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Full load testing:
PMP5099 Test Base with remote sense and 5mOhm current sense resistors for each channel:
Input: 5.09V at 3.929A to both fixture and module
All 4 channels sync’ed to TLC555 timer at 472kHz

Channel 1: AVCC 1.100V at 5.1A rating
Actual current 5.104A to Kikisui load:
1.097V at fixture sense points and 1.141V on module power connector

Channel 2: AVCCRX 1.100V at 3.45A rating
Actual current 3.42A to four 80mOhm resistors in series:
1.100V at fixture sense points and 1.134V on module power connector

Channel 3: AVTT 1.200V at 3.45A rating
Actual current 1.50A to three 250mOhm resistors and one 40mOhms in series:
1.196V at fixture sense points and 1.212V on module power connector

Channel 4: AVCCPLL 1.800V at 2.6A rating
Actual current 2.62A to four 150mOhm resistors and one 80mOhms in series:
1.798V at fixture sense points and 1.820V on module power connector

All outputs within ½ % of targets. Also at no load they were at same values within 1mV.

Power in is 20.00W
Power from all 4 outputs at the J2 MPS-08-7.70-01-L-V connector is:
5.824W + 3.878W + 1.818W + 4.768W or 16.29W
Overall efficiency is 81.5%
3.7 Watts on module board itself
See next page for Thermal data / picture
Thermal data:
PMP5098: 5.1Vin all outputs at full load 3.7W on board
Hottest snubber R116 at 79, lo side FET Q102 at 73.4
hi side Q101 at 69, choke L101 at 72, Q201/2 at 68, R216 at 70,
L201 at 51, Q302 at 64, R316 at 66, Q402 at 67, R416 at 64
ambient 25-28degC
Main waveforms for each channel: start with channel 1: AVCC 1.1V 5.1A
24-Nov-09
13:45:23

Now AVCCRX: 1.1V 3.45A
24-Nov-09
13:46:42
Main waveforms: Continued; Now AVTT 1.2V 1.5A
24-Nov-09
13:47:30

Finally, main waveform for AVCCPLL targeting 1.8V at 2.6A
24-Nov-09
13:49:00
Output ripple: 5.1Vin and all 4 channels at full load:
Start with channel 1: AVCC: measured on Test Base at load connection across 22uF cap
24-Nov-09
13:22:40

\[ \text{Maximum} = 2.64 \text{mV} \]
\[ \text{Frequency} = 165.824 \text{kHz} \]
\[ \text{Ppk} = 5.00 \text{mV} \]
\[ \text{Ppkk} = 5.00 \text{mV} \]
\[ \text{Mean} = -37.3 \text{mV} \]
\[ \text{Vpp} = 0.09 \text{mV} \]

Now channel 2: AVCCRX
24-Nov-09
13:23:50

\[ \text{Maximum} = 1.58 \text{mV} \]
\[ \text{Frequency} = 56.9539 \text{kHz} \]
\[ \text{Ppk} = 3.19 \text{mV} \]
\[ \text{Ppkk} = 1.5 \text{mV} \]
\[ \text{Mean} = -15 \text{mV} \]
\[ \text{Vpp} = 0.09 \text{mV} \]
Output ripple: continued:
Now channel 3: AVTT: 1.196V at 1.50A
24-Nov-09
13:25:12

Finally, AVCCPLL 1.8V at 2.6A
24-Nov-09
13:25:53
Input ripple on input bypass cap(s): Cx14 and Cx15
Worst case was channel 4 AVCCPLL: at 66mVp-p
AVCC had 52mV p-p; AVCCRX had 51mV p-p and AVTT had 59mV p-p

![Waveform diagram]

Max input ripple to channel 4 at input bypass caps

Other channels had 51 to 59mV p-p ripple
Max allowed is not specified for this project
General good EMI practice is to target <100mV p-p
Start up and shutdown: Turn on thresholds not yet programmed
24-Nov-09
19:33:30

Start up: 5Vin applied abruptly
all 4 outputs have resistive loads near rated load
Start up when 5Vin plugged in

1 ms
0.58 V

1 ms
1.08 V

Bump up is real, as it was not seen on channel when probe tied to return

Shutdown: 5Vin removed abruptly (unplugged)
24-Nov-09
19:34:21

Shutdown when 5Vin unplugged abruptly
note: No programming yet to TPS40400s to set turn on/off thresholds. All outputs at load connections

1 ms
0.59 V

1 ms
1.09 V

Bump up is real, as it was not seen on channel when probe tied to return

Note: All outputs have resistive loads near rated load
### Configuration parameters for all 4 outputs:

<table>
<thead>
<tr>
<th>Output name</th>
<th>units</th>
<th>AVCC</th>
<th>AVCCRX</th>
<th>AVTT</th>
<th>AVCCPLL</th>
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<tbody>
<tr>
<td>Vout</td>
<td>Volts</td>
<td>1.1</td>
<td>1.1</td>
<td>1.2</td>
<td>5.1</td>
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<tr>
<td>Imax</td>
<td>Amperes</td>
<td>5.1</td>
<td>3.45</td>
<td>1.5</td>
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<tr>
<td>PMBus add</td>
<td>decimal</td>
<td>24</td>
<td>25</td>
<td>26</td>
<td>27</td>
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<td>Alt address</td>
<td>decimal</td>
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<td>33</td>
<td>34</td>
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<tr>
<td>Vout loop scale</td>
<td>Volts</td>
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<td>0.50</td>
<td>0.332</td>
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<tr>
<td>Current sense</td>
<td>Milli-ohms</td>
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<td>5.0</td>
<td>5.0</td>
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<td>Margin High</td>
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<td>1.319</td>
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<td>Margin Low</td>
<td>Volts</td>
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<td>1.079</td>
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<td>Switching frequency</td>
<td>kHz</td>
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<td>384</td>
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<td>Toff setting</td>
<td>Nano-seconds</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
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<tr>
<td>Vin on rising</td>
<td>Volts</td>
<td>4.0</td>
<td>4.5</td>
<td>4.5</td>
<td>4.5</td>
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<tr>
<td>Vin off falling</td>
<td>Volts</td>
<td>3.5</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
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<tr>
<td>Overvoltage thres.</td>
<td>Volts</td>
<td>1.32</td>
<td>1.32</td>
<td>1.439</td>
<td>2.159</td>
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<tr>
<td>OV response</td>
<td>Hex see note 1</td>
<td>0xBC</td>
<td>0xBC</td>
<td>0xBC</td>
<td>0xBC</td>
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<tr>
<td>Undervoltage thres.</td>
<td>Volts</td>
<td>0.989</td>
<td>0.989</td>
<td>1.08</td>
<td>1.6</td>
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<tr>
<td>UV response</td>
<td>Hex see note 2</td>
<td>0x04</td>
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<td>0x04</td>
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<tr>
<td>Overcurrent fault (OC)</td>
<td>Amperes</td>
<td>6.5</td>
<td>4.5</td>
<td>3.0</td>
<td>4.0</td>
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<tr>
<td>OC response</td>
<td>Hex see note 3</td>
<td>0xBC</td>
<td>0xBC</td>
<td>0xBC</td>
<td>0xBC</td>
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<tr>
<td>Overload warning</td>
<td>Amperes</td>
<td>6.0</td>
<td>4.0</td>
<td>2.5</td>
<td>3.5</td>
</tr>
<tr>
<td>Over temp. response</td>
<td>Hex see note 4</td>
<td>0xC0</td>
<td>0xC0</td>
<td>0xC0</td>
<td>0xC0</td>
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<tr>
<td>On / off</td>
<td>Always on</td>
<td>Always on</td>
<td>CNTL HI</td>
<td>CNTL HI</td>
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<tr>
<td>Power Good rising</td>
<td>Volts</td>
<td>1.05</td>
<td>1.05</td>
<td>1.14</td>
<td>1.699</td>
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<tr>
<td>Power Good falling</td>
<td>Volts</td>
<td>1.00</td>
<td>1.00</td>
<td>1.09</td>
<td>1.649</td>
</tr>
<tr>
<td>Rise time</td>
<td>Milli-sec</td>
<td>0.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>

**Notes:**
1: OV response: 0xBC means immediate shutdown and continuous retry with soft-start
2: UV response: 0x04 means continue to run uninterrupted
3: OC response: 0xBC means immediate shutdown and continuous retry with soft-start
4: OT response: 0xC0 means immediate shutdown with retry after cool down below hysteresis
Start up after programming:

- 10-Dec-09
- 13:39:46

- 1 ms 0.58 V
- 1.30 V

Details of race between AVCC and AVCCRX:

- 19-Dec-09
- 12:54:25

- 0.2 ms 200mV
- 0.1 V DC 0.58 V

josh mandelcorn
Race between AVCC and AVCCRX at no load:

10-Dec-09
12:59:40

- .2 ms 203mV

- .2 ms 203mV

- .2 ms 203mV

- .2 ms 203mV

<table>
<thead>
<tr>
<th>Channel</th>
<th>Input Voltage (mV)</th>
<th>DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20</td>
<td>DC</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td>DC</td>
</tr>
<tr>
<td>3</td>
<td>50</td>
<td>DC</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>DC</td>
</tr>
</tbody>
</table>

- .2 ms EWL mean(4) ↓ -4nV

- Maximum(1) 1.087 V
- Freq(1) -
- pkpk(1) 1.081 V
- mean(1) 728.6 mV

Shutdown when input unplugged:

10-Dec-09
13:33:55

- .1 ms 0.56 V

- .1 ms 0.56 V

- .1 ms 0.56 V

- .1 ms 1.08 V

<table>
<thead>
<tr>
<th>Channel</th>
<th>Input Voltage (mV)</th>
<th>DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50</td>
<td>DC</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>DC</td>
</tr>
<tr>
<td>3</td>
<td>50</td>
<td>DC</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>DC</td>
</tr>
</tbody>
</table>

- .1 ms EWL mean(4) 955 mV

- Maximum(1) 1.125 V
- Freq(1) -
- pkpk(1) 1.224 V
- mean(1) 549.6 mV

- 1 DC 0.812 V

- Channel 1 brown: AVCC 1.1V at no load
- Channel 2 green: AVCCRX 1.1V at no load
- AVCCRX starts first, but AVCC catches up and then
- leads AVCCRX by about 100us to full 1.1V
- time and voltage scales expanded to show detail
- 1.2V and 1.8V (not shown) start rising about
- 1.5ms after AVCCRX reaches regulation

PMP5096: 5Vin all 4 outputs fully loaded model to
all 4 channels of TPS40400 programme

Turn on with 5V applied abruptly

Channel 1 brown: AVCC 1.1V at 5.3A - off last
Channel 2 green: AVCCRX 1.1V at 3.4A - off third
Channel 3 red: AVTT 1.2V at 1.5A - off first
Channel 4 blue: AVCCPLL 1.8V 2.6A - off second
Noise spike where 4 amperes to input interrupted
by pulling plug connection

Josh Mandelcorn page 11 of 12 November 24- Dec. 10, 2009
Bode Plots: (model t4 used)

AVCC:

AVCCRX: (Note: AVTT and AVCCPLL have same filter / compensation as AVCCRX)
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