Magnetoresistive sensors for a Magnetometer

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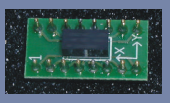
Technology Survey

- Induction sensors
- [illegible]etic sensors
- [illegible] sensors
- Resonance Magnetometers
- Super Conducting Quantum Interference Devices
- Fluxgate Magnetometers
- Anisotropic Magnetoresistors (**AMR**)


Fluxgate


Anisotropic Magnetoresistors

AMR Concept Justification

CONCEPT 1 - Fluxgate

Power Consumption: < 900 mW

Mass: 450 gr

Size: 11 cm x 6cm x 4.5 cm
(Length x Width x Height)

Most widely used in space MTM

CONCEPT 2 - AMR

Power Consumption: < 600 mW

Mass: 195 gr

Size: 8 cm x 6cm x 3.2 cm
(Length x Width x Height)

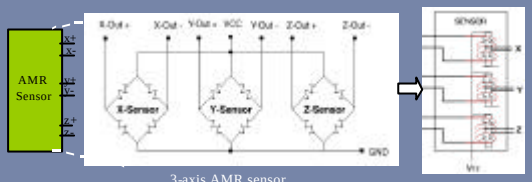
Microchip Technology

Comparison

Concept Technology Comparison Table

Specifications	AMR Concept	Fluxgate Concept
Mass	Lighter	Heavier
Dimensions	Smaller	Bigger
Power	Lower Power Consumption	Higher power consumption
Calibration	Easy to calibrate	Not so easy to calibrate
Orthogonality uncalibrated	Lower orthogonality between (x,y) plane and z axis	Better Orthogonality
Reliability (Proven Technology)	No accurate data. (3-axis AMR sensors were already used in Space)	Good (mission life time)

Analogue AMR
Sensor Element Description



3-axis AMR sensor

- Differential output (out + / out -), varies with the magnetic field
- Output typically (5 to 10 mV)

Analogue AMR
Principles of Operation

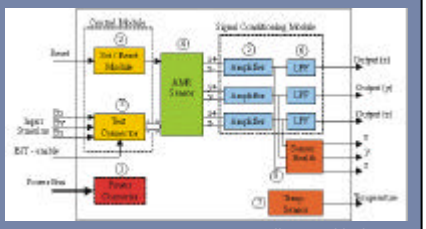
Block Diagram

Power Converter

Set / Reset

Signal Conditioning Module

Test Connector / Health Check

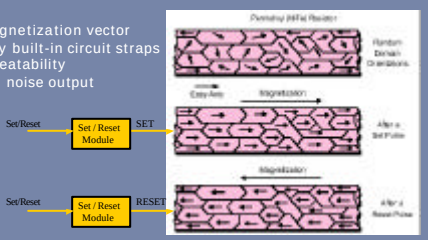


LusospaceAMR magnetometer diagram block

Analogue AMR
Principles of Operation

SET / RESET

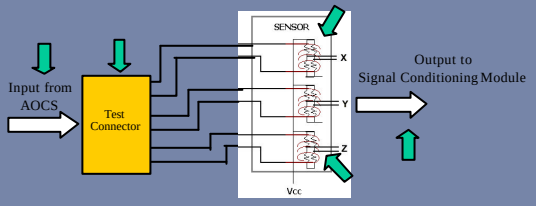
- Restores magnetization vector
- Performed by built-in circuit straps
- Maintain repeatability
- Maintainlow noise output



Analogue AMR
Principles of Operation

Test Connector

- Uses built-in straps to create a magnetic field



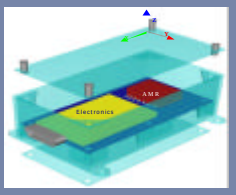
1. AOCS inputs a voltage signal [illegible]

Achieved Parameters with AMR Concept

- Power Consumption: < 600 mW
- Linearity: better that 1%
- Noise: <40 nT
- Resolution: 100 nT
- Offset: < 300 nT (without calibration)
- Mass: 195 gr
- Size: 8 cm x 6cm x 3.2 cm
  (Length x Width x Height)

AMR magnetometer Exploded Diagram

- Length x width x Height:
  8 cm x 6 cm x 3.2 cm
- AMR Sensor: Not Actual Size
  Actual: 8 x 4 x 3.81 mm



Preliminary Tests Already Performed

- Preliminary Tests Already Performed

• Radiation tests	Performed at Estec (Holland)
• Thermal cycling	Performed at Chipidea (Portugal)

Preliminary Tests Already Performed

Radiation Tests
(Performed at Estec)

- Samples were submitted to a total ionizing dose of 16KRad with no effect on the sensor's Performance.

- Two brands of sensors were tested:
  - **2-axes** AMR sensor
  - **3-axes** AMR sensor

Preliminary Tests Already Performed

Thermal Cycling
(Performed at Chipidea)

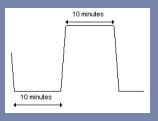
Test performed according with MIL–STD-883E

- Two brands of sensors were tested:
  - **2-axes** AMR sensor
  - **3-axes** AMR sensor
- No effect on sensor´s performance detected

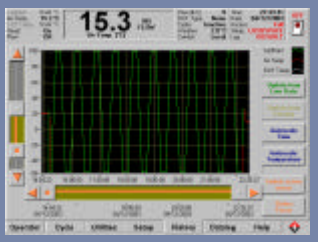
Preliminary Tests Already Performed

Thermal Cycling
Test description

- Ten cycles
- Max temp: +100ºC
- Min temp: -55ºC



1 cycle description



Conclusions

AMR Magnetometer Performances

- Simple
- Small
- Light
- Low Power

} Suitable for AOCS purposes

Future work

- AMR Qualification (End 2003)
- Magnetometer Qualification (2004)
- Possible First flight (2004-2005)

Aknowledments

Financial Support from ESA / ESTEC

Contract "Low Cost Magnetometer Feasibility Study"

Facilities Support from ESA / ESTEC

Radiation Testing