GEC-Marconi
Avionics
Mission Avionics Division

Helicopter Air Data System

HADS

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HELICOPTER AIR DATA SYSTEM

Introduction

GEC-Marconi Avionics have supplied over 1,400 Omni-Directional Helicopter Air Data Systems to customers worldwide for installation on a variety of platforms including:

- Bell AH-1S (modernised) Cobra
- Agusta A-129 Mongoose anti-tank, attack helicopter.
- H-60
- BO-105
- EH-101

M-143 System Operational on the AH-1S Cobra

The system provides full 3-axis, prime accuracy, air data information and the unique Airspeed And Direction Sensor (AADS), simply installed beneath the rotor, enables the system to provide accurate, repeatable data for:

- Rotor downwash throughout the flight envelope
- Ground effect
- Forward, rearward and lateral airspeed (to zero knots)
- Vertical airspeed
- Wind direction, drift and lift margin (when integrated into an avionics suite)
- Enhanced pilot awareness (especially in poor visibility when reference to the ground is difficult)

Installation of the system has demonstrated major improvements for both operational and flight test environments in:

- fire control
- low airspeed, low altitude manoeuvres and Nap-of-the-Earth flight.

Cobra AH-1S M143 Fire and Flight Helicopter Air Data System

The M-143 (NATO Stock Number 1270-01-072-4220) is a standard US Army inventory item with over 1,100 systems in service. The system comprises three Line Replaceable Units :

- Electronics Processor Unit (EPU) : NATO Stock Number 1270-01-071-9277
- Airspeed And Direction Sensor (AADS) : NATO Stock Number 6660-01-073-7284
- Low Airspeed Indicator (LAI) : NATO Stock Number 6610-01-074-4313

Data from the system enables the Fire Control Computer to accurately predict the trajectory of gun rounds and rockets providing a major improvement in weapon delivery accuracy when compared with a conventional air data system.

Forward, rearwards and lateral airspeed information, is displayed to the aircrew on the LAI.

The M-143 is interfaced to the Fire Control Computer (via a 64 bit serial digital data word), the Radar Altimeter and the AN/ASN128 Doppler Navigation Subsystem (provisioned).

M-143 Omni-Direction Helicopter Air Data System

MIL-STD-1553B Helicopter Air Data System (HADS)

The MIL-STD-1553B Helicopter Air Data System (HADS) has been developed to ease the integration of the system with modern avionics suites.

The system utilizes the AADS probe and replaces the EPU with a High Integration Air Data Computer (HIADC) that provides MIL-STD-1553 and RS 485 interfaces.

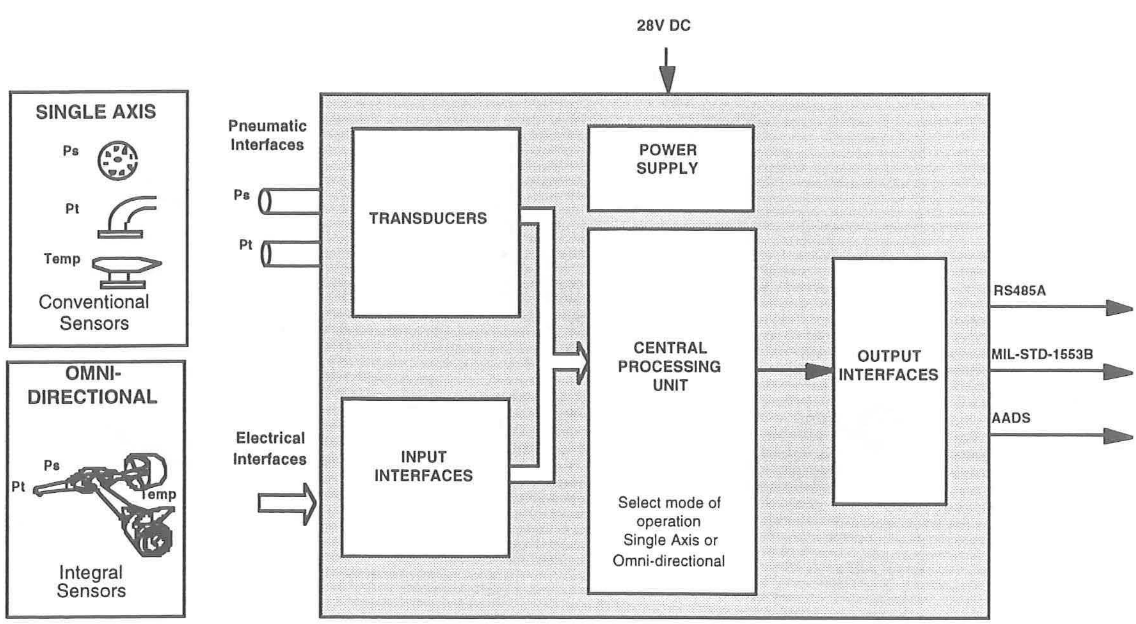
The HIADC has been successfully proven on a number of platforms and is applicable to both fixed and rotary wing aircraft.

By incorporating the AADS analog interfaces and the omni-directional air data software in the fixed wing HIADC the unit offers two modes of operation, from a single hardware configuration:

- conventional single-axis with vertical speed air data computing
- omni-directional air data computing, with the AADS installed

Selection of the appropriate software, and hence output format, is performed by either an identification discrete or by sensing the presence of the AADS.

A pre-production MIL-STD-1553B HADS system has been successfully integrated, installed and flown on a MH-60 as part of a major system upgrade. Productionization and qualification will be complete by the first quarter of 1995.



Helicopter Air Data System configuration demonstrating single axis and omni-directional modes of operation

Technical Description

Airspeed And Direction Sensor

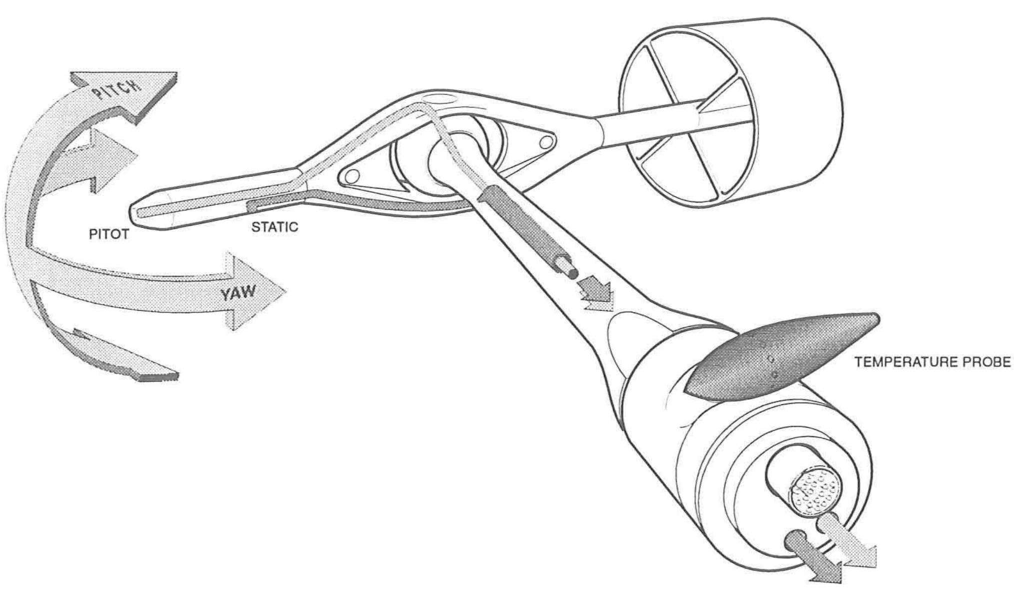
The Airspeed And Direction Sensor (AADS) is a unique, battle proven swivelling pitot-static probe with integral temperature sensor. It is mounted on a boom, under the rotor, which allows the valuable area around the rotor mast to be free for functions such as anti-icing, night vision and weapon aiming.

The sensor accuracy and ease of installation has been demonstrated through research establishments. Systems are in service on the H-60 ADOCS aircraft, now used for the RASCAL program, the Rotor craft Advanced Technology Demonstrator at NASA Ames, the BO-105 and Lynx AH MKI amongst others.

The omni-directional AADS derives the forward, rearward, sideways and vertical flight air data parameters through accurate measurement of:

- airflow speed and direction under the helicopter rotor
- static air pressure
- air temperature

The AADS pressure head is supported on gimbals to allow alignment with the local air flow. Free to rotate through 360 degrees in pitch and ±60 degrees in yaw, the angular position of the head is measured by two synchro resolvers housed in the AADS body. Local air temperature is sensed by an integral platinum resistance temperature sensor.



Omni-Direction AADS

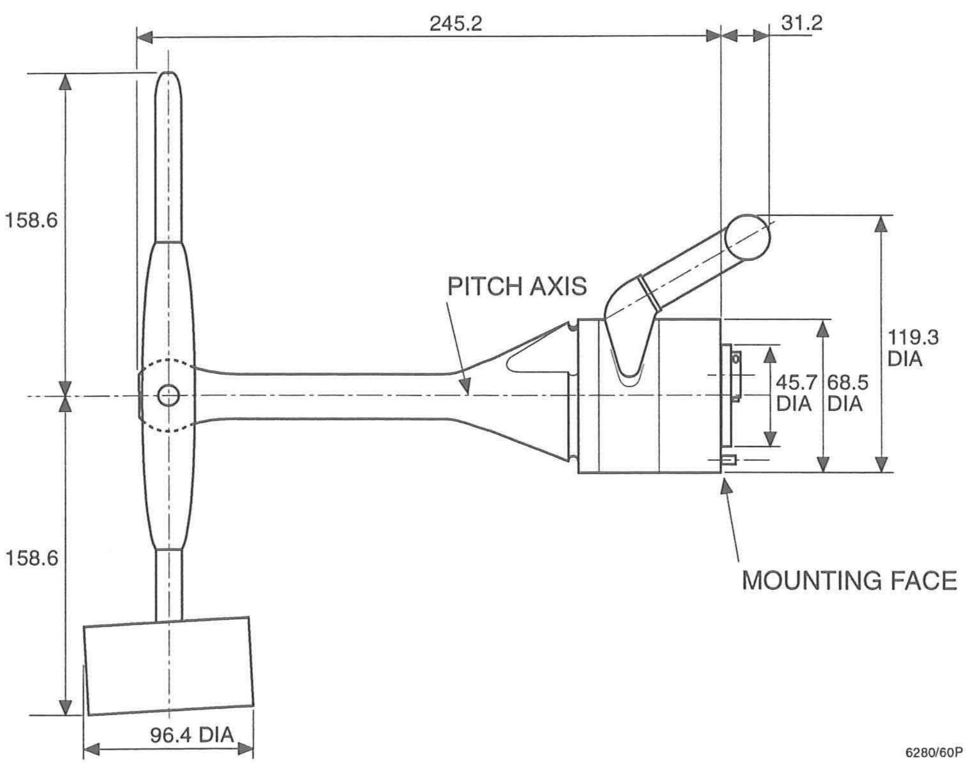
At high forward airspeeds, the AADS is unaffected by rotor downwash and behaves as a conventional pitot-static probe, aligning itself with the local airflow. The sensed airflow angles are therefore the helicopter's angle-of-attack and angle-of-sideslip, which are used to resolve the measured airspeed into the forward, lateral and vertical airspeed components. At low airspeeds rotor downwash becomes the dominant airflow component; the resulting head angle and measured downwash velocity is used to accurately determine the airspeed and direction.

The static pressure and altitude rate is sensed more accurately than is possible with any other known technique as the AADS probe is always aligned with the local flow. Therefore the static pressure measurement does not suffer from the large pressure errors and pressure error/velocity gradients normally associated with conventional altimeter systems.

Physical Characteristics

The overall dimensions of the AADS are as follows:

- Head and Tail: length 12.5, max. diameter 3.8 inches
- Body Assembly: length 10.0, max. diameter 2.7 inches
- Maximum weight: 2.5 lbs



High Integration Air Data Computer

The HIADC performs the following functions:

- Accepts static and pitot pressure; total temperature, radar altimeter and discrete inputs.
- Accepts and processes alpha and alpha-beta (input from AADS).
- Outputs computed air data parameters on the MIL-STD-1553B data bus.
- RS-485 maintenance link.
- Continuous Built-In-Test (BIT)

High Integration Air Data Computer

Installation

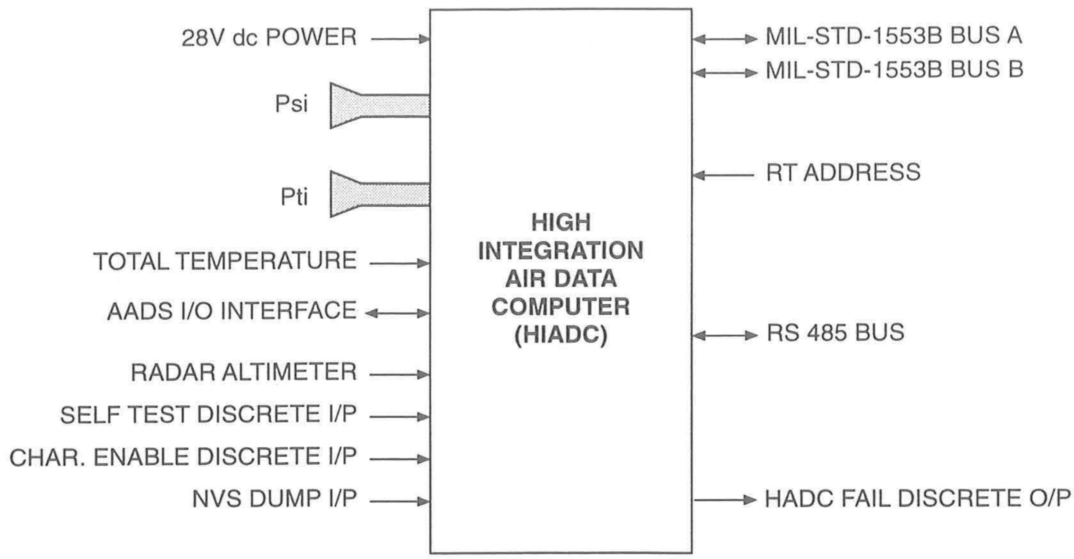
4 -32 UNC taped holes are provided on each of two faces to facilitate mounting in any orientation,. These surfaces are designed such that a mounting flange can be fitted if required. Anti-vibration mountings are not normally required.

Physical Characteristics

The dimensions of the HIADC, (excluding connectors and fixings) are as follows:

- Size: 5.50 x 4.00 x 3.25 in (max)
- Weight: 2.5 lbs (max)
- Power: 28 Volts DC at 6 Watts (max)
- Forced air cooling is not required, as cooling is achieved through conduction and natural convection.

High Integration Air Data Computer (HIADC) Interface



Output characteristics

The following table defines the typical output parameters, ranges and accuracies.

Output Parameter	Range	Accuracy
Barometric Altitude	-1000 to +2000 ft	±50 to ±70 ft
Indicated Airspeed for/aft	-50 to +180 knots	±4 knots
Indicated Airspeed Lateral	-100 to +100 knots	±3 knots
True Airspeed for/aft	-50 to +100 knots	±4 knots
True Airspeed Lateral	-100 to +100 knots	±3 knots
Altitude Rate	±10,000 ft/min	±30 ft/min or ±1%
Static Pressure	1050.4 to 466 mb	±1.4 mb
Static Air Temperature	-60°C to +80°C	±3°C

Installation and Characterization

Every aircraft is unique in design and therefore the flight characteristics and airflow around the airframe must be analyzed.

Corrective measures within the HIADC software ensure that a high level of output accuracy is achieved and maintained throughout the entire flight envelope, especially at low airspeeds and when close to the ground.

Although the design of the HADS has been standardised to keep program costs to an absolute minimum, characteriz-ation of the AADS will normally be required. To ensure program success, it is therefore important that adequate provision is made for:

- Initial installation trials
- Flight data acquisition
- Ground data analysis
- System characterization
- Verification flight.

AADS Installation

To achieve optimum performance, the following general criteria should be considered when determining the location of the AADS.

The AADS should be:

- Mounted forward of the rotor mast and at least 27 inches within the fully developed section of the blade
- At least 18 inches below the lowest possible position of the rotor blade.
- Sufficiently clear from the fuselage to allow freedom of movement within the airflow
- Clear of engine inlet and exhaust ports (including external stores)
- Clear of crew access points
- The sensor should remain within the rotor wake at airspeeds below 25 knots

Once installed the AADS design allows;

- removal and replacement within one minute, using standard tools
- accurate re-alignment of the installed AADS

HIADC Characterization

Each helicopter type exhibits particular differences due to fuselage, downwash and ground effect. These conditions are corrected during normal operation by embedded characterization software.

It is therefore important that adequate dedicated flying time is allocated to ensure that sufficient quality data is acquired during flight trials. This test data will then be analyzed to identify the repeatable errors and to formalise the correction curves within the software. The HIADC, with the resultant characterized software is then returned for a verification flight before incorporation of the final software standard into the production hardware.