Bidirectional GaN power ICs open up new possibilities in off-grid applications

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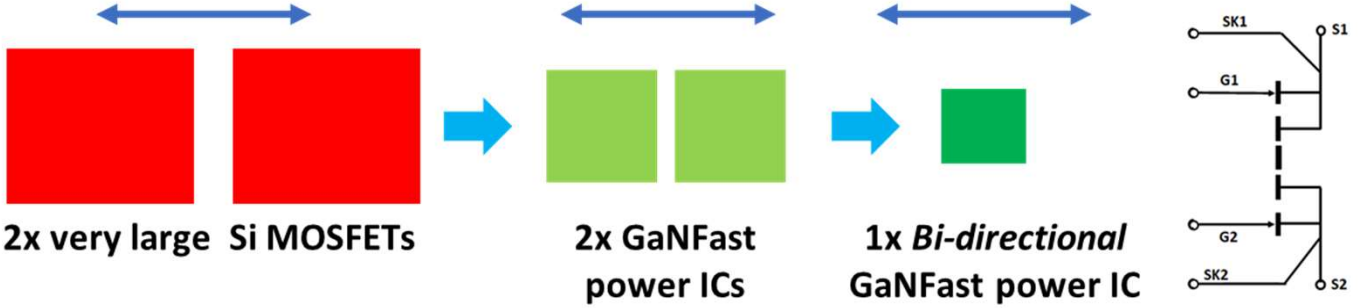
Energy • Efficiency • Sustainability

Agenda

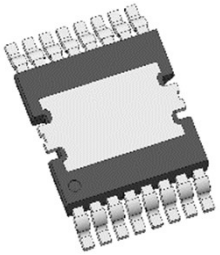
- Bidirectional power switches in GaN technology
- Technology comparison
- New topologies:
    - Vienna rectifier
    - Current-source inverter
    - Solid state circuit breaker
- Summary

World's First Bi-Directional GaNFast™ Power IC



4x smaller than SiC Bidirectional FET, 3x smaller than two unidirectional GaN, 9x smaller than Silicon

- Traditional power semis (MOSFETS, IGBTS) are uni-directional (one-way conduction or isolation)
- Several topologies need bidirectional power flow control – complex and difficult to control
- 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: Power supplies, Industrial, Solar, Energy storage, Motor drives
- Mass production target 2024



Bi-Directional GaNFast™ Power IC
Navitas GaN power ICs unlock the next level of performance

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Feature	Impact	Benefit
Very low switching losses	Reduce losses by >20% over SiC, >50% over Si	Small / no heatsink, easier thermal design, higher reliability
Very high switching frequency possible	Very small / planar magnetic components	Reduced size and system cost
Precise switch timing with low latency and dead time	Improved control loop performance, low EMI	Smaller EMI filter → system cost improvement
High voltage ratings	High robustness against transient overvoltages	Lower field failure rate, surge robustness
Integrated substrate clamp	Reduced dynamic on-resistance drift	Repeatable performance

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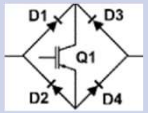
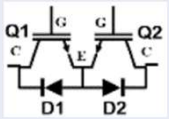
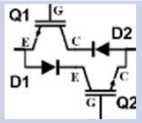
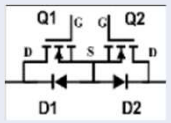
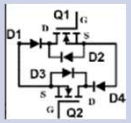
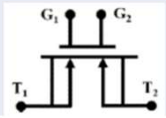
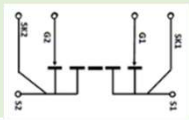
Extended technology comparison *

Switch configuration	Description	Chip area / Size / Complexity	Number of components	ON-state voltage drop	Switching loss	Switching frequency	Gate control complexity
	Diode bridge + asymmetric IGBT	Very high	5	3.5V [2 diodes + 1 IGBT]	High	16kHz	Low
	Asymmetric IGBT + freewheeling diodes	Very high	4	2.5V [1 diode + 1 IGBT]	High	16kHz	Low
	Back-to-back reverse-blocking IGBTs	High	2	2.0V [1 symmetric IGBT]	Very high	8kHz	Medium
	Si power MOSFETs + JBS diodes	High	4	1.25V [1 diode + 1 MOSFET]	Low	60kHz	Low
	Back-to-back SiC power MOSFETs + antiparallel and series JBS diodes	Very high	6	1.25V [1 diode + 1 MOSFET]	Low	100kHz	Medium
	Four-terminal SiC monolithic BiDFET	Medium	1	0.5V [1 BiDFET]	Low	100kHz+	Medium
	Monolithic bidirectional GaN power IC	Lowest	1	0.5V [1 Bidirectional GaN power IC]	Lowest	500kHz+	Medium

* See "Baliga et.al.: The BiDFET Device and Its Impact on Converters", IEEE Power Electronics Magazine, March 2023

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Bi-Directional GaNFast™ Power IC in Vienna Converter

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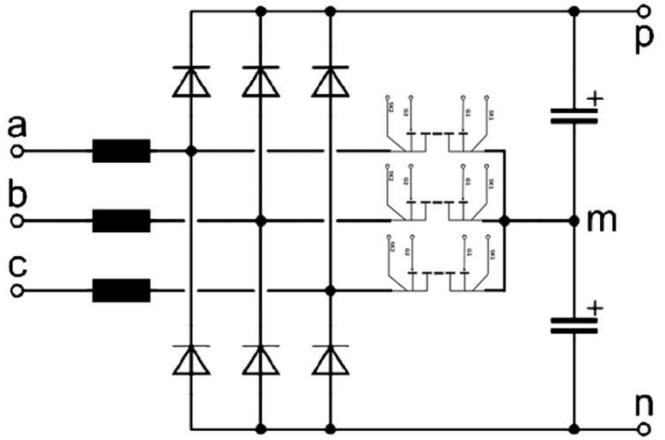
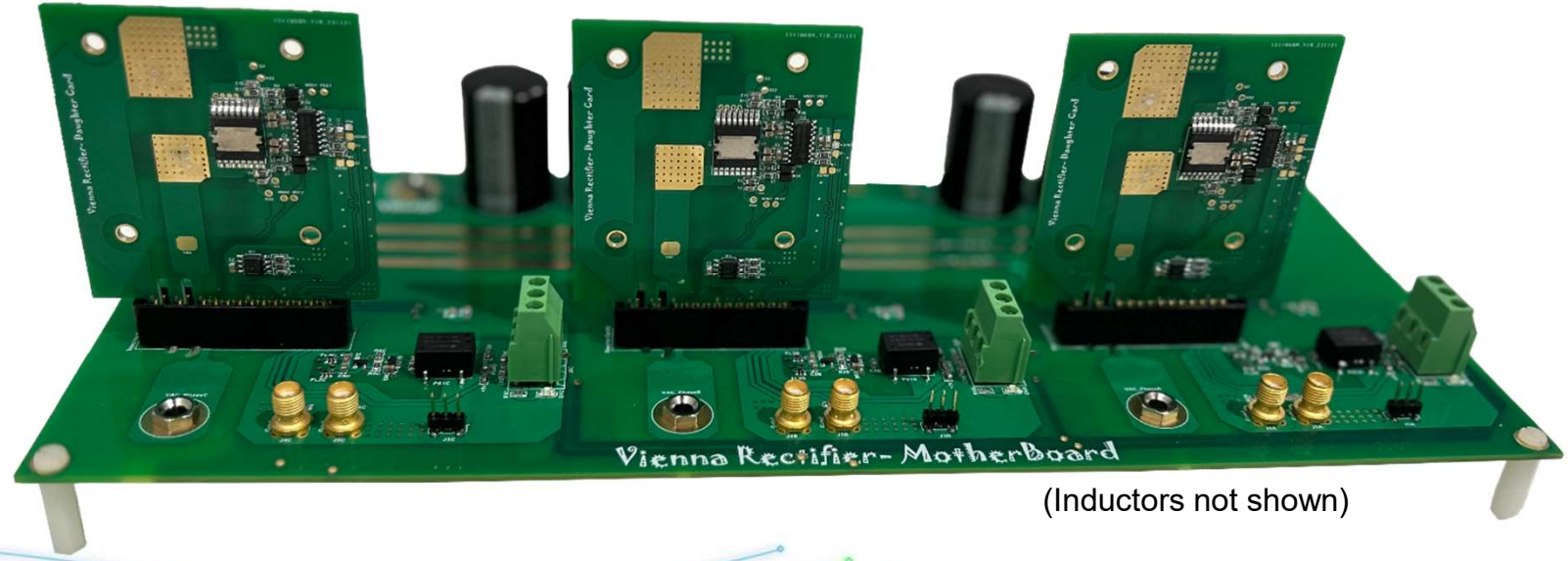
- Input: Universal AC, output: 800V (+/- 400 V)
- Switching frequency: 100 kHz
- Using GaNFast™ Bidirectional GaN in TOLT
- Very high efficiency and low complexity



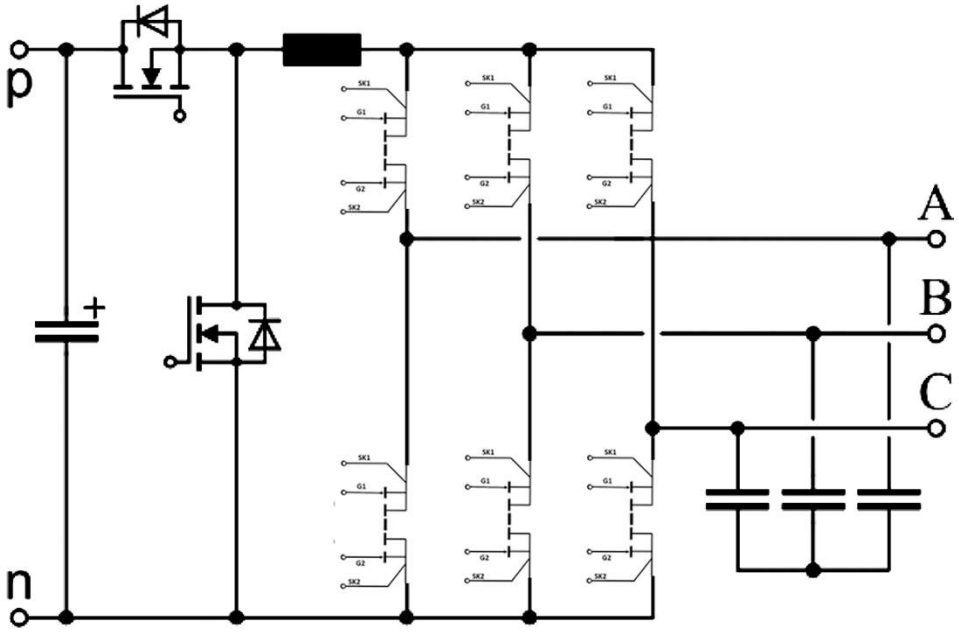


(Inductors not shown)

* See “Huber, Kolar: Monolithic bidirectional power transistors”, IEEE Power Electronics Magazine, March 2023

Bi-Directional GaNFast™ Power IC in Current Source Inverter

- Inherently sinusoidal output
- Very high switching frequency possible through further reduction of the switching losses
- Bidirectional power flow
- Potential to optimize motor size and cost, through lower inductance

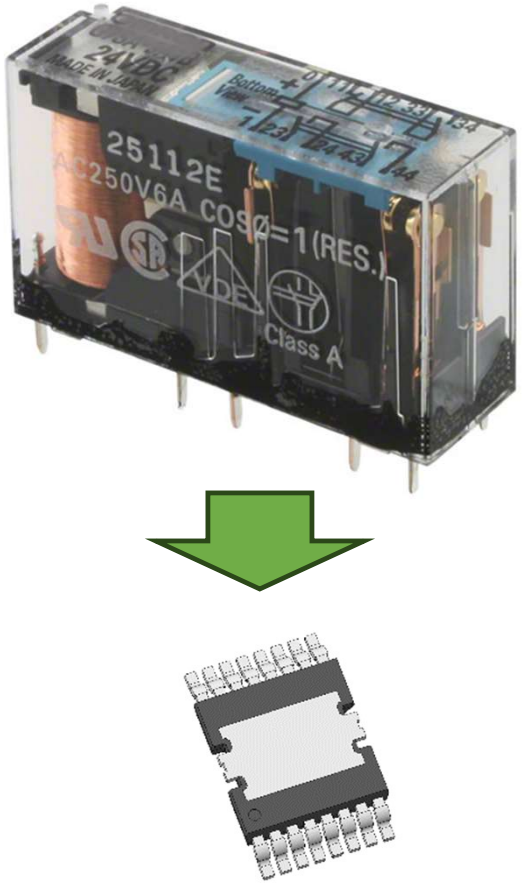


Bi-Directional GaNFast™ Power IC in circuit breakers

- Replacing electromechanical switches with a solid-state switch

Significant advantages for critical applications:

- No arcing
- No degradation from vibration or shock
- Much smaller size and weight
- Fast response time
- No moving parts → better reliability, switch cycles
- Handles AC or DC
- Low power remote control



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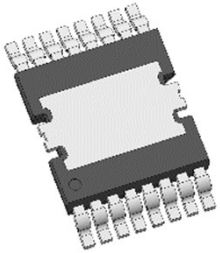

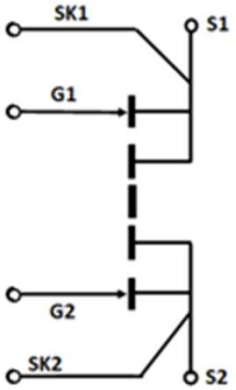

Navitas’ GaNFast™ Bidirectional offers convincing solutions to enable new topologies for better performance and system cost savings

Discover more at
navitassemi.com