Adjustable Precision Shunt Regulator

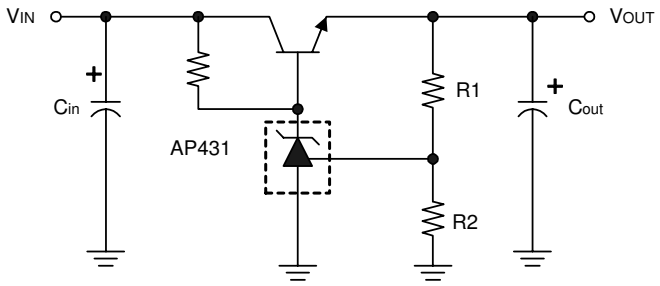
Features

- Precision reference voltage
  2.495V ±1%
- Sink current capability: 100mA.
- Minimum cathode current for regulation: 0.4mA
- Fast turn-on response.
- Low dynamic output impedance: 0.5Ω max.
- Programmable output voltage to 18V
- ESD rating of 5.5kV (per MIL-STD-883D)
- Packages: SOT-89, SOT-23, SO-8
  and TO-92
- RoHS-compliant, halogen-free

Description

The AP431-3 are 3-terminal adjustable precision shunt regulators with guaranteed temperature stability over the temperature range from 0℃ to 105℃.
The output voltage may be set at any level between V_{REF} (approximately 2.5V) up to 18V 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 AP431-3 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



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

Precision Regulator

Ordering information

AP431X-HF-3XX

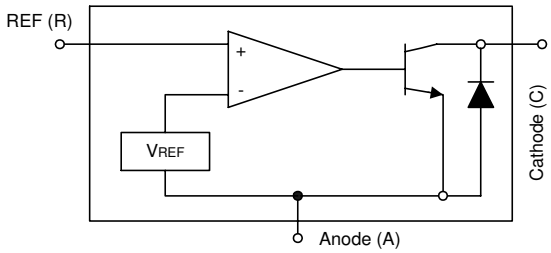
Packing: AP = Ammo-pak (for TO-92)
TR = tape and reel (surface mount packages only)

Package code:
M : SO-8
G : SOT-89
T : TO-92
N : SOT-23

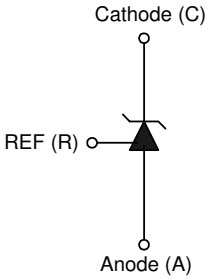
For example, AP431N-HF-3TR:

AP431 in RoHS-compliant halogen-free SOT-23, packed in tape and reel

Block Diagram



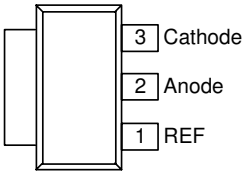
Symbol



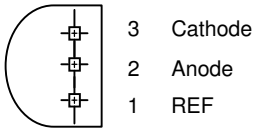
Pin Configurations

Pin Configuration (Top View)

AP431G
(SOT-89)

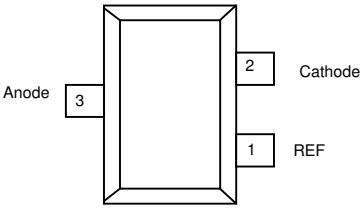


AP431T
(TO-92)

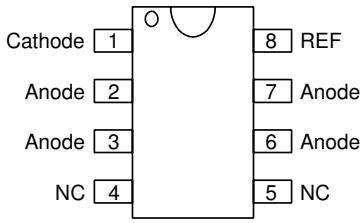


Pin Configuration (Top View)

AP431N
(SOT-23)



AP431M
(SO-8)



Absolute Maximum Ratings

Cathode Voltage		18V
Continuous cathode current		150mA
Reference input current range		10mA
Operating temperature range		0℃ to 105℃
Lead Temperature		260℃
Storage Temperature		-65℃ to 150℃
Power Dissipation (Notes 1, 2)	SOT-89	0. 50W
	TO-92	0.78W
	SOT-23	0.25W
	SO-8	0.6W

Note 1: Maximum junction temperature =125°C.
Note 2: Ratings apply at ambient temperature of 25℃

Electrical Characteristics (T_A=25℃, unless otherwise specified.)

PARAMETER	SYMBOL	TEST CIRCUIT	TEST CONDITIONS	AP431			UNIT
				MIN	TYP	MAX	
Reference voltage 1%	V_{ref}	1	V_{KA} = V_{ref} I_{KA} = 10mA	2470	2495	2520	mV
Deviation of reference voltage over full temperature range	$V_{I(dev)}$	1	V_{KA} = V_{ref} , I_{KA} = 10mA T_A = full range		4	25	mV
Ratio of change in reference voltage to the change in cathode voltage	$\frac{\Delta V_{ref}}{\Delta V_{KA}}$	2	I_{KA} = 10mA ΔV_{KA} = 10 V - V_{ref}		-1.4	-2.7	mV/V
Reference current	I_{ref}	2	I_{KA} = 10mA, R1=10kΩ, R2 = ∞		2	4	μA
Deviation of reference current over full temperature range	$I_{I(dev)}$	2	I_{KA} = 10mA, R1=10kΩ, R2 = ∞ T_A = full range		0.4	1.2	μA
Minimum cathode current for regulation	I_{min}	1	V_{KA} = V_{ref}		0.4	1	mA
Off-state cathode current	I_{off}	3	V_{KA} = 18V, V_{ref} = 0		0.1	1	μA
Dynamic impedance	r_Z	1	I_{KA} = 1mA to 100mA, V_{KA} = V_{ref} f ≤ 1kHz		0.2	0.5	Ω

Test Circuits

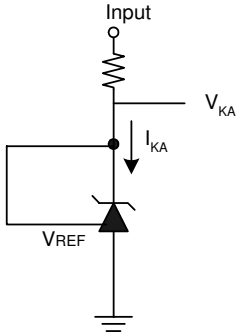
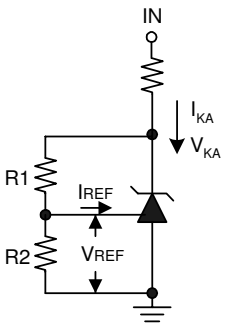


Fig1. Test Circuit for V_{KA}= V_{REF}



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

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

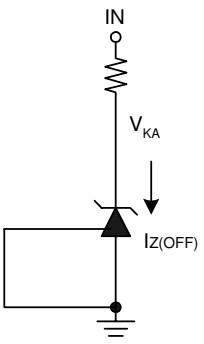
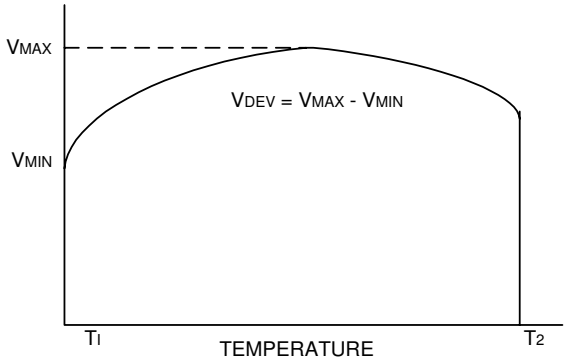


Fig3. Test Circuit for off-state Current

Electrical Characteristics (cont.) (Ta=25℃, 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:

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

Where:
T2 – T1 = 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:

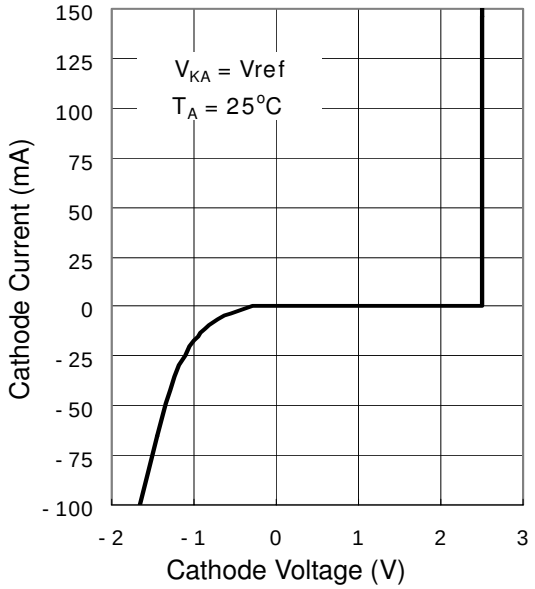
$$\left|Z_{KA}\right| = \frac{\Delta V_{KA}}{\Delta I_{KA}}$$

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

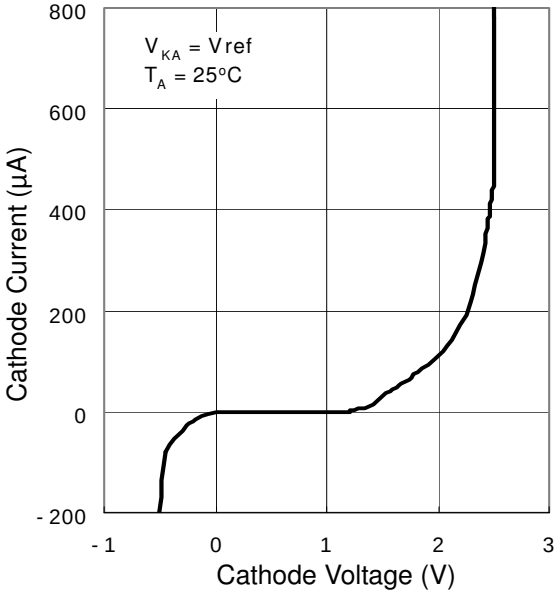
$$\left|Z_{KA}'\right| = \frac{\Delta v}{\Delta i} \sim \left|Z_{KA}\right| \quad (1 + \frac{R1}{R2})$$

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

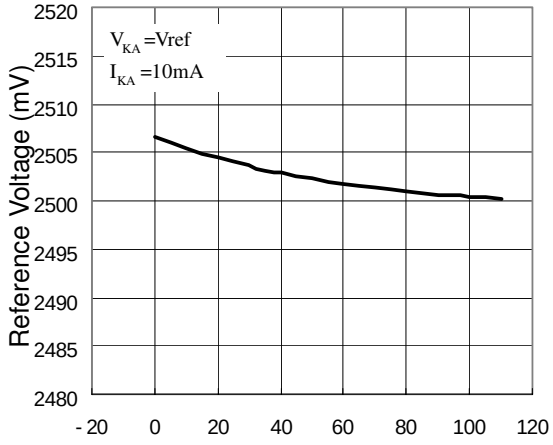
CATHODE CURRENT
Vs.
CATHODE VOLTAGE



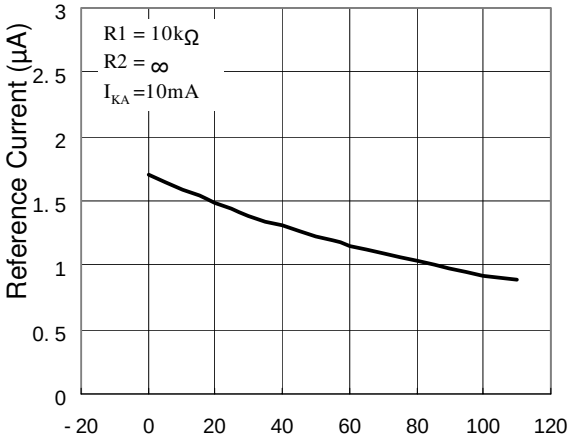
CATHODE CURRENT
Vs.
CATHODE VOLTAGE



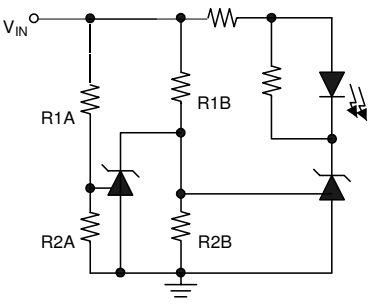
REFERENCE VOLTAGE
Vs.
JUNCTION TEMPERATURE



REFERENCE INPUT CURRENT
Vs.
JUNCTION TEMPERATURE

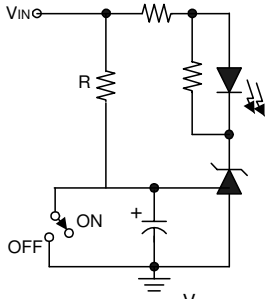


Application Examples



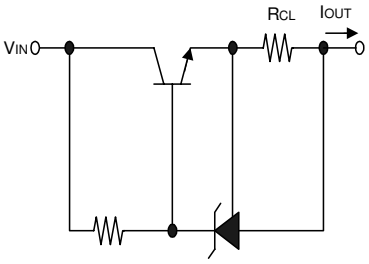
LED on when Low Limit <V_{IN}<High Limit
Low Limit ≈ V_{REF} (1+R1B/R2B)
High Limit ≈ V_{REF} (1+R1A/R2A)

Fig.4 Voltage Monitor



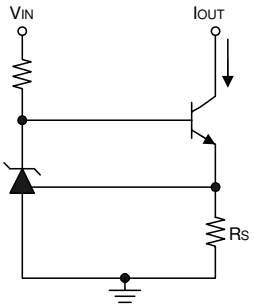
$$\text{Delay} = RC \times \ln\left(\frac{V_{IN}}{V_{IN} - V_{REF}}\right)$$

Fig.5 Delay Timer



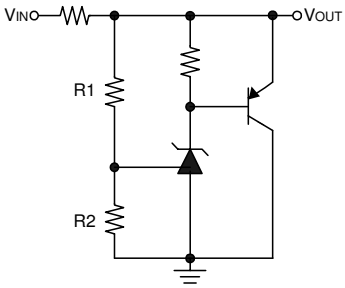
$I_{OUT} = V_{REF} / R_{CL}$

Fig.6 Current Limiter or Current Source



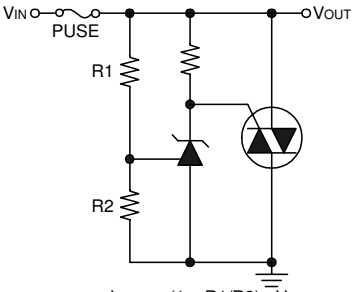
$I_{OUT} = V_{REF} / R_S$

Fig.7 Constant-Current Sink



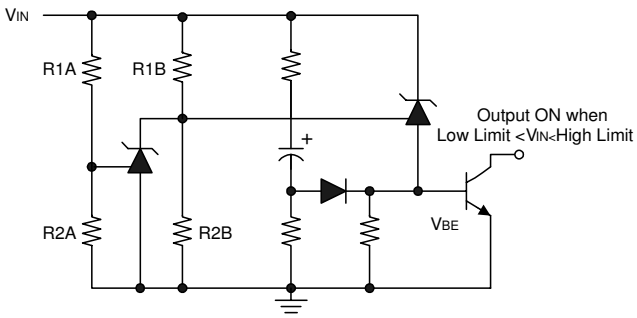
$V_{OUT} = (1 + R1/R2) \times V_{REF}$

Fig.8 Higher-Current Shunt Regulator



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

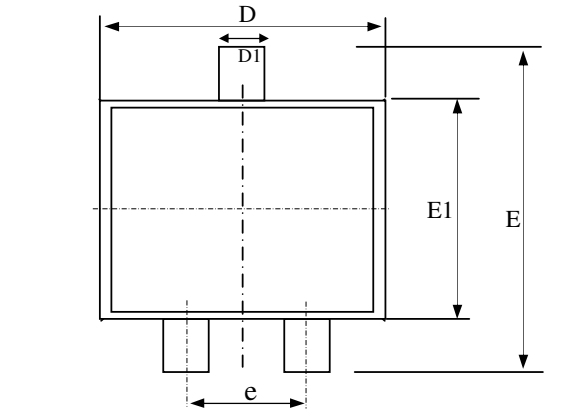
Fig.9 Crow Bar

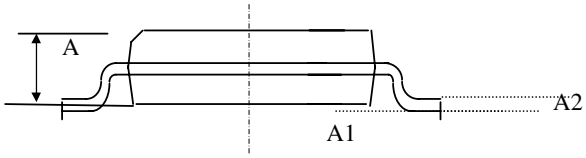


Low Limit ≈ $V_{REF}(1 + R1B/R2B) + V_{BE}$
High Limit ≈ $V_{REF}(1 + R1A/R2A)$

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

Package Dimensions: SOT-23

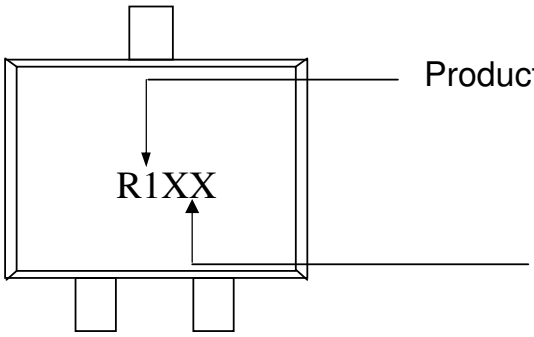




SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	1.00	1.15	1.30
A1	0.00	--	0.10
A2	0.10	0.15	0.25
D1	0.30	0.40	0.50
e	1.70	2.00	2.30
D	2.70	2.90	3.10
E	2.40	2.65	3.00
E1	1.40	1.50	1.60

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

Marking Information

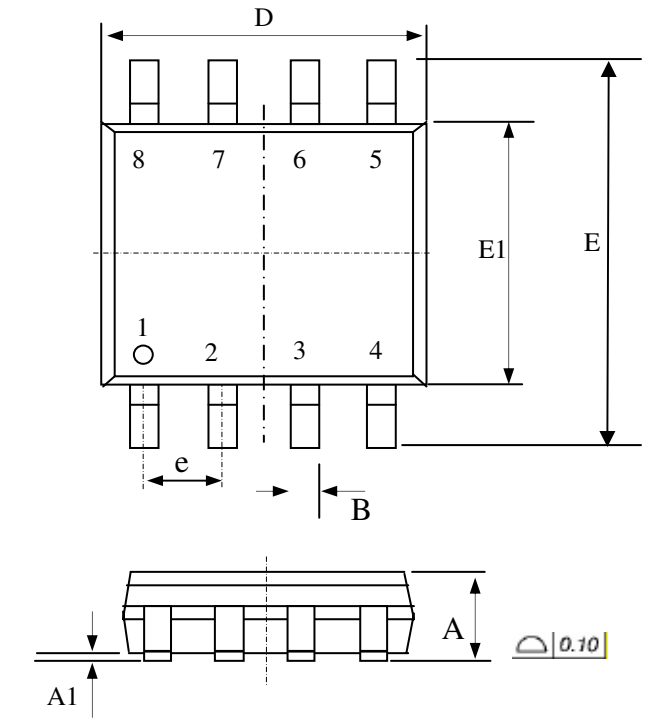


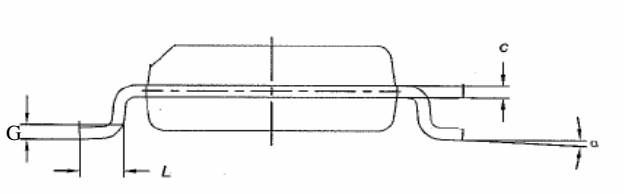
Product: R1XX = AP431N

Date/lot code

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

Package Dimensions: SO-8

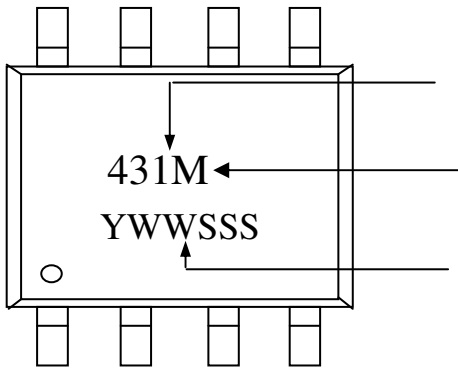




		Millimeters	
SYMBOLS	MIN	NOM	MAX
A	1.35	1.55	1.75
A1	0.10	0.18	0.25
B	0.33	0.41	0.51
c	0.19	0.22	0.25
D	4.80	4.90	5.00
E	5.80	6.15	6.50
E1	3.80	3.90	4.00
e	1.27 TYP		
G	0.254 TYP		
L	0.38	-	0.90
α	0.00	4.00	8.00

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

Marking Information

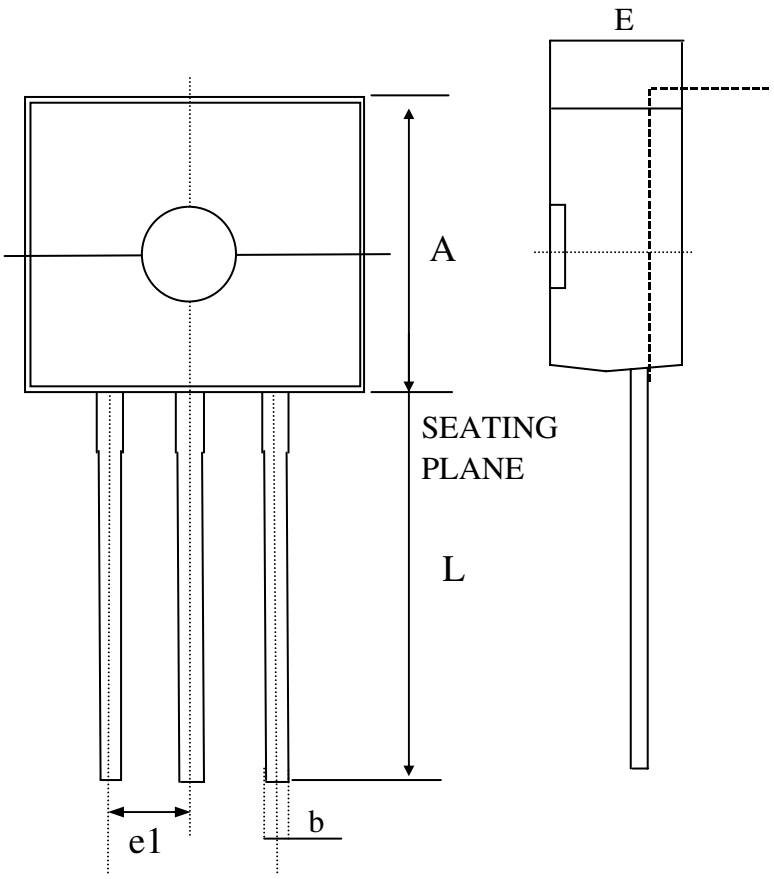


Product: AP431

Package code:
M = RoHS-compliant halogen-free SO-8

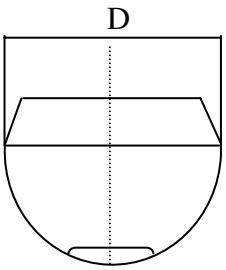
Date/lot code (YWWSSS)
Y: Last Digit Of The Year
WW: Work week
SSS: Lot code sequence

Package Dimensions: TO-92

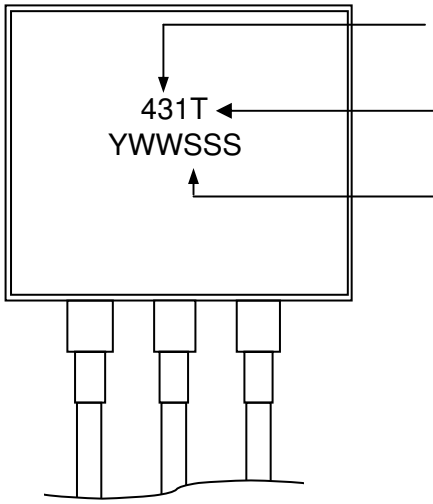


SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	4.32	4.83	5.34
D	4.1	4.8	5.3
E	3.1	3.9	4.7
b	----	0.38	-----
L	12.7	---	----
e1	----	1.27	----

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



Marking Information

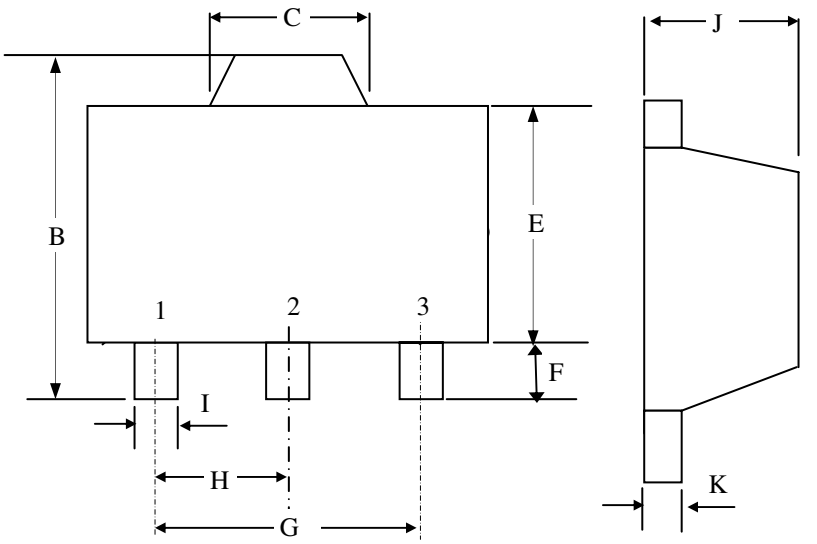


Product: AP431

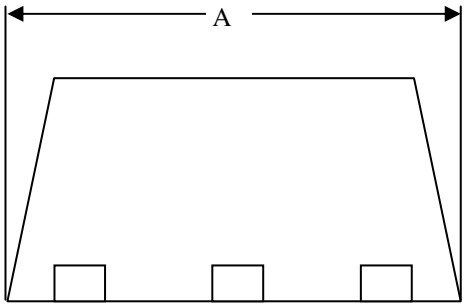
Package code:
T= RoHS-compliant halogen-free TO-92

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