

2.3kW High-efficiency 2-phase CRM Boost Converter for Solar Inverters

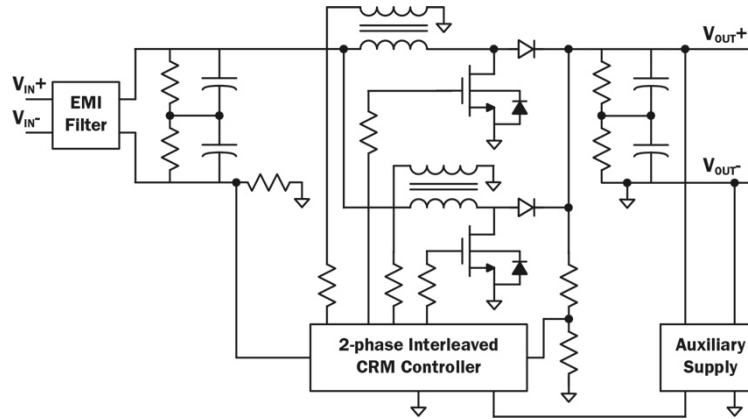


Figure 1. Simplified schematic

Introduction

This Design Guide is a brief description of a convection-cooled, 2.3kW reference design for use as a stand-alone DC-DC converter or as an MPPT boost stage in a PV inverter system.

Key features

- Features 2 x TPH3205WSB—52mΩ (typ), TO-247, 650V (cont), 800V (peak)
- Transphorm GaN FETs enable high frequency:
 - 160kHz per phase at full power at 200V input and 380V output
 - > 350kHz per phase at light load
 - Dual-phase design employs two small, low-cost ferrite PQ40/40 inductors
- 18V max gate voltage allows low-cost MOSFET drivers
- Output voltage: 380V nominal, 600V max
- Input voltage range: 100V to 600 V
- Minimum input voltage range for rated power: 200V
- > 99% efficiency at full load when $(V_o - V_{in}) < 80V$
- Less than 2% efficiency variation from 10% to 100% load across a wide input voltage range

- Utilizes an off-the-shelf, 2-phase Critical-Mode (CRM) PFC controller (UCC28063A)
- CRM operation does not subject diodes to reverse recovery
 - Low-cost Si boost diodes (low V_F , moderate Q_{RR})
- CRM operation reduces input and output capacitor ripple current
 - Reduced EMI filter cost
- Includes an integrated auxiliary supply with an output for powering the DSP subsystem in a typical PV inverter design

Applications

- PV inverters
- Fuel cells

Performance

Figures 2 and 3 show the system efficiency with the output at 380V and includes the auxiliary power consumption. Figure 2 shows efficiency when both phases of the interleaved system are operational and Figure 3 shows efficiency with only one phase operating, which increases efficiency at light load.

Design Guide

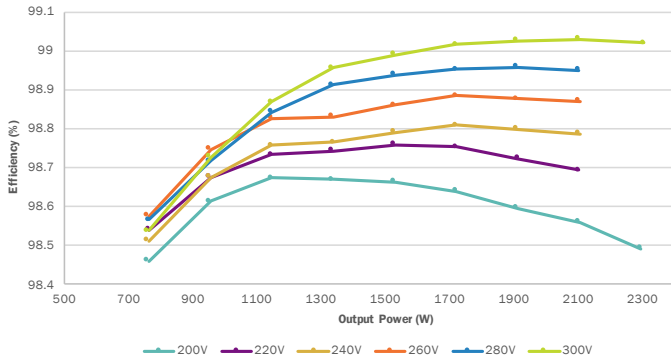


Figure 2. System efficiency with both phases running

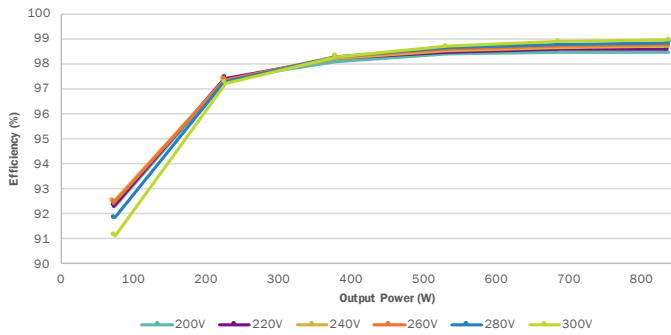


Figure 3. System efficiency with one phase running

Key design notes

The resistors in parallel with both the input and output series-connected electrolytic capacitors guarantee voltage balancing.

In a PV system the feedback loop bandwidth must be low (typically 5Hz - 8Hz) in order that the 100Hz/120Hz output voltage ripple is not rejected, which would produce 100Hz/120Hz ripple current at the input from the PV panels. If the system is intended to be a standalone DC-DC boost converter, the loop compensation bandwidth can be increased.

The optimized inductor design yields a peak-to-peak flux density of ~150 mT at full load. An AWG 42 Litz wire with 270 strands in 1.5 layers is used to minimize eddy current loss from the proximity effect. As shown in Figure 4, a no-go area in the first layer, using 6.2mm margin tape, reduces eddy current losses from the flux concentration near the core gap. Note that increasing the number of strands will increase the total layers and can increase losses despite the lower DCR.

A three-turn sense winding is employed to provide a feedback signal for the controller's zero-crossing detect pin. An optional, single-shorted turn of copper tape can be placed around the bobbin and core to reduce radiated EMI. (This should be connected to input 6 on the bobbin).

- Primary inductance: 57µH -7%/+7%
- Core: PQ40/40 TDK B65883A0000R095 or equivalent

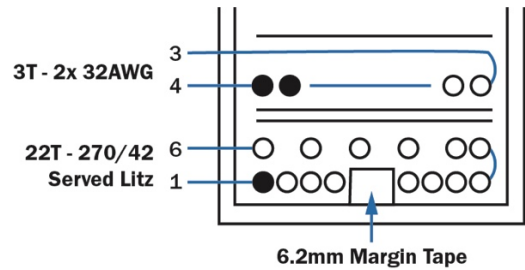


Figure 4. Magnetics diagram

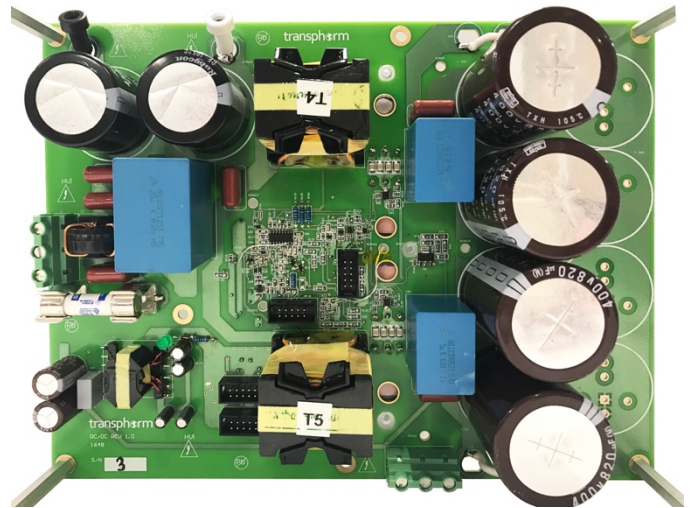


Figure 5. 2.3kW demo board