



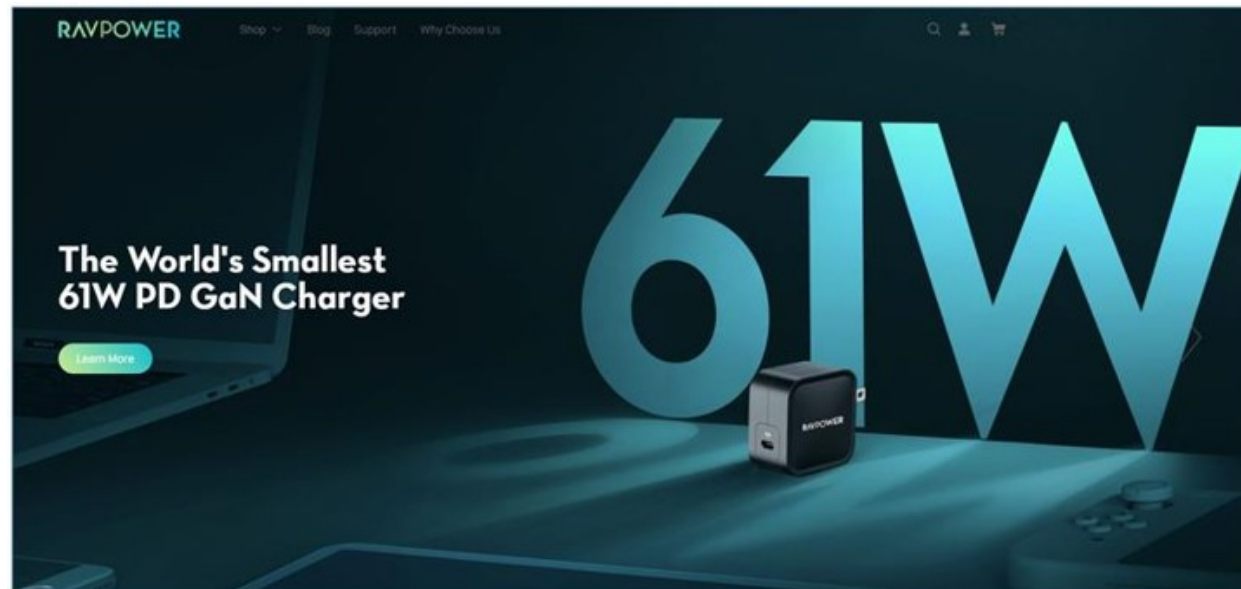
GaN – Powerful, Efficient, Reliable

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CPSSC-PSMA Workshop 2019

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Applications with Size AND Efficiency Needs

- Aftermarket USB PD adapters
- High-end cellphone chargers and other mobile devices
- Notebook adapters
- Products with size OR efficiency needs
 - *Appliances, TVs, server standby, AIO PCs, video games*

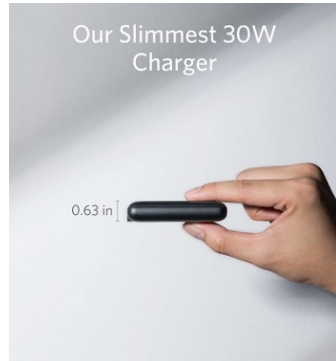


Adapter and Wall Socket Designs

Slick



Slim



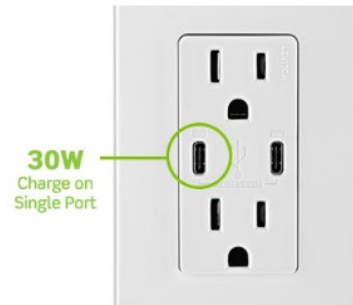
Multiport



Powerful



Compact

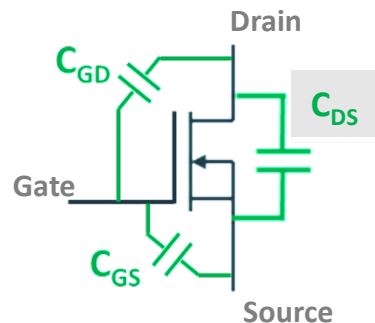


Making GaN Easy to Use

- GaN transistors are better than silicon
 - More efficient, cooler, smaller power supplies
 - Leading the way to “no-heatsink” designs at high power levels
- GaN transistor technology is the future for power conversion
- GaN devices can be used just like other power devices
 - Engineers see significant performance benefits
 - But won't otherwise notice a change

GaN Switches Significantly Reduce Losses

- MOSFET output capacitance is discharged through itself at turn-on
 - Parasitic capacitances are proportional to the size of the MOSFET
 - Bigger MOSFET = more switching loss
 - Also lower $R_{DS(ON)}$ means less conduction loss



$$C_{OSS} = C_{DS} + C_{GD}$$

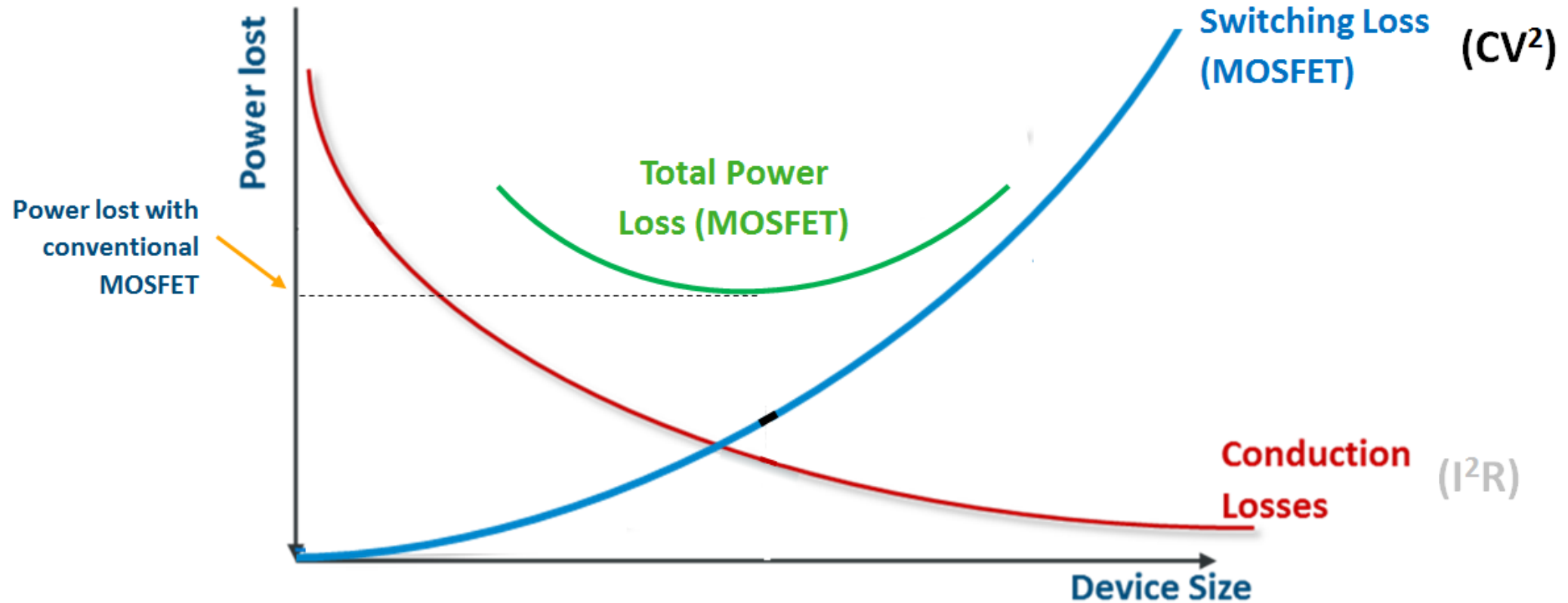
$$P_{(Loss)} = \frac{f \cdot C_{OSS} \cdot V^2}{2}$$

f = Switching frequency

V = Peak of VAC ~ 400 V

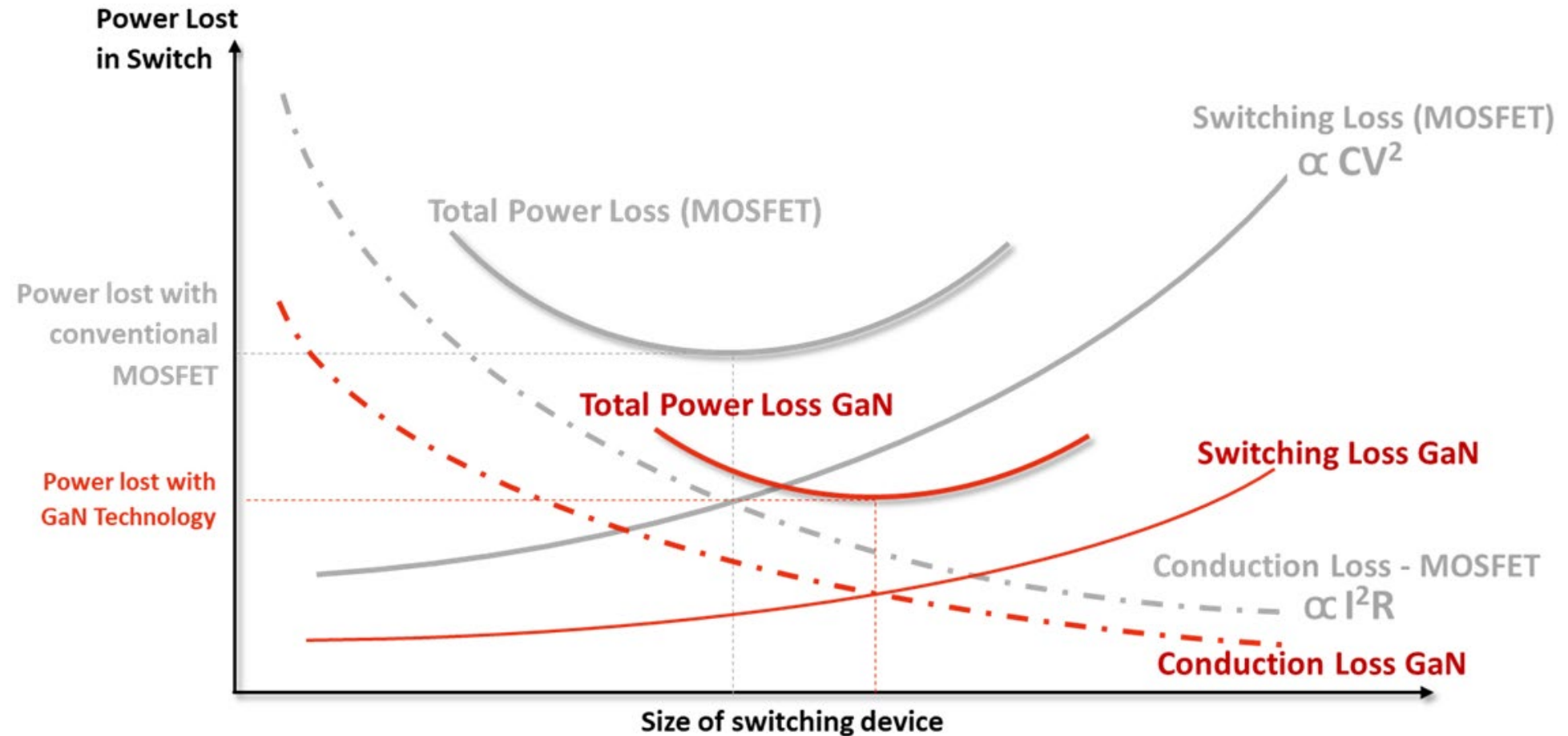
Switching Losses Increase with FET Size

Conduction Losses Decrease with FET Size



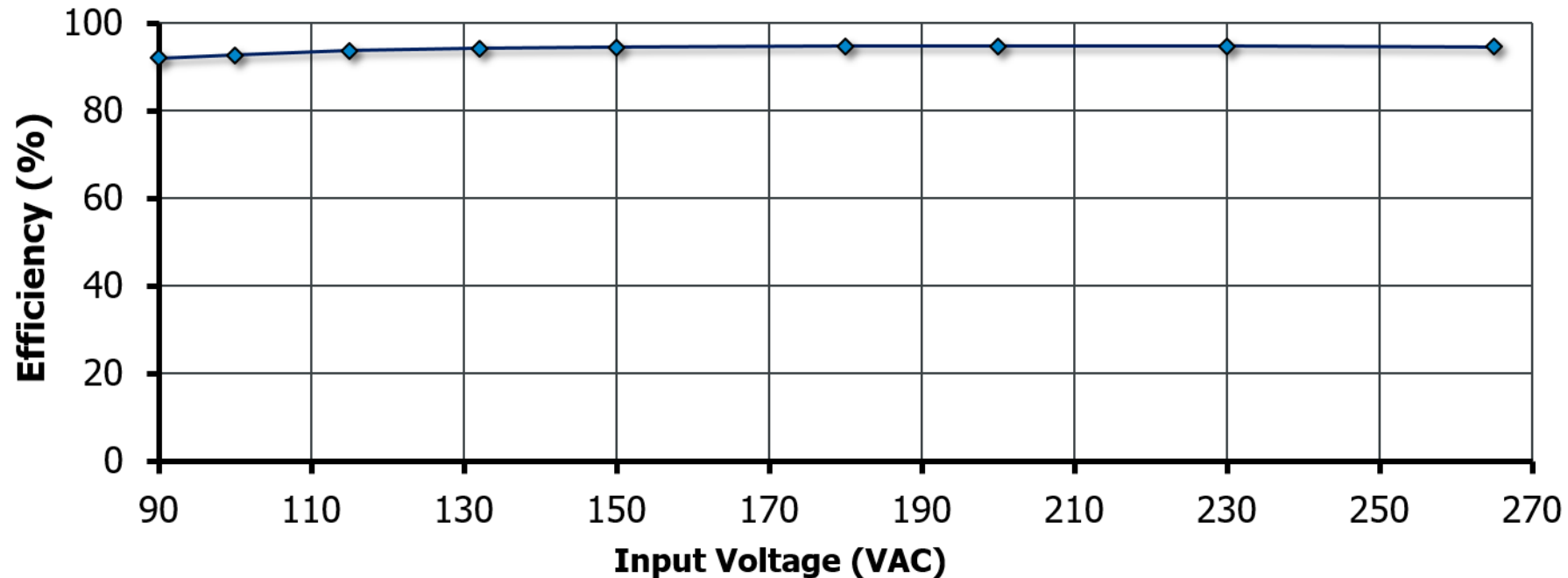
Conduction losses and switching losses work in opposite directions

GaN Switches Change the Curve



GaN-Based Design Achieves 95% Efficiency

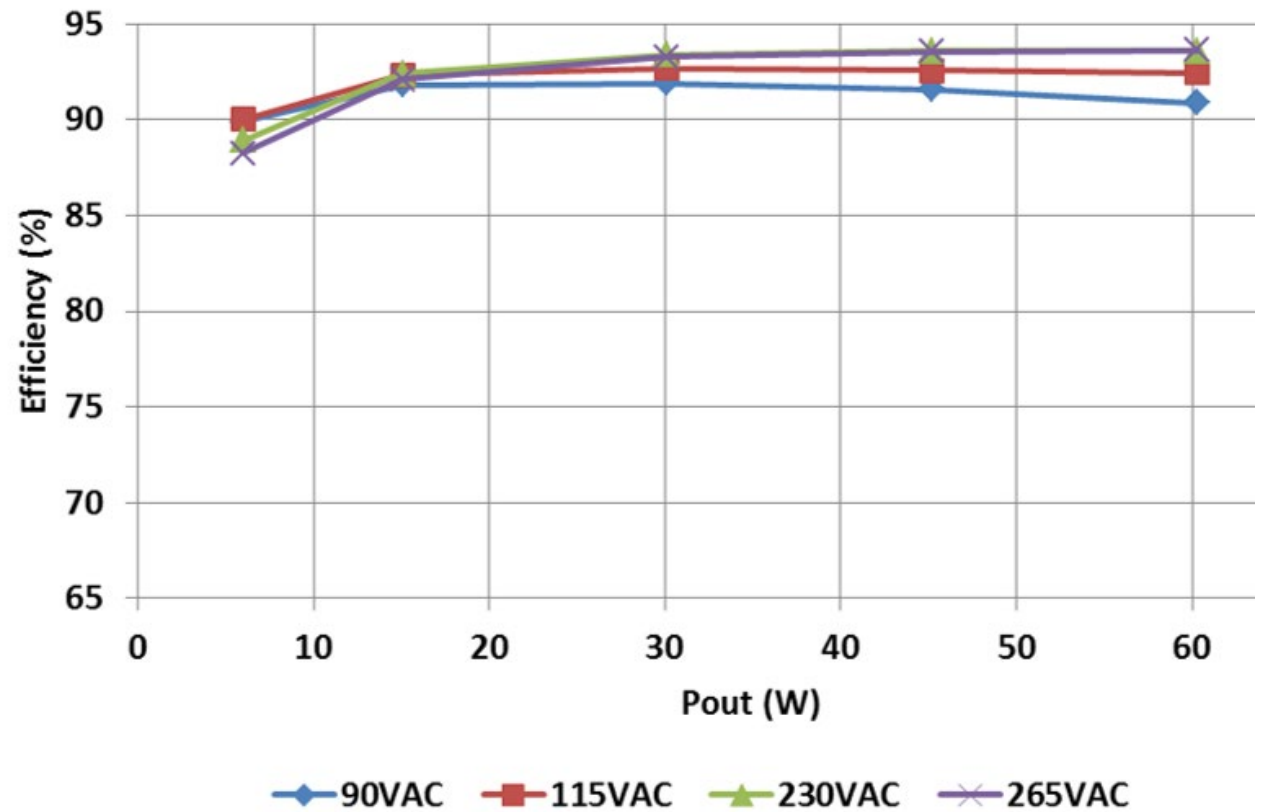
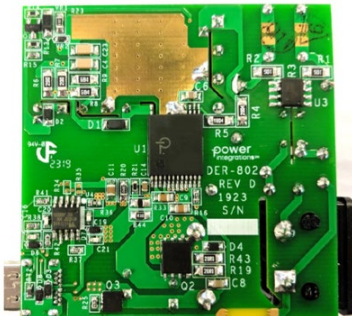
Eliminates Heatsinks from Adapters



- 65 W, 20 V Adapter: Full-load efficiency is 95% at 230 VAC and 94% at 115 VAC

GaN High Efficiency Also Improves Performance Across Load for 60 W USB PD

- High efficiency across load
 - Ideal for high-power USB PD applications
- Average efficiency is 92.5% at 115 VAC and 93.2% at 230 VAC



Be Confident About Reliability

- Fully qualified to JEDEC standard
 - Same standard as all other products
- Easily passed additional accelerated operating life tests
 - DOPL JESD22-A108 1,000 hr. $T_J = 125\text{ }^\circ\text{C}$
 - HALT JESD22-A104 1,000 hr. $T_J = 125\text{ }^\circ\text{C}$, at $85\text{ }^\circ\text{C} / 85\% \text{ R.H.}$
- 750 V non-repetitive rating
 - Ideal for wide-range, single-ended, hard-switching flyback converters

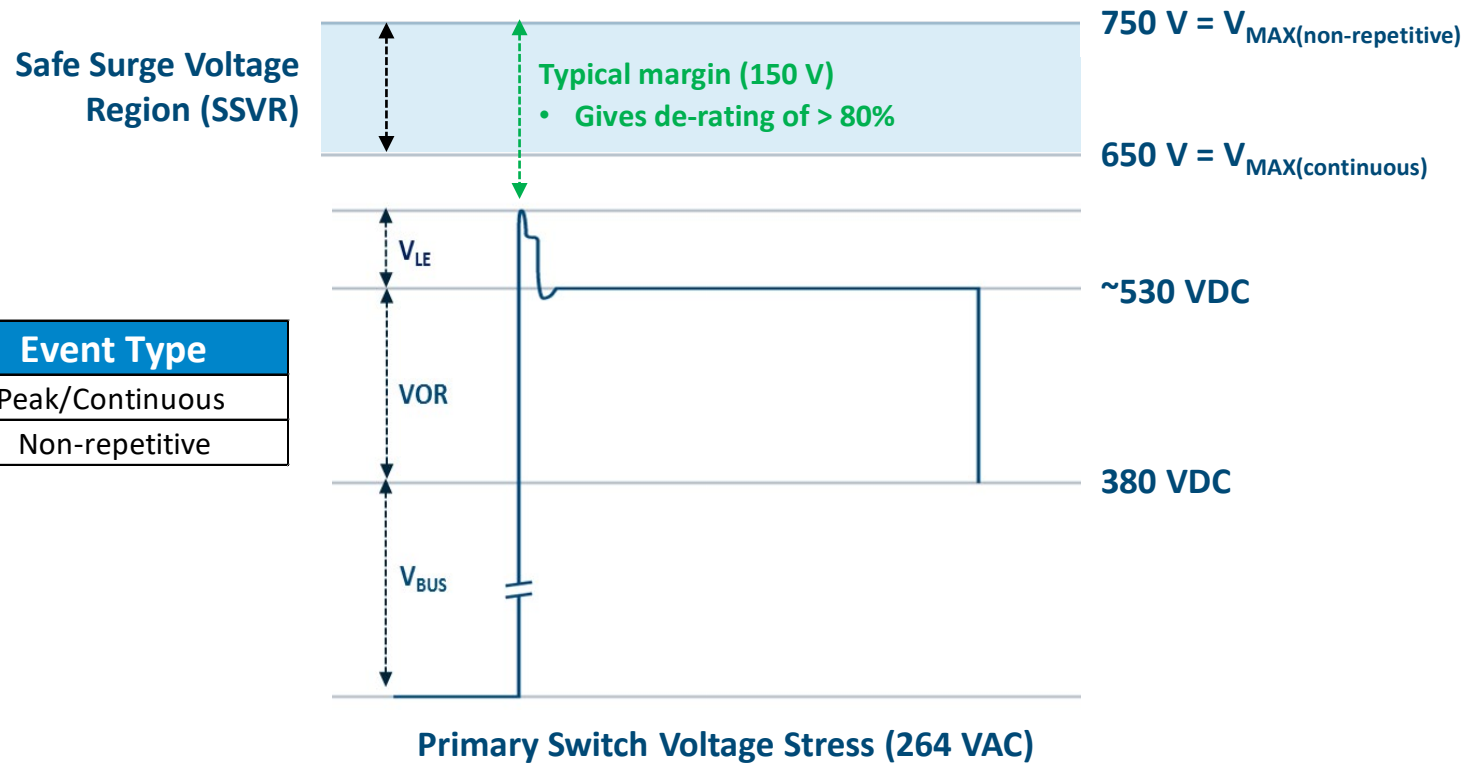
GaN Qualification Mirrors Silicon Product Qualification Protocol



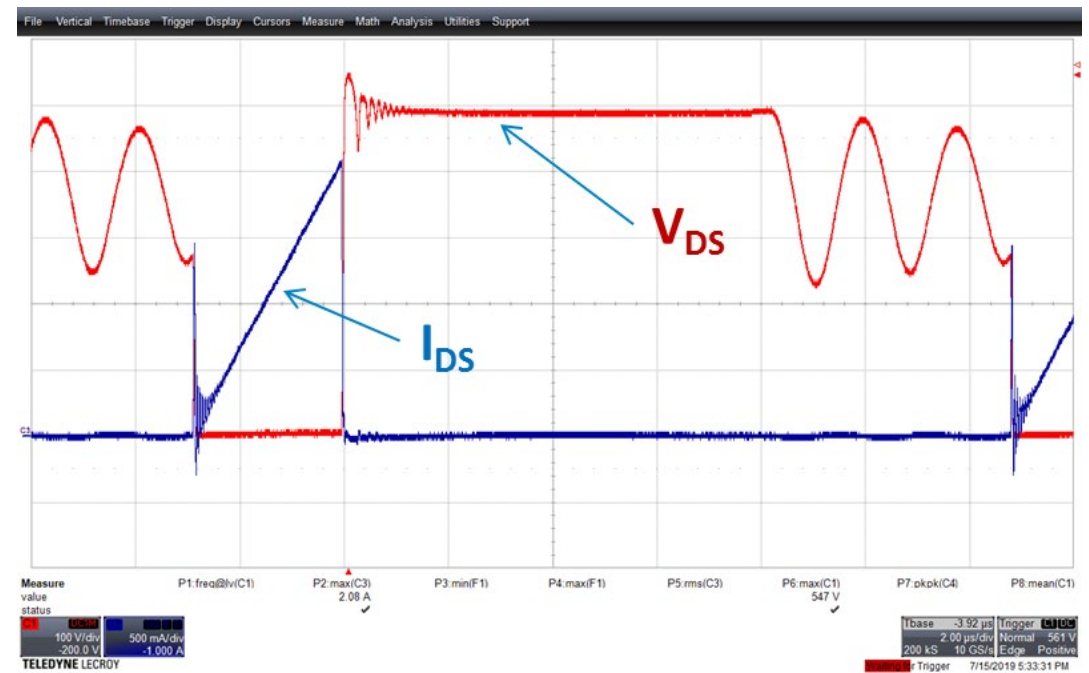
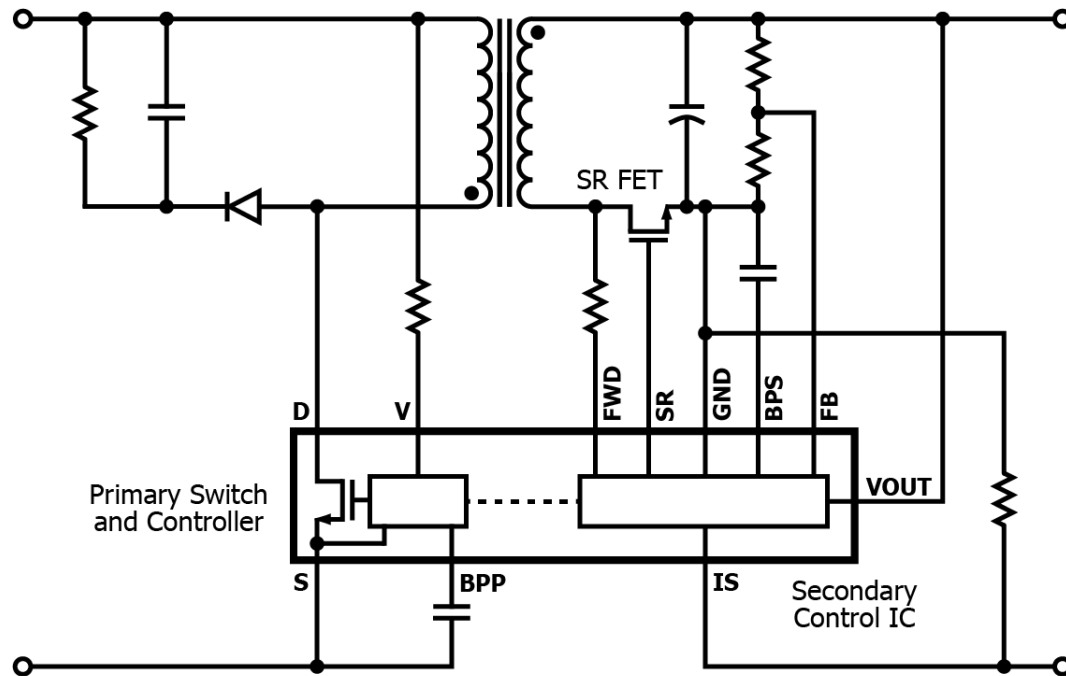
	Test Description	Symbol	Test Method	Silicon-based product	GaN-based product
Fab Process	Preconditioning & Moisture Sensitivity Level	PC	JESD22-A113	MSL3	MSL3
			JEDEC J-STD-020	MSL3	MSL3
	Temperature Humidity Bias	THB	JESD22-A101	Multiple units, multiple lots	Multiple units, multiple lots
	Temperature Cycling	TC	JESD22-A104	Multiple units, multiple lots	Multiple units, multiple lots
	High Temp. Storage Life	HTSL	JESD22-A103	Multiple units, multiple lots	Multiple units, multiple lots
	Dynamic Operating Life	DOPL	JESD22-A108	Multiple units, multiple lots	Multiple units, multiple lots
Fab and Package	Highly Accelerated Life Test	HALT	JESD22-A104	Multiple units, multiple lots	Multiple units, multiple lots
	High Temp. Reverse Bias	HTRB	JESD22-A108	Multiple units, multiple lots	Multiple units, multiple lots
Packaging Process	Preconditioning	PC	JESD22-A113	Multiple units, multiple lots	Multiple units, multiple lots
	Moisture Sensitivity Level	PC	JEDEC J-STD-020	Multiple units, multiple lots	Multiple units, multiple lots
	Temperature Humidity Bias	THB	JESD22-A101	Multiple units, multiple lots	Multiple units, multiple lots
	Temperature Cycling	TC	JESD22-A104	Multiple units, multiple lots	Multiple units, multiple lots
	High Temp. Storage Life	HTSL	JESD22-A103	Multiple units, multiple lots	Multiple units, multiple lots

GaN is Extremely Robust

Event Voltage	Event Type
0 - 650 V	Peak/Continuous
651 - 750 V	Non-repetitive

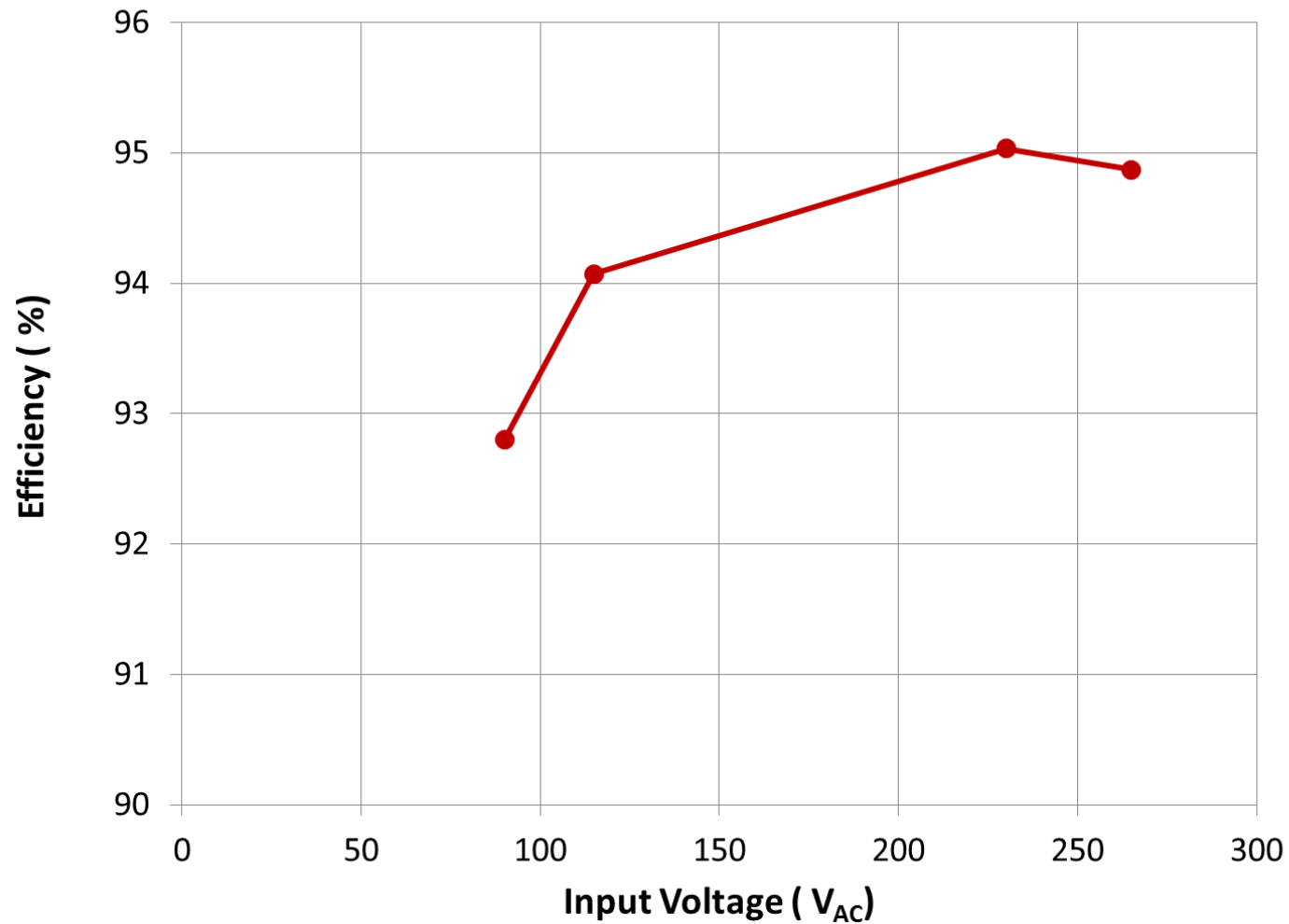


Flyback Switching Waveforms



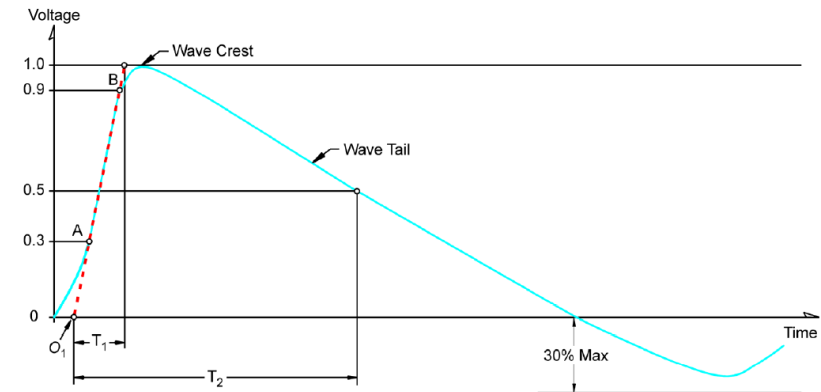
- Voltage and Current waveforms on GaN FET for typical operation at 265 VAC input

Efficiency over Line Voltage

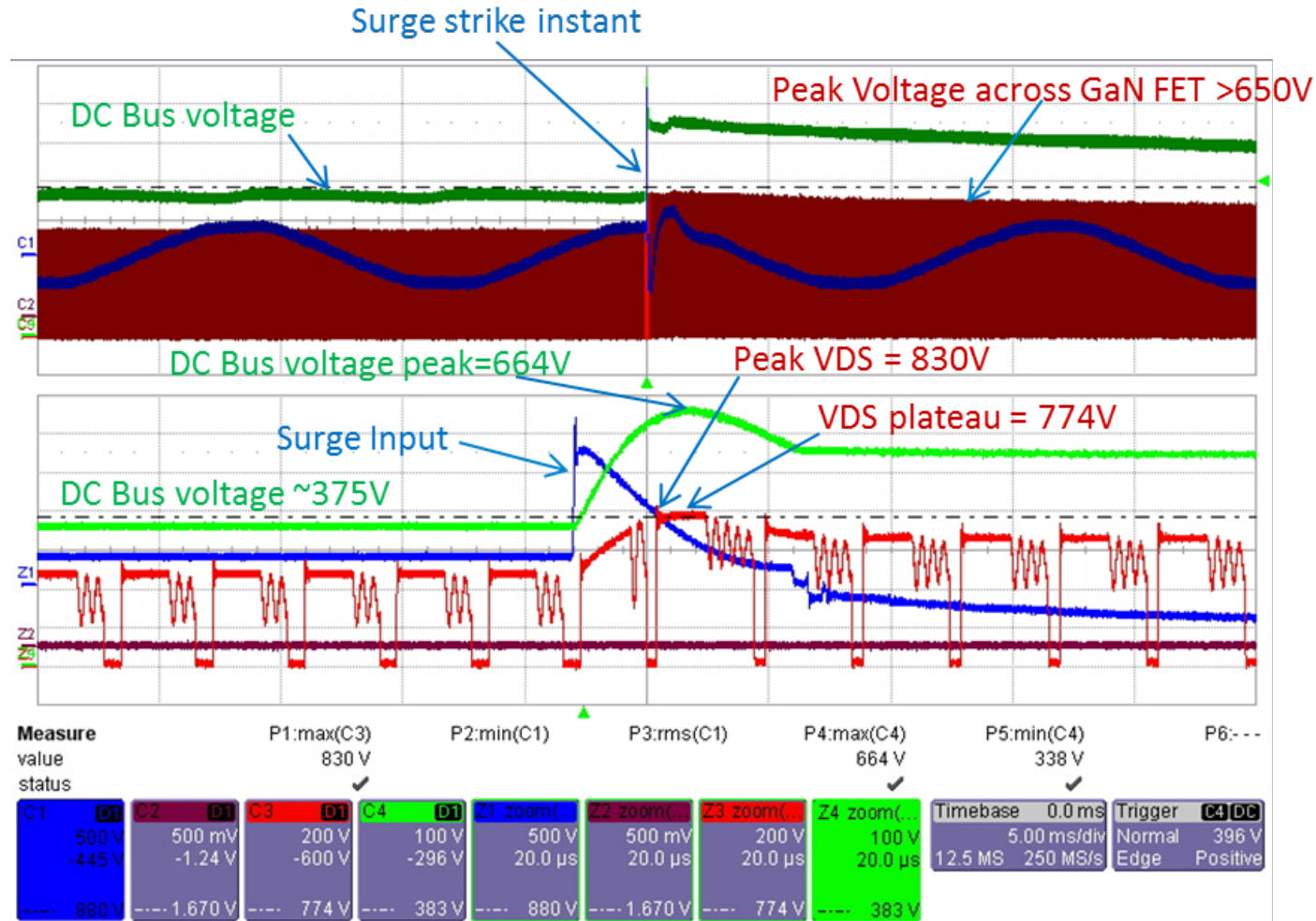


Surge Performance Evaluation

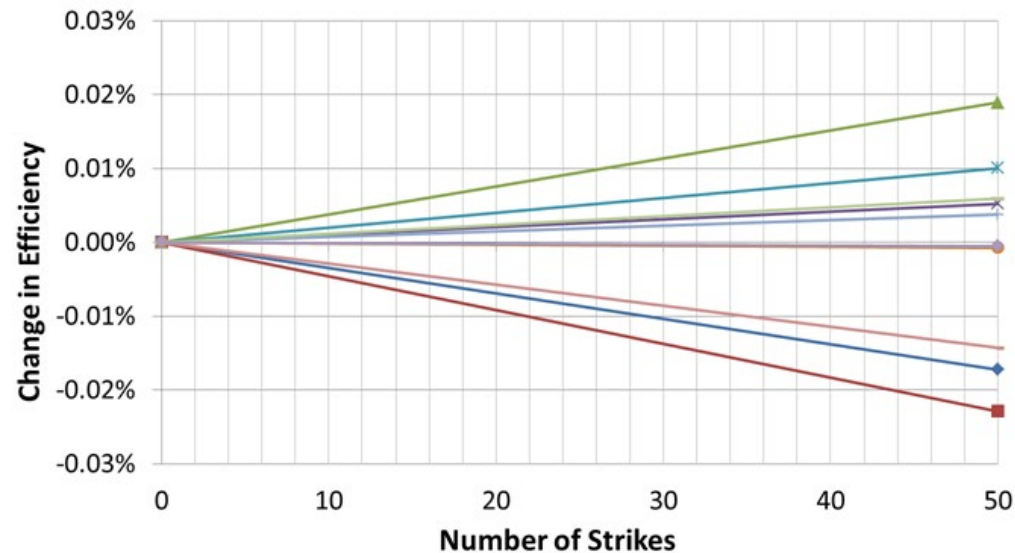
- Methodology for surge testing based on IEC 61000-4-5 standard
- Combination Wave Generator (CWG) used in evaluation
 - 1.2/50us voltage surge waveform
 - 50 strikes per VDE 0884-11 standard
- Converter conditions
 - Operating when surge strikes applied
 - Input bus voltage of 375V (265VAC)
 - Steady-state peak drain voltage of 550V on GaN FET



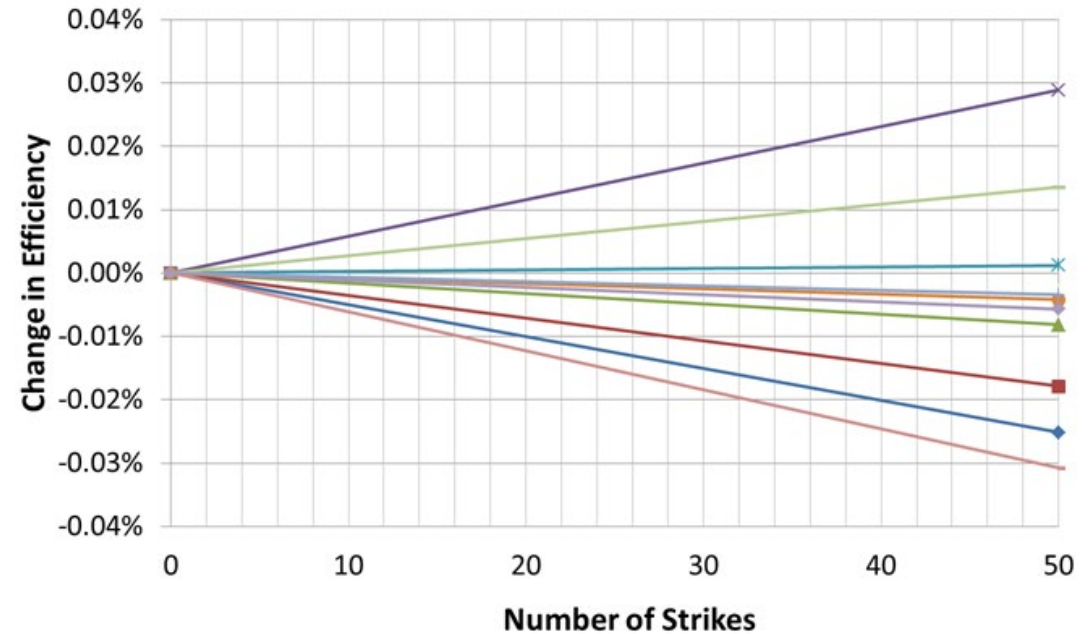
Waveforms During Surge Event



No Degradation of Converter Efficiency



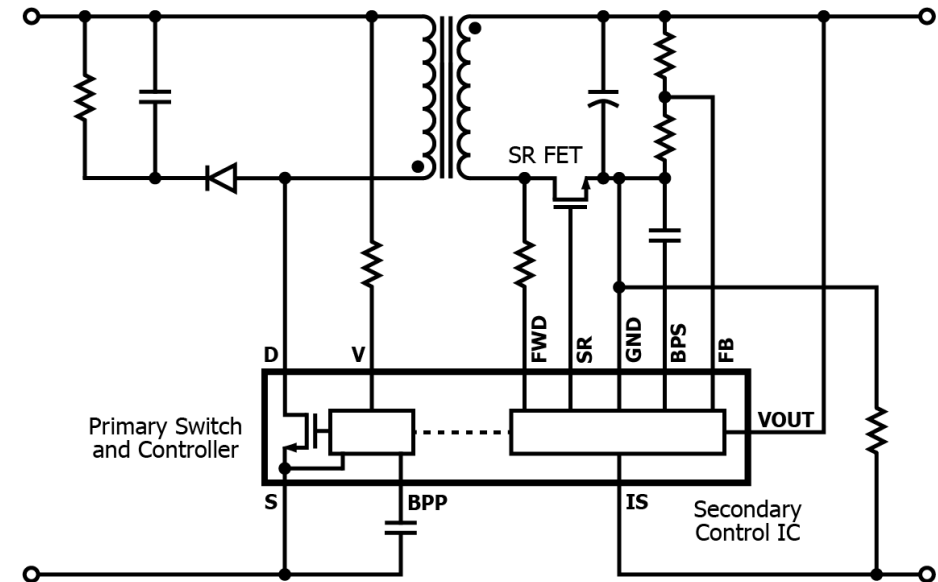
Negligible Change in Efficiency on 10 Production Units after Surge Test (at 265V_{AC})



Negligible Change in Efficiency on 10 Production Units after Surge Test (at 90V_{AC})

GaN – Powerful, Efficient, Reliable

- GaN devices deliver more power
 - Reduced on-resistance
 - Lower switching loss
- Circuit operation indistinguishable from one using silicon devices
- GaN reliable, qualified, and shipping in mass production



QR Flyback Power Supply with a GaN FET

Thank you!
