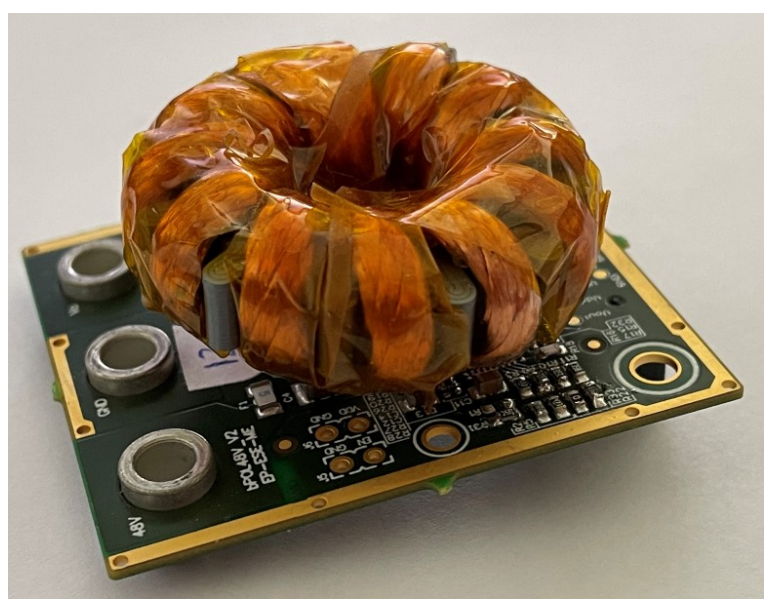
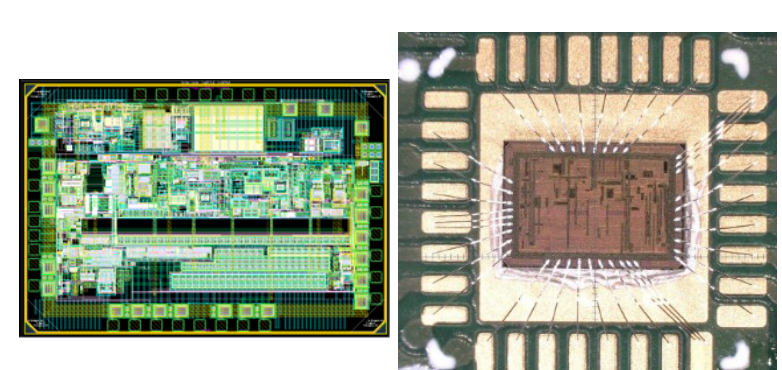
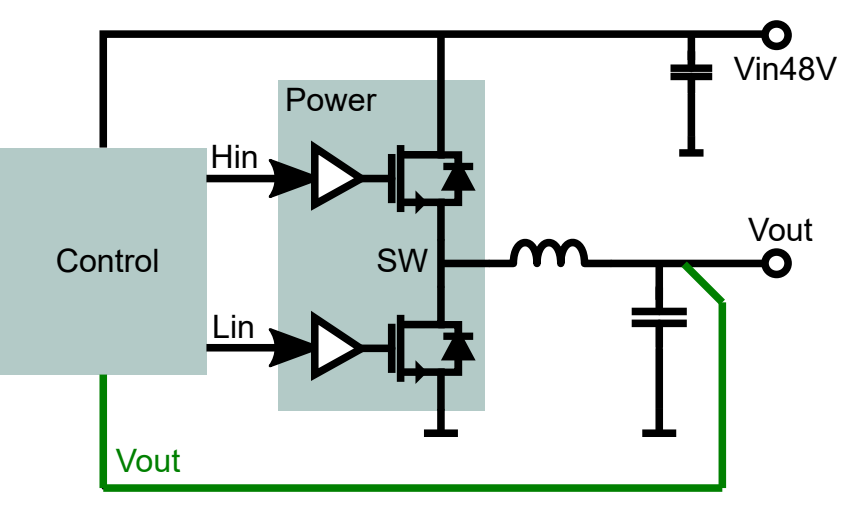


## bPOL48V



### Key features:

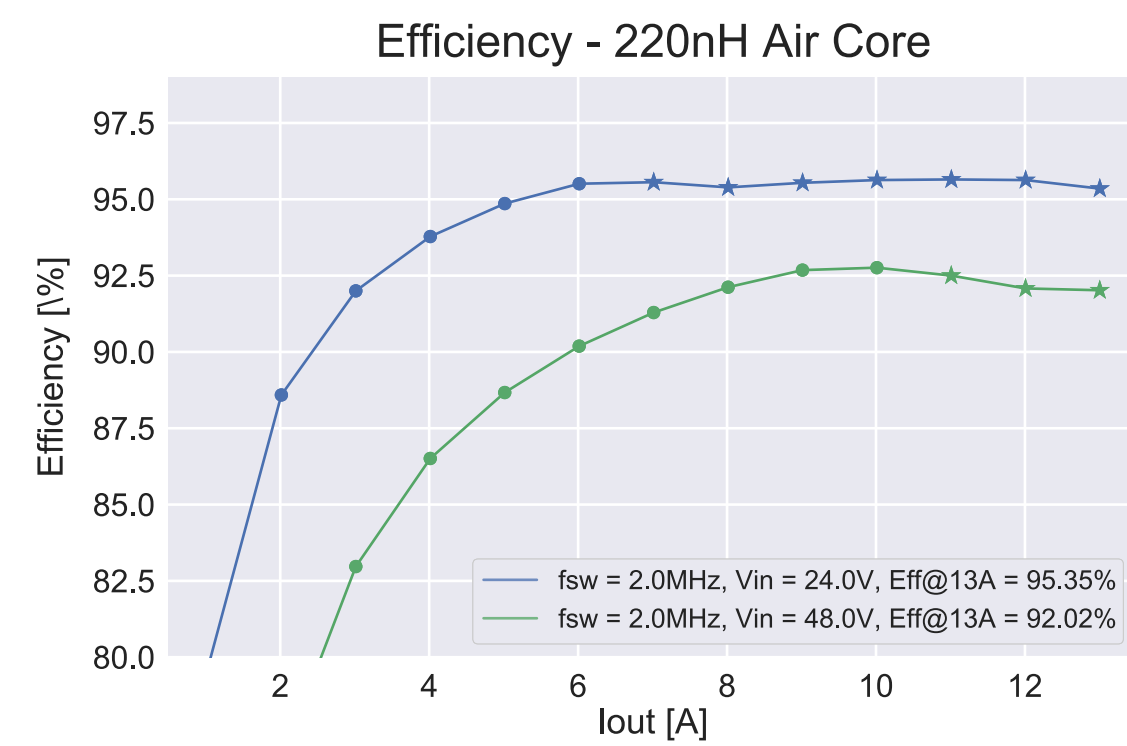
- Buck converter
- GaN commercial ePower power stage
- CMOS CERN rad-hard controller
- 48V input, 12V regulated output
- 10A maximum load (120W)
- High efficiency
- 49mm x 43mm x 25mm (with air core inductor)



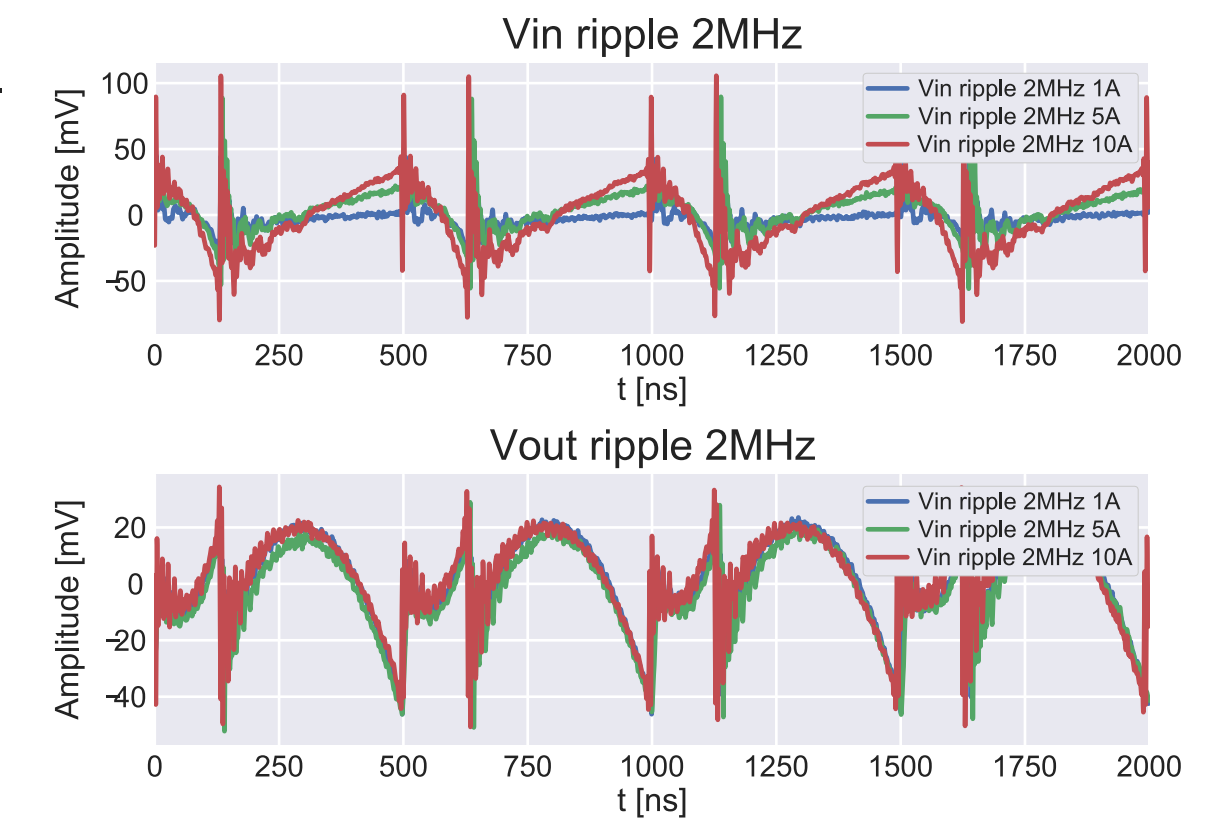
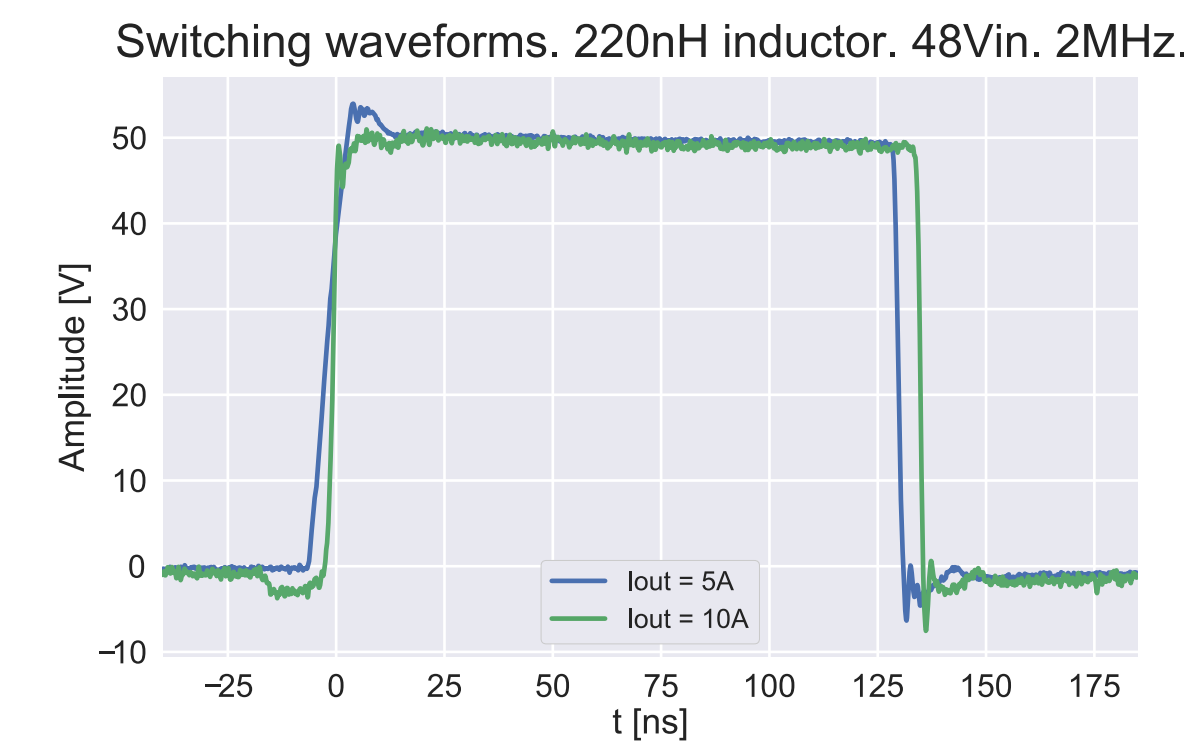
CERN CMOS GaN controller layout and chip-on-board. Final package is QFN32.



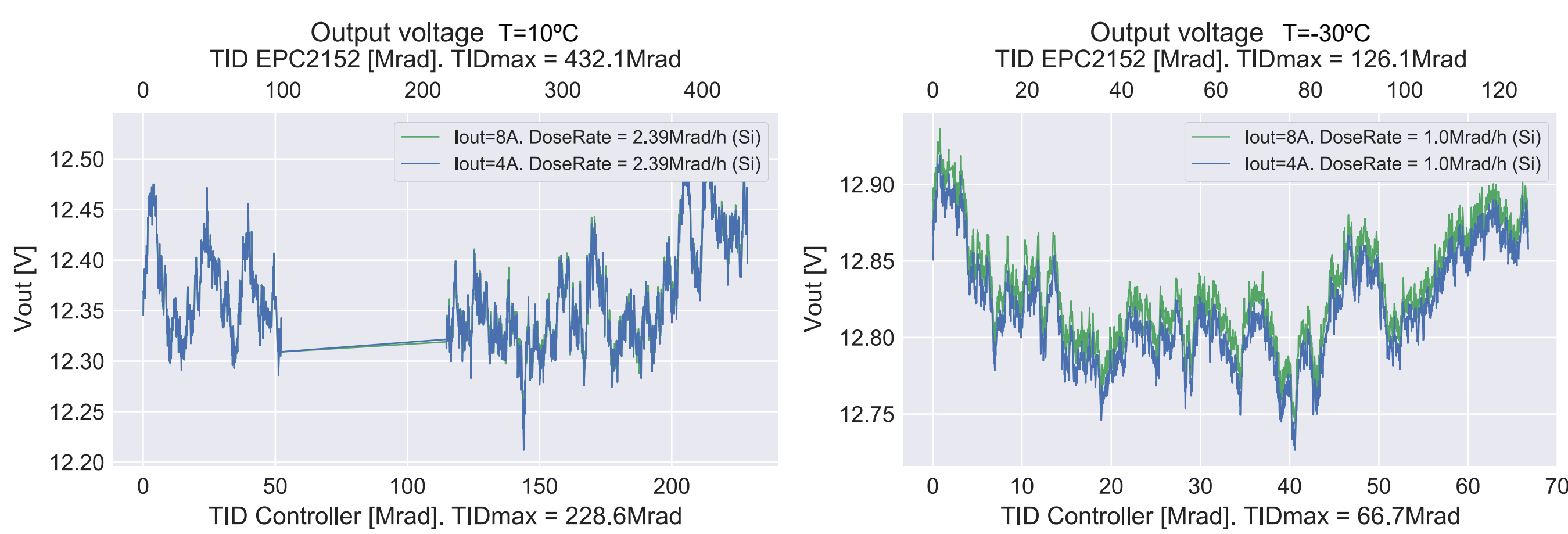
GaN ePower stage



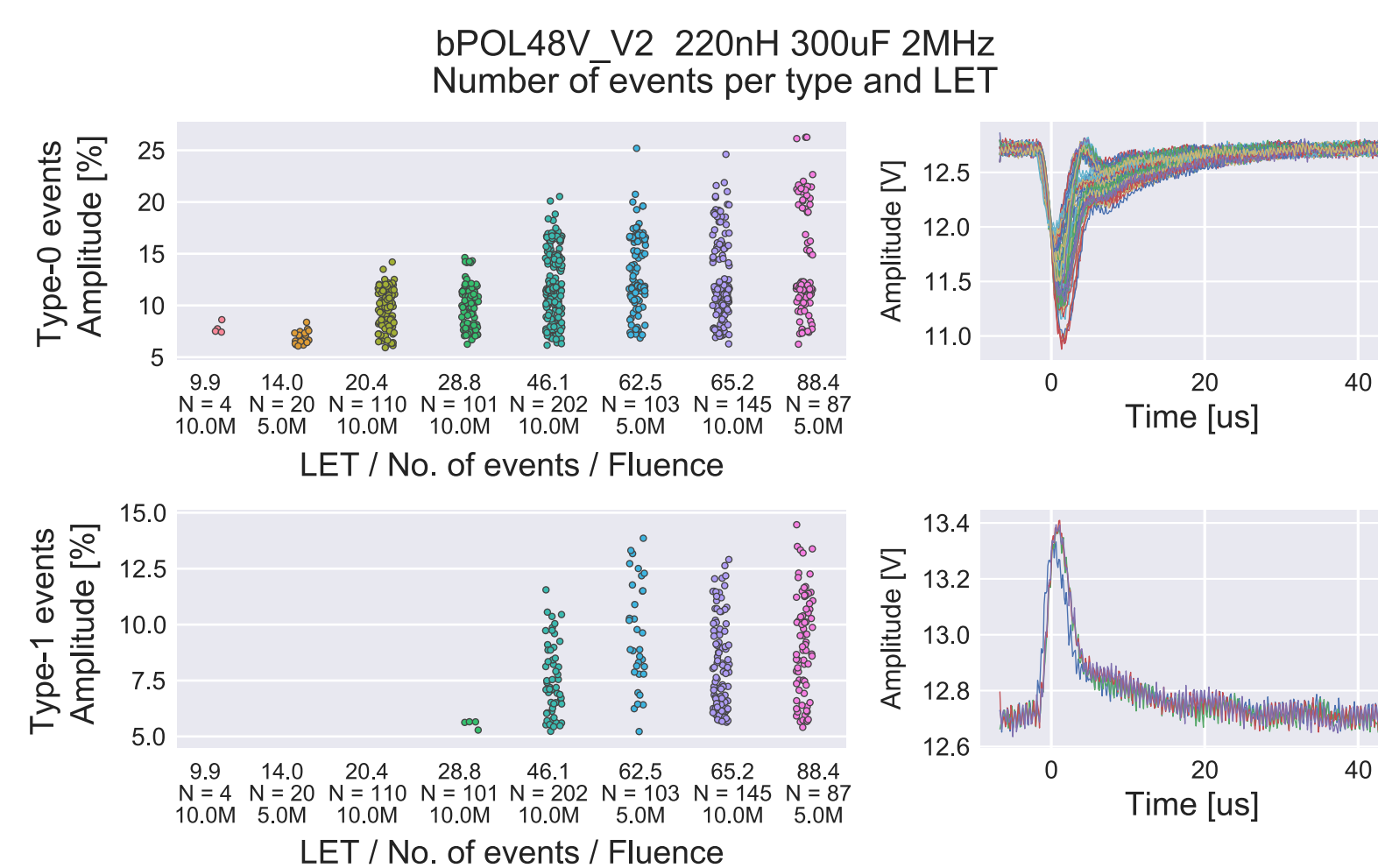
## Electrical characterization



## Radiation characterization



No degradation of performance observed. Variables such as efficiency, internal regulators, proportional-to-absolute temperature (PTAT) and bandgap are also stable and close to pre-rad specifications.



SEE tested with heavy ions up to LET=88 MeV/(mg/cm<sup>2</sup>)  
Only fast transients (2-3us), no permanent damage or long-resets

For CERN applications LET=46MeV/(mg/cm<sup>2</sup>), the transients are smaller than 20% of Vout

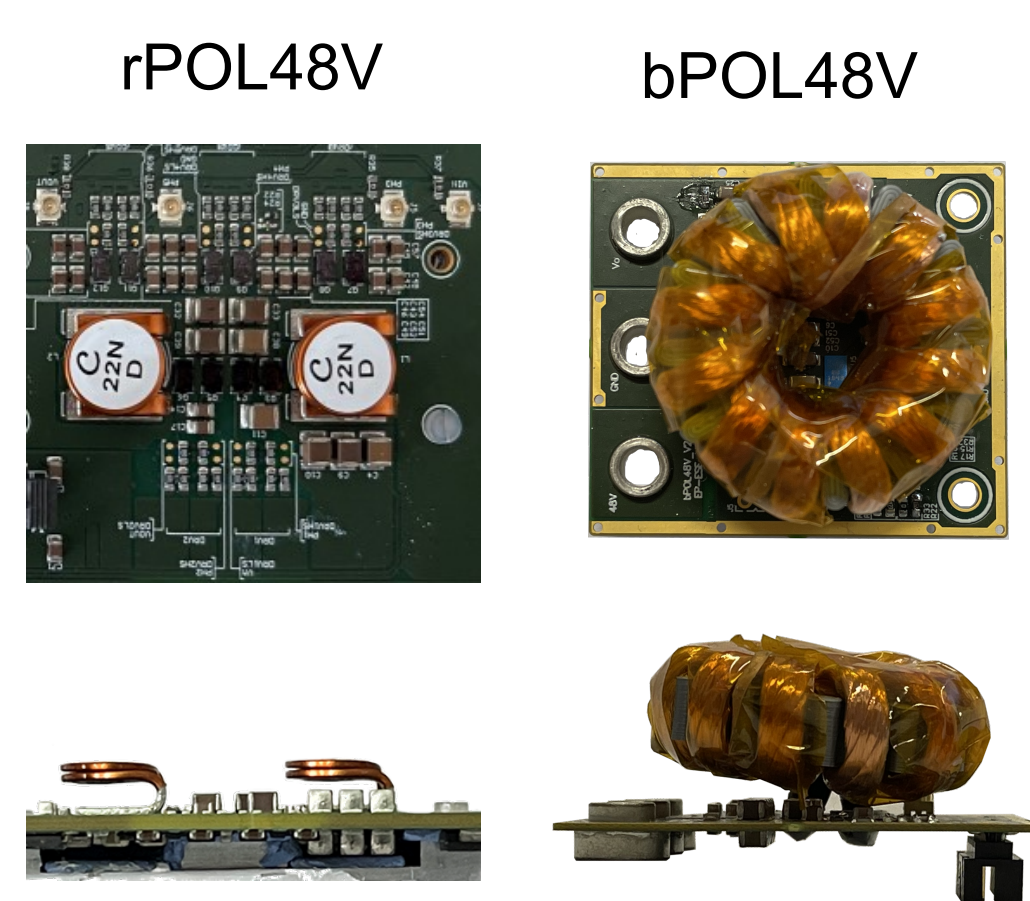
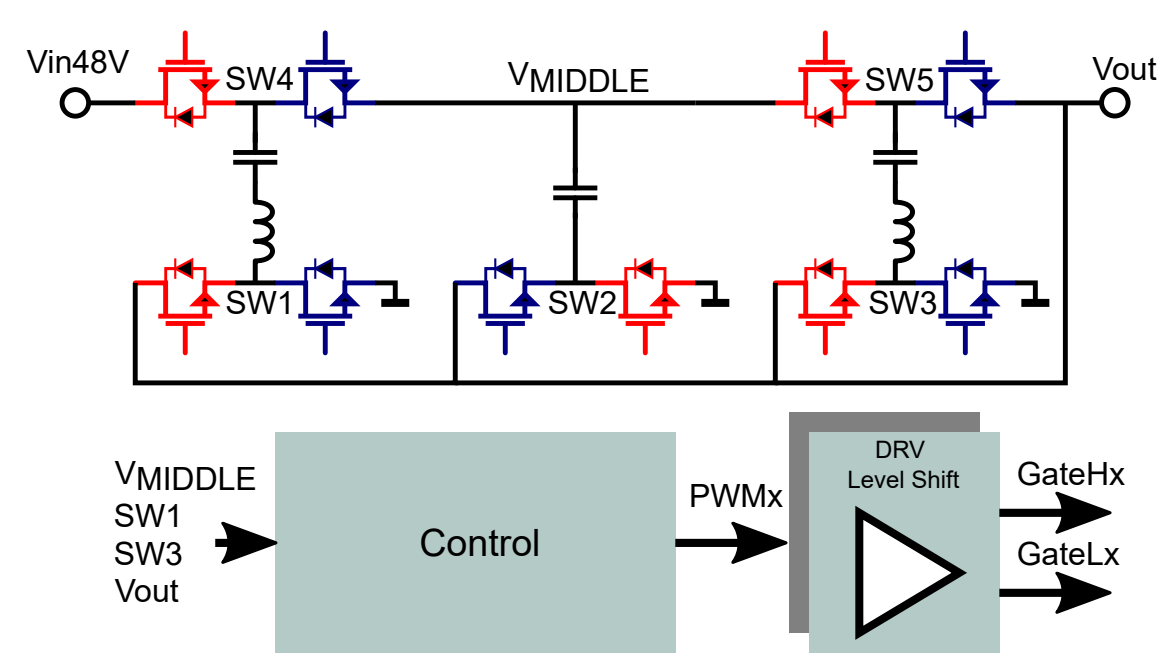
	Protons	Neutrons
CERN CMOS GaN controller	<ul style="list-style-type: none"> <li>• MC40 Birmingham, 25MeV beam</li> <li>• Below 3.3e14 p/cm<sup>2</sup></li> <li>• Fully functional</li> <li>• No effects observed</li> <li>• 3.3e14 p/cm<sup>2</sup> and 5e14 p/cm<sup>2</sup></li> <li>• Functional</li> <li>• Oscillations on the internal linear regulator</li> </ul>	<ul style="list-style-type: none"> <li>• TRIGA reactor, Ljubljana</li> <li>• No effects at 4e14 n/cm<sup>2</sup></li> <li>• Failed to start above or equal 7e14 n/cm<sup>2</sup></li> </ul>
GaN ePower stage	<ul style="list-style-type: none"> <li>• IRRAD CERN</li> <li>• Tested up to 2.5e15 p/cm<sup>2</sup> (1.45e15 n/cm<sup>2</sup> 1MeV eq.)</li> <li>• No effects observed</li> <li>• -0.25% efficiency</li> </ul>	<ul style="list-style-type: none"> <li>• TRIGA reactor, Ljubljana</li> <li>• 7e14 and 1e15</li> <li>• Ok up to 12A</li> <li>• -0.2% efficiency</li> <li>• 2e15, 5e15, 7e15</li> <li>• Derated to QSW operation (8A, L=220nH, f=2MHz)</li> <li>• -0.8% efficiency</li> </ul>

Displacement damage tested separately for the controller and the GaN power stage.

## rPOL48V

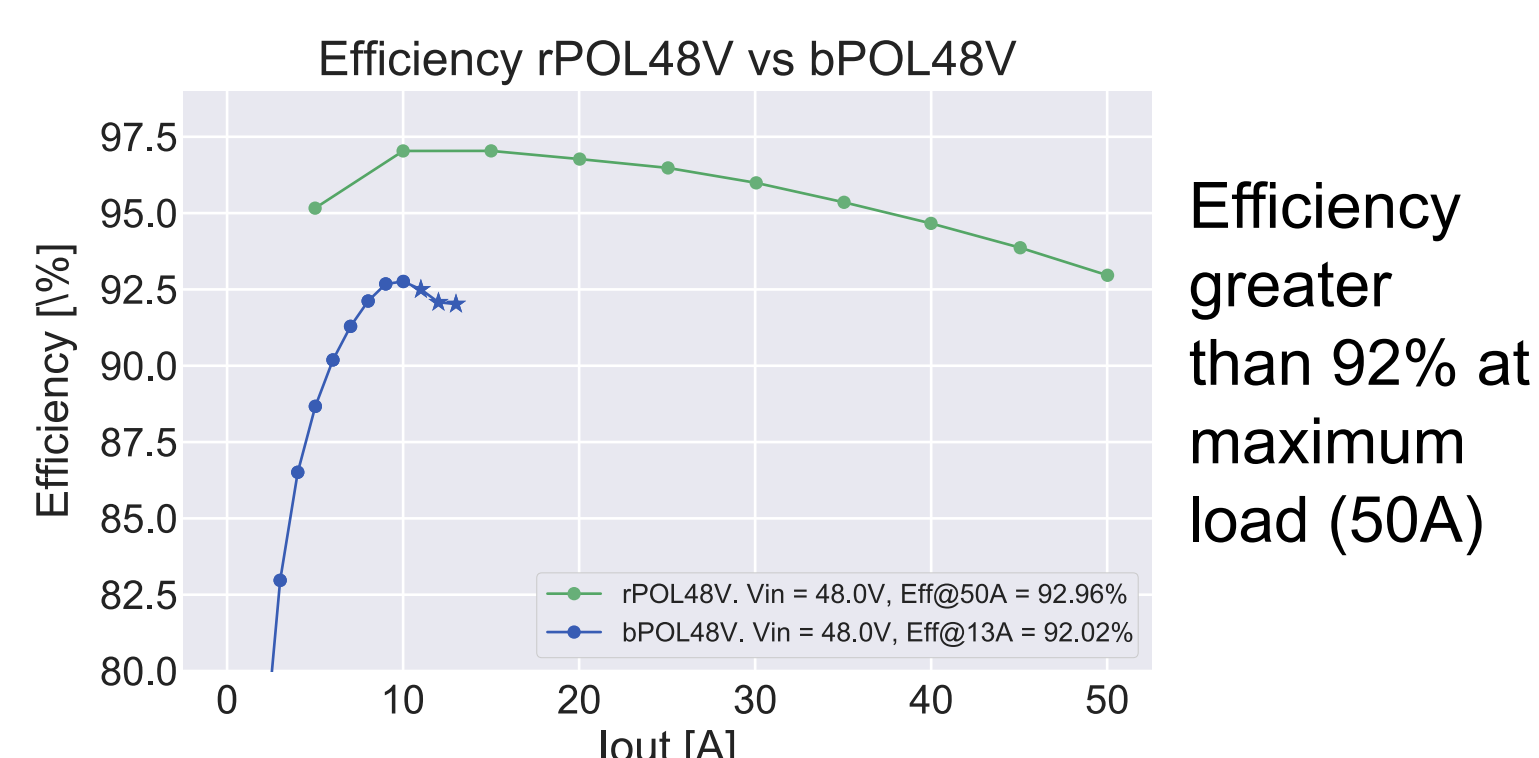
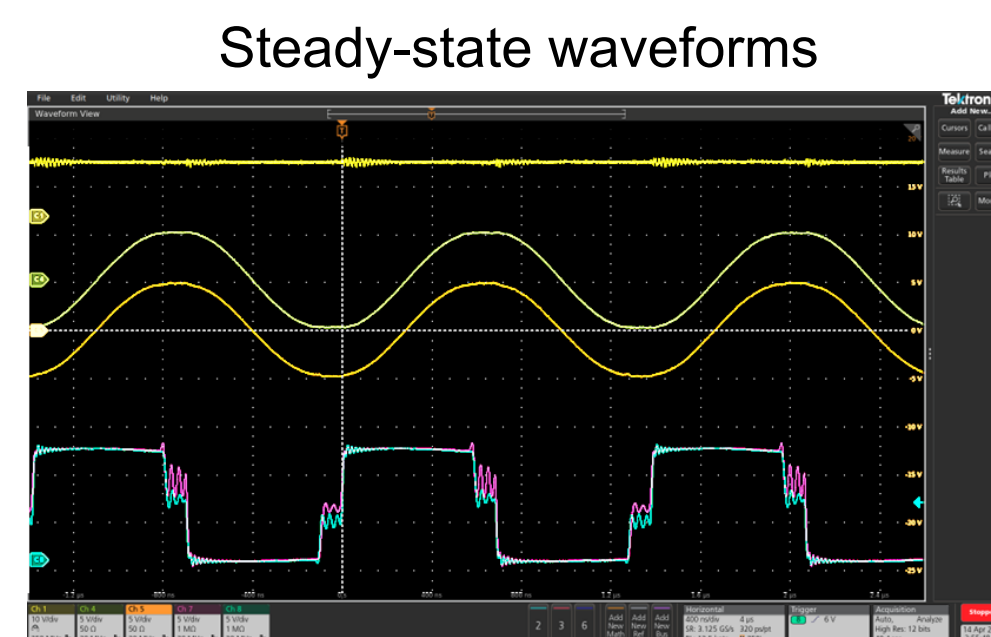
### Key features:

- Resonant topology derived from switched capacitor converter (SCC)
- Standard off-the-shelf inductors
- Fixed conversion ratio (4-to-1)
- 50A maximum load (600W)
- 50mm x 50mm x 12mm



rPOL48V prototype with commercial drivers and FPGA-based controller (left). bPOL48V (production grade) (right).

## Electrical characterization



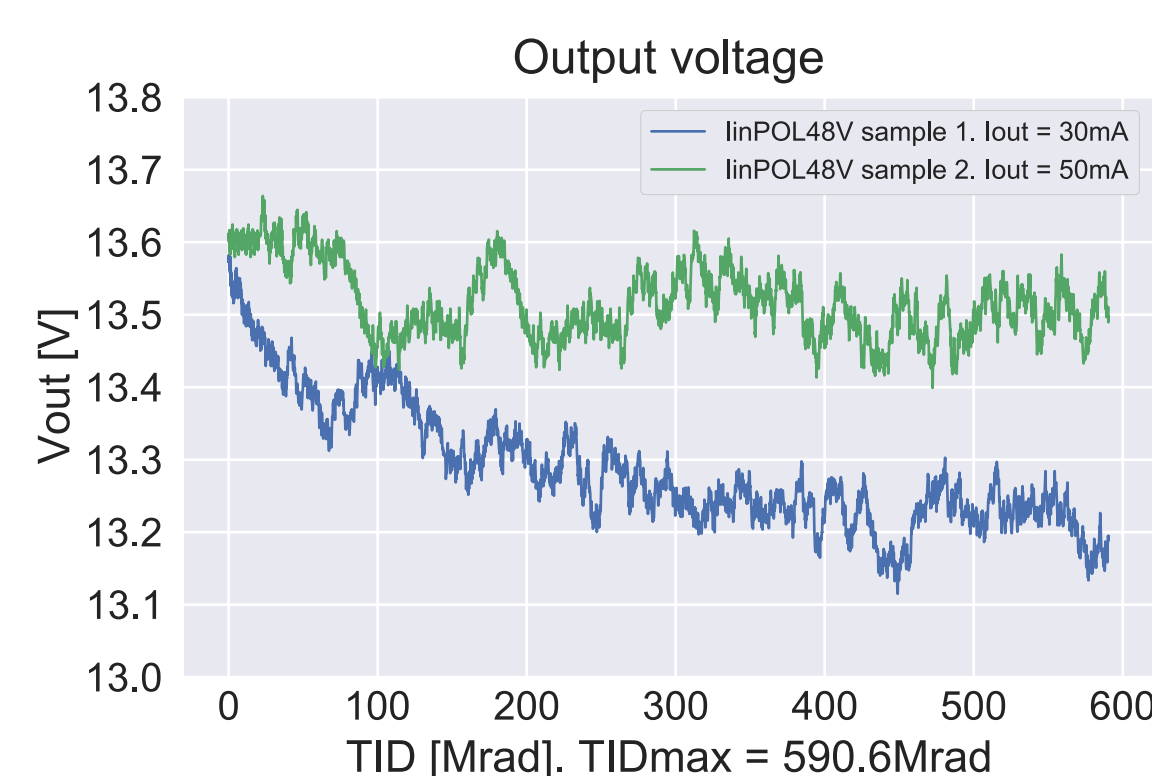
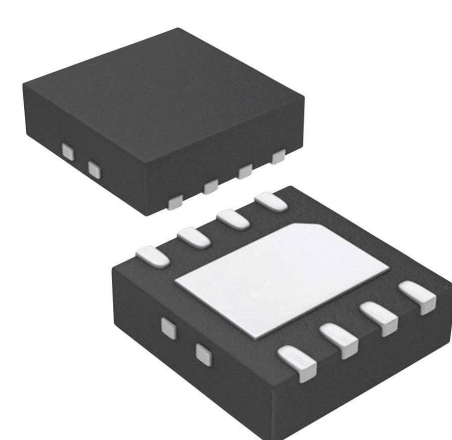
## Towards a rad-hard rPOL48V

ASIC	Technology	Status
EPC2218	GaN (EPC)	Radiation tests are ongoing, tolerant to TID > 600Mrad
linPOL48V	On Semi I3T80 (up to 70V)	In production, tolerant to TID = 600Mrad, LET = 40 MeVcm <sup>2</sup> /mg, 2.23e14 <sup>17</sup> /cm <sup>2</sup> , 4e14 <sup>19</sup> /cm <sup>2</sup>
Level shifter	On Semi I3T80 (up to 70V)	Taped out, prototypes will be tested in 2022
GaN driver	On Semi I3T25 (up to 20V)	Taped out, prototypes will be tested in 2022
STC controller	On Semi I3T25 (up to 20V)	Schematic done

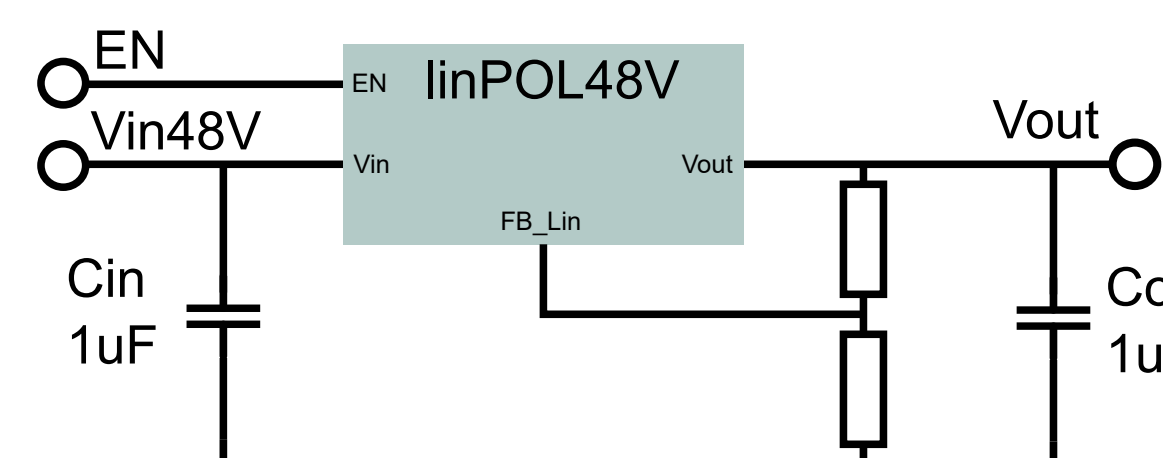
## linPOL48V

### Key features:

- Linear regulator
- Up to 48V input
- 12V default output voltage (adjustable)
- Enable input and under-voltage lockup
- 200mA continuous load (assuming junction temperature is kept below 90°C)
- DFN-8 2mm x 2mm package



SEE tested up to LET=88 MeV/(mg/cm<sup>2</sup>)  
Only fast transients (less than 3us)  
Amplitude of transients less than 10%  
No permanent damage or long-resets.  
DD ok up to 4e14 n/cm<sup>2</sup> and 2.23e14 p/cm<sup>2</sup> (25MeV beam, Birmingham).



## Summary

Two new Point-of-Load (POL) converters and a linear regulator, suitable for the High Luminosity – Large Hadron Collider (HL-LHC) experiments and for space/avionic applications, were presented. The two DCDC converters, called bPOL48V and rPOL48V, allow a significant improvement in the power delivery requirements as they can provide higher power at an increased input voltage of 48V, compared to existing solutions. The linear regulator, called linPOL48V, can supply up to 200mA with programmable output voltage, from up to 48V input, for low current and noise-sensitive applications.

### Development status (Sep. 2022)

Name	Status	Availability
bPOL48V	Fully tested Radiation tolerance OK TID, DD, SEE	Already produced 30 wafers available ~30k samples
linPOL48V	First prototype Tests ongoing Commercial drivers FPGA control Rad-hard controller being designed at CERN	
rPOL48V		

