

ADJUSTABLE PRECISION SHUNT REGULATORS

Description

The AS431 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 AS431 can be set to any value between VREF (2.5V) and the corresponding maximum cathode voltage (36V).

The AS431 precision reference is offered in two voltage tolerance: 0.5% and 1.0%.

This IC is available in 4 packages: TO-92 (bulk or ammo packing), SOT-23, SOT-23-5 and SOT-89.

Features

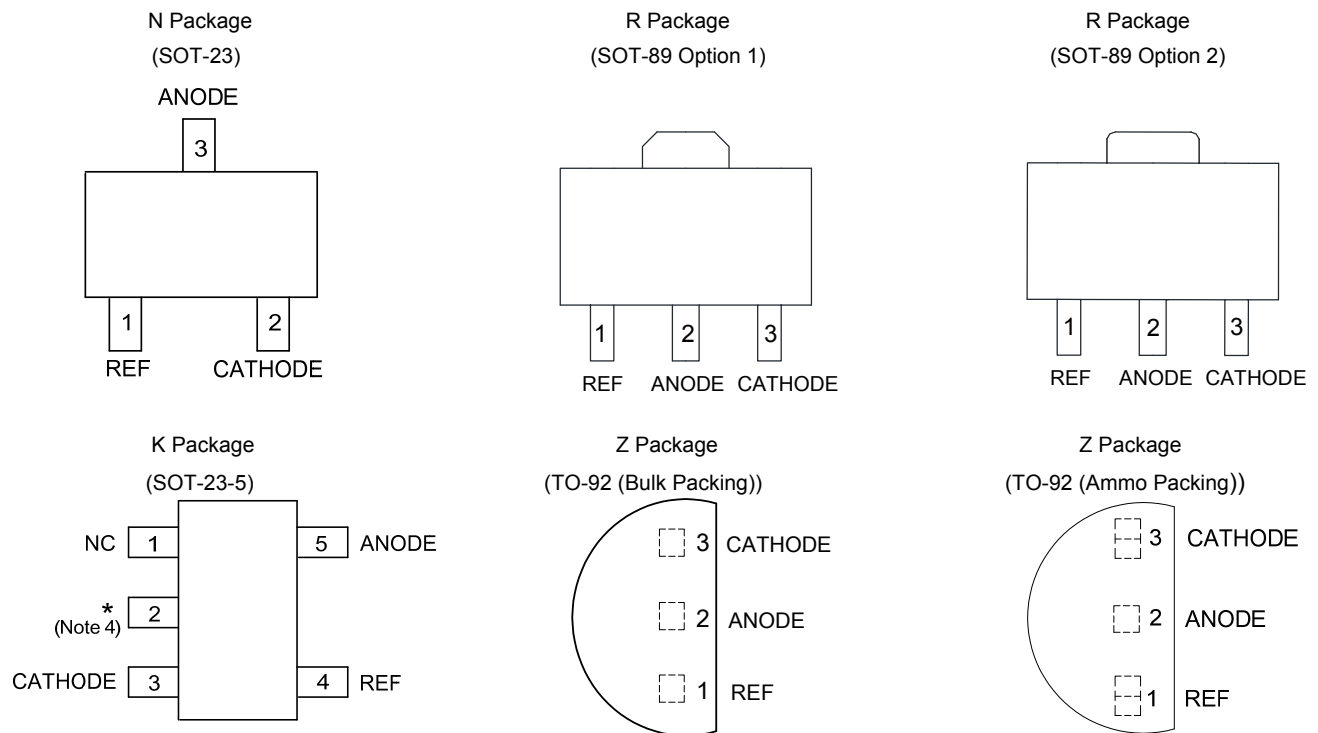
- Programmable Precise Output Voltage from 2.5V to 36V
- High Stability under Capacitive Load
- Low Temperature Deviation: 4.5mV Typical
- Low Equivalent Full-range Temperature Coefficient with 20PPM/°C Typical
- Sink Current Capacity from 1mA to 100mA
- Low Output Noise
- Wide Operating Range of -40 to +125°C
- Lead-Free Packages: SOT-23, SOT-23-5, TO-92, SOT-89
 - **Totally Lead-Free; RoHS Compliant (Notes 1 & 2)**
- Lead-Free Packages, Available in "Green" Molding Compound: SOT-23, SOT-23-5, TO-92, SOT-89
 - **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

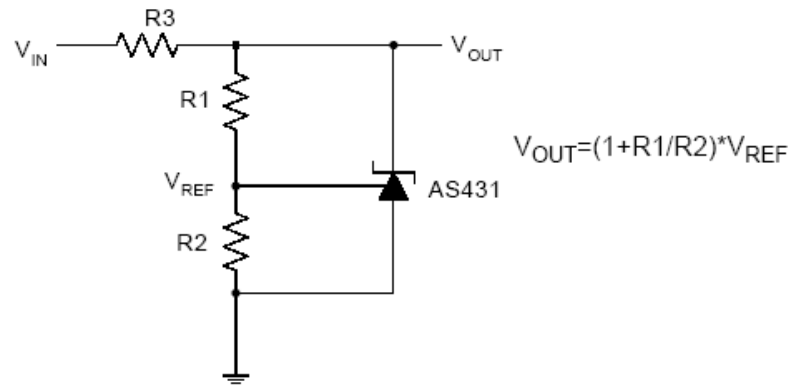
Notes: 1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
 2. See http://www.diodes.com/quality/lead_free.html for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
 3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Pin Assignments

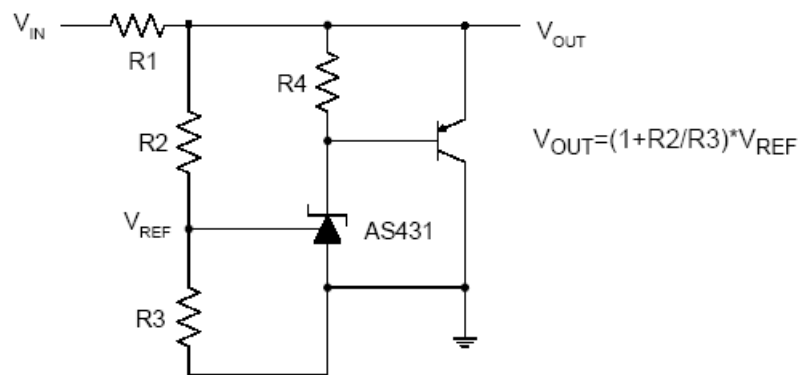


Note: 4. * Pin 2 is attached to substrate and must be connected to ANODE or open.

Typical Applications Circuit

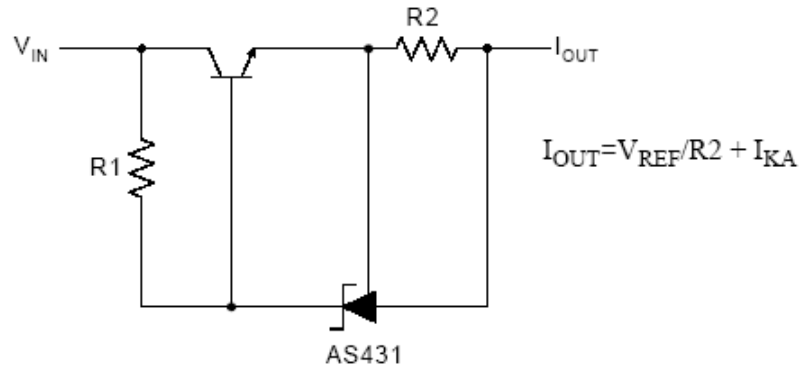


Shunt Regulator

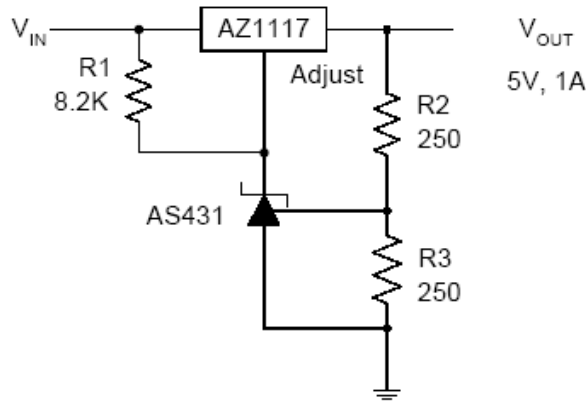


High Current Shunt Regulator

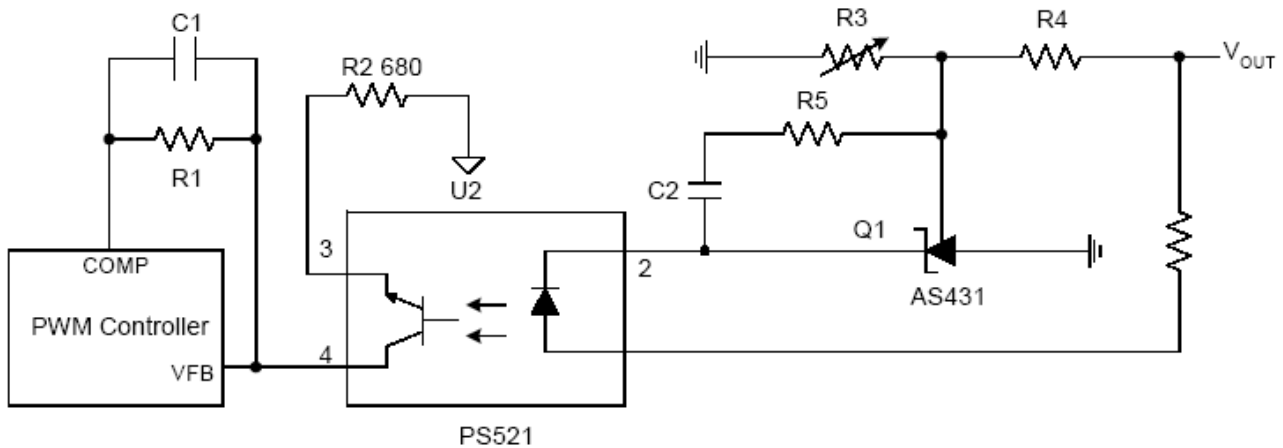
Typical Applications Circuit (Cont.)



Current Source or Current Limit

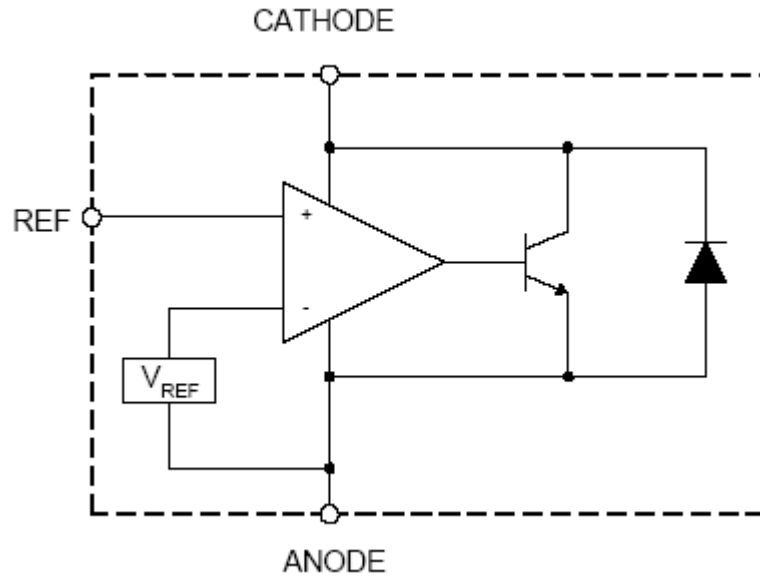


Precision 5V 1A Regulator



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.

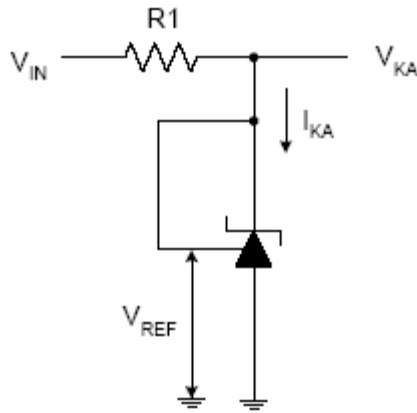
Recommended Operating Conditions

| 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 |

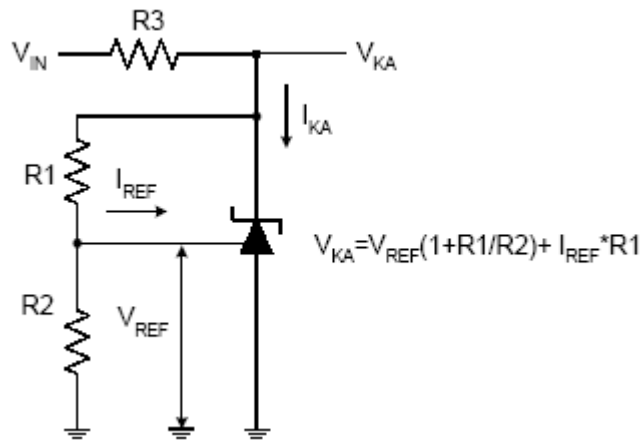
Electrical Characteristics (Operating Conditions: $T_A = +25^\circ\text{C}$, unless otherwise specified.)

| Symbol | Parameter | Test Circuit | Conditions | Min | Typ | Max | Unit | |
|----------------------------------------|-----------------------------------------------------------------------|--------------|-----------------------------------------------------------------------------------------------|---------------------------------------------|-------|-------|--------------------|------|
| V_{REF} | Reference Voltage | 4 | $V_{KA} = V_{REF}, I_{KA} = 10\text{mA}$ | 0.5% | 2.487 | 2.500 | 2.512 | V |
| | | | | 1.0% | 2.475 | 2.500 | 2.525 | |
| ΔV_{REF} | Deviation of Reference Voltage Over Full Temperature Range | 4 | $V_{KA} = V_{REF}, I_{KA} = 10\text{mA}$ | 0 to $+70^\circ\text{C}$ | - | 4.5 | 8 | mV |
| | | | | -40 to $+85^\circ\text{C}$ | - | 4.5 | 10 | |
| | | | | -40 to $+125^\circ\text{C}$ | - | 4.5 | 16 | |
| $\frac{\Delta V_{REF}}{\Delta V_{KA}}$ | Ratio of Change in Reference Voltage to the Change in Cathode Voltage | 5 | $I_{KA} = 10\text{mA}$ | $\Delta V_{KA} = 10\text{V to } V_{REF}$ | - | -1.0 | -2.7 | mV/V |
| | | | | $\Delta V_{KA} = 36\text{V to } 10\text{V}$ | - | -0.5 | -2.0 | |
| I_{REF} | Reference Current | 5 | $I_{KA} = 10\text{mA}, R1 = 10\text{K}\Omega, R2 = \infty$ | - | 0.7 | 4 | μA | |
| ΔI_{REF} | Deviation of Reference Current Over Full Temperature Range | 5 | $I_{KA} = 10\text{mA}, R1 = 10\text{K}\Omega, R2 = \infty, T_A = -40$ to $+125^\circ\text{C}$ | - | 0.4 | 1.2 | μA | |
| I_{KA} (Min) | Minimum Cathode Current for Regulation | 4 | $V_{KA} = V_{REF}$ | - | 0.4 | 1.0 | mA | |
| I_{KA} (Off) | Off-state Cathode Current | 6 | $V_{KA} = 36\text{V}, V_{REF} = 0$ | - | 0.05 | 1.0 | μA | |
| Z_{KA} | Dynamic Impedance | 4 | $V_{KA} = V_{REF}, I_{KA} = 1$ to $100\text{mA}, f \leq 1.0\text{KHz}$ | - | 0.15 | 0.5 | Ω | |
| θ_{JC} | Thermal Resistance | - | SOT-23 | - | 135.9 | - | $^\circ\text{C/W}$ | |
| | | | SOT-23-5 | - | 135.9 | - | | |
| | | | TO-92 | - | 81.9 | - | | |
| | | | SOT-89 | - | 29.8 | - | | |

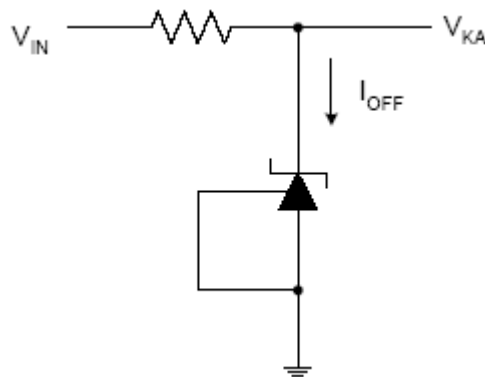
Electrical Characteristics (Cont.)



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



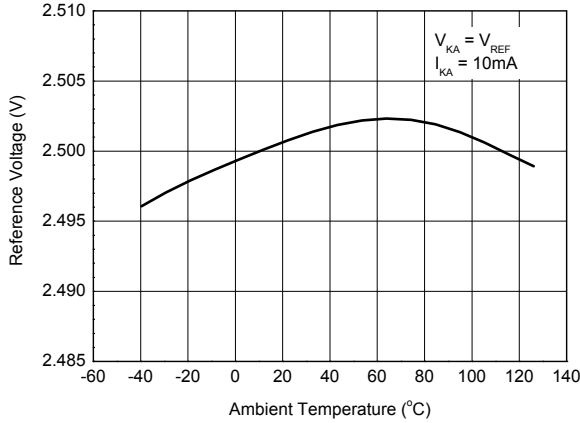
Test Circuit 5 for $V_{KA} > V_{REF}$



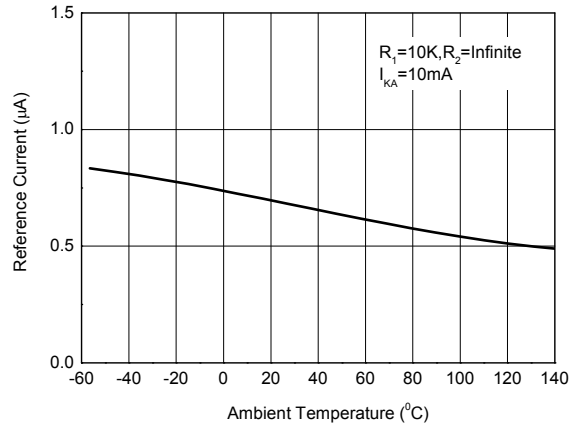
Test Circuit 6 for I_{OFF}

Performance Characteristics

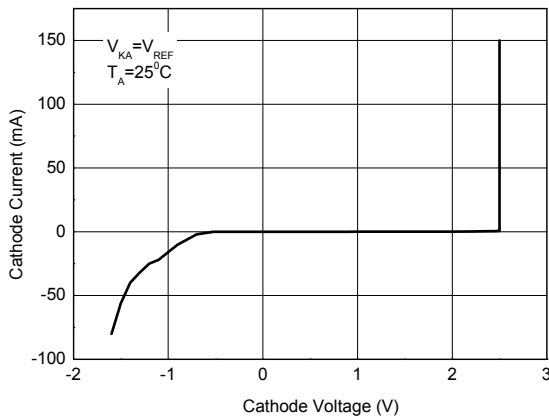
Reference Voltage vs. Ambient Temperature



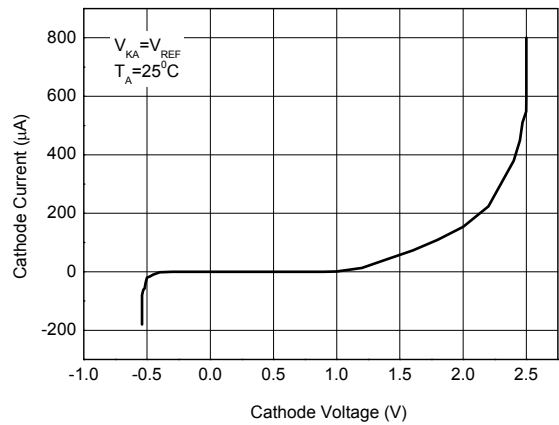
Reference Current vs. Ambient Temperature



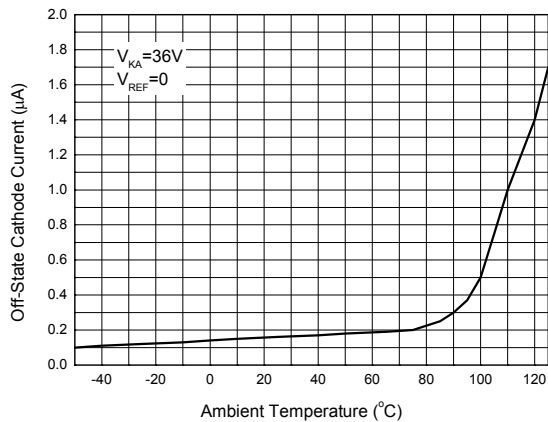
Cathode Current vs. Cathode Voltage



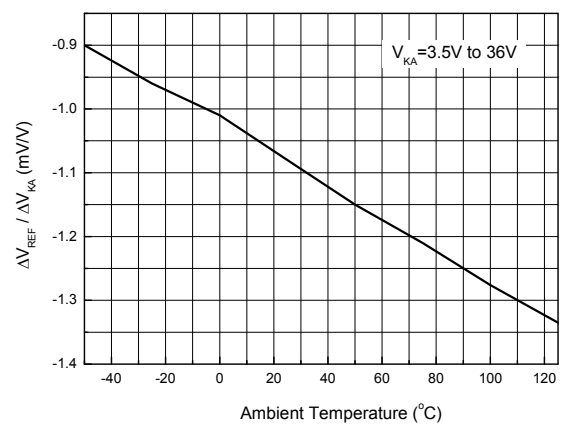
Cathode Current vs. Cathode Voltage



Off-State Cathode Current vs. Ambient Temperature

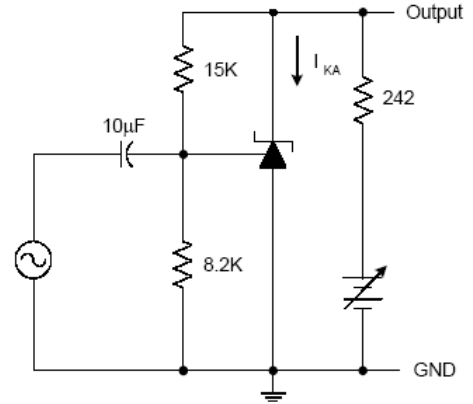
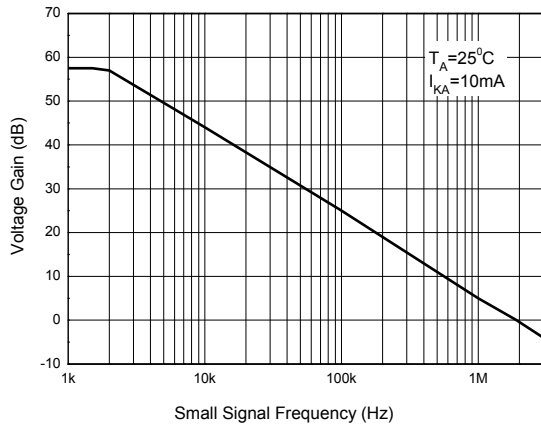


Ratio of Delta Reference Voltage to the Ratio of Delta Cathode Voltage

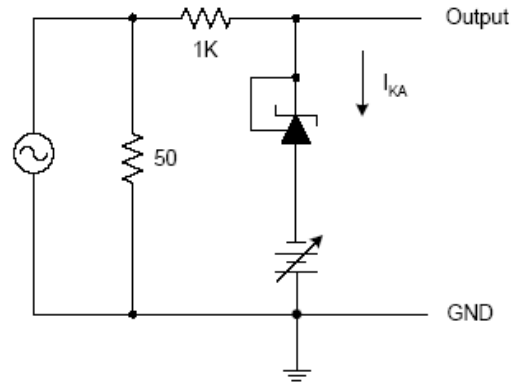
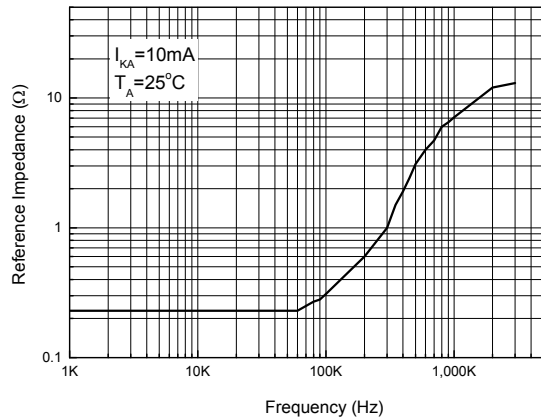


Performance Characteristics (Cont.)

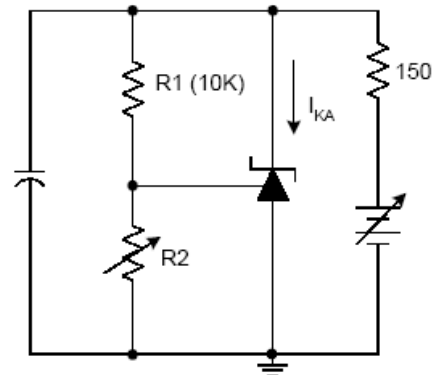
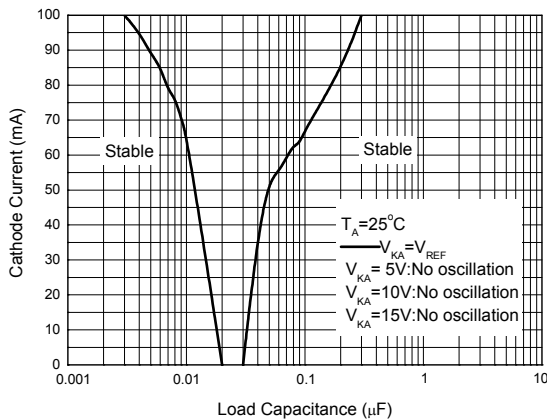
Small Signal Voltage Gain vs. Frequency



Reference Impedance vs. Frequency

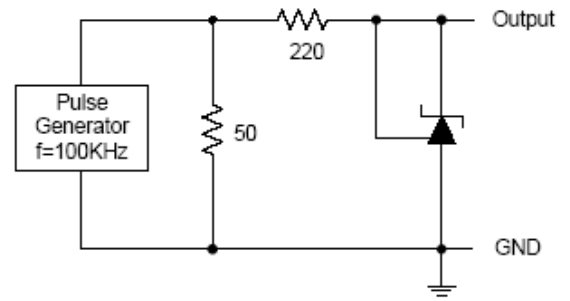
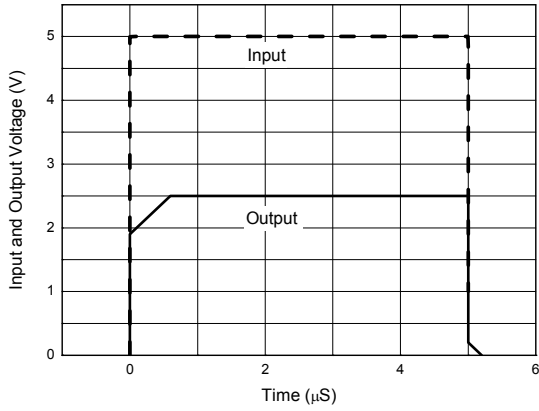


Stability Boundary Conditions vs. Load Capacitance

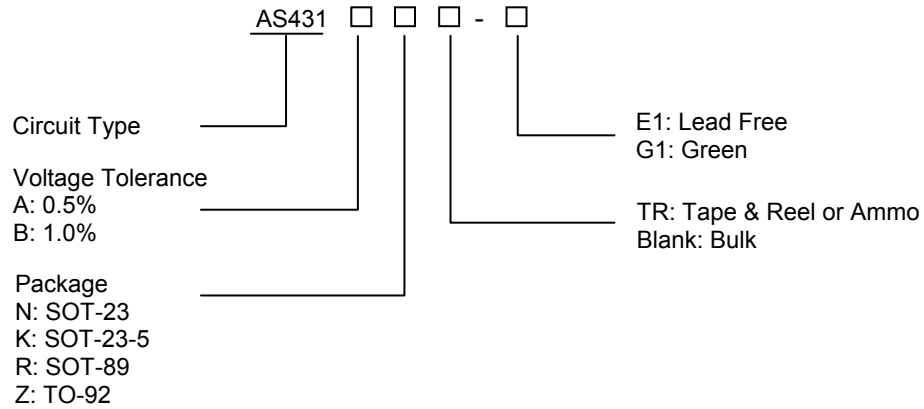


Performance Characteristics (Cont.)

Pulse Response of Input and Output Voltage



Ordering Information

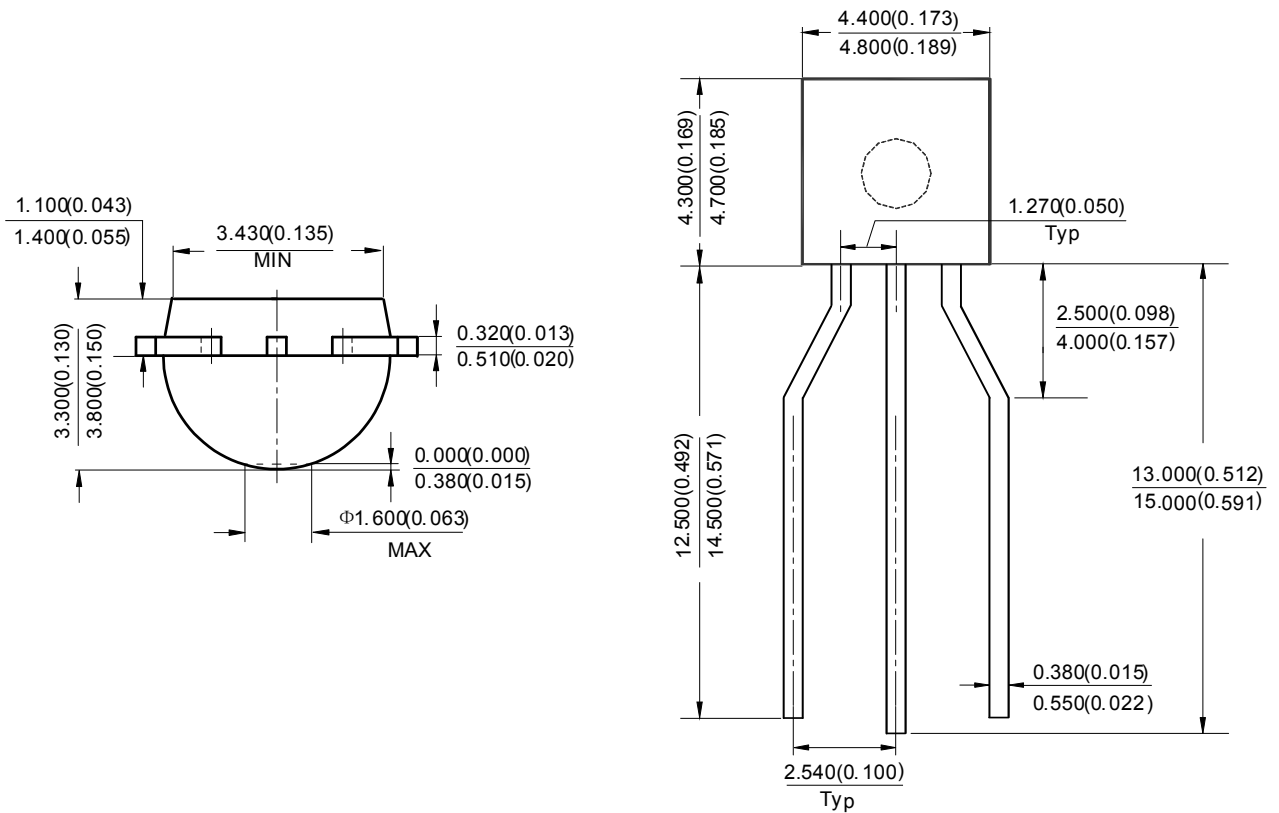


| Package | Temperature Range | Voltage Tolerance | Part Number | | Marking ID | | Packing Type |
|----------|-------------------|-------------------|--------------|--------------|------------|------------|--------------|
| | | | Lead Free | Green | Lead Free | Green | |
| SOT-23 | -40 to +125°C | 0.5% | AS431ANTR-E1 | AS431ANTR-G1 | EB5 | GB5 | Tape & Reel |
| | | 1.0% | AS431BNTR-E1 | AS431BNTR-G1 | EB6 | GB6 | Tape & Reel |
| SOT-23-5 | -40 to +125°C | 0.5% | AS431AKTR-E1 | AS431AKTR-G1 | E6H | G6H | Tape & Reel |
| | | 1.0% | AS431BKTR-E1 | AS431BKTR-G1 | E6I | G6I | Tape & Reel |
| TO-92 | -40 to +125°C | 0.5% | AS431AZ-E1 | AS431AZ-G1 | AS431AZ-E1 | AS431AZ-G1 | Bulk |
| | | 0.5% | AS431AZTR-E1 | AS431AZTR-G1 | AS431AZ-E1 | AS431AZ-G1 | Ammo |
| | | 1.0% | AS431BZ-E1 | AS431BZ-G1 | AS431BZ-E1 | AS431BZ-G1 | Bulk |
| | | 1.0% | AS431BZTR-E1 | AS431BZTR-G1 | AS431BZ-E1 | AS431BZ-G1 | Ammo |
| SOT-89 | -40 to +125°C | 0.5% | AS431ARTR-E1 | AS431ARTR-G1 | E43G | G43G | Tape & Reel |
| | | 1.0% | AS431BRTR-E1 | AS431BRTR-G1 | E43H | G43H | Tape & Reel |

BCD Semiconductor'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.

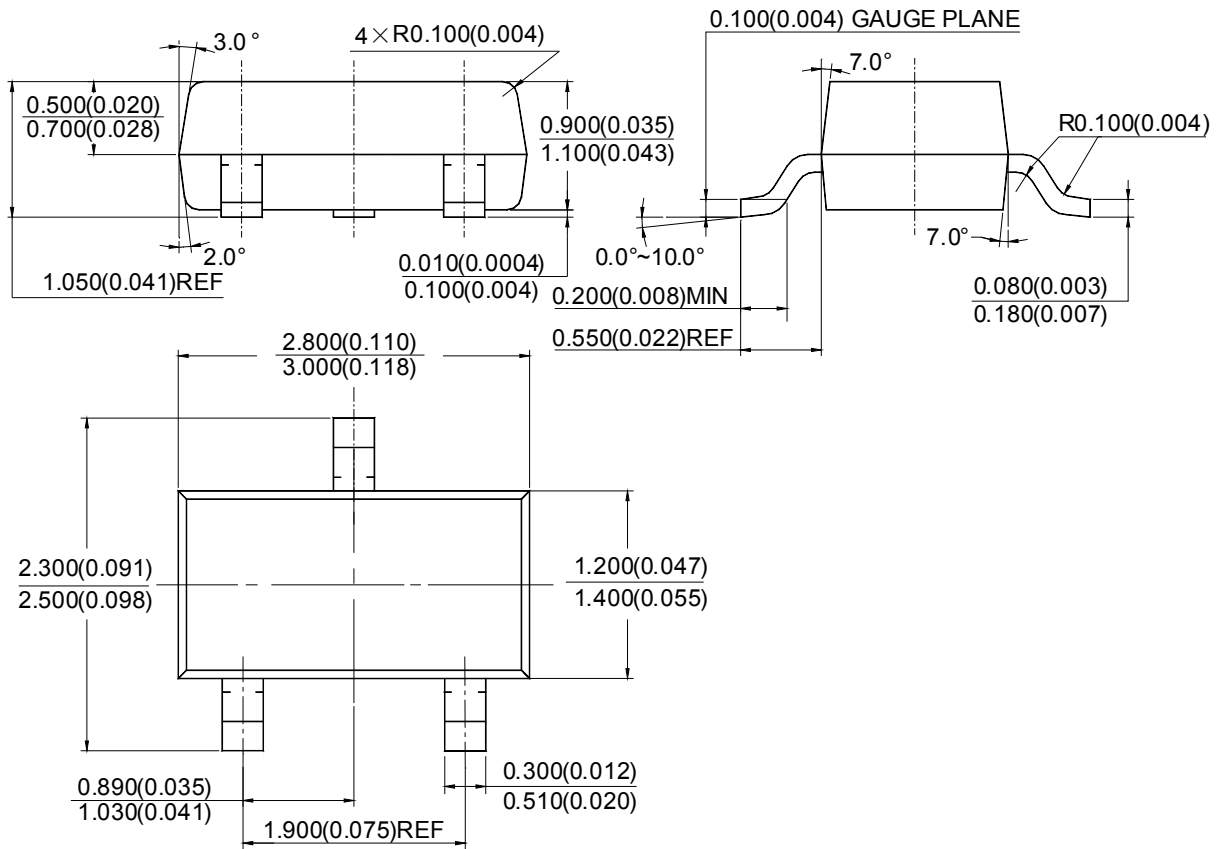
Package Outline Dimensions (Cont. All dimensions in mm(inch).)

TO-92 (Ammo Packing)



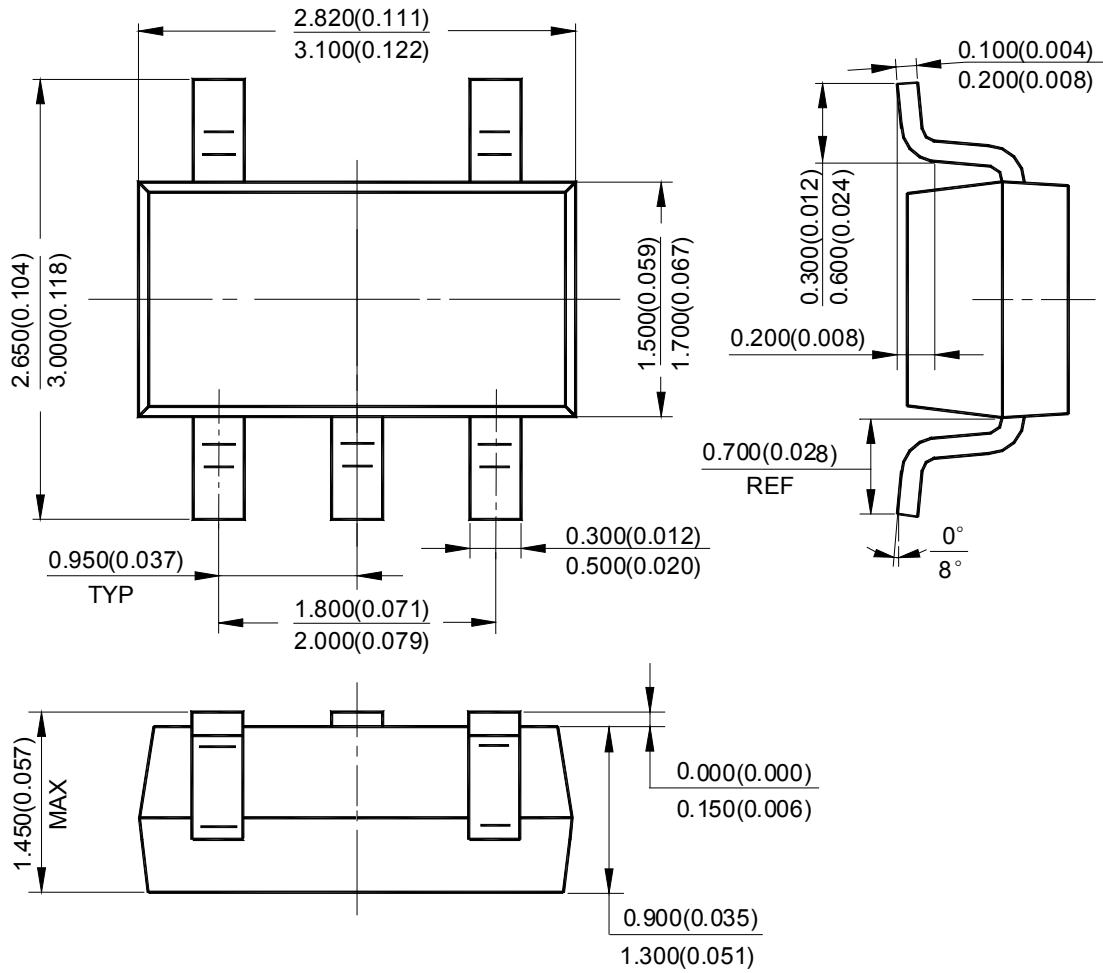
Package Outline Dimensions (Cont. All dimensions in mm(inch).)

SOT-23



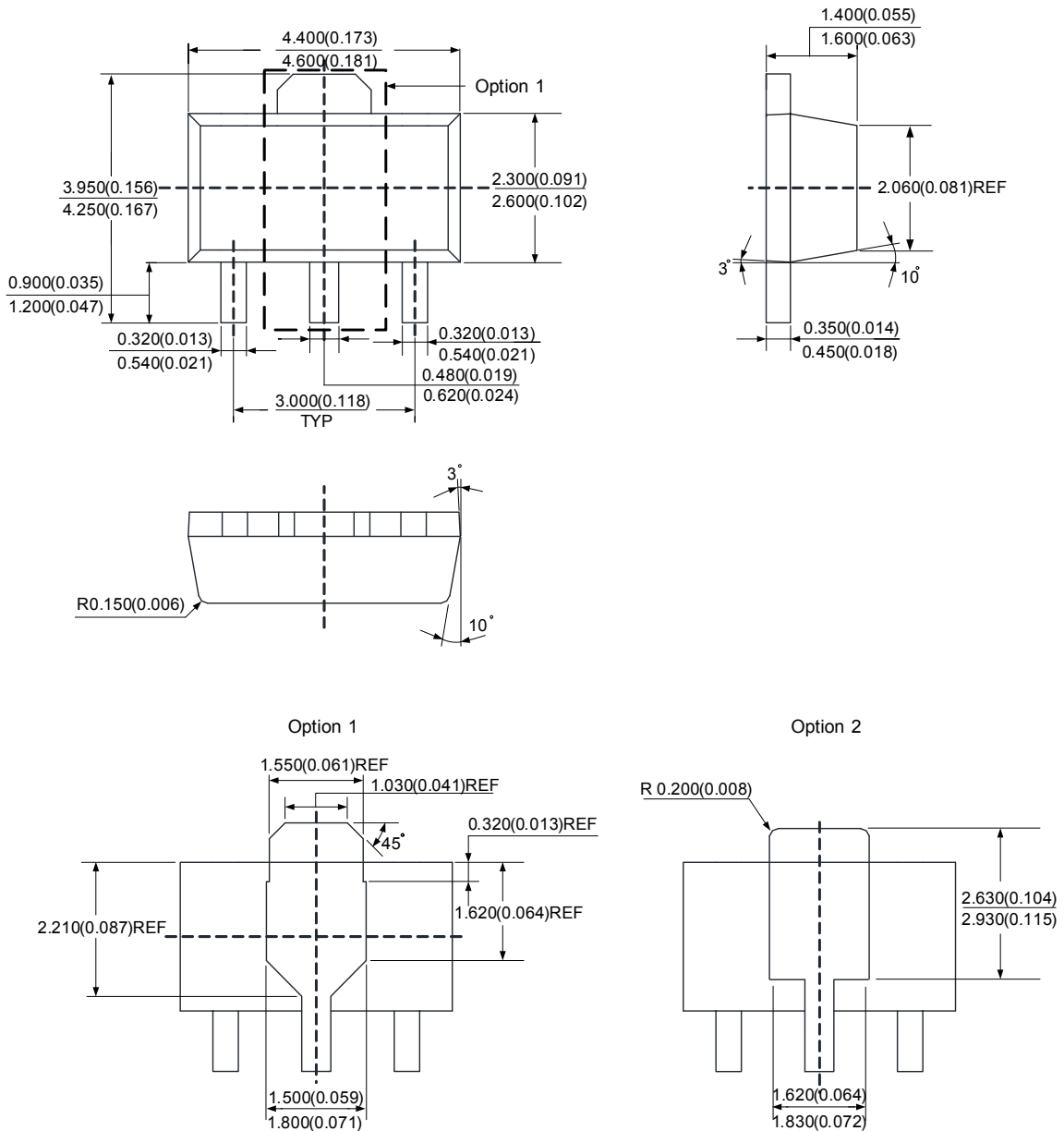
Package Outline Dimensions (Cont. All dimensions in mm(inch).)

SOT-23-5



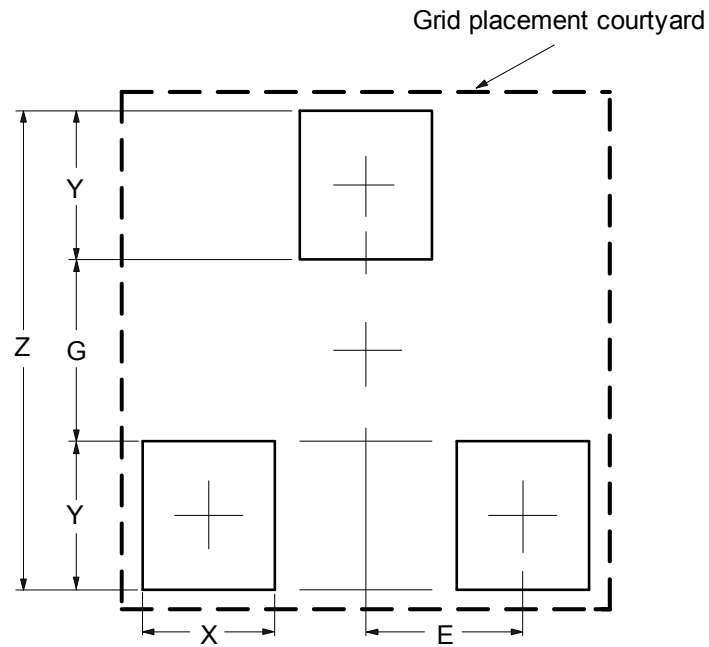
Package Outline Dimensions (Cont. All dimensions in mm(inch).)

SOT-89



Suggested Pad Layout

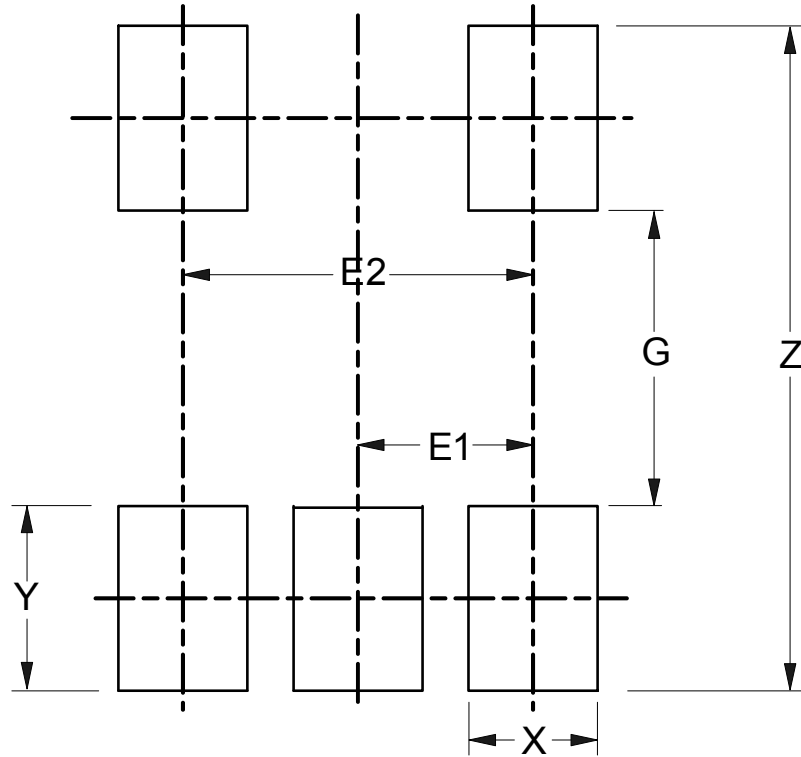
SOT-23



| Dimensions | Z (mm)/(inch) | G (mm)/(inch) | X (mm)/(inch) | Y (mm)/(inch) | E (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.)

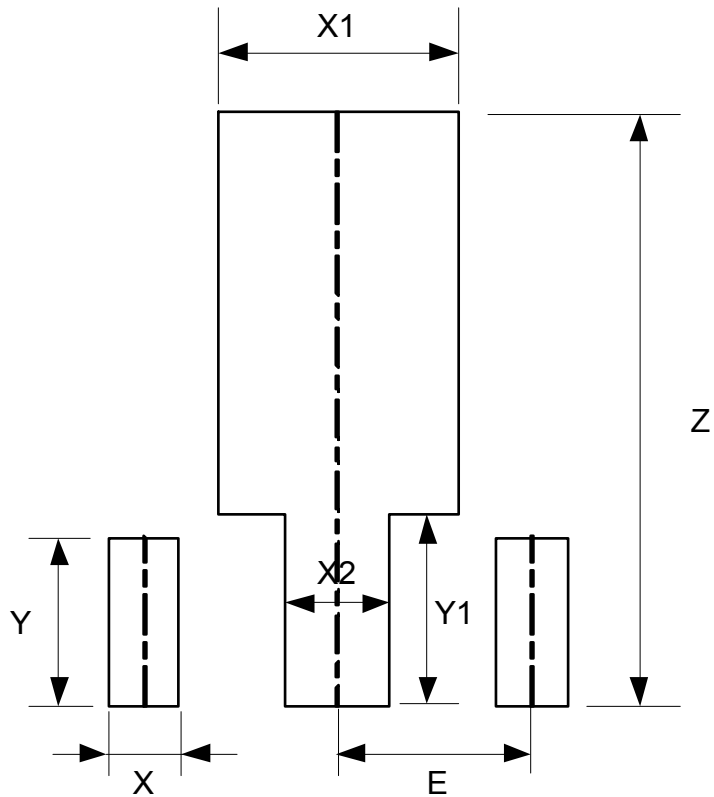
SOT-23-5



| Dimensions | Z (mm)/(inch) | G (mm)/(inch) | X (mm)/(inch) | Y (mm)/(inch) | E1 (mm)/(inch) | E2 (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.)

SOT-89



| Dimensions | Z (mm)/(inch) | X (mm)/(inch) | X1 (mm)/(inch) | X2 (mm)/(inch) | Y (mm)/(inch) | Y1 (mm)/(inch) | E (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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