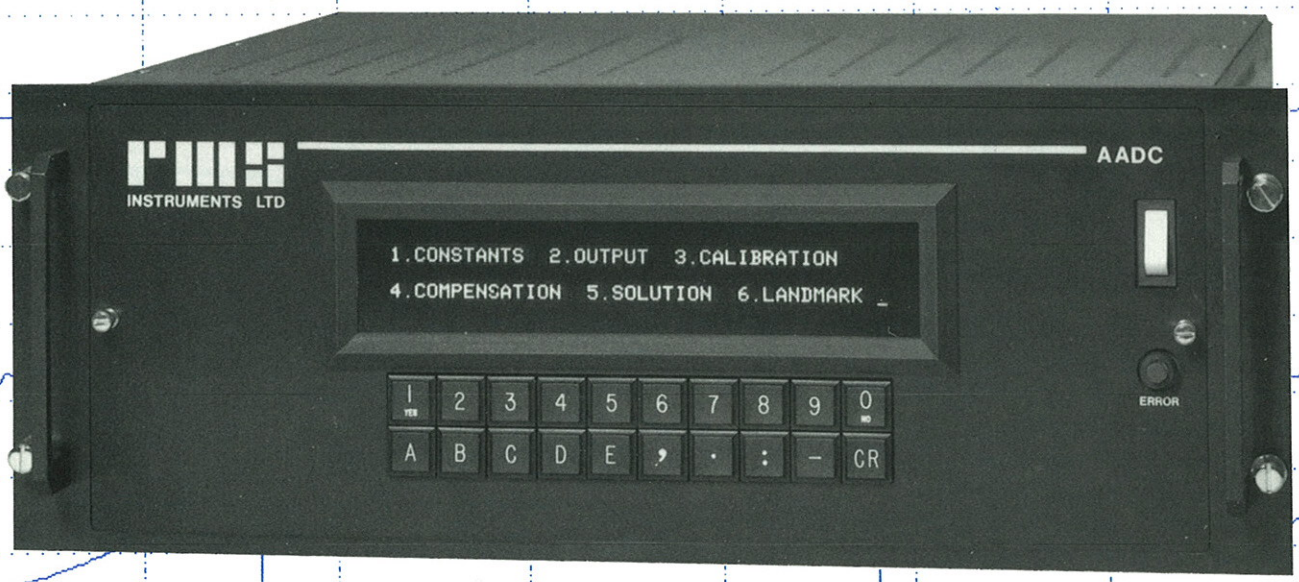
RMS INSTRUMENTS
Data Recording Systems

AADCII

AUTOMATIC AEROMAGNETIC DIGITAL COMPENSATOR



COMPENSATOR FOR HIGH-SENSITIVITY AIRBORNE MAGNETOMETER INSTALLATIONS

AADCII

Automatic Aeromagnetic Digital Compensator

The AADCII is an instrument used to compensate or correct in **real time** for the magnetic interference caused by the aircraft itself and aircraft maneuvering in the earth's magnetic field, when using inboard mounted high sensitivity magnetometers. The compensation accounts for the effects of permanent magnetism, induced magnetism, Eddy currents and also removes the heading errors caused by the sensors themselves. It provides a frequency bandwidth of DC to 0.9 Hz, the frequencies of most interest to the geophysicist. Other bandwidths are optionally available. The signal(s) from the magnetometer(s) are digitized faithfully without aliasing or phase distortion.

The AADCII is based on many years of research and development on automatic aeromagnetic compensation by the National Aeronautical Establishment (NAE), a division of the National Research Council of Canada. Following the transfer of technology, RMS Instruments continued with the development resulting in an instrument which is extremely reliable, capable of accepting the Larmor frequencies of up to four high sensitivity magnetometers and based on a sophisticated compensation algorithm which is extremely robust.

Features:

- **Purely mathematical solution**
- **Solution incorporates up to 30 terms**
- **Compensates pitch, roll, yaw and heading effects in real time**
- **Accepts one to four high sensitivity magnetometer inputs**
- **High resolution magnetometer processor 0.001 nT**
- **Compatible with most high sensitivity magnetometers (Helium, Cesium, Potassium and Proton)**
- **Compensates the total field of each sensor as well as the gradients**
- **Excellent quality control tool - especially with gradiometer systems**
- **Fast calibration - typically 6 to 8 minutes**
- **Solution obtained immediately when calibration terminated**
- **Solutions can be stored and recalled**
- **Provides compensated, uncompensated and aircraft attitude data**
- **High MTBF and low operating costs**
- **Lightweight and easily installed**
- **Fully digital and automatic - no compensation coils required**

THE SYSTEM

The AADCII is a multiprocessor system that consists of a Front End Interface, Counter and Processor which is a Single Board Computer (SBC) for each Larmor frequency input. The magnetometer signal is oversampled, counted, processed and passed to the main Microcomputer.

The fluxgate reference magnetometer is digitized by a 16 bit A/D converter and then processed by a SBC similiar to the Larmor signal.

The Frequency Counter uses a 100 MHz crystal oscillator time base. When more magnetometer sensors are added to the system, the counters use the same 100 MHz crystal oscillator time base eliminating drift and maintaining synchronization.

The main microcomputer contains the compensation and system operating software. Following the processing, the compensated and uncompensated data are available immediately for display and recording.

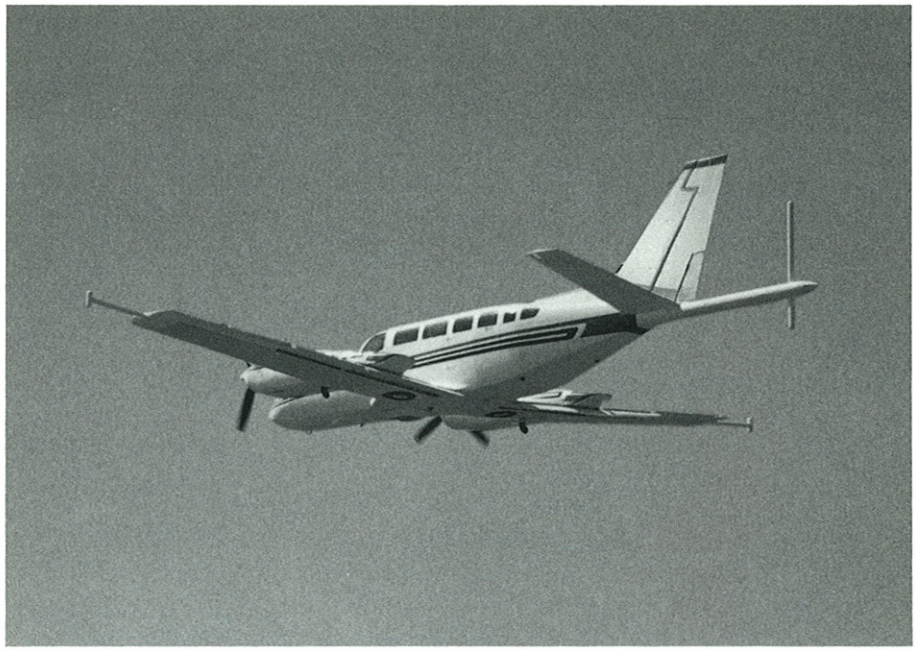
The AADCII is self-calibrating, making it very simple to operate. Following an initial calibration flight of only a few minutes, the AADCII is immediately providing compensated data. A calibration is only repeated when the magnetic configuration of the aircraft is altered.

CALIBRATION

The self-calibrating AADCII uses a 3-axis fluxgate magnetometer to monitor the aircraft's position and motion with respect to the ambient magnetic field while flying a set of standard maneuvers of rolls, pitches and yaws in the cardinal headings. During the calibration mode of approximately 6-8 minutes, the positional data together with the magnetometer sensor(s) readings are utilized by a sophisticated model to arrive at a solution of approximately 30 terms.

SOLUTION

The solution is a comprehensive mathematical model accurately describing the magnetic interference of the moving aircraft. It is available **immediately** upon termination of the calibration maneuvers for actual compensation use or for comparison with other solutions that had been obtained earlier and were stored in memory.



Cessna Titan 404 with a four-sensor triaxial gradiometer system installed. Photo courtesy of Poseidon Geophysics (Pty) Ltd, Botswana.

COMPENSATION or OPERATING MODE

The AADCII automatically enters this mode at power-up and measured values of the total field and gradient (if more than one sensor installed) are corrected for the aircraft interference using the last solution selected. Compensated and uncompensated values of the high sensitivity magnetometers along with the 3-axis vector magnetometer readings are available for display on the front panel, the RS232 serial output port, as well as for the RMS Instruments' GR33A graphic recorder.

OUTPUT DATA

The AADCII can output the data at up to 10 times per second (user selectable) with a bandwidth of 0.9 or 1.8Hz. The output also contains a fiducial number, a clock value and the 4th difference for each magnetometer. The output is user definable with respect to data, serial parameters and data type (ASCII or binary).

REMOTE CONTROL

A standard terminal output is supplied allowing the AADCII to be controlled from a remote location or computer. All of the front panel displays and setup menus are transmitted for the operator's convenience.

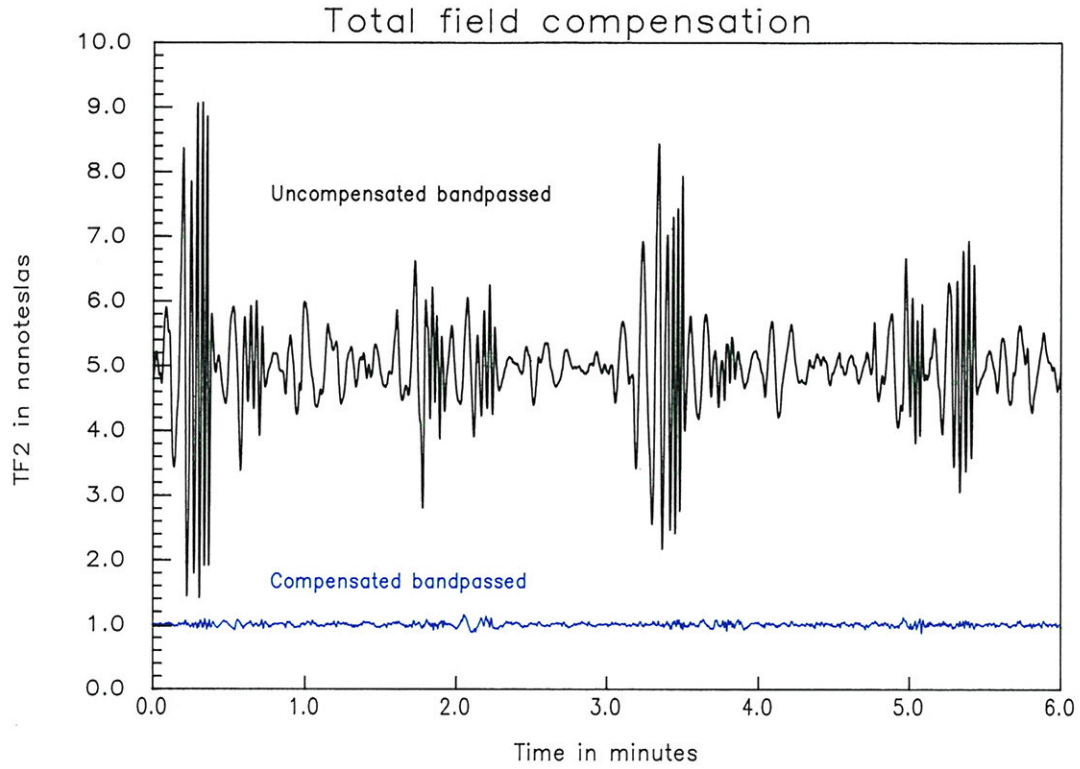
PERFORMANCE INDICATION

Displays provide statistical data to indicate the quality of the calibration enabling the operator to evaluate the system performance. The "Improvement Ratio" (IR) or effectiveness of the compensation is the ratio of the standard deviations of the signals before and after compensation. These values, in nanoteslas, are shown in the display. Typically, IR values in excess of 10 - 20 are routinely achieved in large and magnetically complex aircraft.

RESOLUTION OF HIGH SENSITIVITY MAGNETOMETERS REALIZED

Improvement offered by the AADCII is achieved over and above any passive compensation of the magnetometer installation. If the user has a magnetically "clean" installation or has achieved passive compensation to 0.45 nT, they can expect, with a conservative IR of 15, to achieve system performance of 0.03 nT.

Actual data from a Convair 580 aircraft using the AADCII and the DGR33A data acquisition and recording system.

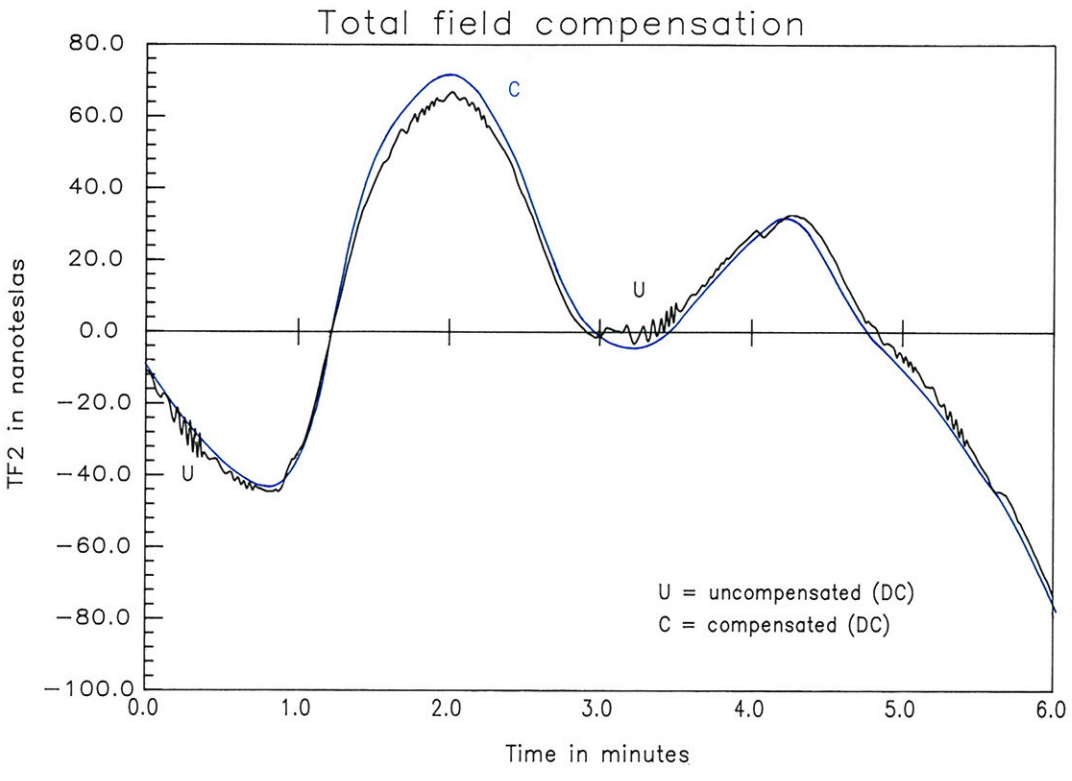


TOP: The uncompensated data is the entire compensation flight (6-8 minutes). The aircraft interference is clearly visible on the four headings.
Below it, is shown the compensated data.
Both plots have been offset for clarity.

The performance indicators are:

Uncompensated	σ	=	0.754 nT	IR	=	24
Compensated	σ	=	0.0315 nT	Mean Value	=	57119.73 nT

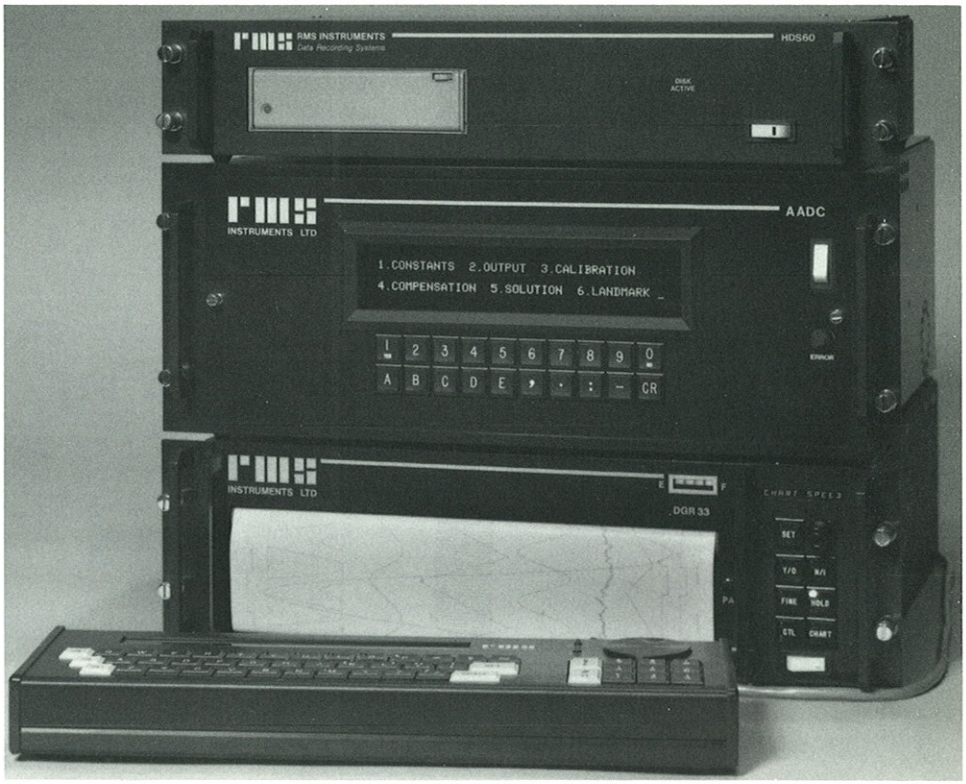
BOTTOM: Profile of the same data with the arithmetic mean subtracted



COST EFFECTIVE

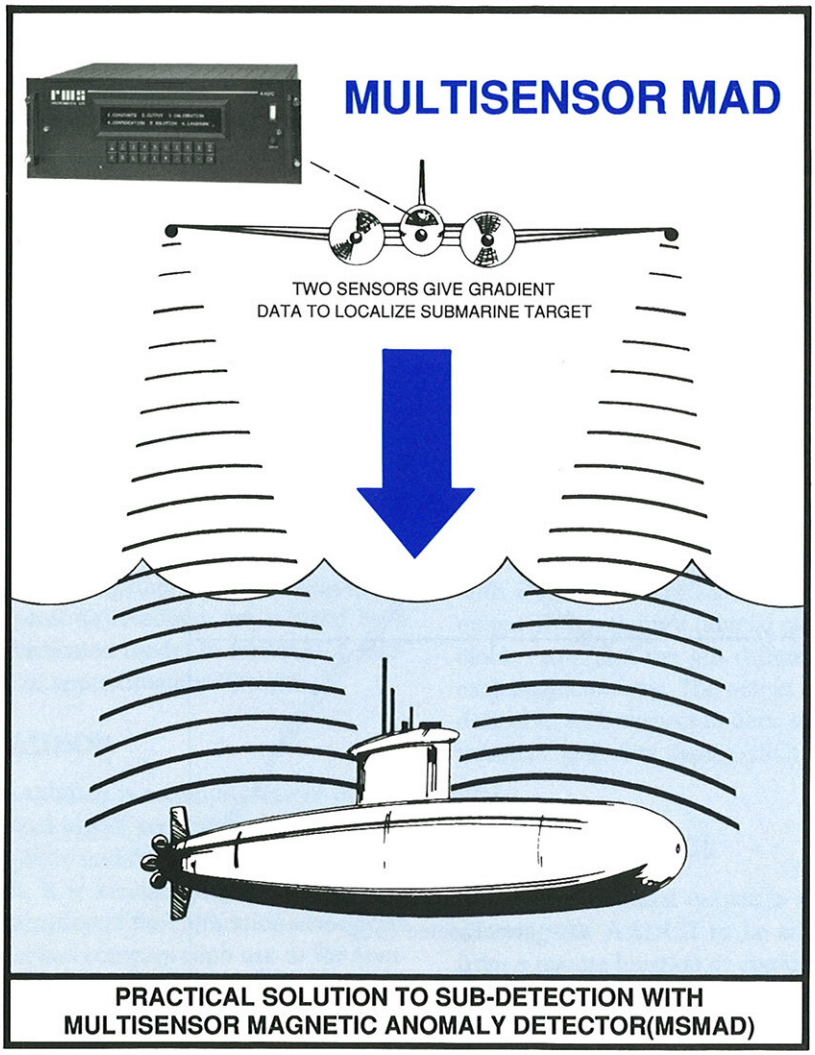
The AADCII provides the user with the ability to mount a magnetometer sensor or sensors inboard an aircraft allowing the user to avoid towed bird systems which are less sensitive, have higher maintenance and are less reliable. The AADCII also permits the use of gradiometer installations of two, three and four magnetometers providing data immediately for total field, horizontal, vertical and longitudinal gradients.

The AADCII is an excellent quality control tool since it provides the compensated data immediately. With the aircraft interference removed the user can observe in real time that the data is meeting the desired criteria. This eliminates the delay encountered with post flight compensation techniques which also must be implemented cautiously especially with gradiometer systems to avoid undesired phase shifts that will distort the data.



Above is shown a complete compensator and recording system consisting of:

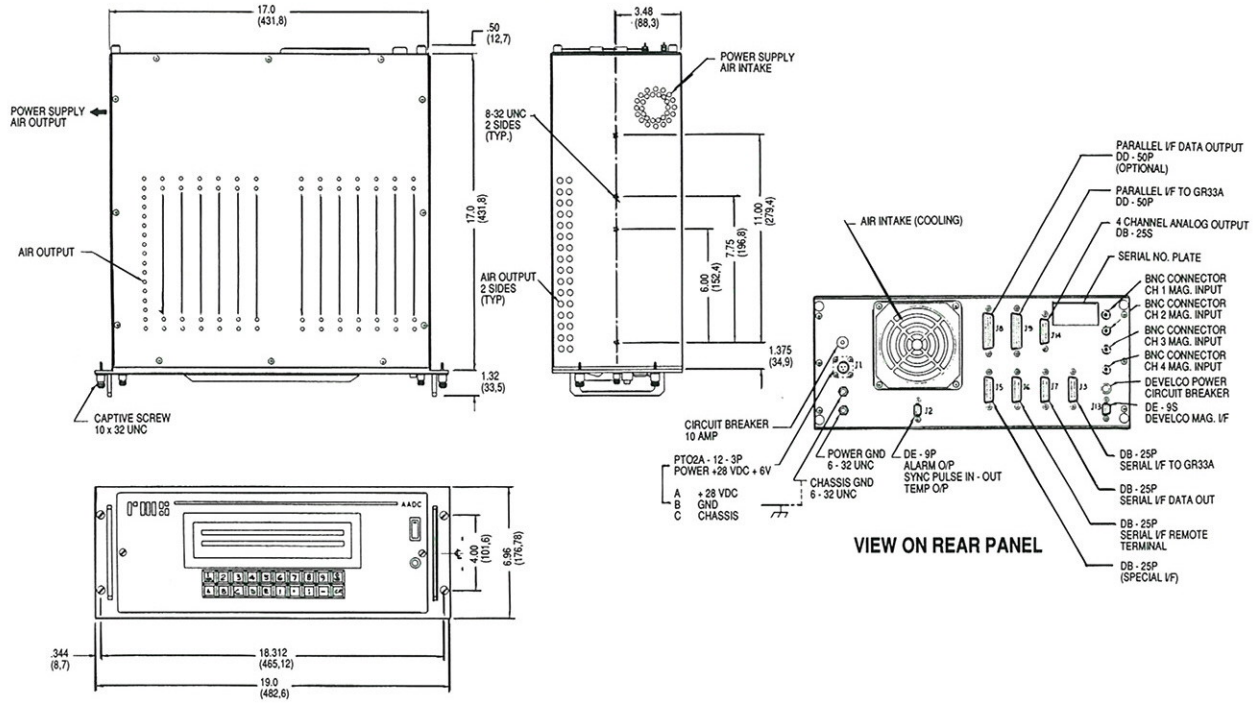
AADCII	
DGR33A	data acquisition /graphic recorder
HDS60	hard disk and streamer tape



PRACTICAL SOLUTION TO SUB-DETECTION WITH MULTISENSOR MAGNETIC ANOMALY DETECTOR(MSMAD)

MILITARY APPLICATIONS

In addition to the narrow bandwidth of the system which is of interest to the military, the use of a lateral gradiometer system provides not only detection but direction as well. This is a great enhancement over traditional single sensor magnetic anomaly detection (MAD) systems currently in use which only provide target recognition.



Inputs: one to four high sensitivity magnetometers

Input Frequency Range:
70 KHz to 350 KHz - Cs sensor
140 KHz to 700 KHz - K sensor
560 KHz to 2800 KHz - He sensor
850 Hz to 4260 Hz - Overhauser

Magnetic Field Range:
20,000 to 100,000 nT

Front End Counter Timebase:
100 MHz

Resolution: 1 pT

Compensation Performance:
improvement ratio 10 to 20 typical for total field
improvement ratio 20 to 100 typical for gradient

Accuracy of Compensation:
0.035 nT standard deviation for the entire aircraft flight envelope in the bandwidth 0 to 1 Hz typical

Data Output Rate:
10 Hz max (User Definable)

Frequency Response:
0 to 0.9 Hz (Other Bandwidths Optional)

Internal System Noise:
less than 2 pT (standard deviation) in the bandwidth 0 to 1 Hz)

Calibration Duration:
6 to 8 minutes typical (Flight Maneuvers)

Vector Magnetometer:
3-axis Fluxgate oversampled, 16 bit resolution

Microcomputer:
Multiprocessor Design

Display:
Green fluorescent, 80 character self scan panel

Outputs:
3 serial RS232C ports; max. rate 19.2 KBaud
a) magnetometer data output
b) direct interface to GR33A recorder
c) terminal/computer interface for remote control

parallel output port:
16 bit with full handshaking (optional)

4 analog outputs with 12 bit resolution, 10 V full scale (optional)

Power:
For single magnetometer
28 VDC ±6 VDC, 5 A, 150 W max.
For gradiometer
6 A, 196 W max.

Environmental:

Operating Temperature:
0 to 50 °C

Storage Temperature:
-20 to 55 °C

Relative Humidity:
0 to 99%, non-condensing

Altitude:
0 to 6000 m (0 to 20,000 ft.)

Size:
483 mm W x 178 mm H x 440 mm D
(19 x 7 x 17.3 inch)

Weight:
12.5 kg (28 lbs)

SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

For additional information on these and other products, contact;

Distributed By:

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