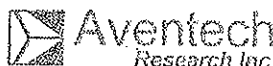# AIMMS-20AQ

Advanced Airborne Meteorological Measurement Solution for...

Temperature
Relative Humidity
Three-Dimensional Wind
Turbulence

Atmospheric Research
Air Quality Studies
Cloud Seeding

⊠ Aventech
Research Inc.

Accurate knowledge of the prevailing meteorological conditions is of paramount importance to airborne operations conducted in support of atmospheric research, air-quality monitoring and cloud seeding programs. To date, expensive, customized systems capable of acquiring such measurements have only been available on a few, select, high-end research aircraft. The AIMMS-20AQ (Aircraft Integrated Meteorological Measurement System) provides a cost-effective means of acquiring research-aircraft grade temperature, humidity, three-mensional wind and turbulence measurements utilizing any class of fixed-wing airborne platform.

## Meeting the Challenge of Airborne Wind Measurement

Accurate wind measurement from an airborne platform poses a challenging problem given the fact that the aircraft is moving many times faster than the wind being measured. As a result, the wind signal of interest is only a small portion of the measured air-motion data and is dominated by the motion of the aircraft itself. Under these circumstances, precision wind measurement to an accuracy better than 0.5 m/s (1 knot) requires acquisition of the true airspeed to better than 0.7 knots accuracy, flow direction (sideslip) to better than 0.1 degree accuracy and true heading to better than 0.2 degree accuracy. The AIMMS-20AQ system delivers this level of performance in a small, integrated, light-weight package that is easy to install and calibrate on any fixed-wing aircraft.

Modular by Design

The AIMMS-20AQ system incorporates three modules, each responsible for acquiring a particular independent set of airborne easurements. Each module can be purchased and operated independently or all of them linked together via a high-speed, digital serial (Controller Area Network) bus to a fourth central processing module responsible for evaluating the wind solution.

Air Data Probe (ADP)

The AIMMS-20AQ air data module precisely acquires the three-dimensional, aircraft-relative flow vector (true airspeed, angle-of-attack and sideslip) utilizing differential pressures measured at five holes located in the nose of the probe and atmospheric temperature and humidity utilizing a proprietary, reverse-flow temperature / humidity chamber design located in the aft section of the probe. The reverse-flow temperature / humidity chamber design allows for adequate, controlled ventilation of the sensor elements in order that accurate dynamic heating corrections may be applied while maintaining a fast measurement time constant. Having the sensor elements removed
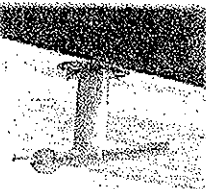
from direct immersion in the airflow protects them from particulate impact and contamination extending their usable service life. In addition, a three-axis accelerometer pack is incorporated into the module to precisely determine the motion of the probe itself to facilitate direct turbulence measurement in three dimensions.

Inertial Measurement Unit (IMU)

The AIMMS-20AQ inertial module is a full six-degree of freedom IMU containing three rate gyros and three accelerometers. Temperature compensated angular rates and accelerations are broadcast 40 times a second in order to precisely track the dynamics of the aircraft attitude over the complete flight envelope.

GPS Module (GPS)

The AIMMS-20AQ utilizes a two antenna, dual GPS processor subsystem to determine aircraft attitude, specifically heading. A differential carrier-phase technique is applied to the signals originating from two wing-tip mounted GPS antennas that, when coupled with inertial information from the IMU, provides 0.1 degree heading accuracy (based on wing-tip to wing-tip antenna baseline of 10 m). In comparison, the most advanced magnetic-based heading technology can only provide 3/4 to 1 degree heading accuracy at best. The GPS module also provides 3-D position and inertial velocity (WAAS DGPS option available).

Central Processing Module (CPM)

Utilizing a sophisticated Kalman Filter Digital Signal Processing Technique, the CPM module optimally combines the differential GPS carrier-phase data with the inertial data to determine accurate aircraft attitude, and then combines this with the raw air-motion data to precisely determine the wind solution to better than 0.5 m/s (1 knot) accuracy. The resulting meteorological data can be logged in the 16 Mbit internal FLASH memory or transmitted to a host computer using one of two built-in RS-232 serial ports.

Features

- Wing-mounted Air Data Probe (ADP) for true airspeed, flow angle, temperature and humidity measurements

- GPS measurement module for differential carrier-phase (aircraft attitude), 3-D position and velocity

- Inertial measurement module (IMU) provides precise heading data throughout the full flight envelope

- Real-time three-dimensional wind evaluated using advanced Kalman Filter Digital Signal Processing (DSP) technique

- Central Processing Module (CPM) for data logging and interfacing to a host computer system

- Rugged construction with hermetically sealed sensor electronics for in-service reliability

- AIMMS-20AQ system includes all sensor hardware, configuration software, power supply and cables

- Other Options Available: WAAS DGPS Capability
                              5 Hz PVT GPS Solution
                              Anti-Icing
                              PMS Canister Mount
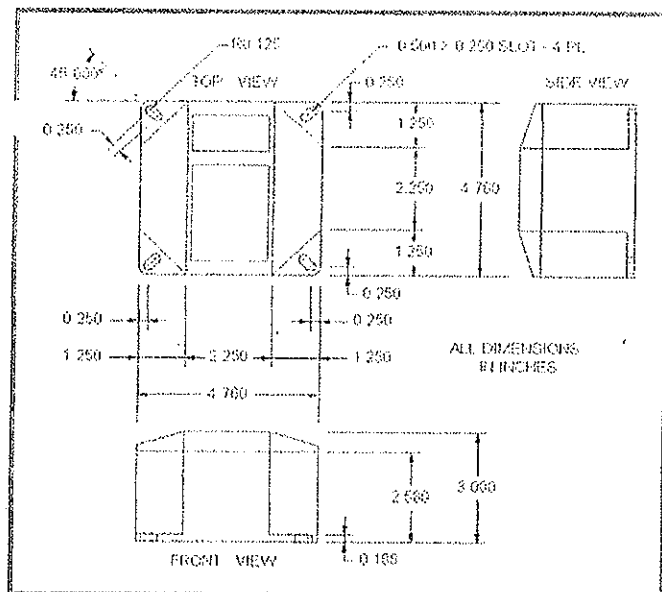
Technical Specifications

Electrical

Operating Voltage:	12.5 - 37 VDC Input
Max. Operating Current:	900 mA @ 12.5 VDC
Digital Interfaces:	Controller Area Network (CAN2A), 500 kbps
	RS-232 Serial Ports (default 19.2 kbps)

Environmental

Operating Temperature:	-20 C to 50 C
	-40 C to 50 C (available under special order)
Storage Temperature:	-40 C to 90 C

Physical

Weights:

Air Data Probe (ADP):	3.36 kg (7.38 lb)
Inertial Measurement Unit (IMU):	0.74 kg (1.63 lb)
GPS Module (GPS):	0.80 kg (1.76 lb)
Central Processing Module:	0.60 kg (1.32 lb)

Technical Specifications

Performance

AIR DATA PROBE (ADP)

Internal Sampling Rate:	200 Hz
Anti-Alias Filter:	60 Hz
Digital Low Pass Frequency Range:	1 Hz - 40 Hz
Maximum Data Output Rate:	40 Hz

Pressures	Range	Accuracy + % of Reading
Barometric (Static):	0 - 110000 Pa	100 Pa + 0.05%
Pitot-Static Differential:	0 - 14000 Pa	20 Pa + 0.05%
Angle-of-Attack / Sideslip Differentials:	+/- 7000 Pa	20 Pa + 0.05%
Three-Axis (X,Y,Z) Acceleration	+/- 5 g	0.005 g

Temperature

Resolution:	0.01 C
Calibrated Accuracy:	0.05 C
Including Dynamic Heating Error Uncertainties:	0.30 C
Time Constant (63% Step Response Time):	5 sec

Relative Humidity

Resolution:	0.1 %RH
Accuracy	2% RH
	(0-100% RH)

INERTIAL MEASUREMENT UNIT (IMU)

Internal Sampling Rate:	200 Hz
Digital Low Pass Frequency Range:	1 Hz - 40 Hz
Maximum Data Output Rate:	40 Hz

|	Range	Accuracy
Three-Axis (X,Y,Z) Acceleration:	+/- 5 g	0.005 g
Three-Axis (P,Q,R) Rates:	+/- 60 deg/sec	0.03 deg/sec

CENTRAL PROCESSING MODULE (CPM)

Processor:	Motorola DSP56F807
Internal FLASH Memory:	16 Mbit

Wind Speed Accuracy:

Horizontal North and East Components:	0.50 m/s (1.0 knot) @ 150 knot TAS
Vertical:	0.50 m/s (1.0 knot) @ 150 knot TAS
Broadcast / Log Update Rate:	1 - 10 Hz
Log Capacity:	45000 Records (12.5 hours @ 1 Hz)

IMU, GPS and CPM Enclosure Physical Dimensions
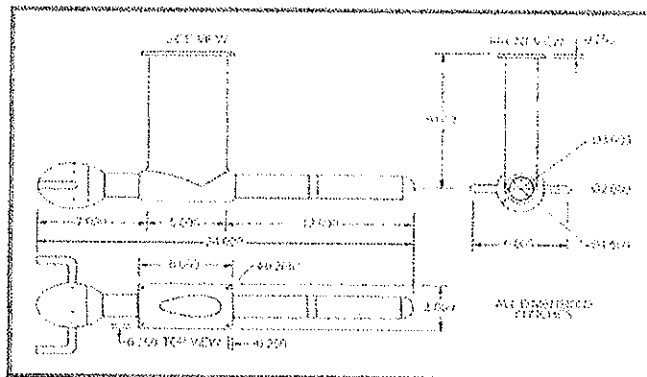
Air Data Probe Physical Dimensions

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