LOW CATHODE CURRENT ADJUSTABLE PRECISION SHUNT REGULATOR

NEW PRODUCT

Description

The AP431S is a 3-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 makes it ideal substitute for Zener diode in applications such as switching power supply, charger and other adjustable regulators.

The AP431S has the same electrical specifications as the industry standard 431 except that it features a low minimum cathode current for regulation. The typical value of 50μA makes the parts ideal for very low power dissipation applications.

The output voltage of AP431S can be set to any value between V_{REF} (2.5V/2.495V) and the corresponding maximum cathode voltage (36V).

The AP431S is offered in two grade initial voltage tolerance at +25°C, 0.5% and 1%.

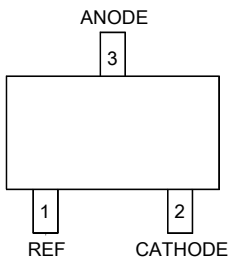
This IC is available in 3 packages: TO92 (ammo packing), SOT23 and SOT89.

Features

- Low Minimum Cathode Current for Regulation: 50μA (Typ.), 100μA (Max.)
- Programmable Precise Output Voltage from 2.5V/2.495V to 36V
- High Stability Under Capacitive Load
- Low Deviation of Reference Voltage Over Full Temperature Range: 11mV Typical (-40°C to +125°C)
- Sink Current Capacity from 100μA to 100mA
- Low Dynamic Impedance: 0.1Ω (Typ.)
- Wide Operating Temperature Range: -40°C to +125°C
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

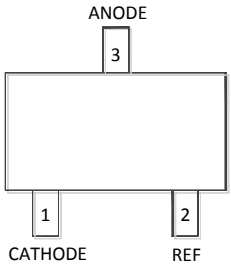
Pin Assignments

(Top View)



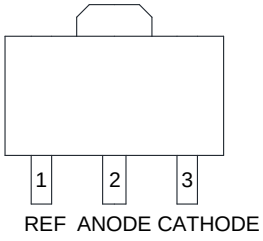
SOT23 (Package Code: N)

(Top View)



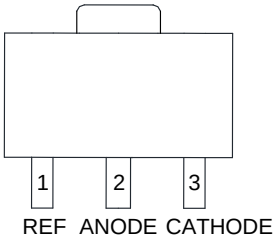
SOT23 (Package Code: N1)

(Top View)



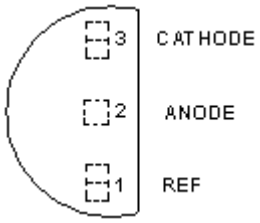
SOT89 (Option 1)

(Top View)



SOT89 (Option 2)

(Top View)



TO92 (Ammo Packing)

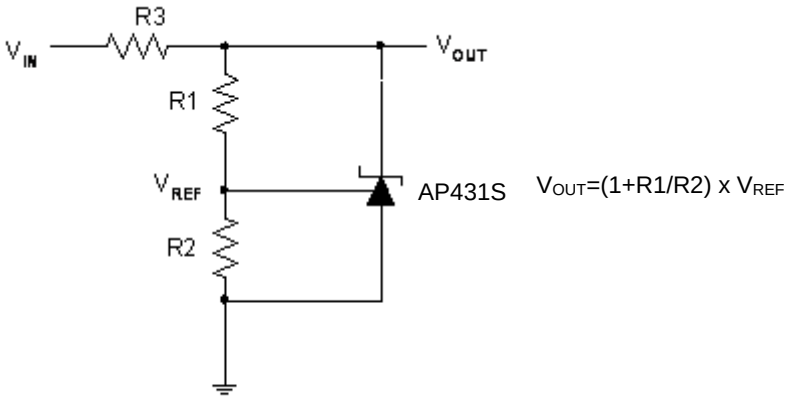
Applications

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

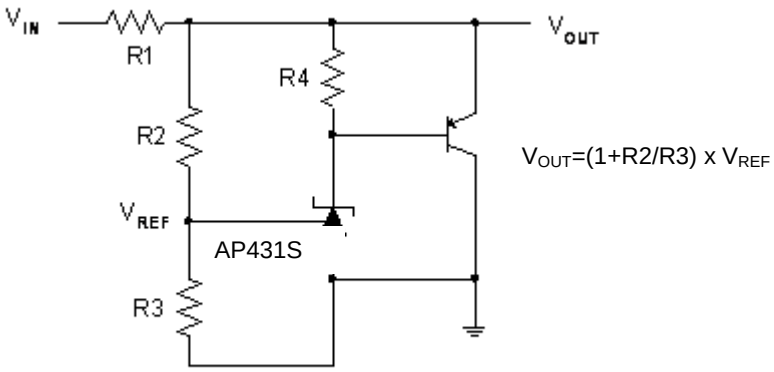
Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
2. See http://www.diodes.com/quality/lead_free.html for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

NEW PRODUCT

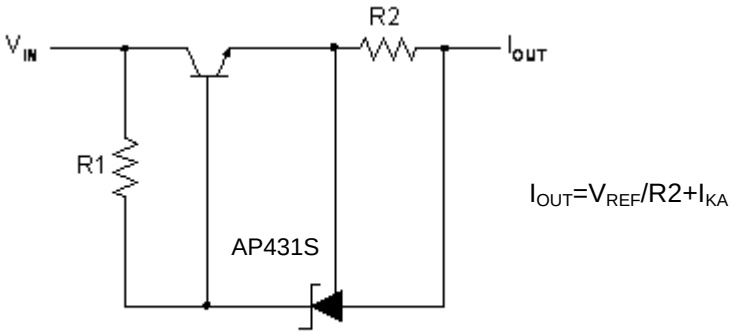
Typical Applications Circuit



Shunt Regulator



High Current Shunt Regulator



Current Source or Current Limit

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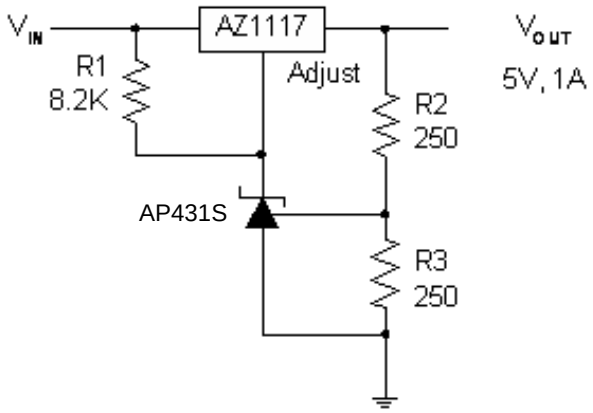
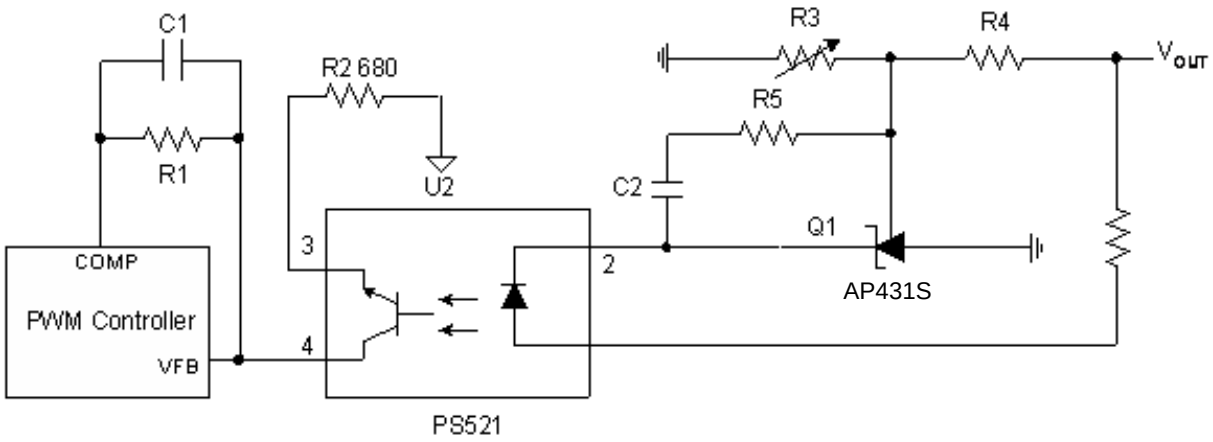
Typical Applications Circuit (Cont.)



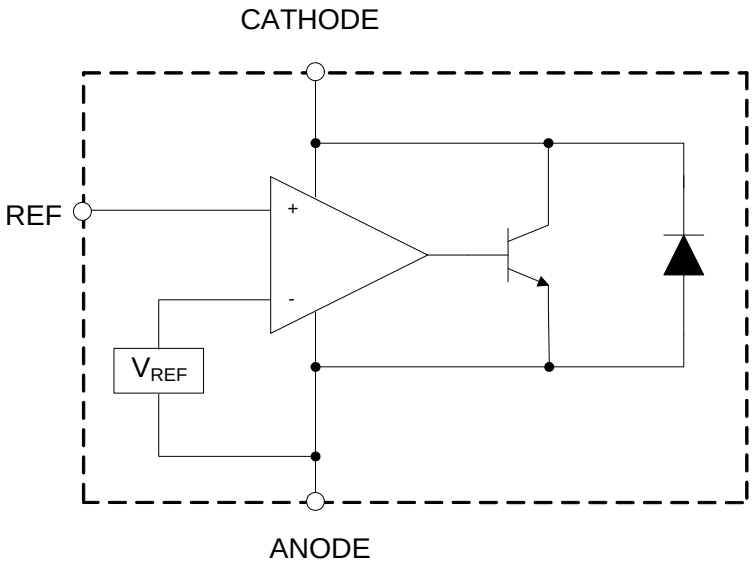
Precision 5V 1A Regulator



PWM Converter with Reference

NEW PRODUCT

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	TO92	750	mW
		SOT89	750	
		SOT23	350	
T_J	Junction Temperature	+150		°C
T_{STG}	Storage Temperature Range	-65 to +150		°C
ESD	ESD (Human Body Model)	5,500		V
ESD	ESD (Machine Model)	300		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	0.1	100	mA
T_A	Operating Ambient Temperature Range	-40	+125	°C

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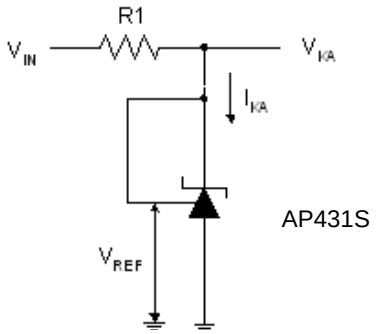
Electrical Characteristics (T_A = +25°C, unless otherwise specified.)

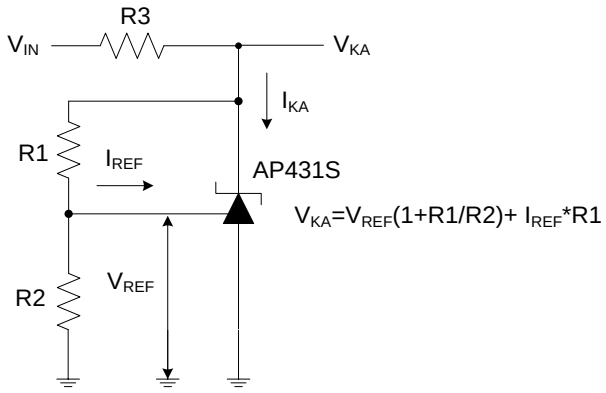
Symbol	Parameter		Test Circuit	Conditions		Min	Typ	Max	Unit
V_{REF}	Reference Voltage	0.5%	4	$V_{KA} = V_{REF}$, I_{KA} = 1mA (AP431SA)		2.487	2.500	2.512	V
				$V_{KA} = V_{REF}$, I_{KA} = 1mA (AP431SHA)		2.483	2.495	2.507	
		1.0%		$V_{KA} = V_{REF}$, I_{KA} = 1mA (AP431SB)		2.475	2.500	2.525	
				$V_{KA} = V_{REF}$, I_{KA} = 1mA (AP431SHB)		2.470	2.495	2.520	
ΔV_{REF}	Deviation of Reference Voltage Over Full Temperature Range		4	$V_{KA} = V_{REF}$ I_{KA} = 1mA	0 to +70°C	—	3	6	mV
					-40 to +85°C	—	6	10	
					-40 to +125°C	—	11	18	
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	Ratio of Change in Reference Voltage to the Change in Cathode Voltage		5	I_{KA} = 1mA	ΔV_{KA} = 10V to V_{REF}	—	-1.0	-2.7	mV/V
					ΔV_{KA} = 36V to 10V	—	-0.5	-2.0	
I_{REF}	Reference Current		5	I_{KA} = 1mA, R1 = 10kΩ, R2 = ∞		—	0.2	0.5	µA
ΔI_{REF}	Deviation of Reference Current Over Full Temperature Range		5	I_{KA} = 1mA, R1 = 10kΩ R2 = ∞, T_A = -40 to +125°C		—	0.1	0.3	µA
I_{KA} (Min)	Minimum Cathode Current for Regulation		4	$V_{KA} = V_{REF}$		—	50	100	µA
I_{KA} (Off)	Off-state Cathode Current		6	V_{KA} = 36V, V_{REF} = 0		—	0.05	1.0	µA
Z_{KA}	Dynamic Impedance		4	$V_{KA} = V_{REF}$, I_{KA} = 1 to 100mA, f ≤ 1.0kHz		—	0.1	0.3	Ω
θ_{JC}	Thermal Resistance		—	TO92		—	80	—	°C/W
				SOT89		—	80	—	
				SOT23		—	140	—	

NEW PRODUCT

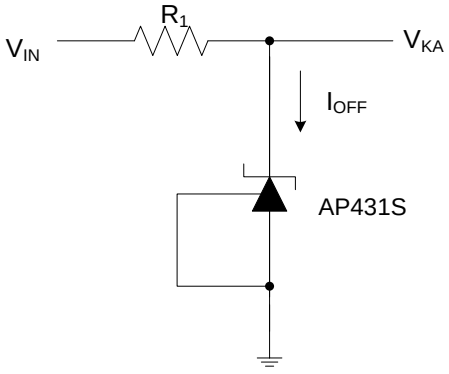
Electrical Characteristics (Cont.)



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



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



Test Circuit 6 for I_{OFF}

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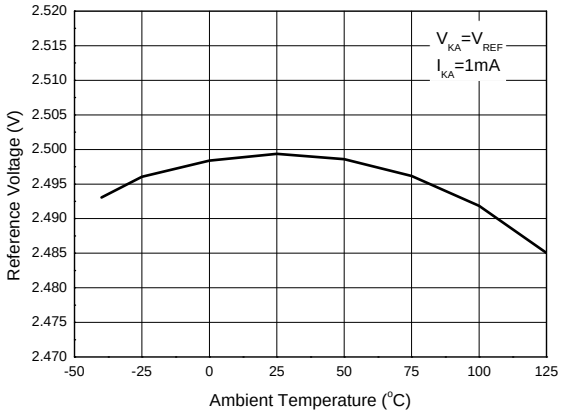
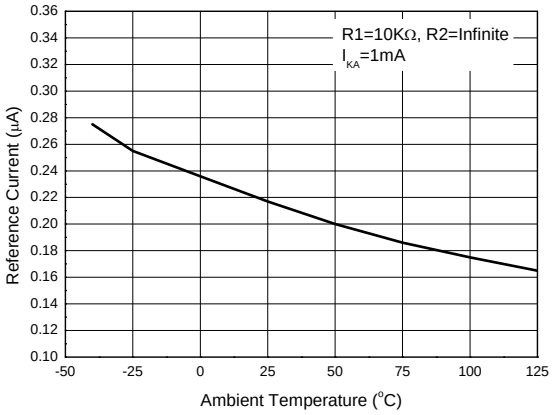
Performance Characteristics

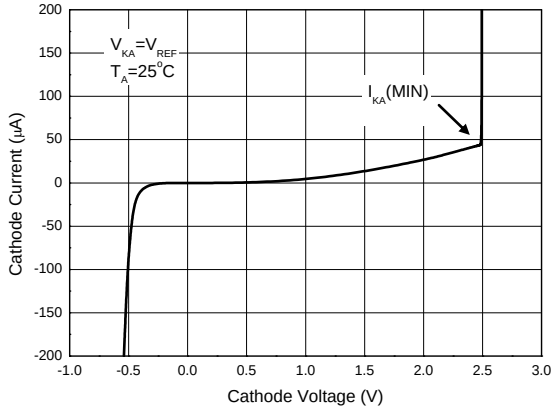
Reference Voltage vs. Ambient Temperature



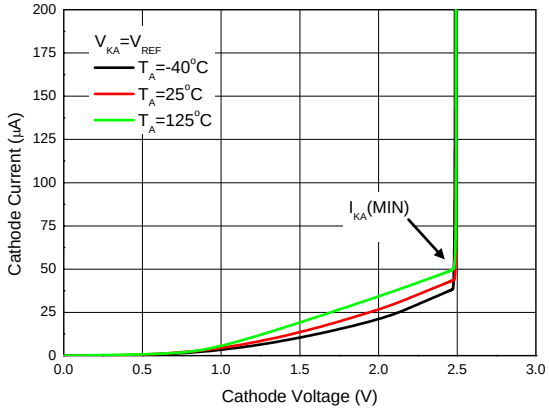
Reference Current vs. Ambient Temperature



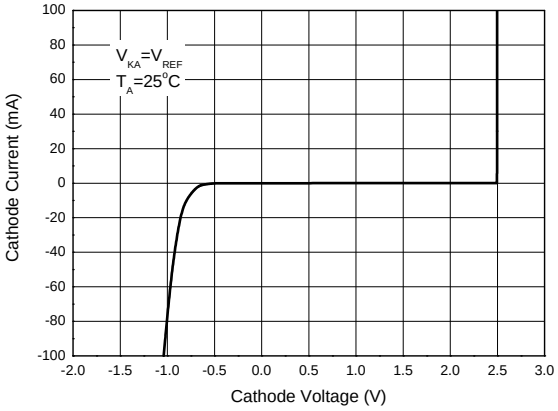
Minimal Cathode Current for Regulation



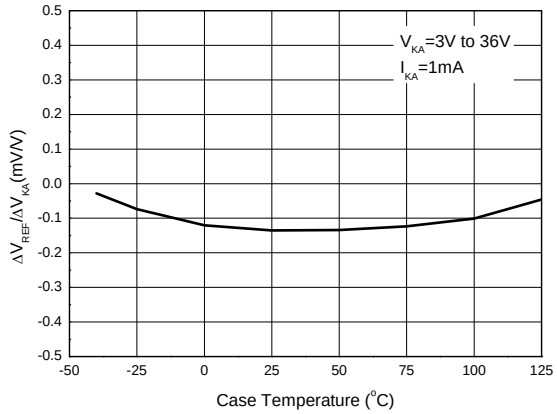
Minimal Cathode Current for Regulation at Different Ambient Temperature



Cathode Current vs. Cathode Voltage



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



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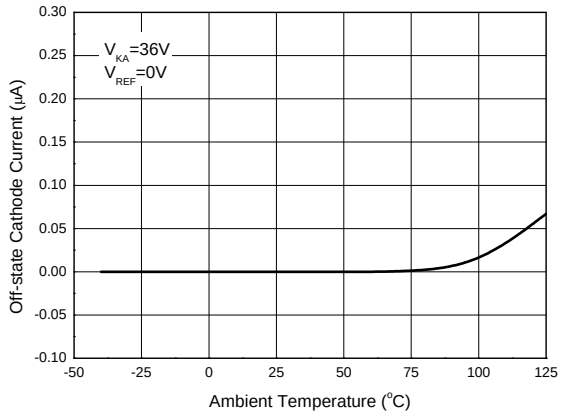
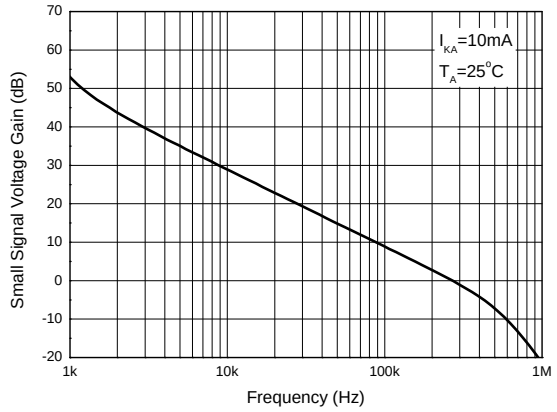
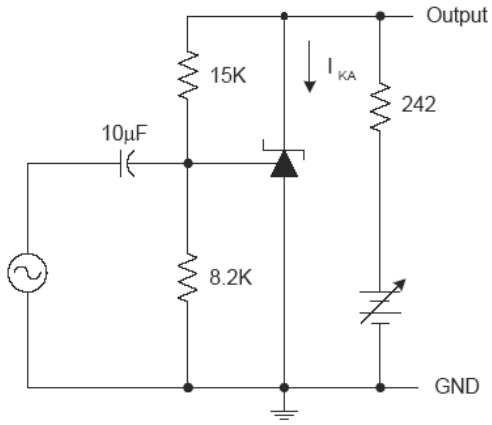
Performance Characteristics (Cont.)

Off-state Cathode Current vs. Ambient Temperature

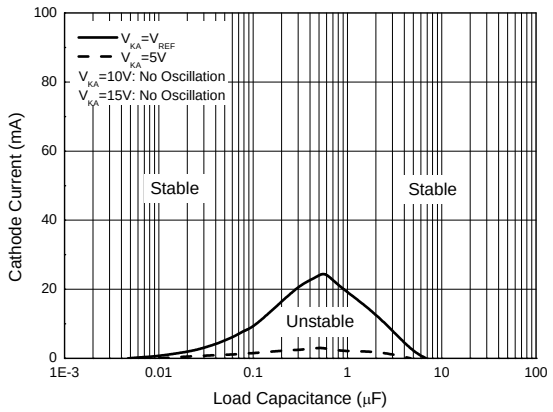


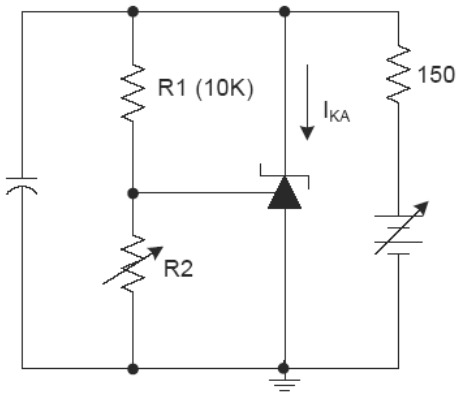
Small Signal Voltage Gain vs. Frequency





Stability Boundary Conditions

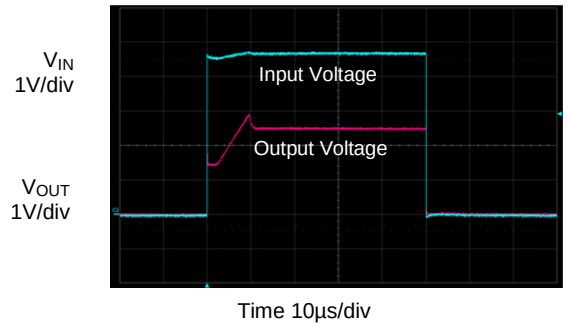


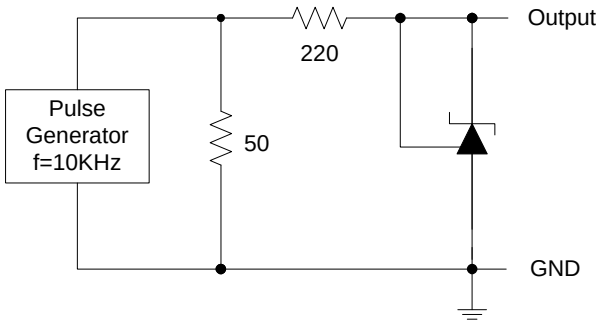


NEW PRODUCT

Performance Characteristics (Cont.)

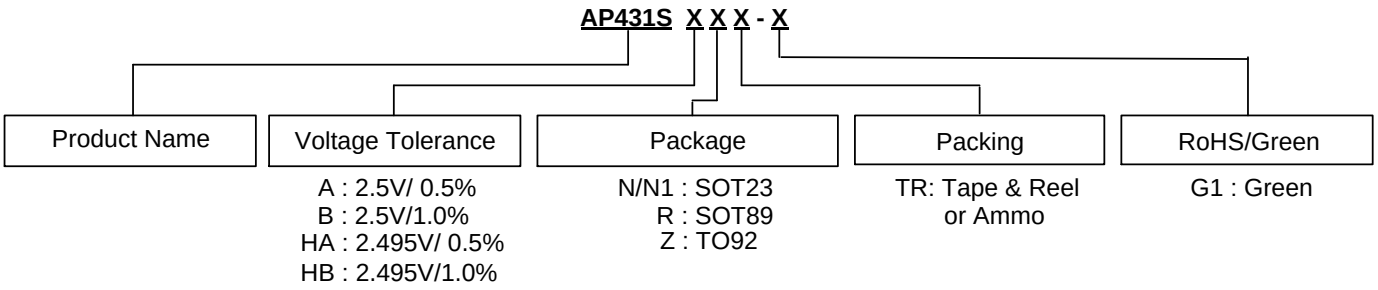
Pulse Response





NEW PRODUCT

Ordering Information



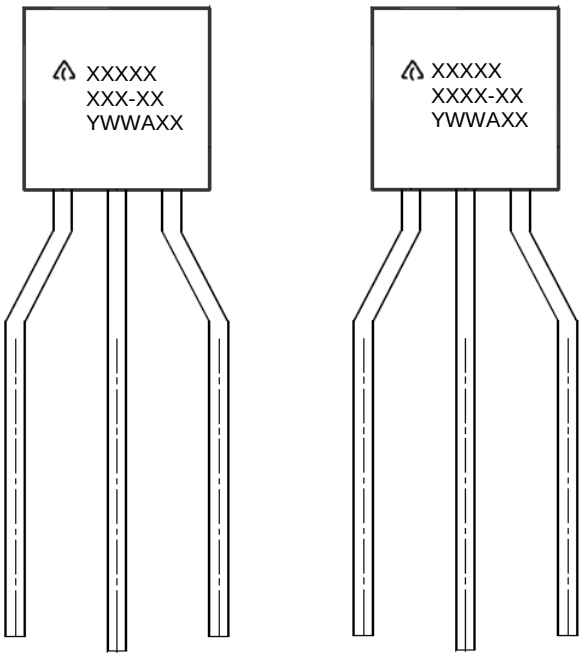
Package	Package Code	Temperature Range	Voltage Tolerance	Part Number	Marking ID	Packing
SOT23	N	-40 to +125°C	0.5%	AP431SANTR-G1	GCA	3,000/Tape & Reel
	N1		0.5%	AP431SAN1TR-G1	GCC	
	N		0.5%	AP431SHANTR-G1	GCD	
	N1		0.5%	AP431SHAN1TR-G1	GCE	
	N		1.0%	AP431SBNTR-G1	GCB	
	N1		1.0%	AP431SBN1TR-G1	GCF	
	N		1.0%	AP431SHBNTR-G1	GCG	
	N1		1.0%	AP431SHBN1TR-G1	GCH	
SOT89	R	-40 to +125°C	0.5%	AP431SARTR-G1	G33M	1,000/Tape & Reel
	R		0.5%	AP431SHARTR-G1	G37M	
	R		1.0%	AP431SBRTR-G1	G33R	
	R		1.0%	AP431SHBRTR-G1	G33S	
TO92	Z	-40 to +125°C	0.5%	AP431SAZTR-G1	AP431SAZ-G1	2,000/Ammo
	Z		0.5%	AP431SHAZTR-G1	AP431SHAZ-G1	
	Z		1.0%	AP431SBZTR-G1	AP431SBZ-G1	
	Z		1.0%	AP431SHBZTR-G1	AP431SHBZ-G1	

NEW PRODUCT

Marking Information

(1) TO92 (Ammo Packing)

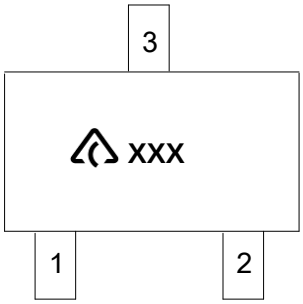
(Front View)



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: Internal Code

(2) SOT23

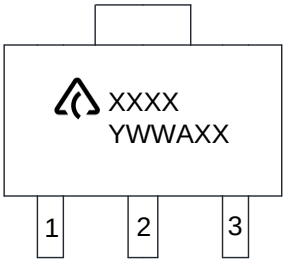
(Top View)



: Logo
XXX: Marking ID (See Ordering Information)

(3) SOT89

(Top View)

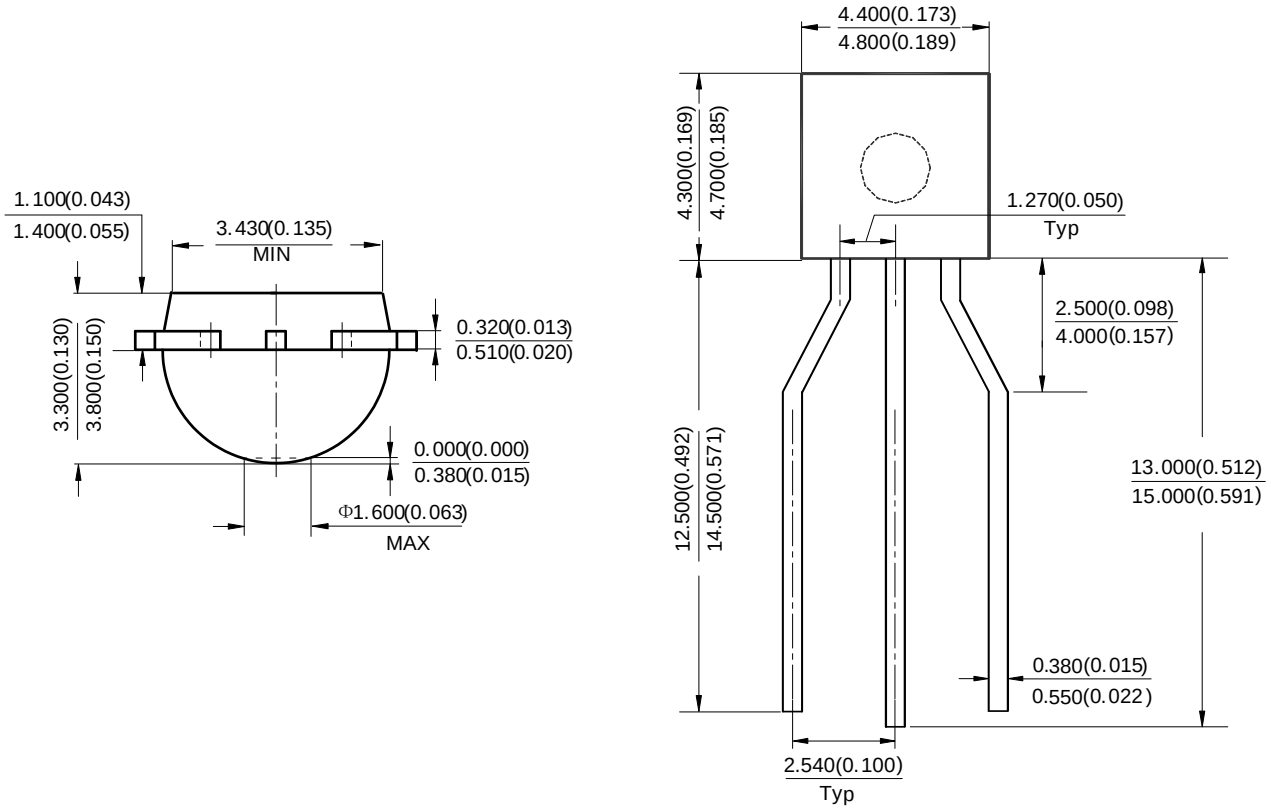


First Line: Logo and Marking ID
(See Ordering Information)
Second Line: Date Code
Y: Year
WW: Work Week of Molding
A: Assembly House Code
XX: Internal Code

NEW PRODUCT

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

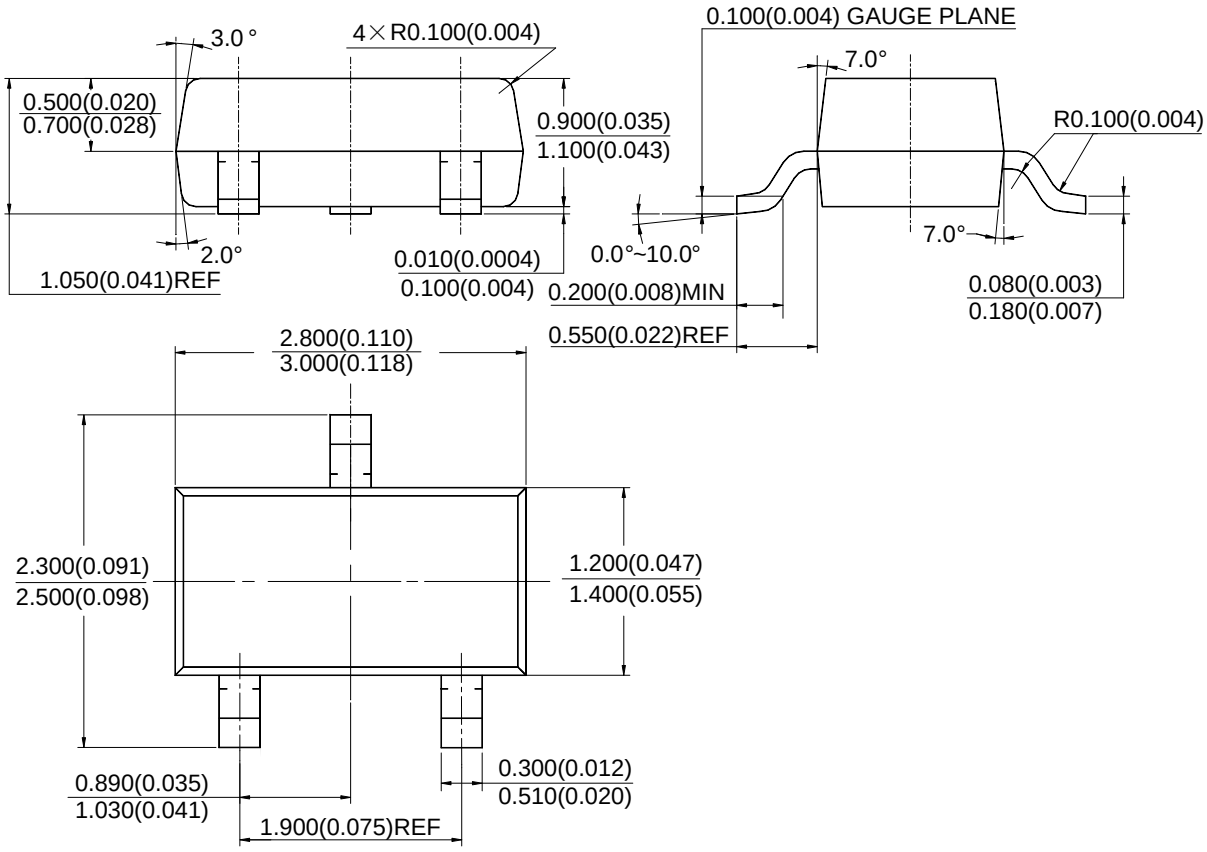
(1) Package Type: TO92 (Ammo Packing)



NEW PRODUCT

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

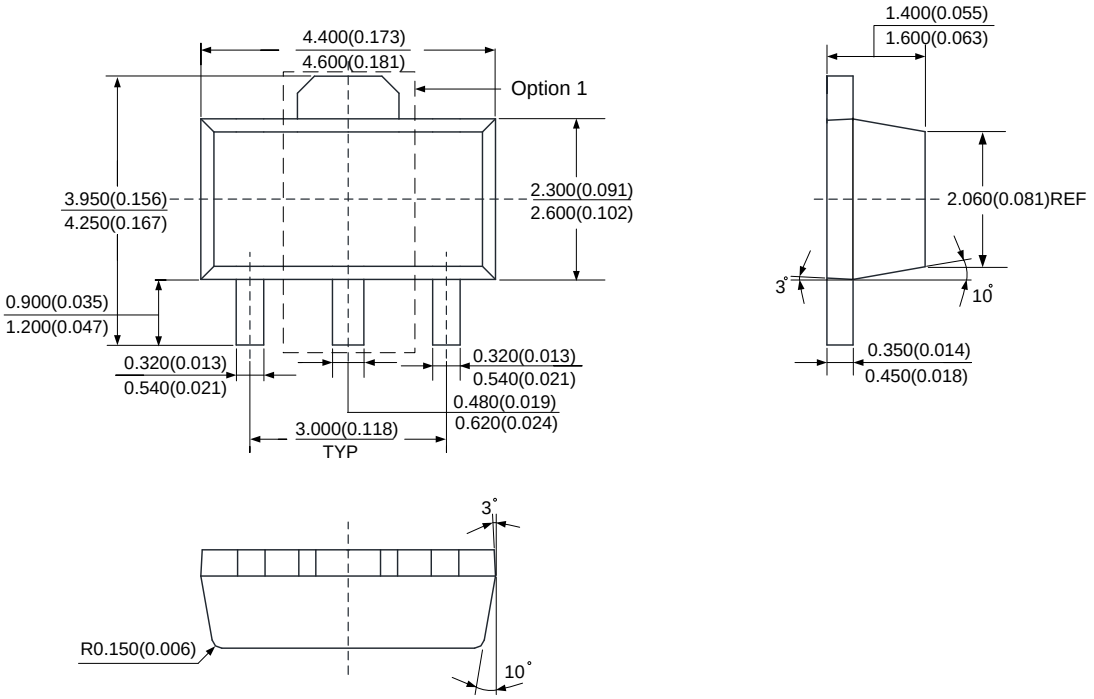
(2) Package Type: SOT23

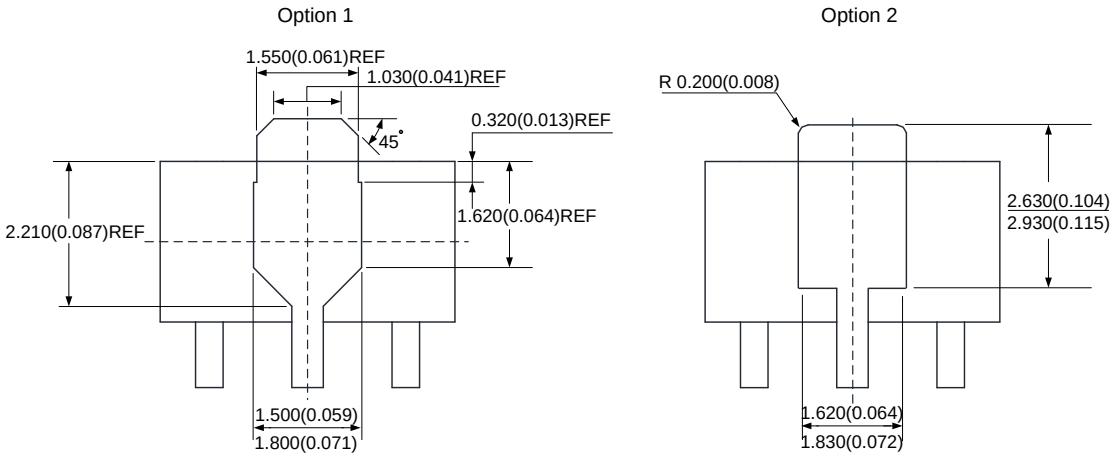


NEW PRODUCT

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

(3) Package Type: SOT89

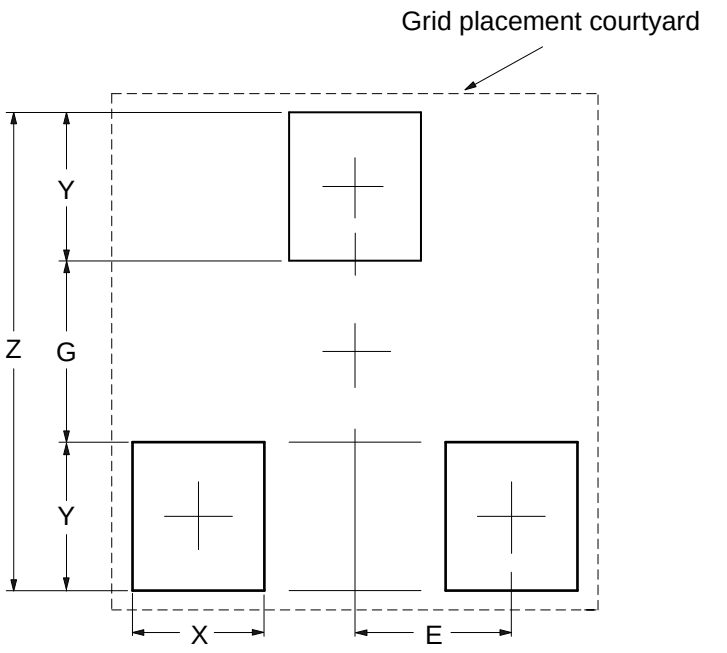




NEW PRODUCT

Suggested Pad Layout

(1) Package Type: SOT23

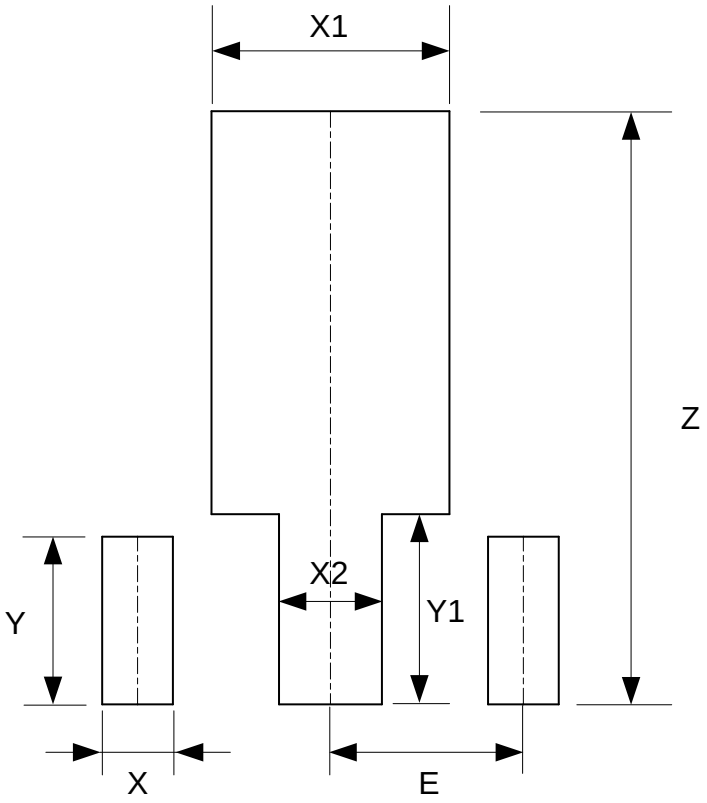


Dimensions	Z (mm)/(inch)	G (mm)/(inch)	X (mm)/(inch)	Y (mm)/(inch)	E (mm)/(inch)
Value	2.900/0.114	1.100/0.043	0.800/0.031	0.900/0.035	0.950/0.037

NEW PRODUCT

Suggested Pad Layout (Cont.)

(2) Package Type: SOT89



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

NEW PRODUCT

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A. Life support devices or systems are devices or systems which:

1. are intended to implant into the body, or
2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

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