

ADJUSTABLE PRECISION SHUNT REGULATORS

AS431

General 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 V_{REF} (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

Applications

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



Figure 1. Package Types of AS431

ADJUSTABLE PRECISION SHUNT REGULATORS

AS431

Pin Configuration

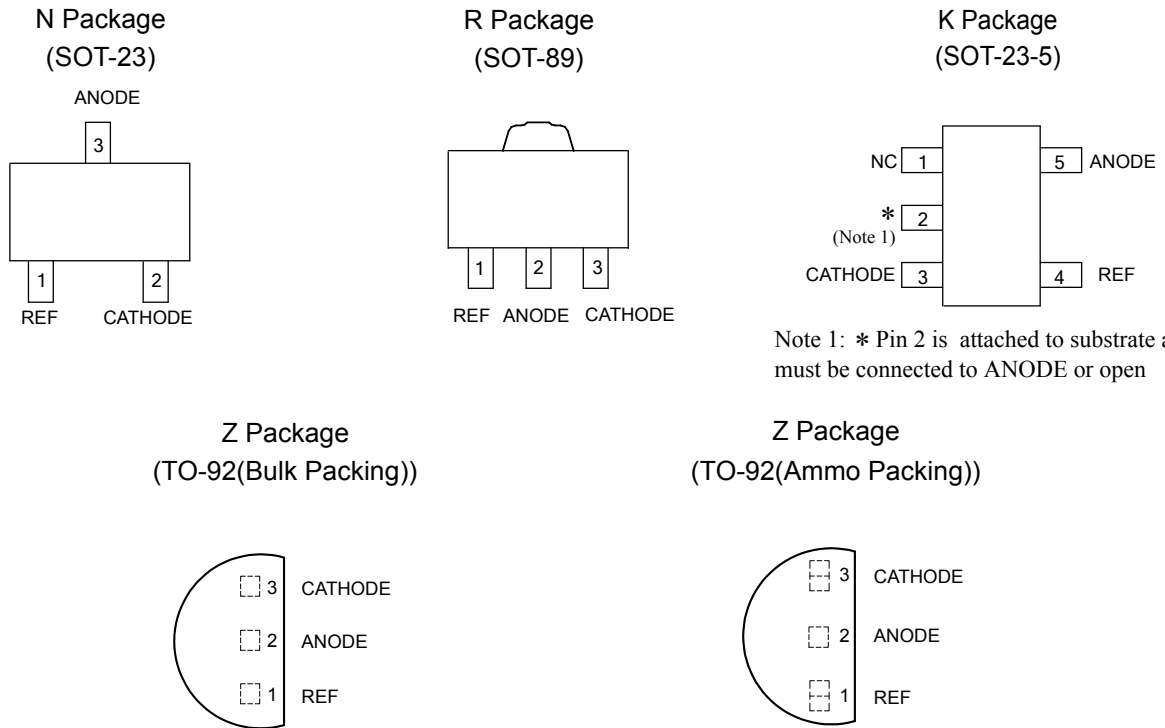


Figure 2. Pin Configuration of AS431 (Top View)

Functional Block Diagram

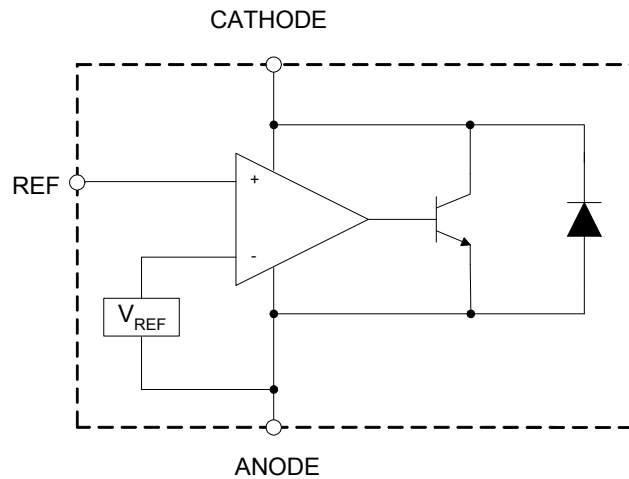


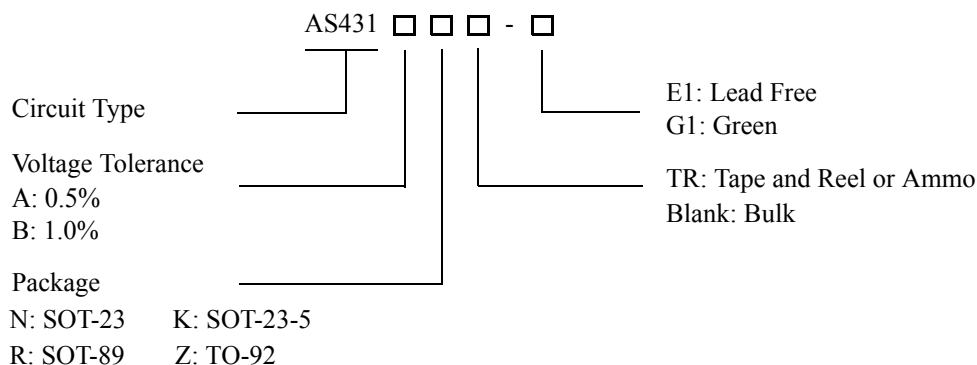
Figure 3. Functional Block Diagram of AS431



ADJUSTABLE PRECISION SHUNT REGULATORS

AS431

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.

**ADJUSTABLE PRECISION SHUNT REGULATORS****AS431****Absolute Maximum Ratings (Note 2)**

| Parameter | Symbol | Value | Unit |
|------------------------------------|-----------|-------------------|------|
| Cathode Voltage | V_{KA} | 40 | V |
| Cathode Current Range (Continuous) | I_{KA} | -100 to 150 | mA |
| Reference Input Current Range | I_{REF} | 10 | mA |
| Power Dissipation | P_D | Z, R Package: 770 | mW |
| | | N, K Package: 370 | |
| Junction Temperature | T_J | 150 | °C |
| Storage Temperature Range | T_{STG} | -65 to 150 | °C |
| ESD (Human Body Model) | ESD | 2000 | V |

Note 2: 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

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



ADJUSTABLE PRECISION SHUNT REGULATORS

AS431

Electrical Characteristics

Operating Conditions: $T_A=25^{\circ}\text{C}$, unless otherwise specified.

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

Electrical Characteristics (Continued)

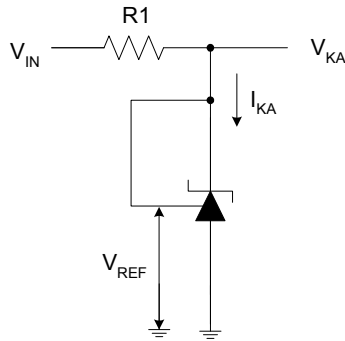


Figure 4. Test Circuit 4 for $V_{KA} = V_{REF}$

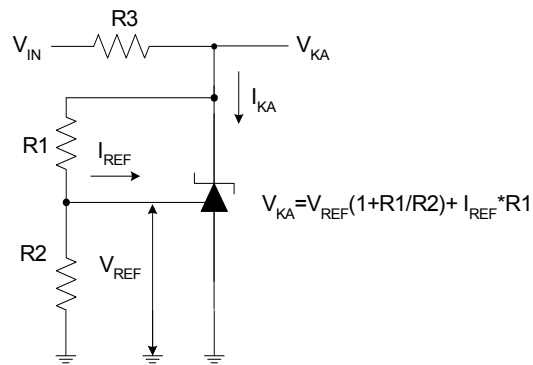


Figure 5. Test Circuit 5 for $V_{KA} > V_{REF}$

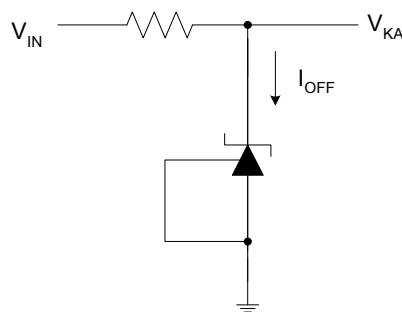


Figure 6. Test Circuit 6 for I_{OFF}



ADJUSTABLE PRECISION SHUNT REGULATORS

AS431

Typical Performance Characteristics



Figure 7. Reference Voltage vs. Ambient Temperature



Figure 8. Reference Current vs. Ambient Temperature

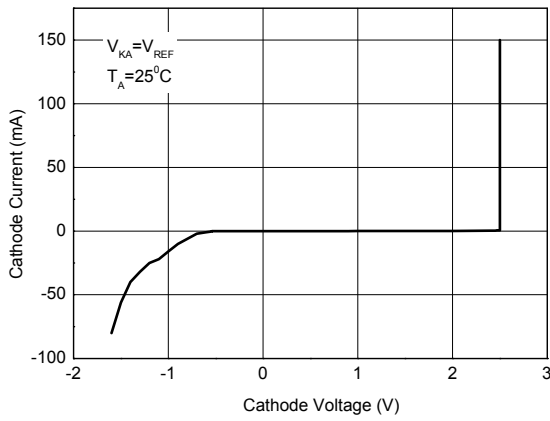


Figure 9. Cathode Current vs. Cathode Voltage

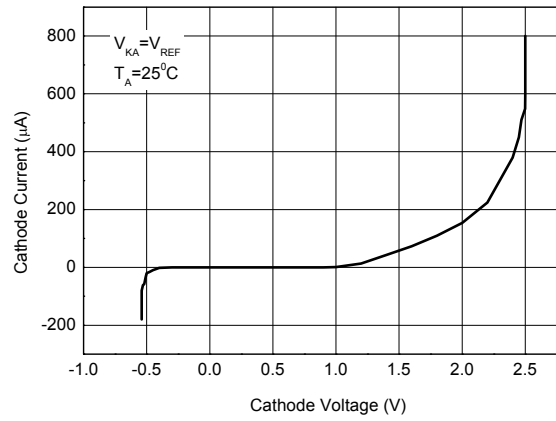


Figure 10. Cathode Current vs. Cathode Voltage



ADJUSTABLE PRECISION SHUNT REGULATORS

AS431

Typical Performance Characteristics (Continued)

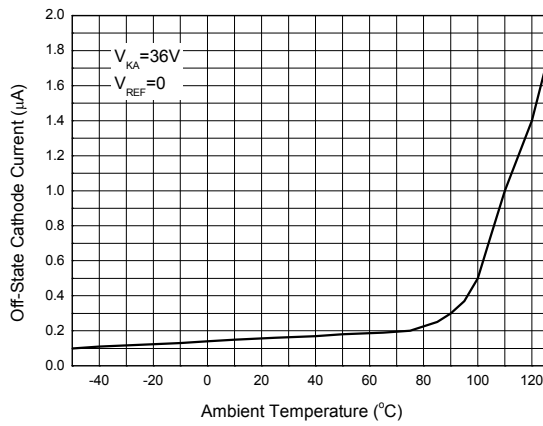


Figure 11. Off-State Cathode Current vs. Ambient Temperature

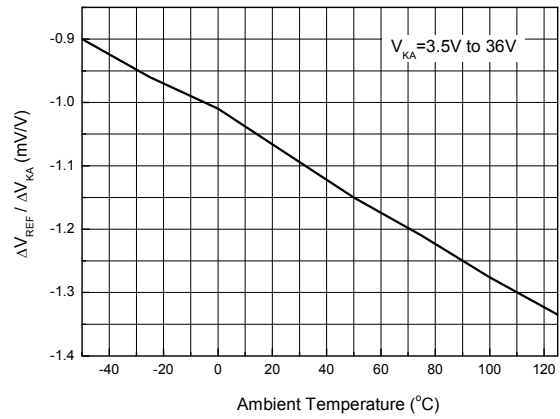


Figure 12. Ratio of Delta Reference Voltage to the Ratio of Delta Cathode Voltage

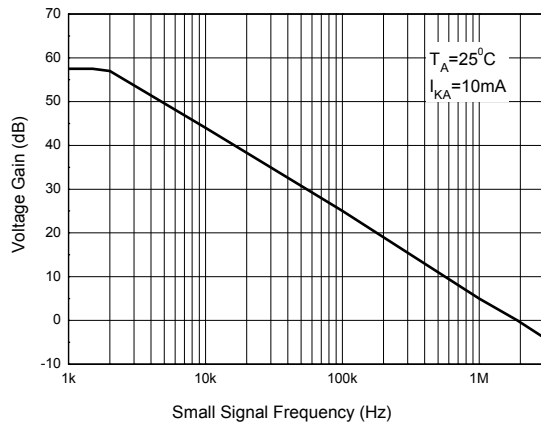
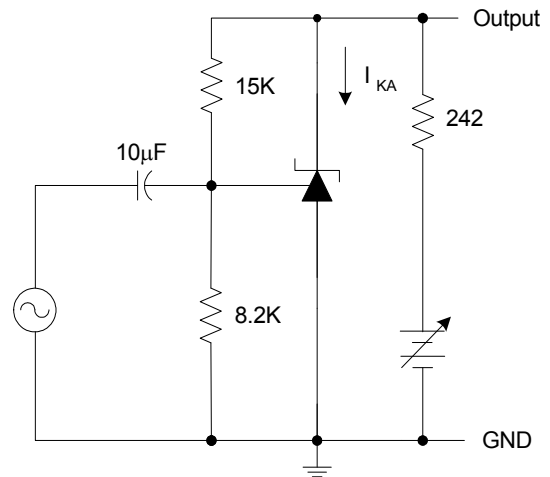


Figure 13. Small Signal Voltage Gain vs. Frequency



ADJUSTABLE PRECISION SHUNT REGULATORS

AS431

Typical Performance Characteristics (Continued)

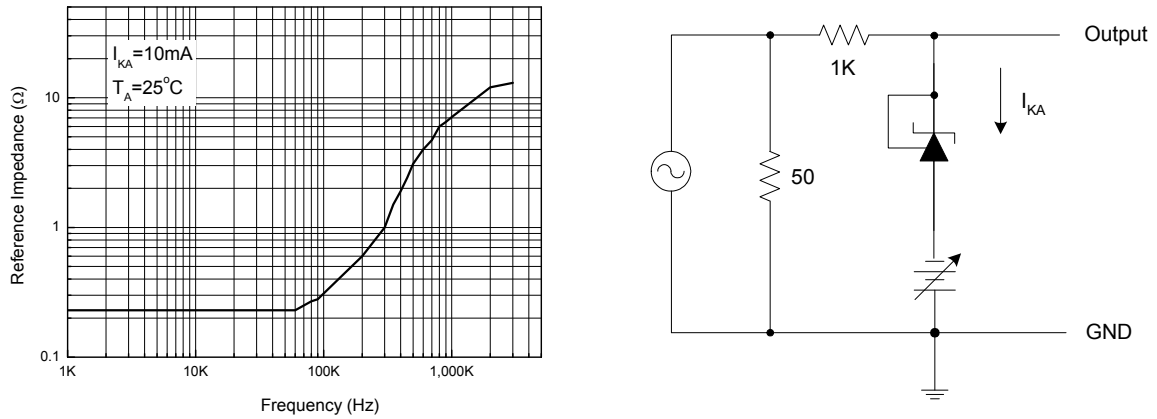


Figure 14. Reference Impedance vs. Frequency



Figure 15. Stability Boundary Conditions vs. Load Capacitance

ADJUSTABLE PRECISION SHUNT REGULATORS

AS431

Typical Performance Characteristics (Continued)



Figure 16. Pulse Response of Input and Output Voltage

Typical Application

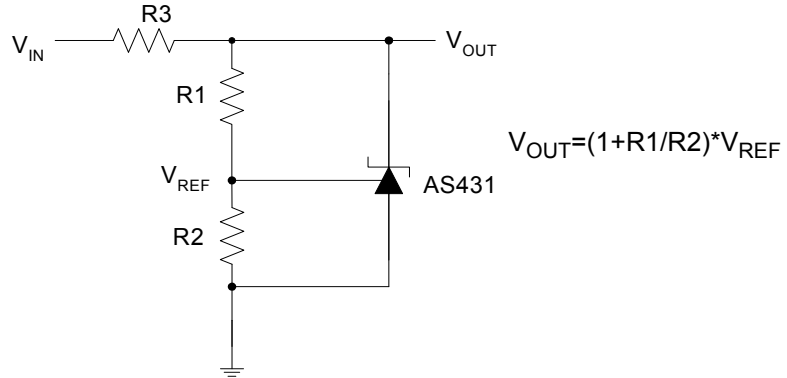


Figure 17. Shunt Regulator

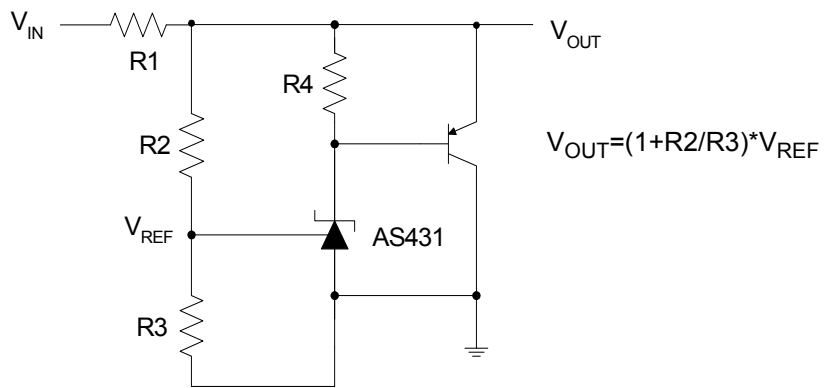


Figure 18. High Current Shunt Regulator

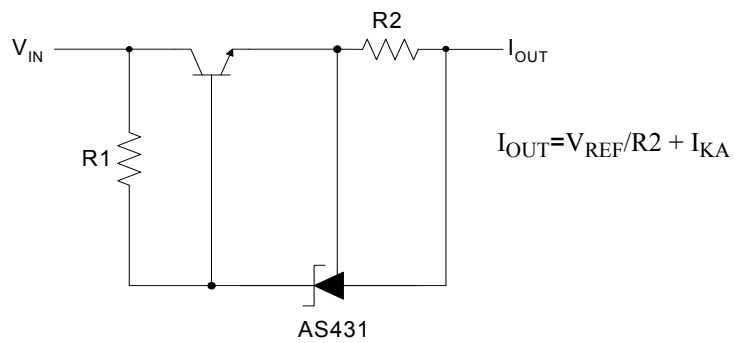


Figure 19. Current Source or Current Limit

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Typical Application (Continued)



Figure 20. Precision 5V 1A Regulator



Figure 21. PWM Converter with Reference



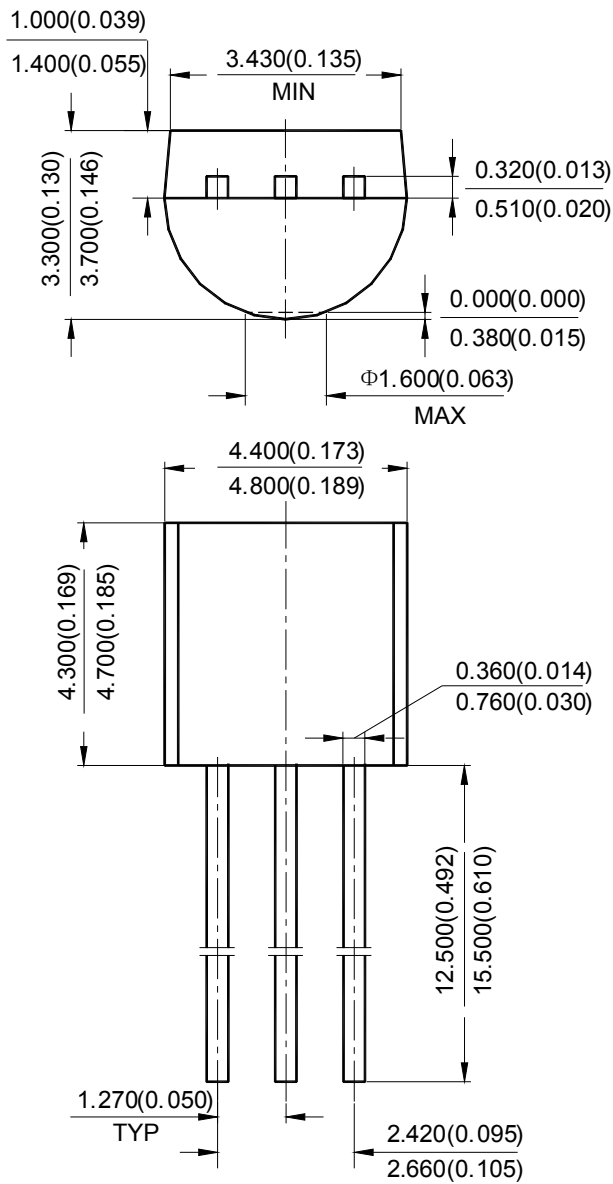
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AS431

Mechanical Dimensions

TO-92(Bulk Packing)

Unit: mm(inch)





ADJUSTABLE PRECISION SHUNT REGULATORS

AS431

Mechanical Dimensions (Continued)

TO-92(Ammo Packing)

Unit: mm(inch)





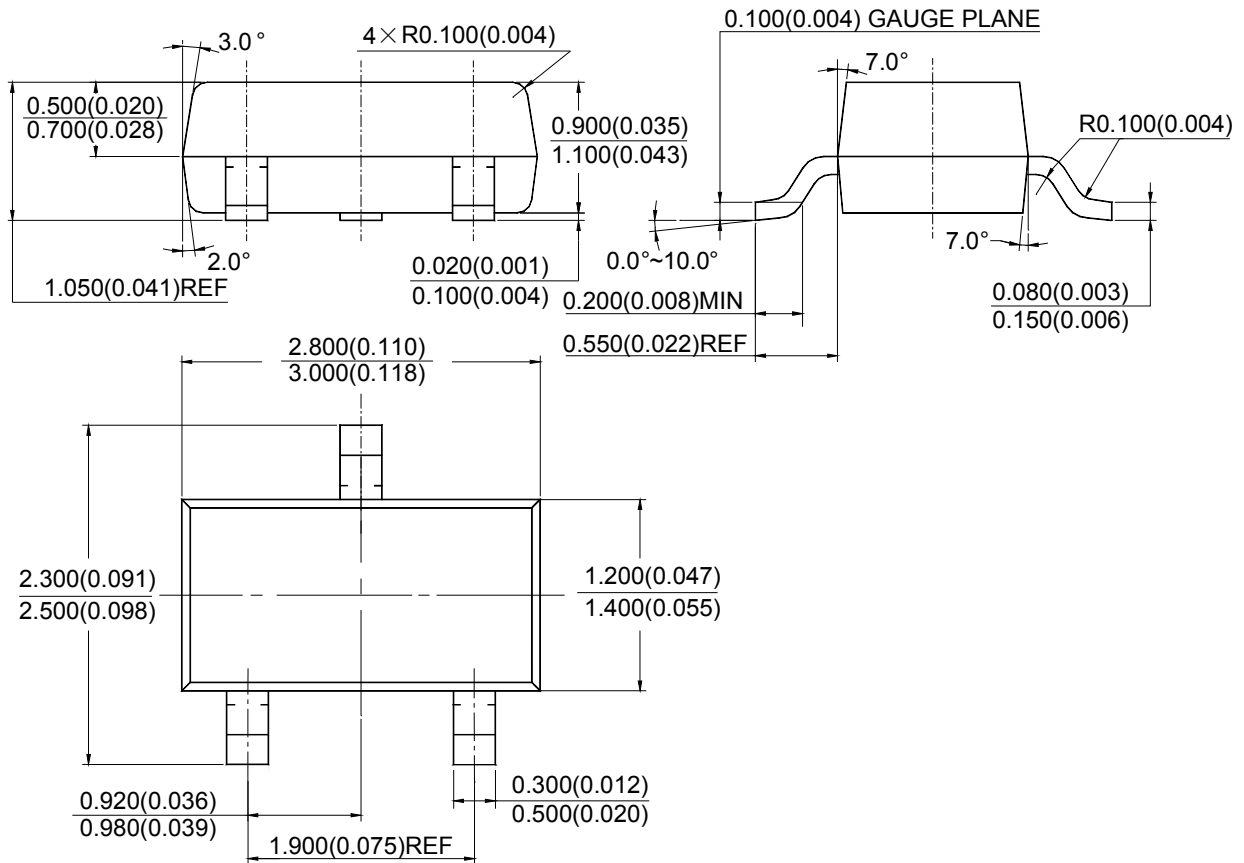
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AS431

Mechanical Dimensions (Continued)

SOT-23

Unit: mm(inch)





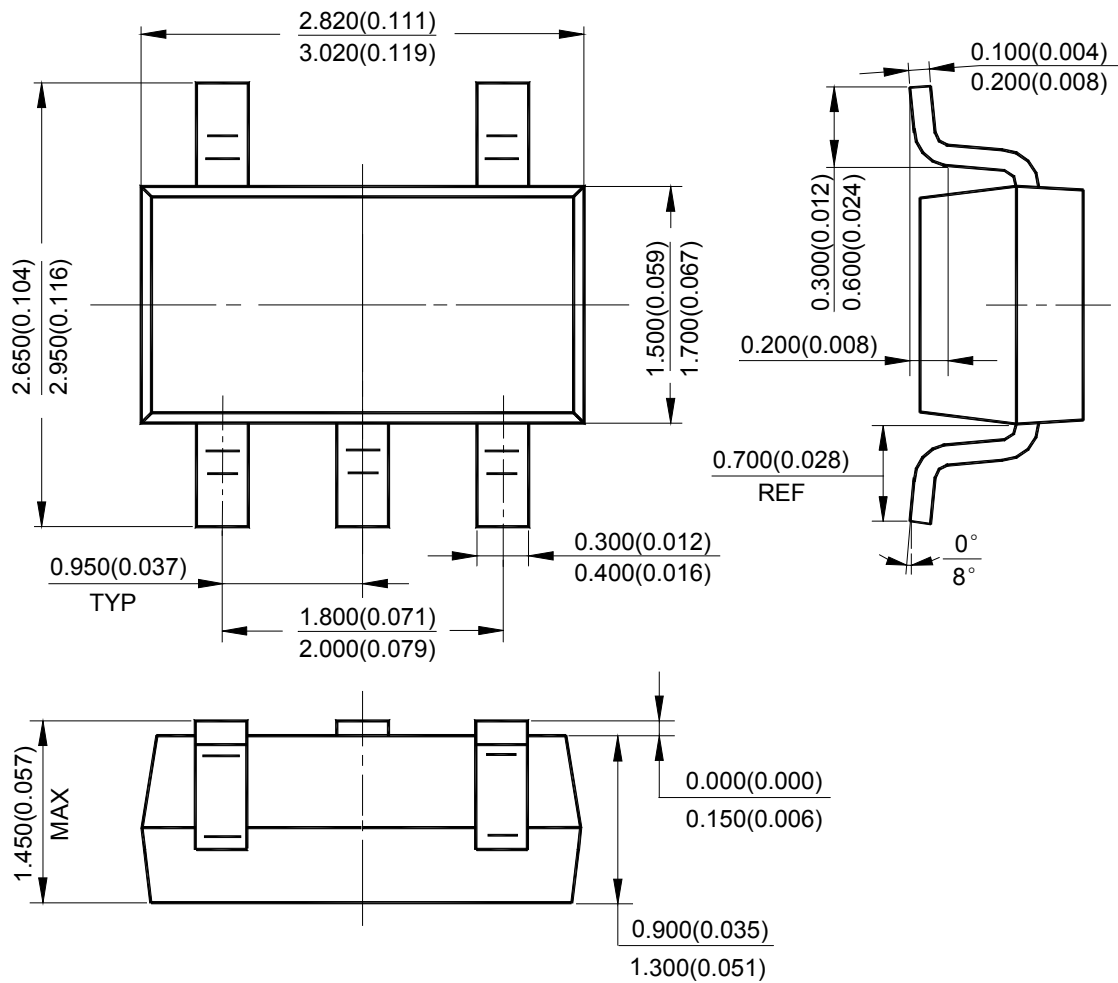
ADJUSTABLE PRECISION SHUNT REGULATORS

AS431

Mechanical Dimensions (Continued)

SOT-23-5

Unit: mm(inch)





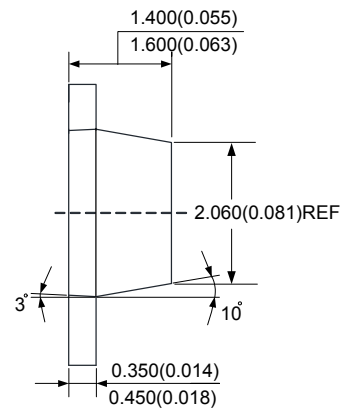
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AS431

Mechanical Dimensions (Continued)

SOT-89

Unit: mm(inch)





BCD Semiconductor Manufacturing Limited

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