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picoRTU-System Distributed, Modular, Intelligent Remote Terminal Unit System

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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

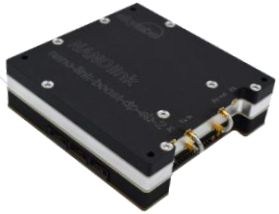
- Highly miniaturised with FT
- Mid- to high-performance

High Processing Computing

- Fault Tolerant reliable HPC
- Clustering supported

Communication

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



LCL

- Latching current limiter IC

EGSE

- RF comm, CCSDS server
- User SW: SDKs, GUIs

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picoRTU overview

Miniaturized, distributed and **intelligent** remote terminal system (**RTU**), based on modular off-the-shelf units for space applications, where each unit has its own set of user interfaces. Distributed RTU system is the first step to enable a truly distributed OBDH architecture with RTU functions closer to the data source.

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picoRTU development history

1. picoRTU-Demonstrator (ESA)
   - First RTU project deleveped by SkyLabs
   - It provided various communcation, analog in high-power interfaces on single board
2. miniRTU / NANOif (ESA / OHB-I)
   - Second iteration of RTU, specialized for communication interfaces
   - Single board solution
3. picoRTU-System (ESA / DEIMOS)
   - 4 specialized units (base, digital, analog, high-power) instead of single board
   - Various configurations can be achived based on customer needs

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Design goals

- Distributed intelligent remote terminal unit system
- Adaptable radiation tolerance
- Standardized interfaces
- Modularity and scalability
- Versatile ground support software
- Verification approach

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Implementation aspects

- PicoSkyFT
- CAP (Combo Analog Pin)
- Communication interfaces
- Digital IOs
- Power IOs
- Interconnect

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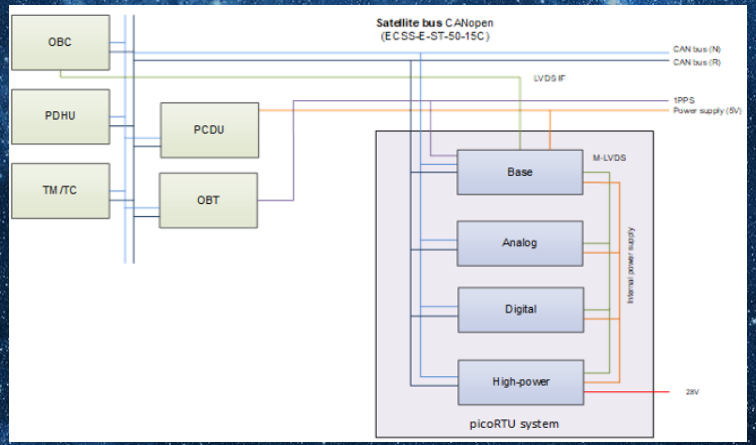
picoRTU-system

High-level Architecture

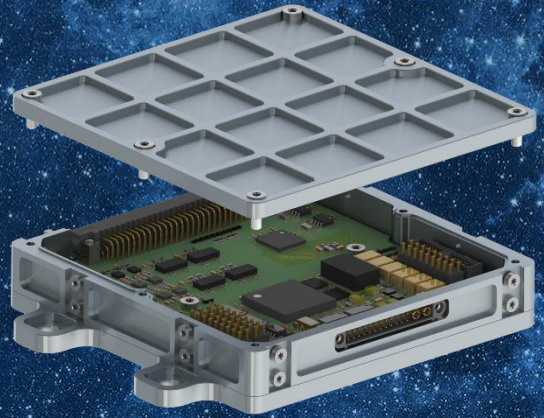
- Four specialized boards form picoRTU-system
- Up to 16 boards can be stacked in a final configuration
- Possibility for various redundant configurations

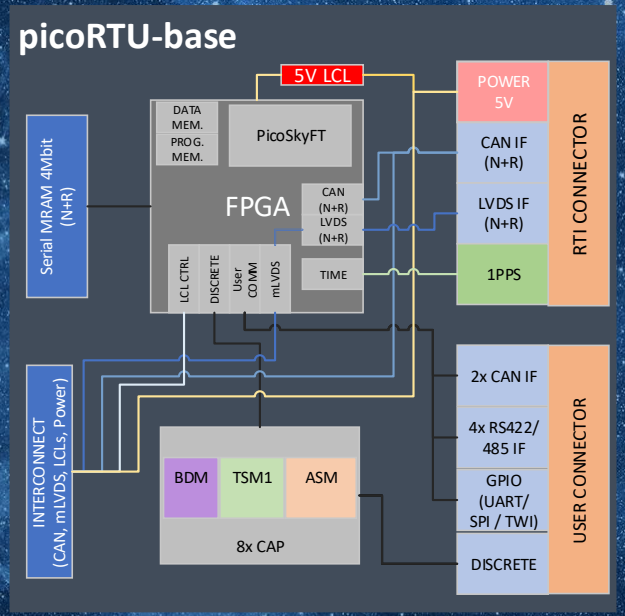
picoRTU variant \ Interfaces	CAPs		PowerIO-HVCs	Digital IOs	RS485/422 interfaces	CAN interfaces
	Single-ended	Differential				
picoRTU-base (Base unit)	8	4	0	16	4	2
picoRTU-analog (Analog acquisition unit)	32	16	0	0	0	0
picoRTU-digital (Digital and communication unit)	0	0	0	16	8	2
picoRTU-hp (High power unit)	0	0	5	0	0	0

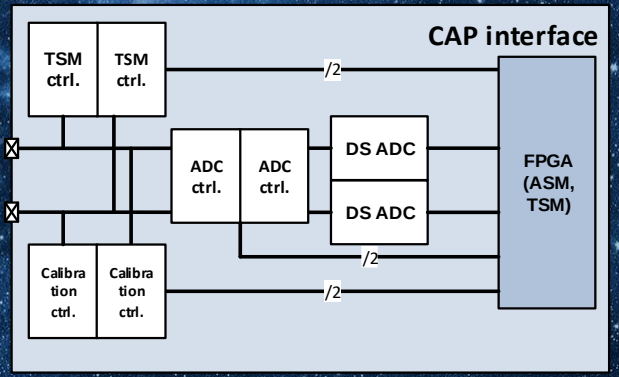


picoRTU-base

- RTI interface: CAN & LVDS
- Analogue user interfaces
  (8x single ended ASM, 4x differential, BDM, TSM)
- Digital user interfaces (16x Digital IO 3V3 LVCMOS)
  - GPIO alternate function (UART, SPI, TWI)
- Communication user Interfaces (4x RS485/422, 2x CAN)
- Supply voltage: 5 V DC (regulated)







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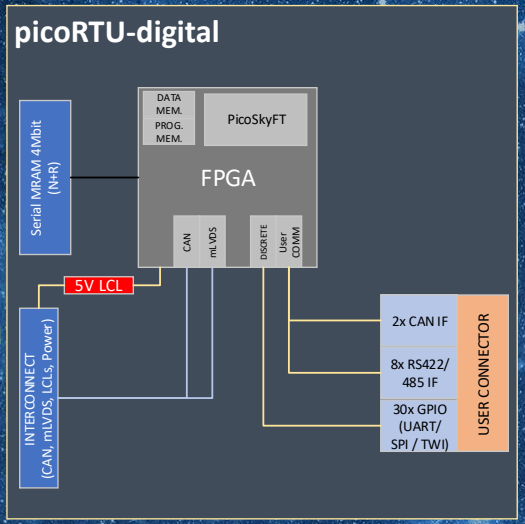
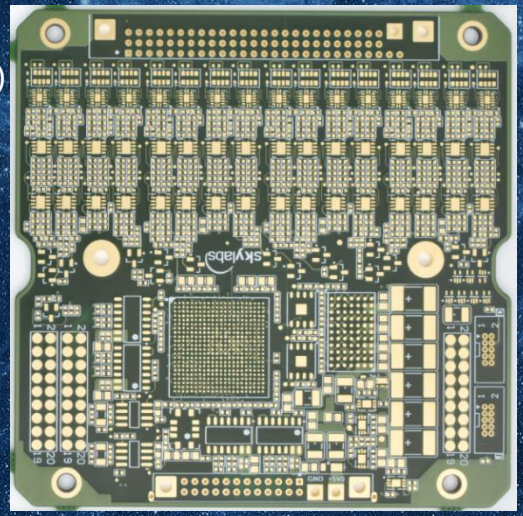
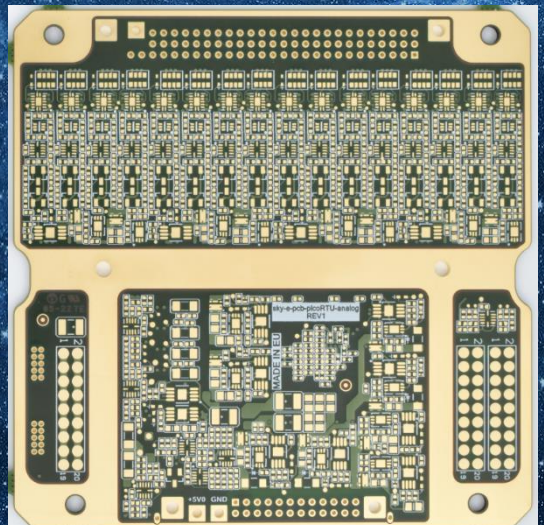
picoRTU-digital

- Interconnect interface: CAN & mLVDS
- Discrete User interfaces:
  - 16x Digital IOs (3V3 LVCMOS)
- Communication User Interfaces:
  - Up to 8x RS485/422 links
  - Up to 2x CAN
  - GPIO alternate function (UART, SPI, TWI)
- Supply voltage: 5 V DC (regulated)







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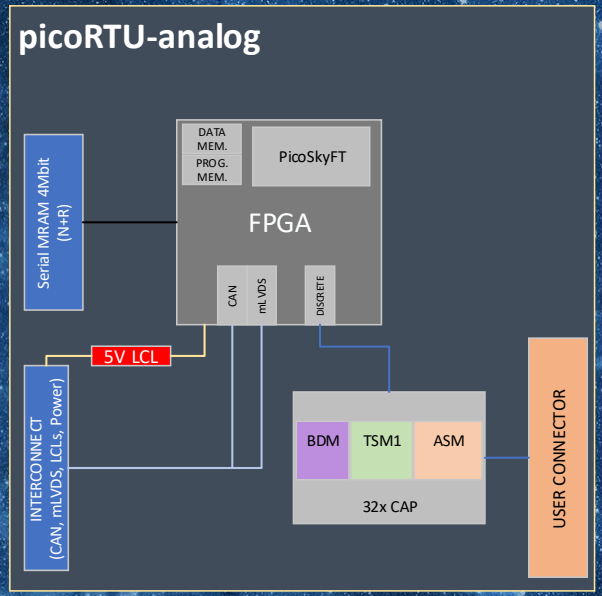
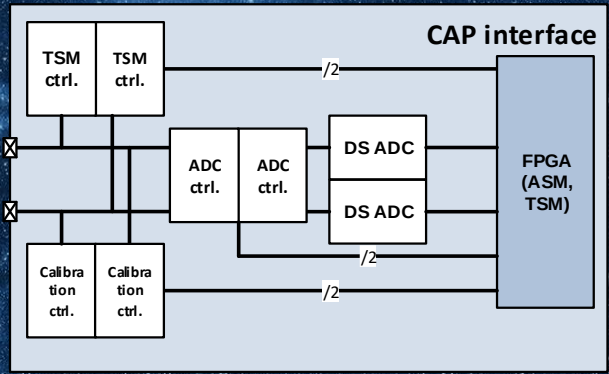
picoRTU-analog

- Interconnect interface: CAN & mLVDS
- User interface: 32x single ended ASM (16x Differential), BDM and TSM with internal calibration support
- Supply voltage: 5 V DC (regulated)



	CAP Pin 1	CAP Pin 2	Sample rate [ksps]	Resolution	Input voltage [V]
Differential ASM	Diff_P	Diff_N	2	12 bit	0 to 5
Single ended	ASM / TSM / BDM	ASM / TSM / BDM	2	12 bit	0 to 5



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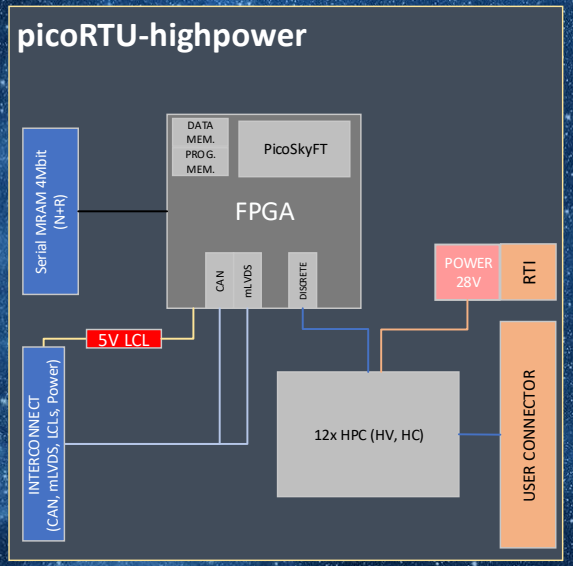
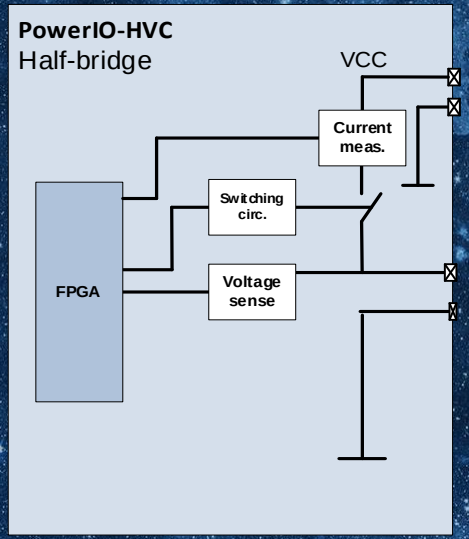
picoRTU-highpower

- Interconnect interface: CAN & mLVDS
- Discrete User interfaces:
  - 5x HC/HV-HPC w/ Arm/Fire support in software
- Supply voltage:
  - Regulated 5 V DC (for FPGA)
  - Regulated 28 V DC (for HPC)





	Current limit / SC current [mA]	Max. Fault Voltage [V]
HV-HPC	≤ 180 (@29V) / 600	33
HC-HPC	≤ 600 (@29V) / 1000	33
LV-HPC	≤ 180 (@16V) / 400	20

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picoRTU-system

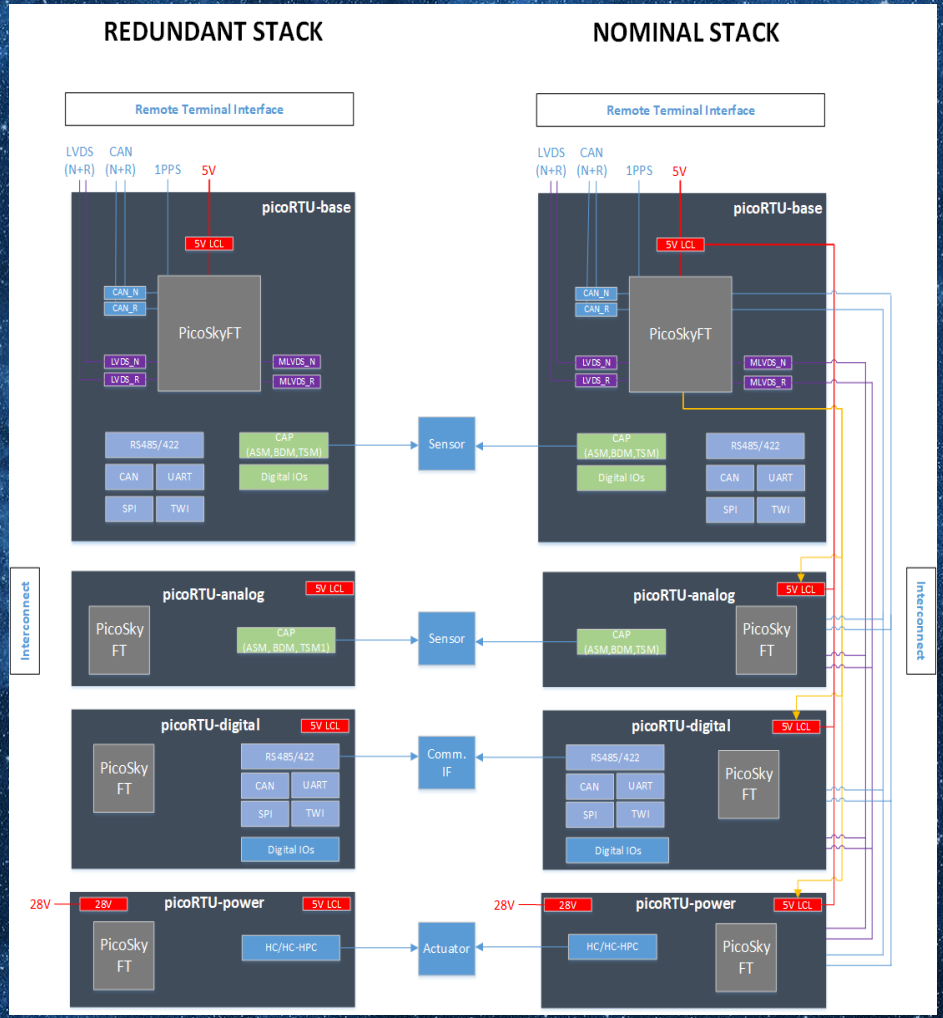
Redundancy management

Cold, warm, hot redundancy configurations are supported.

Redundant stack can be completely powered off or partially powered on.

Redundant system re-configuration procedure:

1. Faulty device in the nominal stack must be first turned off.
2. Replacement device in the redundant stack must be turned on.
3. Self-test procedure must be executed on redundant device.
4. Redundant device transitions to normal operation.



picoRTU-ATD

Automatic Test Device

1. Main goal of the ATD is to reduce time and effort to fully execute functional and electrical tests on picoRTU external interfaces.
2. Following requirements must be met
    1. ATD must be capable of performing following:
        1. Analog & digital electrical tests on UI connector (interface verification according to ECSS)
    2. Analog & digital functional tests on UI connector
    3. Full throughput test on all digital interfaces
    4. Automatic calibration procedure on analogue interfaces
    5. Reconfiguration of analogue interfaces (read, check TM/voltage)
3. ATD must be capable integrating with existing SkyLabs verification setup
4. ATD must provide following features:
    1. Digital multi meter (DMM)
    2. Multiplexing (MUX)
    3. Osciloscope (OSC)
    4. LCR meter (LCR)
    5. Analog output (AO)

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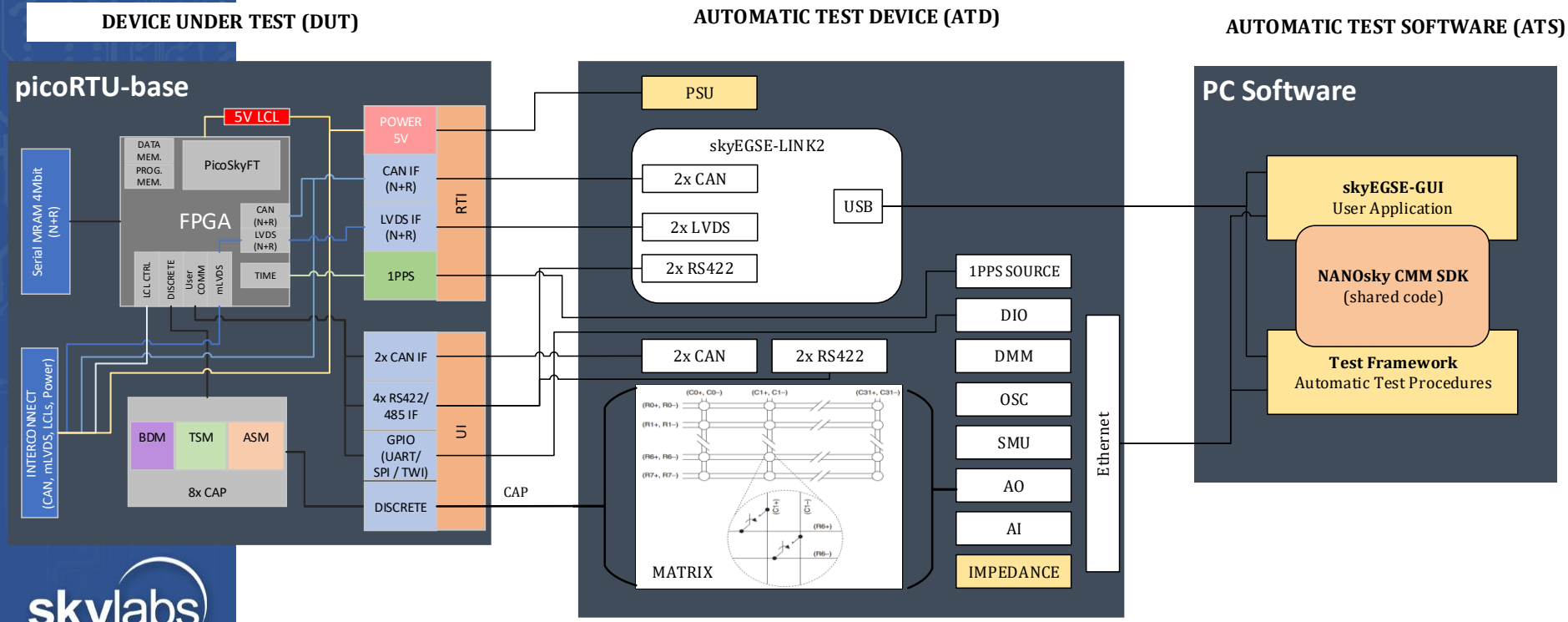
ATD Block Diagram

picoRTU device (DUT) – ATD – testing software



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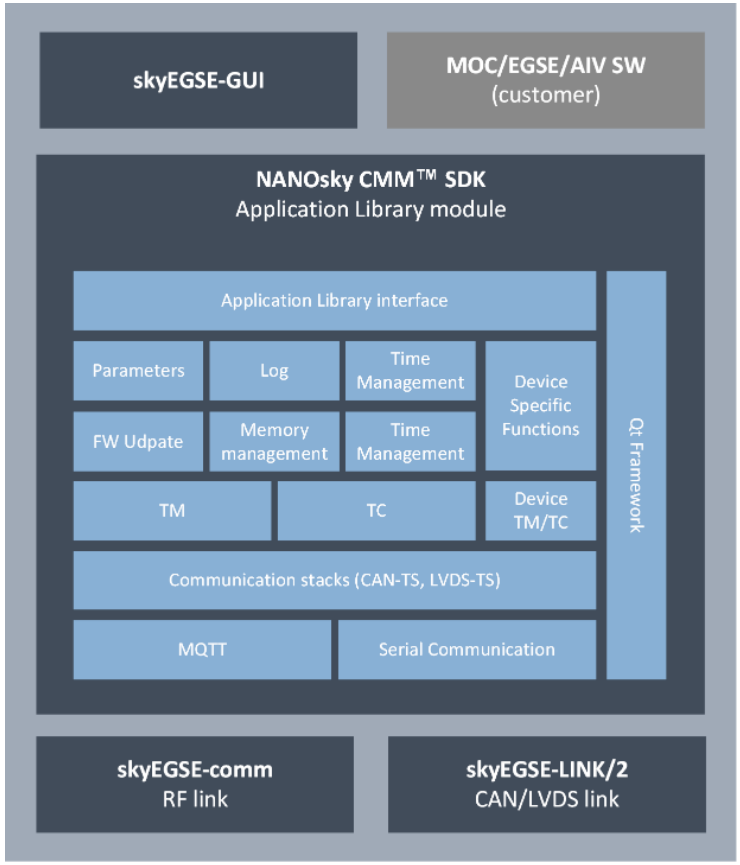
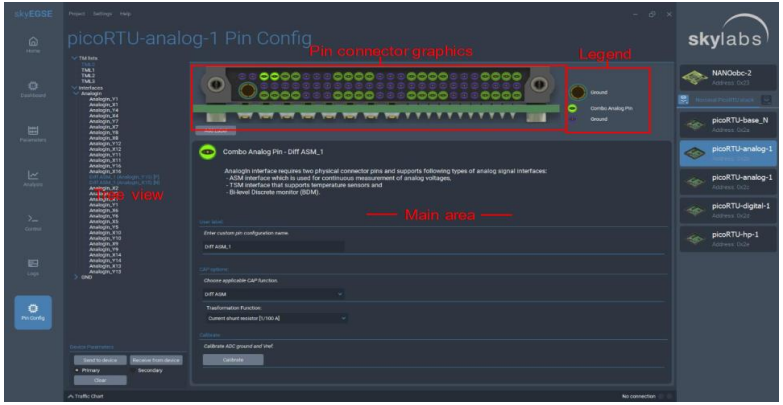
Software – GUI & SDK





Use cases

- Developed with **ESA**
- In projects with
  - OHB Italy (EAGLET-2 and IRIDE missions)
  - Deimos Spain (SAT4EO mission)
- In operation (picoRTU building blocks)
  - TRISAT mission (LEO at 600 km)
  - TRISAT-R mission (MEO at 6000 km)

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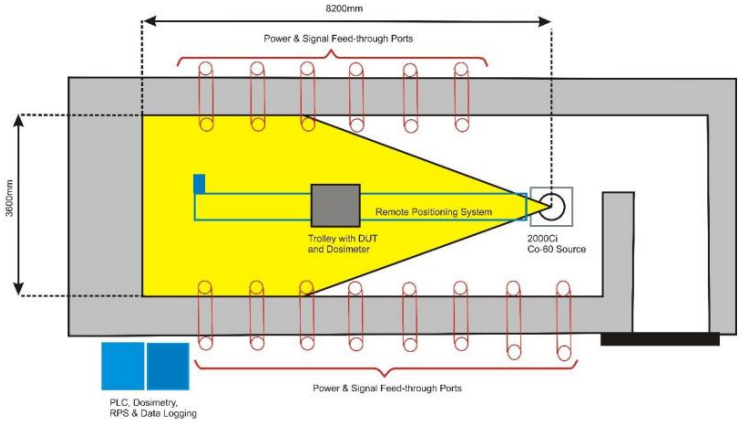
Next steps - SEE and TID radiation test

- SEE: CHARM facility at CERN (**October 2023**)
- TID: ESTEC/ESA Co-60 TID test facility (**2024**)



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Thank you!

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