

Application of Gallium Nitride (GaN) Bidirectional Switches (BDS) in Single-Stage Cycloconverter for Micro PV and Storage Systems

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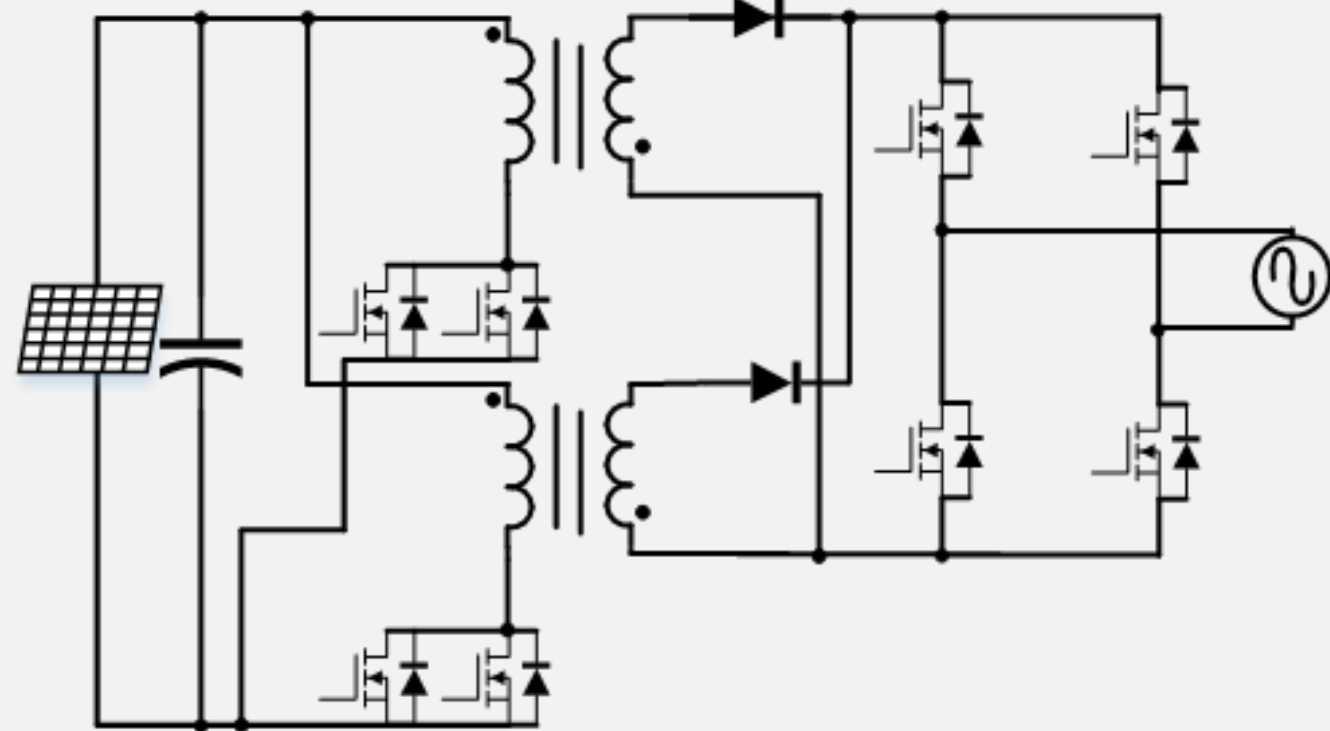
01 Abstract

A novel single-stage resonant cyclo-inverter using 650V GaN BDS is proposed in micro PV/ESS systems. This topology reduces component count by 20%, enhances power density, and supports seamless grid-tied/off-grid/battery charging modes with peak efficiency exceeding 97%.

02 Topology Shift

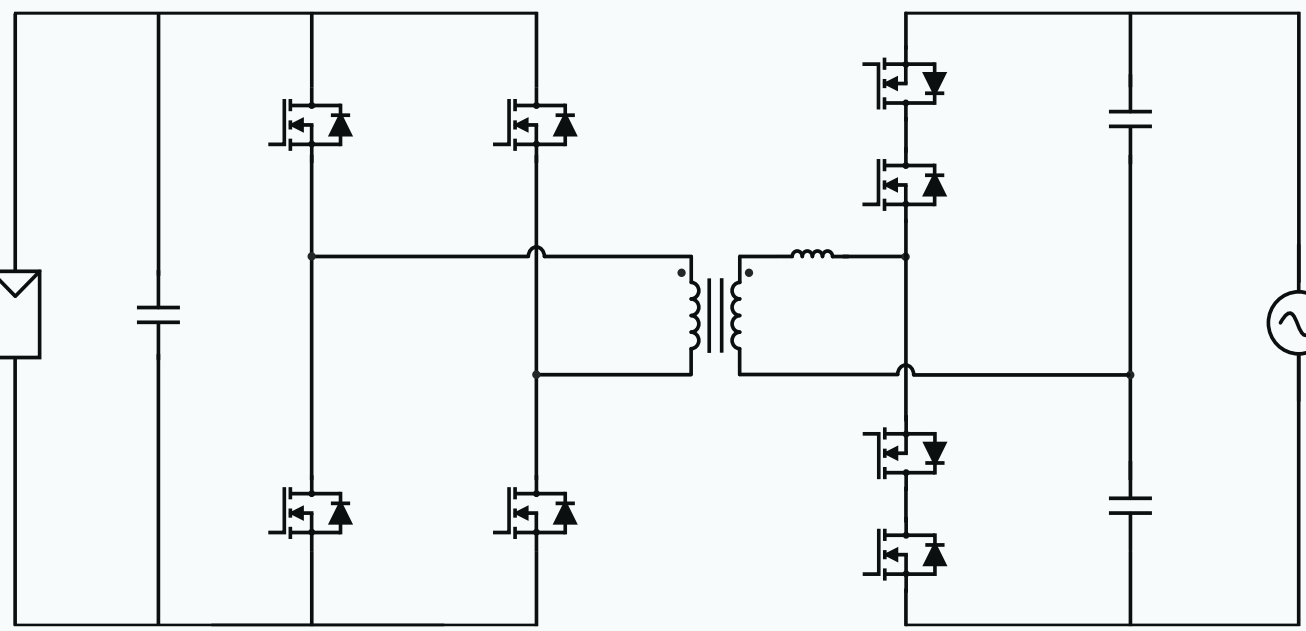
Traditional 2-Stage

2 conversion stages (lossy), unidirectional, low power density, high BOM cost.



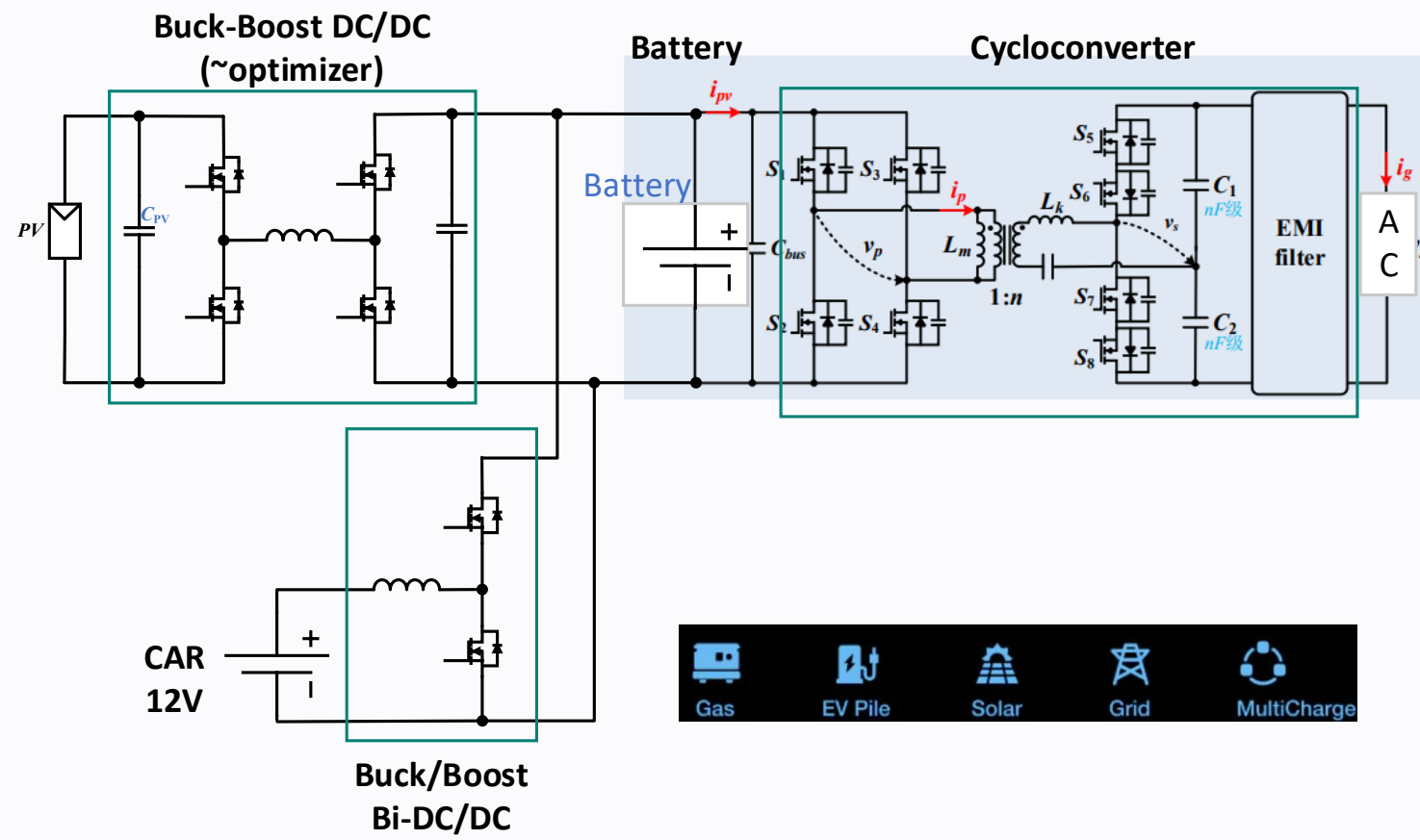
Single-Stage Cycloconverter

Direct DC-AC conversion, 97%+ peak efficiency, compact size, lower cost.



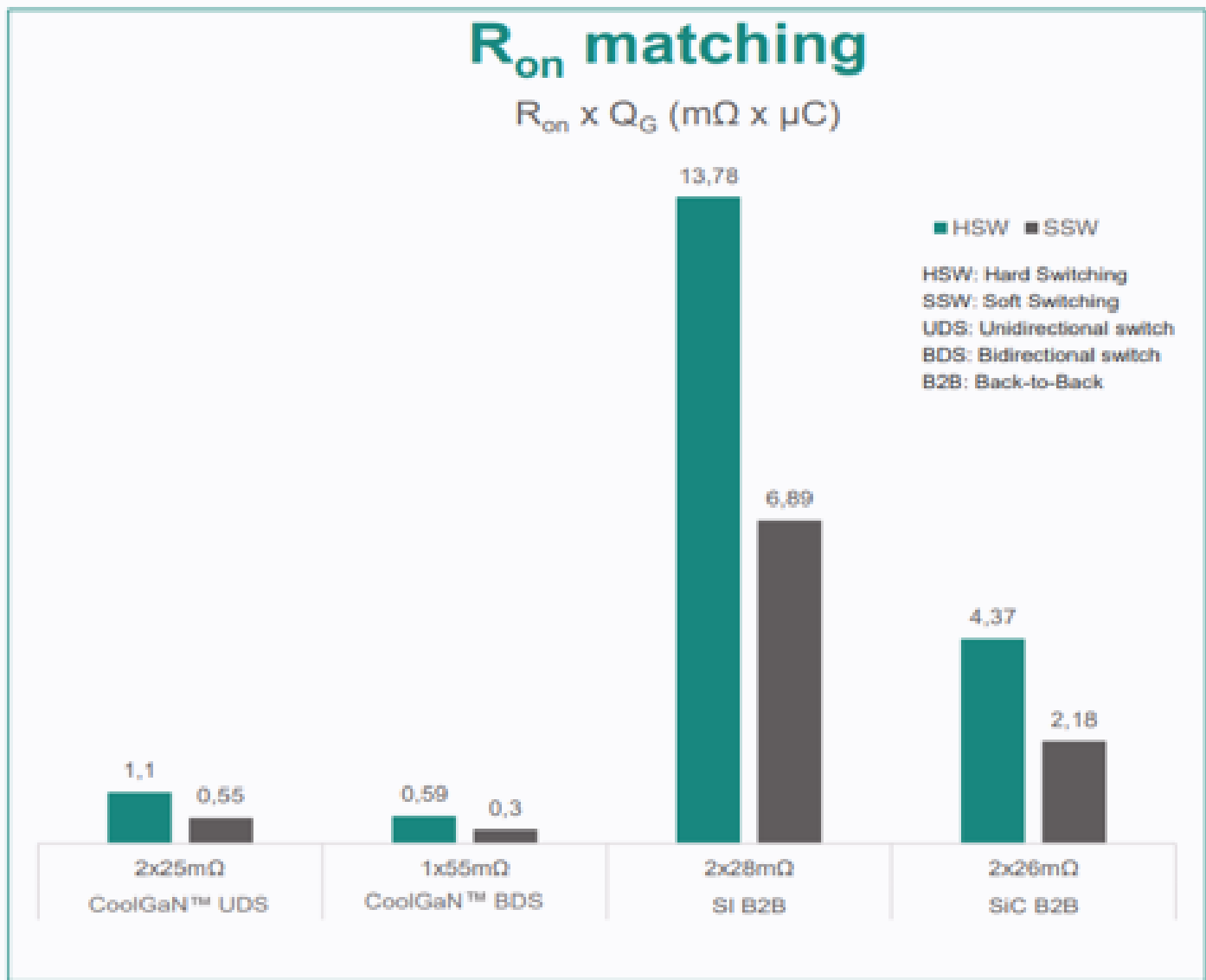
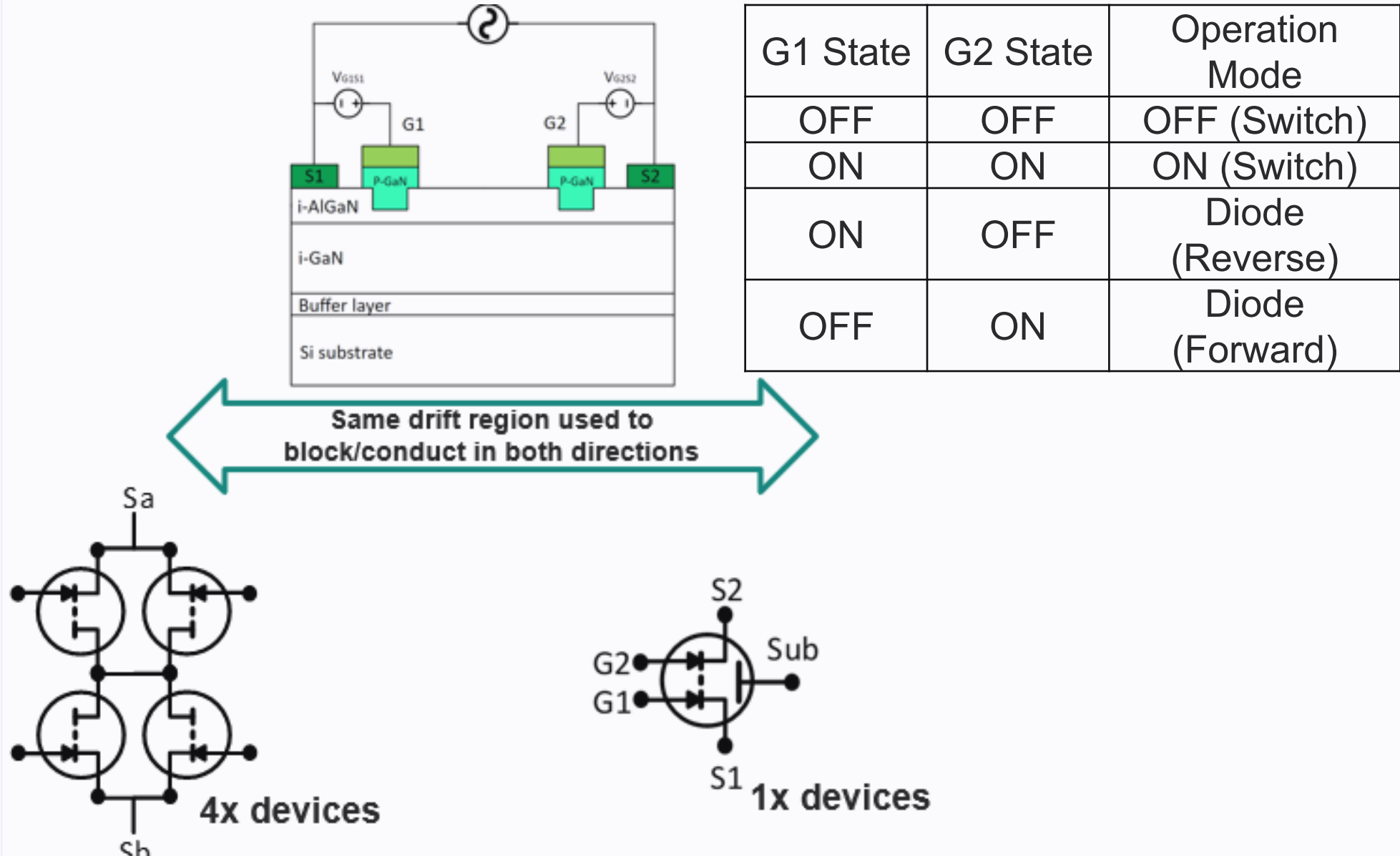
Extensions to Micro-Storage

Single-stage cycloconverter allows direct battery integration for ESS. Furthermore, this concept is extended to hybrid systems.



03 GaN BDS

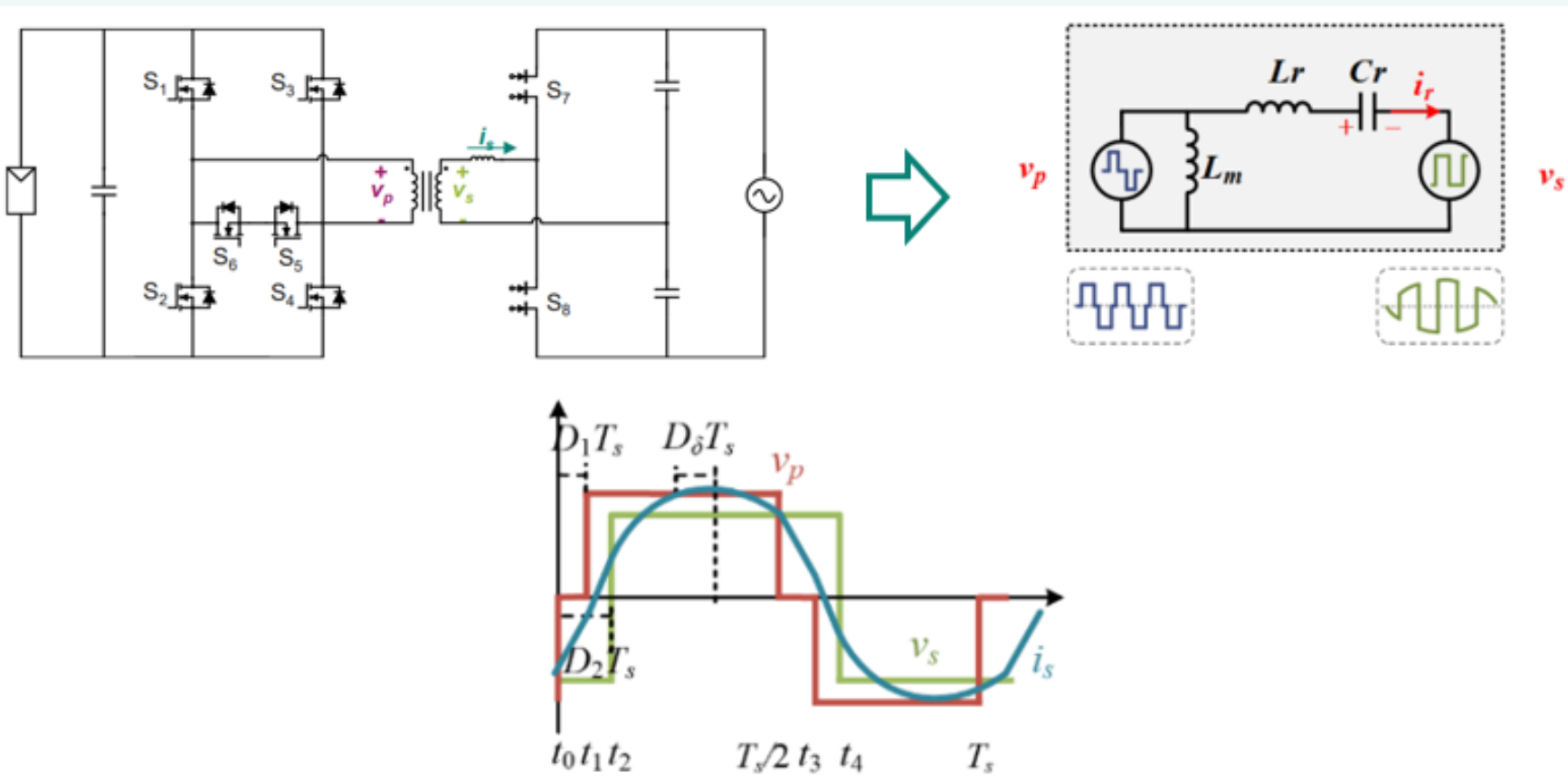
Monolithic 5-terminal device integrating two normally-off GITs. Features ultra-low parasitics, 85% lower $R_{on} \times Q_g$ (FOM) than Si, and 45% lower gate drive loss at 100kHz.



04 Control Principle

Resonant Soft-Switching (ZVS)

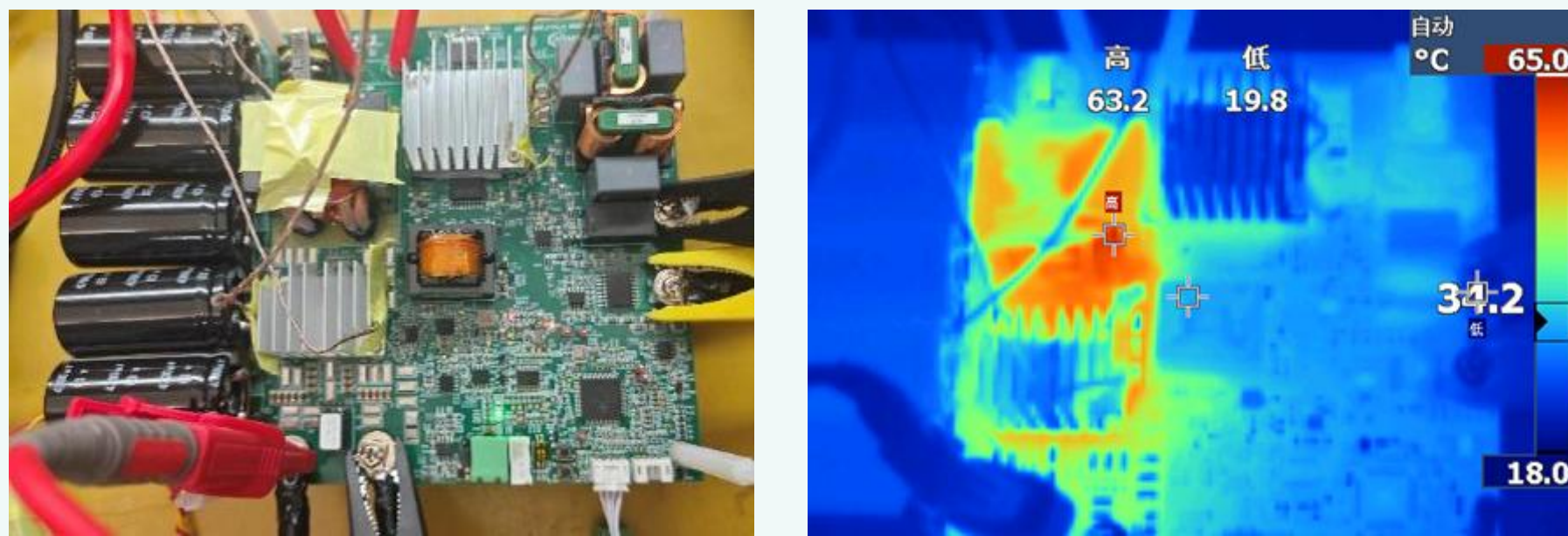
Achieves full-range ZVS via variable frequency and phase-shift control. Seamless transition between grid-tied, standalone off-grid, and grid-to-battery charging modes.



05 Experimental Results

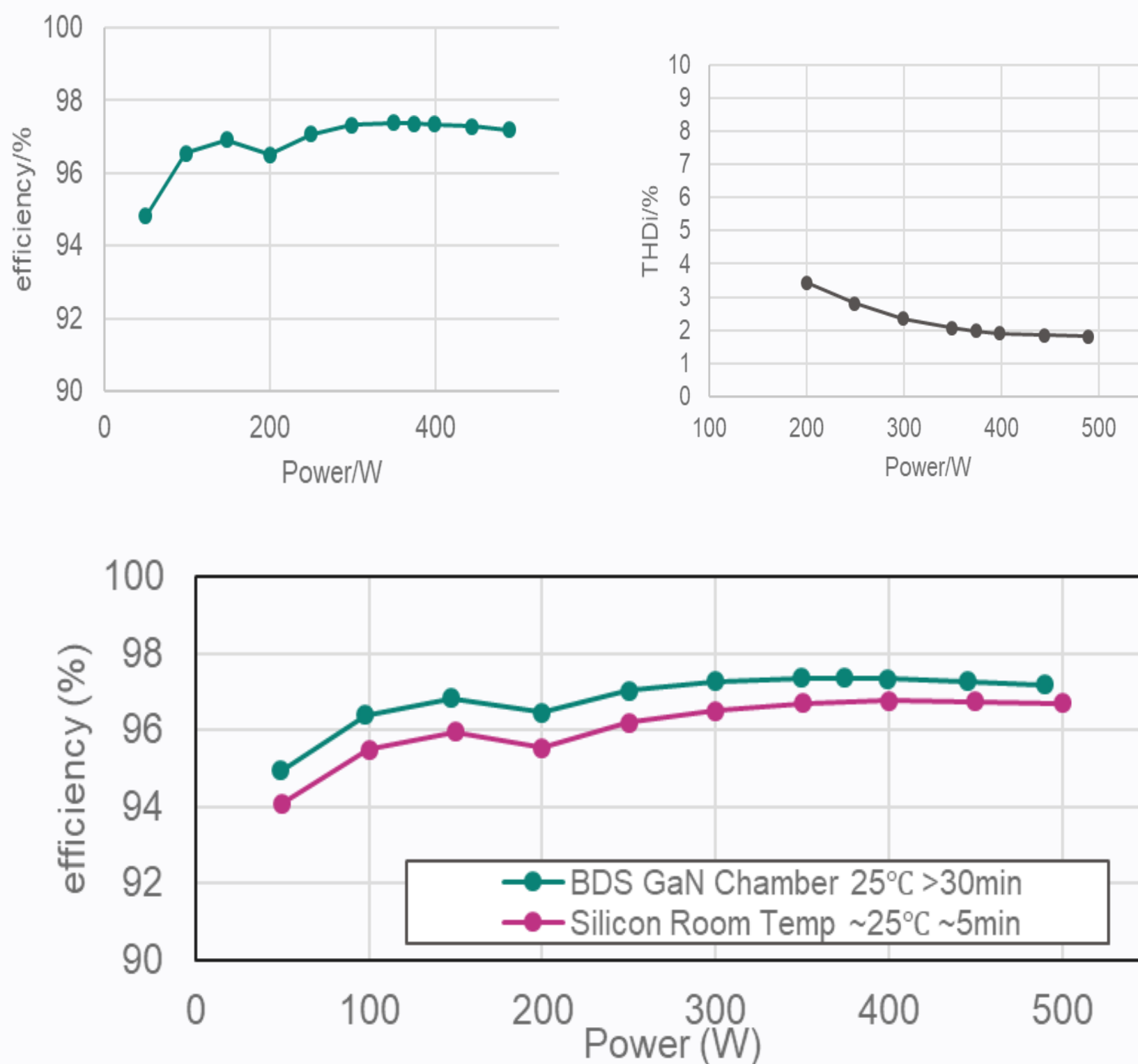
Hardware Prototype

500W under operating conditions: 30V-60V DC input, 240V AC output.

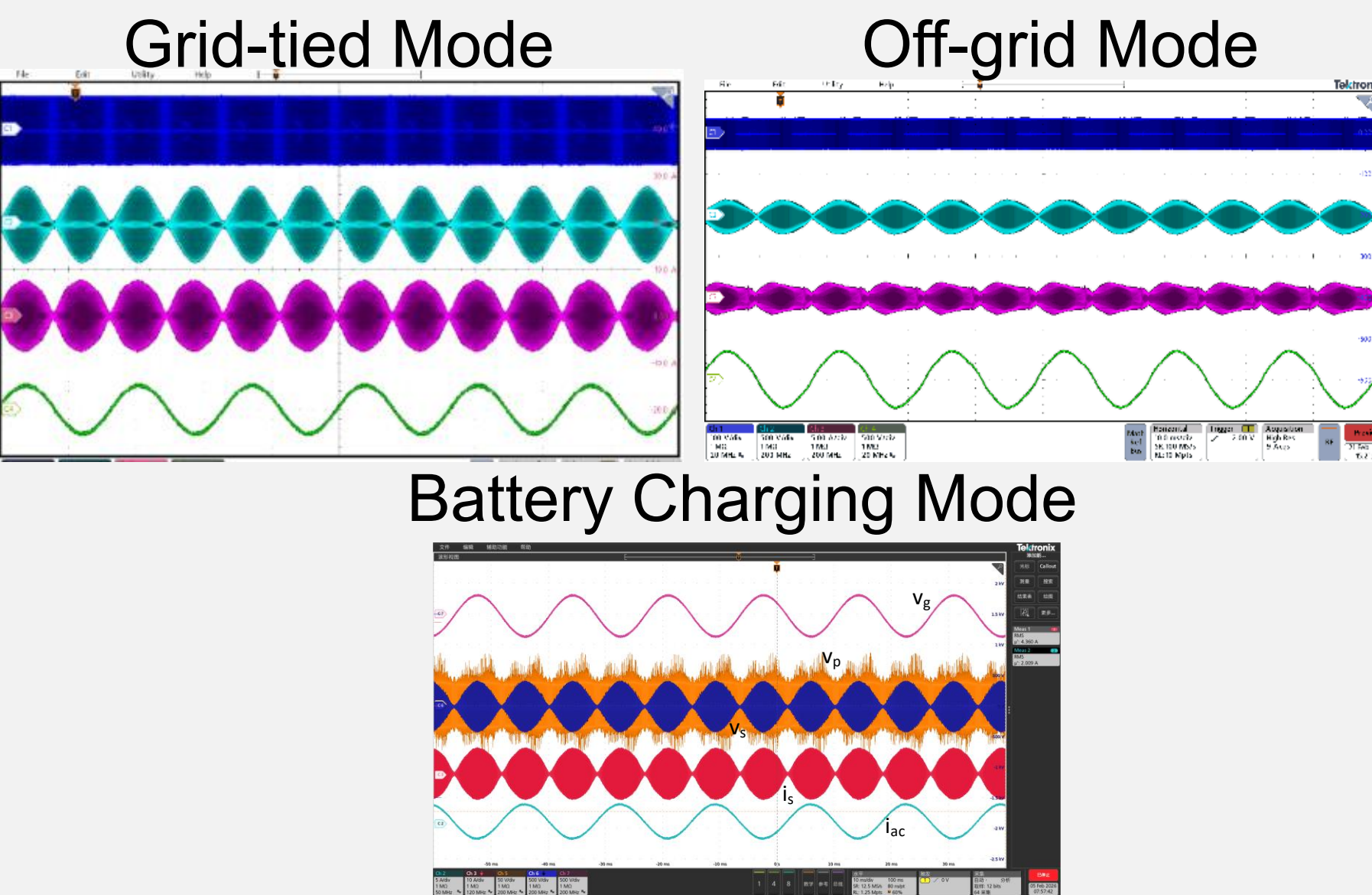


Efficiency & THD

peak efficiency of 97.37% and a CEC efficiency of 96.6%, THDi is ~2% at full load



Multi-Mode Operation



97.37%	< 3%
Peak Efficiency	Total THDi
96.6%	500W
CEC Efficiency	Prototype Power

Conclusion:

GaN-based single-stage topology delivers superior performance over Si-based two-stage designs in efficiency, size, and reliability, enabled by Infineon GaN BDS.

Future Work:

Scale to 1-3kW, field testing for long-term reliability, and integration into commercial PV-battery systems.