07/07/15
PMP10081RevC Test Results

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Topology: SEPIC, added CC charging by additional current ctr (via TLC272)
Device: TPS40210 and CSD18563Q5A

Unless otherwise indicated, resistive load was applied, load current was set to 1.5A;
For charger verification battery YUASA NP 5-12 (= 12V, 5Ah, AGM) was used;
here load current has been set to 1.0A (5Ah @ 20%).

Static measurements:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Fsw</td>
<td>302kHz</td>
<td>OK</td>
</tr>
<tr>
<td>ON</td>
<td>8.8V</td>
<td>OK</td>
</tr>
<tr>
<td>OFF</td>
<td>7.6V</td>
<td>OK</td>
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</table>
Picture A shows the 20W SEPIC power stage controlled by TPS40210 and driven by CSD18563:

Picture B shows the test setup electronic load, resistive load and – here - lead acid battery 5Ah:
1 Startup

The CV startup waveform is shown in the Figure 1. The input voltage was set to 9V,Css 220nF.

![Figure 1](image)

The CV startup waveform is shown in the Figure 2. The input voltage was set to 24V.

![Figure 2](image)
The CV startup waveform is shown in the Figure 3. The input voltage was set to 36V.
2 Shutdown

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

The CV shutdown waveform is shown in the Figure 5. The input voltage was set to 24V. The power supply was disconnected.
The CV shutdown waveform is shown in the Figure 6. The input voltage was set to 36V. The power supply was disconnected.

Figure 6

Ch1=> input voltage
10V/div
Ch2=> output voltage
5V/div
5ms/div
20MHz bw
3 Efficiency

The CV efficiency is shown in the Figure 7 below. The input voltage was set to 9V, 24V and 36V (resistive load).

![Figure 7](image-url)
4 Load Regulation

The CV load regulation of the output is shown in the Figure 8 below. The input voltage was set to 9V, 24V and 36V (resistive load).

![Graph showing load regulation](image)
5 Line Regulation

The CV line regulation is shown in Figure 9. The output current was set about 1.5A.

![Figure 9](image)

With the same setup efficiencies were calculated. This is shown in Figure 10.

![Figure 10](image)
6 Output Ripple Voltage

The CV output ripple voltage at full load 1.5A is shown in Figure 11.

[Diagram showing output ripple voltage measurements with CH1, CH2, and CH3 at different input voltages.

7 Input Ripple Voltage

The input ripple voltage is shown in Figure 12.

[Diagram showing input ripple voltage measurements with CH1, CH2, and CH3 at different input voltages.]
8 Load Transients

The Figure 13 shows the response to load transients with 9V input voltage. The load is switching from 0.75A to 1.5A with 30Hz. N3305 load was used.

Ch1 => output voltage
50mA/div
AC coupling
Ch2 => output current 500mA/div
20MHz bw
5ms/div

The Figure 14 shows the response to load transients with 24V input voltage. The load is switching from 0.75A to 1.5A with a frequency of 30Hz (load N3305A).

Ch1 => output voltage 50mV/div
AC coupled
Ch2 => output current 500mA/div
20MHz bw
5ms/div
The Figure 15 shows the response to load transients with 36V input voltage. The load is switching from 0.75A to 1.5A with a frequency of 30Hz. (N3305 load)

Figure 15
9 Control Loop Frequency Response

Input voltage was set worst case to 9V input, so at maximum duty cycle RHPZ is lowest.

9.1 Resistive Load

Figure 16 shows the closed loop voltage controlled = CV at a load current of 500mA.

Figure 17 shows the closed loop current controlled = CC at a load current of 1A.
9.2 True C/V Battery Loading @ 12V 5Ah

Figure 18, first - current controlled loading at 1A constant current, voltage rises:

Figure 19, second – transfer current control to voltage control, loading now at 13.8V/700mA
Figure 20, further **voltage control**, charging current drops, shown 700mA – 200mA – 70mA

Figure 21 shows comparison voltage control (ye/or) and current control 900mA (rd/bl)
Table 1 + 2 summarizes the results of the Bode measurements:

<table>
<thead>
<tr>
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<th>R Load</th>
<th>5Ah Battery</th>
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<tr>
<td></td>
<td>Vin</td>
<td>V ctrl</td>
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<tr>
<td>Bandwidth (Hz)</td>
<td>296.8</td>
<td>7306</td>
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<td>Phase margin</td>
<td>95.78°</td>
<td>62.54°</td>
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<tr>
<td>slope (20dB/decade)</td>
<td>-0.955</td>
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<tr>
<td>gain margin (dB)</td>
<td>-30.76</td>
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<tr>
<td>slope (20dB/decade)</td>
<td>-1.93</td>
<td>-1.42</td>
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<tr>
<td>freq (Hz)</td>
<td>2565</td>
<td>27230</td>
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</table>

Table 1

<table>
<thead>
<tr>
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<th>5Ah Battery</th>
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<tr>
<td></td>
<td>Vin</td>
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<tr>
<td>Bandwidth (Hz)</td>
<td>52</td>
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<tr>
<td>Phase margin</td>
<td>121°</td>
</tr>
<tr>
<td>slope (20dB/decade)</td>
<td>-0.85</td>
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Table 2

CC/CV loading has been verified at true battery; current control charges battery with constant current set point 1000mA and voltage at battery increases = CC loading. Touching the voltage set point at 13.8V voltage control takes over and charges the battery further at constant voltage 13.8V while current drops continuously = CV loading. Continuously load current decreases to 5mA holdup current.
10 Miscellaneous Waveforms

10.1 Switchnode (drain-source)

The waveform of the voltage on switchnode (drain to source) is shown in Figure 22. Input voltage was set to 9V.

Ch1 =>
5V/div
500ns/div
full bandwidth

Ch1 =>
5V/div
20ns/div

Figure 22
The waveform of the voltage on switchnode (drain to source) is shown in Figure 23. Input voltage was set to 24V.
The waveform of the voltage on switchnode (drain to source) is shown in Figure 24. Input voltage was set to 36V.
10.2 Gate to Source

The waveform of the voltage on the gate to source is shown in Fig. 25. Input voltage was set to 9V.

Figure 25
The waveform of the voltage on gate to source is shown in Figure 26. Input voltage was set to 24V.
The waveform of the voltage on gate to source is shown in Figure 27. Input voltage was set to 36V.
10.3 Voltage D3 (referenced to VOUT)

The waveform of the voltage is shown in Figure 28. Input voltage was set to 9V.

![Waveform Diagram]

Figure 28
The waveform of the voltage is shown in Figure 29. Input voltage was set to 24V.
The waveform of the voltage is shown in Figure 30. Input voltage was set to 36V.
11 Thermal Image

Figure 31 shows the thermal image at 24V input voltage and full load 1.5A for >1hr.

<table>
<thead>
<tr>
<th>Name</th>
<th>Temperature</th>
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<tbody>
<tr>
<td>D3</td>
<td>58.0°C</td>
</tr>
<tr>
<td>L2</td>
<td>56.1°C</td>
</tr>
<tr>
<td>R14</td>
<td>53.0°C</td>
</tr>
<tr>
<td>R13</td>
<td>54.3°C</td>
</tr>
<tr>
<td>Q2</td>
<td>52.3°C</td>
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