**Test Report: PMP21007**

**HV AC-DC buck converter reference design with ultra wide input voltage range**

**Description**

The PMP21007 reference design is an AC-DC Buck converter reference design with ultra-wide input range (20.4-Vac to 276-Vac). Using UCC28881 controller, we only need minimum number of discrete components as the controller has integrated the main switch and high voltage startup with low quiescent current needed. To allow sufficient supply current to the UCC28881 controller, a depletion MOSFET circuit is added as a low power dissipation current source. This design is able to provide 12-V/50-mA output.
1 System Specification

1.1 Board Dimension:

1” x 3.4” x 0.85”

1.2 Input/output Characteristics

The power supply unit should be able to supply 12V/50mA output with 20.4VAC to 276VAC input.
2 Testing and Results

2.1 Board Photos
The photographs below show the top and bottom view of the PMP21007Rev A board. This circuit was built on a PMP20654 Rev A.

2.1.1 Top Side

2.1.2 Bottom Side
2.2 No-Load Regulation

<table>
<thead>
<tr>
<th>Vin (V_{AC})</th>
<th>I_{out} (mA)</th>
<th>V_{out} (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20.4</td>
<td>0</td>
<td>12.34</td>
</tr>
<tr>
<td>150</td>
<td>0</td>
<td>13.03</td>
</tr>
<tr>
<td>270</td>
<td>0</td>
<td>13.08</td>
</tr>
</tbody>
</table>

2.3 Converter Efficiency

![Graph showing efficiency (%) vs. output current (mA) for 20.4VAC, 150VAC, and 270VAC.]
2.4 Thermal Images
The thermal images below show a top view of the board. The ambient temperature was 20°C with no forced air flow. The output was at full load: 12V/50mA.

2.4.1 $V_{in}=20.4V_{AC}/60Hz$

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient</td>
<td>22.0°C</td>
</tr>
<tr>
<td>Area analysis</td>
<td>Value</td>
</tr>
<tr>
<td>$U_1_{Max}$</td>
<td>31.4°C</td>
</tr>
<tr>
<td>$D_3_{Max}$</td>
<td>27.7°C</td>
</tr>
<tr>
<td>$L_1_{Max}$</td>
<td>27.8°C</td>
</tr>
</tbody>
</table>
## 2.4.2 $V_{in}=270V_{AC}/60Hz$

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient</td>
<td>25.0°C</td>
</tr>
<tr>
<td>Area analysis</td>
<td></td>
</tr>
<tr>
<td>$U1_{Max}$</td>
<td>33.0°C</td>
</tr>
<tr>
<td>$L1_{Max}$</td>
<td>38.6°C</td>
</tr>
<tr>
<td>$D3_{Max}$</td>
<td>31.3°C</td>
</tr>
</tbody>
</table>
2.5  **Startup**  
The output voltages at startup are shown in the images below.

2.5.1  **Start Up @ 20.4V\textsubscript{AC}: 12V/50mA.**

2.5.2  **Start Up @ 20.4V\textsubscript{AC}: no load.**
2.5.3 Start Up @ 150VAC: 12V/50mA.

2.5.4 Start Up @ 150VAC: 12V/50mA.
2.5.5 Start Up @ 270VAC: 12V/50mA.

2.5.6 Start Up @ 270VAC: no load.
2.6 Turn Off

The output voltage at turn off transient is shown in the image below at full load (12V/50mA).

2.6.1 Turn off @ 20.4V<sub>AC</sub>: 12V/50mA.
2.6.2 Turn off @ 150V<sub>AC</sub>: 12V/50mA.

![Graph showing turn off at 150V<sub>AC</sub> with 12V/50mA.]

2.6.3 Turn off @ 270V<sub>AC</sub>: 12V/50mA.

![Graph showing turn off at 270V<sub>AC</sub> with 12V/50mA.]

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2.7 Output Ripple Voltages
The output ripple voltages are shown in the plots below.

2.7.1 20.4V\textsubscript{AC}: 12V/50mA:

2.7.2 20.4V\textsubscript{AC}: no load:
2.7.3 150V<sub>AC</sub>: 12V/50mA:

2.7.4 150V<sub>AC</sub>: no load:
2.7.5 270V\textsubscript{AC}: 12V/50mA:

2.7.6 270V\textsubscript{AC}: no load:
2.8 Switching Waveforms

2.8.1 Diode D3 @ 20.4\text{V}_{AC}/60\text{Hz}

2.8.2 Diode D3 @ 270\text{V}_{AC}/60\text{Hz}
2.8.3 L1 current @ 20.4AC (12V/50mA)

2.8.4 L1 current @ 270VAC (12V/50mA)
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