100V INPUT, 12V 40mA REGULATOR TRANSISTOR
PowerDI5

Description

The ZXTR2012P5 monolithically integrates a transistor, zener diode and resistor to function as a high-voltage linear regulator. The device regulates with a 12V nominal output at 15mA. It is designed for use in high-voltage applications where standard linear regulators cannot be used. This function is fully integrated into a PowerDI5 package, minimizing PCB area and reducing number of components when compared with a multi-chip discrete solution.

Features

- Series Linear Regulator Using Emitter-Follower Stage
- Input Voltage = 15V to 100V (For regulated output voltage)
- Output Voltage = 12V ± 10%
- 150kΩ resistor to limit quiescent current
- Fully integrated into a PowerDI5 package
- Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)
- Halogen and Antimony Free. “Green” Device (Note 3)
- Qualified to AEC-Q101 for High Reliability

Applications

Supply voltage regulation in:

- Startup switch in DC-DC converters
- Networking
- Telecommunications
- Power over Ethernet (PoE)

Ordering Information (Note 4)

<table>
<thead>
<tr>
<th>Product</th>
<th>Package</th>
<th>Marking</th>
<th>Reel size (inches)</th>
<th>Tape width (mm)</th>
<th>Quantity per reel</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZXTR2012P5-13</td>
<td>PowerDI-5</td>
<td>ZXTR2012</td>
<td>13</td>
<td>16</td>
<td>5,000</td>
</tr>
</tbody>
</table>

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated’s definitions of Halogen- and Antimony-free, “Green” and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Marking Information

ZXTR2012 = Product Type Marking Code
YY = Manufacturers’ Code Marking
K = Factory Designator
YYWW = Date Code Marking
YY = Last Two Digits of Year (ex: 17 for 2017)
WW = Week code (01 to 53)
## Absolute Maximum Ratings
(Voltage relative to GND, \( T_A = +25^\circ C \), unless otherwise specified.)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Supply Voltage</td>
<td>( V_{IN} )</td>
<td>-0.3 to 100</td>
<td>V</td>
</tr>
<tr>
<td>Continuous Input &amp; Output Current</td>
<td>( I_{IN}, I_{OUT} )</td>
<td>550</td>
<td>mA</td>
</tr>
<tr>
<td>Peak Pulsed Input &amp; Output Current</td>
<td>( I_{IM}, I_{OM} )</td>
<td>2</td>
<td>A</td>
</tr>
<tr>
<td>Maximum Voltage applied to ( V_{OUT} )</td>
<td>( V_{OUT(max)} )</td>
<td>Smaller of ( V_{IN}+12 ) or 18V</td>
<td>V</td>
</tr>
</tbody>
</table>

## Maximum Current at \( V_{IN} = 48V \)
(@\( T_A = +25^\circ C \), unless otherwise specified.)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Output Current</td>
<td>( I_{OUT} )</td>
<td>50</td>
<td>mA</td>
</tr>
<tr>
<td>Pulsed Output Current</td>
<td>( I_{OM} )</td>
<td>880</td>
<td>mA</td>
</tr>
</tbody>
</table>

## Thermal Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Dissipation</td>
<td>( P_D )</td>
<td>1.82</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>( P_D )</td>
<td>0.94</td>
<td>W</td>
</tr>
<tr>
<td>Thermal Resistance, Junction to Ambient</td>
<td>( R_{J&amp;A} )</td>
<td>55</td>
<td>°C/W</td>
</tr>
<tr>
<td></td>
<td>( R_{J&amp;A} )</td>
<td>107</td>
<td>°C/W</td>
</tr>
<tr>
<td>Thermal Resistance, Junction to Lead</td>
<td>( R_{J&amp;L} )</td>
<td>20</td>
<td>°C/W</td>
</tr>
<tr>
<td>Thermal Resistance, Junction to Case</td>
<td>( R_{J&amp;C} )</td>
<td>17.8</td>
<td>°C/W</td>
</tr>
<tr>
<td>Recommended Operating Junction Temperature Range</td>
<td>( T_J )</td>
<td>-40 to +125</td>
<td>°C</td>
</tr>
<tr>
<td>Maximum Operating Junction and Storage Temperature Range</td>
<td>( T_J, T_{STG} )</td>
<td>-65 to +150</td>
<td>°C</td>
</tr>
</tbody>
</table>

## ESD Ratings
(Note 11)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Symbols</th>
<th>Value</th>
<th>Unit</th>
<th>JEDEC Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrostatic Discharge – Human Body Model</td>
<td>ESD HBM</td>
<td>4000</td>
<td>V</td>
<td>3A</td>
</tr>
<tr>
<td>Electrostatic Discharge – Machine Model</td>
<td>ESD MM</td>
<td>400</td>
<td>V</td>
<td>C</td>
</tr>
</tbody>
</table>

Notes:
5. For a device mounted with the exposed \( V_{IN} \) pad on 50mm x 50mm 1oz copper that is on a single-sided 1.6mm FR4 PCB; device is measured under still air conditions whilst operating in steady-state.
6. Same as Note 5, except mounted on 15mm x 15mm 1oz copper.
7. Same as Note 5, whilst operating at \( V_{IN} = 48V \). Refer to Safe Operating Area for other Input Voltages.
8. Same as Note 5, except measured with a single pulse width = 100µs and \( V_{IN} = 48V \).
9. Same as Note 5, except measured with a single pulse width = 10ms and \( V_{IN} = 48V \).
10. \( R_{J&L} \) = Thermal resistance from junction to solder-point (on the exposed \( V_{IN} \) pad).
11. \( R_{J&C} \) = Thermal resistance from junction to the top of case.
11. Refer to JEDEC specification JESD22-A114 and JESD22-A115.
Thermal Characteristics and Derating Information

Steady state D.C.
\[ T_A = 25°C \]
\[ T_J \leq 125°C \]

Safe Operating Area

Input Voltage (V)

Continuous Output Current (mA)

Derating Curve

Continuous Output Current (mA)

Max Power Dissipation (W)

Ambient temperature (°C)

Thermal Resistance (°C/W)

Pulse Width (s)

Max Power Dissipation (W)

Pulse Power Dissipation

Transient Thermal Impedance

Pulse Power Dissipation

Transient Thermal Impedance

Pulse Power Dissipation
Electrical Characteristics  (@\(T_A = +25^\circ C\), unless otherwise specified.)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Test Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Voltage (Note 12)</td>
<td>(V_{OUT})</td>
<td>10.8</td>
<td>12</td>
<td>13.2</td>
<td>V</td>
<td>(V_{IN} = 48V, I_{OUT} = 15mA)</td>
</tr>
<tr>
<td>Line Regulation (Notes 12 &amp; 13)</td>
<td>(\Delta V_{OUT})</td>
<td>—</td>
<td>240</td>
<td>750</td>
<td>mV</td>
<td>(V_{IN} = 15 \text{ to } 72V, I_{OUT} = 15mA)</td>
</tr>
<tr>
<td>Temperature Coefficient</td>
<td>(\Delta V_{OUT}/\Delta T)</td>
<td>—</td>
<td>8.0</td>
<td>—</td>
<td>mV/°C</td>
<td>(T_J = -40^\circ C \text{ to } +125^\circ C)</td>
</tr>
<tr>
<td>Load Regulation (Notes 12 &amp; 14)</td>
<td>(\Delta V_{OUT})</td>
<td>—</td>
<td>-450</td>
<td>-600</td>
<td>mV</td>
<td>(I_{OUT} = 0.1 \text{ to } 30mA, V_{IN} = 48V)</td>
</tr>
<tr>
<td>Minimum Value of Input Voltage Required to Maintain Line Regulation</td>
<td>(V_{IN(MIN)})</td>
<td>15</td>
<td>—</td>
<td>—</td>
<td>V</td>
<td>—</td>
</tr>
<tr>
<td>Quiescent Current</td>
<td>(I_Q)</td>
<td>—</td>
<td>240</td>
<td>590</td>
<td>µA</td>
<td>(V_{IN} = 48V, I_{OUT} = 10\mu A)</td>
</tr>
<tr>
<td>Power Supply Rejection Ratio</td>
<td>(\Delta V_{IN}/\Delta V_{OUT})</td>
<td>—</td>
<td>45</td>
<td>—</td>
<td>dB</td>
<td>(C_{OUT} = 100\mu F, I_{OUT} = 15mA, V_{OUT} = 12V, V_{IN} = 15 \text{ to } 100V, f=100Hz)</td>
</tr>
</tbody>
</table>

Notes:
12. Measured under pulsed conditions. Pulse width ≤ 300µs. Duty cycle ≤ 2%.
13. Line regulation
\(\Delta V_{OUT} = V_{OUT}@V_{IN} = 72V - V_{OUT}@V_{IN} = 15V\)
14. Load regulation
\(\Delta V_{OUT} = V_{OUT}@I_{OUT} = 30mA - V_{OUT}@I_{OUT} = 0.1mA\)
\(\Delta V_{OUT} = V_{OUT}@I_{OUT} = 100mA - V_{OUT}@I_{OUT} = 0.1mA\)

Typical Application Circuit

Example of an 12V regulated supply from a nominal 48V for powering a Controller IC.

Pin Functions

<table>
<thead>
<tr>
<th>Pin Name</th>
<th>Pin Function</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>(V_{IN})</td>
<td>Input Supply</td>
<td>Input voltage can vary from -0.3V to 100V with respect to GND; for VOUT regulated then 15V ≤ (V_{IN}) ≤ 100V. It is recommended to connect a 1µF capacitor to GND.</td>
</tr>
<tr>
<td>GND</td>
<td>Power Ground</td>
<td>This pin should be tied to the system ground.</td>
</tr>
<tr>
<td>VOUT</td>
<td>Voltage Output</td>
<td>Outputs a regulated 12V when 15V ≤ (V_{IN}) ≤ 100V. When (V_{IN}) &lt; 15V, then VOUT maximum = (V_{IN} - 1.5V). The pin can be pulled high to a maximum of +18V with respect to GND, or +12V with respect to (V_{IN}) whichever is lower. It is recommended to connect a 10µF capacitor to GND and a minimum of 10µA to be drawn from VOUT to maintain regulation.</td>
</tr>
</tbody>
</table>
Typical Electrical Characteristics (@T_A = +25°C, unless otherwise specified.)

**Line transient response**

- **V_IN** Input Voltage (V)
- **V_OUT** Output Voltage (V)

**Load transient response**

- **I_OUT** Output Current (mA)

**Line Regulation (Note 15)**

- **I_OUT** = 15mA
- **T_J** = 125°C
- **T_J** = 100°C
- **T_J** = 25°C
- **T_J** = -55°C

**Load Regulation (Note 16)**

- **I_OUT** = 0 to 30mA
- **V_IN** = 18 to 48V
- **C_OUT** = 100nF
- **Slew Rate** = 5V/μs

**Temperature Coefficient (Note 17)**

- **I_OUT** = 10μA
- **T_J** = 125°C
- **T_J** = 85°C
- **T_J** = -55°C

Notes:

15. Line regulation \( \Delta V_{OUT} = V_{OUT} - V_{OUT}(\text{at } V_{IN} = 15V, I_{OUT} = 15mA, T_{J} = +25^\circ C) \)
16. Load regulation \( \Delta V_{OUT} = V_{OUT} - V_{OUT}(\text{at } V_{IN} = 48V, I_{OUT} = 0.1mA, T_{J} = +25^\circ C) \)
17. Temperature Coefficient \( \Delta V_{OUT} = V_{OUT} - V_{OUT}(\text{at } V_{IN} = 48V, I_{OUT} = 15mA, T_{J} = +25^\circ C) \)
Package Outline Dimensions

Please see http://www.diodes.com/package-outlines.html for the latest version.

Suggested Pad Layout

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