

ADJUSTABLE PRECISION SHUNT REGULATORS

Description

The AN431 series ICs are three-terminal adjustable shunt regulators with guaranteed thermal stability over a full operation range. These ICs feature sharp turn-on characteristics, low temperature coefficient and low output impedance, which make them ideal substitutes for Zener diodes in applications such as switching power supply, charger and other adjustable regulators.

The output voltage of these ICs can be set to any value between  $V_{REF}$  (2.5V) and the maximum cathode voltage (36V).

The AN431 precision reference is offered in two voltage tolerance: 0.5% and 1.0%.

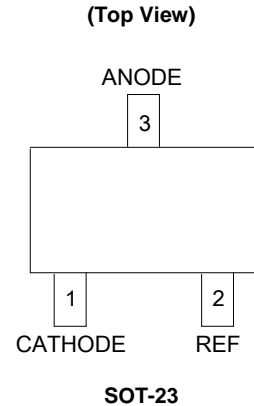
These ICs are available in SOT-23 package.

Features

- Programmable Precise Output Voltage from 2.5V to 36V
- High Stability under Capacitive Load
- Low Temperature Deviation: 4.5mV Typical
- Low Equivalent Full-range Temperature Coefficient with 20PPM/°C Typical
- Low Dynamic Output Resistance: 0.15Ω Typical
- Sink Current Capacity from 1mA to 100mA
- Low Output Noise
- Wide Operating Range of -40 to +125°C
- Lead-Free Packages: SOT-23
  - **Totally Lead-Free; RoHS Compliant (Notes 1 & 2)**
- Lead-Free Packages, Available in "Green" Molding Compound: SOT-23
  - **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
  - **Halogen and Antimony Free. "Green" Device (Note 3)**

- Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
  2. See [http://www.diodes.com/quality/lead\\_free.html](http://www.diodes.com/quality/lead_free.html) 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.

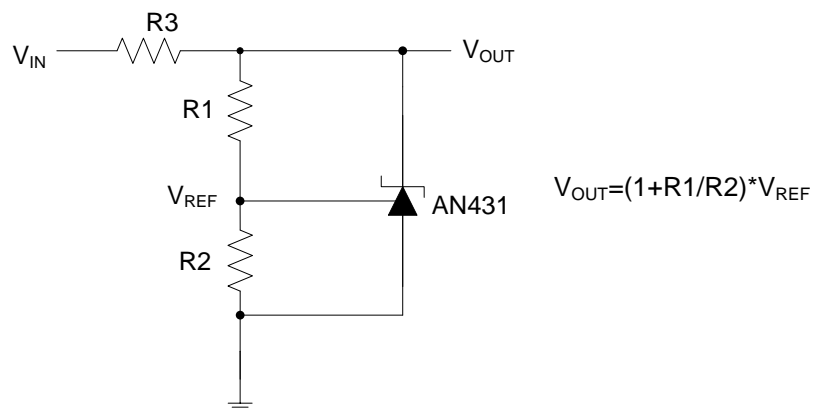
Pin Assignments



Applications

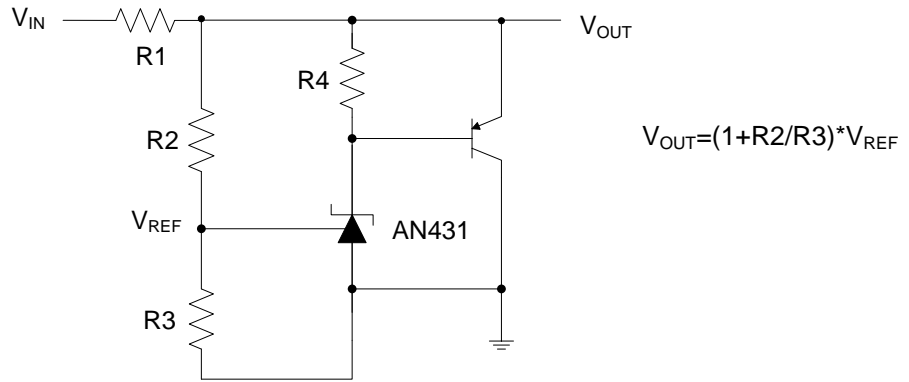
- Charger
- Voltage Adapter
- Switching Power Supply
- Graphic Card
- Precision Voltage Reference

Typical Applications Circuit



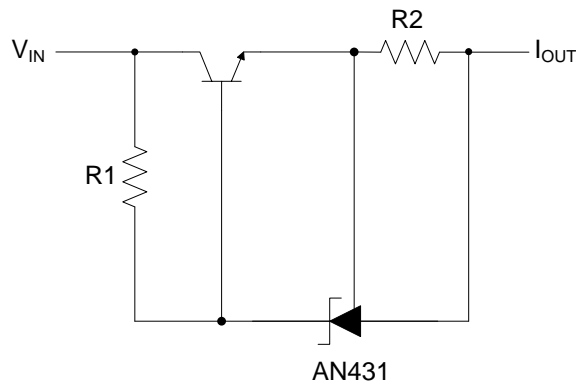
Shunt Regulator

**Typical Applications Circuit (Cont.)**



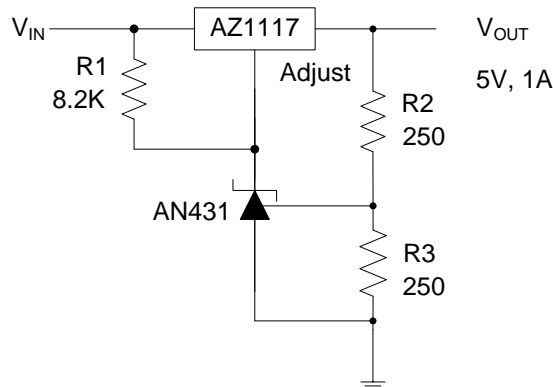
$$V_{OUT} = (1 + R2/R3) * V_{REF}$$

High Current Shunt Regulator



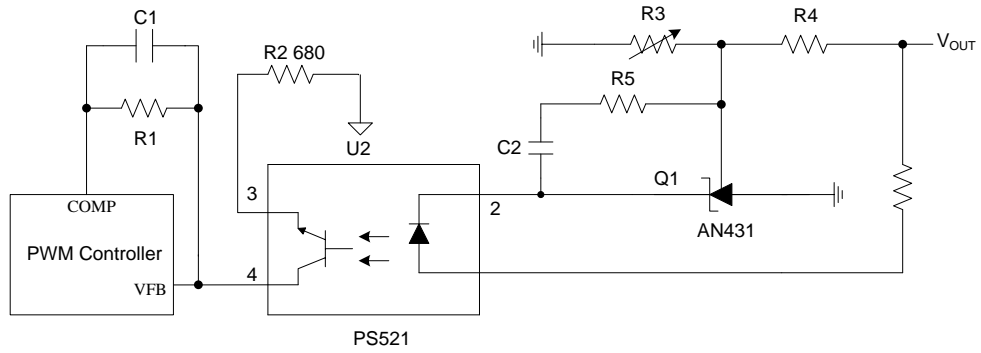
$$I_{OUT} = V_{REF}/R2 + I_{KA}$$

Current Source or Current Limit



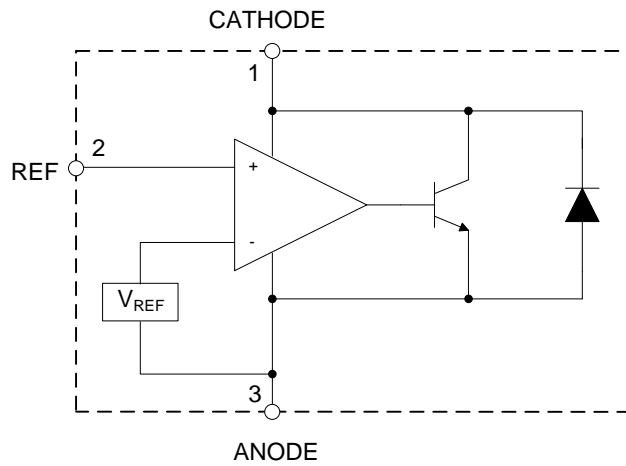
Precision 5V 1A Regulator

**Typical Applications Circuit (Cont.)**



PWM Converter with Reference

**Functional Block Diagram**



## Absolute Maximum Ratings (Note 4)

| Symbol    | Parameter                          | Rating      | Unit |
|-----------|------------------------------------|-------------|------|
| $V_{KA}$  | Cathode Voltage                    | 40          | V    |
| $I_{KA}$  | Cathode Current Range (Continuous) | -100 to 150 | mA   |
| $I_{REF}$ | Reference Input Current Range      | 10          | mA   |
| $P_D$     | Power Dissipation                  | 370         | mW   |
| $T_J$     | Junction Temperature               | +150        | °C   |
| $T_{STG}$ | Storage Temperature Range          | -65 to +150 | °C   |
| ESD       | ESD (Human Body Model)             | 2000        | V    |

Note 4: Stresses greater than 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 Ratings" for extended periods may affect device reliability.

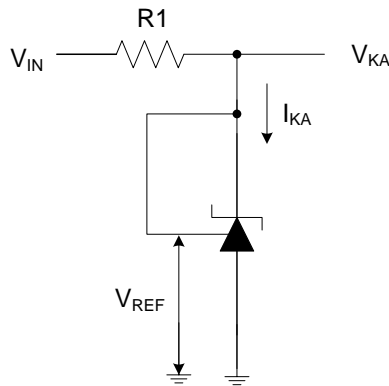
## Recommended Operating Conditions

| Symbol   | Parameter                           | Min       | Max  | Unit |
|----------|-------------------------------------|-----------|------|------|
| $V_{KA}$ | Cathode Voltage                     | $V_{REF}$ | 36   | V    |
| $I_{KA}$ | Cathode Current                     | 1.0       | 100  | mA   |
| $T_A$    | Operating Ambient Temperature Range | -40       | +125 | °C   |

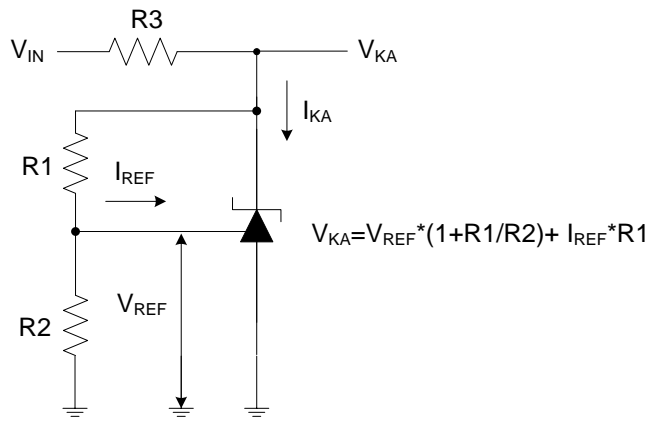
**Electrical Characteristics** (@T<sub>A</sub>=+25°C, unless otherwise specified.)

| Symbol                                  | Parameter   |      | Test Circuit | Conditions  | Min                                       | Typ   | Max   | Unit |      |
|---|---|------|--------------|---|---|-------|-------|------|------|
| V <sub>REF</sub>                        | Reference Voltage   | 0.5% | 4            | V <sub>KA</sub> =V <sub>REF</sub> , I <sub>KA</sub> =10mA                 | 2.487                                     | 2.500 | 2.512 | V    |      |
|   |   | 1.0% |              |   | 2.475                                     | 2.500 | 2.525 |      |      |
| ΔV <sub>REF</sub>                       | Deviation of Reference Voltage Over Full Temperature Range            |      | 4            | V <sub>KA</sub> =V <sub>REF</sub> , I <sub>KA</sub> =10mA                 | 0 to +70°C                                | -     | 4.5   | 8    | mV   |
|   |   |      |              |   | -40 to +85°C                              | -     | 4.5   | 10   |      |
|   |   |      |              |   | -40 to +125°C                             | -     | 4.5   | 16   |      |
| ΔV <sub>REF</sub> /<br>ΔV <sub>KA</sub> | Ratio of Change in Reference Voltage to the Change in Cathode Voltage |      | 5            | I <sub>KA</sub> =10mA   | ΔV <sub>KA</sub> =10V to V <sub>REF</sub> | -     | -1.0  | -2.7 | mV/V |
|   |   |      |              |   | ΔV <sub>KA</sub> =36V to 10V              |       | -0.5  | -2.0 |      |
| I <sub>REF</sub>                        | Reference Current   |      | 5            | I <sub>KA</sub> =10mA, R1=10KΩ, R2=∞                                      | -   | 0.7   | 4     | μA   |      |
| ΔI <sub>REF</sub>                       | Deviation of Reference Current Over Full Temperature Range            |      | 5            | I <sub>KA</sub> =10mA, R1=10KΩ, R2=∞, T <sub>A</sub> =-40 to +125°C       | -   | 0.4   | 1.2   | μA   |      |
| I <sub>KA</sub> (Min)                   | Minimum Cathode Current for Regulation                                |      | 4            | V <sub>KA</sub> =V <sub>REF</sub>   | -   | 0.4   | 1.0   | mA   |      |
| I <sub>KA</sub> (Off)                   | Off-state Cathode Current   |      | 6            | V <sub>KA</sub> =36V, V <sub>REF</sub> =0                                 | -   | 0.05  | 1.0   | μA   |      |
| Z <sub>KA</sub>                         | Dynamic Impedance   |      | 4            | V <sub>KA</sub> =V <sub>REF</sub> , I <sub>KA</sub> =1 to 100mA, f≤1.0kHz | -   | 0.15  | 0.5   | Ω    |      |
| θ <sub>JC</sub>                         | Thermal Resistance  |      | -            | SOT-23  | -   | 135   | -     | °C/W |      |

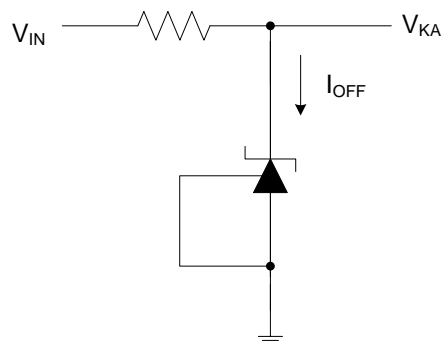
**Electrical Characteristics** (Cont.)



Test Circuit 4 for  $V_{KA}=V_{REF}$



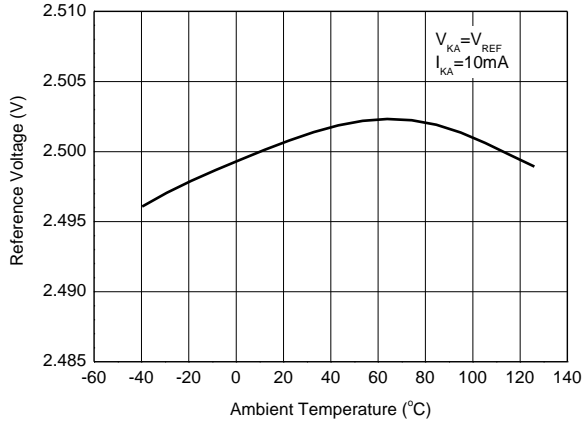
Test Circuit 5 for  $V_{KA} > V_{REF}$



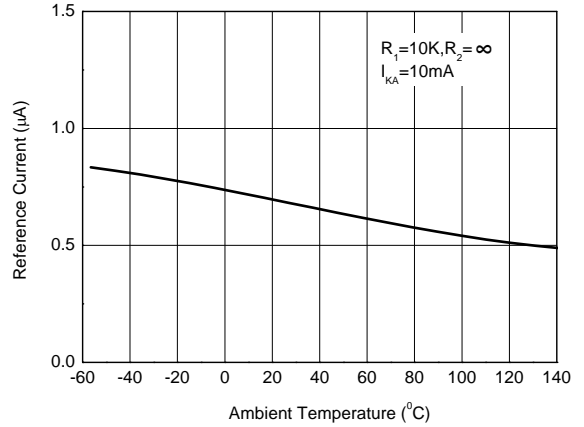
Test Circuit 6 for I<sub>OFF</sub>

**Performance Characteristics**

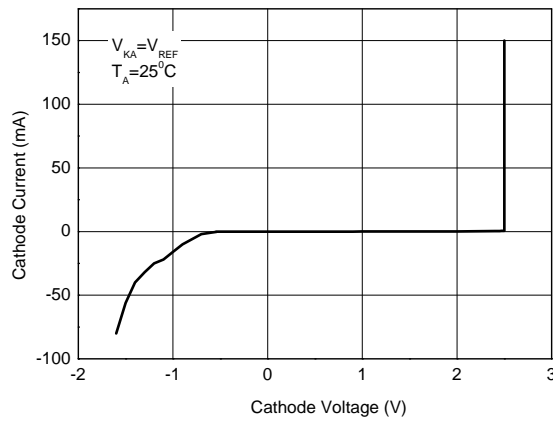
**Reference Voltage vs. Ambient Temperature**



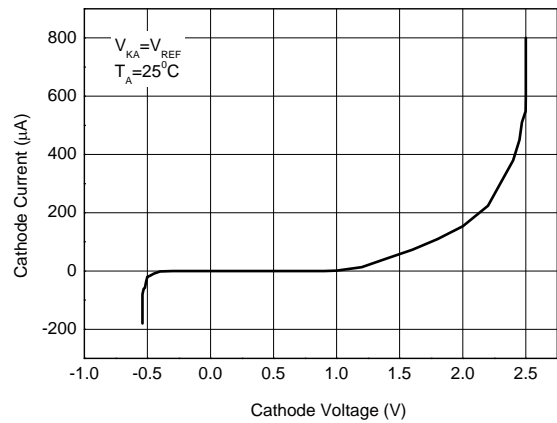
**Reference Current vs. Ambient Temperature**



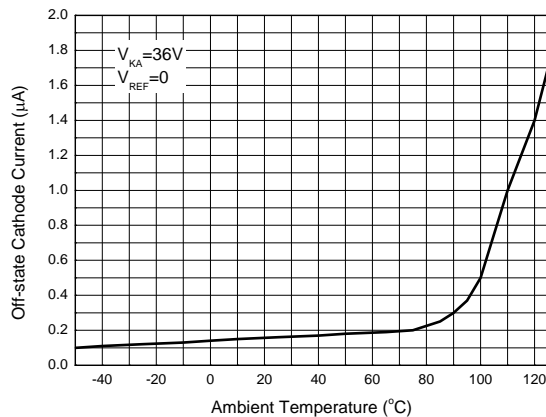
**Cathode Current vs. Cathode Voltage**



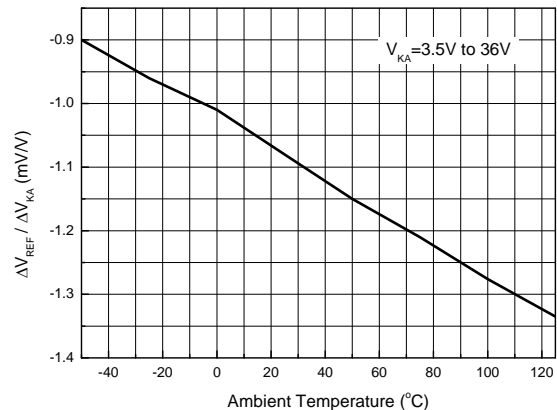
**Cathode Current vs. Cathode Voltage**



**Off-state Cathode Current vs. Ambient Temperature**

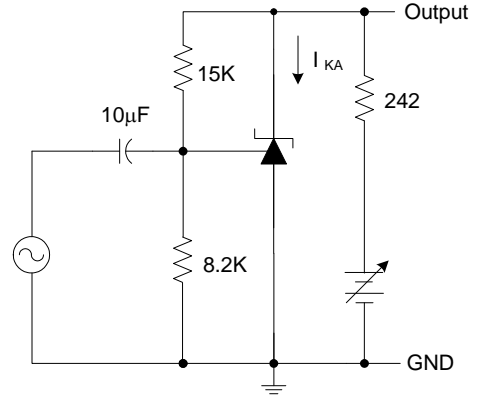
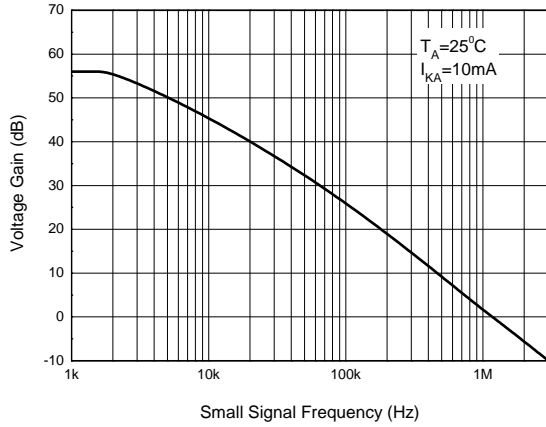


**Ratio of Delta Reference Voltage to the Ratio of Delta Cathode Voltage**

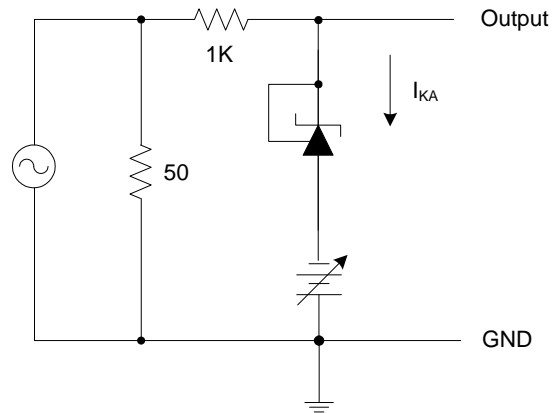
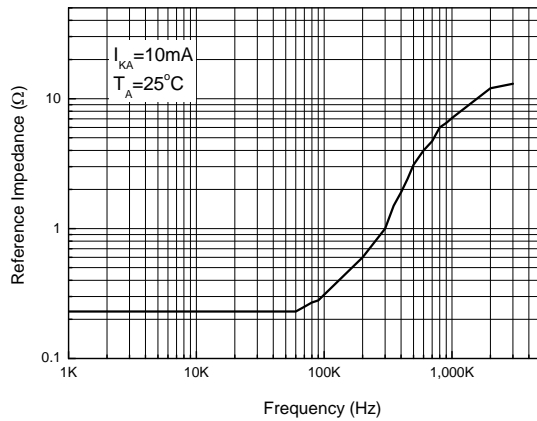


**Performance Characteristics (Cont.)**

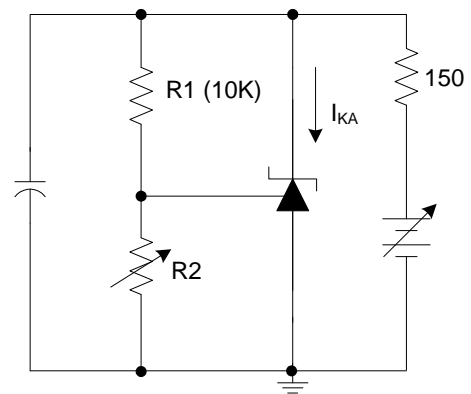
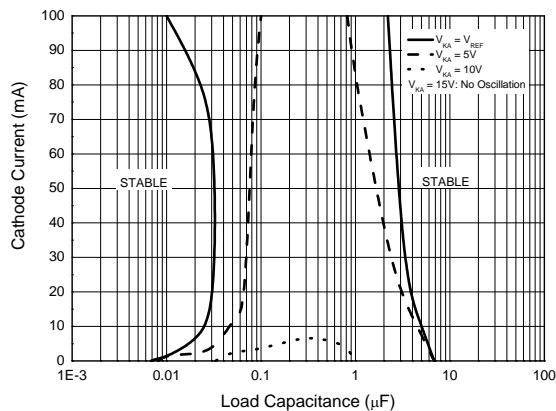
**Small Signal Voltage Gain vs. Frequency**



**Reference Impedance vs. Frequency**



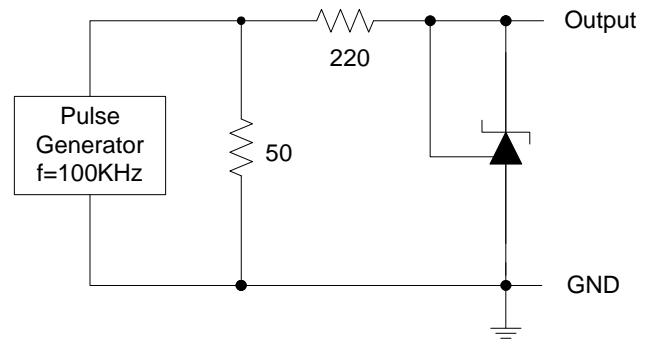
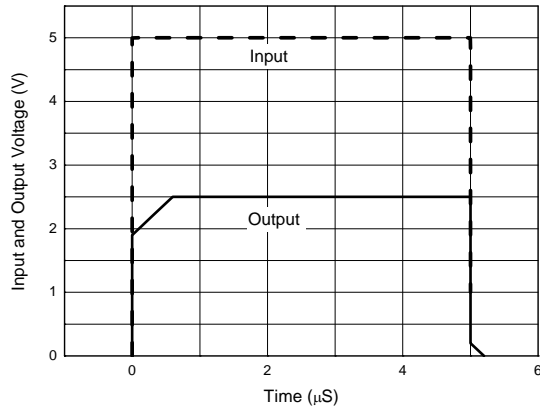
**Stability Boundary Conditions vs. Load Capacitance**



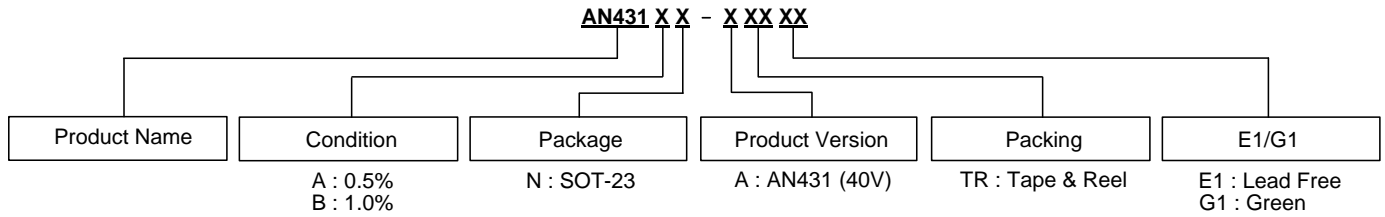


**Performance Characteristics (Cont.)**

**Pulse Response of Input and Output Voltage**



**Ordering Information**

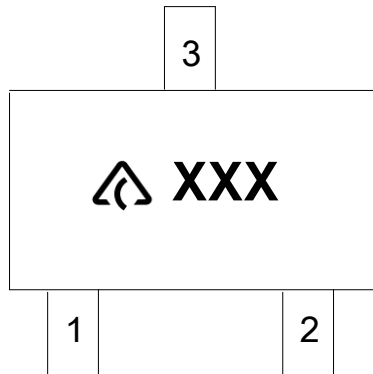


| Package | Temperature Range | Condition | Part Number   |               | Marking ID |       | Packing              |
|---------|-------------------|-----------|---------------|---------------|------------|-------|----------------------|
|         |                   |           | Lead Free     | Green         | Lead Free  | Green |                      |
| SOT-23  | -40 to +125°C     | 0.5%      | AN431AN-ATRE1 | AN431AN-ATRG1 | EB1        | GB1   | 3000/<br>Tape & Reel |
|         |                   | 1.0%      | AN431BN-ATRE1 | AN431BN-ATRG1 | EB2        | GB2   | 3000/<br>Tape & Reel |



**Marking Information**

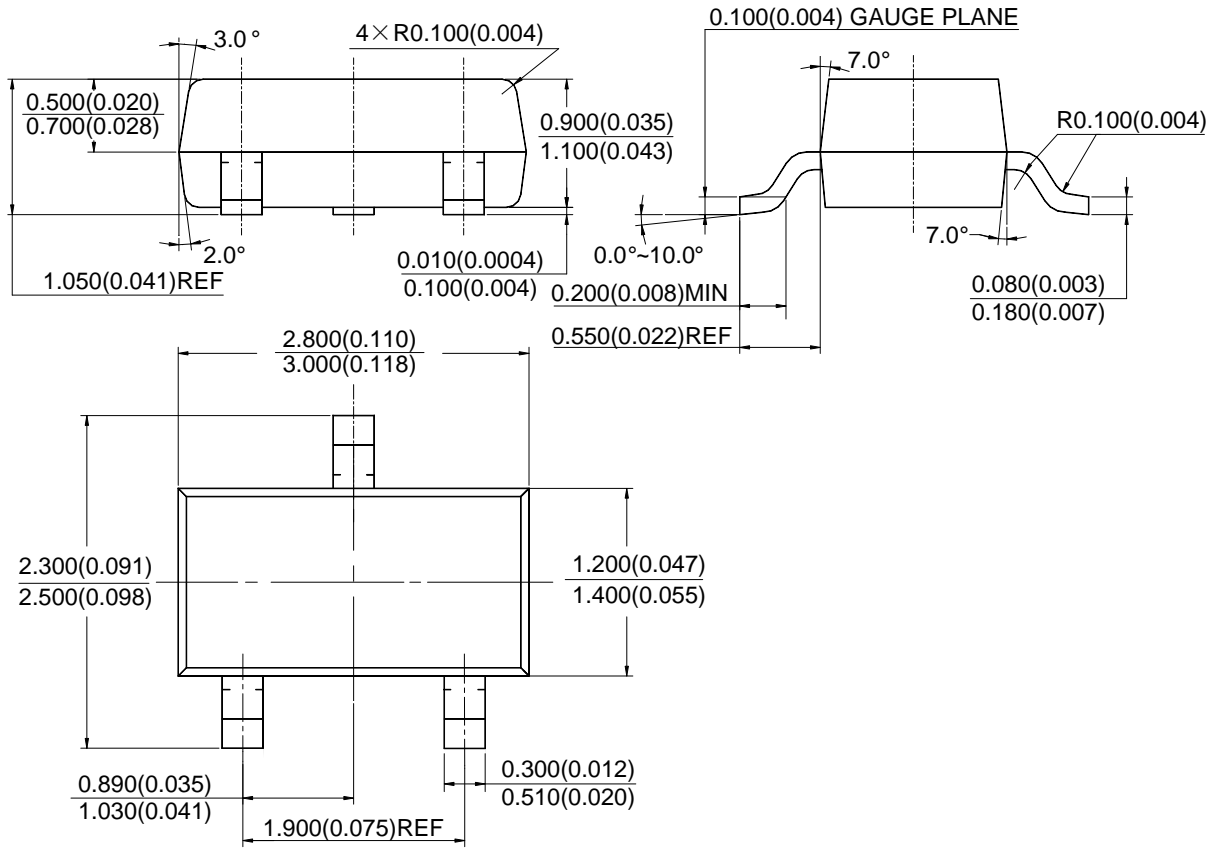
(Top View)



: Logo  
 XXX : Marking ID (See Ordering Information)

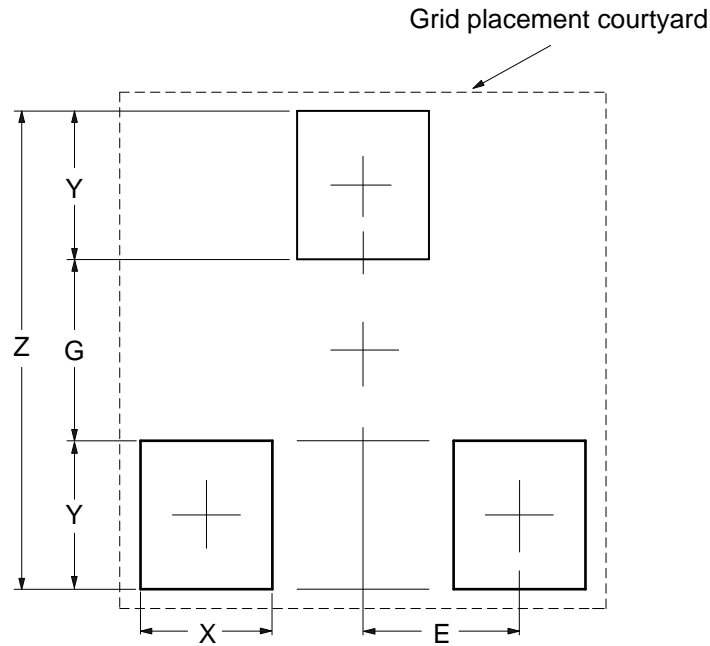
**Package Outline Dimensions** (All dimensions in mm(inch).)

(1) Package Type: SOT-23



**Suggested Pad Layout**

(1) Package Type: SOT-23



| Dimensions | Z<br>(mm)/(inch) | G<br>(mm)/(inch) | X<br>(mm)/(inch) | Y<br>(mm)/(inch) | E<br>(mm)/(inch) |
|------------|------------------|------------------|------------------|------------------|------------------|
| Value      | 2.900/0.114      | 1.100/0.043      | 0.800/0.031      | 0.900/0.035      | 0.950/0.037      |

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