

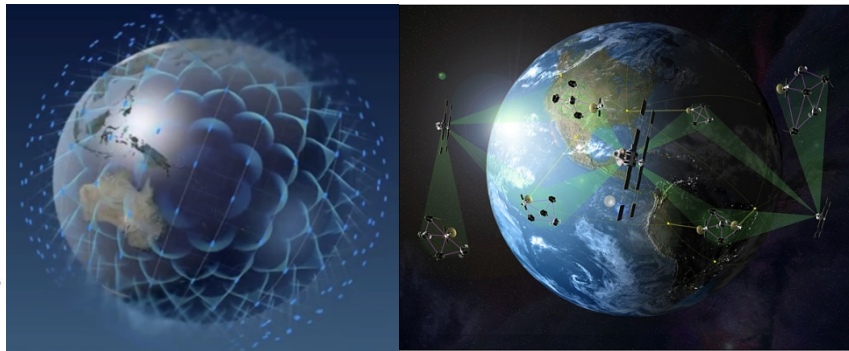
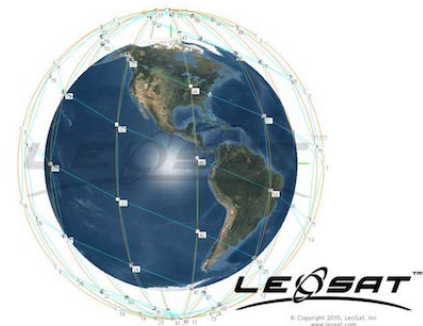
ADCSS2016

Compact SAVOIR OBC

Patrik Sandin, Torbjörn Hult

Chief Engineer, Digital Product Unit

RUAG Space AB



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ahead. **RUAG**

RUAG Space Products

Launcher Structures & Separation Systems



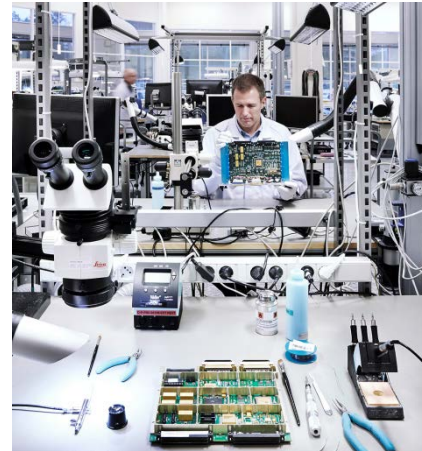
- Launcher Fairings & Structures
- Payload Adapters & Separation Systems
- Sounding Rocket Guidance

Satellite Structures, Mechanisms & Mechanical Equipment



- Satellite Structures
- Satellite Mechanisms
- Sliprings
- Mechanical Ground Support Equipment
- Thermal Systems

Digital Electronics for Satellites and Launchers



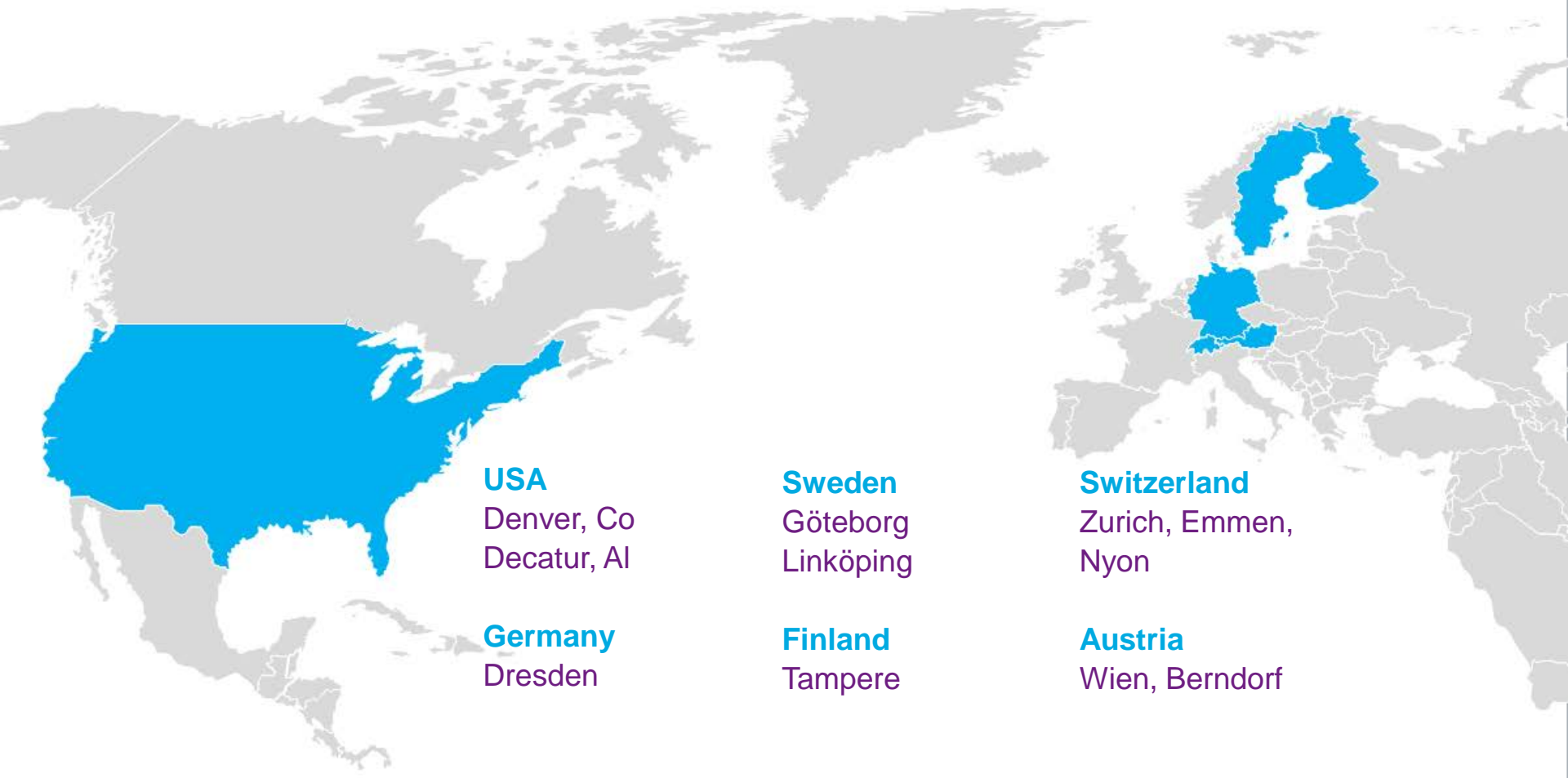
- Satellite & Launcher Computers
- Navigation Receivers & Signal Processing

Satellite Communication Equipment



- Receivers & Converters
- Antennas

RUAG Space – 11 sites worldwide



USA

Denver, Co
Decatur, Al

Germany

Dresden

Sweden

Göteborg
Linköping

Finland

Tampere

Switzerland

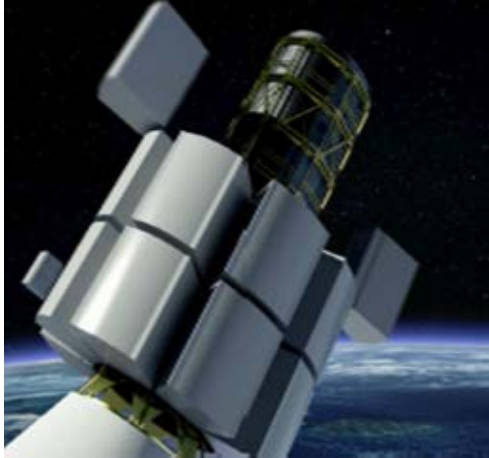
Zurich, Emmen,
Nyon

Austria

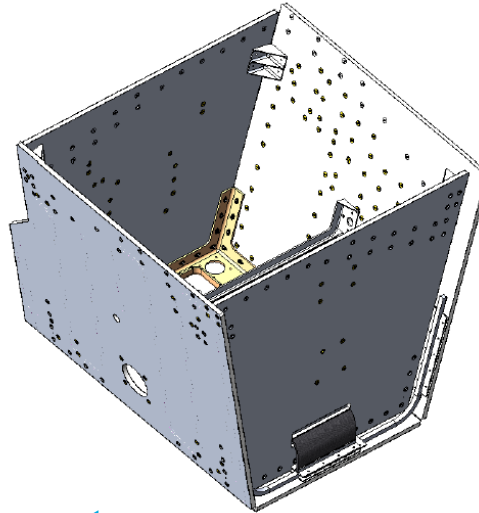
Wien, Berndorf

RUAG Space and mega constellations

Satellite
dispenser



Satellite structure for
mega constellation



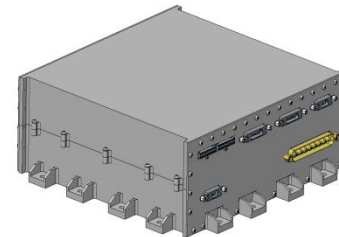
MLI



Compact
SAVOIR OBC



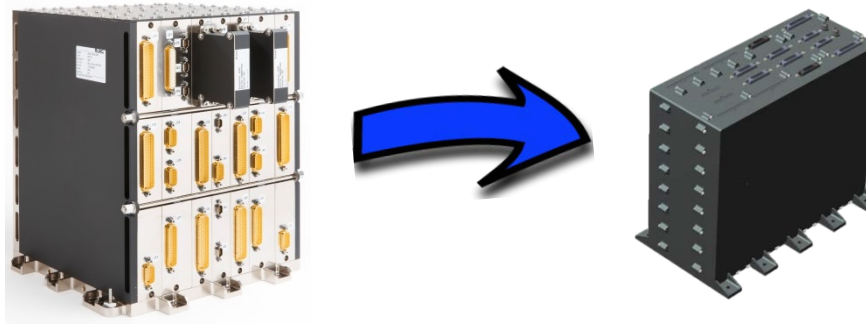
Payload
Interface Unit



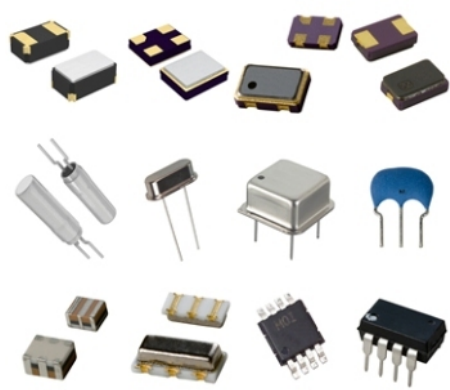
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RUAG Space mega constellation satellite electronics

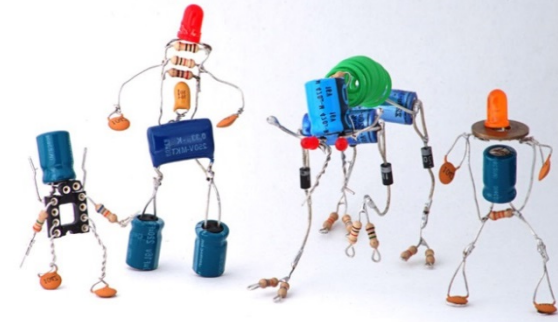
- We have:
 - 40 years of experience in high-reliable launcher and satellite electronics.
 - a design database with existing qualified SW and FPGA IP-modules
 - an internal certified and customer audited design process for high-reliable electronics
 - a high quality and high efficiency electronics production facility already today capable of producing large series industrial electronics
- Our approach is to:
 - reuse the existing design data-base, design processes and production facility
 - Use a mix of high-rel components with up-screened commercial components.
- This enables us to offer:
 - Reliable data handling products with low risk
 - Significantly lower prices and higher performance than the corresponding high-rel products



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High-rel vs COTS

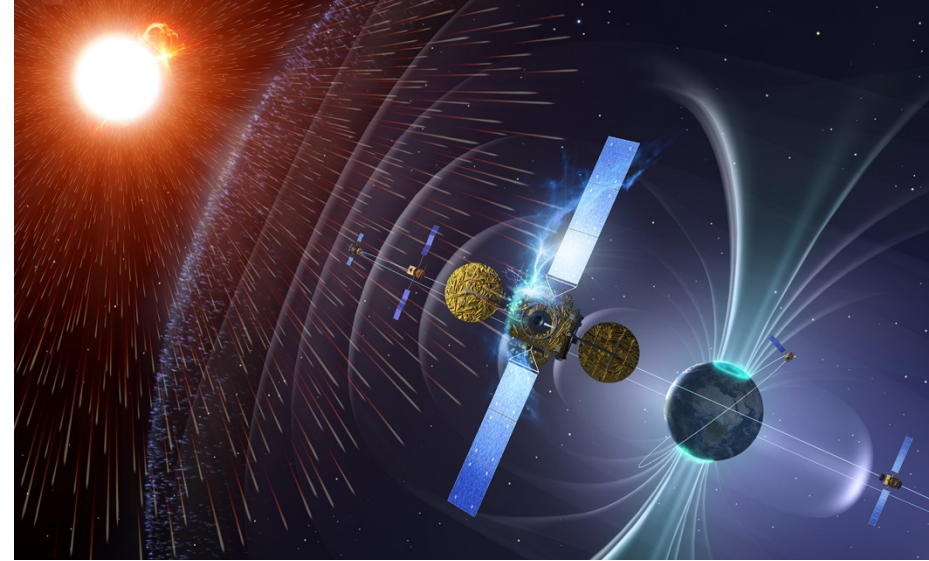
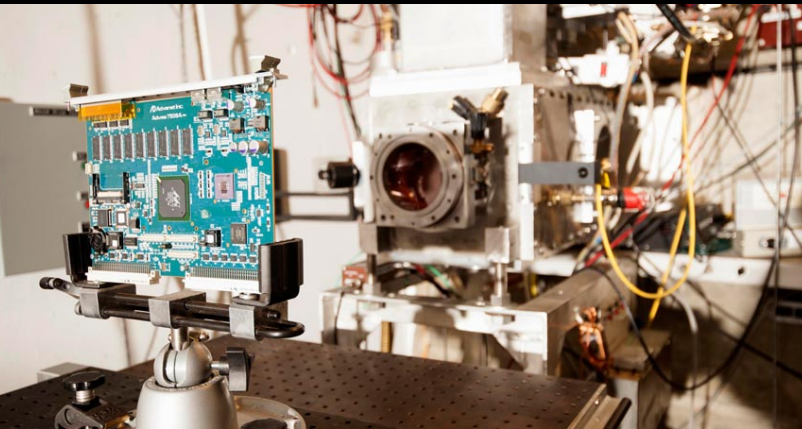
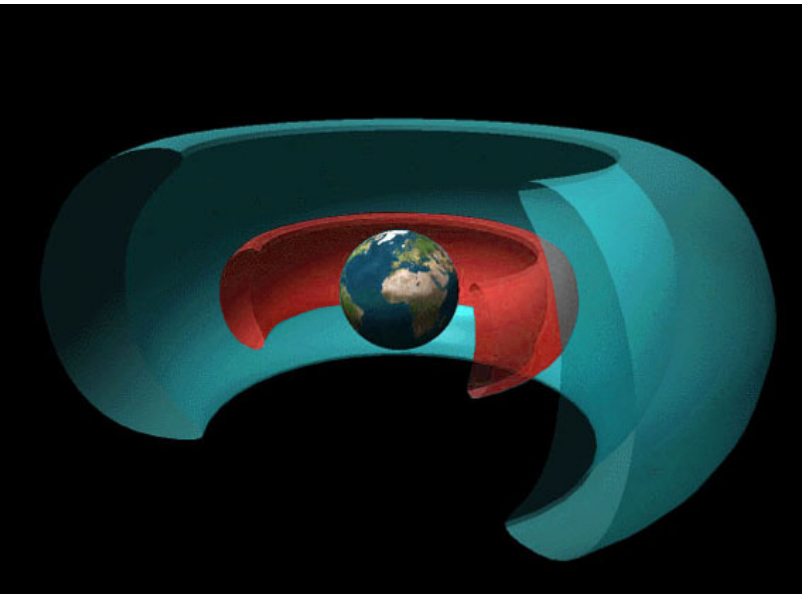


Function	High-rel implementation	COTS implementation
Processor	Rad-hard LEON 2	Commercial processor
Processing memory	Space graded SRAM or SDRAM	Commercial DDR2 RAM
Non-volatile memory	Space graded EEPROM and PROM	Commercial NAND FLASH
TM & TC	Rad-hard ASIC	Commercial FPGA
Reconfiguration	Rad-hard ASIC	Commercial FPGA
I/O controller	Rad-hard ASIC	Commercial FPGA
Analogue and AOCS I/O	Rad-hard transistors, op-amps, comparators, PWMs	Commercial transistors, op-amps, comparators, PWMs
Power Supply	Rad-hard MOS-FETs, diodes	Commercial MOS-FETs, diodes
GPS function	Stand-alone equipment	Integrated, commercial FPGA, GNSS RF receiver and on-board SW

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Radiation

Primarily, only parts with an established radiation pedigree are used



Commercial parts can provide sufficient radiation tolerance for LEO orbits and in some cases even similar tolerance as rad-hard parts

Additional measures if radiation pedigree not available

- Radiation testing of candidate parts
- Shielding (additional metal around sensitive parts)
- Mitigation techniques, including: redundancy, software tasks, EDACs, TMR, current limiting and power cycling

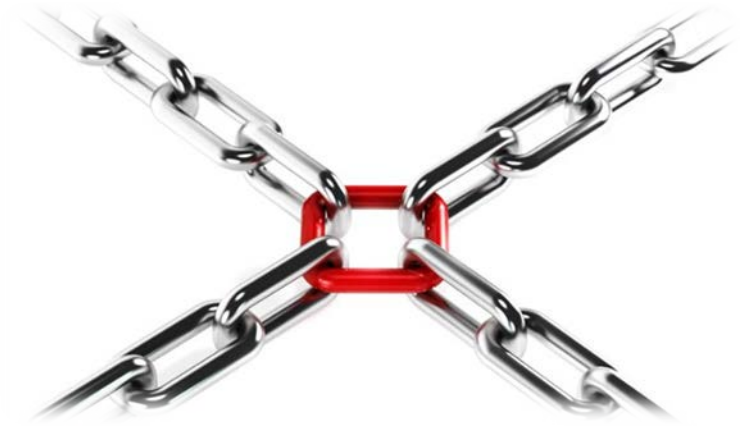
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Parts Reliability

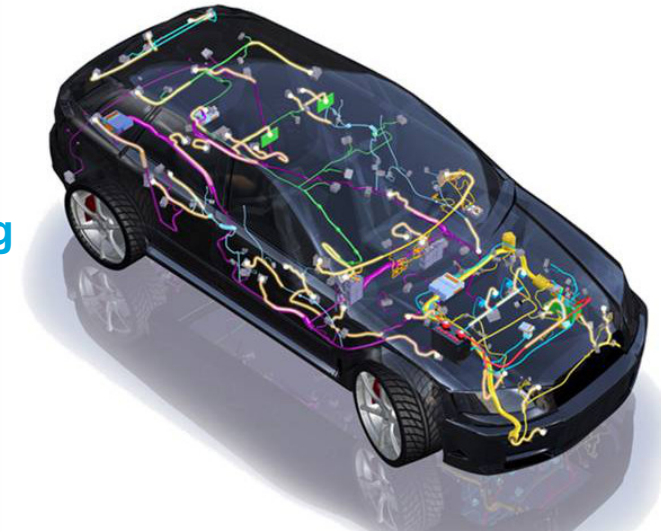
Challenges when using commercial parts

Lack of traceability

- Testing over full temperature range
- Limited testing and no screening for infant mortality
- Different die designs from different foundries with the same part number
- Radiation performance and data are limited and may pertain to an obsolete die
- Lack of change control due to poor communication with the foundry



The gap can be partly filled by using automotive components.



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Electronics

Space grade electronics

- Radiation hard or tolerant
- Large temperature range
- Reliable and traceable
- Very expensive



Automotive grade electronics

- Unknown radiation tolerance
- Reliable and traceable
- Cheap



Commercial grade electronics

- Unknown radiation tolerance
- No traceability to lot
- Very cheap

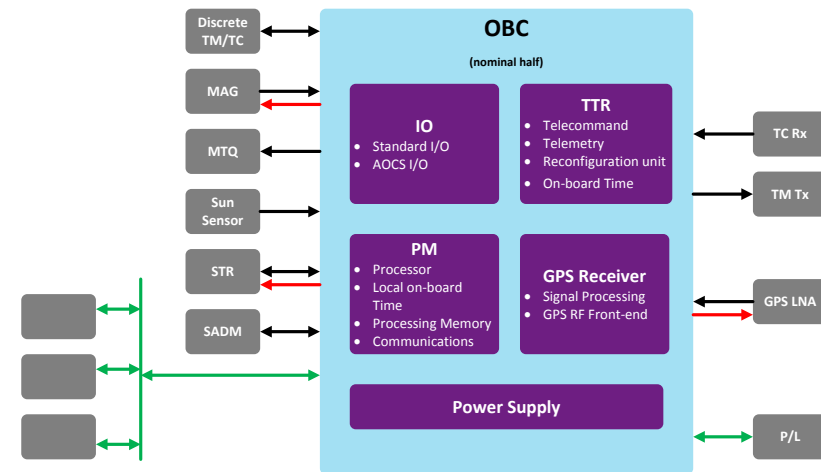
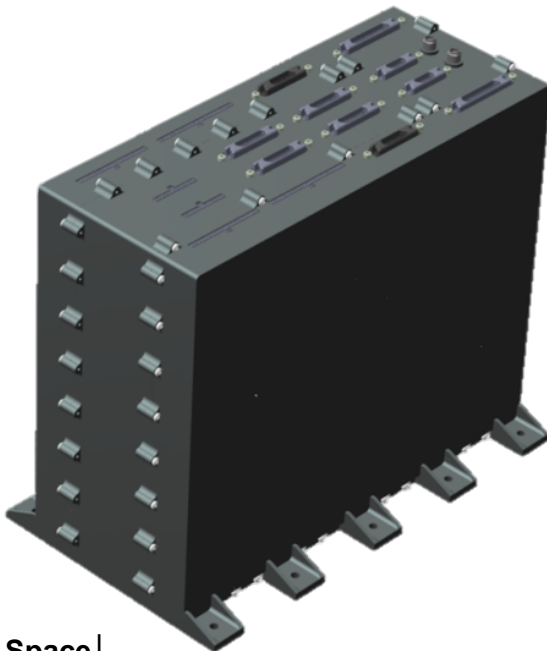


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Functions

- General purpose COTS processor
- Telecommand, Telemetry and OBT
- AES authentication and decryption/encryption
- Software independent Reconfiguration unit
- Standard and AOCS I/O
- Integrated single frequency GPS receiver
- Secondary power distribution
- Platform and payload communication

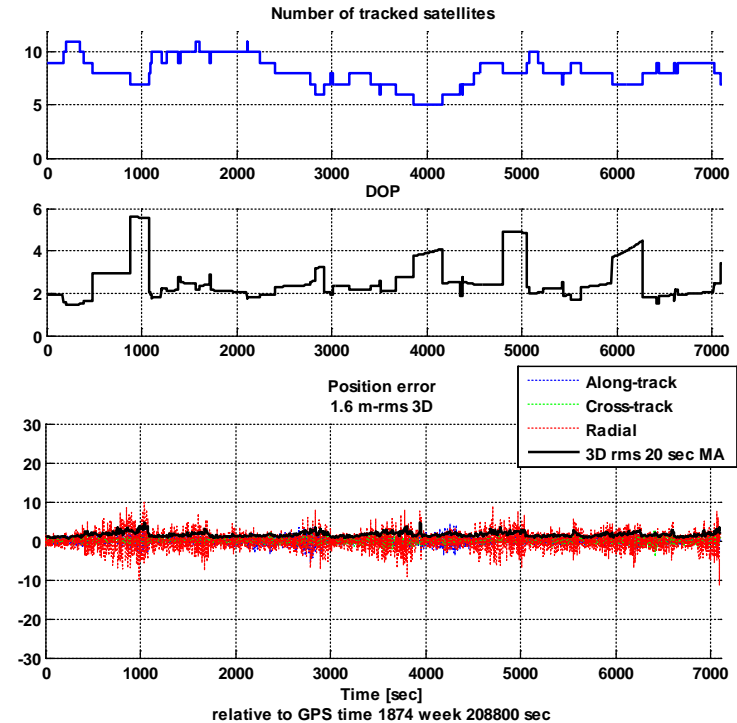
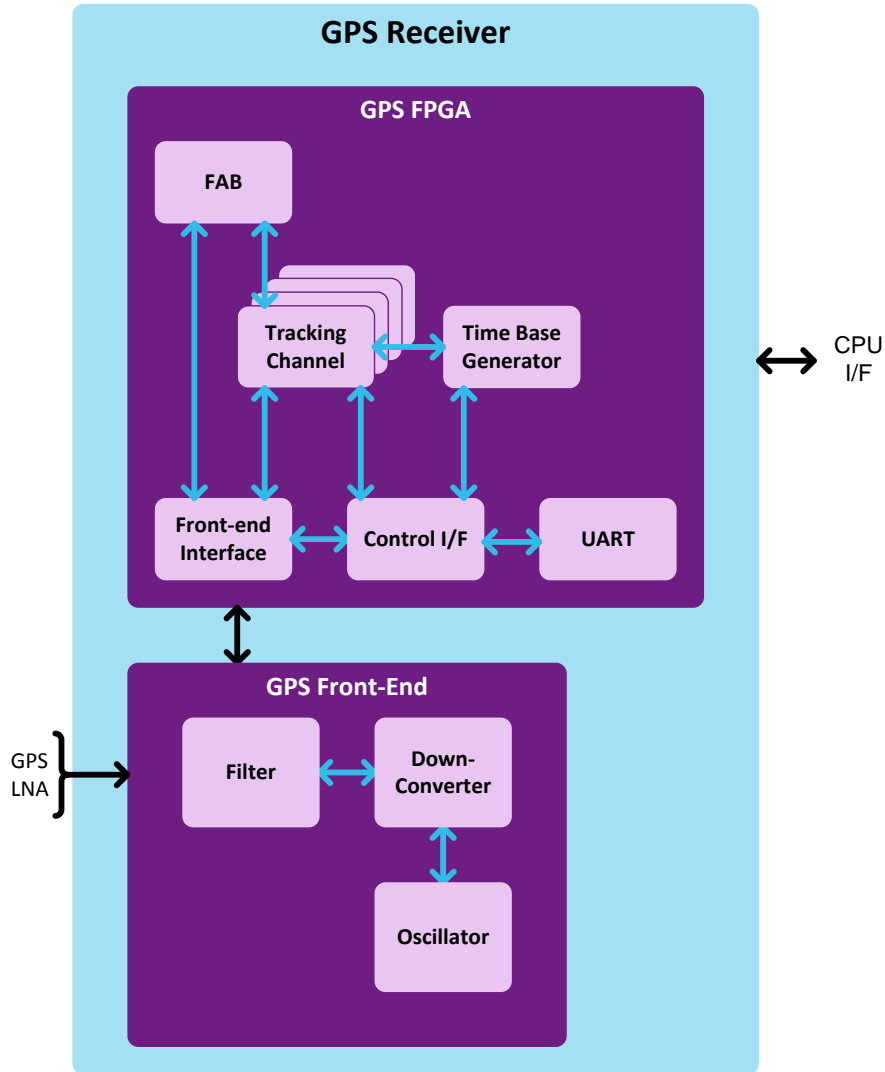


Characteristics

- Physical dimensions: 240x100x200 mm
- Mass: 2.8 kg
- Power consumption: 22 W
- Processing performance: 1800 DMIPS
800 MFLOPS
- Memory resources: 512 MiB RAM
512 MiB NVM
- GPS position error: <10 m_{RMS} 3D
- Navigation startup: 5 min.(warm)
10 min.(cold)
- Discrete analog TM: 20 inputs
- Designed life-time: 6 years LEO
- Reliability: <1100 FITS @ 30°

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Integrated GNSS Receiver



- 12 GPS L1CA Channels
- Cold start: < 10 minutes
- Warm start: < 5 minutes

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High Volume Space Electronics Production

■ Manufacturing

Multi Chip Module Technologies

Surface Mount Technologies

Plated Through Hole Technologies

Electrical & Physical Testing

Environmental testing:

- Thermal Vacuum
- Vibration
- EMC

■ Process Development

■ Component Technology

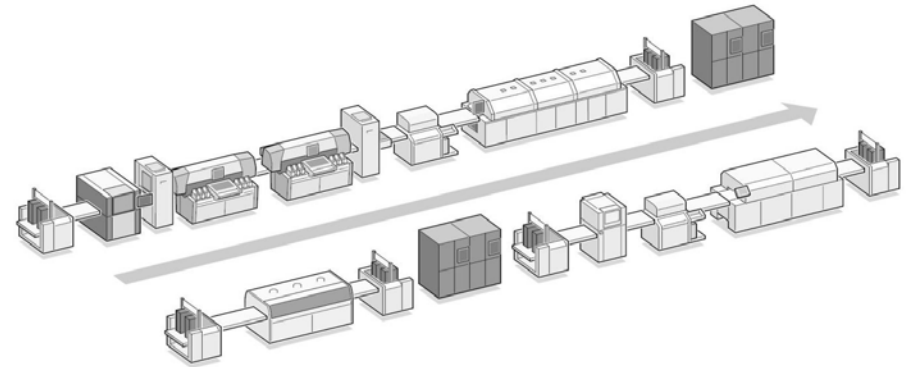
■ Procurement

■ Analysis Laboratory

■ Clean Room

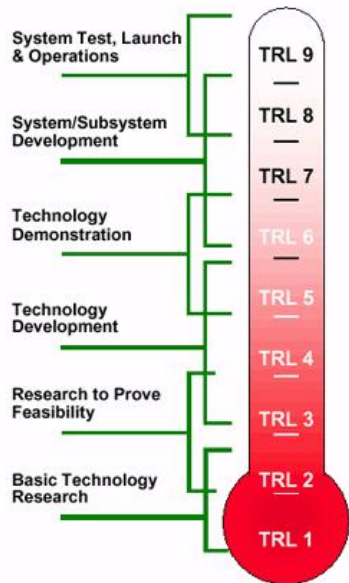
2.700 m² class 100.000 (ISO Class 8)

200 m² class 10.000 (ISO Class 7)



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Ready to take the leap!



Technology	TRL
High Reliability Failure Tolerant Architecture	9
Processing function	6
Reconfiguration Unit function	6
TM/TC function	6
OBT function	6
Power Bus Interface and Power supply function	6
Digital I/O function	6
Analog I/O function	6
GPS receiver function	5
Unit mechanical concept	6
RTEMS Operating System	9
Boot Software	6
Hardware Driver Software	8
GPS Navigation Software	8

