

## ADJUSTABLE PRECISION SHUNT REGULATORS

### Description

The AZ431-A is a three-terminal adjustable shunt regulator with guaranteed thermal stability over a full operation range. It features sharp turn-on characteristics, low temperature coefficient and low output impedance, which make it ideal substitute for Zener diode in applications such as switching power supply, charger and other adjustable regulators.

The output voltage of AZ431-A can be set to any value between  $V_{REF}$  (2.5V) and the corresponding maximum cathode voltage (36V).

The AZ431-A precision reference is offered in two voltage tolerance: 0.4% and 0.8%.

This IC is available in 4 packages: TO92 (bulk or ammo packing), SOT23, SOT25 and SOT89.

### Features

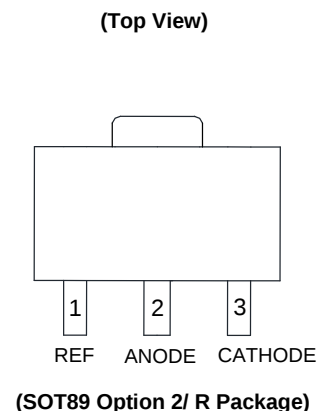
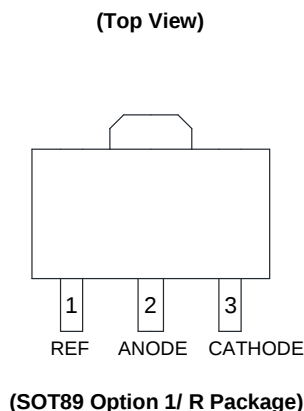
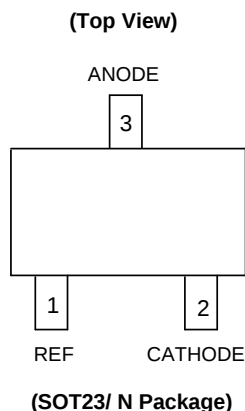
- Programmable Precise Output Voltage from 2.5V to 36V
- High Stability under Capacitive Load
- Low Temperature Deviation: 4.5mV Typical
- Low Equivalent Full-range Temperature Coefficient with 20PPM/°C Typical
- Sink Current Capacity from 1mA to 100mA
- Low Output Noise
- Wide Operating Range of -40 to +125°C
- Lead-Free Packages: TO92, SOT23, SOT25, SOT89
  - **Totally Lead-Free; RoHS Compliant (Notes 1 & 2)**
- Lead-Free Packages, Available in "Green" Molding Compound: TO92, SOT23, SOT25, SOT89
  - **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
  - **Halogen and Antimony Free. "Green" Device (Note 3)**

### Applications

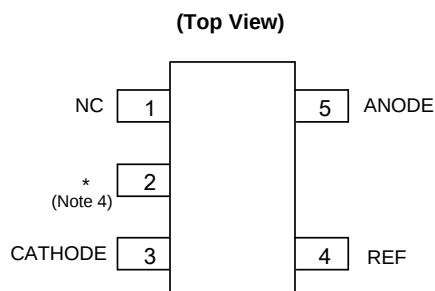
- Charger
- Voltage Adapter
- Switching Power Supply
- Graphic Card
- Precision Voltage Reference

- 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.

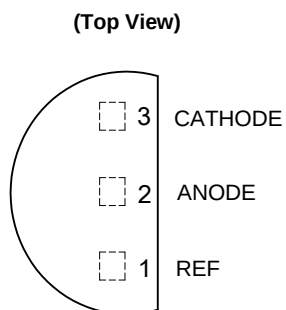
### Pin Assignments



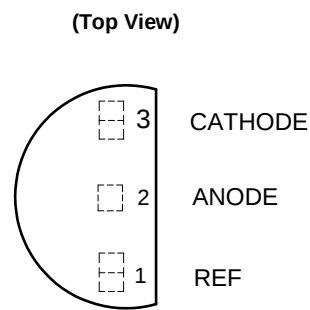
## Pin Assignments (Cont.)



(SOT25/ K Package)



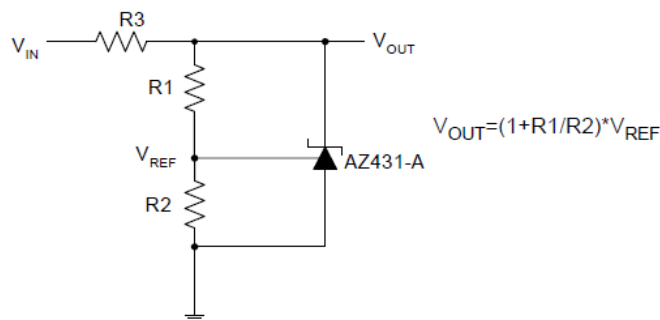
(TO92 (Bulk Packing)/ Z Package)



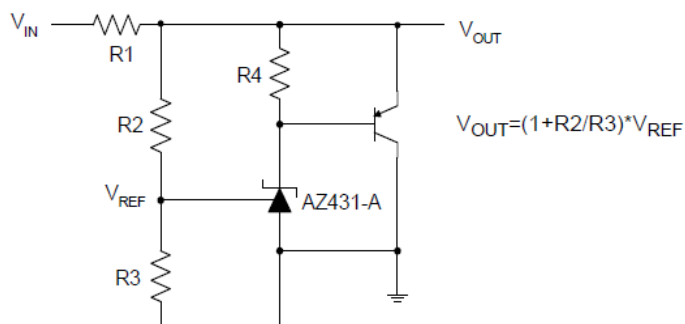
(TO92 (Ammo Packing)/ Z Package)

Note: 4. \* Pin 2 is attached to substrate and must be connected to ANODE or open.

## Typical Applications Circuit

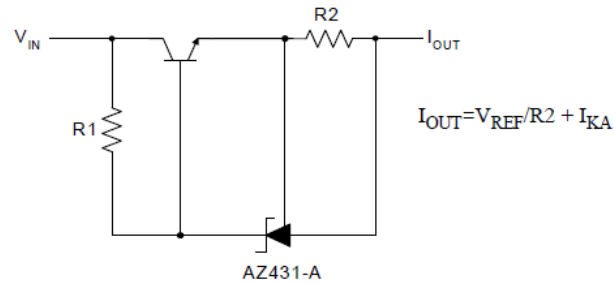


**Shunt Regulator**

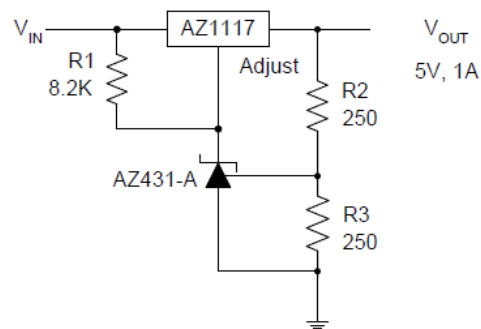


**High Current Shunt Regulator**

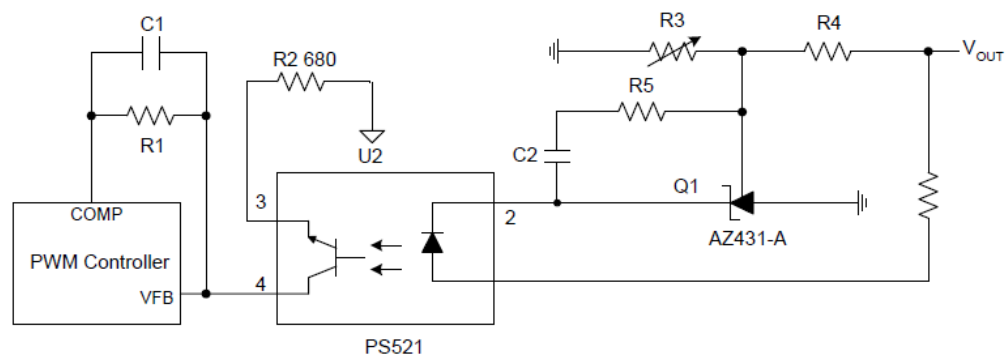
## Typical Applications Circuit (Cont.)



**Current Source or Current Limit**

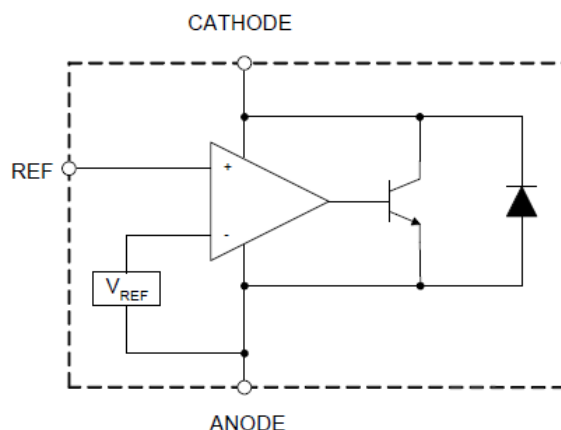


**Precision 5V 1A Regulator**



**PWM Converter with Reference**

## Functional Block Diagram



## Absolute Maximum Ratings (Note 5)

| 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                  | Z, R Package: 770 | mW   |
|           |                                    | N, K Package: 370 |      |
| $T_J$     | Junction Temperature               | +150              | °C   |
| $T_{STG}$ | Storage Temperature Range          | -65 to +150       | °C   |
| ESD       | ESD (Human Body Model)             | 2000              | V    |

Note: 5. 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.

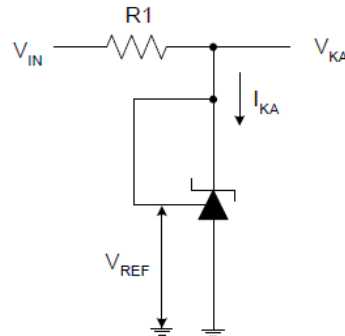
## Recommended Operating Conditions

| 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   |

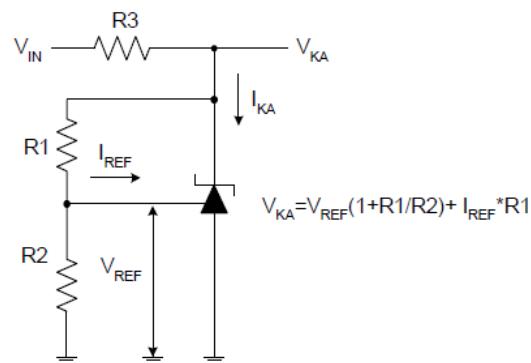
# Electrical Characteristics (@T<sub>A</sub> = +25°C, unless otherwise specified.)

| Symbol                                 | Test Circuit | Parameter                                                             |              | Conditions                                                                       |                                                                             | Min            | Typ               | Max            | Unit |
|----------------------------------------|--------------|-----------------------------------------------------------------------|--------------|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------|----------------|-------------------|----------------|------|
| V <sub>REF</sub>                       | 4            | Reference Voltage                                                     | 0.4%<br>0.8% | V <sub>KA</sub> = V <sub>REF</sub> , I <sub>KA</sub> = 10mA                      |                                                                             | 2.490<br>2.480 | 2.500<br>2.500    | 2.510<br>2.520 | V    |
| ΔV <sub>REF</sub>                      | 4            | Deviation of Reference Voltage Over Full Temperature Range            |              | V <sub>KA</sub> = V <sub>REF</sub><br>I <sub>KA</sub> = 10mA                     | 0 to +70°C<br>-40 to +85°C<br>-40 to +125°C                                 | –<br>–<br>–    | 4.5<br>4.5<br>4.5 | 8<br>10<br>16  | mV   |
| $\frac{\Delta V_{REF}}{\Delta V_{KA}}$ | 5            | Ratio of Change in Reference Voltage to the Change in Cathode Voltage |              | I <sub>KA</sub> = 10mA                                                           | ΔV <sub>KA</sub> = 10V to V <sub>REF</sub><br>ΔV <sub>KA</sub> = 36V to 10V | –<br>–         | -1.0<br>-0.5      | -2.7<br>-2.0   | mV/V |
| I <sub>REF</sub>                       | 5            | Reference Current                                                     |              | I <sub>KA</sub> = 10mA, R1 = 10KΩ, R2 = ∞                                        |                                                                             | –              | 0.7               | 4              | μA   |
| ΔI <sub>REF</sub>                      | 5            | Deviation of Reference Current Over Full Temperature Range            |              | I <sub>KA</sub> = 10mA, R1 = 10KΩ<br>R2 = ∞, T <sub>A</sub> = -40 to +125°C      |                                                                             | –              | 0.4               | 1.2            | μA   |
| I <sub>KA</sub> (Min)                  | 4            | Minimum Cathode Current for Regulation                                |              | V <sub>KA</sub> = V <sub>REF</sub>                                               |                                                                             | –              | 0.4               | 1.0            | mA   |
| I <sub>KA</sub> (Off)                  | 6            | Off-state Cathode Current                                             |              | V <sub>KA</sub> = 36V, V <sub>REF</sub> = 0                                      |                                                                             | –              | 0.05              | 1.0            | μA   |
| Z <sub>KA</sub>                        | 4            | Dynamic Impedance                                                     |              | V <sub>KA</sub> = V <sub>REF</sub> , I <sub>KA</sub> = 1 to 100mA,<br>f ≤ 1.0KHz |                                                                             | –              | 0.15              | 0.5            | Ω    |
| θ <sub>JC</sub>                        | –            | Thermal Resistance                                                    |              | SOT23                                                                            |                                                                             | –              | 135.48            | –              | °C/W |
|                                        | SOT25        |                                                                       |              | –                                                                                | 135.48                                                                      | –              |                   |                |      |
|                                        | TO92         |                                                                       |              | –                                                                                | 81.63                                                                       | –              |                   |                |      |
|                                        | SOT89        |                                                                       |              | –                                                                                | 29.80                                                                       | –              |                   |                |      |

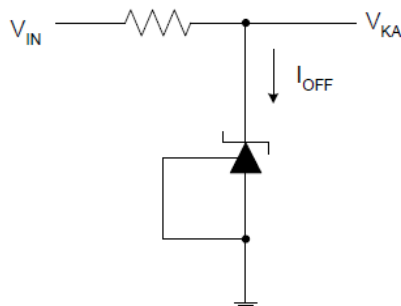
## Electrical Characteristics (Cont.)



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



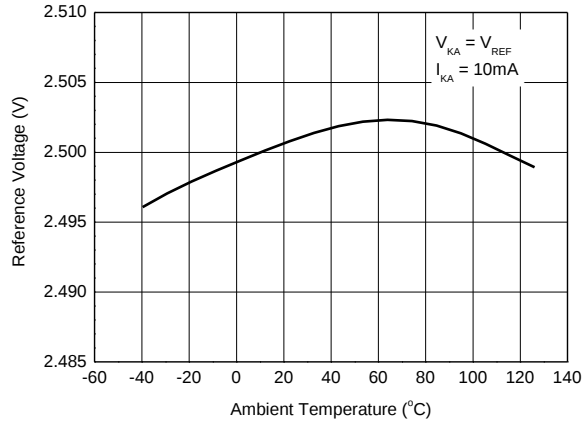
**Test Circuit 5 for  $V_{KA} > V_{REF}$**



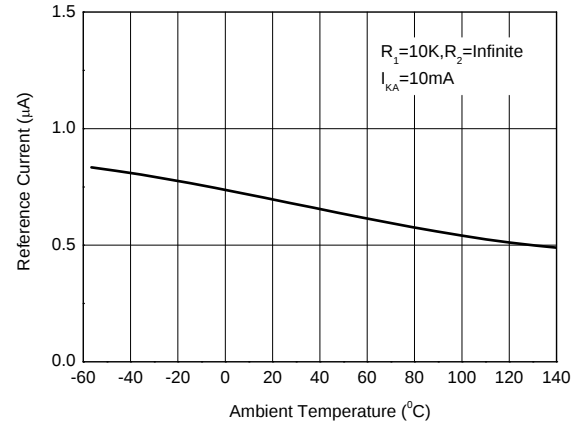
**Test Circuit 6 for  $I_{OFF}$**

## Performance Characteristics

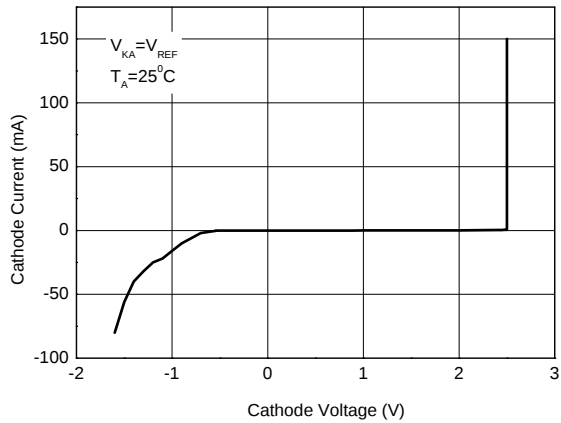
Reference Voltage vs. Ambient Temperature



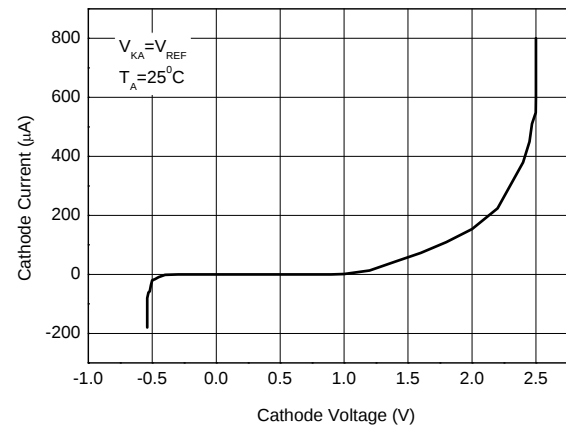
Reference Current vs. Ambient Temperature



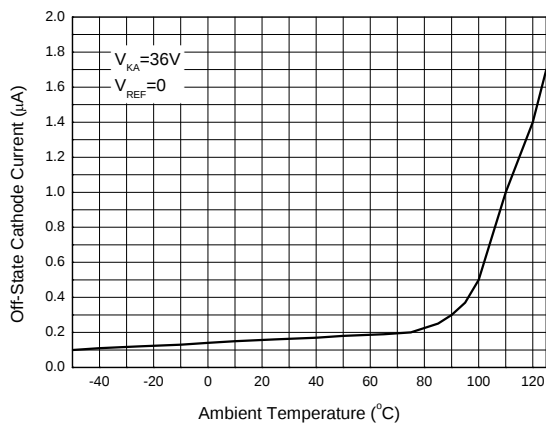
Cathode Current vs. Cathode Voltage



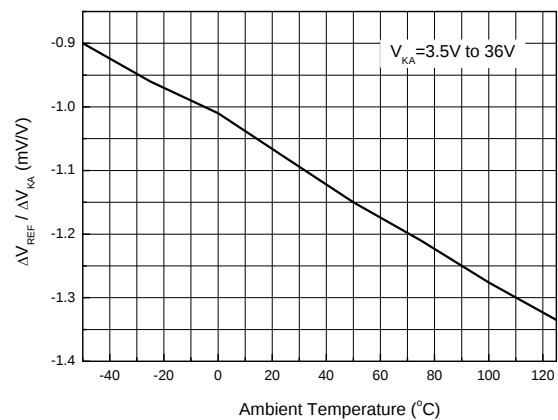
Cathode Current vs. Cathode Voltage



Off-State Cathode Current vs. Ambient Temperature

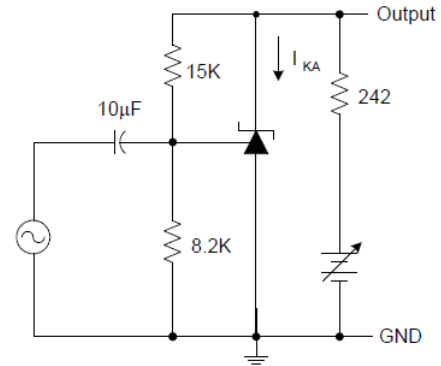
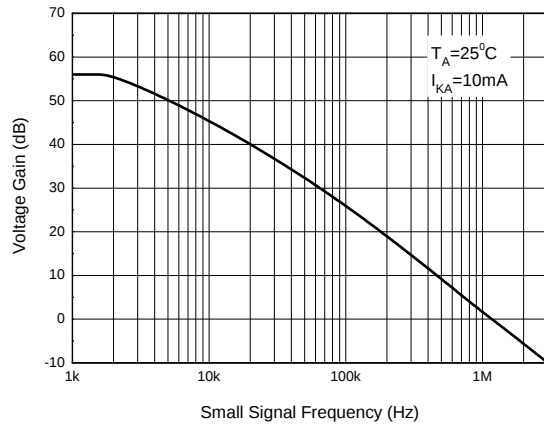


Ratio of Delta Reference Voltage to the Ratio of Delta Cathode Voltage

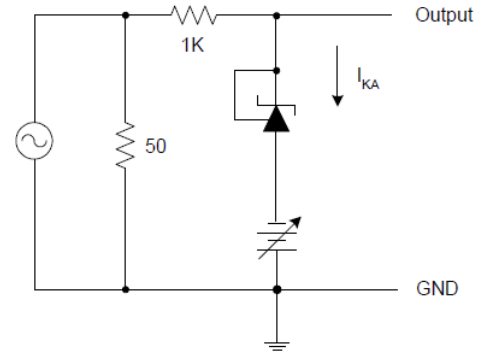
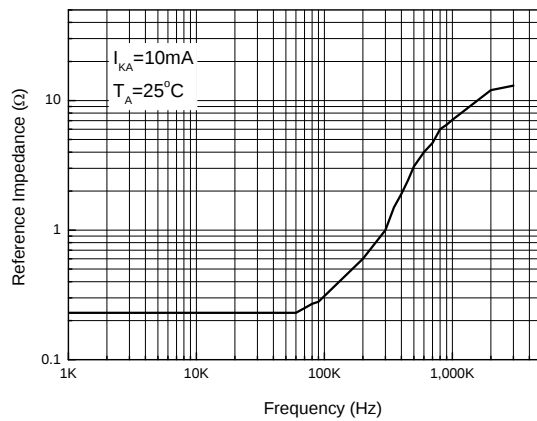


## Performance Characteristics (Cont.)

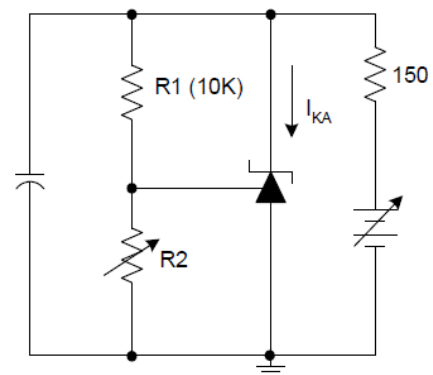
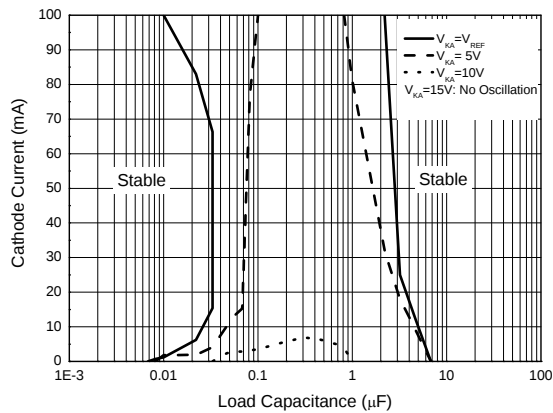
### Small Signal Voltage Gain vs. Frequency



### Reference Impedance vs. Frequency

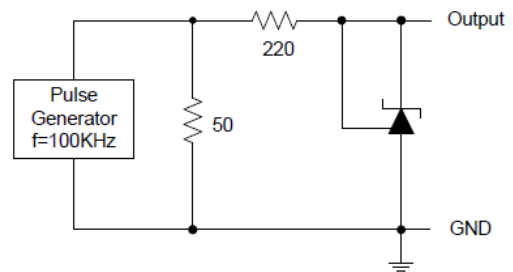
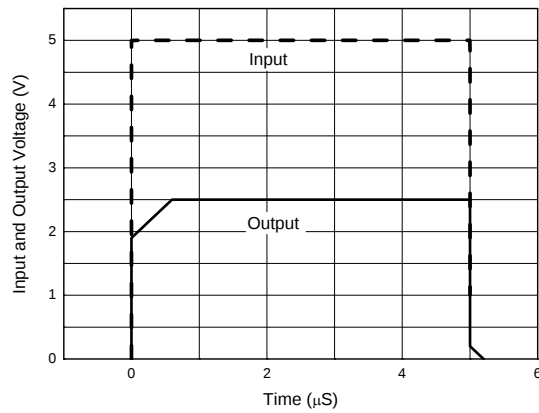


### Stability Boundary Conditions vs. Load Capacitance

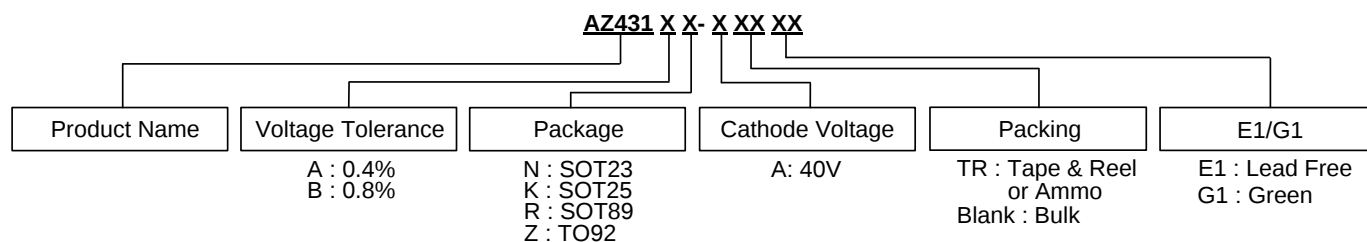


## Performance Characteristics (Cont.)

### Pulse Response of Input and Output Voltage



## Ordering Information



Diodes IC's Pb-free products, as designated with "E1" suffix in the part number, are RoHS compliant.

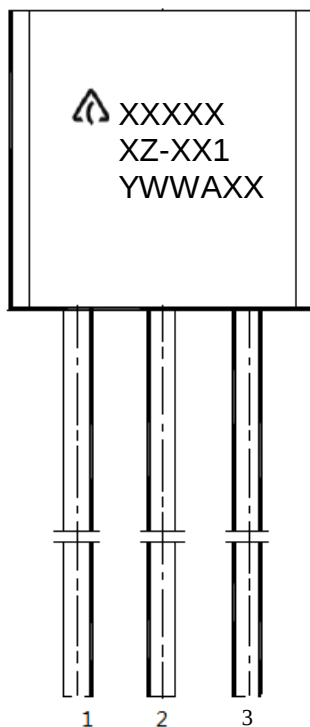
Products with "G1" suffix are available in green packages.

|                                                                                                  | Package | Temperature Range | Voltage Tolerance | Part Number   |               | Marking ID  |             | Packing              |
|--------------------------------------------------------------------------------------------------|---------|-------------------|-------------------|---------------|---------------|-------------|-------------|----------------------|
|                                                                                                  |         |                   |                   | Lead- Free    | Green         | Lead-Free   | Green       |                      |
| <br>Lead-Free   | SOT23   | -40 to +125°C     | 0.4%              | AZ431AN-ATRE1 | AZ431AN-ATRG1 | EA1         | GA1         | 3000/<br>Tape & Reel |
|                                                                                                  |         |                   | 0.8%              | AZ431BN-ATRE1 | AZ431BN-ATRG1 | EA2         | GA2         | 3000/<br>Tape & Reel |
| <br>Lead-Free | SOT25   | -40 to +125°C     | 0.4%              | AZ431AK-ATRE1 | AZ431AK-ATRG1 | E3A         | G3A         | 3000/<br>Tape & Reel |
|                                                                                                  |         |                   | 0.8%              | AZ431BK-ATRE1 | AZ431BK-ATRG1 | E3B         | G3B         | 3000/<br>Tape & Reel |
| <br>Lead-Free | TO92    | -40 to +125°C     | 0.4%              | AZ431AZ-AE1   | AZ431AZ-AG1   | AZ431AZ-AE1 | AZ431AZ-AG1 | 1000/<br>Bulk        |
|                                                                                                  |         |                   | 0.4%              | AZ431AZ-ATRE1 | AZ431AZ-ATRG1 | AZ431AZ-AE1 | AZ431AZ-AG1 | 2000/<br>Ammo        |
|                                                                                                  |         |                   | 0.8%              | AZ431BZ-AE1   | AZ431BZ-AG1   | AZ431BZ-AE1 | AZ431BZ-AG1 | 1000/<br>Bulk        |
|                                                                                                  |         |                   | 0.8%              | AZ431BZ-ATRE1 | AZ431BZ-ATRG1 | AZ431BZ-AE1 | AZ431BZ-AG1 | 2000/<br>Ammo        |
| <br>Lead-Free | SOT89   | -40 to +125°C     | 0.4%              | AZ431AR-ATRE1 | AZ431AR-ATRG1 | E43A        | G43A        | 1000/<br>Tape & Reel |
|                                                                                                  |         |                   | 0.8%              | AZ431BR-ATRE1 | AZ431BR-ATRG1 | E43B        | G43B        | 1000/<br>Tape & Reel |

## Marking Information

### (1) TO92

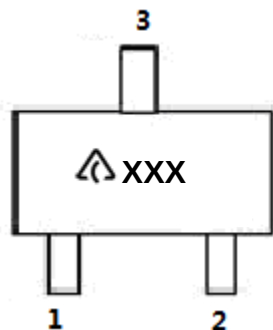
(Top View)



First and Second Line: Logo and Marking ID  
(See Ordering Information)  
Third Line: Date Code  
Y: Year  
WW: Work Week of Molding  
A: Assembly House Code  
XX: 7th and 8th Digits of Batch Number.

### (2) SOT23

(Top View)

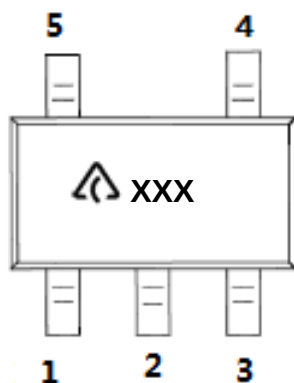


Logo : Logo  
XXX: Marking ID  
(See Ordering Information)

## Marking Information (Cont.)

### (3) SOT25

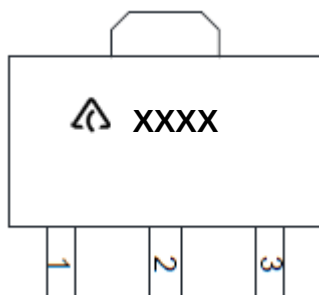
(Top View)



 : Logo  
 XXX: Marking ID  
 (See Ordering Information)

### (4) SOT89

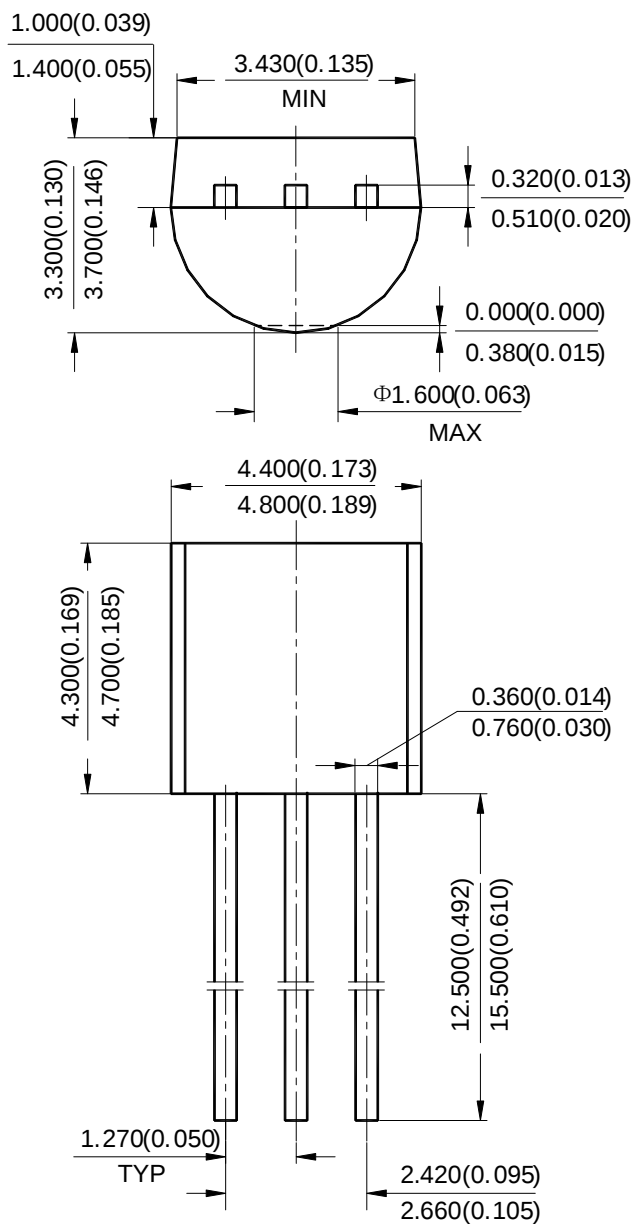
(Top View)



 : Logo  
 XXXX: Marking ID  
 (See Ordering Information)

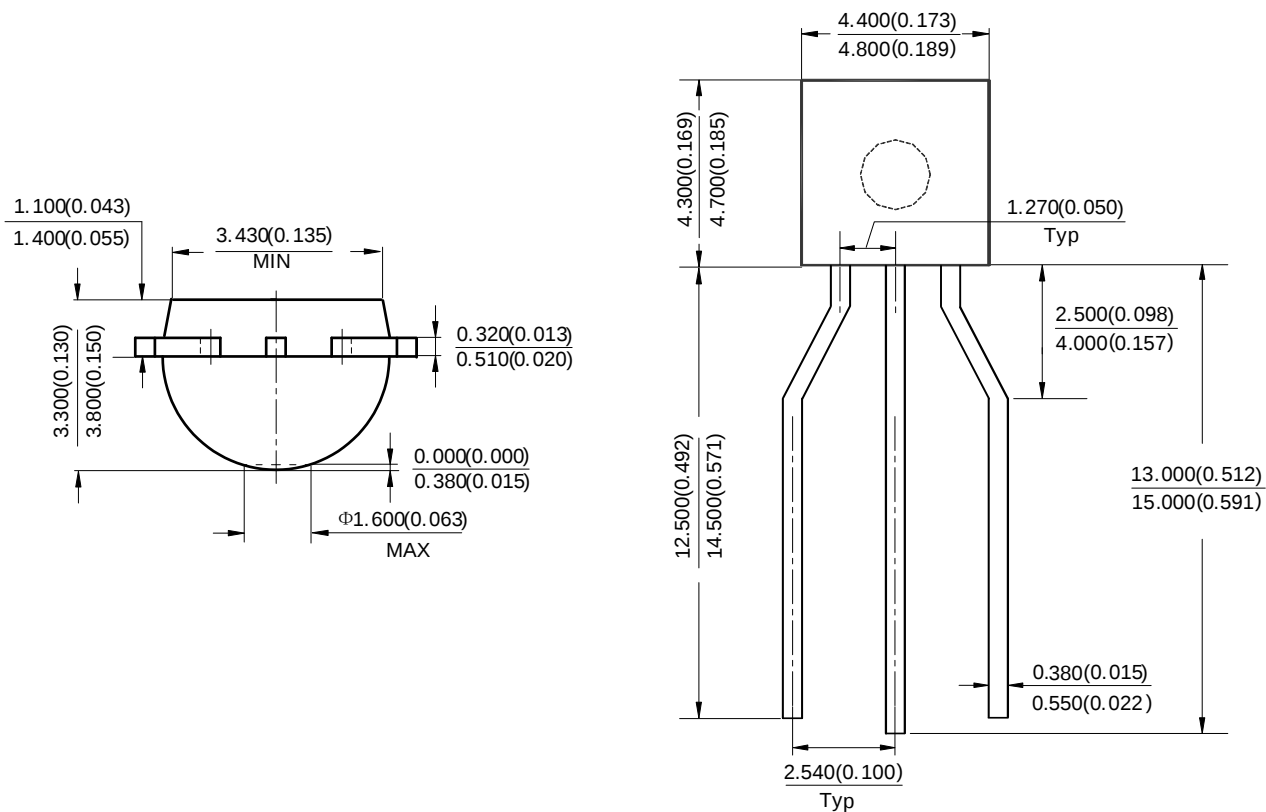
## Package Outline Dimensions

### (1) Package Type: TO92 (Bulk Packing)



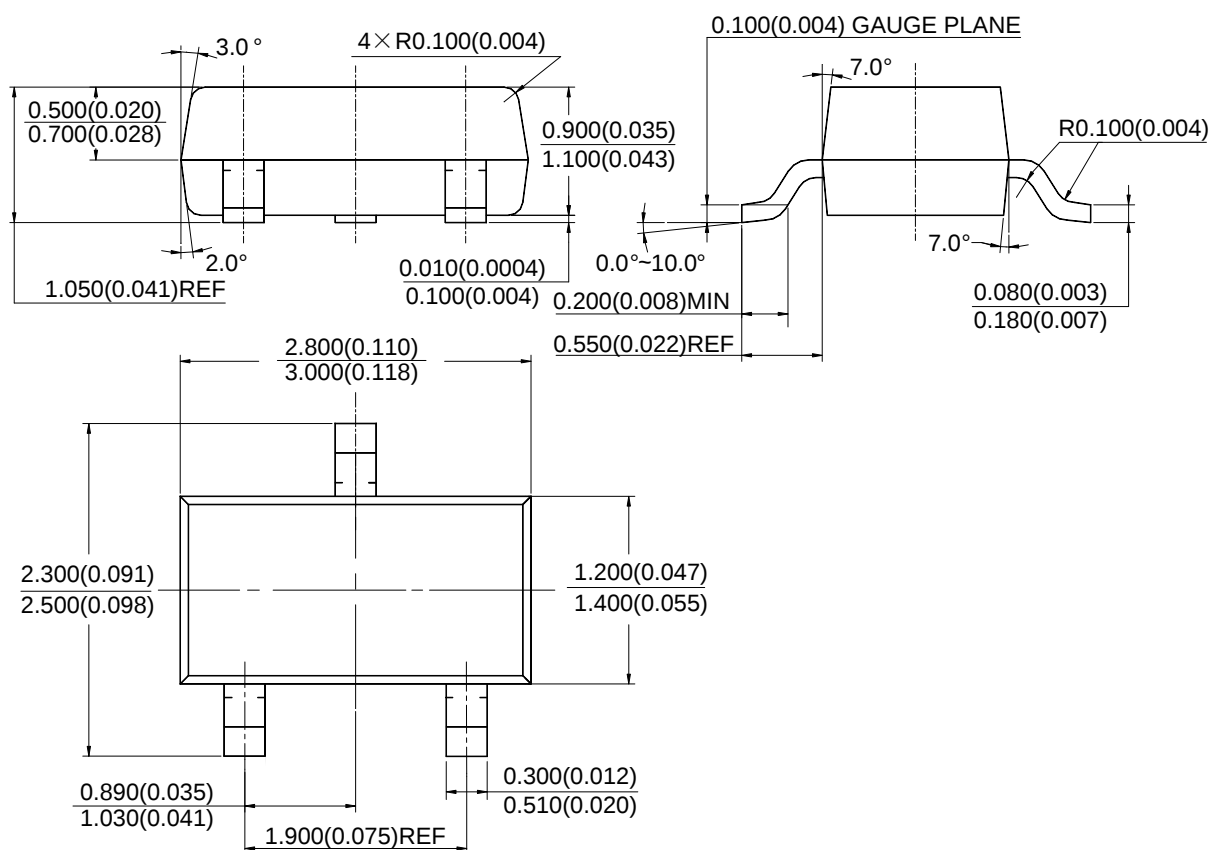
## Package Outline Dimensions (Cont.)

### (2) Package Type: TO92 (Ammo Packing)



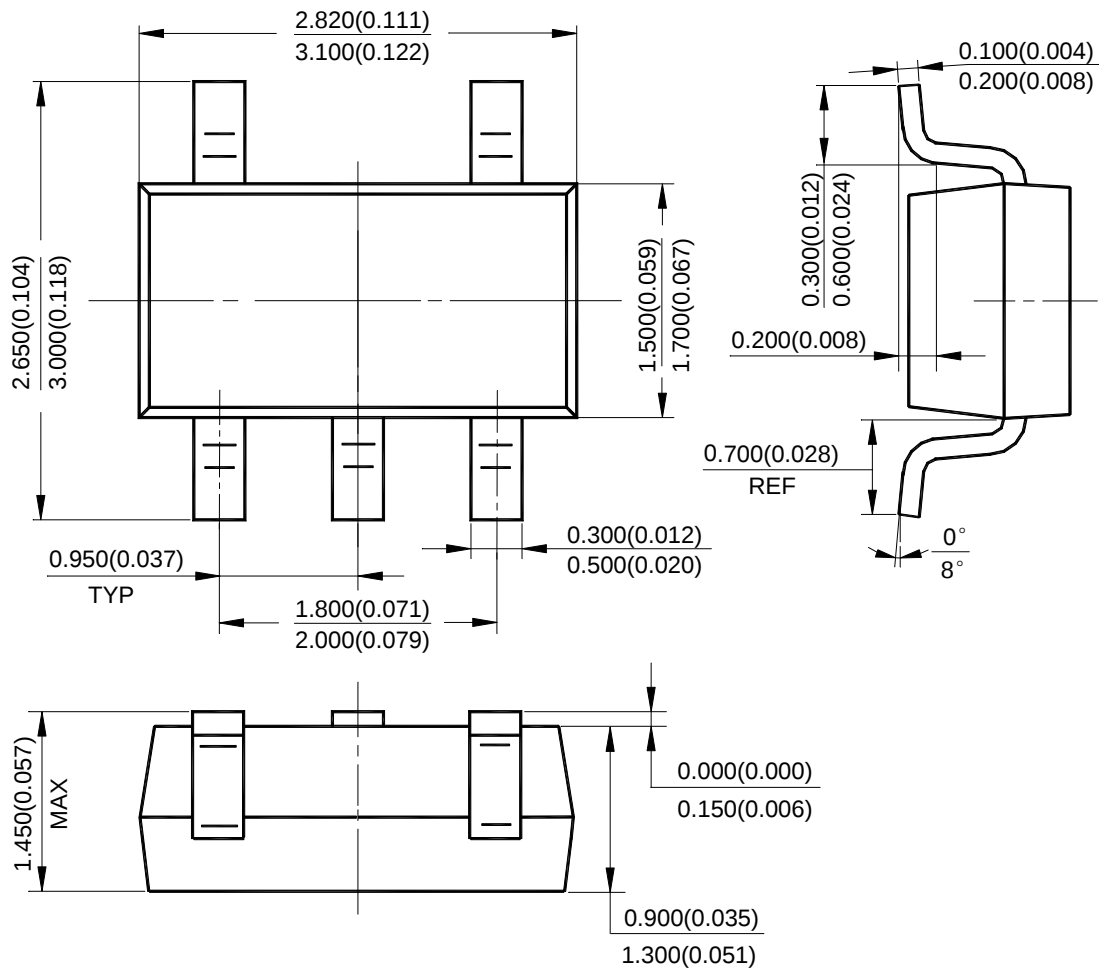
### Package Outline Dimensions (Cont.)

**(3) Package Type: SOT23**



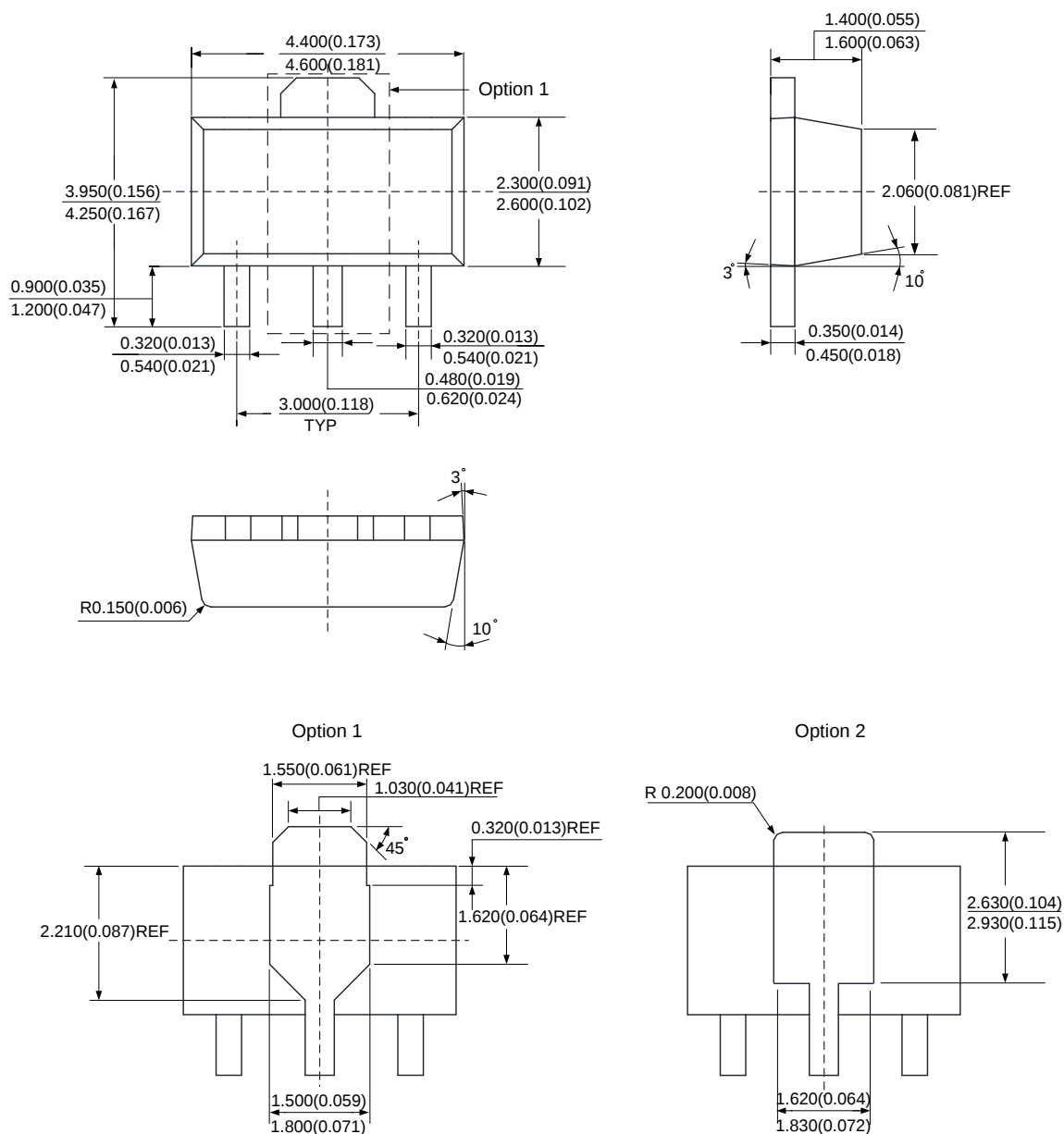
## Package Outline Dimensions (Cont.)

### (4) Package Type: SOT25



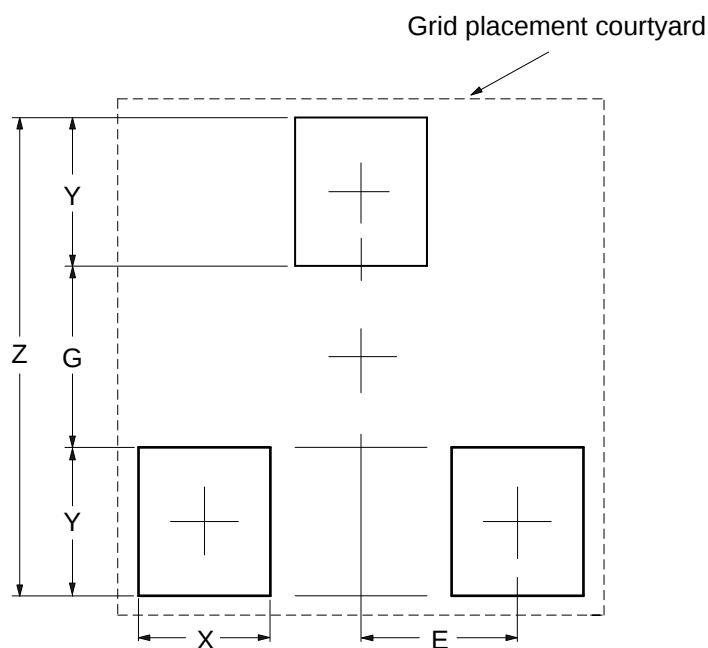
### Package Outline Dimensions (Cont.)

**(5) Package Type: SOT89**



## Suggested Pad Layout

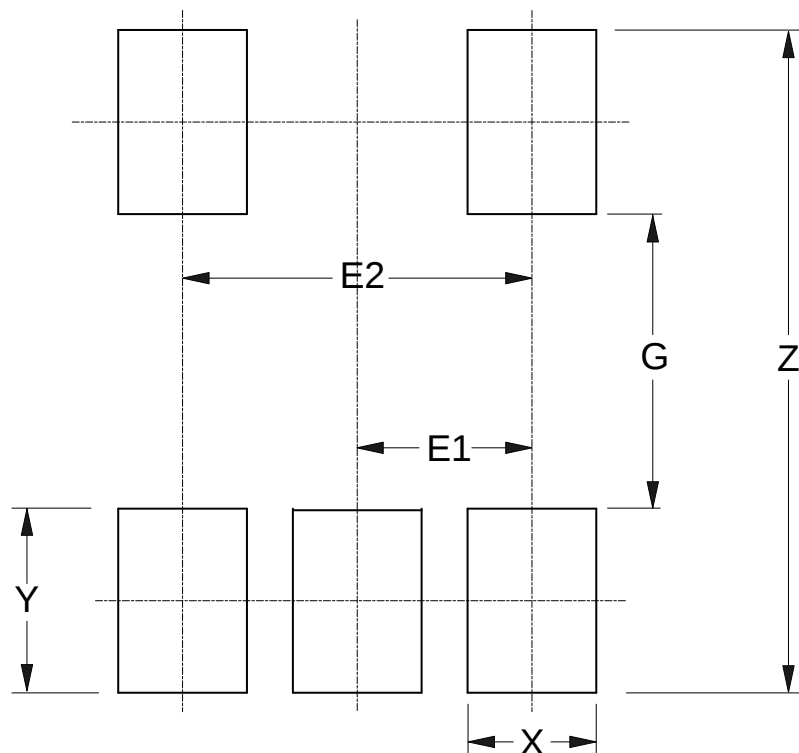
(1) Package Type: SOT23



| 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      |

## Suggested Pad Layout (Cont.)

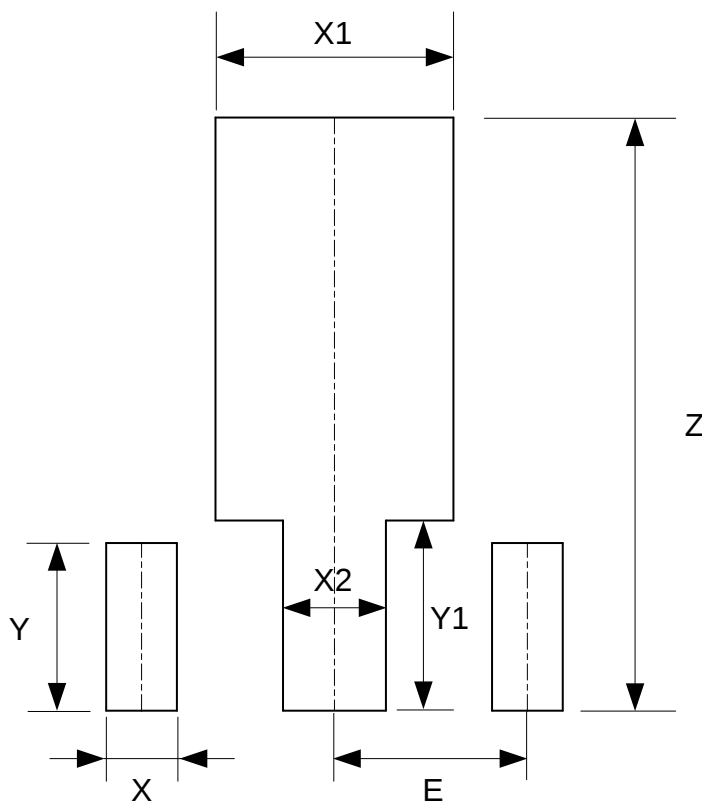
(2) Package Type: SOT25



| Dimensions | Z<br>(mm)/(inch) | G<br>(mm)/(inch) | X<br>(mm)/(inch) | Y<br>(mm)/(inch) | E1<br>(mm)/(inch) | E2<br>(mm)/(inch) |
|------------|------------------|------------------|------------------|------------------|-------------------|-------------------|
| Value      | 3.600/0.142      | 1.600/0.063      | 0.700/0.028      | 1.000/0.039      | 0.950/0.037       | 1.900/0.075       |

## Suggested Pad Layout (Cont.)

(3) Package Type: SOT89



| Dimensions | Z<br>(mm)/(inch) | X<br>(mm)/(inch) | X1<br>(mm)/(inch) | X2<br>(mm)/(inch) | Y<br>(mm)/(inch) | Y1<br>(mm)/(inch) | E<br>(mm)/(inch) |
|------------|------------------|------------------|-------------------|-------------------|------------------|-------------------|------------------|
| Value      | 4.600/0.181      | 0.550/0.022      | 1.850/0.073       | 0.800/0.031       | 1.300/0.051      | 1.475/0.058       | 1.500/0.059      |

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1. are intended to implant into the body, or
2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

Customers represent that they have all necessary expertise in the safety and regulatory ramifications of their life support devices or systems, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of Diodes Incorporated products in such safety-critical, life support devices or systems, notwithstanding any devices- or systems-related information or support that may be provided by Diodes Incorporated. Further, Customers must fully indemnify Diodes Incorporated and its representatives against any damages arising out of the use of Diodes Incorporated products in such safety-critical, life support devices or systems.

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