1. Photo

The PMP8965 is a 12.5W USB adapter reference design using the UCC28740 quasi-
resonant/discontinues flyback controller, with synchronous rectification to improve
efficiency using the UCC24610 Green Rectifier Controller. **Note that this reference
design is not an orderable device from TI, but shows the performance of a
UCC28740/UCC24610 in a constant voltage/constant current controller in a typical
12.5W USB adapter application.** This reference design converts 100V to 240V RMS
input voltage down to 5V DC, with a typical current limit of 2.65A for USB adapter
applications. Please note this design used a single sided PCB.

The PMP8965 reference design meets EU Tier 2 no load power (<75mW) requirements;
as well as, 10%, and 4 point average efficiency requirements. This design also meets the
DOE for low voltage external adaptors no load input power (<100mW) requirements; as
well as, 4 point average efficiency requirements.

![Figure 1, PMP8965 Reference Design, Dimensions 52mmX42mmX17.5mm](image)

2. Electrical Performance Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Notes &amp; Conditions</th>
<th>Min</th>
<th>Nom</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>INPUT CHARACTERISTICS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Voltage</td>
<td>VIN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>No Load Input Power @ 115/230V RMS</td>
<td>VIN = Nom, IOUT = 0A</td>
<td></td>
<td>100</td>
<td>115/230</td>
<td>240</td>
<td>mW</td>
</tr>
<tr>
<td>OUTPUT CHARACTERISTICS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Voltage</td>
<td>VOUT</td>
<td>VIN = Nom, IOUT = NOM</td>
<td>4.75</td>
<td>5</td>
<td>5.25</td>
<td>V</td>
</tr>
<tr>
<td>Line Regulation</td>
<td></td>
<td>VIN = Min to Max, IOUT = Nom</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>%</td>
</tr>
<tr>
<td>Load Regulation</td>
<td></td>
<td>VIN = Nom, IOUT = Min to Max</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>%</td>
</tr>
<tr>
<td>Output Voltage Ripple</td>
<td></td>
<td>VIN = Nom, IOUT = Max</td>
<td>-</td>
<td>200</td>
<td>mVpp</td>
<td></td>
</tr>
<tr>
<td>Output Current</td>
<td>IOUT</td>
<td>VIN = Min to Max</td>
<td>2.5</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Load Step(Vout = 4.1V to 6V)</td>
<td></td>
<td>0.25 to 2.5A</td>
<td>4.1</td>
<td>6</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>SYSTEMS CHARACTERISTICS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td></td>
<td>VIN = Min to Max, IOUT = Min to Max</td>
<td>25</td>
<td>40</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>
### 3. Efficiency

<table>
<thead>
<tr>
<th>Load</th>
<th>Pin</th>
<th>Pin</th>
<th>Efficiency @ 115V RMS</th>
<th>Pin</th>
<th>Pin</th>
<th>Efficiency @ 230V RMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>115</td>
<td>4.996</td>
<td>0.239</td>
<td>115</td>
<td>4.995</td>
<td>0.239</td>
</tr>
<tr>
<td>25%</td>
<td>115</td>
<td>4.994</td>
<td>0.633</td>
<td>230</td>
<td>4.994</td>
<td>0.533</td>
</tr>
<tr>
<td>50%</td>
<td>115</td>
<td>4.993</td>
<td>1.263</td>
<td>230</td>
<td>4.991</td>
<td>1.262</td>
</tr>
<tr>
<td>75%</td>
<td>115</td>
<td>4.991</td>
<td>1.891</td>
<td>230</td>
<td>4.989</td>
<td>1.890</td>
</tr>
<tr>
<td>100%</td>
<td>115</td>
<td>4.990</td>
<td>2.496</td>
<td>230</td>
<td>4.987</td>
<td>2.496</td>
</tr>
</tbody>
</table>

**Four Point Average Efficiency**: 85.5%

**DOE 10% Load Tier 2 Minimum Efficiency**: 71.3%

**EU Tier 2 Minimum**: 80.6%

### 4. VI Curves
5. No Load Input Power
   a. Meets European Union (EU) Tier 2 < 75mW no Load requirements
   b. Meets Department of Energy (DOE) < 100mW

<table>
<thead>
<tr>
<th>Vin</th>
<th>Pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 V RMS</td>
<td>24 mW</td>
</tr>
<tr>
<td>115 V RMS</td>
<td>26 mW</td>
</tr>
<tr>
<td>230 V RMS</td>
<td>33 mW</td>
</tr>
<tr>
<td>265V RMS</td>
<td>35 mW</td>
</tr>
</tbody>
</table>

6. Q1 Drain Voltage at Full Load (CH1, Differential Probe 1:200)

Vin = 90V RMS

Vin = 265V RMS
7. **Startup 115V RMS**

   ![Graph](image1)

   - No Load
   - 2 ohm, Full Load

8. **Startup 230V RMS**

   ![Graph](image2)

   - No Load
   - 2 ohm, Full Load

9. **Startup in less than 600ms after line voltage is applied**

   a. (CH1 = Vout, CH2 = Voltage across C15)

   - \( Vin = 90 \text{ V RMS} \)
   - \( Vin = 265 \text{ V RMS} \)
10. Please note that this reference design does not pass EMI and the design will require more work/adjustments to pass EMI specifications.
   a. EMI data taken with shielded transformer grounded.

Vin = 230V RMS, Full Load

11. Load Transients
   a. CH1 = Vout, With 5V Offset, CH2 = Iout
   b. 0.25 to 2.5A Load Step

Vin = 115V RMS

Vin = 230V RMS
c. 2.5 to 0.25A Load Step

Vin = 115V RMS  \hspace{1cm} \text{Vin} = 230V RMS

12. Output Ripple Voltage
   a. CH1 = Vout, CH2 = Measured at the load after 1M of cable and 1uF of filter capacitance
      Vin = 115V RMS, Full Load  \hspace{1cm} \text{Vin} = 230V RMS, Full Load
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