



SP431

High Voltage Adjustable Precision Shunt Regulators

DESCRIPTION

The SP431 is high-voltage three-terminal adjustable voltage references, with specified thermal stability over applicable industrial and commercial temperature ranges. Output voltage can be set to any value between V_{REF} (2.5V) and 36V with two external resistors. These devices have a typical output impedance of 0.25Ω . Active output circuitry provides a very sharp turn-on characteristic, making the SP431 excellent replacements for low-voltage Zener diodes in many applications, including onboard regulation and adjustable power supplies.

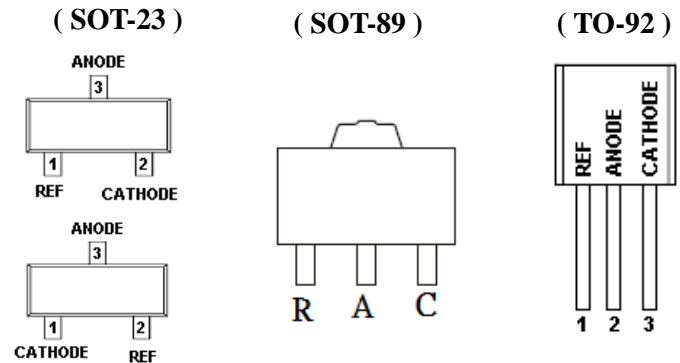
APPLICATIONS

- Battery Power Equipment
- Linear Regulators
- Switch Power Supply
- Cellular Phone
- Digital Cameras
- Computer Disk Drivers
- Instrumentation

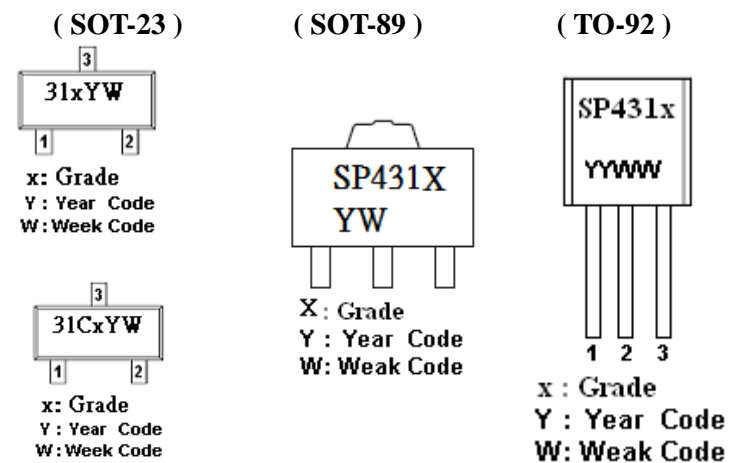
FEATURES

- ◆ Low Output Noise
- ◆ Adjustable Output Voltage, $V_o = V_{ref}$ to 36 V
- ◆ Low Operational Cathode Current
- ◆ 0.25Ω Typical Output Impedance

PIN CONFIGURATION



PART MARKING





SP431

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PIN DESCRIPTION: SP431AS23RGB/SP431BS23RGB/ SP431AS89RGB/ SP431BS89RGB

| Pin | Symbol | Description |
|-----|--------|-------------|
| 1 | R | REF |
| 2 | C | CATHODE |
| 3 | A | ANODE |

PIN DESCRIPTION: SP431AT92AGB/SP431BT92AGB

| Pin | Symbol | Description |
|-----|--------|-------------|
| 1 | R | REF |
| 2 | A | ANODE |
| 3 | C | CATHODE |

PIN DESCRIPTION: SP431CAS23RGB/SP431CBS23RGB

| Pin | Symbol | Description |
|-----|--------|-------------|
| 1 | C | CATHODE |
| 2 | R | REF |
| 3 | A | ANODE |

ORDERING INFORMATION

| Part Number | Voltage Tolerance | Package | Part Marking |
|---------------|-------------------|---------|--------------|
| SP431AS23RGB | 0.5% | SOT-23 | 31AYW |
| SP431BS23RGB | 1.0% | SOT-23 | 31BYW |
| SP431AS89RGB | 0.5% | SOT-89 | SP431A |
| SP431BS89RGB | 1.0% | SOT-89 | SP431B |
| SP431CAS23RGB | 0.5% | SOT-23 | 31CAYW |
| SP431CBS23RGB | 1.0% | SOT-23 | 31CBYW |
| SP431AT92AGB | 0.5% | TO-92 | SP431A |
| SP431BT92AGB | 1.0% | TO-92 | SP431B |

※ Week Code : A ~ Z (1 ~ 26) ; a ~ z (27 ~ 52)

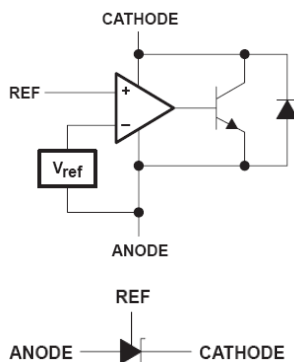
※ SP431AS23RGB/SP431BS23RGB : Tape Reel ; Pb – Free; Halogen – Free

※ SP431AS89RGB/SP431BS89RGB : Tape Reel ; Pb – Free; Halogen – Free

※ SP431CAS23RGB/SP431CBS23RGB : Tape Reel ; Pb – Free; Halogen – Free

※ SP431AT92AGB/SP431BT92AGB : Tape Ammo ; Pb – Free; Halogen – Free

BLOCK DIAGRAM





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High Voltage Adjustable Precision Shunt Regulators

ABSOLUTE MAXIMUM RATINGS

($T_A=25^{\circ}\text{C}$ Unless otherwise specified)

| Parameter | Symbol | Value | Unit |
|---|---------------|------------|-----------------------------|
| Cathode Voltage | V_Z | 37 | V |
| Continuous Cathode Current | I_Z | 150 | mA |
| Reference Current | I_{REF} | 10 | mA |
| Operation Junction Temperature Range | T_J | -40 ~ +150 | $^{\circ}\text{C}$ |
| Storage Temperature Range | T_{STG} | -65 ~ +150 | $^{\circ}\text{C}$ |
| Lead Temperature Range (Soldering 10sec.) | T_{SOL} | 260 | $^{\circ}\text{C}$ |
| Thermal Resistance | Θ_{JA} | 140 | $^{\circ}\text{C}/\text{W}$ |

The IC has a protection circuit against static electricity. Do not apply high static electricity or high voltage that exceeds the performance of the protection circuit to the IC.

ELECTRICAL CHARACTERISTICS

($T_A=25^{\circ}\text{C}$, Unless otherwise specified)

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit | |
|--|-------------------------------|--|---|-------|-------|---------------|---|
| Reference Voltage | V_{REF} | $V_Z = V_{REF}$ $I_Z = 10\text{mA}$ | SP431AS23RGB SP431AS89RGB SP431CAS23RGB SP431AT92AGB | 2.482 | 2.495 | 2.508 | V |
| | | | SP431BS23RGB SP431BS89RGB SP431CBS23RGB SP431BT92AGB | 2.47 | 2.495 | 2.52 | |
| Reference Voltage | V_{REF} | $V_Z = V_{REF}$ $I_Z = 1\text{mA}$ | SP431AS23RGB SP431AS89RGB SP431CAS23RGB SP431AT92AGB | 2.482 | 2.495 | 2.508 | V |
| | | | SP431BS23RGB SP431BS89RGB SP431CBS23RGB SP431BT92AGB | 2.47 | 2.495 | 2.52 | |
| VREF Temp Deviation | V_{DEV} | $T_A=-40^{\circ}\text{C} \sim +80^{\circ}\text{C}$ $V_Z = V_{REF}$, $I_Z = 10\text{mA}$ | | 10 | 25 | mV | |
| Ratio of change in VREF to change in Cathode voltage | $\Delta V_{REF} / \Delta V_Z$ | $I_Z = 10\text{mA}$ $\Delta V_Z = 36\text{V} \sim V_{REF}$ | | -1.4 | -2.7 | mV / V | |
| Reference Input Current | I_{REF} | $R_1=10\text{K}\Omega$, $R_2 = \infty$, $I_Z = 10\text{mA}$ | | 2 | 4 | μA | |
| IREF Temp Deviation | $I_{REF(DEV)}$ | $T_A=-40^{\circ}\text{C} \sim +80^{\circ}\text{C}$ $R_1=10\text{K}\Omega$, $R_2 = \infty$, $I_Z = 10\text{mA}$ | | 0.8 | 2.5 | μA | |
| Off state Cathode Current | $I_{Z(OFF)}$ | $V_{REF} = 0\text{V}$ $V_Z = 36\text{V}$ | | 0.1 | 0.5 | μA | |



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| | | | | | |
|---------------------------|-------------------|--|------|-----|----------|
| Dynamic output impedance | R_Z | $f < 1\text{KHZ}, V_Z = V_{REF}$ $I_Z = 1\text{mA} \sim 100\text{mA}$ | 0.25 | 0.5 | Ω |
| Minimum Operation Current | $I_Z(\text{MIN})$ | $V_Z = V_{REF}$ | 0.4 | 0.7 | mA |

TESTING CIRCUIT

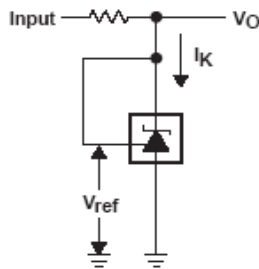


Figure 1. Test Circuit for $V_{KA} = V_{ref}$,
 $V_O = V_{KA} = V_{ref}$

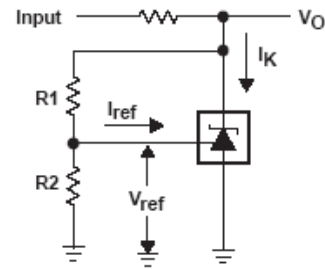


Figure 2. Test Circuit for $V_{KA} > V_{ref}$,
 $V_O = V_{KA} = V_{ref} \times (1 + R1/R2) + I_{ref} \times R1$

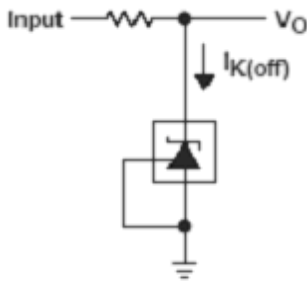


Figure 3. Test Circuit for $I_{K(off)}$

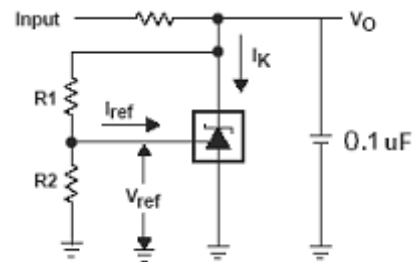


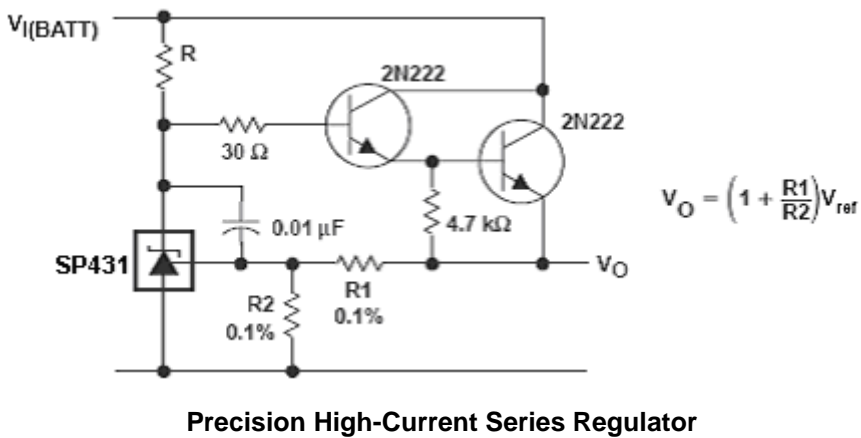
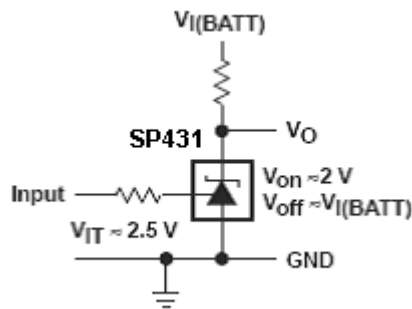
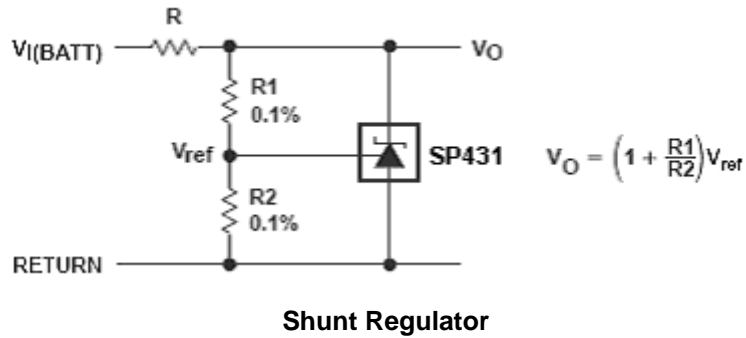
Figure 4. Test Circuit for $V_{KA} > V_{ref}$,
 $V_O = V_{KA} = V_{ref} \times (1 + R1/R2) + I_{ref} \times R1$



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APPLICATION CIRCUIT

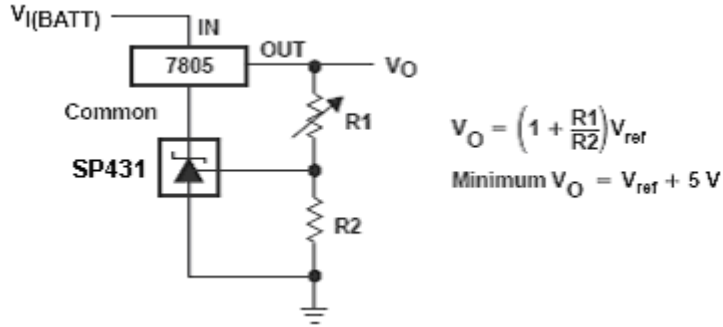




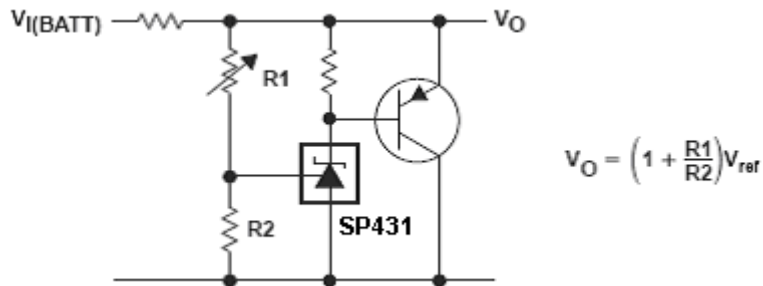
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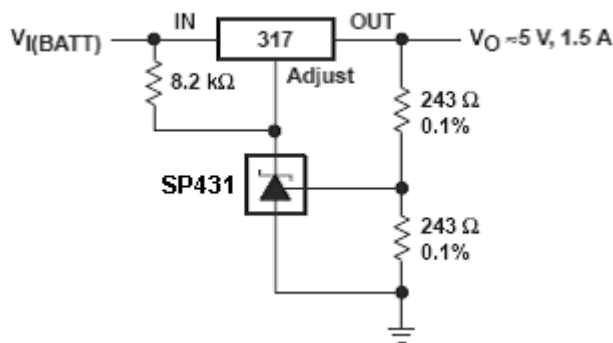
APPLICATION CIRCUIT



Output Control of a Three-Terminal Fixed Regulator



High-Current Shunt Regulator



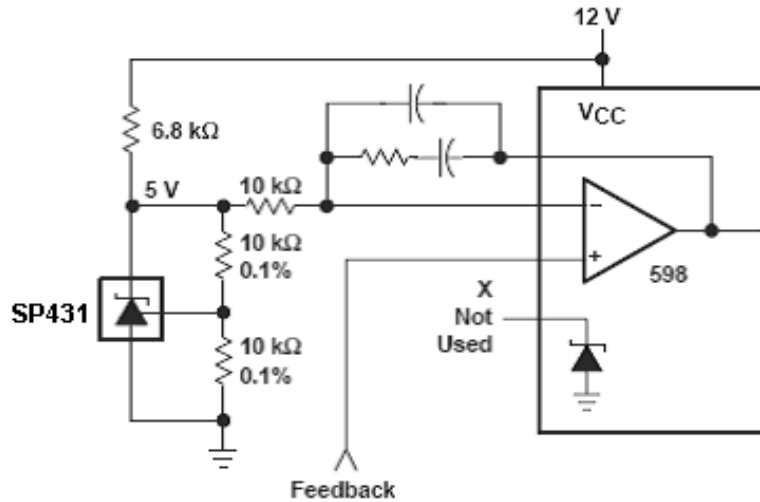
Precision 5-V 1.5-A Regulator



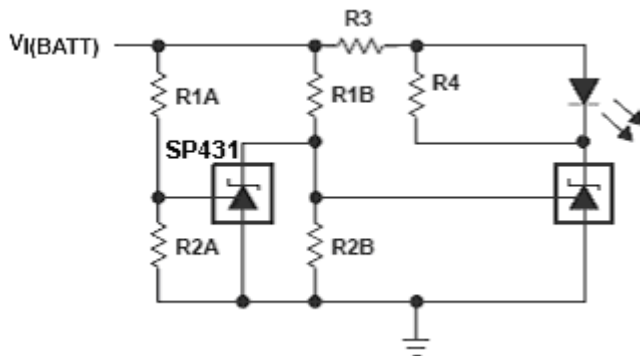
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APPLICATION CIRCUIT



PWM Converter With Reference

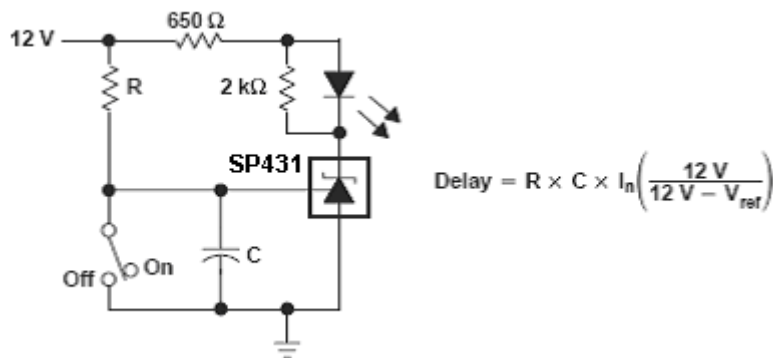


$$\text{Low Limit} = \left(1 + \frac{R1B}{R2B}\right) V_{ref}$$

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

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

Voltage Monitor



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

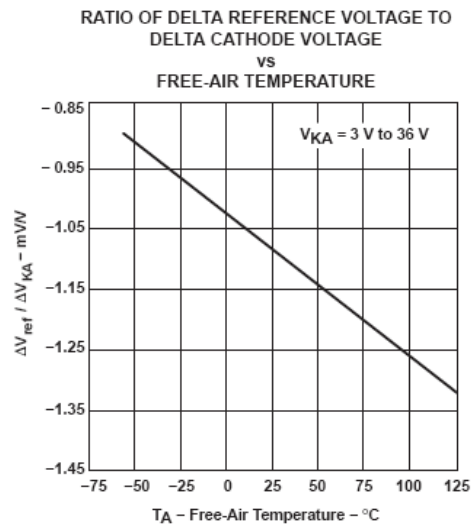
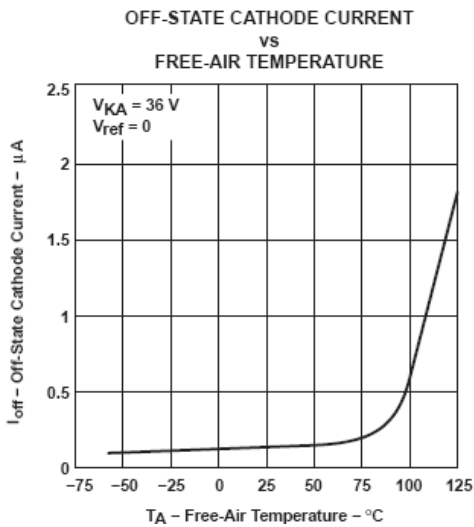
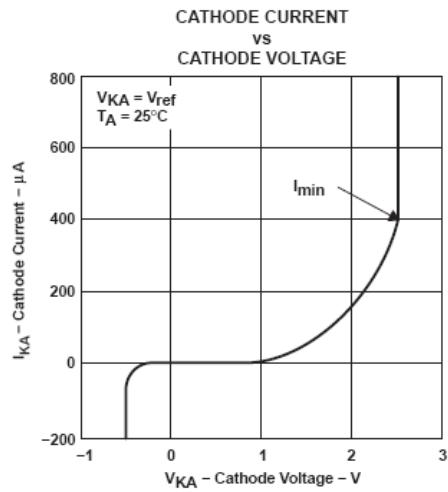
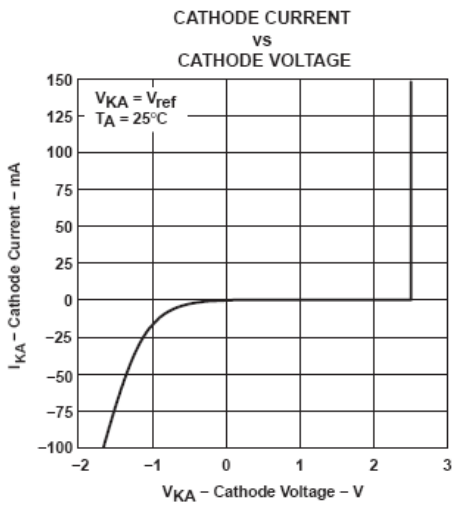
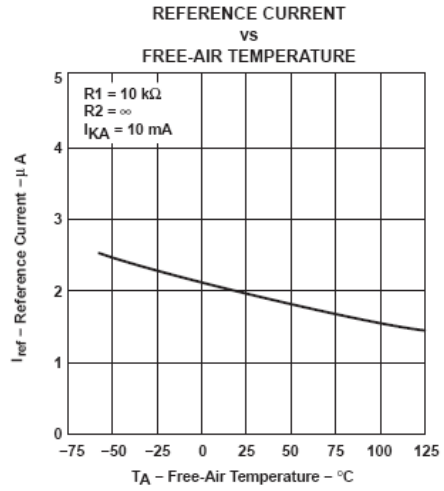
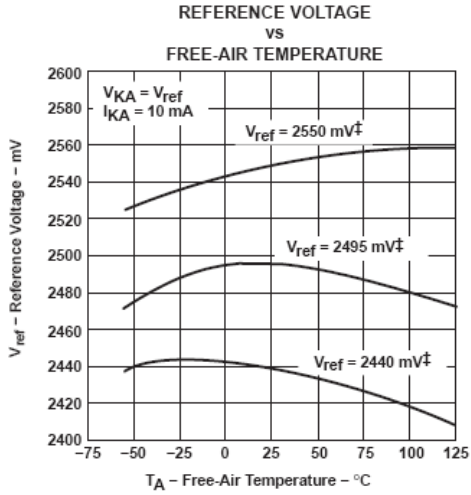
Delay Timer



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PERFORMANCE CHARACTERISTICS

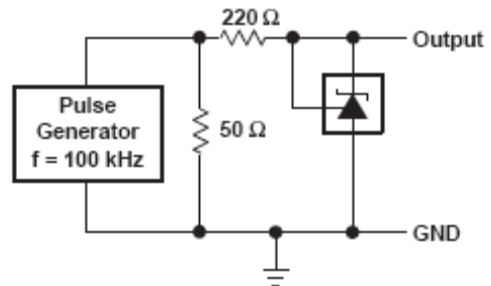
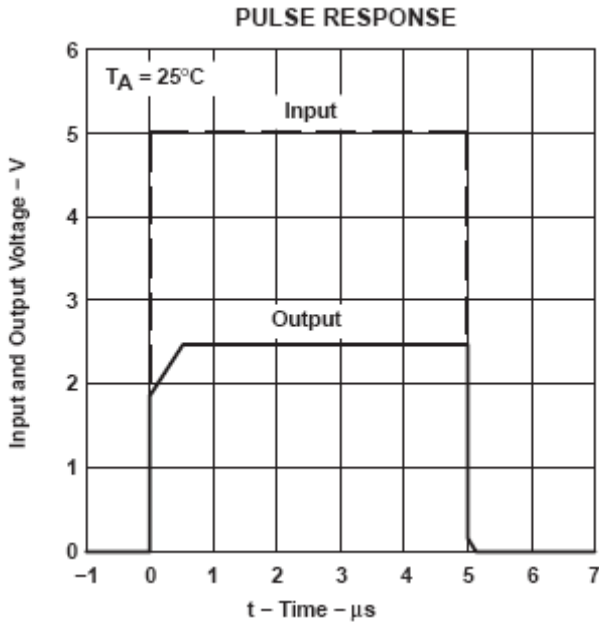




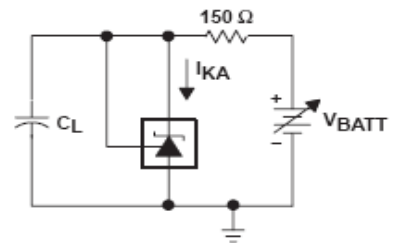
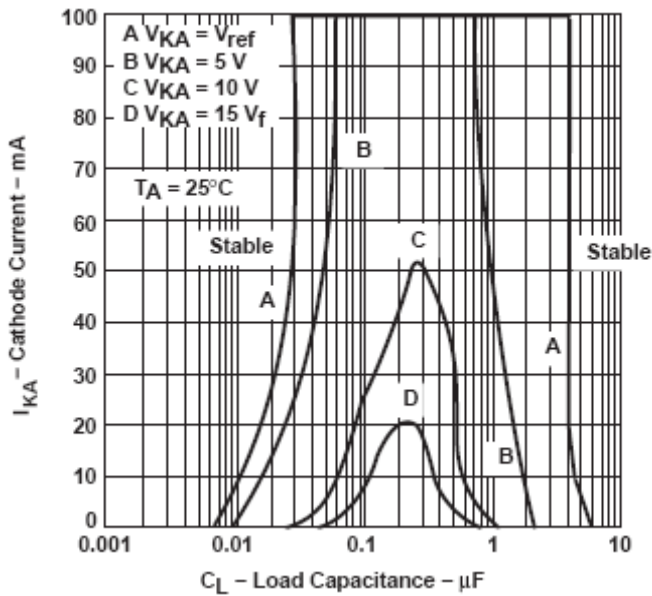
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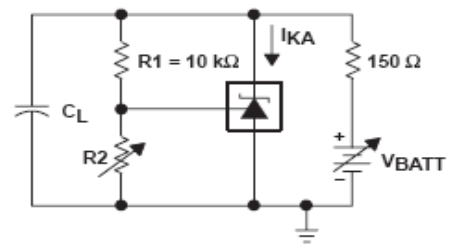
PERFORMANCE CHARACTERISTICS



TEST CIRCUIT FOR PULSE RESPONSE



TEST CIRCUIT FOR CURVE A



TEST CIRCUIT FOR CURVES B, C, AND D

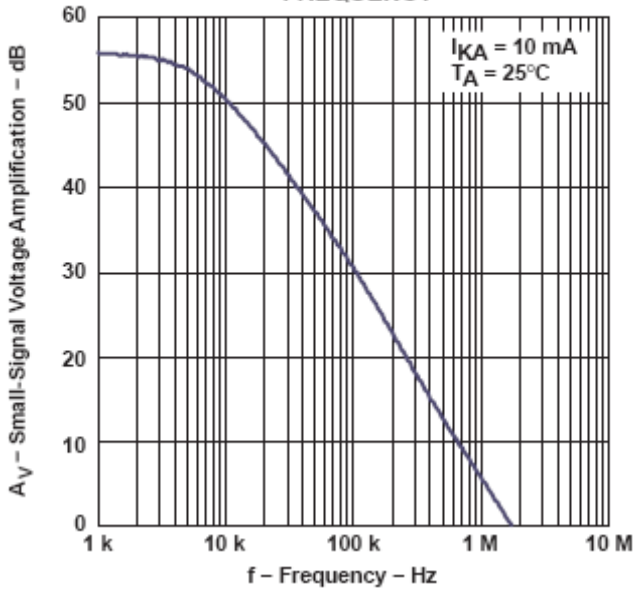


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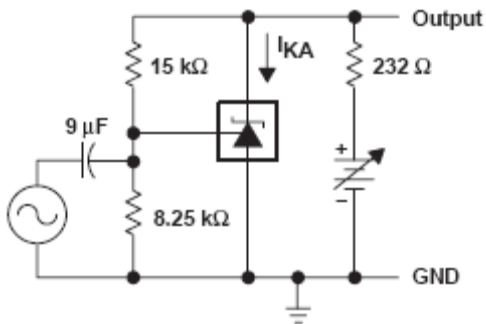
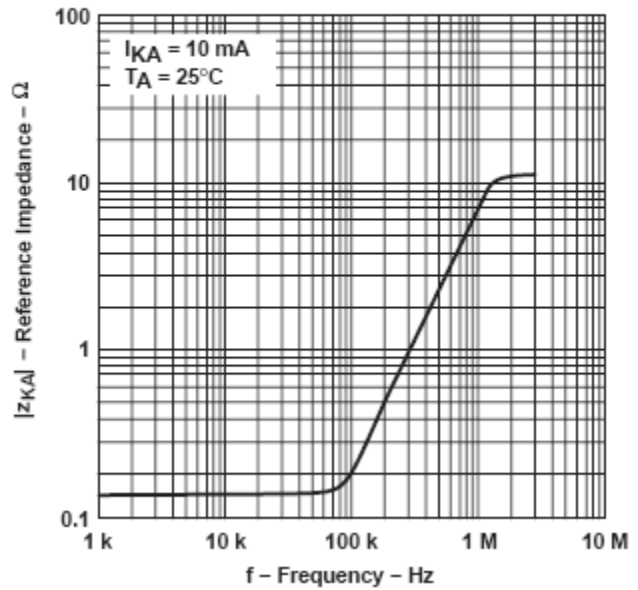
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PERFORMANCE CHARACTERISTICS

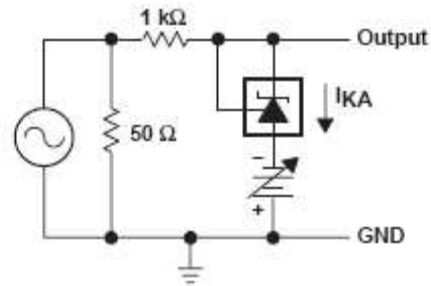
SMALL-SIGNAL VOLTAGE AMPLIFICATION
VS
FREQUENCY



REFERENCE IMPEDANCE
VS
FREQUENCY



TEST CIRCUIT FOR VOLTAGE AMPLIFICATION



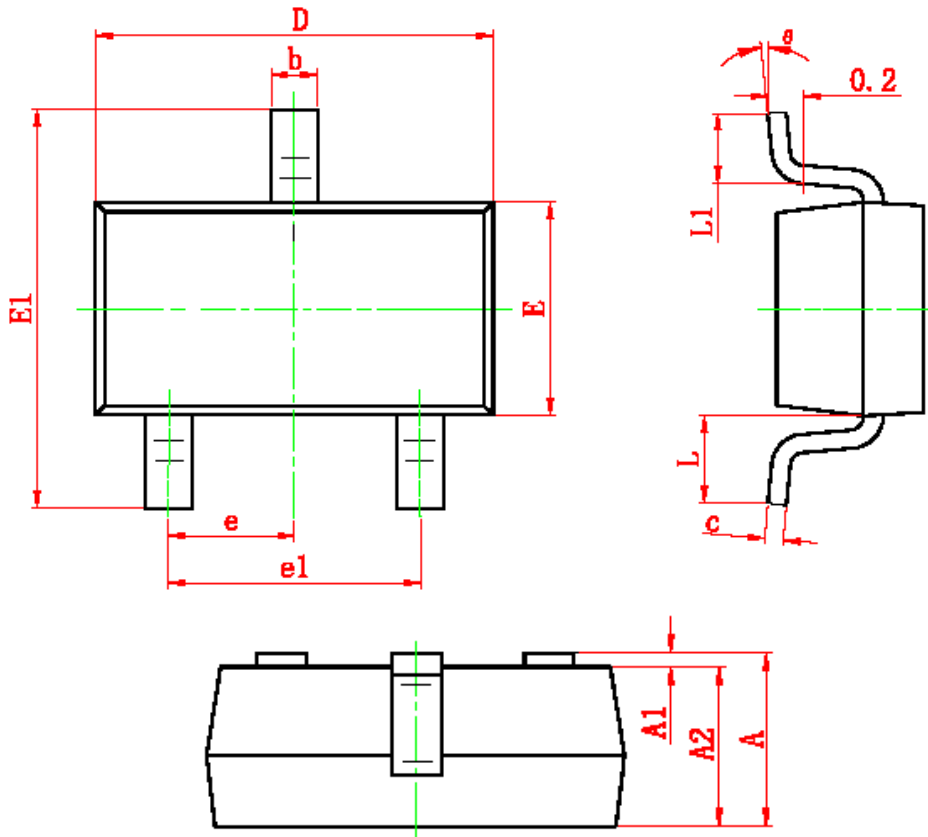
TEST CIRCUIT FOR REFERENCE IMPEDANCE



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SOT-23 PACKAGE OUTLINE



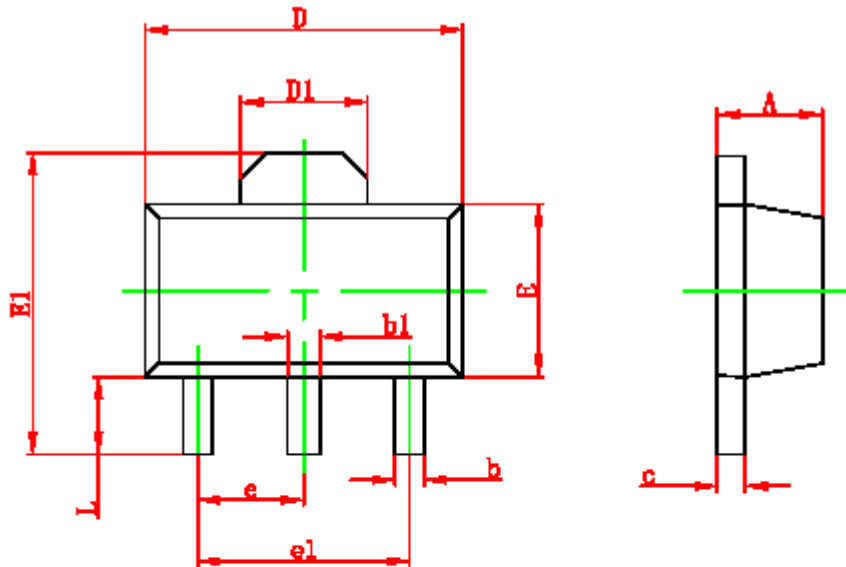
| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|----------|---------------------------|-------|----------------------|-------|
| | Min | Max | Min | Max |
| A | 0.900 | 1.200 | 0.035 | 0.043 |
| A1 | 0.000 | 0.100 | 0.000 | 0.004 |
| A2 | 0.900 | 1.100 | 0.035 | 0.039 |
| b | 0.300 | 0.500 | 0.012 | 0.020 |
| c | 0.080 | 0.150 | 0.003 | 0.006 |
| D | 2.800 | 3.000 | 0.110 | 0.118 |
| E | 1.200 | 1.400 | 0.047 | 0.055 |
| E1 | 2.250 | 2.550 | 0.089 | 0.100 |
| e | 0.950 TYP | | 0.037 TYP | |
| e1 | 1.800 | 2.000 | 0.071 | 0.079 |
| L | 0.550 REF | | 0.022 REF | |
| L1 | 0.300 | 0.500 | 0.012 | 0.020 |
| θ | 0° | 8° | 0° | 6° |



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SOT-89 PACKAGE OUTLINE



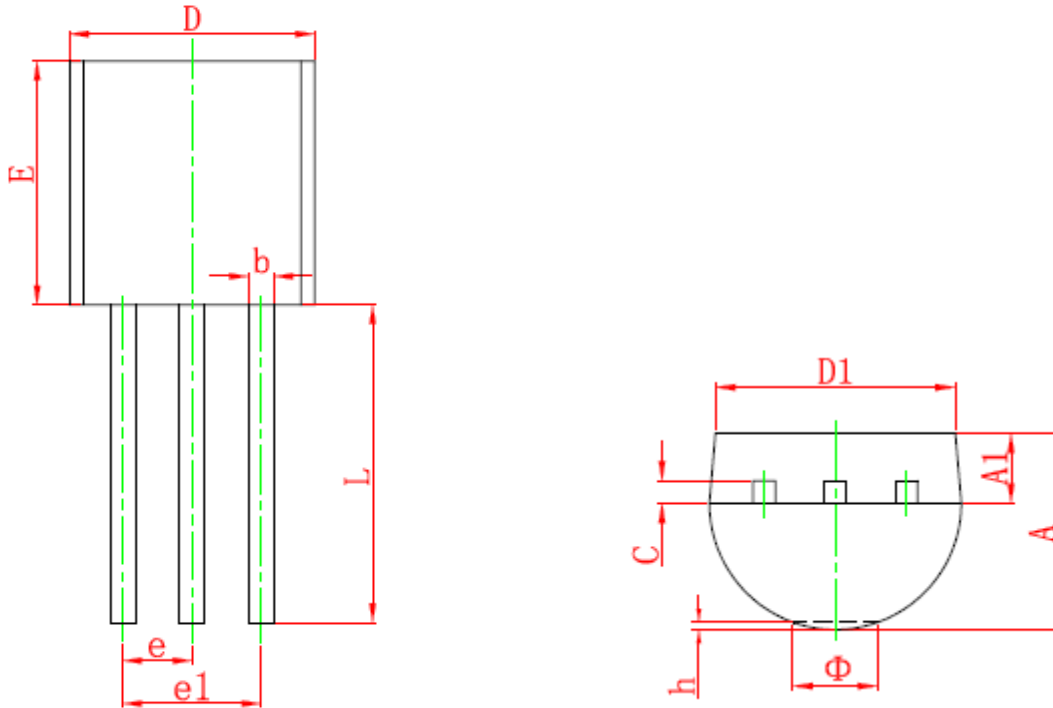
| Symbol | Dimensions in Millimeters | | Dimensions in Inches | |
|--------|---------------------------|-------|----------------------|-------|
| | Min | Max | Min | Max |
| A | 1.400 | 1.600 | 0.055 | 0.063 |
| b | 0.320 | 0.520 | 0.013 | 0.020 |
| b1 | 0.400 | 0.580 | 0.016 | 0.023 |
| c | 0.350 | 0.440 | 0.014 | 0.017 |
| D | 4.400 | 4.600 | 0.173 | 0.181 |
| D1 | 1.550 REF. | | 0.061 REF. | |
| E | 2.300 | 2.600 | 0.091 | 0.102 |
| E1 | 3.940 | 4.250 | 0.155 | 0.167 |
| e | 1.500 TYP. | | 0.060 TYP. | |
| e1 | 3.000 TYP. | | 0.118 TYP. | |
| L | 0.900 | 1.200 | 0.035 | 0.047 |



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TO-92 PACKAGE OUTLINE



| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|--------|---------------------------|--------|----------------------|-------|
| | Min | Max | Min | Max |
| A | 3.300 | 3.700 | 0.130 | 0.146 |
| A1 | 1.100 | 1.400 | 0.043 | 0.055 |
| b | 0.380 | 0.550 | 0.015 | 0.022 |
| c | 0.360 | 0.510 | 0.014 | 0.020 |
| D | 4.400 | 4.700 | 0.173 | 0.185 |
| D1 | 3.430 | | 0.135 | |
| E | 4.300 | 4.700 | 0.169 | 0.185 |
| e | 1.270 TYP | | 0.050 TYP | |
| e1 | 2.440 | 2.640 | 0.096 | 0.104 |
| L | 14.100 | 14.500 | 0.555 | 0.571 |
| Φ | | 1.600 | | 0.063 |
| h | 0.000 | 0.380 | 0.000 | 0.015 |



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