Test Report: PMP23338

3-kW, 180-W/in$^3$ Single-Phase Totem-Pole Bridgeless PFC Reference Design With E-Meter Functionality

Description

This reference design is a Gallium nitride (GaN) based, 3-kW, single-phase, continuous conduction mode (CCM) totem-pole power factor correction (PFC) converter targeting maximum power density. This design includes E-meter functionality with 1% accuracy, eliminating the need for external power metering ICs. The supply is designed to support a maximum input current of 16-A RMS and peak power of 3.6 kW. The power stage is followed by a baby boost converter, which helps to greatly reduce the size of the bulk capacitor. The LMG3522 top-side cooled GaN device with integrated driver and protection, enables higher efficiency and reduces power supply size and complexity. The F28003x C2000™ real-time microcontroller is used for all the advanced controls including fast relay control, baby boost operation during AC drop out event, reverse current flow protection, and communication between PFC and house-keeping controller. The PFC operates at a switching frequency of 100 kHz and achieves peak efficiency of 98.7%.

Features

- > 180 W/in$^3$ power density in an x-y dimension of less than 68-mm × 121-mm space and maximum height of 32 mm
- E-metering with 1% accuracy, meets Server power supply M-CRPS spec
- Peak efficiency of 98.7%
- Semiconductor relay increases power density and reliability
- GaN-optimized with driver integration

Applications

- Rack and server PSU with 48-V output
- Server PSU with 12-V output
- Merchant telecom rectifiers
- Industrial AC-DC
- Single phase online UPS

Board Side View

Board Top View
3-kW, 180-W/in³ Single-Phase Totem-Pole Bridgeless PFC Reference Design
With E-Meter Functionality

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1 Test Prerequisites

1.1 Voltage and Current Requirements

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specifications</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td>85–265</td>
<td>VAC</td>
</tr>
<tr>
<td>Line Frequency</td>
<td>47–63</td>
<td>Hz</td>
</tr>
<tr>
<td>Input Current (Max)</td>
<td>16</td>
<td>A</td>
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<tr>
<td>Output Voltage</td>
<td>380</td>
<td>V</td>
</tr>
<tr>
<td>High Line Output Power</td>
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<td>kW</td>
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<tr>
<td>Low Line Output Power</td>
<td>1.5</td>
<td>kW</td>
</tr>
</tbody>
</table>

1.2 Required Equipment

- AC Source: 250 V, 20 A
- Electronic load
- Digital Power Meter
- Isolated probes

1.3 Considerations

Due to the totem-pole topology, the PFC ground (PGND) is floating. This can lead to common-mode current issues with improper test equipment setups. Use differential voltage probes when using an oscilloscope. Use isolated sources for the 12Vp and 12V1 auxiliary supplies. TI recommends using the PMP20306 isolated bias supply reference design.
2 Testing and Results

2.1 THD Performance

![THD Graph at 120-V AC Input](image1)

![THD Graph at 240-V AC Input](image2)

Figure 2-1. THD Graph at 120-V AC Input

Figure 2-2. THD Graph at 240-V AC Input
2.2 E-meter Performance

Figure 2-3. E-meter Graph at 115-V AC Input

Figure 2-4. E-meter Graph at 230-V AC Input
2.3 Power Factor

The following images show the power factor graphs.

![Figure 2-5. Power Factor at 120-V AC input](image1)

![Figure 2-6. Power Factor at 240-V AC Input](image2)
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