ADJUSTABLE PRECISION ZENER SHUNT REGULATOR

Description

The ZR431 is a three terminal adjustable shunt regulator offering excellent temperature stability and output current handling capability up to 100mA. The output voltage may be set to any chosen voltage between 2.5 and 20 volts by selection of two external divider resistors.

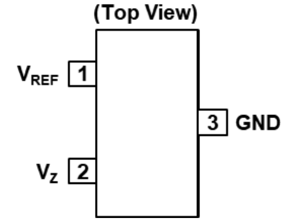
The devices can be used as a replacement for Zener diodes in many applications requiring an improvement in Zener performance.

Features

- Surface-Mount SOT223 and SOT23 Packages
- 2%, 1% and 0.5% Tolerance
- Max. Temperature Coefficient 72ppm/°C
- Temperature Compensated for Operation
- Over the Full Temperature Range
- Programmable Output Voltage
- 50µA to 100mA Current Sink Capability
- Low Output Noise
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **For automotive applications requiring specific change control (i.e. parts qualified to AEC-Q100/101/104/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please contact us or your local Diodes representative.** **https://www.diodes.com/quality/product-definitions/**

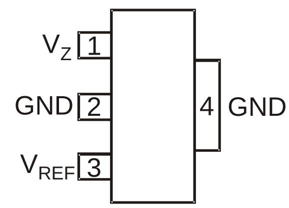
Pin Assignments

(Top View)



SOT23

(Top View)



SOT223 (EOL)

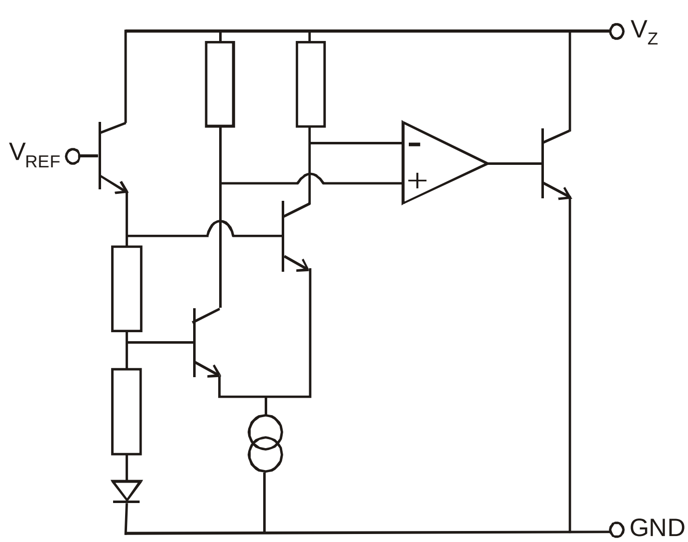
Pin 4 floating or connected to Pin 2.

Applications

- Shunt regulators
- Series regulators
- Voltage monitors
- Overvoltage/undervoltage protections
- Switch mode power supplies

Notes: 1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ 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.

Typical Application Circuit



Absolute Maximum Ratings (Note 4)

Symbol	Parameter		Rating	Unit
V_Z	Cathode Voltage		20	V
I_Z	Cathode Current		150	mA
T_J	Junction Temperature Range		-40 to +150	°C
T_{ST}	Storage Temperature		-55 to +150	°C
P_D	Power Dissipation (Notes 5 & 6)	SOT23	330	mW
		SOT223	2	W

Notes: 4. Stresses greater than those listed under *Absolute Maximum Ratings* can 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 can affect device reliability. Unless otherwise stated, voltages specified are relative to the GND pin.

5. T_J, max = +150°C.

6. Ratings apply to ambient temperature at +25°C.

Recommended Operating Conditions (T_A = +25°C)

Symbol	Parameter	Min	Max	Unit
V_Z	Cathode Voltage	V_{REF}	20	V
I_Z	Cathode Current	0.05	100	mA
T_A	Operating Temperature	-40	+125	°C

Electrical Characteristics (T_A = +25°C, unless otherwise specified.)

Symbol	Parameter	Test Conditions		Min	Typ	Max	Unit
V_{REF}	Reference Voltage (Note 7)	I_L = 10mA (Figure 1) $V_Z = V_{REF}$	2%	2.45	2.50	2.55	V
			1%	2.475	2.50	2.525	
			0.5%	2.487	2.50	2.513	
V_{DEV}	Deviation of Reference Input Voltage over Temperature	I_L = 10mA, $V_Z = V_{REF}$ T_A = Full Range (Figure 1)		—	10	30	mV
$\frac{\Delta V_{REF}}{\Delta V_Z}$	Ratio of the Change in Reference Voltage to the Change in Cathode Voltage	V_Z from V_{REF} to 10V, I_Z = 10mA (Figure 2)		—	-1.85	-2.7	mV/V
		V_Z from 10V to 20V, I_Z = 10mA (Figure 2)		—	-1.0	-2.0	
I_{REF}	Reference Input Current	R1 = 10k, R2 = O/C, I_L = 10mA (Figure 2)		—	0.12	1.0	µA
ΔI_{REF}	Deviation of Reference Input Current over Temperature	R1 = 10k, R2 = O/C, I_L = 10mA T_A = Full Range (Figure 2)		—	0.04	0.2	µA
$I_{Z(MIN)}$	Minimum Cathode Current for Regulation	$V_Z = V_{REF}$ (Figure 1)		—	35	50	µA
$I_{Z(OFF)}$	Off-State Current	V_Z = 20V, V_{REF} = 0V (Figure 3)		—	—	0.1	µA
R_Z	Dynamic Output Impedance	$V_Z = V_{REF}$ (Figure 1), f = 0Hz		—	—	0.75	Ω

Note: 7. 0.5% and 1% SOT23 only.
For definitions of reference voltage temperature coefficient and dynamic output impedance see Notes following *DC Test Circuits*.

DC Test Circuits

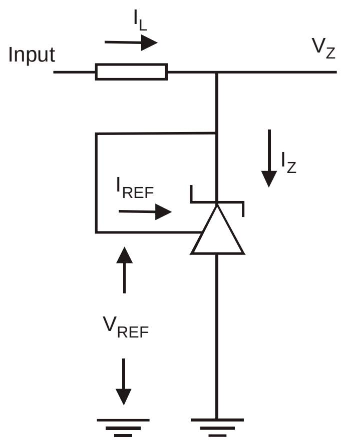


Figure 1. Test Circuit for $V_Z = V_{REF}$

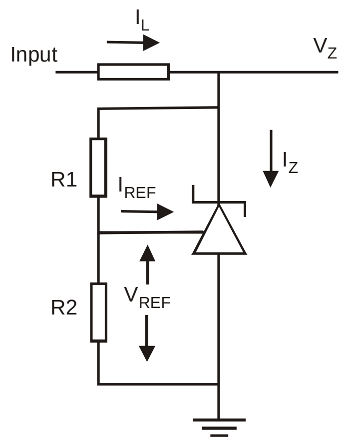


Figure 2. Test Circuit for $V_Z > V_{REF}$

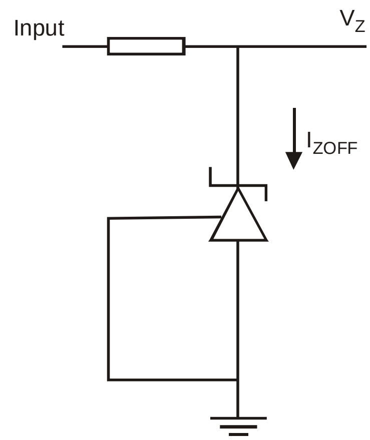
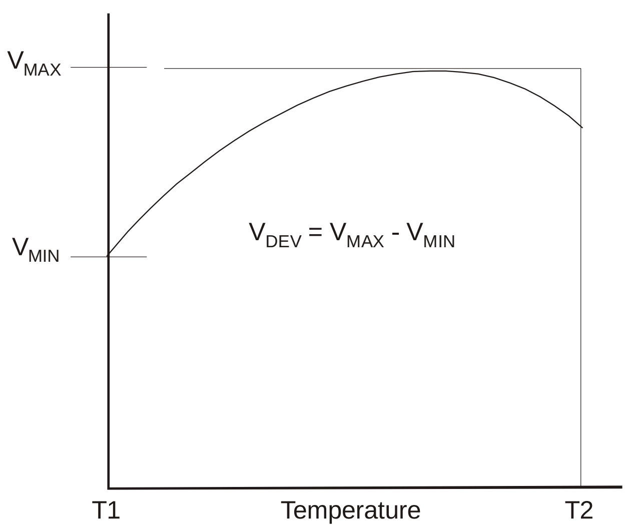


Figure 3. Test Circuit for Off State Current

Deviation of reference input voltage, V_{DEV}, is defined as the maximum variation of the reference input voltage over the full temperature range.

The average temperature coefficient of the reference input voltage, V_{REF} is defined as:



$$V_{ref}(ppm/^{o}C) = \frac{V_{dev} \times 1000000}{V_{ref}(T1 - T2)}$$

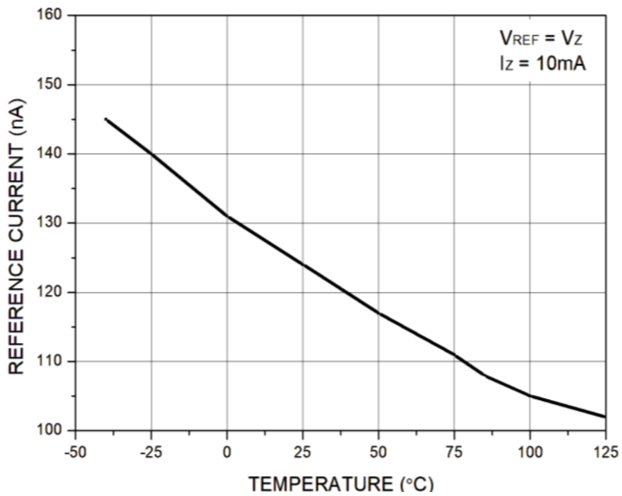
The dynamic output impedance, R_Z is defined as:

$$R_Z = \frac{\Delta V_Z}{\Delta I_Z}$$

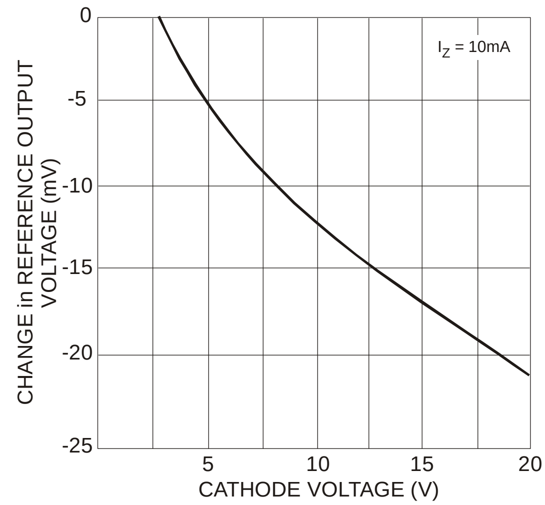
When the device is programmed with two external resistors, R1 and R2, (Figure 2), the dynamic output impedance of the overall circuit, R', is defined as:

$$R' = R_Z \left(1 + \frac{R1}{R2}\right)$$

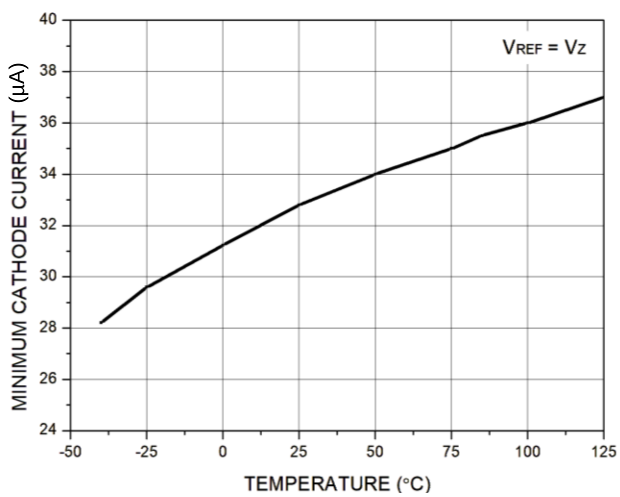
Typical Characteristics



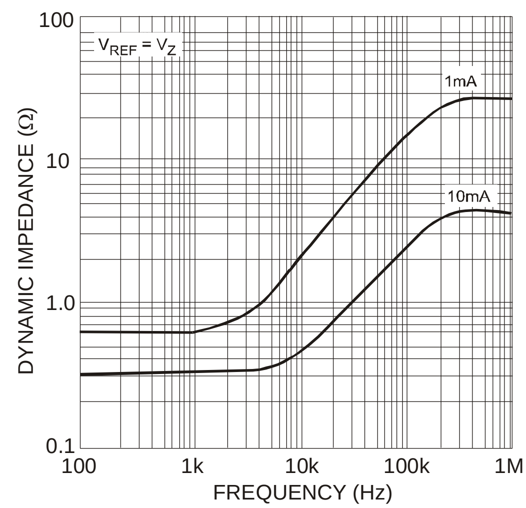
Reference Current vs. Temperature



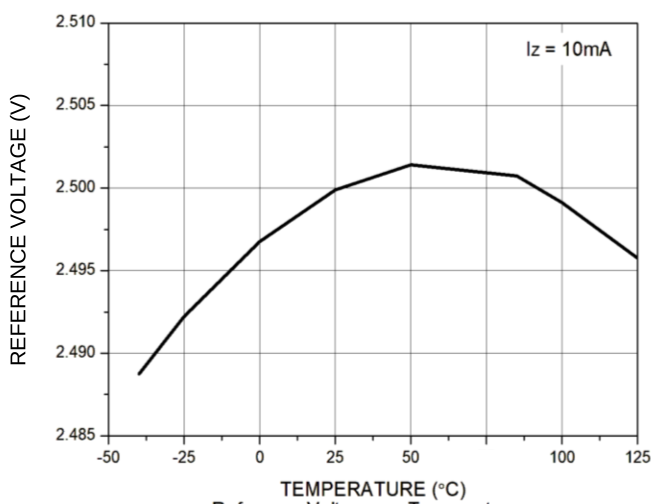
Change in V_{REF} vs. Cathode Voltage



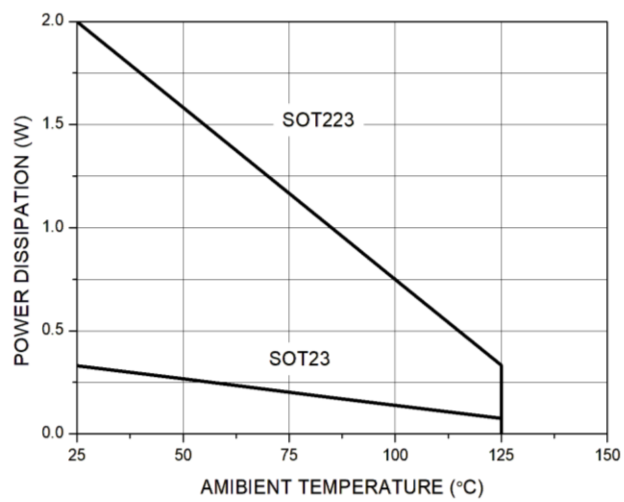
Cathode Current vs. Temperature



Dynamic Impedance vs. Frequency

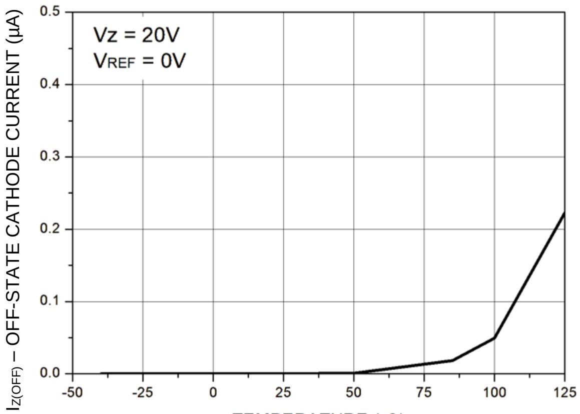


Reference Voltage vs. Temperature

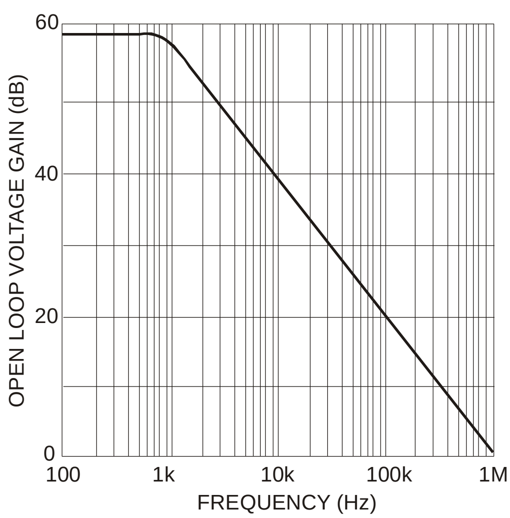


Power Dissipation Derating

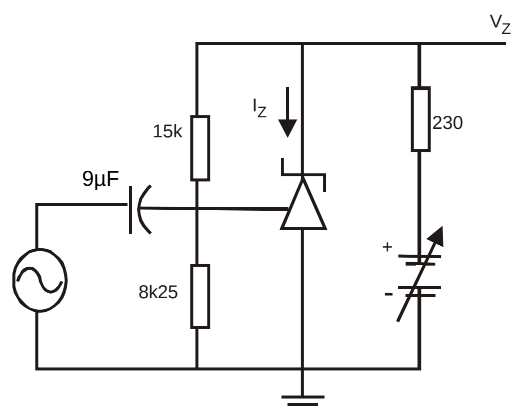
Typical Characteristics (continued)



Off-State Cathode Current vs Temperature

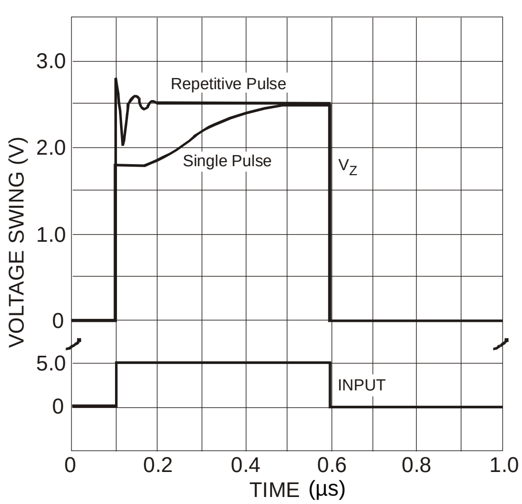


Gain vs. Frequency

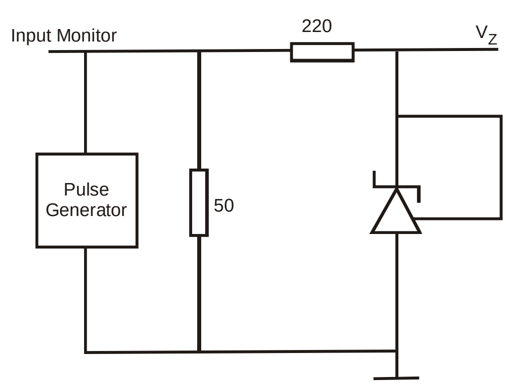


I_Z = 10mA, T_A = +25°C

Test Circuit for Open-Loop Voltage Gain



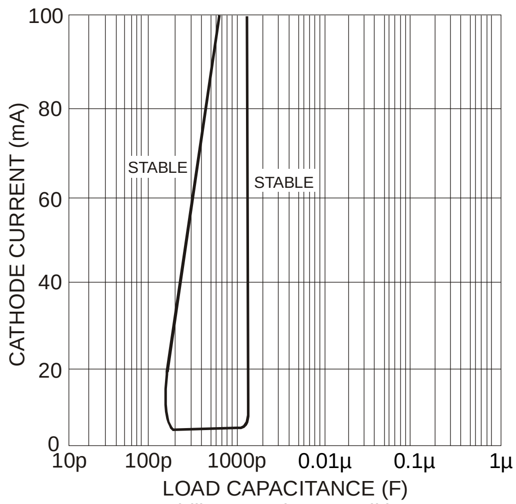
Pulse Response



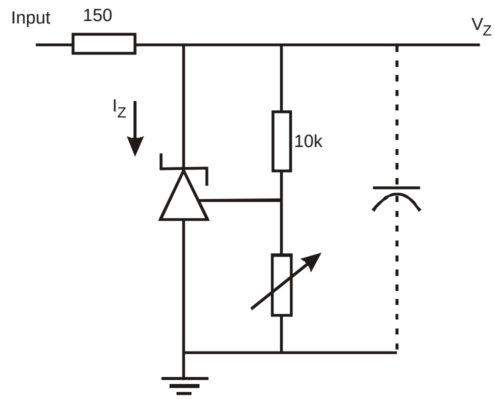
T_A = +25°C

Test Circuit for Pulse Response

Typical Characteristics (continued)



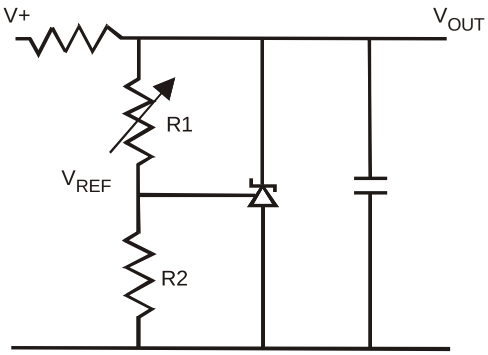
Stability Boundary Conditions



$V_{REF} < V_Z < 20V$, $I_Z = 10mA$, $T_A = +25°C$

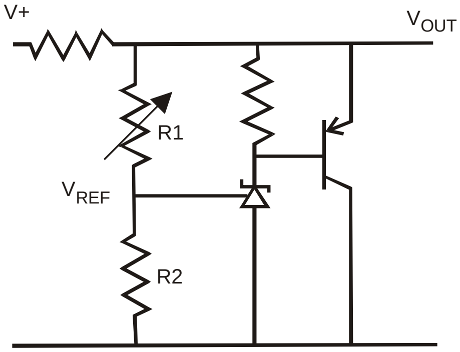
Test Circuit for Stability Boundary Conditions

Application Characteristics



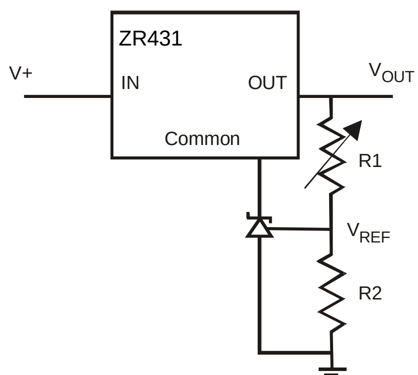
$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) V_{REF}$$

SHUNT REGULATOR



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

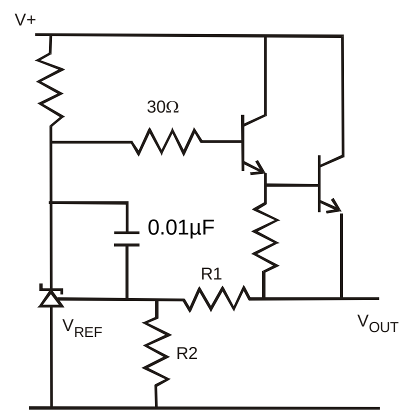
HIGHER CURRENT SHUNT REGULATOR



$$V_{OUT(MIN)} = V_{REF} + V_{REG}$$

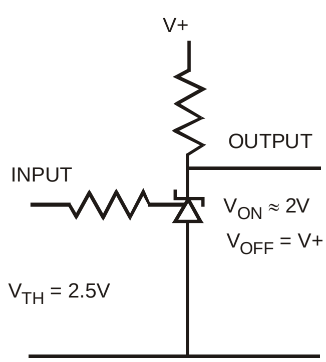
$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) V_{REF}$$

OUTPUT CONTROL OF A THREE TERMINAL FIXED REGULATOR

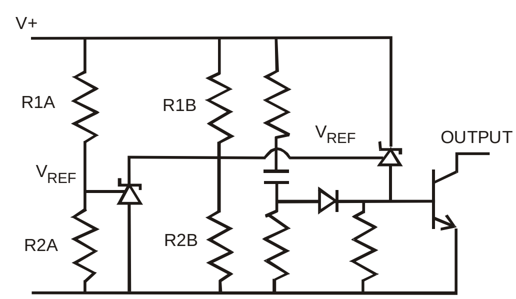


$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) V_{REF}$$

SERIES REGULATOR



SINGLE SUPPLY COMPARATOR WITH TEMPERATURE COMPENSATED THRESHOLD



$$\text{Low limit} + \left(1 + \frac{R1B}{R2B}\right) V_{REF}$$

$$\text{High limit} + \left(1 + \frac{R1A}{R2A}\right) V_{REF}$$

OVERVOLTAGE/UNDERVOLTAGE PROTECTION CIRCUIT

Ordering Information

ZR431 X X X

Package	Tolerance	Packing
F : SOT23 G : SOT223	01 : ±1.0% 005 : ±0.5% Blank : 2%	TA : 7" Tape & Reel

ZR431 X X - X

Package	Tolerance	Packing
F : SOT23	01 : ±1.0% 005 : ±0.5%	7 : 7" Tape & Reel

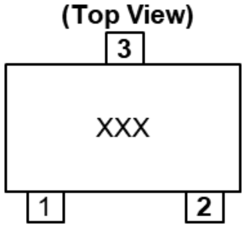
Part Number	Tolerance	Package Code	Identification Code	Package (Note 8)	Packing		Status (Note 9)
					Qty.	Carrier	
ZR431F005-7	0.5%	F	43R	SOT23	3000	7" Tape & Reel	EOL
ZR431F005TA	0.5%	F	43R	SOT23	3000	7" Tape & Reel	In Production
ZR431F01-7	1%	F	43B	SOT23	3000	7" Tape & Reel	EOL
ZR431F01TA	1%	F	43B	SOT23	3000	7" Tape & Reel	In Production
ZR431FTA	2%	F	43A	SOT23	3000	7" Tape & Reel	In Production
ZR431GTA	2%	G	ZR431	SOT223	1000	7" Tape & Reel	EOL

Notes: 8. For packaging details, go to our website at: https://www.diodes.com/design/support/packaging/diodes-packaging/.
9. ZR431F005-7, ZR431F01-7 and ZR431GTA are End of Life (EOL). Please contact us.

Marking Information

(1) SOT23

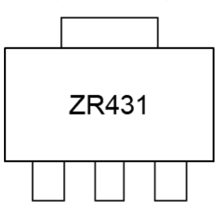
(Top View)



Part Number	Identification Code
ZR431F005-7	43R
ZR431F005TA	43R
ZR431F01-7	43B
ZR431F01TA	43B
ZR431FTA	43A

(2) SOT223

(Top view)

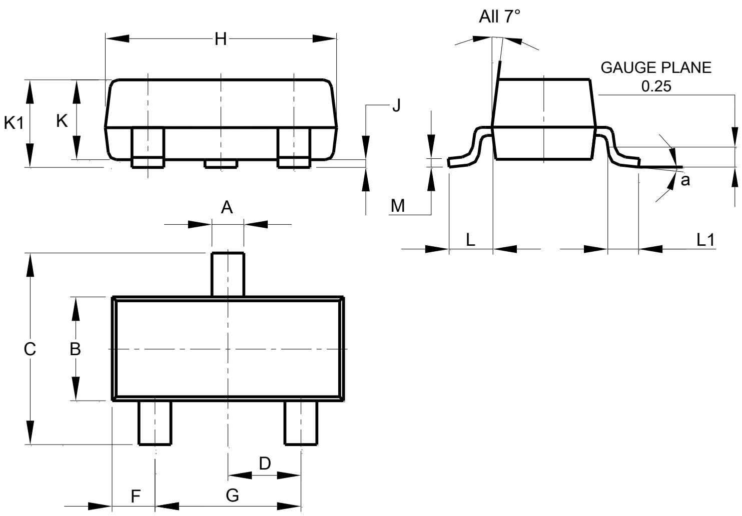


Part Number	Identification Code
ZR431GTA	ZR431

Package Outline Dimensions

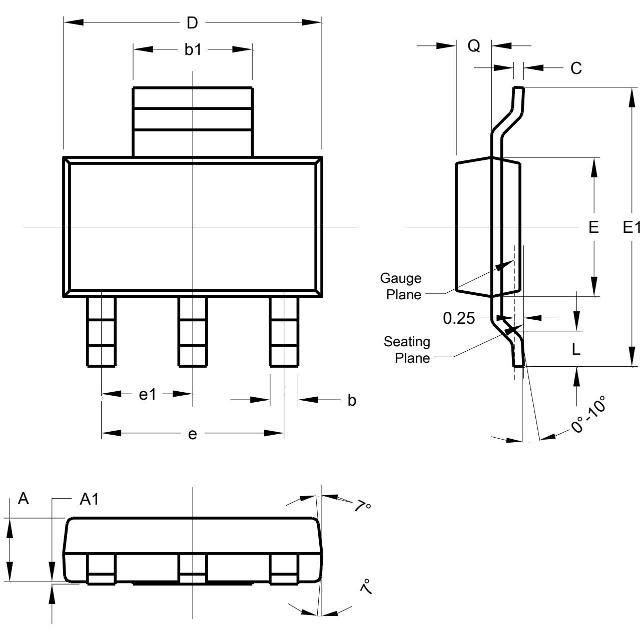
Please see http://www.diodes.com/package-outlines.html for latest version.

(1) Package Type: SOT23



SOT23			
Dim	**Min**	**Max**	**Typ**
A	0.37	0.51	0.40
B	1.20	1.40	1.30
C	2.30	2.50	2.40
D	0.89	1.03	0.915
F	0.45	0.60	0.535
G	1.78	2.05	1.83
H	2.80	3.00	2.90
J	0.013	0.10	0.05
K	0.890	1.00	0.975
K1	0.903	1.10	1.025
L	0.45	0.61	0.55
L1	0.25	0.55	0.40
M	0.085	0.150	0.110
a	0°	8°	--
All Dimensions in mm			

(2) Package Type: SOT223

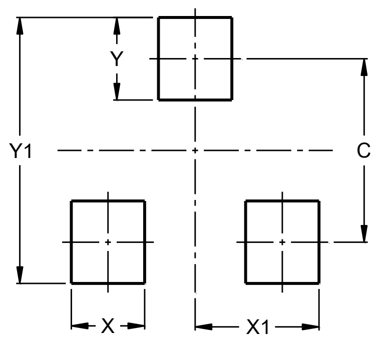


SOT223			
Dim	**Min**	**Max**	**Typ**
A	1.55	1.65	1.60
A1	0.010	0.15	0.05
b	0.60	0.80	0.70
b1	2.90	3.10	3.00
C	0.20	0.30	0.25
D	6.45	6.55	6.50
E	3.45	3.55	3.50
E1	6.90	7.10	7.00
e	-	-	4.60
e1	-	-	2.30
L	0.85	1.05	0.95
Q	0.84	0.94	0.89
All Dimensions in mm			

Suggested Pad Layout

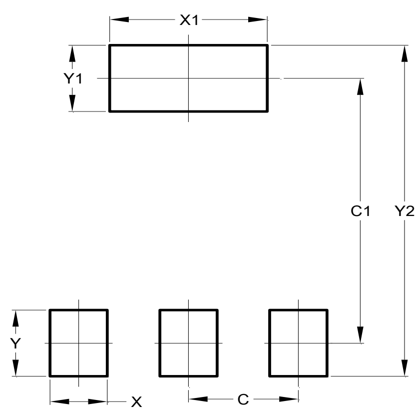
Please see http://www.diodes.com/package-outlines.html for latest version.

(1) Package Type: SOT23



Dimensions	Value (in mm)
C	2.0
X	0.8
X1	1.35
Y	0.9
Y1	2.9

(2) Package Type: SOT223



Dimensions	Value (in mm)
C	2.30
C1	6.40
X	1.20
X1	3.30
Y	1.60
Y1	1.60
Y2	8.00

Mechanical Data

- Moisture Sensitivity:
  - SOT23: Level 1 per J-STD-020
  - SOT223: Level 3 per J-STD-020
- Terminals: Finish — Matte Tin Plated Leads, Solderable per MIL-STD-202, Method 208 (e3)
- Weight:
  - SOT23: 0.009 grams (Approximate)
  - SOT223: 0.112 grams (Approximate)

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