



*Group of Astrodynamics for the Use of Space Systems*

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# GAUSS ELECTRONICS FOR NEW SPACE SYSTEMS



**5<sup>th</sup> IAA Conference on University Satellite Missions and CubeSat Workshop**

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# GAUSS Introduction



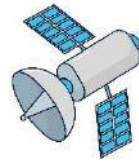
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## Activities and Products



### Launch Services

- Launchers
- ISS



### Design and Manufacturing

- Structure & deployers
- Solar Panels
- EPS
- OBDH
- RF systems
- Remote controlled Groundstations



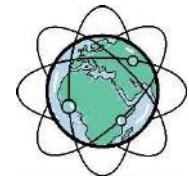
### Ground Operations

- UHF/VHF TT&C
- C / S Band
- Live Monitoring



### Space Debris and Astronomy

- Observation
- Removal



### Mission Analysis

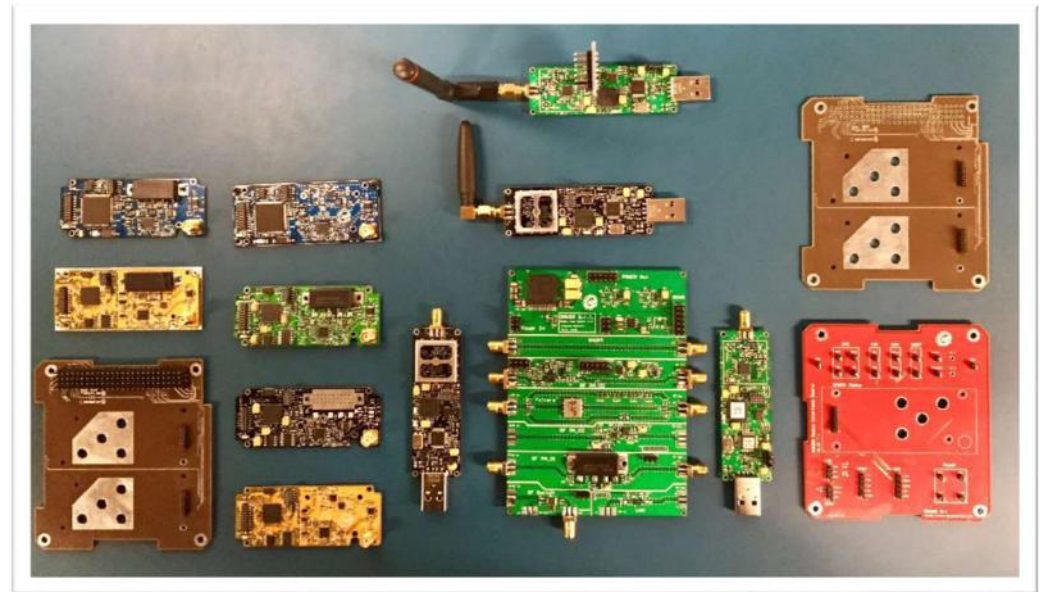


# GAUSS – Lean Electronics R&D



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- **Fast design and delivery**, based on previous versions and experience
- **Fast prototyping** to quickly begin tests
- Electronic components choice based on **supplier availability** (*assuming same features*)
- Max of **three revisions** before final product (*low cost*)
- **Quality and characterization tests** conducted with help from **AI**



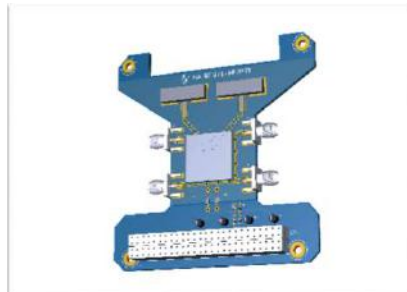
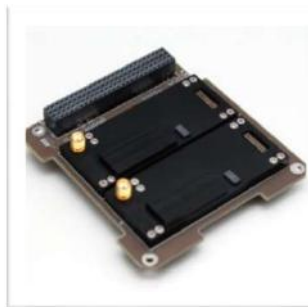


# GAUSS Electronics for Small Sats



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- **On Board Computers (OBC) : ABACUS and HERCULES**
- **UHF Radios:** GAUSS Radio UHF **2W** and **5W**, Dual & Single Radio configurations
- **UHF Radio for GSE:** Mini Ground Dongle UHF
- **RF Switching board**
- **Power Conditioning & Distribution Unit**
- **GNSS receivers for LEO orbit**
- **Automated Groundstations**







# Electronics for Orbital Deployers

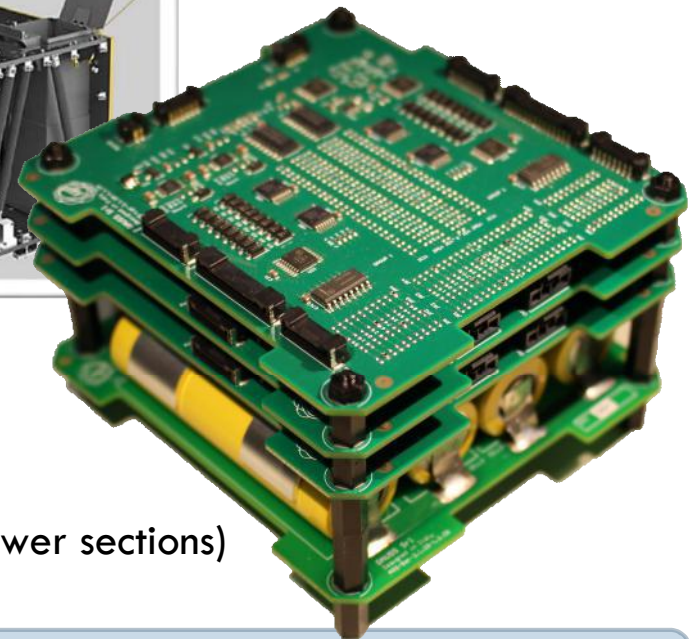
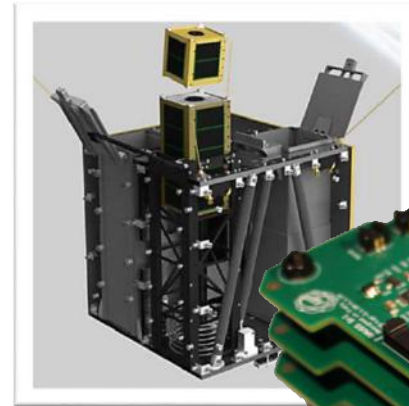


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## Automatic Release System (ARS)

To independently **manage** the **release mechanisms** for the deployment of CubeSats, solar panels, antennas or other release/activation signals

- ❑ Completely **independent digital logic** section
- ❑ **No radiation-sensitive** active components
- ❑ Electronics based on **hard-wired logic**
- ❑ Up to **24 deployment signals**
- ❑ Signals divided in **6 groups of 4 deployers**
- ❑ Max group delay: **68 days**
- ❑ **Full dual redundancy**  
(activation signal, TLM feedback and power supply)
- ❑ **Redundant** and **override command** options
- ❑ **Telemetry feedback** signals for each deployer
- ❑ **Internal** or **external power supply** (for both the logic and power sections)
- ❑ High-current **LiFePO4** internal battery
- ❑ **Hi-reliability**, flight proven **connectors**



Compatible with several Release Mechanisms:  
*TiNi Frangiboli*®, *ERM Ejector*®, Thermal cutters etc.



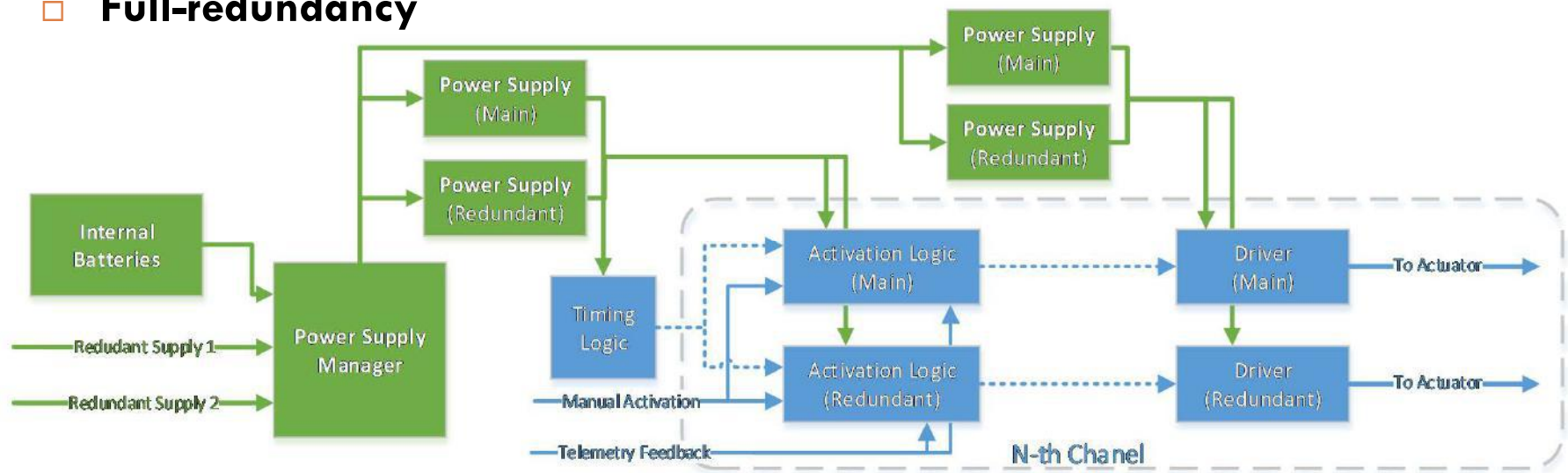
# Electronics for Orbital Deployers



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- **COTS**
- **Low-power** (Logic section)
- **High-power** (Driver section)
- **Easy interfacing**
- **Full-redundancy**

- **Autonomous operation**
- **High reliability**
- **Compatibility**





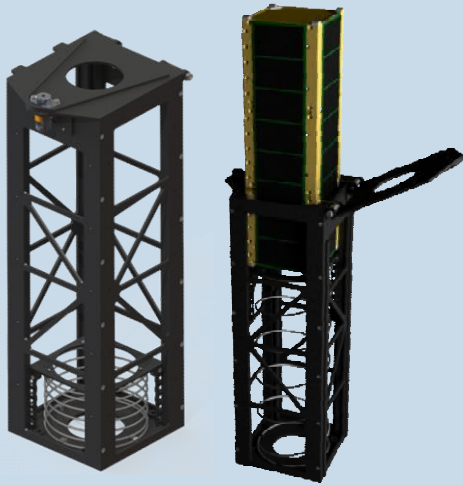
# GAUSS Orbital Deployers



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**GAUSS** has developed its original **deployers** for **3U(+)** / **6U** / **12U CubeSats**

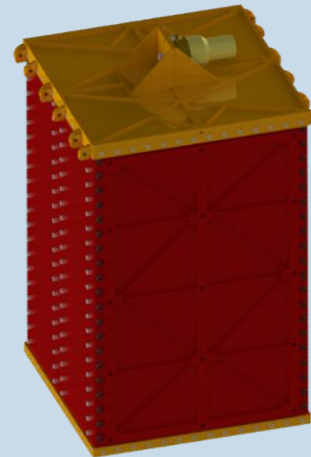
- they can be fixed directly to a **launcher** or inside the **UNISAT Platform**



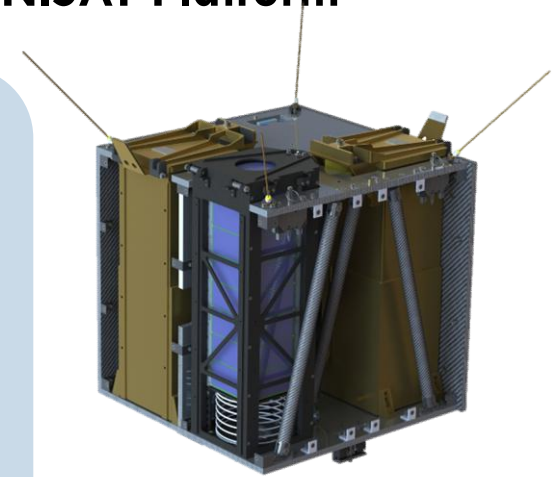
**GPOD-3U**



**GPOD-6U**



**GPOD-12U**



**UniSat Platform**



# ABACUS – On Board Computer for New Space Systems



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GAUSS first OBC is **ABACUS**

**Two Cores**

**MSP430**

**Xylinx *Spartan-3E* FPGA**

- **Independent**
- **Cooperative**
- **Hardware Redundant**
- **Common Mode Fault Tolerant**



- 25MHz HiRel MSP430 for **Aerospace & Defense**
- **FreeRTOS™** Supported 
- Several **Low-Power Consumption** modes
- **Master/Slave/Multi-master**
- RTL Coding and TMR for the FPGA
- **MCU and FPGA Firmware reflash in flight**





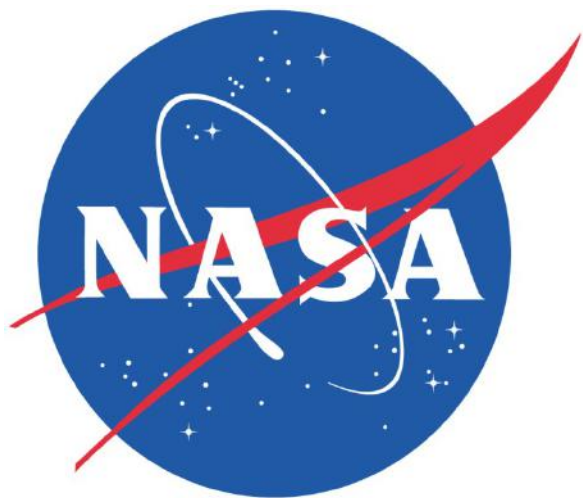
# ABACUS - On Board Computer for New Space Systems



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Memorial  
University of Newfoundland



Some of our **Customers**



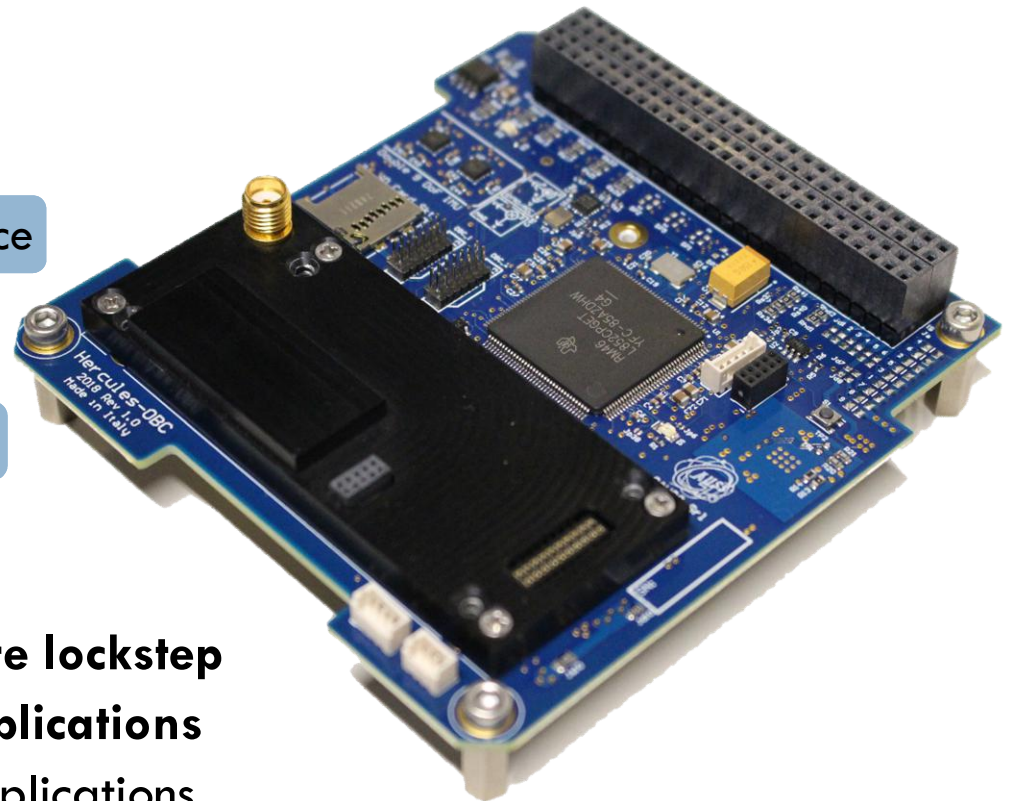
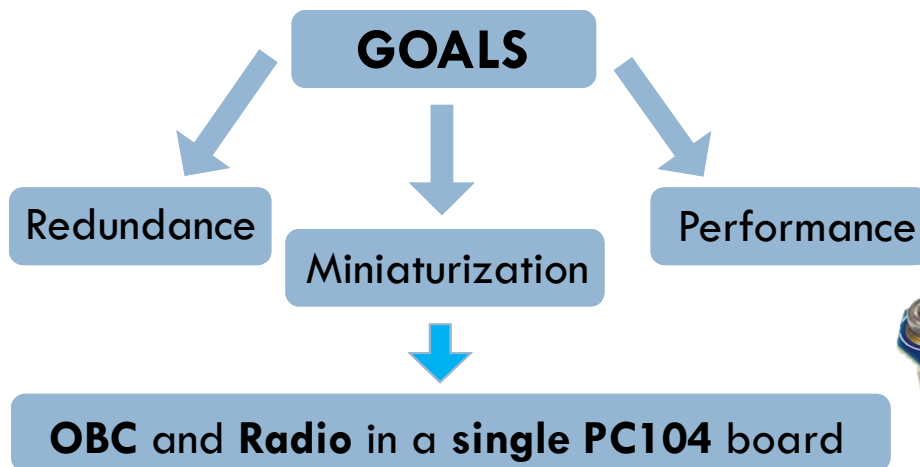


# GAUSS – Advanced OBC for New Space Systems



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Our new advanced OBC is **HERCULES**



- ❑ **ARM Cortex R4F, 220MHz, dual-core lockstep**
- ❑ CPU designed for **Safety Critical Applications**
- ❑ OBC Designed for **task-intensive** applications



# GAUSS – Advanced OBC for New Space Systems



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Our new advanced OBC is **HERCULES**



Complete [**OBC + Comms**] subsystem for **CubeSats**



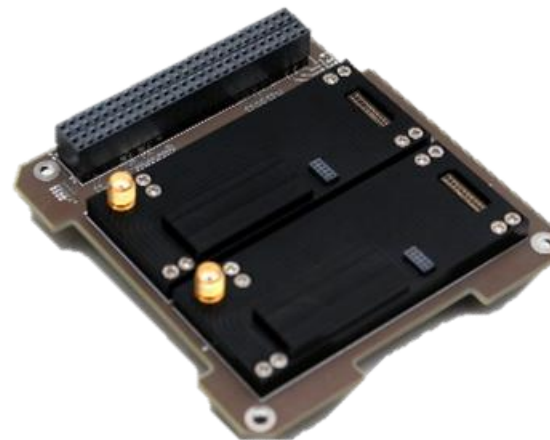
# UHF Radios for *New Space Systems*



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## Our CubeSat-compatible UHF Radios

- Built from scratch using the experience gained with **UniSat** satellites and **GAUSS Groundstations**
- Knowing the limits of our competitors' products
- Firmware can be customized on user request



### 2 Versions available:

- **2W** (33dBm), 50%  $\eta$
- **5W**, (37dBm), 45%  $\eta$



- **I2C, UART and CAN-bus** interface support
- **FSK/MSK/GFSK/GMSK** modulations
- **AX.25 / FEC** and custom protocols
- **Sensitivity: -122dBm @1.2kbps**
- Data rates from 1200bps to 250kbps
- Operating temperature range: -40°C to +85°C
- HW **cold redundancy**: two radios on one PC104
- Libraries to connect it to **ABACUS/Hercules** OBCs
- **Full reconfiguration / Reflash in flight**

**VHF & S-Band versions, coming soon!**





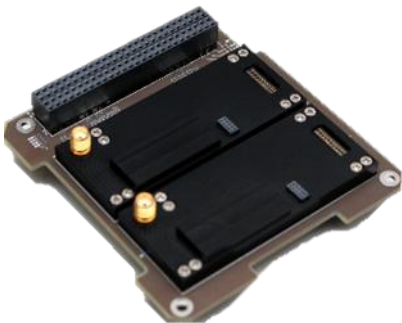
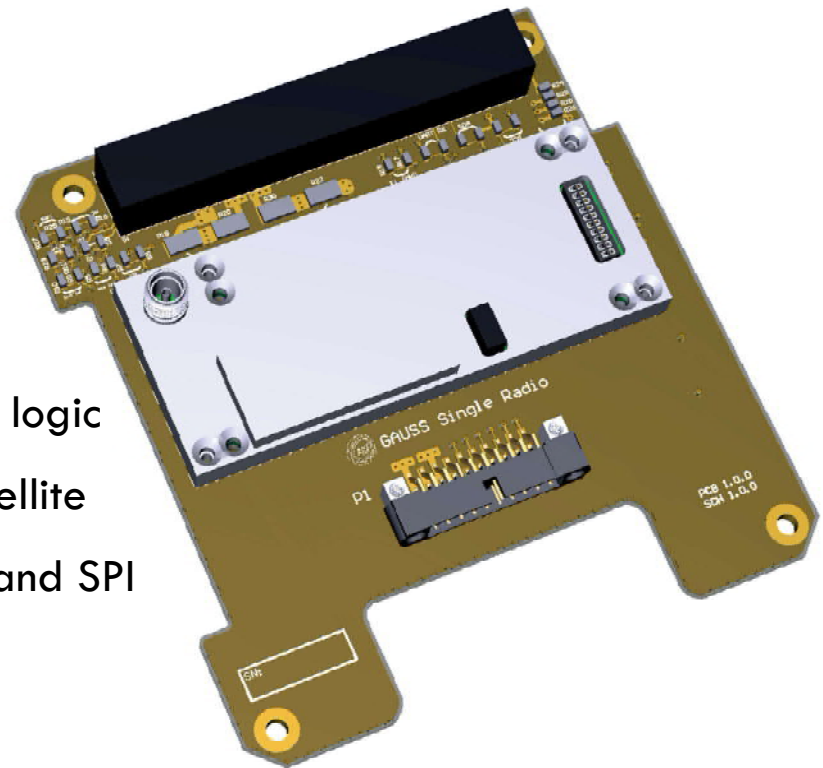
# UHF Radios for *New Space Systems*



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## *Our CubeSat-compatible adapters for GAUSS UHF Radios*

- ❑ **ECSS** compliant
- ❑ Configurable **PC104** Pinout
- ❑ Power can be accessed from several pins
- ❑ External, high-reliability connector for power and logic
- ❑ Integrate GAUSS radios **anywhere** inside the satellite
- ❑ Connect to the PC104 using CAN Bus, I2C, UART and SPI



**UNISEC-compatible adapter coming soon!**



# UHF Radios *for New Space Systems*



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One of our last **Customers:**



**DLR**

**Deutsches Zentrum  
für Luft- und Raumfahrt**



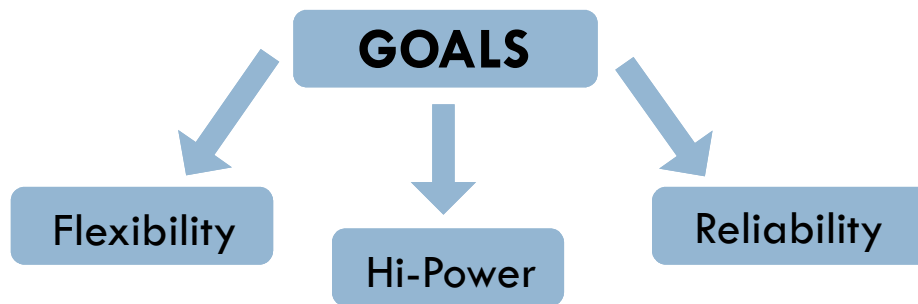
# Hi-Power PCDU for New Space Systems



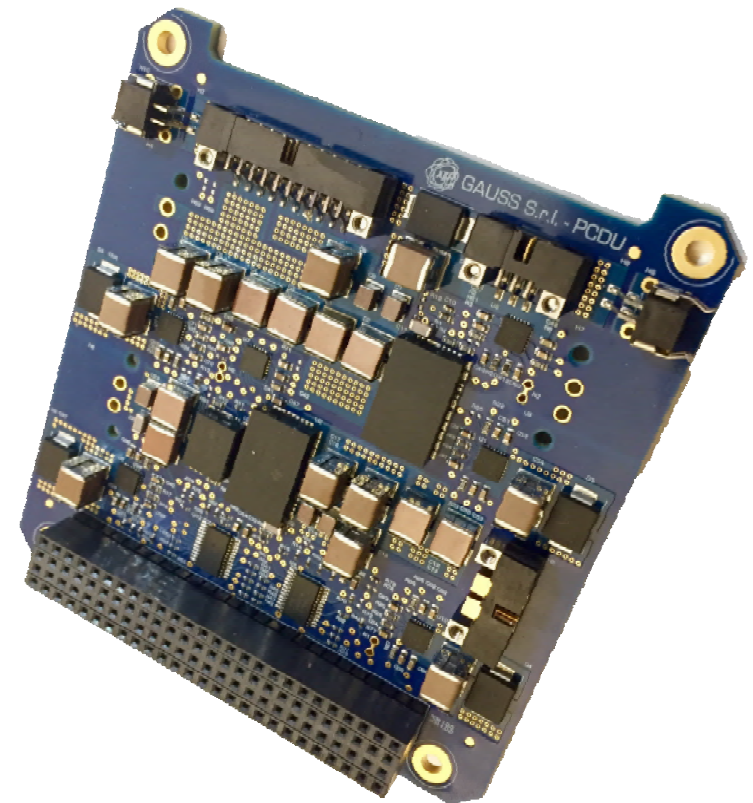
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## Our new **Power Conditioning & Distribution Unit**

Used to electrically interface satellite EPS bus with hosted payloads



- **4 regulated, independent** power channels
- 1 unregulated channel connected to  $V_{BAT}$
- Power modules status monitoring via I2C
- **Current limiter** and **switch** on each output
- All **channel currents monitored**
- Several **Safety measures and fault responses**
- **High-reliability**, high-current **jackscrew connectors**





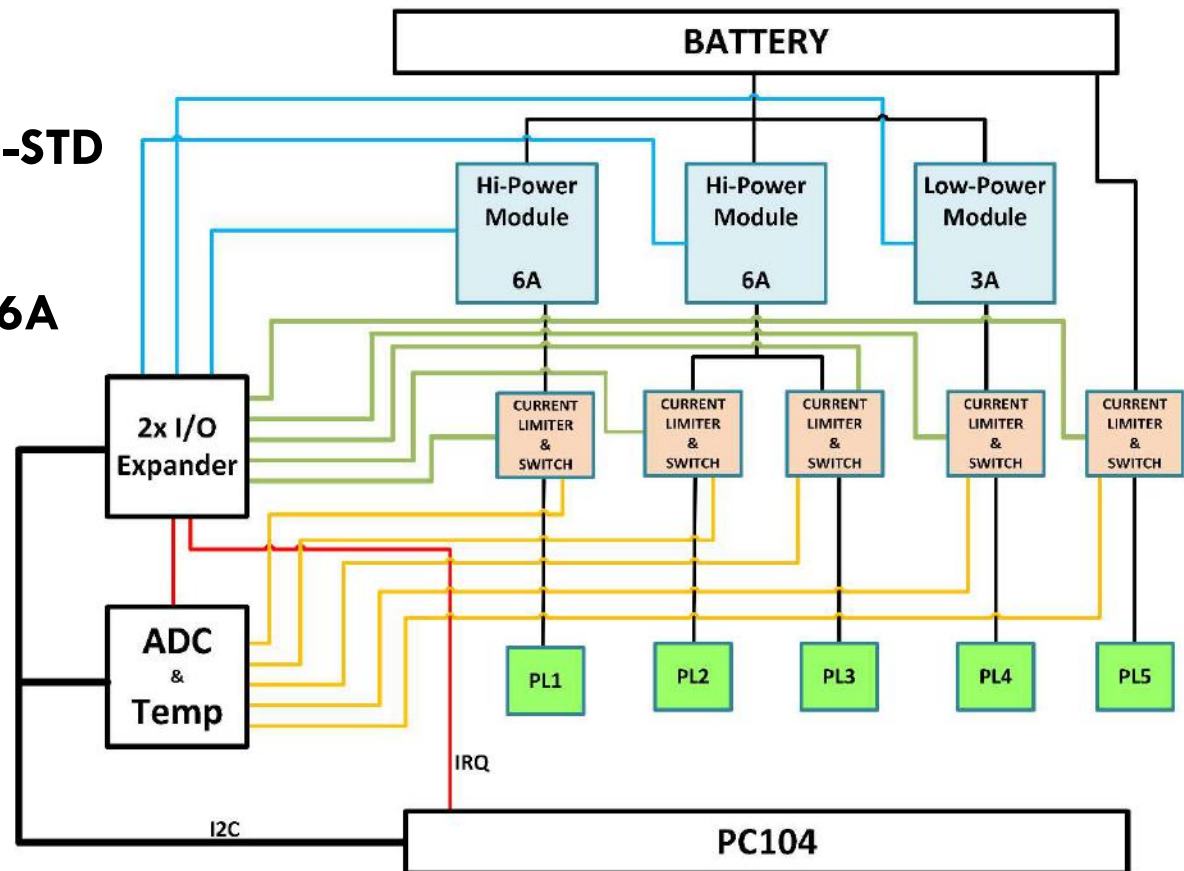
# Hi-Power PCDU for New Space Systems



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## Power Conditioning & Distribution Unit - System Architecture

- Power modules tested to **Mil-STD**
- Efficiency up to **95%**
- Channel current from **2A** to **6A**
- **50W** output at **85°C**







# GAUSS Technical Partners



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## THi TECHNOLOGY FOR PROPULSION AND INNOVATION **REGULUS LOW-THRUST ENGINE**

BASED ON MAGNETIC ENHANCED PLASMA TECHNOLOGY

100 X 100 X 150 [MM] (1,5U)

**TOTAL IMPULSE: 3000 Ns**

**THRUST: 0.7 - 0.8 mN**

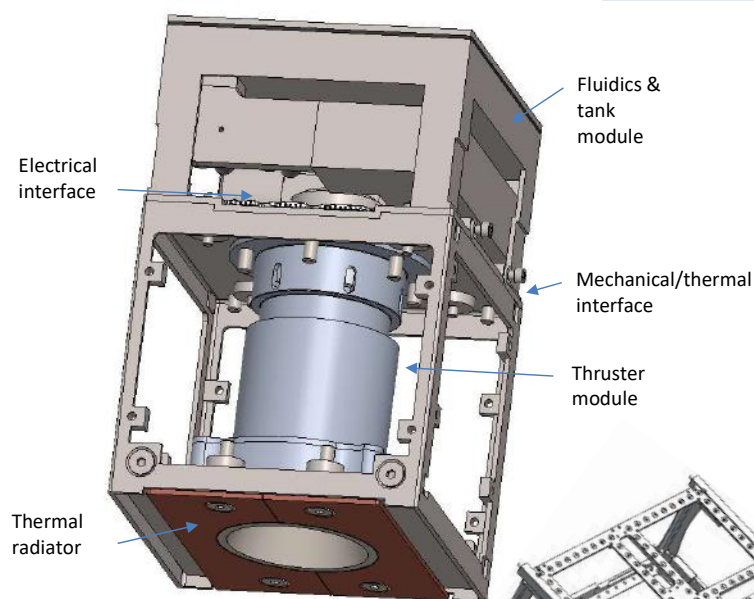
**SPECIFIC IMPULSE: 700 - 800 s**

**REQUIRED POWER: 50W**

**MASS FLOW: 0,1 mg/s**

**PROPELLANT: IODINE ( $I_2$ , SOLID)**

THi TECHNOLOGY FOR PROPULSION AND INNOVATION



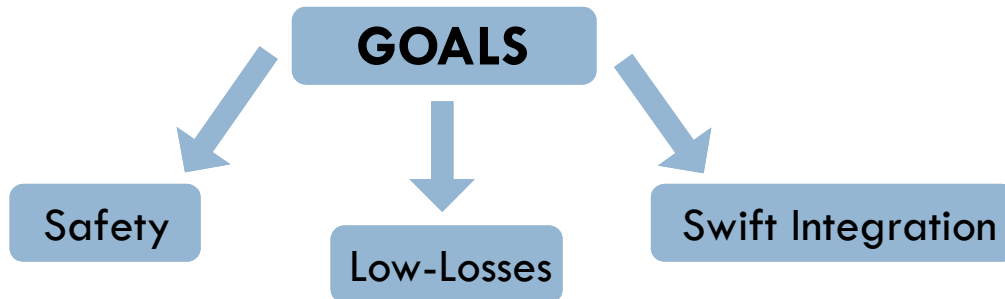
**Tested onboard UniSat-7**

**REGULUS low-thrust engine**

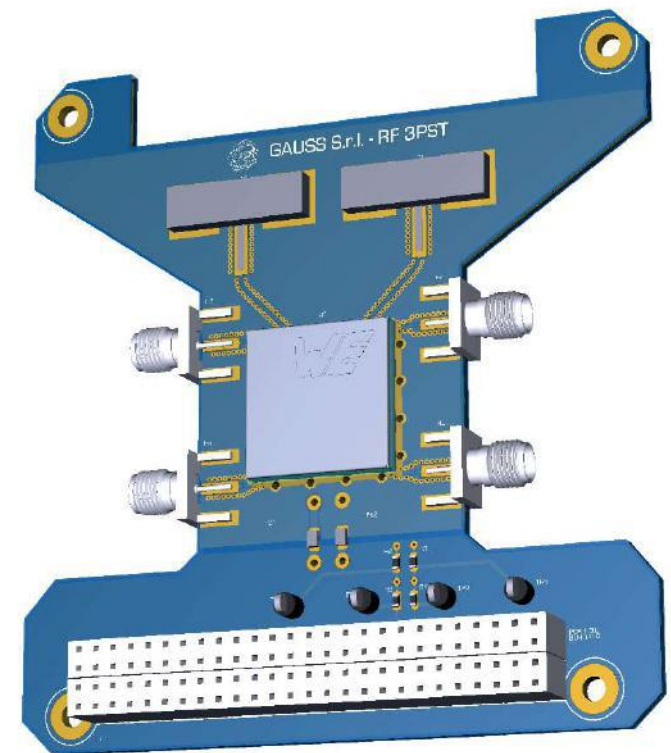


## Our new RF Switch board

Used to interface on-board communication systems with different antenna systems



- Several Switch Configuration available
- Switching controlled by simple **GPIOs** from OBC/RADIO
- Standard configuraion is **3PST**
- **100W, 50Ω RF terminations** for unused switch terminals
- Low Insertion Loss
- Up to **39dBm** input power
- Powered by 3.3V from PC104 stack



**3PST Configuration**

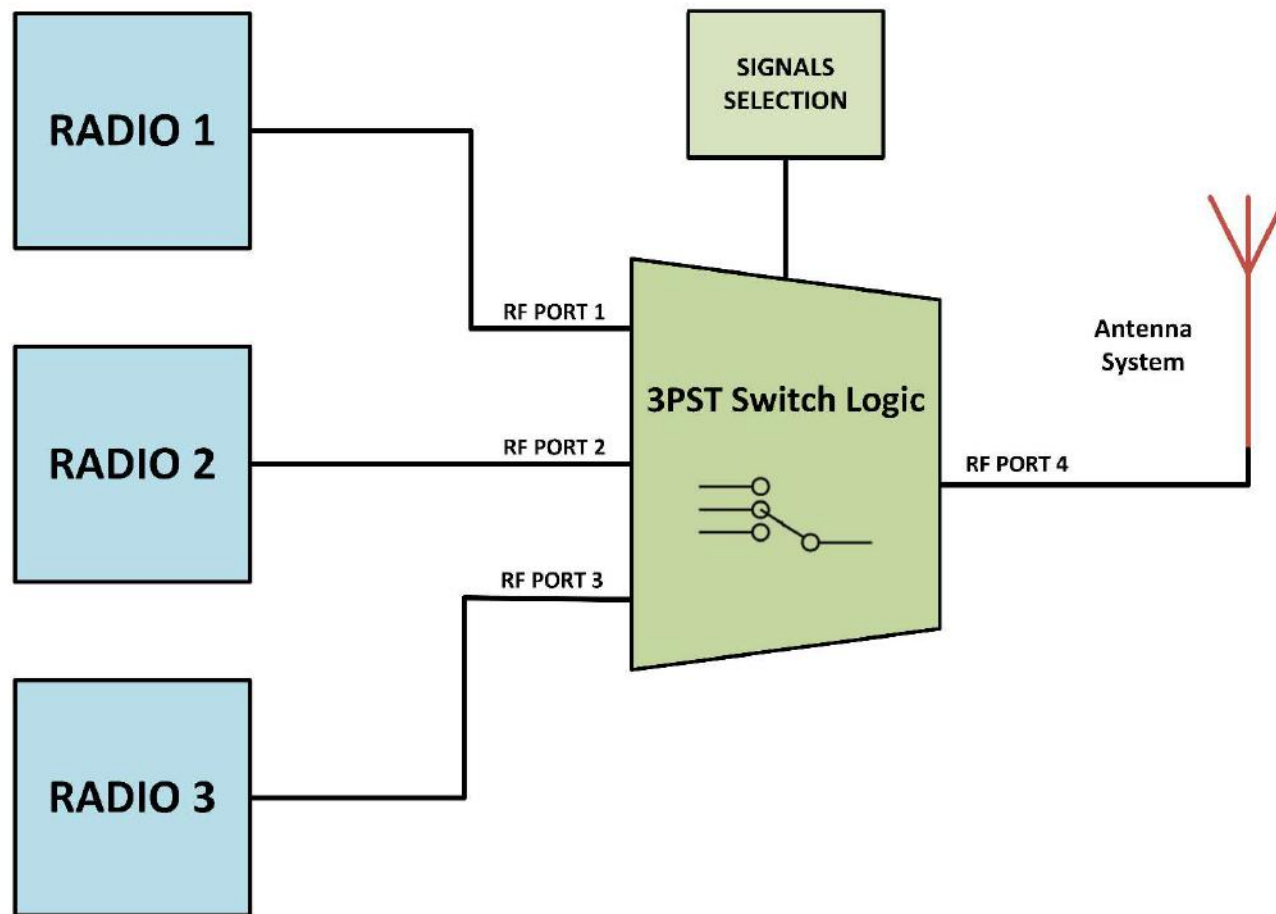


# RF Electronics for New Space Systems



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## *RF Switch Board - System Architecture*





# UniSat BUS for New Space Systems



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## Our next **UniSat-7** mission

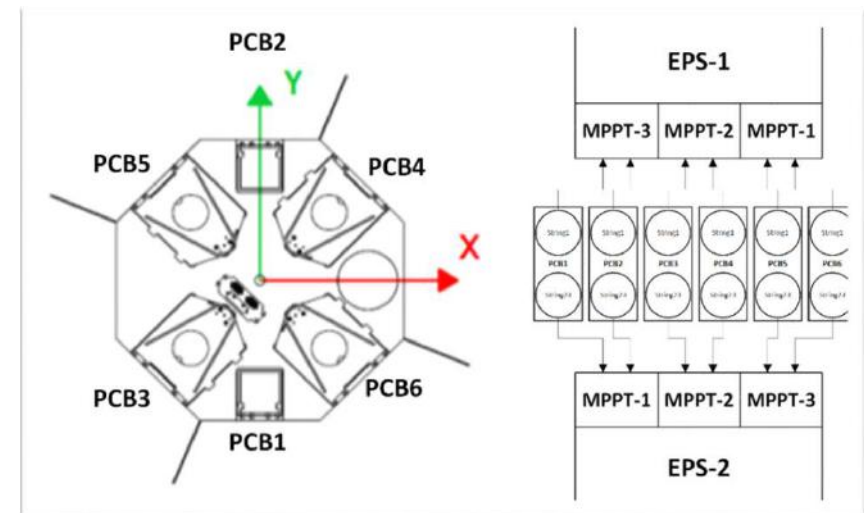
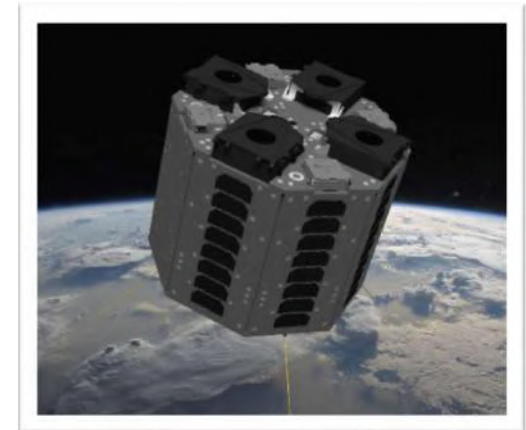
Nano/Pico-satellites in-situ deployer, technology demonstrator

### **Mission Objectives:**

- ❑ Release of CubeSats and PocketQubes
- ❑ **IOD / IOV** tests of third-parties' payloads
- ❑ Evaluation of **new GAUSS subsystems** in orbit
- ❑ **AOCS** (ADCS + **T4i REGULUS** Low-thrust Engine)

### **Mission features:**

- ❑ Soyuz-2 LV
- ❑ SSO, Circular, 550-600km
- ❑ 45W avg. generated power
- ❑ 35kg wet mass
- ❑ Dual EPS Power bus
- ❑ Reinforced carbon-fibre design



Power generation schematic for UniSat-7





# Conclusions



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Questions?

*That's all Folks!*

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