Test Report: PMP41017

3-kW, Two-Phase, Interleaved Half-Bridge LLC With GaN and C2000

Description

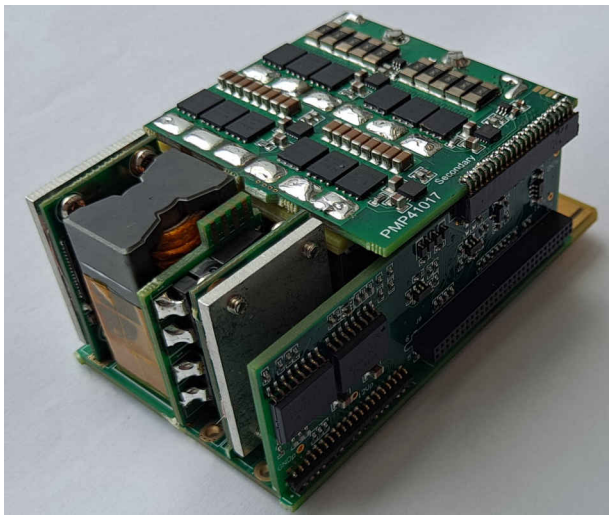
This reference design is a 3-kW, two-phase, interleaved half-bridge inductor-inductor-capacitor (LLC) using the LMG3422 and F280039C devices. The design can achieve 98.1% peak efficiency and 313 W / in^3 power density. This design can be used as the output stage of a common redundant power supply (CRPS) server power supply and can be used to evaluate the control method for two paralleled LLC stages, such as interleaving and current balance.

Features

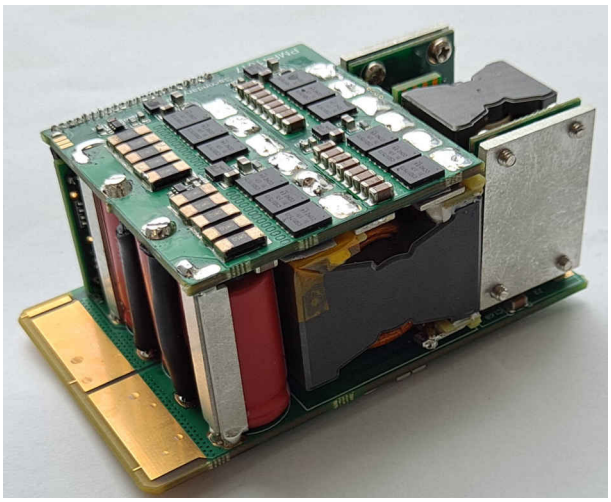
- Two-phase interleaved LLC reference design
- High efficiency with gallium nitride (GaN), peak 98.1%
- Ultra compact size, 64 (width) mm × 35 mm (height) × 70 mm (length)
- High-power density, 313 W / in^3

Applications

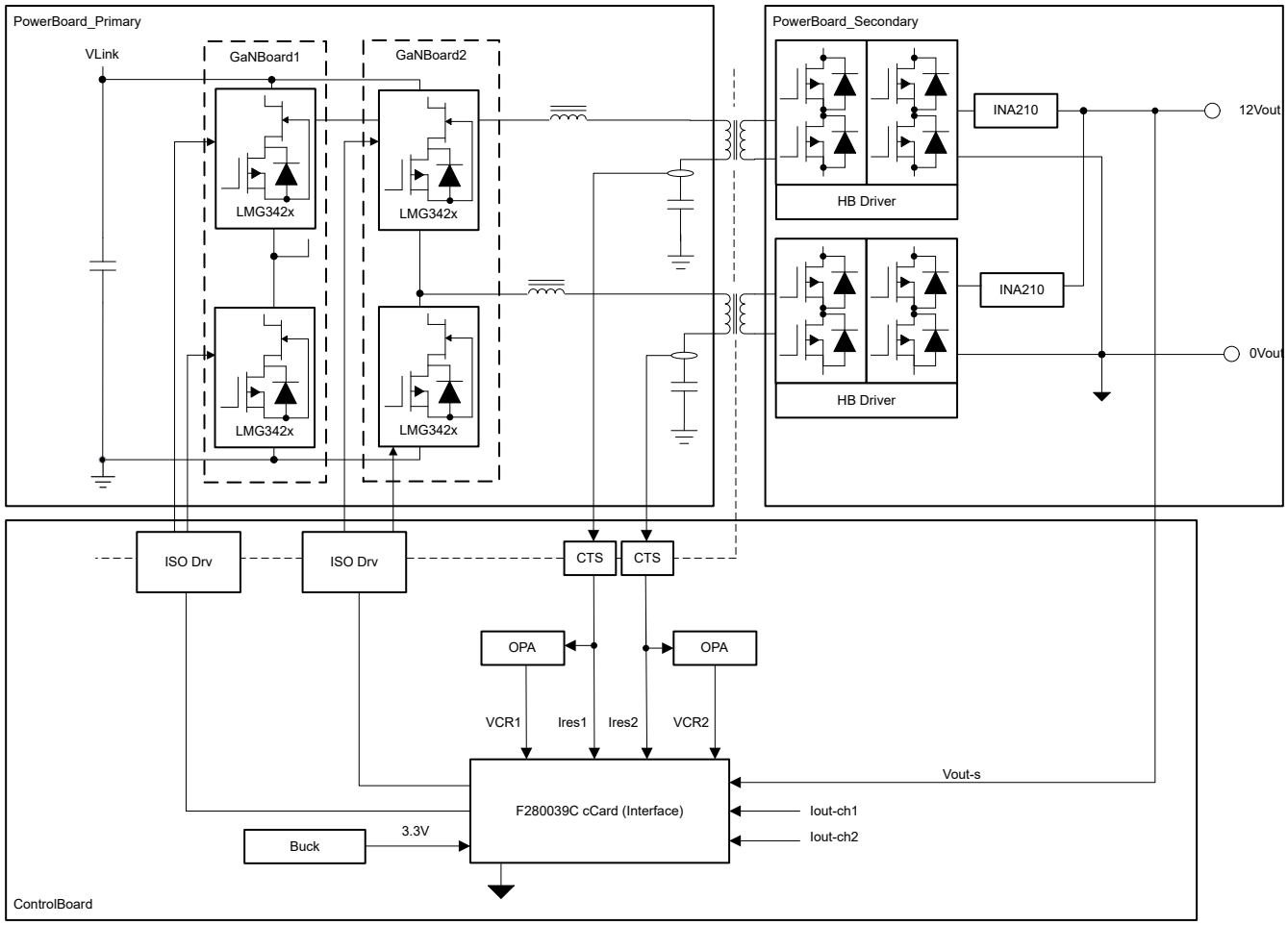
- Server PSU with 12-V output
- Merchant telecom rectifiers
- Industrial AC-DC



Front Angle Photo of the Board



Back Angle Photo of the Board



Block Diagram

1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1-1. Voltage and Current Requirements

Parameter	Specifications
Input Voltage	340 VDC – 420 VDC
Input Current	0 A – 9 A
Output Voltage	12 VDC
Output Current	0 A – 250 A

1.2 Required Equipment

- Computer with Code Composer Studio™ and DigitalPower SDK installed
- TMDSCNCD280039C daughter card
- Chroma 62050H-600, programmable DC power supply
- IT6010c-80-300, used as electronic load
- Dual-channel isolated DC power supply, 12 V, 3 A
- WT500, power analyzer
- Oscilloscope (minimum 100-MHz bandwidth)
- Current probe (minimum 100-kHz bandwidth)
- Multichannel temperature tester

1.3 Considerations

CAUTION

Consider adding a 820-µF, 450-V electronic capacitor near the board input port. This capacitance is not considered in this design because the capacitance is the end stage after a PFC stage.

WARNING

Do not touch the board or the electrical circuits while the PMP41017A board is energized because of high voltages capable of causing an electrical shock hazard. Make sure the high voltage is fully discharged, before handling the board.

1.4 Dimensions

64 (width) mm × 35 mm (height) × 70 mm (length)

1.5 Test Setup

1. Install the TMDSCNCD280039C daughter card to the power board with the C2000™ MCU interposer board
2. Connect two isolated 12-V DC power supplies to the "12Vp / GNDp" and "12Vs / GNDs" on the C2000 interposer board
3. Connect a 400-V, 10-A power supply to the "HVBUS / PBGND" on the primary board
4. Connect a 12-V, 250-A electronic load to the "12Vout / Vo-out" golden finger on the primary board
5. Install power analyzer voltage and current meters, if you want to test the efficiency

2 Testing and Results

2.1 Efficiency Graphs

Efficiency is shown in the following figure.

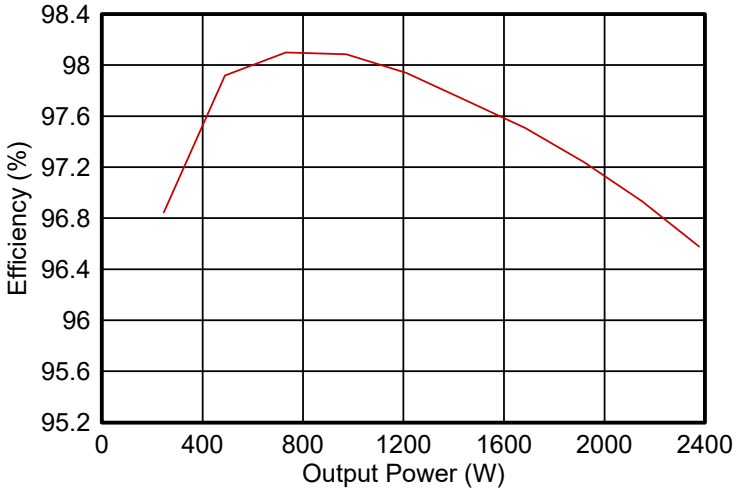


Figure 2-1. Efficiency Test

2.2 Efficiency Data

Efficiency data is shown in the following table.

V_{IN} (V)	I_{IN} (A)	V_{OUT} (V)	I_{OUT} (A)	P_{IN} (W)	P_{OUT} (W)	P_{LOSS} (W)	Efficiency (%)
385.79	0.658	12.294	20	253.89	245.88	8.01	96.85%
385.72	1.2956	12.235	40	499.8	489.4	10.4	97.92%
385.65	1.9338	12.192	60	745.7	731.52	14.18	98.10%
385.59	2.5703	12.154	80	991.3	972.32	18.98	98.09%
385.54	3.8447	12.0733	120	1482.5	1448.76	33.74	97.72%
385.53	5.1168	11.991	160	1973	1918.56	54.44	97.24%
385.44	6.384	11.884	200	2461	2376.8	84.2	96.58%

3 Waveforms

3.1 Output Current Ripple

The ripple current of this design was tested on the output capacitors with different phase shifting. The following list shows the primary current of each phase and the ripple current in output capacitors, with 0 degree shift and 90 degree shift.

- Channel 1, is the primary current of phase A
- Channel 4, is the primary current of phase B
- Channel 3, is the ripple current on the output capacitors

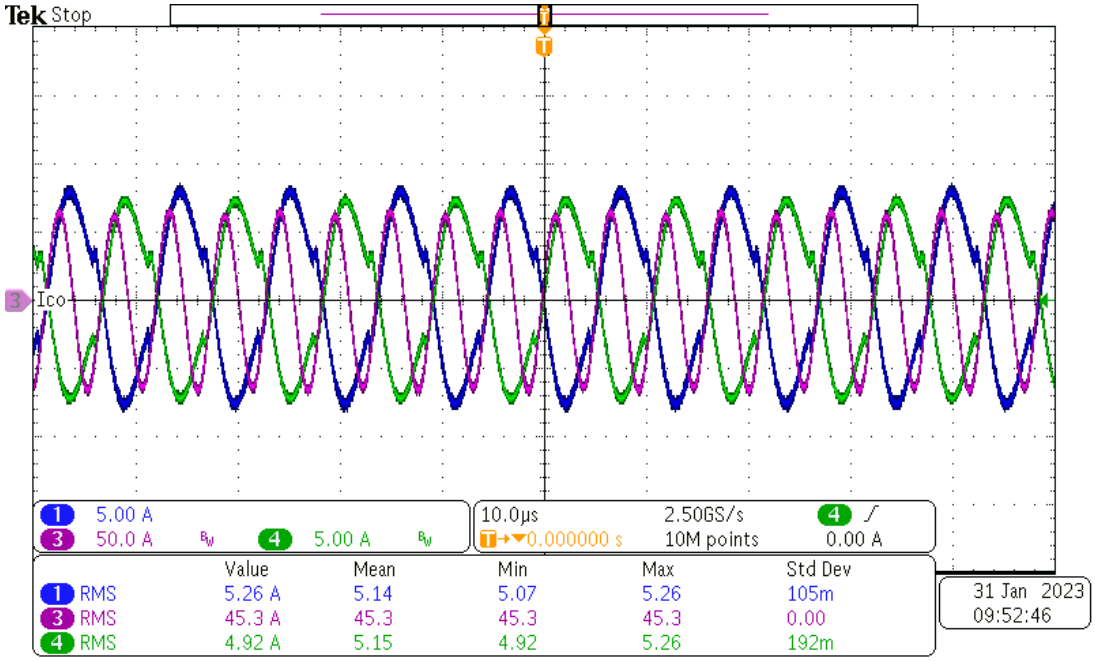


Figure 3-1. Waveform With 0 Degree Shift at133-A Load

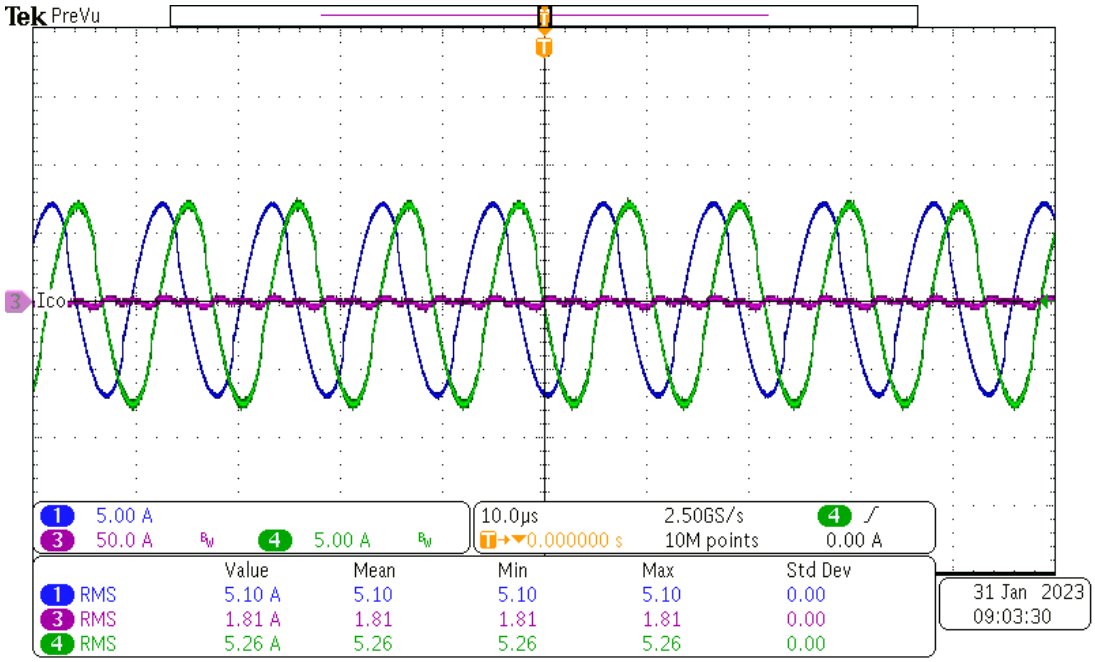


Figure 3-2. Waveform With 90 Degree Shift at 133-A Load

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