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MEDIUM-FLOW PNEUMOTACH TRANSDUCER

- SS11LB and SS11LA for MP3X and MP45 System
- TSD117A & TSD117A-MRI for MP160/150 System
- TSD117B for MP160/150 System
- RX117A-MRI Replacement Airflow Head
- See also: **AFT series** of accessories for airflow and gas analysis

The SS11LB handheld airflow transducer is intended for human use and can be used to perform a variety of tests relating to airflow and lung volume. The transducer is factory-calibrated to measure airflows ranging from -10 to +10 liters/second within +/-5%. The transducer has a removable head (RX117A-MRI) for sterilization and replacement.

The SS11LB transducer incorporates the following improvements over the earlier-model SS11LA:

- No calibration syringe is required.
- Airflow measurement is much less susceptible to changes in transducer orientation.
- New tiered airflow head design allows for direct connection to multiple standard pulmonary ID/OD hoses and components without the need for couplers.
- Flow correction that was previously only included in lessons (via syringe) is now in Lessons and BSL *PRO* analog preset.

Use standard disposable mouthpieces with disposable bacterial filters, or use an autoclavable mouthpiece, depending on budget and/or lab preference. Direct connection to AFT36 35 mm Filtered mouthpiece. The SS11LB can also be used with the AFT22 Non-Rebreathing T-valve for low dead space requirements, and to monitor expiration and inspiration signals separately.

NOTE: SS11LB is compatible with BSL 4.1.1 and above or Acq*Knowledge* 4.4.2 and above. For earlier BSL and Acq*Knowledge* software versions, use SS11LA. (See page 2.)

FLOWCAL Optional SS11LB Calibration/Validation Kit

To perform an optional SS11LB user calibration, use the FLOWCAL Kit.

This kit consists of a calibrated 3-Liter calibration syringe (AFT27) plus coupler (AFT11D) that connects the syringe to the SS11LB. Download the free graph template file and FLOWCAL procedure from the BIOPAC FLOWCAL page.

Users wishing to perform an accurate validation should also have equipment that can measure humidity, temperature, and pressure of the lab environment.

The SS11LB is factory-calibrated for use when directly connected to a mouthpiece. If the flow transducer is connected to a hose, facemask, or other tubing it should be recalibrated with those attachments by using the syringe and this kit.

SS11LA Medium Flow Pneumotach Transducer

Older model SS11LA with RX117 is available for systems running BSL 4.1.0 and below or Acq*Knowledge* 4.4.1 and below (software upgrade recommended), and is the shipping airflow transducer model for Chinese, Italian, and Russian BSL 3.7 Systems. Use AFT1 Filter + AFT2 mouthpiece with SS11LA flow head RX117. See page 5 for SS11LA connection and calibration instructions.

TSD117A Medium Flow Pneumotach Transducer

The TSD117A is intended for human use and can be used to perform a variety of tests relating to air flow, lung volume and expired gas analysis. The new tiered flow head allows for direct connection to multiple standard pulmonary ID/OD hoses and components without the need for couplers. The flow head is removable, for easy cleaning and sterilization or replacement (RX117A-MRI). The TSD117A interfaces with the DA100C general-purpose transducer amplifier. The TSD117A is intended for human use.

Replaces older model TSD117/RX117.

TSD117B Medium Flow Pneumotach Transducer

The TSD117B is similar to the TSD117A, but output and scaling are distinct. The TSD117B is intended for human use and can also be used to test ventilator circuits.

TSD117A-MRI Medium Flow Pneumotach Transducer

The TSD117A-MRI is designed for use in the MRI environment and interfaces with the MECMRI-DA to the DA100C general-purpose transducer amplifier. Includes RX117A-MRI removable flow head.

Replaces older model TSD117-MRI/RX117-MRI.

The TSD117A-MRI terminates in a DSUB9 and requires MECMRI-DA for proper operation.

MRI Use: MR Conditional to 3T

Note: Conductive parts of transducer are electrically and thermally isolated from subject. The TSD117-MRI is used outside the bore in the MRI Chamber Room and AFT7-L tubing is connected to reach the subject using AFT35-MRI non-rebreathing T-valve.

Components: Polyvinyl Chloride (PVC) Plastic, Polycarbonate Clear Plastic, Acrylonitrile Butadiene Styrene (ABS) Thermo-molded, Plastic, Polymer thick film device (rigid substrate, printed semi-conductor), Copper clad fiberglass lamination (PCB material), Stainless steel screen (type 316L), Stainless steel machine screws/nuts, tinned copper wire, Silicone elastomer, PVDF (Kynar®) heat shrink tubing

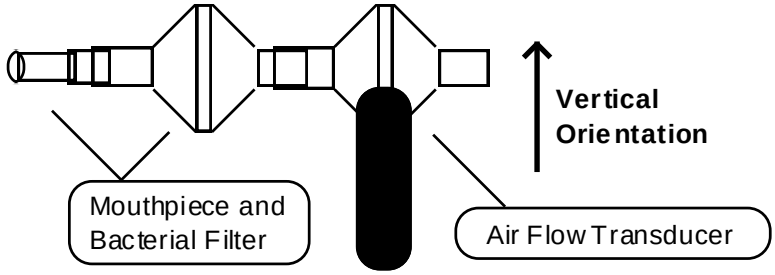
Please note the following for all airflow transducers:

a) The bacterial filter and mouthpiece are disposable and are "one per person" items. Use a new disposable filter and mouthpiece each time a different person is to be breathing through the airflow transducer.

b) For more effective calibration, use a bacterial filter between the calibration syringe and the airflow transducer.

Normal Measurement Connections

- SS11LA/SS11LB plugs directly into the MP3X or MP45 unit
- TSD117A/TSD117B plugs directly into the DA100C amplifier module
- TSD117A-MRI plugs into MECMRI-DA cable to DA100C amplifier module



For the most accurate lung volume recording, be sure to use a noseclip to prevent airflow through the nose. Also, be sure not to remove the airflow transducer assembly from the mouth during the recording. All air leaving or entering the lungs must pass through the airflow transducer during the lung volume measurement.

Use the following measurement procedure for determining lung volume:

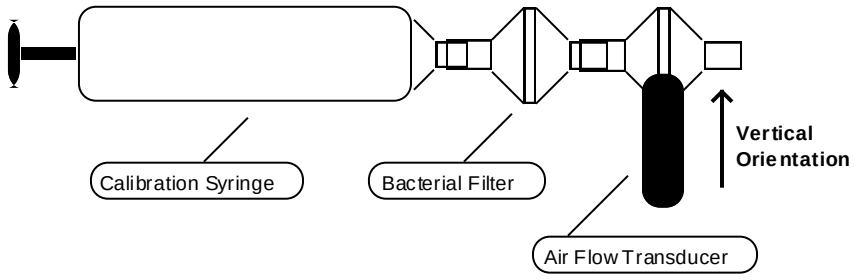
1. Breathe normally for 3 cycles (start on inspire)
2. Inspire as deeply as possible
3. Return to normal breathing for 3 cycles
4. Expire as deeply as possible
5. Return to normal breathing (end on expire)

Data Processing

When integrating the collected data to determine lung volume, it's important to integrate from the starting point of the first inspire, to the end point of the last expire. Before integration, the mean of the selected (airflow) data must be determined and then subtracted from the record. This process insures that the integral will have the same starting and ending point.

Calibration for Medium-Flow Pneumotachs

1. Syringe Calibration



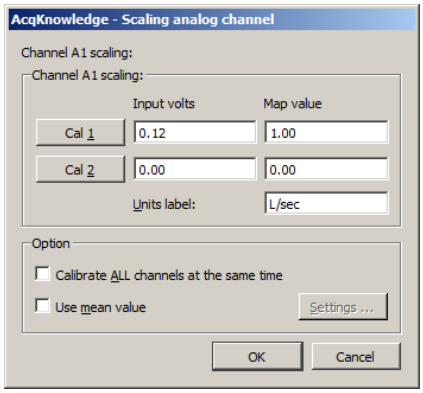
After the calibration process, please remove the calibration syringe and attach a new bacterial filter and mouthpiece to the airflow transducer.

It's very important that each individual use his/her own mouthpiece and bacterial filter.

Place the narrow end of the bacterial filter and mouthpiece assembly into either side of the airflow transducer. Airflow data can now be recorded. For best results, hold the airflow transducer vertically.

2. Mathematical Calibration (TSD117A/B and TSD117-MRI)

The transducer can be roughly calibrated without using the calibration syringe. Using the transducer's nominal output of 60 µV per liter/sec (normalized to 1 volt excitation), the following calibration factors can be entered in the software Scaling window.



Scaling Factors for Rough Calibration of the airflow transducer

The following equation illustrates why 0.12 volts maps to 1.00 liter/sec:

Calibration Constant • Amp Gain • Amp Excitation = Scale Factor

Thus

60 µV/[liter/sec] • 1000 • 2 Volts = 0.12 V / [liter/sec]

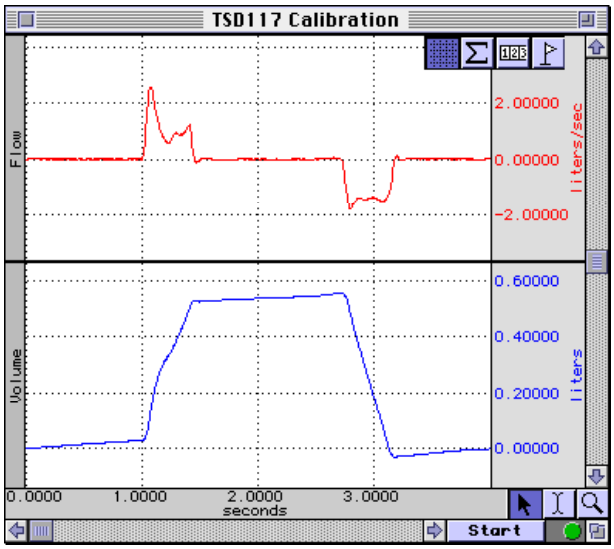
Data can now be collected directly. Prior to analyzing the data, remember that there will always be some offset recorded in the case of zero flow.

Note: With the TSD117A/B and MP160/150 system, it's possible to largely trim this offset out, using the ZERO potentiometer on the DA100C amplifier, but some residual will always remain.

To remove residual offset after the flow data has been collected, select a portion of the baseline (zero flow reading) and calculate the mean value using the popup measurements. Subtract this mean value from the raw data to obtain a mean corrected flow signal.

Now, the integral of the mean can be calculated as shown in this graph →

In this case, a 600 ml-calibration syringe was used to check the rough calibration of the airflow transducer. The rough calibration indicates a syringe volume of about 550 ml, so this method may only be expected to be accurate within ±10% of the real reading.



Flow Measurement and Volume Calculation

To achieve a more exact calibration, start with the above scaling factors and then boost or drop them slightly as indicated by the rough calibration. In this case, if the map value correlating to 0.12 volts were boosted about 10% to 1.10 (from 1.0 liters/sec), the resulting calibration would be fairly accurate.

See also: DA100C Calibration options.

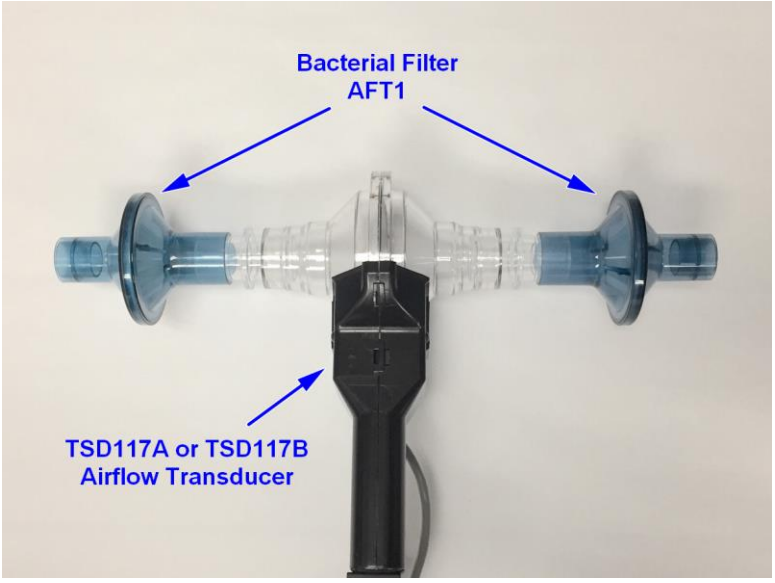
>>> All Instructions also apply to the older airflow transducer — model SS11L with non-removable head <<<

TSD117A and TSD117B Volume Calculations for use with Ventilator Setups only

When the TSD117A / TSD117B is used for volume calculations, the BIOPAC provided polynomial corrections are applied to this connection configuration.

AFT1 + AFT11B + TSD117A/B + AFT11B + AFT1

The AFT11B couplers are oriented so that the larger ID portion is inserted into the inlet and outlet ports of the TSD117A/B.



Correction polynomials are created for positive going flow and negative going flow. Accordingly, inlet/outlet orientation of the TSD117A/B is important to note.

TSD117A and TSD117B Correction Polynomials

	TSD117A	TSD117B
Positive flow, gain 200	(62.2975*(C0.0^5))-(83.9338*(C0.0^4))+(37.713*(C0.0^3))-(7.79054*(C0.0^2))+(9.95619*C0.0)	(104.885*(C0.0^5))-(79.0459*(C0.0^4))+(39.0034*(C0.0^3))-(19.8456*(C0.0^2))+(18.9708*C0.0)
Negative flow, gain 200	-160.886*C1.0^5 - 221.417*C1.0^4 - 98.8812*C1.0^3 - 14.2169*C1.0^2 + 9.04025*C1.0	485.591*C1.0^5 + 431.054*C1.0^4 + 110.998*C1.0^3 + 11.5803*C1.0^2 + 18.5883*C1.0
Positive flow, gain 1000	--	(-0.0269074*(C0.0^5))+(0.572741*(C0.0^4))-(1.40163*(C0.0^3))+(0.447*(C0.0^2))+(3.76072*C0.0)
Negative flow, gain 1000	--	-0.199265*C1.0^5 - 0.394593*C1.0^4 - 0.175574*C1.0^3 + 0.118694*C1.0^2 + 3.75985*C1.0

TSD117A/B correction curves to account for small tube interface turbulence.

Calibration, noise, and accuracy data: download TSD117B to TSI4000 flow standard (xls and txt)

The assumptions for TSD117A/B use are: TSD117A/B connected to DA100C

DA100C set to:

- Gain: 200 (TSD117A/B) and 1000 (TSD117B)
- 10Hz LP ON
- 300Hz LP ON
- DC Coupling
- VREF1 = +5V
- VEF2 = -5V

NOTE: for further accuracy, a syringe calibration is recommended to determine appropriate overall multiplicative factors for specific devices.

SS11LA To MP3X Connection

1. Make sure the BIOPAC MP3X unit is turned OFF.
   Note: Turn the MP3X power off even if the software is running.
2. The airflow transducer (SS11LA) can be plugged into any input channel on the MP3X.
3. After the transducer is plugged in securely, turn the MP3X power ON.
4. Launch the BSL or Acq*Knowledge* software.

IMPORTANT: After launching the software, allow at least 5 minutes for the SS11LA/LB Airflow Transducer to properly warm up.

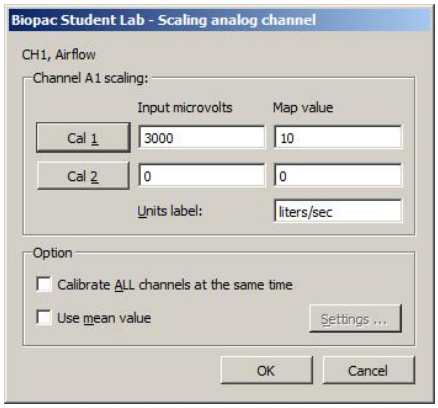
Note: SS11LA to MP connection instructions also apply to 2-channel MP45 hardware.

SS11LA to MP3X connection

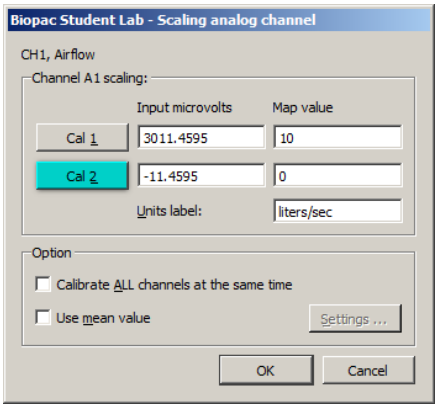
Rough Calibration (MP3X)

1. Choose the MP3X menu and select **Set Up Data Acquisition > Channels**.
2. Select the **Analog** channel that the SS11LA transducer is plugged into and activate it by checking the **Acquire**, **Plot** and **Values** boxes.
3. Click the **Preset** pop-up menu and select **Airflow (SS11LA)** from the Preset list.
4. Click the **Setup** button in upper right of Channels screen.
5. Click the **Scaling** button at bottom of Setup screen. Note the default **Cal1 Input value** is 3000 microvolts, and the **Cal1 Map value** is 10, as shown in upper right example.
6. Click **Cal2**: Note the adjusted **Input value**. (Leave the **Map value** at 0.)
7. Add the adjusted **Cal2 Input value** to the **Cal1 Input value**, as shown in lower right example.
8. Click **OK**.

The SS11LA can be roughly calibrated without using the AFT6 calibration syringe by choosing the SS11LA preset and re-scaling to account for amplifier excitation. Use the "Rough Calibration" steps shown on the left to apply this calibration method.



SS11LA Default Scaling



SS11LA Adjusted Scaling

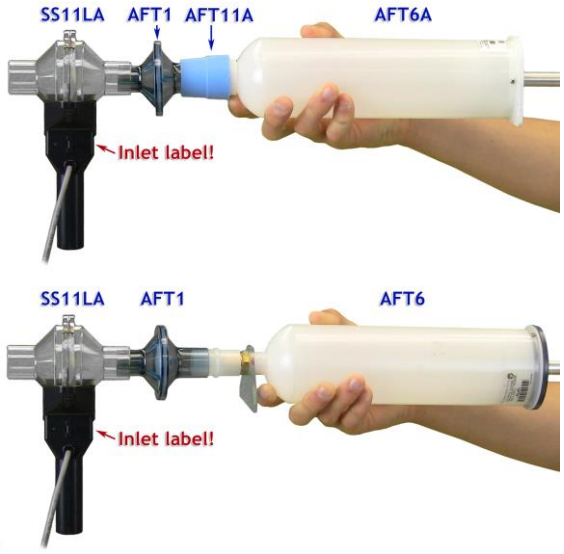
Using the Calibration Syringe

1. Place a filter onto the end of the calibration syringe.

The filter is necessary for calibration because it forces the air to move smoothly through the transducer. This assembly can be left connected for future use. The filter only needs to be replaced if the paper inside the filter tears.

2. **Insert** the Calibration Syringe/Filter Assembly into the airflow transducer.

IMPORTANT!
Always insert on the side labeled "**Inlet**."



Calibration Syringe into airflow transducer

Insert syringe assembly so that the transducer cable exits on the left, as shown above.

- **If** using an older **SS11L** transducer with non-removable head, insert syringe assembly into the <u>larger diameter port</u>.

IMPORTANT: If the lab sterilizes the airflow heads after each use, make sure a clean head is installed now.

<u>Never</u> hold onto the airflow transducer handle when using the Calibration Syringe or the syringe tip may break.

The Airflow Transducer is sensitive to gravity so it needs to be held upright throughout the calibration and recording.

Proper handling of the Calibration Syringe Assembly

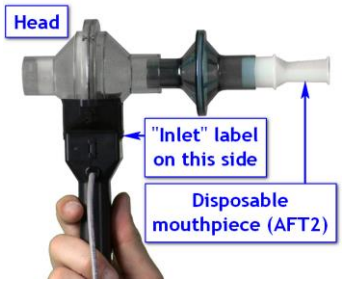
3. **<u>Pump</u>** the plunger several times before the recording. **<u>Always</u>** pull and push the plunger all the way until it stops when using the syringe. This assures that the full volume of air (0.6 liter) flows in and out of the airflow transducer.

Recording with the Airflow Transducer

1) **Attach** the appropriate filter and mouthpiece on the side labeled **Inlet**.

> WARNING
>
> The bacterial filter and mouthpiece are disposable and are "**one per person**" items. Please use a new disposable filter and mouthpiece each time a different person is to be breathing through the airflow transducer.

If using **SS11LA** transducer and <u>not sterilizing the head</u> after each use, insert a filter and mouthpiece into the airflow transducer on the side labeled "Inlet."



SS11LA with unsterilized head

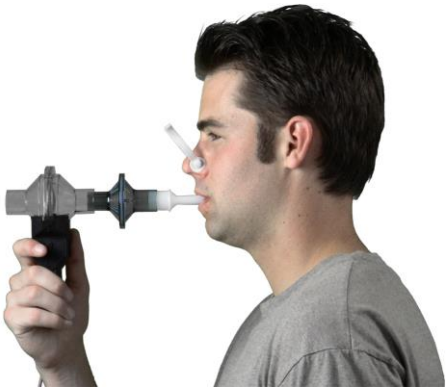
If using **SS11LA** transducer and <u>sterilizing the head</u> after each use, insert a disposable mouthpiece (BIOPAC AFT2) or a sterilizable mouthpiece (BIOPAC AFT8) into the airflow transducer on the side labeled "Inlet."

SS11LA with sterilized head

2) Breathe through the airflow transducer, following the proper procedure defined to the right.

Hints for obtaining optimal data:

a) Keep the Airflow Transducer upright at all times.



b) Always insert on and breathe through the side of the SS11LA airflow transducer labeled "Inlet."

c) Always use a nose clip when breathing through the airflow transducer and secure a tight seal with the mouth so that air can only escape through the airflow transducer.

d) Always begin breathing normally through the airflow transducer <u>prior to the beginning</u> of the recording and continue <u>past the end</u> of the recording.

e) If starting the recording on an inhale, try to end on an exhale, and vice-versa. This is not absolutely critical, but will increase the accuracy of Airflow to Volume calculations.

f) The Subject must try to expand the thoracic cavity to its largest volume during maximal inspiratory efforts. (The Subject should wear loose clothing so clothing does not inhibit chest expansion.)

g) During recording of FEV, the Subject should attempt to exhale as quickly as possible into the mouthpiece.

h) During recording of MVV, the Subject should attempt to exhale and inhale as quickly and deeply as possible. Breathing rates should be faster than 60 breaths/minute or greater than 1 breath/second for the best results. The breathing needs to be maintained for 12-15 seconds.

RX117A-MRI Replacement Airflow Head

The RX117A-MRI is a sterilizable airflow head for the TSD117A/B, TSD117A-MRI, and SS11LA pneumotach transducers. The material used in the flow head is polycarbonate and the screen is Stainless Steel. To reduce the cost of disposable items, use the RX117A-MRI with the AFT8 sterilizable mouthpiece. (22 mm ID/30 mm OD). Multiple RX117A-MRI heads help eliminate equipment downtime during cleaning procedures.

Recommended sterilization: cold sterilization (i.e., Cidex® OPA) or autoclave. If autoclaved, RX117A-MRI Airflow Heads should be cleaned at the lowest autoclave temperature setting. The life cycle will be about 10-20 cycles, depending upon temperature used.

MRI Use: MR Conditional to 3T

Condition: The RX117-MRI head is used with the TSD117A-MRI transducer outside the bore of the MRI Chamber Room and AFT7-L tubing is connected to the subject.

Handheld Pneumotach and Flow Head Specifications

TRANSDUCER:	**TSD117A/TSD117B**	**TSD117A-MRI**	**SS11LA/SS11LB**
Interface:	DA100C	MECMRI-DA to DA100C	MP36/35/45
Cable Length:	3 m shielded	8 m, shielded	3 m, shielded
Flow Rate:	±10 liters/sec (highest linearity (±5 liters/sec)		
Nominal Output:	60 µV/[liters/sec] (normalized to 1 V excitation)		
¼" 25 TPI mounting nut:	Standard camera mount		
Handle Dimensions:	127 mm (length) x 23 mm (thick) x 35 mm (wide)		
Handle Construction:	Black ABS		
RX117A-MRI SPECS:			
Flow Head Construction:	Clear Acrylic		
Flow Bore (Ports):	Inner Diameter: 22 mm, Tiered Outer Diameter: 29 mm, 31 mm, 35 mm		
Flow Head Dimensions:	82.5 mm (diameter) x 101.5 mm (length)		
Flow Head Weight:	80 g		
Handle Weight:	85 g		
Dead Space:	93 ml		