DATA ACQUISITION &
ADAPTIVE AEROMAGNETIC REAL-TIME
COMPENSATION

2nd-Generation DAARC500
Increased performance, functionality and reliability
Fully compatible with 1st-generation installations

- Comprehensive, flexible data acquisition
- Embedded GPS receiver option (single-, dual- or triple-frequency)
- Eight isolated RS232 serial ports (115.2 kbps), two Ethernet (10/100/1000 Mbps)
- Flexible ASCII, binary and raw serial data formats, with large buffers (> 64 KB/port)
- 16 differential/32 single-ended analog inputs, 16-bit resolution
- Serial/analog/Ethernet data synchronized to magnetics, with time & event tags
- Flexible and simple user interface via built-in TFT LCD and external display
- Full monitoring/control from any Windows device (via Ethernet, or through the Internet)
- Real-time graphical output to built-in display, external display and chart recorder
- Embedded Flash memory, internal hard disk, USB-based Flash disk
- Real-time operating system (RTOS): QNX 6.5
- State-of-the-art HW & FW architecture based on advanced 32-bit processors
- Compact and light: 19”-rack mountable, 5.25” height, 19 lb.
- Magnetometer interface for up to 8 high-sensitivity sensors (Cs, He or K)
- User-selectable front-end sampling rates, up to 1280 Hz
- Magnetometer processor: 0.32 pT resolution, < 0.1 pT internal system noise
- Real-time compensation of up to 8 total fields and various gradients
- Proven, extremely robust compensation algorithms (AADCII legacy)
- Adaptive signal processing techniques – improved compensation and simplified calibration procedures
- User may customize Front End processing to specific installation requirements
- Provides compensated, uncompensated and raw data
- Data output & recording: 10, 20, 40, 80 Hz or external trigger
- NEW: Post-flight compensation function
- NEW: Dynamic compensation of on-board electronic systems
- NEW: Gating of magnetometer readings for concurrent use with EM systems
The RMS Instruments' DAARC500 offers the ultimate in aeromagnetic compensation, together with comprehensive and flexible data acquisition and recording. Powerful, versatile and rugged, yet compact and light, the DAARC500 is ideally suited to airborne and mobile geophysical and environmental survey applications.

Aeromagnetic compensation in the DAARC500 has its roots in the AADCII, for many years the de facto standard in aeromagnetic compensation in the geophysical exploration industry throughout the world. The result of many years of R&D by RMS Instruments, and collaborations with the Flight Research Laboratory of the National Research Council of Canada, the DAARC500 continues the AADCII tradition of consistently producing outstanding data in a cost effective manner.

The system is built on the foundation of state-of-the-art, very reliable hardware and firmware, and sophisticated and robust compensation algorithms that have been proven in a multitude of installations. Consistent with compensation, data acquisition is delivered with unparalleled performance, accuracy and reliability.

**Aeromagnetic Compensation**

The quality of the data collected in aeromagnetic surveys is largely dependent on the quality of compensation. Despite the outstanding sensitivity of modern magnetometers, in the absence of good compensation, anomaly signals which fall off as the third or fourth power of distance, can be completely masked out by the interference of the nearby magnetics of the aircraft.

The aircraft’s magnetic interference is related to its motions about its principal axes. A mathematical model may be built to accurately represent the aircraft’s magnetic signature. Careful optimization and implementation of this model, within the framework of sophisticated hardware and firmware technologies, can lead to real-time compensation that effectively eliminates the aircraft’s magnetic interference.

The RMS Instruments’ DAARC500 Data Acquisition System & Adaptive Aeromagnetic Real-Time Compensator provides real-time compensation of local magnetic interference for inboard magnetometer systems in fixed wing aircraft and helicopters, to the point where the full resolution of modern high sensitivity magnetometers can be utilized. The compensation accounts for the effects of permanent and induced magnetism, Eddy currents, and heading errors from the sensors.

**The need for real-time compensation**

The magnetic signature of typical survey aircraft is extremely prone to change in-flight. Something as simple as switching-on a light in the cockpit may cause a significant DC-shift in the compensated data. Detecting these changes while monitoring uncompensated data is practically impossible. State-of-the-art aeromagnetic surveying requires real-time monitoring of compensated data, so that problems are identified immediately and are promptly corrected. Relying solely on post-flight compensation is akin to “flying blind”.

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**Diagram:**

![Diagram](image-url)
Calibration and solution
The DAARC500 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 orthogonal 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.

The solution is a comprehensive mathematical model that accurately describes the magnetic interference of the moving aircraft. It is calculated instantly, upon termination of the calibration maneuvers. It is immediately available for use in compensation mode or for further analysis and comparison with other solutions.

With the DAARC500 there is no need for any post-flight software. The system uses the full 360º pattern to obtain a robust solution. If necessary, in the event full 360º signal acquisition is not possible, the DAARC500 allows calibration for each active zone, and a corresponding solution. Furthermore, any set of such partial calibrations can also be readily combined to produce a single robust solution for all of the sensor's active zones.

Compensation – total fields & gradients
In compensation mode measured values of up to 8 total field high-sensitivity magnetometers and gradients are corrected in real-time using one of the solutions previously obtained. Compensated and uncompensated signals along with the 3-axis vector magnetometer and other ancillary data, are available in real-time for recording on Flash media or hard disk, and for monitoring on the built-in display and other peripheral devices.

Adaptive compensation
The DAARC500 incorporates sophisticated adaptive signal processing techniques that allow the system to continuously "learn" from input signals, and adapt the solution coefficients for optimum compensation. This can lead to improved band-passed and gradient compensation (up to several times lower residual errors), and simplified calibration procedures. Other novel approaches are continuously being developed and can be readily incorporated into the system thanks to its flexible architecture.

Dynamic compensation of OBE systems
The DAARC500 incorporates new technology that allows real-time dynamic compensation of the effects of DC currents from on-board electronic (OBE) systems, such as radios, avionics, intercoms, hydraulic pumps and other instrumentation. The compensation model is augmented by a suitable set of terms calculated by running a simple "calibration" procedure. OBE compensation offers important benefits to users – it simplifies operational requirements for operators during survey flights, increases robustness and tolerance to electrical sources, and improves overall compensation performance. The technology will work both for devices with fixed-current and with variable-current draws, for as many as four independent OBE systems.

Data Acquisition System
Comprehensive and flexible data acquisition and recording complement the aeromagnetic compensation functions in the DAARC500.

External devices with digital (serial) and analog outputs can be connected directly to the DAARC500. The system provides 8 high-speed, isolated, serial (RS232) inputs and outputs, 16 differential (or 32 single-ended) analog inputs, and two 10/100/1000Base-TX Ethernet interfaces (one dedicated to data acquisition).

Flexible serial protocols (ASCII, binary and raw) and practically unlimited buffering space, allow easy interfacing to most devices.

All data sampling, including magnetics and compensation output, is at rates based on the same time base. Data are recorded with time and event tags that allow accurate synchronization to GPS receivers.

Remote Control from Windows
A remote connectivity tool for the DAARC500 allows users full control and operation of the unit from a remote Windows-based system, across an IP network. The user interface of the DAARC500 is seamlessly replicated in the Windows-based computer. The mouse and keyboard attached to the computer have the same effect as if they were directly connected to the DAARC500. The figure below illustrates typical connections and data flow.
This technology facilitates integration of complex systems, with a single computer/laptop being used to control and operate the DAARC500 and other instruments, while simultaneously running complementary software.

**System Description**

RMS Instruments' new compensation and data acquisition technology is based on a flexible architecture that incorporates dual 32-bit processors. It includes state-of-the-art COTS (industrial-grade) electronics, and a new proprietary magnetometer interface module.

**Front End subsystem**

The Front End is based on a high-performance, low-power, RISC PowerPC processor. The magnetometer interface, most critical for high-performance compensation, uses the latest in analog and digital electronics to provide excellent accuracy and synchronization for up to eight total-field magnetometers.

The magnetometer interface uses a very stable, temperature-compensated crystal oscillator time base. The proprietary counter and synchronization hardware deliver outstanding performance with negligible noise and temperature drift.

A three-axis fluxgate (vector) magnetometer is included with the system. Signals are processed using a high-resolution (16-bit) A/D converter.

Front End sampling rates are user-selectable, up to 1280 Hz. Finely tuned, user-selectable transfer functions deliver outstanding anti-aliasing characteristics. The user may also customize Front End processing to the specific requirements of an installation (e.g., minimize effects from the rotor system in a helicopter).

For concurrent use with EM systems a gating signal may be used to qualify magnetometer readings.

Front End raw data are optionally made available. This allows in-depth frequency domain analysis and troubleshooting of installations.

Excellent synchronization to GPS is achieved through the Front End (with or without the GPS receiver option).

The Front End offers outstanding resolution and internal system noise. The figure below illustrates a twofold improvement in system noise over legacy systems.

**Host subsystem**

The host subsystem is built around one of Intel's most recent dual-core processors. The application software and real-time operating system (RTOS) reside in (solid-state) Flash memory. The RTOS is QNX 6.5 (or later). This is a deterministic and extremely reliable operating system tailored to mission-critical applications, that guarantees compliance with the strict timing constraints of all critical tasks.

Raw and compensated data are available in real-time, at up to 80 Hz: (a) for recording in Flash media or the hard drive, (b) for graphical/numerical output on the built-in display and/or external display/monitor, (c) via a 115.2-kbps serial port, and (d) for output to a chart recorder.

The Host software offers optional filtering with user-selectable bandwidths. It includes also facilities for spectral analysis on collected data. The software allows configuration and control through an easy-to-use graphical user interface.
Comprehensive statistical information is provided to assess the quality of the calibration/solution. The information, readily accessible on the display, includes the Improvement Ratio (IR), a standard measure of the effectiveness of the compensation. The DAARC500 will typically achieve IRs in the range of 10–20 for total fields in large and magnetically complex aircraft. For gradients, figures in the range of 20–100 are typical, with better performance possible when using adaptive compensation.

The improvement offered by the DAARC500 is achieved over and above any passive compensation of the magnetometer installation. For example, with a magnetically “clean” installation, or if passive compensation has been achieved to 0.45 nT, a conservative IR of 15 will yield system performance of 0.03 nT.

Data may be recorded in embedded Flash memory (≥16 GB), an internal hard disk (≥160 GB), or a Flash disk connected through any of the USB ports available.

In addition to comprehensive data acquisition functionality, the host subsystem also provides an integrated graphics controller that allows simultaneous output to the built-in display and to any external display connected via the analog RGB interface, and extensive general-purpose I/O (Ethernet, USB, UART).

**Optional decoupler**

In its standard form the DAARC500 accepts decoupled Larmor signals on BNC connectors. An optional power/decoupler module is available for four or eight inputs (on TNC connectors). The decoupler separates the Larmor outputs of the magnetometers from 28-Volt power, and monitors the quality of magnetometer input signals.

**GPS receiver option**

An embedded GPS receiver is the source of all timing within the system. GPS data (time, latitude, longitude, altitude) are appended to recorded and transmitted magnetics data blocks. A variety of receivers are available to satisfy different requirements in accuracy. The DAARC500 gives users direct access to two ports on the receiver. This provides, for example, the interface to a navigation system. The GPS receiver option is also available for use with an external (user-supplied) receiver.

**Post-flight compensation option**

This option offers the capability to compensate surveys post-flight, in the event a suitable calibration was not available at time of flight. While the requirement for real-time compensation is key for productive and efficient airborne magnetometry, this is a valuable option under such conditions. The option also includes functions for in-depth analysis of calibration data.

**Data exporting software**

The data files recorded by the DAARC500 have a structure optimized for efficiency and performance. ExportDAARC is a comprehensive support software package included with the DAARC500 which allows exporting data files to industry-standard formats (e.g., flat-ASCII, ‘XYZ’, Geosoft ‘GBN’).

**ORDERING INFORMATION**

- **DAARC500-x**: DAS & Adaptive Aeromagnetic Real-Time Compensator. [x = # of magnetometer inputs; 2 ... 8]
  - Includes: – Vector (fluxgate) magnetometer.
  - – License/Key for Phindows: Remote control from any Windows computer via IP network over Ethernet.
- **Advanced Functions**: Multiple FE smpl. rates & transf. funcs., raw FE logging, in-field FW updating, mag. gating for concurrent use with EM.
- **Post-Flight Compensation**: PFC and calibration analysis functions. Requires the Advanced Functions option.
- **RMS4880A Magnetometer Power/Decoupler Module**: RMS4880A-1 (up to 4 inputs), RMS4880A-2 (up to 8 inputs).
- **RMS2938-1**: 32 single-ended analog channels (instead of the standard 16 differential channels).
- **GPS Receiver Option**: Internal (consult RMS Instruments for list of receivers available) or External.
- **Front-End-Sampled Analog Inputs**: 4 differential insps., 16-bit ADC (in addition to std. 16/32 chan. Analog Input Module). Required for OBE comp.
Magnetometer Inputs:
Up to 8 high-sensitivity magnetometers; any combination of:
- Cs: Typ. 70 kHz – 350 kHz
- K-41, K-39: Typ. 140 kHz – 700 kHz
- He: Typ. 560 kHz – 2.8 MHz

Magnetic Field Range:
Per the magnetometer’s range; e.g., [4]
- G-822A, G-823A: 20,000 – 100,000 nT
- CS-3, CS-L: 15,000 – 105,000 nT
- GSMP-30A: 20,000 – 100,000 nT

Front End (FE):
- Time base: > 100 MHz, TCXO
- Resolution: 0.32 pT [1]
- System noise: $\sigma < 0.1 \text{ pT} [1]
- Sampling rate: 160, 640, 800 or 1280 Hz – user-selectable [2]
- Transfer function (bandwidth): 1.6 Hz, 3.25 Hz, 6.4 Hz, 9.8 Hz, 20 Hz, 0.16F_{Sh} or Custom Transf. Funct.–user-select. [2]

Compensation Performance:
- IR (total field): 10 – 20, typical
- IR (gradient): 20 – 100, typical

Compensation Accuracy:
$\sigma = 20 \text{ pT}$ for entire flight envelope, 0–1Hz

Optional Filter (Host):
User-selectable, 0.4–3 Hz BW

Calibration Duration:
6–8 minutes, typical

Vector Magnetometer:
- Included with the DAARC500
- 3-axis fluxgate
- Oversampling, 16-bit, self-calibrating ADC

OBE Compensation:
- Dynamic compensation of up to 4 independent on-board elec. systems
- Requires FE-sampled Analog option

Data Output & Recording:
- Rate (F_{Sh}): 10, 20, 40, 80 Hz, external
- Serial port: to 115.2 kbps, ASCII/Binary
- Recording memory: embedded Flash memory (≥ 16 GB), internal hard disk (≥ 160 GB), USB-based Flash disk
- Chart recorder
- Display (built-in and external)

Event Inputs/GPS Synch.:
- Four latched event inputs
- LS-TTL levels, edge-sensitive
- Event tags included with output data

Input resistance: 1 MΩ ≤ Ω ≤ 255

Display:
- 6.5” colour TFT digital LCD
- VGA resolution (640 x 480)
- Antiglare surface treatment
- Luminance: 400 nits

Mouse:
- Silicone-rubber actuators
- Pressure-controlled operation
- No moving parts

Remote Control:
- From any Windows-based computer, via IP ntwk. over Ethernet – replica of DAARC500’s user I/F on computer.
- Via serial (RS232) port – ASCII cmnds.

Post-Flight Compens. – Optional:
- DAARC500 binary d-files

Power:
+28 VDC (± 6 VDC), 3.75 A

Environmental:
- Operating Temperature: 0 to +50ºC
- Storage Temperature: –20 to +55ºC
- Relative Humidity: 0 to 99%, non-cond.
- Altitude: 0 – 3,000 m (0 – 10,000 ft)

Size (W x H x D):
- 483 x 133 x 381 mm,
  (19 x 5.25 x 15 in)

Weight: 8.6Kg (19lb)

Notes:
- [1] Some restrictions apply for 5–8 mag. inputs.
- [2] Requires DAARC500 Advanced Functions Option. Without it, system defaults to 640-Hz front end sampling rate, 1.6-Hz BW.
- [3] The 1-A current rating at turn-on is as per Scintrex, GSMP-30A (GEM Systems).

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Specifications subject to change without notice
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