

OMNIPROBE

• 18-HOLE PROBE • OMNIPROBE REDUCTION SOFTWARE

APPLICATIONS:

- Determination of Three Components of Flow Velocity Plus Total and Static Pressure at Probe Tip
- Accurate Resolution of Velocity Vectors as High as 165° from Probe Axis
- Measurement of Reversed Flows
- Max Frequency Response up to 500 Hz, Depending on Pressure Sensors
- Flow Speeds from 5 m/s to 325 m/s, Mach 0.02 to Mach 0.95

FEATURES:

Omniprobe

- Spherical Tip with 18 Pressure Ports
- Standard Omniprobe Tip Diameter of 9.52 mm, with 6.35 mm Option
- Multiple Standard Probe Geometries
- Rugged Construction from Brass and Stainless Steel, with All-Stainless Option
- Aeroprobe Expertise in Omniprobe Design and Construction
- High-Accuracy, 7000+ Point Calibrations
- Re-calibration of Probe is Not Required under Normal Operation

Omniprobe Pressure-to-Velocity Reduction Software

- High-Accuracy Reduction with Local-Least Square (LLS) Method
- Max Errors of 2% in Velocity Magnitude, 1.5° in Flow Angles
- Multi-Region Searching Algorithm for Sector Boundary Points

INTRODUCTION:

Originally, multi-hole probes were restricted to flow measurements where the velocity vector made an angle of 70° (or less) with the probe axis (see product information for multi-hole probes). The introduction of the omniprobe represented a vast improvement with

regards to the angular resolution of multi-hole probes. By employing 18 pressure ports distributed on the surface of a spherical surface, the omniprobe can accurately measure flows from virtually any direction. Like the traditional multi-hole probes, data acquisition with the omniprobe requires (1) the probe itself, (2) an accurate probe calibration, (3) means to measure the probe port pressures and (4) a pressure-to-velocity reduction method based on the calibration. This document gives product information for (1), (2) and (4) above.

OMNIPROBE:

Standard Omniprobe

Aeroprobe offers two standard omniprobe geometries: straight and L-shaped. Standard construction materials are a combination of brass and stainless steel.

Standard omniprobes have a 9.53 mm tip diameter, and a 152.4 mm overall length. The hex mount is 7.94 mm flat-to-flat. The spherical tip, ferrule and hex mount are manufactured from brass, with the remainder from stainless steel. The exit tubing for pressure connections is 0.89 mm in diameter, 31.75 mm in length and is stainless steel. The standard probes are shown in Figure 1. Geometrically similar probes are available with a tip diameter of 6.35 mm.

All standard omniprobes are supplied with one calibration at a requested speed. Additional calibrations at other speeds may be specified on order. Custom omniprobes are normally supplied with a full calibration, unless this is precluded by geometry restrictions.

The advantage of using an omniprobe rather than a traditional five- or seven-hole probe is in the angular resolution capability. Seven-hole probes are highly accurate until the velocity vector reaches a total angle of about 70° with respect to the flow. For five-hole probes this angle is about 60°. Omniprobes are able to resolve velocity vectors having angles of up to 165° with the probe axis (relative to base-to-tip direction). This allows the omniprobe to measure flows with very high angularity and even reversed flows.

Standard Omniprobe Options

Standard omniprobe options include reduction of tip diameter to 6.35 mm (available in brass only), and complete stainless steel construction.

Custom Omniprobes

Aeroprobe would be happy to consider your requests for custom omniprobes. Each probe is essentially designated by specifying the geometry fields, as

shown in Figure 2. Some minor geometry changes from the standard probes (including, but not limited to, increased/decreased length and increased tip lengths on L-shaped omniprobes) can be easily accommodated. Typical custom geometry ranges are given in Table 1, and probes with parameters within these ranges will have minimized customization costs. Please note the restrictions on bend radii in Table 2.

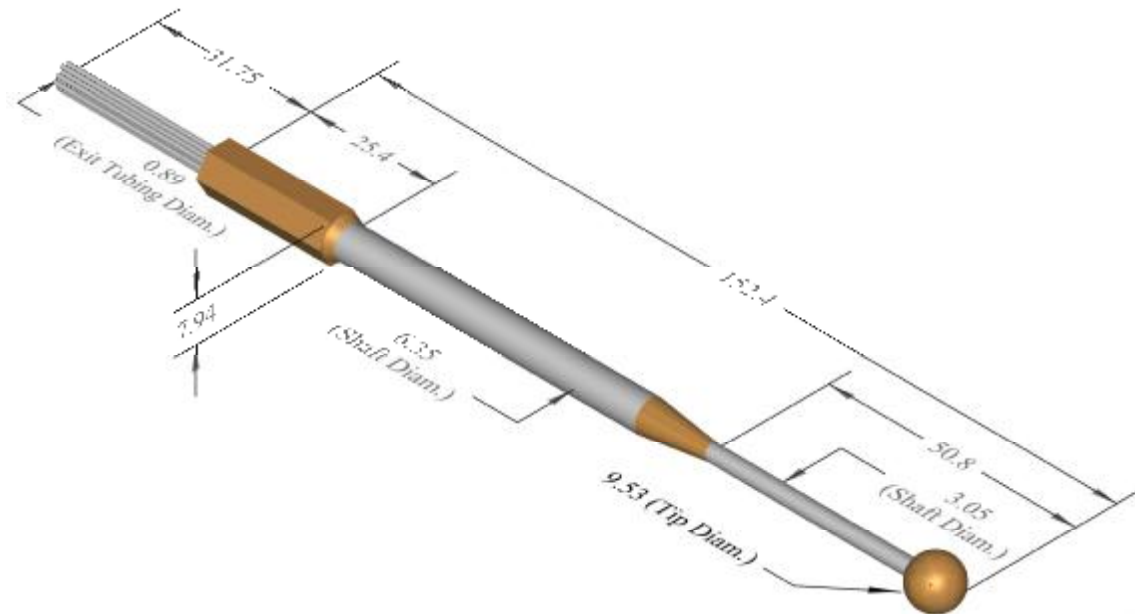


Figure 1(a): Standard Straight Omniprobe. All Dimensions in Millimeters.

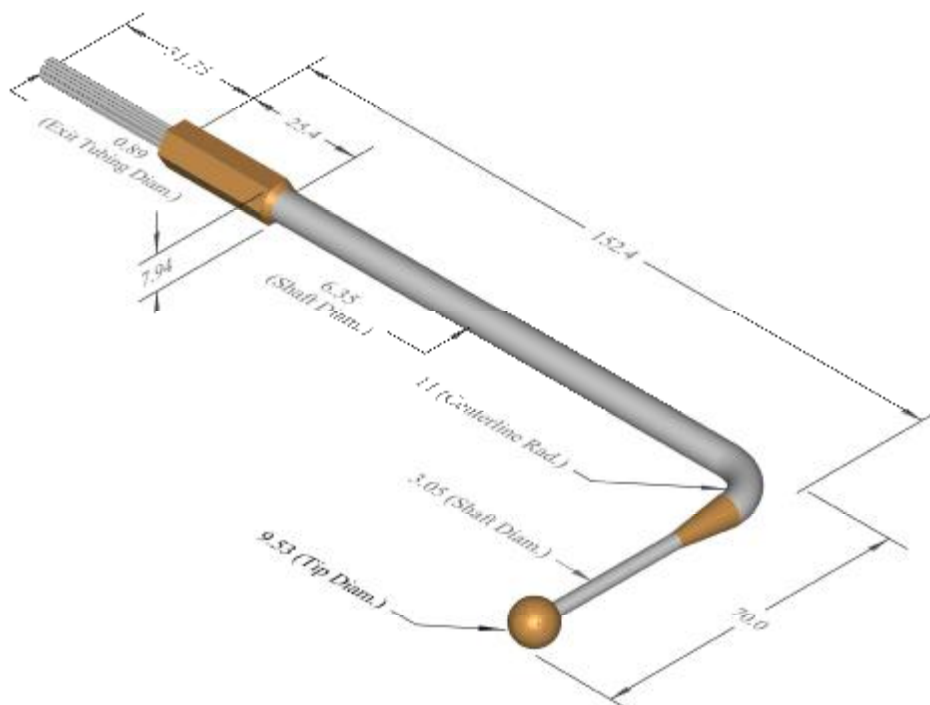
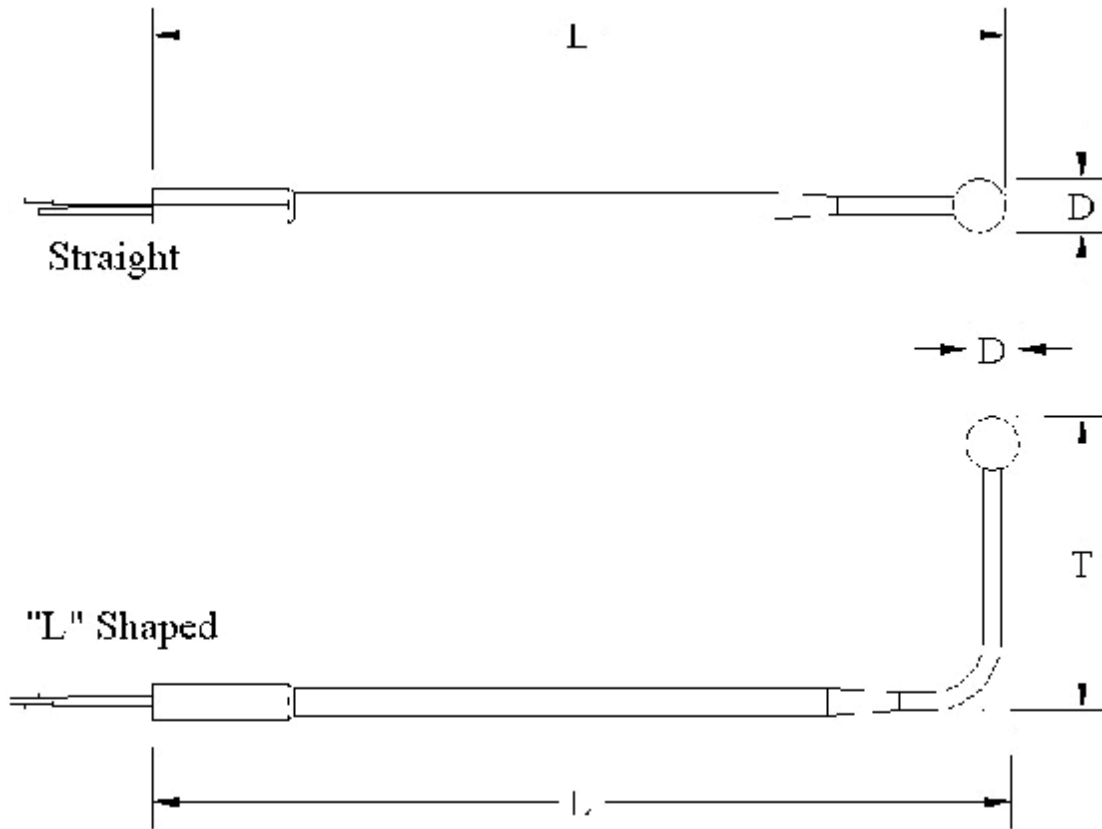


Figure 1(b): Standard L-Shaped Omniprobe. All Dimensions in Millimeters



| Geometry Codes | | Omniprobe Model Number Definition | | | | | | | | | |
|--|------------------|---|---|----------------------------|----------|------------------|---|----------|---|----------|---|
| D | Tip Diameter | P or CP | Probe Type | 18 | - | Tip Geom. | D | - | L | - | T |
| L | Overall Length | | | | | | | | | | |
| T | Probe Tip Length | P = Standard Probe CP = Custom Probe | Straight or L-Shaped See Codes at Left | Number of Probe Ports = 18 | | Spherical = S | Tip Diameter in Hundredths of a Millimeter (Three Digits) | | Overall Length of Probe in Millimeters (Three Digits) | | Length of Probe Tip in Millimeters (Three Digits) |
| Probe Type | | | | | | | | | | | |
| S | Straight | | | | | | | | | | |
| L | L-Shaped | | | | | | | | | | |
| Tip Geometry | | | | | | | | | | | |
| S | Spherical | | | | | | | | | | |
| <i>Note: T is used only if Required, Omitted Otherwise</i> | | | | | | | | | | | |

Figure 2: Probe Design and Specification
Examples:

PL18-S953-152-070 specifies a standard L-shaped omniprobe with a 9.53 mm tip diameter, 152 mm overall length and a 70 mm tip length.

CPS18-S953-1200 specifies a custom straight omniprobe with a 9.53 mm tip diameter and 1200 mm overall length. Note that the length is not within the acceptable range for a standard omniprobe (see Table 1 below).

Table 1: Acceptable Geometry Variations for Standard Omniprobes ¹:

| Dimension | Minimum (mm) | Maximum (mm) |
|--------------------|--------------|--------------|
| Tip Diameter (D) | 6.35 mm | 9.53 mm |
| Overall Length (L) | 102 mm | 255 mm |
| Tip Length (T) | 50 mm | 102 mm |

¹ Probes complying with these geometry ranges will have minimized customization costs.

Table 2: Minimum Bend Radii (Centerline)

| Component Diameter (mm) | Minimum Bend Radius (mm) |
|-------------------------|--------------------------|
| 3.18 | 11.0 |
| 6.35 | 15.9 |

Table 3: Standard Tolerances ¹:

| Dimension or Component | Tolerance |
|---|---------------------------|
| Tip Diameter and Exit Tubes | ±0.025 mm |
| Other Diameters (Housing Tubes): | ±0.051 mm |
| Locations (Centerlines, Ports): | ±0.0508 mm, worst case |
| 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° |

¹ Tighter tolerances may be specified on order of custom probes

OMNIPROBE CALIBRATIONS

The probe calibration is essential to proper operation of the probe. It defines a relationship between the measured probe port pressures and the actual velocity vector.

The omniprobe calibration process consists of placing the probe in a uniform, known flowfield (known in terms of velocity magnitude and direction, density, temperature, static pressure), and then rotating the omniprobe to over 7000 different orientations with respect to the known velocity vector. The probe tip is maintained at the same physical location during the entire calibration process. At each orientation, the probe port pressures and the freestream dynamic pressure are recorded. In this way, a calibration map relating pressure and velocity is created.

For more information about calibration facilities and instrumentation, please see the calibration section contained in the product information sheets for the 5- and 7-Hole probes. Typical calibration speed ranges are given in Table 4 as a function of omniprobe tip diameter.

Table 4: Calibration Speed Restrictions for Typical Omniprobe Tip Diameters

| Omniprobe Tip Diameter | Calibration Velocity Range |
|------------------------|----------------------------|
| 1/4" | 5 to 320 m/sec |
| 3/8" + | 5 to 60 m/sec |

OMNIPROBE PRESSURE-TO-VELOCITY REDUCTION SOFTWARE

The omniprobe pressure-to-velocity reduction software package is a post-processing, Windows-compatible package. A window from the program is shown in Figure 3.

The software utilizes a local-least squares (LLS) fit of the closest (to the test point in question) calibration points, for each of the calibration variables. The LLS searching algorithm uses specialized multi-region search routines to improve accuracy.

The reduction algorithm has typical average errors of 2% (or less) in the velocity magnitude and 1.5° (or less) in the flow angles, when used with calibration data generated in our facilities.

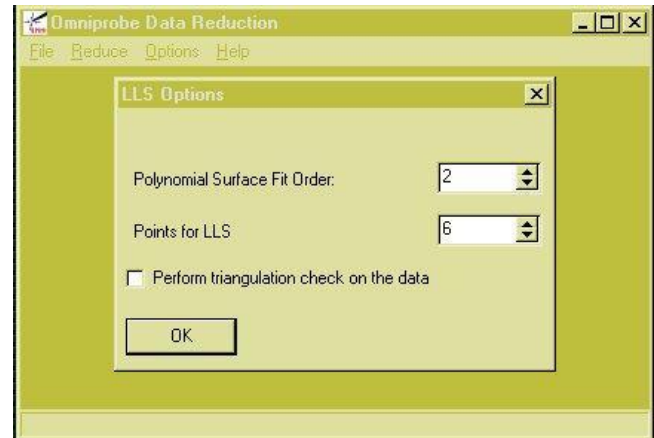


Figure 3: Omniprobe Pressure-to-Velocity Reduction Software Screen Captures

ORDERING INFORMATION

| Item | Description |
|-----------------|--|
| | Standard Omniprobes |
| PS18 | Standard Straight Omniprobe, Calibrated |
| PL18 | Standard L-Shaped Omniprobe, Calibrated |
| | |
| | Standard Omniprobe Options |
| TP18 | 6.35 mm Tip Diameter (Available in Brass Only) |
| SS18 | All Stainless Steel Construction |
| | |
| | Omniprobe Calibrations |
| XC0 | Extra Omniprobe Calibration |
| | |
| | Custom Omniprobes |
| CPS18 | Custom Straight Omniprobe, Calibrated |
| CPL18 | Custom L-Shaped Omniprobe, Calibrated |
| | |
| | Repair |
| PRP | Probe Repair |
| | |
| | Pressure-to-Velocity Reduction Software |
| WIN-OMNI | Omniprobe Reduction Software |

Choice (5 m/s – 320 m/s for 6.35 mm Tips, and 5 m/s – 60 m/s for 9.53 mm Tips). **Specify Speed on Order!**

- Custom Omniprobes Include One Standard Calibration at a Speed of the Customer's Choice if Omniprobe Geometry Permits


ADDITIONAL INFORMATION

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

REQUIREMENTS

Use of omni-probes requires ability to measure port pressures. Aeroprobe provides complete data acquisition systems and software for this purpose. Omniprobe software requires Windows 95/98, NT or 2000.

NOTES:

- Standard Omniprobes Are Shown in Figure 1, All Other Geometries Must Be Given a Custom Designation.
- All Standard Probes Include One Standard Calibration at a Speed of the Customer's