ADCSS CONFERENCE 2022
26TH OCTOBER
PRESENTER: ALEX LYNE

SIREUS GM20

A COST COMPETITIVE GYRO SOLUTION FOR XEO

Date: 26/10/2022
Ref: MGYO-MMG-PRS-TAU-0086
Template: 83230347-DOC-TAS-EN-011

INTRODUCTION

/// Migration of MEMS devices within the AOCS arena initiated over 15 years ago

- First SiREUS product demonstrated
- Performance levels at 10 º/h (bias stability)
- Significant reduction in mass/power/volume, and cost

/// Further cost reductions in progress to meet the New-Space market demands:

- Reduction in electronic component (EEE) procurement cost through further integration and use of up-screened COTS components
- Reduction in detector procurement costs by up-screening of “off-the-line” detector batches
- Automation of the test and calibration process.

/// This presentation presents the recent technology progression by TAS in the Gyro arena :

- Gyro detector component qualification
- Hardware for Traditional and New-Space products
- Development drivers for satellite constellations
- Key performance characteristics and drivers

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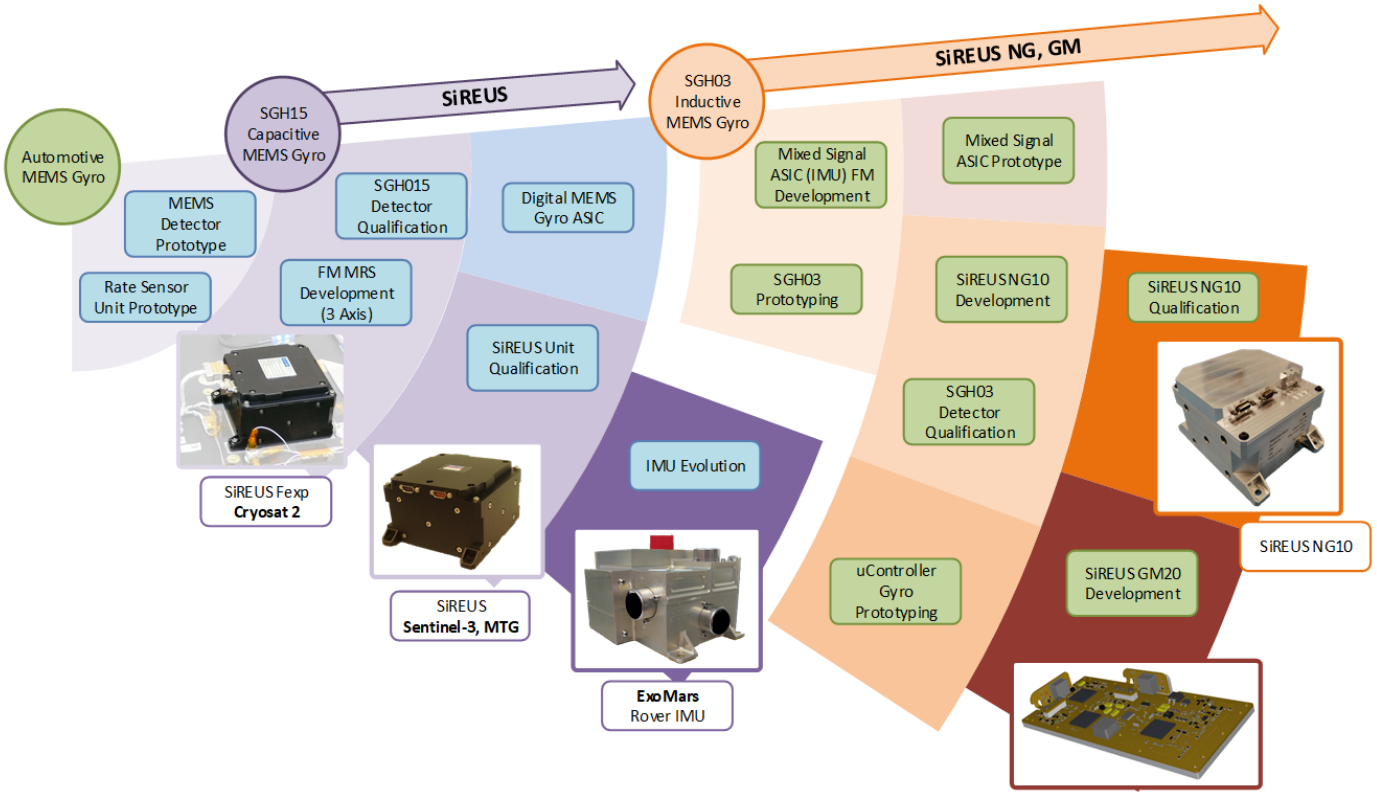
SIREUS EVOLUTION CYCLE



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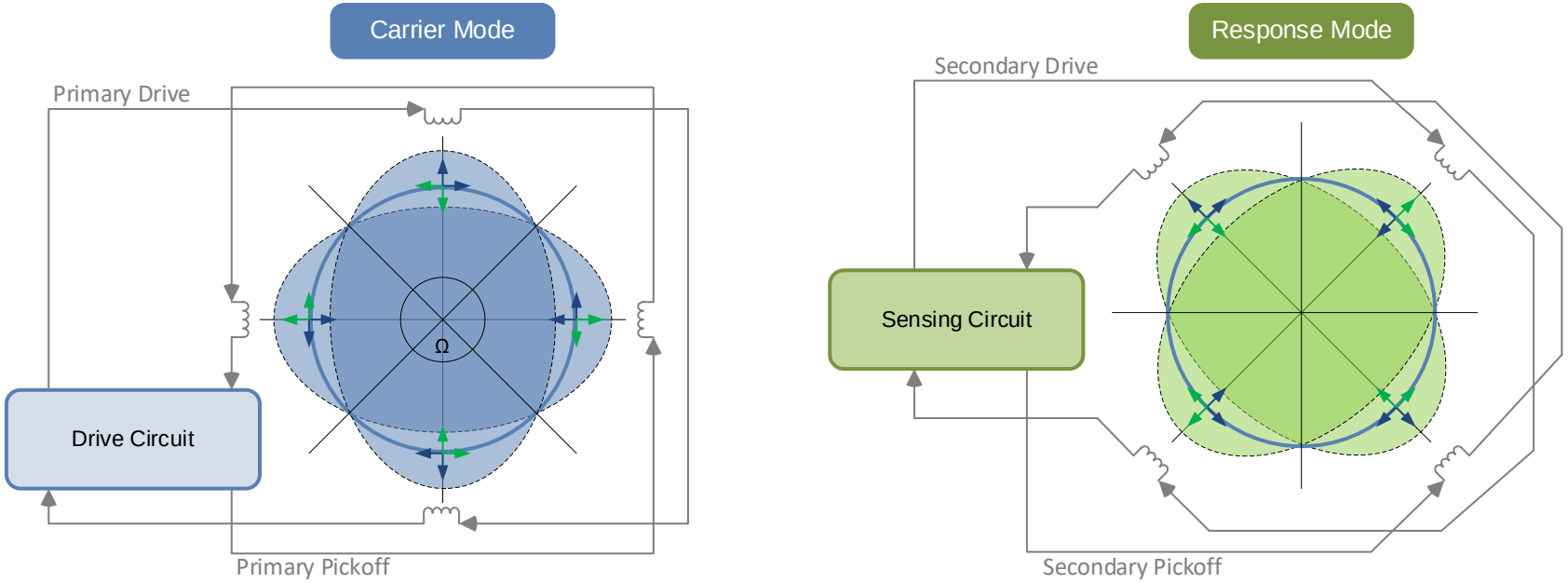
MEMS GYRO PRINCIPLE OF OPERATION



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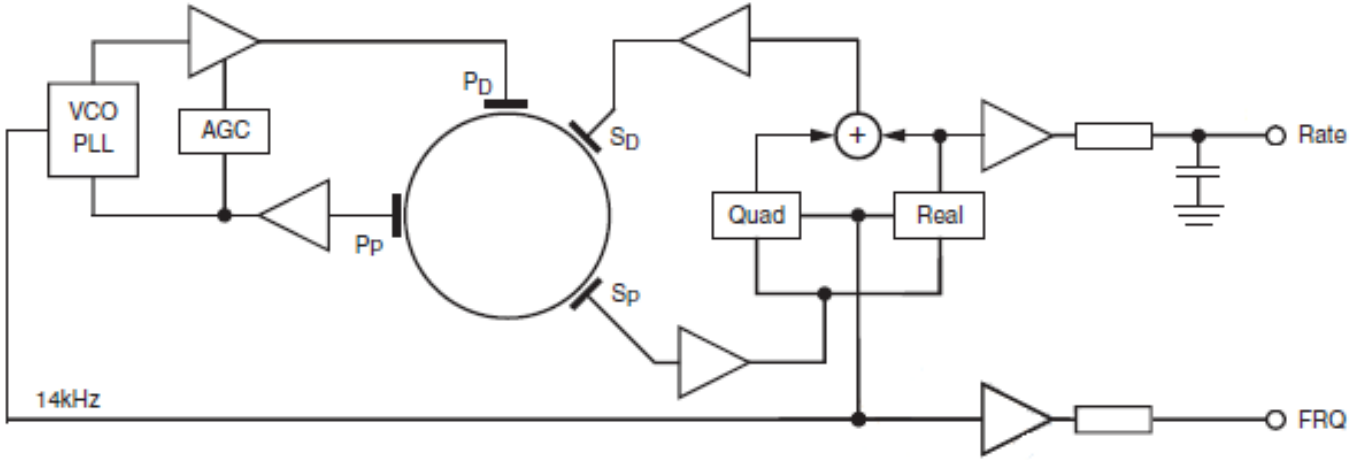
MEMS GYRO EQUIVALENT CIRCUIT



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SGH03 QUALIFICATION

/// Full device batch qualification campaign successfully performed on SGH03

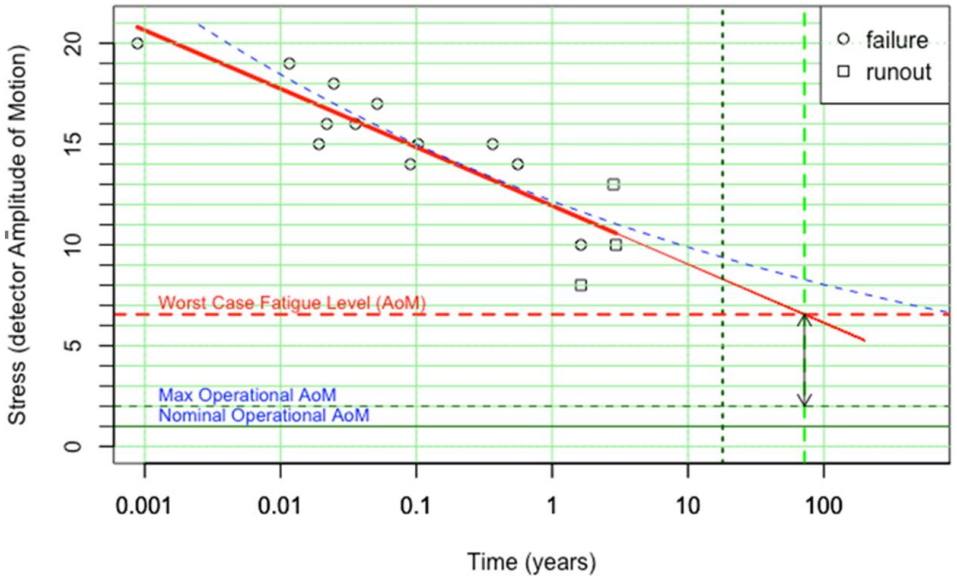
- ECSS-Q-ST-60-13C for commercial EEE components and ESCC226900.

/// Additional shock campaign performed.

- Worst case movement of 8 º/s quad bias at 2000g.
- SiREUS products all null this error internally.

/// SGH03 Endurance Trial

- Additional Endurance Trial initiated in September 2018 as accelerated life test.
- Predicted component lifetime is significantly longer than 18 year requirement.



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PRODUCT: SIREUS NG10

/// Coarse-Medium class gyro unit

- Compact form factor
- Low Mass
- Low Power
- Radiation Hard
- FPGA + discrete electronics + SGH03

Mass	900 grams
Power	6 W
Volume	100*100*70 mm
Thermal	-40 to +80 °C
Shock	2000 g
Misalignment	<1° (absolute) <60 arc-sec (stability)

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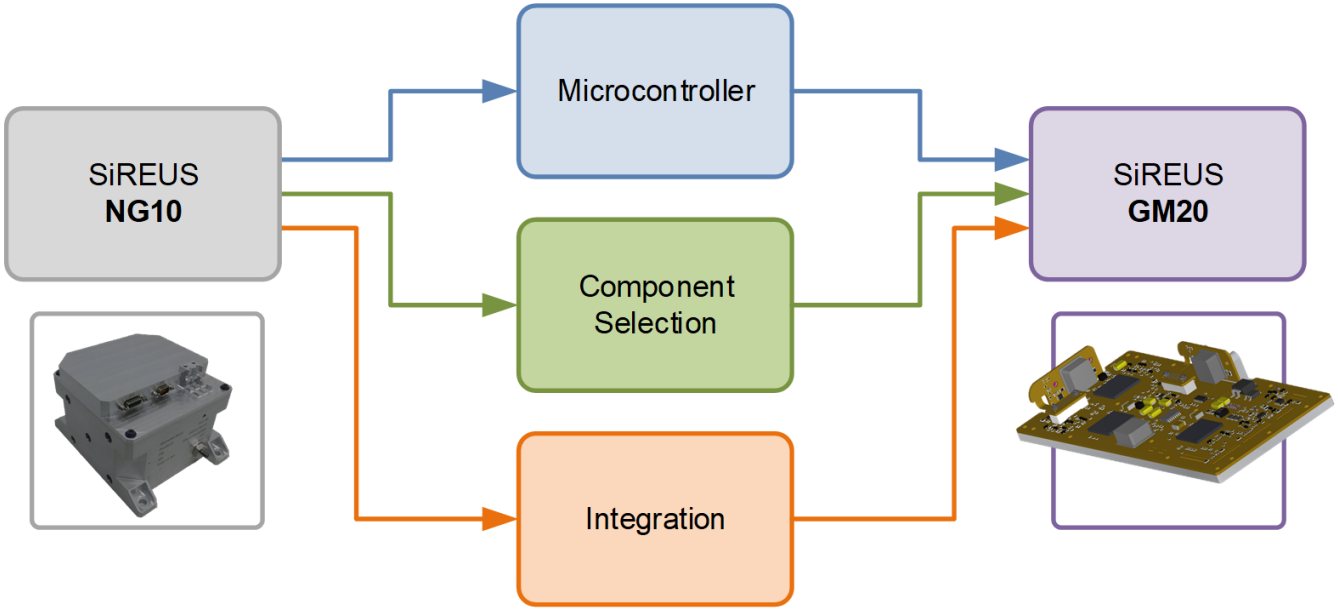
SIREUS GM20 - EVOLUTION



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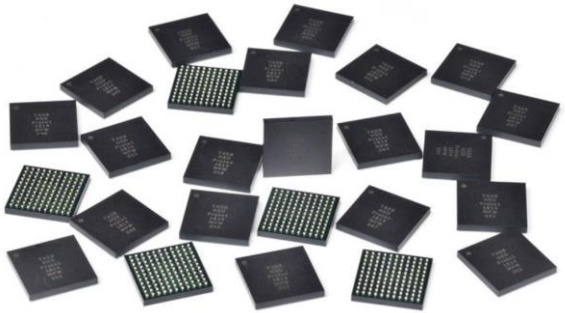
MICROCONTROLLER-BASED SOLUTION

/// Digital Programmable Controller (DPC)

- Radiation Hardened
- Low FM cost
- High Performance
- Large array of on-chip peripherals
- Excellent tool chain and driver support



Manufacturer	Thales Alenia Space
CPU	MSP430
Word size	16
Clock	40 MHz
Cores	3
Endianism	little
Program/Data RAM (kB)	28 / 14
PROM	-
ADC	4 x 13 bit
DAC	3 x 12 bit
Mil-1553B	✓
CANbus	✓
SpaceWire	×
Radiation class	Rad-hard
FM availability	✓

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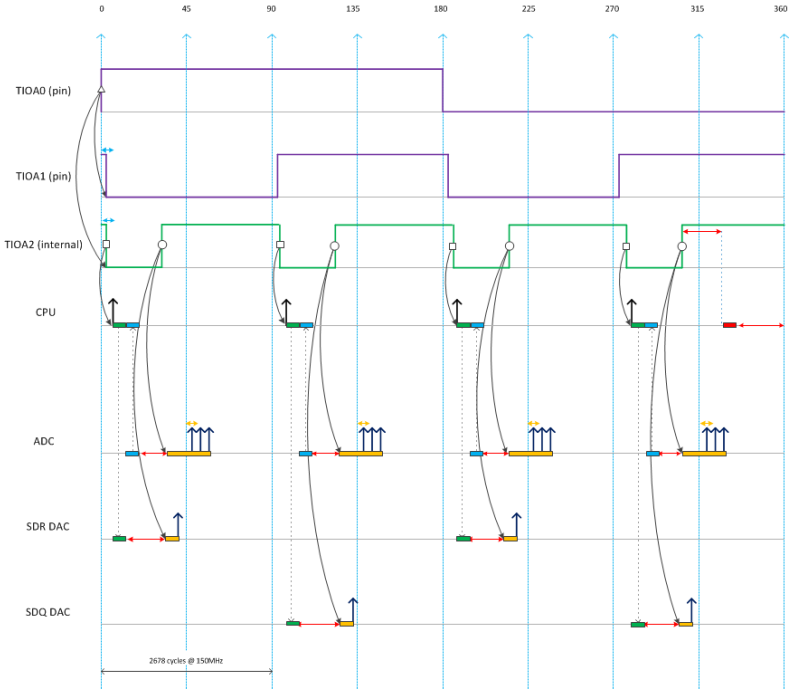
SOFTWARE ARCHITECTURE

/// Gyro on DPC

- Bare metal, interrupt driven runtime
- SW loop rate synchronised with detector resonant frequency
- Chained timers used to generate ADC/DAC sync and external switching waveforms
- Integer based arithmetic used in control loops



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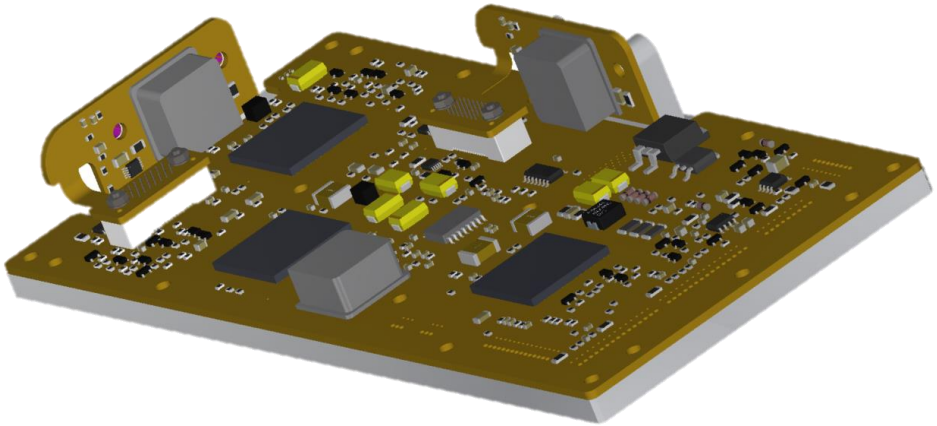
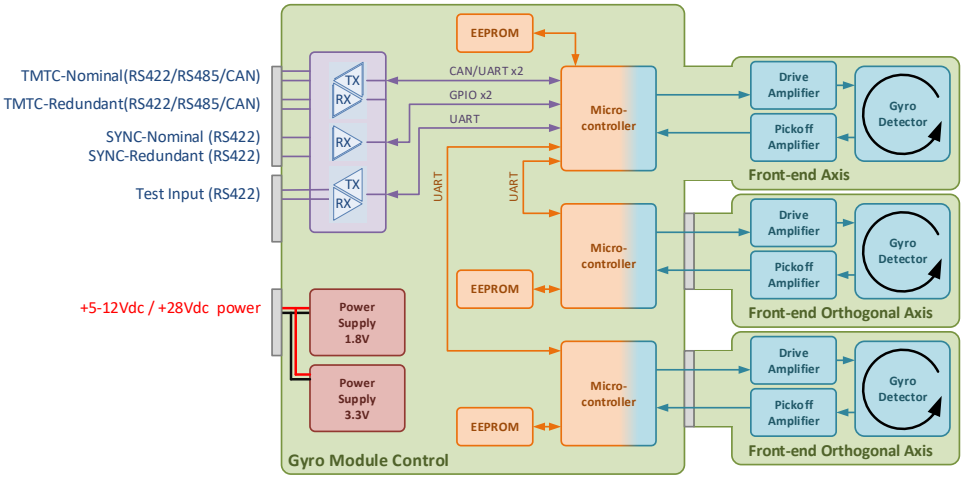
PRODUCT: SIREUS GM20

/// Coarse-Medium class gyro unit

- PCB Module for host unit integration
- Very Low Mass
- Radiation Tolerant
- Micro-controller + SGH03
- Power Supply and TMTC options



Mass	300 grams
Power	7.4 W
Volume	300*90*30 mm
Thermal	-40 to +80 °C
Shock	2000 g
Misalignment	<1° (absolute) <60 arc-sec (stability)



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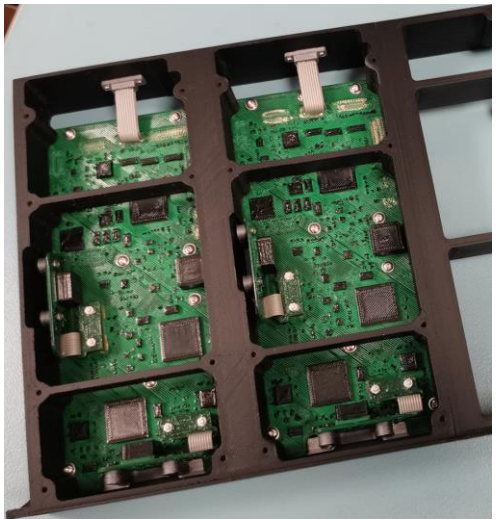
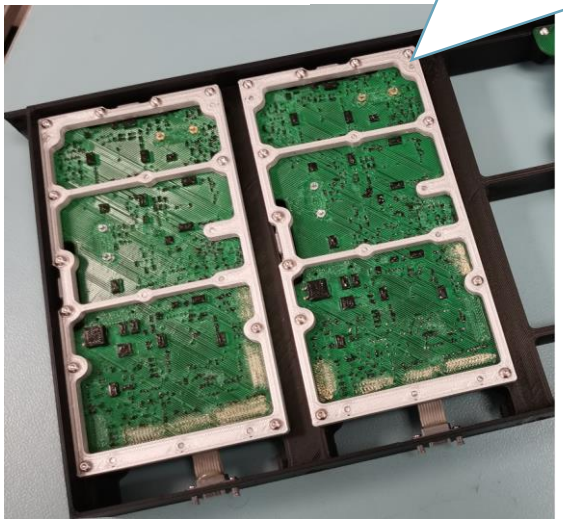
INTEGRATION OF SIREUS GM20 GYRO MODULES

/// SiREUS GM20 is designed for integration into a host flight equipment.

/// Images show SiREUS GM20 space models integrated into a space model of a typical equipment module.

SGM20 Mechanical Frame
- Mechanical Reference Frame (MRF)
- Thermal Reference Point (TRP)





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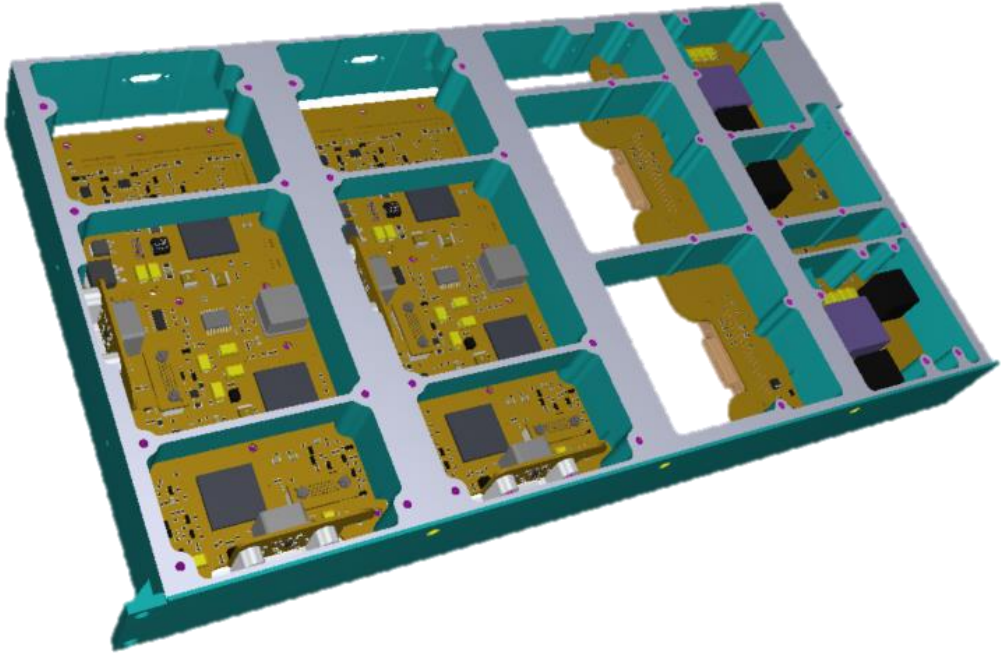
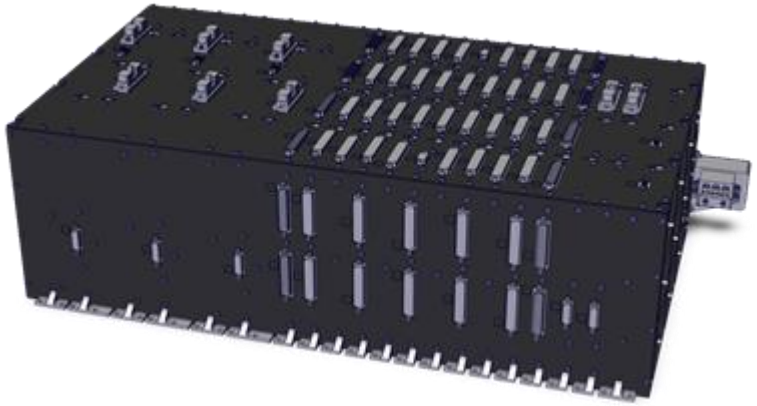
ACE-HPU GYRO MODULE

/// SiREUS GM20 modules integrated into ACE

- Common Power supply module to provide 3.3V to GM20 modules
- Qualification performed at module and ACE equipment level
- Close relationship to ACE Design team





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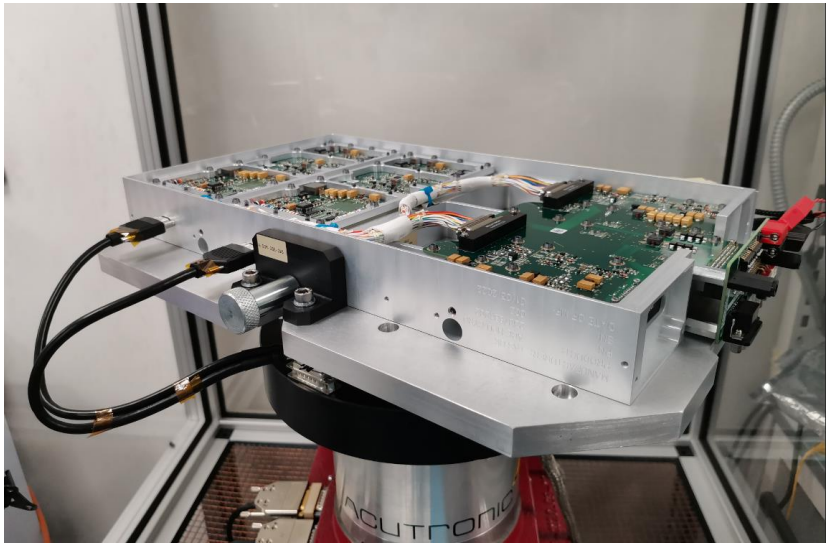
ACE-HPU GYRO EM TESTING

/// Aggravated Test – thermal cycle to +85 and -55C to ensure functionality beyond qualification range

/// Lab Testing on a rate table to determine axis alignment



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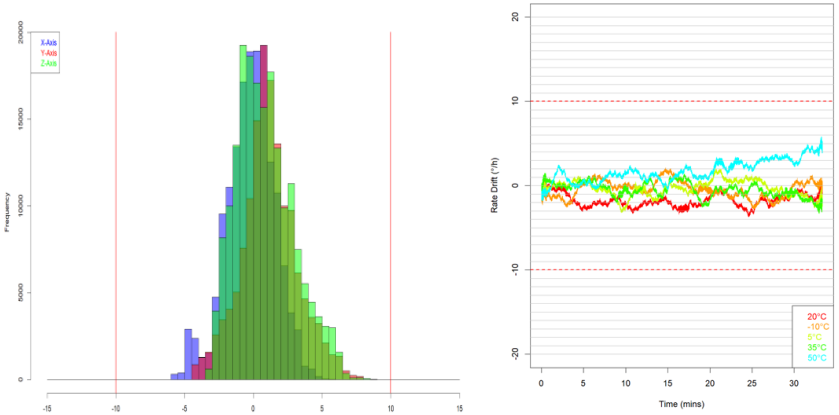
PERFORMANCE ANALYSIS

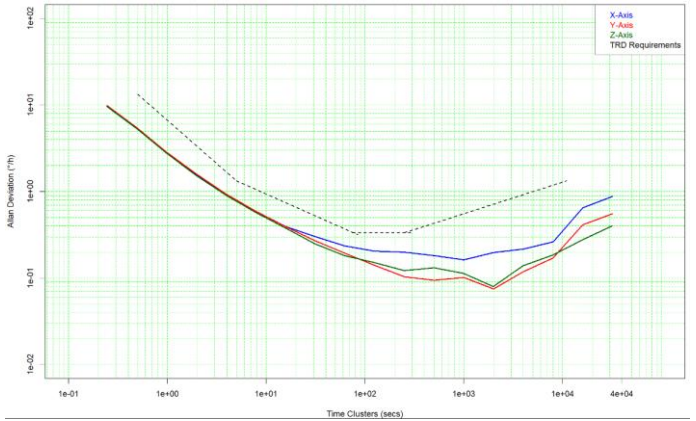
/// Performance results from SiREUS GM20 EM Test Campaign

- Meets all requirements for a coarse rate sensor

Rate Noise	16-23 º/h
Angular Random Walk	0.04 º/√h
Bias Instability/Flicker Noise	0.2-0.6 º/h
Bias Stability	< 2 º/h after 5 hours
Rate Drift	0.5 º/h
Scale Factor Error	<2000 ppm



Rate Bias Over Temperature with +/- 10 º/s Rate Demand



Allan Variance for Bias Stability, ARW, RRW

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IN SUMMARY

/// MEMS technology continues to mature in terms of performance improvement and repeatability.

- Convergence in performance requirements of non-space requirements for MEMS gyros to those for space, leading to potential dramatic reduction in gyro detector procurement costs.

/// SiREUS GM20 meets the needs of todays constellation markets

- Microcontroller developments
- Integrated gyro development and production engineering for batch manufacture and testing
- Minimum cost predicated on:
  - Close space/non-space partnership to:
    - Harden for space: discrete/FPGA and micro-controller based solutions
    - Qualify/up-screen detector batches: SGH03 qualification completed 2020.
  - High user-base (eg. comsat Mega constellations)
    - Common parts procurement across satellite

/// SiREUS GM20 Qualification Q1/Q2 2023

/// Development of MEMS IMU products remains opportunity driven

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QUESTIONS

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