

GaN High Density 300W AC-DC Converter

300 W, 29 W/in³, 95.4%

Tom Ribarich¹, Peter Bredemeier², Stephen Oliver³

^{1,3} Navitas Semiconductor, USA

² ONgineer GmbH, Germany

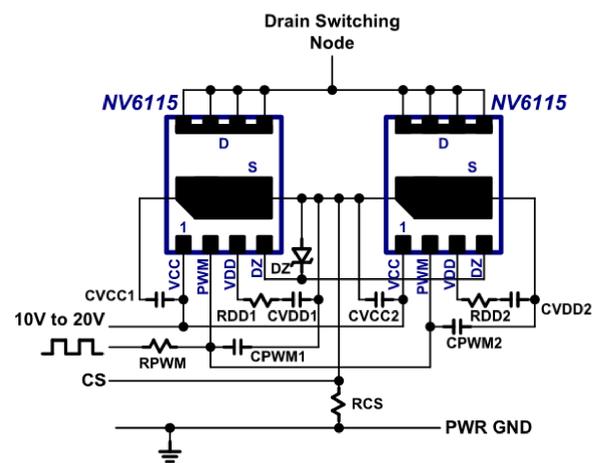
Abstract

A 300W AC-to-DC high-density and low-profile converter has been designed and demonstrated.

The circuit topology includes a 2-phase interleaved PFC input stage, an LLC dc-dc stage, and a synchronous rectification output stage. The design includes GaN power ICs and off-the-shelf controllers running at 500kHz.

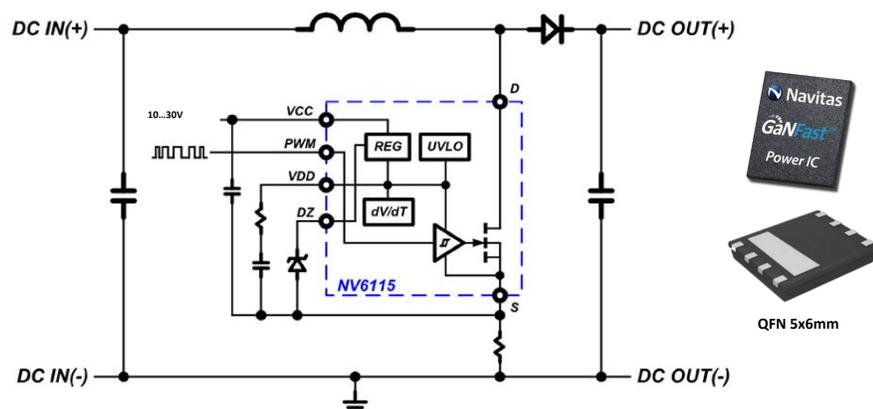
This new design has resulted in a power density of 29W/in³.

The waveforms demonstrate zero-voltage switching in all stages and the performance results show high efficiency and acceptable component temperatures.

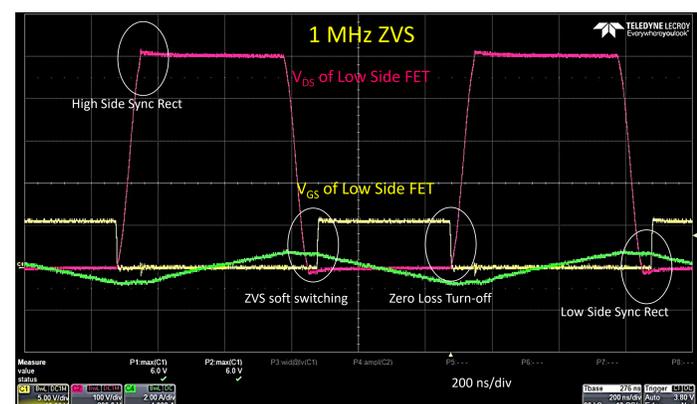


**Easy-to-Parallel
GaN Power ICs**

GaNFast™ Power IC



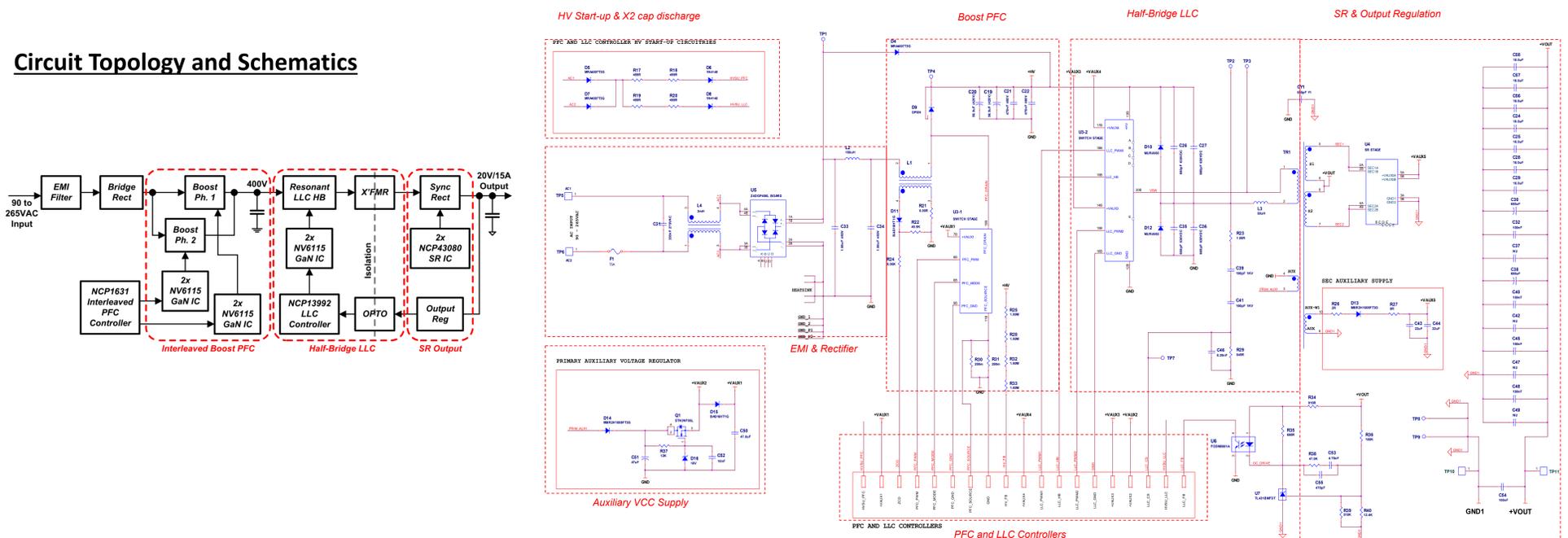
MHz Half-Bridge Performance



Proprietary Navitas technology = **monolithic** integration of 650V eMode GaN FET, GaN Driver, GaN Logic

Mass production GaNFast Power ICs are “Digital-in, Power-out” with 20x lower drive loss than silicon (<35 mW at 1 MHz). Zero impedance between driver output and FET gate means stable, high-efficiency, high-speed operation. Very fast prop delay and turn-on/off of 10-20 ns (from PWM input to change in FET V_{DS}) and high dV/dt immunity (200 V/ns) with slew-rate programmability mean easy high-frequency operation. Switching performance is fast, smooth and predictable with no overshoot, no spikes, no oscillations and smooth ‘S-curves’ transitions for easy EMI compliance. Note the zero-loss turn-on and zero-loss turn-off at 1 MHz.

Circuit Topology and Schematics

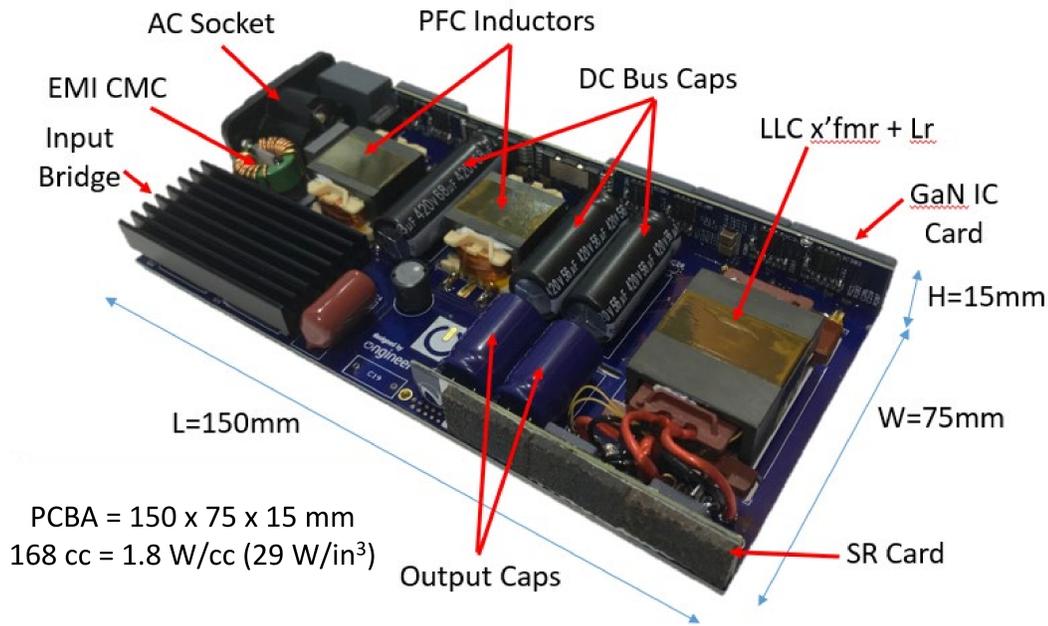


Commercial On Semiconductor controllers were pushed to their highest frequency limit.

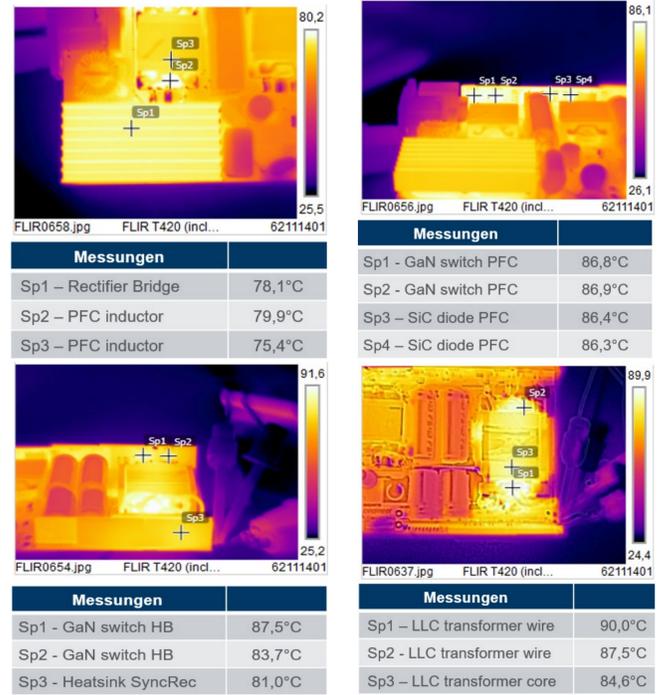
- PFC
 - Interleaved CrCM/DCM Boost using NCP1632 (with frequency-foldback function to reduce power consumption)
 - Minimum 200 kHz (90 V_{AC}, peak-of-line) to maximum 450 kHz
 - Inductors are 2x EF20 with TDK EPCOS N49 material.
- DC-DC
 - LLC using NCP13992 (with adaptive dead-time features, soft-start, comprehensive protection and HV start-up) and NCP4305/NCP43080 (SR)
 - 500 kHz normal operation (with higher frequency during load / start-up burst conditions)
 - LLC transformer is ED26 with N49

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Simple Construction



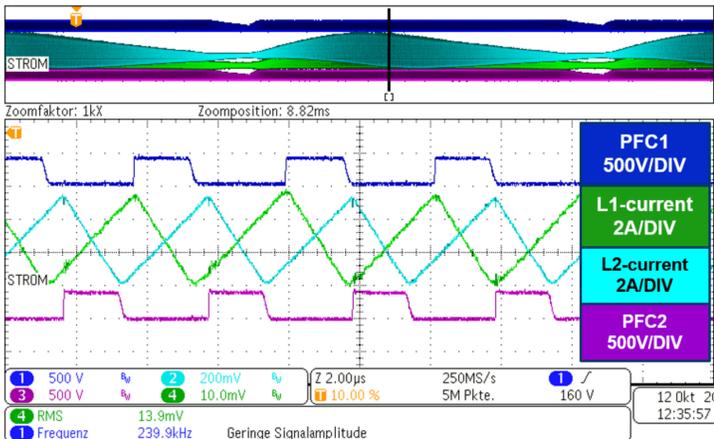
Cool Operation



Modular construction maximizes design flexibility. Low-cost, 2-layer motherboard for bulk caps, magnetics, etc. and 4-layer daughtercards for the powertrain (extra Cu for thermal management). Additional thermal management required (heat spreading, Cu wrapper, etc.).

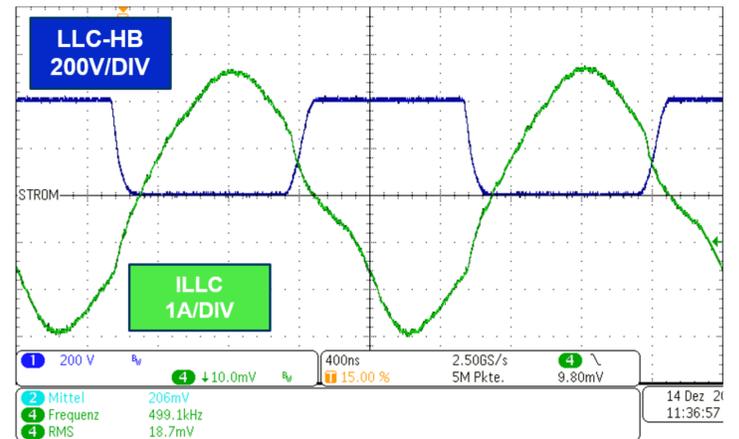
Worst-case condition (90 V_{AC}, full load, 25°C, open-frame). Images highlight the balanced power dissipation across the main passive components and GaNFast Power ICs (85-90°C).

Smooth, High-Frequency Operation



Note very fast switching of the GaN Power ICs

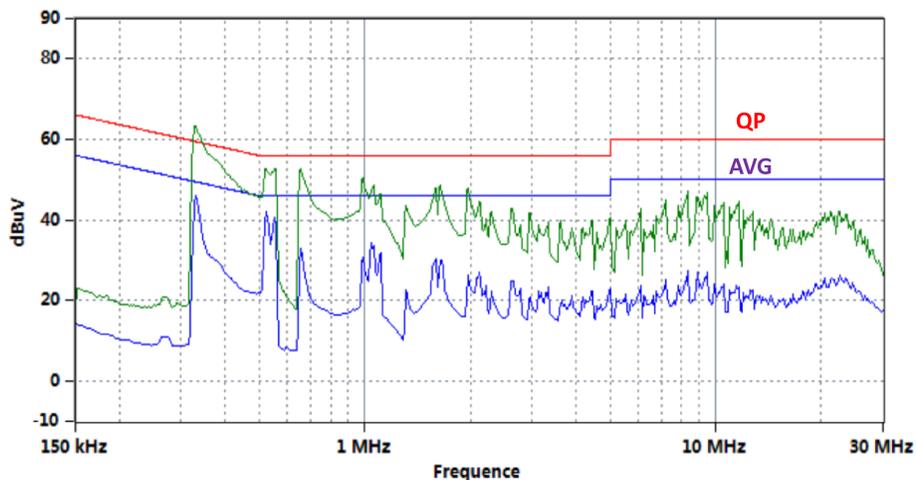
Controller timing may be accelerated to take advantage of the new technology to reduce dead-times and improve converter efficiency



LLC Half-Bridge voltage and LLC tank current (20 V_{OUT}, 15 A)

CrCM Interleaved PFC Boost 90 V_{IN}, 400 V_{OUT}, 300 W, 240 kHz (peak of AC line)

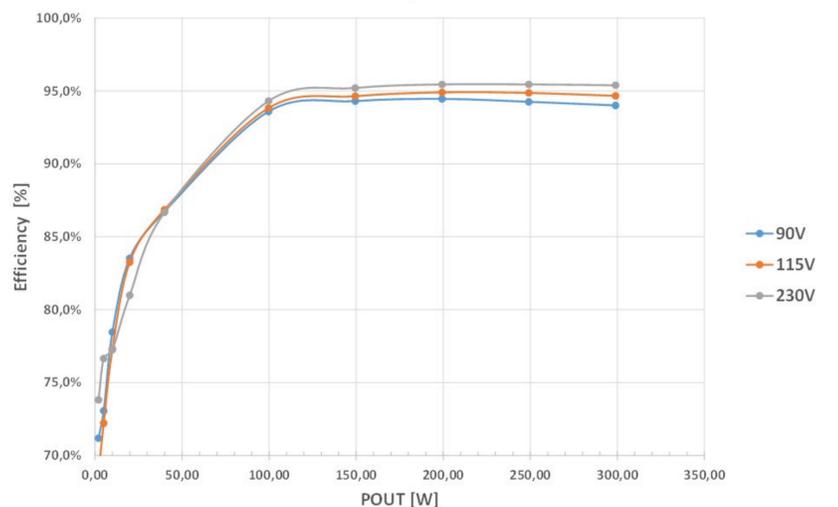
Quiet Operation



Predictable, smooth-switching, high-performance GaNFast Power ICs, plus correct layout ensure good EMI spectra performance vs. EN55022.

High Performance

Efficiency vs load



Full load, 25°C, open-frame, no air-flow. US DoE "Level VI" ave. 94%. Curves are extremely high and flat, from ~25%-100% load.

Acknowledgements

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Let's go GaNFast™

