

Air-Data Applications

Engineering
Flow-Measurement
Solutions



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Aeroprobe Technology:

Air-Data Probes

Small, lightweight and accurate! Aeroprobe's air-data probes are perfect for application in a large range of UAV sizes and capabilities, these air-data probes provide accurate pitch angle, yaw angle, airspeed and static pressure data.



3mm Aeroprobe, for small UAVs



8mm Aeroprobe with Heater Option, for Large UAVs

Operational Overview Probes and Services

We have over 10 years' experience providing multi-hole air-data probe solutions for air vehicle control and flight testing. "Customization is our standard" – tell us about your application requirements and we will work with you to identify the best Aeroprobe for you! We don't supply just the probes, but we also perform the probe calibrations and analysis to generate the required air-data coefficients for accurate reduction of the pressure data to flow angles and airspeed.

The multi-hole probes use pressure differences between pairs of tip ports in order to determine the local flow angles and pressures, and airspeed. The difference between the center port and the static manifold relates to the total pressure and airspeed. The vertically opposed ports are used to determine the angle of attack (α) and the horizontally opposed ports are used to determine the angle of sideslip (β). Measurement of the static manifold relates to the local static pressure. There are no moving parts associated with these measurements, enabling the probes to respond quickly and have a compact design. Typical accuracies are within $\pm 0.5\%$ airspeed and $\pm 0.25^\circ$ flow angles.

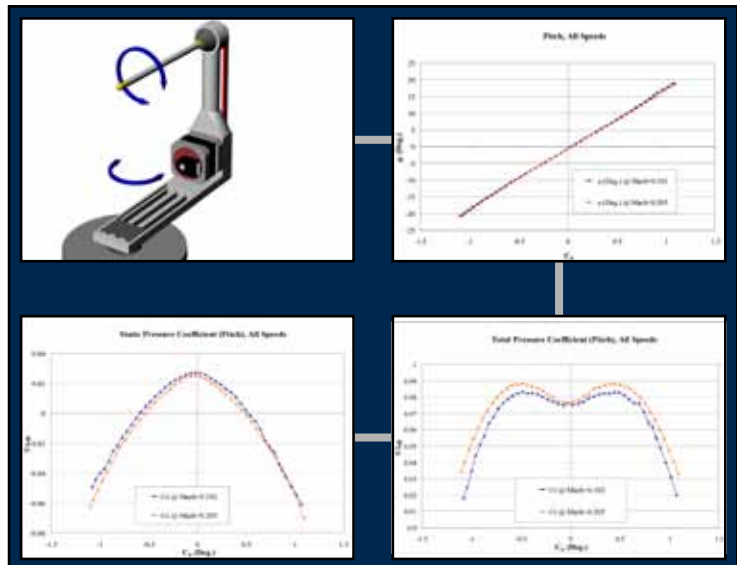
- Conventional Air-Data Probes
- Fast-Response Air-Data Probes
- Standard and Miniature Sizes
- Standard and Custom Designs
- Angles of Attack and Sideslip
- Total and Static Pressure
- Pitot-Static Probes
- Embedded Heater Option
- High-Accuracy Probe Calibrations
- Pneumatic Lag Analysis & Calibrations
- Recommendations for Sensor Support
- Technical Support & Data Analysis

Calibration Services

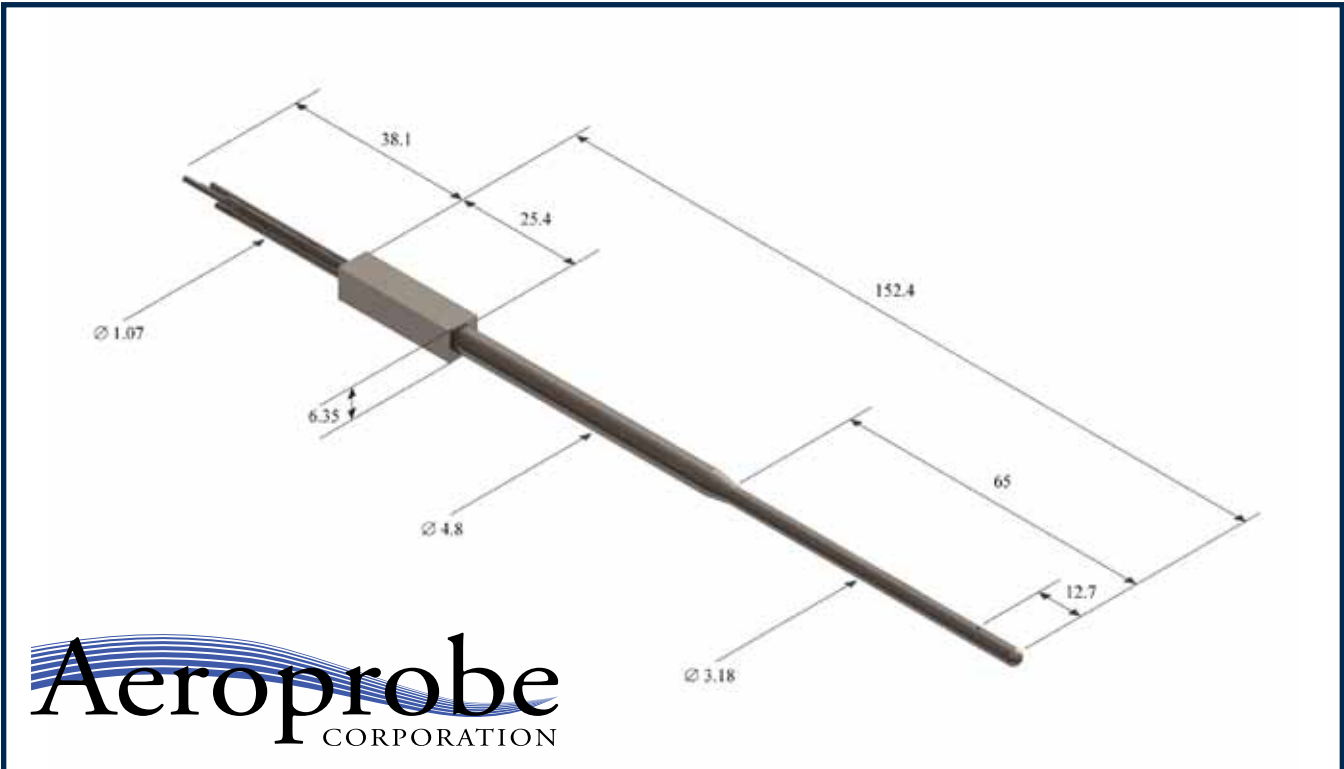
We calibrate the Aeroprobes over the speed range required for the application. Our current capability includes speeds from 10 m/s – 320 m/s, with transonic and supersonic calibrations available on a case-by-case basis. The air-data probes are typically calibrated over $\pm 20^\circ$ in angles of attack and sideslip. The port pressures are recorded, and subsequently used to generate the pressure coefficients for the two flow angles, total pressure and static pressure.

Most of our calibrations are probe-only, but there are applications where aerodynamic interference requires that we calibrate the probes in the presence of the vehicle forebody or probe mount. We also use CFD analysis to aid in properly accounting for the effects of the interference.

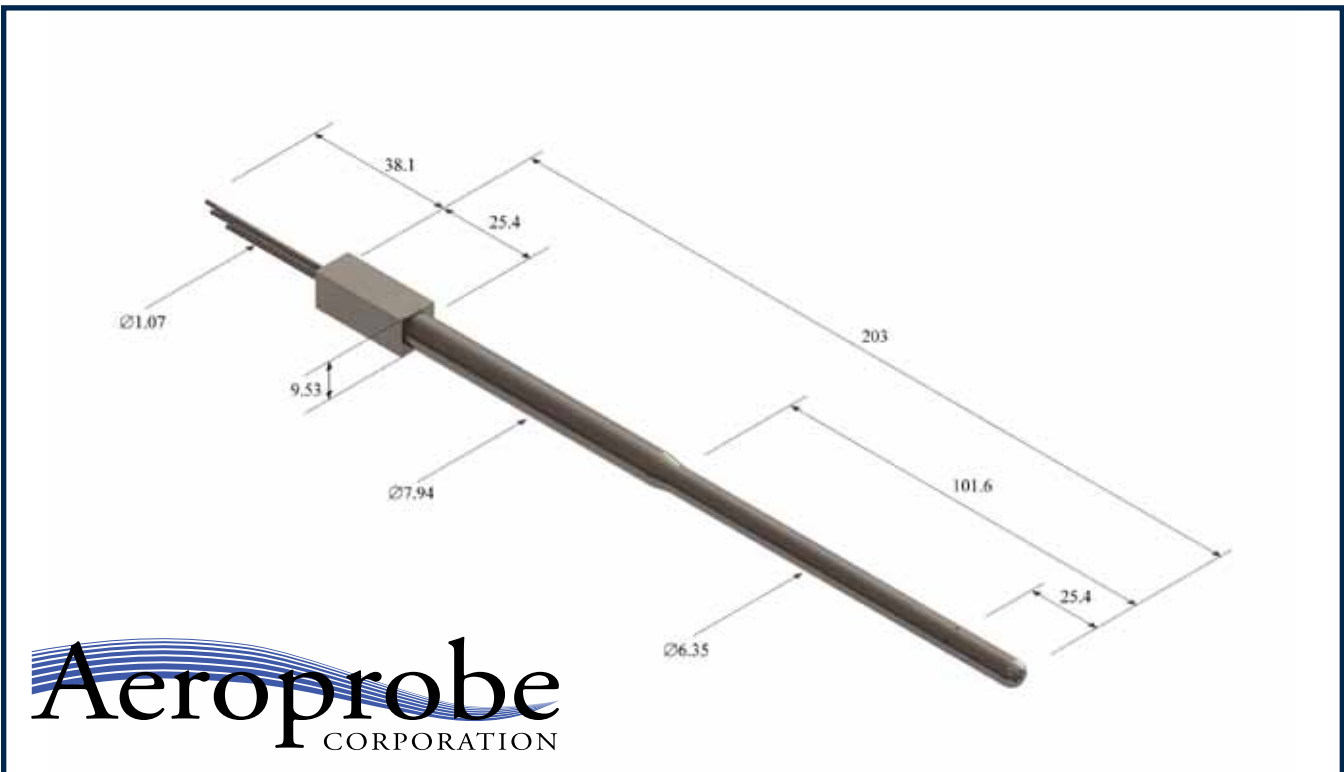
The time lag of the pressure changes through the probe and the lengths of pneumatic tubing connecting the probe to the pressure sensors is a concern when considering the design of the flight-control system. Aeroprobe uses theoretical and experimental techniques to specify the time lag and response of the system at a range of signal frequencies.



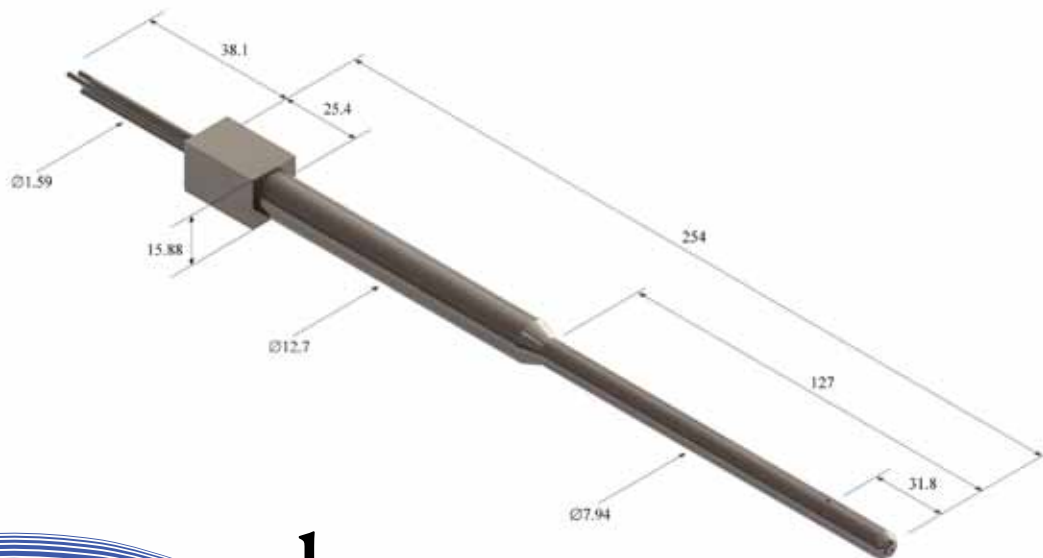
Clockwise from upper-left: Probe Calibration Mount, Angle of Attack Coefficient Graph, Total Pressure Coefficient Graph, Static Pressure Coefficient Graph



Standard Straight Pitch-Yaw Probe, Item PSPY5-3D, Model PPSY5-H318-152.
All Dimensions in Millimeters.

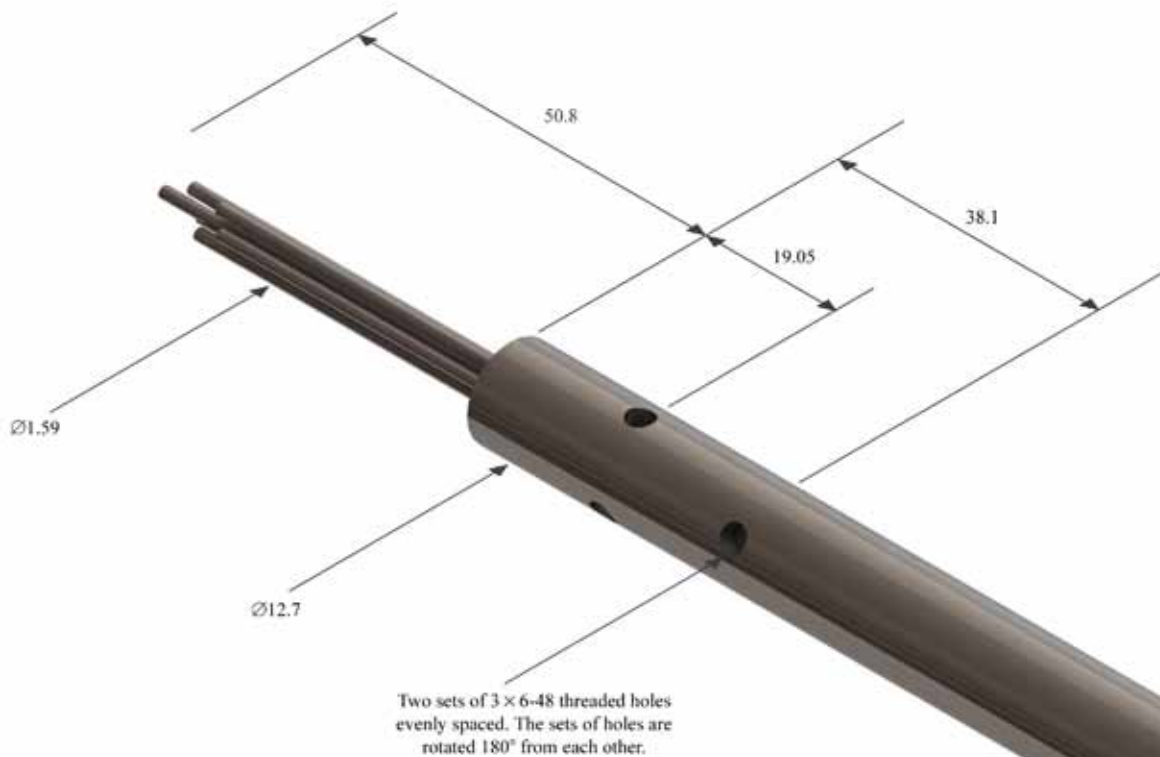


Standard Straight Pitch-Yaw Probe, Item PPSY5-6D, Model PPSY5-H635-203.
All Dimensions in Millimeters.

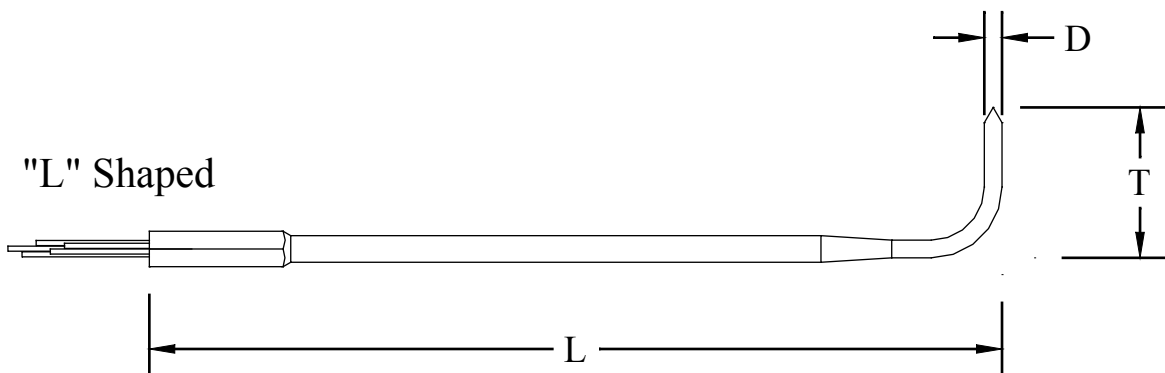
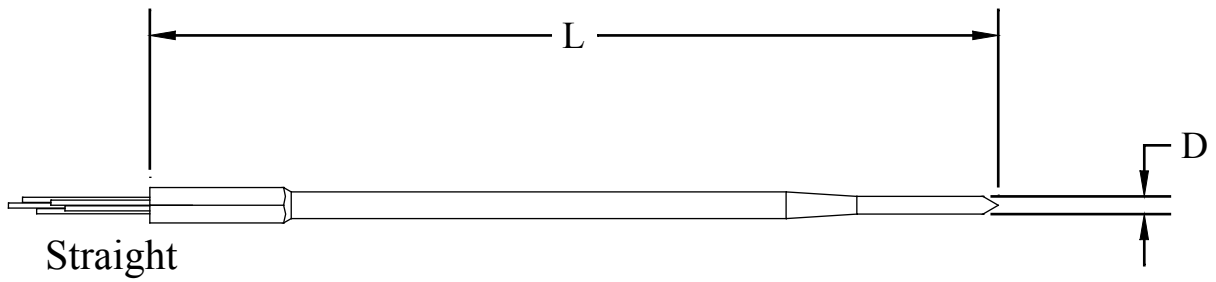


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**Standard Straight Pitch-Yaw Probe, Item PSPY5-8D, Model PSPY5-H794-254.
Embedded Heater Optional. All Dimensions in Millimeters.**



Optional Cylindrical Mount for Item PSPY5-8D and PLPY5-8D



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Air-Data Probe Design and Specification

Probe Design and Specification

Geometry Codes		Probe Type			Tip Geometry	
D	Tip Diameter	S	Straight		C	Conical
L	Overall Length	L	L-Shaped		H	Hemispherical
T	Probe Tip Length					

Omniprobe Model Number Definition	
P or CP	P = Standard Probe CP = Custom Probe
Probe Type	Straight or L-Shaped (See Codes Above)
PY	Designates Probe as Pitch-Yaw, Air-Data Probe
NP	Number of Probe Ports: 3 or 5
H	Optional Embedded Heater, Omit if No Heater
-	
Tip Geometry	Conical or Hemispherical (See Codes Above)
D	Tip Diameter in Hundredths of a Millimeter (Three Digits)
-	
L	Overall Length of Probe in Millimeters (Three Digits)
-	
T	Length of Probe Tip in Millimeters (Three Digits)
<i>Note: T is used only if Required, Omitted Otherwise</i>	

Examples:

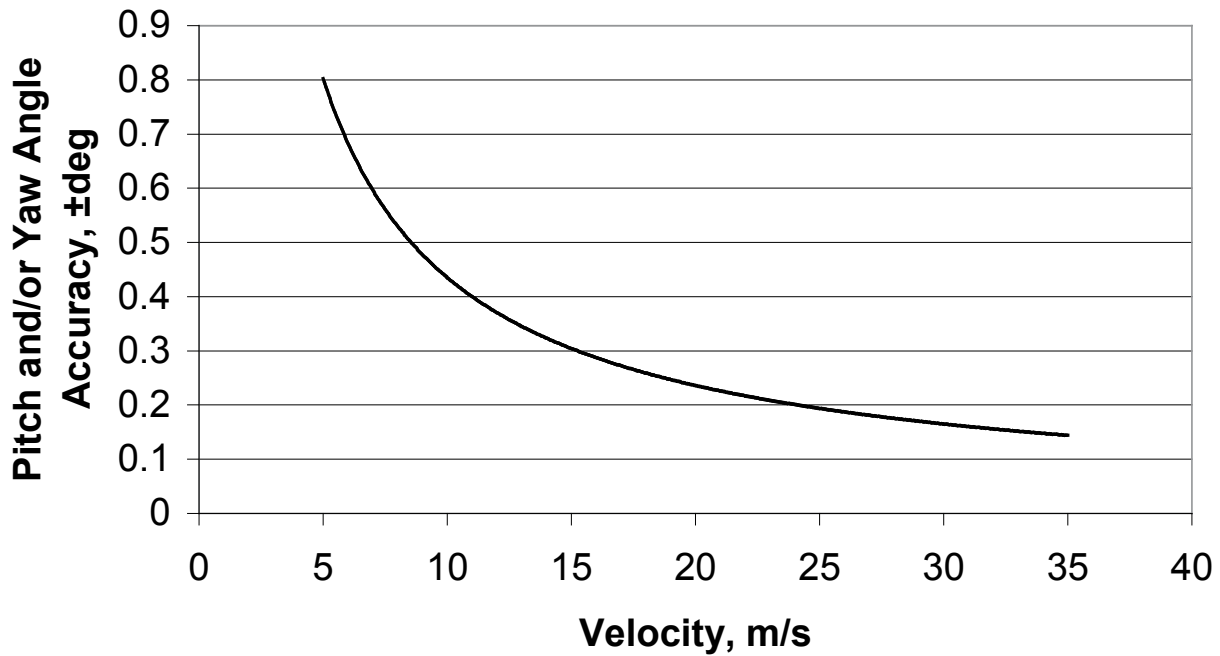
PSPY5-H318-152 specifies a standard straight five-hole pitch-yaw probe with a hemispherical tip, a 3.18 mm tip diameter and 152 mm overall length.

CPLPY3H-H794-400-085 specifies a custom L-shaped three-hole pitch or yaw probe with a hemispherical tip, a 7.94 mm tip diameter, 400 mm overall length, and an 85 mm tip length. This probe includes the optional heater (requires heater option on quotation).

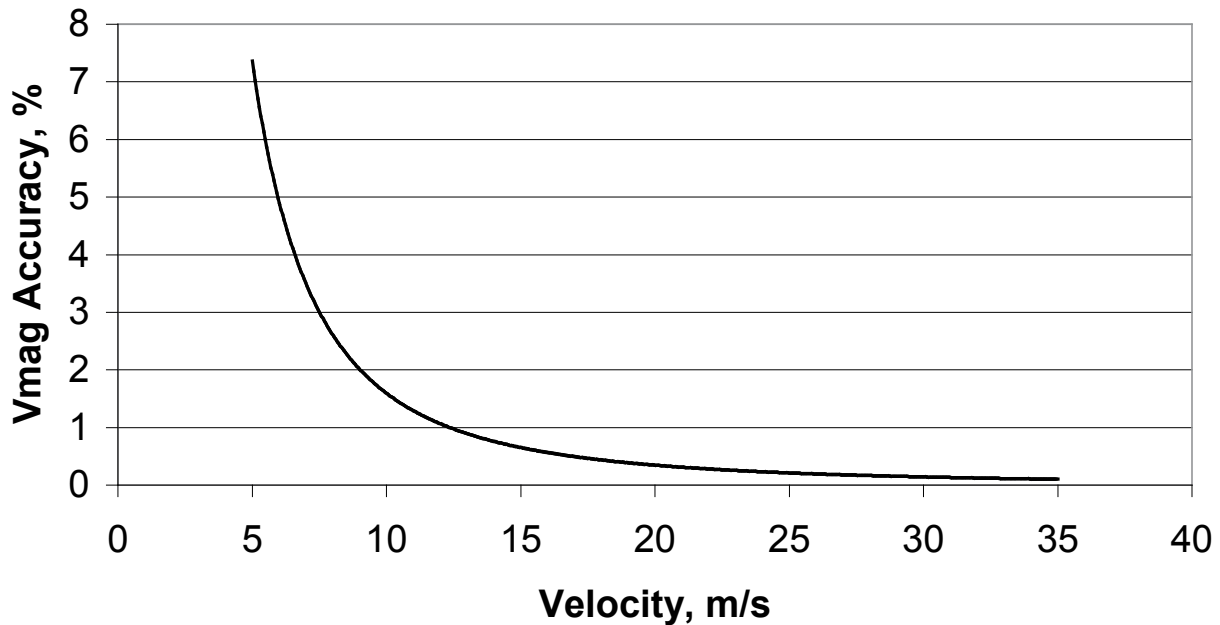
Aeroprobe Air-Data Specifications

Geometry and Construction			Pressure Sensor Rating	
Probe Geometry	Straight (Typical), L-Shaped		Differential Pressure Range (psi / kPa / InH2O):	Max Flow Speed, Sea Level Ambient = Total Pressure (m/s, Air):
Number of Holes	1 (Pitot), 3, or 5; with Additional Static Manifold			
Tip Geometry	Hemispherical (Recommended), Conical		±0.009 / 0.062 / 0.25	10
Tip Diameter	7.94mm, 6.35 mm, 3.2 mm Standard, Other Sizes By Request		±0.018 / 0.124 / 0.50	15
			±0.036 / 0.250 / 1.0	20
Material	Stainless 304		±0.072 / 0.500 / 2.0	30
Pneumatic Connections	Typical Exit Tubing of 0.89 mm – 1.6 mm (0.035” – 0.063”) OD Standard. Staggered Length Corresponding to Port Number Swagelok Fitting Option for 1.6 mm (or larger) Exit Tubes. Tygon R3603 Formulation, 1/32” ID, 3/32” OD Standard for Flex Tubing Connections		±0.18 / 1.245 / 5.0	45
			±0.36 / 2.49 / 10.0	65
			±0.72 / 4.98 / 20.0	95
			±1 / 6.9 / 27.7	110
			±2 / 13.8 / 55.4	155
			±5 / 34.5 / 138	260
			±10 / 68.9 / 277	400
			±15 / 103.4 / 416	N/A
			Mounting	Rectangular Prism, Cylindrical. Custom Mounting Available
Weight	15g (3mm), 165g (8mm w/Heater)			
Probe Reference	Straight Probe: Flat on Hex Mount L-Shaped Probe: Plane of Probe Tip			
Media	Air; Other Media Possible – Contact Aeroprobe		Air Speed	Air Speed (Vmag): ±0.35% FS (a,b < 12°), ±0.7% FS (a,b < 20°)
Operational Temperature	0°C – 150°C Standard, -80°C – 150°C with Heater (Heater Control May be Required)			
Pressure Sensor Requirements and Data Reduction (sensors not included with probe)			Calibration Flow Angles	±20° Pitch and/or Yaw (3HP) ±20° Pitch and Yaw (5HP) Pitot-Static Probe Accuracy with Flow Angle can be Calibrated at up to 20°.
Probe Type	Sensors/Reduction	Available Data		
Pitot-Static	1 Differential + r/ M < 0.25	(P _t - P _s), V	Calibration Flow Speeds	5 m/s to 345 m/s (Mach 0.05 - 1.0) for Probe Tip Diam. < 9.5 mm (3/8”) 5 m/s to 65 m/s (Mach 0.05 - 0.19) for Probe Tip Diam. > 9.5 mm (3/8”)
	1 Differential & 1 Absolute + T _t / M > 0.25	P _t , P _s , M		
3-Hole Pitch or Yaw w/Static Ring	2 Differential + r/ M < 0.25	a or b, (P _t - P _s), V	Auxiliary Data**	Absolute Reference Pressure, Total Temperature
	2 Differential & 1 Absolute + T _t / M > 0.25	a or b, P _t , P _s , M	Pressure Data Reduction	Up to 4 th Order Polynomial Fits for Pressures, Angles (3HP, 5HP)
5-Hole Pitch+Yaw w/Static Ring	3 Differential + r/ M < 0.25	a, b, (P _t - P _s), V	Frequency Response	Low, Best for Determining Time-Averaged Flows, Theoretical Time Lag Calculations Available Upon Request
	3 Differential & 1 Absolute + T _t / M > 0.25	a, b, P _t , P _s , M		
P _t = Local Total Pressure, P _s = Local Static Pressure, a = Pitch Angle, b = Yaw Angle, q = (P _t - P _s) = Dynamic Pressure (Incomp. Flows Only), T _t = Total Temperature, r = Density			^a Utilizing 0.1% accurate pressure sensors ^b Accuracy is specified as a % of calibration velocity as $Accuracy = abs(\bar{x}_{error}) + 2\sigma_{error}$ **For Most Accurate Compressible Pressure-to-Velocity Reduction	
Low-Velocity Accuracy Specification^{c,d,e} (for < 35m/s)				
^c Utilizing 0.1% accurate pressure sensors				
^d No extended angular range (> ±12°) available for sub 35m/s calibrations with hemispherical tip option				
^e Accuracy is specified as a % of calibration velocity as $Accuracy = abs(\bar{x}_{error}) + 2\sigma_{error}$				

**Probe Angle Accuracy
(Hemispherical Tip)
(Valid For ± 12 Degrees Only)**



**Probe Velocity Magnitude Accuracy
(Hemispherical Tip)
(Valid For ± 12 Degrees Only)**



Ordering Information:

Item	Description
	Standard Probes
PSPY5-3D	Standard 3mm Straight Five-Hole Pitch-Yaw Probe, w/Static Ring and Rect. Mount, Calibrated (Specify Speed)
PSPY5-6D	Standard 6mm Straight Five-Hole Pitch-Yaw Probe, w Static Ring and Rect. Mount, Calibrated (Specify Speed)
PSPY5-8D	Standard 8mm Straight Five-Hole Pitch-Yaw Probe, w/Static Ring and Rect. Mount, Calibrated (Specify Speed)
PLPY5-3D	Standard 3mm L-Shaped Five-Hole Pitch-Yaw Probe, w/Static Ring and Rect. Mount, Calibrated (Specify Speed)
PLPY5-6D	Standard 6mm L-Shaped Five-Hole Pitch-Yaw Probe, w Static Ring and Rect. Mount, Calibrated (Specify Speed)
PLPY5-8D	Standard 8mm L-Shaped Five-Hole Pitch-Yaw Probe, w/Static Ring and Rect. Mount, Calibrated (Specify Speed)
PS2	Standard Straight Pitot-Static Probe
PL2	Standard L-Shaped Pitot-Static Probe
	Standard Probe Options
PSPY-CYLMNT	Option for Cylindrical Boom Mount with Threaded Retaining Holes, 8mm Air-Data Probe Only
PSPY-HTR	Standard Heater Option for 8mm Air-Data Probe
PSPY-HTR+TC	Standard Heater Option for 8mm Air-Data Probe, Including Thermocouple for Heater
PSPY-HTR-CNTRL	Standard Heater Controller, for Use with Air-Data Probe with Embedded Heater+Thermocouple
	Probe Aero Calibrations
SPCPS	Standard Setup and Calibration of Pitot-Static Probe (Specify Speed)
SPCPY	Standard Setup and Calibration of 3/5-Hole Pitch/Yaw Probes (Specify Speed)
XCPS	Extra Calibration, Pitot-Static Probe (Specify Speed)
XCPY	Extra Calibration, 3/5-Hole Pitch/Yaw Probe (Specify Speed)
	Custom Probes
CPSPY5	Custom Straight Five-Hole Pitch-Yaw Probe, Calibrated
CPLPY5	Custom L-Shaped Five-Hole Pitch-Yaw Probe, Calibrated
CPSPY3	Custom Straight Three-Hole Pitch or Yaw Probe, Calibrated
CPLPY3	Custom L-Shaped Three-Hole Pitch or Yaw Probe, Calibrated

Requirements

Use of Aeroprobes requires ability to measure port pressures. Aeroprobe can provide complete data acquisition systems and software for this purpose.

Additional Information

For information about other Aeroprobe products, please visit our website: www.aeroprobe.com.

Select Air-Data Applications:

Small UAV Flight Control and Auto-Pilot

Athena Technology, Inc. used Aeroprobes as part of the flight control system for a DARPA project in which an aircraft with simulated battle-damage landed under internal guidance only. Due to their small size, the probes were especially suited to application in the scale-model F-18 aircraft. In addition, the probes were calibrated as an integral part of the aircraft forebody, to properly account for the aerodynamic interference.

“Aeroprobe Corp. was a critical team member in flight testing our Damage Tolerant Controls and AutoLand capability for DARPA. I want to thank the entire Aeroprobe team for their attention to detail and rapid support when needed. Your air-data probe was the ideal sensor for our demonstrations – accurate, lightweight, and highly reliable. The knowledge and skills at the Aeroprobe Corporation are unmatched in the air data sensor industry.”

-- Dave Vos, Ph.D. CEO and CTO, Athena Technologies, Inc.

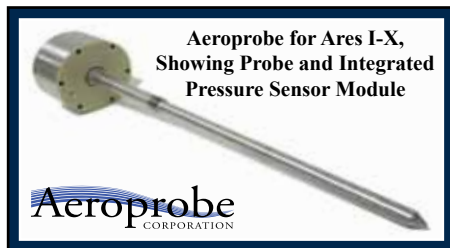


F-18 Model in flight with Aeroprobe installed.



Calibration of Aeroprobe with F-18 Model Forebody in Virginia Tech Wind Tunnel

Ares I-X Atmospheric Rocket Flight



Aeroprobe for Ares I-X, Showing Probe and Integrated Pressure Sensor Module

On October 28th, 2009, Aeroprobe Corporation's five-hole probe successfully took flight atop NASA's Ares I-X, an experimental test rocket that will help NASA improve the design and safety of the next generation of American spaceflight vehicles.

The highly engineered Aeroprobe, with embedded pressure sensors, provided NASA with information about air speed and flow incidence angles. The total and static pressures derived from the

probe data are considered critical quantities, used as a reference for the remainder of the 300+ pressure sensors on the Ares I-X. The five-hole Aeroprobe was also designed to provide NASA with the freestream Mach and angular inclination (both pitch and yaw) of the rocket.



Capped Aeroprobe Mounted on Ares I-X CM/LAS at Kennedy Space Center

Small UAVs

Insitu has sourced multiple Aeroprobes for use on the ScanEagle. Integrated with the flight control system, each probe provides aircraft state information. Only 3 mm in diameter, the standard Aeroprobes are ideal for applications involving very small to mid-sized UAVs.



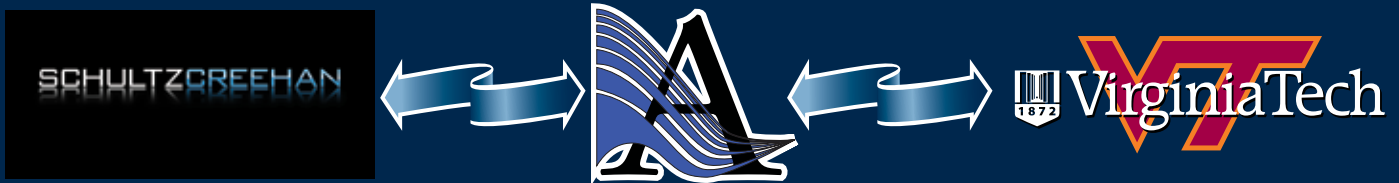
Insitu ScanEagle in flight with Aeroprobe installed.

Aeroprobe Mission:

Design, develop, manufacture, and deliver 21st-century technology air/liquid flow measurement probes characterized by miniaturization, high accuracy & fast response.

More About Aeroprobe:

A Virginia Tech spin-off, Aeroprobe Corporation is located in the VT Corporate Research Center. Maintaining close ties with VT enables Aeroprobe to perform basic and applied research aimed at advancing probe technology.



Aeroprobe works closely with manufacturing partner Schultz-Creehan to design, test, and produce high-quality, custom-built measurement devices and equipment employing modular lean-manufacturing methods. Schultz-Creehan has unique mechanical and electronic design, test, and simulation capabilities, which are applied to meet specific customer needs.

Aeroprobe Customers:

- AeroVironment
- Aurora Flight Sciences
- Boeing
- In Situ
- NASA LaRC
- NASA Dryden
- Textron
- Cranfield Aerospace Ltd.
- Texas A&M University
- Rockwell Collins
- Scripps Air-Ocean Institute
- Naval Post-Graduate School

International Business:

With distributors in 20 countries and approximately 50% of sales outside the USA, Aeroprobe is an internationally recognized name.

We have distributors in the following countries

-
- A globe with a grid overlay, showing the international distribution network. The globe is centered on the Atlantic Ocean, with the Americas on the left and Europe and Africa on the right.
- Argentina
 - Australia
 - Austria
 - Belgium
 - Brazil
 - Czech Republic
 - Finland
 - France
 - Germany
 - India
 - Italy
 - Japan
 - Korea
 - Mexico
 - Netherlands
 - Norway
 - Portugal
 - Singapore
 - Slovakia
 - Spain
 - Sweden
 - Switzerland
 - Turkey
 - U.K.

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