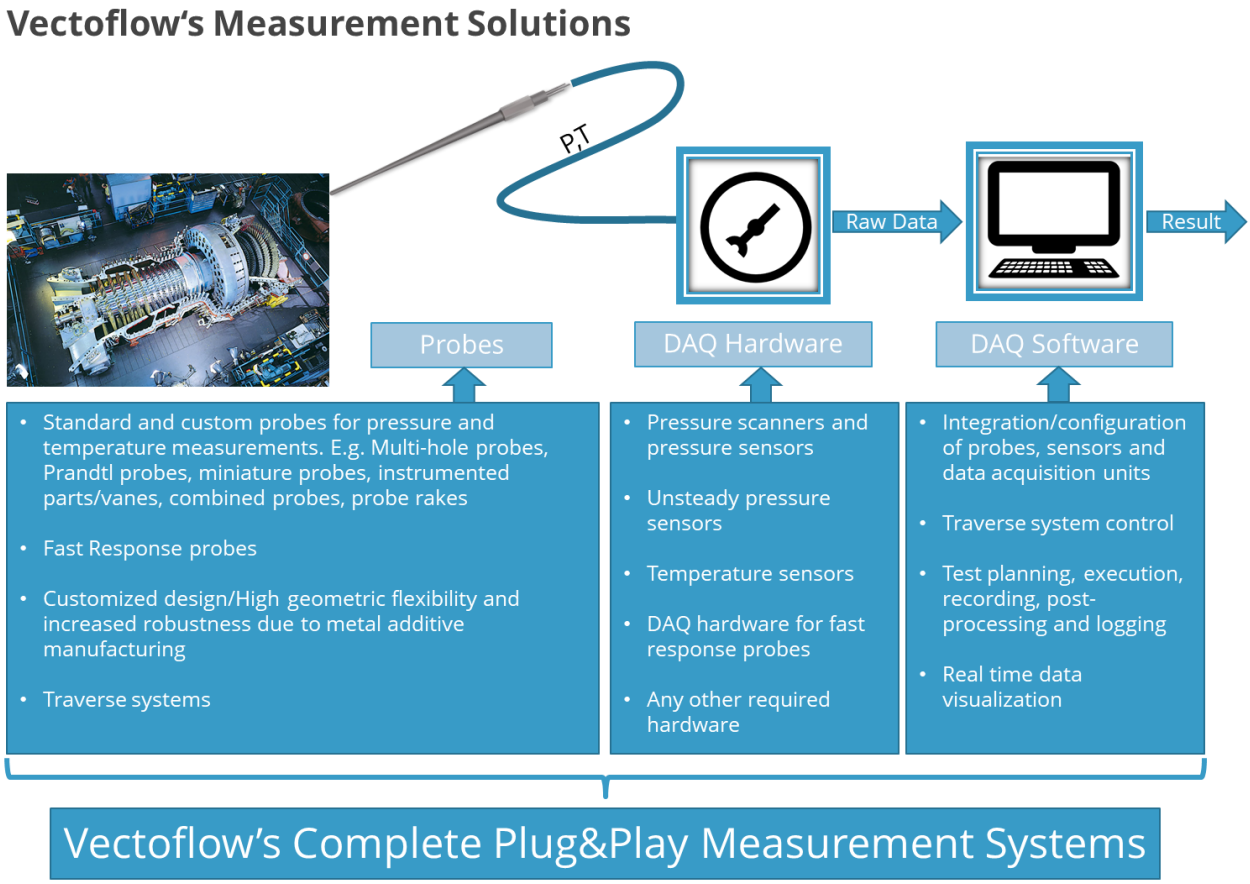

# Portfolio

Version 2019-07-25

Vectoflow GmbH

# Content

# 1 Overview




Who we are:

- Team of 10 professionals
- Profitable start-up with top tier customers
- Awarded company
- An innovative company

Customers:

- Companies around the world in 47 nations
- Top tier companies in the automotive, aviation and energy sector
- We jointly develop cutting edge measurement solutions with research institutes around the world
- We find solutions for almost every possible temperature, pressure and flow measurement task

Partners:

- Distributors around the world
- Research alliances to ensure future competitivity
- Various independent suppliers

# 2 Flow probes

## 2.1 Multi-hole Probes with Standard Geometries

Figure 1 Multi-hole Probes with Standard Geometries

Multi-hole probes are easy to install in your test set-up and enable the simultaneous measurement of pressure, velocity and the angle of attack for a flow. Vectoflow probes are available in standard geometries such as straight, L-shaped, cobra or custom geometries as well. The probe lengths, tip diameters and tip geometry can be adapted to your requirements. The one-piece design makes them very robust. We also offer probe calibration and software. We would be pleased to assist you with the selection of the most appropriate standard geometry for your application.

| | |
|---|---|
| Geometry | Straight, L-shaped, Cobra or Drilled Elbow |
| Number of pressure holes | 3, 5, or 7 |
| Max. length | Max. 250 mm (10 in.), for other lengths see "Custom multi-hole probes" |
| Tip diameter min. | 1.2 mm (standard 3 mm) |
| Tip geometry | Conical, hemi-spherical |
| Material | Stainless steel, titanium, inconel, plastics |
| Mounting method | Square, hexagonal, flattened cylinder |
| Connections | Standard 1.04 mm (0.040 in.) pressure tubes with bulge |
| Reference | Reference surface normal to z-axis |
| Temperature range | Up to 600°C (1100°F) |
| Angular measurement range | ± 70° (depending on number of holes) |
| Angular measurement accuracy | less than ± 1° |
| Velocity measurement range | 3 m/s (10 ft/s) up to Mach 2 |
| Velocity measurement accuracy | less than ± 1 m/s |
| Max. frequency resolution | Up to 50 Hz (depending on probe geometry, frequency calibration possible) |

Table 1 Specifications Multi-hole Probes with Standard Geometries

## 2.2 Custom Multi-hole Probes

Figure 2 Custom Multi-hole Probe

Do you have a special geometry in mind for a probe for a particular task or want to improve the quality of your measurement? Do you have components requiring a very complex inner channel structure that are not realizable with traditional manufacturing methods? Our innovative additive manufacturing method makes it possible to produce nearly any probe geometry or other component. Furthermore, products like thermocouples can be easily integrated into Vectoflow probes.

| | |
|---|---|
| Geometry | TBD by customer |
| Number of pressure holes | TBD by customer |
| Size | TBD by customer |
| Min. tip diameter | 1.2 mm |
| Tip geometry | TBD by customer |
| Material | Stainless steel, Titanium, Inconel, plastics |
| Mounting method | TBD by customer |
| Connections | TBD by customer |
| Reference | TBD by customer |
| Temperature range | Up to 1000°C (1800°F) |
| Angle measurement range | ± 160° (depending on number of holes) |
| Angle measurement accuracy | Less than ± 1° |
| Velocity measurement range | 3 m/s (10 ft/s) up to Mach 2.0 |
| Velocity measurement accuracy | Less than ± 1 m/s (3 ft/s) |
| Max. frequency resolution | Up to 50 Hz (dependent on probe geometry, frequency calibration possible) |

Table 2 Specifications Custom Multi-hole Probes

## 2.3 High Temperature Probes

Figure 3 High Temperature Probe

Did you ever want to measure temperatures and pressures at the exit of a combustion chamber? We have several solutions if you want to use our probes at higher temperatures. These probes are also based on an additive manufacturing process, providing the same advantages as with our other probes. Metal superalloys can be used at up to 1000° C (1800°F). If higher temperatures are required, ceramics such as silicon nitride (SiN) can be used, capable of temperatures up to 1800° C (3250°F). And as mentioned before, these highly customized solutions are made using additive manufacturing allowing for a high degree of customization.

| | |
|---|---|
| Number of measurement heads | TBD by customer |
| Number of holes in measurement head | 1, 3, 5, 7 or TBD by customer |
| Number temperature measurement heads | TBD by customer |
| Geometry | TBD by customer |
| Size | 250mm (10 in.) standard, custom lengths possible |
| Min. tip diameter | 3 mm (1/8") |
| Tip geometry | TBD by customer |
| Material | Ceramics, Inconel, high-temperature stainless steel |
| Mounting method | TBD by customer |
| Connections | TBD by customer |
| Temperature range | up to 1800°C (3250°F) |
| Angle measurement range | ± 70° (depending on number of holes) |
| Angle measurement accuracy | Less than ± 1° |
| Velocity measurement range | 3 m/s (10 ft/s) up to Mach 2 |
| Velocity measurement accuracy | Less than ± 1 m/s (3 ft/s) |
| Temperature measurement accuracy | Depending on thermocouple |
| Max. frequency resolution | Up to 50 Hz (depending on probe geometry, frequency calibration possible) |

Table 3 Specifications High Temperature Probes

## 2.4 Rakes for flow probes

Figure 4 Rake

All of our measurement heads (multi-hole probe, total or static pressure, temperature) can be combined in rakes, leading to a higher spatial resolution. Due to the integration of multi-hole heads into the rake, very high measurement accuracy is also available in these products and because of the additive manufacturing process, it is possible to install Vectoflow probes in applications requiring specialized and custom designs. As always, the rakes are very robust due to their one-piece design.

| | |
|---|---|
| Number of measurement heads | TBD by customer |
| Number of holes in measurement head | 1, 3, 5 or 7 |
| Size | 250mm (10 in.) standard, other lengths possible |
| Tip diameter min. | 1.2 mm (standard 3mm) |
| Geometry measurement head | Conical, spherical, TBD by customer |
| Material | Stainless steel, titanium, inconel, high-temperature stainless steel |
| Fixture | TBD by customer |
| Connections | TBD by customer |
| Reference | TBD by customer |
| Temperature range | up to 1000°C (1800°F) |
| Angle measurement range | ± 70° (depending on number of holes) |
| Angle measurement accuracy | less than ± 1° |
| Velocity measurement range | 3 m/s up (10 ft/s) to Mach 2 |
| Velocity measurement accuracy | less than ± 1 m/s (3 ft/s) |
| Resolvable frequency max | Up to 50 Hz (depending on probe geometry, frequency calibration possible) |

Table 4 Specifications Rakes

## 2.5 Omniprobe

Figure 5 Omniprobe

The 14-hole omnidirectional probe from Vectoflow allows the measurement of flow angles up to 160°. This probe is especially made for measurement tasks, where the angle of attack is unknown, or even reverse flow is expected. Like all probes from Vectoflow, also the 14-hole probe is made by additive manufacturing, giving a high geometrical flexibility and a very high robustness at the same time.

| | |
|---|---|
| Geometry | Straight, L-Shaped |
| Number of holes | 14 |
| Min. tip diameter | >5 mm (10 mm standard) |
| Material | Stainless steel, titanium, Inconel |
| Fastening | Square, hexagonal, one-sided flatened cylinder or custom |
| Connections | Standard 1 mm pressure tubes |
| Reference | Reference surface normal to Z axis |
| Temperature range | up to 600°C |
| Angular range | ± 160° |
| Velocity range | 3 m/s to Mach 0.95 |
| Velocity accuracy | <±1m/s |

Table 5 Specifications Omniprobe

## 2.6 Pitot/Prandtl-probes

Figure 6 Pitot/Prandtl-probes

Total pressure and Prandtl probes are available in 4 different standard geometries: L-shaped, Straight, Cobra or Drilled Elbow. Our pitot probes are constructed as one-piece and therefore very robust, and can be individually customized to fit your application. As with all of our probes, a range of materials is available including stainless steel, titanium and others.

| | |
|---|---|
| Size | 250 mm (10 in.) standard, custom lengths possible |
| Min. tip diameter | 0.5 mm |
| Head geometry | Elliptical, or TBD by customer |
| Material | Stainless steel, titanium, inconel, high-temperature stainless steel |
| Mounting method | Square, hexagonal, flattened cylinder or TBD by customer |
| Connections | Standard 1.04mm (0.040 in.) pressure tubes with bulge |
| Temperature range | up to 1000°C (1800°F) |

Table 6 Specifications Pitot/Prandtl-probes

## 2.7 Kiel probes

Figure 7 Kiel probes

Kiel pressure probes are especially designed to measure the total pressure of a flow in case of a non-zero angle of attack, where with our design, the total pressure can be measured within an angle range of ± 60°. We manufacture Kiel probes as individual items or as rakes. With our additive manufacturing process, we are able to offer a high degree of individuality of Vectoflow probes to our customers.

| | |
|---|---|
| Size | 280mm, other length possible |
| Tip diameter min. | depending on the design |
| Material | stainless steel, titanium, inconel, high-temperature stainless steel |
| Fixture | tbd by customer |
| Connections | tbd by customer |
| Angle range/ Temperature range with less than 1° deviation of measured total temperature to real total temperature/td> | ± 60° |
| Velocity range | up to Mach 2 |
| Temperature range | up to 1000°C |

Table 7 Specifications Kiel probes

# 3 Fast Response Measurement Systems


Figure 9 Fast Response Measurement System

Unsteady probes from Vectoflow make it possible to measure high-frequency flow phenomena in the kHz range and not just in terms of a single measured parameter. All flow parameters normally measurable with a conventional multi-hole probe can be captured, such as velocities, flow angles, total and static pressure, Mach number and density. In order to achieve this high temporal resolution, the pressure sensors are placed as close as possible to the probe head minimizing the attenuation and modulation of the pressure fluctuations in amplitude and phase. The remaining modulation of the pressure signal is corrected by calibration at Vectoflow with a specially developed frequency calibration rig. Of course, all of the advantages of the Vectoflow conventional probes are also available to the customers for the unsteady probes due to our proprietary additive manufacturing process. The geometry of the probe can be fully customized and the one-piece construction of the probe head makes it very robust.

- Complete measurement system for unsteady flow phenomena
- Probes with embedded pressure sensors (high frequency response)
- Conventional probes with high frequency response sensors attached outside of the probe are also available
- Frequency calibration of each pressure channel
- Hardware for data acquisition
- Software for data post-processing

| | |
|---|---|
| Geometry | Straight, L-shaped, Cobra or Drilled Elbow |
| Number of pressure holes | Custom (5-hole is standard) |
| Max. length | Custom |
| Min. tip diameter | Standard 3-4 mm (down to 1.0 mm with Micro-Printing techniques) |
| Shaft Diameter | 15 mm (standard) |
| Tip geometry | Conical, hemi-spherical or custom |
| Material | Stainless steel, titanium, inconel, plastics |
| Mounting method | Square, hexagonal, one-sided flattened cylinder or custom |
| Pressure sensors | per customer request (>1PSIG) |
| Reference | Reference surface normal to z-axis |
| Acquisition Hardware | 2x NI 9237; 1x cDAQ 9181 (Chassis); or custom |
| Acquisition & Postprocessing Software | Included (Labview based) |
| Temperature range | up to 100°C (up to 210°F) (higher with water cooling) |
| Angle range | ± 60° (depending on number of holes) |
| Angle accuracy | less than ± 1° |
| Velocity range | 3 m/s (10 ft/s) up to Mach 1 |
| Velocity accuracy | less than ± 1 m/s (3 ft/s) |

Table 9 Specifications Fast Response Measurement Systems

| | |
|---|---|
| Calibration System | Acoustic Calibration |
| Frequency Range | up to 25 kHz (dependent on probe geometry) |
| Transfer function frequency step size | Custom |

Table 10 Frequency Calibration

Please find our datasheet here:

https://www.vectoflow.de/en/wp-content/uploads/sites/3/2019/07/Datasheet_FastResponseMeasurementSystems-1.pdf

# 4 Probe calibration

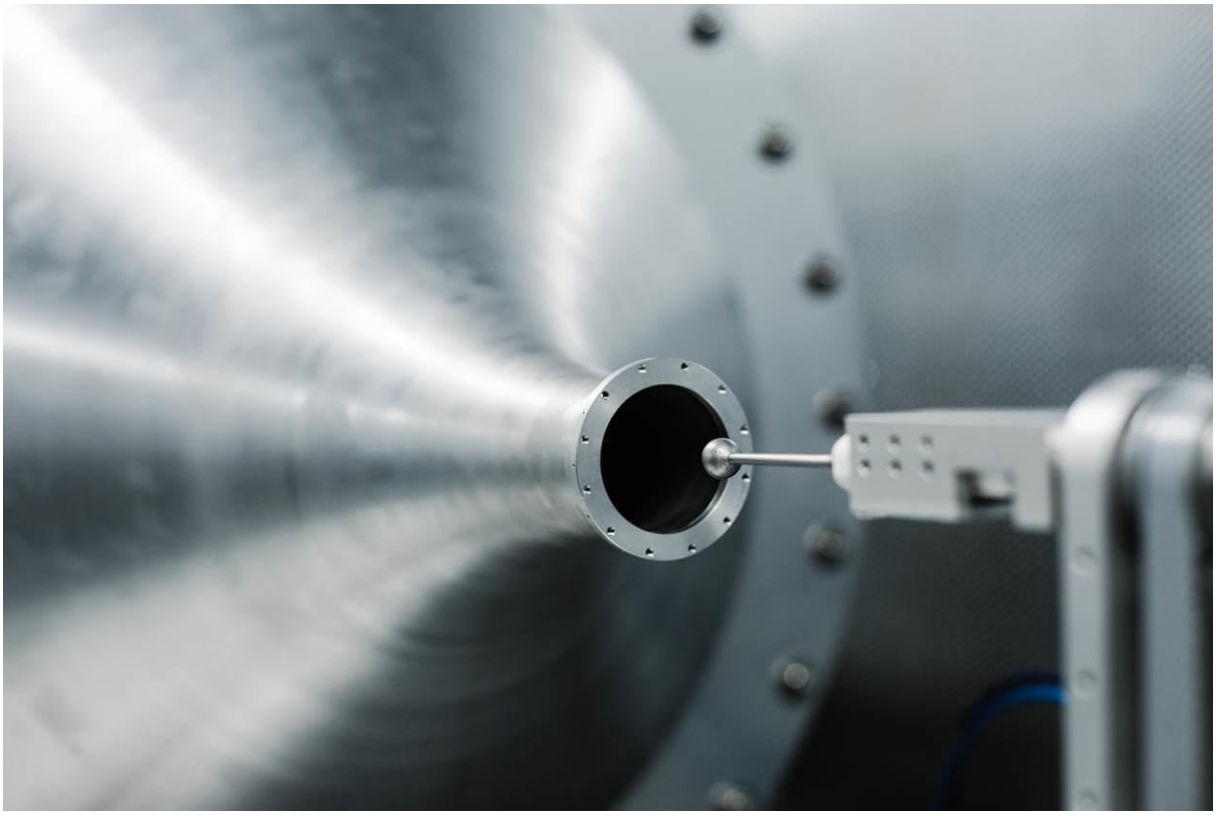


Figure 10 Calibration

We offer calibration services for customer probes as well as for our own customized probes. This includes hot-wire probes. Our calibration wind tunnel is outfitted with special flow nozzles to reach flow speeds from 3 m/s up to Mach 2. We currently offer calibration services up to Mach 0.95 and are developing the capacity to calibrate in the supersonic regime as well. Our high accuracy traverse system covers an angular range of ± 165° in terms of both pitch and yaw angle. We also offer calibrations for unsteady probes and the determination of the required pressure transfer functions.

| | |
|---|---|
| Angle measurement range | ± 165° |
| Velocity measurement range | 3 m/s (10 ft/s) up to Mach 2 |
| Unsteady probes (Determination of transfer function) | Up to 25 kHz |

Table 11 Specifications calibration

# 5 Traversing systems

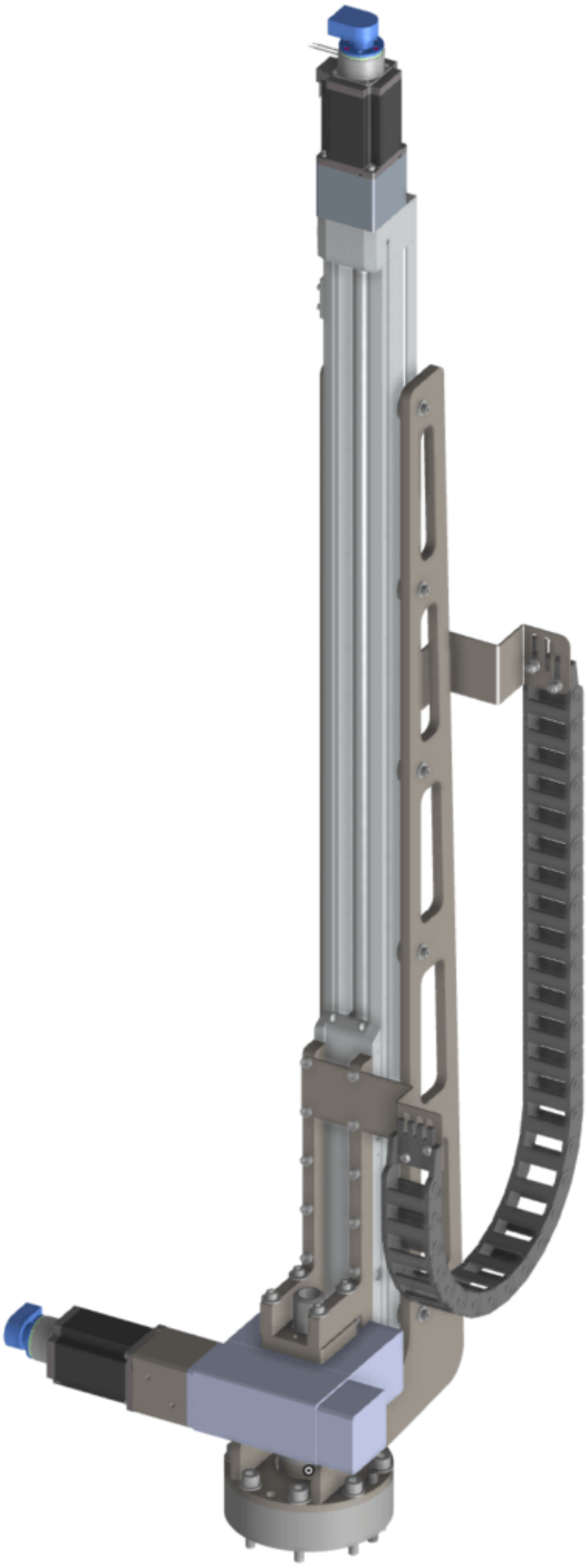


Figure 11 Traversing system

Traverse systems complete the product portfolio finding their application in wind tunnels as well as gas turbines and many other areas. They allow the user to precisely position the flow probe. The traverse systems are fully controllable using the Acquisition and Post-Processing Software VectoVis Pro and thus integrate perfectly into the overall system. Loads up to 1200N and more are no problem for the Vectoflow traverse systems, maintaining high positioning accuracy.

# 6 VectoDAQ Air Data System


Figure 11 VectoDAQ Air Data System

The VectoDAQ Air Data Computer simultaneously measures pressure and temperature signals for a multi-hole probe and evaluates the data in real time to obtain flow parameters such as angle of attack, airspeed and altitude. The device has up to 14 differential pressure channels and an absolute pressure connection, which also serves as a reference for the differential pressure sensors. Each pressure channel can be customized according to customer requirements. The data is transmitted via USB or CAN interface and the transmission rate can be set from 1 to 50 Hz. In combination with a Vectoflow probe, this makes for a lightweight and compact measurement system for mobile applications, e.g. for measurements on air-based systems such as drones or for automotive as well as stationary applications.

| | |
|---|---|
| Weight | 130g (4,6 oz.) |
| Dimensions | 60 x 30 x 80 mm (2.4 x 1.2 x 3.2 in.) |
| Voltage/Current input | Via CAN connector, 7-24V, 50mA |
| Interface: USB | Communication with Host PC (for setup) |
| Interface: Power/CAN | Communication with Host PC via CAN bus |
| Environmental Condition: Operating Temperature | -20 to 70 °C (-5 to 160 °F) |
| Environmental Condition: Operating Medium | Air and other noncorrosive gases |
| Environmental Condition: Humidity | 0...95 %, non condensing |
| Pressure Sensors | up to 14 differential pressure sensors with variable pressure ranges.Optional: Multiple pressure sensors ranges in one device with automatic switching between the sensors for optimal measurement accuracy at all air speeds |
| Pressure Sensor accuracy | Max. +/-0,25% full scale (typical +/-0,1%) |
| Absolute pressure sensor | Barometric or absolute pressure sensor |
| Temperature Acquisition: Temperature | Thermocouple type K or PT100 |
| Temperature Acquisition: Max. temperature | 100 °C (210 °F) standard(up to 300 °C (570 °F) possible) |

Table 12 Specifications VectoDAQ Air Data System

Please find our datasheet here:

https://www.vectoflow.de/en/wp-content/uploads/sites/3/2019/01/Datasheet_VectoDAQAir.pdf

# 7 VectoVis Pro

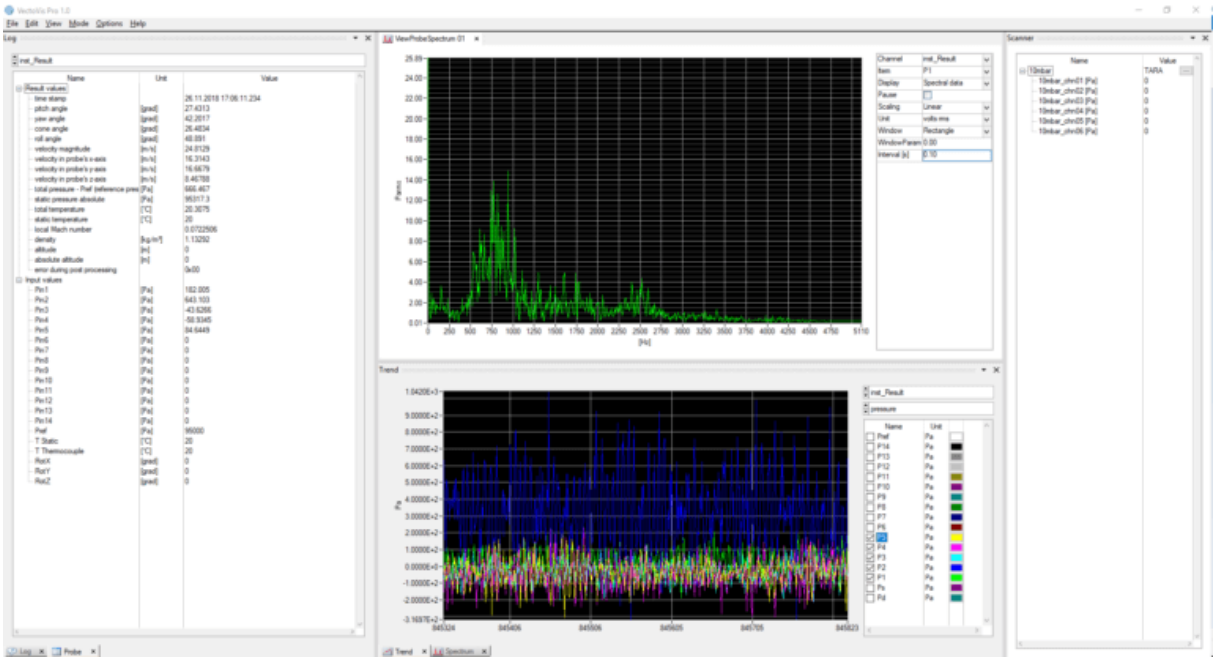


Figure 12 VectoVis Pro

VectoVis Pro software provides an environment for real-time acquisition, visualization and post-processing of the most common sensors and devices related with aerodynamic measurements, including traverse system control. The user can configure the hardware environment including the calibration data for flow probes. Data and outputs from the probes are calculated continuously. The software allows the definition of an automatic test plan which performs traverse movements, acquires and post-processes data and writes the data into a result file. The software consists of a base framework plus modules for different probes.

The VectoVis Pro software offers the following features:

- Easy configuration of different pressure scanners, temperature sensors and flow probes
- Customizable window appearance with graphs, logging and monitoring windows
- Configuration of individual test plans for automatic data acquisition
- Manual data acquisition
- Data logging

Pressure scanners, temperature sensors, multi-hole probes and fast response probes can all be configured easily in VectoVis Pro. Pressure and temperature channels as well as calibration files can be assigned to the different probes. Furthermore, the software allows for the control of the Vectoflow traverse system and data can be acquired manually or automatically. An automatic test sequence can be defined with features like traverse movement, waiting times, acquisition times, file name configuration and many more.

# 8 EvoScann P-Series Pressure Scanner

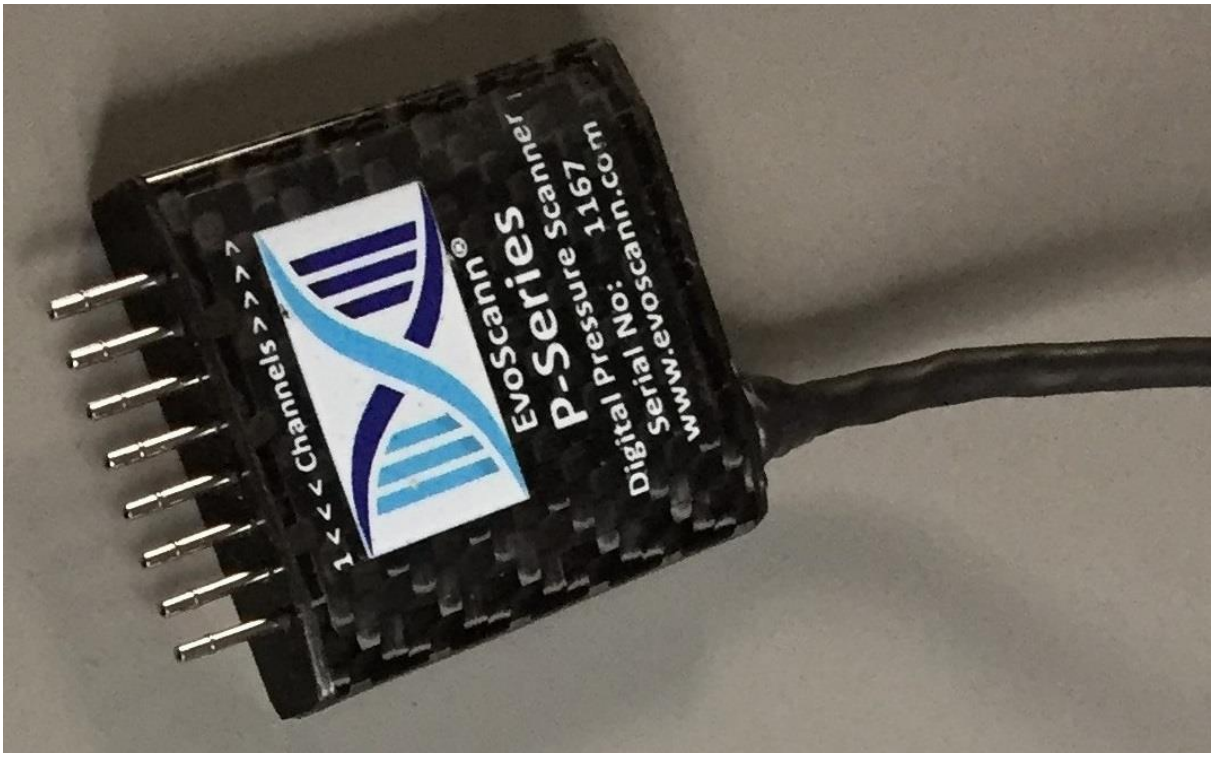



Figure 13 EvoScann P-Series Pressure Scanner

The Evo Scann P-Series Pressure Scanner is a highly miniaturised pressure scanner. With its robust enclosure it is perfect for on-car testing and its small size enables measurements in previously unreachable areas.

| | |
|---|---|
| Inputs (Px) | 0.040" |
| Full Scale Ranges | 200-1200 mbar A, 600-1200 mbar A |
| Accuracy | Absolute: 0.1%FS / Differential: 0.2%FS |
| Overpressure Capability | 5x calibrated range |
| Resolution | 0.01 mbar (0.03 mbar at 1000Hz) |
| Drift | <1mbar / year |
| Construction material: Wetted parts | Stainless Steel / Aluminium / PEI |
| Construction material: Outer case | Carbon Fibre |
| Construction material: Tubulations | Stainless Steel |
| Media | Air - Avoid liquid contaminants |
| Environmental Condition: Operating Temperature | -40°C to +115°C |
| Environmental Condition: Vibration | 9 G / 1000Hz (24 hr) |
| Communication Interface | Direct CANbus, optional CAN / USB Adapter |
| Scan Rate | Variable up to 1000Hz / Channel |
| Power | 9-24v DC |
| Current Consumption | <30mA |
| Electrical Connector | Deutsch, Harwin, Lemo or Flying lead |
| Weight | <15g |
| Dimensions | 36 x 33 x 8mm – P8A, 36 x 33 x 9,2mm – P16A |

Table 13 Specifications EvoScann P8A and P16A

| | |
|---|---|
| Inputs (Px / Ref) | 64 x 0.040" O.D. |
| Full Scale Ranges | +/-100 mbar upto +/-200 mbar |
| Accuracy | 0.5%FS |
| Overpressure Capability | 5x calibrated range |
| Resolution | 0.003 mbar @ 100 mbar range;<br>0.006 mbar @ 200 mbar range |
| Drift | <1mbar / year |
| Construction material: Wetted parts | Stainless Steel / Aluminium / Viton |
| Construction material: Outer case | Windform SP |
| Construction material: Tubulations | Stainless Steel |
| Media | Air - Avoid liquid contaminants |
| Environmental Condition: Operating Temperature | -10°C to +90°C |
| Environmental Condition: Vibration | 9 G / 1000Hz (24 hr) |
| Communication Interface | Direct CANbus, optional CAN / USB Adapter |
| Scan Rate | Variable up to 500Hz / Channel |
| Power | 9-24v DC |
| Current Consumption | <70mA |
| Electrical Connector | Deutsch |
| Weight | 110g |
| Dimensions | 70 (80*) x 55 x 22mm * incl tubulations |

Table 14 Specifications EvoScann P64-D

# 9 Spindle Flow Meter

Figure 14 Spindle Flow Meter

The Spindle Flow Meter operates on the basis of differential pressure. The optimized design offers improved performance above the traditional differential pressure flowmeters. A central body is used as a primary flow element and conditions the incoming flow, allowing for high quality measurements.

The Spindle Flow Meter offers the following features:

- Forced annular channel flow
- Incoming unsteady pipe flow is conditioned for a very stable, repeatable and well characterized flow
- No flow separation
- Minimum drag
- High accuracy
- Certified calibration
- The Spindle fin supports are structurally stable
- The Spindle is well suited for applications in complex industrial environments (behind bends etc.) and for system verification
- Hollow central body provides space for (sealed) measurement equipment

During testing on natural gas pipelines in parallel with other types of flow meters, the Spindle was the only flowmeter which still operated within tolerance limits after 3 months.

# 10 Contact

Questions? Please contact us:

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