The **PMP7246** is a 350W High Speed Full Bridge Phase Shift ZVT – Galvanic Isolated Full Bridge Synchronous Rectification DC/DC reference design. It is built for telecom applications to supply a RF PA stage. On board is additional 12V/5A power stage made in half bridge topology.

The main converter is a two quadrant converter, working forward in voltage mode control and working backward in average current mode limitation. This limitation is adjustable. Control input has a slope limitation, adjustable as well.

Picture of the board – Top side

Picture of the board – Bottom side

Dimensions: 217mm × 96mm
This board has been tested, according to the test report, at 36V, 48V, 55Vin, full load, with a cooling fan with 32 cfm placed at 10cm distance. Connected load described in the specification document (100nH + 20×10μF X7R ceramic capacitors).

1 Power supply description

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Description</th>
<th>Capability</th>
<th>Remarks</th>
<th>Comments</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Minimum Input voltage</td>
<td>36V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Maximum Input voltage</td>
<td>60V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Output voltage</td>
<td>20V to 32V</td>
<td>Adjustable</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Isolation Primary - secondary</td>
<td>500Vdc</td>
<td></td>
<td></td>
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<tr>
<td>5</td>
<td>DC accuracy/tolerance for the output voltage</td>
<td>+/- 2%</td>
<td></td>
<td></td>
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<tr>
<td>6</td>
<td>Output voltage ripple</td>
<td>100mVpp (20MHz BW)</td>
<td>Transformer need another isolation for higher temperatures</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Maximum continuous output current</td>
<td>12A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Efficiency</td>
<td>&gt;90%</td>
<td>for currents 6A -11A</td>
<td>see the measurements</td>
</tr>
<tr>
<td>9</td>
<td>Efficiency</td>
<td>&gt;85%</td>
<td>for currents 1A -2A</td>
<td>see the measurements</td>
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<td>10</td>
<td>Transient performance</td>
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<td>11</td>
<td>Overshoot</td>
<td>&lt;1.5V</td>
<td>output current 0A-11A</td>
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<td>Undershoot</td>
<td>&lt;1.5V</td>
<td>output current 0A-11A</td>
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<td>&lt;200us</td>
<td>@ constant output current 1A</td>
<td>see the measurements</td>
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<td>14</td>
<td>Analog control input</td>
<td>≥10k Ohm input impedance</td>
<td>3.3Vpp maximum</td>
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<td>15</td>
<td>Output voltage overshoot or undershoot when tuning the output voltage</td>
<td>&lt;1.5%</td>
<td></td>
<td>see the measurements</td>
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<td>16</td>
<td>ON/OFF function</td>
<td>active low/active high</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Power good (PGOOD)</td>
<td>No function available</td>
<td></td>
<td></td>
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<tr>
<td>18</td>
<td>Board size</td>
<td>217mm x 96mm</td>
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<td></td>
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<tr>
<td>19</td>
<td>Absolute maximum components height - top side</td>
<td>15mm</td>
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<td></td>
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<td>20</td>
<td>Absolute maximum components height - bottom side</td>
<td>3mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Component placement</td>
<td>Top &amp; Bottom side</td>
<td></td>
<td></td>
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<tr>
<td>22</td>
<td>Power MOSFETs package</td>
<td>PowerPAK SO8</td>
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<td></td>
</tr>
<tr>
<td>23</td>
<td>Operating temperature range</td>
<td>-40 to +90 deg C.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2 Efficiency

The efficiency data are shown in the graph below. The load consisted of an electronic load, manually adjusted; the power supply is able to deliver a maximum current of 55A.

Efficiency curve measured at 36V, 48Vin, 55Vin and 32Vout; the graph shows the efficiency versus output current (maximum 32V*11A)
Efficiency curve measured at 36V, 48V, 55Vin and 20V out; the graph shows the efficiency versus output current (maximum 20V * 7A).
3 Output voltage regulation

The output voltage regulation versus output current
4 Output ripple voltage

Output ripple voltage – measured directly on the converters output – 100mVpp

Output ripple voltage – measured directly on the 200uF (RF Amplifier) – 15mVpp
5 Transient response (load current switched)

The fast transient load step current was produced with a 2.9Ohm. Switching time ON & OFF is in the range of 100ns.

Yellow – Output voltage AC coupled 200MHz band with – 1.2V
Blue – Current on the converters output

The same with markers for overshoot – 620mV
6 Slow Drain Modulation (SDM)

For this test, a waveform function generator was set to provide the rectangular waveform, shown in the graphs below. The input voltage was set to 48V and the output swings between 20V and 32V. The load was set to 1A constant current (worse case). Repetition rate 50Hz.

Load = 1A, 32Vout to 20Vout (maximal down slope limited internally to 500us)
Channel 1: Output Voltage, 5V/div, DC coupled, 200usec/div
Channel 2: Control Voltage, 500mV/div
Channel 3: Current on the converters output 2A/div
Load = 1A, 20Vout to 32Vout (maximal up slope limited internally ~ 100us)
Channel 1: Output Voltage, 5V/div, DC coupled, 200usec/div
Channel 2: Control Voltage, 500mV/div
Channel 3: Current on the converters output 5A/div

Settling time – no settling time issues. Negligible over shoot/undershoot.
7 Switching Node Waveform

The images below show the voltages behavior of the right (TP6) and left (TP7) full bridge legs, the 48Vin operation, full load conditions.

Load = 11A, 32Vout
Channel 1: Drain voltage 10V/div, DC coupled, 500nsec/div
Channel 2: Drain voltage 10V/div, DC coupled, 500nsec/div

The same, in addition CH1-CH2 (Voltage across the transformer)
8 Loop response

Vin = 48V, Vout = 32V, load = 6.8A.

Frequency loop response of the converter – no capacitive load
The measured crossover frequency was around 47 KHz with a phase margin 88deg.

Frequency loop response of the converter – 200uF capacitive load
The measured crossover frequency was around 17 KHz with a phase margin 66deg.
9  AUX Power supply

9.1  Loop response

Frequency loop response resistive load

Cross over frequency: >12kHz
Phase margin: >60Deg
Gain margin: >15dB
Measured @ 48Vin and 5Ohm resistive load
9.2 Load step response:

Load step response rising age
CH2 (red): Output AC voltage 100mV/div, ΔU=133mV
CH4 (green): Output load current 2A/div, ΔI=4.25A

Load step response falling age
CH2 (red): Output AC voltage 100mV/div, ΔU=51mV
CH4 (green): Output load current 2A/div, ΔI=4.25A
9.3 Output ripple voltage

- CH1 (yellow): switch node after diode rectifier
- CH2 (red): Output voltage AC coupled, 100mV/div, ΔU<20mVpp
- CH4 (green): Output DC current 2A/div

9.4 Efficiency

Efficiency = f (Iout)
9.5 **Thermal analysis**

The thermal analysis has been accomplished by an infrared camera at the following conditions:
Vin = 48V, Vout = 32V @ 4A, Vaux = 12V @ 4A. Force air flow.

R10 – **need a bigger package or several connected in parallel**
U3, U4, gate driver ICs – **need to be in MSOP PowerPAD-8**
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