ADP-55 Smart Air Data Boom

The *ADP-55* of Simtec is a highly integrated, smart air data boom with an integrated and regulated heating and drainage system. The system provides a full set of calibrated and aerodynamically corrected air data in a single probe at rates of up to 100Hz over an RS-485 interface. ARINC-429 and CANaerospace data interface modules are available as well.

The purpose of this air data system is to provide a flying vehicle with valuable information about the vehicle's speed, its angle of attack and side-slip, the static pressure and temperature of the ambient air. Derived parameters like pressure altitude, true airspeed, Mach number and static temperature are computed as well.

Many propeller aircraft and UAVs fly slower than jet aircraft and require special pressure and temperature sensors and adapted electronics to account for the much lower impact pressure and the high dynamics of the vehicle. The system has a very low transport delay. Furthermore the *ADP-55* has a TAT sensor that is optimized to work even at very low airspeed.

Key Features

- Self-contained multi-hole air data boom
- Measures static pressure, impact pressure, angle of attack, angle of side-slip and total temperature in a single device
- Outputs fully calibrated and aerodynamically corrected air data at up to 100Hz
- Made of stainless steel and aircraft grade aluminium
- Integrated and regulated heater
- Drainage system
- Less parts compared to a conventional system
- Low transport time and high accuracy
- Low total cost of ownership
- Designed and tested in the wind-tunnel
- RS-485 interface compatible with Swiss Air Data line of Air Data Systems
- Easy configuration of output rate, digital filters, baud-rate via maintenance software

Simtec AG
Gewerbestr. 7
4147 Aesch BL
Switzerland
Tel.: +41 61 7030222
E-Mail: info@simtec.ch

Target Market

- Best solution for Tactical UAV, MALE UAV, Rotary Wing UAV
- Remotely Piloted Aircraft (RPA)
- High Altitude Pseudo Satellites (HAPS)
- Flight Testing (including eVTOL, helicopter)
- Research Aircraft

System Overview

The *ADP-55* heated air data boom provides calibrated and aerodynamically corrected pressure, temperature and air data over the RS-485 interface. Raw but digitized measurement data is read in over the RS-485 interface from the heated air data probe (ADP) and processed by the real-time measurement computer (RTMC). The maintenance interface is used to update calibration values, set output frequency and other values.

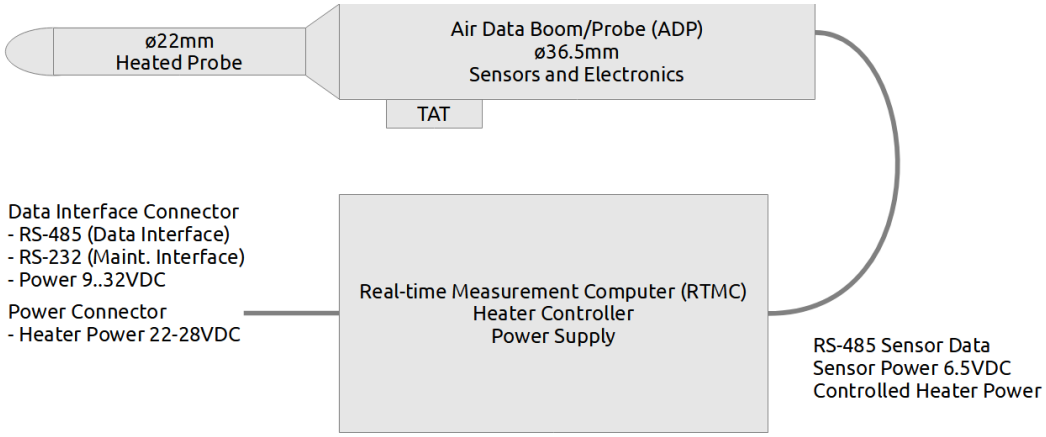

Figure 1. Overview (RS-485 data interface)

The *ADP-55* uses silicon based pressure sensors individually calibrated over the full temperature range of -55°C … +80°C (power up above -40°C) to provide very accurate data.

Angle of attack and angle of sideslip data is measured with a five-hole probe without friction, very quickly and accurately. The following steps describe the basic functionality of the 5-hole probe:

1. The air-stream is picked up at the 5-hole probe and fed to the integrated pressure sensors. Temperature is picked up by the TAT sensor
2. The sensor signals are amplified and digitized by a microprocessor based electronic circuitry (24 bit A/D conversion).
3. The digitized air data is sent via a RS-485 interface to the real-time measurement computer (RTMC).
4. The RTMC performs the sensor calibration and applies aerodynamic corrections. Then the embedded microprocessor computes data like altitude, airspeed, etc. from the sensor data.
5. Data labels are sent via a RS-485 interface to the FCC for further processing.

The five-hole probe technology provides the following important features:

- Integrated correction of impact and static pressure at angle of attack and angle of side-slip
- For highest accuracy and frequency response the sensors and sensor digitizing electronics are directly integrated in the boom thus minimizing tube length to a minimum.
- As the sensors and sensor electronics are adapted to the flight envelop of the flight vehicle the highest accuracy is achieved

Heater

The integrated heating electronics regulates the temperature of the probe within a narrow band of temperature usually at +40°C. Maximum power of the heater is 240 Watt between 22…28 VDC. Both the maximum temperature and the maximum power are configurable. Status labels provide detailed information on the data interface. Command labels are used to switch the heater on and off during flight or to put the heater into auto mode. The heater features a surge protection above 30VDC to protect the internal electronics.

Drainage

The total pressure orifice on the tip of the probe is equipped internally with a cover plate like device and a drain hole to be self-draining in flight. The drain holes are designed in such a way that the error on the stagnation pressures is very small. This error is calibrated and automatically correct by the air data computer (ADC). The static pressure ports are designed so that water drains off at the bottom of the tip.

Built-In Tests

Memory, interfaces and other components are tested at start-up. Sensors and electronics are continuously monitored. Errors are enunciated on the data port.

Maintenance and Test Software

PC-Software to configure, maintain and test the *ADP-55* can be downloaded from https://www.swiss-airdata.com.

Specification

Table 1. Measurement Range and Accuracy

Property	Value	Details
Static Pressure Range	45 hPa … 1'080 hPa -1'800 ft … 69'000 ft	
Dynamic Pressure Range	±16 hPa dif ±30 hPa dif ±75 hPa dif ±150 hPa dif Other ranges on request	~95 KCAS ~135 KCAS ~210 KCAS ~295 KCAS Max. Mach 0.96

Property	Value	Details
AoA and AoS Range	±30°	Optimized accuracy for smaller ranges. Special applications up to ±45° with reduced accuracy. At high airspeed the range is usually reduced to gain some accuracy at low airspeed. Ask for details.
TAT Range	<85°C [1]	
Pressure-Accuracy	larger of 0.1%FS and ±1 Pa [2]	FS: Full Scale, [3]
Temperature-Accuracy	±1°C	

Table 2. Data Rate, Resolution, Delay, Bandwidth

Property	Value	Details
Output Rate	100, 50, 25, 20, 10, 5, 1Hz	
Transport Delay	<25ms	Valid at 100Hz, 230'400bps
Resolution	24 bit	At pressure level
Bandwidth	25 Hz [4]	Cut-off frequency at -3dB
Start-Up Time	<1 sec	

Table 3. Data Labels

Property	Value	Details
Basic Data Labels	Static Pressure (Ps) Dynamic Pressure (Qc) Angle of Attack (AoA) Angle of Sideslip (AoS) Total Air Temperature (TAT)	Note that all data-labels are aerodynamically corrected up to ±30°, the system is comparable to a *swivel-head air data boom* but without moving and delicate parts.
Computed Air Data Labels	Pressure-Altitude (Hp) Barometric-Altitude (Hb) Calibrate Airspeed (CAS) True Airspeed (TAS) Mach-Number (M) Climb-Rate (CR) Static Air Temperature (SAT) Duty Rate Heater (DTR) Heater Temperature (HTR) Heater Current (CUR) Uncorrected sensor-pressure and sensor temperature data labels	

Simtec AG
Gewerbestr. 7
4147 Aesch BL
Switzerland
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E-Mail: info@simtec.ch

Table 4. Environmental Performance

Property	Value	Details
Temperature Range	-40°C..+80°C -55°C..+80°C -55°C..+80°C	Power Up Operating, fully temperature calibrated Storage
Load Factor	±10g	by analysis, many test flights with ±6g and roll rates of 360°/s performed
Media Compatibility	Clean Air	Non-condensing and non-corrosive gases

Table 5. Mechanical

Property	Value	Details
Mass RTMC	0.250kg	Add 0.030kg for ARINC-429 or CANaerospace module
Mass Probe	0.650kg	
Materials	The tip of the probe is build from stainless steel and aviation grade aluminium. The RTMC box is built from aviation grade aluminium.	
Mounting	6x M4 screws, for details see drawings	
Dimensions	For dimensions see CAD drawings of ADP-55	

Table 6. Electrical

Property	Value	Details
Data Interface	RS-485 Full-Duplex	ARINC-429 or CANaerospace module available (replaces RS-485 data interface)
Maintenance Interface	RS-232	
Power Supply	9..32 VDC	Air Data Computer only
Power Consumption	210 mA @ 9V 75 mA @28 V	Air Data Computer only
Heater Power	Max. 240 Watt (regulated)	Max. down to 22V, automatic shut-down above 30V. High power is used at low ambient temperature and high airspeed only.

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Property	Value	Details
Baud-Rate	57'600 bps 115'200 bps 230'400 bps 460'800 bps	
Connector RTMC	DSUB-15 (Deltron DTS15PY/2M85UN) DSUB-15 (Deltron DTS15SY/2M85UN)	15 pins, male and female, for pin-assignment see *ICD*
Connector Probe	MIL-DTL-38999 III (20WB35PN)	13 pins, for pin-assignment see *ICD*

Ordering Information

Table 7. Part-Numbers

Part-Number	Details	Description
SIM-4B0-7B7	Air Data Probe with RTMC	Includes probe, RTMC, mating plugs and software. Configuration: RS-485, ARINC-429 or CANaerospace Options: Heater Module, Transonic Module and TAT-Removed
SIM-53A-8A2	Air Data Probe	Replacement part
SIM-E4A-B76	RTMC Box	Replacement part
SIM-2A8-03A	Installation Brackets	
SIM-20F-215	Tip Cover	Ground Support Equipment (GSE)
SIM-20F-2E3	RTMC-to-USB Converter Cable Assembly	GSE
SIM-906-060	Pressure Test Adapter pt/ps	GSE
SIM-3FB-ED5	Pressure Test Adapter qc/AoA/AoS	GSE
SIM-1FD-A56	Arinc-429 to USB-Converter Box	GSE

RoHS and REACH

RoHS: Simtec's safety critical aerospace products are excluded from the scope of the RoHS Directive.

REACH: Simtec PCBs (printed circuit boards) are soldered with leaded solder. Lead (CAS-No. 7439-92-1) is listed as a substance of very high concern (SVHC). When used as intended, these products are not hazardous to health.

Simtec AG
Gewerbestr. 7
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Switzerland
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Price, Availability and Lead Time

Call factory for details. The pitot-static system is built on order. Depending on user requirements, it takes between 6 to 8 weeks to build, calibrate and test the system.

Service and Support

Service and Repair: Should any damage occur during shipping, handling, or misuse by the user, Simtec is able to service it.

Consultation: Technical consultation can be obtained from Simtec if expertise is needed for the integration of the air data system into the aircraft, during flight-testing or post processing of data.

Contact Information

Simtec AG
Gewerbestrasse 7/7a
CH 4147 Aesch BL
SWITZERLAND

Tel.: +41 61 703 0222
info@swiss-airdata.com
http://www.swiss-airdata.com

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[1] Limit will be increase on new revision.

[2] Accuracy is the sum of repeatability, hysteresis, thermal effects in the specified temperature range, the calibration is traceable to DAkkS.

[3] By periodic nulling (e.g. every 6-12 month) the accuracy of the airspeed and angular errors can be improved. The airspeed and angular errors are mostly offset errors, offset errors can be nulled easily at zero airspeed with the help of the maintenance software or directly via FCC-commands.

[4] To be verified on latest revision