Novel On-board Computer and Data Handling Subsystem for European ADCS for Earth Observation Application

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About SkyLabs

SkyLabs is platform subsystems provider for emerging space market

Electrical Power Systems

- All-in-one solutions
- High-level of integration

Remote Terminal Units

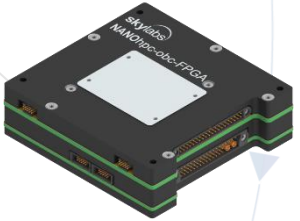
- Build-in high-level functionality
- Scalable & modular approach

On-Board Computers

- Highly miniaturised with FT
- Mid- to high-performance

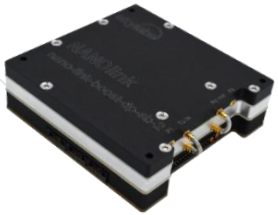
High Processing Computing

- Fault Tolerant reliable HPC
- Clustering supported
- HW AI Extension



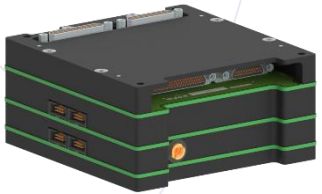
Communication

- S-BAND
- Best SWaP & CCSDS compliant
- ***SDLP-Secure*** connectivity



Attitude Determination and Control System

- E-ADCS (Prime: Indra-Deimos)
- 6U – 75kg



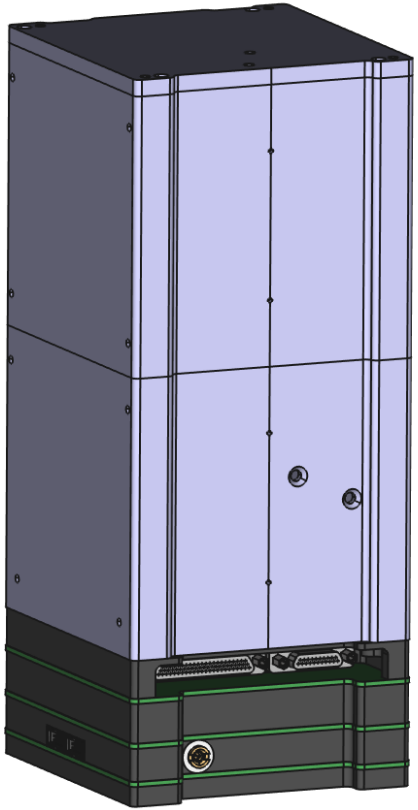
E-ADCS Introduction

- A fully European-built ADCS is vital for space autonomy and independence.
- Aligns with EU and ESA goals for sovereignty in space technology.
- The E-ADCS, developed by **Indra Deimos** (prime) and **SkyLabs** (subcontractor) under an ESA co-funded initiative, strengthens European sovereignty, security, resilience, and leadership in small satellite systems.

E-ADCS Architecture

Main components of E-ADCS:

- **NANOadcs (SkyLabs)**
  - Includes an on-board computer (OBC) for executing GNC algorithms.
  - Processes sensor data to determine satellite attitude.
  - Commands and drives actuators for attitude control.
  - Integrates a GNSS receiver for precise positioning.
  - Integrates on-board magnetometer and gyroscope
- **ADCS Sensors and Actuators (Indra Deimos)**
  - Sensors: sun, star trackers, magnetometer, gyro
  - Actuators: magnetorquers and reaction wheels
- **ADCS Software/GNC Algorithms (Indra Deimos)**
  - Including Kalman filters, quaternions calculus, actuator controls, and housekeeping
- **ADCS Case (Optional, Indra Deimos)**
  - Box/ALU structure holding together all the above components with predefined geometry



E-ADCS Variants and Performance

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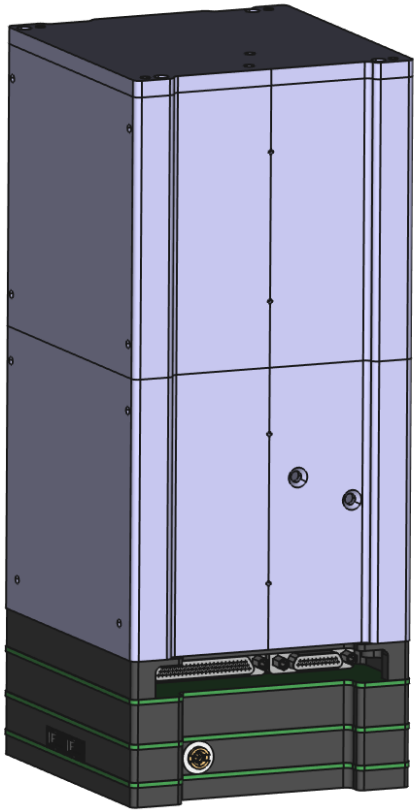
Variant 1: READY-16U, Boxed Version, 6U-16U

Key Performance Metrics	Value
Pointing accuracy	< 0.05 deg < 180 arcsec
Pointing stability	< 0.017 deg/s < 61.2 arcsec / s
Attitude estimation acc.	< 0.042 deg < 150 arcsec
Orbit determination acc.	10 m
Agility	> 1 deg / s
Mass	2 kg
Volume	2.2U
Power (fine pointing mode)	< 10 W
LEO Lifetime	>5 years



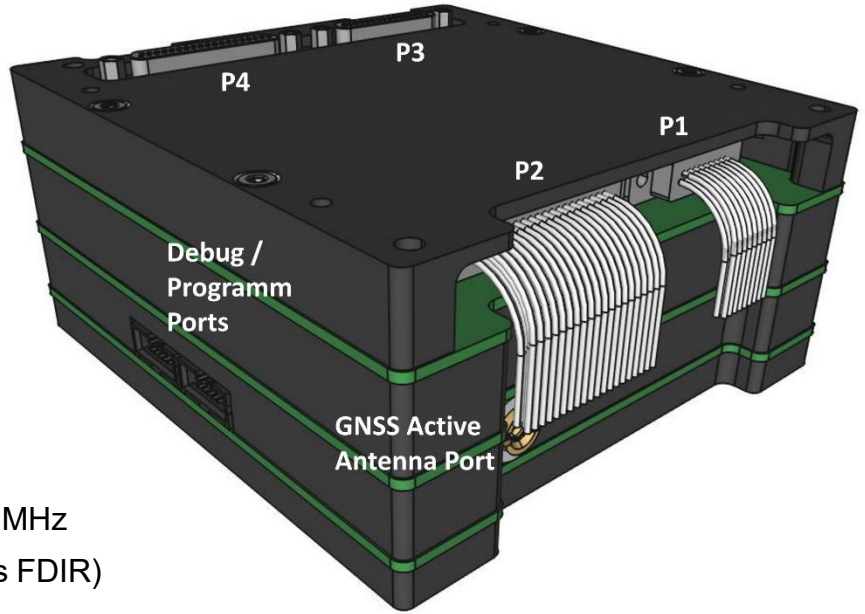
Variant 2: READY-100

Distributed configuration, microsat <75kg

INDRA

NANOadcs Architecture

- Consists of 3 vertically stacked and interconnected PCBs
  - **NANOadcs-conn** (top PCB)
  - **NANOadcs-IF** (middle PCB)
  - **NANOadcs-hpm-obc** (bottom PCB)
- Encapsulated within ALU shield (bottom part of the E-ADCS structure in READY-16U variant)

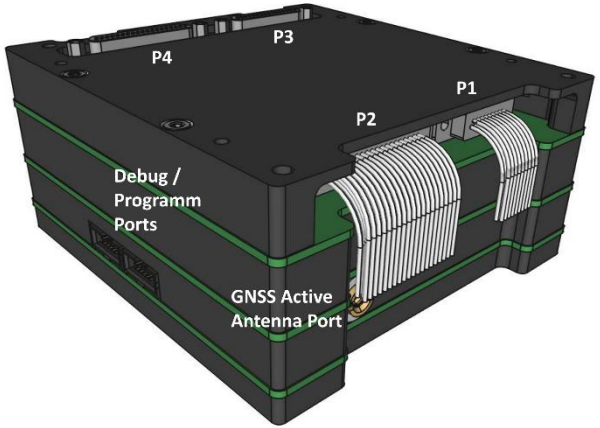


NANOadcs-hpm-obc

- Dual-core RISC-V (RV32IMAF) 32-bit processing platform, @80MHz
- PicoSkyFT softcore processor – Supervisor Module (implements FDIR)
- 256 MB ECC-protected DDR3 RAM.
- 2 GB EDAC-protected NVM storage, 512 MB user-available
- TM data & logs stored in EDAC-protected MRAM NVM (two banks) with 256 kB user-available,.
- Redundant CAN bus using CAN-TS protocol serves as the main TM/TC interface.

NANOadcs Interfaces

- **P1: Platform connector** (power supply input, CAN TM/TC interface, PPS signal output)
- **P2: External ADCS sensors connector** (up to 10 coarse sun sensors, up to 2 fine solar sensors, up to 2 star trackers)
- **P3: Internal ADCS sensors/actuators connector**, Deck 1 (2 Reaction Wheels, 1 Magnetorquer bar, 1 Gyro)
- **P4: Internal ADCS sensors/actuators connector** (2 Reaction Wheels, 2 Magnetorquer bars, 1x Magnetometer, 2x Temperature Sensor NTC)



ADCS Sensor/Actuator	Number of Units	Data Interface Options
Reaction Wheel	4	• CAN (non redundant) • RS485
Gyroscope	1	• RS422
Magnetometer	1	• RS485 • I2C
Star Tracker	2	• RS422 • RS485 • UART
Fine Solar Sensor	2	• RS485 • UART
Coarse Solar Sensor	10	• Analog Input
Magnetorquer	3	• PWM Full-Bridge with Current Ctrl.
Temperature Sensors	2	• Analog Input
Spare Interfaces 1	2	• RS485
Spare Interfaces 2	12	• GPIO, 3.3V

E-ADCS Software System

Attitude Determination

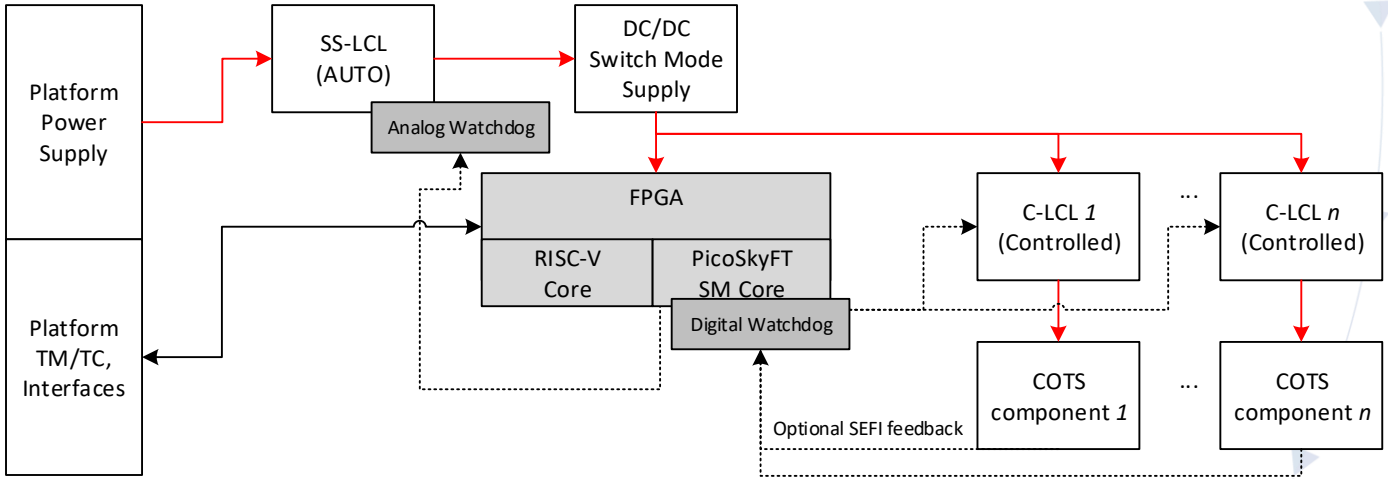
- E-ADCS implements a **multi-mode control algorithm** for precise **three-axis attitude control**.
- Up to **2 star trackers** provide primary attitude reference with arc-second accuracy.
- **Extended Kalman Filter** (EKF) integrates star tracker and three-axis gyroscope data for continuous attitude determination.
- **Three-axis magnetometer** supports geomagnetic attitude reference and magnetic control modes.
- **Coarse sun sensors** (optional) assist in initial acquisition and **safe mode operations**.
- **Two fine solar sensors** deliver high-precision sun vector measurements for **solar pointing** or **star tracker backup**.

Control

- **Four reaction wheels** provide fine three-axis torque control during normal operations.
- Each wheel features an **internal controller** for speed regulation and torque execution.
- **ADCS flight software** sends **torque commands** to the wheel controllers.
- **RW desaturation** utilizes three PWM-controlled magnetorquer bars

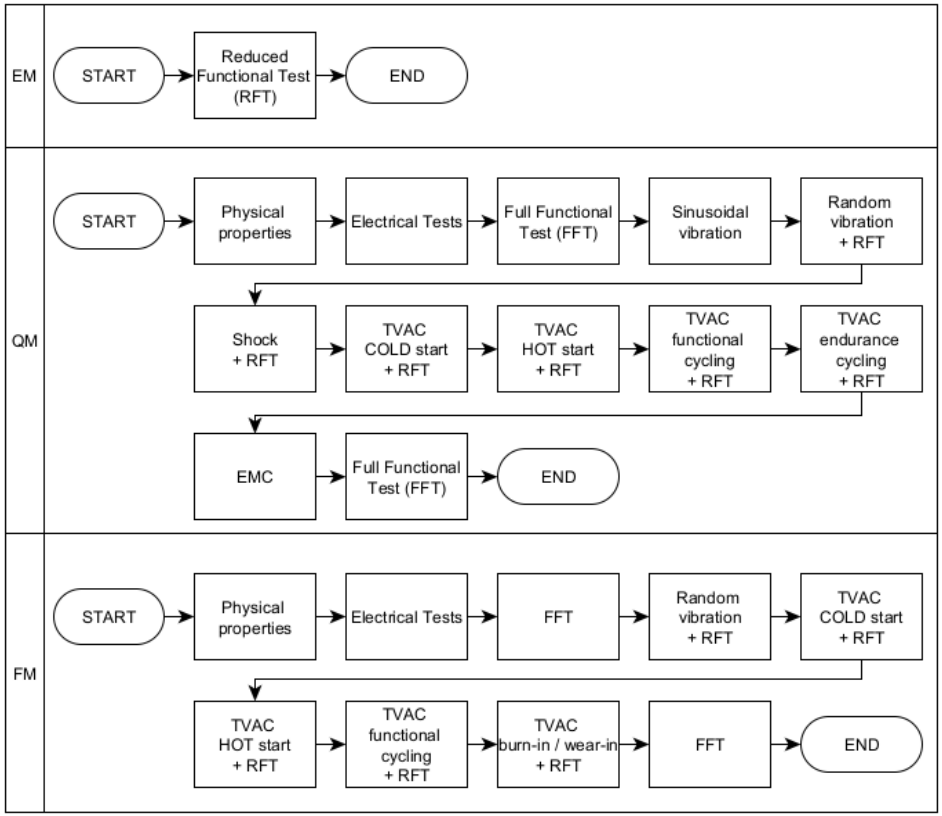
NANOadcs Fault Tolerance, FDIR

- High reliability via radiation-tested, flight-proven components, building blocks, and advanced FDIR architecture.
- **Supervisor Module (SM)** with PicoSkyFT fault-tolerant core in FPGA.
  - Handles boot, firmware load, TM/TC via CAN, and processor resets.
  - Supports in-mission software reprogrammin
  - Manages FDIR, including LCLs for SEL and EDAC DED protection.
  - Hierarchical SEE protection with LCLs, watchdogs, and layered FDIR.
- FPGA safeguarded by SS-LCL, managing COTS components via C-LCLs and watchdogs.



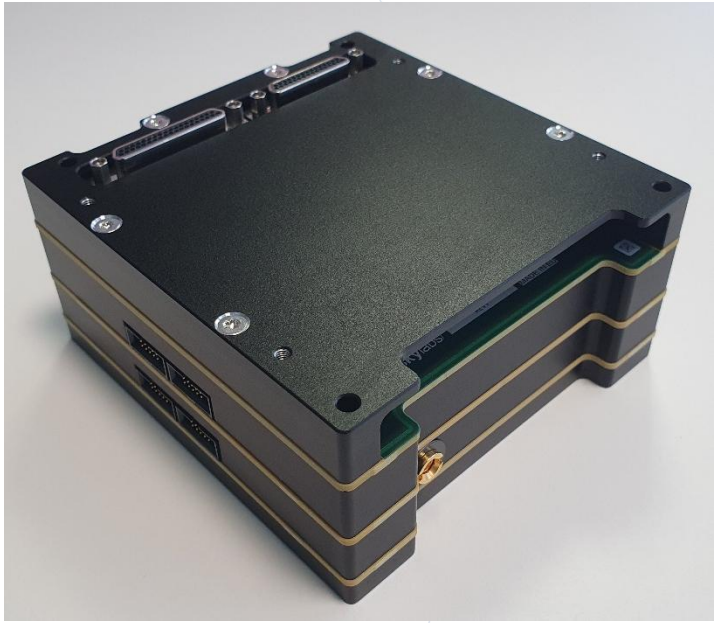
NANOadcs MAIT and Qualification

- MAIT: **IPC-A-610 Class 3**
- Qualification and testing will comply with **ISO 19683:2017** and **ECSS-E-ST-10-03** guidelines.
- Model Philosophy:
  - EM, QM, FM



Conclusion

- **E-ADCS** marks a step forward in European small satellite technology.
- Developed by Indra Deimos and SkyLabs under ESA co-funding.
- Provides **a flexible, scalable ADCS for nanosatellites and microsatellites**.
- **NANOadcs core system** ensures high reliability with flight-proven components and advanced FDIR.
- Developed and qualified through standard satellite electronics stages.
- Positioned as a cutting-edge solution for future European space missions.



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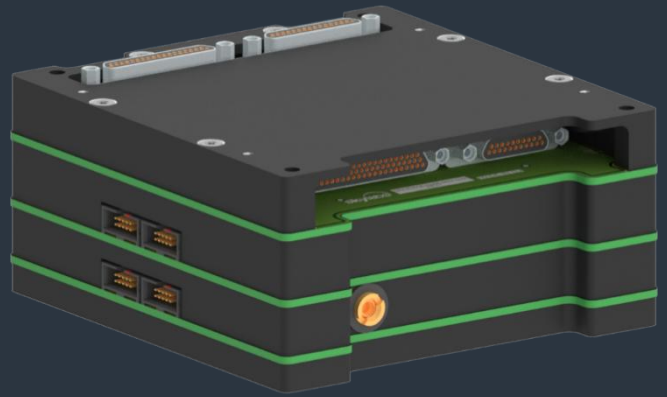

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