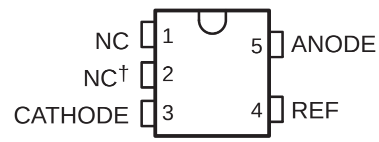
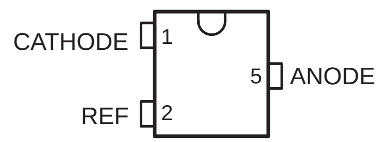
- **Qualified for Automotive Applications**
- **Operation From −40°C to 125°C**
- **Reference Voltage Tolerance at 25°C**
  - **− 1% . . . A Grade**
  - **− 0.5% . . . B Grade**
- **Typical Temperature Drift**
  - **− 14 mV (Q Temp)**
- **Low Output Noise**
- **0.2-Ω Typical Output Impedance**
- **Sink-Current Capability = 1 mA to 100 mA**
- **Adjustable Output Voltage = $V_{ref}$ to 36 V**

**DBV (SOT-23-5) PACKAGE**
**(TOP VIEW)**




NC − No internal connection
† Pin 2 is connected internally to ANODE (die substrate) and should be floating or connected to ANODE.

**TL431, TL431A, TL431B**
**DBZ (SOT-23-5) PACKAGE**
**(TOP VIEW)**




## description

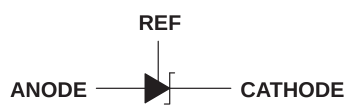
The TL431 is a three-terminal adjustable shunt regulator with specified thermal stability over applicable automotive temperature ranges. The output voltage can be set to any value between $V_{ref}$ (approximately 2.5 V) and 36 V, with two external resistors (see Figure 17). This device has a typical output impedance of 0.2 Ω. Active output circuitry provides a sharp turn-on characteristic, making this device an excellent replacement for Zener diodes in many applications, such as onboard regulation, adjustable power supplies, and switching power supplies.

**Ordering Information†**

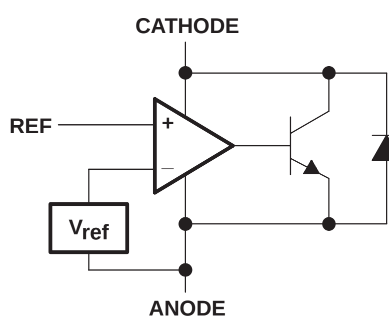
| $T_A$ | PACKAGE‡ | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---|---|---|---|---|
| −40°C to 125°C | SOT-23-5 (DBV) | Reel of 3000 | TL431AQDBVRQ1 | TACQ |
| | SOT-23-3 (DBZ) | Reel of 3000 | TL431BQDBZRQ1 | T3FU |
| | SOT-23-5 (DBV) | Reel of 3000 | TL431QDBVRQ1 | T3QU |
| | SOT-23-3 (DBZ) | Reel of 3000 | TL431AQDBZRQ1 | TAQU |

† For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at http://www.ti.com.
‡ Package drawings, thermal data, and symbolization are available at http://www.ti.com/packaging.

## symbol




## functional block diagram



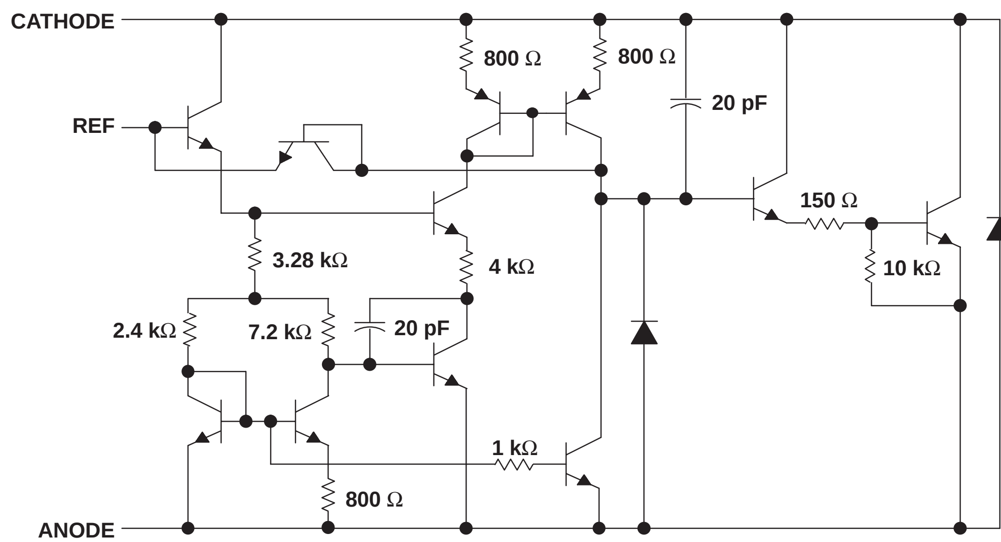

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PowerFLEX is a trademark of Texas Instruments.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

Copyright © 2008, Texas Instruments Incorporated

## equivalent schematic†




† All component values are nominal.

## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)‡

Cathode voltage, $V_{KA}$ (see Note 1) . . . . . 37 V
Continuous cathode current range, $I_{KA}$ . . . . . −100 mA to 150 mA
Reference input current range . . . . . −50 μA to 10 mA
Operating virtual junction temperature, $T_J$ . . . . . 150°C
Storage temperature range, $T_{stg}$ . . . . . −65°C to 150°C
ESD protection level (see Note 2): HBM . . . . . (H2) 2.5 kV
CDM . . . . . (C4) 1 kV
MM . . . . . (M2) 200 V

‡ Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: Voltage values are with respect to the ANODE terminal, unless otherwise noted.
NOTE 2: ESD Protection Level per AEC Q100 Classification

## package thermal data (see Note3)

| PACKAGE | BOARD | $\theta_{JC}$ | $\theta_{JA}$ |
|---|---|---|---|
| SOT-23-5 (DBV) | High K, JESD 51-7 | 131°C/W | 206°C/W |
| SOT-23-3 (DBZ) | High K, JESD 51-7 | 76°C/W | 206°C/W |

NOTE 3: Maximum power dissipation is a function of $T_J$(max), $\theta_{JA}$, and $T_A$. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) - T_A)/\theta_{JA}$. Operating at the absolute maximum $T_J$ of 150°C can affect reliability.

## recommended operating conditions

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| $V_{KA}$ | Cathode voltage | $V_{ref}$ | 36 | V |
| $I_{KA}$ | Cathode current | 1 | 100 | mA |
| $T_A$ | Operating free-air temperature range | −40 | 125 | °C |

## electrical characteristics over recommended operating conditions, $T_A$ = 25°C (unless otherwise noted)

| PARAMETER | | TEST CIRCUIT | TEST CONDITIONS | | TL431Q MIN | TL431Q TYP | TL431Q MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| $V_{ref}$ | Reference voltage | 2 | $V_{KA} = V_{ref}$, $I_{KA}$ = 10 mA | | 2440 | 2495 | 2550 | mV |
| $V_{I(dev)}$ | Deviation of reference voltage over full temperature range (see Figure 1) | 2 | $V_{KA} = V_{ref}$, $I_{KA}$ = 10 mA, $T_A$ = −40°C to 125°C | | | 14 | 34 | mV |
| $\frac{\Delta V_{ref}}{\Delta V_{KA}}$ | Ratio of change in reference voltage to the change in cathode voltage | 3 | $I_{KA}$ = 10 mA | $\Delta V_{KA}$ = 10 V − $V_{ref}$ | | −1.4 | −2.7 | mV/V |
| | | | | $\Delta V_{KA}$ = 36 V − 10 V | | −1 | −2 | |
| $I_{ref}$ | Reference current | 3 | $I_{KA}$ = 10 mA, R1 = 10 kΩ, R2 = ∞ | | | 2 | 4 | μA |
| $I_{I(dev)}$ | Deviation of reference current over full temperature range (see Figure 1) | 3 | $I_{KA}$ = 10 mA, R1 = 10 kΩ, R2 = ∞, $T_A$ = −40°C to 125°C | | | 0.8 | 2.5 | μA |
| $I_{min}$ | Minimum cathode current for regulation | 2 | $V_{KA} = V_{ref}$ | | | 0.4 | 1 | mA |
| $I_{off}$ | Off-state cathode current | 4 | $V_{KA}$ = 36 V, $V_{ref}$ = 0 | | | 0.1 | 1 | μA |
| $\lvert z_{KA} \rvert$ | Dynamic impedance (see Figure 1) | 2 | $I_{KA}$ = 1 mA to 100 mA, $V_{KA} = V_{ref}$, f ≤ 1 kHz | | | 0.2 | 0.5 | Ω |

## electrical characteristics over recommended operating conditions, $T_A$ = 25°C (unless otherwise noted)

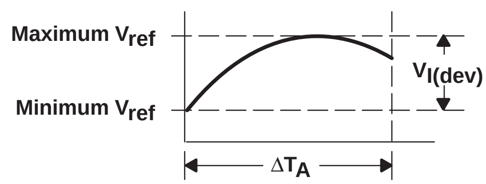
| PARAMETER | | TEST CIRCUIT | TEST CONDITIONS | | TL431AQ MIN | TL431AQ TYP | TL431AQ MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| $V_{ref}$ | Reference voltage | 2 | $V_{KA} = V_{ref}$, $I_{KA}$ = 10 mA | | 2470 | 2495 | 2520 | mV |
| $V_{I(dev)}$ | Deviation of reference voltage over full temperature range (see Figure 1) | 2 | $V_{KA} = V_{ref}$, $I_{KA}$ = 10 mA, $T_A$ = −40°C to 125°C | | | 14 | 34 | mV |
| $\frac{\Delta V_{ref}}{\Delta V_{KA}}$ | Ratio of change in reference voltage to the change in cathode voltage | 3 | $I_{KA}$ = 10 mA | $\Delta V_{KA}$ = 10 V − $V_{ref}$ | | −1.4 | −2.7 | mV/V |
| | | | | $\Delta V_{KA}$ = 36 V − 10 V | | −1 | −2 | |
| $I_{ref}$ | Reference current | 3 | $I_{KA}$ = 10 mA, R1 = 10 kΩ, R2 = ∞ | | | 2 | 4 | μA |
| $I_{I(dev)}$ | Deviation of reference current over full temperature range (see Figure 1) | 3 | $I_{KA}$ = 10 mA, R1 = 10 kΩ, R2 = ∞, $T_A$ = −40°C to 125°C | | | 0.8 | 2.5 | μA |
| $I_{min}$ | Minimum cathode current for regulation | 2 | $V_{KA} = V_{ref}$ | | | 0.4 | 0.7 | mA |
| $I_{off}$ | Off-state cathode current | 4 | $V_{KA}$ = 36 V, $V_{ref}$ = 0 | | | 0.1 | 0.5 | μA |
| $\lvert z_{KA} \rvert$ | Dynamic impedance (see Figure 1) | 2 | $I_{KA}$ = 1 mA to 100 mA, $V_{KA} = V_{ref}$, f ≤ 1 kHz | | | 0.2 | 0.5 | Ω |

## electrical characteristics over recommended operating conditions, $T_A$ = 25°C (unless otherwise noted)

| PARAMETER | | TEST CIRCUIT | TEST CONDITIONS | | TL431BQ MIN | TL431BQ TYP | TL431BQ MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| $V_{ref}$ | Reference voltage | 2 | $V_{KA} = V_{ref}$, $I_{KA}$ = 10 mA | | 2483 | 2495 | 2507 | mV |
| $V_{I(dev)}$ | Deviation of reference voltage over full temperature range (see Figure 1) | 2 | $V_{KA} = V_{ref}$, $I_{KA}$ = 10 mA, $T_A$ = −40°C to 125°C | | | 14 | 34 | mV |
| $\frac{\Delta V_{ref}}{\Delta V_{KA}}$ | Ratio of change in reference voltage to the change in cathode voltage | 3 | $I_{KA}$ = 10 mA | $\Delta V_{KA}$ = 10 V − $V_{ref}$ | | −1.4 | −2.7 | $\frac{mV}{V}$ |
| | | | | $\Delta V_{KA}$ = 36 V − 10 V | | −1 | −2 | |
| $I_{ref}$ | Reference current | 3 | $I_{KA}$ = 10 mA, R1 = 10 kΩ, R2 = ∞ | | | 2 | 4 | μA |
| $I_{I(dev)}$ | Deviation of reference current over full temperature range (see Figure 1) | 3 | $I_{KA}$ = 10 mA, R1 = 10 kΩ, R2 = ∞, $T_A$ = −40°C to 125°C | | | 0.8 | 2.5 | μA |
| $I_{min}$ | Minimum cathode current for regulation | 2 | $V_{KA} = V_{ref}$ | | | 0.4 | 0.7 | mA |
| $I_{off}$ | Off-state cathode current | 4 | $V_{KA}$ = 36 V, $V_{ref}$ = 0 | | | 0.1 | 0.5 | μA |
| $\lvert z_{KA} \rvert$ | Dynamic impedance (see Figure 1) | 1 | $I_{KA}$ = 1 mA to 100 mA, $V_{KA} = V_{ref}$, f ≤ 1 kHz | | | 0.2 | 0.5 | Ω |

The deviation parameters, $V_{ref(dev)}$ and $I_{ref(dev)}$, are defined as the differences between the maximum and minimum values obtained over the recommended temperature range. The average full-range temperature coefficient of the reference voltage, $\alpha_{Vref}$, is defined as:

$$\left|\alpha_{V_{ref}}\right| \left(\frac{ppm}{°C}\right) = \frac{\left(\frac{V_{I(dev)}}{V_{ref}\text{ at } 25°C}\right) \times 10^6}{\Delta T_A}$$




where:
$\Delta T_A$ is the recommended operating free-air temperature range of the device.

$\alpha_{V_{ref}}$ can be positive or negative, depending on whether minimum $V_{ref}$ or maximum $V_{ref}$, respectively, occurs at the lower temperature.

Example: maximum $V_{ref}$ = 2496 mV at 30°C, minimum $V_{ref}$ = 2492 mV at 0°C, $V_{ref}$ = 2495 mV at 25°C, $\Delta T_A$ = 70°C for TL431

$$\left|\alpha_{V_{ref}}\right| = \frac{\left(\frac{4\ mV}{2495\ mV}\right) \times 10^6}{70°C} \approx \frac{23\ ppm}{°C}$$

Because minimum $V_{ref}$ occurs at the lower temperature, the coefficient is positive.

**Calculating Dynamic Impedance**

The dynamic impedance is defined as: $\left|z_{KA}\right| = \frac{\Delta V_{KA}}{\Delta I_{KA}}$

When the device is operating with two external resistors (see Figure 3), the total dynamic impedance of the circuit is given by:

$$\left|z'\right| = \frac{\Delta V}{\Delta I} \approx \left|z_{KA}\right| \left(1 + \frac{R1}{R2}\right)$$

**Figure 1. Calculating Deviation Parameters and Dynamic Impedance**

## PARAMETER MEASUREMENT INFORMATION

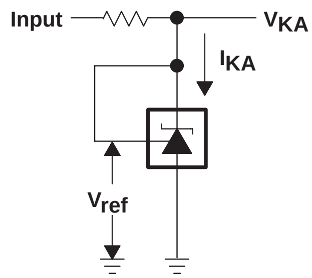



**Figure 2. Test Circuit for $V_{KA} = V_{ref}$**

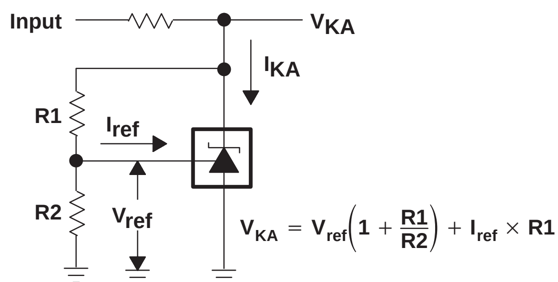



**Figure 3. Test Circuit for $V_{KA} > V_{ref}$**

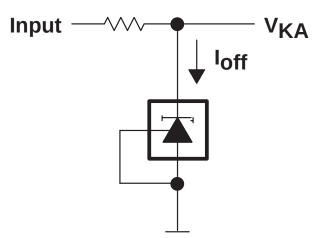



**Figure 4. Test Circuit for $I_{off}$**

## TYPICAL CHARACTERISTICS

### Table 1. Graphs

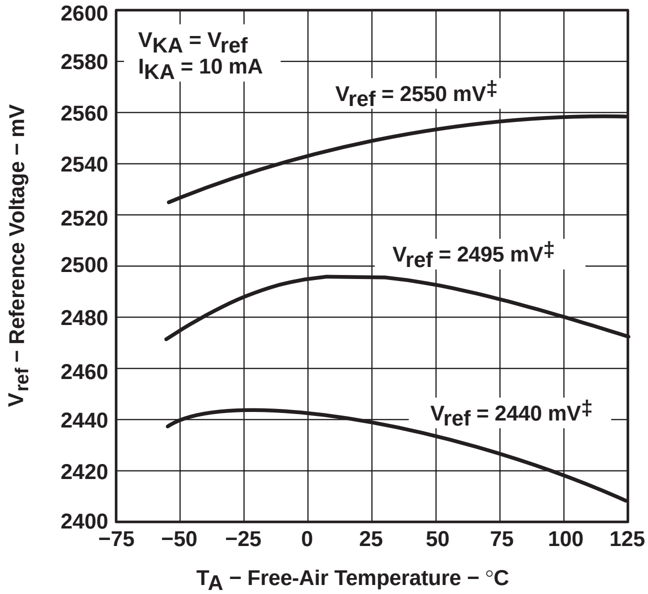
| | FIGURE |
|---|---|
| Reference voltage vs Free-air temperature | 5 |
| Reference current vs Free-air temperature | 6 |
| Cathode current vs Cathode voltage | 7, 8 |
| OFF-state cathode current vs Free-air temperature | 9 |
| Ratio of delta reference voltage to delta cathode voltage vs Free-air temperature | 10 |
| Equivalent input noise voltage vs Frequency | 11 |
| Equivalent input noise voltage over a 10-s period | 12 |
| Small-signal voltage amplification vs Frequency | 13 |
| Reference impedance vs Frequency | 14 |
| Pulse response | 15 |
| Stability boundary conditions | 16 |

### Table 2. Application Circuits

| | FIGURE |
|---|---|
| Shunt regulator | 17 |
| Single-supply comparator with temperature-compensated threshold | 18 |
| Precision high-current series regulator | 19 |
| Output control of a three-terminal fixed regulator | 20 |
| High-current shunt regulator | 21 |
| Crowbar circuit | 22 |
| Precision 5-V 1.5-A regulator | 23 |
| Efficient 5-V precision regulator | 24 |
| PWM converter with reference | 25 |
| Voltage monitor | 26 |
| Delay timer | 27 |
| Precision current limiter | 28 |
| Precision constant-current sink | 29 |

## TYPICAL CHARACTERISTICS†

**REFERENCE VOLTAGE vs FREE-AIR TEMPERATURE**




‡ Data is for devices having the indicated value of $V_{ref}$ at $I_{KA}$ = 10 mA, $T_A$ = 25°C.

**Figure 5**

**REFERENCE CURRENT vs FREE-AIR TEMPERATURE**

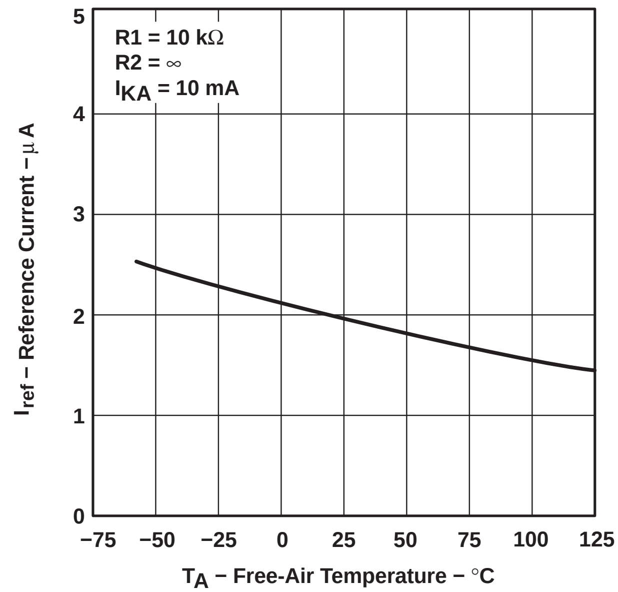



**Figure 6**

**CATHODE CURRENT vs CATHODE VOLTAGE**

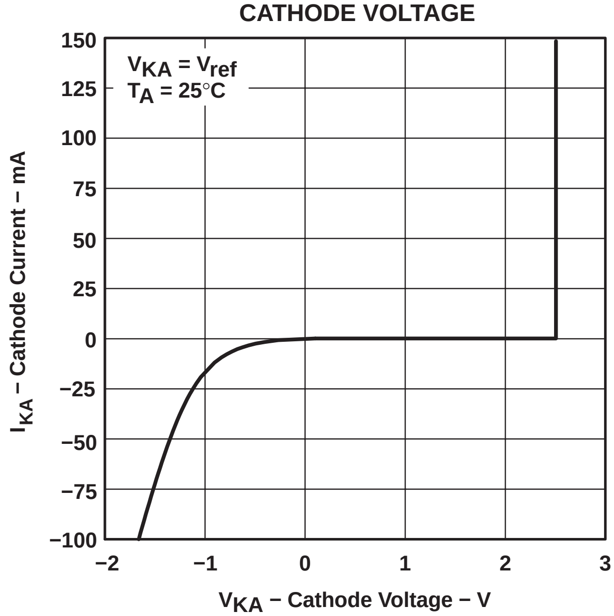



**Figure 7**

**CATHODE CURRENT vs CATHODE VOLTAGE**

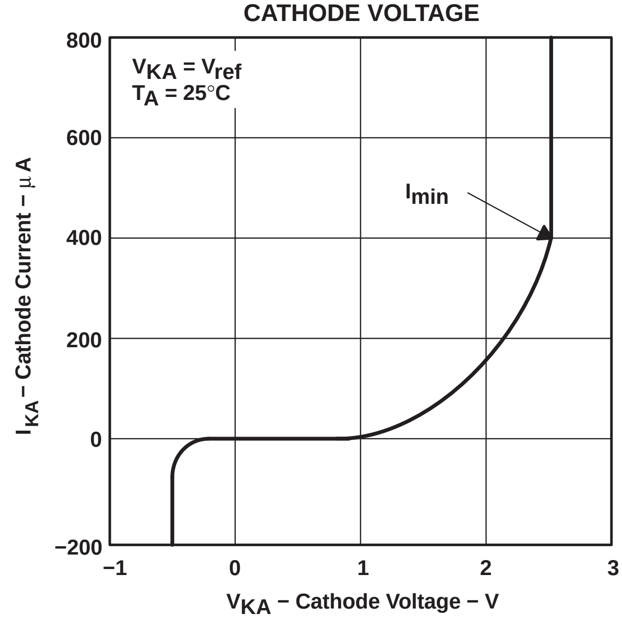



**Figure 8**

† Data at high and low temperatures is applicable only within the recommended operating free-air temperature ranges of the various devices.

## TYPICAL CHARACTERISTICS†

**OFF-STATE CATHODE CURRENT**
**vs**
**FREE-AIR TEMPERATURE**

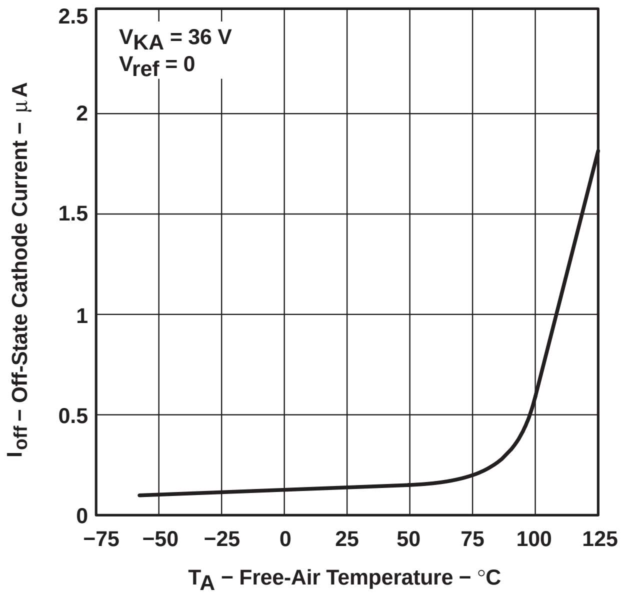



**Figure 9**

**RATIO OF DELTA REFERENCE VOLTAGE TO**
**DELTA CATHODE VOLTAGE**
**vs**
**FREE-AIR TEMPERATURE**

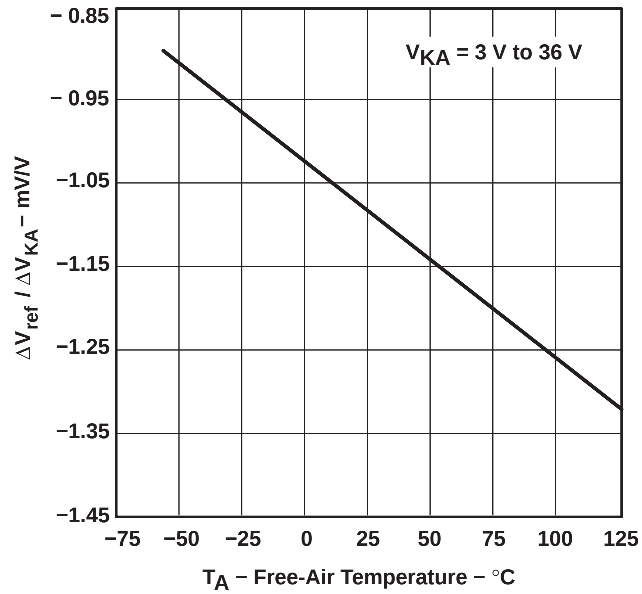



**Figure 10**

**EQUIVALENT INPUT NOISE VOLTAGE**
**vs**
**FREQUENCY**

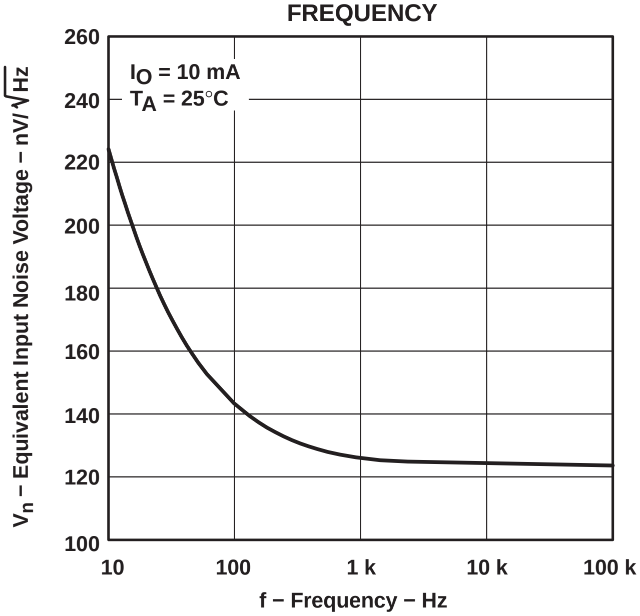
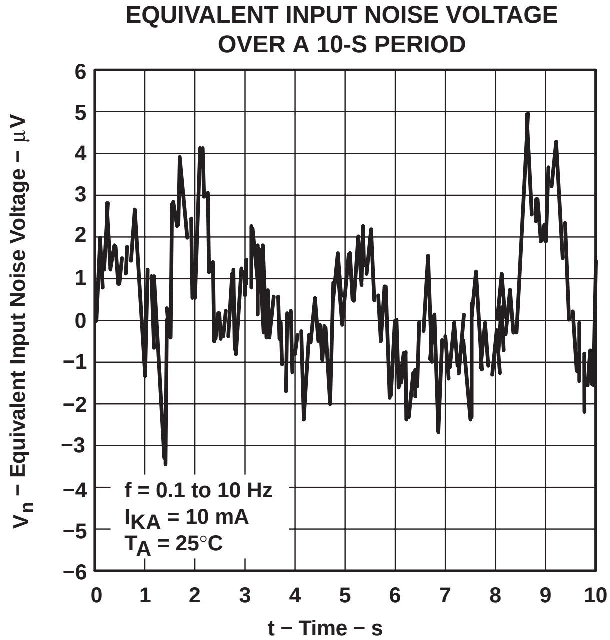



**Figure 11**

† Data at high and low temperatures is applicable only within the recommended operating free-air temperature ranges of the various devices.

## TYPICAL CHARACTERISTICS



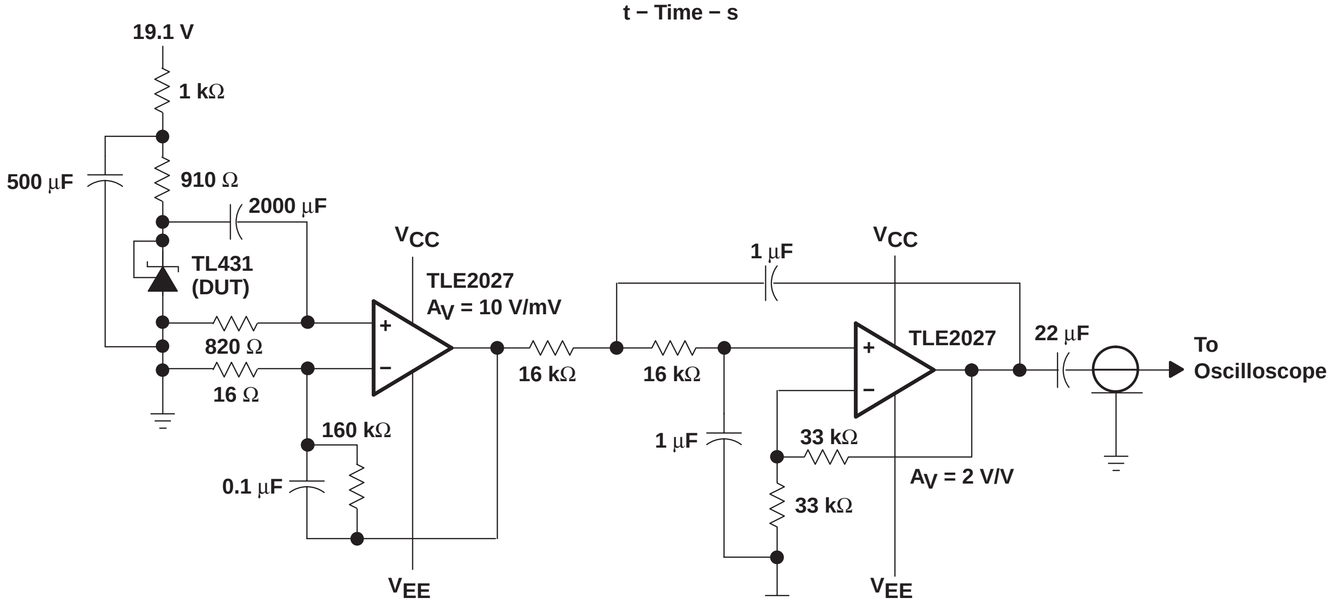
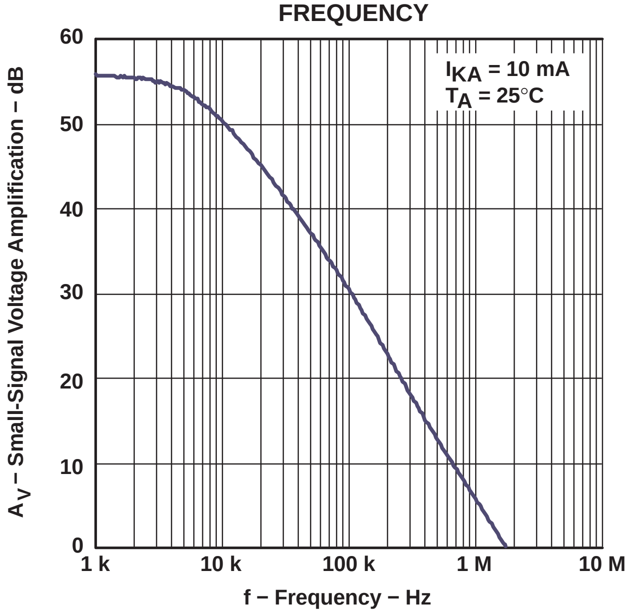
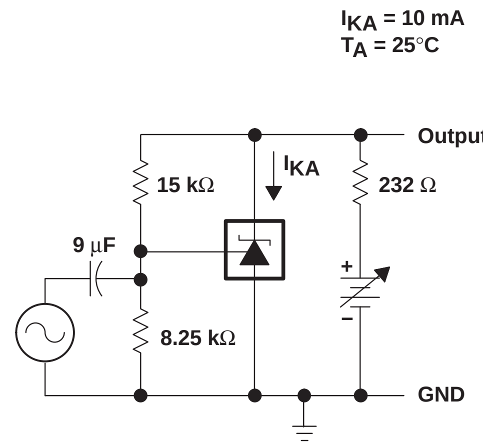




**Figure 12. Test Circuit for Equivalent Input Noise Voltage**

## TYPICAL CHARACTERISTICS

**SMALL-SIGNAL VOLTAGE AMPLIFICATION**
**vs**
**FREQUENCY**

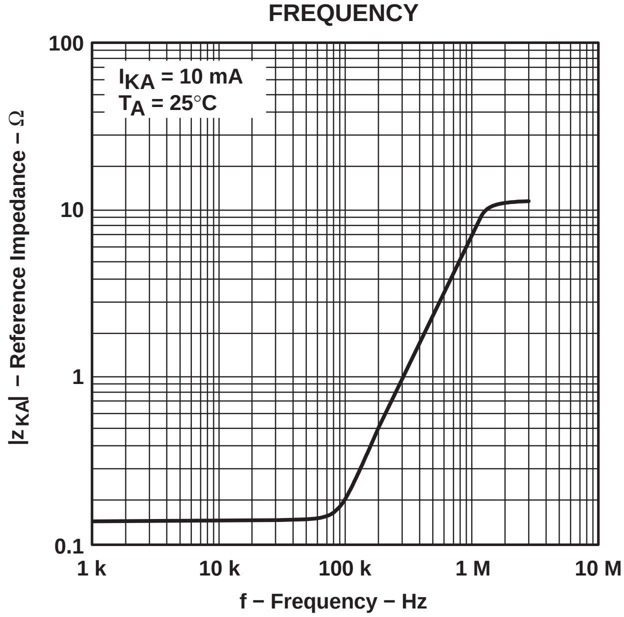


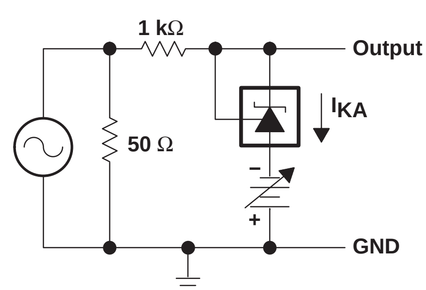




**TEST CIRCUIT FOR VOLTAGE AMPLIFICATION**

**Figure 13**

**REFERENCE IMPEDANCE**
**vs**
**FREQUENCY**

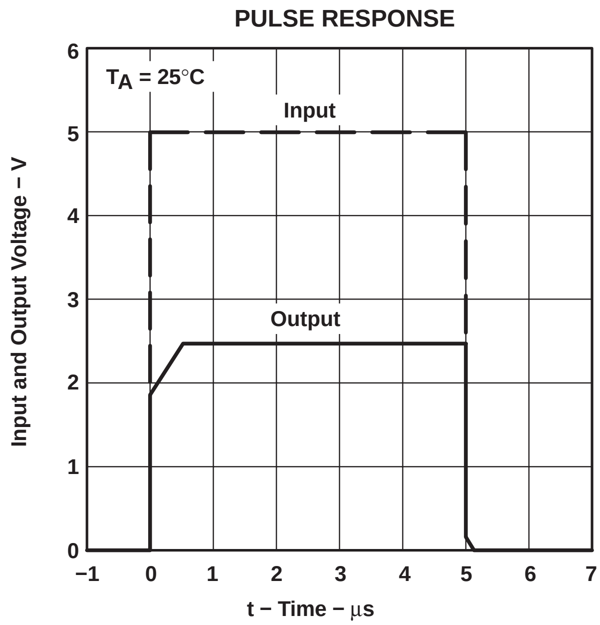



**TEST CIRCUIT FOR REFERENCE IMPEDANCE**

**Figure 14**

## TYPICAL CHARACTERISTICS



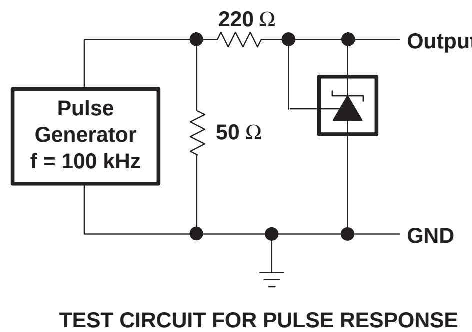
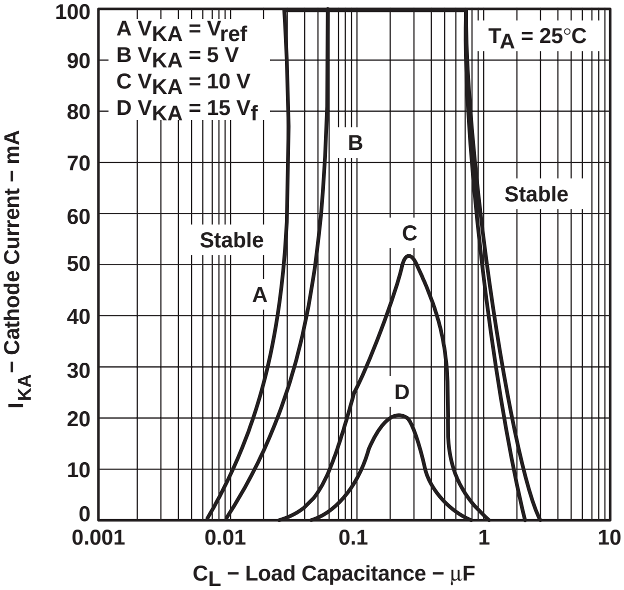
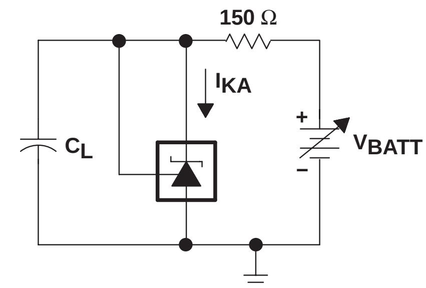




**Figure 15**

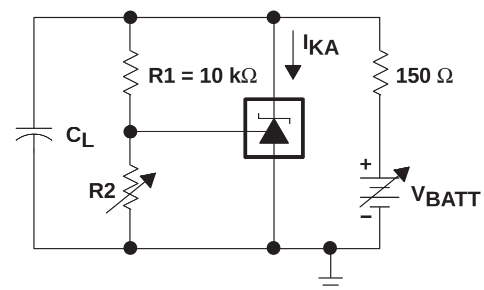
## TYPICAL CHARACTERISTICS

**STABILITY BOUNDARY CONDITIONS†**
**FOR ALL TL431 AND TL431A DEVICES**
**(EXCEPT FOR SOT23-3, SC-70, AND Q-TEMP DEVICES)**



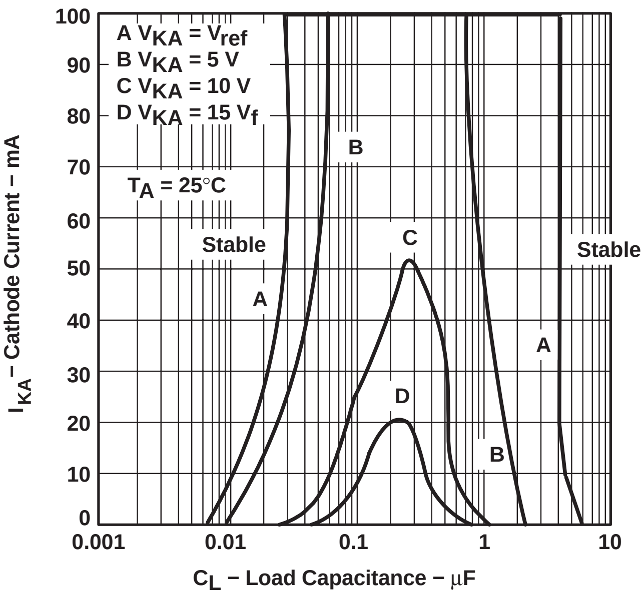



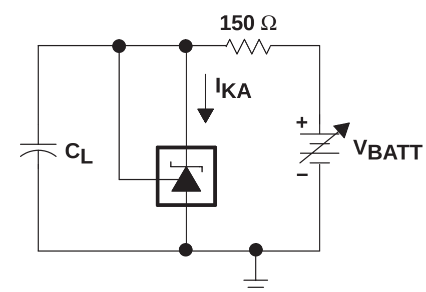

**TEST CIRCUIT FOR CURVE A**



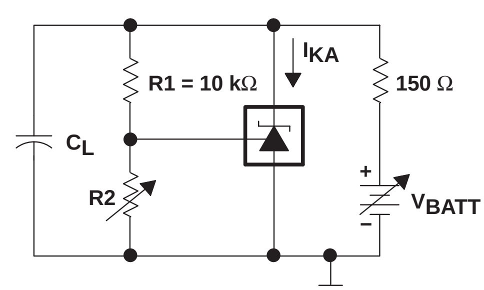

**TEST CIRCUIT FOR CURVES B, C, AND D**

**STABILITY BOUNDARY CONDITIONS†**
**FOR ALL TL431B, TL432, SOT-23, SC-70, AND Q-TEMP DEVICES**




**TEST CIRCUIT FOR CURVE A**

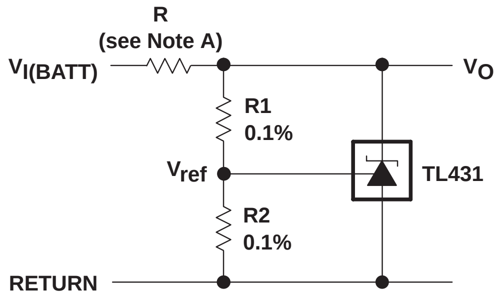



**TEST CIRCUIT FOR CURVES B, C, AND D**

† The areas under the curves represent conditions that may cause the device to oscillate. For curves B, C, and D, R2 and V+ were adjusted to establish the initial $V_{KA}$ and $I_{KA}$ conditions with $C_L = 0$. $V_{BATT}$ and $C_L$ then were adjusted to determine the ranges of stability.

**Figure 16**

## APPLICATION INFORMATION




$$V_O = \left(1 + \frac{R1}{R2}\right)V_{ref}$$

NOTE A: R should provide cathode current ≥1 mA to the TL431 at minimum $V_{I(BATT)}$.

**Figure 17. Shunt Regulator**

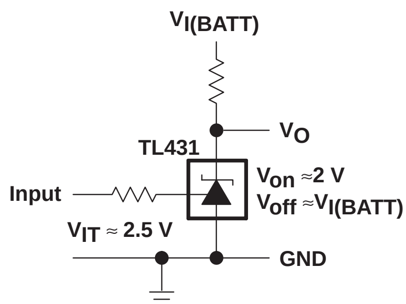
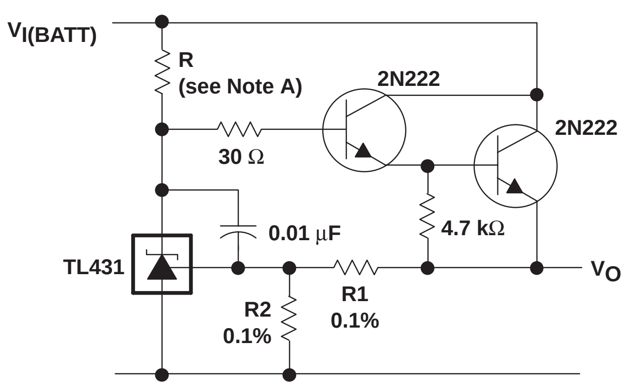



**Figure 18. Single-Supply Comparator With Temperature-Compensated Threshold**




$$V_O = \left(1 + \frac{R1}{R2}\right)V_{ref}$$

NOTE A: R should provide cathode current ≥1 mA to the TL431 at minimum $V_{I(BATT)}$.

**Figure 19. Precision High-Current Series Regulator**

## APPLICATION INFORMATION

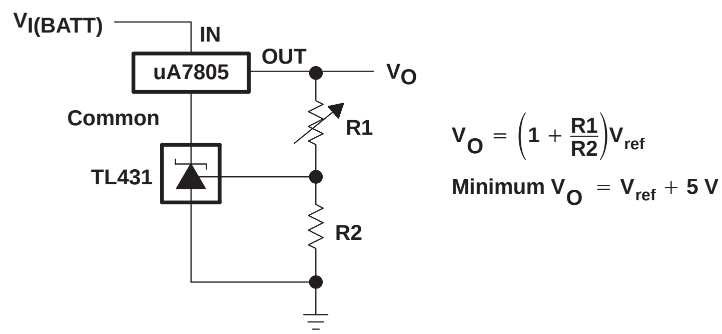



**Figure 20. Output Control of a Three-Terminal Fixed Regulator**

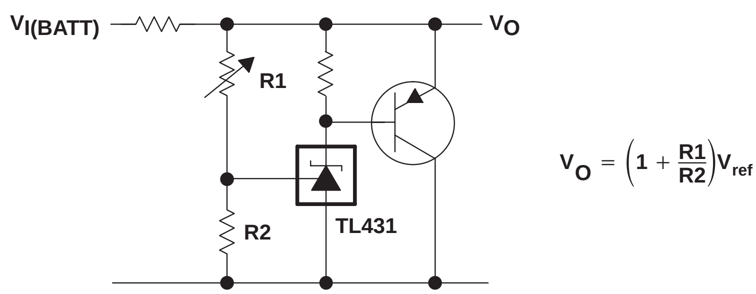
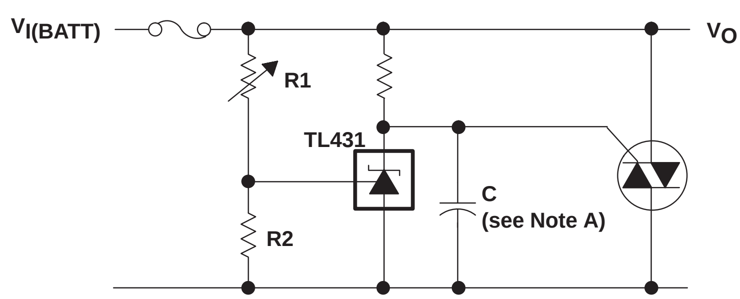



**Figure 21. High-Current Shunt Regulator**




NOTE A: See the stability boundary conditions in Figure 16 to determine allowable values for C.

**Figure 22. Crowbar Circuit**

## APPLICATION INFORMATION

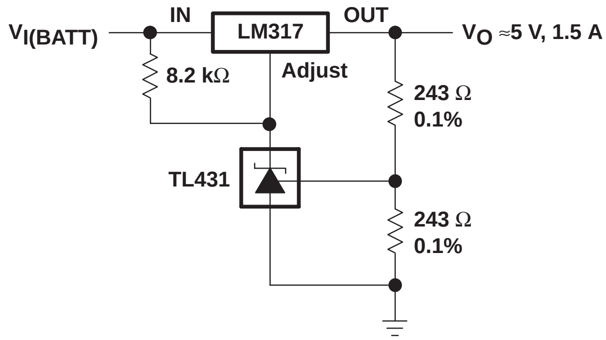
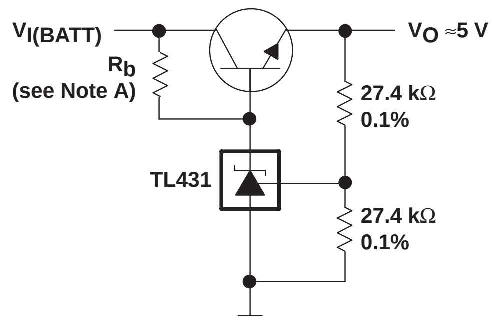



**Figure 23. Precision 5-V 1.5-A Regulator**




NOTE A: $R_b$ should provide cathode current ≥1 mA to the TL431.

**Figure 24. Efficient 5-V Precision Regulator**

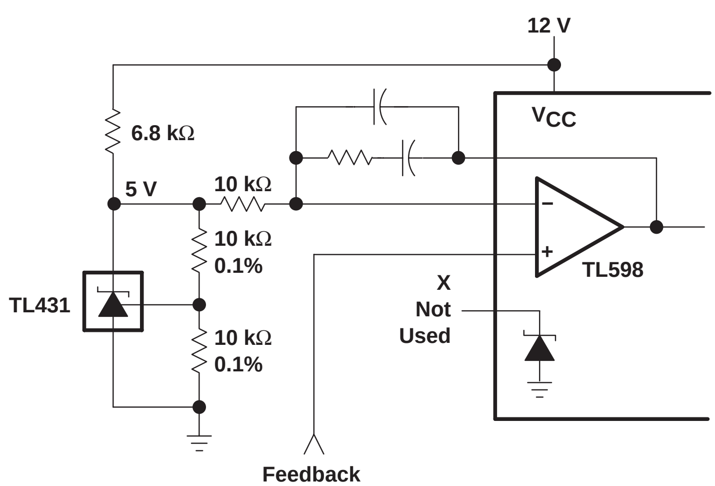
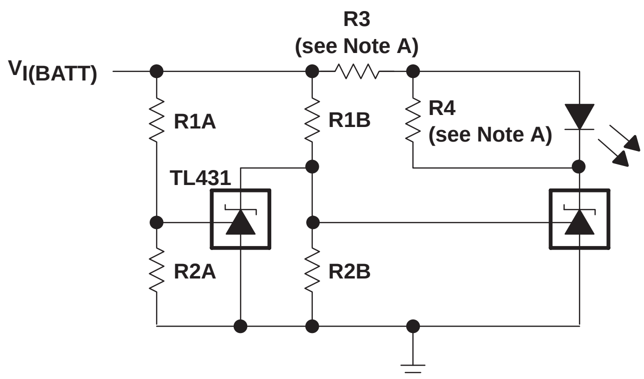



**Figure 25. PWM Converter With Reference**

## APPLICATION INFORMATION



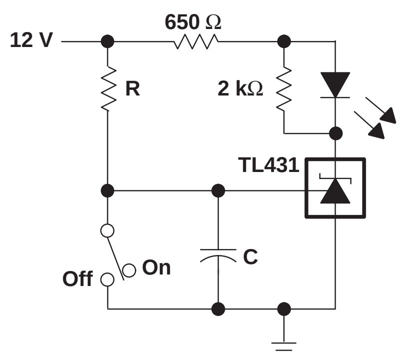

$$\text{Low Limit} = \left(1 + \frac{R1B}{R2B}\right)V_{ref}$$

$$\text{High Limit} = \left(1 + \frac{R1A}{R2A}\right)V_{ref}$$

LED on When Low Limit < $V_{I(BATT)}$ < High Limit

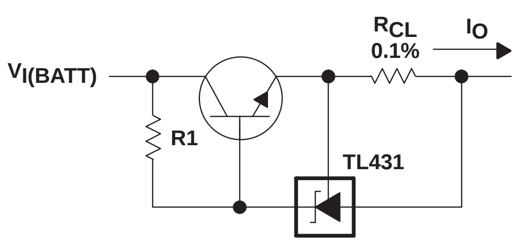
NOTE A: R3 and R4 are selected to provide the desired LED intensity and cathode current ≥1 mA to the TL431 at the available $V_{I(BATT)}$.

**Figure 26. Voltage Monitor**




$$\text{Delay} = R \times C \times I_n\left(\frac{12\ V}{12\ V - V_{ref}}\right)$$

**Figure 27. Delay Timer**




$$I_{out} = \frac{V_{ref}}{R_{CL}} + I_{KA}$$

$$R1 = \frac{V_{I(BATT)}}{\frac{I_O}{h_{FE}} + I_{KA}}$$

**Figure 28. Precision Current Limiter**

## APPLICATION INFORMATION

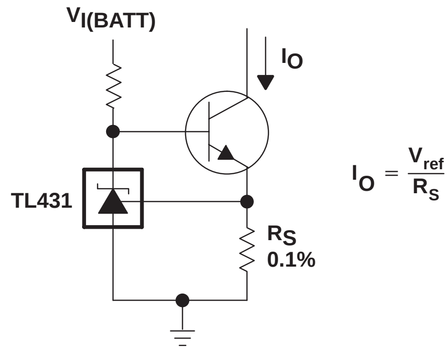



**Figure 29. Precision Constant-Current Sink**

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) |
|---|---|---|---|---|---|---|---|---|
| TL431AQDBVRQ1 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AQDBZRQ1 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BQDBZRQ1 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

(1) The marketing status values are defined as follows:
**ACTIVE:** Product device recommended for new designs.
**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.
**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
**TBD:** The Pb-Free/Green conversion plan has not been defined.
**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

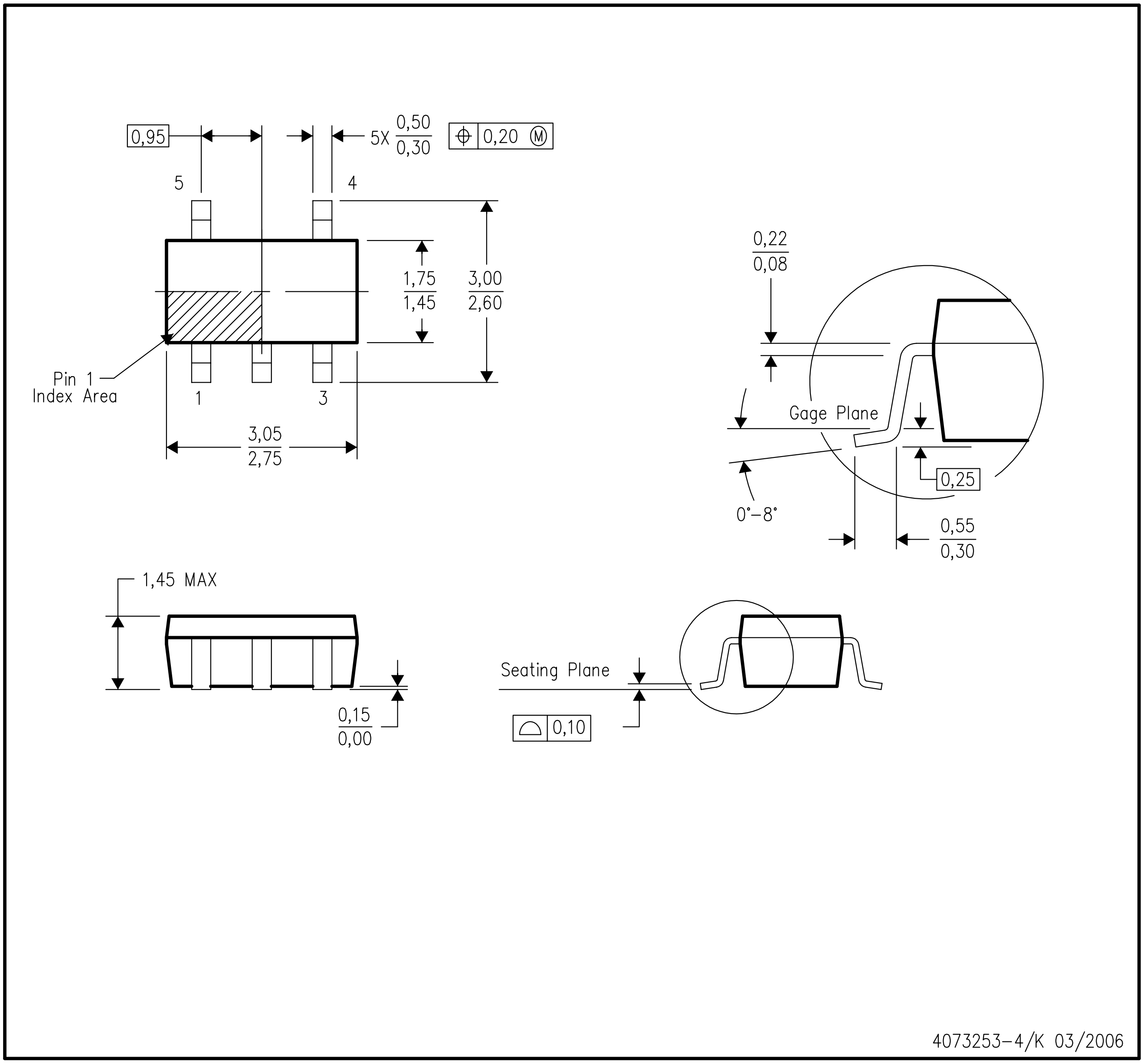
**OTHER QUALIFIED VERSIONS OF TL431A-Q1, TL431B-Q1 :**

- Catalog: TL431A, TL431B

NOTE: Qualified Version Definitions:

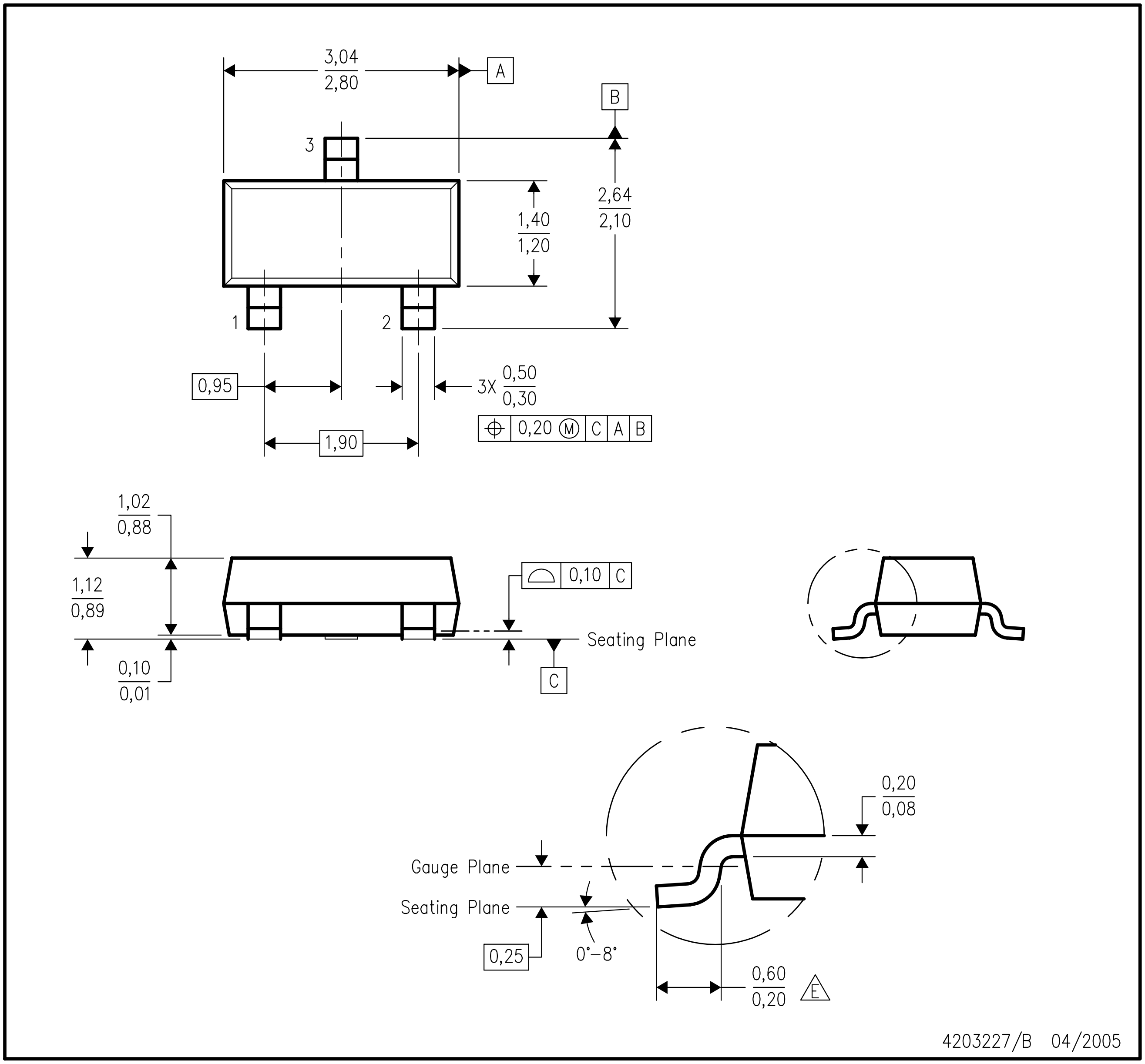
- Catalog - TI's standard catalog product

DBV (R-PDSO-G5) PLASTIC SMALL-OUTLINE PACKAGE




NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
D. Falls within JEDEC MO-178 Variation AA.

DBZ (R-PDSO-G3) PLASTIC SMALL-OUTLINE




NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
- B. This drawing is subject to change without notice.
- C. Lead dimensions are inclusive of plating.
- D. Body dimensions are exclusive of mold flash and protrusion. Mold flash and protrusion not to exceed 0.25 per side.
- E. Falls within JEDEC TO–236 variation AB, except minimum foot length.

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

| **Products** | | **Applications** | |
|---|---|---|---|
| Amplifiers | amplifier.ti.com | Audio | www.ti.com/audio |
| Data Converters | dataconverter.ti.com | Automotive | www.ti.com/automotive |
| DSP | dsp.ti.com | Broadband | www.ti.com/broadband |
| Clocks and Timers | www.ti.com/clocks | Digital Control | www.ti.com/digitalcontrol |
| Interface | interface.ti.com | Medical | www.ti.com/medical |
| Logic | logic.ti.com | Military | www.ti.com/military |
| Power Mgmt | power.ti.com | Optical Networking | www.ti.com/opticalnetwork |
| Microcontrollers | microcontroller.ti.com | Security | www.ti.com/security |
| RFID | www.ti-rfid.com | Telephony | www.ti.com/telephony |
| RF/IF and ZigBee® Solutions | www.ti.com/lprf | Video & Imaging | www.ti.com/video |
| | | Wireless | www.ti.com/wireless |

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2008, Texas Instruments Incorporated