

# LM431A/LM431B/LM431C

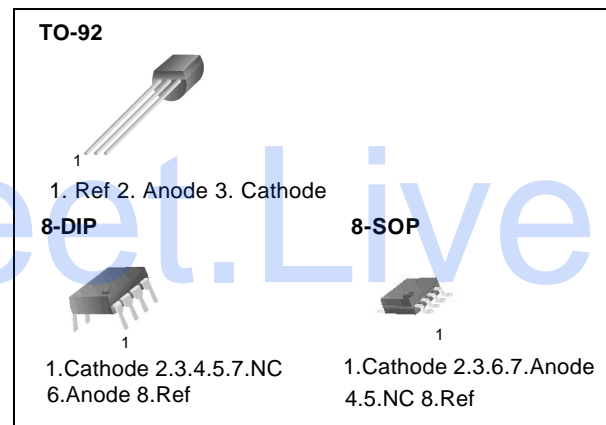
## Programmable Shunt Regulator

### Features

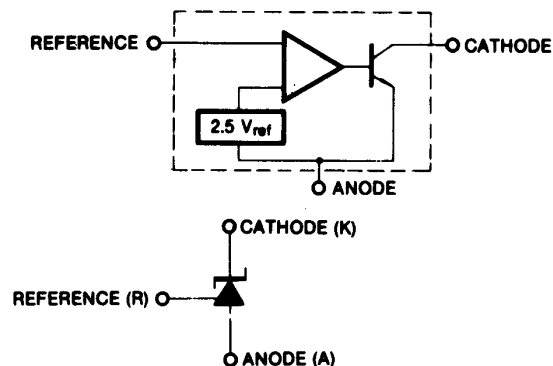
- Programmable Output Voltage to 36 Volts
- Low Dynamic Output Impedance 0.20 Typical
- Sink Current Capability of 1.0 to 100mA
- Equivalent Full-range Temperature Coefficient of 50ppm/°C Typical
- Temperature Compensated for Operation Over Full Rated Operating Temperature Range
- Low Output Noise Voltage
- 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  $V_{REF}$  (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	PD	770 1000	mW
<b>Operating Temperature Range</b>			
LM431xC	T <sub>OPR</sub>	-25 ~ +85	°C
LM431xI		-40 ~ +85	°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<sub>A</sub> = +25°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 <sub>KA</sub> =V <sub>REF</sub> , I <sub>KA</sub> =10mA	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	$\frac{D_{REF}}{DT}$	V <sub>KA</sub> =V <sub>REF</sub> , I <sub>KA</sub> =10mA T <sub>MIN</sub> ≤ T <sub>A</sub> ≤ T <sub>MAX</sub>	-	4.5	17	-	4.5	17	-	4.5	17	mV		
Ratio of Change in Reference Input Voltage to the Change in Cathode Voltage	$\frac{D_{REF}}{D_{KA}}$	I <sub>KA</sub> = 10mA	$\frac{D_{KA}=10V-V_{REF}}$		-	-1.0	-2.7	-	-1.0	-2.7	-	-1.0	-2.7	mV/V
			$\frac{D_{KA}=36V-10V}$		-	-0.5	-2.0	-	-0.5	-2.0	-	-0.5	-2.0	
Reference Input Current	I <sub>REF</sub>	I <sub>KA</sub> =10mA, R <sub>1</sub> =10KΩ, R <sub>2</sub> =∞	-	1.5	4	-	1.5	4	-	1.5	4	μA		
Deviation of Reference Input Current Over Full Temperature Range	$\frac{D_{REF}}{DT}$	I <sub>KA</sub> =10mA, R <sub>1</sub> =10KΩ, R <sub>2</sub> =∞ T <sub>A</sub> = Full Range	-	0.4	1.2	-	0.4	1.2	-	0.4	1.2	μA		
Minimum Cathode Current for Regulation	I <sub>KA(MIN)</sub>	V <sub>KA</sub> =V <sub>REF</sub>	-	0.45	1.0	-	0.45	1.0	-	0.45	1.0	mA		
Off - Stage Cathode Current	I <sub>KA(OFF)</sub>	V <sub>KA</sub> =36V, V <sub>REF</sub> =0	-	0.05	1.0	-	0.05	1.0	-	0.05	1.0	μA		
Dynamic Impedance	Z <sub>KA</sub>	V <sub>KA</sub> =V <sub>REF</sub> , I <sub>KA</sub> =1 to 100mA f ≥ 1.0KHz	-	0.15	0.5	-	0.15	0.5	-	0.15	0.5	Ω		

### Note1

- LM431XC : T<sub>MIN</sub>= -25 °C, T<sub>MAX</sub>= +85 °C
- LM431XI : T<sub>MIN</sub>= -40 °C, T<sub>MAX</sub>= +85 °C

## Test Circuits

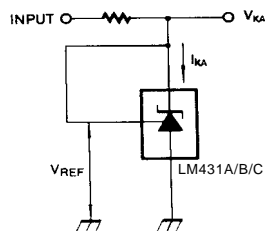


Figure 1. Test Circuit for  $V_{KA} = V_{REF}$

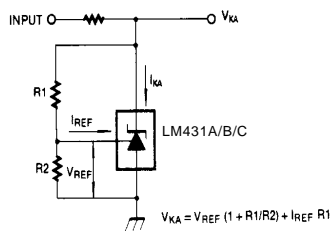


Figure 2. Test Circuit for  $V_{KA} = 3V_{REF}$

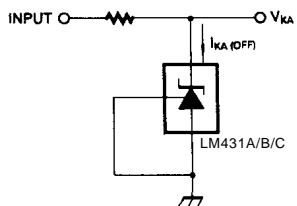


Figure 3. Test Circuit for  $I_{KA(OFF)}$

# Typical Performance Characteristics

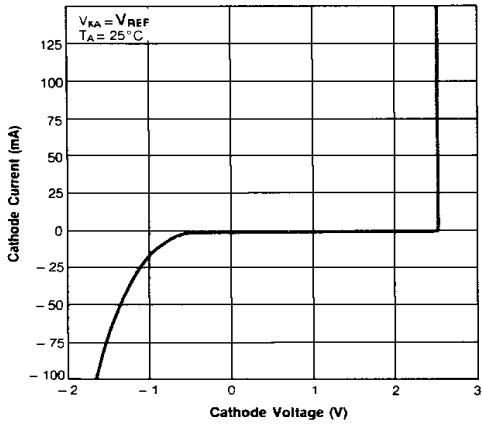


Figure 4. Cathode Current vs. Cathode Voltage

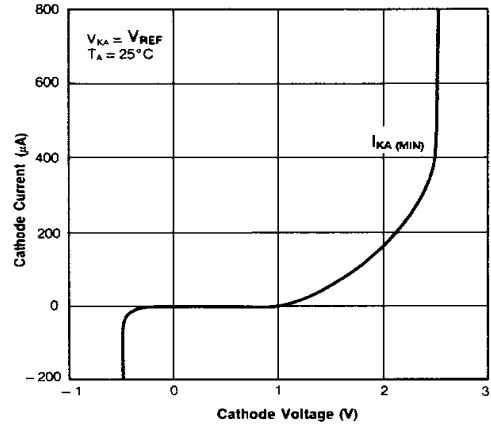


Figure 5. Cathode Current vs. Cathode Voltage

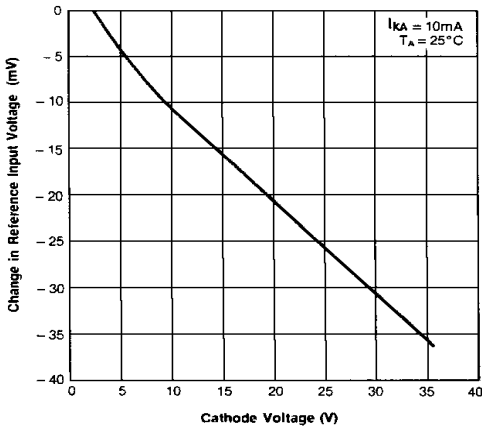


Figure 6. Change In Reference Input Voltage vs. Cathode Voltage

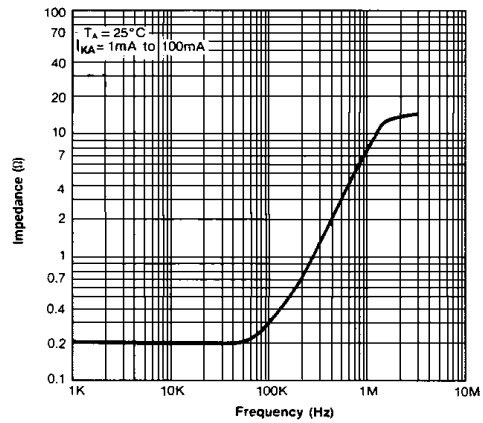


Figure 7. Dynamic Impedance Frequency

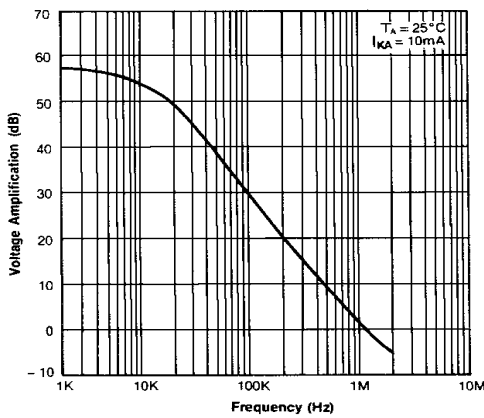


Figure 8. Small Signal Voltage Amplification vs. Frequency

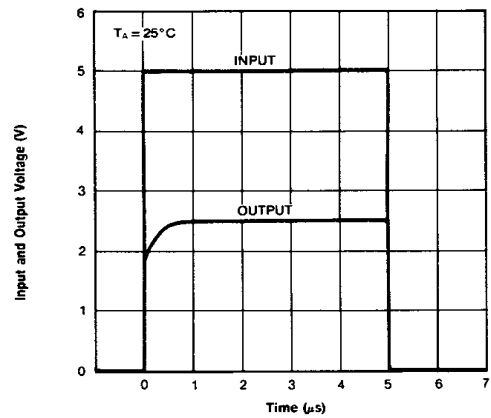


Figure 9. Pulse Response

Typical Performance Characteristics (Continued)

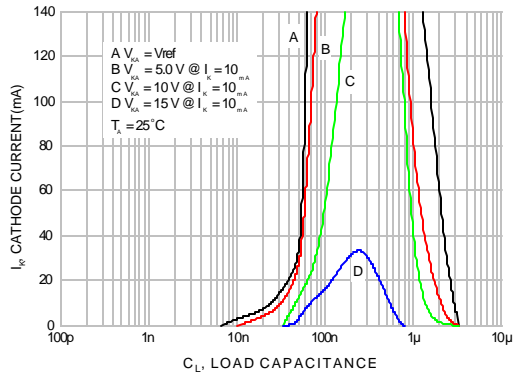


Figure 10. Stability Boundary Conditions

## Typical Application

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

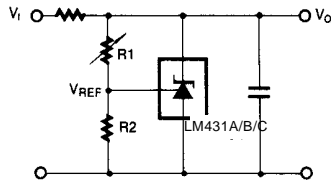


Figure 11. Shunt Regulator

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

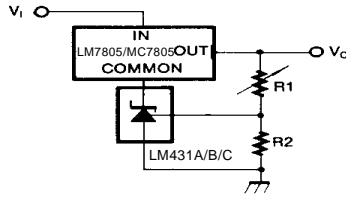


Figure 12. Output Control for Three-Terminal Fixed Regulator

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

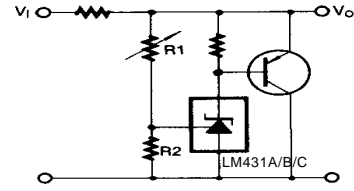


Figure 13. High Current Shunt Regulator

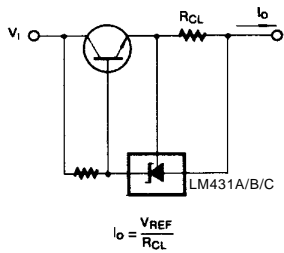


Figure 14. Current Limit or Current Source

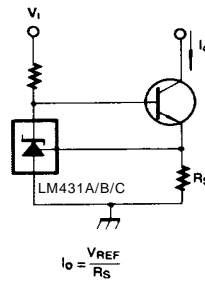


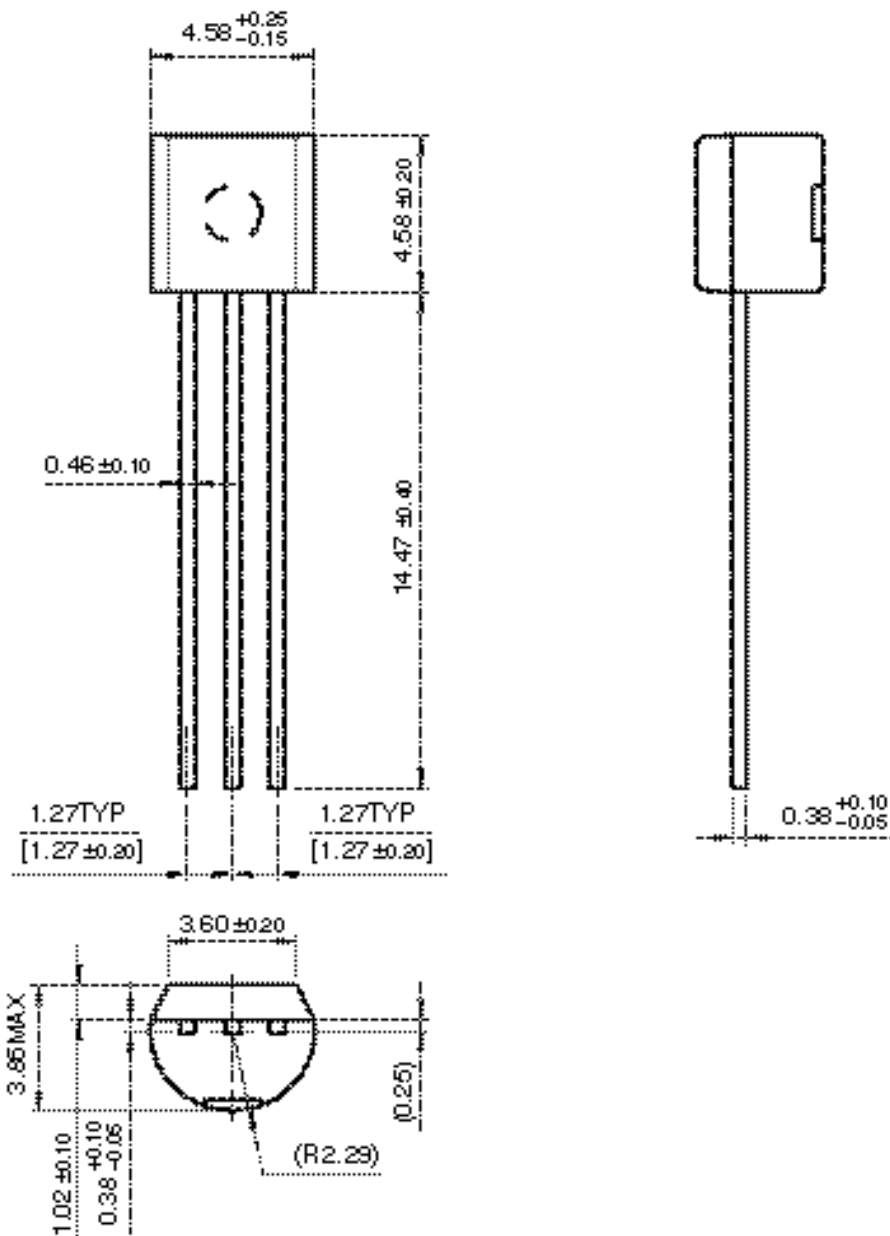
Figure 15. Constant-Current Sink

# Mechanical Dimensions

Package

Dimensions in millimeters

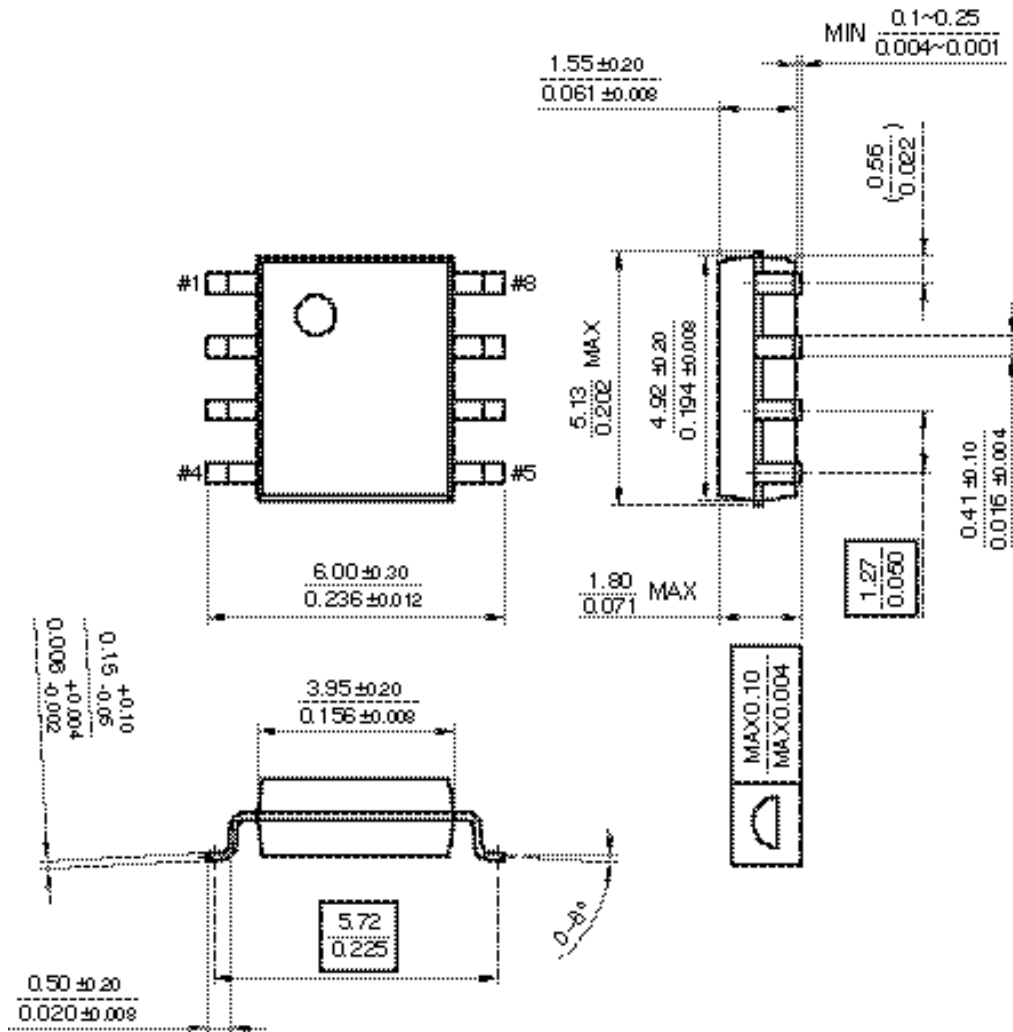
## TO-92





**Mechanical Dimensions** (Continued)**Package**

Dimensions in millimeters

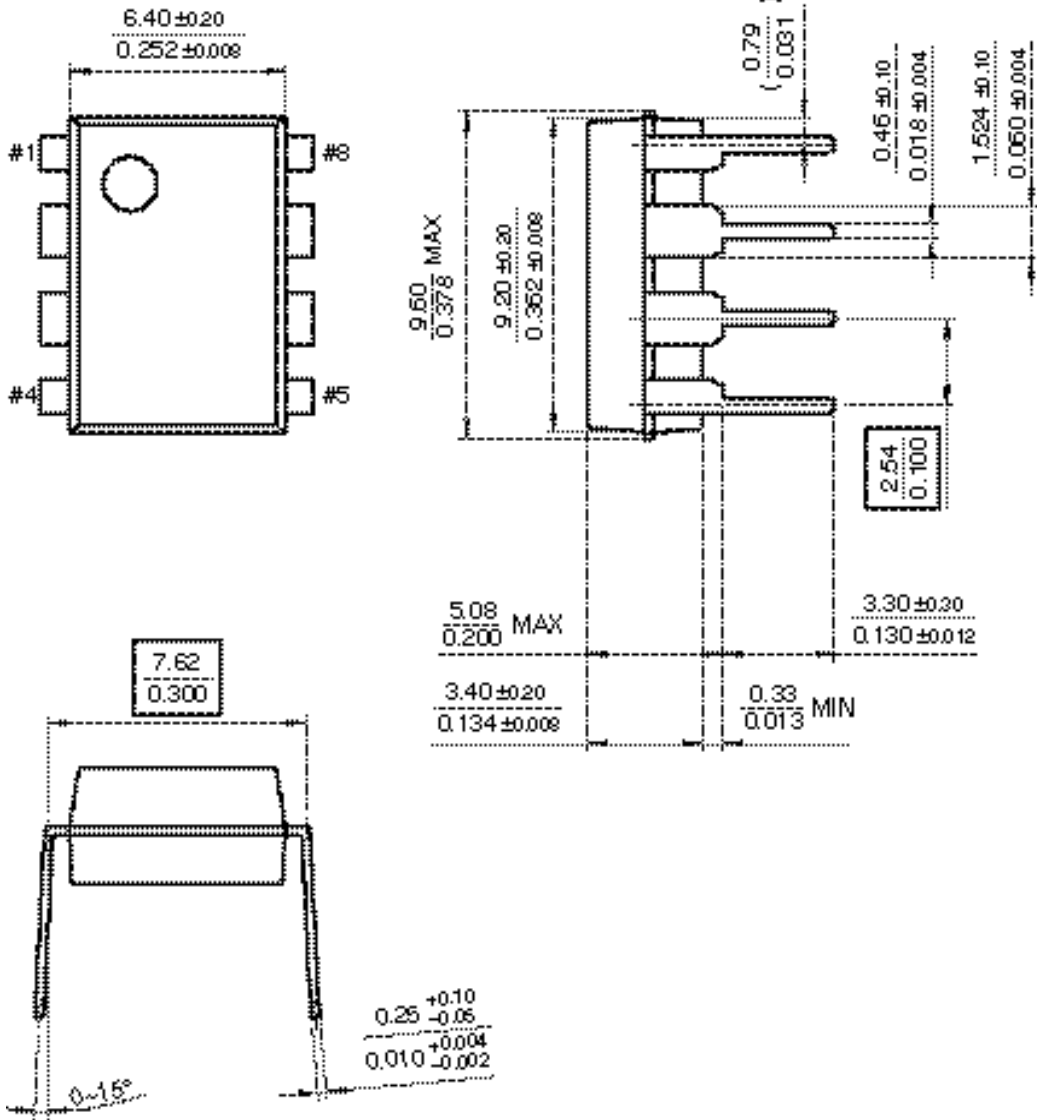
**8-SOP**

**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		
LM431BCM		8-SOP		
LM431ACN	2%	8-DIP		
LM431ACZ		TO-92		
LM431ACM		8-SOP		
LM431CIZ	0.5%	TO-92		-40 ~ +85 °C
LM431CIM		8-SOP		
LM431BIZ	1%	TO-92		
LM431BIM		8-SOP		
LM431AIZ	2%	TO-92		
LM431AIM		8-SOP		

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LM431A

Adjustable/2.5V, 2% Tolerance Shunt  
Regulator

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General 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  $V_{REF}$  (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.

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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/°C typical
- Temperature compensated for operation over full rated operating temperature range
- Low output noise voltage
- Fast turn-on response

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## Product status/pricing/packaging

Product	Product status	Package type	Leads	Package marking	Packing method
LM431ACZ	Full Production	<a href="#">TO-92</a>	3	\$N&2&T LM431 ACZ	BULK
LM431AIMX	Full Production	<a href="#">SOIC</a>	8	N/A	TAPE REEL
LM431AIZX	Full Production	<a href="#">TO-92</a>	3	N/A	TAPE REEL
LM431AIM	Full Production	<a href="#">SOIC</a>	8	N/A	RAIL
LM431ACMX	Full Production	<a href="#">SOIC</a>	8	N/A	TAPE REEL
LM431ACM	Full Production	<a href="#">SOIC</a>	8	N/A	RAIL
LM431ACZX	Full Production	<a href="#">TO-92</a>	3	N/A	TAPE REEL
LM431AIZXA	Full Production	<a href="#">TO-92</a>	3	N/A	TAPE REEL
LM431ACZXA	Full Production	<a href="#">TO-92</a>	3	N/A	TAPE REEL
LM431AIZ	Full Production	<a href="#">TO-92</a>	3	N/A	BULK

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## Application notes

[AN-42043: AN-42043 ML4803 240W Off-Line Power Supply with PFC](#)  
(296 K) Jul 19, 2002

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## LM431B

Adjustable/2.5V, 1% Tolerance Shunt Regulator

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## General 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  $V_{REF}$  (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.

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## 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/°C typical
- Temperature compensated for operation over full rated operating temperature range
- Low output noise voltage
- Fast turn-on response

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## Product status/pricing/packaging

Product	Product status	Package type	Leads	Package marking	Packing method
LM431BCMX	Full Production	<a href="#">SOIC</a>	8	N/A	TAPE REEL
LM431BIZX	Full Production	<a href="#">TO-92</a>	3	N/A	TAPE REEL
LM431BIZXA	Full Production	<a href="#">TO-92</a>	3	N/A	TAPE REEL
LM431BCZ	Full Production	<a href="#">TO-92</a>	3	\$N&2&T LM431 BCZ	BULK
LM431BCZXA	Full Production	<a href="#">TO-92</a>	3	N/A	TAPE REEL
LM431BIMX	Full Production	<a href="#">SOIC</a>	8	N/A	TAPE REEL
LM431BIZ	Full Production	<a href="#">TO-92</a>	3	N/A	BULK
LM431BCM	Full Production	<a href="#">SOIC</a>	8	N/A	RAIL
LM431BCZX	Full Production	<a href="#">TO-92</a>	3	N/A	TAPE REEL
LM431BIM	Full Production	<a href="#">SOIC</a>	8	N/A	RAIL

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## LM431C

Adjustable/2.5V, 0.5% Tolerance Shunt Regulator

## Contents

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## General 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  $V_{REF}$  (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.

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## 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/°C typical
- Temperature compensated for operation over full rated operating temperature range
- Low output noise voltage
- Fast turn-on response

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## Product status/pricing/packaging

Product	Product status	Package type	Leads	Package marking	Packing method
LM431CCM	Full Production	<a href="#">SOIC</a>	8	N/A	RAIL
LM431CCZXA	Full Production	<a href="#">TO-92</a>	3	N/A	TAPE REEL
LM431CIMX	Full Production	<a href="#">SOIC</a>	8	N/A	TAPE REEL
LM431CCZX	Full Production	<a href="#">TO-92</a>	3	N/A	TAPE REEL
LM431CCMX	Full Production	<a href="#">SOIC</a>	8	N/A	TAPE REEL
LM431CCZ	Full Production	<a href="#">TO-92</a>	3	\$N&2&T LM431 CCZ	BULK
LM431CIM	Full Production	<a href="#">SOIC</a>	8	N/A	RAIL
LM431CIZ	Full Production	<a href="#">TO-92</a>	3	N/A	BULK
LM431CIZXA	Full Production	<a href="#">TO-92</a>	3	N/A	TAPE REEL
LM431CIZX	Full Production	<a href="#">TO-92</a>	3	N/A	TAPE REEL

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