

# AIR DATA

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# Introduction

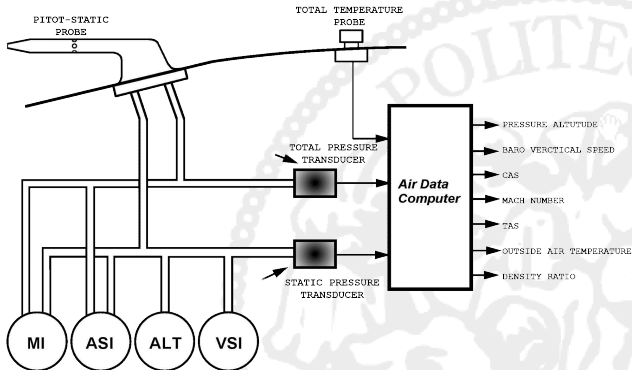
Air data systems and instruments provide the pilot (and/or the on-board automatic systems) with key information needed for the management of flight.

These parameters are derived from measurements of a few quantities from the earth's atmosphere the aircraft is flying through, typically:

- Static pressure  $p_s$
- Total pressure  $p_t$
- Temperature (either static  $T_s$  or total  $T_t$ )
- Angle Of Attack (AOA)

Such quantities are then processed and combined to compute desired parameters.

# General architecture



Air data system, with capsule-based Air Speed Indicator (ASI), Altimeter (ALT), Vertical Speed Indicator (VSI) Mach Indicator (MI) and electronic Air Data Computer (ADC)

# PROBES

Probes pick-up physical quantities from external air and deliver them to an appropriate transducer.

Depending on physical quantity picked-up we have:

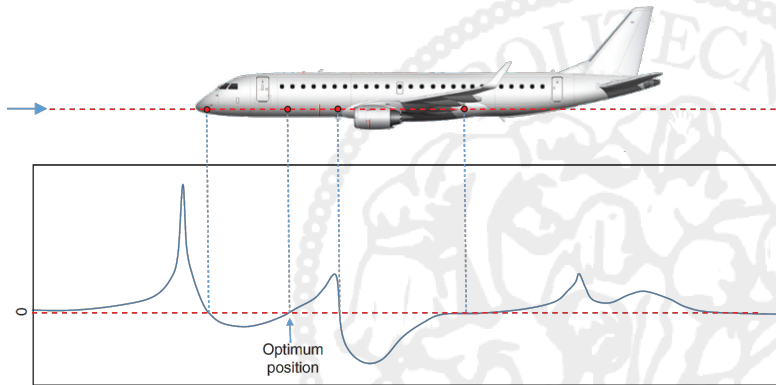
- Pressure:
  - Static : *Static port*
  - Total: *Pitot tube*
  - Total + Static : *Pitot-static probe*
- Temperature:
  - Static: *Outside Air Temperature (OAT) or Static Air Temperature (SAT)*
  - Total: *Total Air Temperature (TAT)*
- AOA:
  - *Stall indicator sensors*
  - *Vanes*
  - *Smart AOA probes*

# PROBES

The presence of the aircraft and of the probe itself introduces a perturbation in the local values of the physical quantity with respect to its asymptotic value. This is particularly true for pressure probes.

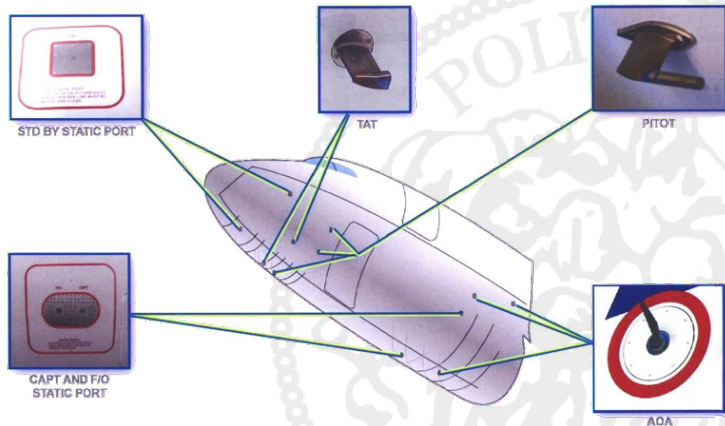
A very careful selection of the installation spot of the probe on the fuselage is therefore necessary. Most of the times, the final installation is the result of an iterative try-and-correct process performed at the early stage of flight tests of the machine.

# PROBES INSTALLATION EXAMPLE



Qualitative error on  $p_5$  depending on probe installation for a given attitude and aerodynamic configuration

# PROBES INSTALLATION



Example of probes installation along the fuselage of a jet liner

# MECHANICAL PRESSURE TRANSDUCERS

The pressure sensing elements used inside air-data instruments are *capsules* which are flexible sealed metal containers that are designed so that they collapse and expand in a predictable way depending on the difference of pressure between the inner chamber and the outside volume.

Depending on the pressure present in the inner chamber, two types of capsules are defined:

- *Aneroid* capsules
- *Differential* capsules

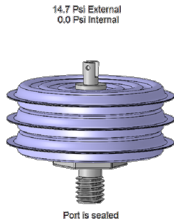
In the former, vacuum is created in the inner chamber and the pressure input port is sealed.

The latter have the pressure input port connected to a relevant pipe.

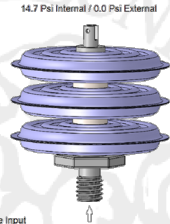
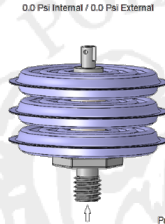
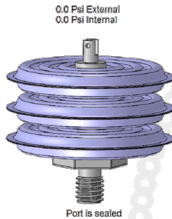


# MECHANICAL PRESSURE TRANSDUCERS

In order to increase sensitivity, capsules are often stacked.

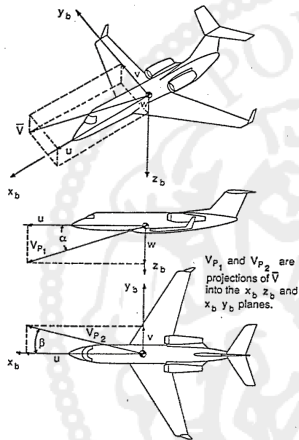


Aneroid capsule operation



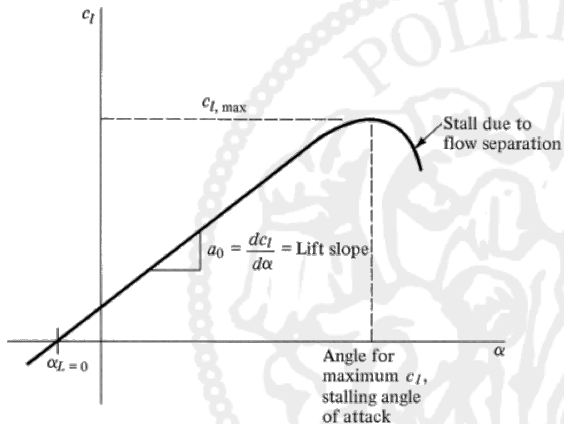
Differential capsule operation

# AERODYNAMIC ANGLES



Definition of AOA and Side Slip Angle (SSA)

# STALL



Stall on  $C_L/\alpha$  curve

# STALL WARNING SWITCH



Stall warning switch

# AOA MEASUREMENT



AOA vane on a Mig 29

# AOA MEASUREMENT



AOA cone sensor and indicator

# AOA PROBE



AOA sensor installation






# AOA PROBE



AOA sensor installation



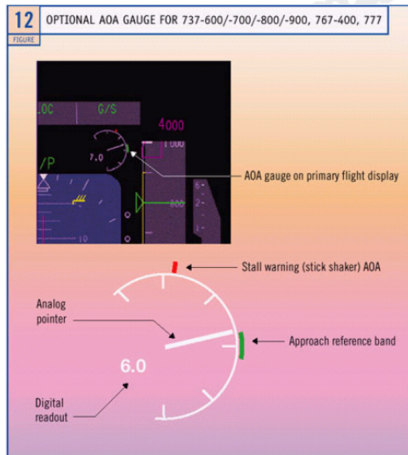
# AOA INDICATION AND USE

ANGLE-OF-ATTACK INDICATOR A.O.A.	MARKER	UNITS	CONDITION
		.85	STALL WARNING WITH FLAPS AND L.G. DOWN
		.45	LANDING APPROACH WITH FLAPS AND L.G. DOWN
		.33	MAXIMUM ENDURANCE
		.23	MAXIMUM RANGE

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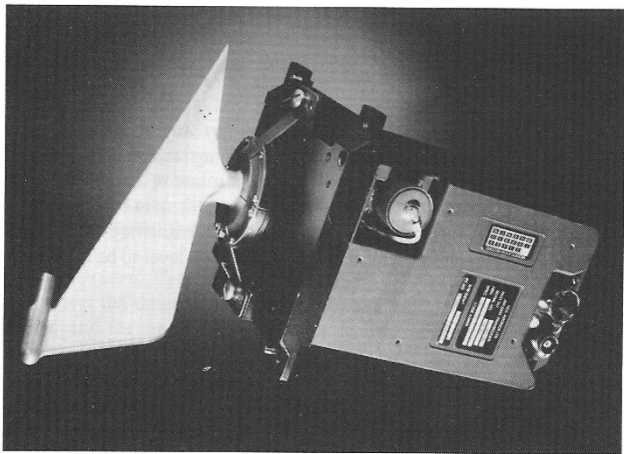
AOA indication and use

# AOA INDICATION



AOA indication on 737 Electronic Flight Instrumentation System (EFIS)

# SMART PROBE



Air data smart probe

# List of Acronyms

<b>ADC</b>	Air Data Computer
<b>ALT</b>	Altimeter
<b>AOA</b>	Angle Of Attack
<b>ASI</b>	Air Speed Indicator
<b>EFIS</b>	Electronic Flight Instrumentation System
<b>MI</b>	Mach Indicator
<b>OAT</b>	Outside Air Temperature
<b>SAT</b>	Static Air Temperature
<b>SSA</b>	Side Slip Angle
<b>TAT</b>	Total Air Temperature
<b>VS</b>	Vertical Speed Indicator

