Test Report: PMP21103
Class 5 PoE PD (12 V/2.5 A) supply reference design with smooth transition to auxiliary

Description
This design implements an IEEE802.3bt compliant Class 5 Power over Ethernet (PoE) Powered Device (PD) with smooth transition between the PoE input and an auxiliary supply connected to the output. The design consists of a 12V/2.5A active clamp forward converter and allows one PoE Power Source Equipment (PSE) supply and one ac/dc wall adapter auxiliary supply to be used in order to decrease the probability of power and data loss in your system. An IEEE802.3bt compliant TPS2373-4 PD controller is utilized for high power PoE control. In addition, a TPS3803 supervisor and additional circuitry enable the PD to achieve a smooth transition from PoE to auxiliary input and back to PoE without an interruption in output voltage or disconnecting from the PSE.

Test Prerequisites

1.1 Voltage and Current Requirements

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SPECIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PoE Input Voltage</td>
<td>42.5-57V (48V nominal)</td>
</tr>
<tr>
<td>Adapter (AUX) Input Voltage</td>
<td>12V +/-10%</td>
</tr>
<tr>
<td>Vout</td>
<td>12V</td>
</tr>
<tr>
<td>Iout</td>
<td>2.5A</td>
</tr>
<tr>
<td>Nominal Switching Frequency</td>
<td>250kHz</td>
</tr>
</tbody>
</table>

1.2 Required Equipment

- IEEE802.3.bt Type 3 PSE
- AC/DC isolated wall adapter, 12V +/-10%, 2.5A minimum
- CAT5e ethernet cables (<100m)
- 12V/2.5A electronic load

1.3 Considerations

All testing performed with a 48V input and 2.5A load unless otherwise noted.
2 Testing and Results

2.1 Efficiency Graph

![Efficiency Graph]

2.2 Efficiency Data

<table>
<thead>
<tr>
<th>J7</th>
<th>J7</th>
<th>J1</th>
<th>J1</th>
<th>J1</th>
<th>J7</th>
<th>J1</th>
<th>J1</th>
<th>J1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iout</td>
<td>Vout</td>
<td>Iin</td>
<td>Vin</td>
<td>Eff</td>
<td>Vout</td>
<td>Iin</td>
<td>Vin</td>
<td>Eff</td>
</tr>
<tr>
<td>0.00</td>
<td>12.22</td>
<td>0.034</td>
<td>48.00</td>
<td>0.0%</td>
<td>10.29</td>
<td>0.034</td>
<td>48.00</td>
<td>0.0%</td>
</tr>
<tr>
<td>0.25</td>
<td>12.21</td>
<td>0.098</td>
<td>48.00</td>
<td>64.9%</td>
<td>10.15</td>
<td>0.083</td>
<td>48.00</td>
<td>63.7%</td>
</tr>
<tr>
<td>0.50</td>
<td>12.21</td>
<td>0.164</td>
<td>48.00</td>
<td>77.6%</td>
<td>10.12</td>
<td>0.140</td>
<td>48.00</td>
<td>75.3%</td>
</tr>
<tr>
<td>0.75</td>
<td>12.21</td>
<td>0.230</td>
<td>48.00</td>
<td>82.9%</td>
<td>10.10</td>
<td>0.196</td>
<td>48.00</td>
<td>80.5%</td>
</tr>
<tr>
<td>1.00</td>
<td>12.20</td>
<td>0.297</td>
<td>48.00</td>
<td>85.6%</td>
<td>10.09</td>
<td>0.253</td>
<td>48.00</td>
<td>83.1%</td>
</tr>
<tr>
<td>1.25</td>
<td>12.20</td>
<td>0.365</td>
<td>48.00</td>
<td>87.0%</td>
<td>10.08</td>
<td>0.311</td>
<td>48.00</td>
<td>84.4%</td>
</tr>
<tr>
<td>1.50</td>
<td>12.20</td>
<td>0.432</td>
<td>48.00</td>
<td>88.3%</td>
<td>10.08</td>
<td>0.369</td>
<td>48.00</td>
<td>85.4%</td>
</tr>
<tr>
<td>1.75</td>
<td>12.19</td>
<td>0.500</td>
<td>48.00</td>
<td>88.9%</td>
<td>10.07</td>
<td>0.426</td>
<td>48.00</td>
<td>86.2%</td>
</tr>
<tr>
<td>2.00</td>
<td>12.19</td>
<td>0.569</td>
<td>48.00</td>
<td>89.3%</td>
<td>10.07</td>
<td>0.485</td>
<td>48.00</td>
<td>86.5%</td>
</tr>
<tr>
<td>2.25</td>
<td>12.19</td>
<td>0.638</td>
<td>48.00</td>
<td>89.6%</td>
<td>10.06</td>
<td>0.543</td>
<td>48.00</td>
<td>86.8%</td>
</tr>
<tr>
<td>2.50</td>
<td>12.18</td>
<td>0.707</td>
<td>48.00</td>
<td>89.7%</td>
<td>10.06</td>
<td>0.603</td>
<td>48.00</td>
<td>86.9%</td>
</tr>
</tbody>
</table>
2.3 Thermal Images

Diode OR-ing:

FET OR-ing:
2.4 Photo

The board measures 89mm x 102mm. Shown with diode OR-ing.
3 Waveforms

3.1 Switching

VDS, Q8, 37V input, 2.5A load, 20V/div, 2usec/div, Measured 106.7Vpeak:

VDS, Q5, 57V input, 2.5A load, 10V/div, 2usec/div, Measured 44Vpeak:

VDS, Q10, 37V input, 2.5A load, 10V/div, 2usec/div, Measured 51Vpeak:
3.2 Voltage Ripple

Input ripple (C8), 20mV/div, 2usec/div, measured 39.3mVpp:

![Input ripple graph]

Output ripple (C41), 20mV/div, 2usec/div, measured 22mVpp:

![Output ripple graph]
### 3.3 Bode Plot

No adapter, 2.5A load:

- **Bandwidth**: 4.7 kHz
- **Phase Margin**: 75 degrees
- **Gain Margin**: 13 dB

Adapter, 0A load:

- **Bandwidth**: 6.1 kHz
- **Phase Margin**: 70 degrees
- **Gain Margin**: 13 dB
3.4 Load Transients

Output load step response, 1.25A to 2.50A load step
200mV/div, 1A/div, 2msec/div, slew rate = 250mA/usec
Measured 733mVpp:

Output load step response, 0A to 2.50A load step
500mV/div, 1A/div, 2msec/div, slew rate = 250mA/usec
Measured 1.45Vpp:
3.5 **Start-up Sequence**

0A load, 1msec/div, 2V/div:

![Graph 1](image1)

<table>
<thead>
<tr>
<th>Measure</th>
<th>P1rms(C3)</th>
<th>P2-...</th>
<th>P3-...</th>
<th>P4-...</th>
<th>P5-...</th>
<th>P6-...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>12.47 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Scope Parameters](image2)

2.5A load, 1msec/div, 2V/div:

![Graph 2](image3)

<table>
<thead>
<tr>
<th>Measure</th>
<th>P1rms(C3)</th>
<th>P2-...</th>
<th>P3-...</th>
<th>P4-...</th>
<th>P5-...</th>
<th>P6-...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>12.48 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Scope Parameters](image4)
4 Smooth Transition

4.1 FET OR-ing

4.1.1 PoE powering system with 2.5A load then connect adapter

CH1: Vout, 2V/div  CH3: Adapter Input, 5V/div  2msec/div

4.1.2 PoE powering system with 0A load then connect adapter

CH1: Vout, 2V/div  CH3: Adapter Input, 5V/div  2msec/div
4.1.3 Adapter powering system with 2.5A load then disconnect adapter

CH1: Vout, 2V/div   CH3: Adapter Input, 5V/div   2msec/div

4.1.4 Adapter powering system with 0A load then disconnect adapter

CH1: Vout, 2V/div   CH3: Adapter Input, 5V/div   2msec/div
4.2 Diode OR-ing

4.2.1 PoE powering system with 2.5A load then connect adapter

CH1: Vout, 2V/div    CH3: Adapter Input, 5V/div    200usec/div

4.2.2 PoE powering system with 0A load then connect adapter

CH1: Vout, 2V/div    CH3: Adapter Input, 5V/div    200usec/div
4.2.3 Adapter powering system with 2.5A load then disconnect adapter

CH1: Vout, 2V/div  CH3: Adapter Input, 5V/div  500usec/div

4.2.4 Adapter powering system with 0A load then disconnect adapter

CH1: Vout, 2V/div  CH3: Adapter Input, 5V/div  5msec/div
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