

# LM431A/LM431B/LM431C

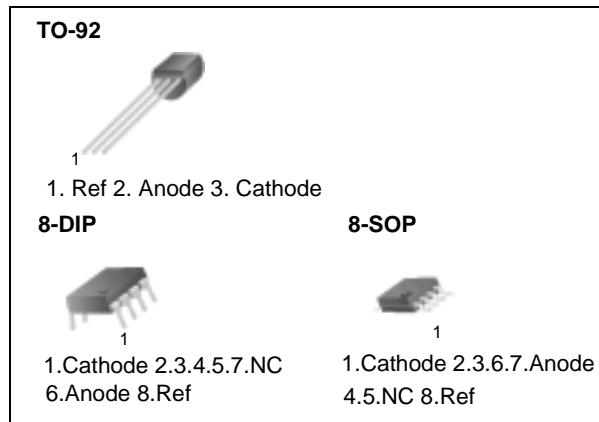
## Programmable Shunt Regulator

### Features

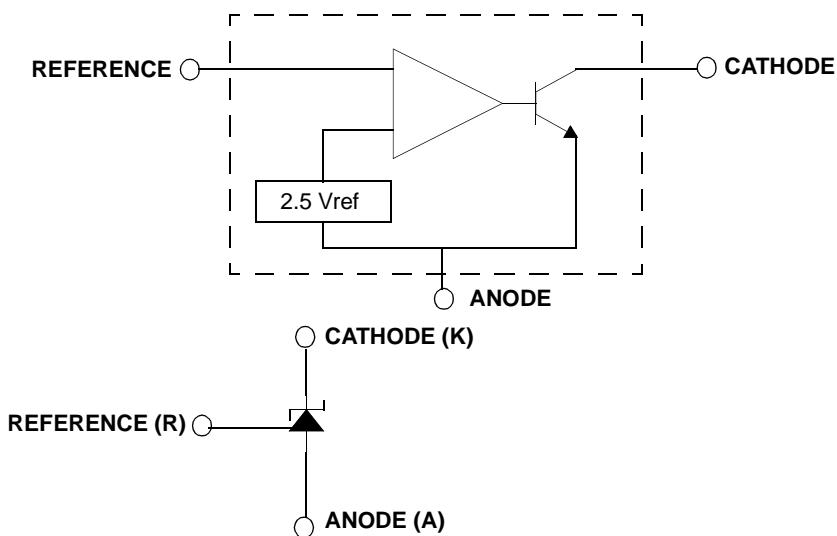
- Programmable Output Voltage to 36 Volts
- Low Dynamic Output Impedance 0.20 Typical
- Sink Current Capability of 1.0 to 100mA
- Equivalent Full-Range Temperature Coefficient of 50ppm/ $^{\circ}$ C Typical
- Temperature Compensated for Operation Over Full Rated Operating Temperature Range
- Low Output Noise Voltage
- Fast Turn-on Response

### Description

The LM431A/LM431B/LM431C are three terminal output adjustable regulators with thermal stability over operating temperature range. The output voltage can be set any value between V<sub>REF</sub> (approximately 2.5 volts) and 36 volts with two external resistors. These devices have a typical dynamic output impedance of 0.2 $\Omega$ . Active output circuit provides a sharp turn-on characteristic, making these devices excellent replacement for Zener Diodes in many applications.



### Internal Block Diagram



## Absolute Maximum Ratings

(Operating temperature range applies unless otherwise specified.)

Parameter	Symbol	Value	Unit
Cathode Voltage	V <sub>KA</sub>	37	V
Cathode Current Range (Continuous)	I <sub>KA</sub>	-100 ~ +150	mA
Reference Input Current Range	I <sub>REF</sub>	0.05 ~ +10	mA
Power Dissipation M, Z Suffix Package N Suffix Package	P <sub>D</sub>	770 1000	mW
<b>Operating Temperature Range</b>			
LM431xC	TOPR	-25 ~ +85	°C
LM431xI		-40 ~ +85	°C
Junction Temperature	T <sub>J</sub>	150	°C
Storage Temperature Range	T <sub>STG</sub>	-65 ~ +150	°C

## Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit
Cathode Voltage	V <sub>KA</sub>	V <sub>REF</sub>	-	36	V
Cathode Current	I <sub>KA</sub>	1.0	-	100	mA

## Electrical Characteristics

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

Parameter	Symbol	Conditions	LM431A			LM431B			LM431C			Unit
			Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Reference Input Voltage	V <sub>REF</sub>	$V_{KA} = V_{REF}$ , $I_{KA} = 10\text{mA}$	2.450	2.500	2.550	2.470	2.495	2.520	2.482	2.495	2.508	V
Deviation of Reference Input Voltage Over-Temperature	$\Delta V_{REF}/\Delta T$	$V_{KA}=V_{REF}$ , $I_{KA}=10\text{mA}$ $T_{MIN} \leq T_A \leq T_{MAX}$	-	4.5	17	-	4.5	17	-	4.5	17	mV
Ratio of Change in Reference Input Voltage to the Change in Cathode Voltage	$\Delta V_{REF}/\Delta V_{KA}$	$I_{KA} = 10\text{mA}$	$\Delta V_{KA}=10\text{V}-V_{REF}$	-	-1.0	-2.7	-	-1.0	-2.7	-	-1.0	-2.7
			$\Delta V_{KA}=36\text{V}-10\text{V}$	-	-0.5	-2.0	-	-0.5	-2.0	-	-0.5	-2.0
Reference Input Current	I <sub>REF</sub>	$I_{KA}=10\text{mA}$ , $R_1=10\text{k}\Omega, R_2=\infty$	-	1.5	4	-	1.5	4	-	1.5	4	$\mu\text{A}$
Deviation of Reference Input Current Over Full Temperature Range	$\Delta I_{REF}/\Delta T$	$I_{KA}=10\text{mA}$ , $R_1=10\text{k}\Omega, R_2=\infty$ $T_A = \text{Full Range}$	-	0.4	1.2	-	0.4	1.2	-	0.4	1.2	$\mu\text{A}$
Minimum Cathode Current for Regulation	I <sub>KA(MIN)</sub>	$V_{KA}=V_{REF}$	-	0.45	1.0	-	0.45	1.0	-	0.45	1.0	mA
Off - Stage Cathode Current	I <sub>KA(OFF)</sub>	$V_{KA}=36\text{V}$ , $V_{REF}=0$	-	0.05	1.0	-	0.05	1.0	-	0.05	1.0	$\mu\text{A}$
Dynamic Impedance	Z <sub>KA</sub>	$V_{KA}=V_{REF}$ , $I_{KA}=1 \text{ to } 100\text{mA}$ $f \geq 1.0\text{kHz}$	-	0.15	0.5	-	0.15	0.5	-	0.15	0.5	$\Omega$

### Note1

- LM431xC :  $T_{MIN} = -25^\circ\text{C}$ ,  $T_{MAX} = +85^\circ\text{C}$
- LM431xI :  $T_{MIN} = -40^\circ\text{C}$ ,  $T_{MAX} = +85^\circ\text{C}$

## Test Circuits

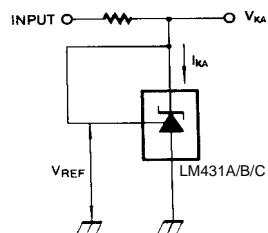


Figure 1. Test Circuit for  $V_{KA}=V_{REF}$

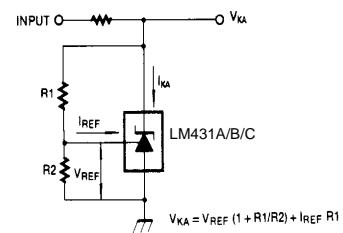


Figure 2. Test Circuit for  $V_{KA} \geq V_{REF}$

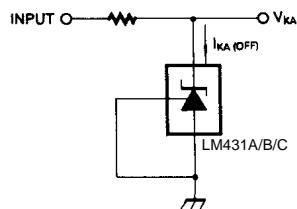
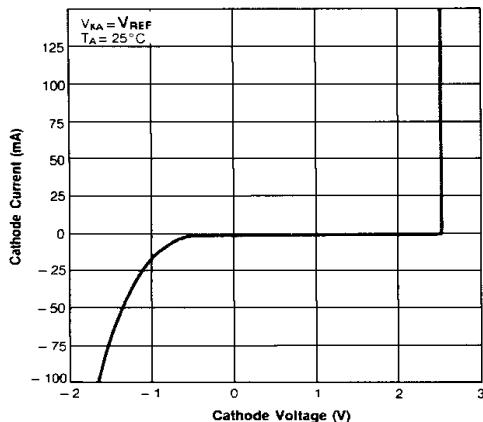
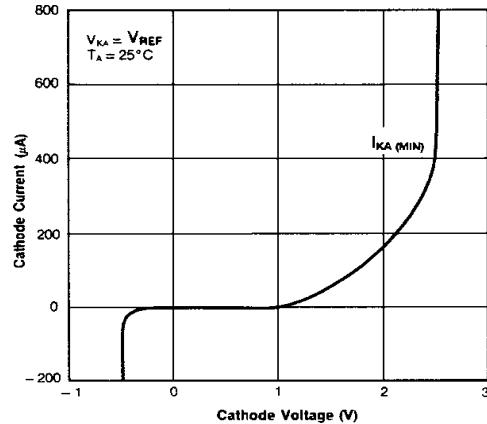


Figure 3. Test Circuit for  $I_{KA(OFF)}$

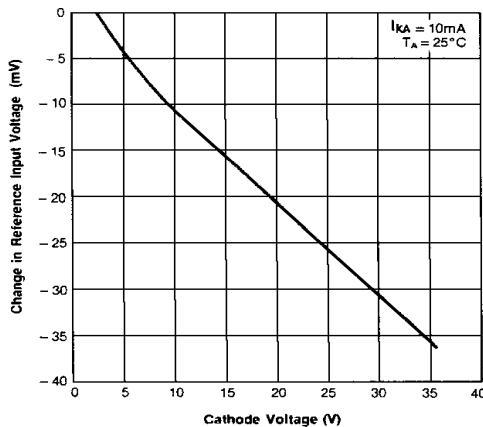
## Typical Performance Characteristics



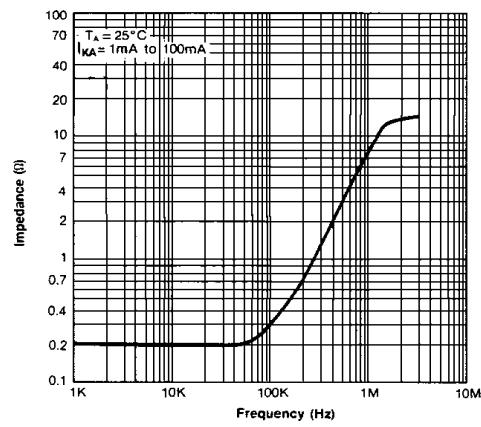
**Figure 4. Cathode Current vs. Cathode Voltage**



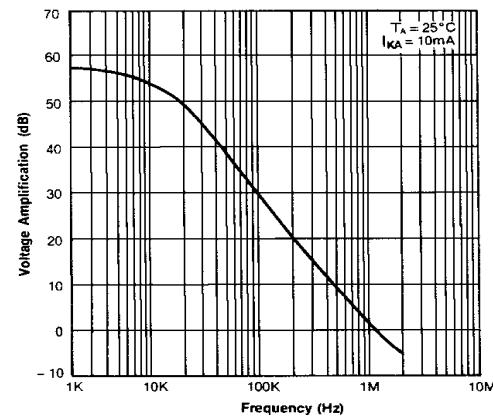
**Figure 5. Cathode Current vs. Cathode Voltage**



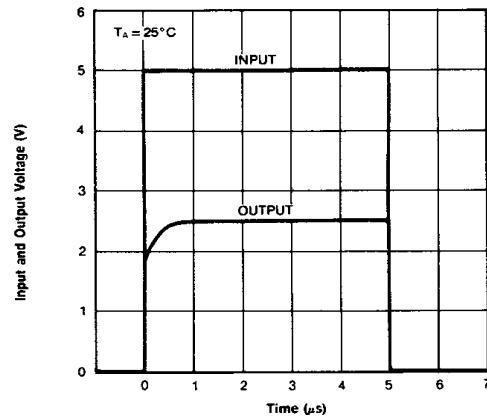
**Figure 6. Change In Reference Input Voltage vs. Cathode Voltage**



**Figure 7. Dynamic Impedance Frequency**

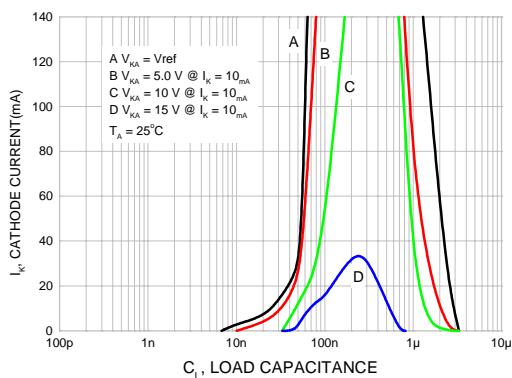


**Figure 8. Small Signal Voltage Amplification vs. Frequency**



**Figure 9. Pulse Response**

## Typical Performance Characteristics (Continued)



**Figure 10. Stability Boundary Conditions**

## Typical Application

$$V_O = \left(1 + \frac{R_1}{R_2}\right)V_{ref}$$

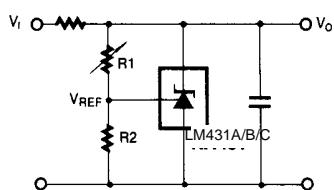


Figure 11. Shunt Regulator

$$V_O = V_{ref} \left(1 + \frac{R_1}{R_2}\right)$$

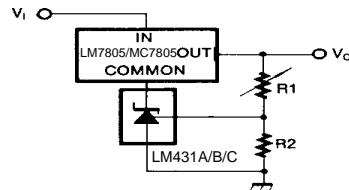


Figure 12. Output Control for Three-Terminal Fixed Regulator

$$V_O = \left(1 + \frac{R_1}{R_2}\right)V_{ref}$$

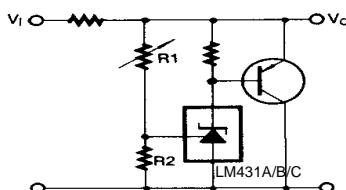


Figure 13. High Current Shunt Regulator

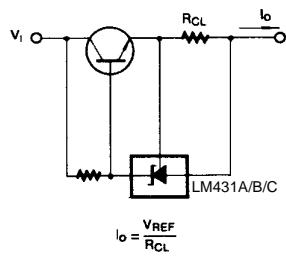


Figure 14. Current Limit or Current Source

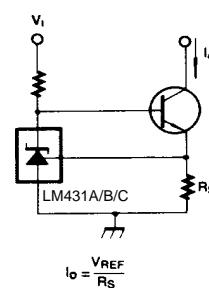


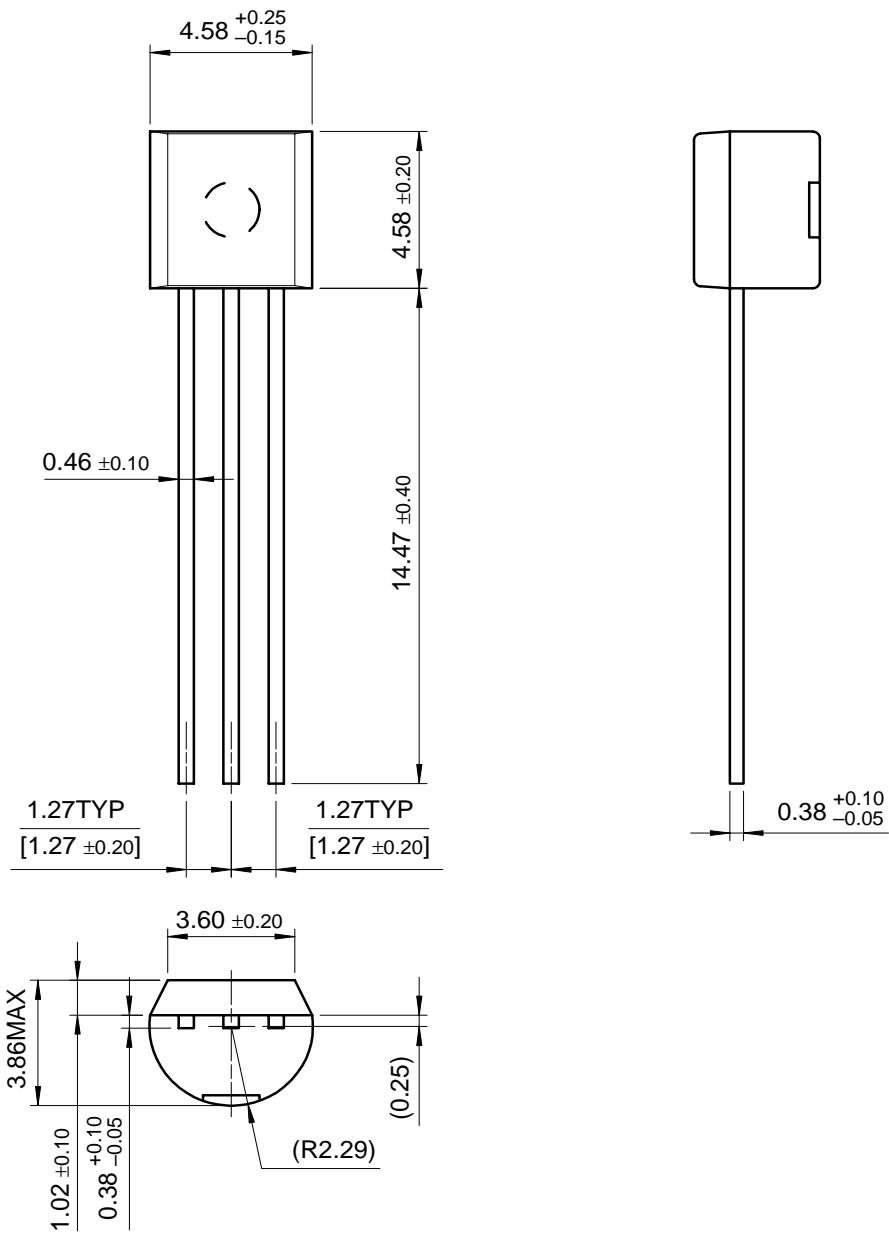
Figure 15. Constant-Current Sink

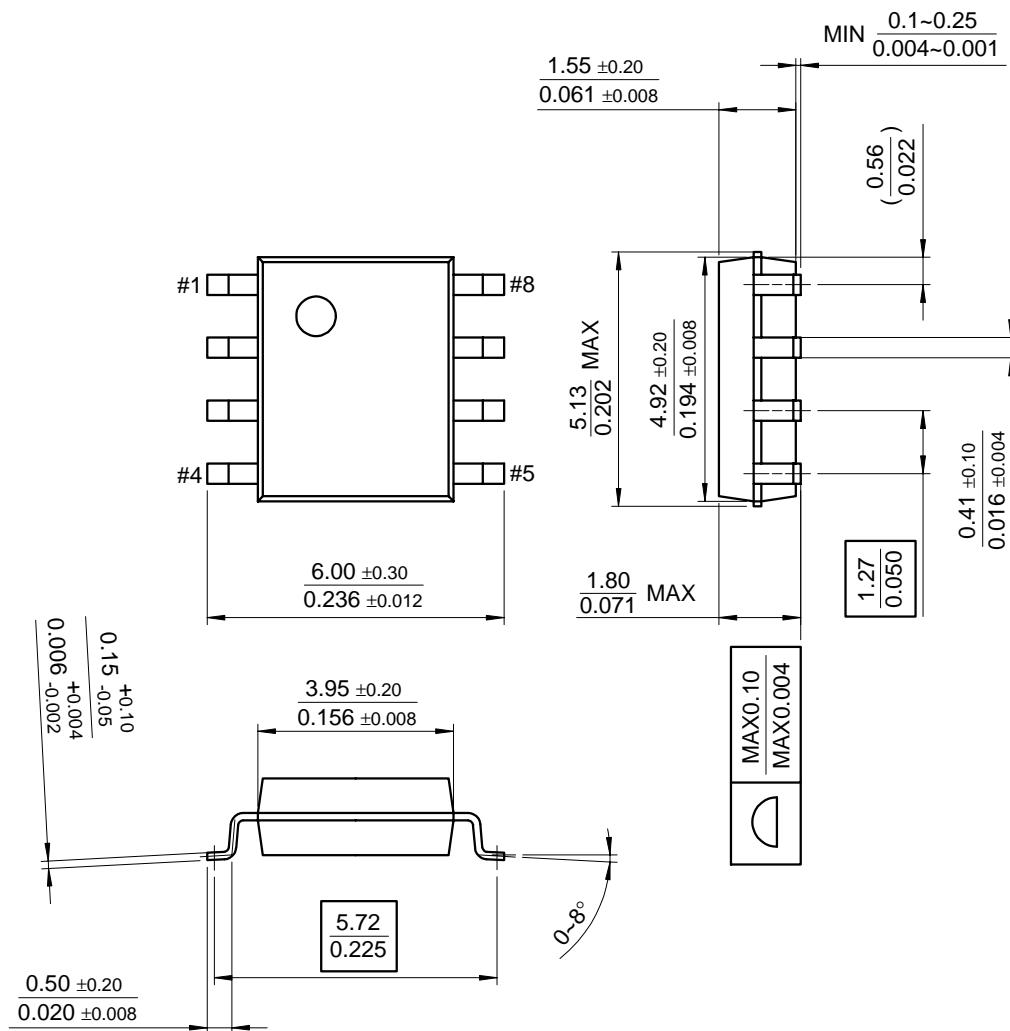
## Mechanical Dimensions

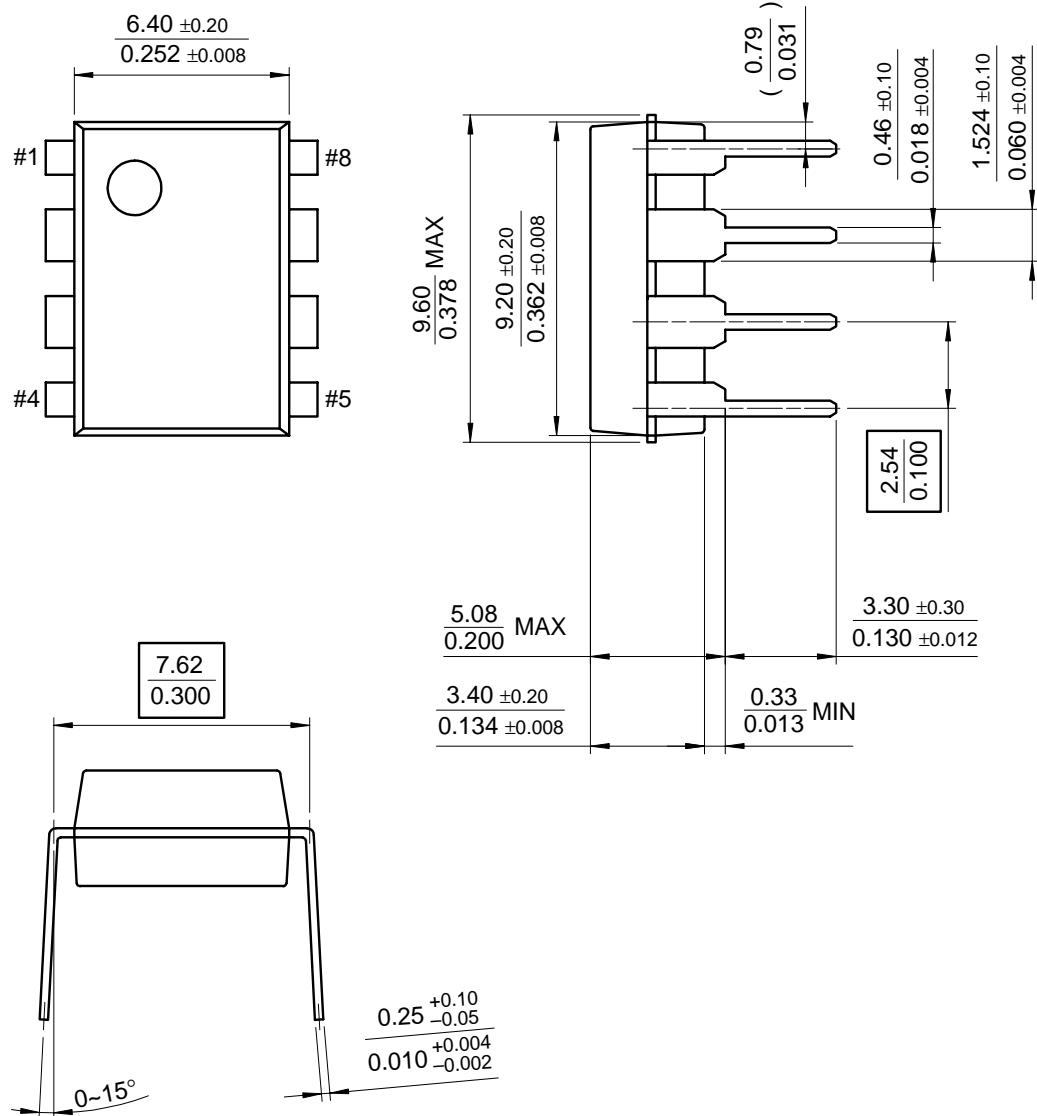
### Package

Dimensions in millimeters

## TO-92



**Mechanical Dimensions** (Continued)**Package****Dimensions in millimeters****8-SOP**

**Mechanical Dimensions** (Continued)**Package****Dimensions in millimeters****8-DIP**

## Ordering Information

Product Number	Output Voltage Tolerance	Package	Operating Temperature
LM431CCZ	0.5%	TO-92	-25 ~ +85 °C
LM431CCM		8-SOP	
LM431BCZ	1%	TO-92	-25 ~ +85 °C
LM431BCM		8-SOP	
LM431ACN	2%	8-DIP	-40 ~ +85 °C
LM431ACZ		TO-92	
LM431ACM		8-SOP	
LM431CIZ	0.5%	TO-92	-40 ~ +85 °C
LM431CIM		8-SOP	
LM431BIZ	1%	TO-92	-40 ~ +85 °C
LM431BIM		8-SOP	
LM431AIZ	2%	TO-92	-40 ~ +85 °C
LM431AIM		8-SOP	

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