



Adjustable Precision Shunt Regulators

Features

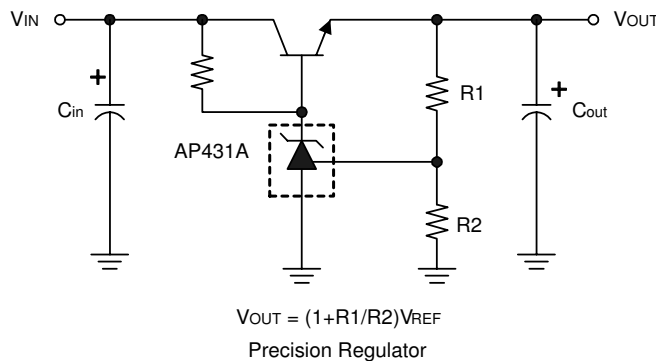
- Precision reference voltage
 B : 2.495V ±1%
 A : 2.495V ±0.5%
- Sink current capability: 200mA.
- Minimum cathode current for regulation: 300µA
- Equivalent full-range temp coefficient: 30 ppm/°C
- Fast turn-on response.
- Low dynamic output impedance: 0.2Ω
- Programmable output voltage to 36V
- Low output noise
- Packages: SOT-89, SOT-23, SOT-23-5L, SO-8 and TO-92
- RoHS-compliant , halogen-free

Description

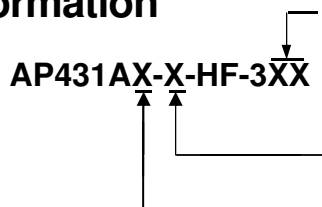
The AP431A-HF-3 are adjustable precision shunt regulators with guaranteed temperature stability over the applicable extended commercial temperature range. The output voltage may be set at any level greater than 2.495V (VREF) up to 36V merely by selecting two external resistors that act as a voltage divider network. These devices have a typical output impedance of 0.2Ω. Active output circuitry provides very sharp turn-on characteristics, making these devices excellent improved replacements for Zener diodes in many applications.

The precise ±1% reference voltage tolerance of the AP431A-HF-3 makes it possible in many applications to avoid the use of a variable resistor, consequently saving cost and eliminating the drift and reliability problems associated with it.

Typical Application



Ordering information



Packing: AP = Ammo-pak (for TO-92)
 TR = tape and reel (surface mount packages only)

Reference Voltage and Tolerance:

A : 2.495V ±0.5%
 Blank : 2.495V ±1%

Package code:

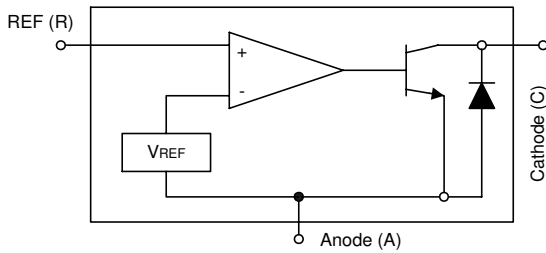
M : SO-8
 G : SOT-89
 T : TO-92
 N/NR : SOT-23
 Y/Y5 : SOT-23-5

For example, AP431AY-HF-3TR:

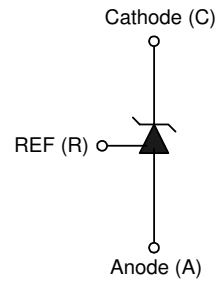
AP431A 1% tolerance in RoHS-compliant halogen-free SOT-23-5, packed in tape and reel



Block Diagram



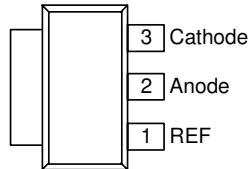
Symbol



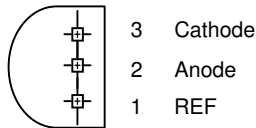
Pin Configurations

Pin Configuration (Top View)

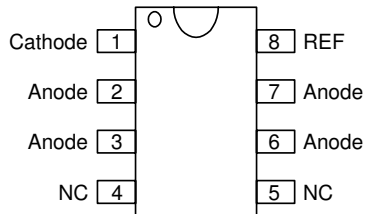
AP431AG
(SOT-89)



AP431AT
(TO-92)

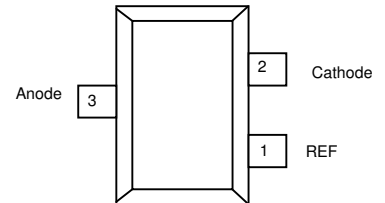


AP431AM
(SO-8)

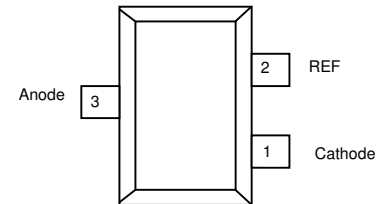


Pin Configuration (Top View)

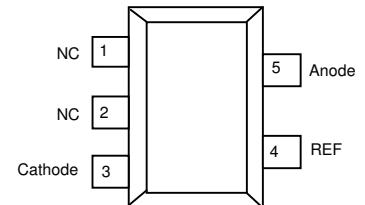
AP431AN
(SOT-23)



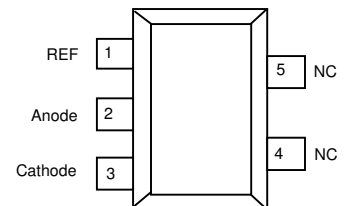
AP431ANR
(SOT-23)



AP431AY
(SOT-23-5)



AP431AY5
(SOT-23-5)



THIS PRODUCT IS SENSITIVE TO ELECTROSTATIC DISCHARGE, PLEASE HANDLE WITH CAUTION.

USE OF THIS PRODUCT AS A CRITICAL COMPONENT IN LIFE SUPPORT OR OTHER SIMILAR SYSTEMS IS NOT AUTHORIZED.

APEC DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS.

APEC RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION OR DESIGN.



Absolute Maximum Ratings

Cathode Voltage.....	.....	36V
Continuous cathode current .....	.....	-10mA ~ 250mA
Reference input current range .....	.....	10mA
Operating temperature range .....	.....	-20°C ~ 85°C
Lead Temperature.....	.....	260 °C
Storage Temperature .....	.....	-65°C ~ 150°C
Power Dissipation (Notes 1, 2)	SOT-89	0.50W
	TO-92.....	0.78W
	SOT-23	0.25W
	SOT-23-5.....	0.25W
	SO-8.....	0.6W

Note 1: Maximum junction temperature =150°C. .
 Note 2: Ratings apply at ambient temperature of 25°C

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

PARAMETER	TEST CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Reference voltage	$V_{KA} = V_{REF}$, $I_{KA} = 10mA$ (Fig.1)	-B -A V_{REF}	2.470 2.482	2.495	2.520 2.507	V
Deviation of Reference input voltage over temperature (Note 3)	$V_{KA} = V_{REF}$, $I_{KA} = 10mA$, $T_a = \text{Full range}$ (Fig.1)	V_{REF}		8.0	20	mV
Ratio of the change in Reference voltage to the change in Cathode voltage	$I_{KA} = 10mA$ (Fig.2)	$V_{KA} = 10V$ $\sim V_{REF}$		-1.4	-2.0	mV/V
		$V_{KA} = 36V \sim 10V$	ΔV_{KA}		-1	-2	mV/V
Reference input current	$R1 = 10k\Omega$, $R2 = \infty$, $I_{KA} = 10mA$ (Fig.2)	I_{REF}		1.4	3.5	μA
Deviation of Reference input current over temperature	$R1 = 10k\Omega$, $R2 = \infty$, $I_{KA} = 10mA$ $T_a = \text{Full range}$ (Fig.2)	αI_{REF}		0.4	1.2	μA
Minimum Cathode current for regulation	$V_{KA} = V_{REF}$ (Fig.1)	$I_{KA(MIN)}$		0.19	0.5	mA
Off-state current	$V_{KA} = 36V$, $V_{REF} = 0V$ (Fig.3)	$I_{KA(OFF)}$		0.1	1.0	μA
Dynamic output impedance (Note 4)	$V_{KA} = V_{REF}$ Frequency $\leq 1kHz$ (Fig.1)	$|Z_{KA}|$		0.2	0.5	Ω

Test Circuits

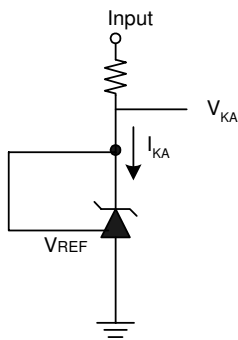


Fig1. Test Circuit for $V_{KA} = V_{REF}$

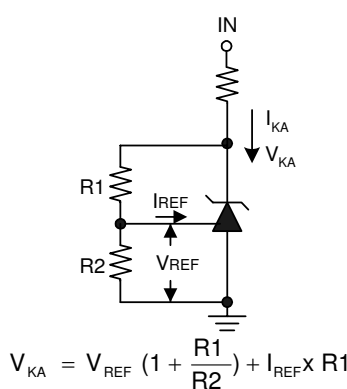


Fig2. Test circuit for $V_{KA} > V_{REF}$

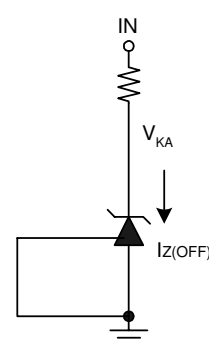
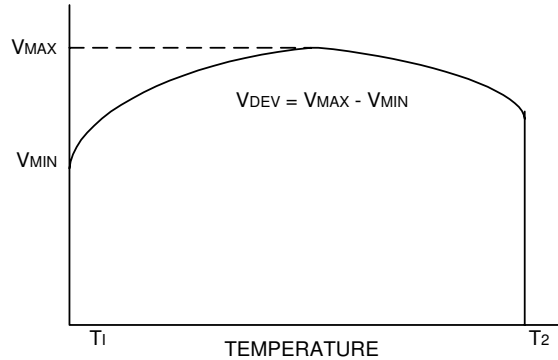


Fig3. Test Circuit for off-state Current



Electrical Characteristics (cont.) (Ta=25°C, unless otherwise specified.)

Note 3. Deviation of reference input voltage over temperature.



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

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

$$|\alpha V_{REF}| = \frac{\left(\frac{V_{DEV}}{V_{REF(25^\circ C)}}\right) \times 10^6}{T_2 - T_1} \dots\dots\dots (\text{ppm}/^\circ\text{C})$$

Where:

$T_2 - T_1$ = full temperature change.

αV_{REF} can be positive or negative depending on whether the slope is positive or negative.

Note 4. The dynamic output impedance, R_z

The dynamic output impedance, R_z , is defined as:

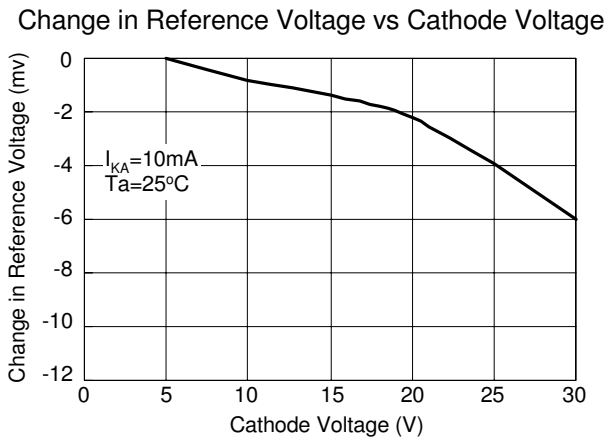
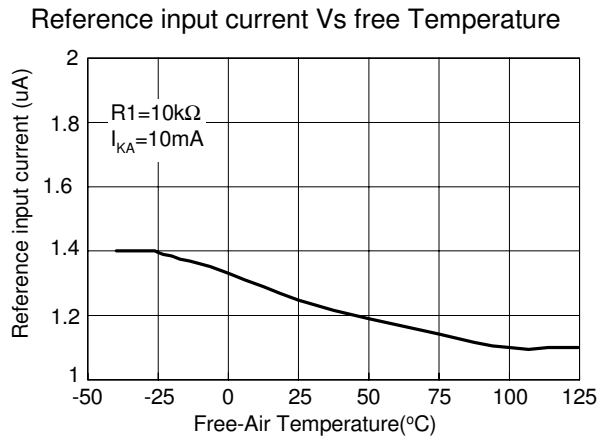
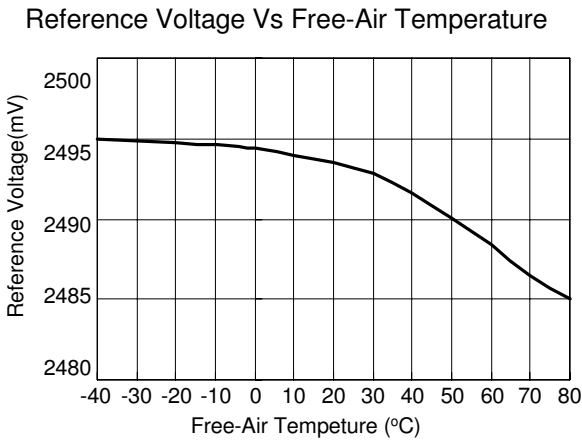
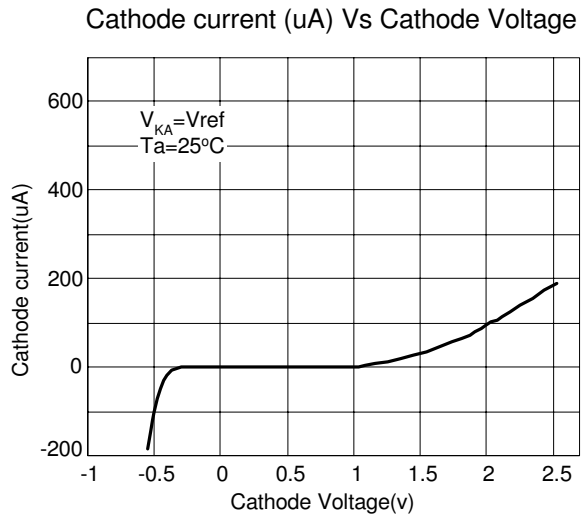
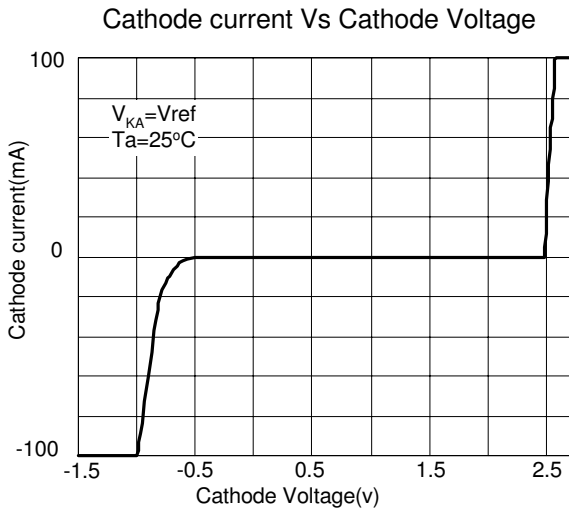
$$|Z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_{KA}}$$

When the device is programmed with two external resistors R_1 and R_2 (see Figure 2.), the dynamic output impedance of the overall circuit, is defined as:

$$|Z_{KA}'| = \frac{\Delta V}{\Delta i} \sim |Z_{KA}| \left(1 + \frac{R_1}{R_2}\right)$$



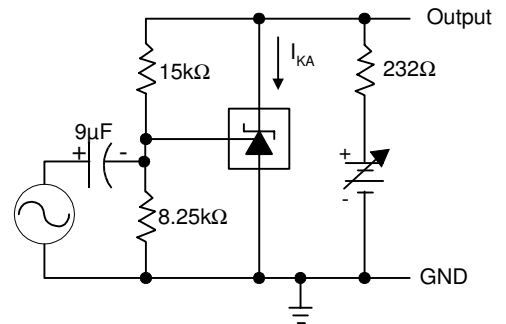
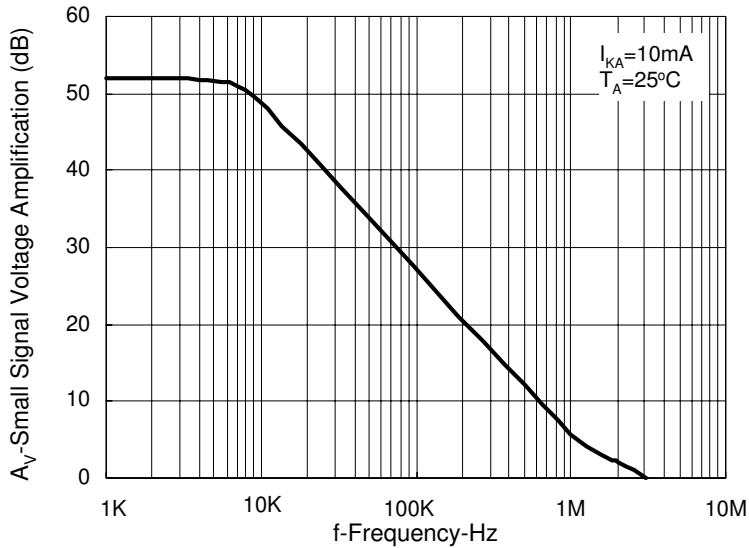
Electrical Characteristics (cont.) ($T_a=25^\circ\text{C}$, unless otherwise specified.)





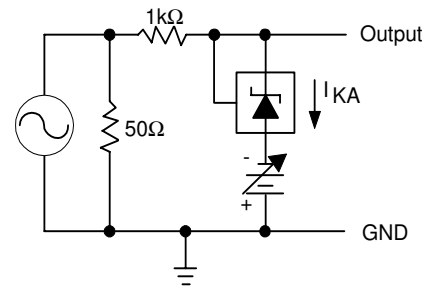
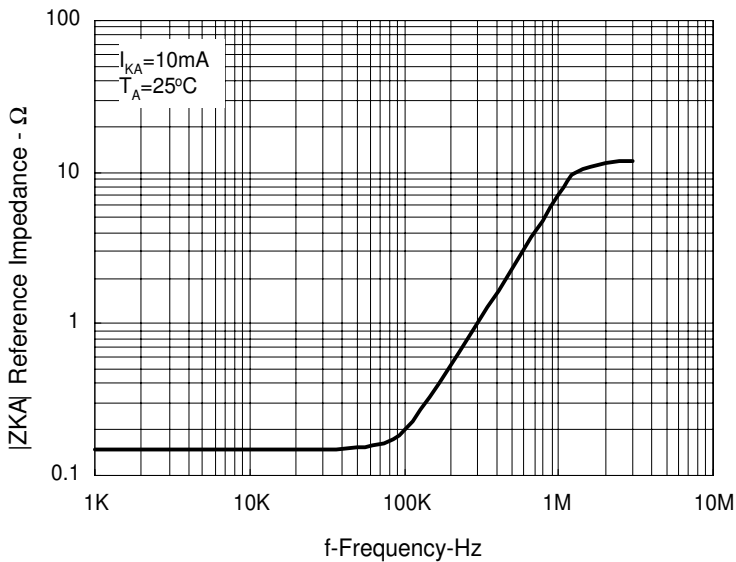
Electrical Characteristics (cont.) ($T_A=25^\circ\text{C}$, unless otherwise specified.)

SMALL-SIGNAL VOLTAGE AMPLIFICATION vs. FREQUENCY



TEST CIRCUIT FOR VOLTAGE AMPLIFICATION

REFERENCE IMPEDANCE vs. FREQUENCY

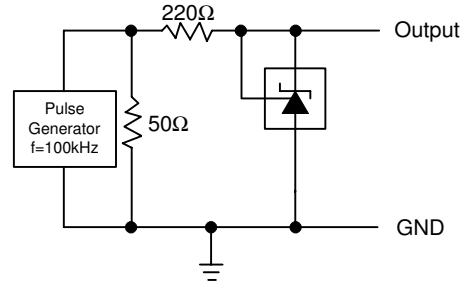
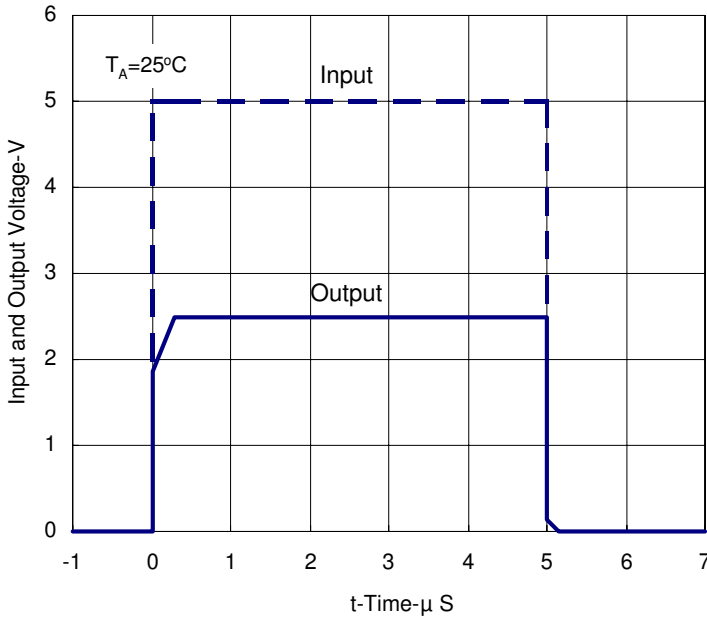


TEST CIRCUIT FOR REFERENCE IMPEDANCE



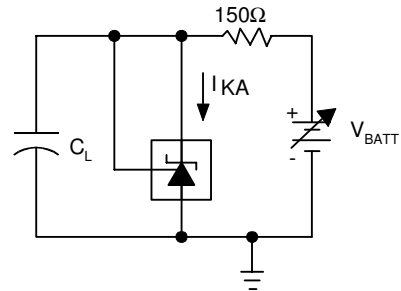
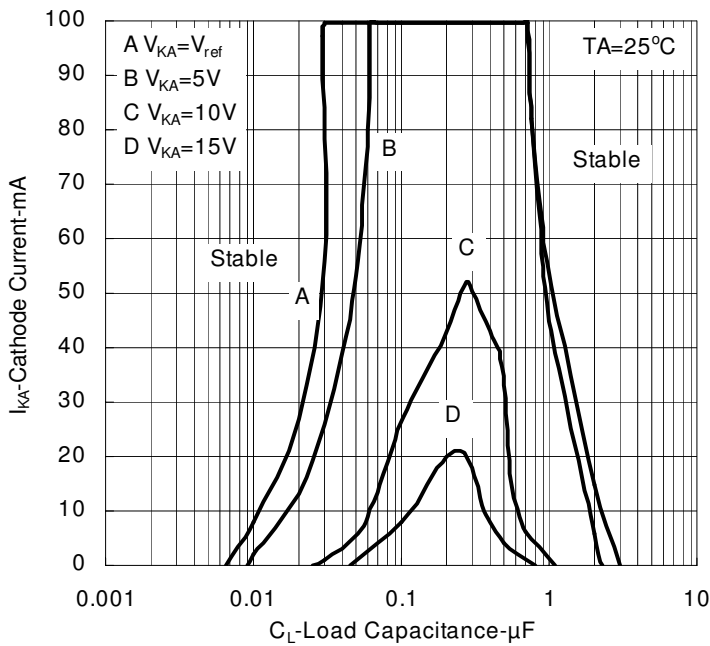
Electrical Characteristics (cont.) (Ta=25°C, unless otherwise specified.)

PULSE RESPONSE

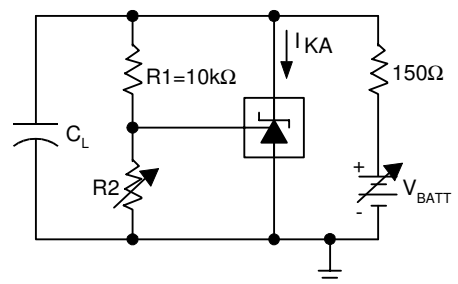


TEST CIRCUIT FOR PULSE RESPONSE

STABILITY BOUNDARY CONDITIONS†



TEST CIRCUIT FOR CURVE A

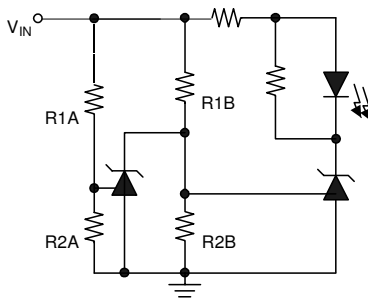


TEST CIRCUIT FOR CURVE B, C, AND D

†The areas under the curves represent conditions that may cause the device to oscillate. For curves B, C, and D, R2 and V+ were adjusted to establish the initial VKA and IKA conditions with CL=0. VBATT and CL were then adjusted to determine the ranges of stability.

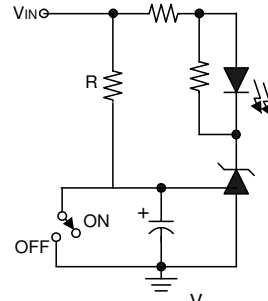


Application Examples



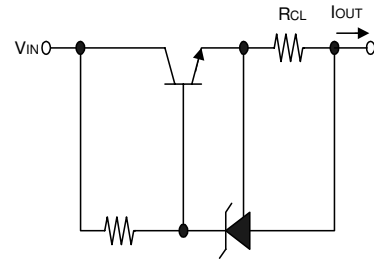
LED on when Low Limit < VIN < High Limit
Low Limit ≈ VREF (1 + R1B/R2B)
High Limit ≈ VREF (1 + R1A/R2A)

Fig.4 Voltage Monitor



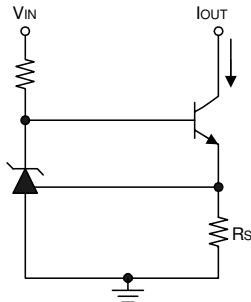
$$\text{Delay} = RC \times \ln\left(\frac{V_{IN}}{V_{IN} - V_{REF}}\right)$$

Fig.5 Delay Timer



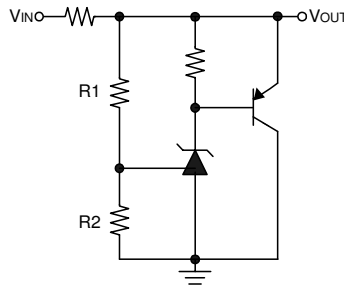
$$I_{OUT} = V_{REF} / R_{CL}$$

Fig.6 Current Limiter or Current Source



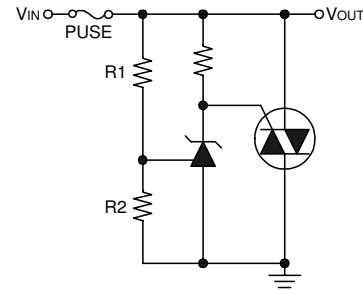
$$I_{OUT} = V_{REF} / R_s$$

Fig.7 Constant-Current Sink



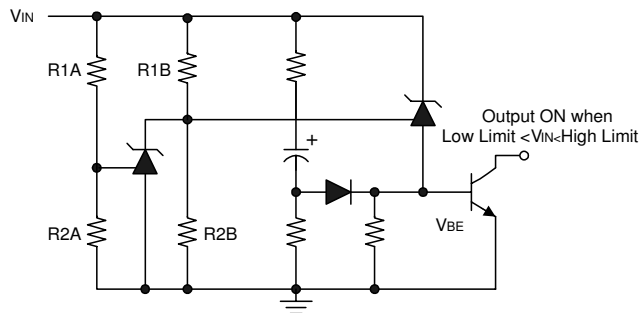
$$V_{OUT} = (1 + R1/R2) \times V_{REF}$$

Fig.8 Higher-Current Shunt Regulator



$$\text{LIMIT} \approx (1 + R1/R2) \times V_{REF}$$

Fig.9 Crow Bar

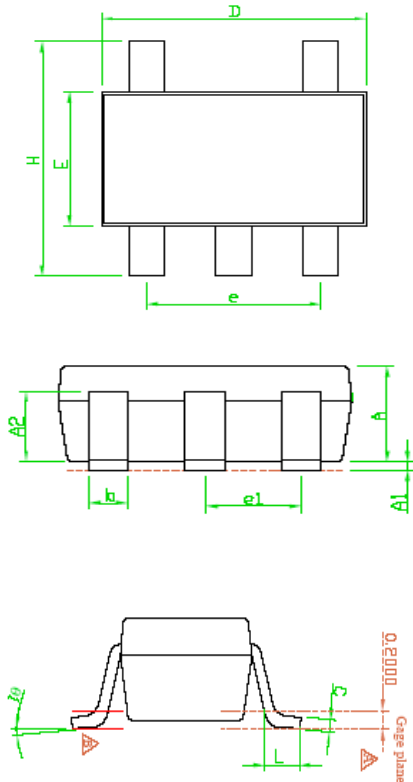


Low Limit ≈ VREF(1 + R1B/R2B) + VBE
High Limit ≈ VREF(1 + R1A/R2A)

Fig.10 Over-Voltage / Under-Voltage Protection Circuit



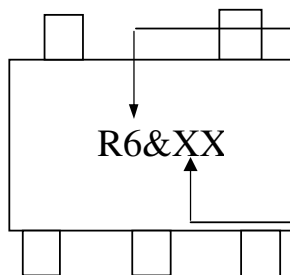
Package Dimensions: SOT-23-5L



SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	1.00	1.10	1.30
A1	0.00	---	0.10
A2	0.70	0.80	0.90
b	0.35	0.40	0.50
C	0.10	0.15	0.25
D	2.70	2.90	3.10
E	1.50	1.60	1.80
e	---	1.90(TYP)	---
H	2.60	2.80	3.00
L	0.37	---	---
$\theta 1$	1°	5°	9°
e2	---	0.95(TYP)	---

- Note 1: Package body sizes exclude mold flash protrusions or gate burrs.
- Note 2: Tolerance ± 0.1000 mm (4mil) unless otherwise specified.
- Note 3: Coplanarity: 0.1000 mm
- Note 4: Dimension L is measured in gage plane.

Marking Information



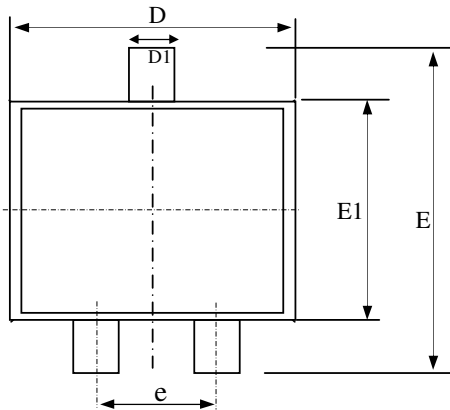
Product: R6XX = AP431AY
R65XX = AP431AY5

Date/lot code

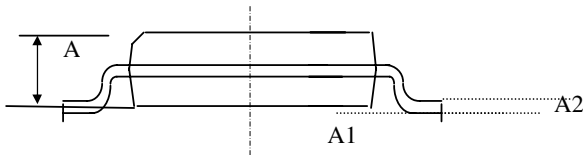
For details of how to convert this to standard YYWW date code format, please contact us directly.



Package Dimensions: SOT-23

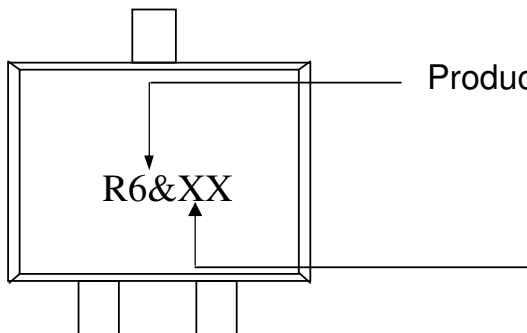


SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	1.00	1.15	1.30
A1	0.00	--	0.10
A2	0.10	0.15	0.25
D1	0.30	0.40	0.50
e	1.70	2.00	2.30
D	2.70	2.90	3.10
E	2.40	2.65	3.00
E1	1.40	1.50	1.60



1. All dimensions are in millimeters.
2. Dimensions do not include mold protrusions.

Marking Information



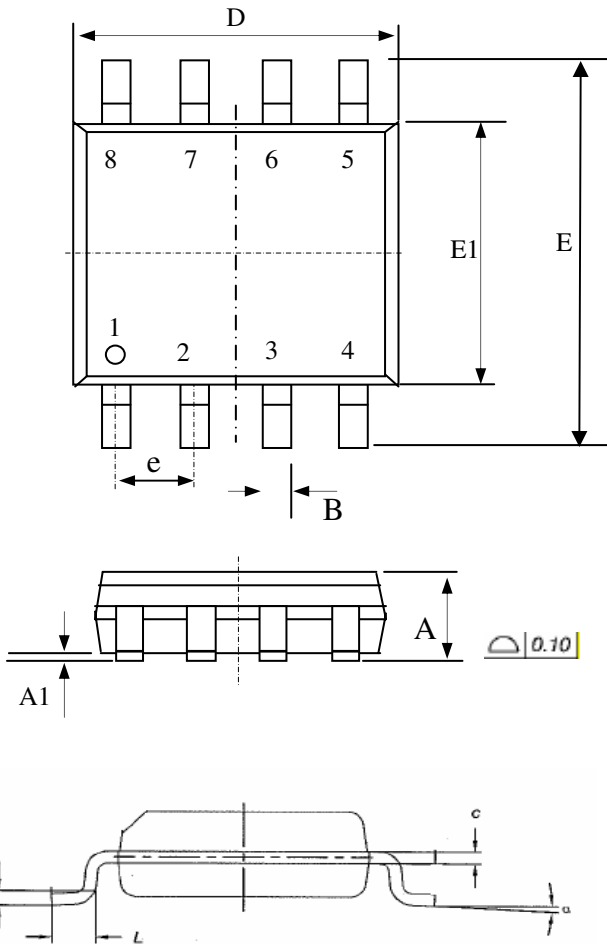
Product: R6XX = AP431AN
R6RXX = AP431ANR

Date/lot code

For details of how to convert this to standard YYWW date code format, please contact us directly.



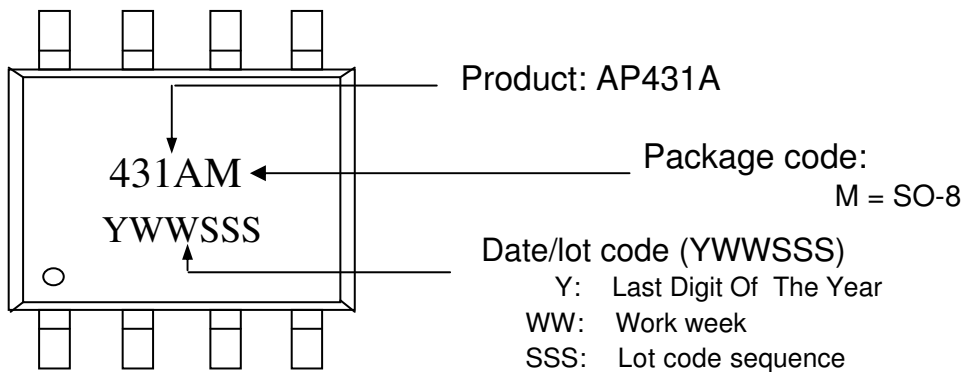
Package Dimensions: SO-8



SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	1.35	1.55	1.75
A1	0.10	0.18	0.25
B	0.33	0.41	0.51
c	0.19	0.22	0.25
D	4.80	4.90	5.00
E	5.80	6.15	6.50
E1	3.80	3.90	4.00
e	1.27 TYP		
G	0.254 TYP		
L	0.38	-	0.90
α	0.00	4.00	8.00

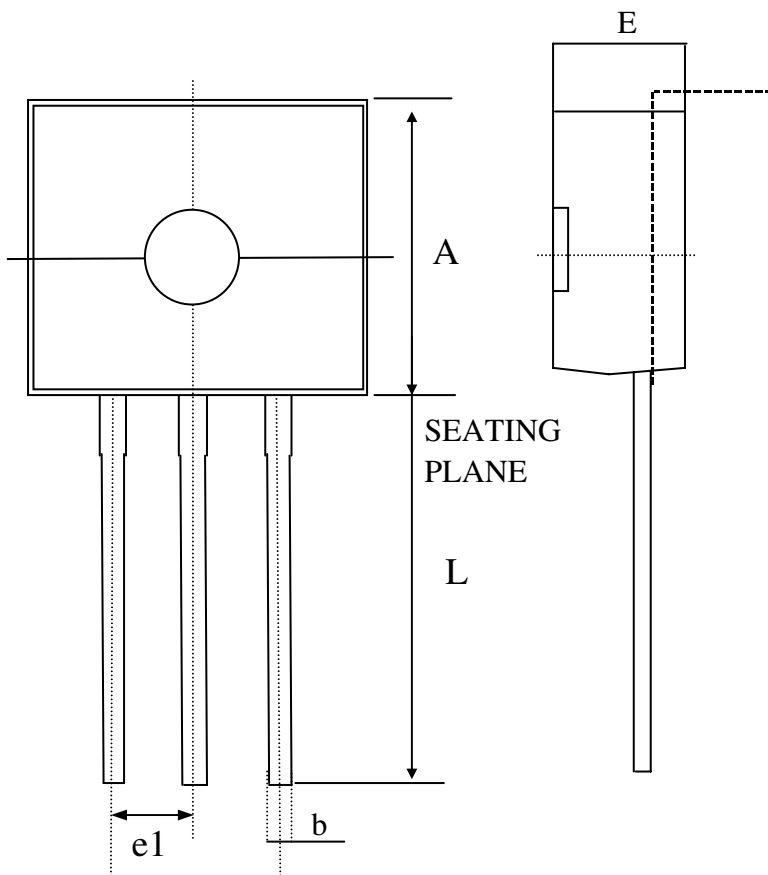
1. All dimensions are in millimeters.
2. Dimensions do not include mold protrusions.

Marking Information



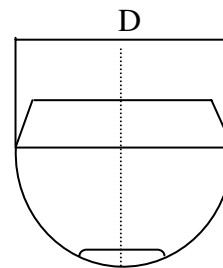


Package Dimensions: TO-92

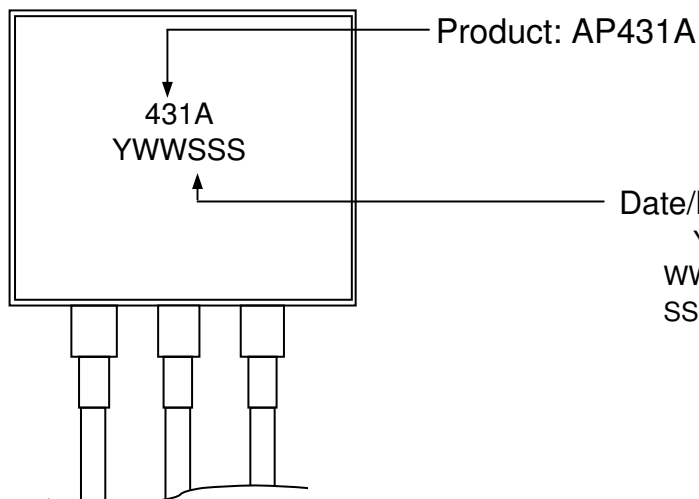


SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	4.32	4.83	5.34
D	4.1	4.8	5.3
E	3.1	3.9	4.7
b	----	0.38	----
L	12.7	---	----
e1	----	1.27	----

1. All dimensions are in millimeters.
2. Dimensions do not include mold protrusions.



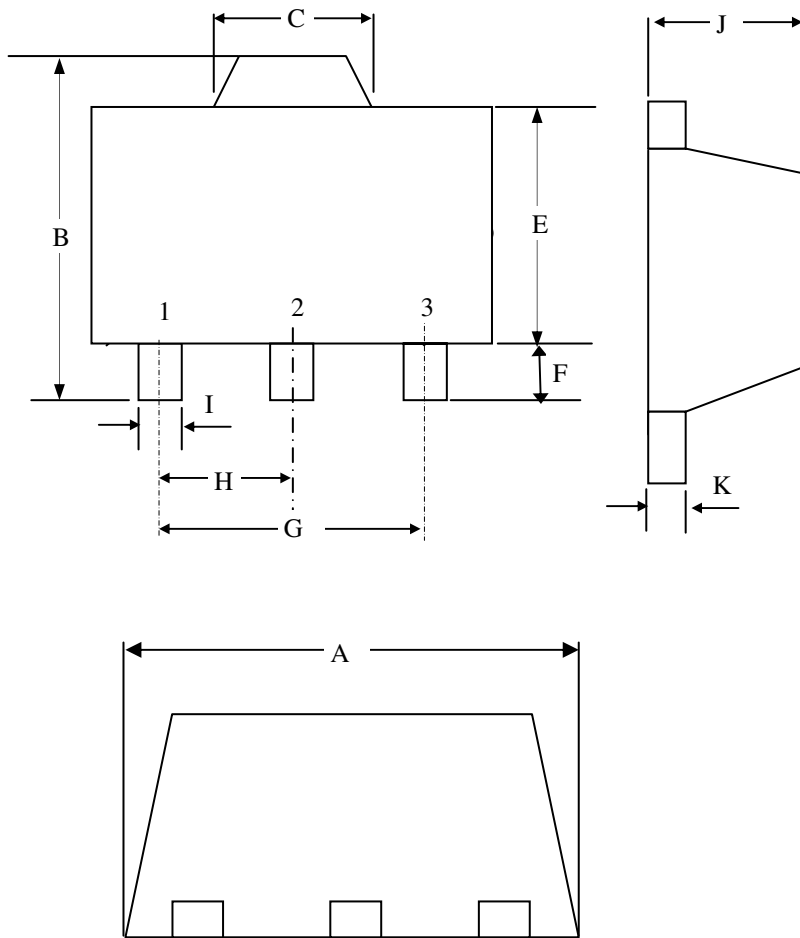
Marking Information



Date/lot code (YWWSSS)
 Y: Last Digit Of The Year
 WW: Work week
 SSS: Lot code sequence



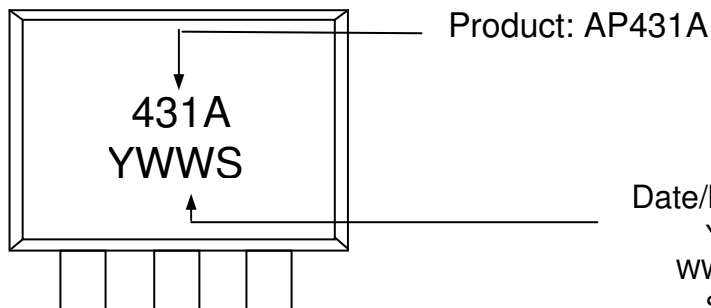
Package Dimensions: SOT-89



SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	4.40	-	4.60
B	4.05	-	4.25
C	1.40	-	1.75
E	2.40	-	2.60
F	0.89	-	1.20
I	0.35	-	0.55
H	----	1.50	----
G	----	3.00	----
J	1.40	-	1.60
K	0.35	-	0.43

1. All dimensions are in millimeters.
2. Dimensions do not include mold protrusions.

Marking Information



Date/lot code (YWWS)
 Y: Last Digit Of The Year
 WW: Work week
 S: Lot code sequence