

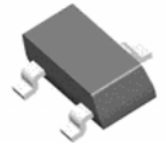
Shunt Regulator

General Description

- The LM431 Series ICs are low voltage three-terminal programmable shunt regulators with guaranteed thermal stability over a full operation range. These monolithic ICs voltage reference operate as a low temperature coefficient Zener which is programmable from V_{ref} to 18V with two external resistors. These devices exhibit a wide operating current range of 80 μ A to 50/100mA with a typical dynamic impedance of 0.05 to 0.22 Ω . The characteristics of these references make them excellent replacements for Zener diodes in many applications such as digital voltmeters, power supplies and op amp circuitry
- The LM431L precision reference is offered in three voltage tolerance for $V_{REF}=1.240V$: 1.5%, 1.0% and 0.5%.
- These ICs are available in 4 packages: TO-92, SOT-23, SOT-23-5 and SOT-89.



TO-92



SOT-23



SOT-23-5



SOT-89



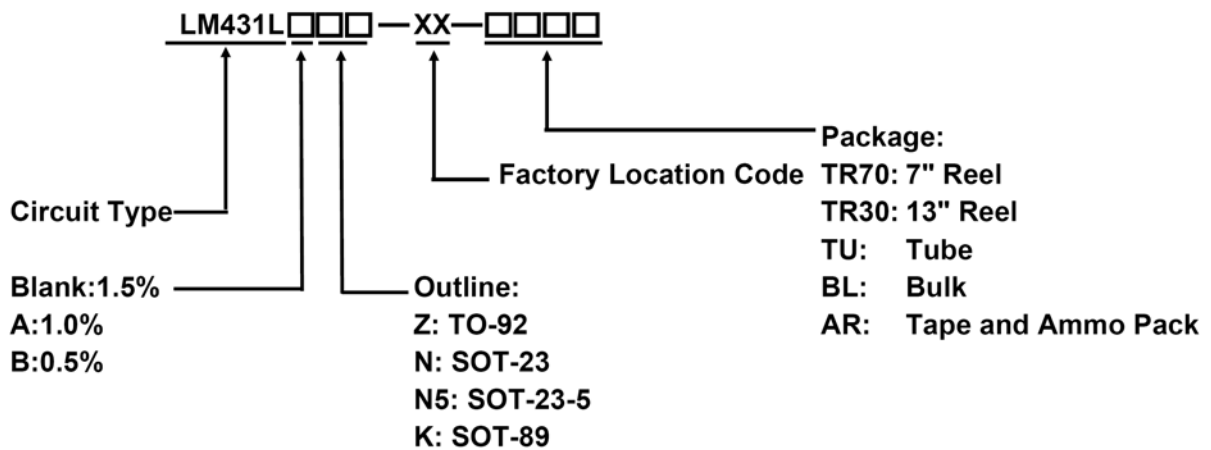
Features

- Programmable Precise Output Voltage from 1.24V to 16/18V
- High Stability under Capacitive Load
- Low Temperature Deviation
- Low Dynamic Output Impedance: 0.05 to 0.22 Ω Typical
- Operating Current from 80 μ A to 50/100mA.
- Low Output Noise Voltage
- RoHS Compliance

Applications

- Graphic Card
- PC Motherboard
- Voltage Adapter
- Switching Power Supply
- Charger

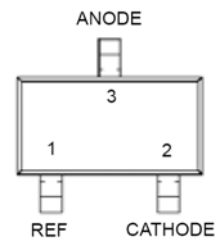
Ordering Information



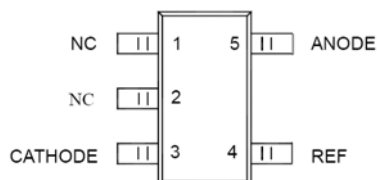
Pin Configuration



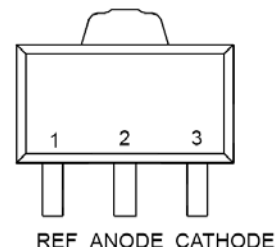
Outline: Z
TO-92



Outline: N
SOT-23



Outline: N5
SOT-23-5

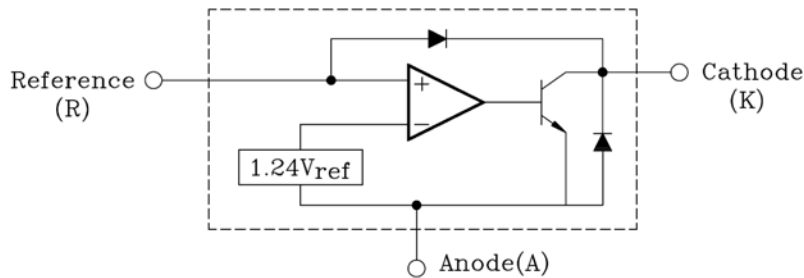


Outline: K
SOT-89

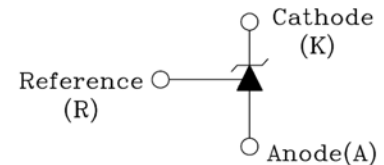
Shunt Regulator

LM431L

Block Diagram



Symbols



Absolute Maximum Ratings (Ta=25° C)

(Full operating ambient temperature range applies unless otherwise noted.)

Symbol	Description	LM431L	LM431LA	LM431LB	Unit
V _{KA}	Cathode Voltage	16	18		V
I _{KA}	Cathode Current Range (Continuous)	50	-100 ~ +100		mA
I _{REF}	Reference Input Current Range (Continuous)	3	10		mA
T _J	Operating Junction Temperature	150			° C
T _{OPR}	Operating Temperature Range	-40 ~ 85	-40 ~ 125		° C
T _{STG}	Storage Temperature Range	-65 ~ 150			° C
P _D	Power Dissipation	Z:TO-92	700	770	mW
		N:SOT-23	350	370	
		N5:SOT-23-5	550	370	
		K: SOT-89	-	770	
R _{thJA}	Package Thermal Impedance	Z:TO-92	180	150	° C/W
		N:SOT-23	360	330	
		N5:SOT-23-5	230	250	
		K: SOT-89	-	50	

Shunt Regulator

LM431L

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

Symbol	Description	LM431L			LM431LA			LM431LB			Unit	Test Circuit	Conditions		
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.					
V_{REF}	Reference Input Voltage	1.222	1.240	1.258	1.228	1.240	1.252	1.234	1.240	1.246	V	Fig.1	$V_{KA}=V_{REF}, I_{KA}=10\text{mA}$		
ΔV_{REF}	Reference Input Voltage Deviation	0-70 °C	-	-	-	-	2	1-	-	2	10	mV	Fig.1 (Note1)	$V_{KA}=V_{REF}, I_{KA}=10\text{mA}$	
		-40-85 °C	-	7.0	20	-	3	10	-	3	10				
		-40-125 °C	-	-	-	-	4	15	-	4	15				
$\Delta V_{REF}/\Delta V_{KA}$	Ratio of Change in Reference Input Voltage to Change in Cathode to Anode Voltage	-	-0.6	-1.5	-	-0.5	-1.5	-	-0.5	-1.5	mV/V	Fig.2	$I_{KA}=10\text{mA}$ $\Delta V_{KA}=V_{KA(max)}-V_{REF}$		
I_{REF}	Reference Input Current		$T_A=25^\circ\text{C}$	-	0.15	0.3	-	0.15	0.4	-	0.15	0.4	μA	Fig.2	$I_{KA}=10\text{mA}, R_1=10\text{K}\Omega, R_2=\infty$
ΔI_{REF}	Reference Input Current Deviation Over Temperature Range	-	0.05	0.08	-	0.1	0.4	-	0.1	0.4	μA	Fig.2	$I_{KA}=10\text{mA}, R_1=10\text{K}\Omega, R_2=\infty$		
I_{MIN}	Min. Cathode Current For Regulation	-	55	80	-	55	80	-	55	80	μA	Fig.1	$V_{KA}=V_{REF}$		
I_{OFF}	Off-State Cathode Current	-	2.6	1000	-	40	100	-	40	100	nA	Fig.3	$V_{KA}=V_{KA(max)}, V_{REF}=0\text{V}$		
		-	-	-	-	10	50	-	10	50			$V_{KA}=6\text{V}, V_{REF}=0\text{V}$		
Z_{KA}	Dynamic Impedance	-	0.22	0.4	-	0.05	0.15	-	0.05	0.15	Ω	Fig.1 (Note2)	$V_{KA}=V_{REF}, I_{KA}=1.0\text{mA} \sim I_{KA(max)}, f \leq 1.0\text{KHz}$		

Fig.1- Test Circuit for $V_{KA}=V_{REF}$

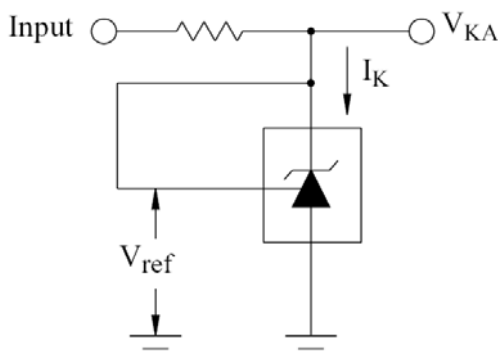
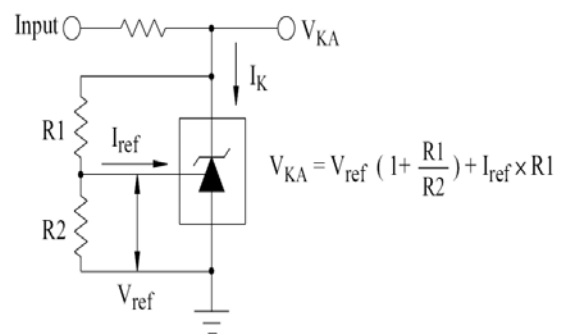
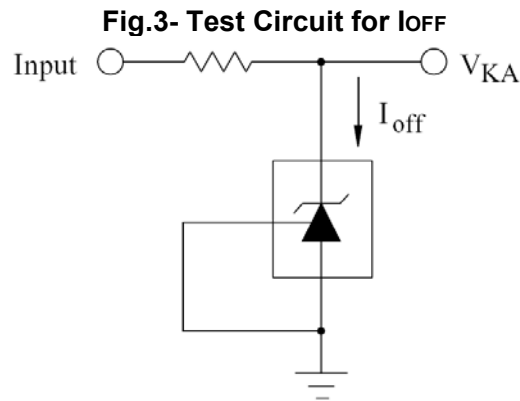


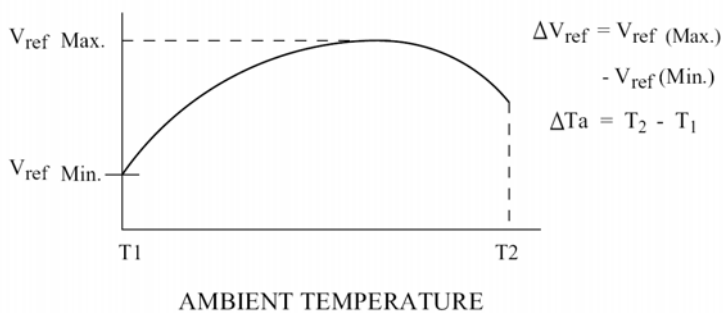
Fig.2- Test Circuit for $V_{KA}>V_{REF}$





Note1:

The deviation parameter ΔV_{ref} is defined as the differences between the maximum and minimum values obtained over the full operating ambient temperature range that applies.



The average temperature coefficient of the Reference input voltage, αV_{ref} , is defined as:

$$\alpha V_{ref} \left(\frac{\text{ppm}}{^{\circ}\text{C}} \right) = \frac{\left(\frac{\Delta V_{ref}}{V_{ref} \text{ at } 25^{\circ}\text{C}} \right) \times 10^6}{\Delta T_a}$$

$$= \frac{\Delta V_{ref} \times 10^6}{\Delta T_a (V_{ref} \text{ at } 25^{\circ}\text{C})}$$

αV_{ref} can be positive or negative depending on whether $V_{ref} \text{ Min.}$ or $V_{ref} \text{ Max.}$ occurs at the lower ambient temperature.

Note2:

The dynamic impedance Z_{ka} is defined as:

$$|Z_{ka}| = \frac{\Delta V_{KA}}{\Delta I_k}$$

When the device is programmed with two external resistors, R1 and R2, (refer to Figure 2) the total dynamic impedance of the circuit is defined as:

$$|Z_{ka'}| = |Z_{ka}| \left(1 + \frac{R1}{R2} \right)$$

Typical Characteristics Curves

Fig.4- VREF - TJ

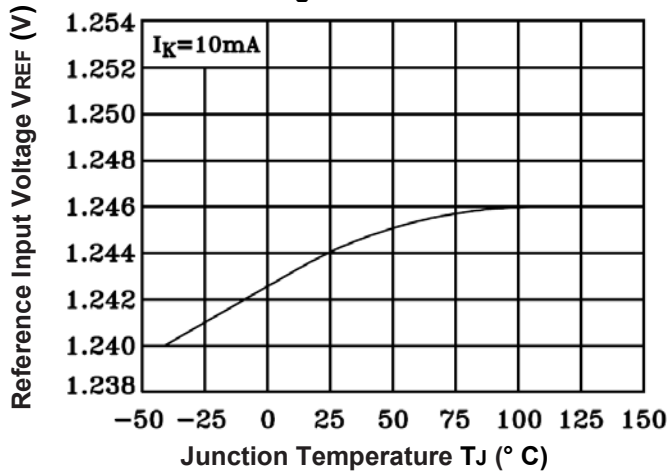


Fig.5- IREF - TJ

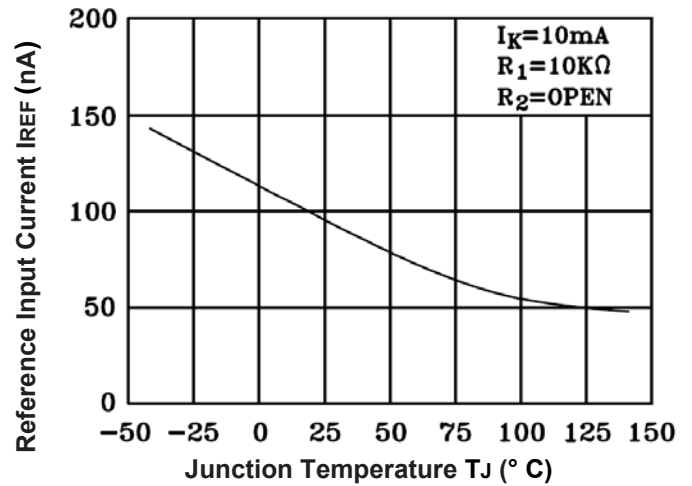


Fig.6- $I_K - V_{KA}$ (1)

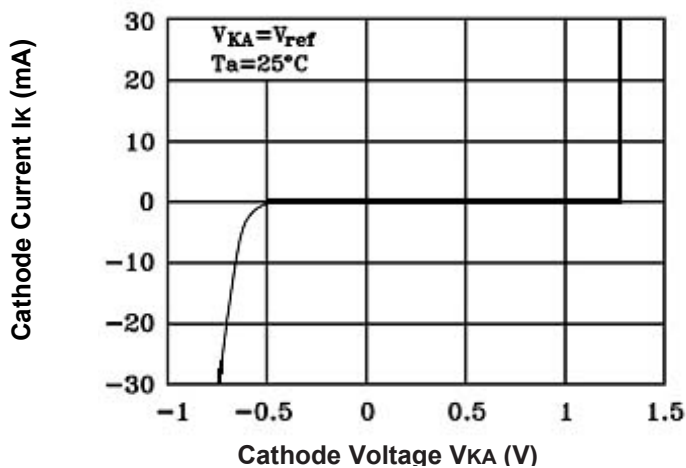
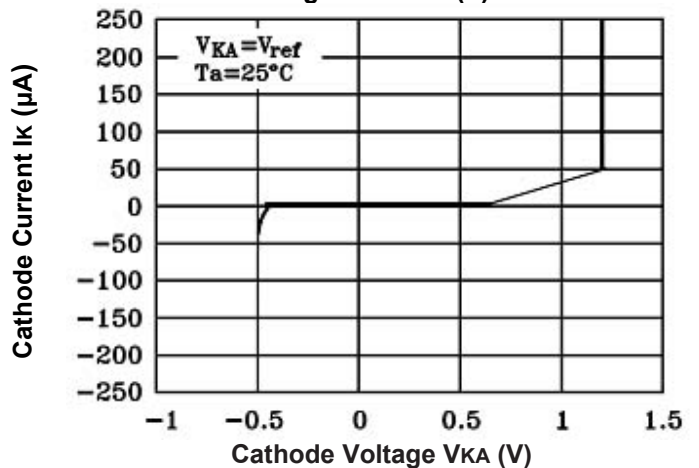


Fig.7- $I_K - V_{KA}$ (2)



Shunt Regulator

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Fig.8- Gvo - f

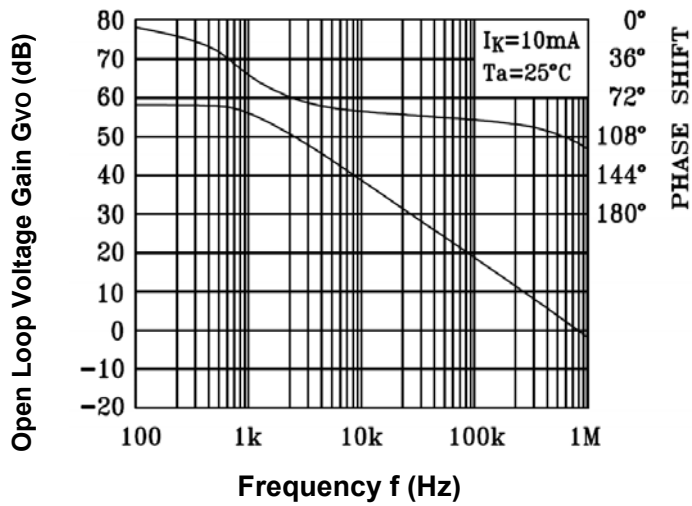


Fig.9- Pulse Response

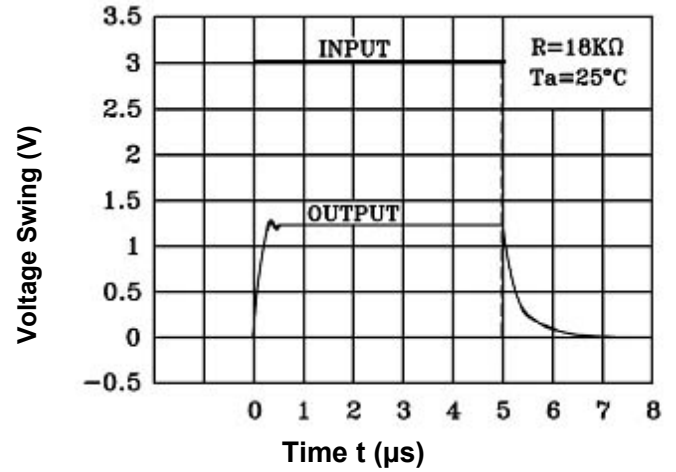


Fig.10- $\Delta V_{REF} - T_J$

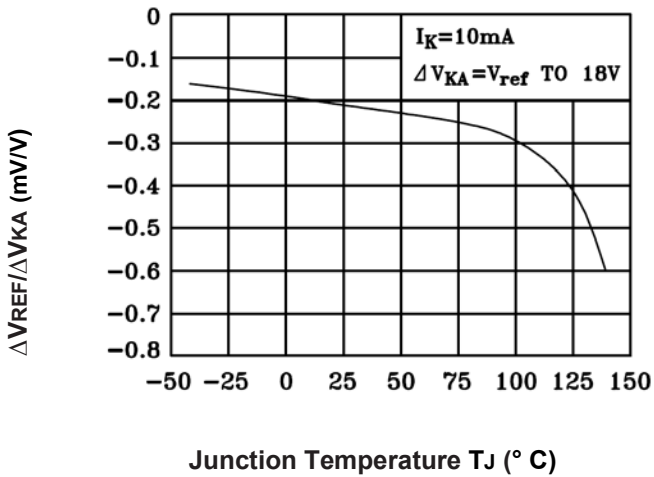
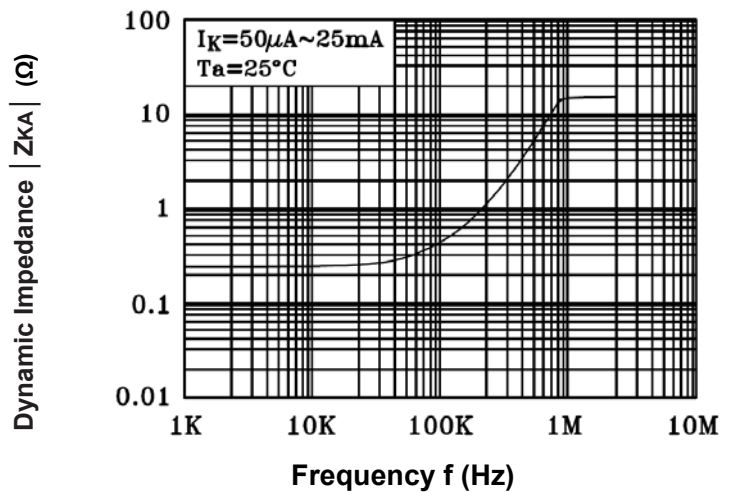


Fig.11- $Z_{KA} - f$



Typical Application

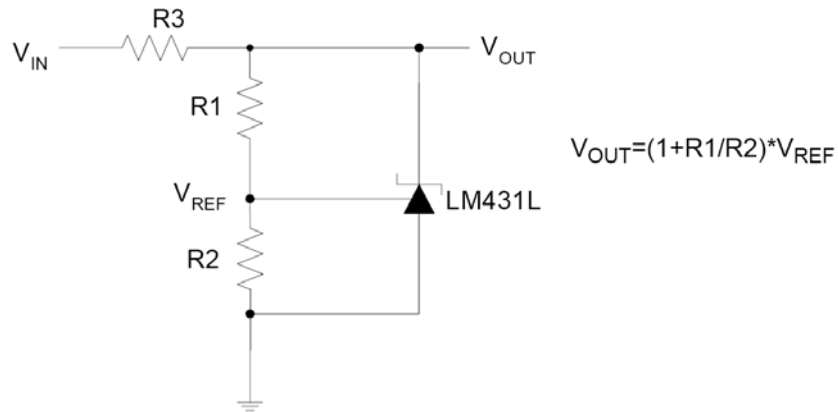


Fig.12-Shunt Regulator

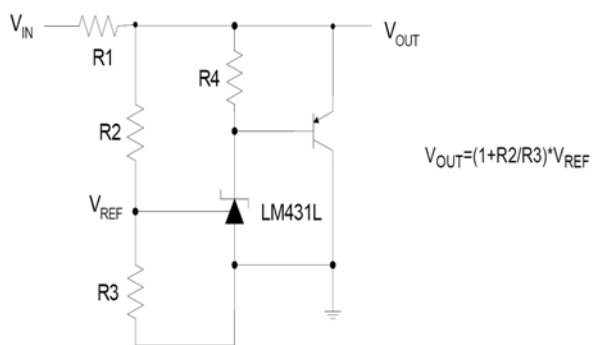


Fig.13- High Current Shunt Regulator

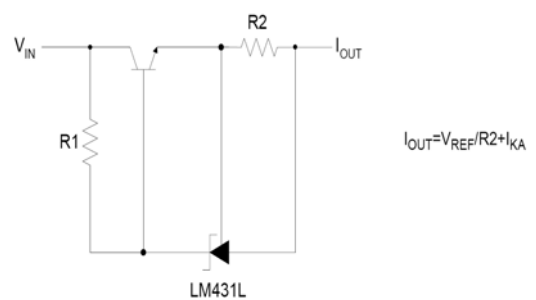


Fig.14- Current Source of Current Limit

Typical Application (Continued)

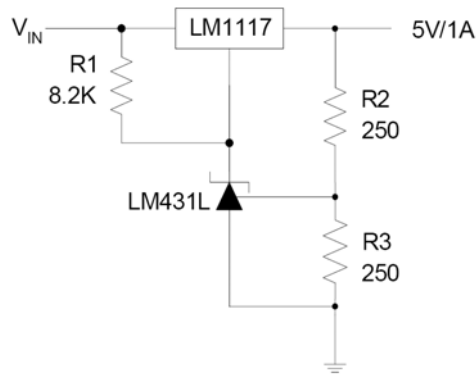


Fig.15- Precision 5V 1A Regulator

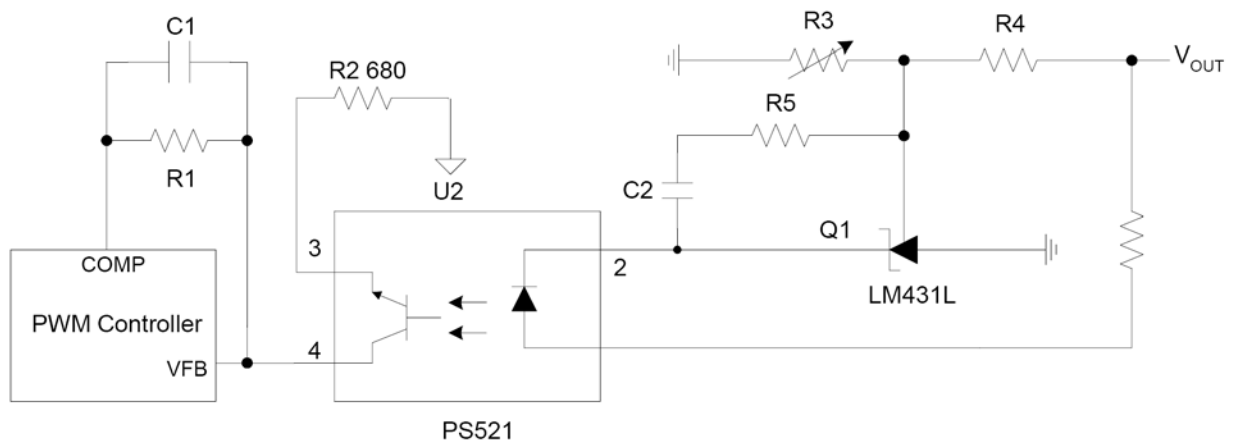
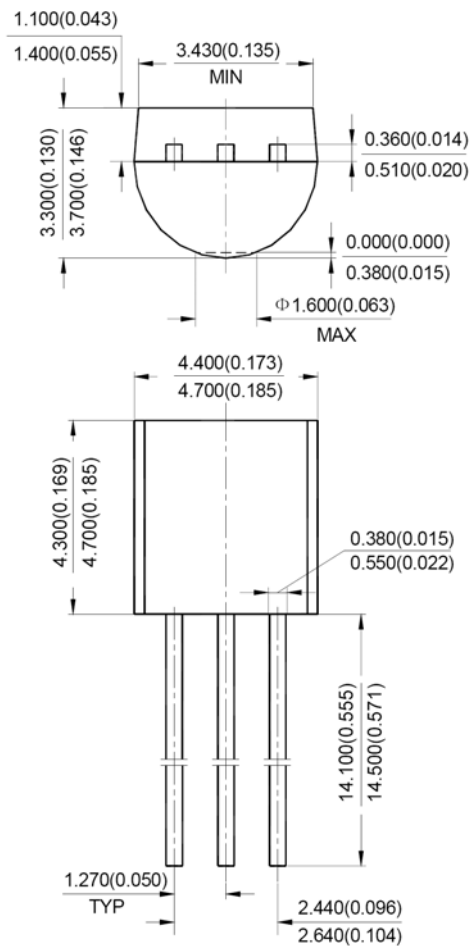


Fig.16- PWM Converter with Reference

Device Marking Code

Circuit	Tolerance		SOT-23 (N)	SOT-23-5 (N5)	SOT-89 (K)
	LM431L	Blank	1.5%	24A	24A
A		1.0%	EA7	E6A	E41B
B		0.5%	EA6	E5A	E41A

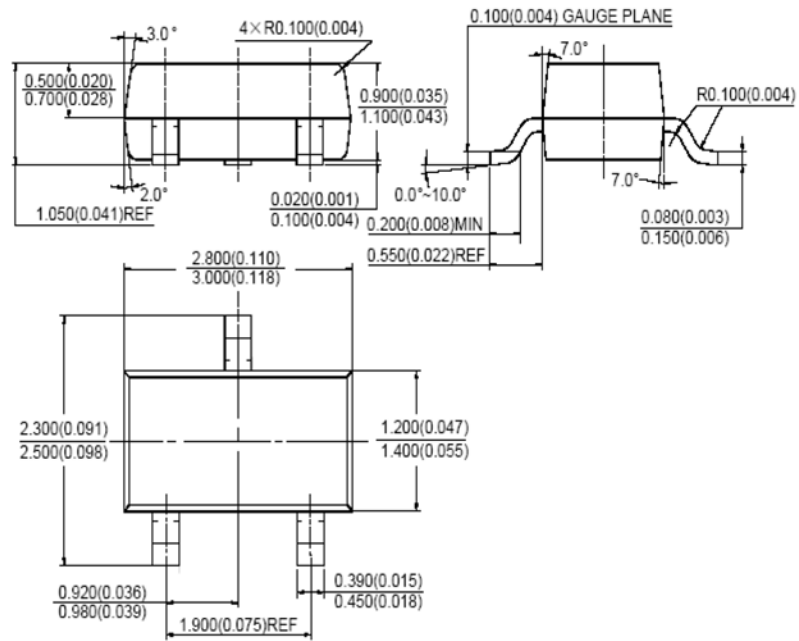
Dimensions in inches (mm)



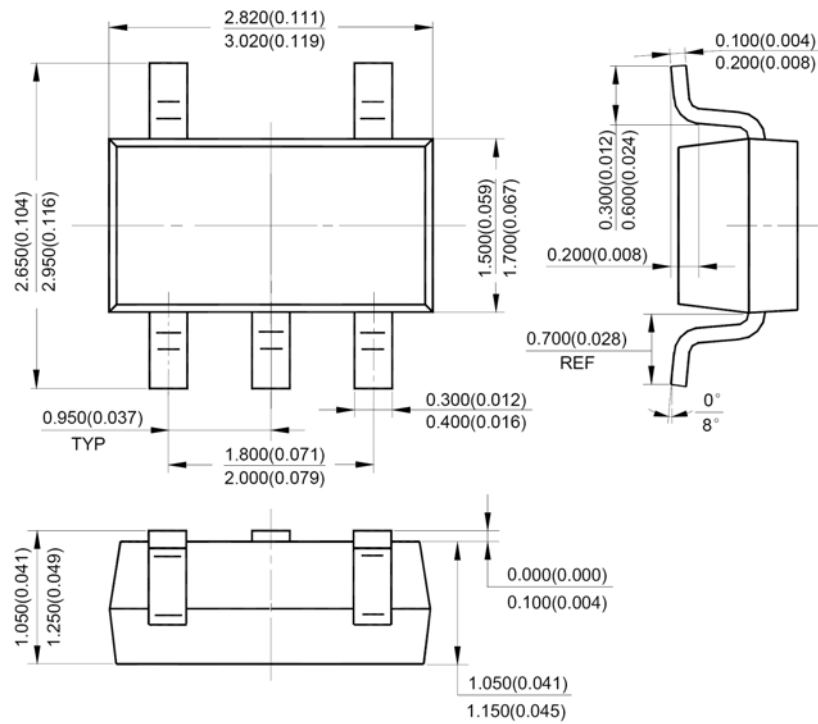
TO-92

Shunt Regulator

LM431L



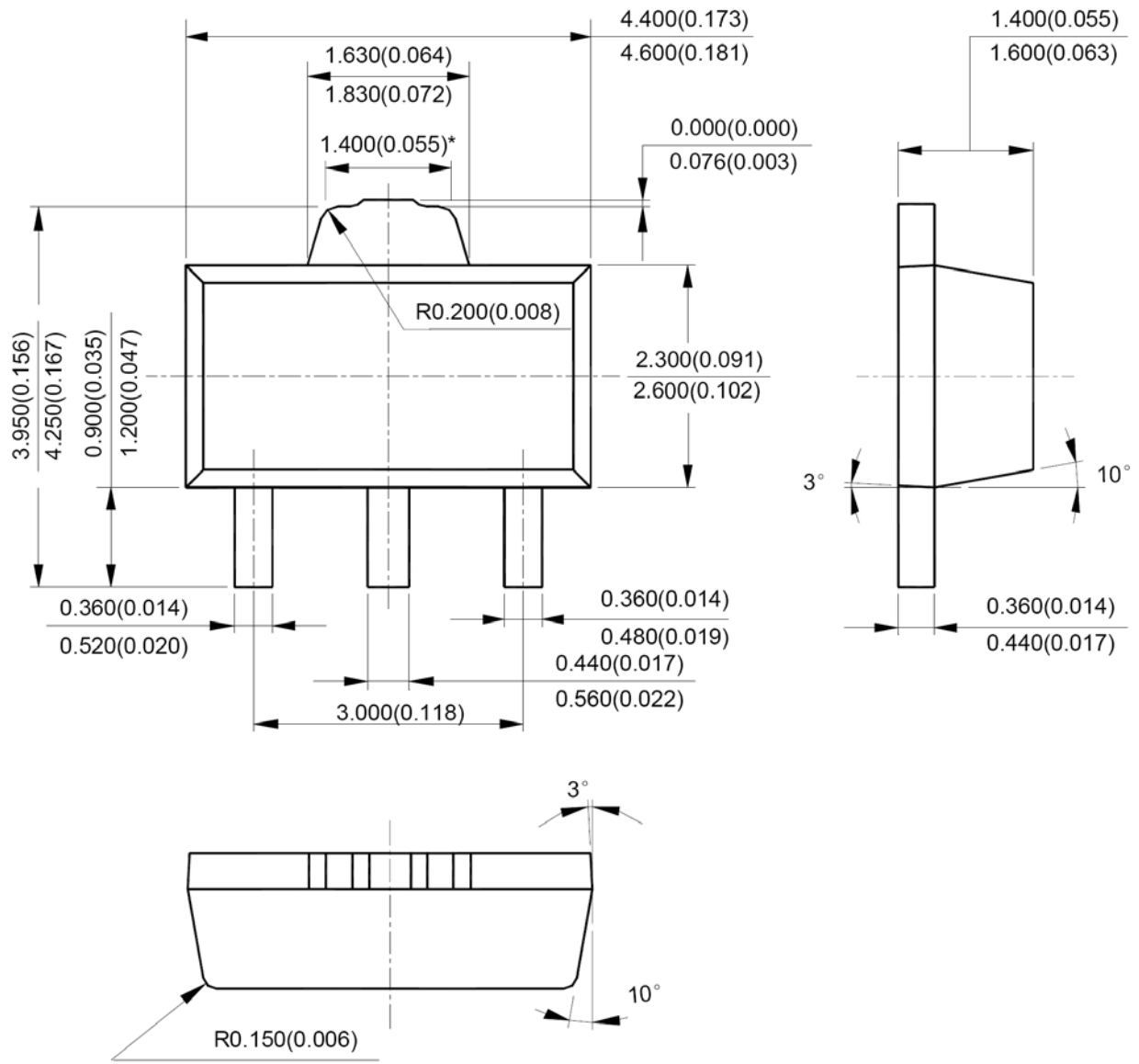
SOT-23



SOT-23-5

Shunt Regulator

LM431L



SOT-89

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