Electric motors benefit from GaNFast™

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Energy • Efficiency • Sustainability

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Older motors are being replaced with BLDC motors and inverters*

- BLDC* motors are more efficient (80%+) versus older AC motors (60%), smaller and lighter
- However, BLDC motors need an inverter to operate → additional system complexity
- The inverter allows for torque and speed control

➔ **Efficiency gain and added features are the key reasons for the trend to BLDC**

* BLDC = brushless (or electronically commutated) DC motor

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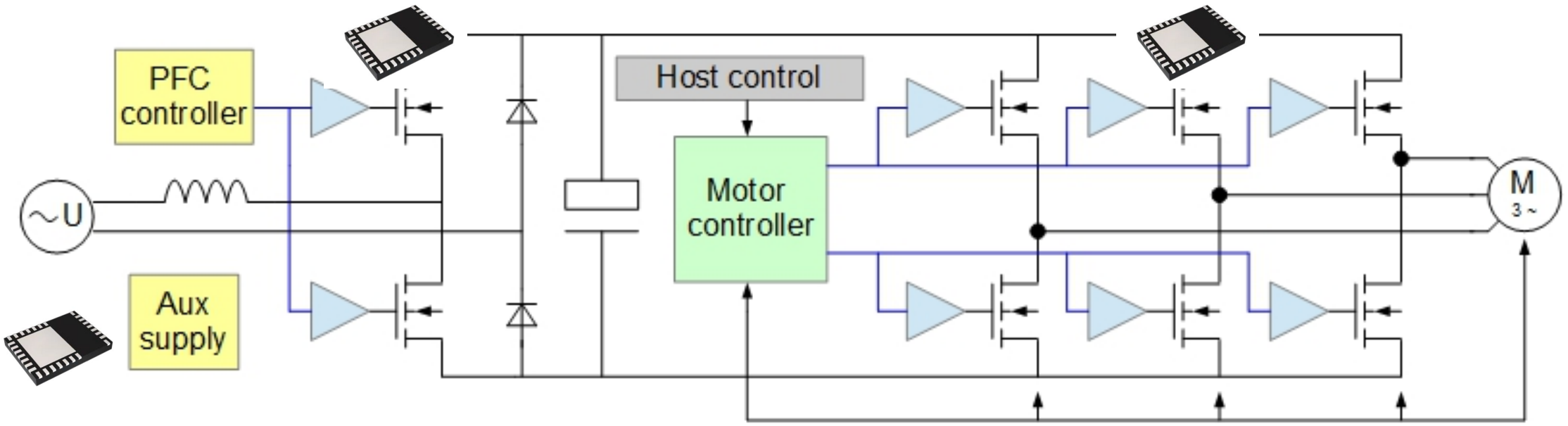
GaN switches for Motor Inverters
Full system solution



- Motor inverter: GaNFast™ halfbridges for compact and highly efficient power stage, with significantly reduced cooling efforts
- PFC in totem-pole or boost converter configuration with highest efficiency and smallest passive components
- Ultracompact, efficient aux supply (QR/ACF) with copackaged controller

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Total cost of ownership (TCO) for motor inverters

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Cost category	Raw materials	Component cost			Assembly	Design effort	Transpor-tation	Usage	Recycling
		Power	Control	Passives					
Typical drivers	Copper, Aluminum	Power switches, rectifiers	Microcontrollers, digital signal processors	EMI filters, heatsinks, inductors	Manual assembly, thermals	R&D bandwidth for control loop, gate drive	Size and weight	Electrical efficiency	Complex material mix
GaNFast™ advantage	Reduced materials consumption through lower losses	Reduced component cost through higher integration (less external components)	Easier control circuit through GaNSense™ Higher control loop bandwidth possible	Lower losses enable reduced heatsink, lower emissions for smaller EMI filter	Reduced assembly cost with smaller / no heatsink	Ease of use through high integration levels of GaNFast™	Smaller heatsink, motors for reduced weight and size	Lower losses for lower electricity consumption	Smaller / no heatsink for reduced waste

- Biggest cost impact through reduced heatsink size and electricity consumption
- Additionally, better performance and protections

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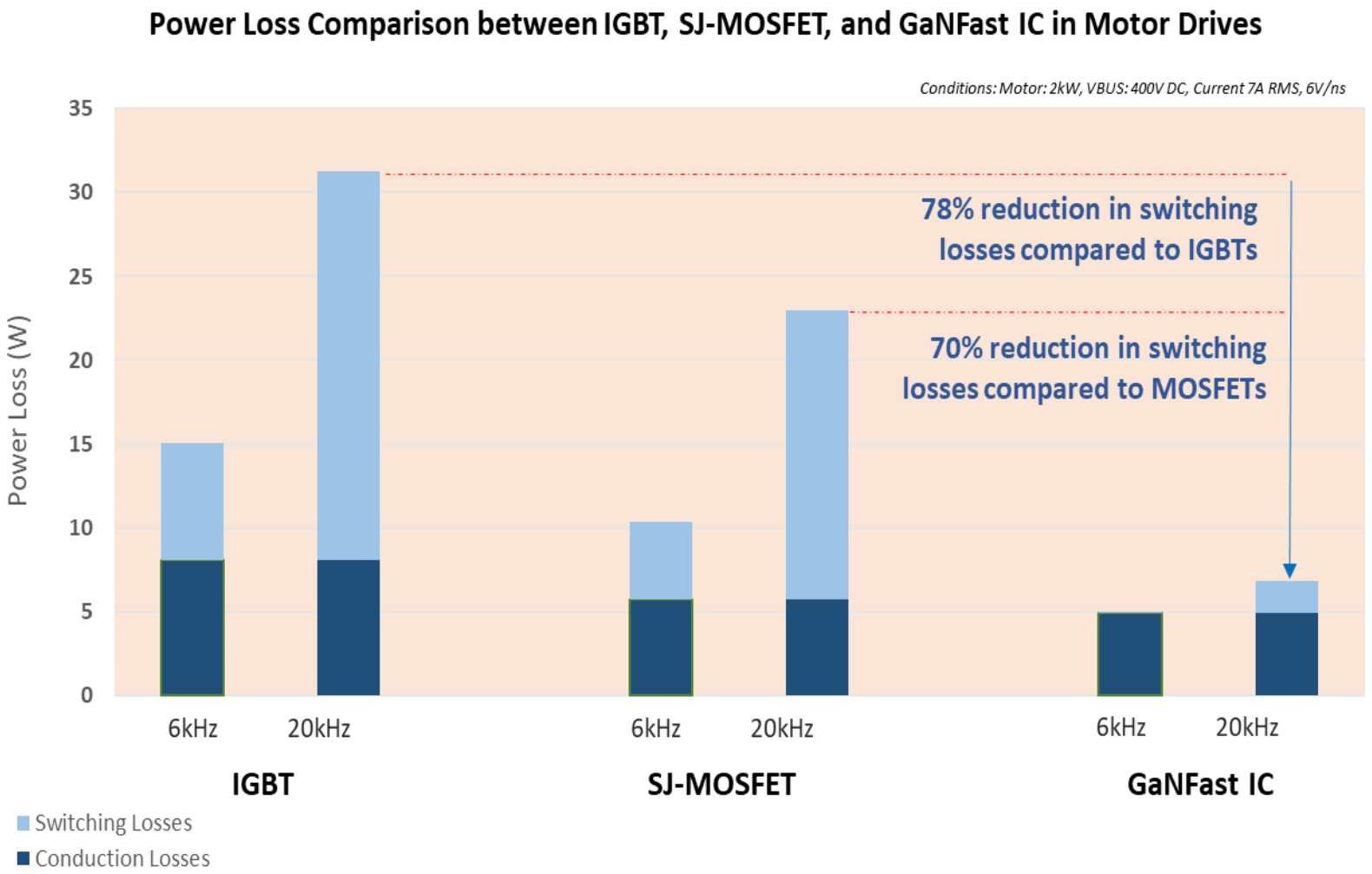
Total loss comparison of Silicon IGBT, silicon MOSFET and GaN FET



Application case:

- Bus voltage 400V
- Current 7A RMS
- Motor power 2kW
- Switching 6V/ns
- GaN and MOSFET same conduction losses

Using GaN FETs, the inverter efficiency increases by 2.5% (96%→98,5%) and total losses are halved (15W→6,8W)

→Significant reduction in cost, weight and size of thermal mgmt (like heatsink, fans, other thermal components)

→ Benefit even larger at higher switching frequency

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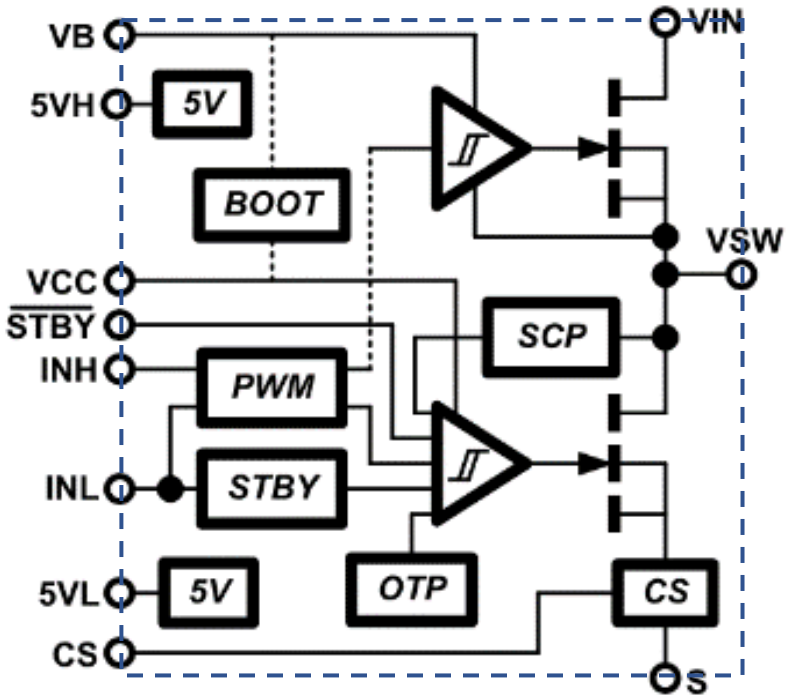
Key benefits of GaNFast™ and GaNSense™
Enabling motor-integrated inverters



- **High, stable and repeatable performance** → design margins can be reduced
  - Very low prop delay for best control loop performance
- Controlled gate drive conditions enable **outstanding reliability**
- **Much reduced component count** → system size and cost reduced, enabling motor-integrated inverters
- Easy to use → **fast time to market**
- Lossless current sensing **removes shunt resistors** → cost, size, reliability and performance improvement
- Fast and precise overcurrent protection → improved **system robustness**
- On-chip temperature sensing for better thermal design margin
- Precise overtemperature turn-off→ improved **system robustness**

GaNFast™ and GaNSense™ offer highest performance, integration, robustness

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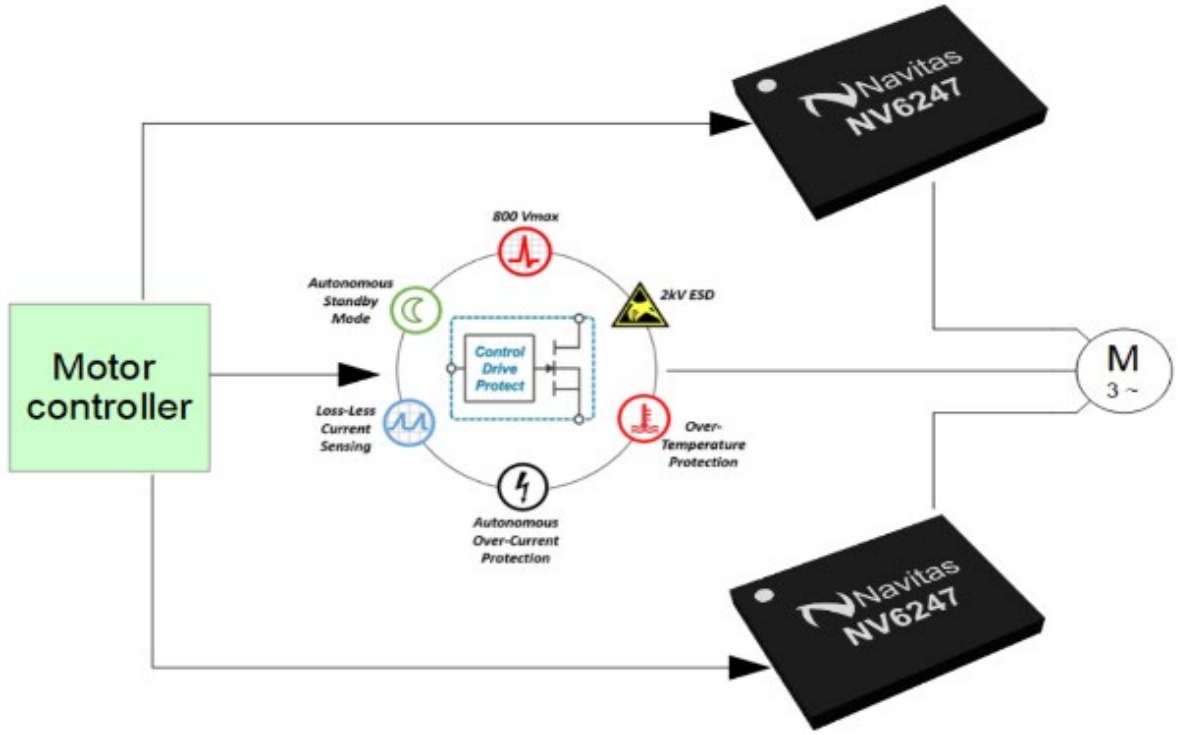
Motor inverter using three halfbridges
Enable thermal spreading on the PCB



Part #	Type	$V_{DS(CONT)}$ (V)	$R_{DS(ON)}$ (mΩ, typ)	Package	Status	Motor power*
NV6247	Half-Bridge	650	160/160	PQFN 6x8	Production	300
NV6245C	Half-Bridge		275/275	PQFN 6x8	Production	200

(* Motor power estimated and depending on application conditions, in particular thermal design)

- Scalable solution for motor power 40…300W without heatsink*
- Very few external components for compact design
- Good thermal spreading through separation of the power stages

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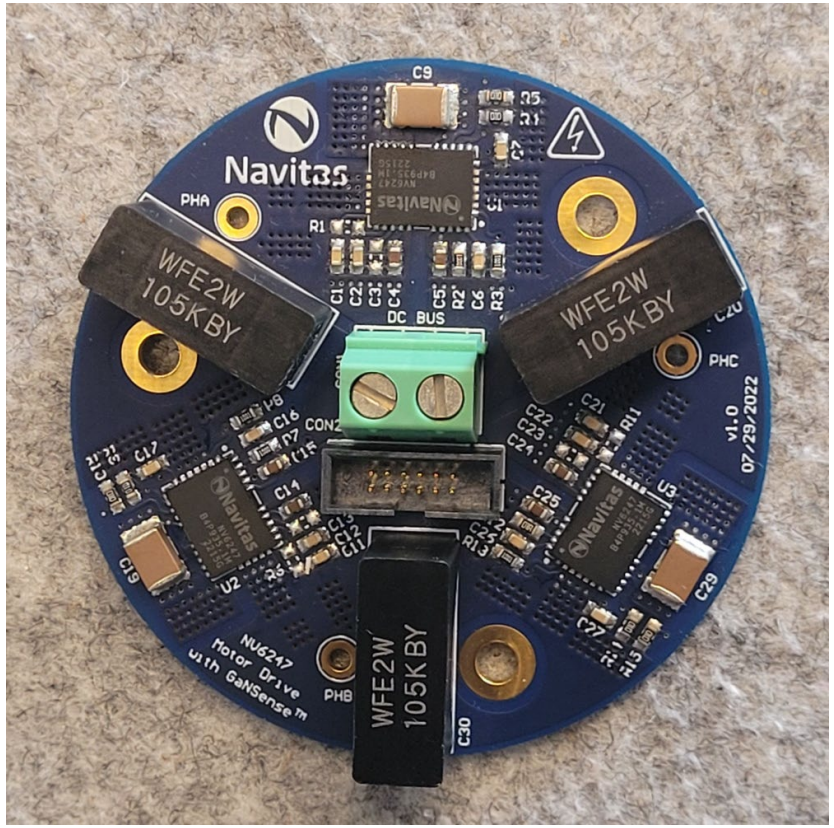
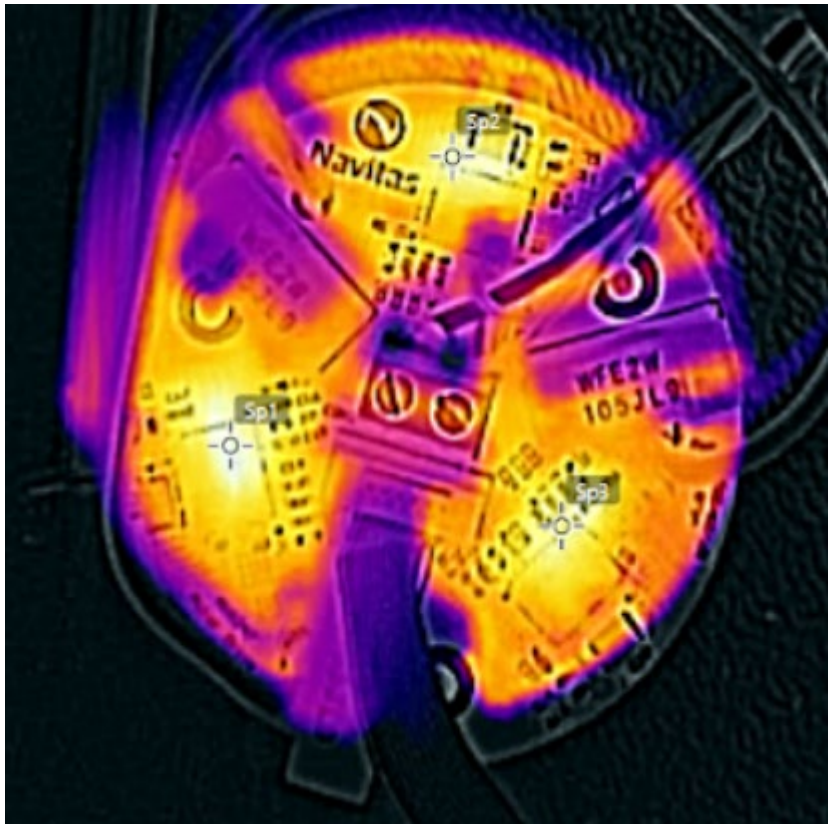
Reference design
300W motor integrated inverter / power stage

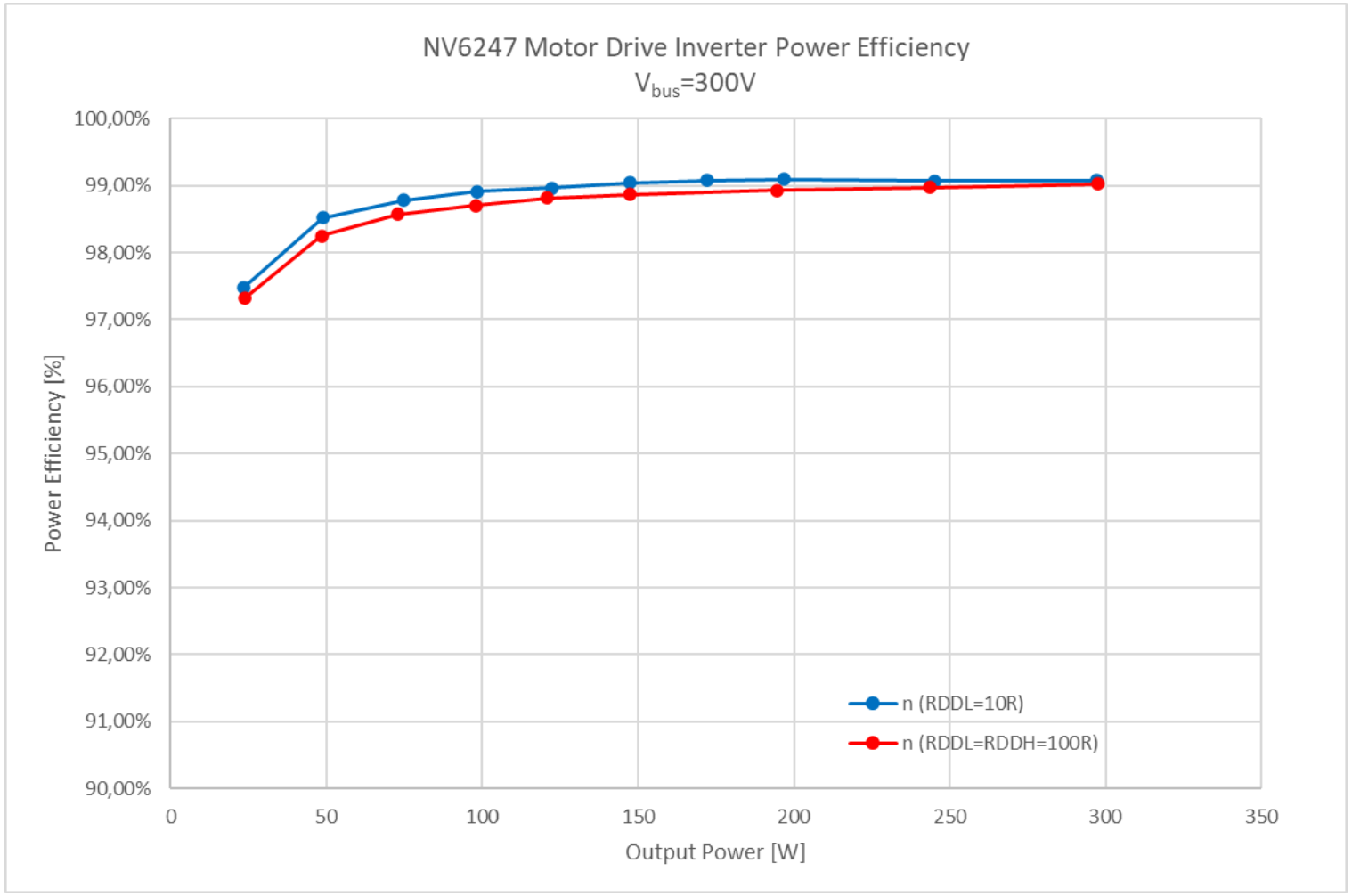


Board diameter 56mm



Thermal scan @ 300W, 20kHz
Peak temperatures are ~52°C

Reference design
300W motor integrated inverter



Inverter efficiency for different switching speeds (20V/ns, 50V/ns)

Using GaNFast™ and GaNSense™ for Motor Inverters

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- Trends in electric motor drive applications:
  - Improved energy efficiency
  - System cost and TCO reduction
  - Size and weight reduction
  - Improved performance
  - New / different motors
- Challenge to reduce design time / effort and improve end customer experience

GaNFast™ and GaNSense™ offer convincing solutions for motor drive trends and challenges – the next level of performance and integration

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Thank you!


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