GaN Half-Bridge Power IC and AHB/Totem-Pole Topologies Enable 240W, 150cc, PD3.1 Solution with 96% Efficiency

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Presentation Outline

- 240W GaN Chargers
- Topology Comparisons
- NV6269C GaNSense Half-Bridge IC
- 240W-1C PD3.1 150cc Charger Design
- Conclusions

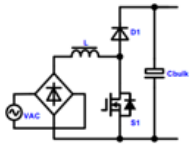
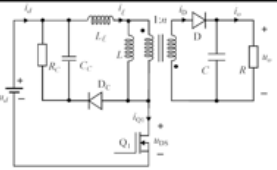
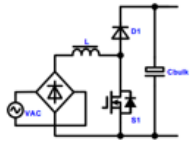
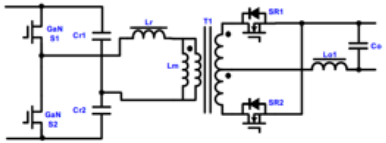
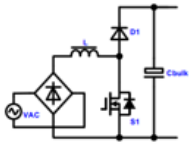
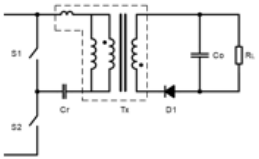
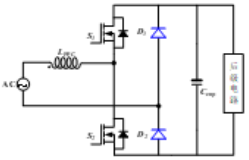
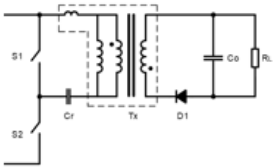
240W USB-C GaN Chargers Are Here!

Anker Prime 240W-3C/1A
104.5 x 78.4 x 33.8 mm = 277 cc
Power Density = 0.87 W/cc
Efficiency = 92% (90Vac/100%)

WOTOBEUS 240W-3C/2A
113 x 86 x 32 mm = 311 cc
Power Density = 0.77 W/cc
Efficiency = 91.3% (90Vac/100%)

CHIPOFY 240W-3C/1A
90 x 65 x 36 mm = 211 cc
Power Density = 1.14 W/cc
Efficiency = 90.5% (90Vac/100%)

NV6269C Enables Next Gen High-Frequency, High EFF, High Power Density, Half-Bridge Topologies!

Topology	PFC Stage	DC-DC Stage	Pros	Cons	Summary
PFC + QR (< 120W)			• 2x HV Switches • 1x SR Switch • Variable Vout • Low cost • Many controllers	• Low Power Density • Low Efficiency • Low flux cancellation	Used for low cost, low power density, variable Vout solutions (PD3.1)
PFC + LLC (200-300W)			• High flux cancellation • High efficiency • High power density • Many controllers	• 3x HV switches • 2x SR switches • Fixed Vout • Addt'l buck for variable Vout • High cost	Used for high efficiency, high power density, fixed Vout solutions
PFC + AHB (200-300W)			• 1x SR Switch • Variable Vout • Good flux cancellation • High efficiency • High power density	• 3x HV switches • Few controllers • Medium cost	Used for high efficiency, high power density, variable Vout solutions (PD3.1)
TTP + AHB (200-300W)			• 1x SR Switch • Variable Vout • Good flux cancellation • Highest efficiency • Highest power density	• 6x HV switches • High cost • Few controllers	Used for highest efficiency, highest power density, variable Vout solutions (PD3.1)

NV6269C GaNSense Half-Bridge IC

NV6269C GaNSense Half-Bridge IC

Features

GaNFast™ Power IC

- Two independent logic PWM inputs
- 3.3, 5, 12 V PWM input compatible
- Floating high-side with internal level shift
- Integrated high-side bootstrap
- Integrated gate drive & voltage
- Wide V_{CC} range (10 to 24 V)
- Hi & Lo-side turn-on dV/dt slew rate control

GaN Power FETs

- 150/150 mΩ (NV6267C/M), 70/70 mΩ (NV6269C/M)
- Zero reverse recovery charge
- 800 Vmax_tran & 650 Vmax_cont ratings

GaNSense™ Technology

- Integrated loss-less current sensing
- Over-current & over-temperature protection
- Autonomous low-current standby mode

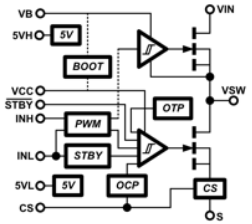
Small, low-profile SMT PQFN

- 8x10 mm footprint
- Minimized package inductance
- Large cooling pads

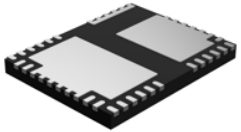
Key System Benefits

- ✓ No external half-bridge driver required
- ✓ Loss-less current sensing = +0.5 EFF benefit
- ✓ No ext. RCS resistors, no 85C RCS hot spot
- ✓ OCP, OTP protection features
- ✓ Autonomous low standby current mode
- ✓ Enlarged cooling pads
- ✓ Low RDSON + larger package enables 50% to 67% higher power levels!

Simplified Schematic

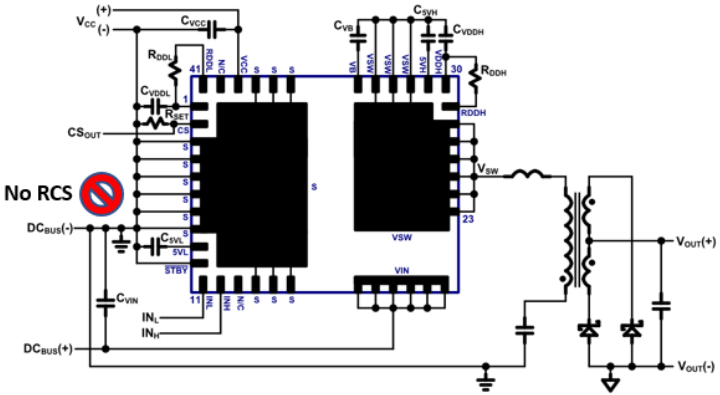


Package

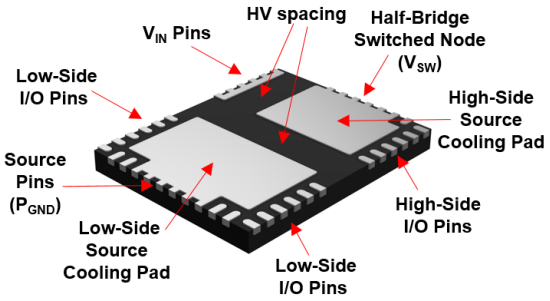


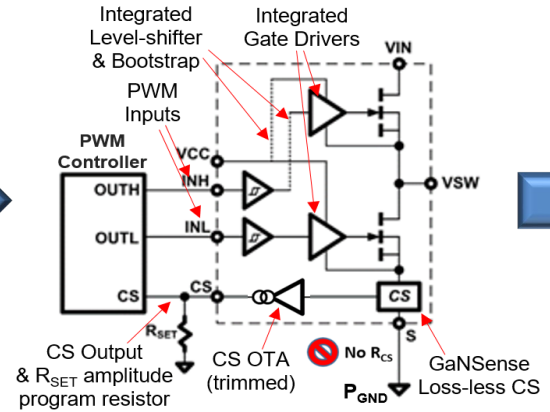
QFN 8x10

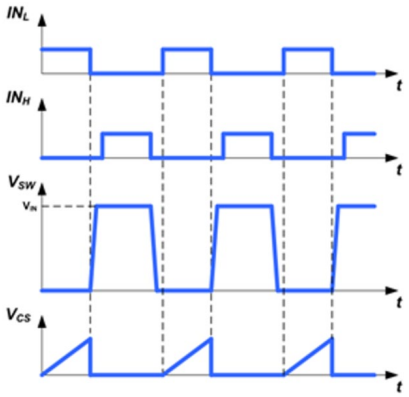
Typical Application Schematic (LLC)



NV6269C = Highest Integration, Lowest RDSON, Largest Cooling Pads & Simple Circuit Block







NV6269C

- ✓ QFN 8x10 package
- ✓ Large cooling pads
- ✓ Low-side I/O pins
- ✓ High-side I/O pins
- ✓ 650V functional isolation

Fully-Integrated GaNSense Half-Bridge IC

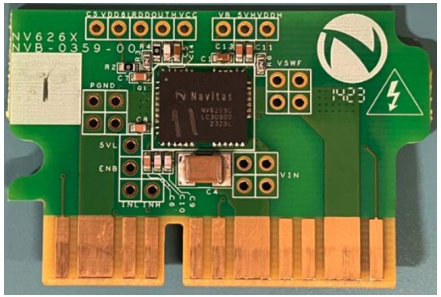
- ✓ Wide range VCC
- ✓ PWM inputs
- ✓ Level-shifting
- ✓ Gate drivers
- ✓ Bootstrap
- ✓ 2x 70m GaN power FETs
- ✓ Loss-less GaNSense with CS output

Simple Half-Bridge Circuit Block

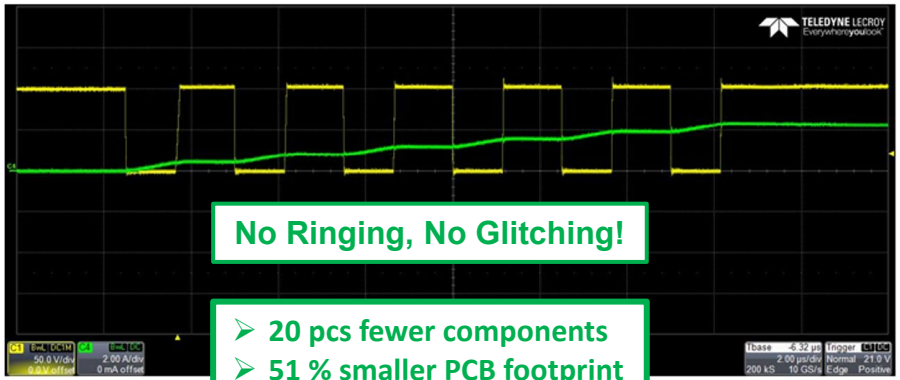
- ✓ 2x Low-side wide range PWM inputs
- ✓ 650V GaN half-bridge switched node output
- ✓ Programmable CS output
- ✓ Extra protection circuits (OCP/OTP)

GaNSense Half-Bridge IC = Smallest PCB Area, Fewest Components, No Ringing, No Glitching!

NV6269C GaNSense Half-Bridge IC



- ✓ 13 components
- ✓ 122mm2 footprint
- ✓ Int. level shifters
- ✓ Int. bootstrap
- ✓ Int. gate drivers
- ✓ No exposed gates

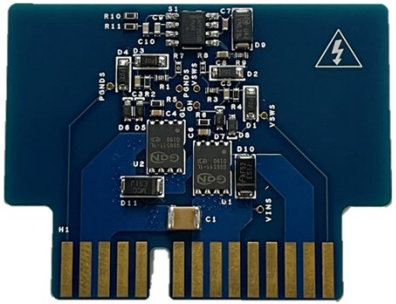


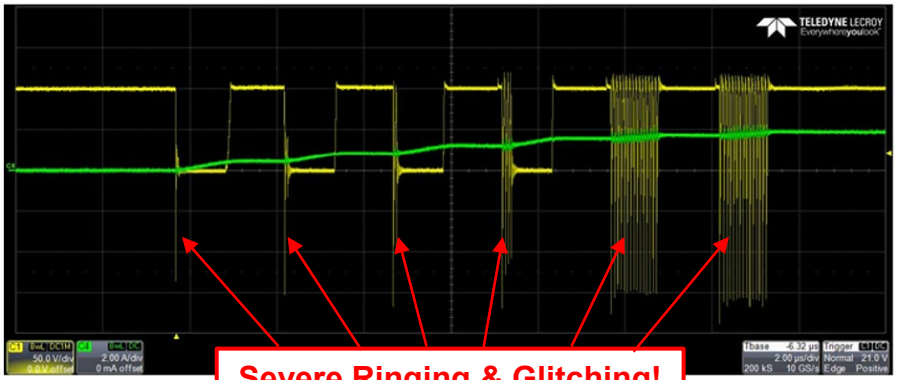
No Ringing, No Glitching!

- ➢ 20 pcs fewer components
- ➢ 51 % smaller PCB footprint
- ➢ No exposed gates
- ➢ Clean, reliable switching!

Discrete GaN Half-Bridge

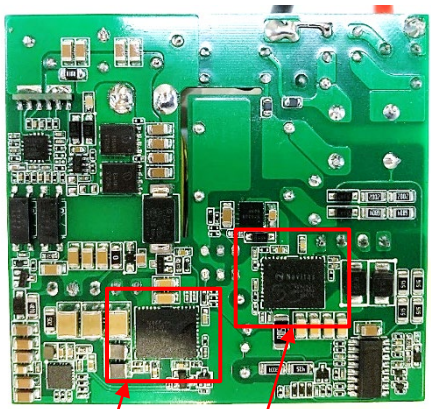
- × 33 components
- × 250mm2 footprint
- × 1x ext. HB driver HVIC
- × 1x ext. HV bootstrap
- × 2x HV bypass diodes
- × 2x gate drive circuits
- × Exposed gates

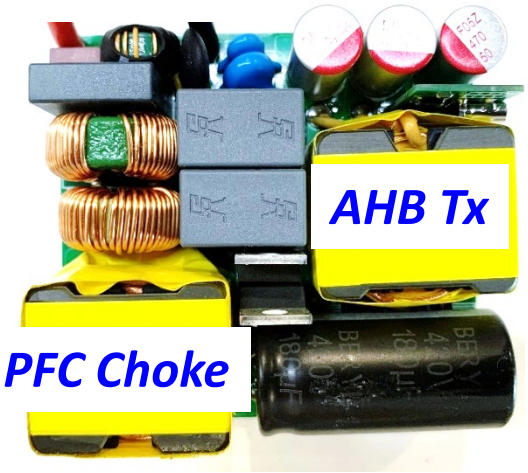


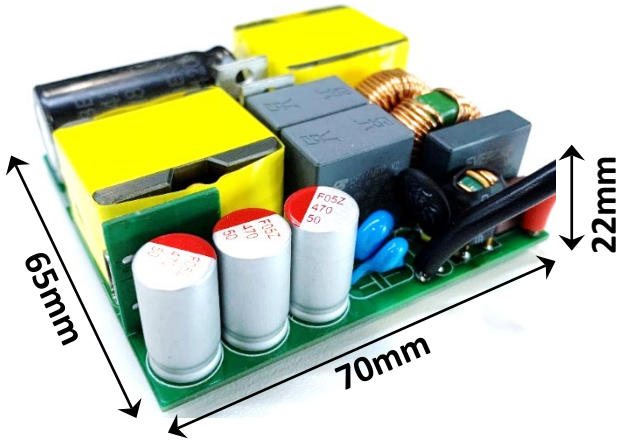


Severe Ringing & Glitching!

240W-1C TTP + AHB + GaNSense = 150 cc



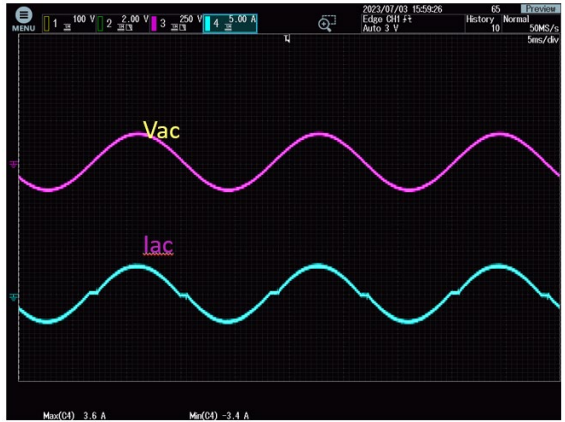


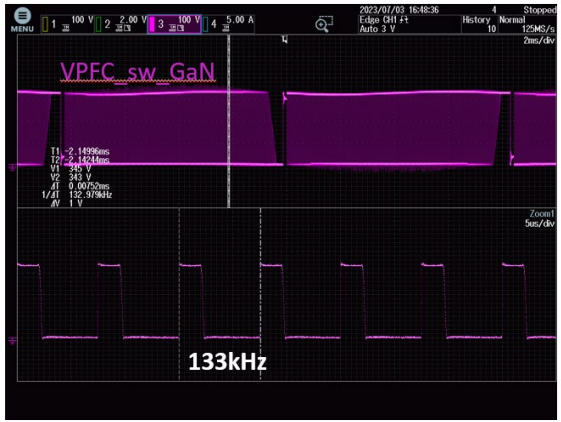


- Efficiency: 96 % (@90Vac/36V/6.7A)
- PCBA: 70 x 65 x 22 mm^3 = 100 cc
- Cased: 76 x 71 x 28 mm^3 = 150 cc
- +4% to +5.5% efficiency benefit vs existing designs!
- 29% to 52% smaller size vs existing designs!

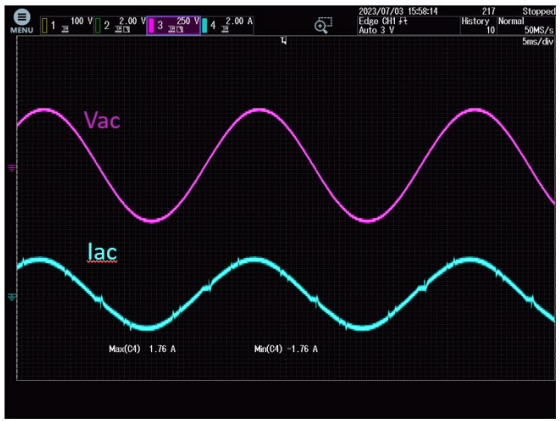
TTP Waveforms = Clean & Sinusoidal

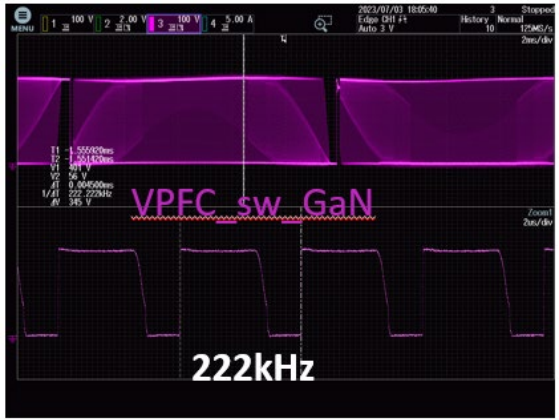
115Vac/60Hz @ 240W





230Vac/60Hz @ 240W



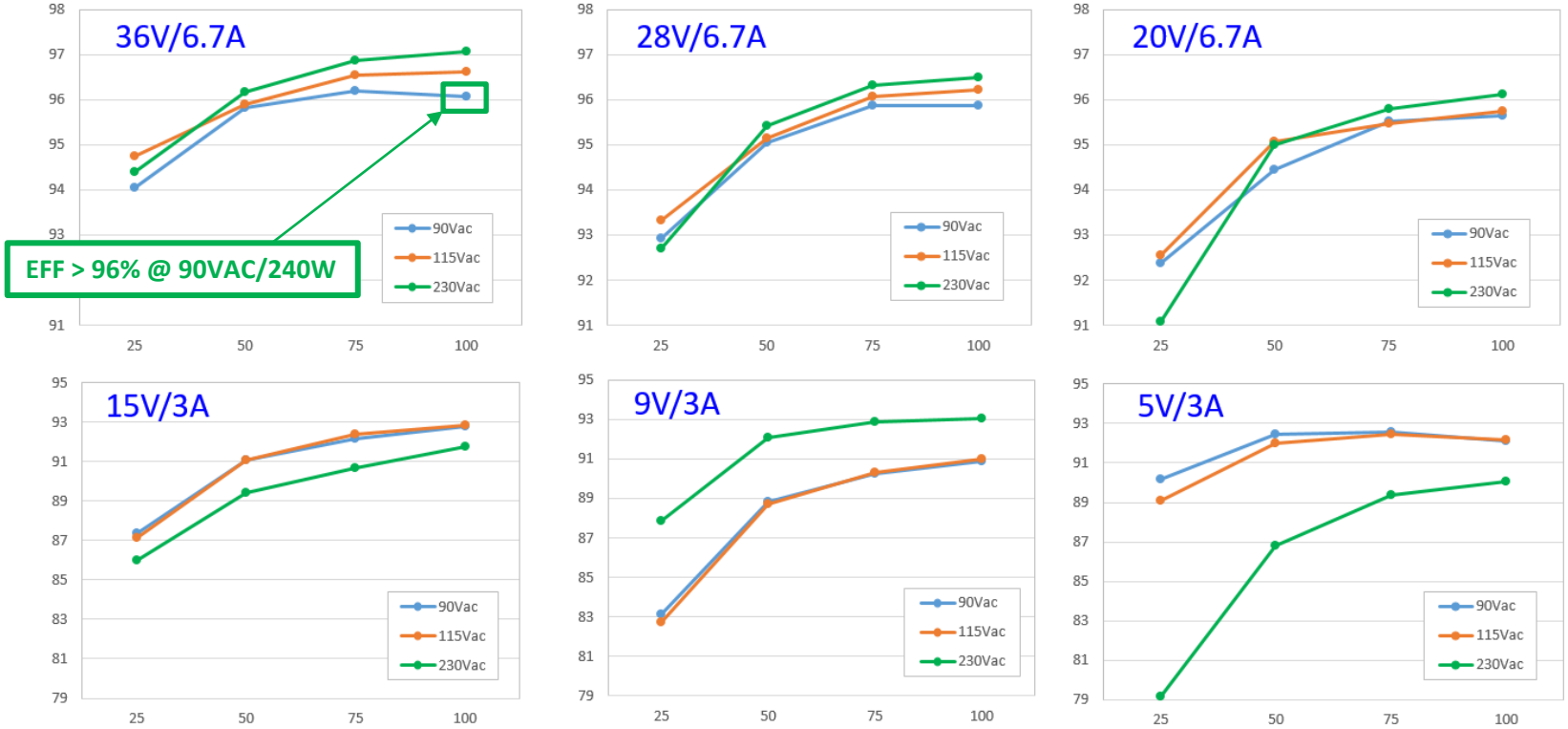


AHB ZVS Waveforms = Smooth & Clean

115Vac/36V/6.7A

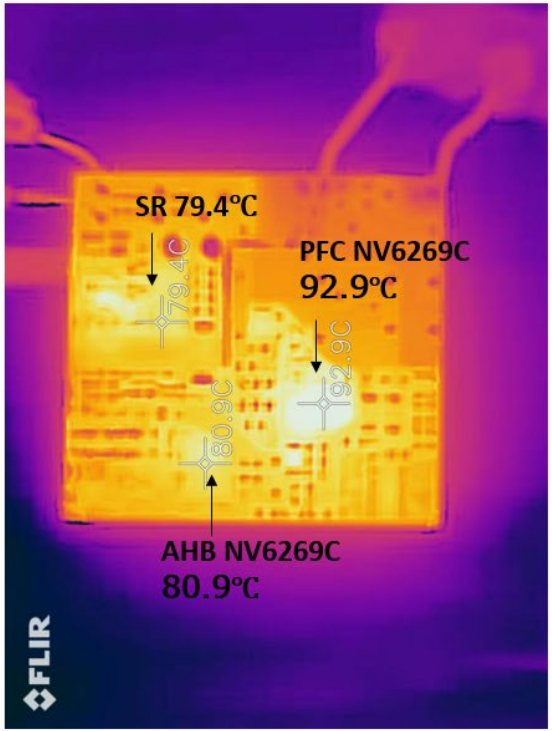
230Vac/36V/6.7A

Peak Efficiency > 97%

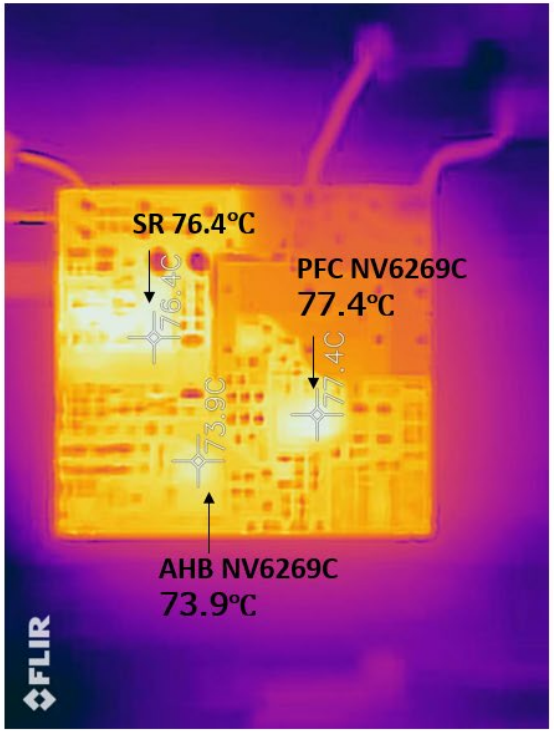


	115Vac	230Vac
Pin @Standby (5V/0A)	64mW	142mW

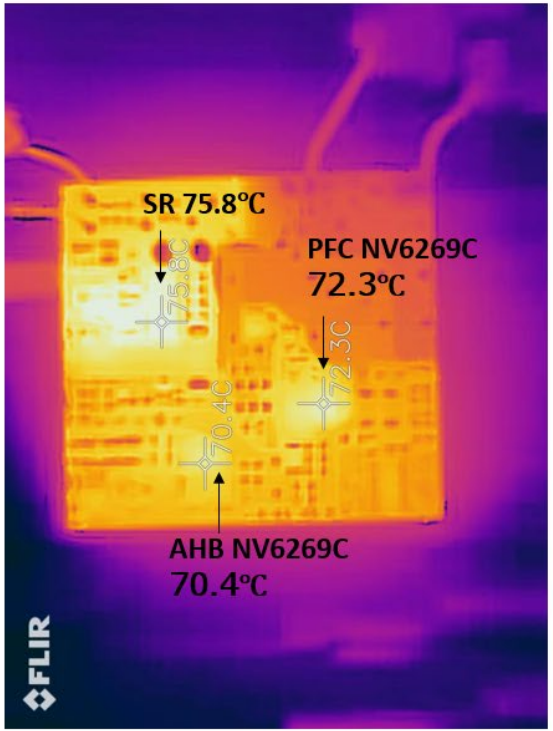
Lower Losses = Lower Thermals!



90Vac



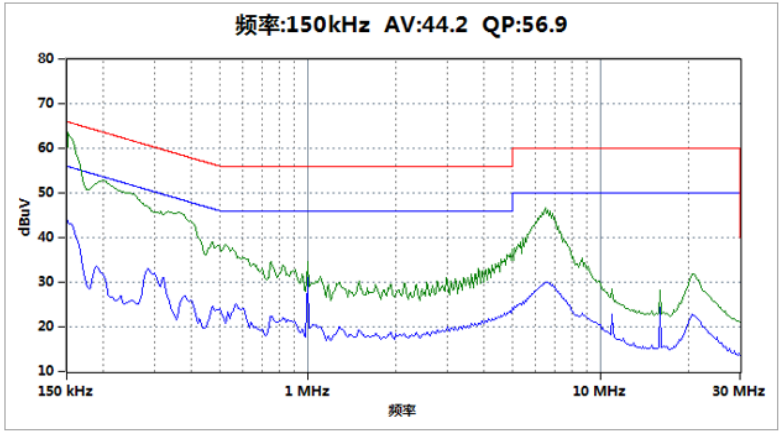
115Vac



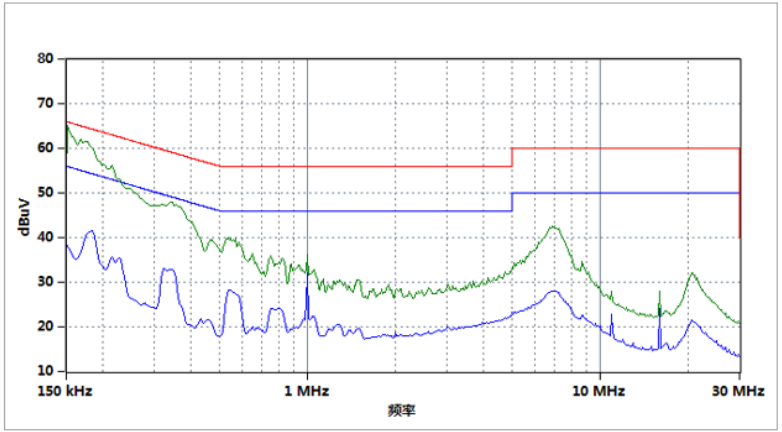
230Vac

ZVS = Low EMI!

115Vac



230Vac



Conclusions

- ✓ Existing 240W GaN chargers still have room for improvement (0.77 – 1.1 W/cc, 90.5% - 92% efficiency)
- ✓ Use Totem-Pole + AHB for highest efficiency, high frequency, ZVS, & smallest size
- ✓ NV6269C is an excellent GaN half-bridge building block IC, easy to use, small footprint, & reliable switching
- ✓ 240W-1C charger design using Totem-Pole + AHB + GaN Half-Bridge IC demonstrates 96% efficiency, 150cc size, & low EMI
- ✓ +4% to +5.5% higher efficiency vs existing designs!
- ✓ 29% to 52% smaller size vs existing designs!

EVBs & Design Files Available!