Test Report: PMP22210

High-Efficiency Neutral-Less Upside-Down Buck
With 12-V/30-mA Output Reference Design

Description
This reference design uses the UCC28910 in an upside-down buck topology to make a 12-V output capable of 30-mA loading from a 120-Vac input. The design can achieve over 70% efficiency at full loading. All components are placed on one side of the board to reduce assembly complexity and cost. The overall dimensions are 1.35” x 1.35” for the board with a max height of 0.3” (excluding test points). Across loading conditions the floating output stays within 1% regulation.

![Board Top]

Figure 1. Board Top
1 Test Prerequisites

1.1 Voltage and Current Requirements

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SPECIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage Range</td>
<td>120 Vac +/- 10%</td>
</tr>
<tr>
<td>Output Voltage</td>
<td>12 V +/- 1%</td>
</tr>
<tr>
<td>Output Current</td>
<td>30 mA</td>
</tr>
<tr>
<td>Switching Frequency</td>
<td>36 kHz</td>
</tr>
</tbody>
</table>

1.2 Considerations

Except for load transient measurements, resistive load was used. Unless otherwise indicated the input voltage was set to 120 Vac.
2 Testing and Results

2.1 Efficiency Graphs

![Efficiency Graph with 12 Vdc Input](image)

**Figure 3.** Efficiency with 12 Vdc Input

2.2 Load Regulation

![Load Regulation Graph with 9 Vdc Input](image)

**Figure 4.** Efficiency with 9 Vdc Input
2.3 Efficiency Data

<table>
<thead>
<tr>
<th>Power Factor</th>
<th>Input Power (mW)</th>
<th>Input Voltage (Vrms)</th>
<th>Input Current (mA RMS)</th>
<th>Output Voltage (Vdc)</th>
<th>Output Current (mA)</th>
<th>Output Power (mW)</th>
<th>Total Efficiency (%)</th>
<th>Power Loss (mW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.324</td>
<td>123.8</td>
<td>120.19</td>
<td>3.183</td>
<td>11.9896</td>
<td>5.009</td>
<td>59.959</td>
<td>48.44</td>
<td>63.841</td>
</tr>
<tr>
<td>0.370</td>
<td>216.3</td>
<td>120.19</td>
<td>4.864</td>
<td>12.0186</td>
<td>10.006</td>
<td>120.257</td>
<td>55.597</td>
<td>96.043</td>
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<tr>
<td>0.400</td>
<td>290.9</td>
<td>120.19</td>
<td>6.057</td>
<td>12.0217</td>
<td>15.010</td>
<td>180.446</td>
<td>62.030</td>
<td>110.454</td>
</tr>
<tr>
<td>0.419</td>
<td>363.3</td>
<td>120.19</td>
<td>7.208</td>
<td>12.0402</td>
<td>20.048</td>
<td>241.382</td>
<td>66.441</td>
<td>121.918</td>
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<tr>
<td>0.437</td>
<td>436.8</td>
<td>120.18</td>
<td>8.317</td>
<td>12.0715</td>
<td>25.008</td>
<td>301.884</td>
<td>69.113</td>
<td>134.916</td>
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<tr>
<td>0.449</td>
<td>502.7</td>
<td>120.19</td>
<td>9.323</td>
<td>12.0655</td>
<td>30.011</td>
<td>362.098</td>
<td>72.031</td>
<td>140.602</td>
</tr>
</tbody>
</table>

Figure 5. Efficiency data

2.4 Thermal Images

Thermal image was taken after a 30 minute soak with the 12 V output at 30 mA loading and no airflow.

Figure 6. Board Top
Figure 7. Switching node with 30 mA load on the output
3.2 Output Voltage Ripple

Measurements were taken using the tip and barrel method across the output cap with the output at full load and a 12 Vdc input.

Figure 8.
3.3 Load Transients

For this measurement the output current was stepped between 5 mA and 25 mA at the 12 Vdc output.

Figure 9.
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