



EPIC Workshop

May, 11th 2023



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ECOPROPU : acronym for Electrical Competitive PROPulsion

Grant Agreement No 101081987

The consortium planned to develop a disruptive PPU able to drastically reduce cost, weight and volume of EP systems. The project started on January 2023 and lasts for 3 years.

ECOPROPU focuses on a power converters beyond the state of the art, with the following objectives :

- Anode module with wide range voltage: 2-7kW up to high voltage operating
- High converter efficiency : > 96%
- Power density : 0,5kg/kW
- Cost reduction by a factor of 2

The aim is to implement and evaluate the architectural changes and innovative control laws to drastically improve the systems global performance and mission capabilities.

ECOPROPU takes over the H2020 GaNOMIC project completed in 2021.

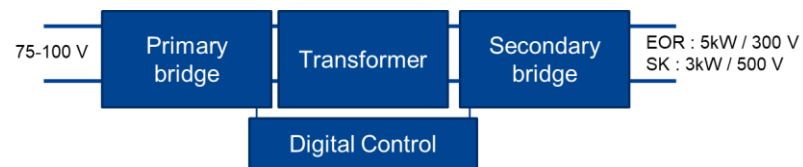
Heritage from GaNOMIC

One single DC/DC converter for both operating points.

Primary bridge embeds 4 GaN 100V transistors in parallel.

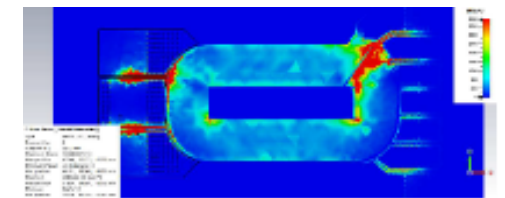
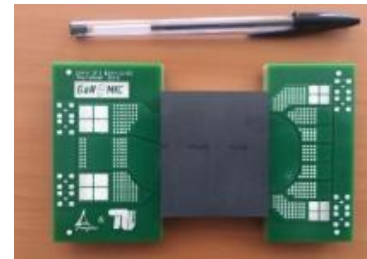
Secondary bridge embeds 2 GaN 650V transistors in parallel.

Switching frequency of 500kHz

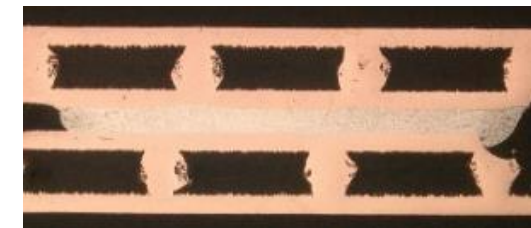


Planar transformer is able to sustain :

- High current on primary side (up to 100A peak)
- High voltage on secondary side (up to 500V)
- High frequency (up to 1,5MHz)
- Efficiency measured and simulated > 99%



- Thick Planar PCB manufacturing based on Sinter-Lamination-Technology from TUB and standard PCB assembly process



Results from GaNOMIC

Coupling tests with PPS® Dual Mode-EM completed successfully in Pivoine 2G test bench.

Firing tests at 300V (EOR) 3kW up to 5kW and at 500V (SK) 3kW down to 2kW.

All major operating points reached and exceeded with safe warm transients all along the coupling tests.

GaNOMIC ended with Successful achievements :

- Dual Active Bridge topology converter using GaN,
- embedded components, planar transformer and digital control reaching high efficiency, high power density and reduced recurring cost

These achievements provide a Technologies maturity level (TRL 4/5) allowing to initiate building blocks development for new generation of PPU's.



ECOPROPU Objectives

ECOPROPU will concentrate on five key generic Building Blocks:

- The Anode Module
- The Digital Processing
- The Magnet power converter
- DAB digital controller
- Planar Transformer

The objective of the project is to bring the targeted building to TRL5/6 and to develop and Engineering Bread Board to assess the EPS performances.



Building Blocks

Building Block 1: Anode Module based on Dual Active Bridge which takes full benefits of GaNOMIC project

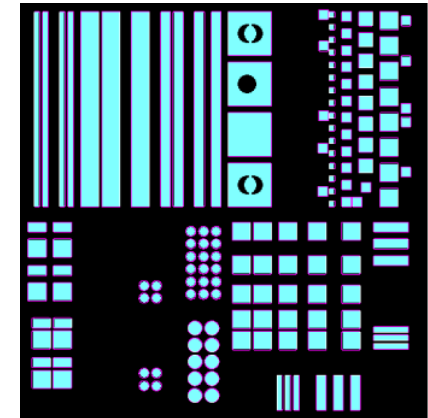
- 250V to high Voltage with an high efficiency
- Power delivered: 2,5 to 7 kW
- Architecture Trade to be conducted to define the best topology to sustain the high voltage
- Design compliant to space standards and design rules
- Environmental characterization required

Building Block 2: DAB digital controller

- Regulate the Anode converter with robust stability on the wide range voltage
- Maximize the soft switching to limit power losses
- Use of Field Programmable Gate Array (FPGA) compatible with the space industry

Building Block 3: Planar Transformer

- Stable electrical and mechanical interconnection between PCB. Improve the sinter lamination assembly by understanding the technology limits. Build a test vehicle to evaluate environmental impact using several prepreg shape
- Industrialize and space qualify the planar transformer PCB technology



Building Blocks

Building Block 4 : Digital Processing

- Control processing of the DAB digital controller and other controller of the PPU
- Configurable state machine for EPS sequencing
- Extended use of Look Up Table for EPS parameters

Building Block 5 : Magnet Power converter

- Static and dynamic performances compliant to EBB requirements
- Reuse of Anode components to limit qualification

Beyond state of the art

PPU: ECOPROPU will have a high power density, wide range voltage and reduced cost. This extended operating is designed to drive a large range of missions operating points.

GaN Semiconductors: The consortium will select robust and natural compatible components with radiative environments, in line with the goal to reduce dependence on non EU suppliers. The project will contribute to extend the knowledge on Gan maturity.

Digital Controller: Improve knowledge on EU manufacturers compatible with space capabilities.

Thank you for your attention