

# **AEROPROBE SYSTEM SUMMARY AND SPECIFICATIONS**

**Conventional Aeroprobe Systems  
Omniprobe Systems  
Fast-Response Probe Systems  
Multimedia Probe Systems  
Air-Data Probe Systems**

**April 13th, 2007**

## **AEROPROBE CORPORATION**

**1700 Kraft Drive, Suite 2413  
Blacksburg, Virginia 24060**

**Voice: (540) 951-3858    FAX: (540) 951-8618**

**[www.aeroprobe.com](http://www.aeroprobe.com)  
[sales@aeroprobe.com](mailto:sales@aeroprobe.com)**

# Aeroprobe System Overview

## ***Introduction:***

Multi-hole probes are fluid mechanics instruments designed to determine the flow velocity and pressure through direct measurement of the pressures at the probe tip. These probes measure flow velocity and pressure by interfering (as little as possible) with the flow in a particular and consistent manner. The probes are calibrated at multiple flow angles in an airstream of constant speed. In a unknown test flow, the measured port pressures are compared to the calibration map by sophisticated pressure-to-velocity reduction software, which returns the total and static pressures at the probe tip, as well as the flow angles. Using thermodynamic data (reference pressure and total temperature) provided by the user, the unknown velocity vector, as well as the total and static pressure at the measurement location may be determined.

There are four basic elements required for flow measurement using a multi-hole Aeroprobe:

1. The probe itself. Aeroprobe provides many probe options, with various geometries and capabilities.
2. An accurate probe calibration, or multiple probe calibrations, as required to properly cover the expected speed range of the probe. For over 10 years, Aeroprobe has been providing accurate, robust probe calibrations supported by data from precise pressure sensors with NIST-traceable calibrations.
3. The proper pressure sensors to critical in order to accurately measure the probe port pressures. These sensors should be accurate and properly ranged for the speed of the flow being measured. Aeroprobe has experience with the integration and application of many major brands of pressure sensors, and provides accurate calibrations of these sensors to the end user.
4. The data acquisition hardware and software required to measure the output from the pressure sensors. AeroAcquire data acquisition software provides an integrated environment for multi-hole probe positioning, pressure data acquisition, pressure-to-velocity reduction (through the integration of Multiprobe™) and data storage.
5. A reduction algorithm to convert the measured port pressures to velocity components based on the calibration map. Multiprobe™ is the most advanced commercially-available multi-hole probe pressure-to-velocity reduction software.

In addition, there are several additional components that add to the usefulness of the Aeroprobes and the data resulting from their use:

6. An automated traversing system to position the probe (or multiple probes in a rake) within the test environment. All full traversing system typically consists of
  - Motor Controller (AP3KM, AP4KM)
  - Stepper Motors
  - Motor Encoders for Positional Feedback (AP4KM Controller Option)
  - Traversing Scales (1D, 2D or 3D Configurations)
  - Probe Mounts, Mounting Rods and Sleeves

7. Scientific visualization software for the graphing and analysis of the three-dimensional velocity data generated through use of the Aeroprobes. AeroAcquire exports data to Tecplot (by AmTec) for visualization.
8. For fast-response probes, it is crucial that the pneumatic system between the tip of the probe and the sensors be calibrated for the attenuation/amplification and phase change of pressure waves as a function of frequency. Aeroprobes has experience in both generating and employing these calibrations within the scope of probe data acquisition and data reduction, through the use of the Acoustic Recovery (ARC) software. It is possible to apply this technique to conventional systems as well, effectively increasing the available bandwidth of the system.

***Aeroprobes System Types:***

- Conventional Systems for Air Flow Applications (5/7-Hole Aeroprobes)
  - Pressure Sensors
  - Pressure Scanners
- Conventional Systems for Multimedia (Air & Liquid) Applications (5/7-Hole Aeroprobes)
- Omniprobe Systems for High-Angularity Air Flow Applications (12-Hole Omniprobes)
  - Pressure Sensors
  - Pressure Scanners
- Fast-Response Systems for Air Flow Applications (5/7-Hole Embedded-Sensor Probes)

***Customization:***

Typical systems are described below. However, we are accustomed to accommodating requests from customers for customized probes and systems that will better suit their applications. If you don't see a probe or system option or capability that you require, please do not hesitate to ask Aeroprobes personnel about a custom system.

## Conventional Aeroprobe System

- 5/7-Hole Aeroprobes
- ATX Pressure Sensor Modules
- Time-Averaged Air Flows



**Standard Straight Aeroprobe with 1.6 mm (1/16") ProbeTip, Model PS5-C160-152**



**Standard Straight Aeroprobe with 3.2 mm (1/8") ProbeTip, Model PS5-C320-152**

**System Type:** Conventional

**General Application:** Measurement of Time-Averaged Air Flows with Total Angle  $< 70^\circ$

**Pressure Sensors:** ATX Pressure Sensor Module

**Flow Velocity Magnitude:** 5 – 320 m/s (Full Scale)

**Bandwidth:** Low,  $< 25$  Hz Typical

**Accuracy:**  $\pm 0.4^\circ$  Flow Angles,  $\pm 0.8\%$  Velocity Magnitude

**Description:** Conventional 5/7-Hole Aeroprobe connected to AP3KTX pressure sensor module via pneumatic tubing ( $> 1$  m typical). Laptop or desktop CPU with AeroAcquire allows user-defined pressure data acquisition. AeroAcquire integrates Multiprobe to allow pressure-to-velocity reduction, and AeroMove to allow control of probe positioning with traversing system.

## Conventional 5/7-Hole Aeroprobe & AP3KTX Sensor System Specifications:

<b>Recommended System Function:</b>	Pressure Data Acquisition for Investigation of Time-Averaged Flow Variables, with Integrated P-V Reduction (Multiprobe) and Probe Positioning (AeroMove)		<b>Probe Capabilities**:</b>	<b>Probe Types:</b> 5-Hole & 7-Hole Aeroprobes (Straight, L-Shaped and Cobra Geometries)
<b>Software Interface &amp; Integration:</b>	AeroAcquire Data Acquisition Software (External DAQ Board with Ethernet Interface); Integrated ARC DLL, Multiprobe DLL, AeroMove DLL (Each Sold Separately);			<b>Probe Tip Diameter:</b> 3.2 mm Standard, 1.6 mm & 6.35 mm Optional.
<b>Triggering:</b>	Software, Manual, External TTL			<b>Max. Resolvable Cone Angle:</b> 60° (5-Hole), 70° (7-Hole)
<b>DAQ Modes:</b>	Automatic and Manual Grid Acquisition w/ User Defined Grids; Time-Series Data, Averaged Data, Continuous with Real-Time Display			<b>Accuracy:</b> ±0.4° Flow Angles, ±0.8% Velocity Magnitude*
<b>DAQ Frequency:</b>	300 kHz, Maximum Total Throughput;			<b>Spatial Resolution:</b> 0.8 mm (1.6 mm Tip), 1.6 mm (3.2 mm Tip), 3.2 mm (6.35 mm Tip)
<b>Traversing System Interface &amp; Integration:</b>	Communicate to Motor Controllers via RS232 (AP3KM) or Ethernet (AP4KM); 1, 2 or 3-axis Traversing System Support			<b>* With Use of Multiprobe Reduction, Aeroprobe Calibrations</b>
<b>AP3KTX Pressure Sensor Module Ranges:</b>  (Custom Ranges Available Upon Request)	<b>Differential Pressure Range (psi / kPa):</b>	<b>Max Flow Speed, Sea Level Ambient = Total Pressure (m/s, Air):</b>	<b>Number of Probes Supported:</b>	Up to 5 Standard for Rake Implementation, Additional Probe Support on Request
	±0.009 / 0.062	10	<b>Aeroprobe, Tubing and Sensor System Bandwidth:</b>	<ul style="list-style-type: none"> <li>• Less than 25 Hz, Typical</li> <li>• Less than 500 Hz for Custom Systems with Requested Acoustic Calibrations</li> </ul>
	±0.018 / 0.124	15		
	±0.036 / 0.250	20	<b>System Output:</b>	ACSII Text Files Containing Time-Series of Pressure/Velocity; Averaged Pressure/Velocity vs. Probe Position
	±0.072 / 0.500	30		
	±0.18 / 1.245	45		
	±0.36 / 2.49	65		
	±0.72 / 4.98	95		
	±1 / 6.9	110		
	±2 / 13.8	155		
	±5 / 34.5	260		
±10 / 68.9	400			
±15 / 103.4	N/A	<b>Output Format:</b>	Various Tab-Separated Text-File Formats (see Aeroprobe File Formats Document for More Information); Data Export to TecPlot File Format	
<b>Probe/Sensor Calibration &amp; Integration:</b>	<b>Aeroprobes:</b>		<b>Sensor Specs**:</b>	<b>Pressure Sensors:</b> <ul style="list-style-type: none"> <li>• 1-5 V, Single-Ended</li> <li>• ±0.75% Accurate with Sensor Zeroing</li> </ul> <b>External Channels:</b> 0-5 V, Single Ended  <b>**See AP3KTX Pressure Sensor Module Manual for More Info</b>
	<ul style="list-style-type: none"> <li>• Multiple Probe Calibrations, as Required, for Input to Multiprobe</li> <li>• Available Range 5-320 m/s</li> </ul>			
	<b>Pressure Sensors:</b> <ul style="list-style-type: none"> <li>• NIST Traceable Calibrations for Input to AeroAcquire</li> <li>• Optional Calibration vs. Temperature (-30°C – 200°C)</li> <li>• AeroAcquire Provides Sensor Zeroing Option</li> </ul>			
<b>Integrated Thermocouples (Option):</b>		<b>PC System Requirements:</b>	Ethernet Capable, 100 MB Hard Drive, 256 MB RAM, Laptop or Desktop	
Voltage vs. Temperature for Input to AeroAcquire (-30°C – 200°C), 3.2+ mm Tips Only		<b>PC Operating Systems:</b>	Windows 95/98/2000/XP, Windows DLL	

## Conventional Omniprobe System

- 12-Hole Omniprobes

- ATX Pressure Sensor Modules



### Standard Omniprobe Model PS12-S953-152

**System Type:** Conventional

**General Application:** Measurement of Time-Averaged Air Flows with Total Angle  $< 160^\circ$

**Pressure Sensors:** ATX Pressure Sensor Module

**Flow Velocity Magnitude:** 5 – 320 m/s (Full Scale)

**Bandwidth:** Low,  $< 25$  Hz Typical

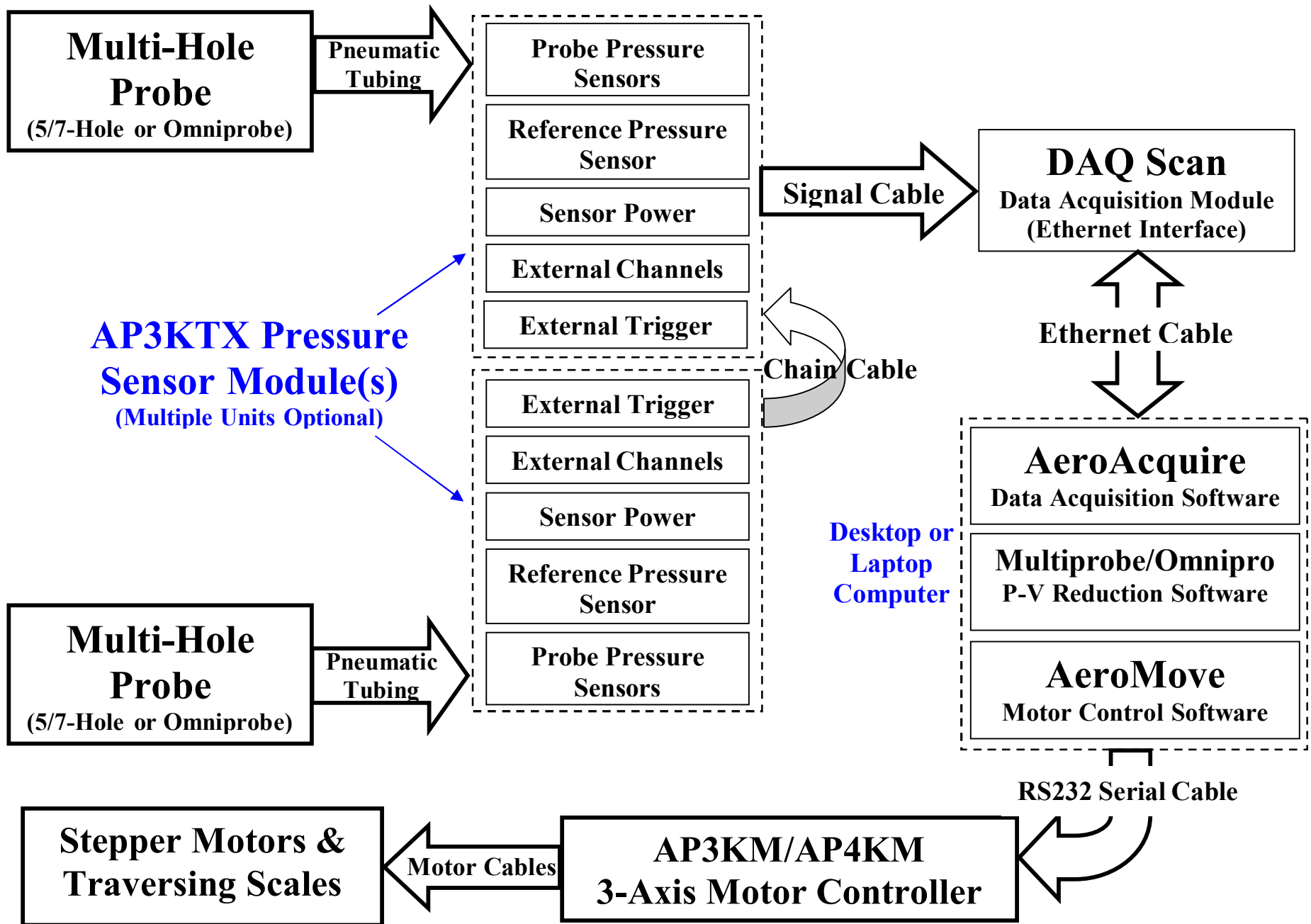
**Accuracy:**  $\pm 0.4^\circ$  Flow Angles,  $\pm 0.8\%$  Velocity Magnitude

**Description:** 12-Hole Omniprobe connected to AP3KTX pressure sensor module via pneumatic tubing ( $> 1$  m typical). Laptop or desktop CPU with AeroAcquire allows user-defined pressure data acquisition. AeroAcquire integrates Omniprobe to allow pressure-to-velocity reduction, and AeroMove to allow control of probe positioning with traversing system.

## 12-Hole Omniprobe & AP3KTX Sensor System Specifications:

<b>Recommended System Function:</b>	Pressure Data Acquisition for Investigation of Time-Averaged Air Flow Variables, with Integrated P-V Reduction (Omnipro) and Probe Positioning (AeroMove)		<b>Probe Capabilities**:</b>	<p><b>Probe Types:</b> 12-Hole &amp; 18-Hole<sup>†</sup> Omniprobes (Straight &amp; L-Shaped Geometries)</p> <p><b>Probe Tip Diameter:</b> 9.53 mm Standard, 6.35 mm Optional.</p> <p><b>Max. Resolvable Cone Angle:</b> 160°, Straight Omniprobe 150°, L-Shaped Omniprobe</p> <p><b>Accuracy:</b> ±0.4° Flow Angles, ±0.8% Velocity Magnitude*</p> <p><b>Spatial Resolution:</b> 3.2 mm (6.35 mm Tip), 4.75 mm (9.53 mm Tip)</p> <p><sup>†</sup> New 12-Hole Omniprobes Will Be Sold Starting 1/1/07, Existing 18-Hole Omniprobes Will Still Be Supported * With Use of Omnipro Reduction, Aeroprobes Calibrations **See Conventional Omniprobe Specifications for More Info</p>
<b>Software Interface &amp; Integration:</b>	AeroAcquire Data Acquisition Software (External DAQ Board with Ethernet Interface); Integrated ARC DLL, Omnipro DLL, AeroMove DLL (Each Sold Separately);			
<b>Triggering:</b>	Software, Manual, External TTL			
<b>DAQ Modes:</b>	Automatic and Manual Grid Acquisition w/ User Defined Grids; Time-Series Data, Averaged Data, Continuous with Real-Time Display			
<b>DAQ Frequency:</b>	300 kHz, Maximum Total Throughput;			
<b>Traversing System Interface &amp; Integration:</b>	Communicate to Motor Controllers via RS232 (AP3KM) or Ethernet (AP4KM); 1, 2 or 3-axis Traversing System Support			
<b>AP3KTX Pressure Sensor Module Ranges:</b>  (Custom Ranges Available Upon Request)	<b>Differential Pressure Range (psi / kPa):</b>	<b>Max Flow Speed, Sea Level Ambient = Total Pressure (m/s, Air):</b>	<b>Number of Probes Supported:</b>	Up to 5 for Rake Implementation, Additional Probe Support on Request
	±0.009 / 0.062	10	<b>Omniprobe, Tubing and Sensor System Bandwidth:</b>	<ul style="list-style-type: none"> <li>• Less than 25 Hz, Typical</li> <li>• Less than 200 Hz for Custom Systems with Requested Acoustic Calibrations</li> </ul>
	±0.018 / 0.124	15		
	±0.036 / 0.250	20		
	±0.072 / 0.500	30	<b>System Output:</b>	ACSII Text Files Containing Time-Series of Pressure/Velocity; Averaged Pressure/Velocity vs. Probe Position
	±0.18 / 1.245	45		
	±0.36 / 2.49	65		
	±0.72 / 4.98	95		
	±1 / 6.9	110		
	±2 / 13.8	155		
	±5 / 34.5	260		
±10 / 68.9	400	<b>Output Format:</b>	Various Tab-Separated Text-File Formats (see Aeroprobes File Formats Document for More Information); Data Export to TecPlot File Format	
±15 / 103.4	N/A			
<b>Probe/Sensor Calibration &amp; Integration:</b>	<p><b>Aeroprobes:</b></p> <ul style="list-style-type: none"> <li>• Multiple Probe Calibrations, as Required, for Input to Omnipro</li> <li>• Available Range 5-320 m/s</li> </ul>		<b>Sensor Specs**:</b>	<p><b>Pressure Sensors:</b></p> <ul style="list-style-type: none"> <li>• 1-5 V, Single-Ended</li> <li>• ±0.75% Accurate with Sensor Zeroing</li> </ul> <p><b>External Channels:</b> 0-5 V, Single Ended</p> <p><b>**See AP3KTX Pressure Sensor Module Manual for More Info</b></p>
	<p><b>Pressure Sensors:</b></p> <ul style="list-style-type: none"> <li>• NIST Traceable Calibrations for Input to AeroAcquire</li> <li>• Optional Calibration vs. Temperature (-30°C – 200°C)</li> <li>• AeroAcquire Provides Sensor Zeroing Option</li> </ul>			
<b>PC Operating Systems:</b>	Windows 95/98/2000/XP, Windows DLL		<b>PC System Requirements:</b>	Ethernet Capable, 100 MB Hard Drive, 256 MB RAM, Laptop or Desktop

# Multi-Hole Probe Data Acquisition System – AP3KTX Pressure Sensor Module



## Conventional Aeroprobe System for Multimedia Applications

- 5/7-Hole Aeroprobes
- DK Series Pressure Sensor Modules
- Time-Averaged Flows in Water and Air



**System Type:** Conventional

**General Application:** Measurement of Time-Averaged Air Flows with Total Angle  $< 160^\circ$

**Pressure Sensors:** ATX Pressure Sensor Module

**Flow Velocity Magnitude:** 5 – 320 m/s (Full Scale)

**Bandwidth:** Low,  $< 25$  Hz Typical

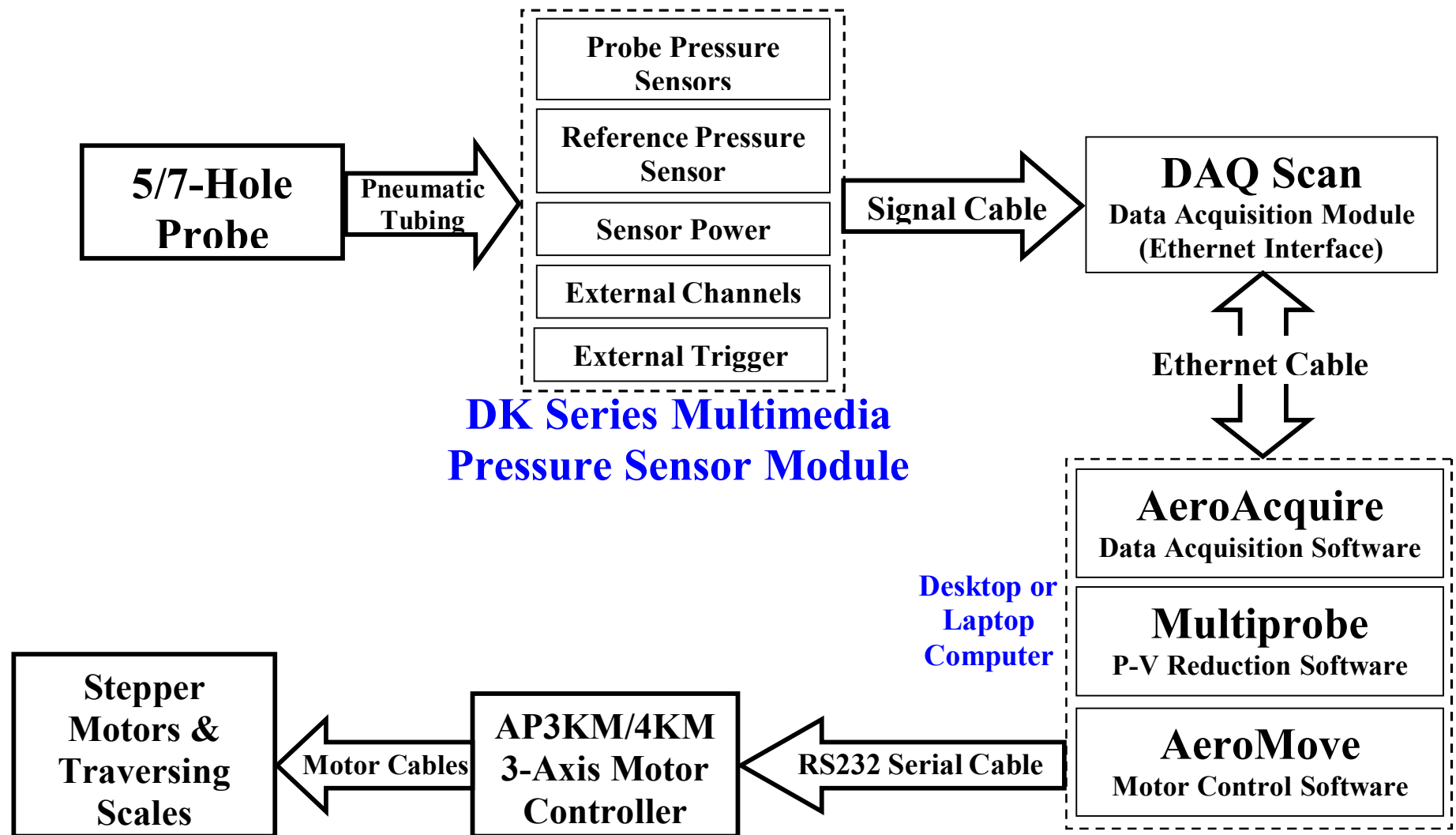
**Accuracy:**  $\pm 0.4^\circ$  Flow Angles,  $\pm 0.8\%$  Velocity Magnitude

**Description:** 12-Hole Omniprobe connected to AP3KTX pressure sensor module via pneumatic tubing ( $> 1$  m typical). Laptop or desktop CPU with AeroAcquire allows user-defined pressure data acquisition. AeroAcquire integrates Omnipro to allow pressure-to-velocity reduction, and AeroMove to allow control of probe positioning with traversing system.

**Conventional 5/7-Hole Aeroprobe & DK-Series  
Multimedia Pressure Sensor System Specifications:**

<b>Recommended System Function:</b>	Pressure Data Acquisition for Investigation of Time-Averaged Air/Water Flow Variables, with Integrated P-V Reduction (Multiprobe) and Probe Positioning (AeroMove)			<b>Probe Capabilities**:</b>	<b>Probe Types:</b> 5-Hole & 7-Hole Aeroprobes (Straight, L-Shaped and Cobra Geometries)
<b>Software Interface &amp; Integration:</b>	AeroAcquire Data Acquisition Software (External DAQ Board with Ethernet Interface); Integrated ARC DLL, Multiprobe DLL, AeroMove DLL (Each Sold Separately);				<b>Probe Tip Diameter:</b> 6.35 mm or Larger Recommended for Water Flows, 3.2 mm Optional.
<b>Triggering:</b>	Software, Manual, External TTL				<b>Max. Resolvable Cone Angle:</b> 60° (5-Hole), 70° (7-Hole)
<b>DAQ Modes:</b>	Automatic and Manual Grid Acquisition w/ User Defined Grids; Time-Series Data, Averaged Data, Continuous with Real-Time Display				<b>Accuracy:</b> ±0.4° Flow Angles, ±0.8% Velocity Magnitude*
<b>DAQ Frequency:</b>	300 kHz, Maximum Total Throughput;				<b>Spatial Resolution:</b> 1.6 mm (3.2 mm Tip), 3.2 mm (6.35 mm Tip)
<b>Traversing System Interface &amp; Integration:</b>	Communicate to Motor Controllers via RS232 (AP3KM) or Ethernet (AP4KM); 1, 2 or 3-axis Traversing System Support				<b>* With Use of Multiprobe Reduction, Aeroprobe Calibrations</b>  <b>**See Conventional Aeroprobe Specifications for More Info</b>
<b>DK Series Multi-media Pressure Sensor Module Ranges*:</b>  <b>(Custom Ranges Available Upon Request, See Water System Document for More Info)</b>	<b>Gauge Pressure Range* (psi / kPa)</b>	<b>Max Flow Speed, Gauge Pressure = P<sub>s</sub> (m/s, Air)</b>	<b>Max Flow Speed, Depth = 0 (m/s, H<sub>2</sub>O)*</b>	<b>Number of Probes Supported:</b>	Up to 5 Probes (for Rake Implementation), Additional Probe Support on Request
	1 / 6.90	113	3.7	<b>Aeroprobe, Tubing and Sensor System Bandwidth:</b>	<ul style="list-style-type: none"> <li>• Less than 25 Hz, Typical</li> <li>• Up to 1 kHz for Custom Systems with Rigid Tubing</li> </ul>
	2.5 / 17.2	182	5.9		
	5 / 34.5	268	8.3		
	10 / 69.0	-	11.7		
	15 / 103.5	-	14.4		
*Since the Proper Ranging of the Sensors for the Water Systems Depends on the Maximum Depth of the Probe as Well as the Reference Pressure of the Sensors, Aeroprobe Prefers to Recommend Sensor Ranges for Water Systems			<b>System Output:</b>	ASCII Text Files Containing Time-Series of Pressure/Velocity; Averaged Pressure/Velocity vs. Probe Position	
			<b>Output Format:</b>	Various Tab-Separated Text-File Formats (see Aeroprobe File Formats Document for More Information); Data Export to TecPlot File Format	
<b>Probe/Sensor Calibration &amp; Integration:</b>	<b>Aeroprobes:</b> <ul style="list-style-type: none"> <li>• Multiple Probe Calibrations, as Required, for Input to Multiprobe</li> </ul>			<b>Pressure Sensor/Input Specs**:</b>	<b>Pressure Sensor Output:</b> <ul style="list-style-type: none"> <li>• 1-5 V DC, Single-Ended, 0.25% Sensors</li> <li>• 0-2 V DC, Single Ended, 0.08% Sensors</li> </ul>
	<b>Available Speed Range:</b> <ul style="list-style-type: none"> <li>• 5-320 m/s, Air</li> <li>• 0-6 m/s, Water</li> </ul> <b>Pressure Sensors:</b> <ul style="list-style-type: none"> <li>• NIST Traceable Calibrations for Input to AeroAcquire</li> <li>• Optional Calibration vs. Temperature (-30°C – 200°C)</li> <li>• AeroAcquire Provides Sensor Zeroing Option</li> </ul>				<b>Pressure Sensor Accuracy:</b> <ul style="list-style-type: none"> <li>• ±0.25% or ±0.08% Accurate with Sensor Zeroing (±0.04% Optional)</li> </ul> <b>External Channels:</b> 0-5 V, Single Ended  <b>**See DK-Series Pressure Sensor Module Manual for More Info</b>
<b>PC Operating Systems:</b>	Windows 95/98/2000/XP, Windows DLL			<b>PC System Requirements:</b>	Ethernet Capable, 100 MB Hard Drive, 256 MB RAM, Laptop or Desktop

# Multi-Hole Probe Data Acquisition System – Multimedia Pressure Sensors



## Fast-Response Aeroprobe Systems

- 5/7-Hole Fast-Response Aeroprobes
- Embedded Sensors
- Unsteady Air Flow Applications
- AP3KAX Sensor Amplifier



**Aeroprobe Fast-Response Probe Model FRPS7-C160-152 (w/Calibration Mount)**

**System Type:** Fast-Response

**General Application:** Measurement of Unsteady Air Flows with Total Angle  $< 70^\circ$

**Pressure Sensors:** Embedded, Unamplified with AP3KAX Dedicated Sensor Amplifier

**Flow Velocity Magnitude:** Flows with Dynamic Pressure  $> 0.1$  psi (690 Pa), Full Scale

**Bandwidth:** 2.5 kHz Typical for 1.6 mm Probe Tips, 4.5 kHz Typical for 3.2 mm Probe Tips

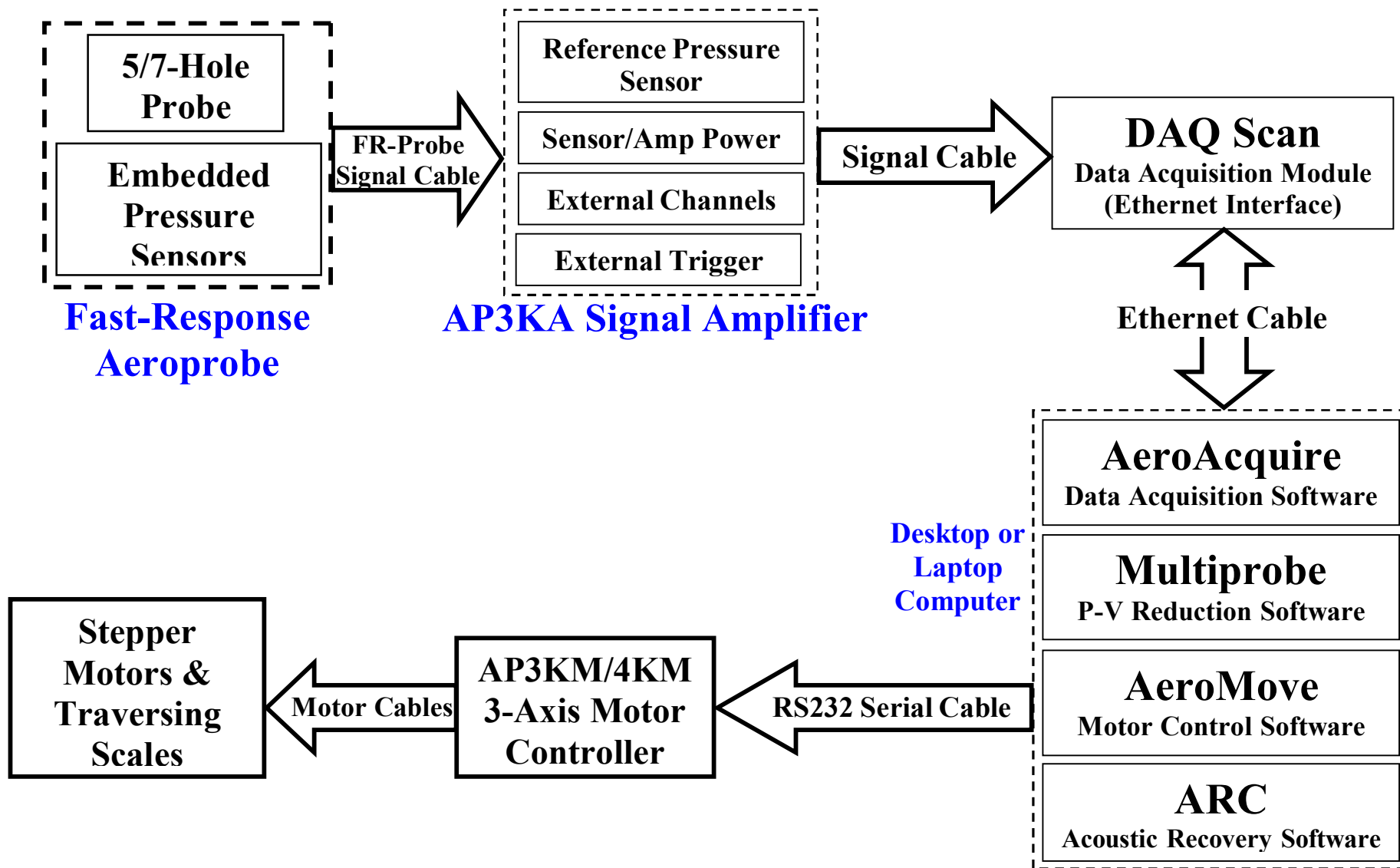
**Accuracy:**  $\pm 0.4^\circ$  Flow Angles,  $\pm 0.8\%$  Velocity Magnitude

**Description:** A fast-response 5/7-hole probe is employed, with calibrated probe tip, pressure sensors and acoustic response. The outputs from the probe are voltages corresponding to the port pressures. These are amplified by the AP3KAX Sensor Amplifier, providing signals to the data acquisition system. AeroAcquire enables the user to acquire the probe signals, manipulate the time-series of pressures to account for the acoustic attenuation/amplification due to the probe pneumatics (by integration of the ARC software), and perform the reduction to velocity magnitude and flow angles (by integration of the Multiprobe software). Through the use of the AeroAcquire, AeroMove software and a traversing system, the user can define a positional grid, automatically traverse the probe to the defined positions and acquire unsteady pressure data at each location.

## Fast-Response Aeroprobe & AP3KAX System Specifications:

<b>Recommended System Function:</b>	Pressure Data Acquisition via AeroAcquire for Investigation of Unsteady Air Flows, with Acoustic Recovery (ARC), P-V Reduction (Multiprobe) and Probe Positioning (AeroMove)		<b>Probe Capabilities**:</b>	<b>Probe Types:</b> 5-Hole & 7-Hole Aeroprobes (Straight, L-Shaped and Cobra Geometries)	
<b>Software Interface &amp; Integration:</b>	AeroAcquire Data Acquisition Software (External DAQ Board with Ethernet Interface); Integrated ARC DLL, Multiprobe DLL, AeroMove DLL (Each Sold Separately);			<b>Probe Tip Diameter:</b> 3.2 mm Standard, 1.6 mm & 6.35 mm Optional.	
<b>Triggering:</b>	Software, Manual, External TTL			<b>Max. Resolvable Cone Angle:</b> 60° (5-Hole), 70° (7-Hole)	
<b>DAQ Modes:</b>	Automatic and Manual Grid Acquisition w/ User Defined Grids; Time-Series Data, Averaged Data, Continuous with Real-Time Display			<b>Accuracy:</b> ±0.4° Flow Angles, ±0.8% Velocity Magnitude*	
<b>DAQ Frequency:</b>	300 kHz, Maximum Total Throughput;			<b>Spatial Resolution:</b> 0.8 mm (1.6 mm Tip), 1.6 mm (3.2 mm Tip), 3.2 mm (6.35 mm Tip)	
<b>Traversing System Interface &amp; Integration:</b>	Communicate to Motor Controllers via RS232 (AP3KM) or Ethernet (AP4KM); 1, 2 or 3-axis Traversing System Support			<b>* With Use of Multiprobe Reduction, Aeroprobe Calibrations</b>	
				<b>**See Fast-Response Aeroprobe Specifications for More Info</b>	
	<b>Differential Pressure Range (psi / kPa):</b>	<b>Max Flow Speed, Sea Level Ambient = Total Pressure (m/s, Air):</b>	<b>Number of Probes Supported:</b>	Up to 5 Standard for Rake Implementation, Additional Probe Support on Request	
<b>Embedded Pressure Sensor Ranges:</b>	±1 / 6.9	110	<b>Aeroprobe, Tubing and Sensor System Bandwidth:</b>	<ul style="list-style-type: none"> <li>• 2.5 kHz Typical, 1.6 mm Probe Tip</li> <li>• 4.5 khz Typical, 4.5 mm Probe Tip</li> </ul>	
	±2 / 13.8	155			
	±5 / 34.5	260			
	±10 / 68.9	400			
	±15 / 103.4	N/A			
<b>Probe Temperature Compensated Range:</b>	-30°C to +93°C (0°F to +200°F)		<b>System Output:</b>	ACSII Text Files Containing Time-Series of Pressure/Velocity; Averaged Pressure/Velocity vs. Probe Position	
	Custom Compensation Available Upon Request		<b>Output Format:</b>	Various Tab-Separated Text-File Formats (see Aeroprobe File Formats Document for More Information); Data Export to TecPlot File Format	
<b>Probe/Sensor Calibration &amp; Integration:</b>	<b>Aeroprobes:</b>		<b>Sensor Specs**:</b>	<b>Pressure Sensors:</b>	
	<ul style="list-style-type: none"> <li>• Multiple Probe Calibrations, as Required, for Input to Multiprobe</li> <li>• Available Range 5-320 m/s</li> </ul>				<ul style="list-style-type: none"> <li>• 1-5 V, Single-Ended</li> <li>• ±0.75% Accurate with Sensor Zeroing</li> </ul>
	<b>Pressure Sensors:</b>				
<ul style="list-style-type: none"> <li>• NIST Traceable Calibrations for Input to AeroAcquire</li> <li>• AeroAcquire Provides Sensor Zeroing Option</li> </ul>		<b>**See AP3KTAX Pressure Sensor Module Manual and Sensor Specifications for More Info</b>			
	<b>Integrated Thermocouples (Option):</b>		<b>PC System Requirements:</b>	Ethernet Capable, 100 MB Hard Drive, 256 MB RAM, Laptop or Desktop	
	Voltage vs. Temperature for Input to AeroAcquire (-30°C – 200°C), 3.2+ mm Probe Tips Only		<b>PC Operating Systems:</b>	Windows 95/98/2000/XP, Windows DLL	

# Fast-Response Multi-Hole Probe Data Acquisition System – Embedded Sensors



## Conventional Aeroprobe Systems

- 5/7-Hole Aeroprobes
- Pressure Scanners
- Time-Averaged Air Flows



**Aeroprobe System with Conventional Probe and Pressure Scanner**

**System Type:** Conventional

**General Application:** Measurement of Time-Averaged Air Flows with Total Angle  $< 70^\circ$

**Pressure Sensors:** 16-Channel, 32-Channel, or 64-Channel Pressure Scanners

**Flow Velocity Magnitude:** 5 – 320 m/s (Full Scale)

**Bandwidth:** Low,  $< 25$  Hz Typical

**Accuracy:**  $\pm 0.4^\circ$  Flow Angles,  $\pm 0.8\%$  Velocity Magnitude

**Description:** A conventional 5/7-Hole Aeroprobe is connected to pressure scanner via pneumatic tubing ( $> 1$  m typical). The AP3KE Scanner Support Module interfaces the internally multiplexed scanner bank to the data acquisition, providing I/O signal conditioning and auto-calibration (pressure standard sold separately) and auto-zeroing capability. Up to four pressure scanners can be simultaneously supported. Laptop or desktop CPU with AeroAcquire allows user-defined pressure data acquisition. AeroAcquire integrates Multiprobe to allow pressure-to-velocity reduction, and AeroMove to allow control of probe positioning with traversing system.

## Conventional 5/7-Hole Aeroprobe & AP3KE Scanner System Specifications:

<b>Recommended System Function:</b>	Pressure Data Acquisition for Investigation of Time-Averaged Flow Variables, with Integrated P-V Reduction (Multiprobe) and Probe Positioning (AeroMove)		<b>Probe Capabilities**:</b>	<p><b>Probe Types:</b> 5-Hole &amp; 7-Hole Aeroprobes (Straight, L-Shaped and Cobra Geometries)</p> <p><b>Probe Tip Diameter:</b> 3.2 mm Standard, 1.6 mm &amp; 6.35 mm Optional.</p> <p><b>Max. Resolvable Cone Angle:</b> 60° (5-Hole), 70° (7-Hole)</p> <p><b>Accuracy:</b> ±0.4° Flow Angles, ±0.8% Velocity Magnitude*</p> <p><b>Spatial Resolution:</b> 0.8 mm (1.6 mm Tip), 1.6 mm (3.2 mm Tip), 3.2 mm (6.35 mm Tip)</p> <p><b>* With Use of Multiprobe Reduction, Aeroprobe Calibrations</b></p> <p><b>**See Conventional Aeroprobe Specifications for More Info</b></p>
<b>Software Interface &amp; Integration:</b>	AeroAcquire Data Acquisition Software (PCI Data Acquisition Board); Integrated Multiprobe DLL, AeroMove DLL (Each Sold Separately);			
<b>Triggering:</b>	Software, Manual, External TTL			
<b>DAQ Modes:</b>	Automatic and Manual Grid Acquisition w/ User Defined Grids; Time-Series Data, Averaged Data, Continuous with Real-Time Display			
<b>DAQ Frequency:</b>	300 kHz, Maximum Total Throughput;			
<b>Traversing System Interface &amp; Integration:</b>	Communicate to Motor Controllers via RS232 (AP3KM) or Ethernet (AP4KM); 1, 2 or 3-axis Traversing System Support			
	<b>Differential Pressure Range (psi / kPa):</b>	<b>Max Flow Speed, Sea Level Ambient = Total Pressure (m/s, Air):</b>	<b>Number of Probes Supported:</b>	Up to 5 Standard for Rake Implementation, Additional Probe Support on Request
<b>Pressure Scanner Ranges:</b>	±0.36 / 2.49	65	<b>Aeroprobe, Tubing and Sensor System Bandwidth:</b>	<ul style="list-style-type: none"> <li>• Less than 25 Hz, Typical</li> <li>• Less than 500 Hz for Custom Systems with Requested Acoustic Calibrations</li> </ul>
	±0.72 / 4.98	95		
	±1 / 6.9	110		
	±2 / 13.8	155	<b>System Output:</b>	ACSII Text Files Containing Time-Series of Pressure/Velocity; Averaged Pressure/Velocity vs. Probe Position
	±5 / 34.5	260		
	±10 / 68.9	400		
	±15 / 103.4	N/A		
<b>Probe/Sensor Calibration &amp; Integration:</b>	<p><b>Aeroprobes:</b></p> <ul style="list-style-type: none"> <li>• Multiple Probe Calibrations, as Required, for Input to Multiprobe</li> <li>• Available Range 5-320 m/s</li> </ul>		<b>Output Format:</b>	Various Tab-Separated Text-File Formats (see Aeroprobe File Formats Document for More Information); Data Export to TecPlot File Format
	<p><b>Pressure Sensors:</b></p> <ul style="list-style-type: none"> <li>• NIST Traceable Calibrations for Input to AeroAcquire</li> <li>• Optional Temperature Sense</li> <li>• Optional Scanner Heater</li> <li>• AeroAcquire and AutoCal Module (Optional) Provide <b>Automatic, In-Test</b> Sensor Zeroing and Calibration (Pressure Standard Required, Sold Separately) , User-Defined Intervals</li> </ul>		<b>Sensor Specs**:</b>	<p><b>Pressure Sensors:</b></p> <ul style="list-style-type: none"> <li>• ±5 V, Single-Ended</li> <li>• ±0.075% Accurate with Sensor Zeroing</li> </ul> <p><b>External Channels:</b> ±5 V, Single Ended</p> <p><b>**See Pressure Scanner Specification for More Information</b></p>
	<p><b>Integrated Thermocouples (Option):</b> Voltage vs. Temperature for Input to AeroAcquire (-30°C – 200°C), 3.2+ mm Tips Only</p>		<b>PC System Requirements:</b>	100 MB Hard Drive, 256 MB RAM, Desktop or Laptop w/Docking Station, 1 Free PCI Slot
		<b>PC Operating Systems:</b>	Windows 95/98/2000/XP, Windows DLL	

## Conventional Omniprobe Systems

- 12-Hole Omniprobes
- Pressure Scanners
- Time-Averaged Air Flows

**System Type:** Conventional

**General Application:** Measurement of Time-Averaged Air Flows with Total Angle  $< 160^\circ$

**Pressure Sensors:** 16-Channel, 32-Channel, or 64-Channel Pressure Scanners

**Flow Velocity Magnitude:** 5 – 320 m/s (Full Scale)

**Bandwidth:** Low,  $< 25$  Hz Typical

**Accuracy:**  $\pm 0.4^\circ$  Flow Angles,  $\pm 0.8\%$  Velocity Magnitude

**Description:** A conventional 12-Hole Omniprobe is connected to pressure scanner via pneumatic tubing ( $> 1$  m typical). The AP3KE Scanner Support Module interfaces the internally multiplexed scanner bank to the data acquisition, providing I/O signal conditioning and auto-calibration (pressure standard sold separately) and auto-zeroing capability. Up to four pressure scanners can be simultaneously supported. Desktop CPU with AeroAcquire allows user-defined pressure data acquisition. AeroAcquire integrates Omnipro to allow pressure-to-velocity reduction, and AeroMove to allow control of probe positioning with traversing system.

## 12/18-Hole Omniprobe & AP3KE Scanner System Specifications:

<b>Recommended System Function:</b>	Pressure Data Acquisition for Investigation of Time-Averaged Flow Variables, with Integrated P-V Reduction (Multiprobe) and Probe Positioning (AeroMove)		<b>Probe Capabilities**:</b>	<p><b>Probe Types:</b> 5-Hole &amp; 7-Hole Aeroprobes (Straight, L-Shaped and Cobra Geometries)</p> <p><b>Probe Tip Diameter:</b> 3.2 mm Standard, 1.6 mm &amp; 6.35 mm Optional.</p> <p><b>Max. Resolvable Cone Angle:</b> 60° (5-Hole), 70° (7-Hole)</p> <p><b>Accuracy:</b> ±0.4° Flow Angles, ±0.8% Velocity Magnitude*</p> <p><b>Spatial Resolution:</b> 0.8 mm (1.6 mm Tip), 1.6 mm (3.2 mm Tip), 3.2 mm (6.35 mm Tip)</p> <p><b>* With Use of Omnipro Reduction, Aeroprobe Calibrations</b></p> <p><b>**See Conventional Omniprobe Specifications for More Info</b></p>
<b>Software Interface &amp; Integration:</b>	AeroAcquire Data Acquisition Software (PCI Data Acquisition Board); Integrated Omnipro DLL, AeroMove DLL (Each Sold Separately);			
<b>Triggering:</b>	Software, Manual, External TTL			
<b>DAQ Modes:</b>	Automatic and Manual Grid Acquisition w/ User Defined Grids; Time-Series Data, Averaged Data, Continuous with Real-Time Display			
<b>DAQ Frequency:</b>	300 kHz, Maximum Total Throughput;			
<b>Traversing System Interface &amp; Integration:</b>	Communicate to Motor Controllers via RS232 (AP3KM) or Ethernet (AP4KM); 1, 2 or 3-axis Traversing System Support			
	<b>Differential Pressure Range (psi / kPa):</b>	<b>Max Flow Speed, Sea Level Ambient = Total Pressure (m/s, Air):</b>	<b>Number of Probes Supported:</b>	Up to 5 Standard for Rake Implementation, Additional Probe Support on Request
<b>Pressure Scanner Ranges:</b>	±0.36 / 2.49	65	<b>Aeroprobe, Tubing and Sensor System Bandwidth:</b>	<ul style="list-style-type: none"> <li>• Less than 25 Hz, Typical</li> <li>• Less than 200 Hz for Custom Systems with Requested Acoustic Calibrations</li> </ul>
	±0.72 / 4.98	95		
	±1 / 6.9	110		
	±2 / 13.8	155	<b>System Output:</b>	ACSII Text Files Containing Time-Series of Pressure/Velocity; Averaged Pressure/Velocity vs. Probe Position
	±5 / 34.5	260		
	±10 / 68.9	400		
	±15 / 103.4	N/A	<b>Output Format:</b>	Various Tab-Separated Text-File Formats (see Aeroprobe File Formats Document for More Information); Data Export to TecPlot File Format
<b>Probe/Sensor Calibration &amp; Integration:</b>	<b>Aeroprobes:</b> <ul style="list-style-type: none"> <li>• Multiple Probe Calibrations, as Required, for Input to Omnipro</li> <li>• Available Range 5-320 m/s</li> </ul>		<b>Sensor Specs**:</b>	<p><b>Pressure Sensors:</b></p> <ul style="list-style-type: none"> <li>• ±5 V, Single-Ended</li> <li>• ±0.075% Accurate with Sensor Zeroing</li> </ul> <p><b>External Channels:</b> ±5 V, Single Ended</p> <p><b>**See Pressure Scanner Specification for More Information</b></p>
	<b>Pressure Sensors:</b> <ul style="list-style-type: none"> <li>• NIST Traceable Calibrations for Input to AeroAcquire</li> <li>• Optional Temperature Sense</li> <li>• Optional Scanner Heater</li> <li>• AeroAcquire and AutoCal Module (Optional) Provide <b>Automatic, In-Test</b> Sensor Zeroing and Calibration (Pressure Standard Required, Sold Separately) , User-Defined Intervals</li> </ul>			
	<b>Integrated Thermocouples (Option):</b> Voltage vs. Temperature for Input to AeroAcquire (-30°C – 200°C), 3.2+ mm Tips Only			
			<b>PC System Requirements:</b>	100 MB Hard Drive, 256 MB RAM, Desktop or Laptop w/Docking Station, 1 Free PCI Slot
			<b>PC Operating Systems:</b>	Windows 95/98/2000/XP, Windows DLL

# Multi-Hole Probe Data Acquisition System – Pressure Scanners

