



圓創科技股份有限公司

AT431

Low-Voltage Adjustable Precision Shunt Regulator

Features

- Low-Voltage Operation: Down to 1.24V
- 1% Reference-Voltage Tolerance
- Adjustable Output Voltage, $V_o = V_{ref}$ to 12V
- Low Operational Cathode Current... $50 \mu A$
- 0.25Ω Typical Output Impedance
- SOT-23-3, SOT-23-5 and TO-92 Packages

Application

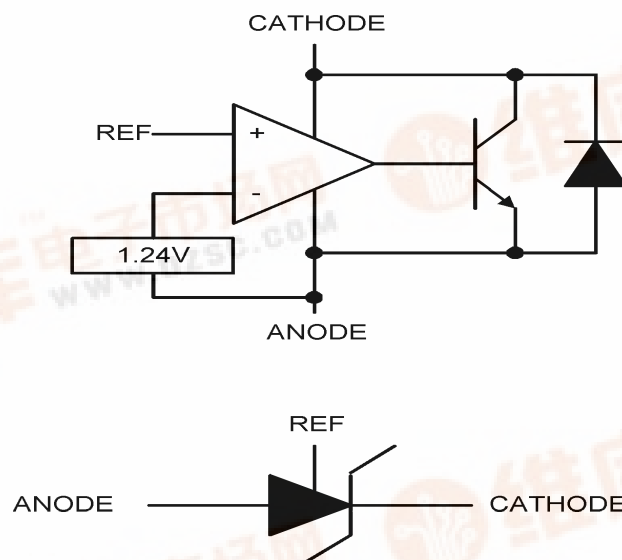
- Linear Regulators
- Voltage Reference for Power Circuit

Description

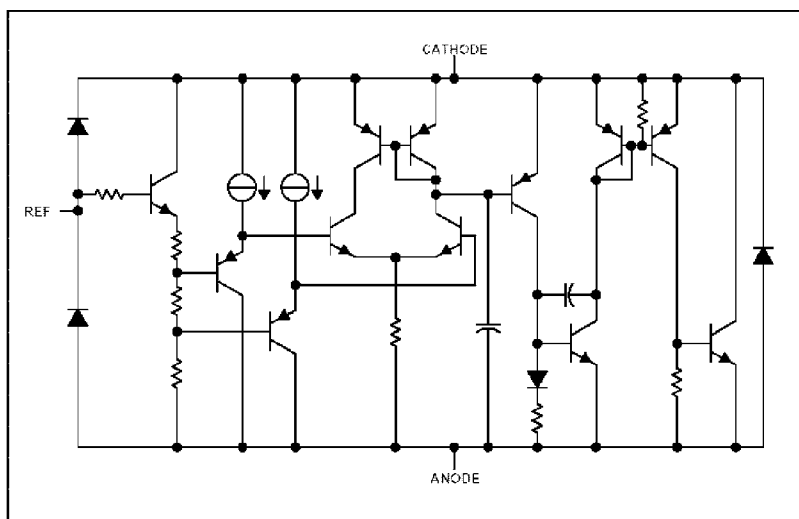
The AT431 is low-voltage three-terminal adjustable voltage reference with specified thermal stability over applicable commercial temperature ranges. Output voltage may be set to any value between V_{ref} (1.24V) and 12V with two external resistors (see Figure 2).

When used with an optocoupler, the AT431 is ideal voltage reference in isolated feedback circuits for 1.8V to 12 V switching-mode power supplies. This device has typical output impedance of 0.20Ω . Active output circuitry provides a very sharp turn-on characteristic, making the AT431 excellent replacements for low-voltage zener diodes in many applications, including onboard regulation and adjustable power supplies.

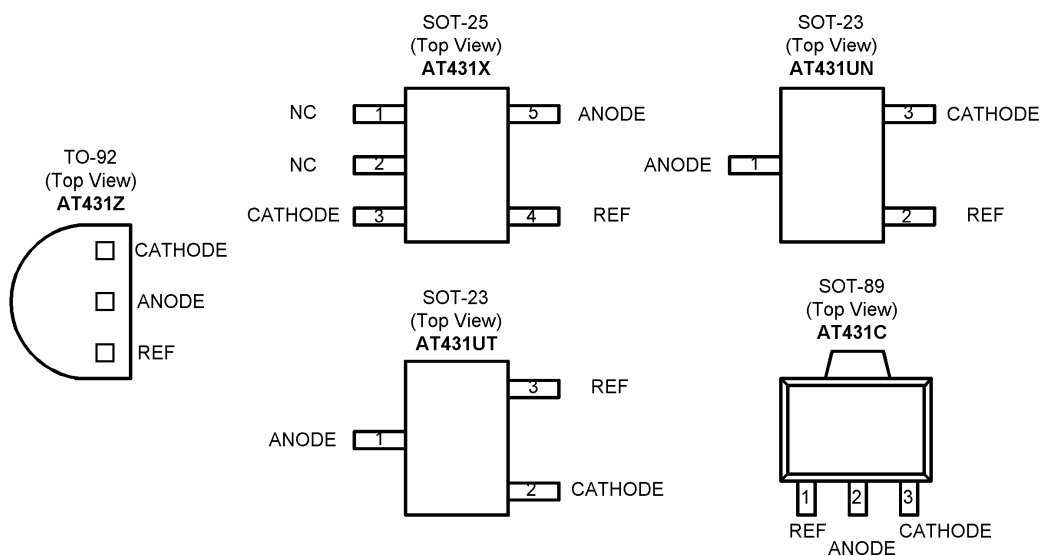
Block Diagram and Symbol



Equivalent Schematic



Pin Assignments



Ordering Information

Part number	Package	Marking
AT431Z	TO-92	□□□Z
AT431X	SOT-25	□□□X
AT431UN	SOT-23	□□□N
AT431UT	SOT-23	□□□T
AT431C	SOT-89	□□□C

* □□□: Data Code

Absolute maximum ratings (T_A = 25°C)

Parameter	Symbol	Limits	unit
Cathode voltage	V _{KA}	12	V
Continuous cathode current range	I _K	-20~20	mA
Reference Current	I _{REF}	-0.05~3	mA
Operating temperature	T _{OPR}	-30~+85	°C
Storage temperature	T _{STG}	-55~+150	°C
Package thermal impedance θ _{JA}	SOT-23-5 SOT-23-3	347	°C / W
	TO-92	156	
Power Dissipation	PD	(T _{J(max)} -T _A)/ θ _{JA}	

Stresses beyond those listed under " absolute maximum ratings" may cause permanent damage to the device. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Recommend operating condition

Parameter	min	Max	unit
Cathode voltage V _{KA}	V _{ref}	12	V
Continuous cathode current range I _K	0.05	15	mA
Operating free-air temperature range T _A	0	70	°C

Electrical characteristics (unless otherwise noted)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Reference Voltage	V _{ref} (T _A = 25°C)	1.228	1.24	1.252	V	V _{KA} = V _{ref}
	V _{ref} (T _A = full range 0~70 °C)	1.221	-	1.259	V	I _K =10mA (Figure 1)
V _{ref} deviation over full temperature range	V _{ref} (dev)	-	4	20	mV	V _{KA} = V _{ref} I _K =10mA (Figure 1)
Ratio of V _{ref} change in cathode voltage change	Δ V _{ref} /Δ V _{KA}	-	-1.5	-2.7	mV/V	V _{KA} = V _{ref} to 12V I _K =10mA (Figure 2)
Reference terminal current	I _{ref}	-	0.15	0.5	μA	I _K =10mA R1=10KΩ (Figure 2)
I _{ref} deviation over full temperature range	I _{ref} (dev)	-	0.05	0.3	μA	I _K =10mA R1=10KΩ R2=open (Figure 2)
Minimum cathode current for regulation	I _K (min)	-	40	50	μA	V _{KA} = V _{ref} (Figure 1)
Off-state cathode current	I _K (off)	-	0.001	0.1	μA	V _{KA} =12V V _{ref} =0V (Figure 3)
Dynamic impedance	Z _{KA}	-	0.20	0.4	Ω	V _{KA} = V _{ref} f≤1KHz I _K =0.1mA to 15mA (Figure 1)

* The dynamic impedance is defined as : |Z_{KA}| = Δ V_{KA} / Δ I_{KA}

Parameter Measurement Information

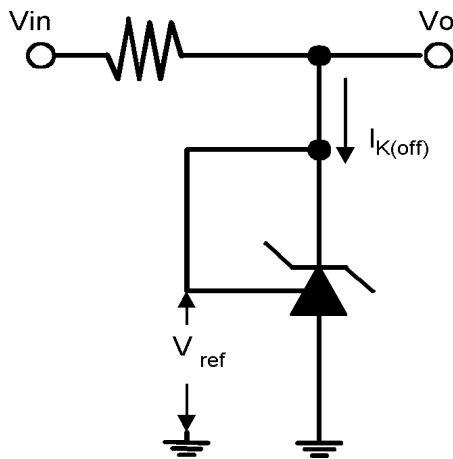


Figure 1. Test Circuit for $V_{KA} = V_{ref}$
 $V_O = V_{KA} = V_{ref}$

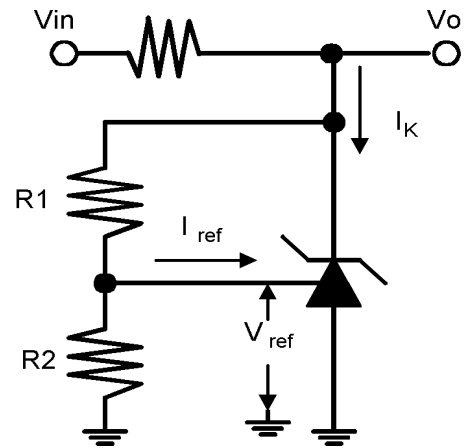


Figure 2. Test Circuit for $V_{KA} > V_{ref}$
 $V_O = V_{KA} = V_{ref} * (1 + R1/R2) + I_{ref} * R1$

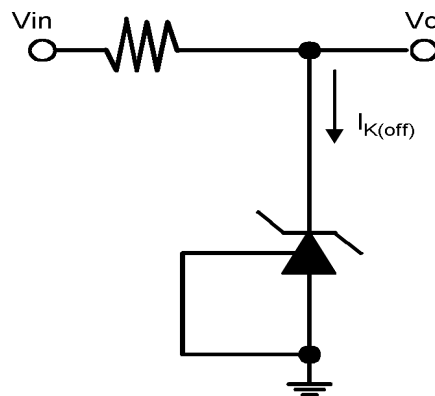


Figure 3. Test Circuit for $I_{K(off)}$

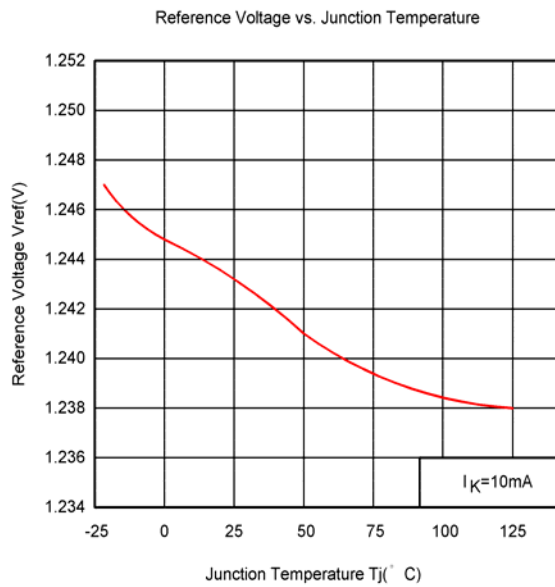


Figure 4.

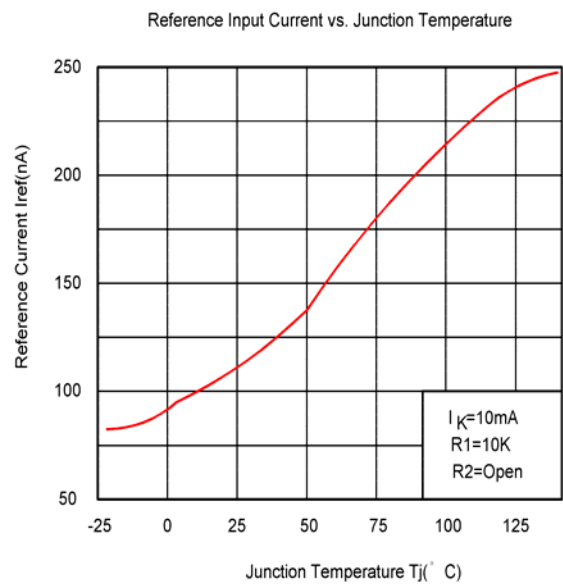


Figure 5.

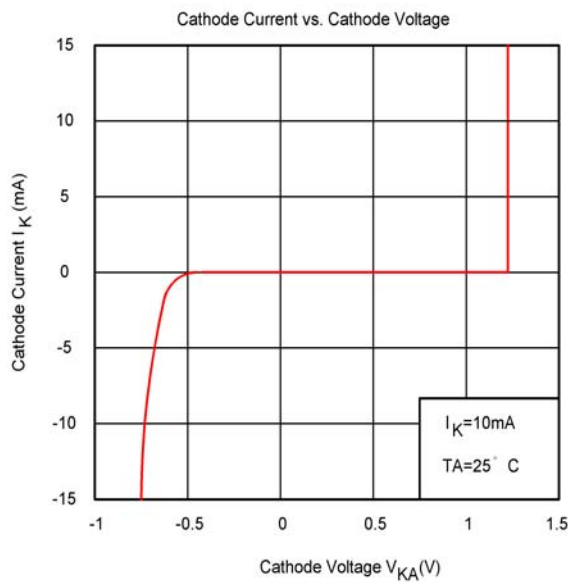


Figure 6.

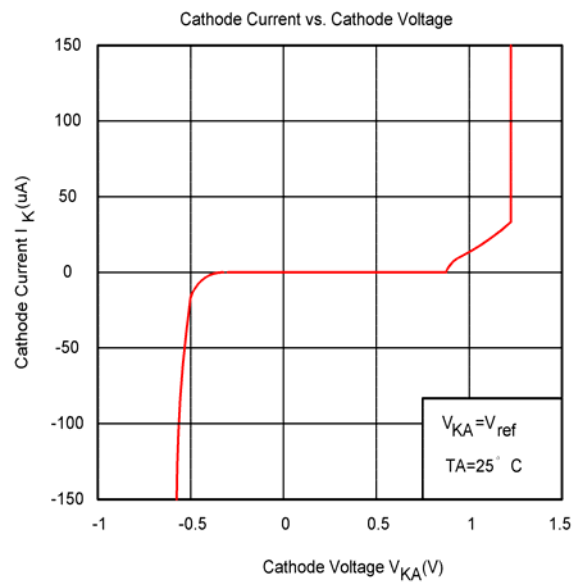


Figure 7.

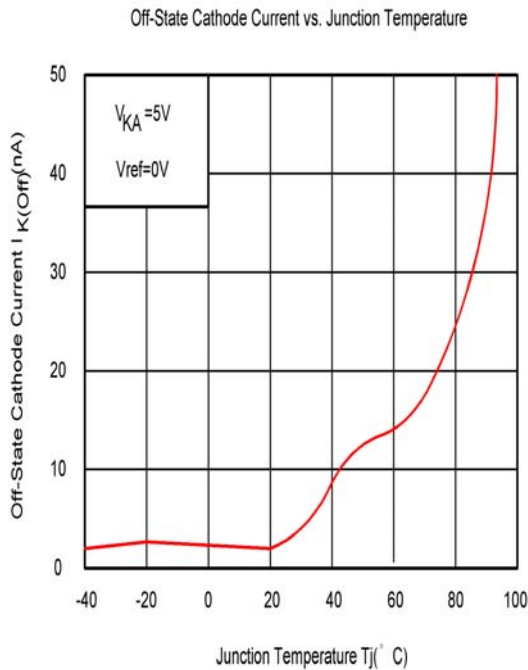


Figure 8.

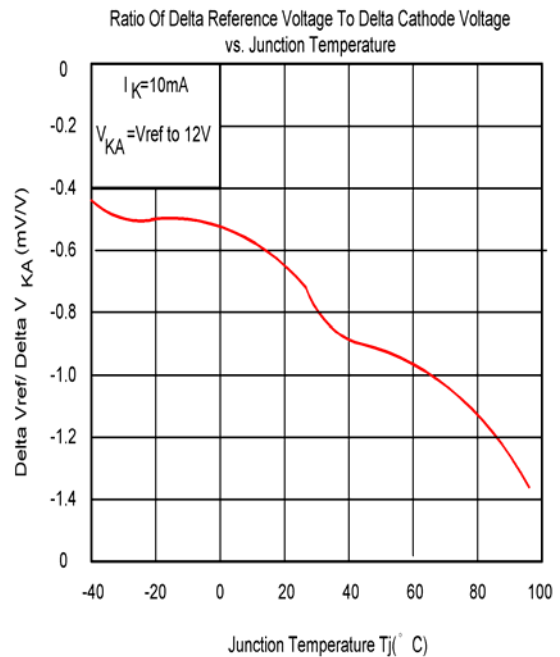


Figure 9.

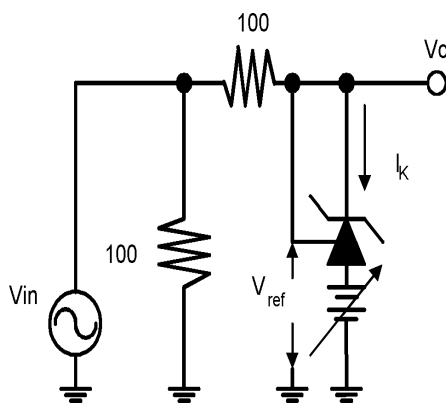
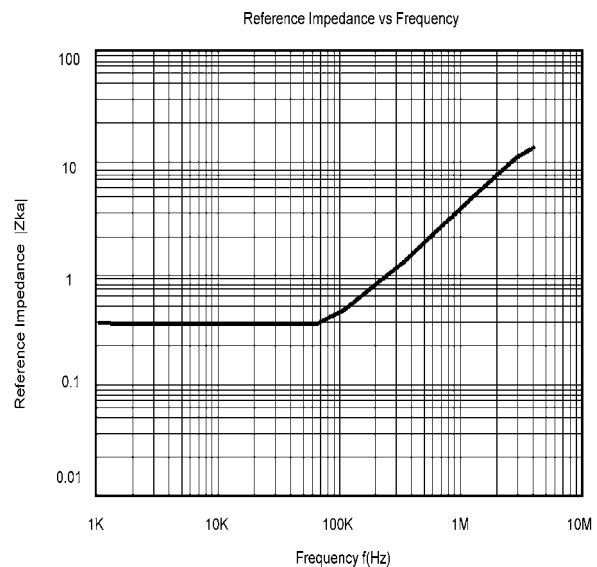
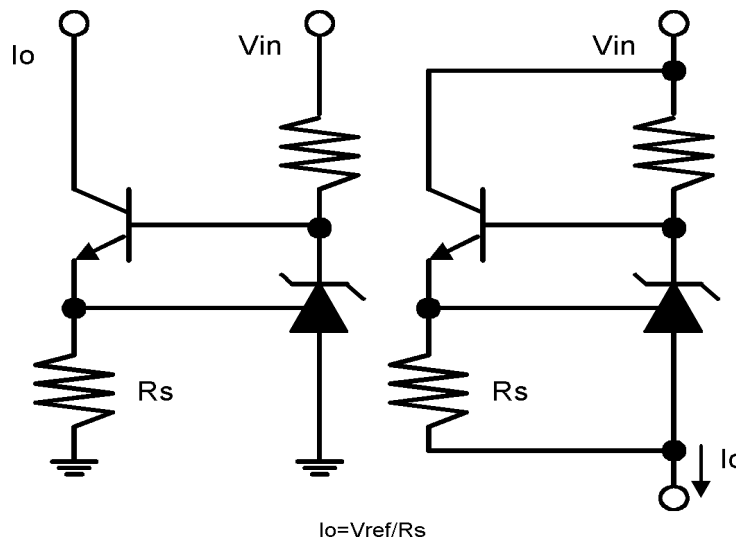


Figure 10.

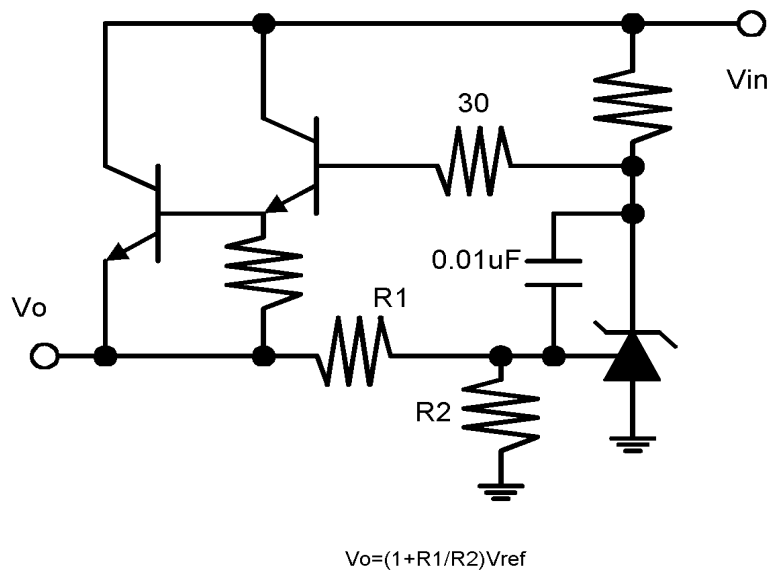


Application Circuit

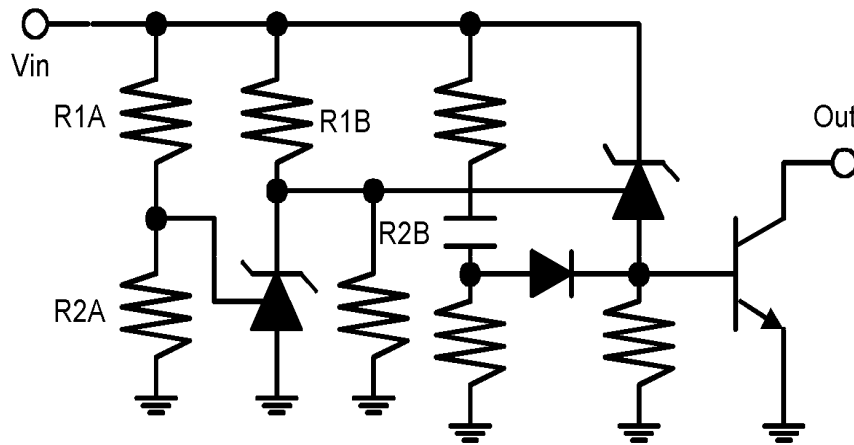
Constant Current Sink/
 Current Limiter or Current Source



Series Regulator



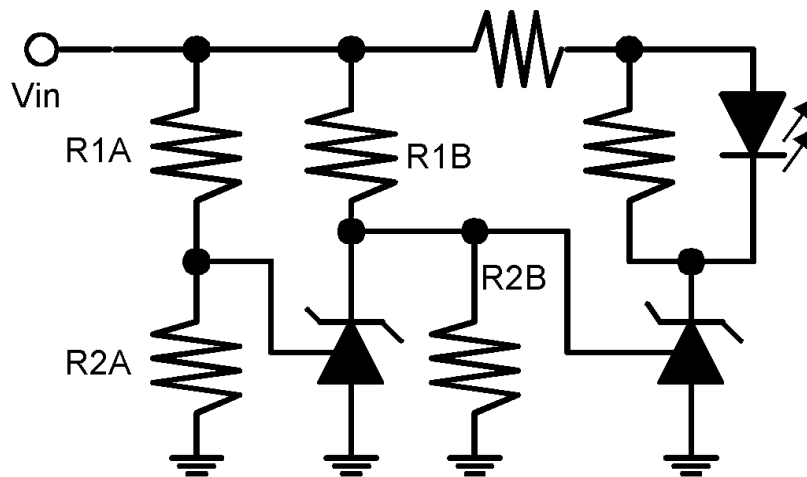
Over Voltage/Under Voltage Protection Circuit



$$\text{Low Limit} = (1 + R1B/R2B)V_{ref} + V_{be}$$

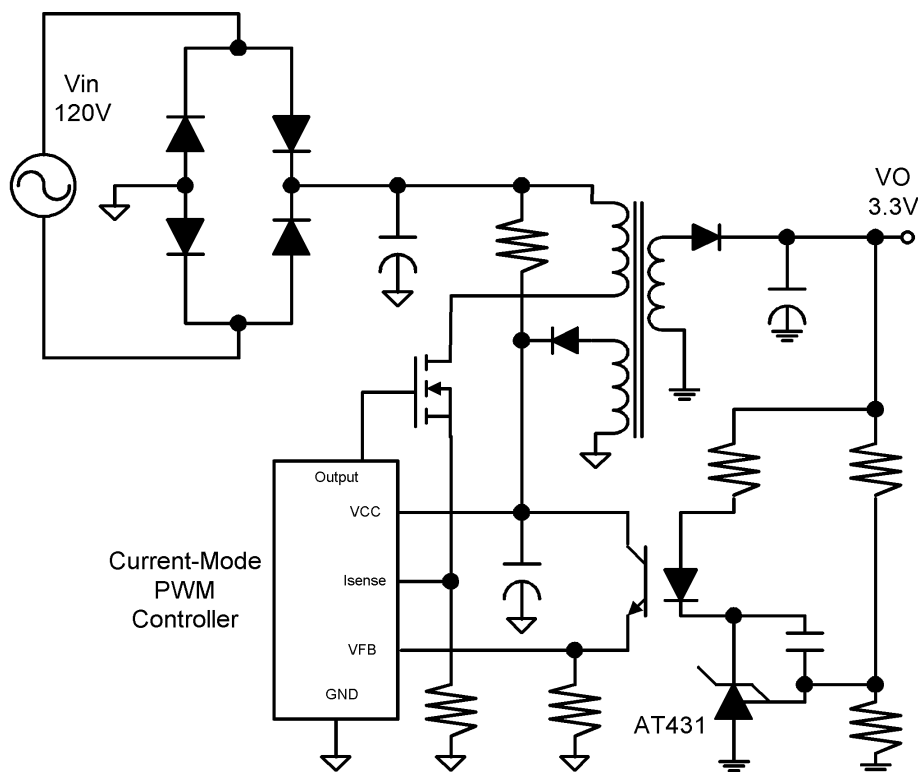
$$\text{High Limit} = (1 + R1A/R2A)V_{ref}$$
 Out ON When $\text{Low Limit} < V_{in} < \text{High Limit}$

Voltage Monitor Circuit



$$\text{Low Limit} = (1 + R1B/R2B)V_{ref}$$

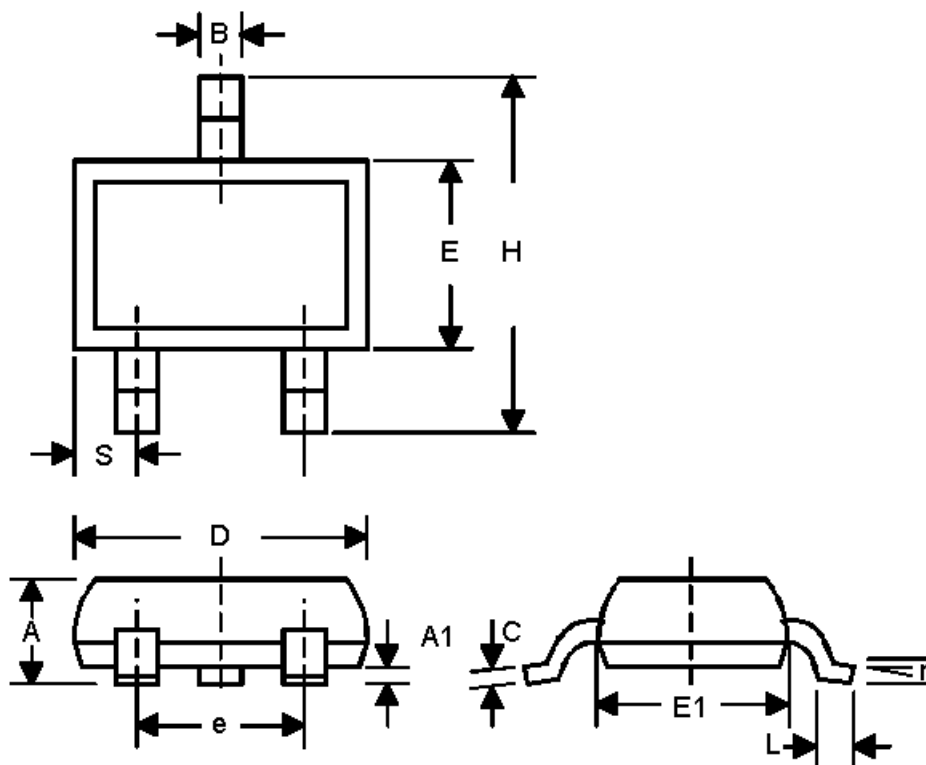
$$\text{High Limit} = (1 + R1A/R2A)V_{ref}$$
 LED ON When $\text{Low Limit} < V_{in} < \text{High Limit}$



Above shows the AT431 used in a 3.3V isolated flyback supply. Output voltage V_o can be as low as reference voltage V_{ref} ($1.24V \pm 1\%$). The output of the regulator, plus the forward voltage drop of the optocoupler LED ($1.24+1.4=2.64V$), determine the minimum voltage that can be regulated in an isolated supply configuration. Regulated voltage as low as 2.7V is possible using the circuit.

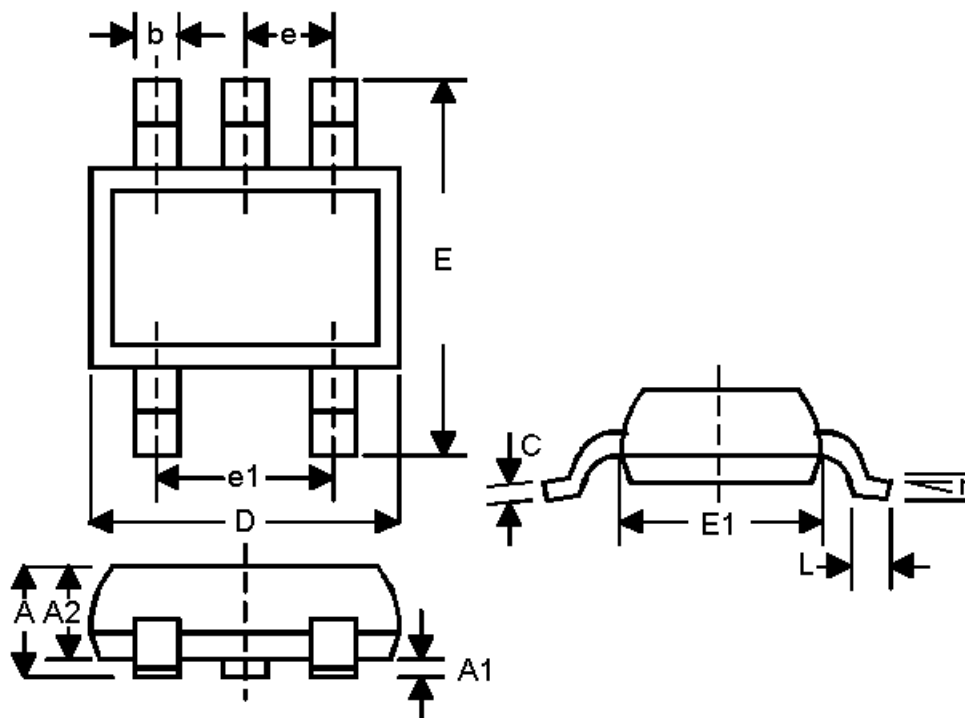
Package Information

SOT-23



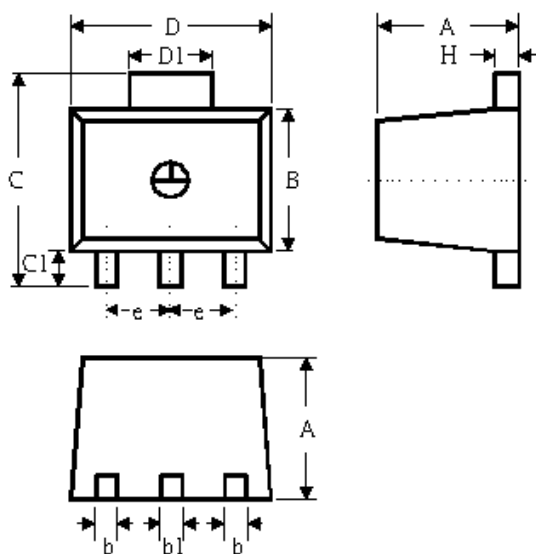
SYMBOL	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	0.787	1.194	0.031	0.047
A1	0.025	0.127	0.001	0.005
B	0.356	0.559	0.014	0.022
C	0.086	0.152	0.0034	0.006
D	2.667	3.048	0.105	0.120
E	1.194	1.397	0.047	0.055
E	1.778	2.032	0.070	0.080
H	2.083	2.489	0.082	0.098
L	0.102	0.305	0.004	0.012
S	0.432	0.559	0.017	0.022
R	0°	8°	0°	8°

SOT-25



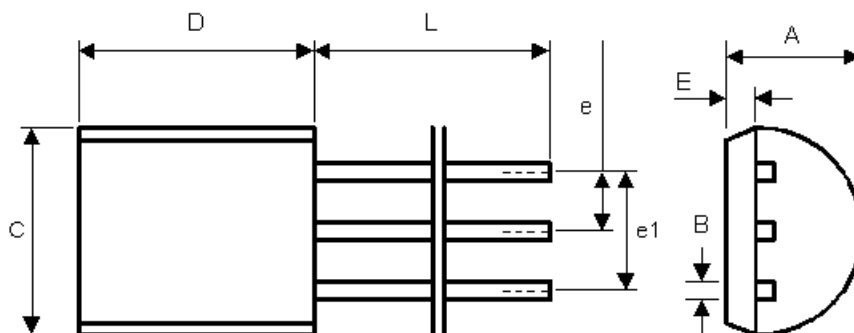
SYMBOL	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.035	0.057	0.90	1.45
A1	0.000	0.006	0.00	0.15
A2	0.035	0.051	0.90	1.30
b	0.010	0.020	0.25	0.50
C	0.003	0.008	0.08	0.20
D	0.110	0.122	2.80	3.10
E	0.102	0.118	2.60	3.00
E1	0.059	0.069	1.50	1.75
L	0.014	0.022	0.35	0.55
e	0.037ref		0.95ref	
E1	0.075ref		1.90ref	
r	0 ⁰	10 ⁰	0 ⁰	10 ⁰

SOT-89



SYMBOL	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	1.397	1.600	0.055	0.063
B	0.356	0.483	0.014	0.019
B	2.388	2.591	0.094	0.102
b1	0.406	0.533	0.016	0.021
C	--	4.242	--	0.167
C1	0.787	1.194	0.031	0.047
D	4.394	4.597	0.173	0.181
D1	1.397	1.753	0.055	0.069
E	1.448	1.549	0.057	0.061
H	0.381	0.432	0.015	0.017

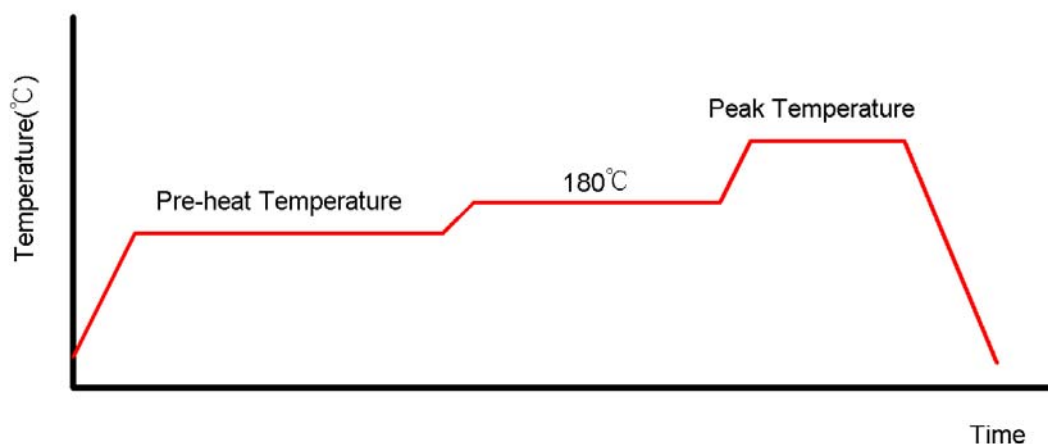
TO-92



SYMBOL	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	3.4	3.8	0.134	0.150
B	0.3	0.5	0.012	0.020
C	4.4	4.8	0.173	0.189
D	4.4	4.8	0.173	0.189
E	0.9	1.5	0.035	0.059
e	1.17	1.37	0.046	0.054
e1	2.39	2.69	0.094	0.106
L	12	16	0.472	0.630

Reflow Condition (IR/Convection or VPR Reflow)

Reference JEDEC Standard J-STD-020A



Classification Reflow Profiles

	Convection or IR/Convection	VPR
Average Heating Rate(180°C to peak)	5°C/second max.	10°C/second max.
Preheat Temperature(125±20°C)	120 seconds max.	
Temperature maintained above 180°C	10~150 seconds	
Time within 5°C of actual Peak Temperature	10~20 seconds	60 seconds
Peak Temperature Range(Note 1)	219~225°C or 235~240°C	219~225°C or 235~240°C
Cooling Rate	6°C /second max.	10°C/second max.
Time 25°C to Peak Temperature	6 minutes max.	

*1 The maximum peak temperatures for IR and VP reflow are depending on package dimensions.

Package Reflow Conditions

Pkg. Thickness ≥2.5mm and all bags	Pkg. Thickness <2.5mm and Pkg. Volume ≥350 mm ³	Pkg. Thickness <2.5mm and Pkg. Volume <350 mm ³
Convection 219~225°C		Convection 235~240°C
VPR 219~225°C		VPR 235~240°C
IR/Convection 219~225°C		IR/Convection 235~240°C