INTEGRATED HEALTH & USAGE MONITORING SYSTEM PA3700

FLIGHT RECORDING

- **CAA/FAA, EUROCAE ED 55**
- **Combined CVR/FDR Option**
- **64 or 128 Words/Second**
- **ARINC 429 Compatible**
- **Comprehensive BIT**
- **On-board Data Dump**

HEALTH & USAGE MONITORING

- **Engine Usage, Vibration & Exceedences**
- **Rotor Track & Balance**
- **Gearboxes & Transmission**
- **Oil Debris**
- **Component Usage**
- **Ground Diagnostics**

Electronic Systems Division
(A Division of GEC-Marconi Defence Systems)

BRISTOW HELICOPTERS

PA3700
Integrated Health & Usage Monitoring System

General

Electronic Systems Division and Bristow Helicopters Limited have combined their systems and operating expertise to develop an Integrated Flight Data Recording Health and Usage Monitoring System (IHUMS) for use in many aircraft applications.

To satisfy CAA/FAA and European Legislation regarding the installation of mandatory Flight Data and Cockpit Voice Recorders into helicopters, the IHUMS provides the facility to meet these legal requirements whilst also giving significant improvements in flight safety and aircraft maintenance.

The maintenance and flight safety elements of the system are complimented by the considerable proven experience of Westland Helicopters (gearbox health through vibration analysis) and MJA Dynamics (rotor track and balance).

System Description

The IHUMS has been designed to fulfil the functions of a Digital Flight Data Recorder (DFDR), a Cockpit Voice Recorder (CVR) and a Health and Usage Monitoring System (HUMS). The system architecture has been optimised to provide a minimum hardware solution by the combination of these functions.

Each airborne system comprises:

Data Acquisition and Processing Unit (DAPU)

Cockpit Voice and Flight Data Recorder (CVFDR)

Card Maintenance Data Recorder (CMDR)

Control and Display Unit (CDU).

Pilot Interface Panel (PIP)

In addition to this core system, other options are available including:

    Control and Display Unit (CDU)
    Pilot Interface Panel (PIP)
    Cockpit Warning Panel (CWP)
    Quick Access Recorder (QAR)

A full range of first line test equipment and other ground based support equipment is also available.

PA3701 Data Acquisition and Processing Unit (DAPU)

This Unit contains all the conditioning circuitry necessary to sample and accurately monitor a wide range of different types of electrical inputs for subsequent recording, measurement or processing. The mandatory data output interfaces to a standard ARINC 573/717 Flight Data Recorder and a standard ARINC Quick Access Recorder. Selected mandatory data, together with raw and partially processed HUM data, is also fed to a ruggedised Maintenance Data Recorder. Data can be displayed on the optional Control and Display Unit as required.

PA3701 Data Acquisition and Processing Unit (DAPU).

The microprocessor subsystem architecture performs continuous real time computation of user defined algorithms whilst simultaneously handling pilot or automatically initiated 'health and usage' routines for maintenance purposes.

A non-volatile memory is incorporated within the DAPU which contains computed results such as Low Cycle Fatigue (LCF) counts, exceedances and component operating times. Documentary data such as aircraft identification, engine number, gearbox number etc is also stored. This memory can be downloaded/uploaded by the aircrew via the Maintenance Data Recorder.

Comprehensive BIT facilities to satisfy the new CAA requirements have also been incorporated.

900 series crash protected Cockpit Voice and Flight Data Recorder (CVFDR)

There are several versions of this Penny and Giles crash protected recorder available to customers with differing requirements. For this application, two versions are recommended, as follows:

D51506

This CVFDR provides five hours of continuous digital recording at a data rate of 128 twelve-bit words per second and one hour of voice on each of three separate tracks. This capacity, in conjunction with a fully instrumented HUM capability, satisfies the new CAA and Air Navigation Order requirements for aircraft above 2700kg.

D51506 crash protected Cockpit Voice and Flight Data Recorder (CVFDR).

D51508

This CVFDR provides eight hours of data recording at 64 words per second, and one hour of voice on each of three separate tracks.

All versions of this Unit utilise the same fully approved crash protected case and the same proven tape transport mechanism. The recorder incorporates all the circuitry necessary to erase, prior to writing data to the crash protected tape, after which it is read both for BITE purposes and during data dumps.

Card Maintenance Data Recorder

This Unit was designed to meet ARINC 615 as a high speed data loader. The recording medium is a 2 Mbyte SRAM card. The data interface is bi-directional using RS232C protocol. The Unit is rugged, compact and the recording medium easily transportable, which makes it ideal for use as a Card Maintenance Data Recorder.

The bi-directional interface to the DAPU enables upload of documentary data from a card as well as download of raw and pre-processed data for maintenance purposes.

Card Maintenance Data Recorder.

Software/Processing Capability

Ada Software language is used throughout except in time critical areas where Assembler is used. Object orientated analysis and design techniques for software has been adopted throughout, resulting in a well structured, fully documented and therefore flexible package. All software within this system complies with DO- 178A Level II.

Ground Diagnostics

The downloaded airborne DAPU data is supported by a comprehensive ground replay and analysis computer system. This support system has been developed by Bristow Helicopters and is based on the extensive operational and engineering experience only available to a major helicopter operator. A number of options are available, ranging from a portable personal computer designed to support single aircraft operation, through to a comprehensive networked computer system capable of supporting a large fleet of aircraft and incorporating existing or proposed ground maintenance systems.

Two significant sections of the ground based diagnostics are based on the proven experience of the following two organisations who have built considerable reputations in their particular fields:

1. Westland Helicopters Limited, as part of the Westland Group plc, has developed considerable expertise in the field of helicopter gearbox health monitoring through the use of vibration analysis.

The techniques used by Westland allow, via the airborne acquisition of enhanced gearbox vibration signal averages, the early detection of gearbox damage.

When used in conjunction with gearbox oil system debris detection, the system provides the best possible indication of gearbox health and condition.

2. MJA Dynamics Limited has a proven reputation in the field of helicopter rotor track and balance diagnostics.

The DAPU ability to capture rotor track and balance information during normal operations, allows the ground based diagnostic package to provide the maintenance engineer with single shot multi-adjustment data.

MJA Dynamics' reputation has developed through the successful implementation of their multi-adjustment diagnostics in several aircraft types. The advanced techniques being utilised will lead to incipient failure detection in rotor systems and other helicopter airframe components.

Ground Support Equipment

A wide selection of first line test equipment is available ranging from a simple hand held data extraction Unit for monitoring exceedances and LCF counts, to a comprehensive lap-top PC capable of full diagnostics for 'on the spot' maintenance.

D50331 Data Transfer Unit (DTU)

The DTU is a portable data dumping machine used to download all the digital data from the FDR and to store it on a data cartridge at eight times the record speed. The audio channels can be similarly transferred but at normal speed only, and there is an interlock/protection system to safeguard the security of the recorded audio data.

System Interrogation Unit (SIU)

The SIU uses a rugged portable computer fitted with specially designed interface circuitry to support all of the maintenance tasks. These include:

Monitor, dump and calibrate DFDR data

Test the Cockpit Voice Recorder in the aircraft

Upload and download DAPU data

Test MDR and CDU interface and cabling

Acquire vibration data for on-aircraft analysis

Acquire Track and Balance data for on-aircraft analysis

Ground Station Computer

PA3700 Integrated Health and Usage Monitoring System
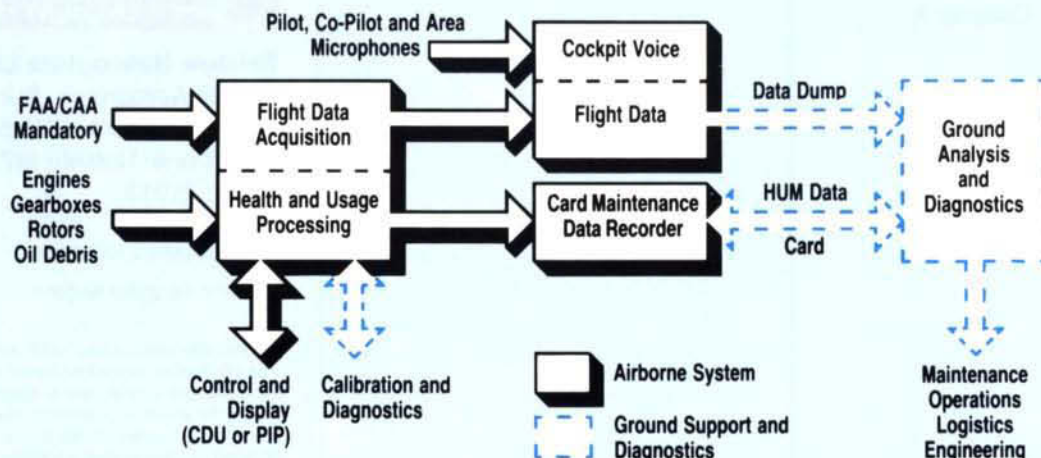
DATA SUMMARY

PA3701 Data Acquisition and Processing Unit

Input Capability

1. Analogue Signals
Synchro
DC Voltage
AC and DC Ratiometric Voltage
Potentiometer

2. Discrete Inputs
Shunt (0V or open circuit)
Series (open circuit or 28V)   } ARINC 573
Marker Beacon
Latched Shunt
Latched Series

3. Digital
ARINC 429
Honeywell ASCB (option)
MIL−STD−1553B (option)

4. Frequency
Tacho (8 to 256Hz)
Pulse Probe (up to 32kHz)

5. HUM Sensors
Accelerometers
Rotor Tracker

Output Capability

FDR: Harvard Bi-phase at 64, 128 or 256 wps
CMDR: RS232C up to 19.2K baud
QAR: RZ at 64, 128 or 256 wps
Test Facility: RS232C
CDU: RS422 up to 19.2K baud
PIP: 5 buffered TTL inputs
6 buffered TTL outputs

Environmental

To RTCA DO−160B

Operating Temp	−30° C to +70° C
Temperature/ Altitude	Category B1
Humidity	Category A
Vibration	Category J/Y
Mech. Shock	Section 7
Electromagnetic Compatibility	Category A

Power Input

Nominal 28V DC to
DO−160B Category A
Maximum Consumption 51W

Dimensions

½ ATR Short − ARINC 404A.

Weight

6.2kg (13.6 lbs)

D51506 crash protected Cockpit Voice and Flight Data Recorder

Input Capability

Harvard Bi-phase (ARINC 573/717)
3 audio (voice) channels

Recording

Tape speed: $^{15}/_{16}$ inches per second
Density: 1638 bits per inch
Error rate: 1 bit in 10^5

Retrieval

x8 data transfer

Environmental

To TSO−C51A and RTCA DO−160B

Operating Temp	−20° C to +55° C
Temperature/ Altitude	Category D1
Humidity	Category A
Vibration	Category N
Mech. Shock	Section 7
Electromagnetic Compatibility	Category A

Power Input

Nominal 28V DC to
DO−160B Category A
Maximum Consumption 14W

Dimensions

Height: 115.6mm (4.55ins)
Width: 173.5mm (6.83ins)
Depth: 440.5mm (17.33ins)

Weight

8.5kg (18.7 lbs)

Card Maintenance Data Recorder

Input/Output Signal

RS232C

Capacity

2Mbytes minimum (formatted)

Environmental

To RTCA DO−160B

Temperature Altitude Humidity	} Category A1
Vibration	Category K
Mech. Shock	Section 7
Electromagnetic Compatibility	Category A

Power Input

Nominal 28V DC to
DO−160B Category A
Maximum Consumption 10W

Dimensions

Height: 38.1mm (1.5ins)
Width: 133.35mm (5.75ins)
Depth: 132.05mm (5.12ins)

Weight

0.5kg (1.1 lbs)

GEC-Marconi

Defence Systems

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