



Navitas

Let's go **GaNFast**[™]

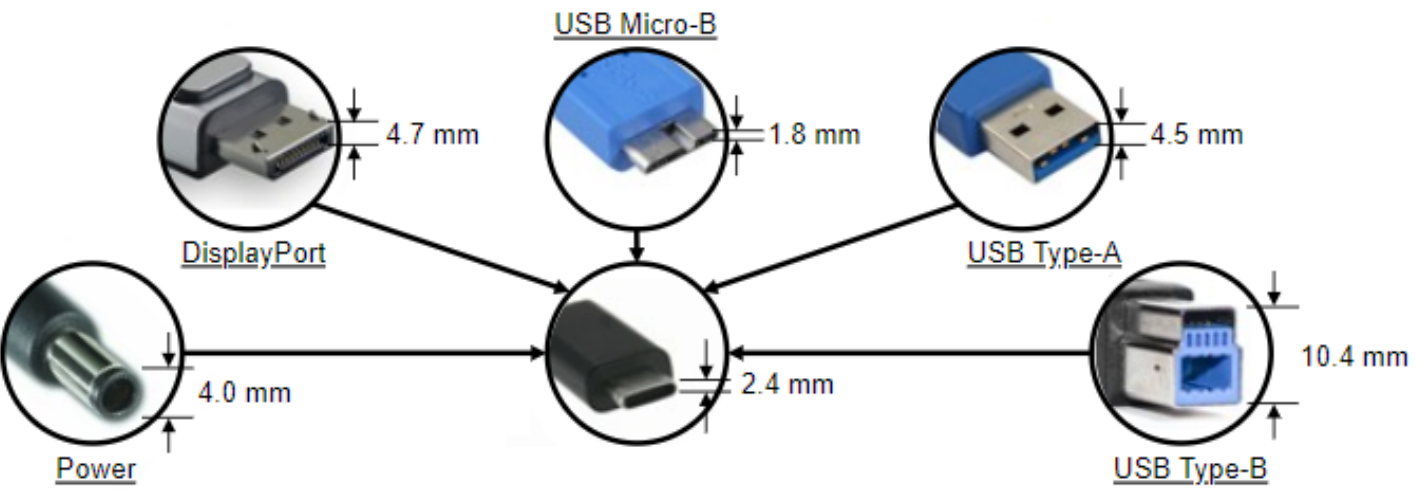
GaN ICs Enabling Next-Gen ACF for Adapter/Charger Application

Xiucheng Huang, Ph.D

Mar 21st 2019



USB Type C & Power Delivery



All in one: Type C connector



One for all: PD adapter/charger



Mu One 45W PD: World Thinnest Adapter



- 5V/3A, 9V/3A, 12V/3A, 15V/3A, 20V/2.25A
- 14 mm profile
- CE, UL, etc.
- Available now on www.amazon.com





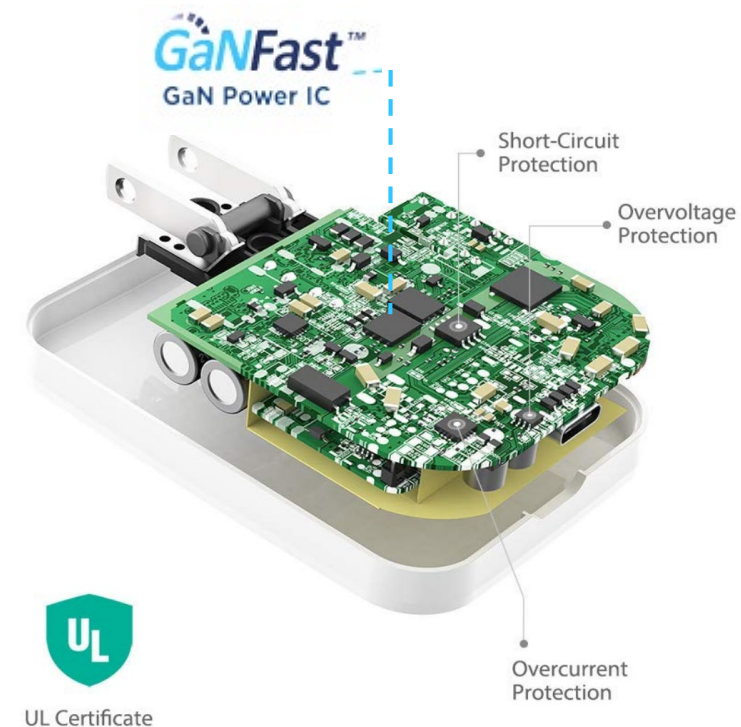
RAVPower 45W: Same Platform



45W Power Delivery
2.5X Faster

Macbook 12"
2.0 hrs

iPhone XS Max
1.8 hrs



- Available now on www.amazon.com

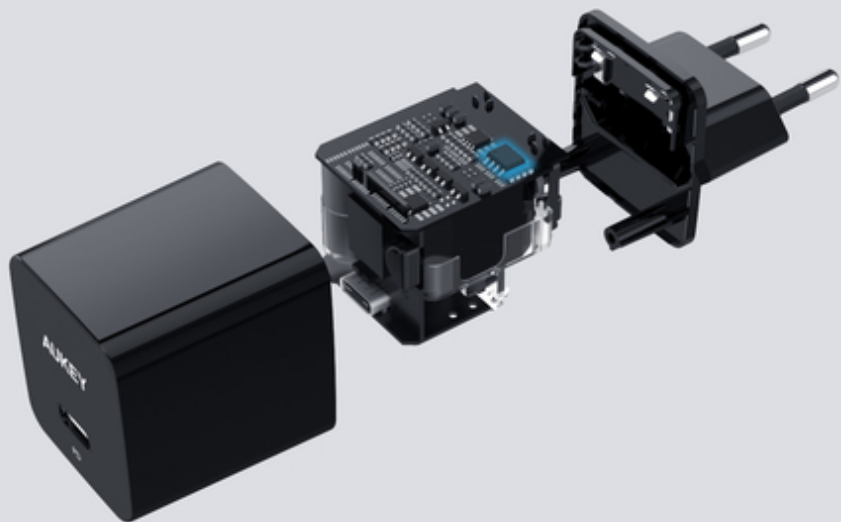


AUKEY 24W, 27W, 30W



AUKEY | **GaNFast™**

Up to 3x faster charging with half the size and weight for unparalleled mobility.



27W USB-C PD



27W USB-C PD



2 x 12W USB-A



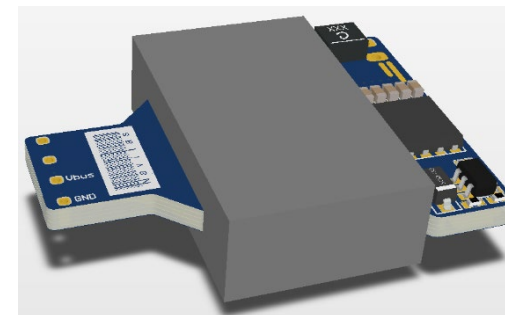
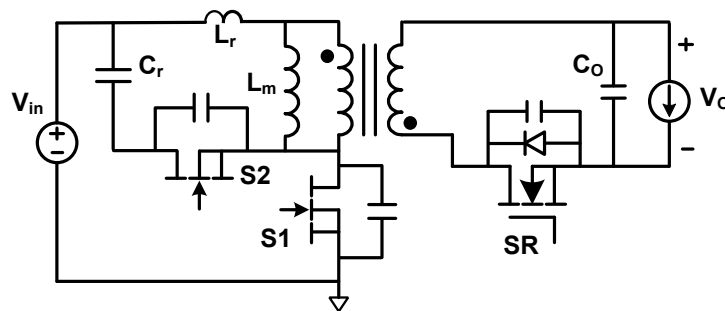
30W USB-C PD

- Available now on www.amazon.com



How Can We Make It?

- A. Select the right semiconductor devices
- B. Select the right topology, frequency and control
- C. Select the right magnetics and design properly

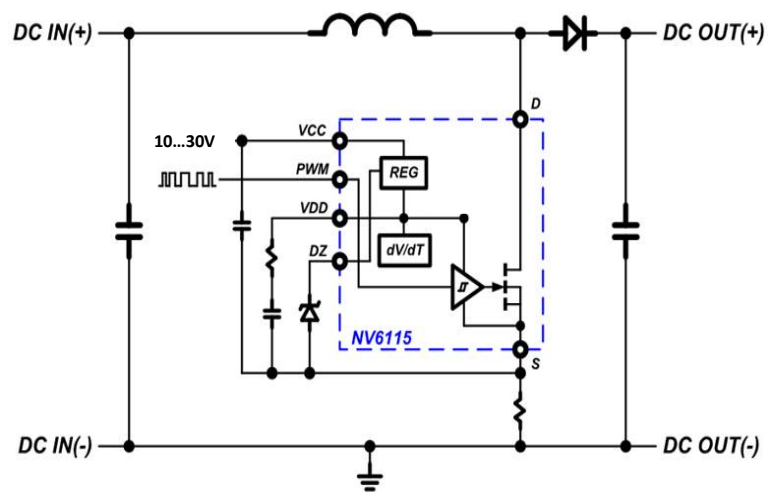




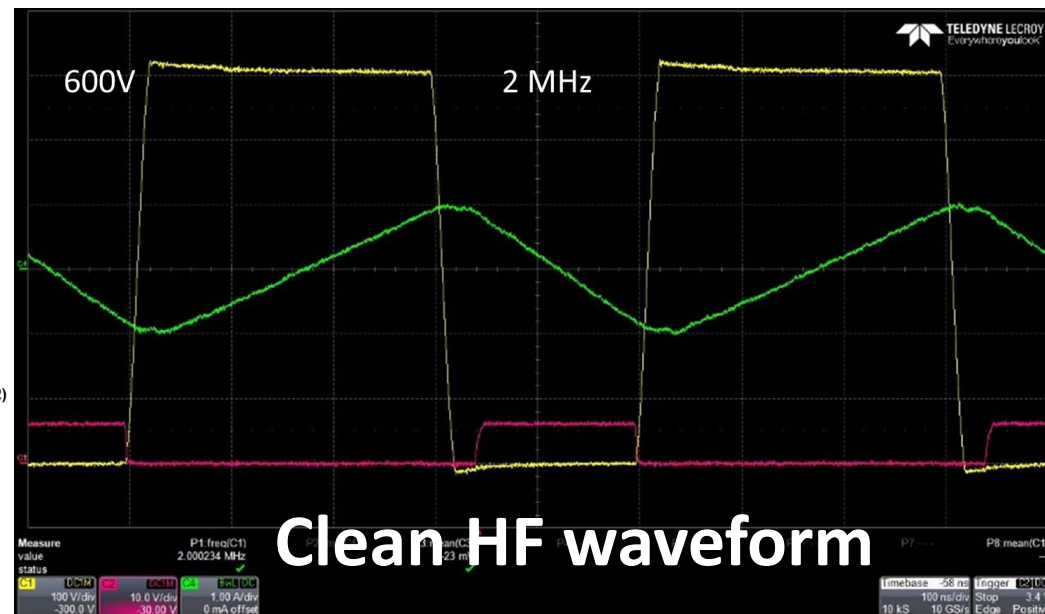
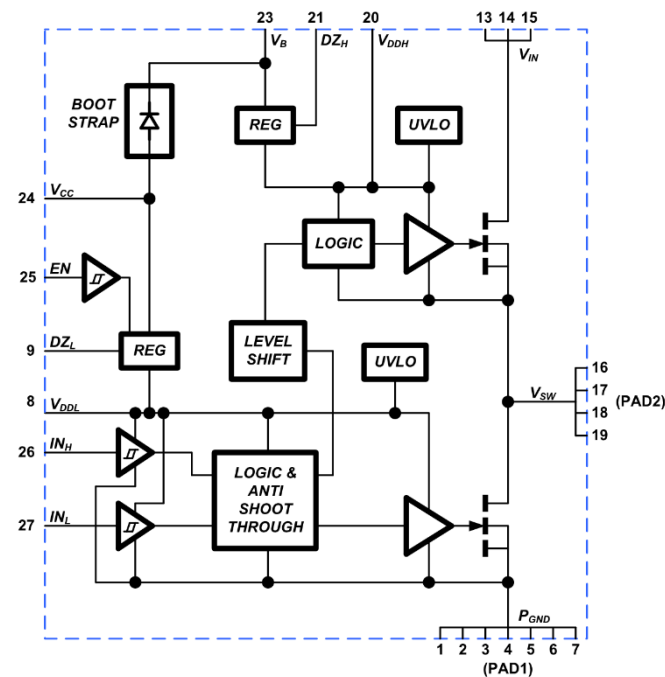
World First GaN Power IC



Single GaN IC



Half-bridge GaN IC

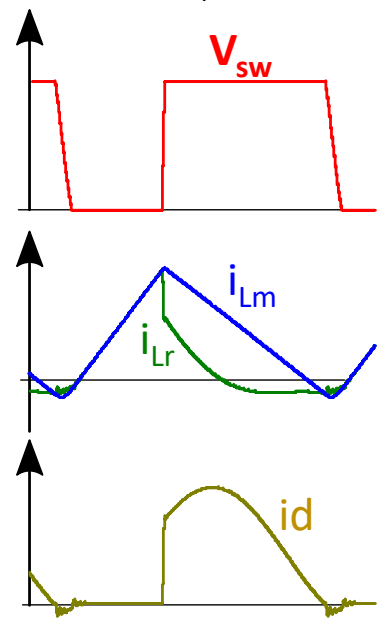
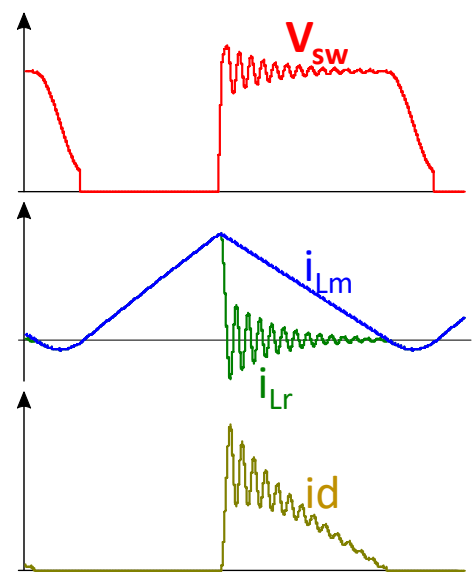
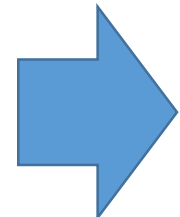
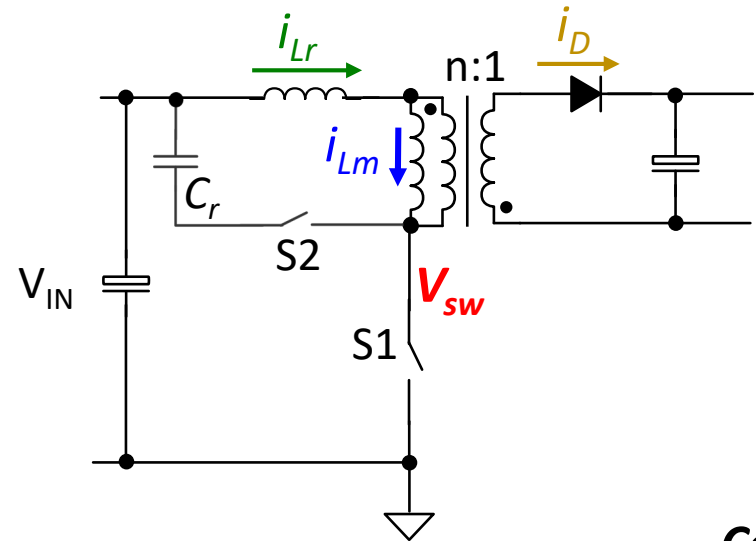
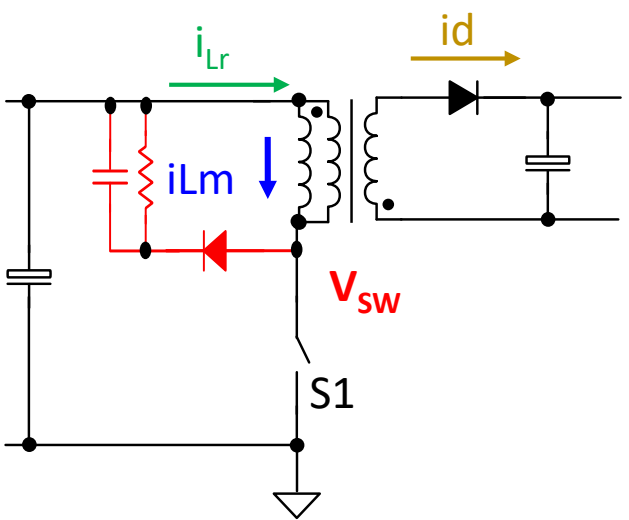


- Monolithic integration, 650V
- GaN FET + GaN Driver + GaN Logic

- Monolithic integration, 650V
 - 2x GaN FETs
 - 2x GaN drivers
 - GaN Logic (level-shift, bootstrap, shoot-through)



Active Clamp Flyback with Soft-Switching

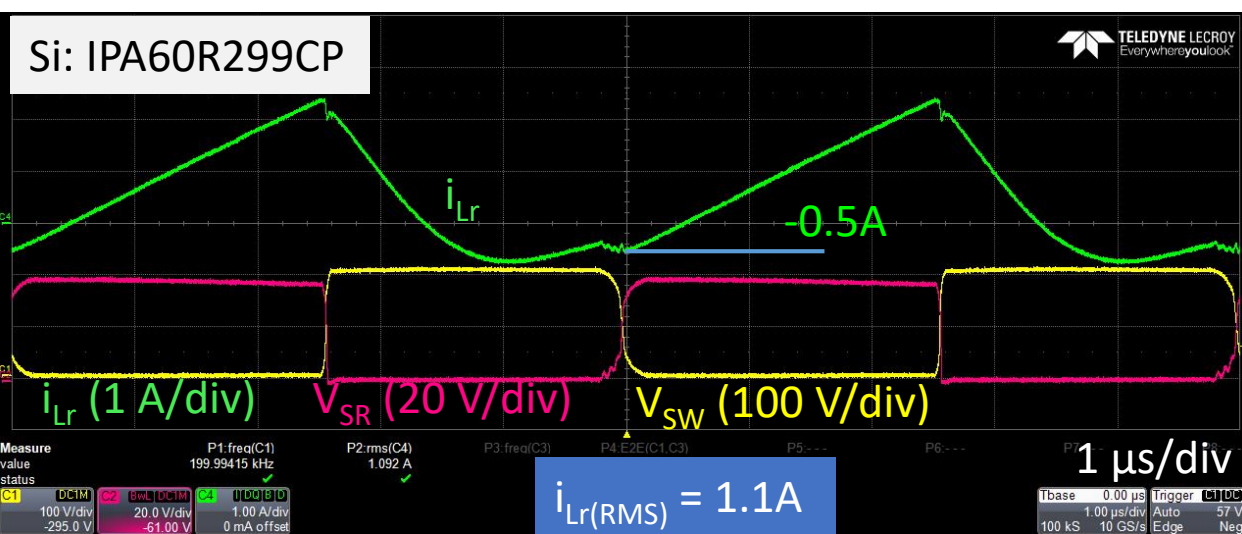
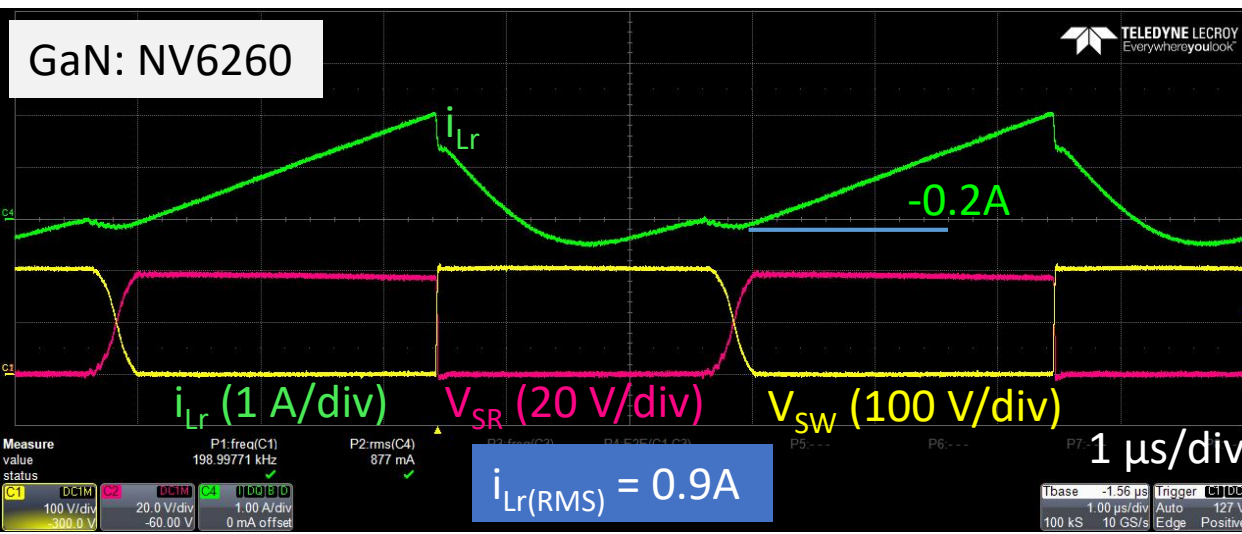


Commercial IC Available !!

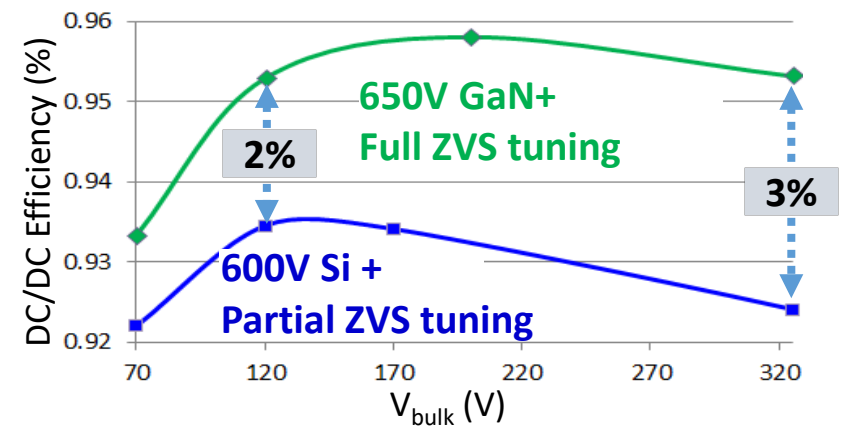


GaN vs. Si in ACF

2%-3% Higher Efficiency with Low C_{OSS} , Q_G , Q_{rr} , E_{off}



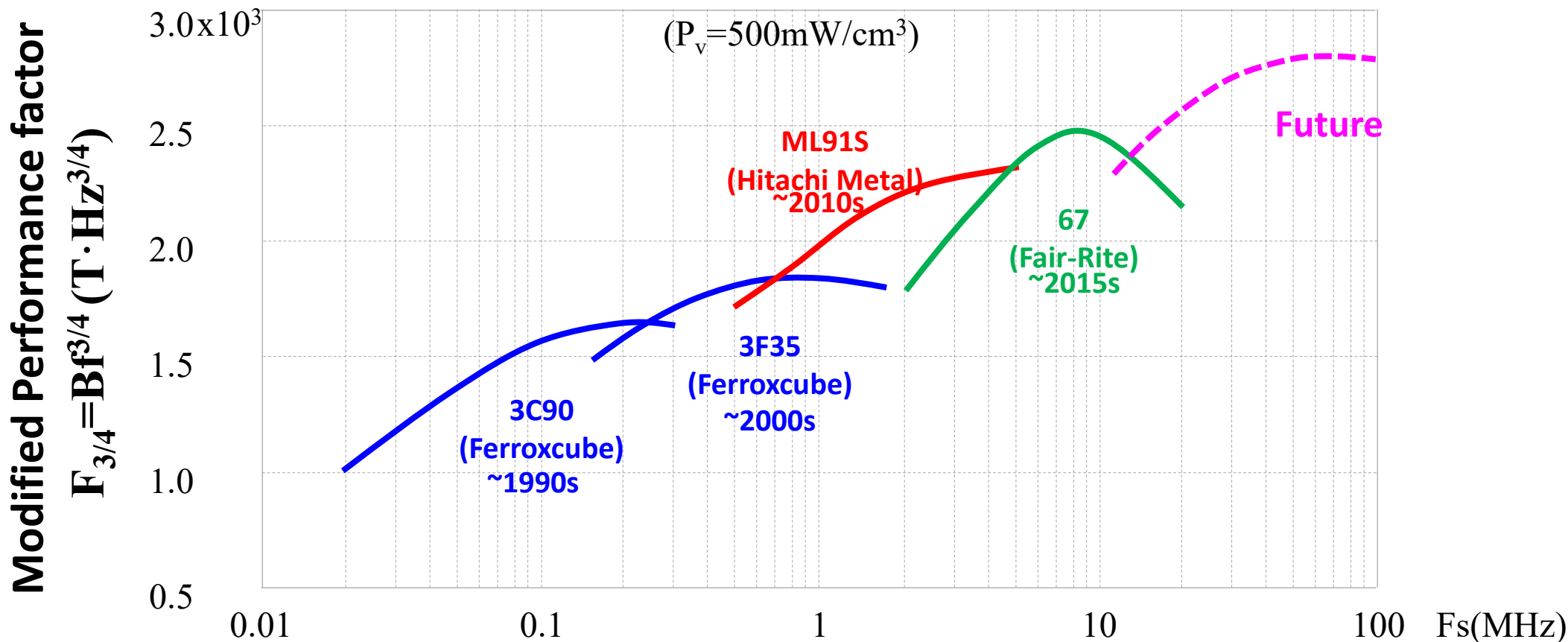
	IPA60R299CP	NV6260 (per FET)
Voltage Rating (V)	650	650
$R_{DS(ON)}$	270	40% ↓ 160
$C_o(tr)$ (pF)	120	60% ↓ 50
Q_g (nC)	22	90% ↓ 2.5
Q_{rr} (nC)	3900	0



Courtesy of Texas Instruments (ACF w/ pri resonance)



Advanced Magnetic Material



Y. Han, G. Cheung, A. Li, C. R. Sullivan and D. J. Perreault, "Evaluation of Magnetic Materials for Very High Frequency Power Applications," in *IEEE Transactions on Power Electronics*, vol. 27, no. 1, pp. 425-435, Jan. 2012.

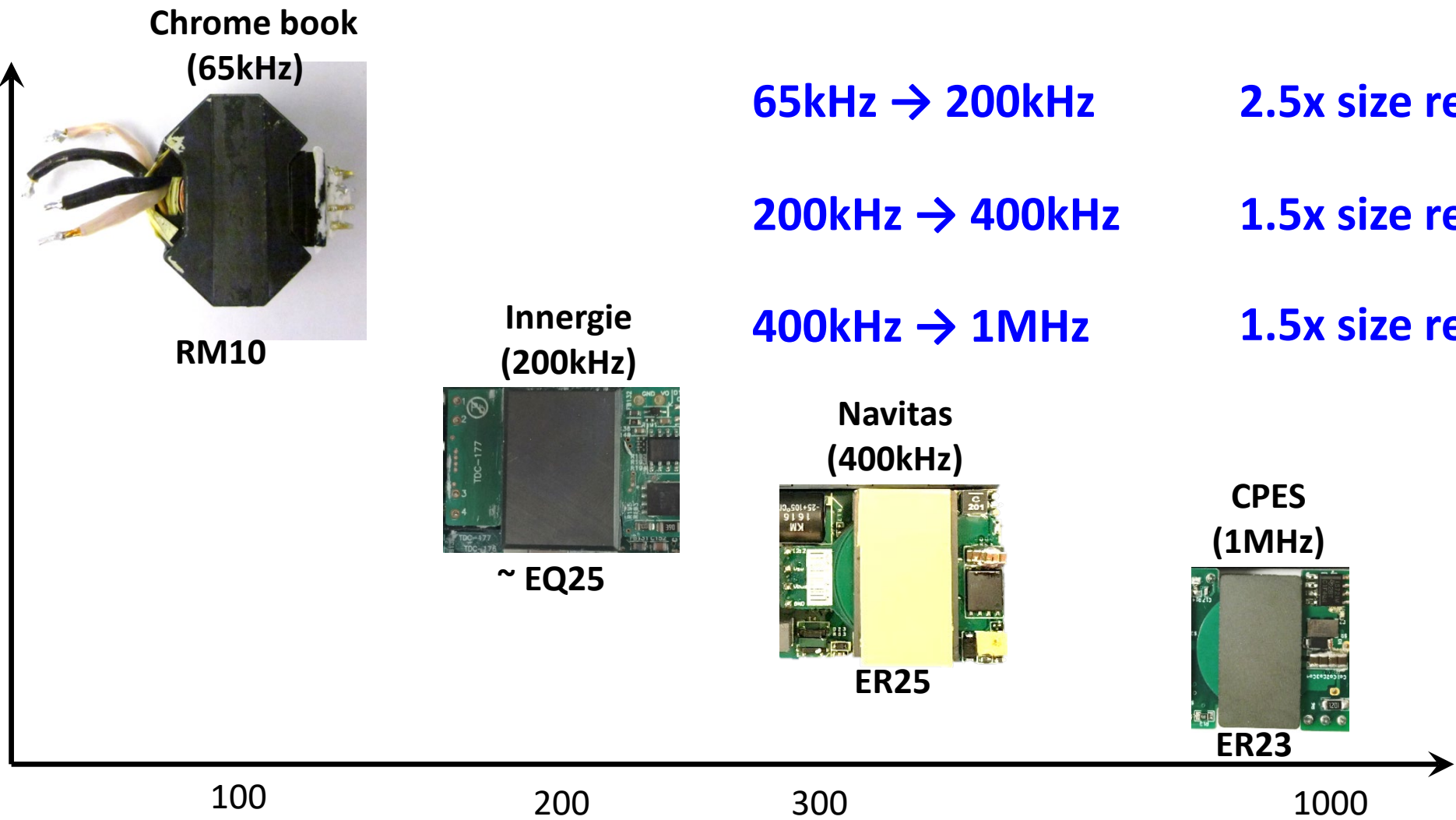
A. J. Hanson, J. A. Belk, S. Lim, C. R. Sullivan and D. J. Perreault, "Measurements and Performance Factor Comparisons of Magnetic Materials at High Frequency," in *IEEE Transactions on Power Electronics*, vol. 31, no. 11, pp. 7909-7925, Nov. 2016.



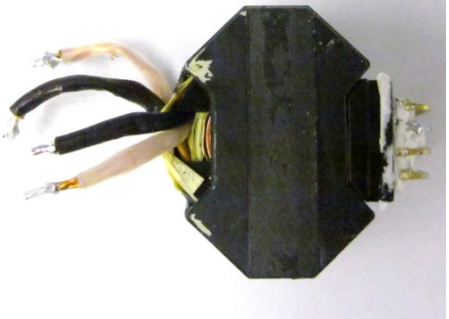
Magnetic: Bulky / Expensive → Small / Cheap



Vol (mm³)



Chrome book
(65kHz)



RM10

65kHz → 200kHz

2.5x size reduction

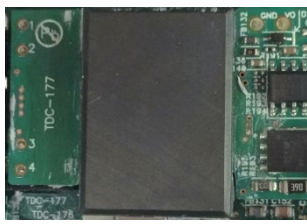
200kHz → 400kHz

1.5x size reduction

400kHz → 1MHz

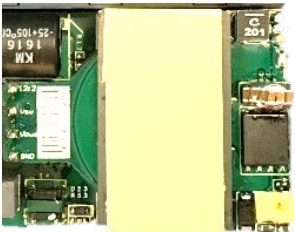
1.5x size reduction

Innergie
(200kHz)



~ EQ25

Navitas
(400kHz)



ER25

CPES
(1MHz)

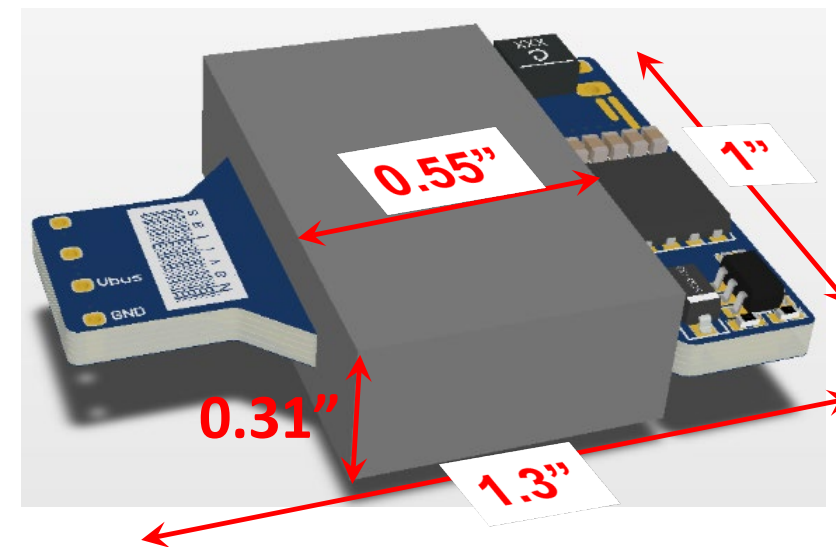
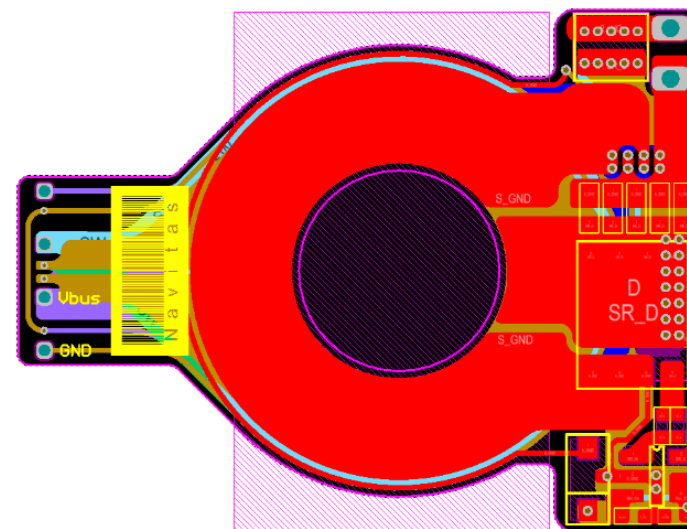
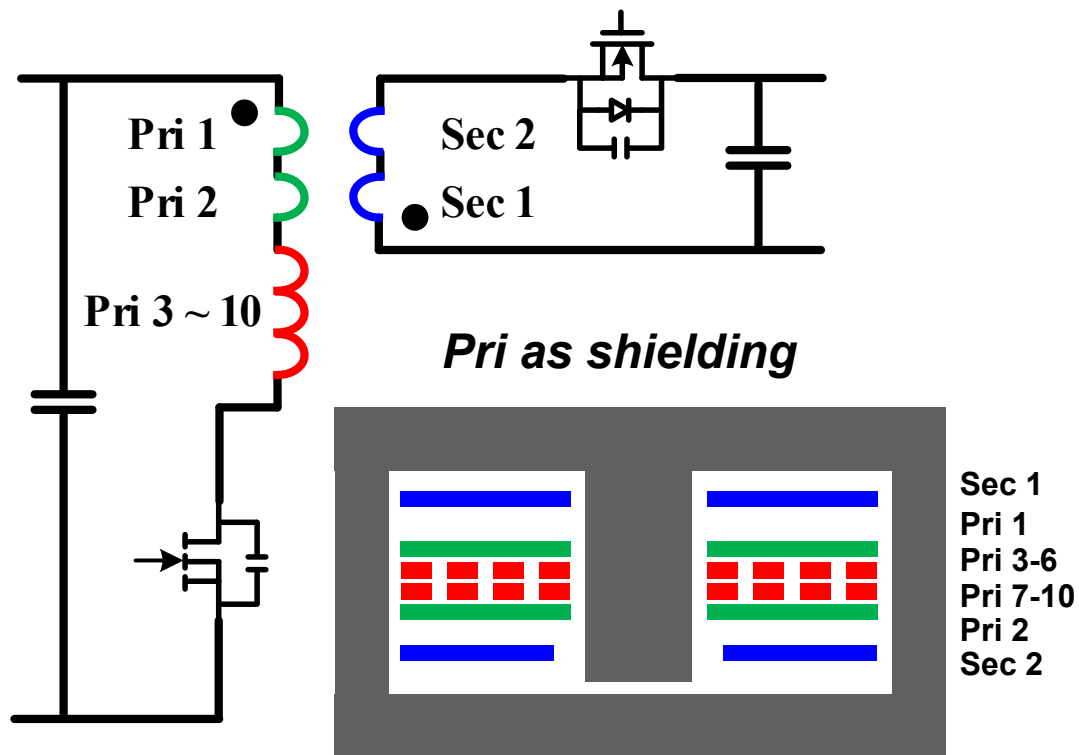


ER23

Freq (kHz)



Planar Magnetics → Manufacturability



- SR on sec winding, minimized L_k & R_{ac}
- Shielding integrated as pri winding
- Safety rule compliance



Cool Operation

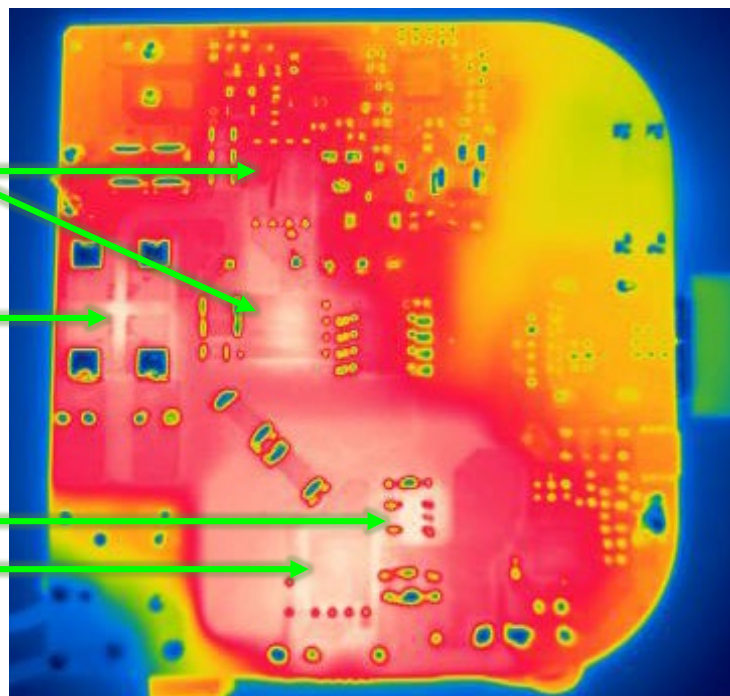
Top

Bottom

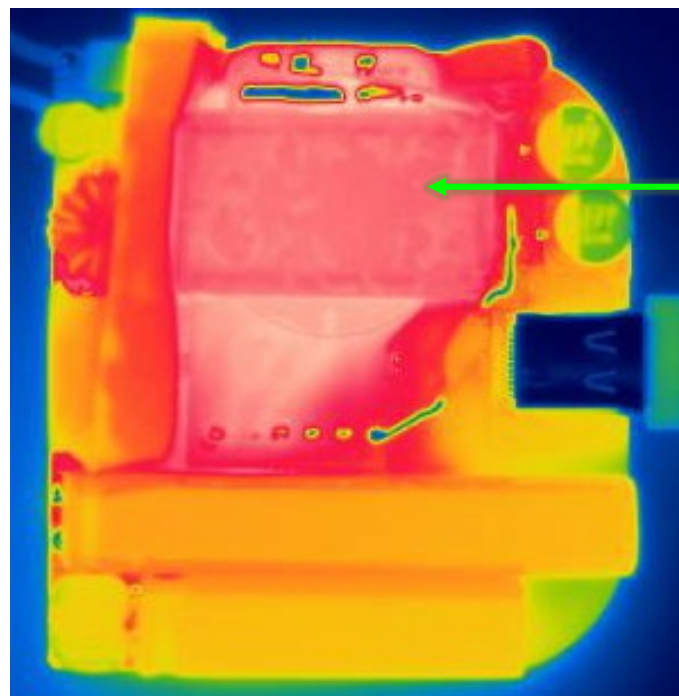
GaNFast
Power IC 75°C, 80°C

AC Bridge 80°C

SR IC 85°C
SR FET 85°C



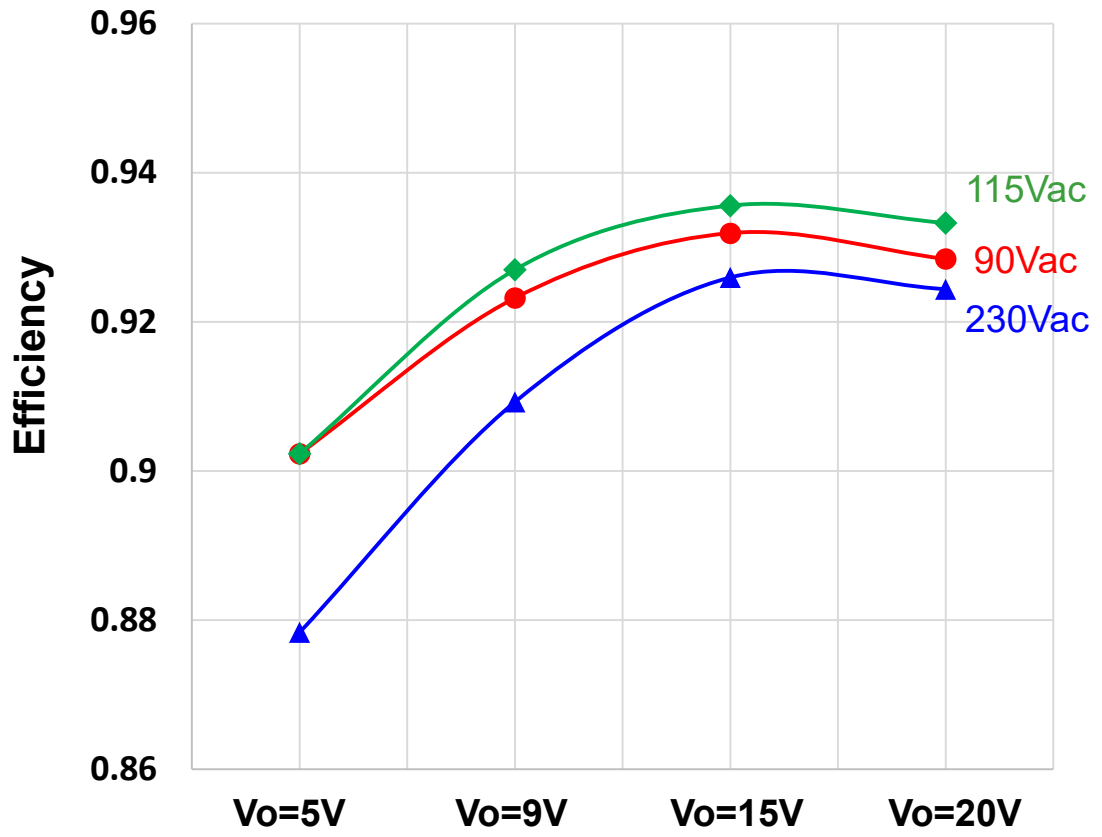
Transformer 80°C



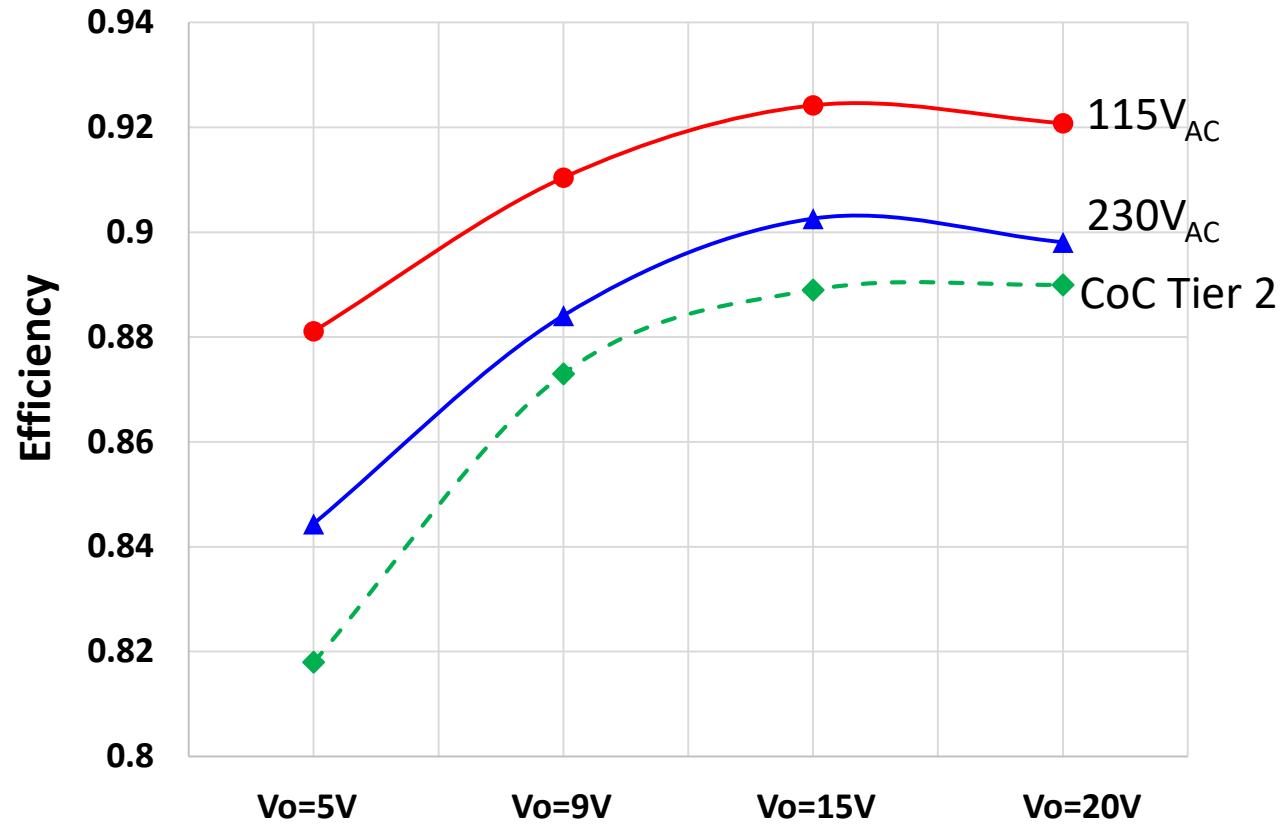
90 V_{AC}, 45 W, 25 °C, uncased, no airflow,
no thermal compound / heatsinking



Full Load Efficiency

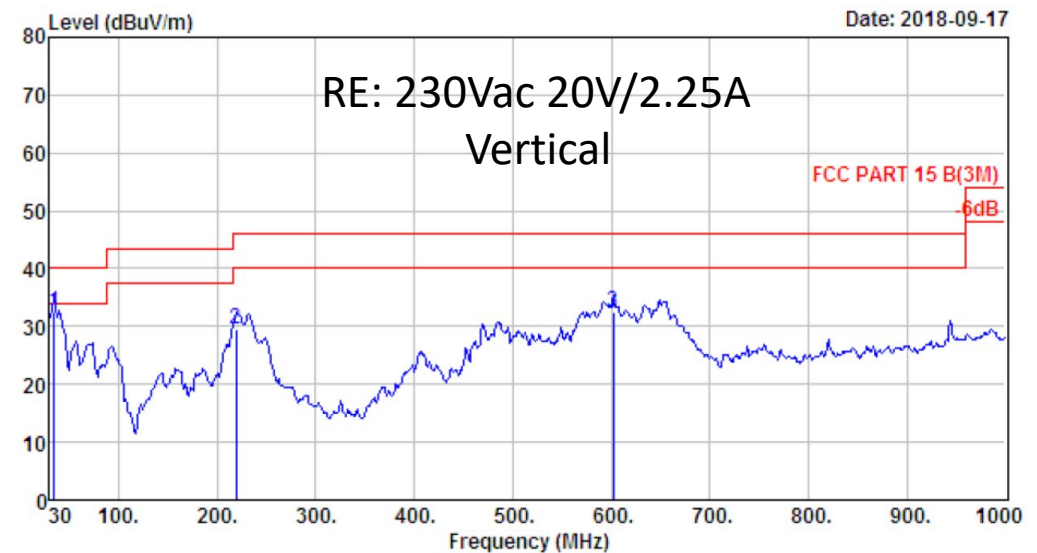
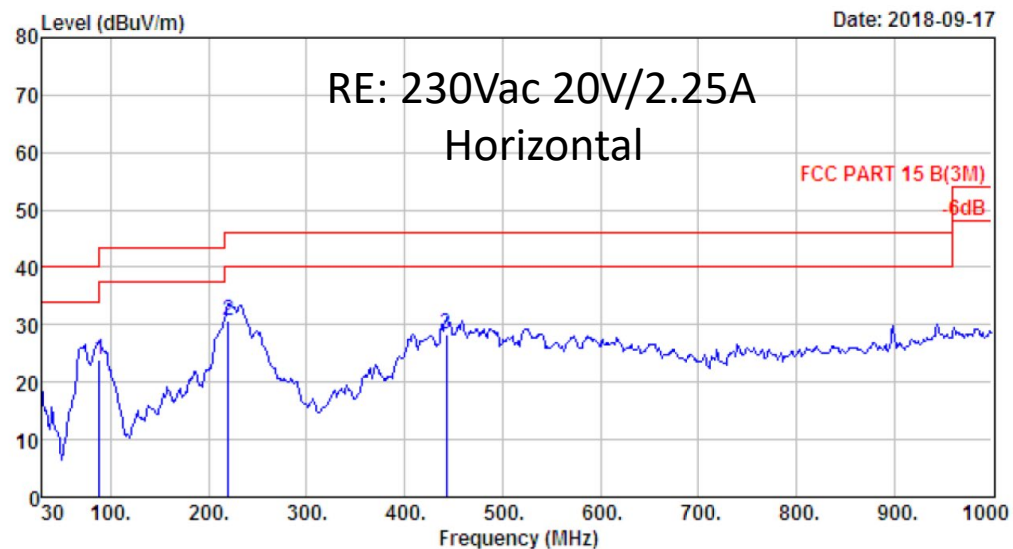
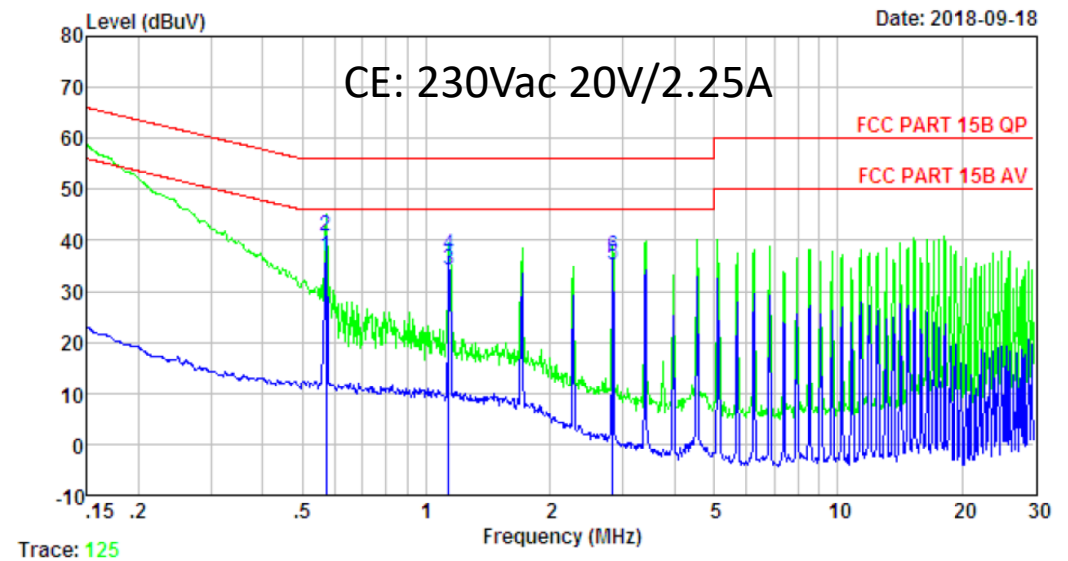
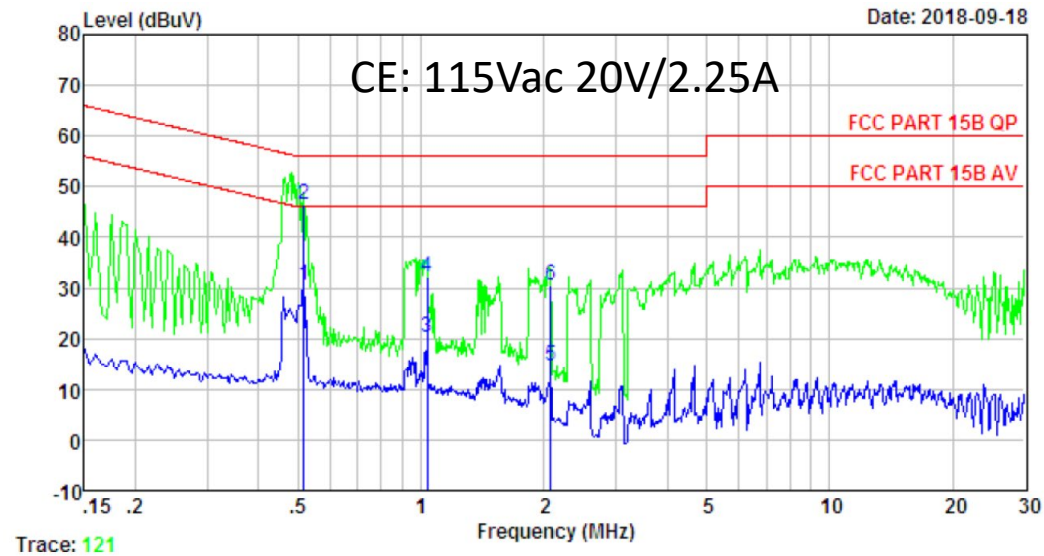


4-Point Average Efficiency



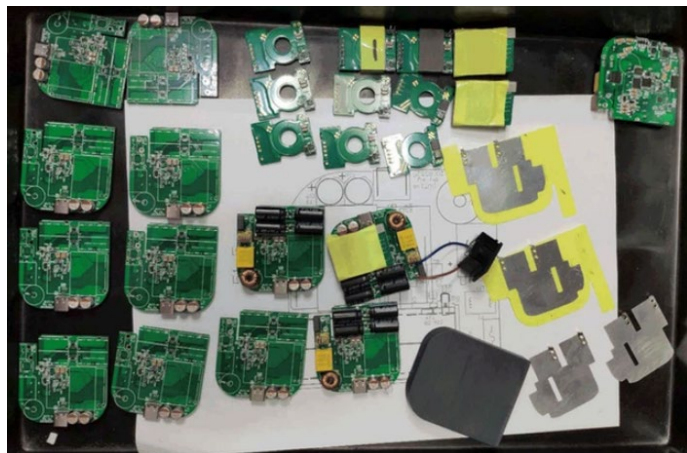


Quiet EMI (Conducted, Radiated)





Mu One: From Prototype to Mass Production

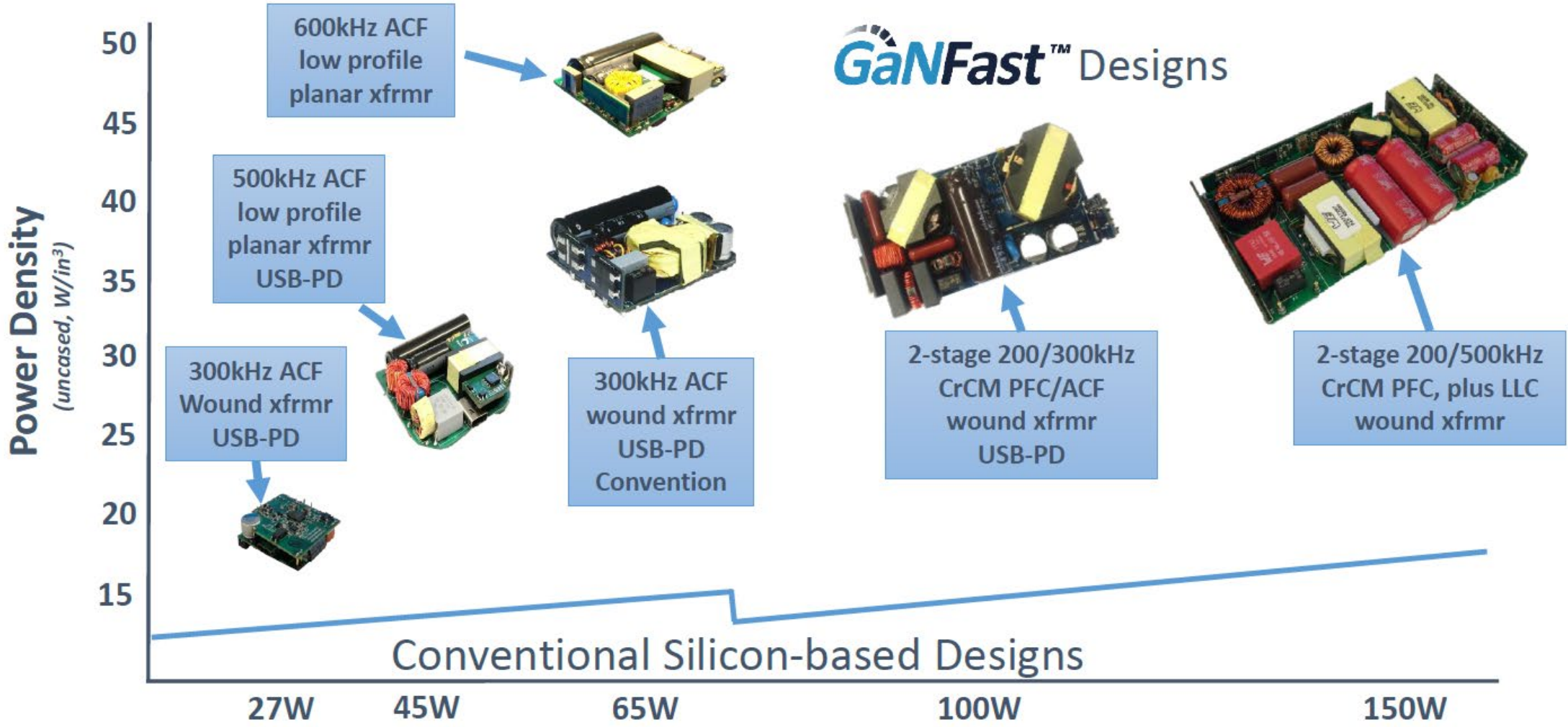


- Thanks to Matt Judkins, CEO of Made-in-Mind (Mu)
- Available via www.amazon.com and airport stores in **NOW!**



The New World of Fast Charging

GaNFast™ Designs





Let's go **GaNFast™**