

POWER MANAGEMENT

Description

The SC431 is a three terminal adjustable shunt regulator with thermal stability guaranteed over temperature. The output voltage can be adjusted to any value from 2.5V (V_{REF}) to 30V with two external resistors. The SC431 has a typical dynamic output impedance of 0.25Ω . Active output circuitry provides a very sharp turn on characteristic, making the SC431 an excellent replacement for zener diodes.

The SC431 shunt regulator is available with four voltage tolerances (0.5%, 1.0% and 2.0% over $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$ and 0.5% over $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$) and two package options (SOT-23-3 and SO-8). This allows the designer the opportunity to select the optimum combination of cost and performance for their application.

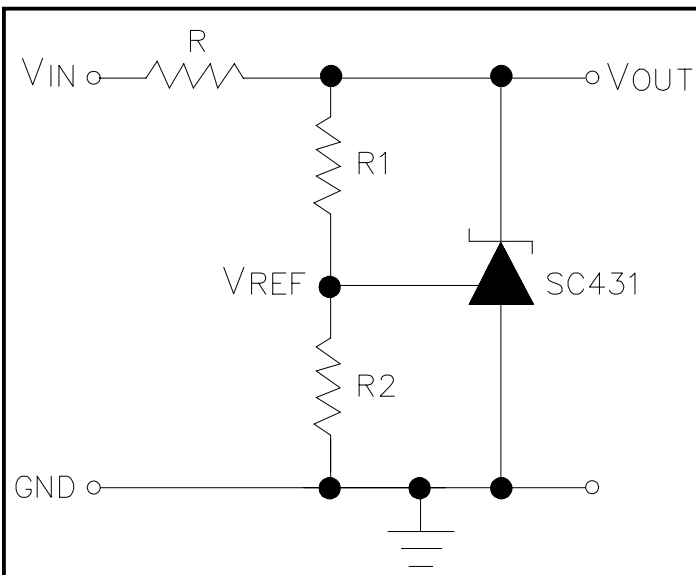
Features

- ◆ Wide operating current range 130 μA to 150mA
- ◆ Low dynamic output impedance $0.25\ \Omega$ typ.
- ◆ Trimmed bandgap design $\pm 0.5\%$
- ◆ Alternate for TL1431, TL431, LM431 & AS431
- ◆ Industrial temperature range
- ◆ Available in SOT-23-3 and SO-8 packages.
Also available in Lead-free, fully WEEE and RoHS compliant.

Applications

- ◆ Linear Regulators
- ◆ Adjustable Supplies
- ◆ Switching Power Supplies
- ◆ Battery Operated Computers
- ◆ Instrumentation
- ◆ Computer Disk Drives

Typical Application Circuit⁽¹⁾⁽²⁾



Notes:

- 1) Set V_{OUT} according to the following equation:

$$V_{OUT} = V_{REF} \left(1 + \frac{R1}{R2} \right) + I_{REF} R1$$

- 2) Choose the value for R as follows:

- The maximum limit for R should be such that the cathode current, I_z , is greater than the minimum operating current (130 μA) at $V_{IN(MIN)}$.

- The minimum limit for R should be such that I_z does not exceed 150mA under all load conditions, and the instantaneous turn-on value for I_z does not exceed 200mA. Both of the following conditions must be met:

$$R_{min} \geq \frac{V_{IN(max)}}{200\text{mA}} \quad (\text{to limit instantaneous turn-on } I_z)$$

$$R_{min} \geq \frac{V_{IN(max)} - V_{OUT}}{I_{OUT(min)} + 150\text{mA}} \quad (\text{to limit } I_z \text{ under normal operating conditions})$$

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Absolute Maximum Ratings

Exceeding the specifications below may result in permanent damage to the device, or device malfunction. Operation outside of the parameters specified in the Electrical Characteristics section is not implied.

| Parameter | Symbol | Maximum | Units |
|---|---------------|---------------------------|--------------------|
| Cathode Voltage | V_Z | 31 | V |
| Continuous Cathode Current | I_Z | 150 | mA |
| Reference Input Current | I_{REF} | 10 | mA |
| Power Dissipation at $T_A = 25^\circ\text{C}$ SOT-23-3 SO-8 | P_D | 0.37 0.78 | W |
| Thermal Resistance SOT-23-3 SO-8 | θ_{JA} | 336 163 | $^\circ\text{C/W}$ |
| Operating Ambient Temperature Range SC431Cx-.5, SC431Cx-1, SC431Cx-2 SC431CxQ | T_A | -40 to +85 -40 to +125 | $^\circ\text{C}$ |
| Operating Junction Temperature Range | T_J | -40 to +150 | $^\circ\text{C}$ |
| Storage Temperature Range | T_{STG} | -65 to +150 | $^\circ\text{C}$ |
| Lead Temperature (Soldering) 10 seconds | T_{LEAD} | 300 | $^\circ\text{C}$ |
| ESD Rating (Human Body Model) | V_{ESD} | 2 | kV |

Electrical Characteristics

Unless specified: $T_A = 25^\circ\text{C}$. Values in **bold** apply over full operating ambient temperature range.

| Parameter | Symbol | Condition | SC431Cx-.5, SC431CxQ | | | SC431Cx-1 | | | Units |
|--|-------------------------------------|---|-------------------------|--------------|--------------|-----------|--------------|--------------|---------------|
| | | | Min | Typ | Max | Min | Typ | Max | |
| Reference Voltage | V_{REF} | $V_Z = V_{REF}, I_Z = 10\text{mA}^{(1)}$ | 2.482 | 2.495 | 2.507 | 2.470 | 2.495 | 2.520 | V |
| V_{REF} Temp Deviation | V_{DEV} | $V_Z = V_{REF}, I_Z = 10\text{mA}^{(1)}$ | | 8 | 17 | | 8 | 25 | mV |
| Ratio of Change in V_{REF} to Change in V_Z | $\frac{\Delta V_{REF}}{\Delta V_Z}$ | $I_Z = 10\text{mA}, \Delta V_Z = 10\text{V to } V_{REF}$ $I_Z = 10\text{mA}, \Delta V_Z = 30\text{V to } 10\text{V}$ | | -0.5 -1.0 | -2.7 -2.0 | | -0.5 -1.0 | -2.7 -2.0 | mV/V |
| Reference Input Current | I_{REF} | $R1 = 10\text{k}\Omega, R2 = \infty,$ $I_Z = 10\text{mA}^{(2)}$ | | 0.5 | 4 | | 0.5 | 4 | μA |
| I_{REF} Temperature Deviation | $I_{REF(DEV)}$ | $R1 = 10\text{k}\Omega, R2 = \infty,$ $I_Z = 10\text{mA}^{(2)}$ | | 0.4 | 1.2 | | 0.4 | 1.2 | μA |
| Off-State Cathode Current | $I_{Z(OFF)}$ | $V_{REF} = 0\text{V}, V_Z = 30\text{V}^{(3)}$ | | 0.04 | 0.50 | | 0.04 | 0.50 | μA |
| Dynamic Output Impedance | r_z | $f < 1\text{kHz}, V_Z = V_{REF}$ $I_Z = 130\mu\text{A to } 100\text{mA}^{(1)}$ | | 0.25 | 0.50 | | 0.25 | 0.50 | Ω |
| Minimum Operating Current | $I_{Z(MIN)}$ | $V_Z = V_{REF}^{(1)}$ | | | 130 | | | 130 | μA |

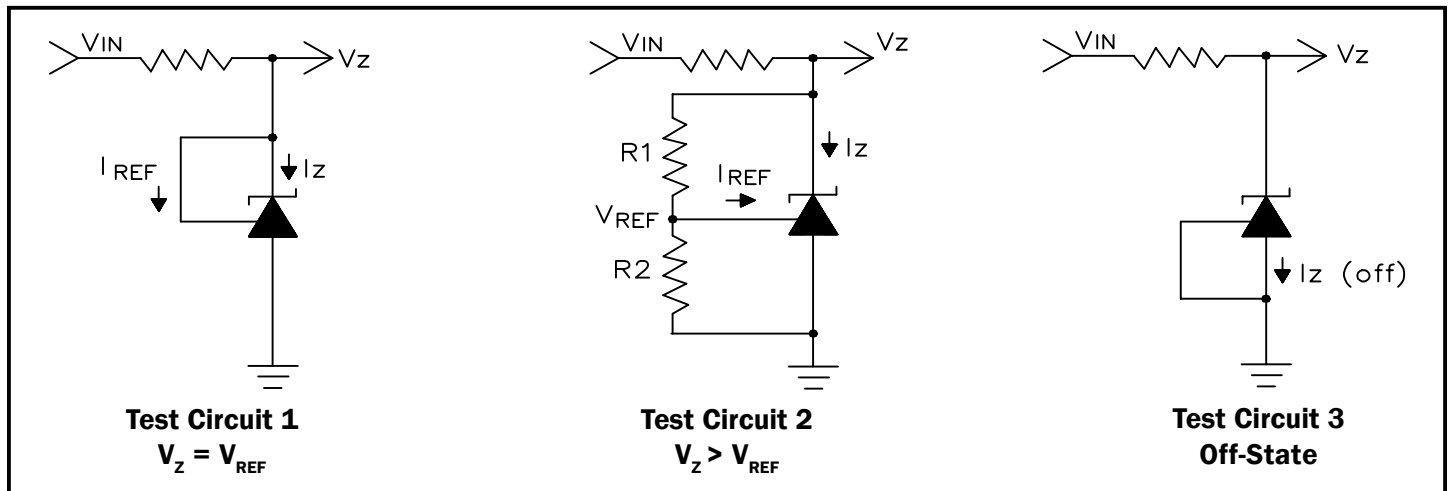
POWER MANAGEMENT
Electrical Characteristics (Cont.)

 Unless specified: $T_A = 25^\circ\text{C}$. Values in **bold** apply over full operating ambient temperature range.

| Parameter | Symbol | Condition | SC431Cx-2 | | | Units |
|---|-------------------------------------|---|-----------|------------|------------|---------------|
| | | | Min | Typ | Max | |
| Reference Voltage | V_{REF} | $V_Z = V_{REF}, I_Z = 10\text{mA}^{(1)}$ | 2.445 | 2.495 | 2.545 | V |
| V_{REF} Temp Deviation | V_{DEV} | $V_Z = V_{REF}, I_Z = 10\text{mA}^{(1)}$ | | 15 | 30 | mV |
| Ratio of Change in V_{REF} to Change in V_Z | $\frac{\Delta V_{REF}}{\Delta V_Z}$ | $I_Z = 10\text{mA}, \Delta V_Z = 10\text{V to } V_{REF}$ | | -0.5 | -2.7 | mV/V |
| | | $I_Z = 10\text{mA}, \Delta V_Z = 30\text{V to } 10\text{V}$ | | -1.0 | -2.0 | |
| Reference Input Current | I_{REF} | $R1 = 10\text{k}\Omega, R2 = \infty, I_Z = 10\text{mA}^{(2)}$ | | 0.5 | 4 | μA |
| I_{REF} Temperature Deviation | $I_{REF(DEV)}$ | $R1 = 10\text{k}\Omega, R2 = \infty, I_Z = 10\text{mA}^{(2)}$ | | 0.4 | 1.2 | μA |
| Off-State Cathode Current | $I_{Z(OFF)}$ | $V_{REF} = 0\text{V}, V_Z = 30\text{V}^{(3)}$ | | 0.04 | 0.50 | μA |
| Dynamic Output Impedance | r_z | $f < 1\text{kHz}, V_Z = V_{REF}, I_Z = 130\mu\text{A to } 100\text{mA}^{(1)}$ | | 0.25 | 0.50 | Ω |
| Minimum Operating Current | $I_{Z(MIN)}$ | $V_Z = V_{REF}^{(1)}$ | | | 130 | μA |

Notes:

- (1) See Test Circuit 1 below.
- (2) See Test Circuit 2 below.
- (3) See Test Circuit 3 below.

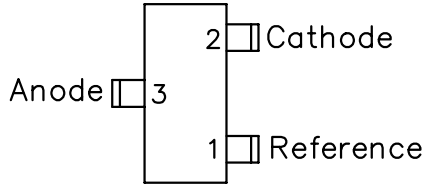
Test Circuits

Recommended Operating Conditions

| | Min | Max | Symbol |
|------------------------|-----------|-----|--------|
| Cathode Voltage, V_Z | V_{REF} | 30 | V |
| Cathode Current, I_Z | 0.130 | 150 | mA |

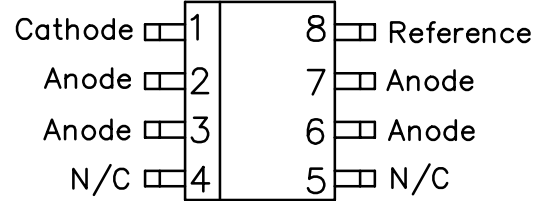
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Pin Configurations

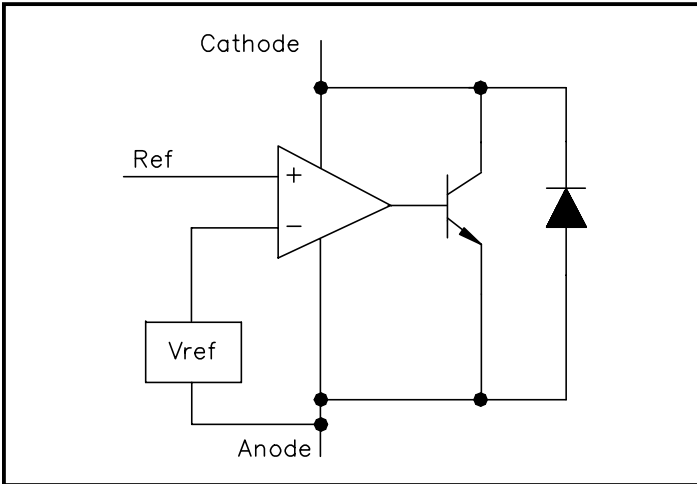
SOT-23-3 (Top View)



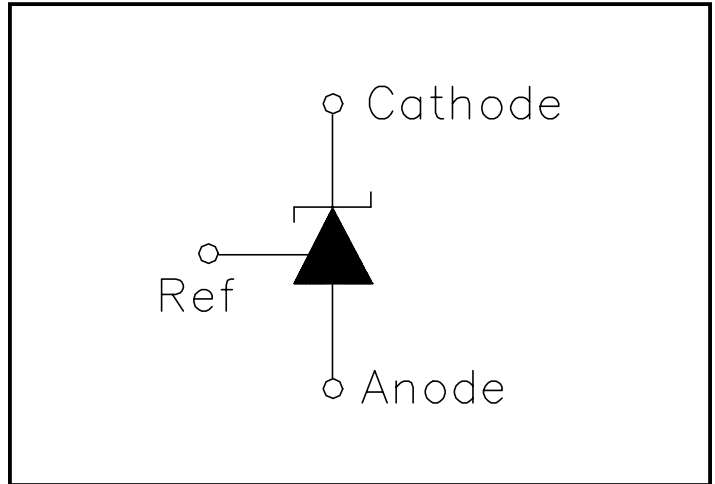
SO-8 (Top View)



Block Diagram



Symbol



Ordering Information

| Tolerance | 0.5% | 0.5% | 1.0% | 2.0% |
|-----------------------------|----------------|-----------------|----------------|----------------|
| Ambient Temperature Range | -40°C to +85°C | -40°C to +125°C | -40°C to +85°C | -40°C to +85°C |
| SOT-23-3 ⁽¹⁾ | SC431CSK-.5 TR | SC431CSKQTR | SC431CSK-1.TR | SC431CSK-2.TR |
| SOT-23-3 ^{(1),(3)} | SC431CSK-.5TRT | SC431CSKQTRT | SC431CSK-1TRT | SC431CSK-2TRT |
| SO-8 ⁽²⁾ | SC431CS-.5 TR | SC431CSQTR | SC431CS-1.TR | SC431CS-2.TR |
| SO-8 ^{(2),(3)} | SC431CS-.5 TRT | SC431CSQTRT | SC431CS-1.TR | SC431CS-2.TR |

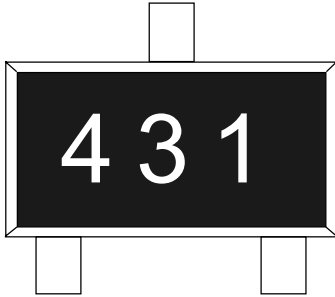
Notes:

- (1) Only available in tape and reel packaging. A reel contains 3000 devices.
- (2) Only available in tape and reel packaging. A reel contains 2500 devices.
- (3) "T" at end of part number indicates "lead free". This product is fully WEEE and RoHS compliant.

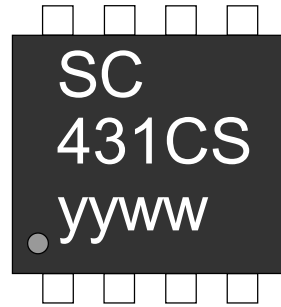
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Marking Information

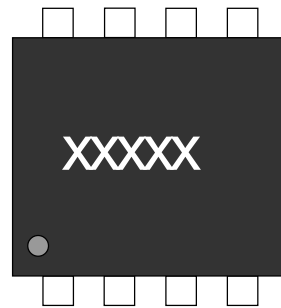
SOT-23-3 (Top View)



S0-8 (Top View)



S0-8 (Bottom View)

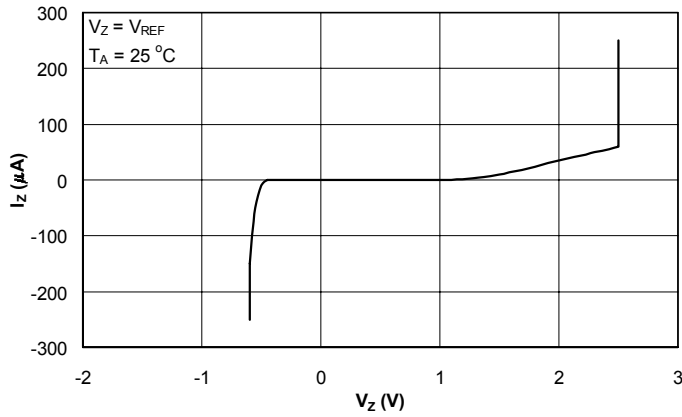


yyww = Datecode (Example: 0008)
xxxxx = Semtech Lot # (Example: 00101)

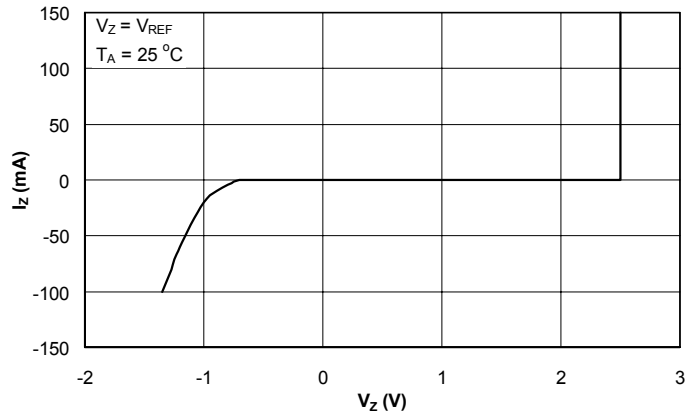
POWER MANAGEMENT

Typical Characteristics

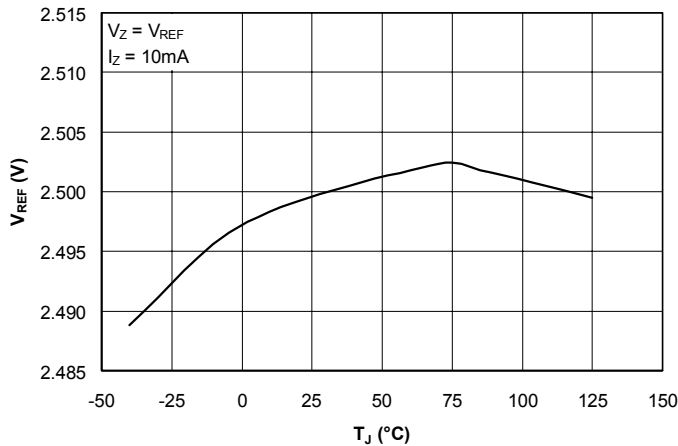
Cathode Current vs. Cathode Voltage



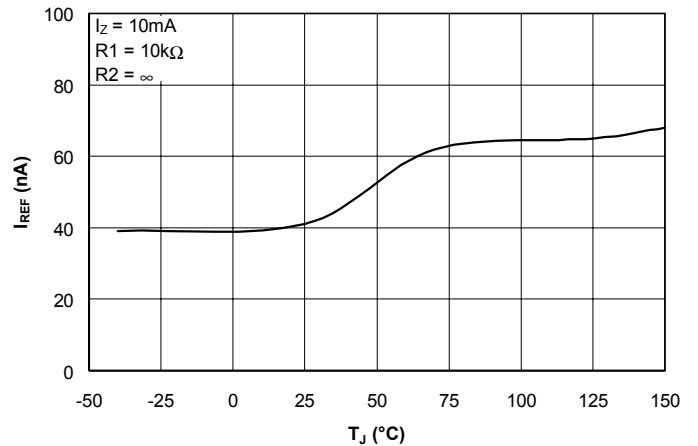
Cathode Current vs. Cathode Voltage



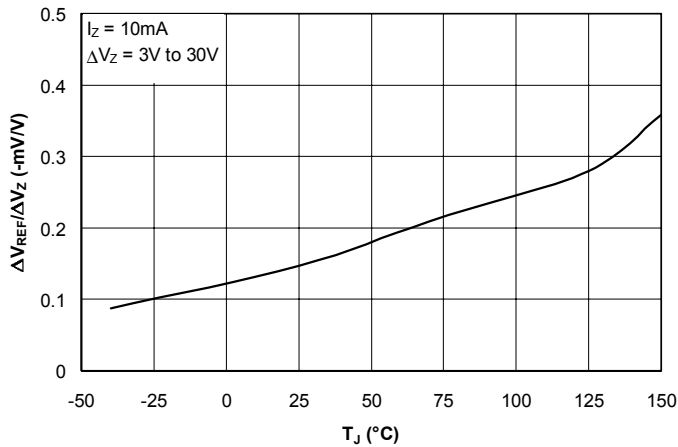
Reference Voltage vs. Junction Temperature



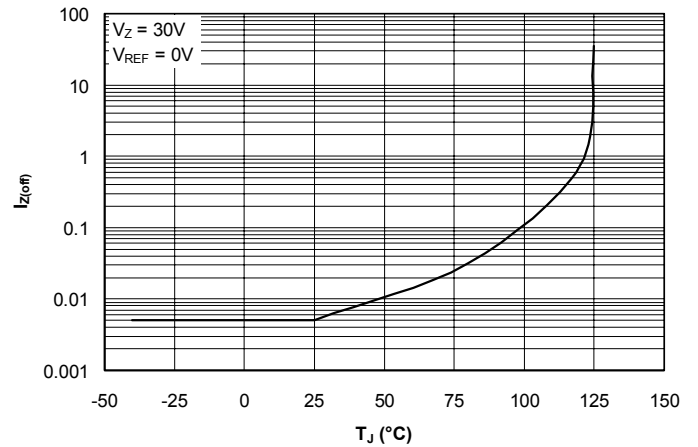
Reference Input Current vs. Junction Temperature



Ratio of Delta Reference Voltage to Delta Cathode Voltage vs. Junction Temperature



Off-State Cathode Current vs. Junction Temperature

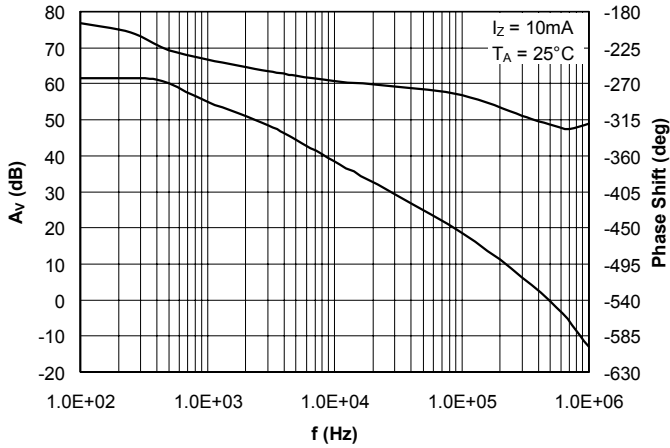


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Typical Characteristics (Cont.)

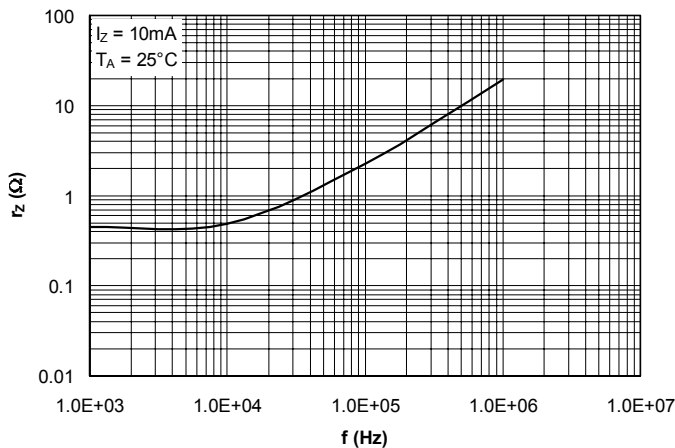
Small-Signal Gain and Phase Shift

vs. Frequency

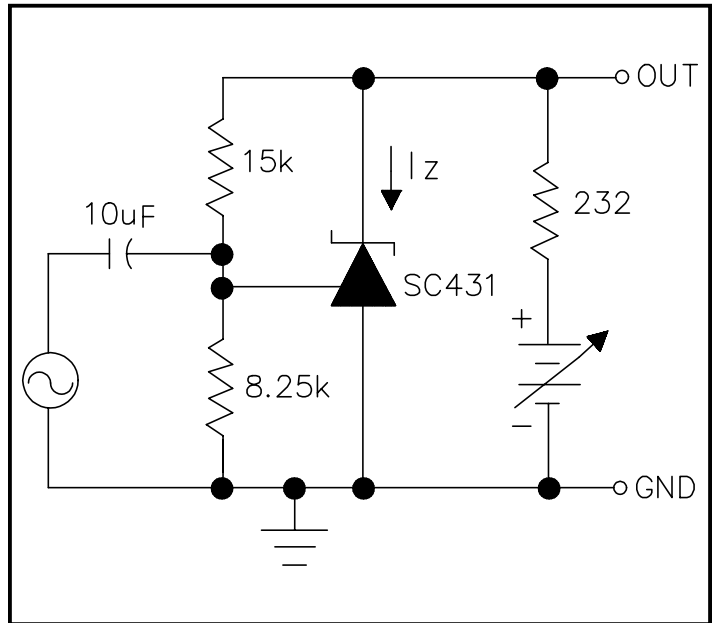


Reference Impedance

vs. Frequency

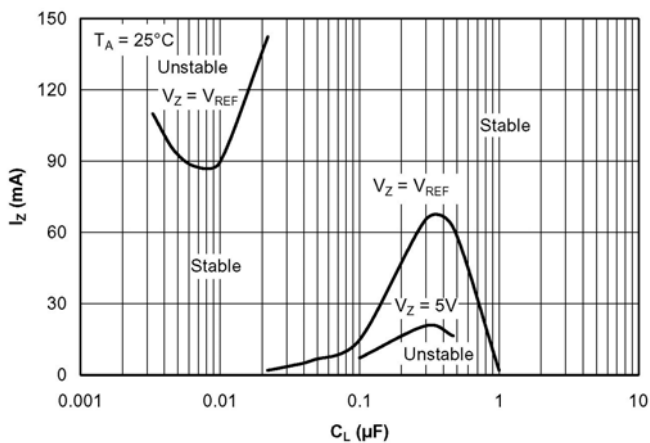


Test Circuit - Small-Signal Gain and Phase

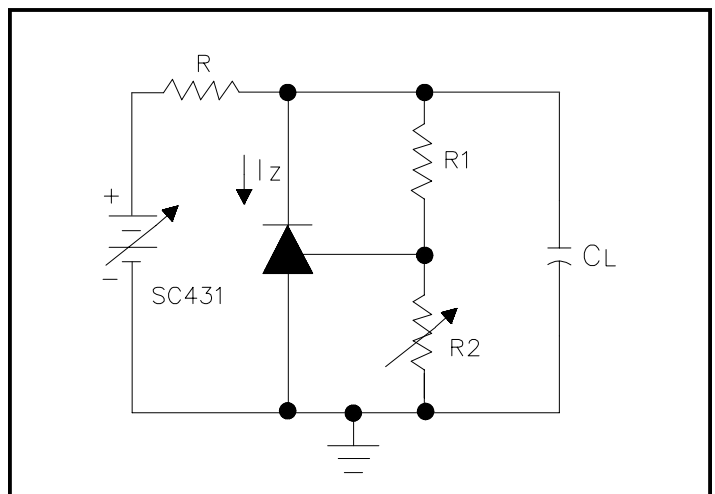


Stability Boundary Condition For Shunt Regulation

vs. Cathode Current and Load Capacitance

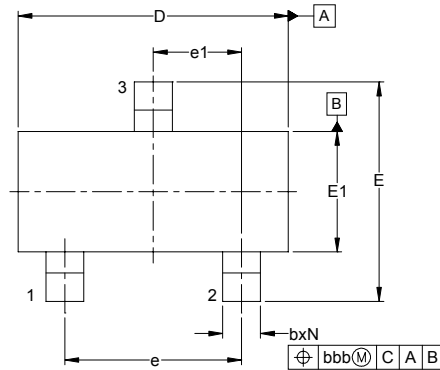


Test Circuit - Stability

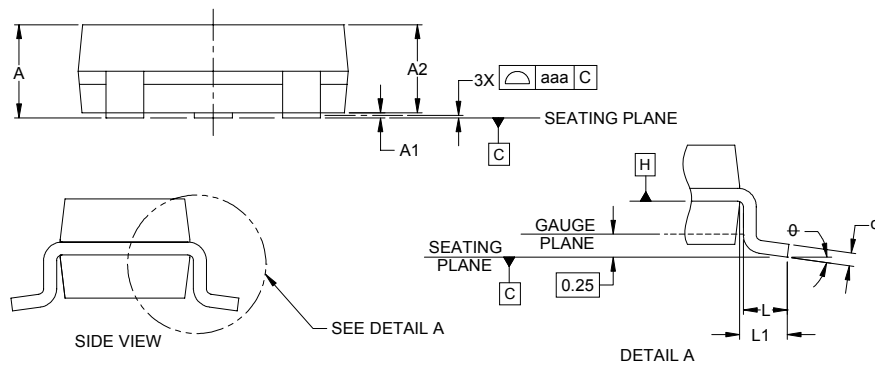


POWER MANAGEMENT

Outline Drawing - SOT-23-3

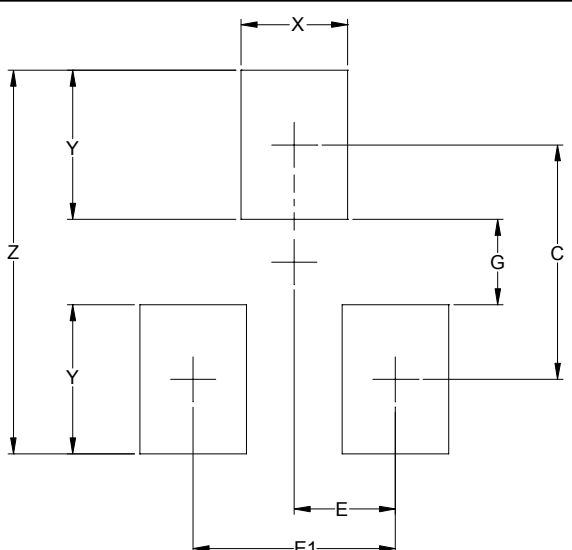


| DIM | INCHES | | | MILLIMETERS | | |
|-----|--------|------|------|-------------|------|------|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | .035 | - | .044 | 0.89 | - | 1.12 |
| A1 | .000 | - | .004 | 0.01 | - | 0.10 |
| A2 | .035 | .037 | .040 | 0.88 | 0.95 | 1.02 |
| b | .012 | - | .020 | 0.30 | - | 0.51 |
| c | .003 | - | .007 | 0.08 | - | 0.18 |
| D | .110 | .114 | .120 | 2.80 | 2.90 | 3.04 |
| E | .082 | .093 | .104 | 2.10 | 2.37 | 2.64 |
| E1 | .047 | .051 | .055 | 1.20 | 1.30 | 1.40 |
| e | .075 | | | 1.90 BSC | | |
| e1 | .037 | | | 0.95 BSC | | |
| L | .015 | .020 | .024 | 0.40 | 0.50 | 0.60 |
| L1 | .022 | | | (0.55) | | |
| N | 3 | | | 3 | | |
| φ | 0° | - | 8° | 0° | - | 8° |
| aaa | .004 | | | 0.10 | | |
| bbb | .008 | | | 0.20 | | |



- NOTES:
1. CONTROLLING DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES).
 2. DATUMS **-A-** AND **-B-** TO BE DETERMINED AT DATUM PLANE **-H-**
 3. DIMENSIONS "E1" AND "D" DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.

Land Pattern - SOT-23-3

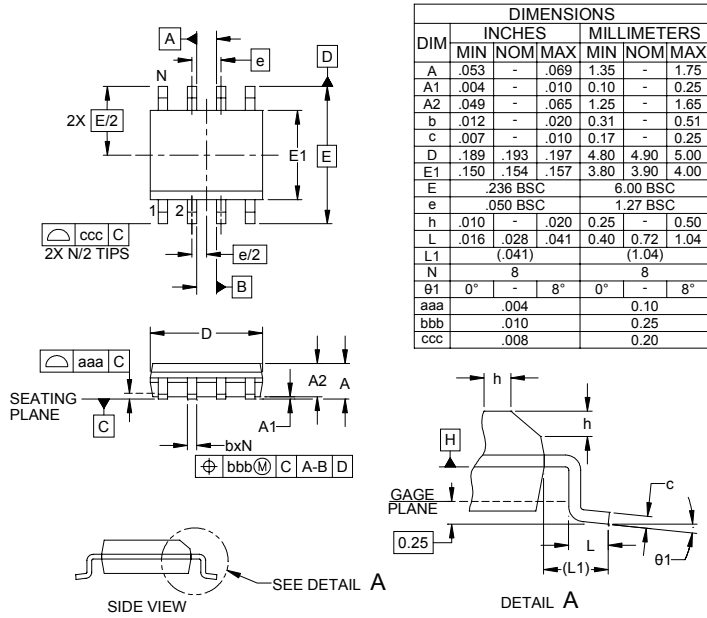


| DIM | DIMENSIONS | |
|-----|------------|-------------|
| | INCHES | MILLIMETERS |
| C | (.087) | (2.20) |
| E | .037 | 0.95 |
| E1 | .075 | 1.90 |
| G | .031 | 0.80 |
| X | .039 | 1.00 |
| Y | .055 | 1.40 |
| Z | .141 | 3.60 |

- NOTES:
1. THIS LAND PATTERN IS FOR REFERENCE PURPOSES ONLY CONSULT YOUR MANUFACTURING GROUP TO ENSURE YOUR COMPANY'S MANUFACTURING GUIDELINES ARE MET.
 2. REFERENCE IPC-SM-782A.

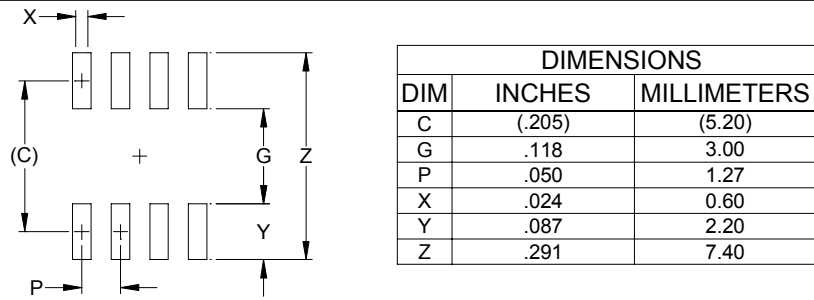
POWER MANAGEMENT

Outline Drawing - SO-8



- NOTES:
1. CONTROLLING DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES).
 2. DATUMS [-A-] AND [-B-] TO BE DETERMINED AT DATUM PLANE [-H-]
 3. DIMENSIONS "E1" AND "D" DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.
 4. REFERENCE JEDEC STD MS-012, VARIATION AA.

Land Pattern - SO-8



- NOTES:
1. THIS LAND PATTERN IS FOR REFERENCE PURPOSES ONLY. CONSULT YOUR MANUFACTURING GROUP TO ENSURE YOUR COMPANY'S MANUFACTURING GUIDELINES ARE MET.
 2. REFERENCE IPC-SM-782A, RLP NO. 300A.

Contact Information

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