GEC-Marconi
AVIONICS

High Integration Air Data Computer
HIADC

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FLIGHT SYSTEMS DIVISION
Instrument Systems Group

HIGH INTEGRATION AIR DATA COMPUTER

Distributed Air System

GEC-Marconi Avionics has been manufacturing air data computers for over thirty years and offer a full range of air data products to the meet a multitude of flight platform and system requirements.

In cases where it is desirable to separate the air data sensing element from the user system, a 'smart' distributed air data transducer unit is required. The GEC-Marconi Avionics latest range of High Integration Air Data Computers (HIADC) have been designed to meet this requirement, across a wide range of flight envelopes for both new build and retrofit programs.

The HIADC typically interfaces to the aircraft Total Air Temperature and Angle of Attack sensor; measures Pitot, Static or Differential Pressures; corrects for systematic error characteristics; computes a full range of accurate air data parameters for output on a serial digital interface.

The standard HIADC has been designed and developed to allow ease of system integration as a 'stand alone' Line Replaceable Unit (LRU). However, as the technology of aircraft sensors advances, 'centralized' integration of a number of functions (e.g. pressure, acceleration, inertial measurement and GPS, necessary for flight control, pilot display, navigation and weapon delivery) into one single LRU is possible. The HIADC, through its simple, robust and compact modular construction, is ideally suited to this 'centralized' function approach, where size, volume and program cost benefits can be achieved.

The HIADC utilizes advanced production techniques, miniaturized air data transducers and features low individual component count and power consumption to provide a prime accuracy, highly reliable Air Data Computer achieving optimum performance at minimum cost.

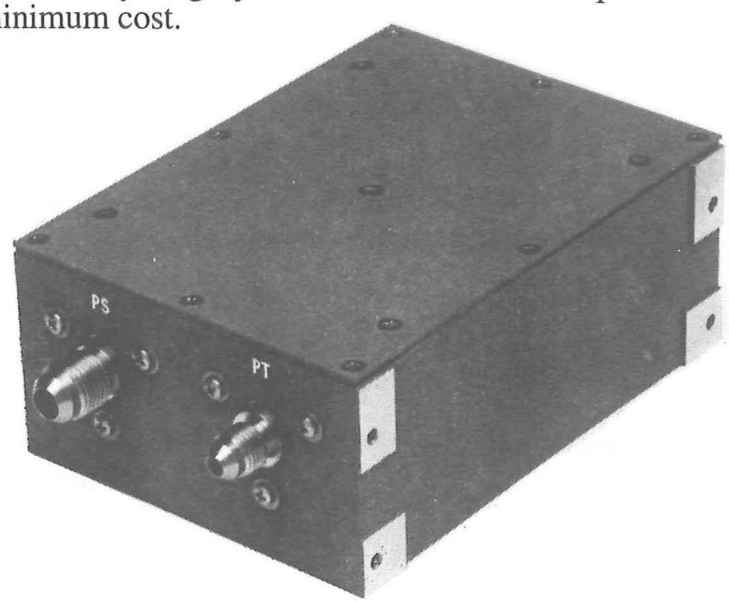


Figure 1 HIADC, Part Number 50-127-01

HIADC Introduction

The standard Arinc-429 HIADC, Part Number 50-127-01 (NSN 6610-99-322-3173), illustrated in Figure 1, has been flight evaluated on the German C-160D aircraft as part of an integrated navigation system. Environmental and EMC qualification of this unit will be completed by the end of January 1994. Production contract award for a batch of 90 units has been received and delivery will commence mid 1994.

Based extensively on the proven design of the Arinc-429 HIADC, further private venture funding was allocated and development work started to produce and test a MIL-STD-1553B HIADC. The first MIL-STD-1553B configuration, Part Number 50-131-01, has been selected as part of a Weapon Delivery System upgrade. This features additional analog and discrete interfaces with provision for an IFF interface.

Further configurations of the HIADC are possible based on a high degree of non-development hardware and software, please refer to Appendix A.

HIADC Technical Description

The following paragraphs provide an overview of the HIADC and the technology used.

Pneumatic Inputs

The HIADC accepts two pneumatic inputs from the aircraft's pitot-static system. A pair of Schlumberger vibrating cylinder absolute pressure transducers are used to convert the inputs into frequency modulated signals. The Pressure Transducer sub-assembly interfaces directly to the HIADC computation module.

HIADC Computation Module

Processing

- All air data computations, characterisations, input and output control and Built-In-Test functions are performed by a micro-controller. The HIADC features RAM, EPROM plus serially accessed EEPROM.

Input Interfaces

- Transducer interface.
- Analog conditioning interfacing (e,g. Temperature Probe, Angle of Attack Vane, Barometric Pressure Setting).

Output Interfaces

- Standard
    - RS-422, data format tailored to customer requirements.
    - Arinc 429, low speed (12.5KHz) in accordance with ARINC standard.
- Optional
    - MIL-STD-1553B.
    - Customer/aircraft specific outputs to include, analogue synchro drives, Altitude Encoding for IFF/SSR or discrete switching outputs.

Power Supply

- The standard HIADC is powered from a 28 volts DC supply which will meet the characteristics and limits defined in MIL-STD-704. (115 volts AC, 400Hz can be implemented.)

Reliability

- A typical HIADC configuration assumes a very high reliability yielding a MIL-HDBK-217E Mean Time Between Failure prediction of over:
    - 50,000 hours, based on an ambient temperature of +56 °C and an Airborne Inhabited Cargo (AIC) environment.
    - 25,000 hours, based on an ambient temperature of +71 °C and an Airborne Uninhabited Fighter (AUF) environment.

Built-In-Test (BIT)

- The BIT functions include continuous monitoring of input validity and HIADC functionality. A detected failure will result in the appropriate validity bit or bits being set in the serial output data words.
- HIADC Self Test can be commanded over the serial bus or by a discrete BIT input.

HIADC Performance

- Computed air data parameters are updated and output every 50ms.
- Response to total or static pressure variations greater than 2 Hz.
- High accuracy is obtainable over the full military range.
- Static Source Error Correction (SSEC) curves can be imbedded in the software for specific aircraft application.

The range and accuracy of a typical HIADC digital output is shown in Table 4 below.

PARAMETER	RANGE	ACCURACY
Pressure Altitude (Hp)	-1,500 to +80,000 ft	Greater of ± 15 ft or 0.2% Hp
Barometric Corrected Altitude (Hbc)	-1,500 to +80,000 ft	Greater of ± 15 ft or 0.2% Hp plus ±7 ft for applied baro corrections
Mach Number (M)	100 to 2,000 millimach	± 2 millimach at 100 millimach ± 5 millimach at 800 millimach ± 8 millimach at 2,000 millimach
Calibrated Airspeed (Vc)	40 to 700 knots	± 6.0 knots at 40 knots ± 4.8 knots at 50 knots <± 1.0 knots at 250 knots and above
True Airspeed (Vt)	50 to 1,300 knots	± 2.5 knots at 100 knots ± 5.0 knots at 1,300 knots and above
Total Temperature (Tt)	-100 to +350°C	± 1.0°C
Altitude Rate (dHpr)	±60,000 ft/min	Greater of ± 30 ft/min or ±0.5%
Static Air Temperature (Ts)	-100 to +50°C	±1.0°C
Impact Pressure (Qc)	1.46 to 1,050 mb	± 0.77 mb
Corrected Static Pressure (Ps)	27.6 to 1,069.4 mb	± 0.55 mb
Barometric Pressure Setting (Bps)	800 to 1,050 mb	±0.2 mb

HIADC Construction

The standard HIADC, illustrated in Figure 2, contains a single hardwired Electronics Assembly and incorporates the following principal features:

- Pressure Transducer sub-assembly utilising Schlumberger type 7881 vibrating cylinder pressure transdueers.
- Single Card containing all functions necessary for air data computation.
- Serial digital outputs, RS-424, ARINC 429 (standard) and MIL-STD-1553B (optional).
- Power Supply sub-assembly, for internal use only.
- Chassis allows hardmounted installation with an option of two mounting surfaces.
- Software modules written in high level language 'C', developed and documented in accordance with DEF-STAN-0031.

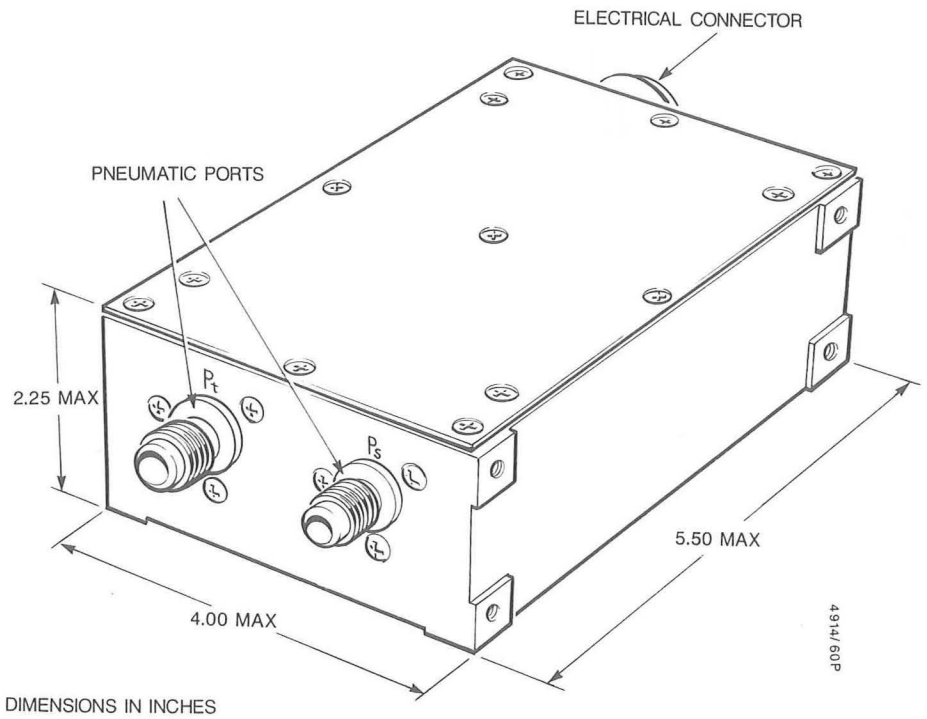


Figure 2 Standard HIADC Construction

Figure 3 illustrates the standard HIADC envelope dimensions and installation criteria.

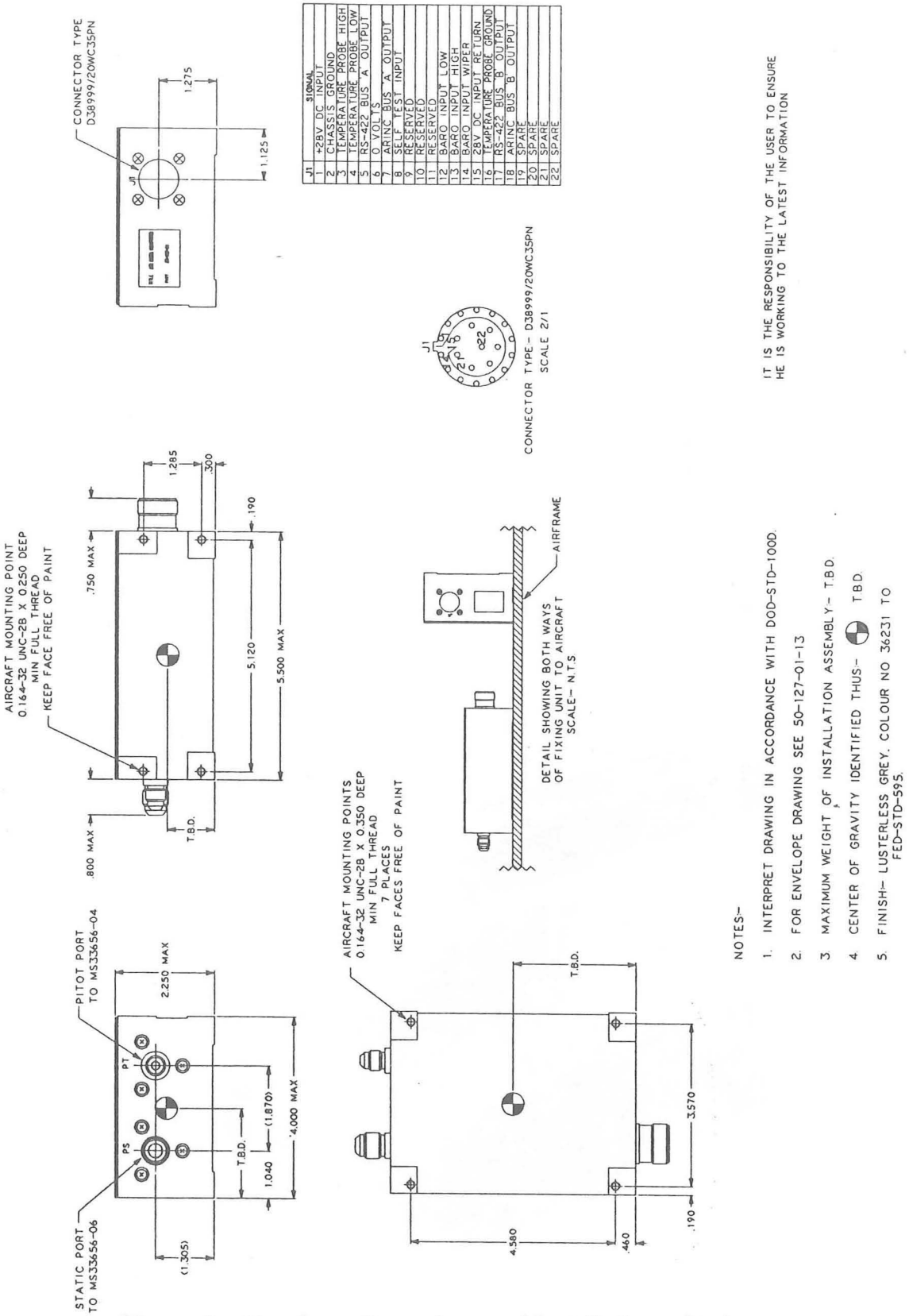


Figure 3 Envelope dimensions and installation criteria

To minimize the associated development costs when reconfiguring the standard HIADC to incorporate customer specific 'growth' requirements, such as analogue synchro drives, IFF or discrete switching outputs, an additional module can be added using a 'Sandwich' technique.

An extra layer is inserted between the existing casting and the power supply top cover. This layer will comprise an extension frame which provides fixing provisions for an extra PWB assembly. The existing combined Power Supply and Top Cover will then be fitted to complete the chassis enclosure. Any additional connector requirements, for example, the MIL-STD-1553B connectors, will be mounted on this frame and connected directly to the Interface Module.

The anticipated dimensions, weight and power consumption of the Optional HIADC is compared to the Standard HIADC in Table 5 below.

Configuration	Weight	Dimensions (inches)	Power Consumption
Standard	2lb	5.5 x 4 x 2.25	5W
Optional	2lb 8oz	5.5 x 4 x 3.25	6W

An illustration of this sandwich technique is shown in Figure 4

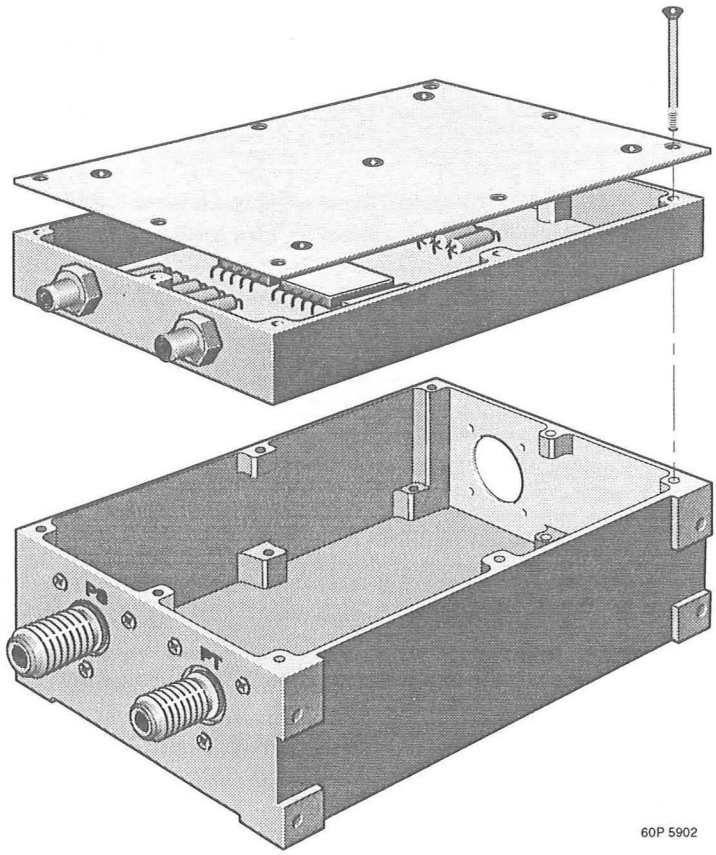


Figure 4 HIADC Growth Construction

APPENDIX A

HIADC types are identified by a four digit code which indicates the range and number of transducers and the specific input and output interfaces of each configurations. Details of specific HIADC interfaces can be supplied on request. As a guideline, the coding for standard HIADC configurations is identified in the following tables.

Table 1 1st Digit

TRANSDUCERS	COMMENTS
1 = 1 low range	Low range, 19 psi (0 to 1309 mb) full scale pressure transducer. Normal range for static pressure (Ps)
2 = 1 high range	High range, 38 psi (0 to 2620 mb) full scale pressure transducer. Normal range for pitot pressure (Pt)
3 = 2 low range	Low Air Speed ADC or Helicopter Air Data System (HADS)
4 = 1 low & 1 high range	High Air Speed ADC
5 = 2 high range	High pressure range transducer

Note: Alternate pressure transducer combinations and pressure ranges are available on request.

Table 2 2nd Digit

INPUT INTERFACE	COMMENTS
0 = No other inputs	
1 = Temperature Probe (TP)	50 or 500 ohms resistive, other types available
2 = TP & Baroset Pot. Input	Baroset potentiometer or DC analog input
3 = Helicopter Probe & TP	GEC proprietary Helicopter AADS (see Note)
4 = TP & AoA Pot.	Angle of Attack Potentiometer or DC analog
5 = TP & AoA Synchro	400 Hz, 11 volt line to line
6 = TP & BPS -ARINC Input	TP and Baroset input on ARINC 429

Note: The GEC-Marconi Avionics Airspeed and Directional Sensor (AADS) used with a HIADC Type 3304 provides a very capable, full three axis Helicopter Air Data System (HADS).

Table 3 3rd and 4th Digits

OUTPUTS 3rd & 4th DIGITS		COMMENTS
00 =	RS422	19.2 Kbit/s Speed
01 =	ARINC 429	12.0 - 14.5 Kbit/s Speed
02 =	MIL-STD-1553B I/O	Bi-directional, HIADC will accept Baroset and other inputs from the bus
03 =	2 Synchro + Altitude Encoding + 2 Alt. Power	Form, Fit, Function replacement for CPU-66 or CPU-46 (IFF, Mode C)
04 =	HADS	
05 =	RS422 + ARINC 429	Baseline HIADC configuration
06 =	Single Analog	Simple DC Output
07 =	6 Analogs	
08 =	2 Synchro + Altitude Encoding + ARINC 429	18.8V Synchro. Gilham coded Hp signal for IFF/SSR Mode C operation
09 =	2 Synchro + Altitude Encoding + 1553B	18.8V Synchro. Gilham coded Hp signal for IFF/SSR Mode C operation
10 =	MIL-STD-1553B + IFF	
11 =	ARINC 429 + IFF	

High Integration Air Data Computer (HIADC)

Achievements:

New family of Air Data Computers

- Flexible design concept
- Standard configurations defined

System Pedigree

- HIADC Type 1000

- Extensively evaluated by McDonnell Douglas Aerospace

- HIADC Type 3000

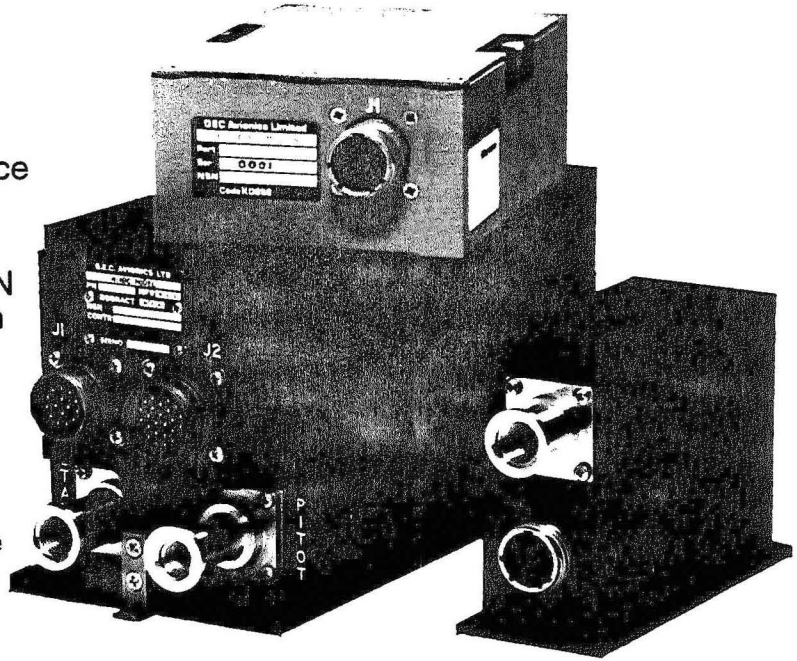
- Flight test evaluation on Beech King Air, as part of USN Ground Proximity Warning System integration program

- HIADC Type 3205

- Part No. 50-127-01
- NSN 6610-99-322-3173
- Selected for the C-160D Transall for German Air Force
- Environmental and EMC Qualification Program now completed
- Two pre-production units delivered and successfully flight evaluated
- First Production delivery on schedule for June 1994

- HIADC Type 4003 (CPU-66 F^3 replacement)

- Tested at NAWC Patuxent River 1992



HIADC Type No. Encoding

Transducer Configuration 1st DIGIT	Other Inputs 2nd DIGIT	Output Options 3rd & 4th DIGITS
1 = 1 low range	0 = None	00 = RS422
2 = 1 high range	1 = Temperature Probe (TP)	01 = Arinc 429
3 = 2 low range	2 + TP + BPs Pot	02 = MIL-STD-1553B
4 = 1 low + 1 high range	3 = TP + HADS Resolver	03 = 2 Synchros + IFF + 2 alt. power
5 = 2 high range	4 = TP + AoA Pot	04 = HADS
	5 = TP + AoA Synchro	05 = RS422 + Arinc 429
	6 = TP + BPs via Arinc Input	06 = Singl analog
		07 = 6 analogs
		08 = 2 Synchros + IFF + Arinc 429
		09 = 2 Synchros + IFF + 1553
		10 = 1553 + IFF
		11 = Arinc 429 + IFF

HIADC Type 3205 System Interfaces (1)

Pitot
Static
Probe

HIADC
Part No.50-127-01

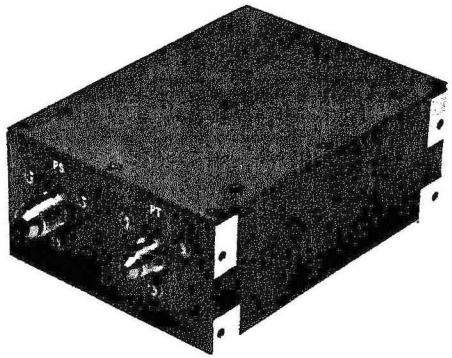
Ps

Pt

Baroset

Discrete I/P

TAT

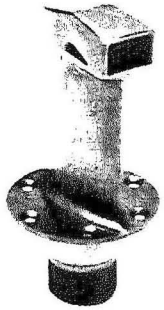


ARINC 429

RS422

- Impact Pressure (Qc)
- Total Temperature (Tt)
- Corrected Static Pressure (Ps)
- Pressure Altitude (Hp)
- Altitude Rate (dHp)
- Calibrated Airspeed (Vc)
- Mach No. (M)
- Static Air Temperature (Ts)
- True Airspeed (Vt)
- Barometric Pressure Setting (Bps)
- Barometric Corrected Altitude (Hbc)
- Elapsed Time Indication (ETI)
- Maintenance Data

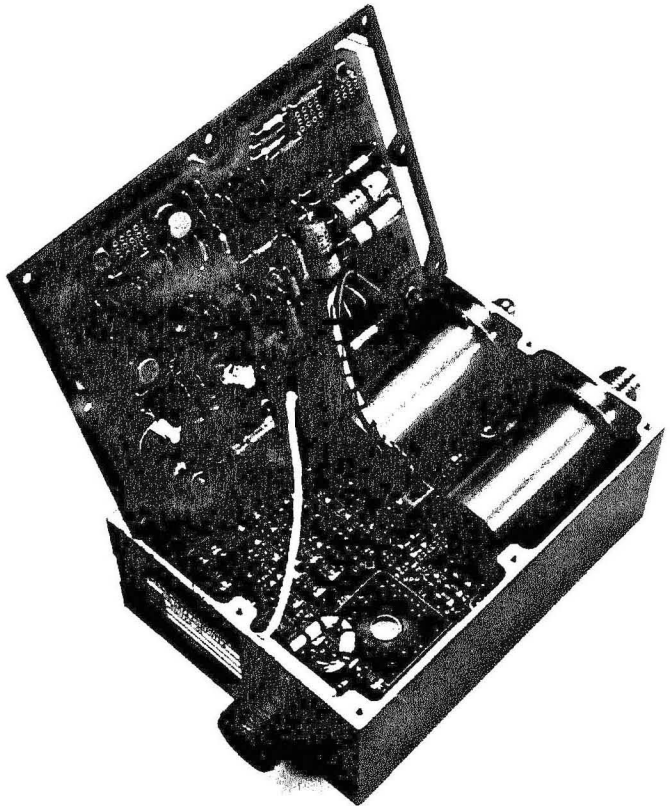
28V DC



Total Air
Temperature
Probe

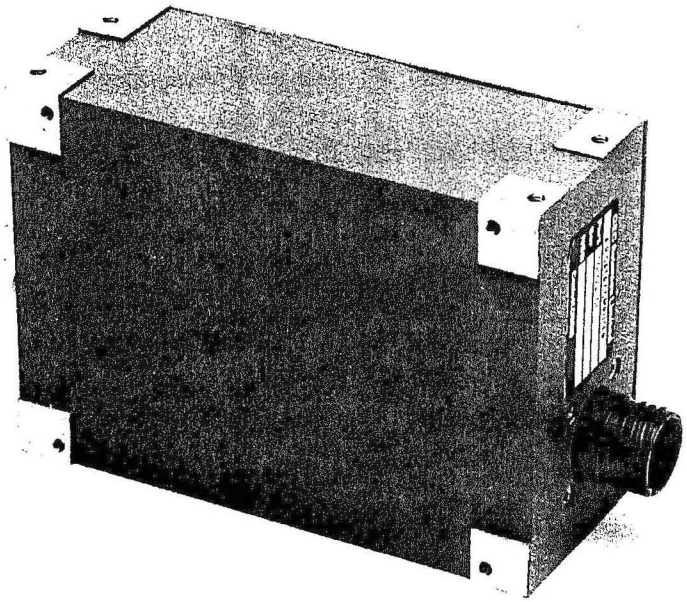
De-icing heater power

HIADC Type 3205 System Interfaces (2)



- **Provides functions of Air Data Computation**
- **Inputs:**
  - Pneumatic Pressures
  - Total Air Temperature
  - Barometric Pressure
  - Discrete
- **Outputs computed parameters via two independent serial interfaces:**
  - ARINC 429
  - RS-422
- **Built-In-Test information continuously available via serial interfaces**
- **Input power:**
  - 28 V dc at 4.0 W (max.)
    - to MIL-STD-704C

HIADC Type 3205 Characteristics



- **Size:** (excluding connectors and fixings)
  - 5.5 inches (139.7 mm) long
  - 4.0 inches (101.6 mm) wide
  - 2.25 inches (57.2 mm) high
- **Installation:**
  - Hardmounted via four 8-32 UNC tapped holes
    - Option of two mounting surfaces
  - Compact design allows flexibility of location
- **Weight:**
  - ≤2.0 lbs (0.91 kg)
- **Cooling:**
  - Conduction and natural convection only
- **Reliability:**
  - >30,000 hours (MIL-HDBK-217F AUF at +71°C)
  - Suitable for two-level maintenance philosophy