

## CLAMP-ON VS. IN-LINE FLOW MEASUREMENT SOLUTION

### 1 Our Flow Measurement Solutions

As part of PSG® Biotech, em-tec offers ultrasound-based flow measurement solutions for the bioprocessing market. Whether it is in chromatography, filtration, buffer preparation, or filling processes, a reliable flow measurement is a key feature throughout the entirety of these applications as it can be used to monitor and control dosing, pump speed, and/or filter loading rates. In addition, it provides information regarding the efficiency of running processes and helps detect and prevent anomalies, thus minimizing any disruptions.

Depending on your specific setup and process requirements, there are two general types of flow measurement solutions available: the non-invasive clamp-on system and the in-line system.

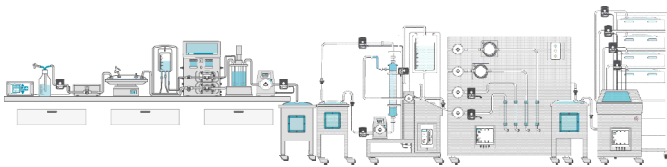


Figure 1: BioProTT™ flow measurement solutions from lab scale (left) to industrial applications (right)

### 2 Clamp-On Solution

The BioProTT™ FlowMeasurement System is available for both laboratory and industrial applications. It consists of a transmitter — either the BioProTT™ FlowTrack SL or a device within the BioProTT™ FlowMCP Series — and a compatible flow sensor of the BioProTT™ Clamp-On SL range.



Figure 2: BioProTT™ Flow Measurement Solutions from lab scale (left) to industrial applications (right)

The main benefits of the clamp-on system are highlighted in the following chapters.

#### 2.1 Non-Invasive Flow Measurement Method

The function of the BioProTT™ FlowMeasurement System is based on an ultrasonic measurement principle, the transit time difference method. This method works by sending an ultrasound signal from one piezo ceramic to another through a defined measurement section, i.e. the flow channel. As the signals alternatively travel with (downstream) and against (upstream) the flow, the speed of the signal depends on the direction it travels in. By looking at and comparing the difference in transit time, it is possible to determine the volumetric flow rate of the flowing liquid. Using this measurement principle means that the flow sensors are non-invasive, i.e. they need no direct contact to the medium, which makes a splicing of the lines unnecessary. Moreover, the fact that the sensors are clamped onto the outside of the tube means that they comply to even strict hygienic requirements and do not add to the risk of (cross) contamination.

#### 2.2 Ease of Use

The non-invasive flow sensors can be easily clamped onto the tube containing the liquid for which the flow rate is to be determined. With a sensor portfolio that comprises up to 16 different sizes, they can be used for a wide array of applications. In fact, as the transmitters are compatible with the full range of flow sensors, it is possible to use several different tube sizes with only one transmitter — albeit several sensor(s) (sizes). In combination with the BioProTT™ FlowTrack SL, which is mainly aimed at laboratory applications, the sensors represent a plug-and-play solution that is easy to set up and easy to use while also allowing for a direct data transfer via RS-232 and/or analog interface. For industrial applications, which tend to use variants of the BioProTT™ FlowMCP Series and compatible flow sensors, the setup might be a little more intricate as the BioProTT™ FlowMCP must be integrated into the PLC environment. Nevertheless, once implemented, the flow measurement system can be seamlessly integrated into the overall process skid.

## 2.3 Economy

Both parts of the BioProTT™ FlowMeasurement System — transmitter and flow sensor — are multi-use devices built for long-term use. Aside from cleaning the devices as needed, i.e. according to your process and application requirements, the only regular maintenance action that is required is a recalibration of sensors.

## 2.4 Sensor Placement

It is possible to vary and change the positioning within the tubing system at any time the process and setup allow. Nevertheless, the tube type must be identical and position requirements be met as the sensors are not integrated into the tubing system and/or manifold itself, but clamped onto the outside of it. Moreover, the maximum cable length between sensor and flow meter is four meters, allowing for a comparatively wide range within which the devices can be placed. Together, these factors grant a high level of flexibility as the sensors and their specific position can adapt to changes within the process without having to completely update (i.e. redesign) or splice the lines.

## 3 In-Line Flow Measurement Solution

The in-line flow measurement solution, the BioProTT™ FlowSU System, is comprised of two parts:

- The multi-use transmitter including the electronics, the BioProTT™ FlowSU System
- and the single-use flow sensor, the BioProTT™ FlowSU Sensor.

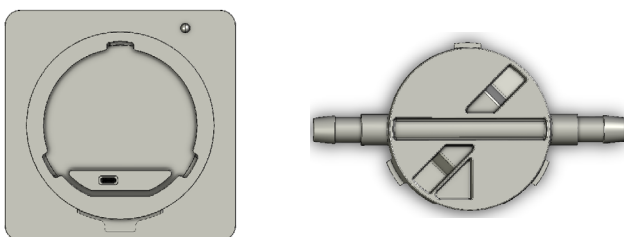


Figure 3: multi-use BioProTT™ FlowSU System (left) and single-use BioProTT™ FlowSU Sensor (right)

Other than the clamp-on solution, the in-line sensor here is part of the flow path, i.e. directly integrated into the tubing system and consequently aimed at single-use applications within the biopharma industry. Depending on the overall system and process requirements, the following key features might make the BioProTT™ FlowSU System an ideal addition for your application.

## 3.1 Improved Resistance against Outside Disturbances (EMC)

The housing of the multi-use part, which also includes the electronics, is made of stainless steel and without a cable at the front, both of which make it comparatively resistant against outside disturbances. This, in turn, helps with the electromagnetic compatibility of the overall system it is integrated into while also protecting the integrity of the measurement values.

## 3.2 Not Limited by Cable Length

As mentioned before, the BioProTT™ FlowSU System does not have a cable at the front. The connection to the single-use BioProTT™ FlowSU Sensor is ensured via a USB-C port, the connection and communication to the host system via Power over Ethernet and Modbus TCP interface. Not only does this help with keeping the overall layout of the skid as organized and clear as possible, but it also means that there are much less limitations within the setup due to cable length. With PoE, the maximum cable length is 100 m or 328 ft.

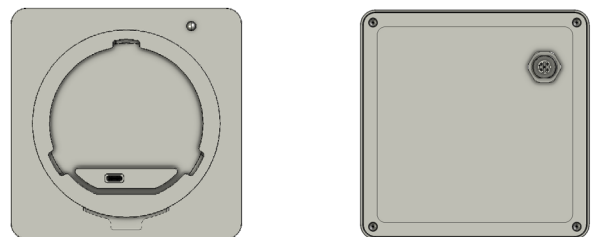


Figure 4: BioProTT™ FlowSU System front (left) and back (right)

## 3.3 No Individual Calibration

The BioProTT™ FlowSU Sensor is a standardized part which is not individually calibrated anymore. This makes ordering of the sensor easy and quick as all necessary parameters are part of the BioProTT™ FlowSU Systems. The stored default parameters were determined for pre-defined setup conditions and can be changed and adapted to the actually prevalent conditions such as installation position, temperature of fluid and type of fluid by using the on-site adjustment feature.

## 3.4 Additional Features

Aside from its flow measurement function, the BioProTT™ FlowSU System also offers an adjustable bubble detection. Depending on how sensitive your application is to air in line, you can select different sensitivities of the bubble detection and by doing so decide what size of bubbles will be reported to the host system. Another feature that makes the process much easier and that enables the highest possible accuracy

is the on-site adjustment, which helps process specific parameters such as integration position or fluid type and/or temperature. To do so, a new regression line is created, meaning that each transit time difference value (measured in pico seconds) is connected to a new, i.e. adjusted, flow value. This means that this regression line replaces the original line that was based on default values so it represents the actual conditions and values of your application. For more detailed information regarding the on-site adjustment, see our TechNote “Sensor Positioning and On-Site Adjustment”.

### 3.5 Stability and Flexibility

Among the main influencing factors when it comes to ultrasound-based flow measurement with clamp-on systems is the tube as every material impacts the ultrasound signal and transit time difference and thus also the flow values in a different way. For the BioProTT™ FlowSU System, this factor is made irrelevant as the in-line single-use sensors are directly integrated into the flow path, meaning they are connected to the tube but not clamped onto it, so the tube material and/or type do not affect the ultrasound signal at all. Furthermore, other than solutions where the sensor is clamped onto the tube and that consequently only work with flexible tubing systems, the BioProTT™ FlowSU System can be used with nearly all types of tubing that can be easily connected to each side of the sensor. With the tube as influential factor eliminated, both findings during R&D processes as well as flow measurement results on-site are reproducible to a higher degree than would be the case with the tube influencing the measurements.

An additional benefit of not being dependent on the type of tubing that is used is the fact that a flow measurement solution is now also available for applications with higher pressure rates. For one, this is due to the fact that flexible tubing systems tend to not be as pressure resistant as firmer or braided tubing types are. For another, high pressure impacts more flexible tubing in that it can temporarily reduce the wall thickness of the tube and thus affect the ultrasound signal, or rather its transit time difference, which, in turn affects the overall accuracy.

### 3.6 Gamma-Sterilizable

Since the BioProTT™ FlowSU Sensor has direct contact to the flowing medium, there are strict

hygienic requirements it must fulfill to avoid any contamination of the final product. Consequently, the BioProTT™ FlowSU Sensor, and therefore the wetted part, is gamma-sterilizable once with up to 50 kGy and packaged under ISO Class 7 cleanroom conditions and compliant to USP 85, 87, 88, 661, 788, ISO 10993-11, and DIN 11737-1: 2021.

### 3.7 Time and Cost Efficiency

With its single-use sensors, the BioProTT™ FlowSU System needs little to no maintenance as there is no calibration or other recurring actions necessary for it to run smoothly, which decreases the overall costs of the system. Furthermore, by integrating one multi-use BioProTT™ FlowSU System, you gain access to five different sensor sizes that can be exchanged in a quick and uncomplicated manner, allowing for the option to upscale and downscale as needed without having to invest in an additional flow measurement solution.

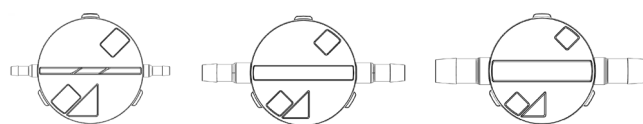


Figure 5: BioProTT™ FlowSU Sensors in different sizes (examples)

This is also reflected in the on-site adjustment: As the system is not impacted by different tube types, the on-site adjustment can be carried out and then be saved and applied to processes using a different kind of tubing whereas a calibration factor must be determined individually for each specific application and tube type.

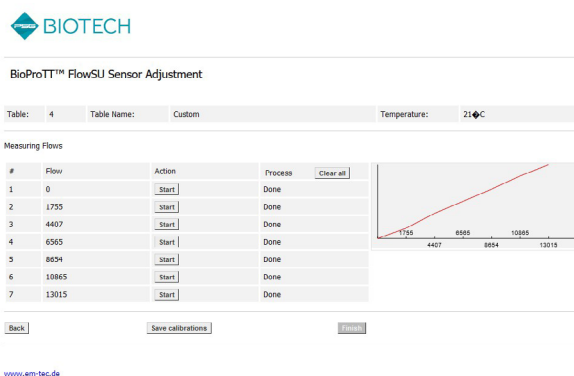


Figure 6: On-Site Adjustment of the BioProTT™ FlowSU System

## 4 Conclusion

All BioProTT™ products — the clamp-on system for laboratory and/or industrial applications or the in-line system — represent state-of-the-art flow measurement solutions based on an established and proven measurement principle. Consequently, it depends on your specific setup and requirements whether the non-invasive clamp-on solution or the single-use in-line solution are better suited for your process and application.

Find out more about the clamp-on system [here](#), and visit [this page](#) to learn about the in-line solution. In addition, we are always happy to help you find out what works best for you, so please don't hesitate to contact us.

## 5 Contact

You can reach us at:

**em-tec GmbH**

Lerchenberg 20

86923 Finning

GERMANY

Phone: +49 8806 9236 0

E-Mail: [biotech@psgdover.com](mailto:biotech@psgdover.com)

Internet: [psgdover.com/biotech](http://psgdover.com/biotech)