



*GaN power IC Innovations For High-Frequency,
High-Power Industrial Motor Drive*

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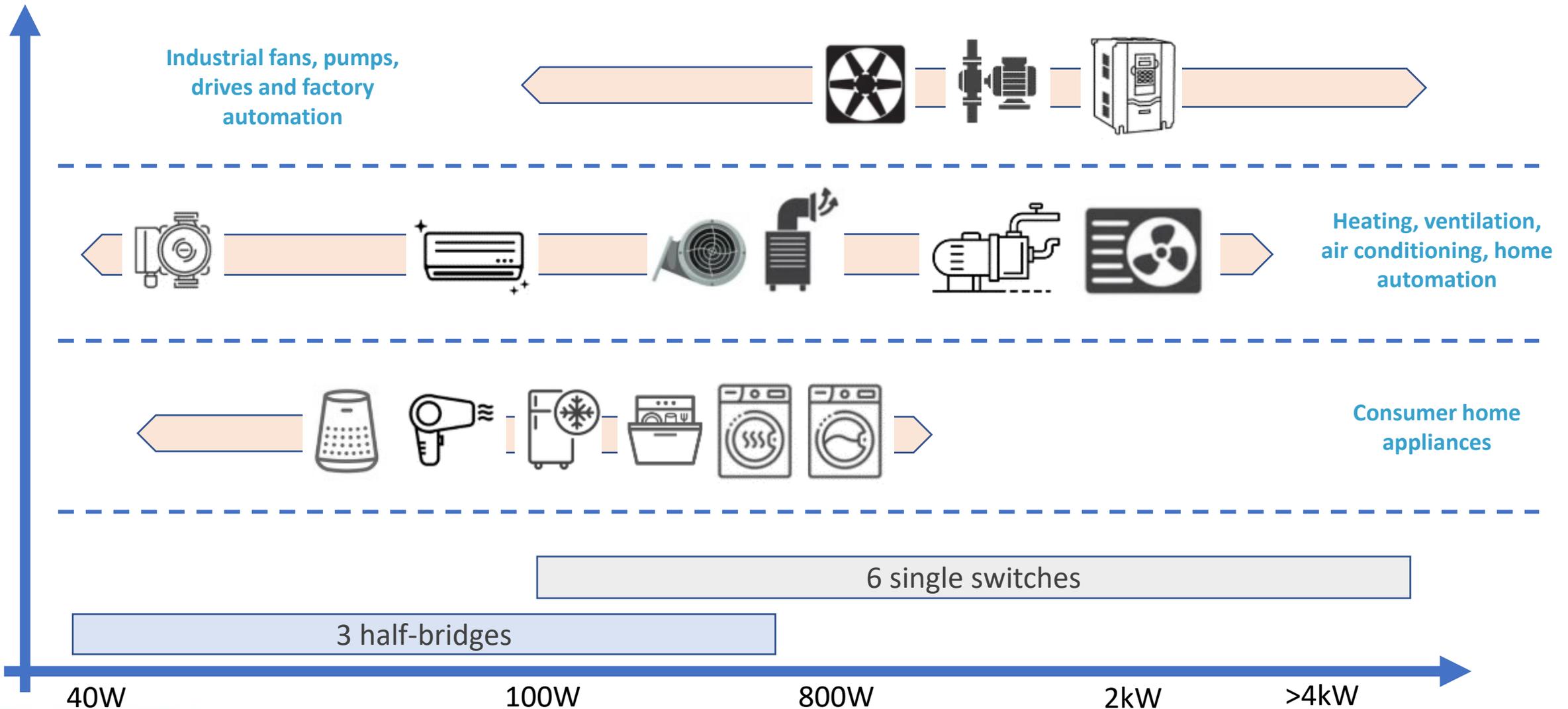
**Bodo's
Wide Bandgap
Event 2023**

December 13
Gallium Nitride / GaN

- Electric motor applications, key requirements / benefits
- 300W, 1kW examples
- Integrated GaN power ICs enable Performance and Reliability
- GaNSense™ and GaNSafe™ explained
- Conclusion

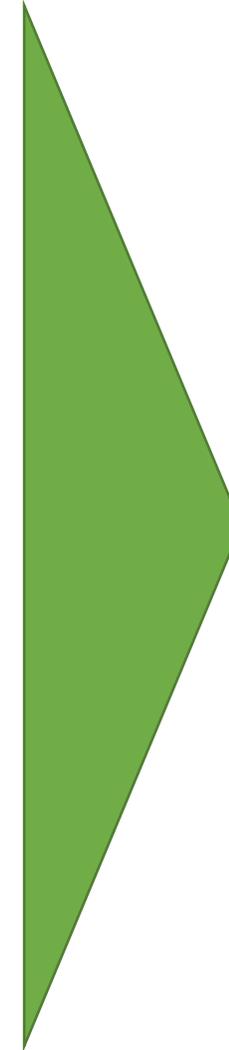


Wide Range of Scalable GaNFast Solutions for Motor Drive Navitas



Feature
Very low switching losses
Very high switching frequency possible (50 kHz+)
Precise switch timing with low latency and dead time
High voltage ratings (650V DC / 800V transient)
Integrated gate driver and voltage regulator
Integrated lossless current sensing and temperature sensor
High level of integration – less components on PCB

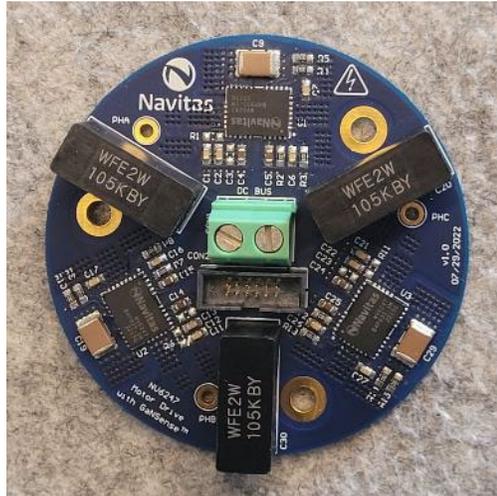
Impact
Reduce losses by >20% over SiC, >50% over Si
Sinusoidal modulation Lower motor inductance
Improved control loop performance, low EMI
High robustness against transient overvoltage peaks
Excellent reliability through precise gate drive conditions
Excellent robustness through very fast and precise action
Very compact size and higher reliability



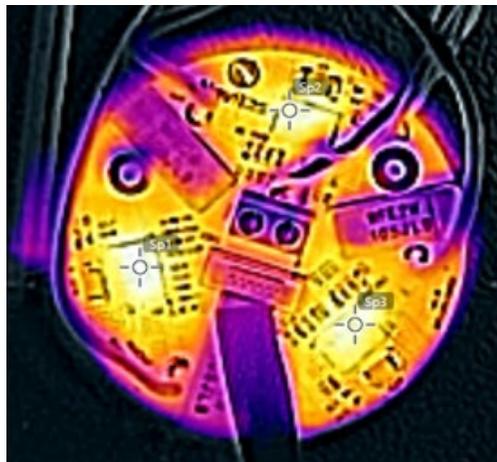
Benefit
Small or no heatsink, easier thermal design, higher reliability
2% better efficiency, less harmonics; smaller, up to 30% lower cost motor, 20% smaller EMI filter
Smaller EMI filter, better dynamic performance under load steps
10x lower field failure rate
Improved lifetime and low field failure rate
Robust, protected application and low failure rate; 1% better efficiency
10% smaller system size and cost, and very easy to use

GaNFast: “No Heatsink” High-Speed Motor Drives

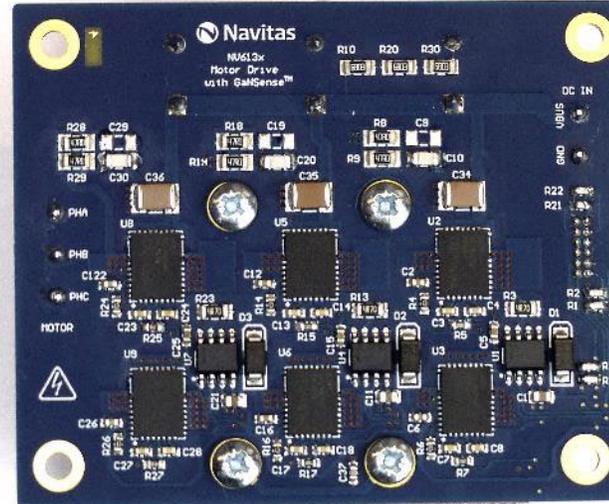
No heatsink, $\Delta T=49K$
Board diameter 56mm



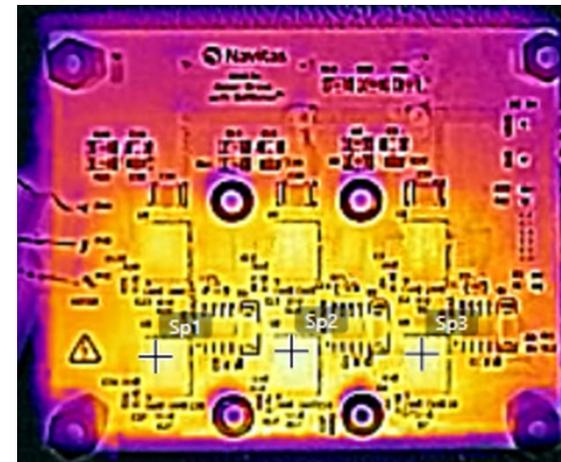
150 W



No heatsink, $\Delta T=46K$
Board size 74mm x 62mm



500 W



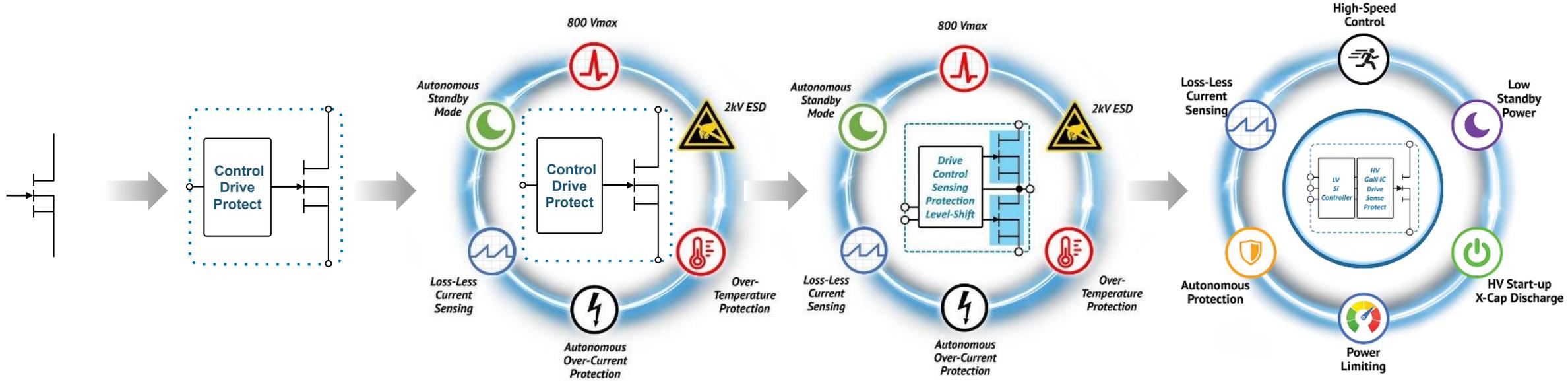
Discrete GaN

GaNFast™

GaNSense™

GaNSense Half-Bridge

GaNSense Control



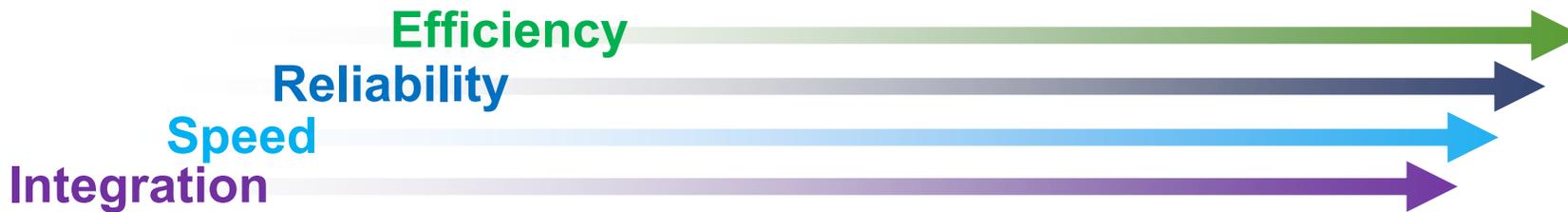
- Vulnerable
- Difficult to use
- Unknown reliability

- ✓ Robust
- ✓ Easy to use
- ✓ Proven reliability

- GaNFast plus:*
- ✓ Autonomous protection
 - ✓ Loss-less current sensing

- GaNSense plus:*
- ✓ Integrated HS, LS, level-shift isolation
 - ✓ Complete protection

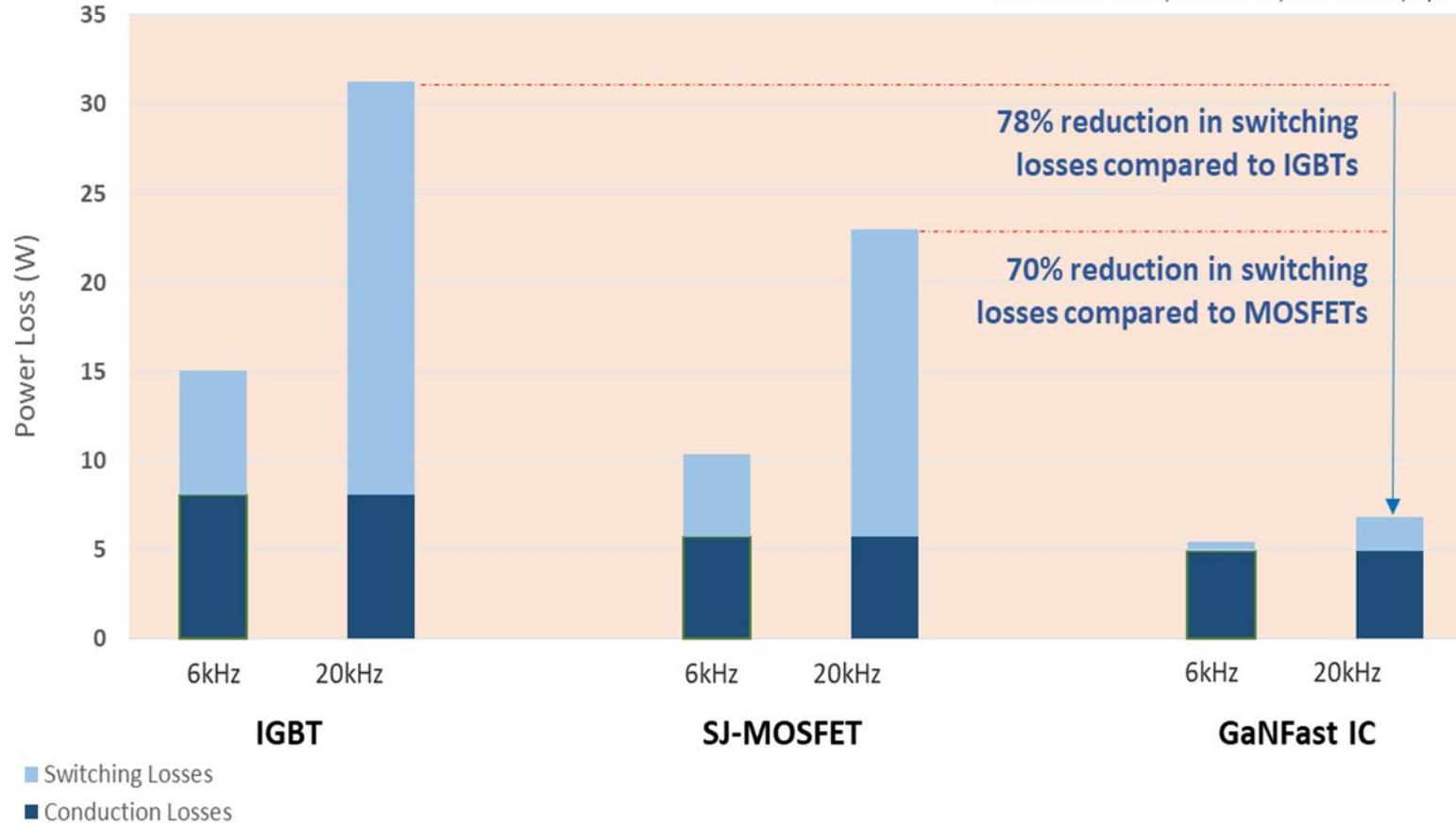
- GaNSense plus:*
- ✓ LV silicon system controller
 - ✓ Fewest components



Highest performance and integration – robust and reliable

Power Loss Comparison between IGBT, SJ-MOSFET, and GaNFast IC in Motor Drives

Conditions: Motor: 2kW, VBUS: 400V DC, Current 7A RMS, 6V/ns



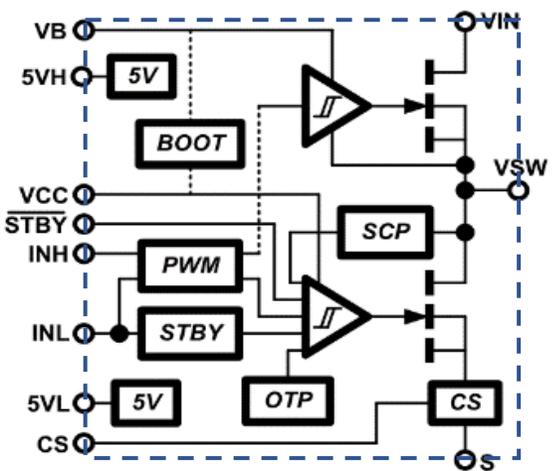
Application case:

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

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

- ➔ Significant reduction in cost, weight and size of thermal mgmt (like heatsink, fans, other thermal components)
- ➔ Benefit even larger at higher switching frequency

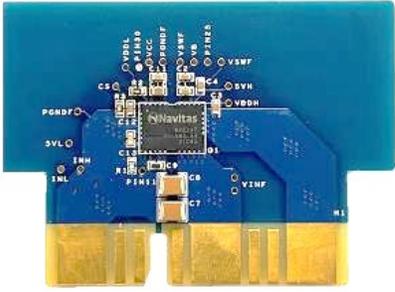
GaNSense™ Half-bridge



- **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**
- Adjustable switching speed to **control EMI**
- **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**



Discrete half-bridge

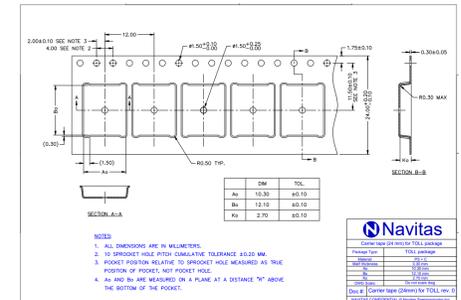


GaNFast half-bridge with GaNSense technology

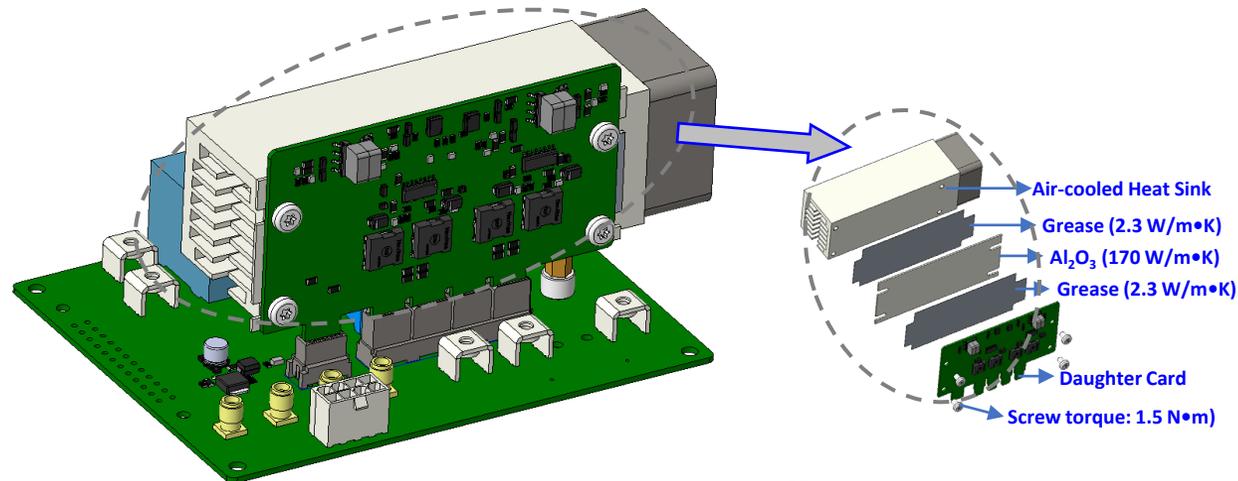
GaNFast™ and GaNSense™ offer highest performance, integration, robustness

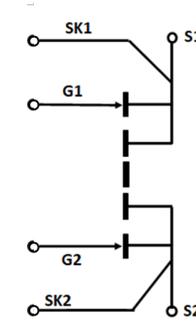
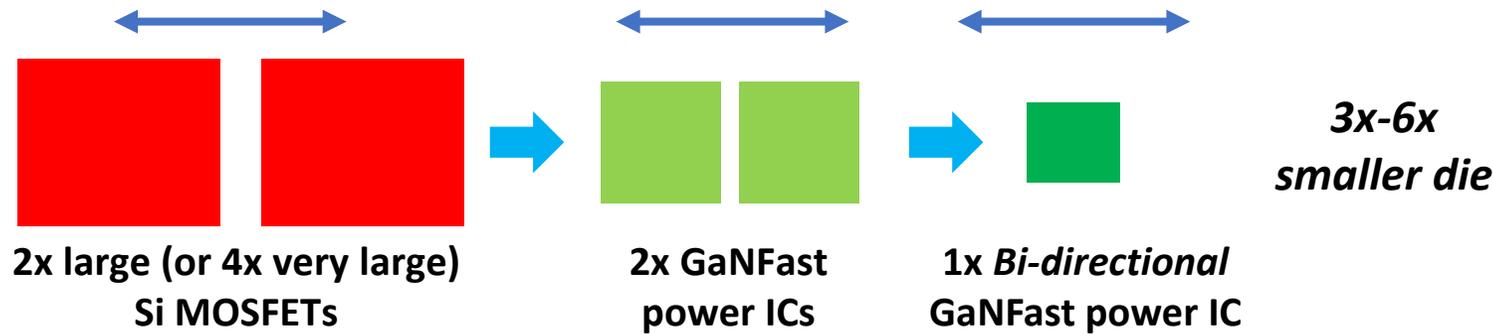
GaNSafe™ : Next level of power density

Part#	V _{DS} (Cont, Max) (V)	V _{DS} (Dyn, Max) (V)	R _{DS(ON)} (Max 25°C) (mΩ)	I _D (Max) (A)	Package	Evaluation Kit
NV6515	650	800	35	57	TOLL 10x10 Bottom-cool	Power Board, Full Bridge Daughter Card, and FanSink/TIM ~ configurable for DPT or Half-Bridge testing
NV6513			45	48		
NV6512			55	34		
NV6511			98	22		

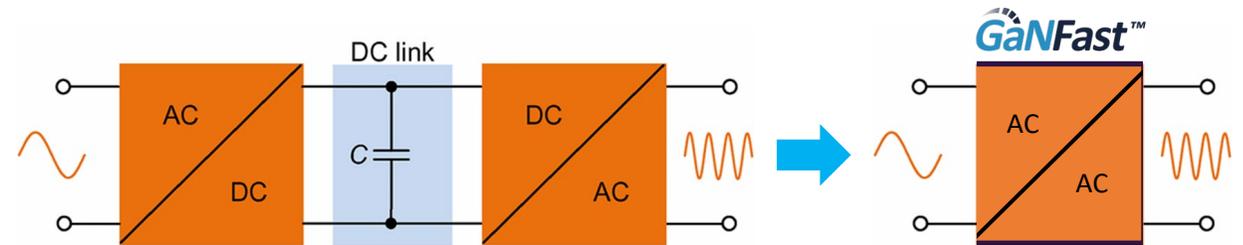


TnR Ordering	
Mini-Reel (7" dia)	Qty500 Pcs "-MR" suffix
Standard (13" dia)	Qty2,000 Pcs





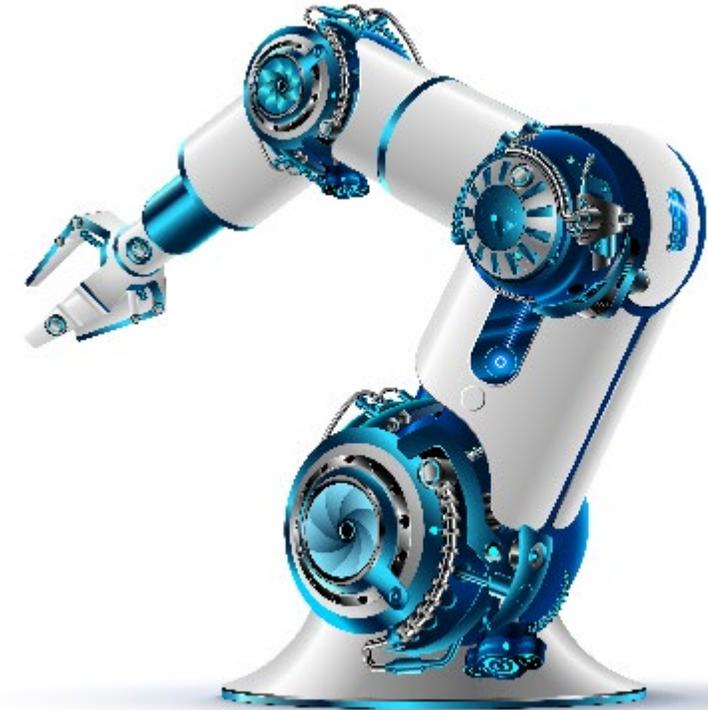
- Traditional power semiconductors (MOSFETS, IGBTs) are uni-directional (one-way conduction or isolation)
- Several applications need two-way (bi-directional, or positive/negative) operation – so multiple, large-chip parts needed
- Proprietary, ‘bi-directional’ GaNFast power ICs are the smallest, most efficient, lowest system cost solution
 - Optimized for fast switching, AC voltage applications
 - Enable ‘previously-impractical’ topologies
 - Integrated circuitry ensures reliability
- Applications: High-power industrial, solar, energy storage, motor drives
- Topologies: Heric Inverter, Vienna Converter, T-type NPC Inverter, Matrix AC/AC Converter
- Mass production target 2024



Direct power conversion with bi-directional GaNFast means simple, small, efficient, low system-cost AC-AC motor drive

Conclusion – The time is now

- Through GaNFast™ / GaNSense™ integration, GaN power ICs are ready now
 - Reliable and repeatable performance of e-mode GaN power transistors
 - Complete protections for reliability and robustness
 - Smallest form factor and lowest losses
 - Easy to use digital power stage
- Massive performance improvement over silicon alternatives
- Very good availability and plentiful supply chain
 - Re-using older Si fabs, low CapEx, low waste



GaN power ICs enable the next level of performance, reliability and robustness in power electronics applications

Danke!



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