

1 Introduction

The BioProTT™ FlowMeasurement System always consists of an evaluation device—also referred to as flow meter—and one of our BioProTT™ Clamp-On Transducers. Its function is based on the ultrasonic transit time method, which determines the flow by measuring the difference in the transit time between ultrasonic signals. To do so, the signals are alternately sent with and against the flow. Since parameters such as the tubing material or the medium as well as its temperature influence the ultrasonic signal and thus the transit time difference between them, they play a significant role in the measurement. To compensate for them and their impact on the measurement, every single BioProTT™ Clamp-On Transducer is individually adjusted and calibrated before it leaves our factory. The relevant parameters for the adjustment and calibration are:

- tubing material
- medium
- flow range
- medium temperature

To ensure the highest possible accuracy, em-tec GmbH does not use default parameters, but customer-specific ones.

2 Adjustment vs. Calibration

2.1 Definitions

2.1.1 Adjustment

An adjustment represents the act of modifying something to fit a certain standard. Consequently, it involves an actual intervention in the measurement system.

2.1.2 Calibration

The term ‘calibration’, on the other hand, refers to the act of checking the accuracy of a measurement device by comparing its measurement values with those of a device with a known accuracy. This comparison is subject to a specified measurement setup and specified measurement conditions. During the calibration process, neither the devices involved nor any of their parameters may be changed, manipulated, or altered in any way.

2.2 Adjustment & Calibration of em-tec’s BioProTT™ Clamp-On Transducers

As was mentioned before, each of our sensors is individually adjusted according to customer specifications prior to leaving our premises. Nevertheless, we do recommend regular calibrations to be carried out in order to ensure a consistent quality of measurement values and consequently the final product. Other than adjustments—which should remain an exception—calibrations can and should be performed regularly. As a rule of thumb, em-tec GmbH recommends intervals of 24 months. As the calibration does not involve any technical intervention, it can be carried out by the customer on-site by running the BioProTT™ FlowMeasurement System alongside a reference system (e.g. a Coriolis flow meter).

Please note: A calibration should always be accompanied by the calibration verification, i.e. the proper documentation of your measurement results according to your respective ISO standard.

If, during a calibration, the measurement values turn out to be outside the specifications, or if general parameters such as medium temperature, tube material or the maximum flow rate (Q_{max}) need to be changed, an adjustment becomes necessary. To adjust the sensor, parameters such as for example the amplitude of the ultrasonic signal and the length of the ultrasonic burst might have to be changed.

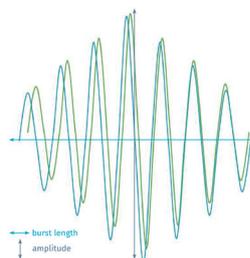


Figure 1: Ultrasonic Signal; example only

As a result, it is an action that permanently alters the device as the setting of the burst signal (scan window and amplitude) and the sequential balance line are changed. Since these parameters have a deep impact on the sensor’s performance, and since adjusting the sensor represents an intervention of the measurement system, adjustments may only be carried out by em-tec GmbH.

So to guarantee an optimal performance of the BioProTT™ Clamp-On Transducer, please contact us if you are in need of an adjustment.

You can reach us at em-tec-info@psgdover.com to receive further information about the next steps.

3 Calibration on Customer-Site

3.2.1 How to Perform a Calibration

To perform an on-site calibration, please follow the steps listed below:

1. Check the BioProTT™ Clamp-On Transducer for any damages or defects.
2. Check the calibration report for details regarding the calibration verification.
3. Set up a calibration rig.

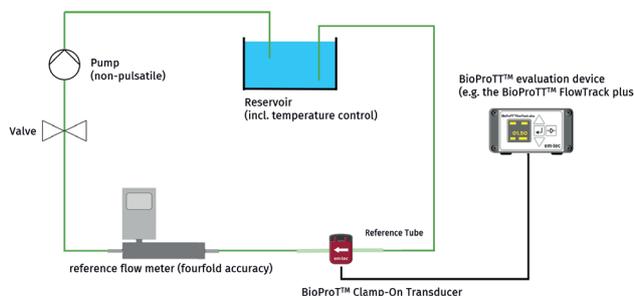


Figure 2: Calibration Setup, Example

Please note: The parameters during the calibration on site must be the same the BioProTT™ Clamp-On Transducer was originally adjusted for. For details concerning the original calibration carried out by em-tec GmbH, please refer to the Calibration Report that was included with the sensor (see the report at the end of this document as reference).

4. Attach the sensor to the tube.

Please note: Ideally, the tube is straight for a distance of $15 \times ID$ (=inner diameter) of the tube on either side of the sensor.

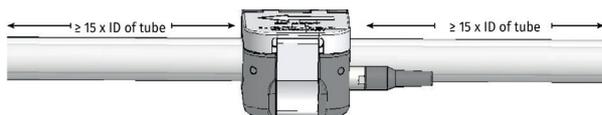


Figure 3: Inlet Section of the Sensor

5. Allow for enough time so the system can equilibrate (usually 5 to 10 minutes).

Please note: the ambient temperature should be within the range of 18°C to 25°C .

6. Zero the flow at all involved evaluation devices (i.e. the em-tec and the reference flow meter). For the zero flow adjustment,
 - the sensor must be clamped on in the correct installation position
 - the tube must be filled with liquid, but the liquid must not move.
 - there must be no air bubbles in the tube.
7. Perform a calibration verification for specific measurement points (=specific flow values).
8. Record the measured data if the flow is stable.
9. Check and record if the verification was successful (“passed”) or not (“failed”) in your calibration report.
10. Repeat steps 7 to 9 for all measurement points within the relevant calibration table.
11. Once this is done, go to the next calibration table, change the parameters accordingly and repeat the process including the zero flow adjustment.
12. Generate the calibration verification report.

Please see the Calibration Report at the end of this document as reference.

It is assumed that all above mentioned steps are being followed and taken into account by everyone involved in carrying out the calibration verification.

If the measurement values during the calibration turn out to be outside the specification, there are two possible solutions:

1. You can determine and set a calibration factor (see chapter 3.2.2 for more information).
2. You can send the sensor to em-tec GmbH for an adjustment.

3.2.2 Calibration Factor

To compensate offsets detected during the calibration or the use of a medium or medium temperature that is different from the one the sensor was originally adjusted for, it is possible to set a calibration factor. This can be done on-site and means the measured flow is adapted by a linear factor.

For more information about the calibration factor and how to determine and use it, contact em-tec GmbH and ask for our application note titled “Determining the Calibration Factor”.

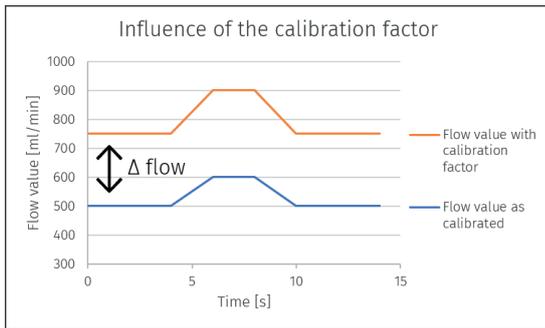


Figure 4: Influence of the Calibration Factor

3.2.3 Liabilities and Responsibilities

If carried out by another party, em-tec is not responsible for any errors or damages occurring during the calibration verification or the documentation of the results. The company performing the calibration verification is solely responsible for the verification and its documentation.

If there are any questions concerning the information in this document, or if you are having trouble at some point during the calibration verification, please contact em-tec GmbH. You can reach us at:

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 86923 Finning
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Please note: If, for some reason, it is not possible for the customer to carry out the recalibration of the BioProTT™ Clamp-On Transducer, em-tec GmbH offers the option of sending the sensor to us where it can be calibrated instead. In this case, please use the address above to contact us.

Annex: Calibration Report

The form below shows the calibration report, which is included in every BioProTT™ Clamp-On Transducer shipment. While the document that is used on-site might not look exactly the same, this nevertheless serves as a general guideline and reference regarding the documentation of the calibration verification.

em-tec Calibration Report					em-tec	
Product				Serial No.		
BioProTT™ Clamp-On Transducer						
Report for		Initial Calibration		Overall Result		
Check of Offset Stability (at room temperature)			Error Limit [ml/min]	Start Value [ml/min]	End Value [ml/min]	Result
Flow Drift over 30min at zero flow (0,1 Hz)						
Calibration information for Check of Flow Accuracy						
Table No.	Medium	Temp [°C]	TubeMaterial	Max. Flow [ml/min]	AC*	
1						
2						
3						
4						
5						
6						
7						
<small>*Medium Temperature; other environment conditions are insignificant for calibration **AC= Acoustic Couplant applied</small>						
Check of Flow Accuracy						
Table No.	Flow Accuracy at [ml/min]	Target Range [ml/min]	Max. Error [%]	Actual Value [ml/min]	Actual Error [%]	Result
1						
2						
3						
4						
5						
6						
7						
The device has been manufactured, calibrated and packaged in a facility which complies to the standard ISO 13485. All em-tec measurement equipment used for calibration is traceable to national or international metrology institutes. Recalibration is recommended in 24 months.						
Measurement Equipment used:			Calibr. station:	MagFlow:		
Calibration Procedure used:						
Comments/Modifications:						
Name:		Signature			Date	

Figure 5: em-tec Calibration Report