

## 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.

## Applications

Supply voltage regulation in:

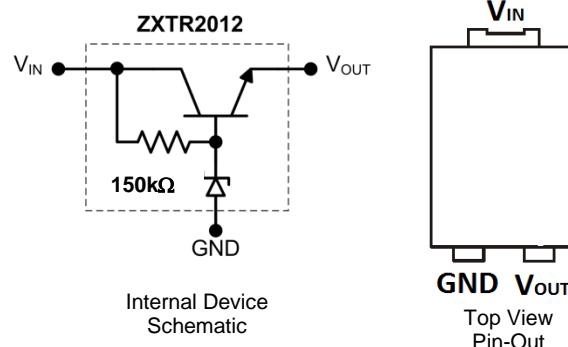
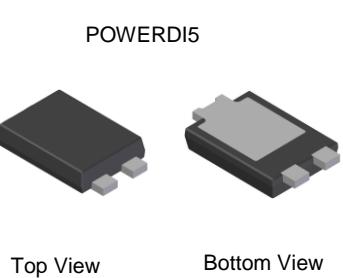
- Startup switch in DC-DC converters
- Networking
- Telecommunications
- Power over Ethernet (PoE)

## Features

- Series Linear Regulator Using Emitter-Follower Stage
- Input Voltage = 15V to 100V (For regulated output voltage)
- Output Voltage = 12V  $\pm$  10%
- 150k $\Omega$  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

## Mechanical Data

- Case: PowerDI5
- Case Material: Molded Plastic, "Green" Molding Compound.
- UL Flammability Rating 94V-0
- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish - Matte Tin Plated Leads.
- Solderable per MIL-STD-202, Method 208 (E3)
- Weight: 0.100 grams (Approximate)



| Pin Name  | Pin Function   |
|-----------|----------------|
| $V_{IN}$  | Input Supply   |
| $GND$     | Power Ground   |
| $V_{OUT}$ | Voltage Output |

## Ordering Information (Note 4)

| Product       | Package   | Marking  | Reel size (inches) | Tape width (mm) | Quantity per reel |
|---------------|-----------|----------|--------------------|-----------------|-------------------|
| ZXTR2012P5-13 | PowerDI-5 | ZXTR2012 | 13                 | 16              | 5,000             |

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.
4. For packaging details, go to our website at <http://www.diodes.com/products/packages.html>.

## Marking Information



ZXTR2012 = Product Type Marking Code  
 ZXTR = 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, @ $T_A = +25^\circ\text{C}$ , unless otherwise specified.)

| Characteristic                       | Symbol            | Value                                 | Unit |
|--------------------------------------|-------------------|---------------------------------------|------|
| Input Supply Voltage                 | $V_{IN}$          | -0.3 to 100                           | V    |
| Continuous Input & Output Current    | $I_{IN}, I_{OUT}$ | 550                                   | mA   |
| Peak Pulsed Input & Output Current   | $I_{IM}, I_{OM}$  | 2                                     | A    |
| Maximum Voltage applied to $V_{OUT}$ | $V_{OUT(max)}$    | Smaller of $V_{IN}+12\text{V}$ or 18V | V    |

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

| Characteristic            | Symbol    | Value | Unit |
|---------------------------|-----------|-------|------|
| Continuous Output Current | $I_{OUT}$ | 50    | mA   |
| Pulsed Output Current     | $I_{OM}$  | 880   | mA   |
|                           |           | 180   |      |
|                           |           |       |      |

**Thermal Characteristics**

| Characteristic   | Symbol          | Value       | Unit |
|--|-----------------|-------------|------|
| Power Dissipation  | $P_D$           | 1.82        | W    |
|  |                 | 0.94        |      |
| Thermal Resistance, Junction to Ambient                  | $R_{\theta JA}$ | 55          | °C/W |
|  |                 | 107         |      |
| Thermal Resistance, Junction to Lead                     | $R_{\theta JL}$ | 20          | °C   |
| Thermal Resistance, Junction to Case                     | $R_{\theta JC}$ | 17.8        |      |
| Recommended Operating Junction Temperature Range         | $T_J$           | -40 to +125 | °C   |
| Maximum Operating Junction and Storage Temperature Range | $T_J, T_{STG}$  | -65 to +150 |      |

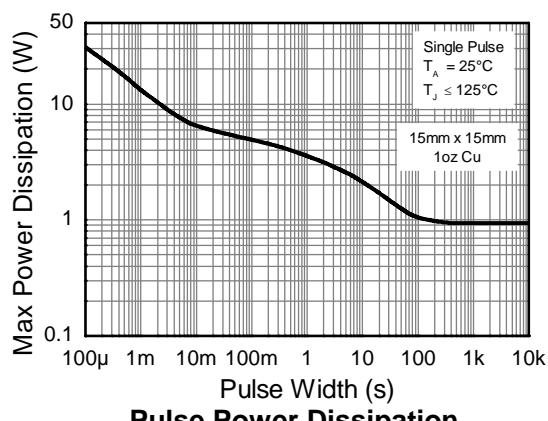
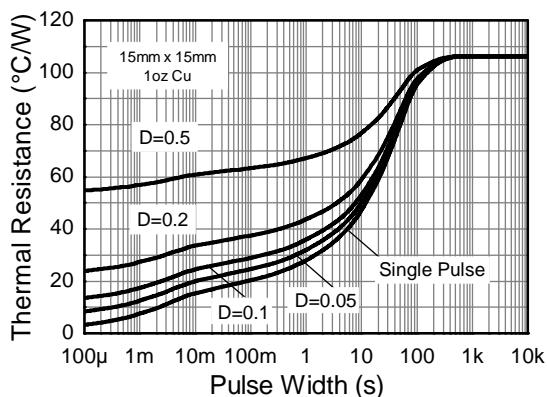
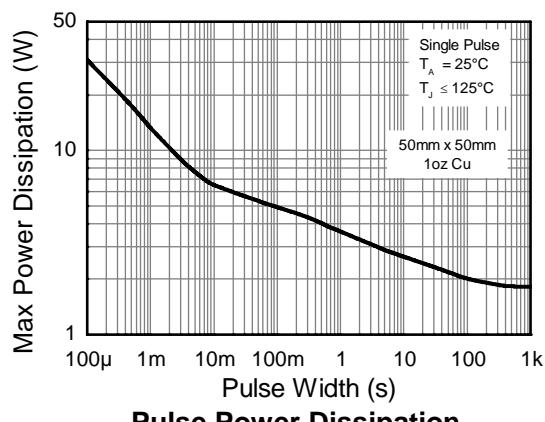
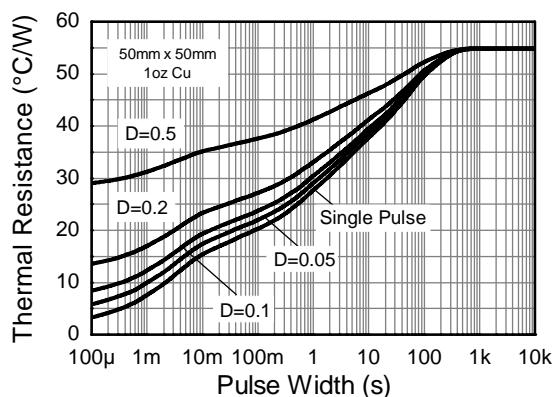
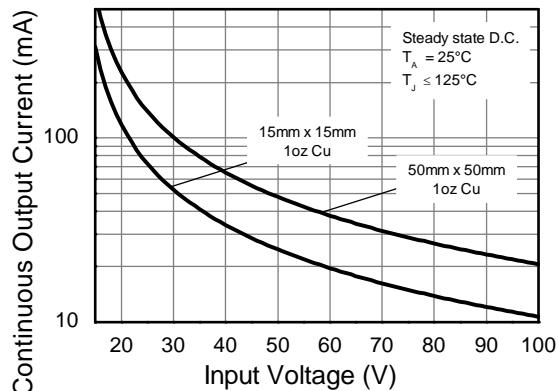
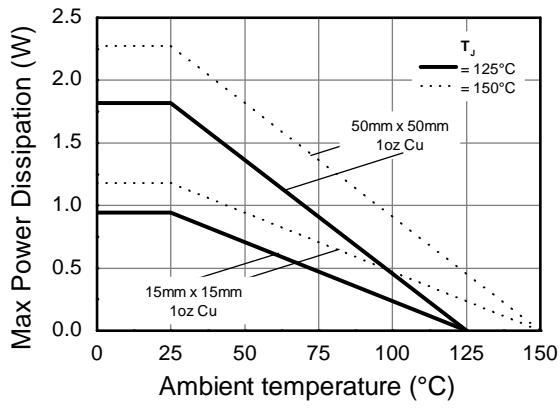
**ESD Ratings** (Note 11)

| Characteristics                            | Symbols | Value | Unit | JEDEC Class |
|--|---------|-------|------|-------------|
| Electrostatic Discharge – Human Body Model | ESD HBM | 4000  | V    | 3A          |
| Electrostatic Discharge – Machine Model    | ESD MM  | 400   | V    | C           |

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  $V_{IN} = 48\text{V}$ . Refer to Safe Operating Area for other Input Voltages.
8. Same as Note 5, except measured with a single pulse width = 100 $\mu\text{s}$  and  $V_{IN} = 48\text{V}$ .
9. Same as Note 5, except measured with a single pulse width = 10ms and  $V_{IN} = 48\text{V}$ .
10.  $R_{\theta JL}$  = Thermal resistance from junction to solder-point (on the exposed  $V_{IN}$  pad).
11. Refer to JEDEC specification JESD22-A114 and JESD22-A115.

## Thermal Characteristics and Derating Information

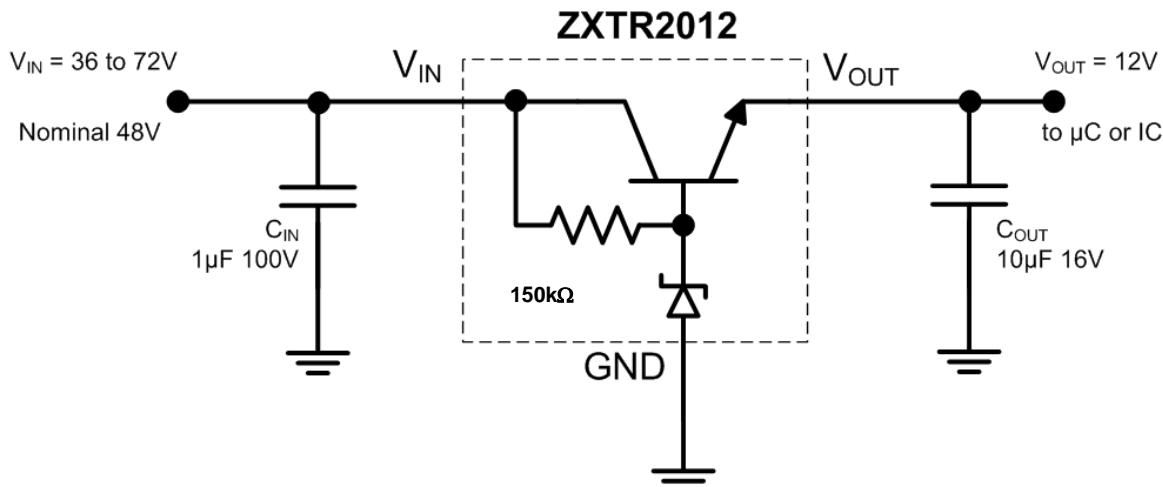


**Electrical Characteristics** (@ $T_A = +25^\circ\text{C}$ , unless otherwise specified.)

| Characteristic  | Symbol                                       | Min  | Typ          | Max          | Unit                       | Test Condition   |
|---|--|------|--------------|--------------|----------------------------|--|
| Output Voltage (Note 12)  | $V_{\text{OUT}}$                             | 10.8 | 12           | 13.2         | V                          | $V_{\text{IN}} = 48\text{V}$ , $I_{\text{OUT}} = 15\text{mA}$  |
| Line Regulation (Notes 12 & 13)                                     | $\Delta V_{\text{OUT}}$                      | —    | 240          | 750          | mV                         | $V_{\text{IN}} = 15$ to $72\text{V}$ , $I_{\text{OUT}} = 15\text{mA}$  |
| Temperature Coefficient   | $\Delta V_{\text{OUT}}/\Delta T$             | —    | 8.0          | —            | $\text{mV}/^\circ\text{C}$ | $T_J = -40^\circ\text{C}$ to $+125^\circ\text{C}$<br>$V_{\text{IN}} = 48\text{V}$ , $I_{\text{OUT}} = 15\text{mA}$   |
| Load Regulation (Notes 12 & 14)                                     | $\Delta V_{\text{OUT}}$                      | —    | -450<br>-600 | -600<br>-750 | mV                         | $I_{\text{OUT}} = 0.1$ to $30\text{mA}$ , $V_{\text{IN}} = 48\text{V}$<br>$I_{\text{OUT}} = 0.1$ to $100\text{mA}$ , $V_{\text{IN}} = 48\text{V}$                |
| Minimum Value of Input Voltage Required to Maintain Line Regulation | $V_{\text{IN(MIN)}}$                         | 15   | —            | —            | V                          | —  |
| Quiescent Current   | $I_Q$  | —    | 240<br>590   | 400<br>900   | $\mu\text{A}$              | $V_{\text{IN}} = 48\text{V}$ , $I_{\text{OUT}} = 10\mu\text{A}$<br>$V_{\text{IN}} = 100\text{V}$ , $I_{\text{OUT}} = 10\mu\text{A}$                              |
| Power Supply Rejection Ratio  | $\Delta V_{\text{IN}}/\Delta V_{\text{OUT}}$ | —    | 45           | —            | dB                         | $C_{\text{OUT}} = 100\text{nF}$ , $I_{\text{OUT}} = 15\text{mA}$ ,<br>$V_{\text{OUT}} = 12\text{V}$ , $V_{\text{IN}} = 15$ to $100\text{V}$ , $f = 100\text{Hz}$ |

Notes:

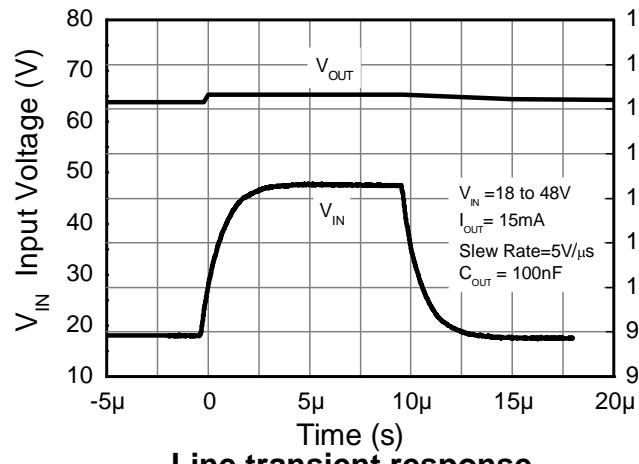
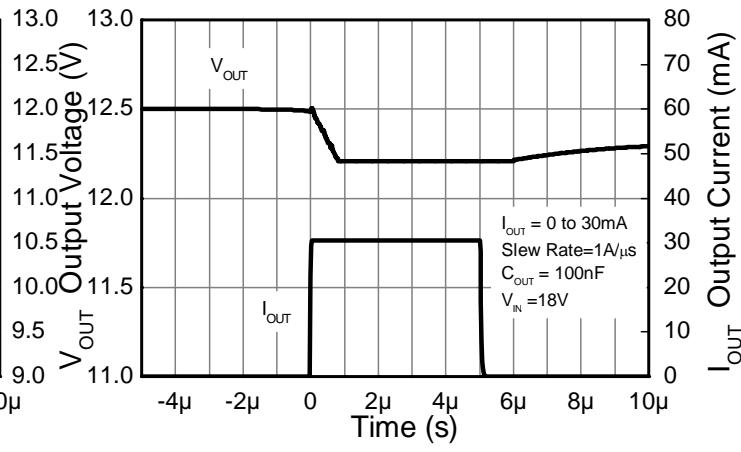
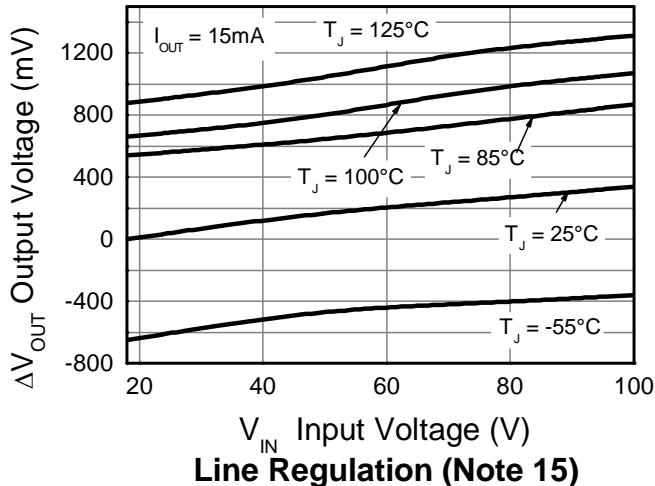
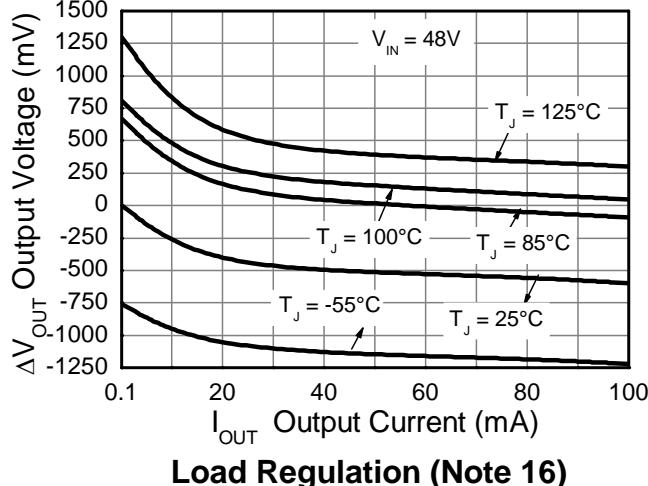
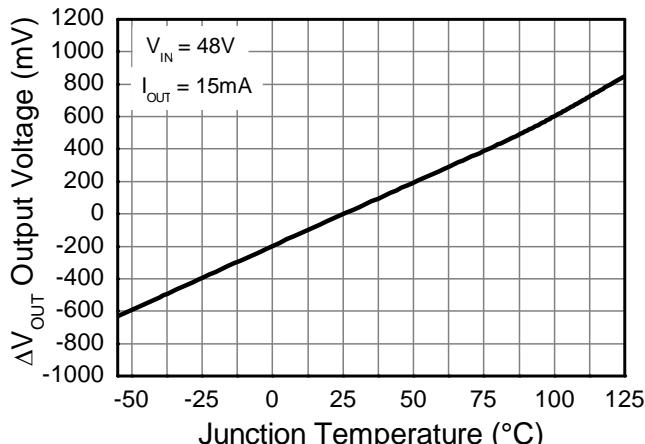
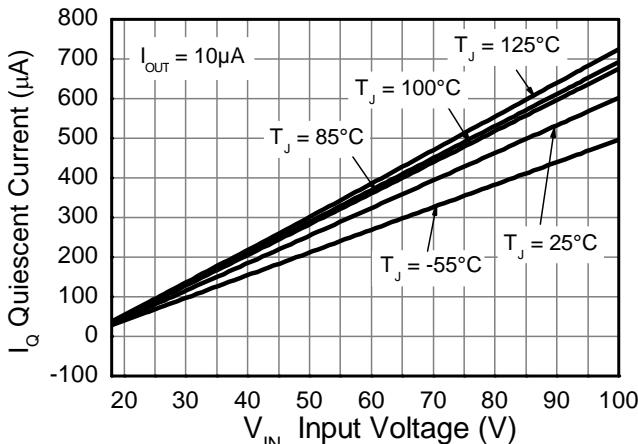
12. Measured under pulsed conditions. Pulse width  $\leq 300\mu\text{s}$ . Duty cycle  $\leq 2\%$ .
13. Line regulation  $\Delta V_{\text{OUT}} = V_{\text{OUT}}(@ V_{\text{IN}} = 72\text{V}) - V_{\text{OUT}}(@ V_{\text{IN}} = 15\text{V})$
14. Load regulation  $\Delta V_{\text{OUT}} = V_{\text{OUT}}(@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

**Typical Application Circuit**


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

**Pin Functions**

| Pin Name               | Pin Function   | Notes   |
|------------------------|----------------|---|
| <b>V<sub>IN</sub></b>  | Input Supply   | Input voltage can vary from -0.3V to 100V with respect to GND; for V <sub>OUT</sub> regulated then $15\text{V} \leq V_{\text{IN}} \leq 100\text{V}$ . It is recommended to connect a 1µF capacitor to GND.  |
| <b>GND</b>             | Power Ground   | This pin should be tied to the system ground.   |
| <b>V<sub>OUT</sub></b> | Voltage Output | Outputs a regulated 12V when $15\text{V} \leq V_{\text{IN}} \leq 100\text{V}$ . When $V_{\text{IN}} < 15\text{V}$ , then V <sub>OUT</sub> maximum = $V_{\text{IN}} - 1.5\text{V}$ . The pin can be pulled high to a maximum of +18V with respect to GND, or +12V with respect to V <sub>IN</sub> , whichever is lower. It is recommended to connect a 10µF capacitor to GND and a minimum of 10µA to be drawn from V <sub>OUT</sub> to maintain regulation. |

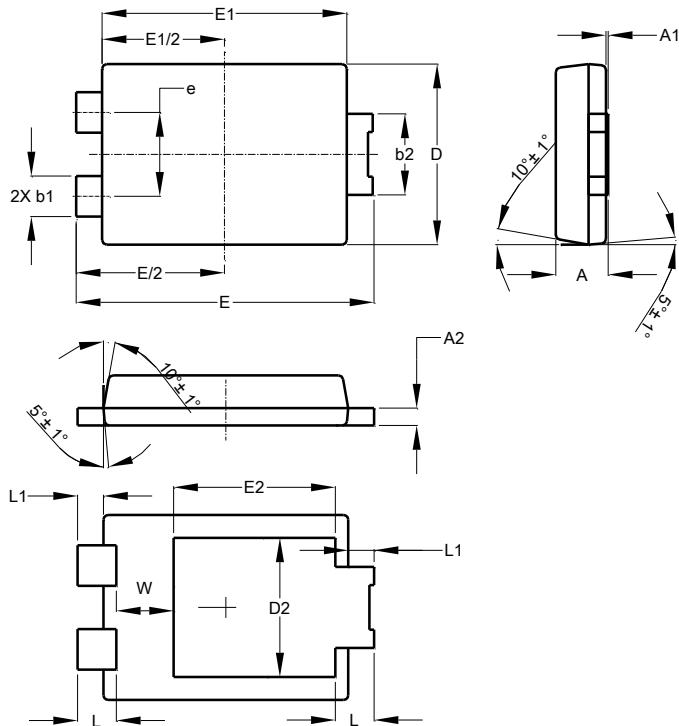
**Typical Electrical Characteristics** (@ $T_A = +25^\circ\text{C}$ , unless otherwise specified.)

**Line transient response**

**Load transient response**

**Line Regulation (Note 15)**

**Load Regulation (Note 16)**

**Temperature Coefficient (Note 17)**

**Quiescent Current**

Notes:

15. Line regulation  $\Delta V_{OUT} = V_{OUT} - V_{OUT}(@ V_{IN} = 15\text{V}, I_{OUT} = 15\text{mA}, T_J = +25^\circ\text{C})$
16. Load regulation  $\Delta V_{OUT} = V_{OUT} - V_{OUT}(@ V_{IN} = 48\text{V}, I_{OUT} = 0.1\text{mA}, T_J = +25^\circ\text{C})$
17. Temperature Coefficient  $\Delta V_{OUT} = V_{OUT} - V_{OUT}(@ V_{IN} = 48\text{V}, I_{OUT} = 15\text{mA}, T_J = +25^\circ\text{C})$

## Package Outline Dimensions

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

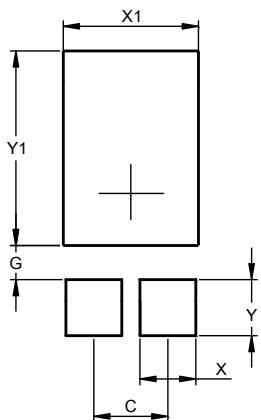


| PowerDI5  |      |      |       |
|-----------|------|------|-------|
| Dim       | Min  | Max  | Typ   |
| <b>A</b>  | 1.05 | 1.15 | 1.10  |
| <b>A1</b> | 0.00 | 0.05 | --    |
| <b>A2</b> | 0.33 | 0.43 | 0.381 |
| <b>b1</b> | 0.80 | 0.99 | 0.89  |
| <b>b2</b> | 1.70 | 1.88 | 1.78  |
| <b>D</b>  | 3.90 | 4.05 | 3.966 |
| <b>D2</b> | --   | --   | 3.054 |
| <b>E</b>  | 6.40 | 6.60 | 6.504 |
| <b>e</b>  | --   | --   | 1.84  |
| <b>E1</b> | 5.30 | 5.45 | 5.37  |
| <b>E2</b> | --   | --   | 3.549 |
| <b>L</b>  | 0.75 | 0.95 | 0.85  |
| <b>L1</b> | 0.50 | 0.65 | 0.57  |
| <b>W</b>  | 1.10 | 1.41 | 1.255 |

All Dimensions in mm

## Suggested Pad Layout

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



| Dimensions | Value (in mm) |
|------------|---------------|
| <b>C</b>   | 1.840         |
| <b>G</b>   | 0.852         |
| <b>X</b>   | 1.390         |
| <b>X1</b>  | 3.360         |
| <b>Y</b>   | 1.400         |
| <b>Y1</b>  | 4.860         |

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