GaN on Silicon Technology: Devices and Applications

Alex Lidow

Efficient Power Conversion Corporation

Agenda

- Hard Switched Circuits
  - Buck Converter
  - Envelope Tracking
- Resonant Circuits
  - Wireless Power Transmission
- What is in the future?

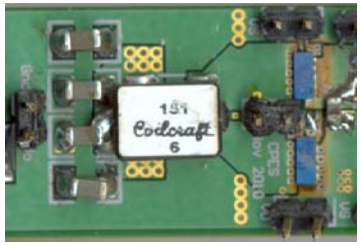
Key Applications Today

- RF DC-DC “Envelope Tracking” – GaN Enabled
- Wireless Power Transmission – GaN Enabled
- RadHard
- LiDAR
- RF Transmission
- Network and Server Power Supplies
- Point of Load Modules
- Solar Micro-inverters
- Energy Efficient Lighting
- Class D Audio

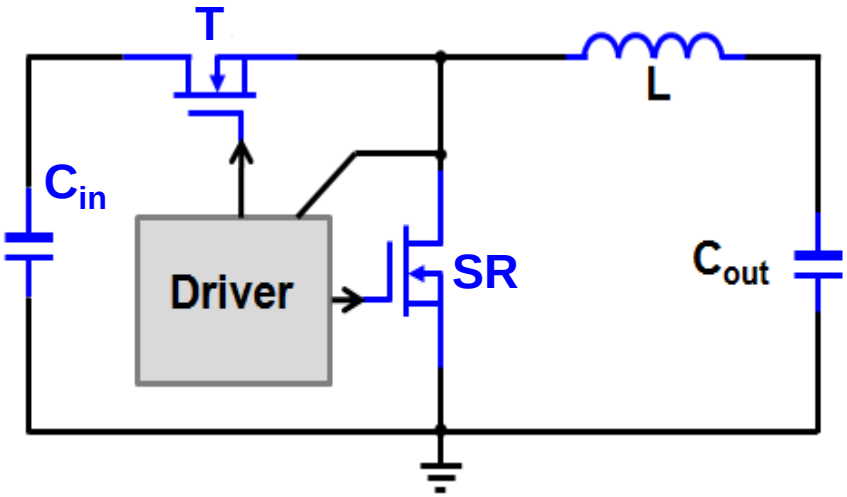
High Frequency Buck Converters

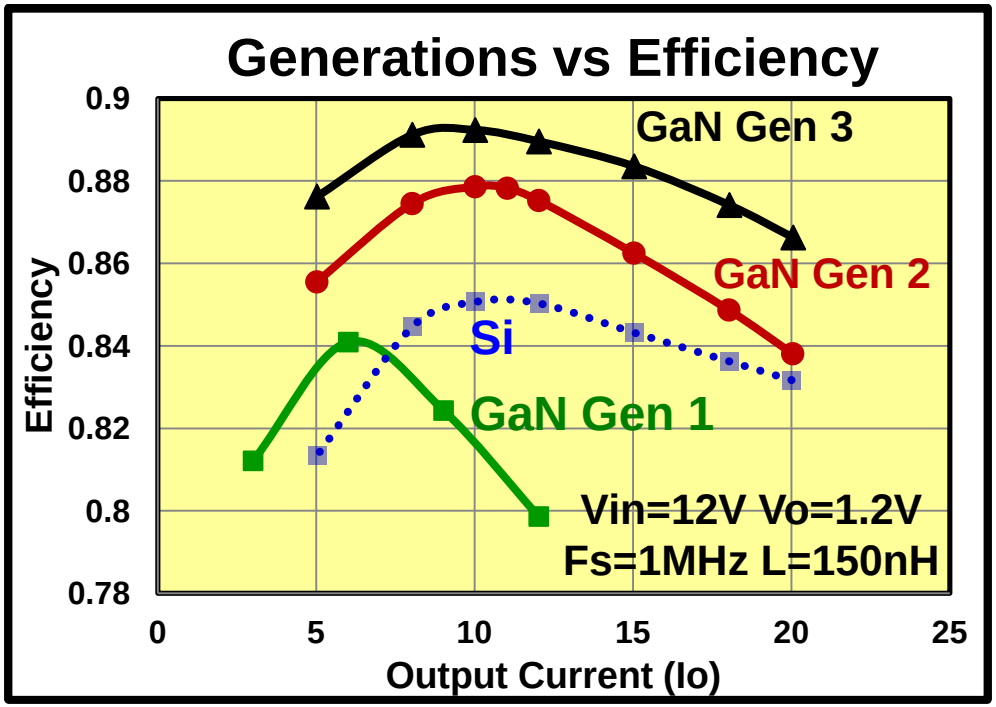
CPES Gen 1

CPES Gen 2



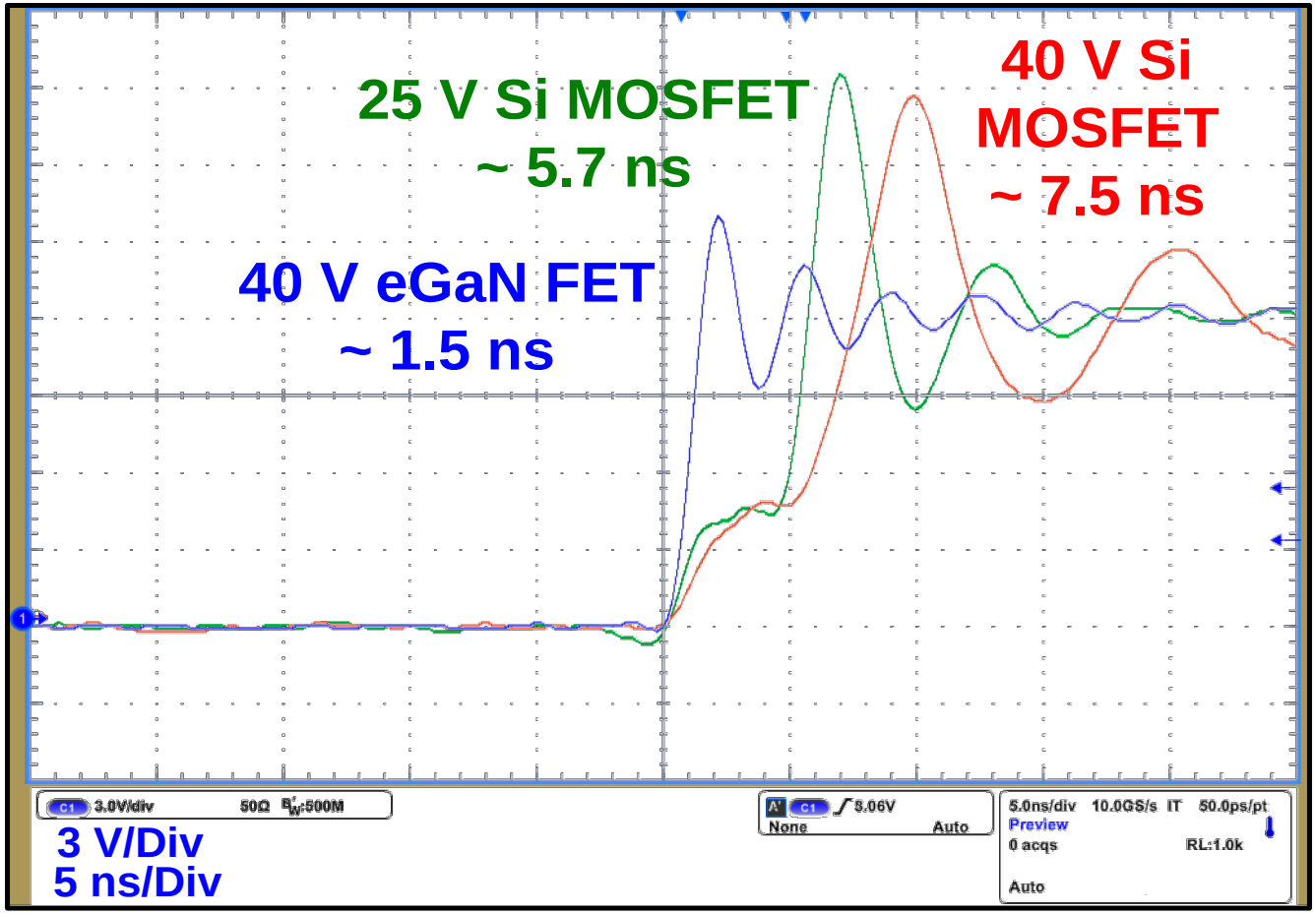
CPES Gen 3





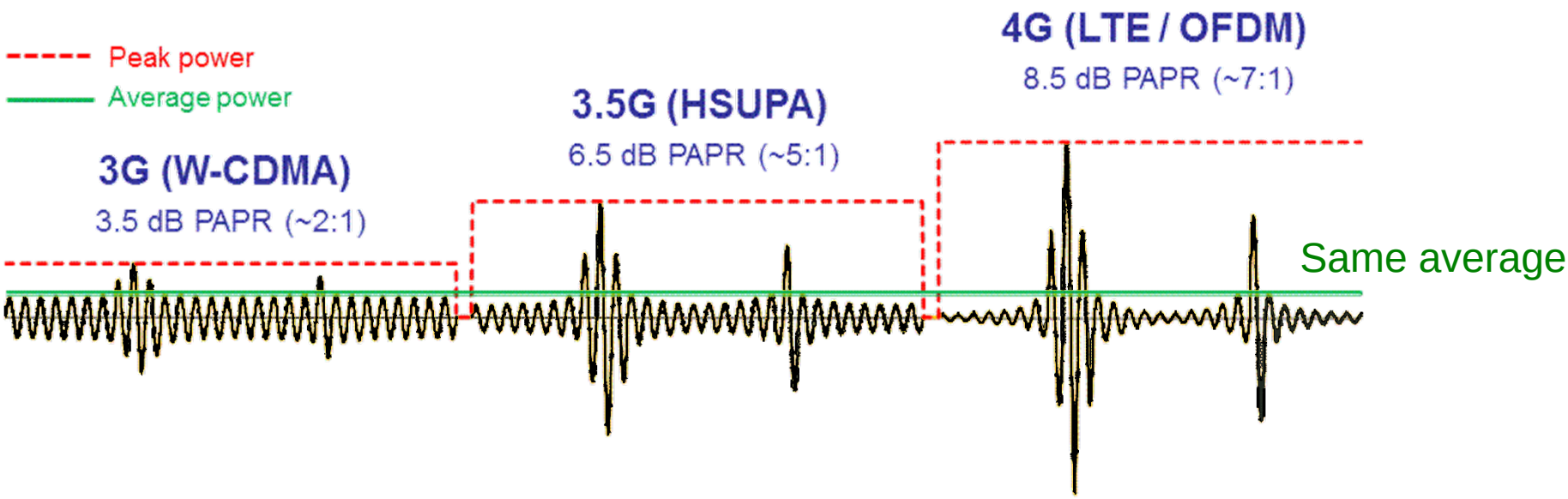
Reference: D. Reusch, D. Gilham, Y. Su, and F.C. Lee, C, "Gallium Nitride Based 3D Integrated Non-Isolated Point of Load Module," APEC 2012

Switchnode Peak and Ringing



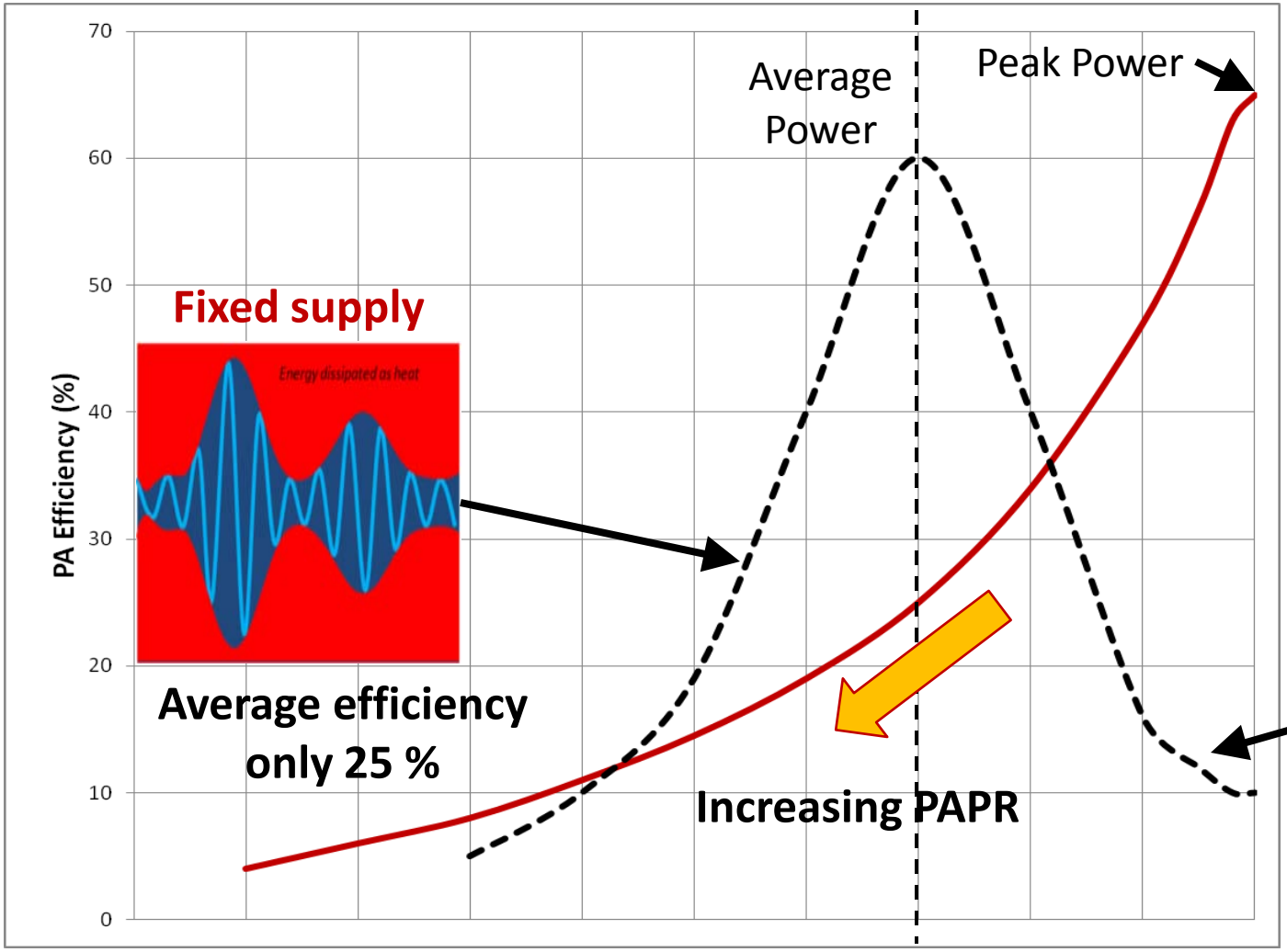
Envelope Tracking (ET)

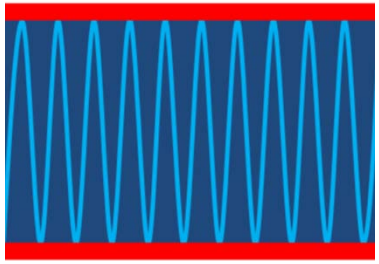
Peak to Average Power Ratio



Reference: Nujira.com website

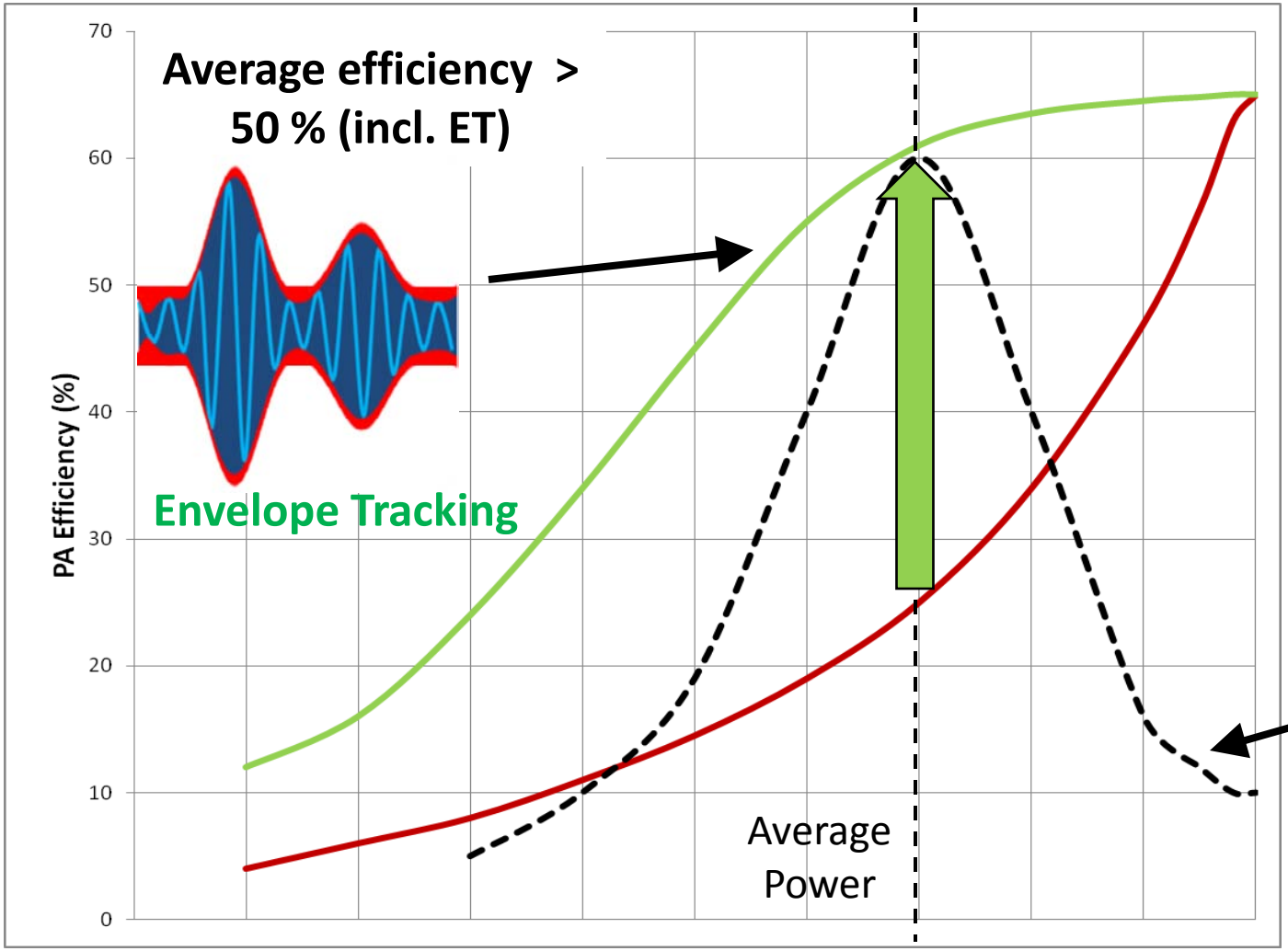
Effect of PAPR





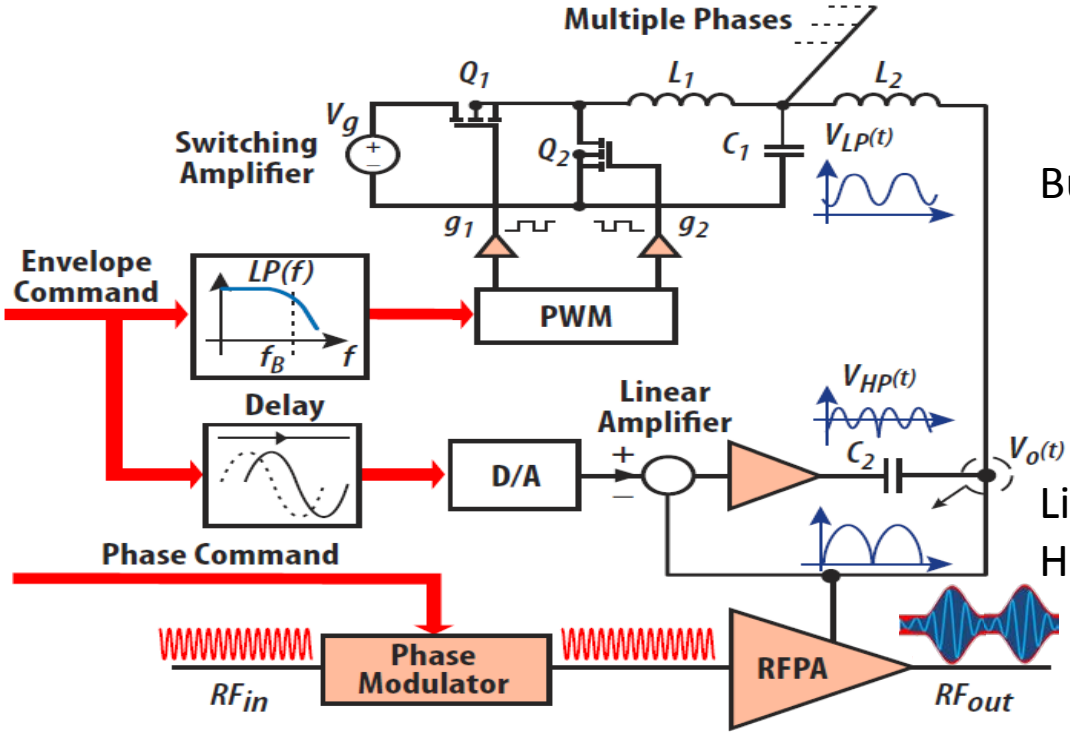
PAPR = 0dB
Peak efficiency up to 65%

Effect of Envelope Tracking



Envelope Tracking Supply

- ET power supply topologies vary
  - Open loop boost – full BW required
  - Closed loop linear-assisted Buck*



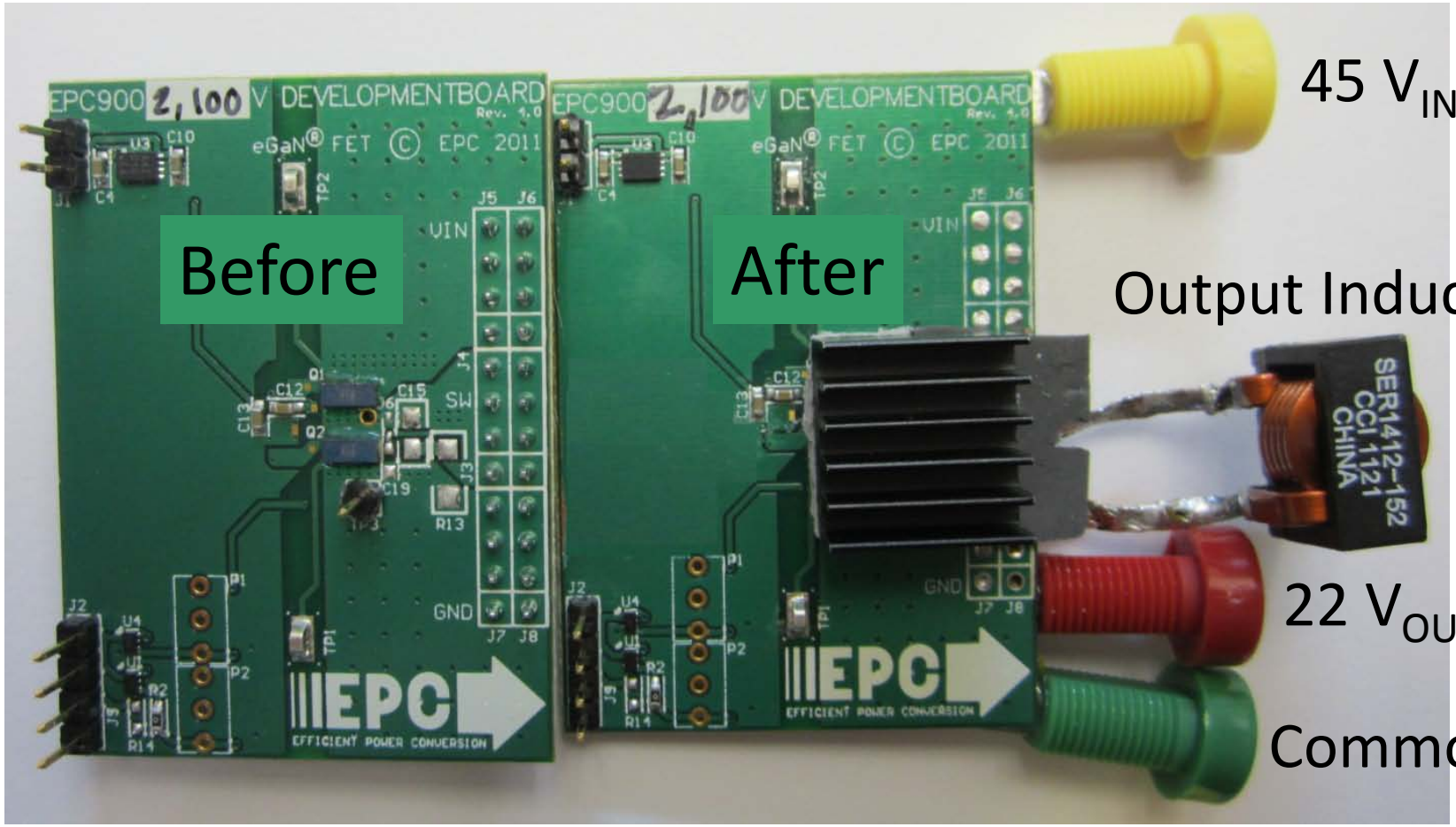
Buck ~ 10% Bandwidth
~ 90% Power

Linear AMP ~ 10% Power
Highest 90% of Bandwidth

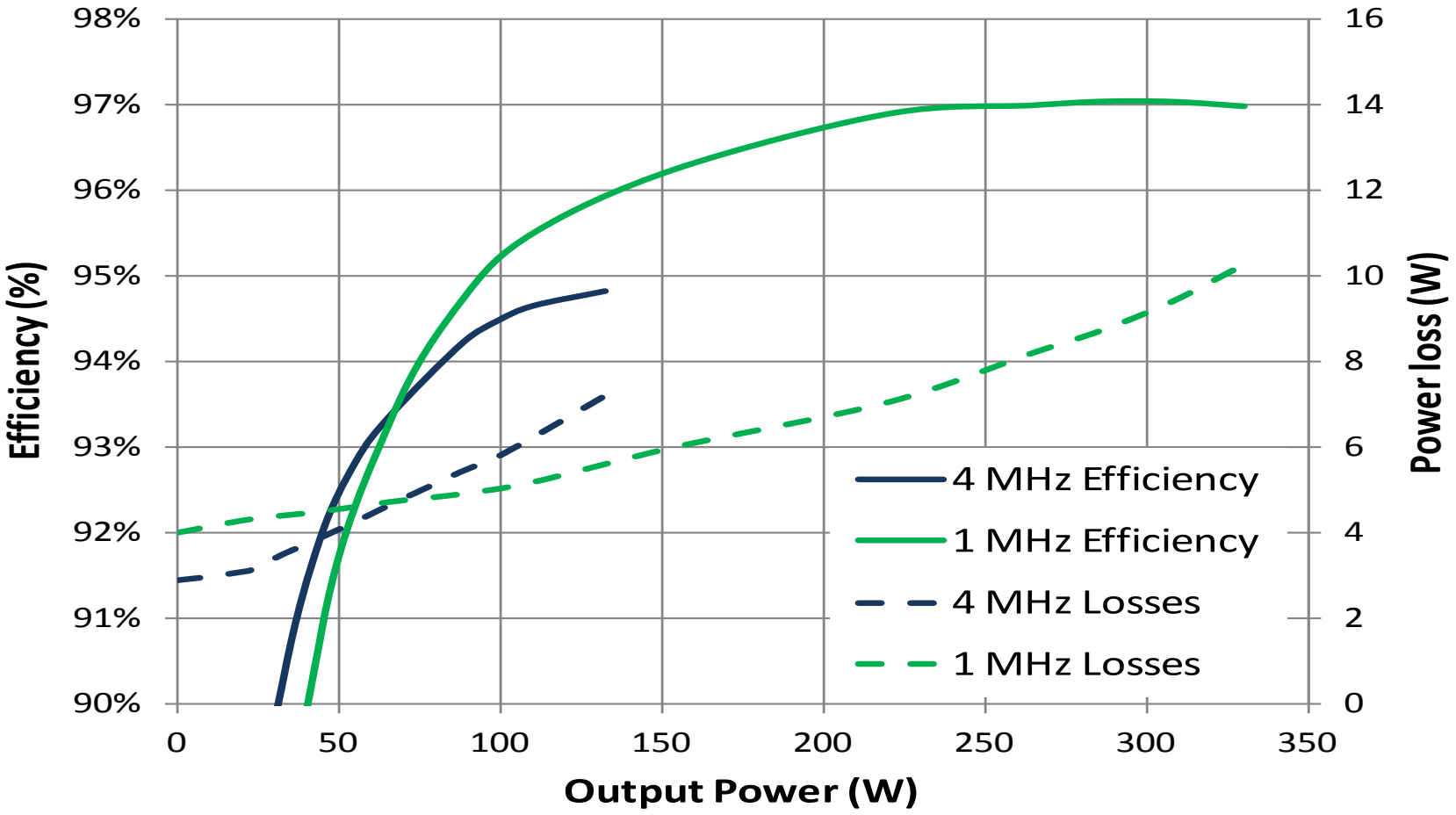
*Reference: V. Yousefzadeh, et al, Efficiency optimization in linear-assisted switching power converters for envelope tracking in RF power amplifiers, ISCAS 2005

15 A_{OUT} / 1 MHz Single ϕ Buck

- Modified an EPC9002 development board

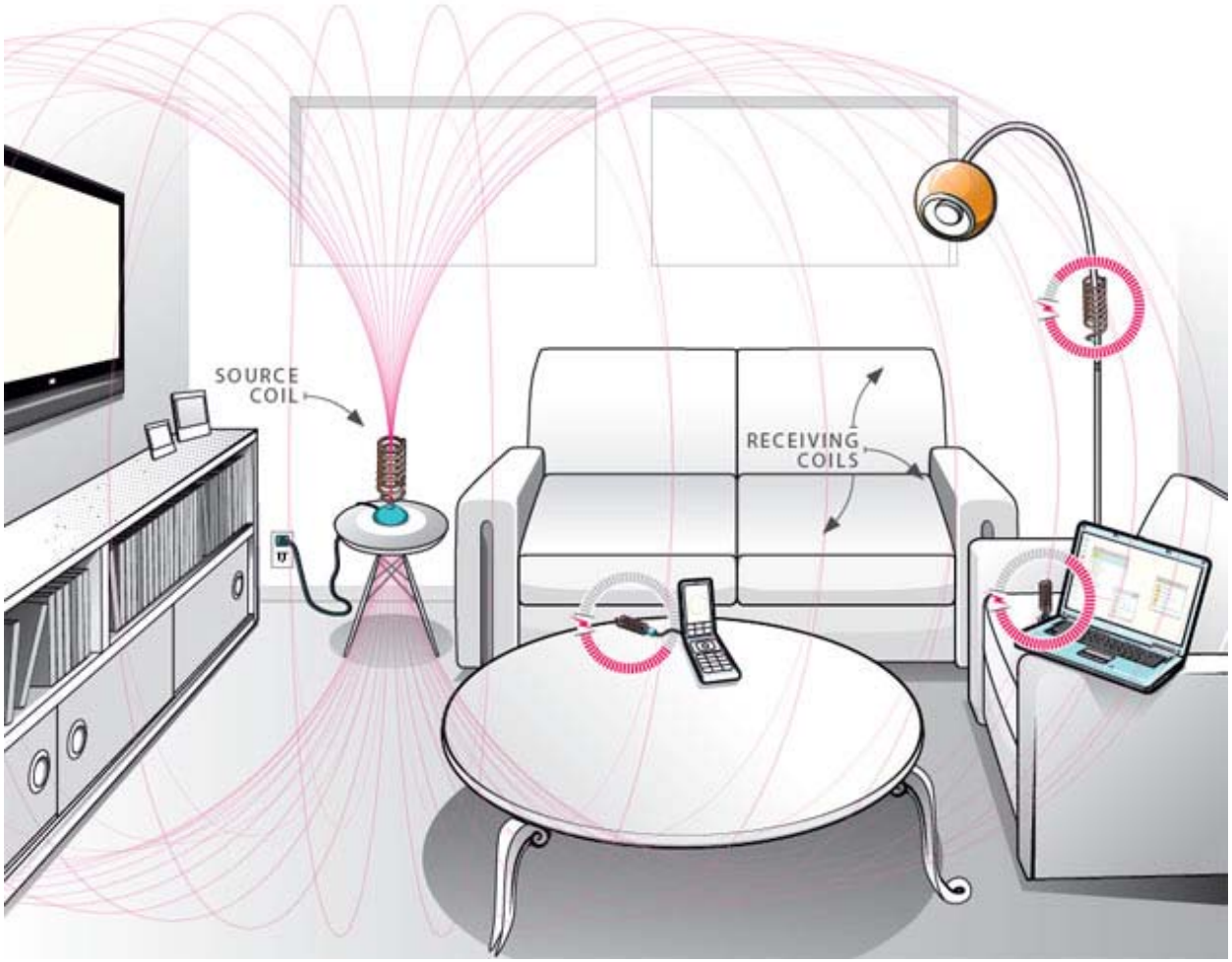


Efficiency Results

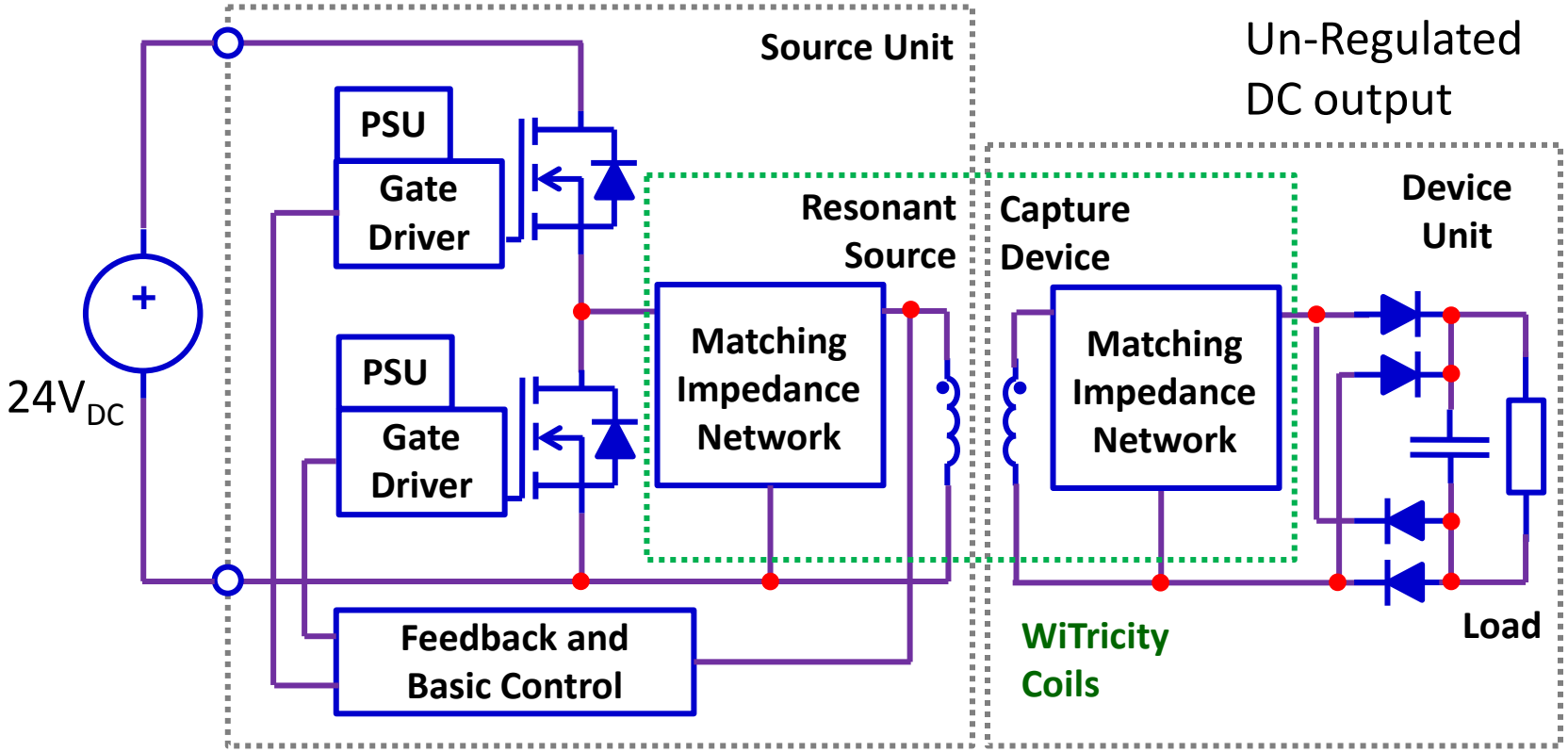


Wireless Power

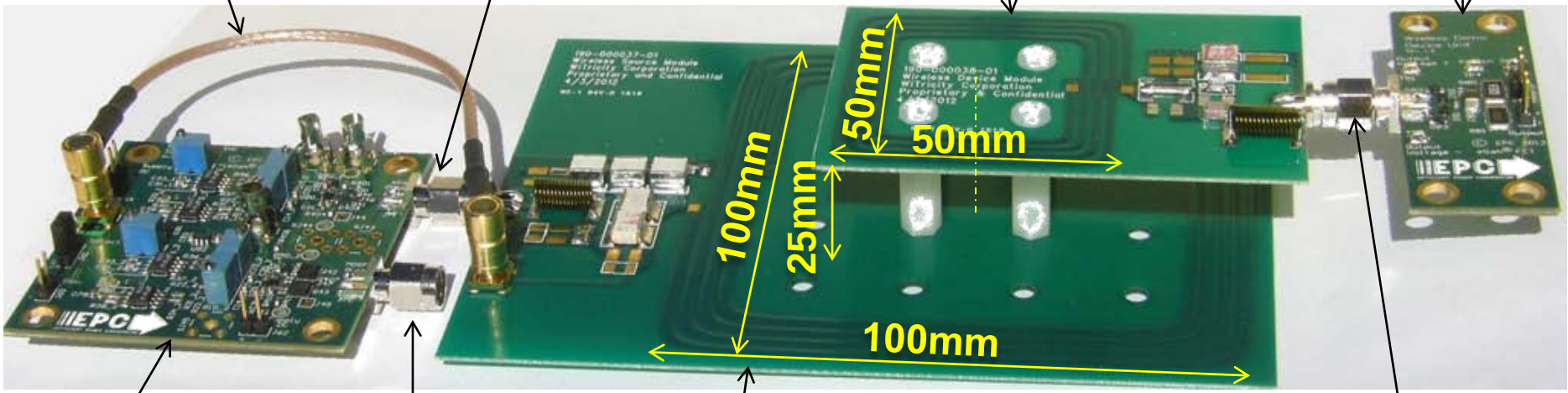
Wireless Power



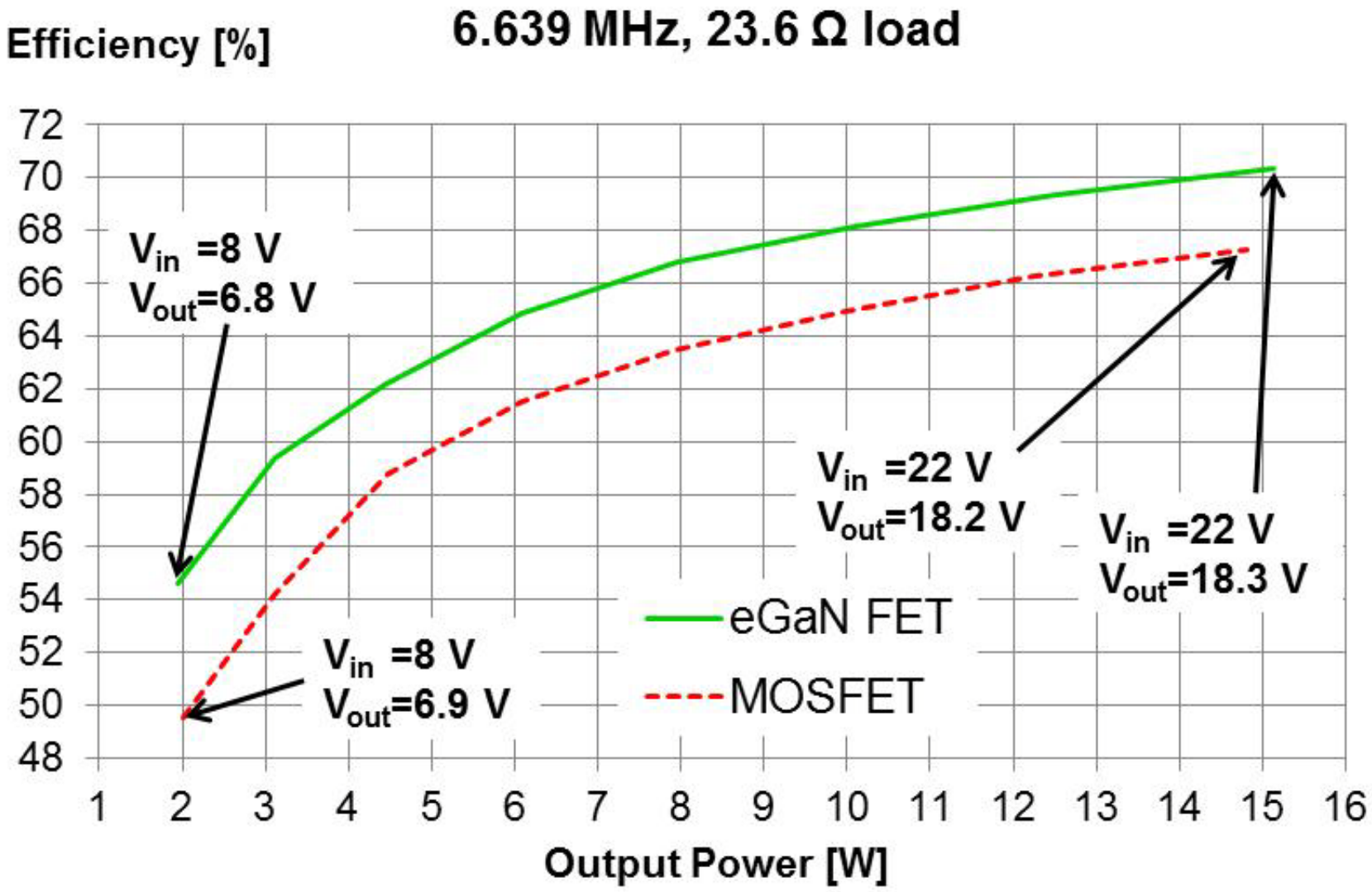
Block Diagram of the Wireless System



Experimental System Setup

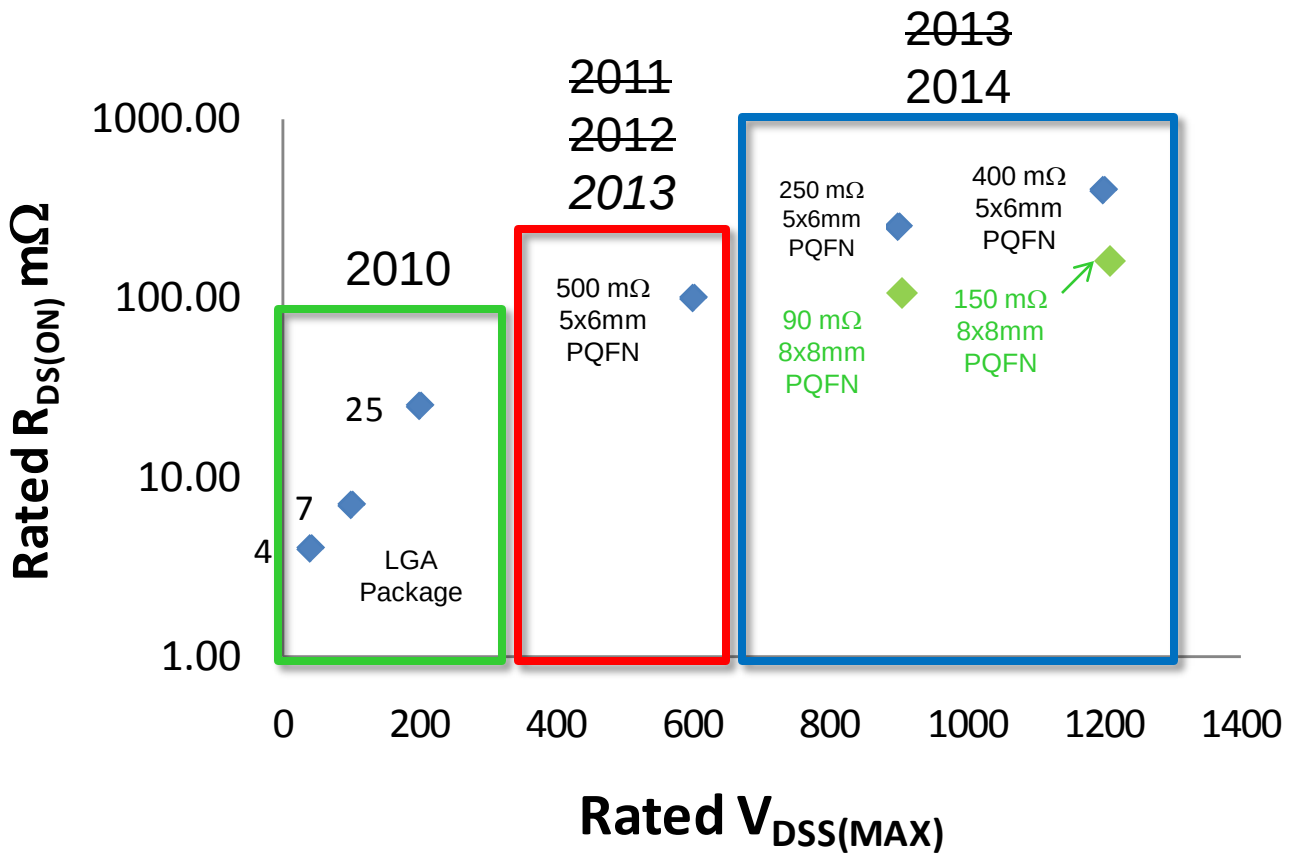


Efficiency as Function of Load Power



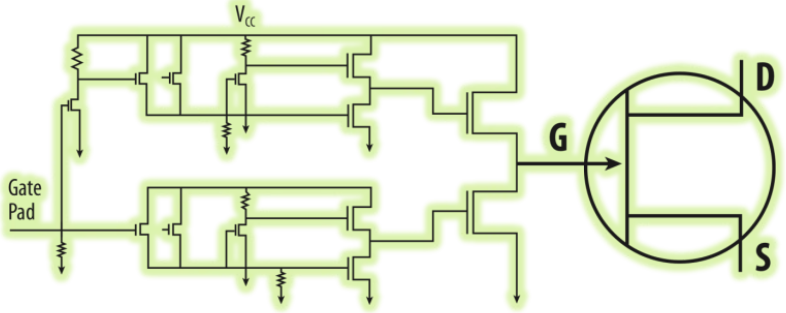
What's in the Future?

Beyond 600 Volts

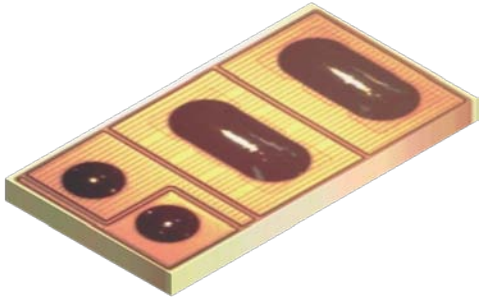


Beyond Discrete Devices

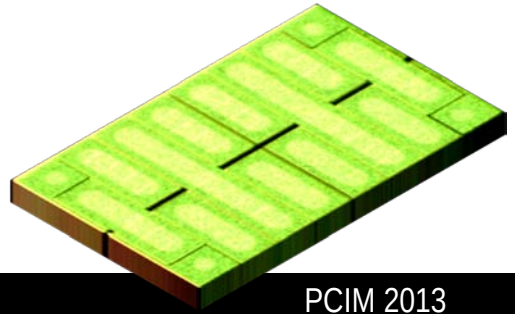
Driver On Board



Discrete FET with Driver



Full-Bridge with Driver and Level Shift



Summary

- GaN transistors enable exciting new applications such as RF Envelope Tracking and Wireless Power Transmission
- GaN transistors have the potential to replace silicon power MOSFETs in power conversion applications with a low-cost and higher efficiency solution
- eGaN FETs are straightforward to use, but you can't just drop them into a MOSFET socket. Some R&D is needed – start today!

EPC
EFFICIENT POWER CONVERSION

The end of the road for silicon…..

is the beginning of the eGaN FET journey!