



# AEROPROBE

corporation

## STANDARD PROBES



Drilled Elbow

Straight

L-Shaped

Cobra



## DATA SHEET

*Engineering Flow-Measurement Solutions*

### Features

- Standard probe geometries for 3, 5, and 7-hole probes with customizable variations for each
- Tip diameters as small as 1.59 mm
- Average Angular Accuracy of  $<1^\circ$
- Average Velocity Accuracy of 1% or  $\pm 1$  m/s
- Temperature Ratings to 500°C
- Probe Calibrations from 5 m/s to Mach 2.0

### Applications

- General aerodynamics
- Turbomachinery
- Wind tunnels
- UAVs and manned aircraft
- Wind turbines
- Water flows
- Automotive wakes, engine compartments

# PRODUCT SPECIFICATIONS

## Measurement Accuracy

Flow angles <sup>1,2</sup>	$\pm 1^\circ$
Velocity Magnitude <sup>1,2</sup>	<1% or 1 m/s, (whichever is larger)
Thermodynamic Data <sup>3</sup>	Reference Pressure, Total Temperature
Flow Cone Angle of Receptivity	20° (3HP), 60° (5HP), 70° (7HP) NOTE: This is not directly related to the conical angle of the tip
Calibration Flow Speeds	5 m/s to Mach 2.0
Frequency Response	Standard <sup>4</sup> : <50 Hz Optional: Frequency Calibration Available
Media	Standard: Non-Reactive Gases, Water Optional: Other Media
Temperature Measurement	Optional: Thermocouple

<sup>1</sup>Based on Average of Test Point Data

<sup>2</sup>Utilizing 0.1% Accurate Pressure Sensors Properly Rated for Flow Speed

<sup>3</sup>For Most Accurate Compressible P-V Reduction. Additional Equipment Required

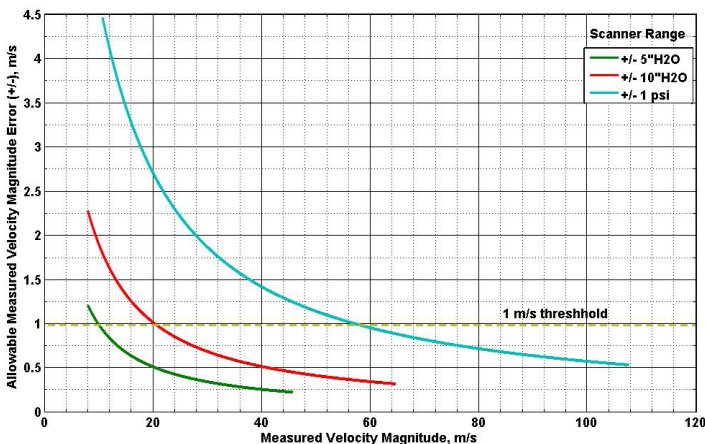
<sup>4</sup>Optimized for time-averaged flows

## Geometry and Construction

Probe Geometry	Straight, Cobra, L-Shaped, Drilled Elbow
Number of Holes	3, 5, 7
Tip Geometry <sup>5</sup>	Standard: 60° Conical Optional: Hemispherical
Tip Diameter	Standard: 3.18 mm Optional: 1.59 mm, 2.38 mm, 6.35 mm
Material	300 Series Stainless Steel Construction, Including Shafts and Internal Tubing
Pneumatic Connection	Exit Tubing of 1.02 mm (0.040") OD with Tubulation
Mounting	Standard: Hex Prism Optional: Rectangular Prism, Cylindrical with Flat
Probe Reference	Flat on Hex Mount
Flow Temp. Limits	Standard: 0 – 500°C

<sup>5</sup>Indicates Full-Angle Measurements

## Velocity Magnitude Elaborated



The stated velocity accuracy for Aeroprobe's multihole probes is 1 m/s or 1% of the measured velocity, whichever is larger, assuming a properly ranged scanner. The graph below illustrates the effect of scanner range on velocity accuracy. The graph shows the allowable velocity error as a function of velocity for three different pressure scanner ranges, all with 0.5% full-scale span error. The calculated error assumes that the pressure measured by the scanner is the dynamic pressure and no system or reduction error is accounted for.

When designing a multihole probe test it is important to consider the effect of pressure measurement error at the desired flow velocity. For example, the user should not expect accuracies of less than 1/ms using the +/- 1 psi scanner with 0.5% FSS error for a measurements below approximately 60 m/s.

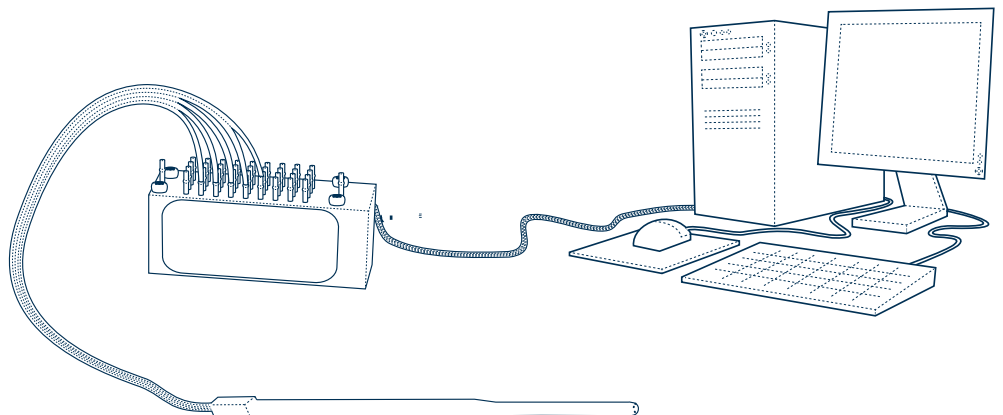
## SYSTEM SCHEMATIC

Where your probe fits in our system

Aeroprobe provides complete system solutions to challenging and unique flow measurement problems.

Aeroprobe systems include:

- Measurement instruments
- Supporting hardware
- Data acquisition
- Software



# PRODUCT SPECIFICATIONS

## Minimum Bend Radii<sup>1</sup> (r) (Centerline)

Component Diameter	Minimum Bend Radius
1.59 mm	3.90 mm
2.38 mm	6.35 mm
3.18 mm	9.53 mm
6.35 mm	14.30 mm

<sup>1</sup>Refer to technical drawing below for notations

## Minimum Bent Tip Dimensions

Tip Diameter	Min. Tip Lengths <sup>1,2</sup> (t-Min) (Cobra and Bent)	Min. Bent Neck Lengths <sup>1,2</sup> (n-Min) (Cobra Only)
1.59 mm	17.50 mm	16.01 mm
2.38 mm	22.00 mm	22.00 mm
3.18 mm	25.40 mm	34.00 mm
6.35 mm	47.50 mm	51.00 mm

<sup>1</sup>Refer to technical drawing below for notations

<sup>2</sup>Measured to shaft centerline

## Min., Standard, & Max. Drilled Elbow Tip Lengths<sup>1,2</sup> (e)

Tip Diameter	Min. Tip Lengths	Std. Tip Lengths	Max. Tip Lengths
1.59 mm	3.00 mm	4.50 and 6.00 mm	8.00 mm
2.38 mm	4.50 mm	6.00 mm	8.00 mm
3.18 mm	6.00 mm	10.00 mm	12.00 mm
6.35 mm	9.40 mm	N/A	18.00 mm

<sup>1</sup>Refer to technical drawing below for notations

<sup>2</sup>Measured to shaft centerline

## Geometry Limitations for Multi-Hole Probes

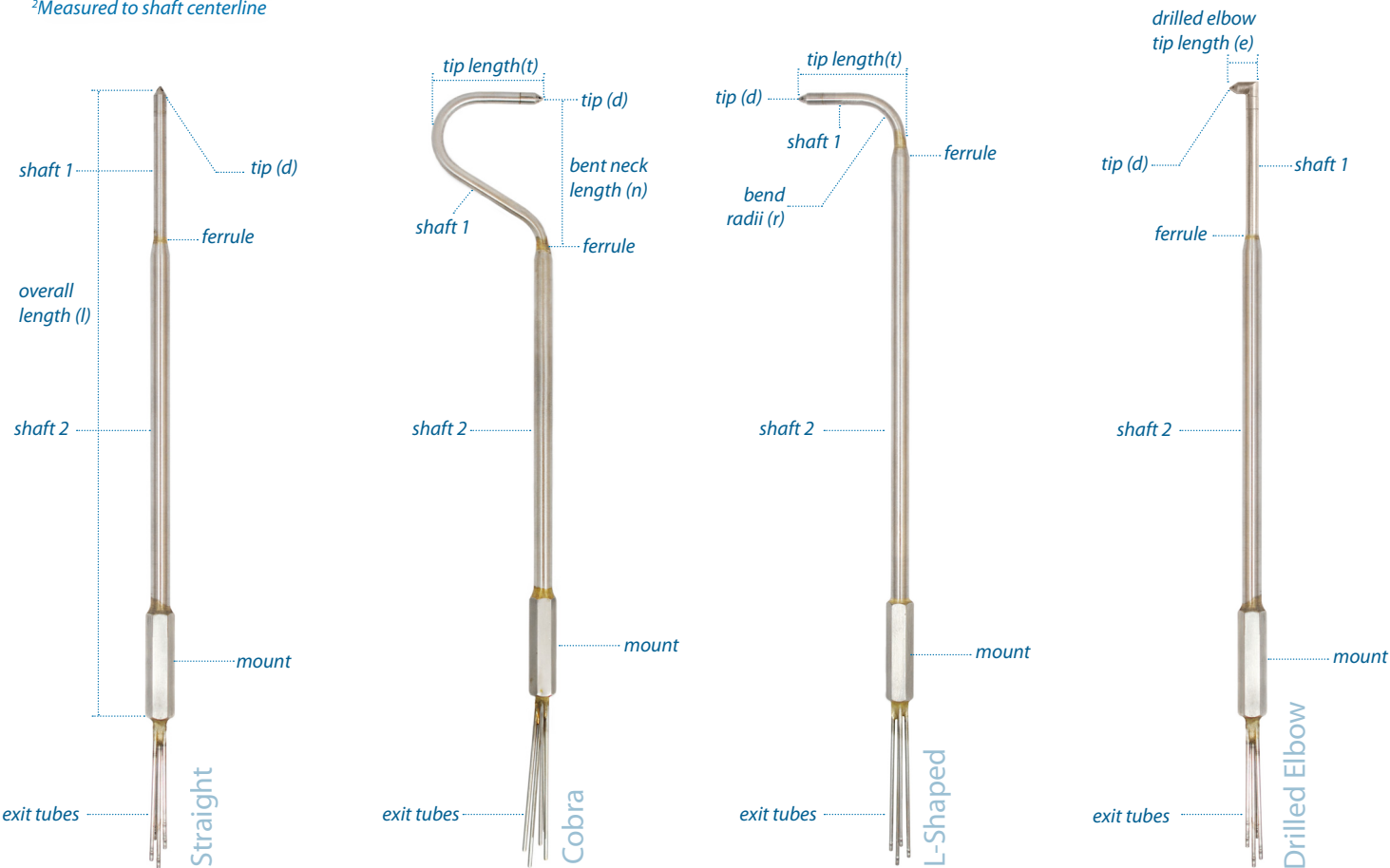
Dimension	Minimum	Maximum
Tip Diameter (d) <sup>1</sup>	1.59 mm	6.35 mm
Overall Length (l) <sup>1</sup>	102 mm	255 mm
Tip Length (t) <sup>1,3</sup>	t-min	102 mm
Neck Length (n) <sup>1,3</sup>	n-min	102 mm
Included Tip Angle (Conical)	60°	60°

<sup>1</sup>Refer to technical drawing at bottom-left for notations

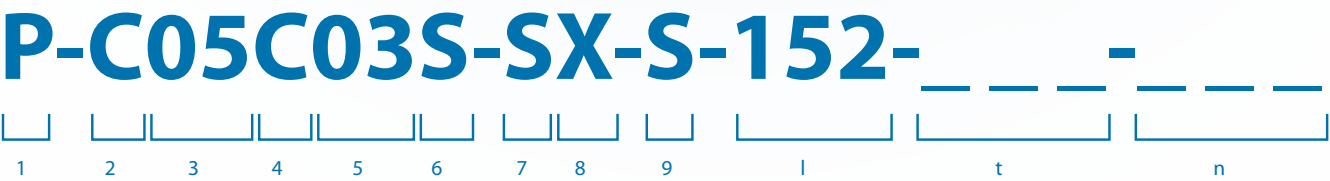
<sup>3</sup>Minimum tip lengths and neck lengths are centerline measurements, and are given in two tables to the left

## Standard Tolerances

Dimension or Component	Tolerance
Tip Diameter and Exit Tubes	± 0.05 mm
Other Diameters (Housing Tubes)	± 0.10 mm
Locations (Centerlines, Ports)	± 0.05 mm
Primary Lengths ( Overall Length, Exit Tubes, Hex Mount, Ferrules)	± 2.54 mm
Other Lengths (Bent Leg, Housing Stages)	± 5.1 mm
Included Tip Angle (Conical)	± 0.5°
On-Axis Bend Angle	± 1°
Off-Axis Bend Angle	± 5°



PROBE MODEL NUMBER STRUCTURE:



Multi-Hole Probe Model Number Definition

1	P: Standard Probe
2	C: Conventional
3	Number of Probe Ports (03, 05, 07)
4	Tip Style (C = Conical, H = Hemispherical, D = Drilled Elbow, R = Boundary Layer Drilled Elbow)
5	Tip Diameter <sup>4</sup> (01 = 1.59 mm, 02 = 2.38 mm, 03 = 3.18 mm, 06 = 6.35 mm)
6	Shaft Style (S = Straight, L = L-Shaped, C = Cobra, E = Eccentric)
7	Temperature Rating (S = 500°C, H = 900°C, U = 1200°C)
8	Thermal Capability Enhancement (X = None, T = Thermocouple, H = Heater, B = Thermocouple and Heater)
9	Customization (S = Standard, N = Near Standard, C = Custom)
l	Overall Length of Probe <sup>4</sup> (mm)
t	Length of Probe Tip <sup>4, 5</sup> (mm)
n	Length of Cobra Neck <sup>4, 6</sup> (mm)

<sup>4</sup>References Geometry Variables

<sup>5</sup>L-Shaped and Cobra Only

<sup>6</sup>Cobra Only

Example Probe Model Numbers:

Standard 1.6 mm Drilled-Elbow Five-Hole Probe with Thermocouple for Turbomachinery Applications. Overall Length 152 mm, Tip length 4 mm.

Model Number: P-C05C01D-ST-S-152-004

Near-Standard 3.18 mm Cobra Seven-Hole Probe for Aerodynamic Testing. Overall Length 250 mm, Tip Length 25 mm, Cobra Neck Length 38 mm.

Model Number: P-C07C03C-SX-N-250-025-038

Custom 6.35 mm Straight Five-Hole Probe for Testing in Water. Overall Length 300 mm. Customization Due to Custom Mount and Use of Inconel for Oxidation Resistance.

Model Number: P-C05C06S-SX-C-300

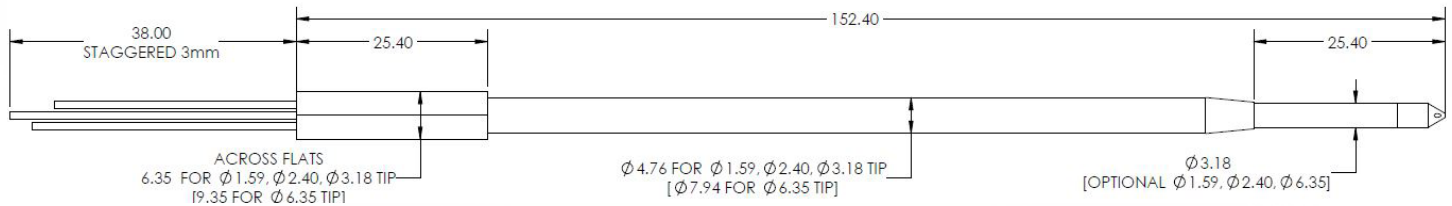
Please Note:

- Standard probes are manufactured with 1.59 mm, 2.38 mm, 3.18 mm and 6.35 mm tip diameters, and are 152 mm in length.
- Near-standard probes have standard geometry EXCEPT for the length of the shafts.
- Custom probes have variations from the standard that include non-standard tip sizes, non-standard probe or mount geometry, or non-standard materials.
- **Important:** Near-standard and custom probes require confirmation of probe drawing by customer, prior to manufacturing.

# STANDARD TECHNICAL DRAWINGS

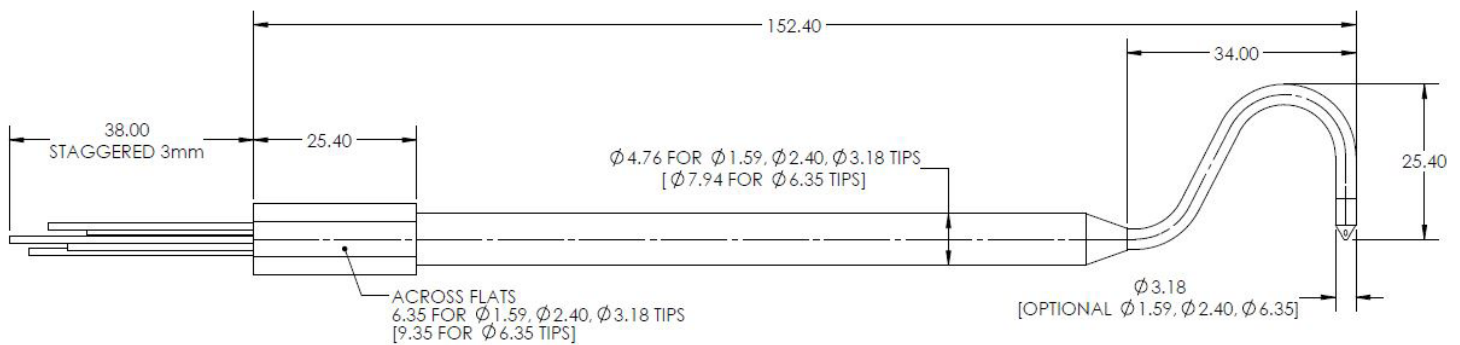
## Straight

Model Number: P-C03C03S-SX-S-152



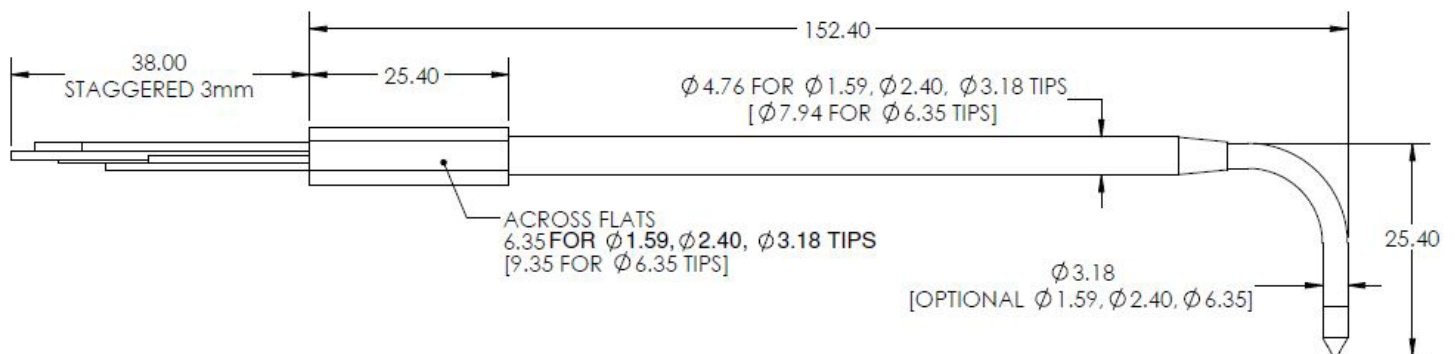
## Cobra

Model Number: P-C03C03C-SX-S-152-025-034



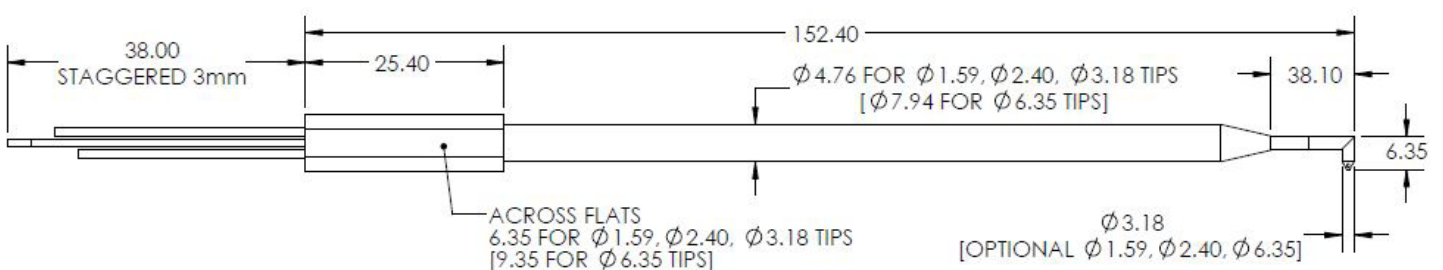
## L-Shaped

Model Number: P-C03C03L-SX-S-152-025



## Drilled Elbow

Model Number: P-C03C03D-SX-S-152-006



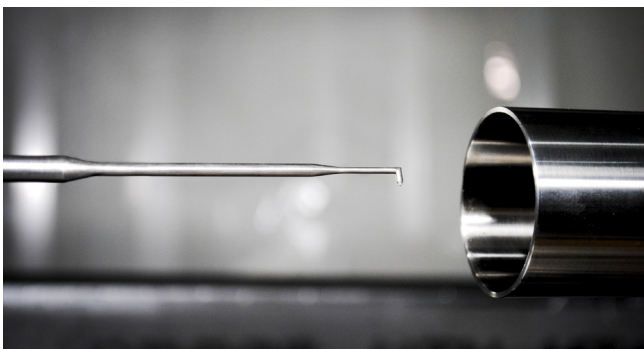
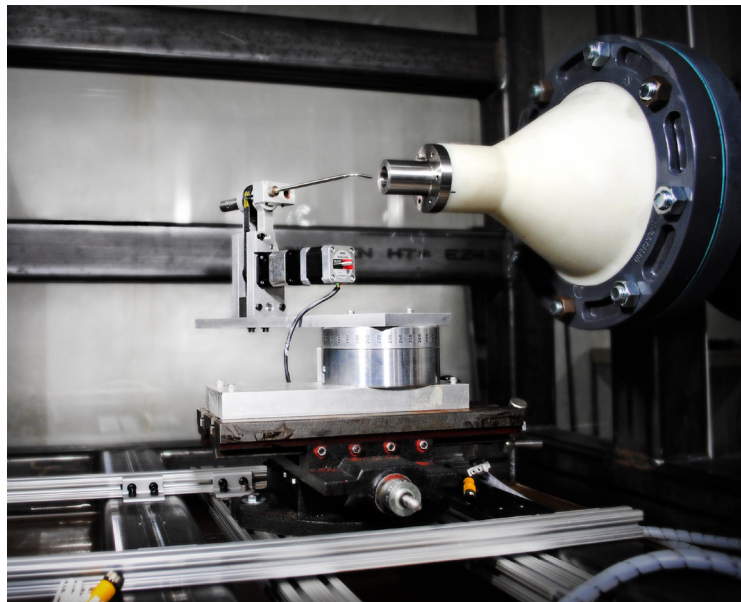


## CALIBRATION & SERVICES

### ONE SOURCE FOR A FULL SOLUTION

The probe calibration is essential to the proper operation of the probe. It defines the relationship between the measured probe port pressures and the actual velocity vector sensed by the probe and pressure transducers. The probe is placed in a known flowfield and rotated to between 2000 and 6000 discrete points (depending on probe type). A calibration map is then generated for use with pressure to velocity reduction software, such as AeroFlow, Aeroprobe's data acquisition and data reduction software.

Aeroprobe's calibration wind tunnels are thoroughly-characterized free jets, configured to allow continuous flow at 5 m/s to Mach 2.0. This configuration allows Aeroprobe to record extreme number of calibration points for each calibration. Aeroprobe can calibrate probes for other fluid flows via Reynolds number matching, and can recommend a calibration schedule for any probe and application.



### CAPABILITIES

Probe Calibrations from 5 m/s to Mach 2.0	NIST-Traceable Calibrations
Average Angular Accuracy of $<1^\circ$	Specialized Calibrations Available
Average Velocity Accuracy of 1% or $\pm 1$ m/s	2000-6000 Calibration Points

\*\* Reported probe calibration accuracies are based on the measured error values for a comprehensive set of test points collected in Aeroprobe's laboratory wind tunnel facilities. Flow environments exist where expected errors could be larger. Contact Aeroprobe for more information.

## COMPANY SUMMARY

*Engineering Flow-Measurement Solutions*

### Unique challenges. Quality solutions.

Aeroprobe provides air data measurement systems to aerospace, automotive, turbomachinery, wind turbine, and wind tunnel testing industries around the world. Aeroprobe's air data systems for unmanned aircraft provide real time air speed, angle of attack and angle of sideslip for improved flight performance. Turnkey systems include instrumentation for measurement, hardware for data collection, and software for data reduction, analysis and visualization. High temperature probes operate in flows up to 1200°C. Omniprobes, featuring a 300° flow angle range, are capable of measuring reversed flow. Fast response probes provide a frequency response exceeding 4 KHz. Rake configurations allow for simultaneous multi-point, unsteady measurements. The company conducts international business through a network of over 20 distributors.



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