Product Specifications

Product Name: PZT High Voltage Power Supply

Product Number: PPT05P5020XA2

Approval:
# Revision History

<table>
<thead>
<tr>
<th>No.</th>
<th>Reason of Revision</th>
<th>Date</th>
<th>Rvsd</th>
<th>Appd</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>First</td>
<td>May/26/2009</td>
<td>Endo</td>
<td></td>
</tr>
</tbody>
</table>
1 Application
This specification applies to the PZT High Voltage Power Supply PPT05P5020XA2.

2 Electrical characteristic

<table>
<thead>
<tr>
<th>Items</th>
<th>Symbol</th>
<th>Specification</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input voltage</td>
<td>VBAT</td>
<td>9.5V - 14V</td>
<td></td>
</tr>
<tr>
<td>Output voltage range</td>
<td>Vout</td>
<td>0V to +5000V max</td>
<td>Vcon = 0 - 2.1V</td>
</tr>
<tr>
<td>Input current</td>
<td>Iin</td>
<td>0.8A max</td>
<td></td>
</tr>
<tr>
<td>Output power</td>
<td>Pout</td>
<td>5W max</td>
<td></td>
</tr>
<tr>
<td>Control voltage</td>
<td>VCMP</td>
<td>0V - 2.1V</td>
<td></td>
</tr>
<tr>
<td>Shut-off current</td>
<td>Doff</td>
<td>&gt; 4.4+/-.0.3mA</td>
<td></td>
</tr>
<tr>
<td>Ripple</td>
<td>Rip</td>
<td>1% p-p max</td>
<td></td>
</tr>
</tbody>
</table>

3 Dimension

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**Fig. 3.1 Dimension**
4 Input & Output connector

1) CN1: Input connector - SM06B-SRSS-TB (JST)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Symbol</th>
<th>Function</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PGND</td>
<td>GND</td>
<td>0V</td>
</tr>
<tr>
<td>2</td>
<td>VBAT</td>
<td>Input Voltage</td>
<td>9.5V - 14V</td>
</tr>
<tr>
<td>3</td>
<td>SGND</td>
<td>GND</td>
<td>0V</td>
</tr>
<tr>
<td>4</td>
<td>STBY</td>
<td>Standby control</td>
<td>No use</td>
</tr>
<tr>
<td>5</td>
<td>VCMP</td>
<td>Output Voltage</td>
<td>0V - 2.1V -&gt; Output 0V - 5000V</td>
</tr>
<tr>
<td>6</td>
<td>DI</td>
<td>Output Current</td>
<td>$DI(V) = -1000 \left( \frac{V_{out}}{90 \cdot 10^6} + I_{out} \right)$</td>
</tr>
</tbody>
</table>

2) CN2: Output connector - SM02B-BHSS-1 (JST)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Symbol</th>
<th>Function</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HV</td>
<td>Output</td>
<td>Output Voltage 0V - 5000V</td>
</tr>
<tr>
<td>2</td>
<td>NC</td>
<td>Non connection</td>
<td></td>
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</tbody>
</table>

5 Test circuit

A1: Ammeter; V3 and V4: Volt meter; F: Frequency counter

B1, V1: Power supply and Volt meter for Main power.

B2, V2: Power supply and Volt meter for VCMP

Oscilloscope: Measure the ripple

ANT: Antenna for detects the frequency.

R1: Load resistor. R2: 10kohm for detects the Iout.

C1: 2.2nF/20kV for detects the ripple.

Fig. 5.1 Test circuit
6 Environment / reliability

1) Operation temperature: 0°C to +55°C
2) Operation humidity: 10% RH - 90% RH (No dew-condensation)
3) Storage temperature: -10°C to +75°C
4) Storage humidity: 5% RH - 95% RH (No dew-condensation)
5) Vibration: Frequency: 5Hz > 55Hz > 5Hz, sweep time: 1 minute
   Amplitude: 1.5mmp-p XYZ each direction / 2 hours
6) Shock: Acceleration 50G / 6ms
   XYZ each direction 3 times, Total 18 times

7 Attention

1) High Voltage: High voltage occurs in the output of the PZT power supply. Disconnect the
   DC/DC converter from the power supply during the work.
2) Storage and transport
   a. Avoid placing the unit under dusty environments or under gas corrosive atmospheres.
   b. Preferably, temperature and humidity conditions should be about 5°C to 35°C and
      45-75% RH. Avoid environments having very high temperature (> 55°C), high
      humidity (>90% RH) and a rapid change in temperature.
   c. Keep the product in a packing material during the delivery. The product should not
      gain a load (weight) when you take it from the package or when you pile it up.
3) Handling
   a. Please do not bend this product in your assembly process.
   b. Please do not use the product after you drop it accidentally because it might get
      unusual vibrations or shocks when it is dropped.
   c. Please do not strongly push the transformer of the product in your process.

8 About NCC product number.

<table>
<thead>
<tr>
<th>PPT05</th>
<th>P5020XA2</th>
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</thead>
<tbody>
<tr>
<td>Revision</td>
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<tr>
<td>Design number</td>
<td></td>
</tr>
<tr>
<td>Customer number</td>
<td></td>
</tr>
<tr>
<td>Output voltage</td>
<td></td>
</tr>
<tr>
<td>Output polarity P=(+), N=(-)</td>
<td></td>
</tr>
<tr>
<td>Output power</td>
<td></td>
</tr>
<tr>
<td>PIEZO Power Supply</td>
<td></td>
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</tbody>
</table>
9 Control Voltage Response (Vcc=12V)

Control Voltage to Output Voltage

Control Voltage (V) vs. Output Voltage (kV)

Control Voltage to Efficiency

Control Voltage (V) vs. Efficiency (%)

Control Voltage to Input Current

Control Voltage (V) vs. Input Current (A)

Control Voltage to Ripple

Control Voltage (V) vs. Ripple (Vp-p)
10 Input Voltage Regulation Response

- **Input Voltage to Output Voltage**
  - Input Voltage (V): 7 to 14
  - Output Voltage (kV): 0 to 6
  - 5Mohm VCMP2.1V
  - 5Mohm VCMP1.5V
  - 5Mohm VCMP1.1V

- **Input Voltage to Efficiency**
  - Input Voltage (V): 7 to 14
  - Efficiency (%): 0% to 100%
  - 5Mohm VCMP2.1V
  - 5Mohm VCMP1.5V
  - 5Mohm VCMP1.1V

- **Input Voltage to Input Current**
  - Input Voltage (V): 7 to 14
  - Input Current (A): 0 to 1.0
  - 5Mohm VCMP2.1V
  - 5Mohm VCMP1.5V
  - 5Mohm VCMP1.1V

- **Input Voltage to Ripple**
  - Input Voltage (V): 7 to 14
  - Ripple (Vp-p): 0 to 50
  - 5Mohm VCMP2.1V
  - 5Mohm VCMP1.5V
  - 5Mohm VCMP1.1V
11 How to Test the DC-DC evaluation module

Inside of the package you will find the DC-DC module/s and the required input and output connection wires. Please strip the free end of the wires to your needs.

1. Connect the wires to the low voltage and high voltage connectors of the module. The connectors are single position connectors, so they will only fit in one way. The figure below provides a view of what the connection should look like.

Low voltage side connector. Ground is the black wire and VBAT (9.5-14Vdc) is the red wire.

High voltage side connector. The high voltage wire is the pink wire, this provides VHV-DC

2. Connect an OUTPUT resistor (acting as a load) between HVout and Gnd. The nominal equivalent load is 5Mohm, which corresponds to 5kV and 5W output power. For higher power loads (like 2.5Mohm), the DC/DC converter operates but will not reach 5kV. The operation characteristics, at different load/power levels, are given in the attached Data Sheet plots. For lower power loads than the nominal (for instance 10Mohm, i.e. 2.5W), the DC/DC converter will provide full regulation.

3. A sensing resistance of 10kohm, for instance, may be added in series with the load to measure the output voltage with a high impedance multimeter as “Vdet”. The voltage in Vdet will be proportional to Vout as:

\[ V_{det} = \frac{R_{sense}}{R_{load} + R_{sense}} \]

4. Prepare the connection for two power supplies (VBAT and VCMP): One power supply will provide the power to the driver (VBAT 9.5V to 14Vdc). The second power supply will provide the control of the output voltage (VCMP 0 to 2.1Vdc). By varying the voltage in PIN 5-VCMP, the output voltage will be varied from 0 to 100% Vout max (i.e. 5kV). Refer to the following schematic for the connections.
Suggested initial testing set-up includes:

- VBAT = 12Vdc;
- VCMP = 0V (to be regulated from 0V to 2.1V after turning-on power supply)
- Rload = 5Mohm;
- Rsense = 10kohm
- STBY pin disconnected.

Initially, this will provide zero output voltage when VBAT is turned on (since VCMP is “0”). From this point, VCMP can be varied between 0 to 2.1 V so the output voltage will increase from 0 to 5kV.

5. The module includes a Standby Pin (PIN STBY). The threshold voltage of the STBY pin is 2V. When STBY sees a voltage higher than the threshold, the converter is ON (operates). When “STBY” sees a “low” (a value lower than the threshold), the converter will be OFF (turns off). The STBY pin is internally pulled up to VDD in the circuit. Thus, if “STBY” of CN1 is not connected, the voltage will reach 5kV (in the case of VBAT=12V) and the circuit will operate normally. Thus, if STBY function is not required during tests the pin can be left open. This will trigger the operation immediately after turning on the power supply.

Note that if STBY is floating, when the VBAT is connected the circuitry detects an initial “Ground” level in the pin STBY till the voltage reaches VDD=12V. This may be just a few milliseconds. During this time, the output may show a small increase in the voltage and then reduce to zero as soon as STBY pin meets the threshold level.

A proper turn-on for the power supply is to keep STBY at Ground, then connect the power supply (this power the circuitry but maintains the output voltage at zero due to STBY = “0”). Once STBY is connected to a voltage higher than 2V, the output voltage will reach the value set-up by VCMP.
6. The DI pin provides a voltage that is proportional to the output current. Voltage at pin “DI” shows the following value:

\[ V_{\text{pin DI}} = - R_{\text{DI}} \times (I_{\text{out}} + \frac{V_{\text{out}}}{R_{\text{feedback}}}) \]

So, in case of \( I_{\text{out}}=1\text{mA} / V_{\text{out}}=5\text{kV} \), the voltage at DI will show around -1.056V.

Note that when Vout is positive (case of this converter), “DI” value is negative.

7. Short-circuit protection: The short-circuit protection can be implemented through the DI signal and the STBY pin through external circuitry. Short-circuit protection can be internally implemented in the final circuit design based on specific module needs.