



TSI 4146 Primary Calibrators User Guide

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**PRIMARY CALIBRATORS MODEL 4046/4146
USER'S GUIDE
P/N 1980512, REVISION F MARCH 2016**



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WARNING

TSI calibrators employ a heated platinum sensor. They should not be used in the presence of flammable or explosive gases or mixtures.



caution

TSI calibrators are not medical devices under FDA 510k and in no situation should they be utilized for human respiration measurements.

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Seller warrants the goods, excluding software, sold hereunder, under normal use and service as described in the operator's manual, to be free from defects in workmanship and material for 24 months, or if less, the length of time specified in the operator's manual, from the date of shipment to the customer. This warranty period is inclusive of any statutory warranty. This limited warranty is subject to the following exclusions and exceptions:

- a. Hot-wire or hot-film sensors used with research anemometers, and certain other components when indicated in specifications, are warranted for 90 days from the date of shipment;
- b. Pumps are warranted for hours of operation as set forth in product or operator's manuals;
- c. Parts repaired or replaced as a result of repair services are warranted to be free from defects in workmanship and material, under normal use, for 90 days from the date of shipment;
- d. Seller does not provide any warranty on finished goods manufactured by others or on any fuses, batteries or other consumable materials. Only the original manufacturer's warranty applies;
- e. This warranty does not cover calibration requirements, and the seller warrants only that the instrument or product is properly calibrated at the time of its manufacture. Instruments returned for calibration are not covered by this warranty;
- f. This warranty is VOID if the instrument is opened by anyone other than a factory authorized service center with the one exception where requirements set forth in the manual allow an operator to replace consumables or perform recommended cleaning;
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Service Policy

Knowing that inoperative or defective instruments are as detrimental to TSI as they are to our customers, our service policy is designed to give prompt attention to any problems. If any malfunction is discovered, please contact your nearest sales office or representative, or call TSI's Customer Service department at (800) 874-2811 (USA) or (001 651) 490-2811 (International) or visit www.tsi.com.

Trademarks

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Unpacking and Parts Identification

Carefully unpack the instrument and accessories from the shipping container. Check the individual parts against the list of components in Table 1. If any parts are missing or damaged, notify TSI immediately.

Table 1. List of Components (see figures 1-1 and 1-2)

Qty	Item Description	Part/ Model
1	Calibrator	4046 or 4146
1	Filter Model 4046: 22 mm 1S0 taper Model 4146: 63 mm HEPA filter with 0.375-inch barbed fittings	
		1602292
		1602342
1	Tubing Kit Model 4046 with connectors and battery pack mounting lugs Model 4146 with connectors and battery pack mounting lugs	
		TK4000
		TK4100
1	Battery Pack	4199
1	Soft Carrying Case	
	Model 4046	1319403
	Model 4146	1319404
1	Model 4046/4146 User's Guide	1980512
1	Dampening Module (Model 4146 only)	1040229

Table 2. Optional Accessories

Qty	Item Description	Part/ Model
1	AC Adapter 115 V, North America, ungrounded 100–240 V, NEMA 5-15 plug, grounded 100–240 V, Europlug, CEE 7/16, grounded 100–240 V, Great Britain, grounded, fused 100–240 V, Australia/NZ	2613033 8918-NA 8918-EC 8918-GB 8918-AT



Figure 1-1 Model 4046 Components

1. Calibrator
2. Soft-Sided Carrying Case
3. Mounting Lugs
4. Tubing
5. 6 AA-size Batteries
6. Adapter
7. User's Guide
8. High-Efficiency Inlet Filter



Figure 1-2 Model 4146 Components

1. Calibrator
2. Soft-Sided Carrying Case
3. Mounting Lugs
4. Latex Tubing
5. 6 AA-size Batteries
6. High-Efficiency Inlet Filter
7. User's Guide
8. Adapters
9. Dampening Module

Chapter 2

Setting-Up

Assembly Instructions for the Calibrators The calibrator can be quickly attached to the battery pack by screwing the mounting lugs into the threaded holes in the base of the calibrator. The lugs should then be placed over the receiving holes in the top of the battery pack and snapped gently into place. Insert the connector from the battery pack to the receptacle in the back of the calibrator. The calibrator is now ready to use.

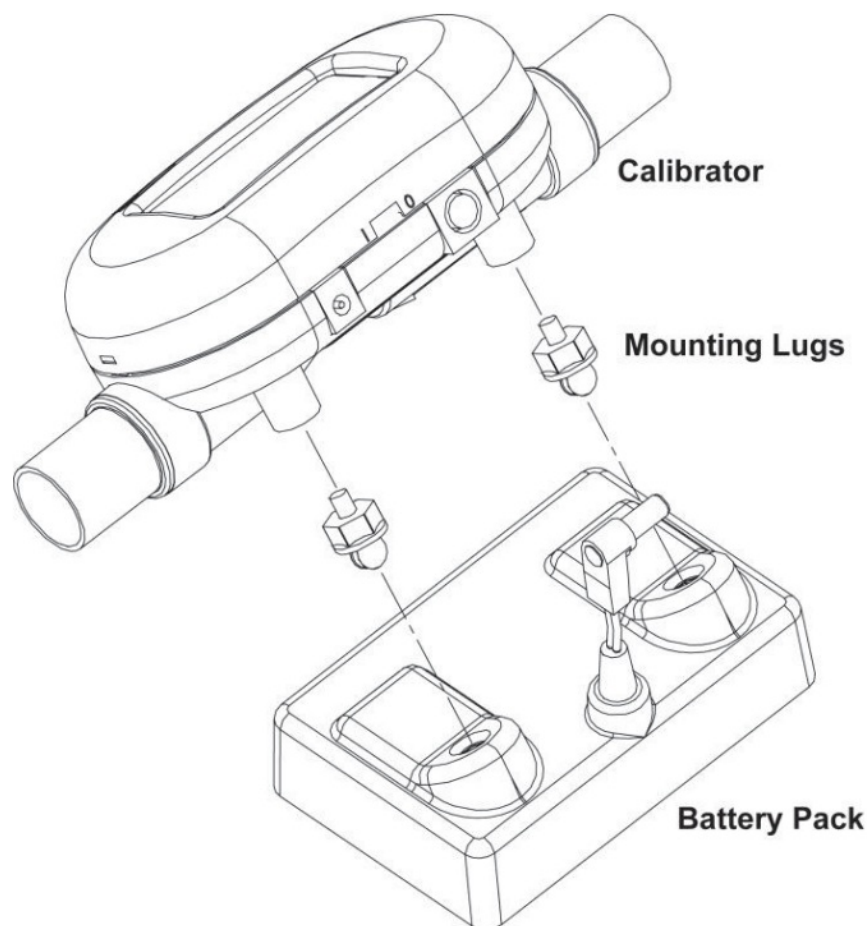


Figure 2-1 Calibrator Assembly

Supplying Power

The calibrator can be powered in one of two ways: through the power jack using the supplied 4199 battery pack or using an optional AC adapter. The DC power input connector is shown below along with the power requirements.

Power Supply: 7.5 VDC \pm 1.5 V, 300 mA maximum

DC INPUT



Connecting Filter and Flow Tubes

The Model 4046/4146 has a thermal sensor exposed to the airflow that must be protected from foreign matter and particles. TSI supplies a filter that should be connected to the inlet of the calibrator; however, any filter will work as long as it has a minimum efficiency of 99.9%.



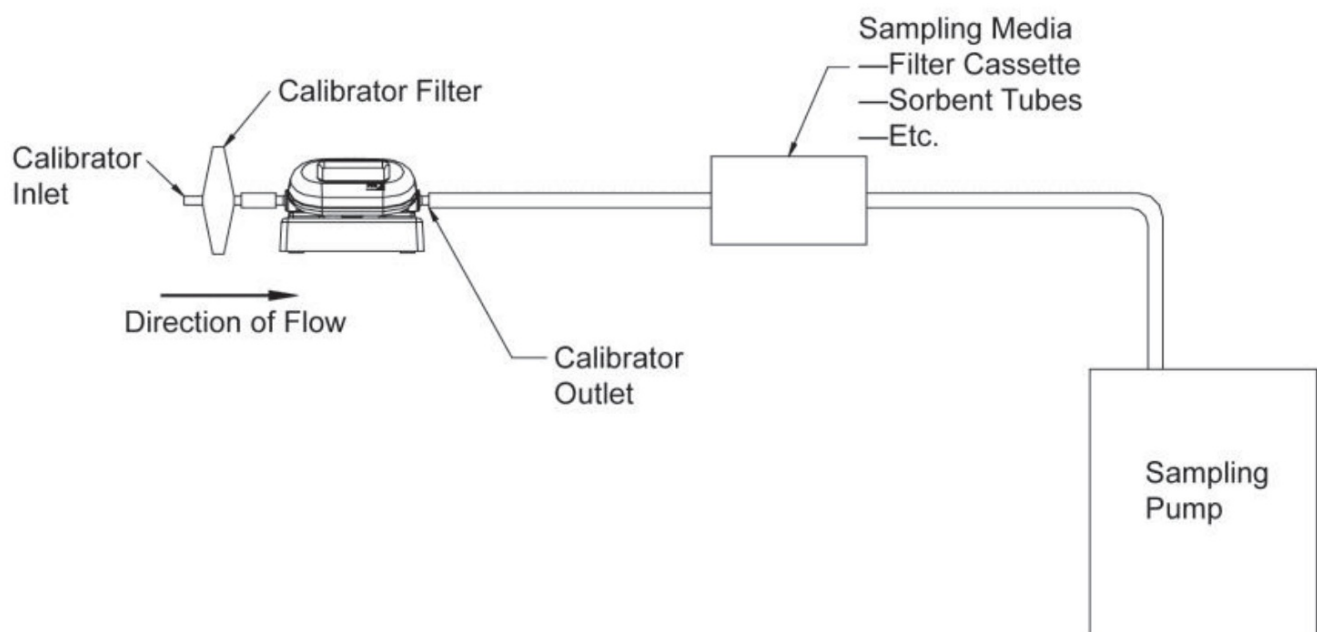
Caution

Always use a filter on the inlet of the calibrator. Failure to filter the airflow may change the calibration and/or permanently damage the sensor.

Note: Flow direction is identified by the large arrow printed on the bottom side of the calibrator and on the bottom of the battery pack.

Attach the filter to the inlet of the calibrator using supplied tubing and/or adapters. Connecting a tube to the outlet of the calibrator will create backpressure. See Appendix A for calibrator accuracy specifications when operating at various pressures. In general, minimize back pressure on the calibrator by using shorter lengths of tubing to maintain the highest level of accuracy.

Sampling Pump with internal dampening chamber



Active Sampling Instrument with internal dampening chamber

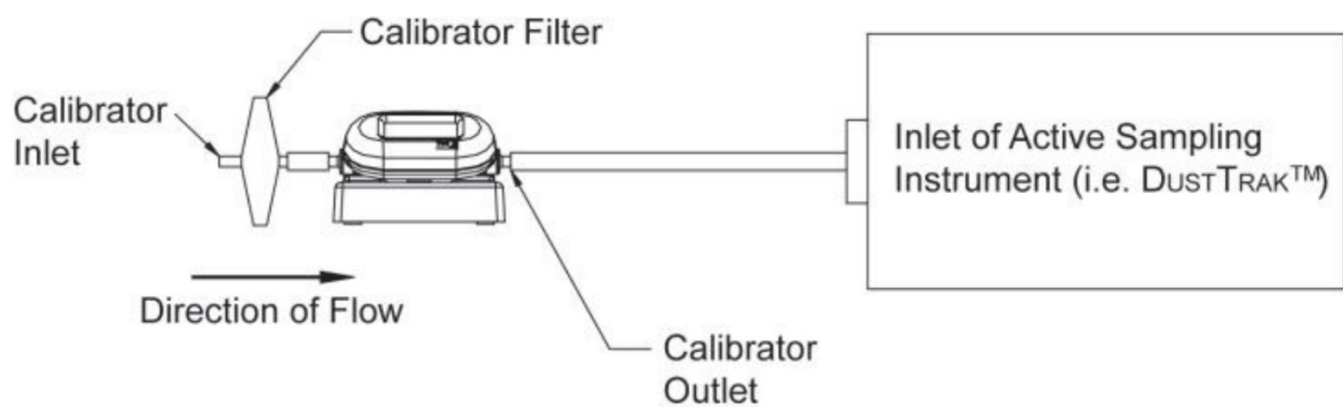


Figure 2-2 Typical Setup Configurations

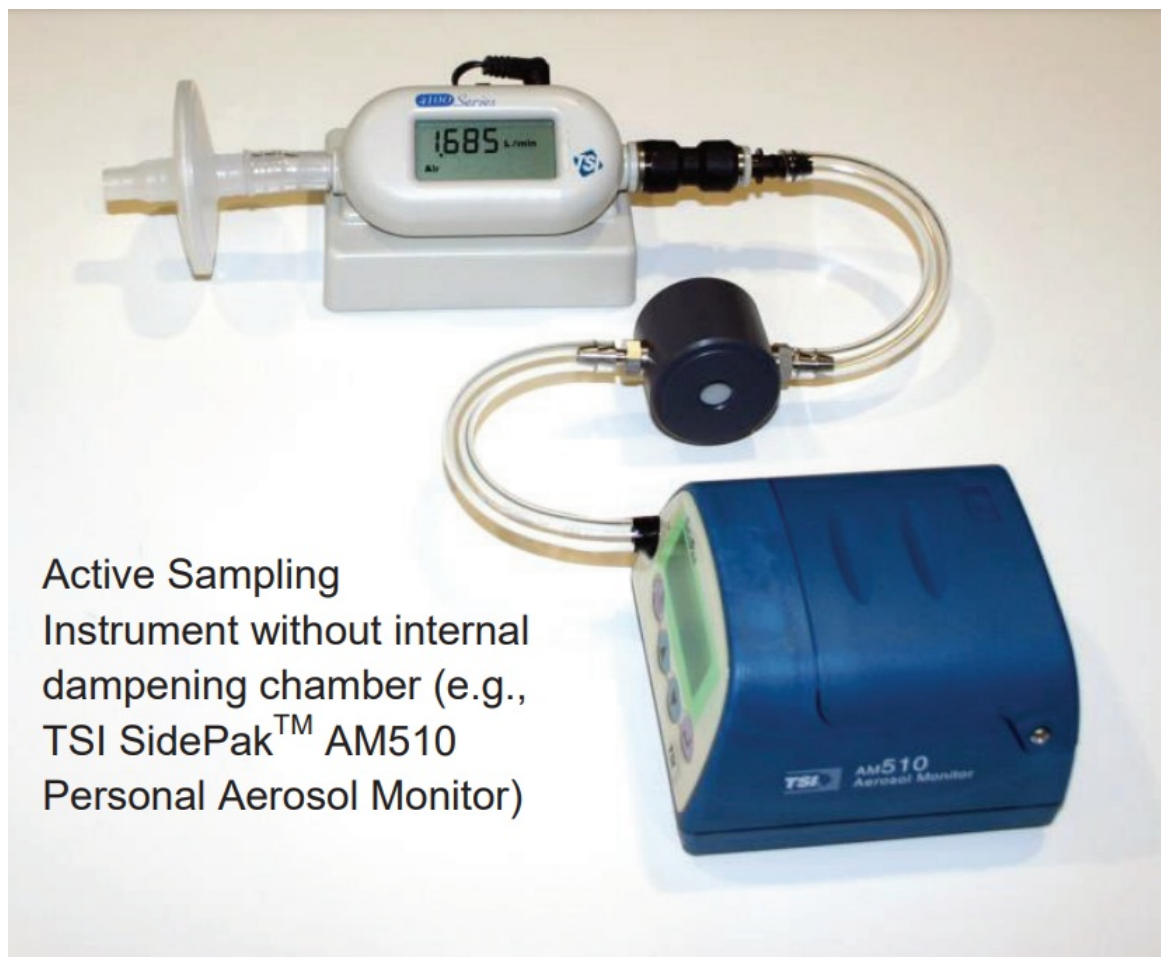


Figure 2-3 Typical Dampening Module Set Up

Use the 6 in. (15 cm) tubing to connect the dampening chamber inline between the Model 4146 Calibrator and the instrument. For best results, position Dampening Module with openings to the side, off the work surface.

Operation

Overview The Model 4046/4146 Calibrator measures the volumetric flow rate inside the flow tube. All measurements made by Models 4046/4146 are NIST traceable.

ON/OFF Switch

Slide the switch to the ON position. The LCD displays volumetric flow in units of liters per minute (L/min).

Flow Rate Measurement

Flow rate data will be displayed on the Model 4046/4146 through the LCD.

Volumetric flow is displayed in units of liters per minute (L/min).

Setting Flow Rates and Calibrating Instruments

The Model 4046/4146 Calibrator may be used to set flow rates and calibrate sampling pumps or other instruments which draw an active flow sample. Be sure to follow all instrument manufacturer's flow settings and calibration procedures.

1. Start up the Model 4046/4146 Calibrator and let it warm up for 1 minute prior to setting any flow rates or conducting any calibrations.
2. Configure your sampling with the desired sampling media and sampling train to be used.
3. Connect the outlet of the Model 4046/4146 Calibrator to the inlet of the sample media (used with sampling pumps) or to the inlet of the active sampling instrument using the tubing supplied
4. Follow the instrument manufacturer's flow setting and/or calibration procedures. The volumetric flow in units of liters per minute (L/min) will be continuously displayed on the LCD of the calibrator.

Dampening Module

The Dampening Module is included for use with systems that do not have internal dampening chambers. The Dampening Module (P/N 1040229) can be added inline between the end of the sampling train and the Model 4146 calibrator. The Dampening Module reduces flow pulsation with an insignificant effect on the flow rate or backpressure.

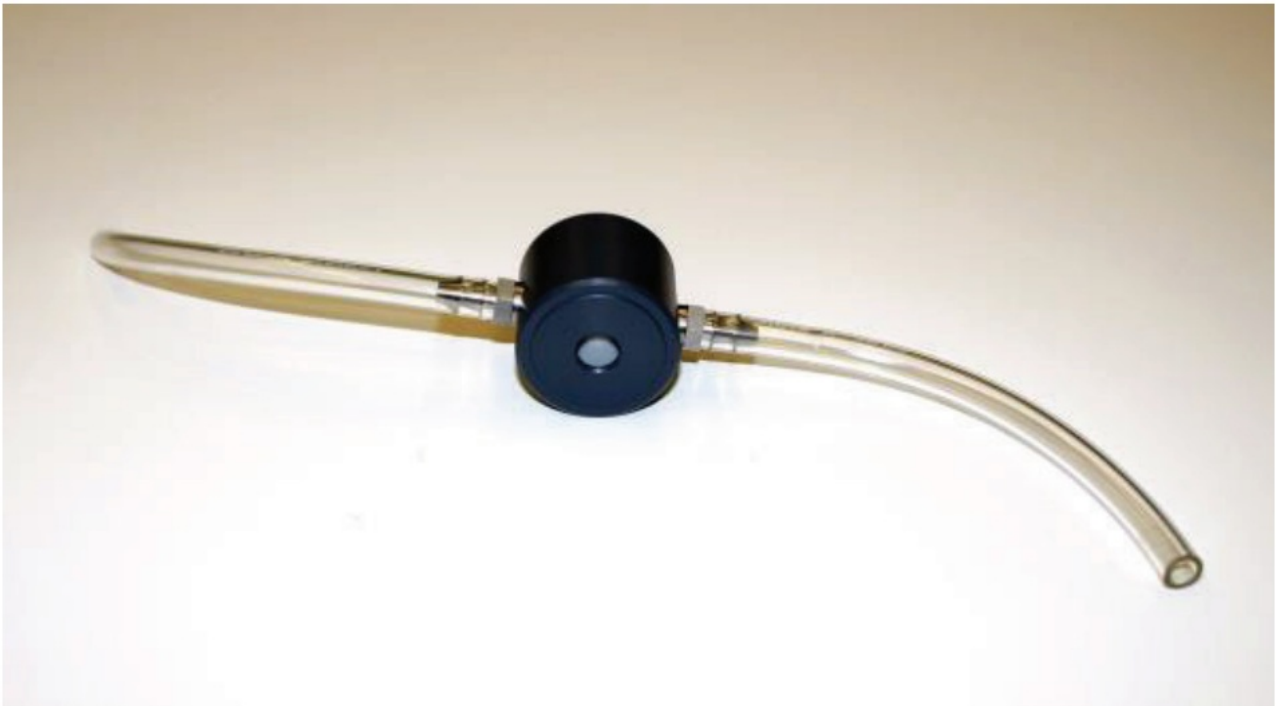


Figure 3-1 Dampening Module with Tubing Attached

All diaphragm pumps produce flow pulsations during operation. Most commercially available 3 L/min and 5 L/min sampling pumps are designed with internal dampening chambers to minimize flow pulsations.

Some common air sampling instruments that may not have internal flow pulsation dampening chambers are listed below. Contact your instrument manufacturer if you have questions. This list is just an example and is not intended to be all-inclusive.

- Low flow personal sampling pumps
- Confined space meters
- Photometers
- Optical Particle
- Counters (OPCs)
- Condensation Particle Counters (CPCs)
- Photo Ionization Detectors (PIDs)
- Flame Ionization Detectors (FIDs)

Note:

The TSI DustTrak™ and SidePak™ Sampling Pumps contain internal dampening chambers. The Dampening Module is not needed to measure flow rates with these instruments.

The TSI SidePak™ AM510 Personal Aerosol Monitor does not contain an internal dampening chamber. TSI recommends using the Dampening Module when using the Model 4146 Calibrator to measure AM510 flow rates.

Maintenance

Flow Sensor Periodically inspects the flow sensor by looking into the outlet of the calibrator. Remove dust, particles, and fibers from the sensor with clean, dry compressed air. The flow sensor may break if touched. Never run liquids through the calibrator and never touch the sensor with a brush. Dust or other deposits on the flow

sensor will degrade the 4046/4146's flow accuracy.



Caution

The calibrator must be switched off for cleaning. Only use clean, dry, compressed air when attempting to remove contamination from the sensor.

Re-certification To maintain a high degree of confidence in the measurements made by the Model 4046/4146, TSI recommends that the instrument be returned to TSI every 12 months for re-certification. The calibrator will be recalibrated and returned with a certificate of calibration to US National Institute of Standards Technology (NIST) traceable standards.

Cases

If the instrument case or storage case needs cleaning, wipe it off with a soft cloth dipped in isopropyl alcohol or mild detergent. Never submerge the calibrator or allow liquids to enter the flow tube.

Storage

When storing the calibrator, always cover the ends of flow tubes with the caps provided to prevent dust or other foreign matter from entering the tube.

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Troubleshooting

Table 3 lists the symptoms, possible causes, and recommended solutions for common problems encountered with Model 4046/4146 Calibrators. If the symptom is not listed, or if none of the solutions solves the problem, please contact TSI Technical Support at 1-800874-2811 or 651-490-2811.

Table 3. Troubleshooting

Symptom	Possible Causes	Corrective Action
No display.	Unit not switched on.	Switch on the unit.
	No power to the instrument.	Check power connection.
The temperature reads high at low or zero flows.	The temperature sensor is being heated from the flow sensor.	The temperature value will track the actual air temperature once the flow rate through the calibrator exceeds 1 Std L/min.
Flow readings fluctuate greatly.	The flow is fluctuating.	Improve inlet conditions or increased display averaging time.
The display shows flow over the range with no flow passing through the flow tube.	The sensor may be damaged or broken.	Return calibrator to TSI for service.

Technical Contacts

If you have any difficulty installing the Model 4046/4146, or if you have technical or application questions about this instrument, contact an applications engineer at TSI Incorporated, at (651) 490-2811 or contact answers@tsi.com.

If the Model 4046/4146 fails, or if you are returning it for service, visit our website at <http://rma.tsi.com> or contact TSI at:

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Specifications

	Specifications*
Flow Measurement Measurement Range Accuracy Air	Model 4046: 2.5 to 300 L/min Model 4146: 0.01 to 20 L/min
	Model 4046: $\pm 2\%$ of reading or 0.05 std. L/min, whichever is greater Model 4146: $\pm 2\%$ of reading or 0.005 std. L/min, whichever is greater
	at standard conditions (21.1°C and 101.3 kPa) See notes 1 through 5 below.
Instrument Temp. Range Operation, Ambient Storage, Ambient	0 to 50°C -20 to 60°C
Physical Dimensions External Dimensions Tube Adapters (Inlet & Outlet) Weigh Flow Body Material	Model 4046: 7.2 in. × 2.5 in. × 2.1 in. (18.3 cm × 6.4 cm × 5.3 cm) Model 4146: 5 in. × 2 in. × 1.25 in. (12.7 cm × 5 cm × 3.2 cm)
	Model 4046: 3.0 Model 4046: 22 mm male ISO taper Model 4146: 0.375 inch O.D. straight
	Model 4046: 1.2 lbs (0.5 kg) Model 4146: 1.7 lbs (0.8 kg)
	Polycarbonate
Warm-up Time	1 min
Power	Battery pack 7.5 VDC \pm 1.5 V, 300 mA maximum

Notes:

1. Accuracy is stated at standard conditions of 21.1°C and 101.3 kPa.
2. Accuracy stated with air temperature and flow body temperature within $\pm 10^\circ\text{C}$ of one another.
3. Accuracy stated measuring dry air (less than 10% R.H.).
4. Includes $\pm 0.5\%$ of reading repeatability.
5. The volumetric flow rate is calculated from the mass flow measurement. Add an additional 0.25% reading to the flow accuracy to account for the uncertainty in measuring air temperature and pressure.

*Specifications are subject to change without notice.

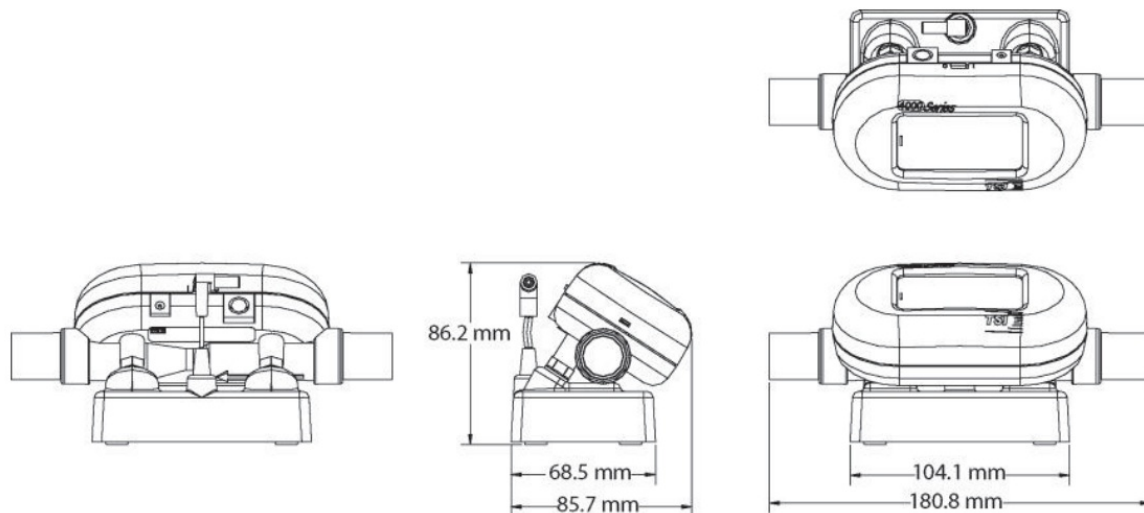


Figure A-1 Model 4046 Dimensions

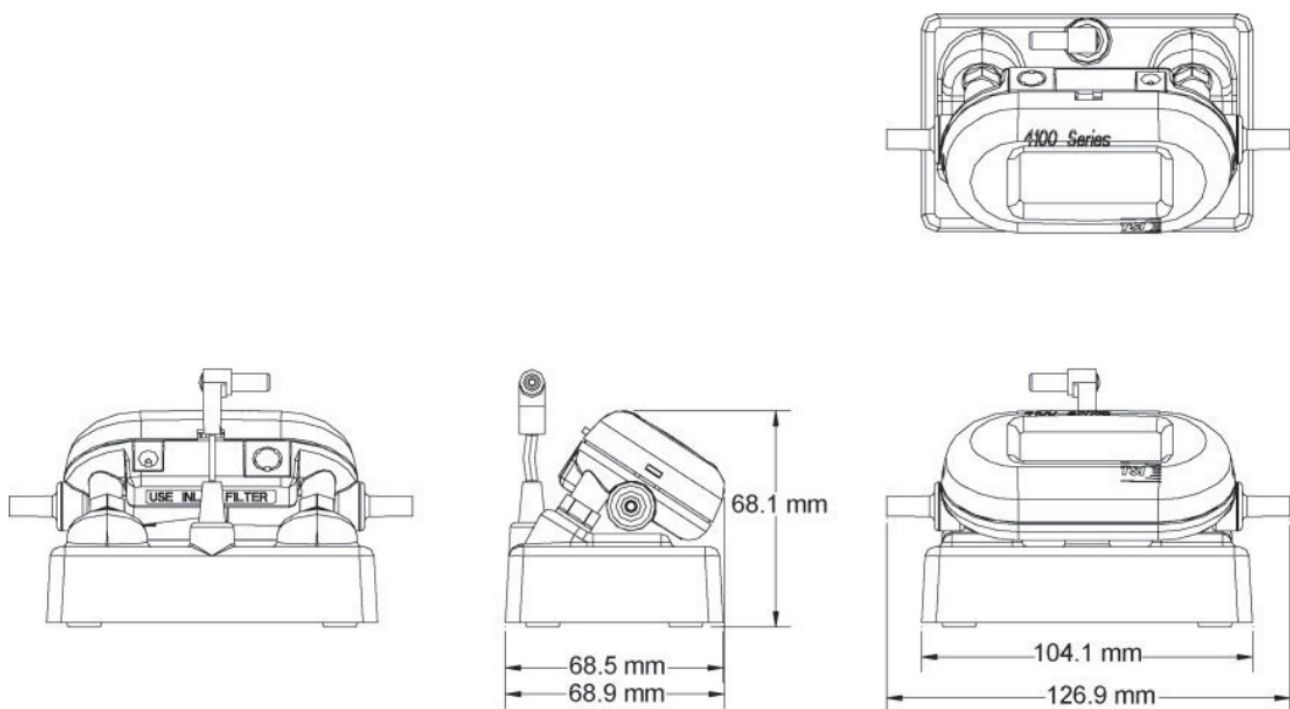


Figure A-2 Model 4146 Dimensions

Primary vs. Secondary Standard

By definition, a primary standard is one whose value is without relation or comparison to any other reference. There are three primary standards—mass, length, and time. There is no primary standard for airflow rate since the measurement is dependent on all three primary standards of mass, length, and time. Hence, all airflow calibrators are secondary standards in the strictest sense of the definition.

In the industrial hygiene arena, the terms “primary” and “secondary” have become generally accepted terms over time and should not be confused with actual primary and secondary standards as prescribed by the National Institute of Science and Technology (NIST). Some manufacturers of calibrators, by their own definition, refer to their products as “primary” standards referring to the manner they are applied and generally accepted for use in the industry. Other manufacturers adequately refer to their instruments as “calibrators”. There are no industry standards established for such designations based on the measurement technology being employed.

What is important is accuracy, repeatability, and regular, documented verification to a higher accepted standard such as NIST. Both primary and secondary calibrators must be verified on a regular basis and that testing recorded. Some guidelines recommend an annual calibration to a higher accepted standard while others suggest as frequently as every 30 days or before a significant survey. It is important to have a certificate of traceability to

NIST or other industry-recognized testing organizations indicating that an instrument has been calibrated against some mother device verified by NIST.(This page was intentionally left blank)



N O V E L

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Documents / Resources

	<p>TSI 4146 Primary Calibrators [pdf] User Guide 4046, 4146, Primary Calibrators, 4146 Primary Calibrators</p>
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References

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