

## LOW CATHODE CURRENT ADJUSTABLE PRECISION SHUNT REGULATOR

### Description

The AS431I 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 AS431I can be set to any value between  $V_{REF}$  (2.5V) and the corresponding maximum cathode voltage (36V).

The AS431I is offered in two grade initial voltage tolerance at +25°C, 0.5%, and 1%.

This IC is available in 3 packages: TO-92 (bulk or ammo packing), SOT-23 and SOT-89.

### Features

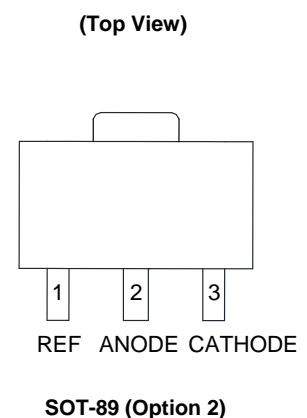
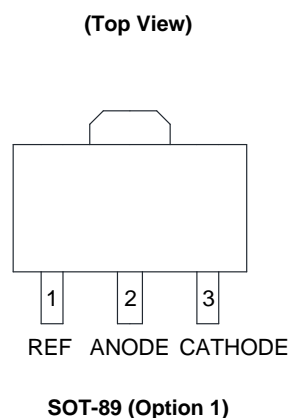
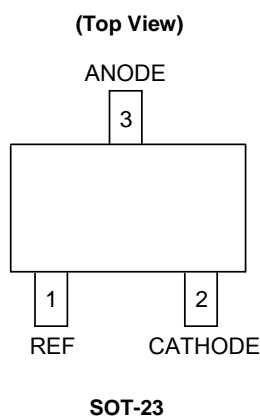
- Programmable Precise Output Voltage from 2.5V to 36V
- High Stability Under Capacitive Load
- Low Minimum Cathode Current for Regulation: 10 $\mu$ A (Typ.), 50 $\mu$ A (Max.)
- Low Temperature Deviation: 4.5mV Typical
- Sink Current Capacity from 50 $\mu$ A to 100mA
- Low Output Noise
- Wide Operating Range: -40 to +125°C
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

### Applications

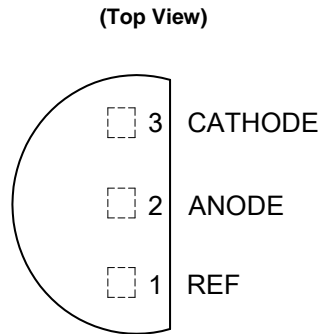
- Charger
- Voltage Adapter
- Switching Power Supply
- Graphic Card
- Precision Voltage Reference

- Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
  2. See [http://www.diodes.com/quality/lead\\_free.html](http://www.diodes.com/quality/lead_free.html) 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.

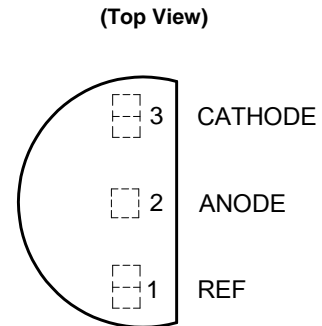
### Pin Assignments



**Pin Assignments** (Cont.)

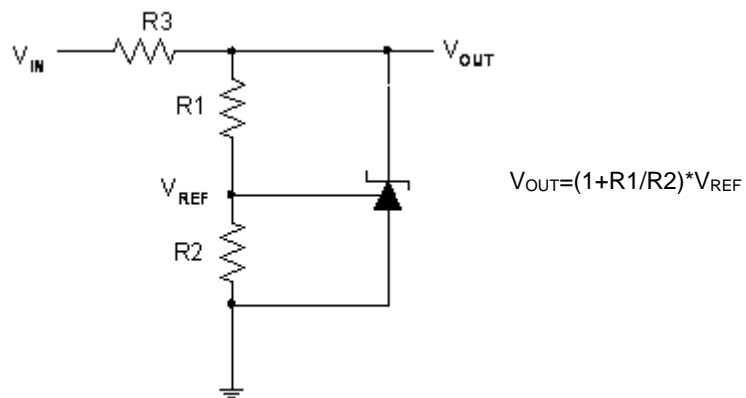


TO-92 (Bulk Packing)



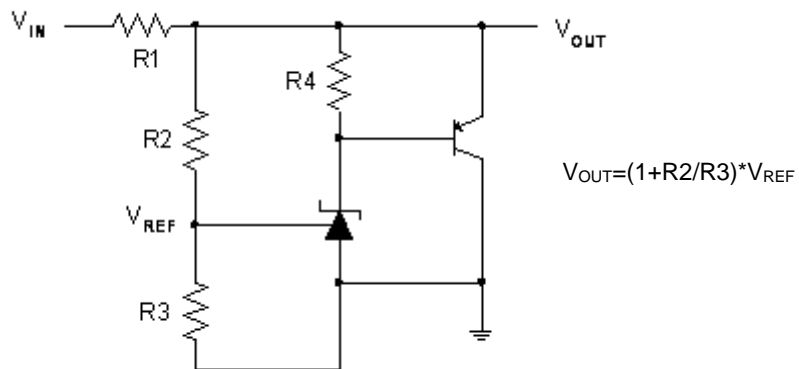
TO-92 ( Ammo Packing)

**Typical Applications Circuit**



$$V_{OUT} = (1 + R1/R2) * V_{REF}$$

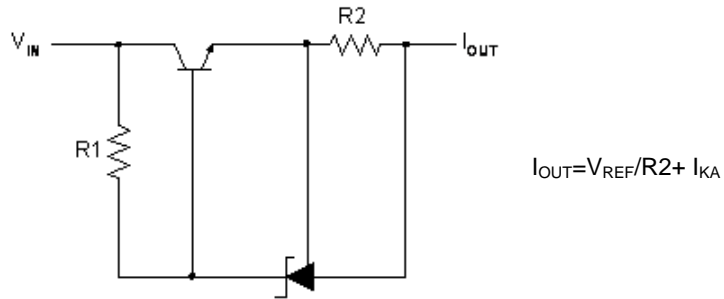
Shunt Regulator



$$V_{OUT} = (1 + R2/R3) * V_{REF}$$

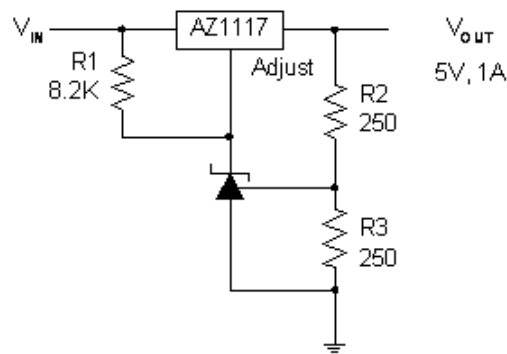
High Current Shunt Regulator

**Typical Applications Circuit (Cont.)**

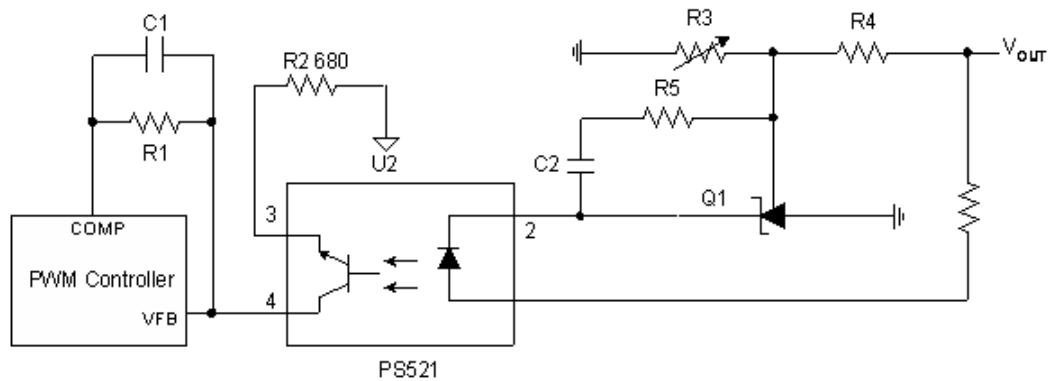


$$I_{OUT} = V_{REF}/R2 + I_{KA}$$

Current Source or Current Limit

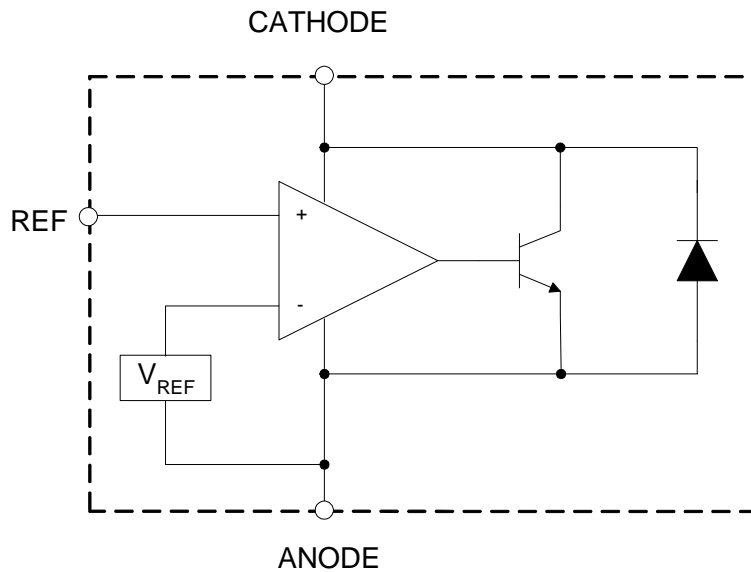


Precision 5V 1A Regulator



PWM Converter with Reference

## Functional Block Diagram



## Absolute Maximum Ratings (Note 4)

Symbol	Parameter	Rating		Unit
$V_{KA}$	Cathode Voltage	40		V
$I_{KA}$	Cathode Current Range (Continuous)	-100 to 150		mA
$I_{REF}$	Reference Input Current Range	10		mA
$P_D$	Power Dissipation	TO-92	770	mW
		SOT-89	770	
		SOT-23	370	
$T_J$	Junction Temperature	+150		°C
$T_{STG}$	Storage Temperature Range	-65 to +150		°C
ESD	ESD (Human Body Model)	2000		V

Note 4: 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.

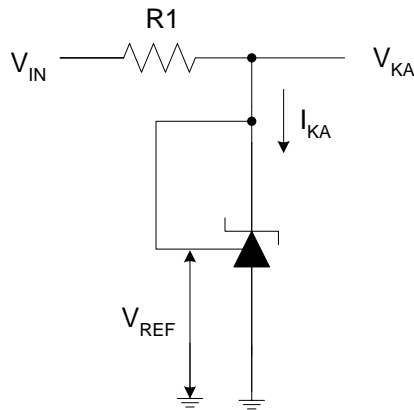
## Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
$V_{KA}$	Cathode Voltage	$V_{REF}$	36	V
$I_{KA}$	Cathode Current	0.05	100	mA
$T_A$	Operating Ambient Temperature Range	-40	+125	°C

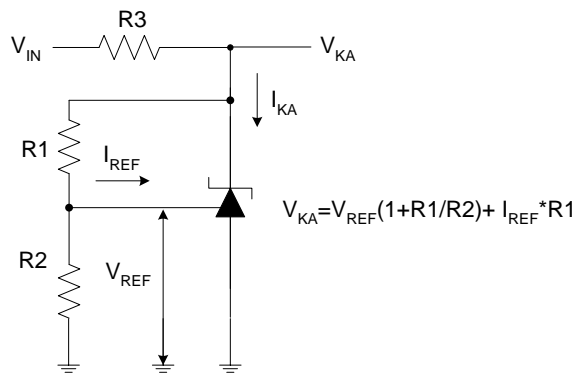
**Electrical Characteristics** (Operating Conditions:  $T_A = +25^\circ\text{C}$ , unless otherwise specified.)

Symbol	Parameter		Test Circuit	Conditions	Min	Typ	Max	Unit	
$V_{REF}$	Reference Voltage	0.5%	4	$V_{KA} = V_{REF}, I_{KA} = 10\text{mA}$	2.487	2.500	2.512	V	
		1.0%			2.475	2.500	2.525		
$\Delta V_{REF}$	Deviation of Reference Voltage Over Full Temperature Range		4	$V_{KA} = V_{REF}, I_{KA} = 10\text{mA}$	0 to $+70^\circ\text{C}$	-	4.5	8	mV
					$-40$ to $+85^\circ\text{C}$	-	4.5	10	
					$-40$ to $+125^\circ\text{C}$	-	4.5	16	
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	Ratio of Change in Reference Voltage to the Change in Cathode Voltage		5	$I_{KA} = 10\text{mA}$	$\Delta V_{KA} = 10\text{V}$ to $V_{REF}$	-	-1.0	-2.7	mV/V
					$\Delta V_{KA} = 36\text{V}$ to $10\text{V}$	-	-0.5	-2.0	
$I_{REF}$	Reference Current		5	$I_{KA} = 10\text{mA}, R1 = 10\text{K}\Omega, R2 = \infty$	-	0.035	0.5	$\mu\text{A}$	
$\Delta I_{REF}$	Deviation of Reference Current Over Full Temperature Range		5	$I_{KA} = 10\text{mA}, R1 = 10\text{K}\Omega, R2 = \infty, T_A = -40$ to $+125^\circ\text{C}$	-	0.03	0.3	$\mu\text{A}$	
$I_{KA}$ (Min)	Minimum Cathode Current for Regulation		4	$V_{KA} = V_{REF}$	-	10	50	$\mu\text{A}$	
$I_{KA}$ (Off)	Off-state Cathode Current		6	$V_{KA} = 36\text{V}, V_{REF} = 0$	-	0.05	1.0	$\mu\text{A}$	
$Z_{KA}$	Dynamic Impedance		4	$V_{KA} = V_{REF}, I_{KA} = 1$ to $100\text{mA}, f \leq 1.0\text{KHz}$	-	0.15	0.5	$\Omega$	
$\theta_{JC}$	Thermal Resistance		-	TO-92	-	68	-	$^\circ\text{C/W}$	
				SOT-89	-	29	-		
				SOT-23	-	113	-		

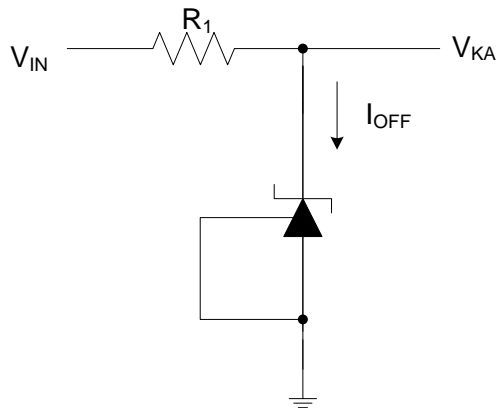
**Electrical Characteristics** (Cont.)



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



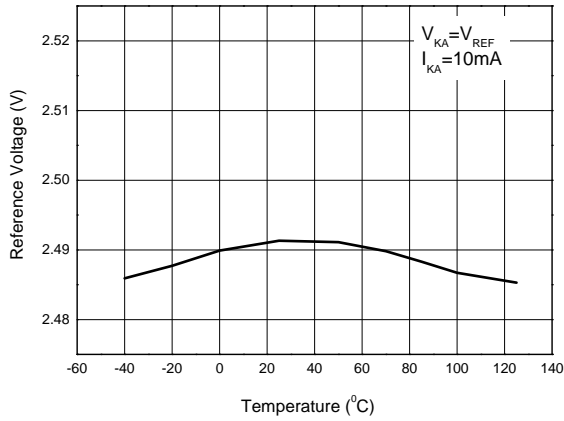
Test Circuit 5 for  $V_{KA} > V_{REF}$



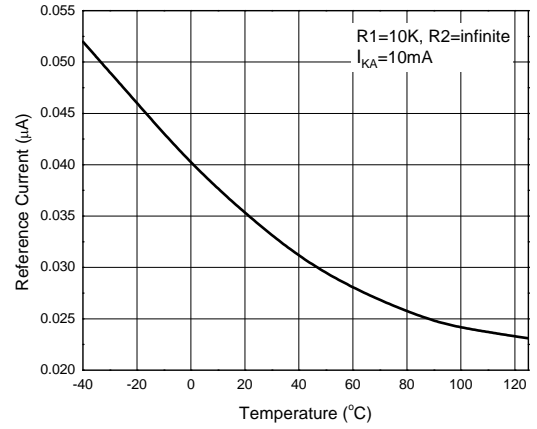
Test Circuit 6 for  $I_{OFF}$

**Performance Characteristics**

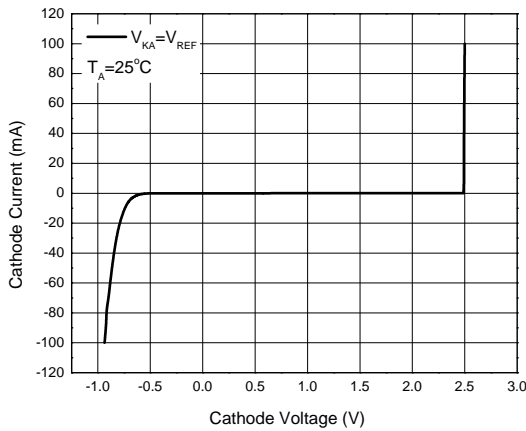
**Reference Voltage vs. Ambient Temperature**



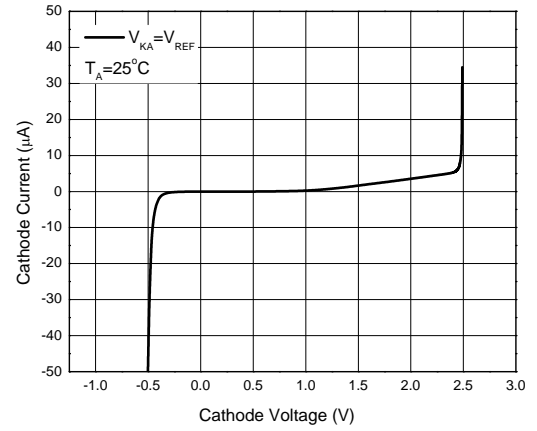
**Reference Current vs. Ambient Temperature**



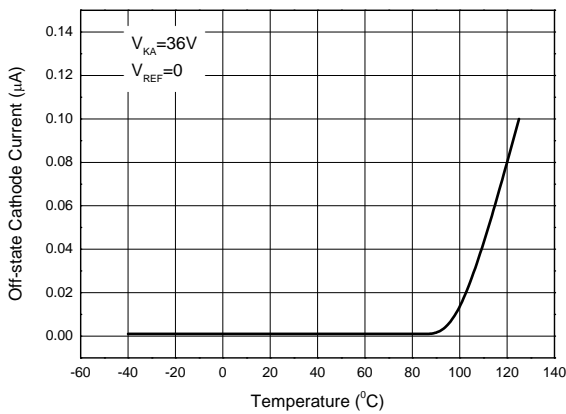
**Cathode Current vs. Cathode Voltage**



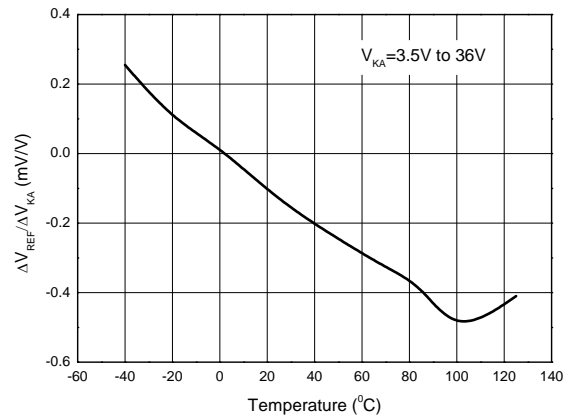
**Cathode Current vs. Cathode Voltage**



**Off-state Cathode Current vs. Ambient Temperature**

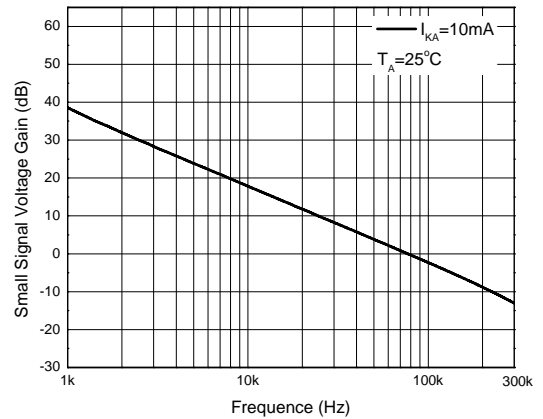
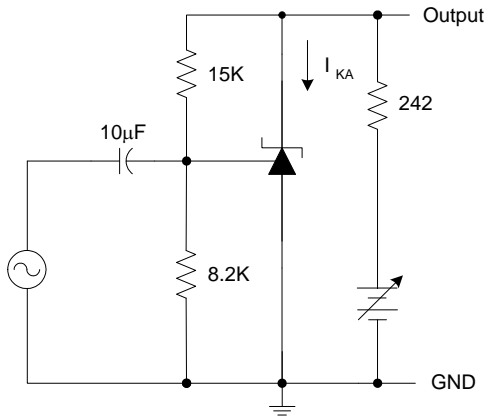


**Ratio of Delta Reference Voltage to the Ratio of Delta Cathode Voltage**

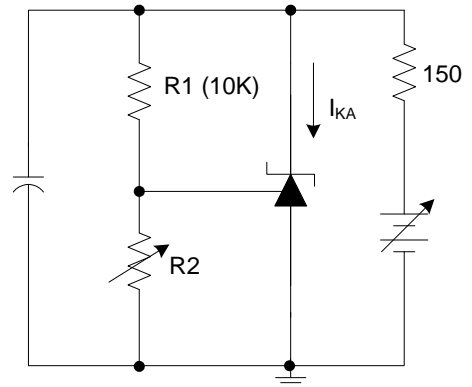
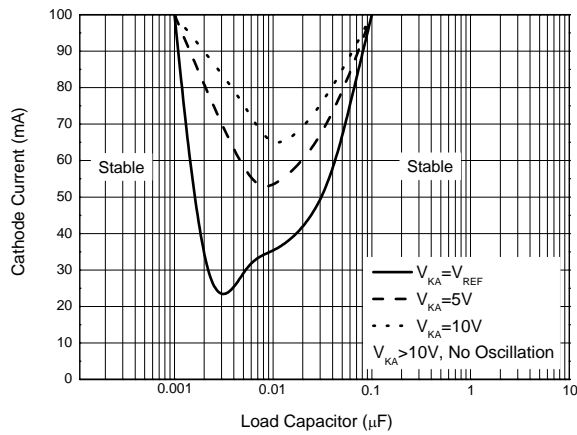


**Performance Characteristics (Cont.)**

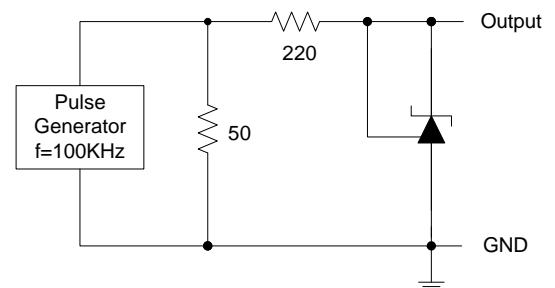
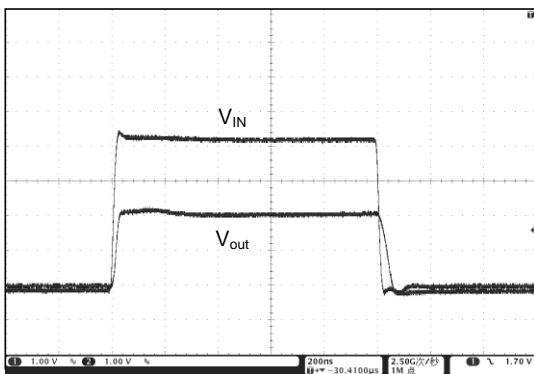
**Small Signal Voltage Gain vs. Frequency**



**Stability Boundary Conditions vs. Load Capacitance**

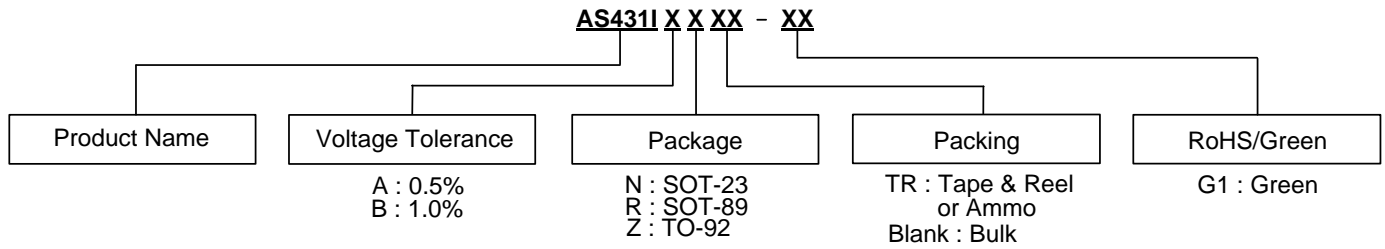


**Pulse Response of Input and Output Voltage**





**Ordering Information**



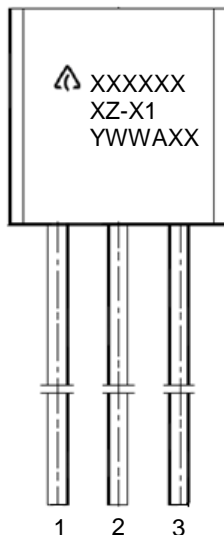
Diodes IC's Pb-free products with "G1" suffix in the part number, are RoHS compliant and green.

Package	Temperature Range	Voltage Tolerance	Part Number	Marking ID	Packing
SOT-23	-40 to +125°C	0.5%	AS431IANTR-G1	GB9	3000/Tape & Reel
		1.0%	AS431IBNTR-G1	GC9	3000/Tape & Reel
TO-92	-40 to +125°C	0.5%	AS431IAZ-G1	AS431IAZ-G1	1000/Bulk
		0.5%	AS431IAZTR-G1	AS431IAZ-G1	2000/Ammo
		1.0%	AS431IBZ-G1	AS431IBZ-G1	1000/Bulk
		1.0%	AS431IBZTR-G1	AS431IBZ-G1	2000/Ammo
SOT-89	-40 to +125°C	0.5%	AS431IARTR-G1	G43J	1000/Tape & Reel
		1.0%	AS431IBRTR-G1	G43K	1000/Tape & Reel

**Marking Information**

(1) TO-92

(Front View)

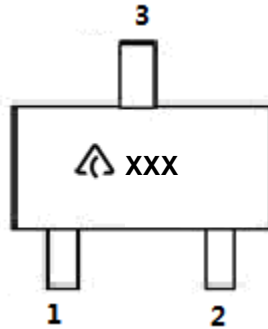



First and Second Lines: Logo and Marking ID  
(See Ordering Information)  
Third Line: Date Code  
Y: Year  
WW: Work Week of Molding  
A: Assembly House Code  
XX: 7<sup>th</sup> and 8<sup>th</sup> Digits of Batch No.

**Marking Information** (Cont.)

(2) SOT-23

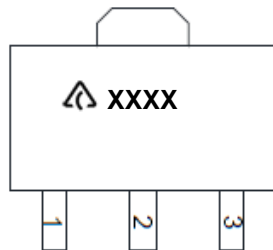
(Top View)




 : Logo  
XXX: Marking ID (See Ordering Information)

(3) SOT-89

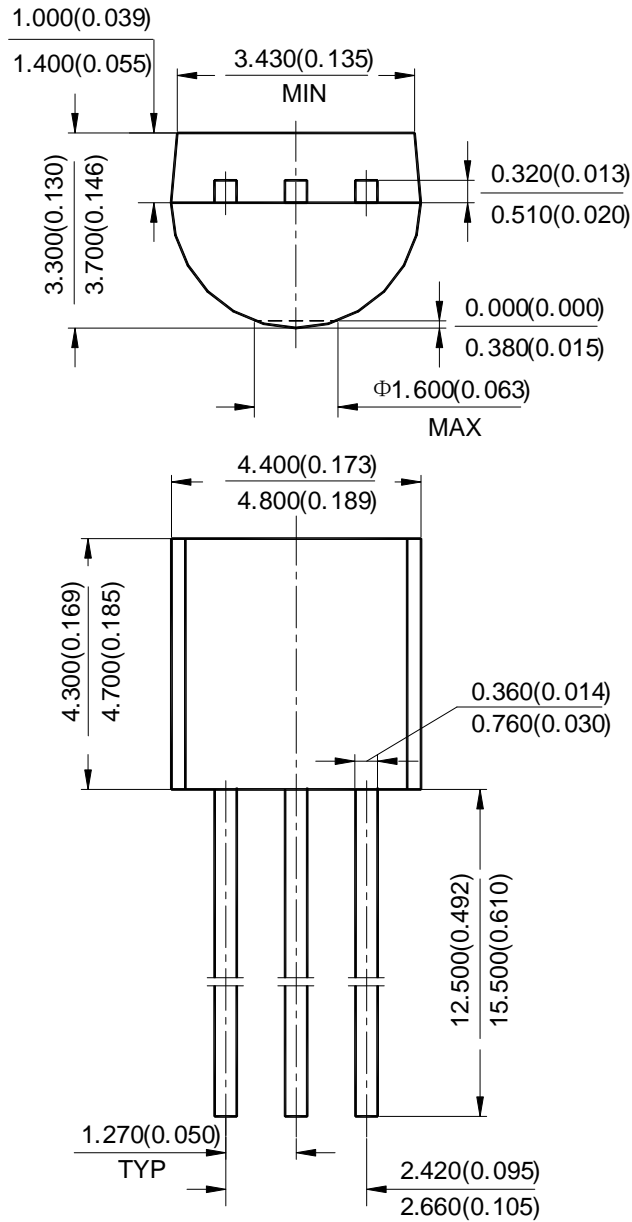
(Top View)



 : Logo  
XXXX: Marking ID (See Ordering Information)

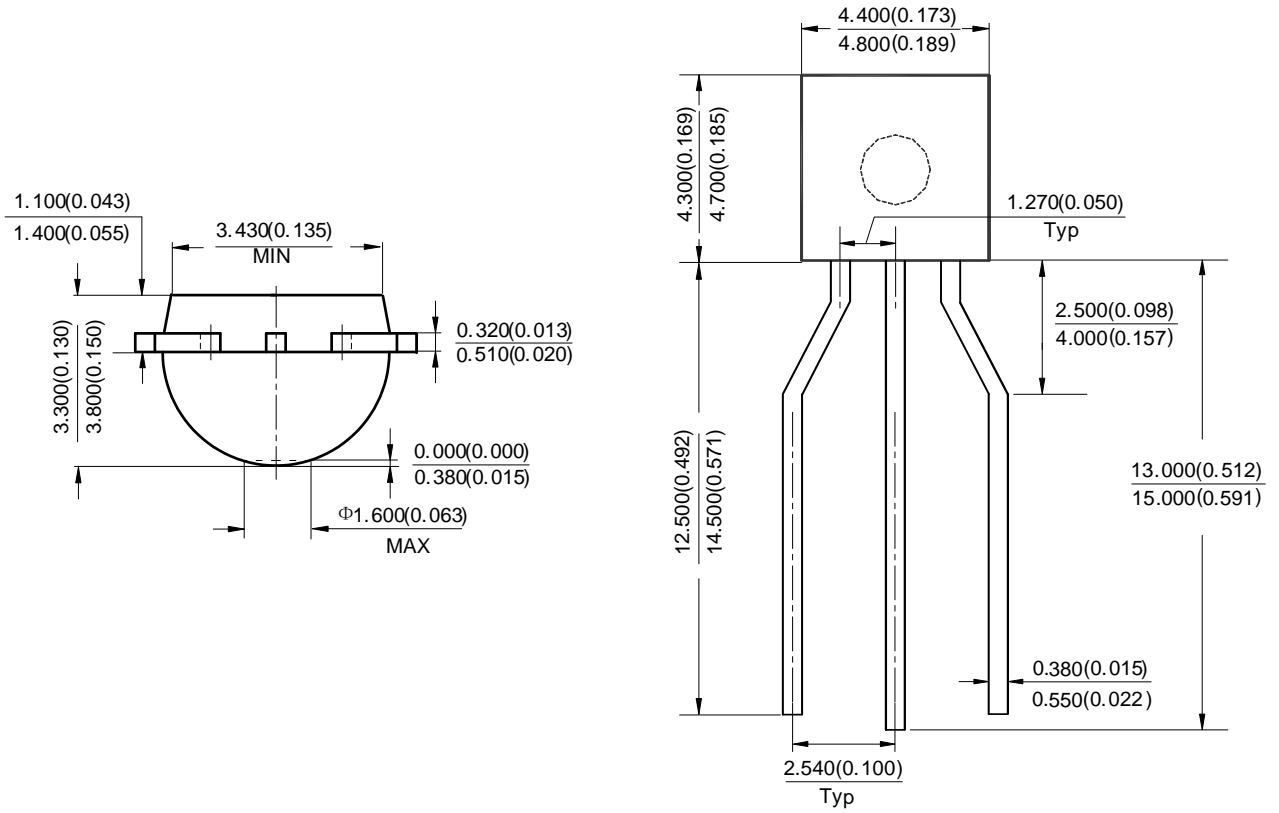
**Package Outline Dimensions** (All dimensions in mm(inch).)

(1) Package Type: TO-92 (Bulk Packing)



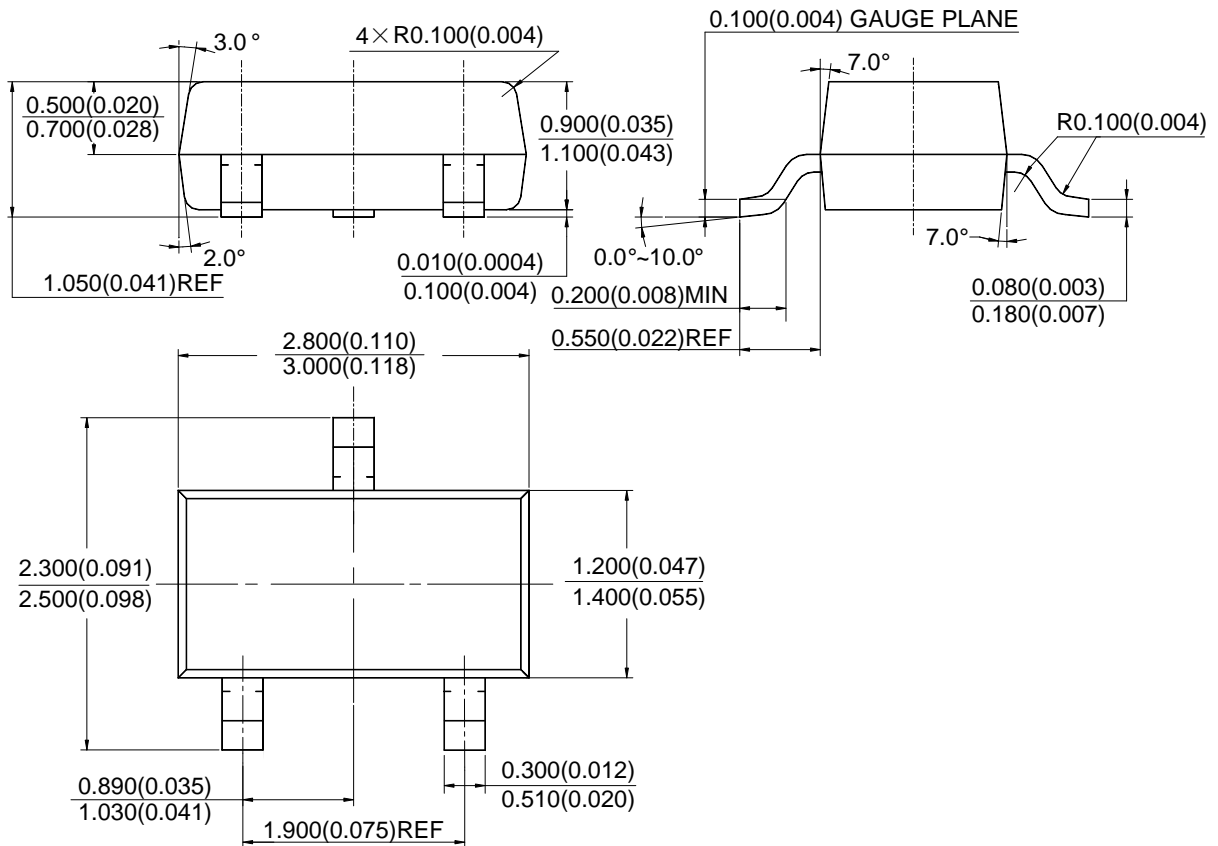
**Package Outline Dimensions** (Cont. All dimensions in mm(inch).)

(2) Package Type: TO-92 (Ammo Packing)



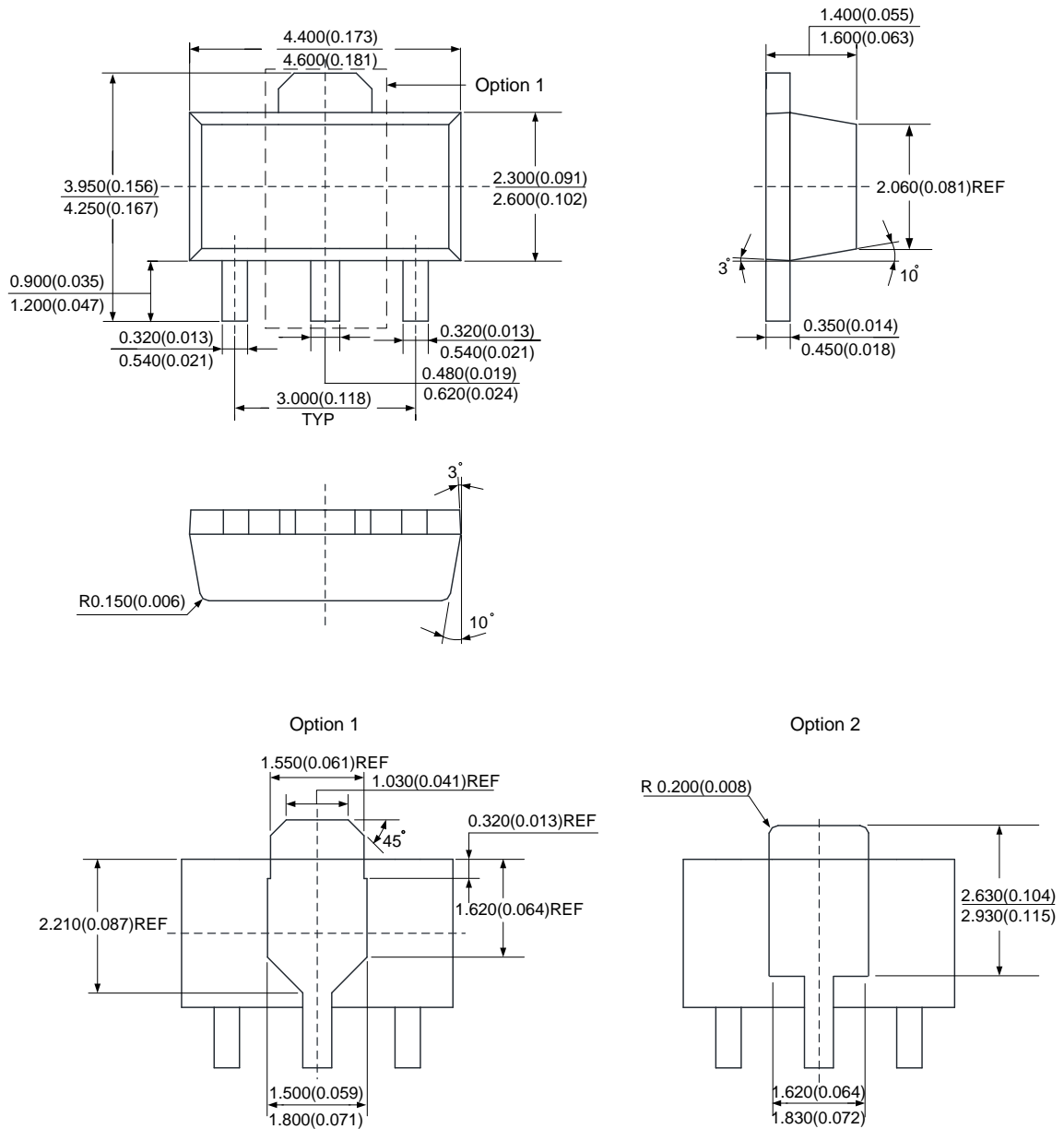
**Package Outline Dimensions** (Cont. All dimensions in mm(inch).)

(3) Package Type: SOT-23



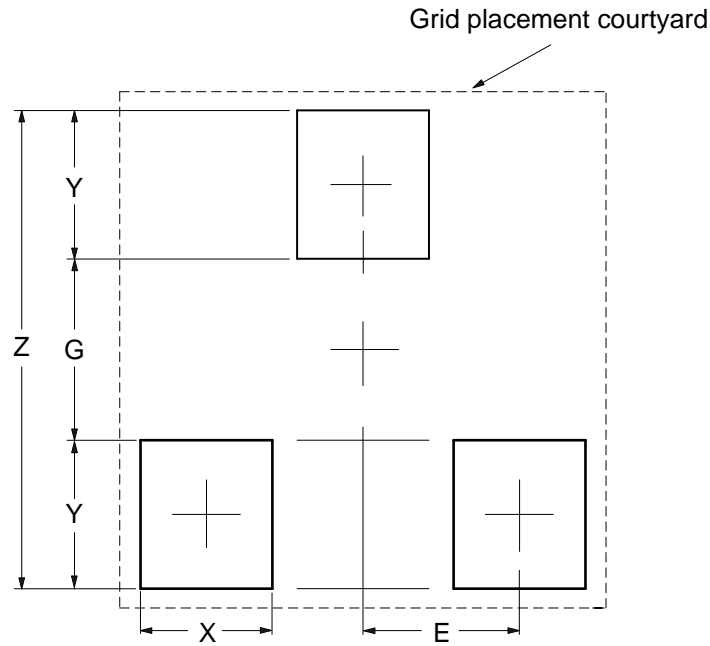
**Package Outline Dimensions** (Cont. All dimensions in mm(inch).)

(4) Package Type: SOT-89



## Suggested Pad Layout

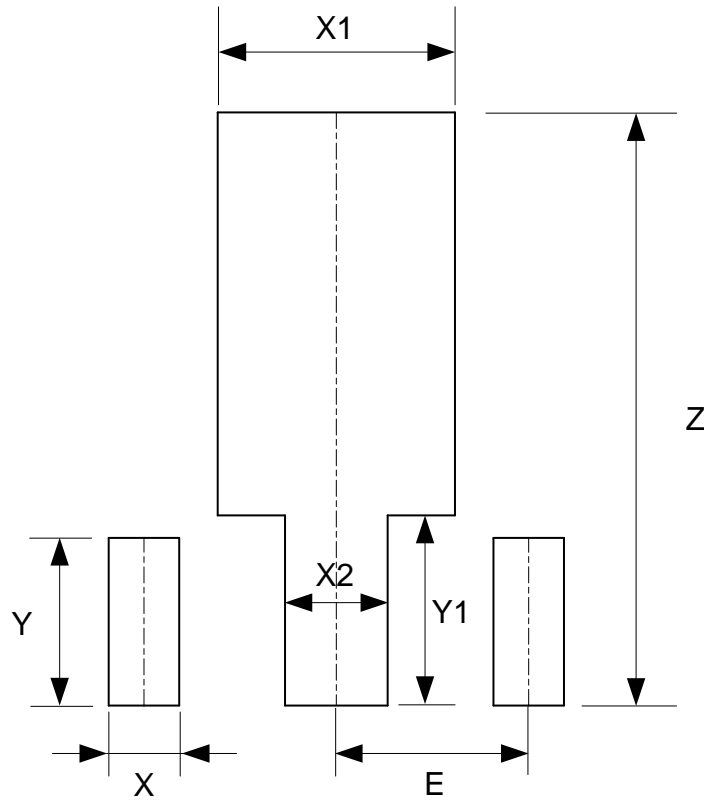
(1) Package Type: SOT-23



Dimensions	Z (mm)/(inch)	G (mm)/(inch)	X (mm)/(inch)	Y (mm)/(inch)	E (mm)/(inch)
Value	2.900/0.114	1.100/0.043	0.800/0.031	0.900/0.035	0.950/0.037

**Suggested Pad Layout (Cont.)**

(2) Package Type: SOT-89



Dimensions	Z (mm)/(inch)	X (mm)/(inch)	X1 (mm)/(inch)	X2 (mm)/(inch)	Y (mm)/(inch)	Y1 (mm)/(inch)	E (mm)/(inch)
Value	4.600/0.181	0.550/0.022	1.850/0.073	0.800/0.031	1.300/0.051	1.475/0.058	1.500/0.059



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