

## Multi-hole Probes

Multi-hole Probes are used to measure the flow velocity and direction in a wide range of measurement conditions. Most commonly they are used in wind tunnels, turbomachinery, and test rigs in the aerospace and automotive sectors. A wide range of geometries and sizes allows for accurate measurements no matter the scale, from a 10mm high compressor flow channel to a 100m diameter wind turbine, we have you covered.



For specialty measurement requirements our 0.7mm diameter 7-hole boundary layer probe takes measurements in the smallest regions. For complex flows, our Omniprobe can cover up to 150° of flow angle. Our high-temperature capable probes can handle up to 900°C without any cooling system.

Head sizes range from 1.6mm (1/16") to 9.5mm (3/8") and geometries include Straight, Drilled Elbow, or L-shaped so you can easily access your flow channel. We offer 3-hole,

5-hole, and 7-hole variants depending on your measurement needs. Our 7-hole probe can meet our strict accuracy requirements at up to flow angles of 60° (away from the stem). With a factory calibration, we guarantee accuracy in flow angle of  $\pm 1^\circ$  and velocity of  $\pm 1$  m/s or 1% whichever is greater and can calibrate from low subsonic ( $M = 0.05$ ) to supersonic ( $M = 1.8$ ) in our on-site wind tunnels.



## Features:

- Spherical tip geometry
- Standard tip diameter starting at 6.35mm
- Capable of measuring flow vectors up to  $\pm 150^\circ$
- Temperature ratings up to  $500^\circ\text{C}$
- High accuracy NIST traceable aerodynamic calibrations
- Up to 9000 discrete aerodynamic calibration points per speed
- 303, 304 Stainless steel construction; Optional nickel based super alloy for high strength
- Custom engineering solutions available
- Standard media: non-reactive gases, air, water, and other fluids
- Angle error less than  $\pm 2^\circ$
- Velocity error less than  $\pm 3\%$

## Omniprobes

For flows with high amounts of swirl, such as in the wake behind automobiles, our 12-hole Omniprobe is an ideal measurement choice. A micro-machined spherical tip accommodates 12 pressure ports that allow for measurement of  $\pm 150$  degrees of flow angle.



Omniprobes are frequently used for high-angularity wake measurements around automobile wheels, wake measurements behind automobiles and rolling-road wind tunnels. Omniprobes are also ideal in applications where the predominant direction of the flow is not known in advance or where the probe may see a complete reversal of the flow during testing, such as in wind engineering or combustor swirl flows.

## Features:

- 12-hole
- Spherical tip geometry
- Standard tip diameter starting at 6.35mm
- Capable of measuring flow vectors up to  $\pm 150^\circ$
- Temperature ratings up to  $500^\circ\text{C}$
- High accuracy NIST traceable aerodynamic calibrations
- Up to 9000 discrete aerodynamic calibration points per speed
- 303, 304 Stainless steel construction; Optional nickel based super alloy for high strength
- Custom engineering solutions available
- Available in Straight and L-shaped geometries
- Standard media: non-reactive gases, air, water, and other fluids
- Angle error less than  $\pm 2^\circ$
- Velocity error less than  $\pm 3\%$

# Kiel Probes

Kiel Probes are used to measure the total pressure of a flow with high accuracy over a wide range of flow angles. Unlike a Pitot Probe, the Kiel Probe's shroud acts to straighten the incoming flow and remove measurement errors associated with varying flow angles. Kiel Probes do not require aerodynamic calibration.



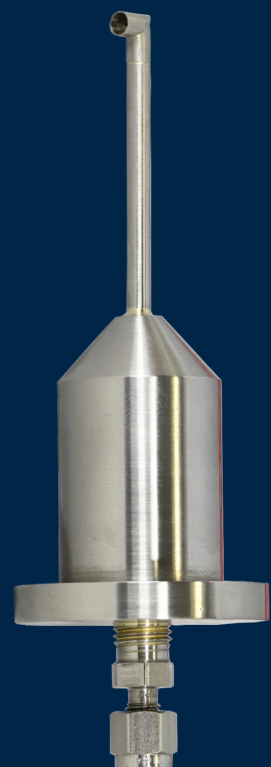
Combination Kiel-Total Air Temperature (TAT) Probes are also available to provide pressure and temperature data with one instrument. Additionally, Aeroprobe specializes in the custom design and engineering of Kiel probes for integration into rake geometries and specialized mounting hardware.



While the advantage of a Kiel Probe is its insensitivity to flow angle, it does not provide a measurement of the flow angle. If simultaneous measurement of flow angle as well as total and static pressure is required, please see our Multi-hole Probe products.

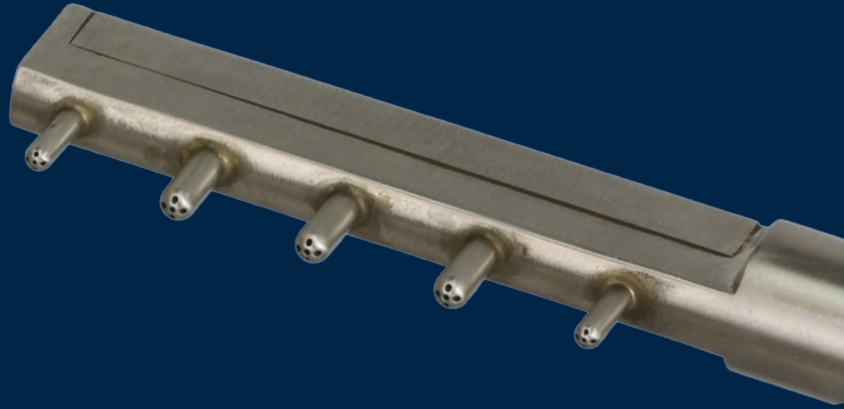
## Features:

- Standard tip diameters of 2.4, 3.2, 6.35 mm
- Temperature ratings up to 500° C
- Standard Stainless steel (300 series) construction; optional nickel based super alloy for high strength and temperature.
- Custom engineering solutions available
- Standard media: non-reactive gases, air, water, and other fluids



# Rakes

A Rake is a probe or probe assembly with multiple tips and allows for multiple measurements to be taken simultaneously. These probes save valuable resources by reducing setup and test times.



Rake Probes are custom-designed for each application, are manufactured in an array of sizes, and can incorporate Multi-hole Probe tips, Kiel, Total Air Temperature (TAT), or combinations of these. .

Rake Probes are ideal in applications where schedule or cost must be reduced. Because multiple measurements are taken simultaneously, there is no need to run a test, move the instrument, and rerun the test. Rake probes are often used when measuring high swirl inlet flows for turbomachinery and automotive engine compartments.

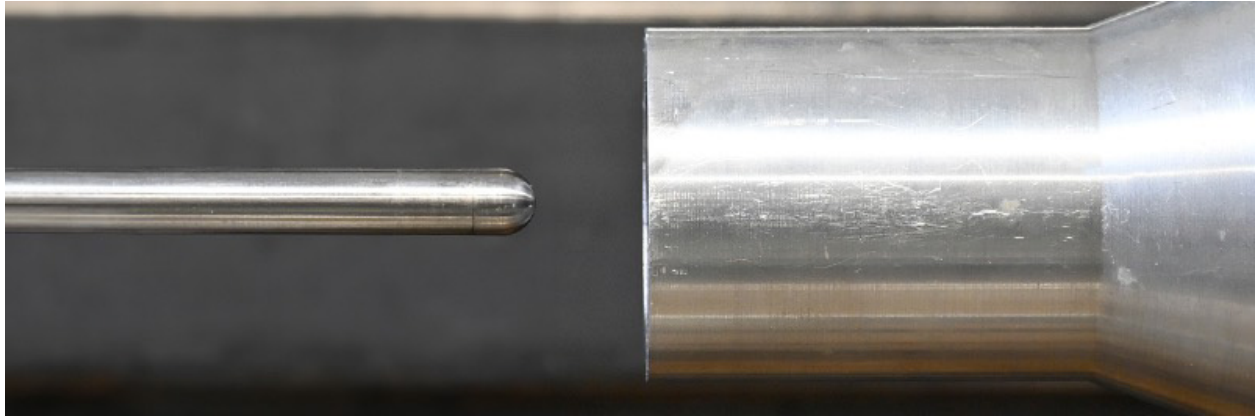
## Features:

- 1, 3, 5, or 7-hole
- Kiel, Pitot, or TAT heads available
- Standard tip diameter is customizable
- Accepts flow angles up to  $\pm 30^\circ$  (in a single plane) for 3-hole probe,  $\pm 50^\circ$  for 5-hole probe, and  $\pm 70^\circ$  for 7-hole probe
- Temperature ratings up to  $500^\circ\text{C}$
- High accuracy NIST traceable aerodynamic calibrations
- Up to 3000 discrete aerodynamic calibration points per speed
- Standard 300 Stainless steel construction
- Standard media: non-reactive gases, air, water, and other fluids
- Angle error of less than  $\pm 1^\circ$
- Velocity error\* of less than  $\pm 1\%$  or  $\pm 1\text{ m/s}$



# Aerodynamic Probe Calibration

Kiel Probes are used to measure the total pressure of a flow with high accuracy over a wide range of flow angles. Unlike a Pitot Probe, the Kiel Probe's shroud acts to straighten the incoming flow and remove measurement errors associated with varying flow angles. Kiel Probes do not require aerodynamic calibration.



Aeroprobe aerodynamic probe calibrations are performed on-site by highly trained expert staff to produce the most accurate calibrations in the industry.

To aerodynamically calibrate a Multi-hole Probe, the probe is first placed in one of Aeroprobe's free-jet wind tunnel facilities, where the flow speed and direction are known. The probe is then rotated to several thousand discrete orientations relative to the jet, while maintaining a fixed probe tip position. Finally, the mean pressure measured at each of the probe tip ports is recorded at each discrete orientation and correlated with reference total and static pressure measurements. .

The aerodynamic calibration of the probe is critical to its operation. The data set collected during calibration forms a map that is necessary to relate the measured probe tip pressures to the flow quantities interest.

- Velocity vector components (flow angles)
- Total and static pressure
- Mach number

The accuracy of the aerodynamic calibration directly influences the accuracy of the Multi-hole Probe measurement results during operation.

## Technical Capabilities

- Calibration speeds from 5 m/s to Mach 1.8
- Angle uncertainty\* less than 1°
- Velocity uncertainty\* less than 1 m/s
- NIST traceable calibration certificates
- Custom calibration grids available upon request

\*Based on  $2\sigma$  confidence interval. Assumes AeroFlow 3 software used. Excludes contribution from test specific pressure sensor error.

# AeroFlow

AeroFlow is the premier Multi-hole Probe data processing and visualization application for aerodynamicists. It applies Multi-hole Probe aerodynamic calibrations to measured pressure data to calculate the flow velocity vector, total and static pressure, Mach number, and total temperature.

## Superior Accuracy:

AeroFlow uses a proprietary adaptive algorithm to deliver the minimum error in the measurement over a wide range of conditions.

## Ultra-Fast Processing:

Developed with speed in mind, AeroFlow swiftly processes data to ensure a continuous flow of answers.

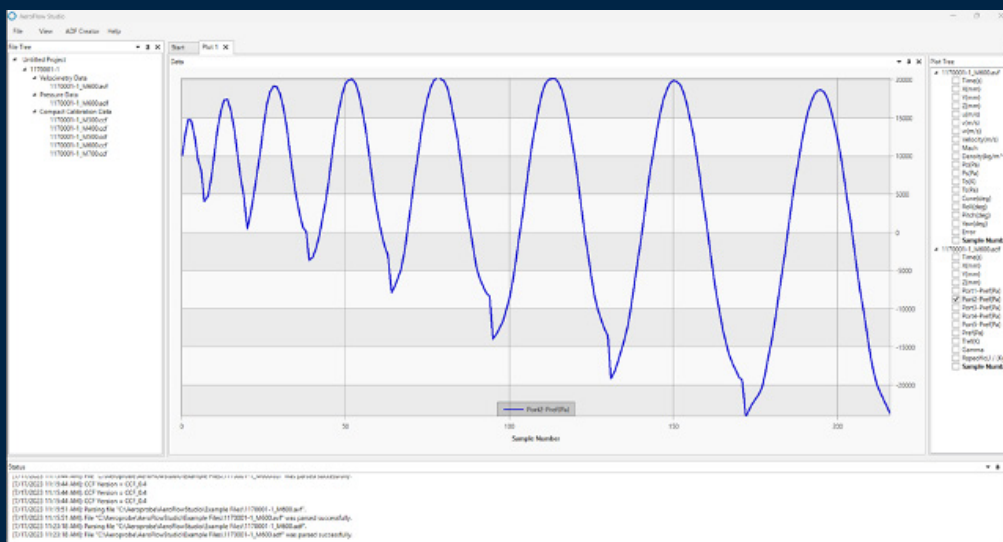
## Private & Secure:

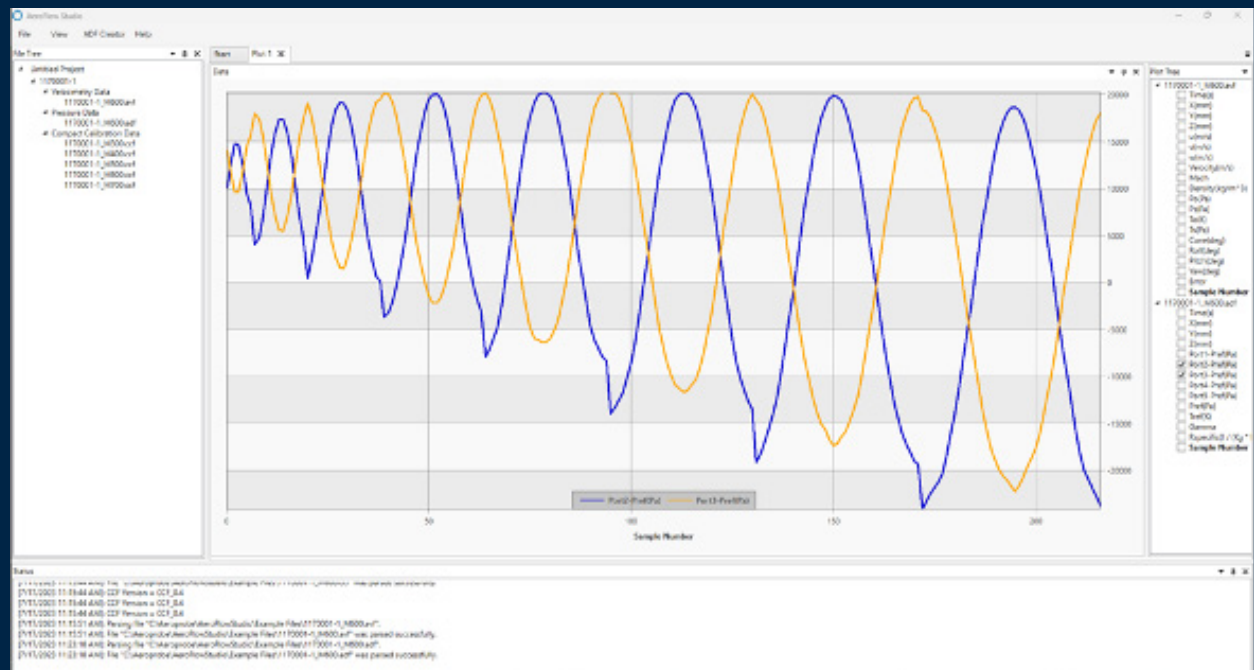
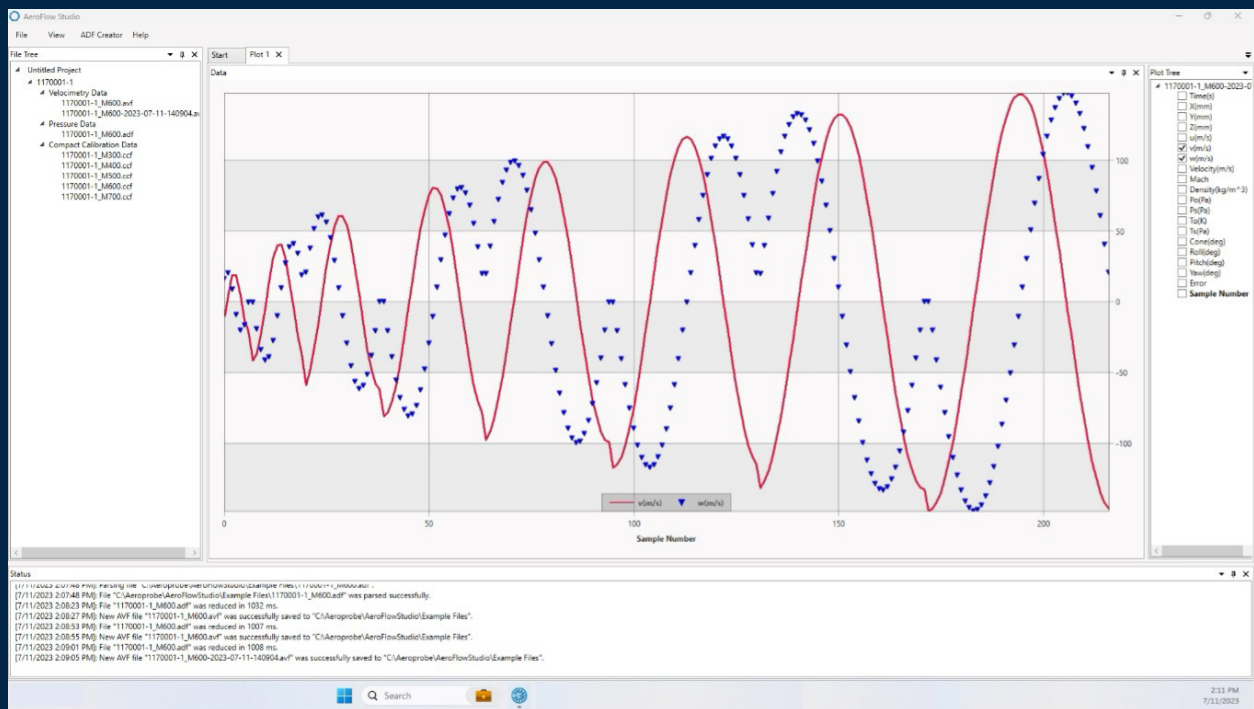
AeroFlow operates independently of cloud-based technology, allowing you to always retain full control of your data.

The AeroFlow ENGINE is a dynamically linked library that supports integration into 3rd party software.

## Including code written in:

- C++
- C#
- Python
- MATLAB
- LabView





AeroFlow STUDIO is a user-friendly data visualization and analysis application, powered by the AeroFlow Engine, where no coding is required, enabling you to swiftly obtain results. With access to the AeroFlow reduction libraries, you can perform on-the-fly data processing of multiple Aeroprobes multi-hole probes when seamlessly integrated with your existing customer data acquisition software. Additionally, within AeroFlow STUDIO, you can effortlessly view, graph, manipulate, and export a wide range of critical parameters, including velocity components, velocity magnitude, Mach number, density, total and static pressure, total and static temperature, Mach number, cone and roll angles (spherical coordinate angles), as well as pitch and yaw angles (angle-of-attack and angle-of-sideslip).

## Micro Air Data Computers

Aeroprobe's Micro Air Data Computers ( $\mu$ ADC) are a critical component of the aircraft avionics system. Optimized for use on Uncrewed Aerial Vehicles (UAV), they provide real-time measurement of airspeed, altitude, angle-of-attack, and angle-of-sideslip which the pilot or flight control unit use to conduct the mission efficiently and safely. Each model was designed for a specific mission profile to meet the aggressive performance requirements of your aircraft. Choose the right model for your mission.

### Multi-Function Air Data Probe Compatible Micro Air Data Computers



#### Defiant:

The Defiant is best in class for size, weight, and power. Optimized for use with a Multi-Function Air Data Probe, the Defiant provides measurements of angle-of-attack and angle-of-sideslip with no moving parts.

The Defiant operates over a  $\pm 20^\circ$  angle-of-attack and angle-of-sideslip range and up to 612 knots indicated airspeed.

#### Hyperion:

For a high-altitude mission or when AS8002 altitude accuracy is needed, the Hyperion is the right choice. The Hyperion provides measurements of angle-of-attack and angle-of-sideslip with no moving parts.

Designed to operate at altitudes up to 75,000 ft, the Hyperion is ideal for High Altitude Long Endurance (HALE) applications where precise angle-of-attack, airspeed, and altitude are all critical to mission success.

## Athena:

Optimized for use with a Multi-Function Air Data Probe, the Athena provides measurements of angle-of-attack and angle-of-sideslip over a wide range of airspeed from 10 to 612 knots indicated airspeed.

The Athena is the right choice to support missions with the widest range of airspeed without compromise.

## Endurance:

Optimized for use with a Multi-Function Air Data Probe, the Endurance provides measurements of angle-of-attack and angle-of-sideslip with no moving parts over a  $\pm 40^\circ$  angle-of-attack and angle-of-sideslip range.

When the mission requires high maneuverability or operation in near-stall or post-stall envelopes, the Endurance is the right choice.

## Pitot-Static Probe Compatible Micro Air Data Computers



## Atlas:

Optimized for use with a Pitot-static Probe, the Atlas provides air data over a wide range of airspeed from 10 to over 612 knots indicated airspeed.

When paired with Aeroprobe's heated and drained Pitot-static probes, the Atlas is ideal for missions in harsh conditions such as rain and ice.

## Horizon:

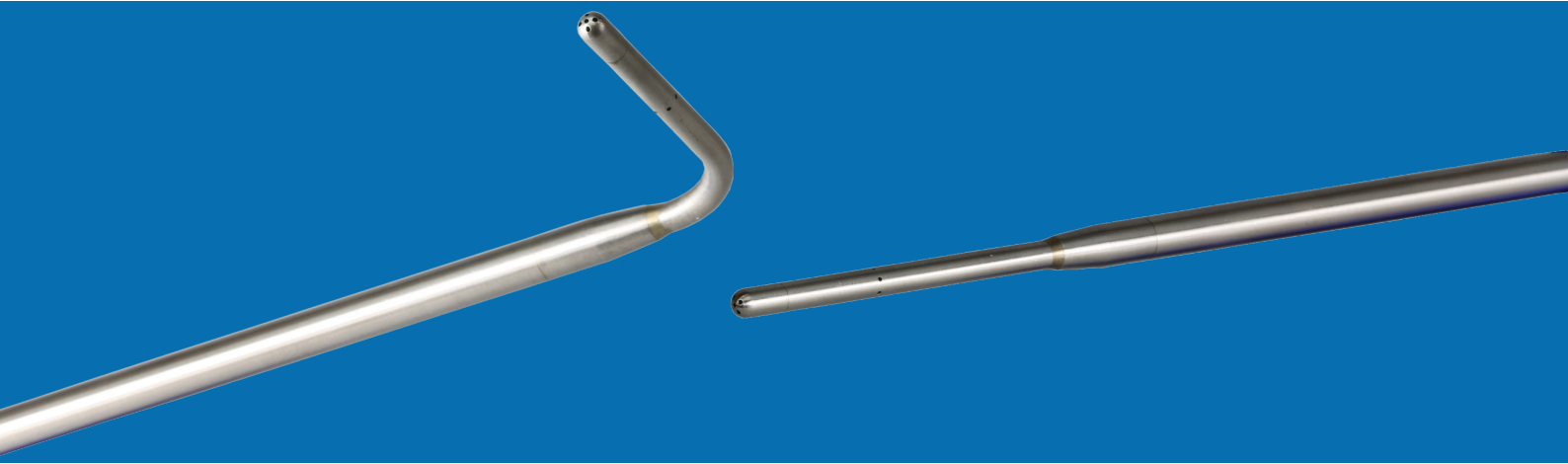
For a high-altitude mission or when AS8002 altitude accuracy is needed, the Horizon is the right choice. Horizon is optimized for use with a Pitot-static Probe and operates over a wide range of altitudes and airspeed from 10 to 612 knots indicated airspeed.

The Horizon is designed to operate well beyond the ceiling of most manned aircraft and operates at altitudes up to 75,000 ft.

## Multi-function Air Data Probes

Designed for simple integration with the Micro Air Data Computer ( $\mu$ ADC), the Multi-function Air Data Probe is an effective lightweight solution for measuring angle-of-attack, angle-of-sideslip, airspeed, and altitude where mobility is critical. With no moving parts, the

Multi-function Air Data Probe is a reliable choice for pilots and engineers looking to push the limits of performance and control.



Multi-function Air Data Probes allow for calculation of the complete flow vector. Its comprehensive design improves on traditional air data solutions (ex: Air Data Boom) by eliminating pitch and yaw vanes, which have moving parts with inertial effects that introduce inaccuracy and increase weight and response time.

### Features:

- AoA & AoS error less than  $\pm 1^\circ$
- Airspeed error less than  $\pm 1\%$  or  $\pm 1$  m/s
- Standard acceptance angle up to  $\pm 20^\circ$  AoA & AoS
- Optional extended angle up to  $\pm 40^\circ$  AoA & AoS
- As low as 15 grams mass
- Straight, L-Shaped, and Strut-mounted geometries
- 5 tip ports with a static ring
- Rugged stainless-steel construction
- Optional internal heater (22 or 42 Watts) for icing protection
- Optional integrated total air temperature sensor



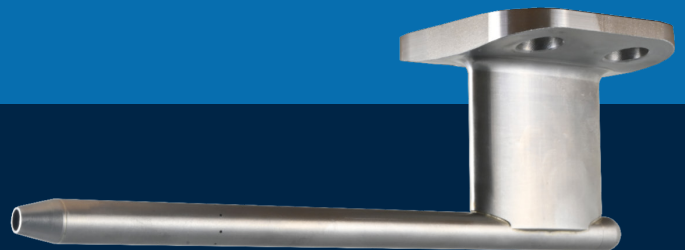
# Pitot/Pitot-Static Probes

Aeroprobe offers a line of Drained Pitot/Pitot-Static Probes to allow uncrewed platforms to operate in more extreme weather conditions.



Pitot-Static Probes measure total and static pressures to derive airspeed and altitude. Commonly used for flight applications, these probes can be straight for boom mounting ahead of the aircraft or include an aerodynamic strut for fuselage mounting.

Pitot-Static Probes are commonly used in applications where only an air speed measurement is desired. Wind Tunnel facilities commonly use Pitot-Static Probes to characterize their wind tunnels because the angle of the air flow is known. The aviation and uncrewed systems industries also use Pitot-Static Probes to measure the aircraft's speed, Mach number, and altitude.



## Features:

- Probes offered with or without a static ring
- Designed to meet AS8006 performance standard
- Drained tip designed to meet AS5562 rain standard
- Optional safety feature: PT100 RTD to monitor internal probe temperature
- Low weight (as low as 50 g unheated and 100 g heated)
- Configurable for specific platforms & envelopes
- Two tip diameters – 9.5mm (standard) / 7.9mm (optional)
- Straight, L-Shaped, or Strut Mounted Designs
- For use up to Mach = 0.85 (performance testing available)
- Compatible with Aeroprobe's Micro Air Data Computer ( $\mu$ ADC) or connected directly to your existing hardware with pitot and static ports
- Standard heater options at 12V/18W, 15V/23W, or 28V/42W for anti-icing capability – other higher power heaters options possible
- Anti-icing heater
- Choice of pneumatic connector
- Rugged brazed stainless steel construction



# Total Air Temperature Probes

Total Air Temperature (TAT) Probes play a crucial role in flight operations, influencing fuel temperatures on long journeys, guiding anti-ice system usage based on both TAT and static air temperature (SAT), aiding in Mach number and true airspeed calculations essential for cruise flight and navigation, and providing the necessary data for engine thrust settings and auto throttles.



Our flight specific TAT Probes are designed to reduce errors associated with radiative heat transfer, withstand varied environmental conditions, and operate at velocities up to Mach 1. TAT Probes can be manufactured in a variety of configurations for use in flight, engine and wind tunnel testing, and even integrated with other air data solutions.

## Features:

- Standard tip diameter 3.18 mm; Optional, 2.38 mm, or 6.35 mm
- Temperature ratings up to 500°
- Standard 300 Stainless steel construction
- Custom engineering solutions available
- Standard media: non-reactive gases, air, water, and other fluids