FEATURES

- High accuracy over line and load: ±0.9% at 25°C, ±1.5% over temperature
- Ultralow dropout voltage: 230 mV (typical) at 1.5 A
- Requires only C_out = 1.0 μF for stability
- anyCAP = stable with any type of capacitor (including MLCC)
- Current and thermal limiting
- Low noise
- 2.8 V to 6 V input voltage range
- −40°C to +85°C ambient temperature range
- SOT-223 package

APPLICATIONS

- Notebooks, palmtop computers
- SCSI terminators
- Battery-powered systems
- PCMCIA regulators
- Bar code scanners
- Camcorders, cameras

GENERAL DESCRIPTION

The ADP3339 is a member of the ADP33xx family of precision, low dropout, anyCAP® voltage regulators. The ADP3339 operates with an input voltage range of 2.8 V to 6 V and delivers a load current up to 1.5 A. The ADP3339 stands out from the conventional LDOs with a novel architecture and an enhanced process that enables it to offer performance advantages and higher output current than its competition. Its patented design requires only a 1.0 μF output capacitor for stability. This device is insensitive to output capacitor equivalent series resistance (ESR), and is stable with any good quality capacitor, including ceramic (MLCC) types for space-restricted applications. The ADP3339 achieves exceptional accuracy of ±0.9% at room temperature and ±1.5% over temperature, line, and load variations. The dropout voltage of the ADP3339 is only 230 mV (typical) at 1.5 A. The device also includes a safety current limit and thermal overload protection. The ADP3339 has ultralow quiescent current: 130 μA (typical) in light load situations.
COMPARABLE PARTS
View a parametric search of comparable parts.

DOCUMENTATION
Application Notes
- AN-1072: How to Successfully Apply Low Dropout Regulators
- AN-262: Low-Noise Low Drop-Out Regulator for Portable Equipment
- AN-835: Understanding High Speed ADC Testing and Evaluation
- AN-934: 60 dB Wide Dynamic Range, Low Frequency AGC Circuit Using a Single VGA

Data Sheet
- ADP3339: High-Accuracy Ultralow $I_Q$, 1.5 A, anyCAP Low Dropout Regulator Data Sheet

User Guides
- UG-093: Evaluation Board User Guide for the Dual, Continuous Time Sigma-Delta Modulator

TOOLS AND SIMULATIONS
- ADI Linear Regulator Design Tool and Parametric Search
- ADIsimPower™ Voltage Regulator Design Tool

REFERENCE DESIGNS
- CN0158

REFERENCE MATERIALS
Solutions Bulletins & Brochures
- ADI’s anyCAP® LDO Family (March 2003)

Technical Articles
- Part 1: Simplifying Design of Industrial Process-Control Systems with PLC Evaluation Boards
- Part 2: Simplifying Design of Industrial Process-Control Systems with PLC Evaluation Boards

DESIGN RESOURCES
- ADP3339 Material Declaration
- PCN-PDN Information
- Quality And Reliability
- Symbols and Footprints

DISCUSSIONS
View all ADP3339 EngineerZone Discussions.

SAMPLE AND BUY
Visit the product page to see pricing options.

TECHNICAL SUPPORT
Submit a technical question or find your regional support number.

DOCUMENT FEEDBACK
Submit feedback for this data sheet.

This page is dynamically generated by Analog Devices, Inc., and inserted into this data sheet. A dynamic change to the content on this page will not trigger a change to either the revision number or the content of the product data sheet. This dynamic page may be frequently modified.
TABLE OF CONTENTS

Features .............................................................................................. 1
Applications....................................................................................... 1
Functional Block Diagram .............................................................. 1
General Description ......................................................................... 1
Revision History ............................................................................... 2
Specifications..................................................................................... 3
Absolute Maximum Ratings............................................................ 4
   ESD Caution.................................................................................. 4
Pin Configuration and Function Descriptions............................. 5
Typical Performance Characteristics ............................................. 6
Theory of Operation .........................................................................9
Applications Information .............................................................. 10
   Capacitor Selection ................................................................. 10
   Output Current Limit ............................................................... 10
   Thermal Overload Protection ................................................... 10
   Calculating Power Dissipation ................................................. 10
   Printed Circuit Board Layout Considerations ....................... 10
Outline Dimensions ....................................................................... 11
Ordering Guide .......................................................................... 11

REVISION HISTORY

8/11—Rev. B to Rev. C
   Changes to Ordering Guide ...................................................... 11

4/11—Rev. A to Rev. B
   Change to Features Section ...................................................... 1
   Changed I to ILOAD Throughout ............................................. 3
   Updated Outline Dimensions ................................................... 11
   Changes to Ordering Guide ...................................................... 11

6/04—Rev. 0 to Rev. A
   Updated Format ........................................................................ Universal
   Changes to Table 1 ................................................................. 3
   Changes to Thermal Overload Protection Section ................. 10
   Updated Outline Dimensions ................................................... 12
   Changes to Ordering Guide ...................................................... 12

10/01—Revision 0: Initial Version
### SPECIFICATIONS

$V_{IN} = 6.0\, V,\ C_{IN} = C_{OUT} = 1\ \mu F,\ T_{J} = -40^\circ C\ to\ +125^\circ C$, unless otherwise noted.

#### Table 1.

<table>
<thead>
<tr>
<th>Parameter$^{1,2}$</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OUTPUT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage Accuracy$^3$</td>
<td>$V_{OUT}$</td>
<td>$V_{IN} = V_{OUTNOM} + 0.5, V$ to $6, V,\ I_{LOAD} = 0.1, mA$ to $1.5, A,\ T_{J} = 25^\circ C$</td>
<td>-0.9</td>
<td>+0.9</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{IN} = V_{OUTNOM} + 0.5, V$ to $6, V,\ I_{LOAD} = 0.1, mA$ to $1.5, A,\ T_{J} = -40^\circ C$ to $+125^\circ C$</td>
<td>-1.5</td>
<td>+1.5</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{IN} = V_{OUTNOM} + 0.5, V$ to $6, V,\ I_{LOAD} = 100, mA$ to $1.5, A,\ T_{J} = 150^\circ C$</td>
<td>-1.9</td>
<td>+1.9</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Line Regulation$^3$</td>
<td></td>
<td>$V_{IN} = V_{OUTNOM} + 0.5, V$ to $6, V,\ T_{J} = 25^\circ C$</td>
<td>0.04</td>
<td></td>
<td>mV/V</td>
<td></td>
</tr>
<tr>
<td>Load Regulation</td>
<td></td>
<td>$I_{LOAD} = 0.1, mA$ to $1.5, A,\ T_{J} = 25^\circ C$</td>
<td>0.004</td>
<td></td>
<td>mV/mA</td>
<td></td>
</tr>
<tr>
<td>Dropout Voltage</td>
<td>$V_{DROP}$</td>
<td>$V_{OUT} = 98%$ of $V_{OUTNOM}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{LOAD} = 1.5, A$</td>
<td>230</td>
<td>480</td>
<td>mV</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{LOAD} = 1, A$</td>
<td>180</td>
<td>380</td>
<td>mV</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{LOAD} = 500, mA$</td>
<td>150</td>
<td>300</td>
<td>mV</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{LOAD} = 100, mA$</td>
<td>100</td>
<td></td>
<td>mV</td>
<td></td>
</tr>
<tr>
<td>Peak Load Current</td>
<td>$I_{LDPK}$</td>
<td>$V_{IN} = V_{OUTNOM} + 1, V$</td>
<td>2.0</td>
<td></td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Output Noise</td>
<td>$V_{NOISE}$</td>
<td>$f = 10, Hz$ to $100, kHz,\ C_{L} = 10\ \mu F,\ I_{LOAD} = 1.5, A$</td>
<td>95</td>
<td></td>
<td>$\mu V$ rms</td>
<td></td>
</tr>
<tr>
<td><strong>GROUND CURRENT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In Regulation</td>
<td>$I_{GND}$</td>
<td>$I_{LOAD} = 1.5, A$</td>
<td>13</td>
<td>40</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{LOAD} = 1, A$</td>
<td>9</td>
<td>25</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{LOAD} = 500, mA$</td>
<td>5</td>
<td>15</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{LOAD} = 100, mA$</td>
<td>1</td>
<td>3</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{LOAD} = 0.1, mA$</td>
<td>130</td>
<td>200</td>
<td>$\mu A$</td>
<td></td>
</tr>
<tr>
<td>In Dropout</td>
<td>$I_{GND}$</td>
<td>$V_{IN} = V_{OUTNOM} - 100, mV,\ I_{LOAD} = 0.1, mA$</td>
<td>100</td>
<td></td>
<td>$\mu A$</td>
<td></td>
</tr>
</tbody>
</table>

$^1$ All limits at temperature extremes are guaranteed via correlation using standard statistical quality control (SQC) methods.

$^2$ Application stable with no load.

$^3$ $V_{IN} = 2.8\, V$ for models with $V_{OUTNOM} \leq 2.3\, V$. 
ABSOLUTE MAXIMUM RATINGS

Unless otherwise specified, all voltages are referenced to GND.

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those listed in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Only one absolute maximum rating may be applied at any one time.

Table 2.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Supply Voltage</td>
<td>–0.3 V to +8.5 V</td>
</tr>
<tr>
<td>Power Dissipation</td>
<td>Internally limited</td>
</tr>
<tr>
<td>Operating Ambient Temperature Range</td>
<td>–40°C to +85°C</td>
</tr>
<tr>
<td>Operating Junction Temperature Range</td>
<td>–40°C to +150°C</td>
</tr>
<tr>
<td>θJA, 4-Layer Board</td>
<td>62.3°C/W</td>
</tr>
<tr>
<td>θJC</td>
<td>26.8°C/W</td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>–65°C to +150°C</td>
</tr>
<tr>
<td>Lead Temperature (Soldering 10 sec)</td>
<td>300°C</td>
</tr>
<tr>
<td>Vapor Phase (60 sec)</td>
<td>215°C</td>
</tr>
<tr>
<td>Infrared (15 sec)</td>
<td>220°C</td>
</tr>
</tbody>
</table>

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.
PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

Table 3. Pin Function Descriptions

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Mnemonic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GND</td>
<td>Ground Pin.</td>
</tr>
<tr>
<td>2</td>
<td>OUT</td>
<td>Output of the Regulator. Bypass to ground with a 1 μF or larger capacitor.</td>
</tr>
<tr>
<td>3</td>
<td>IN</td>
<td>Regulator Input. Bypass to ground with a 1 μF or larger capacitor.</td>
</tr>
</tbody>
</table>
TYPICAL PERFORMANCE CHARACTERISTICS

$T_A = 25^\circ C$, unless otherwise noted.

Figure 4. Output Voltage vs. Input Voltage

Figure 7. Ground Current vs. Load Current

Figure 5. Output Voltage vs. Load Current

Figure 8. Output Voltage Variation Percentage vs. Junction Temperature

Figure 6. Ground Current vs. Supply Voltage

Figure 9. Ground Current vs. Junction Temperature
Figure 10. Dropout Voltage vs. Load Current

Figure 11. Power-Up/Power-Down

Figure 12. Line Transient Response

Figure 13. Line Transient Response

Figure 14. Load Transient Response

Figure 15. Load Transient Response
**Figure 16. Short-Circuit Current**

**Figure 17. Power Supply Ripple Rejection**

**Figure 18. RMS Noise vs. C_L (10 Hz to 100 kHz)**

**Figure 19. Output Noise Density**
THEORY OF OPERATION

The ADP3339 anyCAP LDO uses a single control loop for regulation and reference functions. The output voltage is sensed by a resistive voltage divider, consisting of R1 and R2, which is varied to provide the available output voltage option. Feedback is taken from this network by way of a series diode (D1) and a second resistor divider (R3 and R4) to the input of an amplifier.

A very high gain error amplifier is used to control this loop. The amplifier is constructed in such a way that equilibrium produces a large, temperature-proportional input offset voltage that is repeatable and very well controlled. The temperature-proportional offset voltage is combined with the complementary diode voltage to form a virtual band gap voltage that is implicit in the network, although it never appears explicitly in the circuit.

Ultimately, this patented design makes it possible to control the loop with only one amplifier. This technique also improves the noise characteristics of the amplifier by providing more flexibility on the trade-off of noise sources that leads to a low noise design. The R1/R2 divider is chosen in the same ratio as the band gap voltage to the output voltage. Although the R1/R2 resistor divider is loaded by Diode D1 and a second divider consisting of R3 and R4, the values can be chosen to produce a temperature-stable output. This unique arrangement specifically corrects for the loading of the divider, thus avoiding the error resulting from base current loading in conventional circuits.

The patented amplifier controls a new and unique noninverting driver that drives the pass transistor, Q1. The use of this special noninverting driver enables the frequency compensation to include the load capacitor in a pole-splitting arrangement to achieve reduced sensitivity to the value, type, and ESR of the load capacitance.

Most LDOs place very strict requirements on the range of ESR values for the output capacitor because they are difficult to stabilize due to the uncertainty of load capacitance and resistance. Moreover, the ESR value required to keep conventional LDOs stable changes depending on load and temperature. These ESR limitations make designing with LDOs more difficult because of their unclear specifications and extreme variations over temperature.

With the ADP3339 anyCAP LDO, this is no longer true. The ADP3339 can be used with virtually any good quality capacitor, with no constraint on the minimum ESR. This innovative design allows the circuit to be stable with just a small 1 μF capacitor on the output. Additional advantages of the pole-splitting scheme include superior line noise rejection and very high regulator gain, which lead to excellent line and load regulation. An impressive ±1.5% accuracy is guaranteed over line, load, and temperature.

Additional features of the circuit include current limit and thermal shutdown.
APPLICATIONS INFORMATION

CAPACITOR SELECTION

Output Capacitor
The stability and transient response of the LDO is a function of the output capacitor. The ADP3339 is stable with a wide range of capacitor values, types, and ESR (anyCAP). A capacitor as low as 1 μF is all that is needed for stability. A higher capacitance may be necessary if high output current surges are anticipated, or if the output capacitor cannot be located near the output and ground pins. The ADP3339 is stable with extremely low ESR capacitors (ESR ≈ 0) such as multilayer ceramic capacitors (MLCC) or OSCON. Note that the effective capacitance of some capacitor types falls below the minimum over temperature or with dc voltage.

Input Capacitor
An input bypass capacitor is not strictly required but is recommended in any application involving long input wires or high source impedance. Connecting a 1 μF capacitor from the input to ground reduces the circuit’s sensitivity to PC board layout and input transients. If a larger output capacitor is necessary, a larger value input capacitor is also recommended.

OUTPUT CURRENT LIMIT
The ADP3339 is short-circuit protected by limiting the pass transistor's base drive current. The maximum output current is limited to about 3 A. See Figure 16.

THERMAL OVERLOAD PROTECTION
The ADP3339 is protected against damage due to excessive power dissipation by its thermal overload protection circuit. Thermal protection limits the die temperature to a maximum of 160°C. Under extreme conditions (that is, high ambient temperature and power dissipation) where the die temperature starts to rise above 160°C, the output current is reduced until the die temperature has dropped to a safe level.

Current and thermal limit protections are intended to protect the device against accidental overload conditions. For normal operation, the device’s power dissipation should be externally limited so that the junction temperature does not exceed 150°C.

CALCULATING POWER DISSIPATION
Device power dissipation is calculated as follows:

\[ P_D = (V_{IN} - V_{OUT}) \times I_{LOAD} + (V_{IN} \times I_{IGND}) \]

where \( I_{LOAD} \) and \( I_{IGND} \) are the load current and ground current, and \( V_{IN} \) and \( V_{OUT} \) are the input and output voltages, respectively.

Assuming worst-case operating conditions are \( I_{LOAD} = 1.5 \text{ A} \), \( I_{IGND} = 14 \text{ mA} \), \( V_{IN} = 3.3 \text{ V} \), and \( V_{OUT} = 2.5 \text{ V} \), the device power dissipation is

\[ P_D = (3.3 \text{ V} - 2.5 \text{ V}) \times 1500 \text{ mA} + (3.3 \text{ V} \times 14 \text{ mA}) = 1246 \text{ mW} \]

Therefore, for a junction temperature of 125°C and a maximum ambient temperature of 85°C, the required thermal resistance from junction to ambient is

\[ \theta_{JA} = \frac{125°C - 85°C}{1.246 \text{ W}} = 32.1°C/\text{W} \]

PRINTED CIRCUIT BOARD LAYOUT CONSIDERATIONS
The thermal resistance, \( \theta_{JA} \), of SOT-223 is determined by the sum of the junction-to-case and the case-to-ambient thermal resistances. The junction-to-case thermal resistance, \( \theta_{JC} \), is determined by the package design and specified at 26.8°C/W. However, the case-to-ambient thermal resistance is determined by the printed circuit board design.

As shown in Figure 22, the amount of copper onto which the ADP3339 is mounted affects thermal performance. When mounted onto the minimal pads of 2 oz. copper (see Figure 22a), \( \theta_{JA} \) is 126.6°C/W. Adding a small copper pad under the ADP3339 (see Figure 22b) reduces the \( \theta_{JA} \) to 102.9°C/W. Increasing the copper pad to 1 square inch (see Figure 22c) reduces the \( \theta_{JA} \) even further, to 52.8°C/W.

Use the following general guidelines when designing printed circuit boards:

1. Keep the output capacitor as close to the output and ground pins as possible.
2. Keep the input capacitor as close to the input and ground pins as possible.
3. PC board traces with larger cross sectional areas remove more heat from the ADP3339. For optimum heat transfer, use thick copper and use wide traces.
4. The thermal resistance can be decreased by adding a copper pad under the ADP3339, as shown in Figure 22b.
5. If possible, use the adjacent area to add more copper around the ADP3339. Connecting the copper pad to the output of the ADP3339, as shown in Figure 22c, is best, but thermal performance is improved even if it is connected to other pins.
6. Use additional copper layers or planes to reduce the thermal resistance. Again, connecting the other layers to the output of the ADP3339 is best, but is not necessary. When connecting the output pad to other layers, use multiple vias.
OUTLINE DIMENSIONS

Figure 23. 3-Lead Small Outline Transistor Package [SOT-223] (KC-3)
Dimensions shown in millimeters

ORDERING GUIDE

<table>
<thead>
<tr>
<th>Model1</th>
<th>Temperature Range</th>
<th>Output Voltage (V)</th>
<th>Package Description</th>
<th>Package Option2</th>
<th>Branding</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADP3339AKC-1.5-RL</td>
<td>−40°C to +85°C</td>
<td>1.5</td>
<td>3-Lead SOT-223</td>
<td>KC-3</td>
<td></td>
</tr>
<tr>
<td>ADP3339AKCZ-1.5-RL</td>
<td>−40°C to +85°C</td>
<td>1.5</td>
<td>3-Lead SOT-223</td>
<td>KC-3</td>
<td>L1C</td>
</tr>
<tr>
<td>ADP3339AKCZ-2.5-RL</td>
<td>−40°C to +85°C</td>
<td>2.5</td>
<td>3-Lead SOT-223</td>
<td>KC-3</td>
<td>L1D</td>
</tr>
<tr>
<td>ADP3339AKCZ-3-RL</td>
<td>−40°C to +85°C</td>
<td>3.0</td>
<td>3-Lead SOT-223</td>
<td>KC-3</td>
<td>L3F</td>
</tr>
<tr>
<td>ADP3339AKCZ-3.3-RL</td>
<td>−40°C to +85°C</td>
<td>3.3</td>
<td>3-Lead SOT-223</td>
<td>KC-3</td>
<td>L1A</td>
</tr>
<tr>
<td>ADP3339AKCZ-3.3-R7</td>
<td>−40°C to +85°C</td>
<td>3.3</td>
<td>3-Lead SOT-223</td>
<td>KC-3</td>
<td>L1A</td>
</tr>
<tr>
<td>ADP3339AKCZ-5-R7</td>
<td>−40°C to +85°C</td>
<td>5.0</td>
<td>3-Lead SOT-223</td>
<td>KC-3</td>
<td>L3G</td>
</tr>
</tbody>
</table>

1 Z = RoHS Compliant Part.
2 This package option is halide free.