Power conversion with bidirectional GaN in a single-stage converter for micro inverters and portable power stations

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Making WBG Designs Happen

GaN

GaN | Micro inverters and portable power stations

Higher efficiency

Smaller passive components

Integrated protection and driver with TI GaN

Benefits of GaN over Si-based designs

- Overall efficiency **~98%**
- Higher switching frequency allows for **smaller magnetics,** allowing for **40% size reduction**
- Enable **bidirectional topologies** and increase power density and lower costs

GaN-based, single-stage cycloconverter…

reduces: Size, Cost

increases: Density, Efficiency

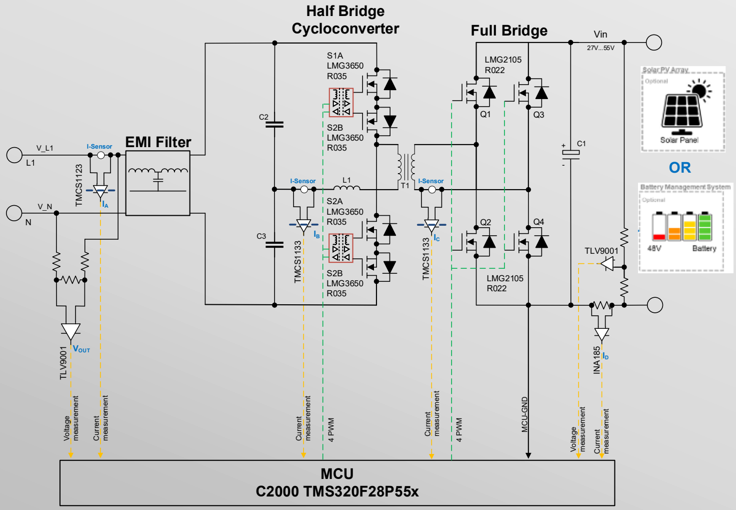
600W single-stage cycloconverter

TIDA-010954

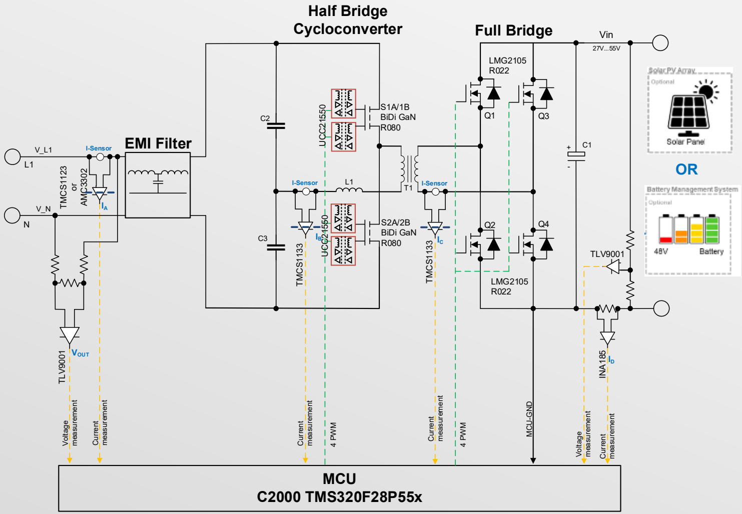
Case study: Cycloconverter

- Traditionally implemented with discrete back-to-back FETs in common-source configuration
- Comparison to implementation with bidirectional GaN in common-drain configuration

Common source: 2 x 35mΩ Uni-GaN FET

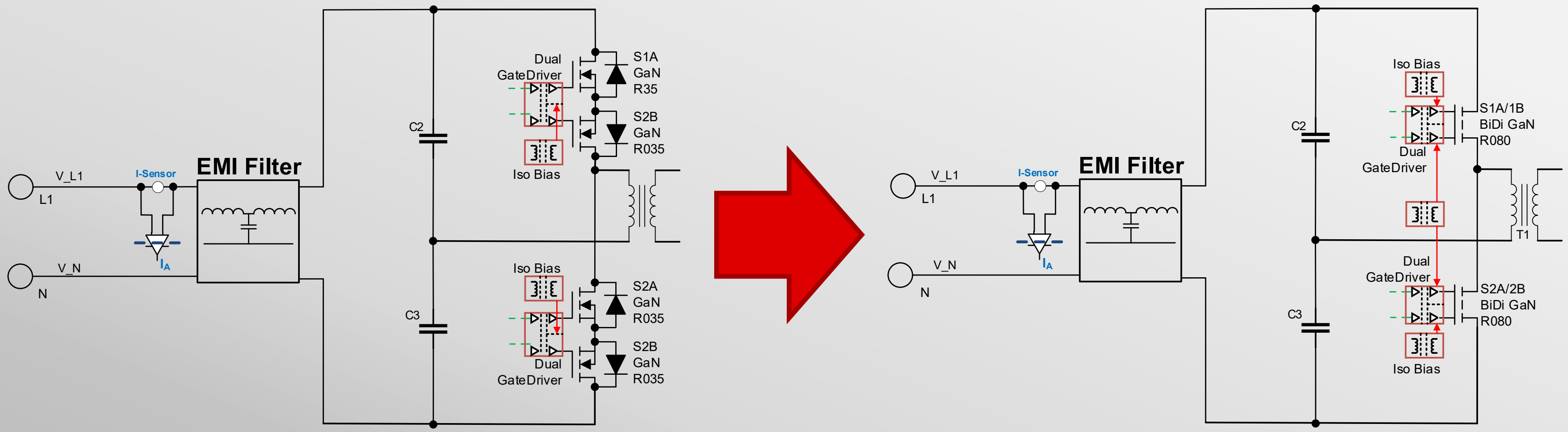


Common drain: 80mΩ Bidi GaN



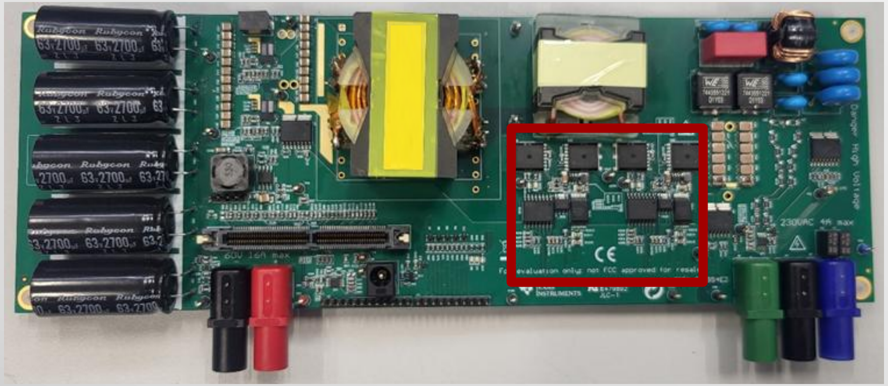
Biasing and parasitic

- Common-source configuration:
  - four power devices needed
  - two isolated bias needed
  - more parasitic capacitance at common source
- Common-drain configuration:
  - two power devices needed
  - three isolated bias needed
  - far less parasitic capacitance at common drain

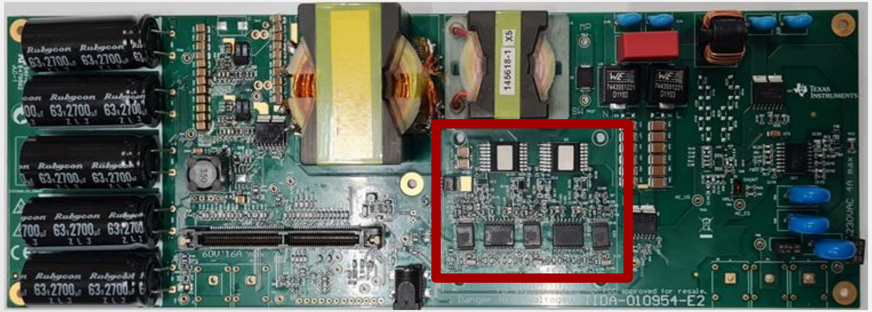


Cycloconverter: board comparison

Common-source implementation: back-to-back GaN



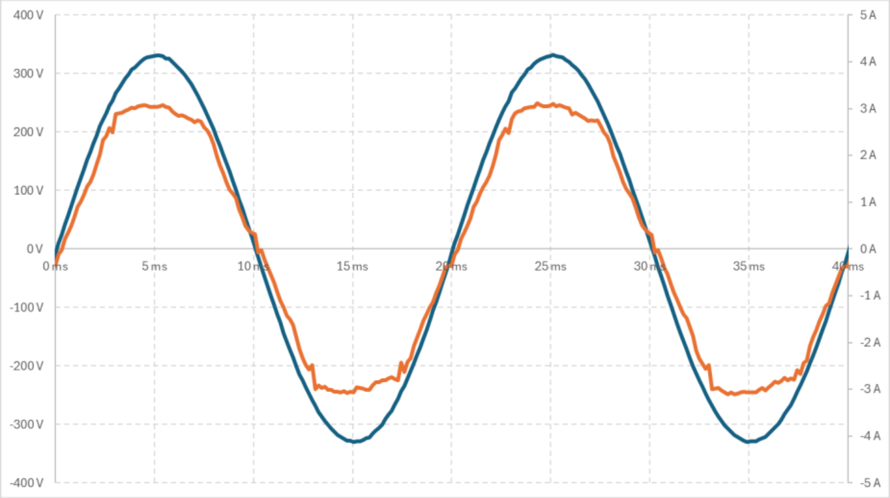
Common-drain implementation: Bidi GaN



Board size: 290mm × 100mm × 32mm
Maximum power: 600W
Operating f_{PWM}: 300-600kHz

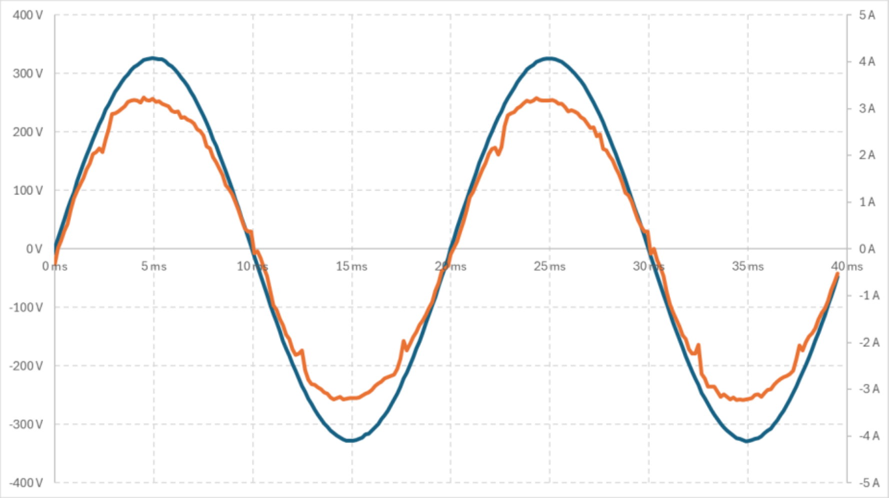
AC-output waveform comparison in open loop @ 500W

Common-source implementation: back-to-back Uni GaN



THD: **6.36%**

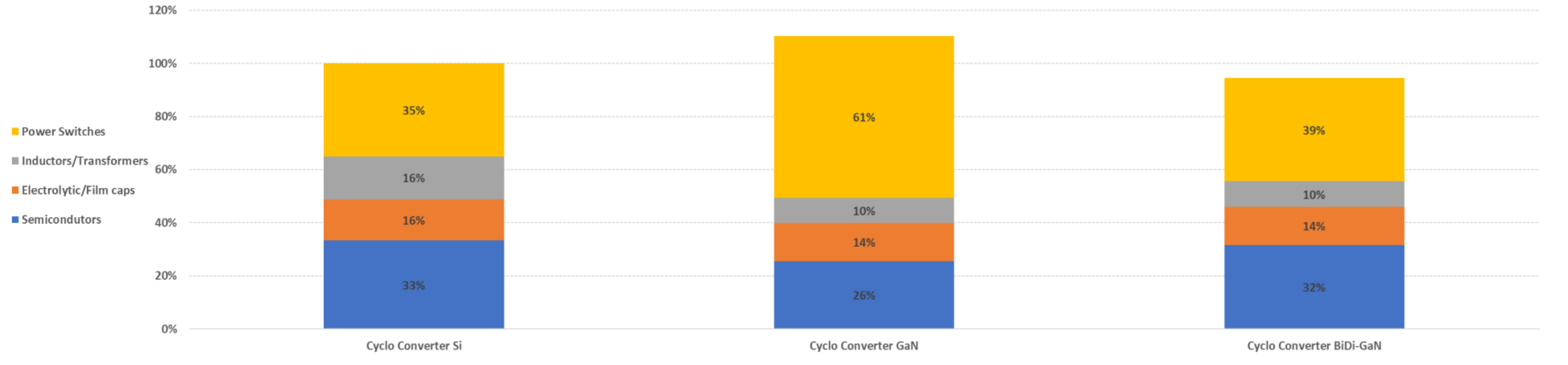
Common-drain implementation: Bidi GaN



THD: **5.15%**

Bidi GaN improves ~1.2% THD compared to Uni GaN

System cost comparison



System cost comparison:

- Normalized pricing applied
- Baseline (100%) is implementation with common-source Si-FETs operated at f_{PWM} = 100kHz
- Semiconductors cost slightly lower with common-source GaN
- Inductors, transformers, capacitors greatly impact cost
- **Cyclo with Bidi GaN is lowest cost implementation at highest power density**

In summary, bidirectional GaN technology…

… enables an **improved performance** in micro inverter and portable battery storage systems by **reducing parasitic capacitances** in common-drain configuration.

… can **increase power density** in applications, increasing overall performance of a solar power system.

… can **lower total solution cost**.

Thank you!