PMP10210RevB Test Results

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Topology: inverting BuckBoost, built on buck PCB PMP2763 RevA
Device: TPS54060A

Unless otherwise mentioned, the measurements were done with 150mA output current

Static measurements:
ON @ 8.5V OK
Fsw 485kHz OK
1 Startup

The startup waveform is shown in the Figure 1. The input voltage was set at 9V:

![Figure 1](image1)

The startup waveform is shown in the Figure 2. The input voltage was set at 14V:

![Figure 2](image2)
The startup waveform is shown in the Figure 3. The input voltage was set at 18V:

- **Ch1**: input voltage, 5V/div
- **Ch2**: output voltage, 5V/div
- 20ms/div
- 20MHz bw

![Figure 3](image)
2 Shutdown

The shutdown waveform is shown in the Figure 4. The input voltage was set at 9V. The power supply was disconnected.

![Figure 4](image1)

The shutdown waveform is shown in the Figure 5. The input voltage was set at 14V. The power supply was disconnected.

![Figure 5](image2)
The shutdown waveform is shown in the Figure 6. The input voltage was set at 18V. The power supply was disconnected.
3 Efficiency

The efficiency is shown in the Figure 7 below. The input voltage was set to 9V, 14V and 18V. Using inductor DR125-221-R will improve efficiency 1%..2% (size is 12.5mm x 12.5mm x 6mm)

Figure 7
4 Load Regulation

The load regulation of the output is shown in the Figure 8 below. The input voltage was set to 9V, 14V and 18V.

![Figure 8](image_url)
5 Line Regulation

The line regulation is shown in Figure 9.

![Figure 9](image9)

With the same setup the efficiencies are shown in Figure 10.

![Figure 10](image10)
6  Output Ripple Voltage
The output ripple voltage is shown in Figure 11, ripple is below 50mVpp at bandwidth 200MHz.

7  Input Ripple Voltage
The input ripple voltage is shown in Figure 12.
8  Loop Compensation & Transient Response

Revision A, calculated for Fco 1kHz,
compensation ZERO at load pole 30Hz
compensation POLE at 30kHz
R1 53k6 / C10 100nF / C9 100pF

Measured at min. Vin 9V (= max. duty = lowest RHPZ = worst case) and at full load 150mA

Loop compensation designed ultraconservative for flyback topology; high phase & gain margin.
Results correspond to calculations:
- crossover frequency 931 Hz
- 85 degs phase margin
- -25 dB gain margin
- slope -1.1 (roughly -20dB/decade)

Next step is to increase gain by nearly x3 by keeping compensation pole and zero;
A shift in gain close to +9dB could be expected, crossover in the area 2 kHz to 3 kHz.
Revision A1, calculated for crossover frequency 2.5kHz, compensation ZERO at load pole 30Hz compensation POLE at 30kHz

\[ R1 \ 150k / C10 \ 33nF / C9 \ 33pF \]

crossover frequency 2.4 kHz, 76 degs phase margin, -16dB gain margin, slope -1, PERFECT

Bode Plot is small signal analysis in frequency domain, now large signal analysis in time domain, the TRUE behavior of the power supply:

load transient 10mA <->150mA, deviation 250mV = 1.8% of Vout -14V:

Figure 13 150k
Revision B, calculated for Fco 5kHz, twice the gain, +6dB, “pushing the edge”
compensation ZERO at load pole 30Hz
moved compensation POLE to 50kHz, a decade above crossover
\( R1 \ 309k / C10 \ 15nF / C9 \ 10pF \)
crossover frequency 4.97 kHz, 64 phase margin, -12dB gain margin (!), slope -1
load transient 10mA <-> 150mA, deviation 160mV = 1.1% of Vout -14V:

Figure 14 309k

Figure 14 309k
9 Miscellaneous Waveforms

Switch to -VOUT

The waveform of the voltage on switchnode is shown in Figure 15. Input voltage was set to 9V.

![Waveform Diagram]

no ringing, no overshoot
The waveform of the voltage on switchnode is shown in Figure 16. Input voltage was set to 14V. 

Figure 16 

no ringing, no overshoot
The waveform of the voltage on swichnode is shown in Figure 17. Input voltage was set to 18V.

Figure 17

no ringing, no overshoot
10 Thermal Image

Figure 18 shows the thermal image at 14V input voltage and 200mA output current (=overload condition). The picture has been taken after one hour operation, NO FORCED COOLING, PCB horizontally:

Temperature rise at inductor slightly more than 20K - silicon far below 20K;

Main Image Markers

<table>
<thead>
<tr>
<th>Name</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>L2</td>
<td>44.3°C</td>
</tr>
<tr>
<td>U1</td>
<td>38.9°C</td>
</tr>
<tr>
<td>D2</td>
<td>35.9°C</td>
</tr>
</tbody>
</table>
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