



# LM431SA/LM431SB/LM431SC

## 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 LM431SA/LM431SB/LM431SC 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.

#### SOT-89



1

1. Ref 2. Anode 3. Cathode

#### SOT-23F

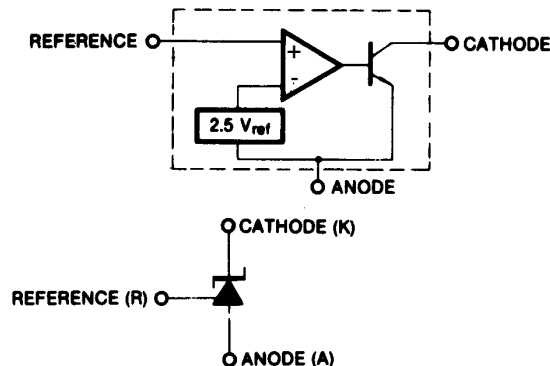
3



1 2

1. Cathode 2. Ref 3. Anode

### 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
Thermal Resistance Junction-Air (Note1,2) MF Suffix Package ML Suffix Package	R <sub>θJA</sub>	350 220	°C/W
Power Dissipation (Note3,4) MF Suffix Package ML Suffix Package	P <sub>D</sub>	350 560	mW
Junction Temperature	T <sub>J</sub>	150	°C
Operating Temperature Range	T <sub>OPR</sub>	-25 ~ +85	°C
Storage Temperature Range	T <sub>STG</sub>	-65 ~ +150	°C

### Note:

- Thermal resistance test board  
Size: 76.2mm \* 114.3mm \* 1.6mm (1S0P)  
JEDEC Standard: JESD51-3, JESD51-7
- Assume no ambient airflow.
- T<sub>JMAX</sub> = 150 °C, Ratings apply to ambient temperature at 25 °C
- Power dissipation calculation:  $P_D = (T_J - T_A)/R_{\theta JA}$

## 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	LM431SA			LM431SB			LM431SC			Unit
			Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Reference Input Voltage	$V_{REF}$	$V_{KA}=V_{REF}, I_{KA}=10\text{mA}$	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	$\Delta V_{REF}/\Delta V_{KA}$	$I_{KA}=10\text{mA}$	-	-1.0	-2.7	-	-1.0	-2.7	-	-1.0	-2.7	mV/V
			-	-0.5	-2.0	-	-0.5	-2.0	-	-0.5	-2.0	
Reference Input Current	$I_{REF}$	$I_{KA}=10\text{mA}, R_1=10\text{K}\Omega, R_2=\infty$	-	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	$I_{KA(MIN)}$	$V_{KA}=V_{REF}$	-	0.45	1.0	-	0.45	1.0	-	0.45	1.0	mA
Off -Stage Cathode Current	$I_{KA(OFF)}$	$V_{KA}=36\text{V}, V_{REF}=0$	-	0.05	1.0	-	0.05	1.0	-	0.05	1.0	$\mu\text{A}$
Dynamic Impedance	$Z_{KA}$	$V_{KA}=V_{REF}, I_{KA}=1 \text{ to } 100\text{mA}, f \geq 1.0\text{kHz}$	-	0.15	0.5	-	0.15	0.5	-	0.15	0.5	$\Omega$

### Note1

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

## Test Circuits

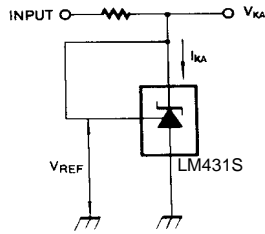


Figure 1. Test Circuit for  $V_{KA}=V_{REF}$

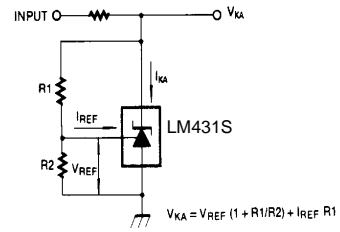


Figure 2. Test Circuit for  $V_{KA} \geq V_{REF}$

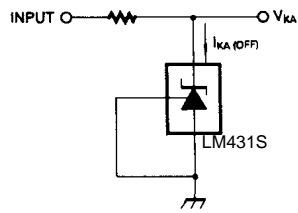


Figure 3. Test Circuit for  $I_{KA(OFF)}$

# Typical Performance Characteristics

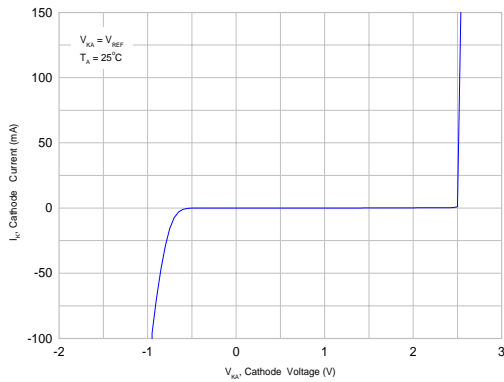


Figure 4. Cathode Current vs. Cathode Voltage

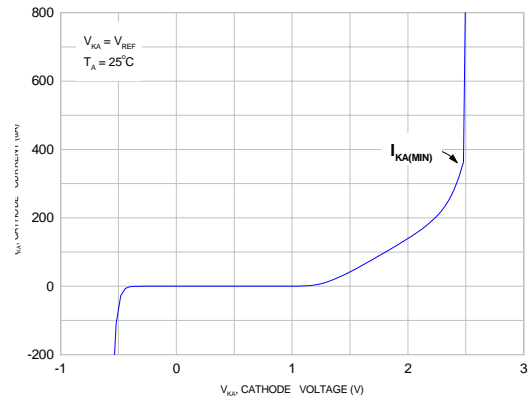


Figure 5. Cathode Current vs. Cathode Voltage

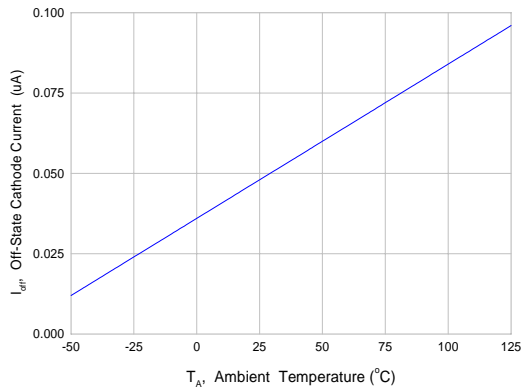


Figure 6. OFF-State Cathode Current vs. Ambient Temperature

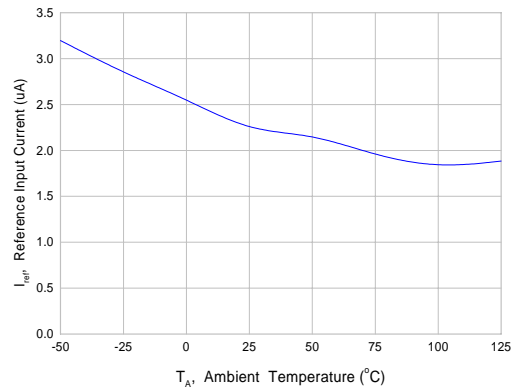


Figure 7. Reference Input Current vs. Ambient Temperature

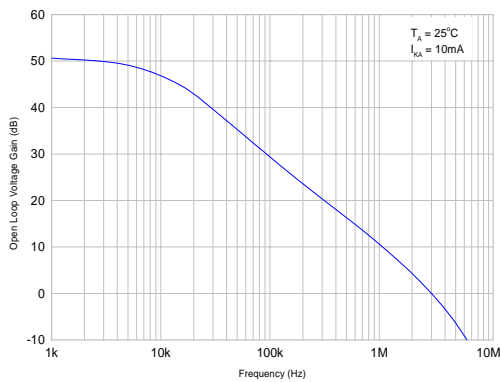


Figure 8. Small Signal Voltage Amplification vs. Frequency

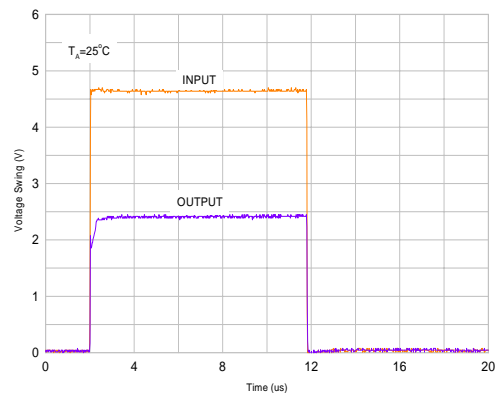


Figure 9. Pulse Response

Typical Performance Characteristics (Continued)

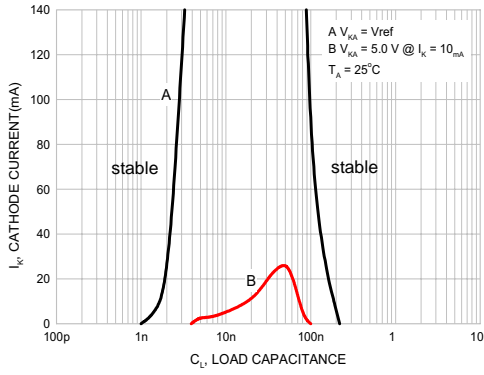


Figure 10. Stability Boundary Conditions

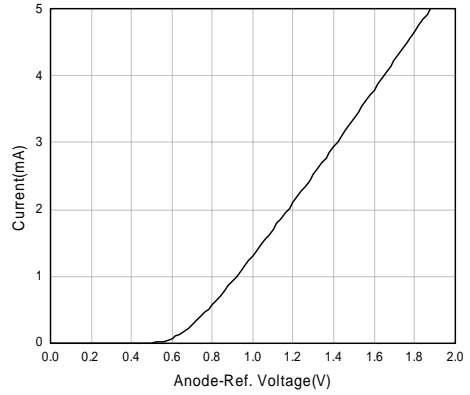


Figure 11. Anode-Reference Diode Curve

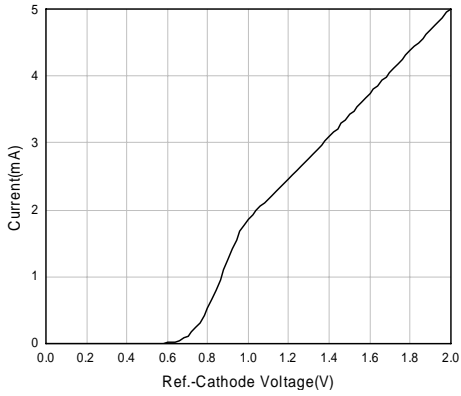


Figure 12. Reference-Cathode Diode Curve

## Typical Application

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

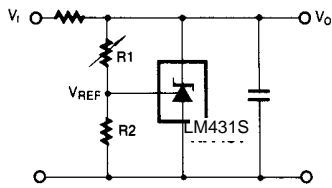


Figure 13. Shunt Regulator

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

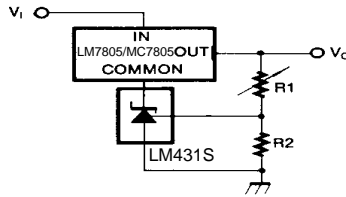


Figure 14. Output Control for Three-Terminal Fixed Regulator

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

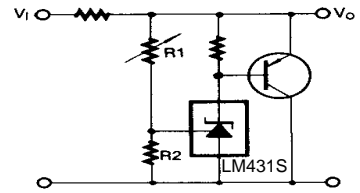


Figure 15. High Current Shunt Regulator

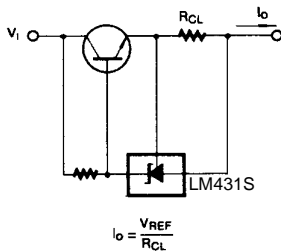


Figure 16. Current Limit or Current Source

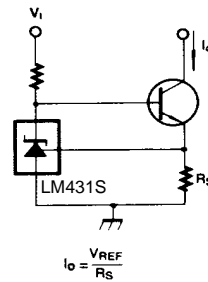


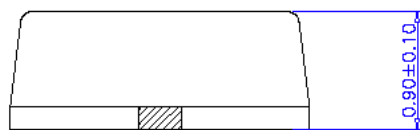
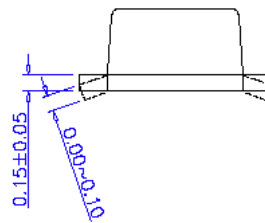
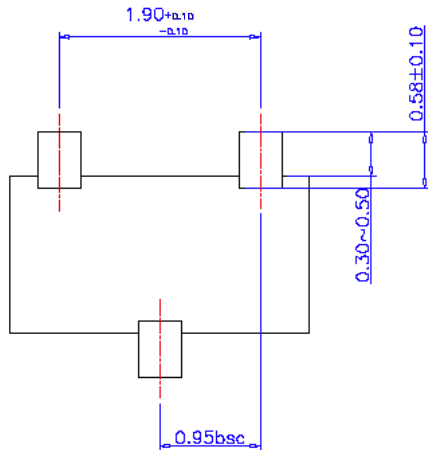
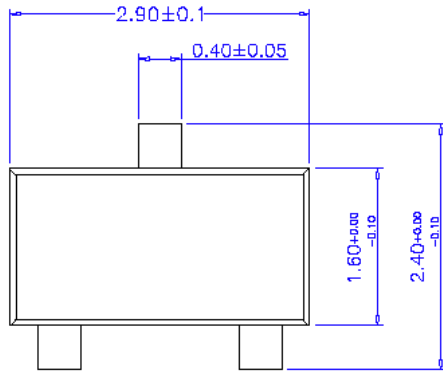
Figure 17. Constant-Current Sink

# Mechanical Dimensions

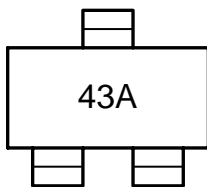
## Package

Dimensions in millimeters

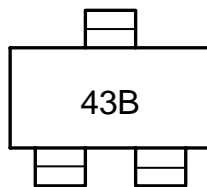
### SOT-23F



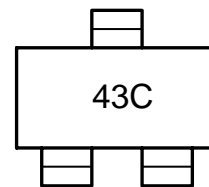
## Marking



2% tolerance



1% tolerance



0.5% tolerance

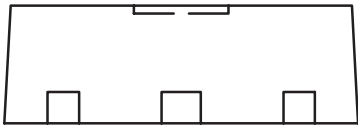
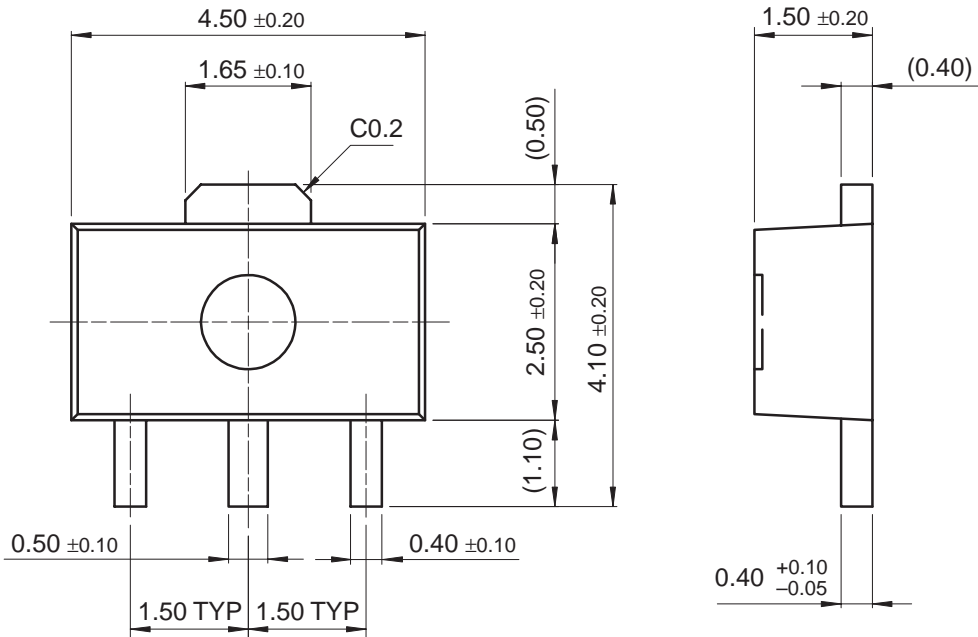


**Mechanical Dimensions** (Continued)

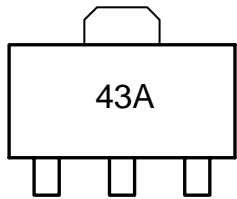
**Package**

Dimensions in millimeters

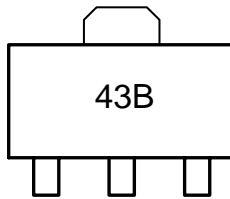
**SOT-89**



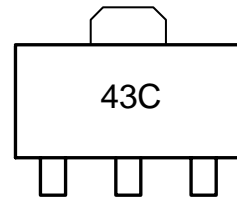
**Marking**



2% tolerance



1% tolerance



0.5% tolerance

## Ordering Information

Product Number	Output Voltage Tolerance	Package	Operating Temperature
LM431SCCML	0.5%	SOT-89	-25 ~ +85°C
LM431SCCMF		SOT-23F	
LM431SBCML	1%	SOT-89	
LM431SBCMF		SOT-23F	
LM431SACML	2%	SOT-89	
LM431SACMF		SOT-23F	

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