

Features

- Low-Voltage Operation: Down to 1.24V
- 1% Reference-Voltage Tolerance
- Adjustable Output Voltage, $V_o = V_{ref}$ to 12V
- Low Operational Cathode Current...50 μ A
- 0.25 Ω Typical Output Impedance
- SOT-23-3 , SOT-23-5 and TO-92 Packages

Application

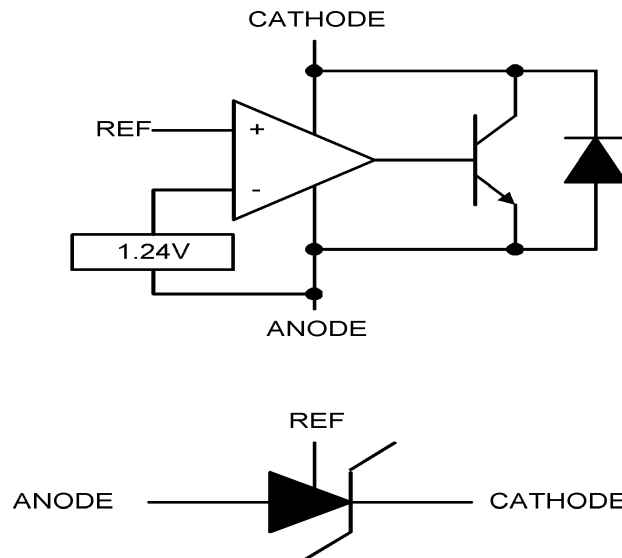
- Linear Regulators
- Voltage Reference for Power Circuit

Description

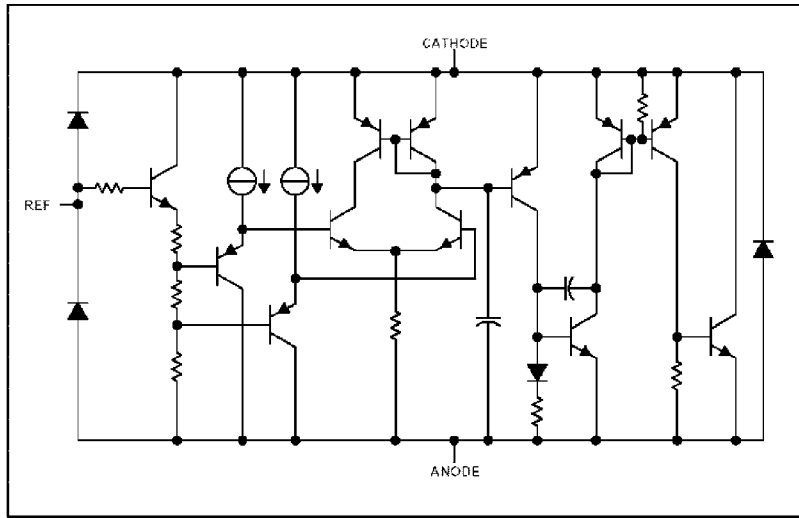
The AT431 is low-voltage three-terminal adjustable voltage reference with specified thermal stability over applicable commercial temperature ranges. Output voltage may be set to any value between V_{ref} (1.24V) and 12V with two external resistors (see Figure 2).

When used with an optocoupler, the AT431 is ideal voltage reference in isolated feedback circuits for 1.8V to 12 V switching-mode power supplies. This device has typical output impedance of 0.20 Ω . Active output circuitry provides a very sharp turn-on characteristic, making the AT431 excellent replacements for low-voltage zener diodes in many applications, including onboard regulation and adjustable power supplies.

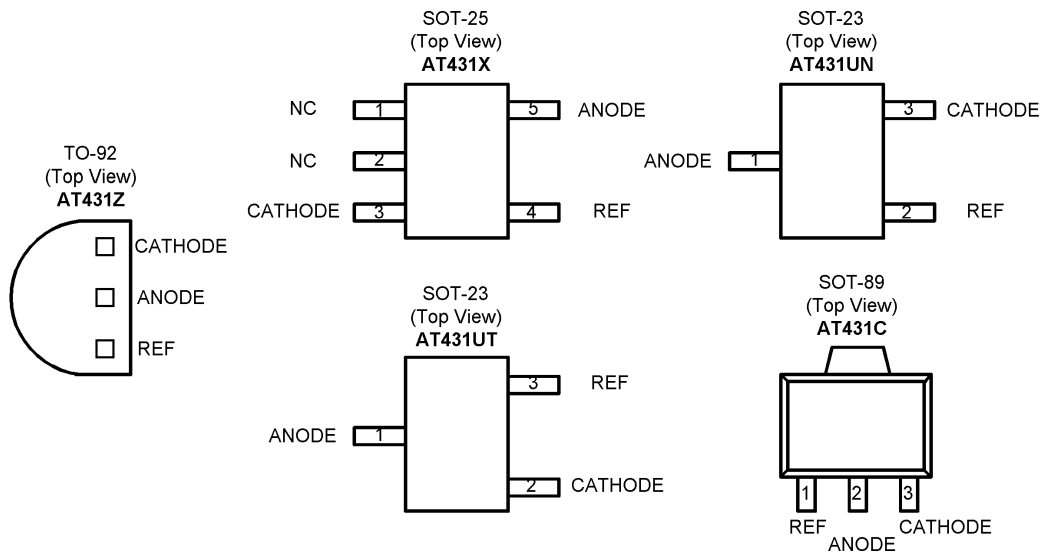
Block Diagram and Symbol



Equivalent Schematic



Pin Assignments



Ordering Information

| Part number | Package | Marking |
|-------------|---------|---------|
| AT431Z | TO-92 | □□□Z |
| AT431X | SOT-25 | □□□X |
| AT431UN | SOT-23 | □□□N |
| AT431UT | SOT-23 | □□□T |
| AT431C | SOT-89 | □□□C |

* □□□: Data Code

Absolute maximum ratings (T_A = 25°C)

| Parameter | Symbol | Limits | unit |
|---|------------------|---|--------|
| Cathode voltage | V _{KA} | 12 | V |
| Continuous cathode current range | I _K | -20~20 | mA |
| Reference Current | I _{REF} | -0.05~3 | mA |
| Operating temperature | T _{OPR} | -30~+85 | °C |
| Storage temperature | T _{STG} | -55~+150 | °C |
| Package thermal impedance θ _{JA} | SOT-23-5 | 347 | °C / W |
| | SOT-23-3 | | |
| | TO-92 | 156 | |
| Power Dissipation | PD | (T _{J(max)} -T _A)/ θ _{JA} | |

Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Recommend operating condtion

| Parameter | min | Max | unit |
|---|------------------|-----|------|
| Cathode voltage V _{KA} | V _{ref} | 12 | V |
| Continuous cathode current range I _K | 0.05 | 15 | mA |
| Operating free-air temperature range T _A | 0 | 70 | °C |

Electrical characteristics (unless otherwise noted)

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Conditions |
|--|--|-------|-------|-------|------|--|
| Reference Voltage | V _{ref} (T _A = 25°C) | 1.228 | 1.24 | 1.252 | V | V _{KA} = V _{ref} |
| | V _{ref} (T _A = full range 0~70 °C) | 1.221 | - | 1.259 | V | I _K = 10mA (Figure 1) |
| V _{ref} deviation over full temperature range | V _{ref} (dev) | - | 4 | 20 | mV | V _{KA} = V _{ref} I _K = 10mA (Figure 1) |
| Ratio of V _{ref} change in cathode voltage change | Δ V _{ref} / Δ V _{KA} | - | -1.5 | -2.7 | mV/V | V _{KA} = V _{ref} to 12V I _K = 10mA (Figure 2) |
| Reference terminal current | I _{ref} | - | 0.15 | 0.5 | μA | I _K = 10mA R1 = 10KΩ (Figure 2) |
| I _{ref} deviation over full temperature range | I _{ref} (dev) | - | 0.05 | 0.3 | μA | I _K = 10mA R1 = 10KΩ R2 = open (Figure 2) |
| Minimum cathode current for regulation | I _K (min) | - | 40 | 50 | μA | V _{KA} = V _{ref} (Figure 1) |
| Off-state cathode current | I _K (off) | - | 0.001 | 0.1 | μA | V _{KA} = 12V V _{ref} = 0V (Figure 3) |
| Dynamic impedance | Z _{KA} | - | 0.20 | 0.4 | Ω | V _{KA} = V _{ref} f ≤ 1KHz I _K = 0.1mA to 15mA (Figure 1) |

* The dynamic impedance is defined as : |Z_{KA}| = Δ V_{KA} / Δ I_{KA}

Parameter Measurement Information

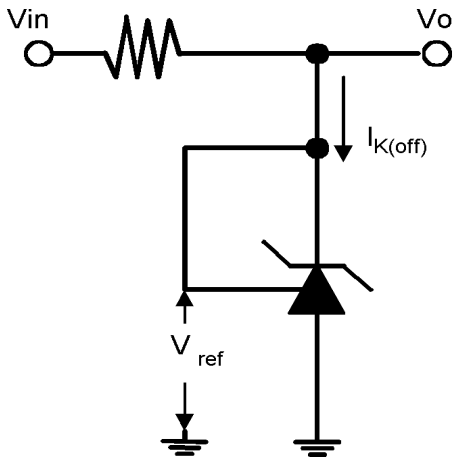


Figure 1. Test Circuit for $V_{KA} = V_{ref}$
 $V_O = V_{KA} = V_{ref}$

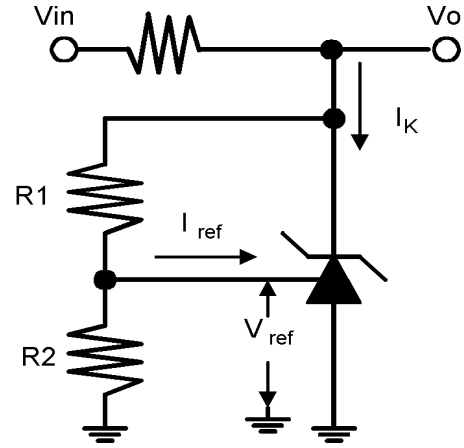


Figure 2. Test Circuit for $V_{KA} > V_{ref}$
 $V_O = V_{KA} = V_{ref} * (1 + R1/R2) + I_{ref} * R1$

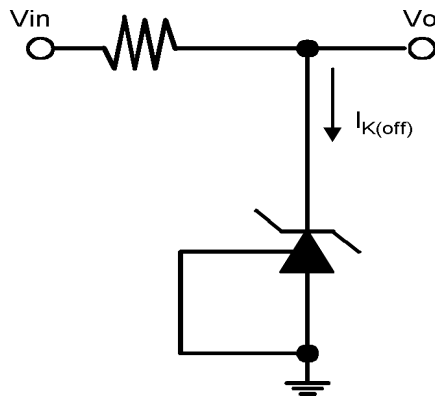


Figure 3. Test Circuit for $I_{K(off)}$

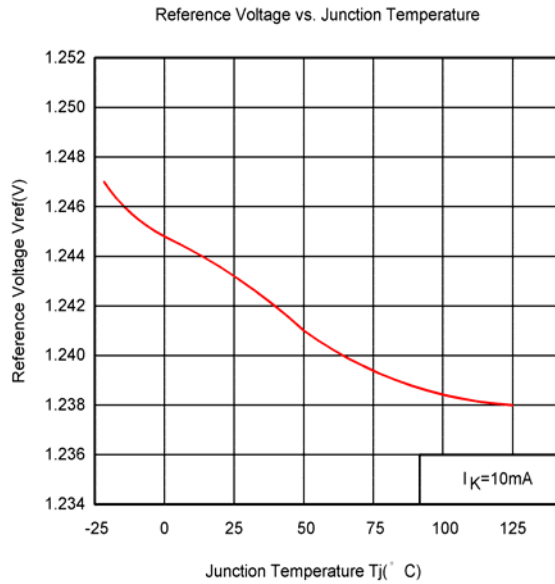


Figure 4.

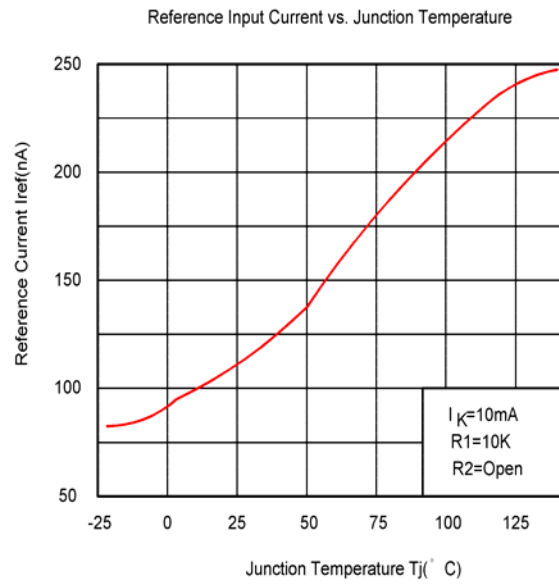


Figure 5.

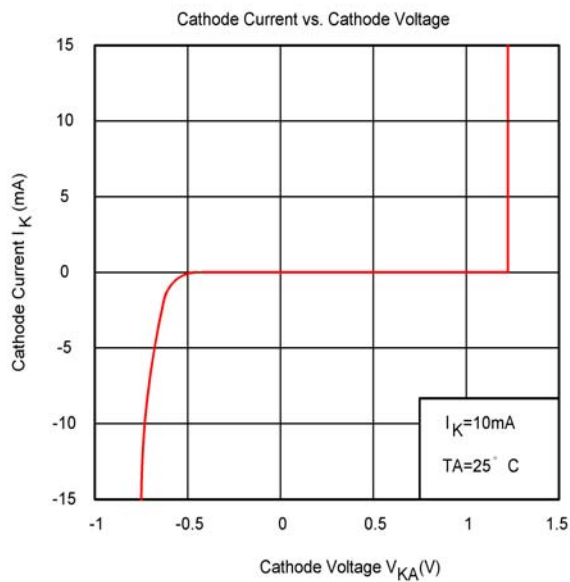


Figure 6.

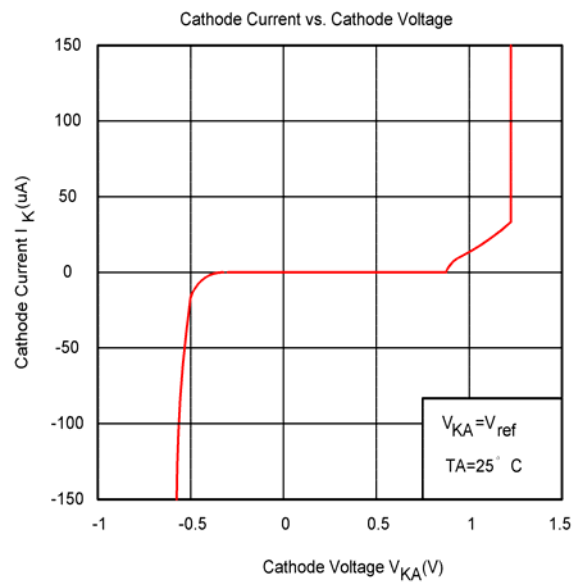


Figure 7.

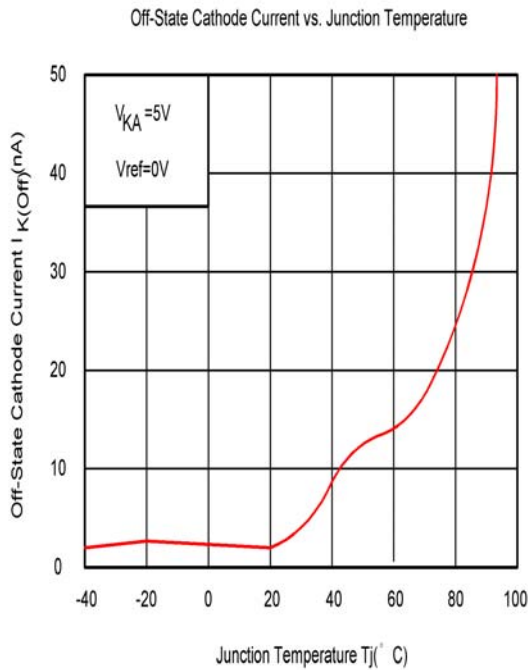


Figure 8.

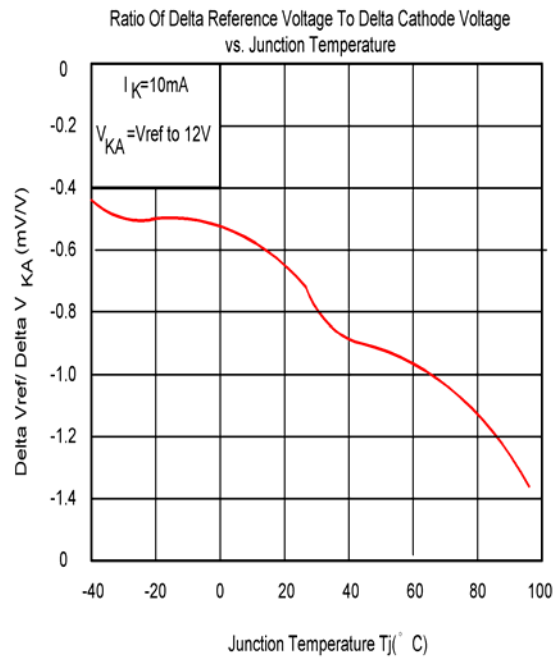


Figure 9.

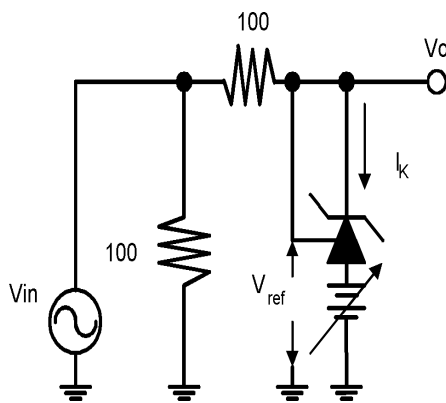
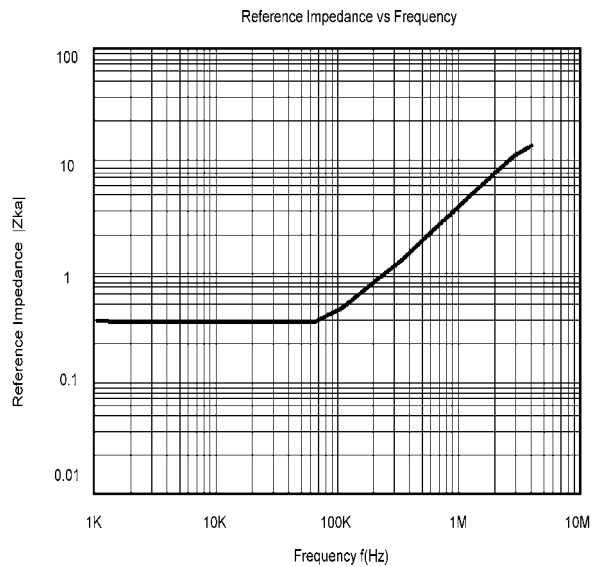
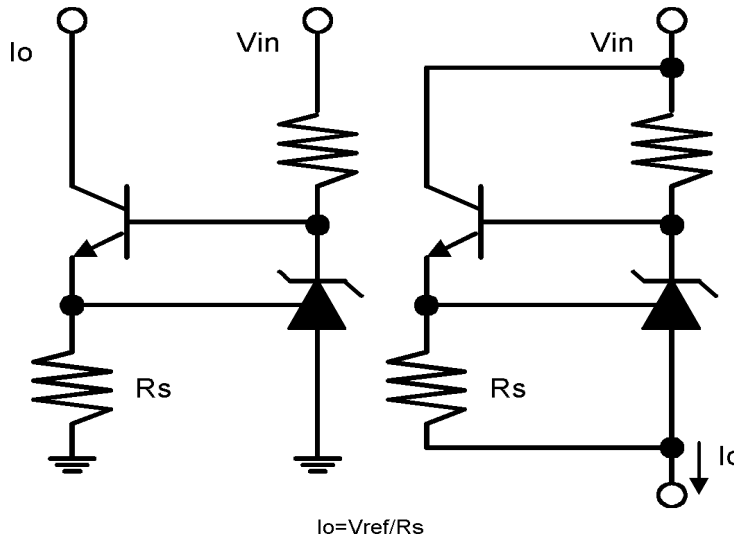


Figure 10.

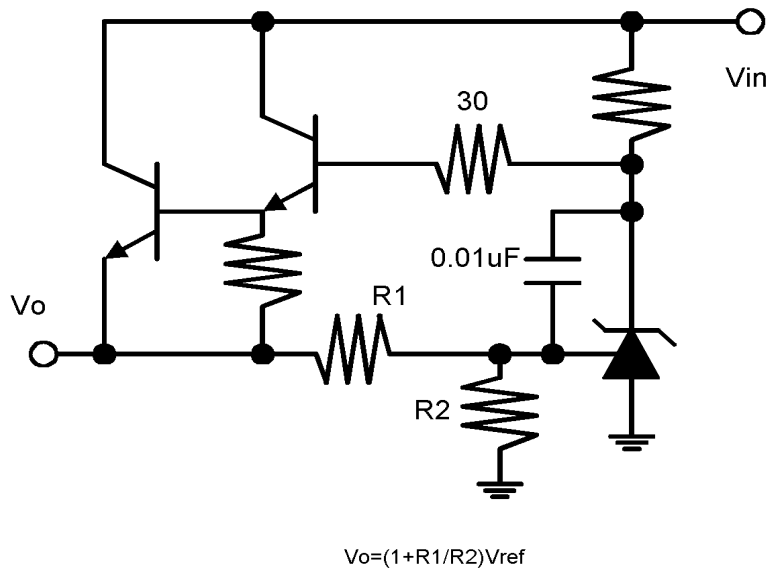


Application Circuit

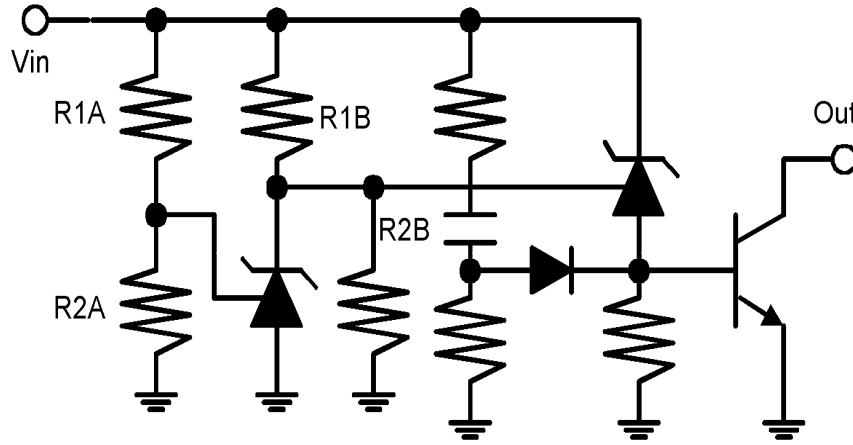
Constant Current Sink/
Current Limiter or Current Source



Series Regulator

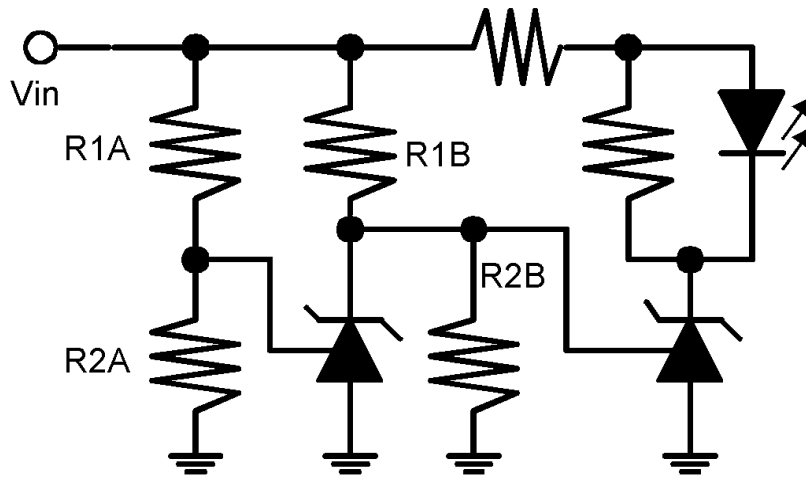


Over Voltage/Under Voltage Protection Circuit

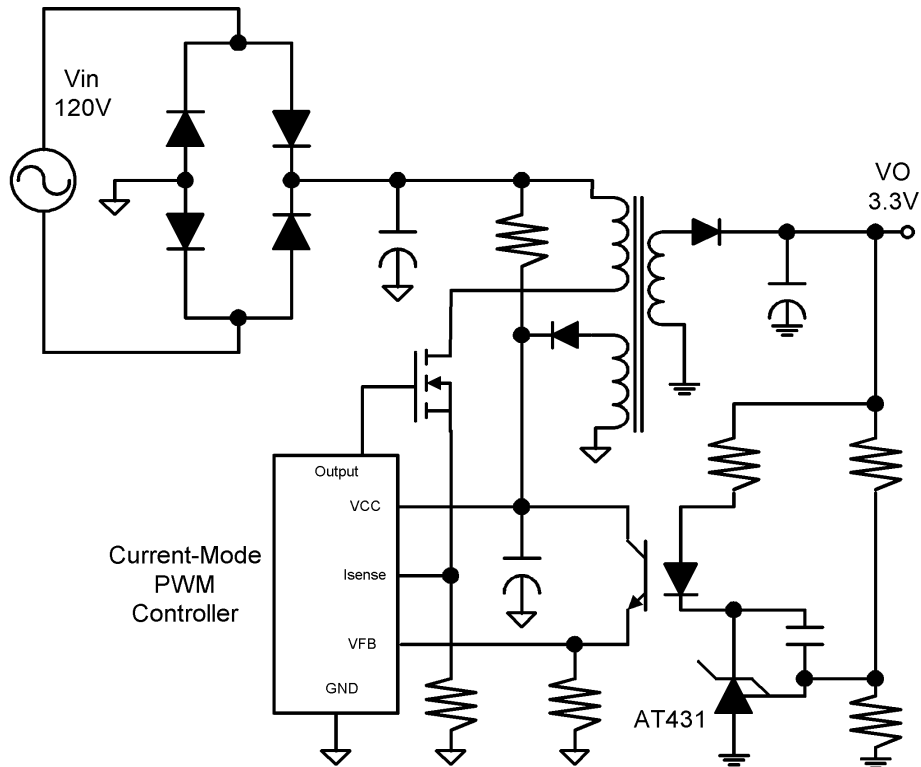


$Low\ Limit = (1 + R1B/R2B)V_{ref} + V_{be}$
 $High\ Limit = (1 + R1A/R2A)V_{ref}$
 Out ON When $Low\ Limit < V_{in} < High\ Limit$

Voltage Monitor Circuit



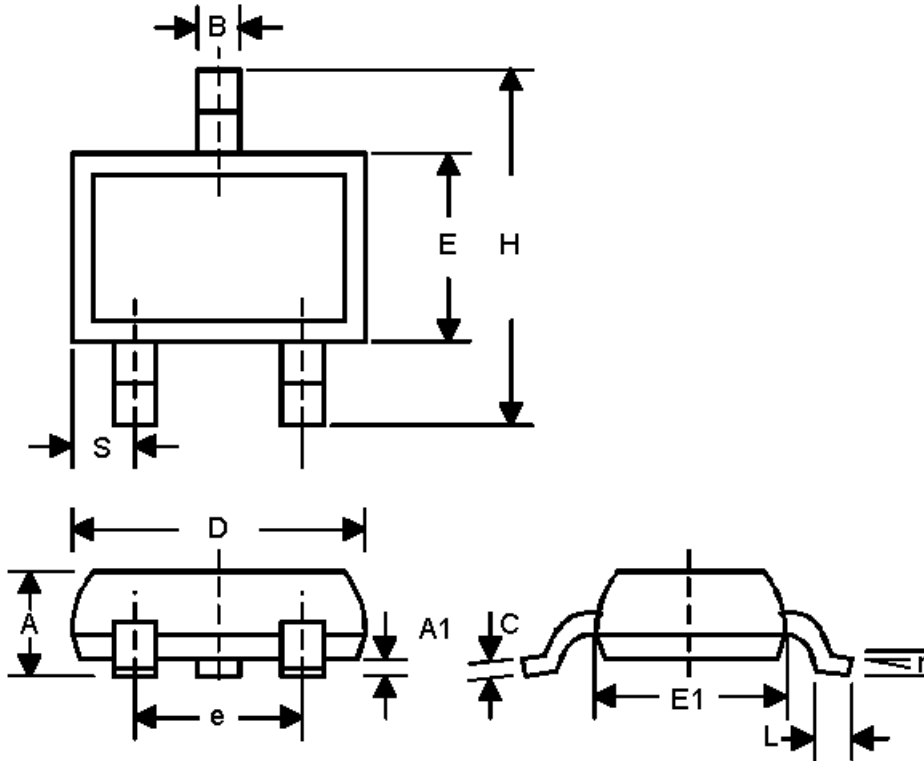
$Low\ Limit = (1 + R1B/R2B)V_{ref}$
 $High\ Limit = (1 + R1A/R2A)V_{ref}$
 LED ON When $Low\ Limit < V_{in} < High\ Limit$



Above shows the AT431 used in a 3.3V isolated flyback supply. Output voltage V_o can be as low as reference voltage V_{ref} ($1.24V \pm 1\%$). The output of the regulator, plus the forward voltage drop of the optocoupler LED ($1.24+1.4=2.64V$), determine the minimum voltage that can be regulated in an isolated in an isolated supply configuration. Regulated voltage as low as 2.7V is possible using the circuit.

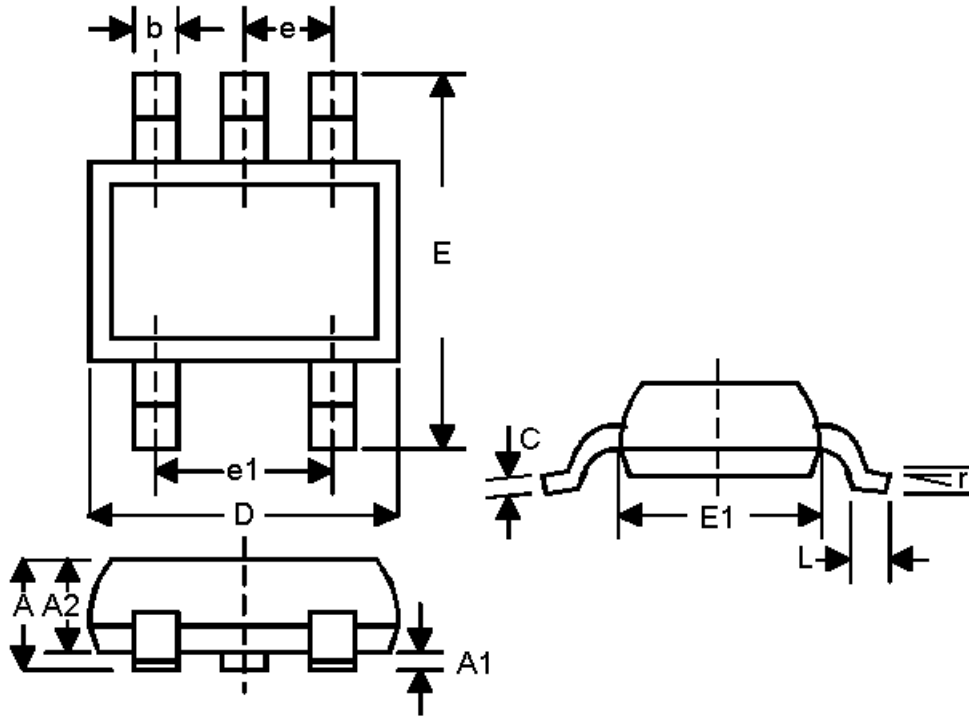
Package Information

SOT-23



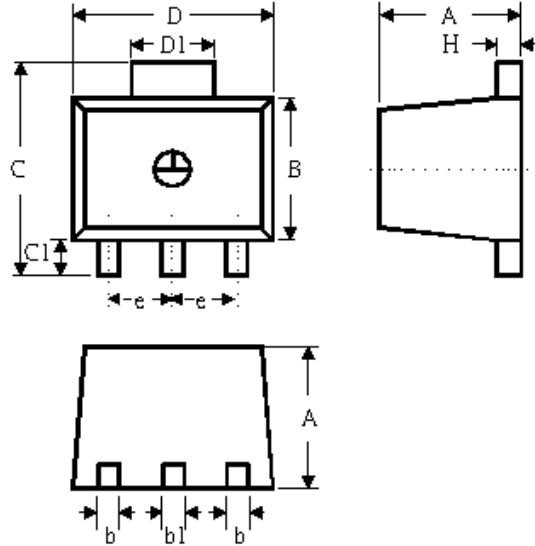
| SYMBOL | MILLIMETERS | | INCHES | |
|--------|-------------|-------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.787 | 1.194 | 0.031 | 0.047 |
| A1 | 0.025 | 0.127 | 0.001 | 0.005 |
| B | 0.356 | 0.559 | 0.014 | 0.022 |
| C | 0.086 | 0.152 | 0.0034 | 0.006 |
| D | 2.667 | 3.048 | 0.105 | 0.120 |
| E | 1.194 | 1.397 | 0.047 | 0.055 |
| E | 1.778 | 2.032 | 0.070 | 0.080 |
| H | 2.083 | 2.489 | 0.082 | 0.098 |
| L | 0.102 | 0.305 | 0.004 | 0.012 |
| S | 0.432 | 0.559 | 0.017 | 0.022 |
| R | 0° | 8° | 0° | 8° |

SOT-25



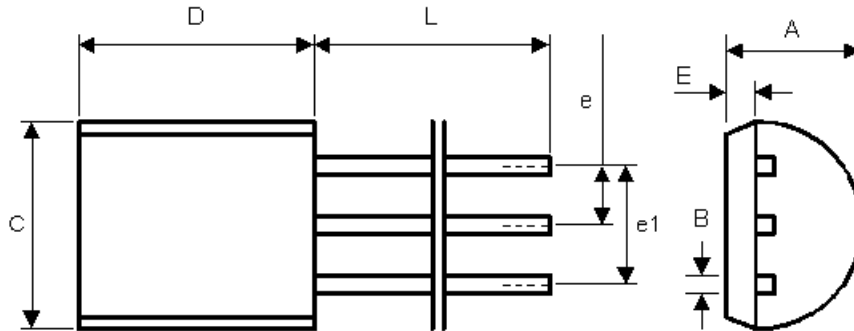
| SYMBOL | INCHES | | MILLIMETERS | |
|--------|----------------|-----------------|----------------|-----------------|
| | MIN | MAX | MIN | MAX |
| A | 0.035 | 0.057 | 0.90 | 1.45 |
| A1 | 0.000 | 0.006 | 0.00 | 0.15 |
| A2 | 0.035 | 0.051 | 0.90 | 1.30 |
| b | 0.010 | 0.020 | 0.25 | 0.50 |
| C | 0.003 | 0.008 | 0.08 | 0.20 |
| D | 0.110 | 0.122 | 2.80 | 3.10 |
| E | 0.102 | 0.118 | 2.60 | 3.00 |
| E1 | 0.059 | 0.069 | 1.50 | 1.75 |
| L | 0.014 | 0.022 | 0.35 | 0.55 |
| e | 0.037ref | | 0.95ref | |
| E1 | 0.075ref | | 1.90ref | |
| r | 0 ⁰ | 10 ⁰ | 0 ⁰ | 10 ⁰ |

SOT-89



| SYMBOL | MILLIMETERS | | INCHES | |
|--------|-------------|-------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 1.397 | 1.600 | 0.055 | 0.063 |
| B | 0.356 | 0.483 | 0.014 | 0.019 |
| B | 2.388 | 2.591 | 0.094 | 0.102 |
| b1 | 0.406 | 0.533 | 0.016 | 0.021 |
| C | -- | 4.242 | -- | 0.167 |
| C1 | 0.787 | 1.194 | 0.031 | 0.047 |
| D | 4.394 | 4.597 | 0.173 | 0.181 |
| D1 | 1.397 | 1.753 | 0.055 | 0.069 |
| E | 1.448 | 1.549 | 0.057 | 0.061 |
| H | 0.381 | 0.432 | 0.015 | 0.017 |

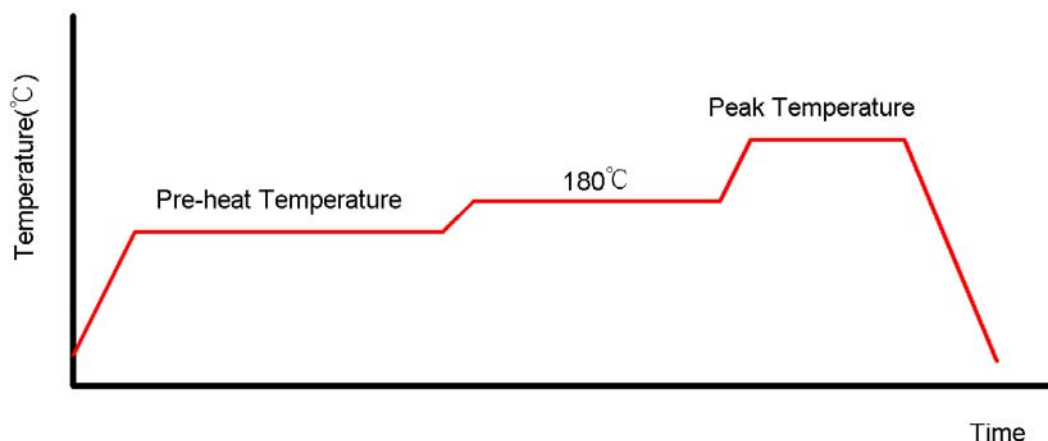
TO-92



| SYMBOL | MILLIMETERS | | INCHES | |
|--------|-------------|------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 3.4 | 3.8 | 0.134 | 0.150 |
| B | 0.3 | 0.5 | 0.012 | 0.020 |
| C | 4.4 | 4.8 | 0.173 | 0.189 |
| D | 4.4 | 4.8 | 0.173 | 0.189 |
| E | 0.9 | 1.5 | 0.035 | 0.059 |
| e | 1.17 | 1.37 | 0.046 | 0.054 |
| e1 | 2.39 | 2.69 | 0.094 | 0.106 |
| L | 12 | 16 | 0.472 | 0.630 |

Reflow Condition (IR/Convection or VPR Reflow)

Reference JEDEC Standard J-STD-020A



Classification Reflow Profiles

| | Convection or IR/Convection | VPR |
|--|-----------------------------|------------------------|
| Average Heating Rate(180°C to peak) | 5°C/second max. | 10°C/second max. |
| Preheat Temperature(125±20°C) | 120 seconds max. | |
| Temperature maintained above 180°C | 10~150 seconds | |
| Time within 5°C of actual Peak Temperature | 10~20 seconds | 60 seconds |
| Peak Temperature Range(Note 1) | 219~225°C or 235~240°C | 219~225°C or 235~240°C |
| Cooling Rate | 6°C /second max. | 10°C/second max. |
| Time 25°C to Peak Temperature | 6 minutes max. | |

*1 The maximum peak temperatures for IR and VP reflow are depending on package dimensions.

Package Reflow Conditions

| Pkg. Thickness ≥2.5mm and all bags | Pkg. Thickness <2.5mm and Pkg. Volume ≥350 mm ³ | Pkg. Thickness <2.5mm and Pkg. Volume <350 mm ³ |
|------------------------------------|--|--|
| Convection 219~225°C | | Convection 235~240°C |
| VPR 219~225°C | | VPR 235~240°C |
| IR/Convection 219~225°C | | IR/Convection 235~240°C |