

SpaceAge Control angle of attack and air temperature sensors measure Mach 1 and well beyond on platforms such as rockets to test the launch of space vehicles.

**SpaceAge Control**

# Air Data Sensing

*Flight Test Special Edition*

S165(NC)

## Air Data Sensors for Hypersonic Applications

*High-temperature and high-strength materials ensure operation in demanding environment.*

Engineers and avionics designers now have a suite of hypersonic-capable air data products available:

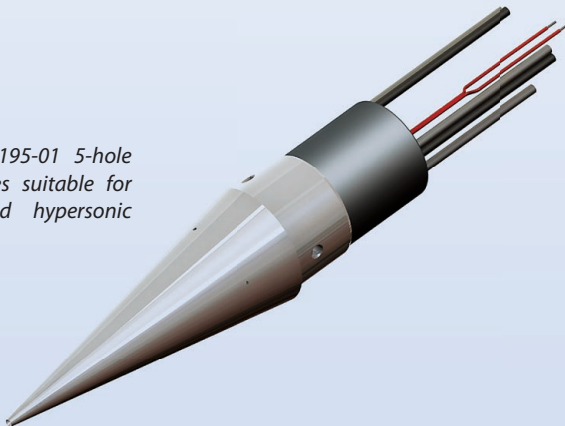
- **4195-01 flush air data probes with multiple-hole pressure-transmitting ports**
- **4228-01 angle of sideslip sensors with external balance**
- **4376-01 angle of attack sensors with internal balance**
- **4382-01 air temperature sensors**

The products are constructed of nickel, Inconel, titanium, and stainless steel to meet the 1500+ degree F (816+ degree C) high-temperature, high-strength requirements of Mach 5+ flight. The flush air data probes are heated to support de-icing at initial stowage and launch speeds.

Components of the air data suite have been or will soon be in use on research, space exploration, and military programs to include:

- **Mach 7 class scramjet-powered air vehicle**
- **Mach 4 class strike vehicle**
- **Next-generation moon exploration launch platform**

*Nickel-based 4195-01 5-hole air data probes suitable for supersonic and hypersonic airflows*



*The stainless steel-based 4382-01 air temperature sensor and titanium-vaned 4376-01 angle of attack sensor were first used in next-generation rocket testing*

The air data suite and its components are suitable for:

- **Hypersonic military air vehicles**
- **Supersonic business jets**
- **Hypersonic engine sensors**
- **Hypersonic research vehicles**
- **Reusable space vehicles**

Initially, SpaceAge Control was reluctant to enter the hypersonic air data probe market as it was perceived to be a small, niche market segment with possibly unachievable performance requirements. A customer persuaded SpaceAge Control to join their hypersonic program. The initial angle of sideslip sensor product from that program resulted in the development of an air data suite capable of sensing the entire range of air data parameters.

A view of the trailing cone during the initial deployment phase on a transport aircraft.

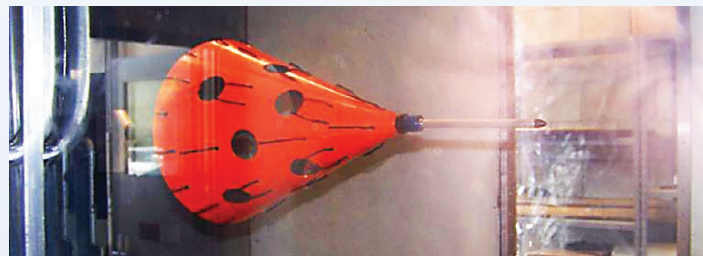
## Trailing Cones for Static Pressure Measurement

Manufacturers, Avionics Firms, and Operators Can Measure Static Pressure Errors

100100-type trailing cones are available in lengths exceeding 3000 inches (76.2 meters).

SpaceAge Control produces the 100100 and 100101 trailing cone systems that allow users to conduct their own static system error calibrations. These trailing cones are the first static pressure calibration tool broadly available to aircraft manufacturers, avionics firms, and operators.

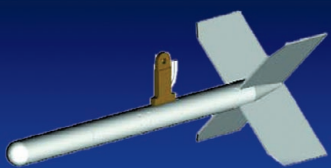
With selected models designed for use at airspeeds up to Mach 0.9+ and at temperatures of  $-54^{\circ}\text{C}$ , the trailing cones give users an easy way of calibrating the static pressure error of a pitot-static system. It does this by giving an accurate measurement of the ambient atmospheric pressure (static pressure). The trailing cone system consists of a cone that trails at least one wingspan length behind the aircraft via a high-strength pressure tube (PN 100100-XXXX) or with integrated cable (PN 100101-XXXX). Static pressure is measured forward of the cone by static ports. The cone stabilizes and aligns the ports relative to the freestream airflow.



The SpaceAge Control cone assembly during wind tunnel testing.

## Trailing Bomb for $P_t$ and $P_s$ Measurements at Modest Airspeeds

Towed Source for 0 to 200 Knots



The 100800 trailing bomb is well-suited for the modest airspeeds of rotary wing aircraft.

Page 2

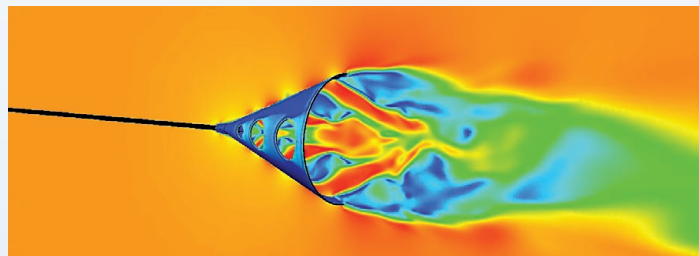
Rotary and fixed wing aircraft can obtain higher accuracy air data by using the SpaceAge Control 100800 trailing bomb. The 170-oz. (4.82 kg) trailing bomb is deployed outside the aircraft's airstream allowing much higher total and static pressure measurement accuracy.



Prior to the 100100 and 100101 trailing cones, users were required to produce their own trailing cones which involved a lot of trial and error and a number of "lost" trailing cones. This trial and error required expensive development and flight testing efforts. Application-specific configurations are available that add skids, carbon fiber cone assemblies, heat shields, and specialized pressure fittings. Lengths of over 3000 inches have been produced.

Why are trailing cones so popular in certification work? Primarily because the FAA and JAA specify them as one of several methods that can be used to perform flight calibrations. The trailing cone method is one of the most cost-effective and easiest of the methods. For more information on trailing cones and certification requirements, visit:

<http://spaceagecontrol.com/trailing-cone.htm>



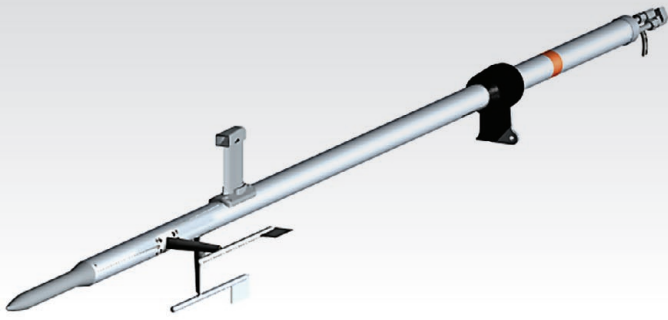
Graphic from the CFD analysis of the SpaceAge Control cone assembly.

Constructed of machined and brazed stainless steel, aluminum, and brass, the 100800 trailing bomb is extended below and aft of the aircraft with a small-diameter cable during flight. This installation method avoids the aircraft modifications required when air data booms are used on the nose of the aircraft.

With a length of 22 inches (559 mm) and a diameter of 10 inches (254 mm), the product is easily stowed within the aircraft during periods of non-use. Developed in concert with the U.S. Army, the trailing bomb has been used on a number of current helicopter flight test programs including the UH-60, V-22, Apache, and Apache Longbow.

A trailing bomb usage note can be viewed at:

<http://spaceagecontrol.com/100800use>



PN 100700-051 air data boom with pitot pressure, static pressure, angle of attack, angle of sideslip, and air temperature sensing capabilities.

## The World's Most Heavily-Tested Flight Test Air Data Boom

*PN 100700-051 Endures the Limits of Aircraft Capabilities*

### User Flight Test Experience

#### Terrafugia Transition with PN 100400 Air Data Boom

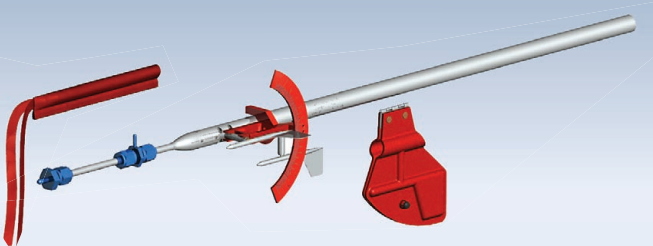
*"The challenges we encounter in collecting ground and airborne air data are made easier with the use of the SpaceAge Control mini air data probe. Its small size and excellent low airspeed performance, coupled with its low mass and power requirements makes the 100400 air data probe a perfect fit for the Transition's flight test program."*

*"Right out of the box, the 100400 mini air data probe worked perfectly. Airspeed, altitude, alpha, and beta were all reliably and accurately captured."*

*"The initial flight test with full instrumentation went off without a hitch and the data collected by the 100400 air data probe will be invaluable in validating and improving the design."*

– Dr. Samuel Schweighart,

Vice President of Engineering and Co-Founder, Terrafugia  
<http://terrafugia.com/>



The 100400 air data boom shown with accessories.

Flight test air data booms are generally used for fewer than 500 flight hours. Some programs, however, require extended use of flight test air data booms for the life of the aircraft. To meet one specific program requirement, the PN 100700-051 air data boom was designed and test over an 18-month period. This air data boom has been environmentally qualified to meet the performance requirements of military fighter aircraft to a 12,000-flight-hour lifetime. As such, the product has been dubbed "The World's Most Heavily-Tested Flight Test Air Data Boom."

The 100700-051-type air data boom provides heated total and static pressure ports, angle of attack and angle of sideslip sensors, and a total air temperature sensor. It successfully passed a gauntlet of environmental testing including icing, temperature/pressure, vibration, acceleration, shock, salt mist exposure, contaminants exposure, fungus, and EMI. The pitot-static section underwent wind tunnel testing to Mach 1.2.

The world's most heavily tested flight test air data boom installed on trainer aircraft.



Nose-mounted 100700-051 air data boom (air)



The C-5M transport with the 100510-08 air data boom leading the way.



The swivel-head "business end" of the UH-60 helicopter during flight testing.



NASA Langley UAV with 2 each 101100-XX air data booms.

# Technical Information Request

To obtain technical information on the products below, check the items you are interested in and return this form via:

- fax **+1-661-273-4240**
- e-mail **s165@spaceagecontrol.com**
- or mail **SpaceAge Control, 38850 20th Street East, Palmdale, CA 93550 USA**

- |   |   |
|---|---|
| <input type="checkbox"/> standard-size air data booms     | <input type="checkbox"/> hovervanes                       |
| <input type="checkbox"/> miniature air data booms         | <input type="checkbox"/> pitot-static probes              |
| <input type="checkbox"/> air temperature sensors          | <input type="checkbox"/> pitot probes                     |
| <input type="checkbox"/> AOA (alpha) / AOS (beta) sensors | <input type="checkbox"/> multi-hole probes                |
| <input type="checkbox"/> static pressure ports            | <input type="checkbox"/> multi-functional air data probes |
| <input type="checkbox"/> trailing bombs                   | <input type="checkbox"/> trailing cones                   |

Or, send an e-mail or fax message with your contact details.



**38850 20th Street East  
Palmdale, CA 93550 USA**  
**www.spaceagecontrol.com**  
RETURN SERVICE REQUESTED



日本代理店  
株式会社 パシフィック テクノロジー  
TEL: 047-426-1650 FAX: 047-426-1652  
E-mail: sales@pac-tech.com  
URL: <http://www.pac-tech.com>

**AIR DATA SENSING**  
**FLIGHT TEST SPECIAL EDITION**

## A Sampling of Air Data Products for Flight Test Applications

