

ESA's power activities for New Space

Arturo Fernandez

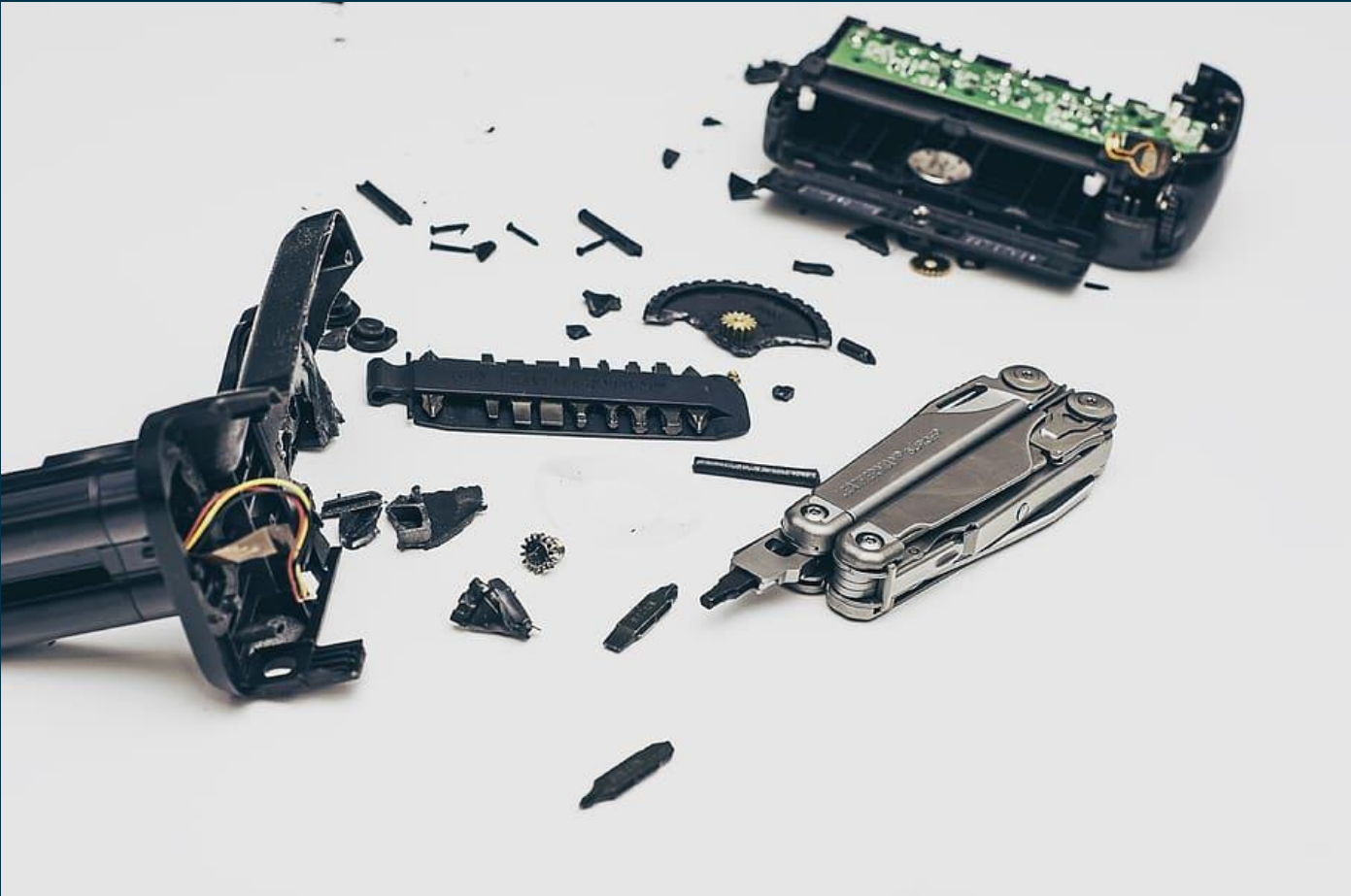
Head of Power Management Section



New Toy for power engineers



And we want to play with it!!



Low risk accepted

High Risk accepted

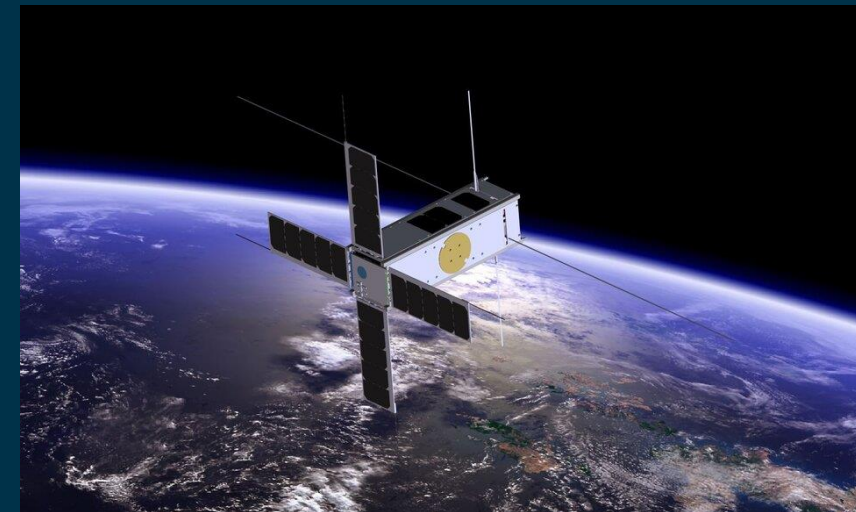
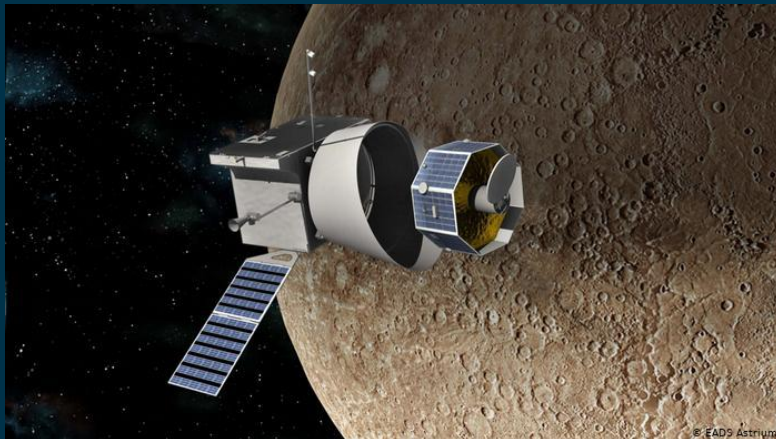
Full Hi Rel

Intermediate options?

Full COTS

Bepi Colombo

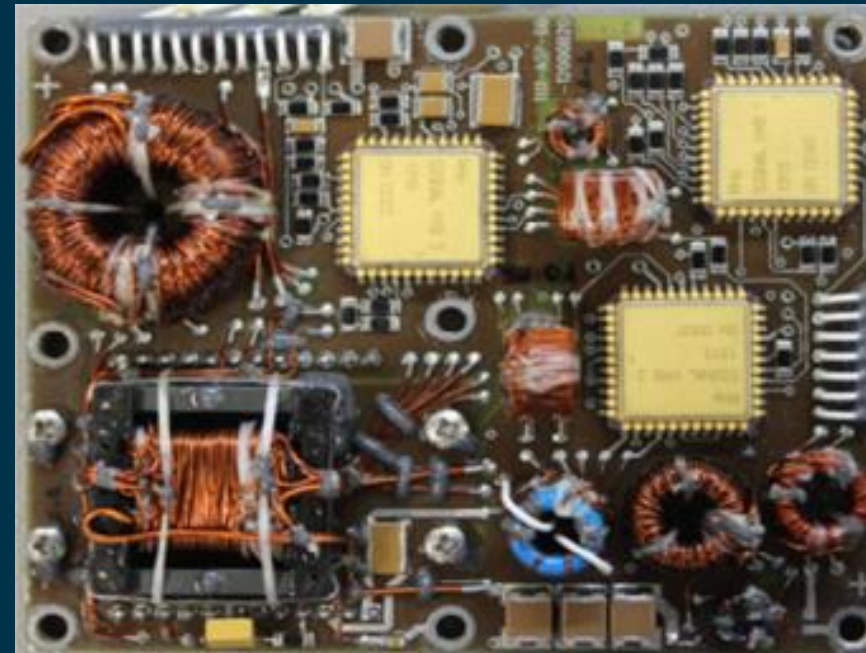
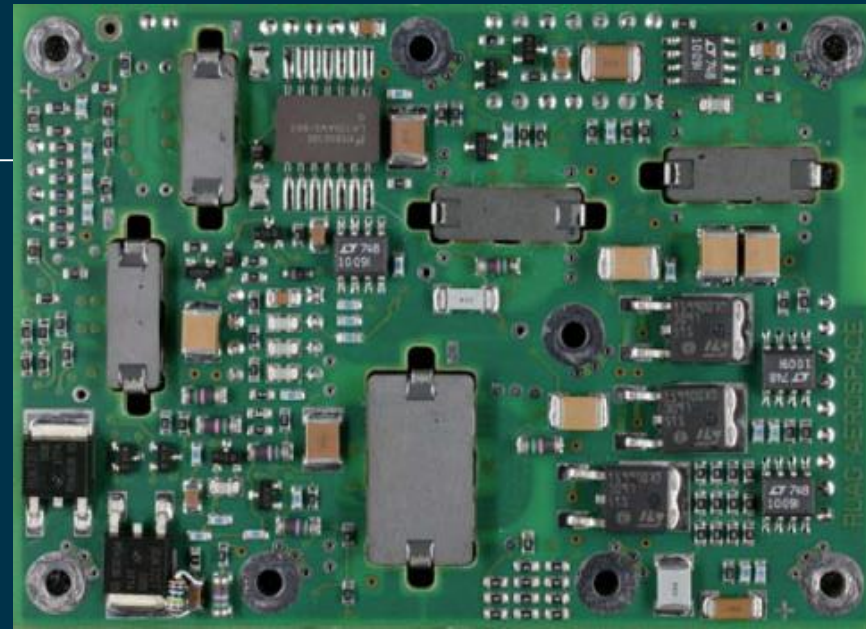
Cubesat



COTS in power

2008, RUAG and ASP

- DC/DC converter
- Full COTS
- Automotive components
- Understand upscreening
- Understand procurement process



Tests being performed on EEE COTS

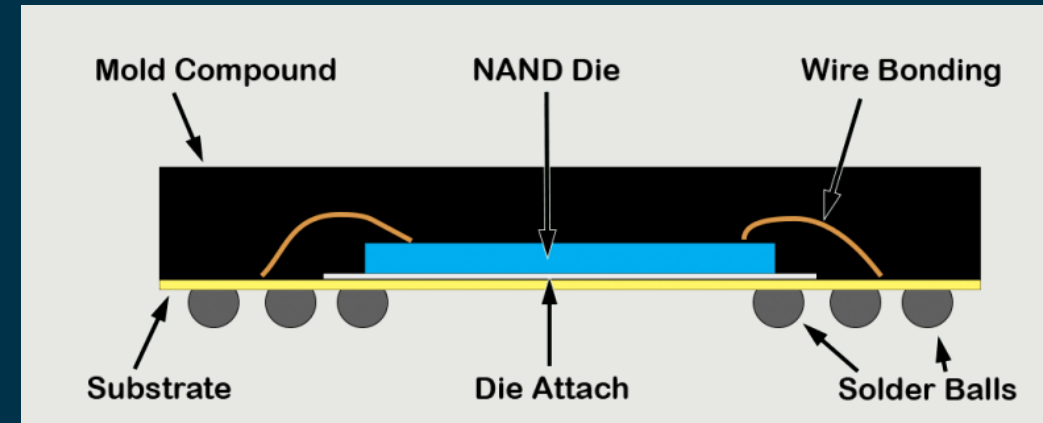
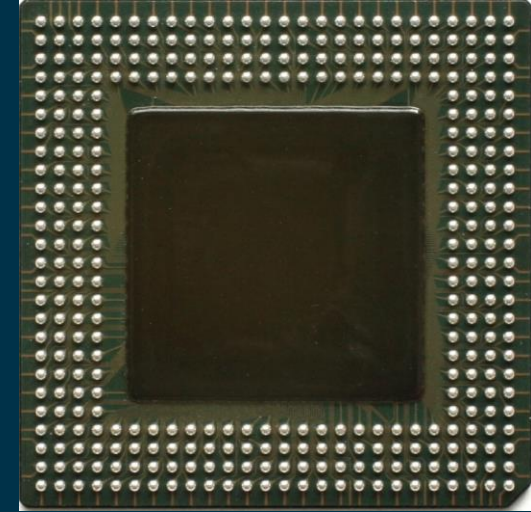
Working on Reference designs with COTS

Understand performance advantage

Use of mitigation techniques

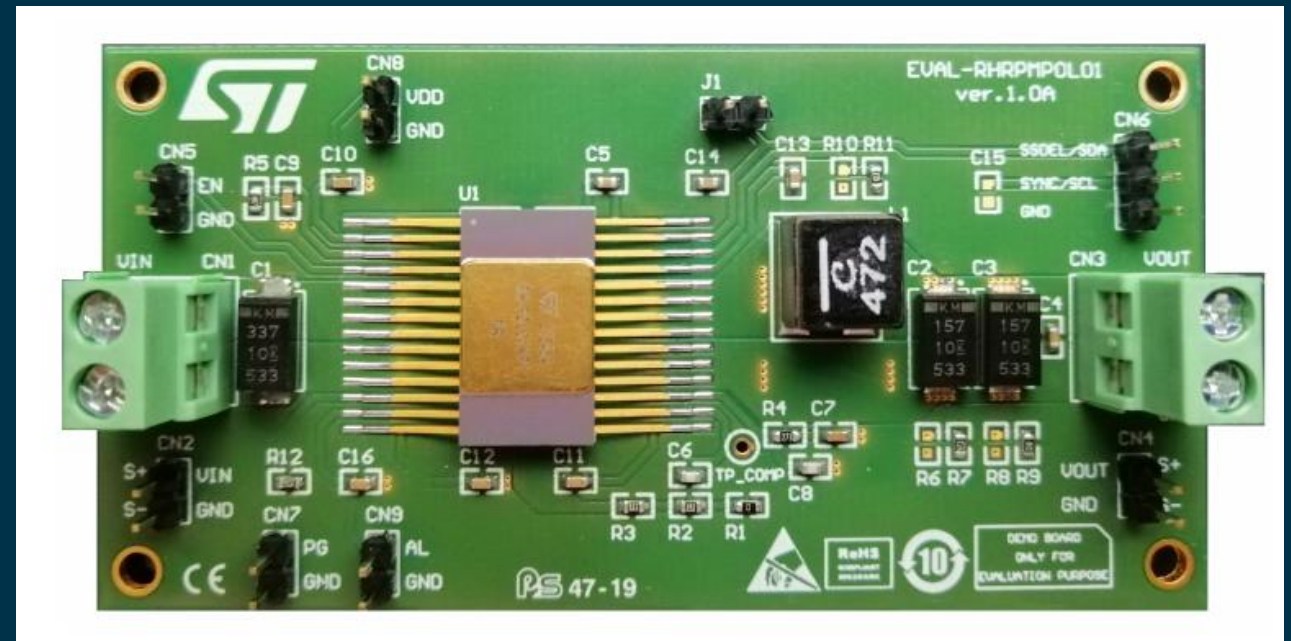
BGA packaging

- Based on FR4 substrate
- Multichip
- Plastic packaging
- Hi reliability production lines



RHRPMPOL01

- V_{in} : 5 V
- V_{out} : 1.2 V
- I_{out} : 5 A



Plastic package enhances thermal/electrical capabilities

DPC – Digital Processing Controller

- Building block for avionic units
- Motor Control
- Analogue & digital I/O bus client
- MIL-1553B or CAN interfaces
- Monitoring and protection
- Intelligent remote sensors management

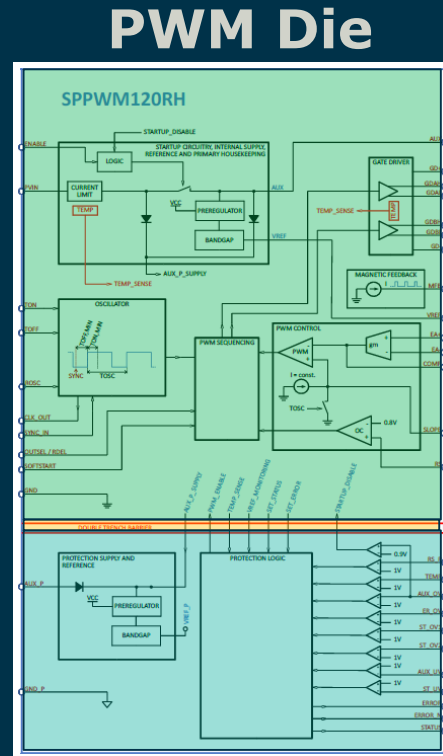
Exploring plastic packaging



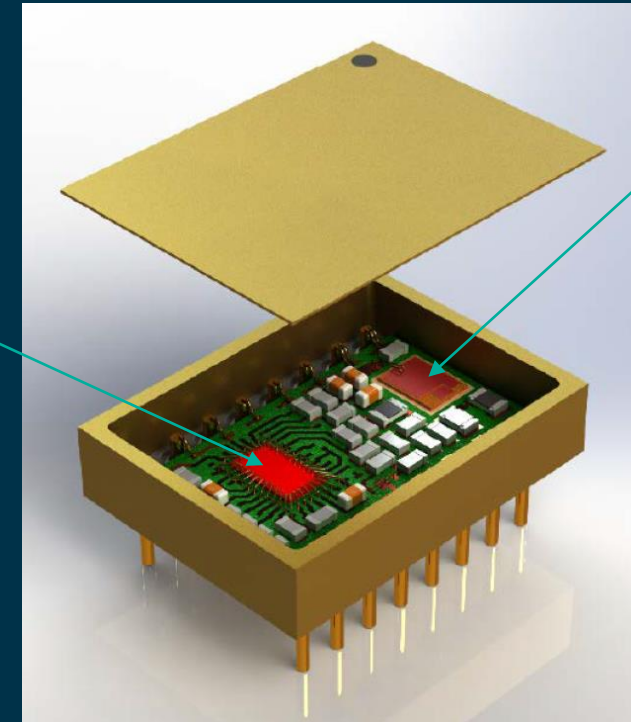
New power components

Integrated power switch for Aux Power supplies

- Start up circuit
- PWM
- Driver
- Control circuit
- Protections



Hybrid demonstrator



Integrated HiRel Si MOSFET

Control
SOI
Protections

$$V_{inmax} = 120V$$

Development of GaN switch and driver

Rad tolerant

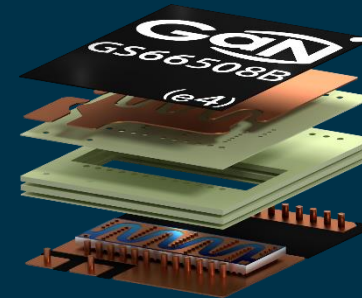
- TID
- Heavy Ion



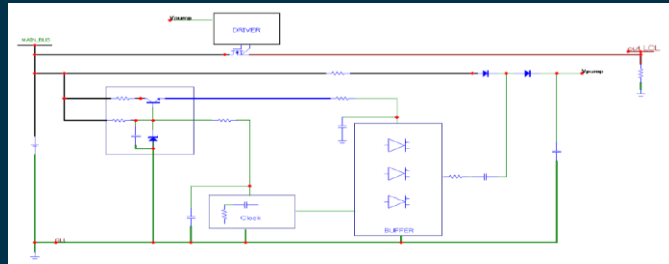
Space applications in mind

GaN Power Unit

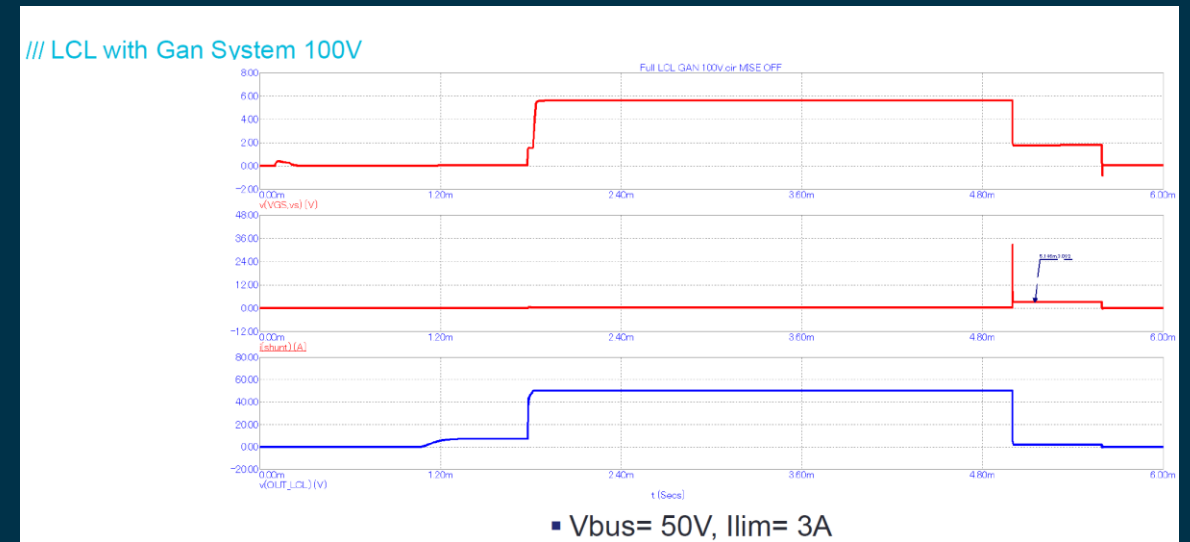
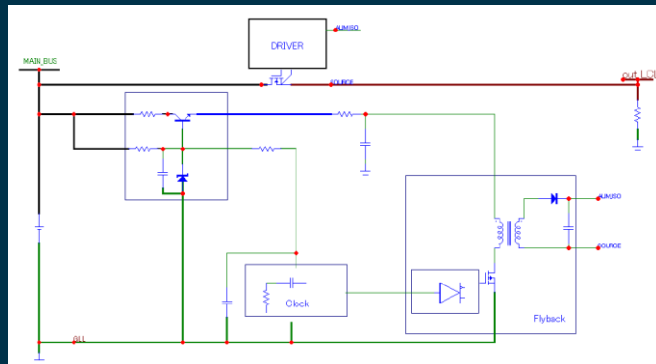
Study to replace all Si MOSFETs by GaN in a power unit



Charge pump



Small Isolated converter



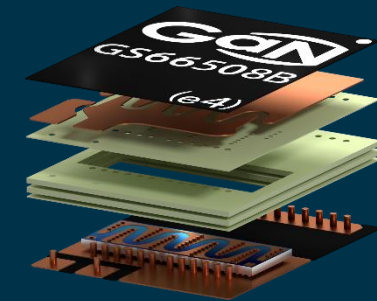
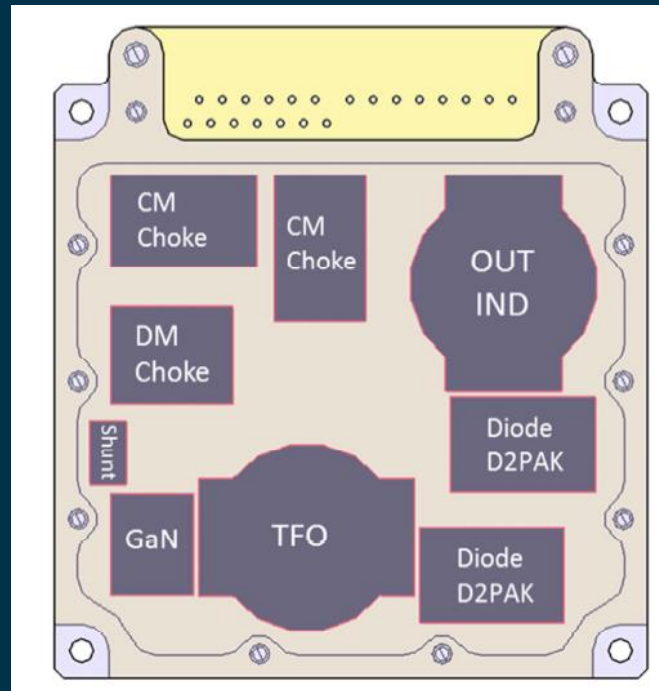
GaN DC/DC converter

Power module based on GaN switch

Variants for 28, 50 and 100 V bus

- 15 V
- 5 V
- 3.3 V

25 W

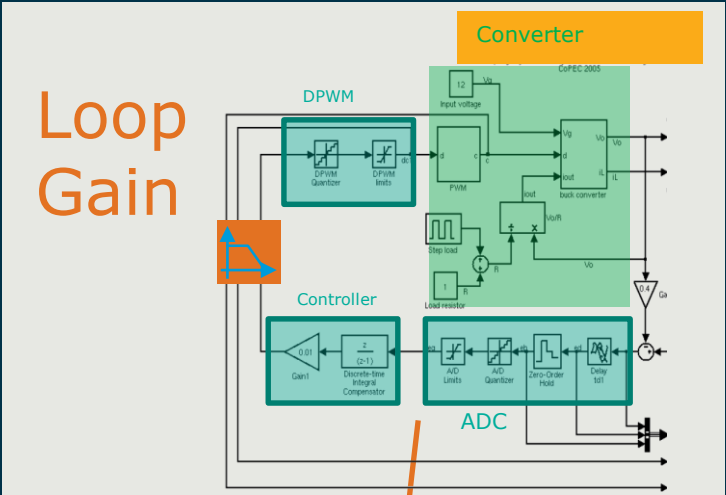


Brave FPGA - NanoXplore

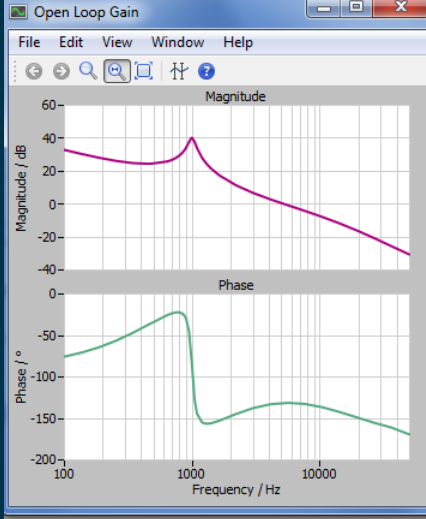
- Small FPGA
- Integrated ADCs
- Integrated memory
- PWM modules



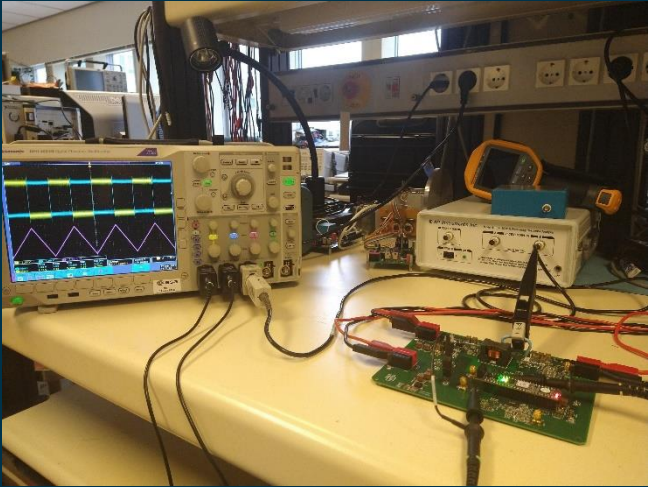
Discrete Modeling DC-DC Converters



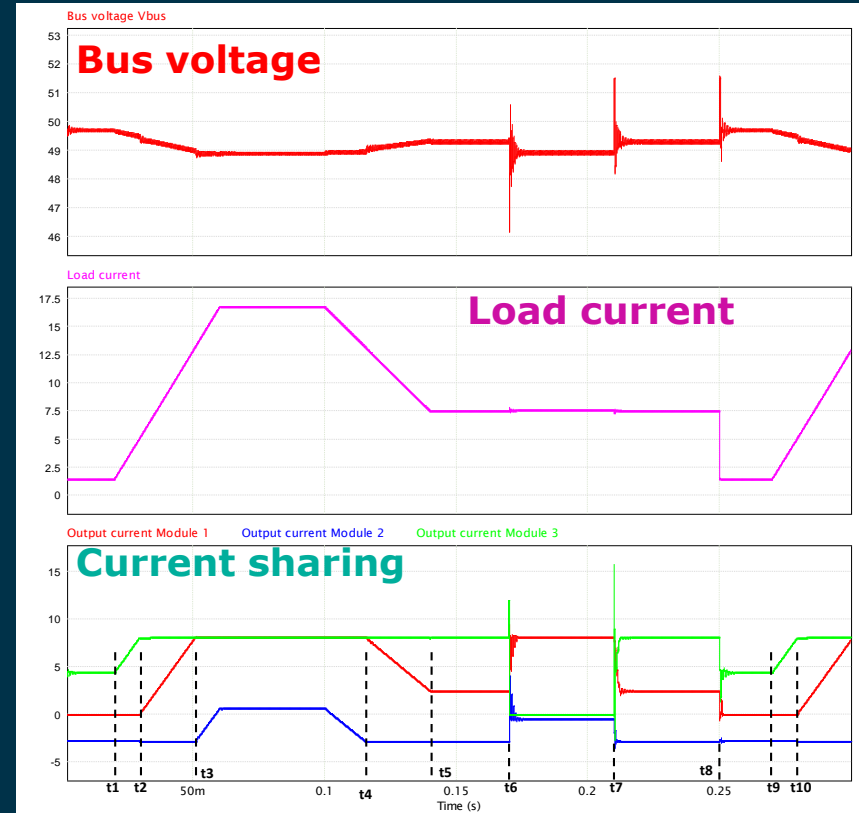
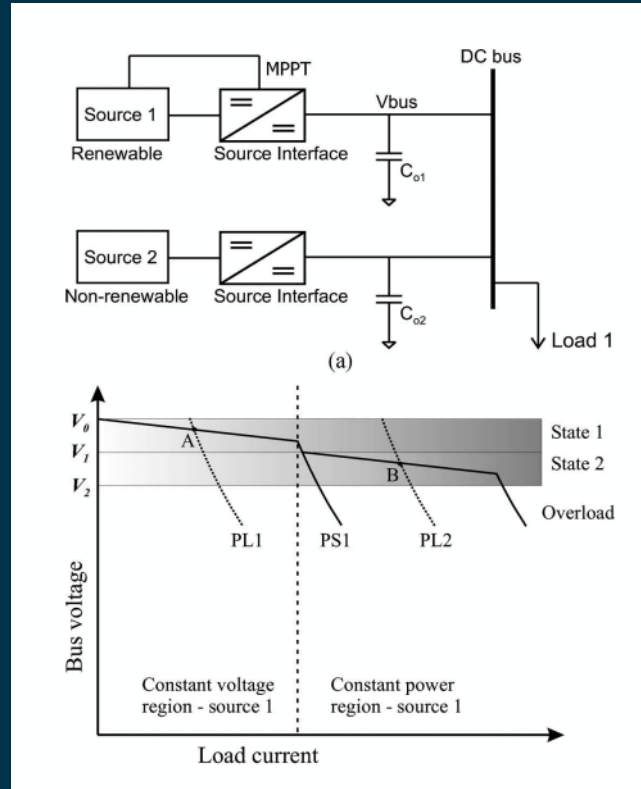
Stability Assessment



TEST Prototype

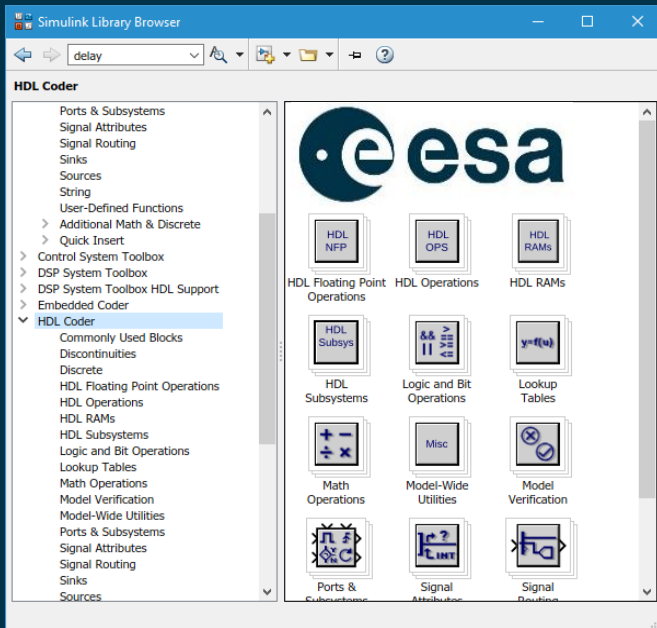


DC-BUS Signaling

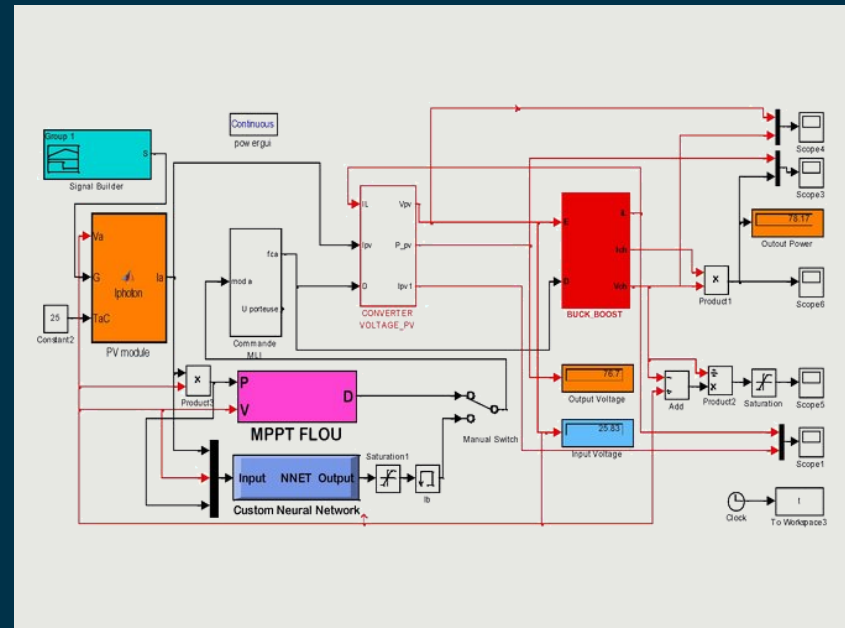


Power flow control using DC-BUS characteristics
Easy paralleling

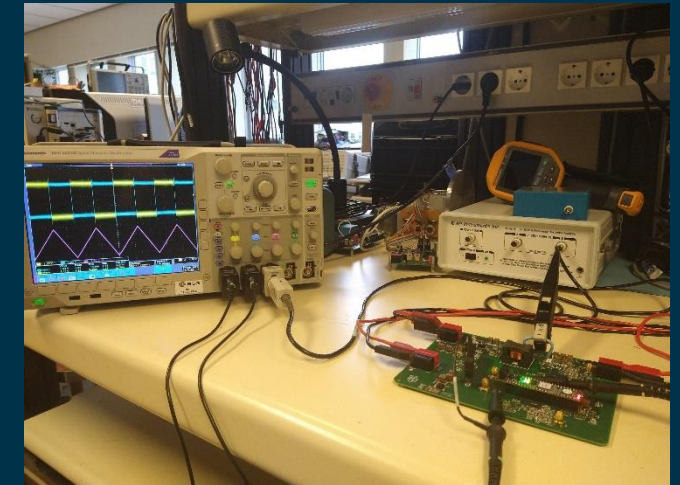
ESA VHDL Library



Digital MPPT algorithm PCDU



TEST Prototype



SiC – High Voltage / High Power

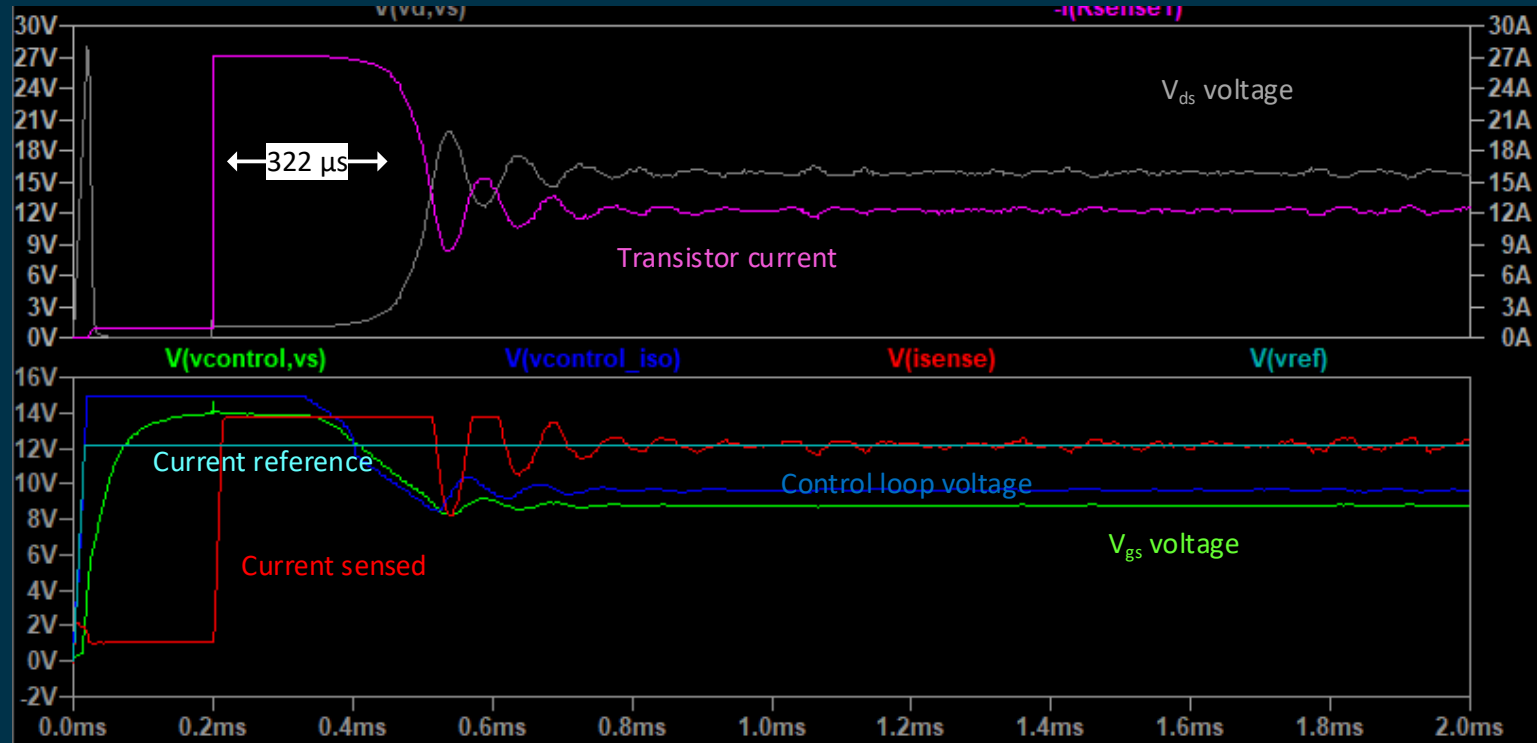
High Power LCL

SiC MOSFET

$V_{bus} > 100\text{ V}$

$I_{lim} > 15\text{ A}$

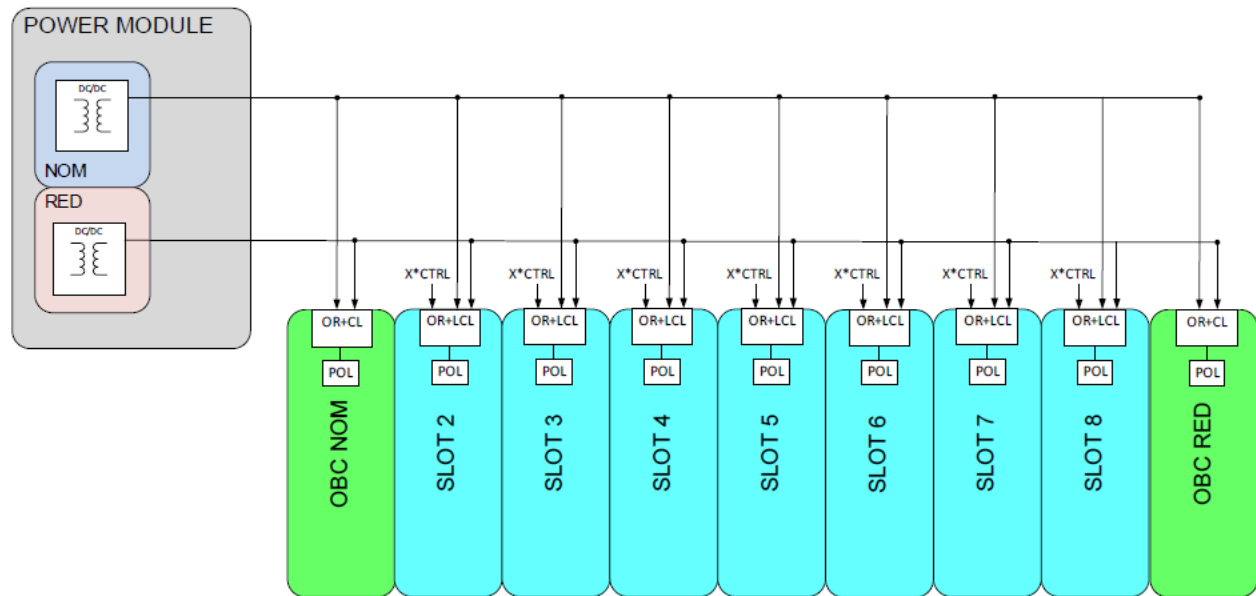
Temp rating: 175 – 200 °C



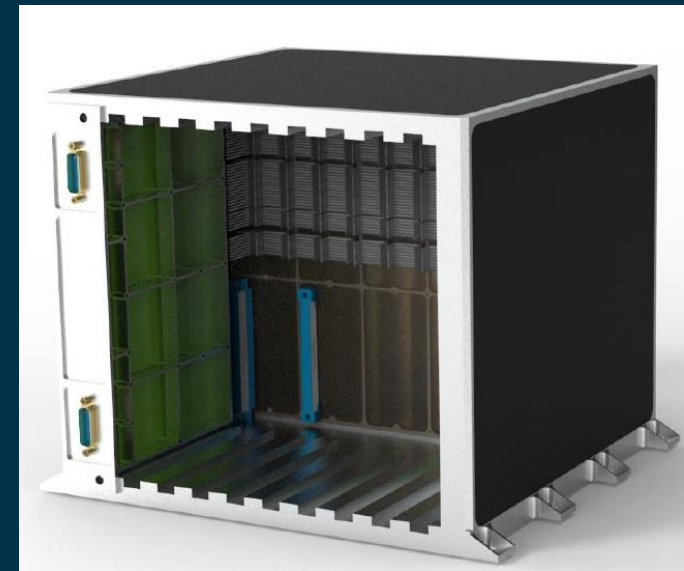
ECSS efforts to standardize interfaces:

- ECSS-E-ST-20-20C – Latching Current Limiters
- ECSS-E-ST-20-21C - Actuators

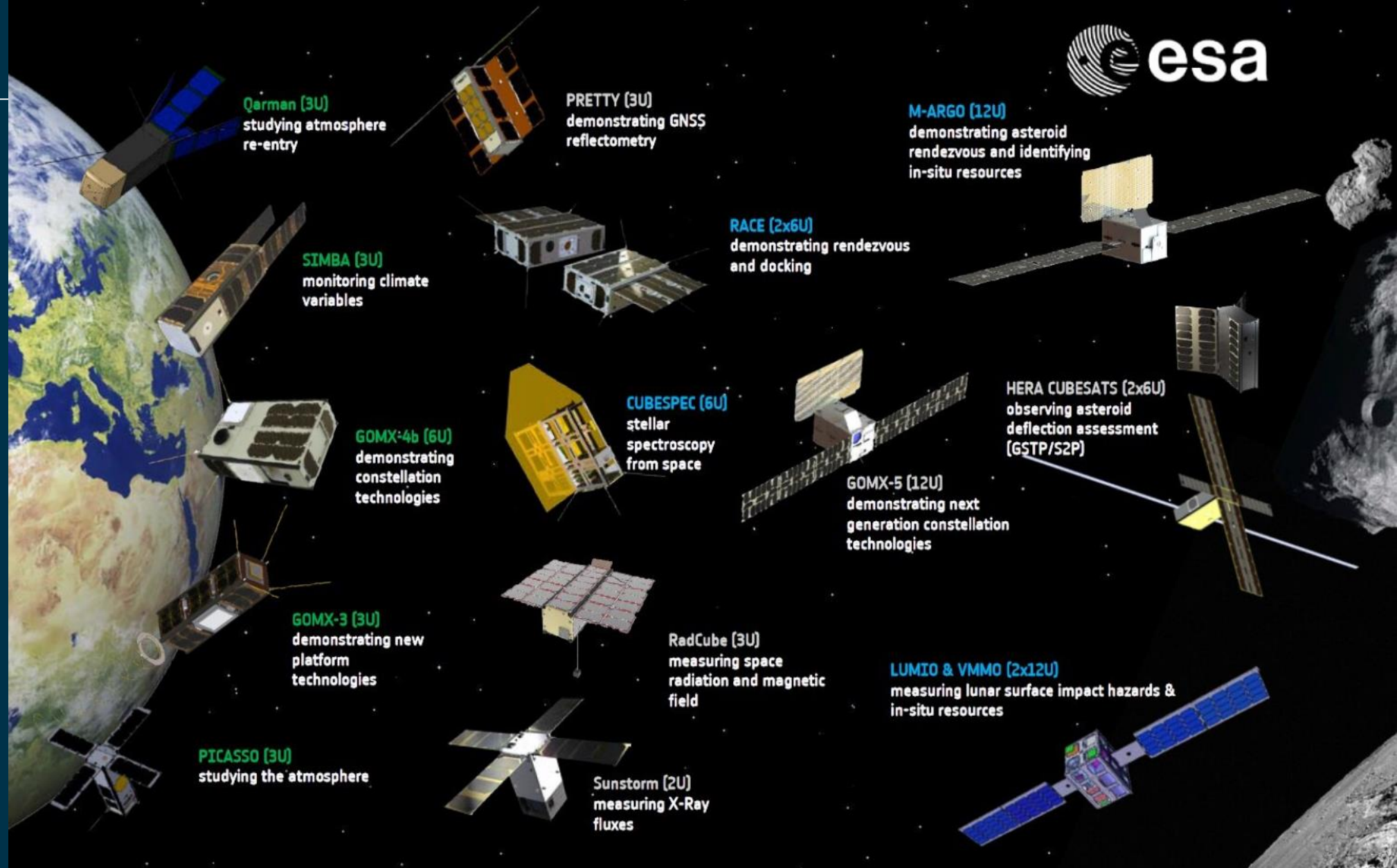
ADHA standard avionics – power module



ADHA



Cubesats



Qarman (3U)
studying atmosphere re-entry

PRETTY (3U)
demonstrating GNSS reflectometry

M-ARGO (12U)
demonstrating asteroid rendezvous and identifying in-situ resources

SIMBA (3U)
monitoring climate variables

RACE (2x6U)
demonstrating rendezvous and docking

GOMX-4b (6U)
demonstrating constellation technologies

CUBESPEC (6U)
stellar spectroscopy from space

HERA CUBESATS (2x6U)
observing asteroid deflection assessment (GSTP/S2P)

GOMX-5 (12U)
demonstrating next generation constellation technologies

GOMX-3 (3U)
demonstrating new platform technologies

RadCube (3U)
measuring space radiation and magnetic field

LUMIO & VMMO (2x12U)
measuring lunar surface impact hazards & in-situ resources

PICASSO (3U)
studying the atmosphere

Sunstorm (2U)
measuring X-Ray fluxes

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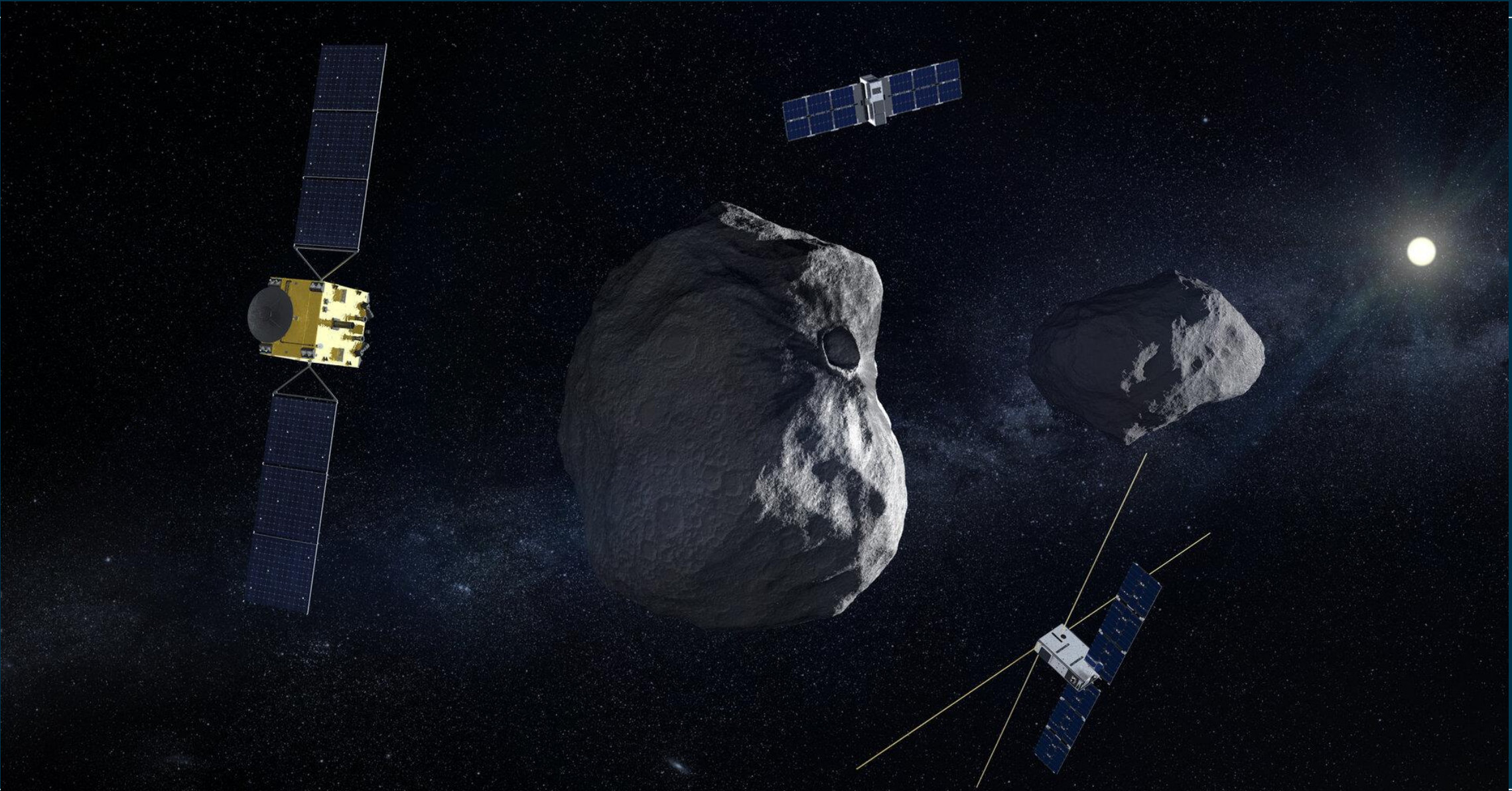
→ ESA'S TECHNOLOGY CUBESAT FLEET

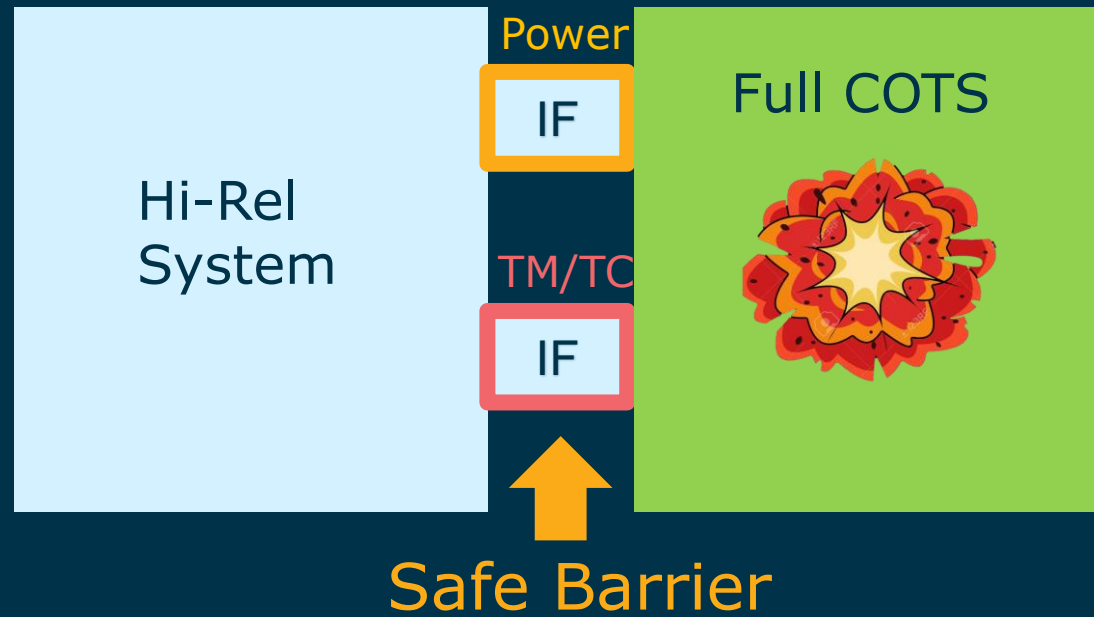
European Space Agency

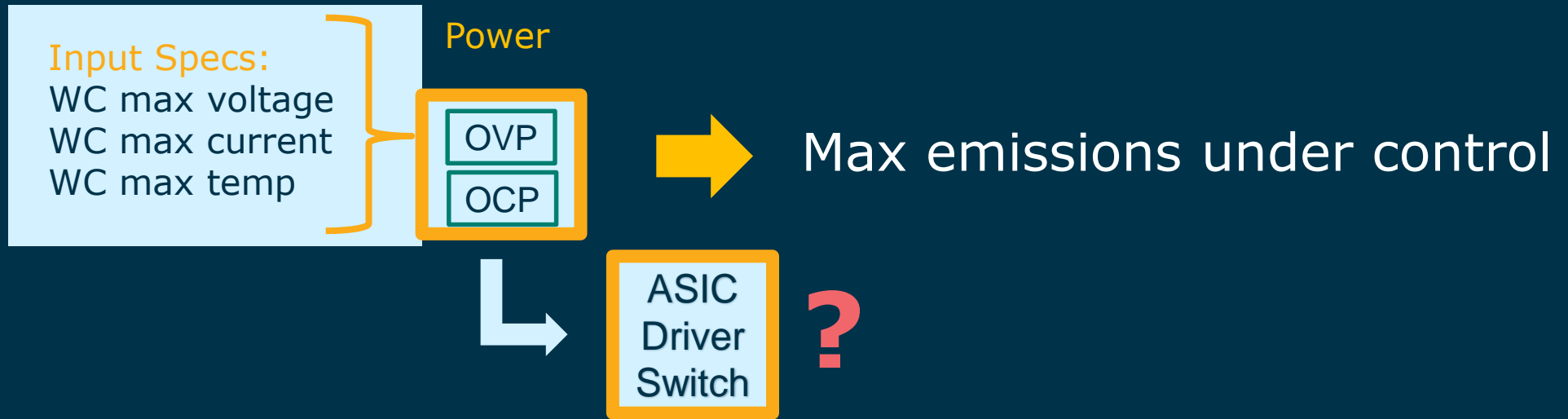


Funded in GSTP Fly

HERA – Asteroid deflection – 2 cubesats







FMEA tool based on simulation

Import netlist

Own failure mode component models

Automatic simulation of all cases

