GENERAL DESCRIPTION

The XRP29302 is a 3A, highly accurate voltage regulator with a low dropout voltage of 600mV (typical) at 3A.

This regulator is specifically designed for low voltage applications that require a low dropout voltage and a fast transient response. It is fully fault protected against over-current, reverse battery, and positive and negative voltage transients. On-Chip trimming adjusts the reference voltage to 1% initial accuracy.

The XRP29302 is offered in 5-pin TO-220 & TO-263 packages.

APPLICATIONS

- Adjustable Power Supplies
- Constant Current Regulators
- Audio and Video/Graphic Cards
- Battery Chargers

FEATURES

- 3A Guaranteed Output Current
- Low Dropout Voltage of 600mV @ 3A
- Adjustable Output down to 1.25V
- 1% Output Accuracy
- Tight Load and Line Regulation
- Fast Transient Response
- Reverse Battery Protection
- Zero Current Shutdown
- Drop-in Replacement to SPX29302
- Lead Free 5-pin TO220 and TO263 Packages

(5-pin TO220 version is obsolete)

TYPICAL APPLICATION DIAGRAM

![XRP29302 Application Diagram](Fig. 1: XRP29302 Application Diagram)
## ABSOLUTE MAXIMUM RATINGS
These are stress ratings only and functional operation of the device at these ratings or any other above those indicated in the operation sections of the specifications below is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.

- Input Voltage $V_{IN}$: 20V
- Storage Temperature: -65°C to 150°C
- Lead Temperature (Soldering, 5 sec): 260°C
- ESD Rating (HBM - Human Body Model):
  - All pins except EN: 2kV
  - En pin: 1kV

## OPERATING RATINGS

**Input Voltage Range** $V_{IN}$: 16V  
**Junction Temperature Range**: -40°C to 125°C  
**Thermal Resistance**:  
- TO-220 Junction to Case @ $T_A$: 3°C/W  
- TO-220 Junction to Ambient: 60°C/W  
- TO-263 Junction to Case @ $T_A$: 3°C/W  
- TO-263 Junction to Ambient: 60°C/W  

Note 1: Maximum positive supply voltage of 20V must be of limited duration (<100ms) and duty cycle of less than 1%. The maximum continuous supply voltage is 16V.

## ELECTRICAL SPECIFICATIONS
Specifications with standard type are for an Operating Junction Temperature of $T_J = T_A = 25°C$ only; limits applying over the full Operating Junction Temperature range are denoted by a "•". Minimum and Maximum limits are guaranteed through test, design, or statistical correlation. Typical values represent the most likely parametric norm at $T_J = 25°C$, and are provided for reference purposes only. Unless otherwise indicated, $V_{IN} = V_{OUT} + 1V$ and $I_{OUT} = 10mA$, $C_{IN} = 6.8µF$, $C_{OUT} = 10µF$, $T_A = 25°C$.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line Regulation</td>
<td></td>
<td>0.06</td>
<td>0.5</td>
<td>%</td>
<td>$I_{OUT} = 10mA$, $(V_{OUT} + 1V) \leq V_{IN} \leq 16V$</td>
</tr>
<tr>
<td>Load Regulation</td>
<td></td>
<td>0.2</td>
<td>1</td>
<td>%</td>
<td>$V_{IN} = V_{OUT} + 1V$, $10mA \leq I_{OUT} \leq I_{FL}$ (note 2)</td>
</tr>
<tr>
<td>$\Delta V/\Delta T$</td>
<td></td>
<td>20</td>
<td>300</td>
<td>ppm/°C</td>
<td></td>
</tr>
<tr>
<td>Dropout Voltage (note 3)</td>
<td></td>
<td>380</td>
<td>525</td>
<td>mV</td>
<td>$I_{OUT} = 100mA$, $I_{OUT} = 1.5A$, $I_{OUT} = 2.5A$, XRP29302A only</td>
</tr>
<tr>
<td></td>
<td></td>
<td>600</td>
<td>800</td>
<td></td>
<td>$I_{OUT} = 3A$</td>
</tr>
<tr>
<td>Ground Current (note 5)</td>
<td></td>
<td>30</td>
<td>60</td>
<td>mA</td>
<td>$I_{OUT} = 1.5A$</td>
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<tr>
<td>Ground Pin Current at Dropout</td>
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<td>40</td>
<td>60</td>
<td>mA</td>
<td>$I_{OUT} = 3A$</td>
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<tr>
<td>Current Limit</td>
<td></td>
<td>3.0</td>
<td>4.5</td>
<td>A</td>
<td>$I_{OUT} = 0V$ (note 4)</td>
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<tr>
<td>Output Noise Voltage</td>
<td></td>
<td>400</td>
<td>260</td>
<td>$\mu V_{RMS}$</td>
<td>10Hz-100KHz, $I_{OUT} = 100mA$, $C_{OUT} = 10µF$</td>
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<tr>
<td>Reference Voltage</td>
<td></td>
<td>1.228</td>
<td>1.252</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.215</td>
<td>1.265</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjust Pin Bias Current</td>
<td></td>
<td>40</td>
<td>80</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>120</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Reference Voltage Temperature Coefficient</td>
<td>20</td>
<td>ppm/°C</td>
<td>Note 7</td>
<td></td>
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<tr>
<td>Adjust Pin Bias Current Temperature Coefficient</td>
<td>0.1</td>
<td>nA/°C</td>
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<td>Enable Input</td>
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<tr>
<td>Input Logic Voltage Low (OFF)</td>
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<td>0.8</td>
<td></td>
<td>V</td>
<td>$V_{IN} &lt; 10V$</td>
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<td>Input Logic Voltage High (ON)</td>
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<td>2.4</td>
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<td></td>
<td></td>
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<tr>
<td>Enable Input Pin</td>
<td></td>
<td>100</td>
<td>750</td>
<td>µA</td>
<td>$V_{EN} = 16V$</td>
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<tr>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td>$V_{EN} = 0.8V$</td>
</tr>
<tr>
<td>Regulator Output Current in Shutdown</td>
<td>10</td>
<td>500</td>
<td></td>
<td>µA</td>
<td>$V_{EN} = 0.8V$, $V_{OUT} = 10mA$</td>
</tr>
</tbody>
</table>

Note 2: Full load current (I_l) is defined as 3.0A.
Note 3: Dropout voltage is defined $(V_{IN}-V_{OUT})$ when the output voltage drops to 99% of its nominal value.
Note 4: $V_{IN} = V_{OUT}(\text{nom}) + 1V$. Use pulse-testing procedures to minimize temperature rise.
Note 5: Ground pin current is the regulator quiescent current. The total current drawn from the source is the sum of the load current to the ground current.

Note 6: Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

Note 7: Thermal regulation is defined as the change in output voltage at time T after a change in power dissipation is applied, excluding load/line regulation effects. Specifications for a 200mA load pulse as $V_{IN}=20V$ (a 4W pulse) for $t=10ms$.

Note 8: $V_{EN} \leq 0.8V$ and $V_{IN} \leq 16V$, $V_{OUT} = 0$.

**BLOCK DIAGRAM**

![Block Diagram](image)

Fig. 2: XRP29302 Block Diagram

**PIN ASSIGNMENT**

![Pin Assignment](image)

5-pin TO-220 version is obsolete

Fig. 3: XRP29302 Pin Assignment
### ORDERING INFORMATION\(^{(1)}, (2)\)

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Junction Temperature Range</th>
<th>Package</th>
<th>Packing Method</th>
<th>Lead Free(^{(3)})</th>
<th>Note 1</th>
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<tbody>
<tr>
<td>XRP29302ETBTR-L</td>
<td>-40°C ≤ TJ ≤ +125°C</td>
<td>5-pin TO263</td>
<td>Tape &amp; Reel</td>
<td>Yes</td>
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<tr>
<td>XRP29302AETBTR-L</td>
<td>-40°C ≤ TJ ≤ +125°C</td>
<td>5-pin TO263</td>
<td>Tape &amp; Reel</td>
<td>Yes</td>
<td>Adjustable</td>
</tr>
</tbody>
</table>

Notes:

1. Refer to [www.maxlinear.com/XRP29302](http://www.maxlinear.com/XRP29302) for most up-to-date Ordering Information.
2. 5-pin TO220 version is obsolete.
4. XRP29302AETBTR-L has the same package marking as XRP29302ETBTR-L. The “A” designator is only provided on the packaging label.
TYPICAL PERFORMANCE CHARACTERISTICS

All data taken at $V_{IN} = V_{OUT} + 1V$, $T_J = T_A = 25^\circ C$, unless otherwise specified.

![Fig. 4: Dropout Voltage vs Load Current](image1)

![Fig. 5: Startup](image2)

![Fig. 6: Line Regulation](image3)

![Fig. 7: Load Regulation](image4)

$I_{OUT}=10mA$, $V_{OUT}=3.3V$
THEORY OF OPERATION

The XRP29302 incorporates protection against over-current faults, reversed load insertion, over temperature operation, and positive and negative transient voltage.

THERMAL CONSIDERATIONS

Although the XRP29302 offers limiting circuitry for overload conditions, it is still necessary to insure that the maximum junction temperature is not exceeded in the application. Heat will flow through the lowest resistance path, the junction-to-case path. In order to insure the best thermal flow of the component, proper mounting is required.

TO-220 DESIGN EXAMPLE:

Assume that $V_{IN} = 10V$, $V_{OUT} = 5V$, $I_{OUT} = 1.5A$, $T_A = 50^\circ C$, $\theta_{HA} = 1^\circ C/W$, $\theta_{CH} = 2^\circ C/W$, and $\theta_{JC} = 3^\circ C/W$, where:

- $T_A$ = ambient temperature,
- $\theta_{HA}$ = heatsink to ambient thermal resistance
- $\theta_{CH}$ = case to heatsink thermal resistance
- $\theta_{JC}$ = junction to case thermal resistance

The power calculated under these conditions is:

$$P_D = (V_{IN} - V_{OUT}) \times I_{OUT} = 7.5W$$

And the junction temperature is calculated as

$$T_J = T_A + P_D \times (\theta_{HA} + \theta_{CH} + \theta_{JC})$$

or

$$T_J = 50 + 7.5 \times (1 + 2 + 3) = 95^\circ C$$

Reliable operation is insured.

CAPACITOR REQUIREMENTS

The output capacitor is needed to insure stability and minimize the output noise. The value of the capacitor varies with the load. However, a minimum value of 10μF aluminum capacitor will guarantee stability over all load conditions.

A tantalum capacitor is recommended if a faster load transient response is needed. If the power source has high AC impedance, a 0.1μF ceramic capacitor between input & ground is recommended.

MINIMUM LOAD CURRENT

To ensure a proper behavior of the regulator under light load, a minimum load of 5mA for XRP29302 is required.

ADJUSTABLE REGULATOR DESIGN

The XRP29302 is an adjustable regulator that can be programmed to any value between 1.25V and 16V using 2 external resistors, $R_1$ and $R_2$. The relationship between the resistors and the output voltage is:

$$R_1 = R_2 \times \left( \frac{V_{OUT}}{1.240} - 1 \right)$$

ENABLE INPUT

The XRP29302 has an Enable function that switches the regulator on and off. Their thresholds are TTL compatible. When the regulator is active, approximately 20 μA flows through the Enable pin.

TYPICAL APPLICATION CIRCUITS

Figure 1 represents the typical implementation for an adjustable output regulator. The values of $R_1$ and $R_2$ set the output voltage value as follows:

$$V_{OUT} = V_{REF} \times \left( 1 + \frac{R_1}{R_2} \right)$$

A minimum value of 10kohms is recommended for $R_2$ with a range between 10kΩ and 47kΩ.
*: Dimension "A" (overall package thickness) is controlled to 0.181" maximum for XRP29302 only. Typical dimension "A" guaranteed for any other device in a 5-pin TO263 is 0.190" inch maximum.
REVISION HISTORY

<table>
<thead>
<tr>
<th>Revision</th>
<th>Date</th>
<th>Description</th>
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<tr>
<td>1.0.0</td>
<td>12/17/2009</td>
<td>Initial Release of Datasheet</td>
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<tr>
<td>1.1.0</td>
<td>12/23/2009</td>
<td>Addition of ESD data</td>
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<tr>
<td>1.2.0</td>
<td>10/19/2010</td>
<td>Corrected Adjustable Regulator Design paragraph equation</td>
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<tr>
<td>1.3.0</td>
<td>11/25/2013</td>
<td>Added XRP29302A with 2.5A dropout specification</td>
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<td>Updated Package Outline Drawing. ECN 1348-10</td>
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<tr>
<td>1.4.0</td>
<td>03/25/2014</td>
<td>Corrected pin out drawings where EN was shown as VIN. ECN 14xx-xx</td>
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<tr>
<td>1.4.1</td>
<td>11/04/2019</td>
<td>Updated to MaxLinear logo. Updated Ordering Information.</td>
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