checked. It should be ≥ 60 %.
     → **A zero flow adjustment must be carried out before each measurement** to avoid possible offsets from the measured values.

During the flow measurement:

- Ensure that the coupling is within the operating range (i.e. ≥ 60%). If the coupling falls below 50%, depending on the respective evaluation device, there is either a warning issued or no flow value is displayed as the low coupling might impair the measurement.
- It is important that any unwanted interruption of the process due to damage or kinking of the tubing is avoided at all times.
- Any changes in the medium itself or its temperature can cause errors or anomalies in the measurement.
- It must be ensured that the correct calibration parameters are used.
- While it is possible to carry out measurements outside of the specified flow range, em-tec GmbH cannot guarantee that resulting flow values will be within the given accuracy range.

The parameters of the connected BioProTT™ Clamp-On SL and the selected calibration table are accessible via the display or the web interface of the respective BioProTT™ evaluation device.

Please note:
The stated measurement accuracy of the BioProTT™ Clamp-On SL is only valid if the parameters of your process and application are the same ones the sensor was calibrated and adjusted for and if your setup respects the factors stated in the TechNote "Optimizing Accuracy".

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6.5 Disassembly and Storage of the BioProTT™ Clamp-On SL

It is best to disassemble and store the sensor once the measurement process has been completed in order to not impair the measurement and to protect the BioProTT™ Clamp-On SL from damage.

To disconnect the BioProTT™ Clamp-On SL, follow these steps:

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1. Open the spring-loaded lock and swing back the lid.
2. Remove the tube from the channel.
3. Close the lid and carefully remove the plug from the sensor connection on the evaluation device as to not risk any damage to the sensor or the plug.

Once you have disconnected the BioProTT™ Clamp-On SL, check for any residue of the medium or any other kind of dirt or grime and clean the sensor if necessary. Store the sensor according to storage specifications. Make sure to store it in a place where it cannot fall off or be dropped and ensure that the plug is dry.

6.6 Cleaning and Disinfection of the BioProTT™ Clamp-On SL

Make sure that no detergents or disinfectants leak into the sensor plug.

For the cleaning of the device, we recommend commonly used detergents and/or the recommended disinfectants stated below. In order to avoid stains and dirt from drying out, grime residue should be removed after each application.

To clean the BioProTT™ Clamp-On SL, use a lint-free cloth. Be sure to remove any dirt in the clamping area. Additionally, please follow the legal regulations valid in your country and the hygiene regulations for your specific application.

- The BioProTT™ Clamp-On SL may not be submerged into cleaning or disinfecting solution.
- The BioProTT™ Clamp-On SL is not suited for cleaning processes using machines. Sterilization processes, especially steam sterilization or autoclaving, may not be used.

The following surface disinfectant is recommended:

Name	Manufacturer	Contact
Bacillol® AF	Hartmann	www.hartmann.de

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6.7 Exchanging the BioProTT™ Clamp-On SL

If the BioProTT™ Clamp-On SL was exchanged before switching on the evaluation device, the new calibration parameters will be shown either on the Web Interface or on the display of the respective BioProTT™ evaluation device after the next start-up sequence. If the BioProTT™ Clamp-On SL is exchanged during the operation of the respective evaluation device, the alarm is activated with an error message. Once the new BioProTT™ Clamp-On SL is connected, the alarm is reset and the calibration data can be seen on the Web Interface or the display respectively.

- Make sure that the BioProTT™ Clamp-On SL is attached at a different place on the tube each time to avoid deformation.
- Ensure that the calibration table used is the one needed for your respective application.

6.8 Optional Mounting Solutions

In order to mount the sensor or to fix it in one position, em-tec offers optional mounting solutions. The features differ slightly in regard to their design and handling depending on the sensor size.

Sensors with an OD of up to 3/4"

For sensors suitable for outer tube diameters of up to 3/4", the mounting feature is part of the sensor, i.e. the thread inserts are firmly attached to the sensor and cannot be taken off.

Thread Size	M3
Recommended Thread Length of the Screw in the Base Body	4 mm
Tightening Torque	max. 0.7 Nm

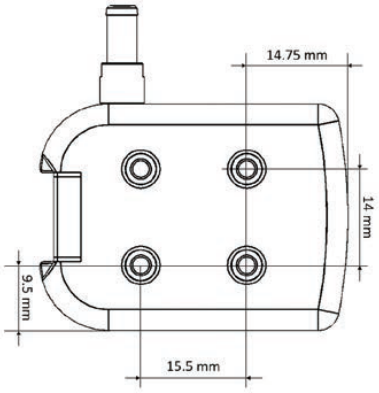

Figure 4: Mounting Feature

Please note: The order numbers for sensors with mounting feature differe from those without.

Sensors with an OD of up to 1-5/8"

Sensors suitable for an outer tube diameter of up to 1-5/8", can be mounted with a separate BioProTT™ Clamp-On Bracket, which is available in two differet sizes, size 35 and size 46.

Mounting	four M5 screws
Tightening Torque	5 Nm

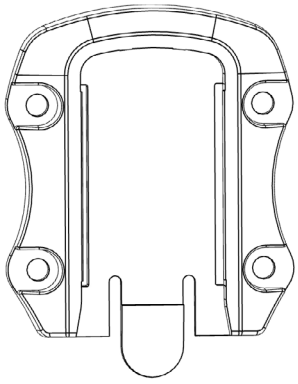

Figure 5: BioProTT™ Clamp-On Bracket

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Technical Drawings:

Size 35

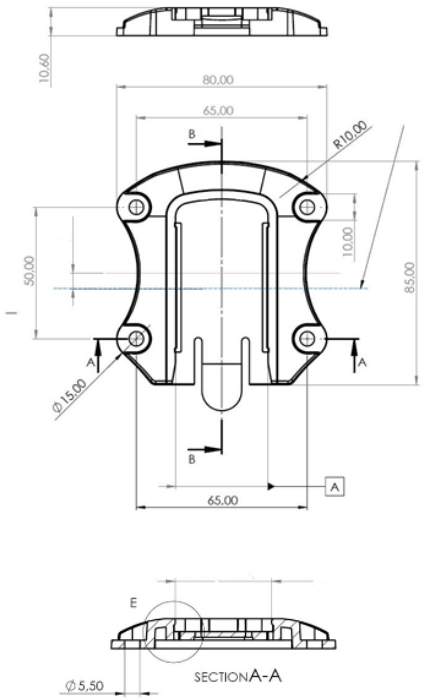

Figure 6: BioProTT™ Clamp-On Bracket Size 35

Size 46

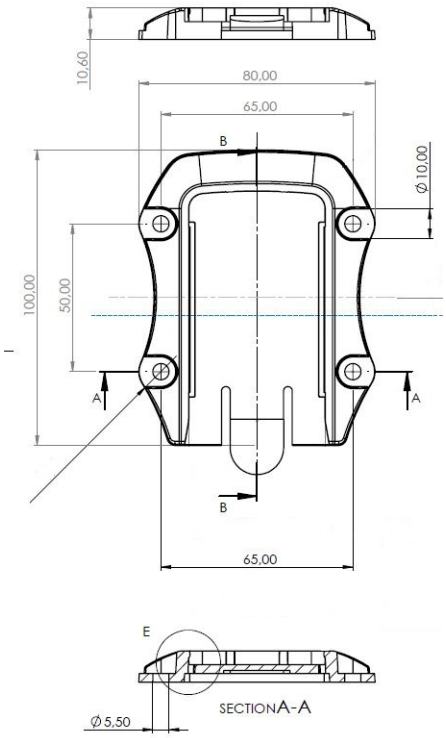

Figure 7: BioProTT™ Clamp-On Bracket Size 46

Suitable for:

- PCT 1/2" x 3/16"
- PCT 3/4" x 1/8"
- PCT 3/4" x 3/16"

Suitable for:

- PCT 1" x 1/8"
- PCT 1" x 3/16"
- PCT 1-1/4" x 3/16"

Please note:

- The mounted BioProTT™ Clamp-On SL is not suitable for tube mounting.
  → The tube must be fixed separately.
- If the load or torsial moment caused by the tube are too high, the thread may tear, the sensor base body may break, or the sensor might be levered out.
- If the mounting feature and thus sensor is not positioned correctly in regard to the tubing, e.g. due to kinking or excessive bending, this might impact the flow measurement and lead to incorrect flow values.

For more information, see chapter 10.3 "BioProTT™ Mounting Solutions".

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7 Adjustment and Calibration of the BioProTT™ Clamp-On SL

In order to ensure the highest possible accuracy, all BioProTT™ Clamp-On SLs are pre-adjusted according to customer specifications in regard to the relevant paramters prior to shipment.

If any of these parameters change, it is possible to send the sensors in for a re-adjustment. In addition, em-tec GmbH recommends regular calibrations to be carried out. Ideally, the time between re-calibrations should not exceed 24 months. Other than the adjustment, the calibration can be carried out by the customer on site. For more information regarding this process, please contact em-tec GmbH and ask for our TechNote "Adjustment vs. Calibration".

It is, of course, also possible to send the sensor to us so we can carry out the calibation.

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8 Troubleshooting

If there are any issues with the BioProTT™ Clamp-On SL, try the following suggestions. If the problem cannot be solved, please contact your local distributor or em-tec GmbH directly.

Problem	Possible Cause	Action
Sensor lid does not close.	• Sensor might be damaged. • Tube might be too large.	1. Check if the sensor is damaged. 2. Check if the tube size is the one indicated for your sensor. 3. If necessary, exchange the tube for the right one. If the sensor is damaged, contact our service department*.
Sensor does not stay in place.	• Sensor might be damaged. • Tube might be too small.	1. Check if the sensor is damaged. 2. Check if the tube size is the one indicated for your sensor. 3. If necessary, change the tube for the right one. If the sensor is damaged, contact our service department*.
Sensor emits noise.	There might be electromagnetic fields influencing the sensor.	1. Check if there are any electromagnetic fields or disturbance sources that are not compliant with standards that could influence the sensor or if the sensor or its cable came into contact with an electric cautery. 2. Check the grounding of the valves and pumps or any other devices that might create electromagnetic disturbances. 3. Remove the source of the electromagnetic field or carry the measurement out somewhere else. If the problem persists, contact our service department*.
Sensor is not recognized. There is no measurement possible.	Memory might have been damaged or deleted by electromagnetic fields.	1. Check if the sensor is damaged or not connected properly to the device. 2. Check if there are any electromagnetic fields or disturbance sources that are not compliant with standards that could influence the sensor or if the sensor or its cable came into contact with an electric cautery. 3. Check the grounding of the valves and pumps or any other devices that might create electromagnetic disturbances. 4. Remove the source of the electromagnetic field or carry the measurement out somewhere else. If the problem persists, contact our service department*.

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Problem	Possible Cause	Action
Sensor is not recognized. There is no measurement possible.	The connected sensor is the wrong sensor type.	1. Check if the correct sensor is connected and if the connected sensor is not damaged. 2. If the sensor is correct, dis- and then reconnect it. If the problem persists, return the sensor to em-tec GmbH for recalibration*.
	The cable is damaged.	1. Check if the sensor is damaged or not connected properly to the device. 2. Check if the cable is damaged. 3. If the cable is damaged, return the sensor and cable for servicing. If the problem persists, contact our service department*.
	The plug is damaged (e.g. broken PIN).	1. Check if the sensor is damaged or not connected properly to the device. 2. Check if the plug is damaged or if there are any broken PINs 3. If the plug is damaged, return the device for servicing. If the problem persists, contact our service department*.
Acoustic coupling is too low.	Sensor lid might not be closed properly.	1. Check if the sensor lid is closed properly. 2. Close the lid. If the problem persists, contact our service department*.
	The tube size and/ or material is not the one indicated for the sensor.	1. Check if the tube size and material are the ones the sensor was adjusted and calibrated for. 2. If necessary, exchange the tube for the right one. If the problem persists, contact our service department*.
	There is dirt in the flow channel.	1. Check if there is dirt in the flow channel. 2. If necessary, clean the flow channel. If the problem persists, contact our service department*.
	Sensor might be damaged.	1. Check if the sensor or the sensor lid (e.g. broken hinge) is damaged. 2. If the sensor is damaged, stop the measurement and return the sensor for servicing. If the problem persists, contact our service department*.
	There are air bubbles in the tube.	1. Check if there are air bubbles in the tube. 2. Remove any air within the tube. 3. Repeat the flow measurement following the steps described in chapter 6.4. If the problem persists, contact our service department*.

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Problem	Possible Cause	Action
Measurement appears to be false.	Sensor might be damaged.	1. Check if the sensor or the sensor lid (e.g. broken hinge) is damaged. 2. If the sensor is damaged, stop the measurement and return the sensor for servicing. If the problem persists, contact our service department*.
	Sensor lid might not be closed properly.	1. Check if the sensor lid is closed properly. 2. Check if there is any dirt or grime in or on the snapper or on the lid. 3. Close the lid. If the problem persists, contact our service department*.
	The tube size and/ or material is not the one indicated for the sensor.	1. Check if the tube size and material are the ones the sensor was adjusted and calibrated for. 2. If necessary, exchange the tube for the right one. If the problem persists, contact our service department*.
	There is debris or dirt in the flow channel.	1. Check if there is debris or dirt in the flow channel. 2. If necessary, clean the flow channel. If the problem persists, contact our service department*.
	There might be electromagnetic fields influencing the sensor.	1. Check if the sensor is damaged or not connected properly to the device. 2. Check if the sensor is damaged or not connected properly to the device. 3. Check if there are any electromagnetic fields or disturbance sources that are not compliant with standards that could influence the sensor or if the sensor or its cable came into contact with an electric cautery. 4. Check the grounding of the valves and pumps or any other devices that might create electromagnetic disturbances. 5. Remove the source of the electromagnetic field or carry the measurement out somewhere else. If the problem persists, contact our service department*.
	Wrong calibration table selected.	1. Check if the selected calibration table is the one appropriate for your application. 2. If necessary, select the right calibration table. If the problem persists, contact our service department*.

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Problem	Possible Cause	Action
Measurement appears to be false.	The cable is damaged or broken.	1. Check if the cable is damaged or broken. 2. If the cable is damaged or broken, stop the measurement and disconnect the sensor. 3. If the cable is not damaged, check the coupling. If the problem persists, contact our service department*.
	The plug is damaged (e.g. broken PIN).	1. Check if the sensor is damaged or not connected properly to the device. 2. Check if the plug is damaged or if there are any broken PINs. 3. If the plug is damaged, return the device for servicing. If the problem persists, contact our service department*.

For more troubleshooting, please refer to the user manual of your respective evaluation device:

- BioProTT™ FlowTrack SL
- BioProTT™ FlowMCP

*For more information concerning the return and servicing of our products, please refer to chapter 5.7 "Maintenance and Service".

9 Environmental Protection and Disposal

Packaging

Packaging materials are made from environmentally friendly materials. The packaging materials will be disposed of by em-tec GmbH upon request.

Disposal

The BioProTT™ Clamp-On SL and its accessories must be disposed of in accordance with the applicable national provisions for electronic components. In accordance with the requirements of EU Directive **2012/65/EC** Waste Electrical and Electronic Equipment (WEEE), our customers in the EU are entitled to return all waste deriving from the products to us – in clean and disinfected condition. The em-tec GmbH WEEE registration number is: **DE 99135207**.

Upon receipt, we repair or dispose of these components properly. For our address please see the very beginning of these operating instructions. For the best utilization of raw materials, the product and its components and accessories should not be disposed of together with household waste. All parts must be collected separately from household waste and disposed of in an environmentally responsible way in accordance to local regulations.

- Before disposal, decontaminate all parts according to the procedure applicable in the clinic.
- If you have questions about disposal, please contact em-tec GmbH's service department.
- Waste may only be brought to the appropriate recycling facility if there is no risk of potential infection from electrical and electronic waste.

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10 Technical Specifications

10.1 BioProTT™ Clamp-On SL

Size (HxWxD), Weight (incl. cable & plug)	25 x 33 x 45 mm (IDs 13427; 13423; 13424; 13420; 13421; 13425 & 13426), 137 g 28 x 38 x 51 mm (IDs 13422 & 13428, 13433), 153 g 35 x 43 x 69 mm (IDs 13430; 13429 & 13431), 225-245 g 46 x 56 x 84 mm (IDs 13432; 13434 & 13435), 380-400 g
BioProTT™ Clamp-On SL with mounting feature: Size (HxWxD), Weight (incl. cable & plug)	31 x 33 x 45 mm (ID 13650, 13651); 148 g 34 x 38 x 51 mm (ID 13652); 165 g
Housing and Lid Material	Epoxy Resin, Aluminum, Brass (for IDs 13427; 13423; 13424; 13420; 13421; 13425; 13426; 13433; 13422 & 13428) Polymeric Compound, Aluminum, Brass (for IDs 13430; 13429; 13431; 13432; 13434 & 13435)
Cable length**	2.9 m ±5 cm with extension cable: max. 4 m
Connector plug	16-pin round plug
IP-Code	without connector: IP67 (protected against splashing water)
Recommended tube type	flexible, non-reinforced tubing; e.g. silicone, PVC
Possible adjustment temperature range	4 °C to 45 °C (40 °F to 113 °F)

***Please note:**
It is possible to adjust the cable length according to customer specifications as long as the total cable length does not exceed 4 m.

Accuracy* in Combination with the BioProTT™ Product Range:

Outer Tubing Diameter (OD)	Accuracy
up to OD 3/4"	±2 % of reading ±20 ml/min
up to OD 7/8"	±2 % of reading ±80 ml/min
up to OD 1-1/8"	±2 % of reading ±200 ml/min
up to OD 1-5/8"	±2 % of reading ±400 ml/min

*The specified accuracies were determined under the following conditions:

Medium: Water
Medium Temperature: Adjustment Temperature
Straight Inlet Section: 15 x inner diameter (ID) of tubing
Fully developed flow profile
Tubing: Tube the sensor was adjusted and calibrated for.

The accuracy stated above can only be guaranteed if the parameters throughout the measurement are the same as the ones the sensor was adjusted and calibrated for (e.g. medium type, medium temperature, tube size, tube material).

Please note:
- The accuracy is specified within the flow measurement range indicated in the table below. The flow measurement range is limited by the Qmin and the Qmax.
- Qmin refers to the minimum flow value for which the accuracy is specified.
- Qmax refers to the maximum flow value for which the accuracy is specified.
- The given values describe the positive flow range, but are the same for negative flow values.
- The installation position of the BioProTT™ Clamp- On SL as well as the positioning of pumps and valves within the circuit impact the measurement and must be taken into account when it comes to the accuracy of the BioProTT™ FlowMeasurement System.

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Ambient Conditions during Transport and Storage:

Atmospheric Pressure	70 kPa to 106 kPa
Temperature Range	-20 °C to 55 °C (-4 °F to 131 °F)
Relative Humidity	10 % to 96 % (non-condensing)

Ambient Conditions during Operation:

Atmospheric Pressure	70 kPa to 106 kPa
Temperature Range	10 °C to 40 °C (50 °F to 104 °F)
Relative Humidity	10 % to 96 % (non-condensing)

Range of BioProTT™ Clamp-On SLs and Their Maximum Measurement Range

ID	Size*	Flow Range 1** [l/min]		Flow Range 2** [l/min]		Flow Range 3** [l/min]		Tube Size***		
		Qmin	Qmax	Qmin	Qmax	Qmin	Qmax	ID [in]	WT [in]	OD [in]
13427	PCT 1/8” x 1/16”	0.017	2.0	—		—		1/8	1/16	1/4
13424	PCT 11/64” x 3/64”	0.017	2.0	0.100	6	—		11/64	3/64	17/64
13423	PCT 3/16” x 1/16”	0.017	2.0	0.100	6	—		3/16	1/16	5/16
13420	PCT 1/4” x 1/16”	0.017	2.0	0.100	8	—		1/4	1/16	3/8
13421	PCT 1/4” x 3/32”	0.017	2.0	0.100	8	—		1/4	1/16	7/16
13425	PCT 3/8” x 1/16”	0.017	2.5	0.100	10	—		3/8	1/8	1/2
13426	PCT 3/8” x 3/32”	0.017	2.5	0.100	10	—		3/8	3/32	9/16
13433	PCT 3/8” x 1/8”	0.017	2.5	0.100	10	—		3/8	1/8	5/8
13422	PCT 1/2” x 3/32”	0.017	2.5	0.100	16.9	2	40	1/2	3/32	11/16
13428	PCT 1/2” x 1/8”	0.017	2.5	0.100	16.9	2	40	1/2	1/8	3/4
13430	PCT 1/2” x 3/16”	0.017	2.5	0.100	16.9	2	40	1/2	3/16	7/8
13431	PCT 3/4” x 1/8”	—		2	75	—		3/4	1/8	1
13429	PCT 3/4” x 3/16”	—		2	75	—		3/4	3/16	1-1/8
13434	PCT 1” x 1/8”	—		2	100	—		1	1/8	1-1/4
13432	PCT 1” x 3/16”	—		2	100	—		1	3/16	1-3/8
13435	PCT 1-1/4” x 3/16”	—		2	100	—		1-1/4	3/16	1-5/8

* Custom sizes are available upon request.
**Please note:
- Customized flow ranges must be requested and checked regarding their feasibility.
- While a measurement is possible outside the given flow measurement range, the accuracy indicated above is only valid within that range.
- The possible flow rate also depends on the tubing.

*** ID = Inner Diameter; WT = Wall Thickness; OD = Outer Diameter

Please specify the adjustment parameters at time of ordering, e.g. medium type, medium temperature, and tubing type (i.e. size and material).

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10.2 BioProTT™ Mounting Solutions

Mounting Feature for Sensors with an OD of up to 3/4":

Article No. & Size	ID 13650 ID 13651 ID 13652	1/8" x 1/16" 1/4" x 1/16" 1/2" x 1/8"
Material	epoxy resin	
Mounting	four M3 screws with a recommended thread length of 4 mm	
Tightening Torque	max. 0.7 Nm	
Expected Product Life	10 years	
Cleaning & Disinfection	commonly used detergents and/or Bacillol® AF by Hartmann (for more information also see chapter 6.6)	

BioProTT™ Clamp-On Bracket for Sensors with an OD of up to 1-5/8":

	BioProTT™ Clamp-On Bracket Size 35	**BioProTT™ Clamp-On Bracket Size 46**
Article No.	ID 13678	ID 13679
Compatible with	PCT 1/2” x 3/16” PCT 3/4” x 1/8” PCT 3/4” x 3/16”	PCT 1” x 1/8” PCT 1” x 3/16” PCT 1 - 1/4” x 3/16”
Size (H x W x D)	85 x 80 x 10.6 mm	100 x 80 x 10.6 mm
Weight	28 g	31 g
Material	polyamide	polyamide
Mounting	four M5 screws	four M5 screws
Tightening Torque	5 Nm	5 Nm
Expected Product Life	5 years	5 years
Cleaning & Disinfection	disinfect easily using alcohol based surface cleaners	

Ambient Conditions

Transport and Storage:	
Atmospheric Pressure	70 kPa to 106 kPa
Temperature Range	-20 °C to 55 °C (-4 °F to 131 °F)
Relative Humidity	10 % to 96 % (non-condensing)
Operation:	
Atmospheric Pressure	70 kPa to 106 kPa
Temperature Range	10 °C to 40 °C (50 °F to 104 °F)
Relative Humidity	10 % to 96 % (non-condensing)

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About em-tec GmbH

em-tec has been a specialist for flow measurement systems in the medical and bioprocessing technology sector for over 30 years. The company's core competence is the non-invasive flow measurement using the ultrasonic transit-time method, that is used for applications in extracorporeal circulation systems of life-sustaining systems as well as in biopharma applications that use flexible tubes. Headquartered in Finning, Germany, em-tec is part of PSG®, a Dover company.

For more information about em-tec, please visit em-tec.de. For more information about PSG®, please visit psgdover.com.

About Dover

Dover is a diversified global manufacturer and solutions provider with annual revenue of approximately $7 billion. We deliver innovative equipment and components, consumable supplies, aftermarket parts, software and digital solutions, and support services through five operating segments: Engineered Products, Fueling Solutions, Imaging & Identification, Pumps & Process Solutions and Refrigeration & Food Equipment. Dover combines global scale with operational agility to lead the markets we serve. Recognized for our entrepreneurial approach for over 60 years, our team of over 23,000 employees takes an ownership mindset, collaborating with customers to redefine what's possible. Headquartered in Downers Grove, Illinois, Dover trades on the New York Stock Exchange under "DOV." Additional information is available at dovercorporation.com.