FAIRCHILD SEMICONDUCTOR®

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LM431SA/LM431SB/LM431SC

Programmable Shunt Regulator

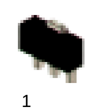
Features

- 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

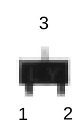
The LM431SA/LM431SB/LM431SC are three terminal output adjustable regulators with thermal stability over operating temperature range. The output voltage can be set any value between V_{REF} (approximately 2.5 volts) and 36 volts with two external resistors. These devices have a typical dynamic output impedance of 0.2Ω Active output circuit provides a sharp turn-on characteristic, making these devices excellent replacement for Zener Diodes in many applications.

SOT-89



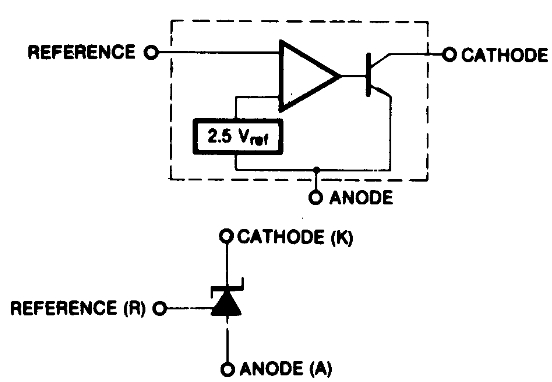
1. Ref 2. Anode 3. Cathode

SOT-23F



1. Cathode 2. Ref 3. Anode

Internal Block Diagram



Rev. 1.0.3

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Absolute Maximum Ratings

(Operating temperature range applies unless otherwise specified.)

Parameter	Symbol	Value	Unit
Cathode Voltage	V_{KA}	37	V
Cathode current Range (Continuous)	I_{KA}	-100 ~ +150	mA
Reference Input Current Range	I_{REF}	0.05 ~ +10	mA
Thermal Resistance Junction-Air (Note1,2) MF Suffix Package ML Suffix Package	$R_{\theta JA}$	 350 220	°C/W
Power Dissipation (Note3,4) MF Suffix Package ML Suffix Package	P_D	 350 560	mW
Junction Temperature	T_J	150	°C
Operating Temperature Range	T_{OPR}	-25 ~ +85	°C
Storage Temperature Range	T_{STG}	-65 ~ +150	°C

Note:

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

Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Cathode Voltage	V_{KA}	V_{REF}	-	36	V
Cathode Current	I_{KA}	1.0	-	100	mA

Electrical Characteristics

(T_A = +25°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}=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	$\Delta V_{REF}/\Delta T$	V_{KA}=V_{REF}, I_{KA}=10mA $T_{MIN} \leq T_A \leq T_{MAX}$	-	4.5	17	-	4.5	17	-	4.5	17	mV
Ratio of Change in Reference Input Voltage	$\Delta V_{REF}/\Delta V_{KA}$	I_{KA} =10mA, ΔV_{KA}=10V-V_{REF}	-	-1.0	-2.7	-	-1.0	-2.7	-	-1.0	-2.7	mV/V
to the Change in Cathode Voltage		I_{KA} =10mA, ΔV_{KA}=36V-10V	-	-0.5	-2.0	-	-0.5	-2.0	-	-0.5	-2.0	mV/V
Reference Input Current	I_{REF}	I_{KA}=10mA, R_1=10KΩ,R_2=∞	-	1.5	4	-	1.5	4	-	1.5	4	μA
Deviation of Reference Input Current Over Full Temperature Range	$\Delta I_{REF}/\Delta T$	I_{KA}=10mA, R_1=10KΩ,R_2=∞ T_A =Full Range	-	0.4	1.2	-	0.4	1.2	-	0.4	1.2	μA
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}=36V, V_{REF}=0	-	0.05	1.0	-	0.05	1.0	-	0.05	1.0	μA
Dynamic Impedance	Z_{KA}	V_{KA}=V_{REF}, I_{KA}=1 to 100mA ,f ≥1.0kHz	-	0.15	0.5	-	0.15	0.5	-	0.15	0.5	Ω

Note1

T_{MIN} = -25°C, T_{MAX} = +85°C

Test Circuits

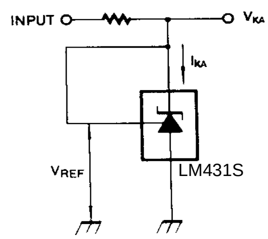


Figure 1. Test Circuit for V_{KA}=V_{REF}

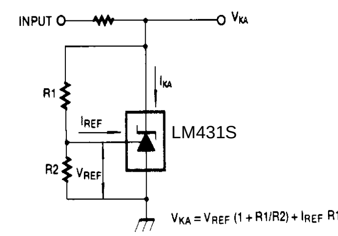


Figure 2. Test Circuit for $V_{KA} \geq V_{REF}$

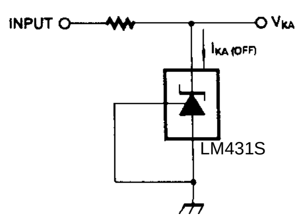


Figure 3. Test Circuit for $I_{KA(OFF)}$

Typical Performance Characteristics

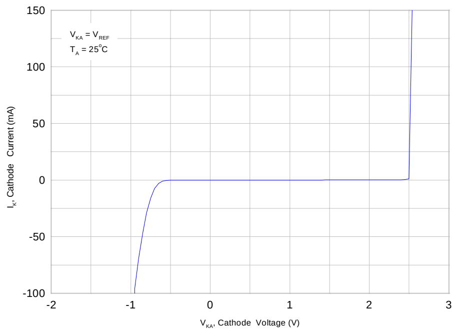


Figure 4. Cathode Current vs. Cathode Voltage

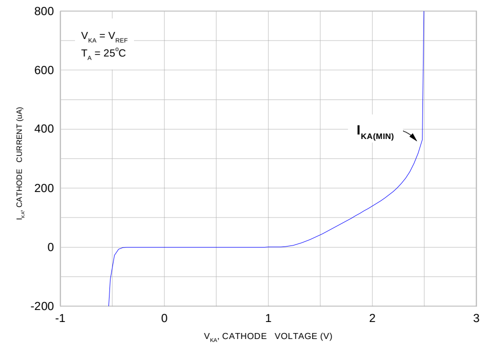


Figure 5. Cathode Current vs. Cathode Voltage

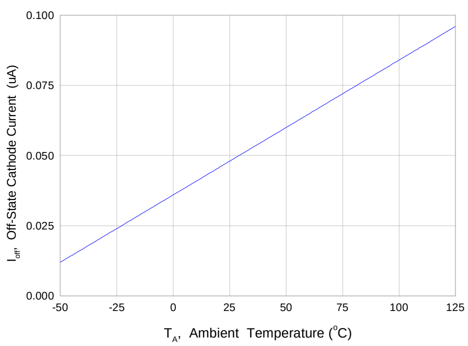


Figure 6. OFF-State Cathode Current vs. Ambient Temperature

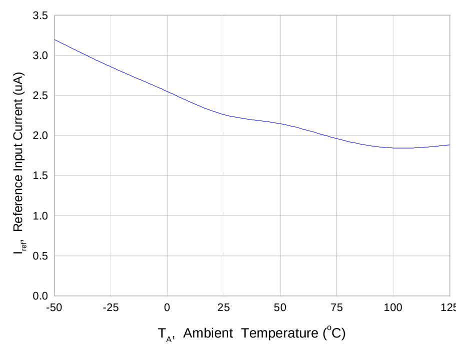


Figure7. Reference Input Current vs. Ambient Temperature

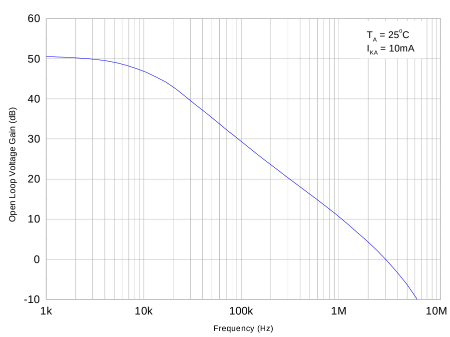


Figure 8. Small Signal Voltage Amplification vs. Frequency

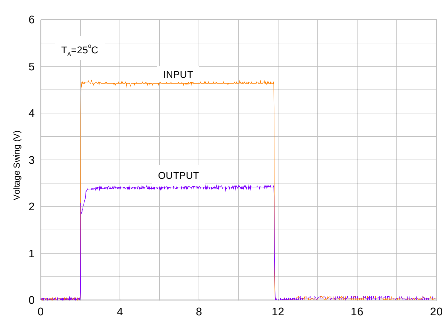


Figure 9. Pulse Response

Typical Performance Characteristics (Continued)

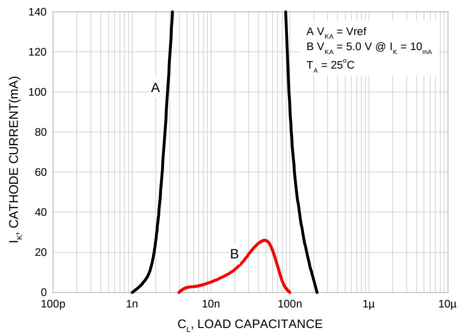


Figure 10. Stability Boundary Conditions

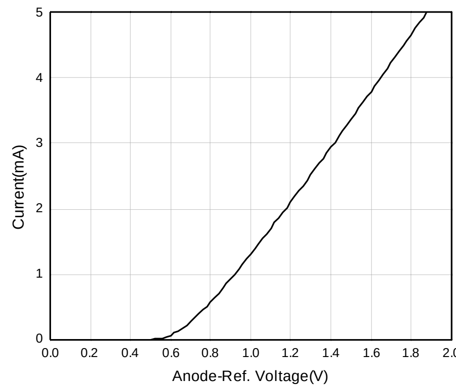


Figure 11. Anode-Reference Diode Curve

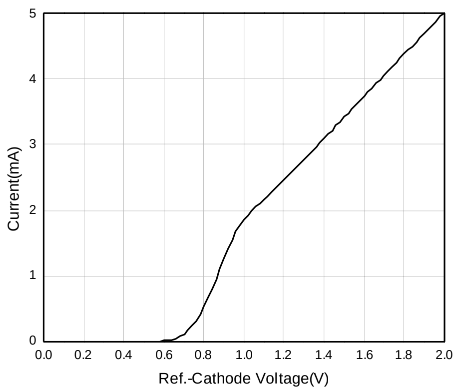


Figure 12. Reference-Cathode Diode Curve

Typical Application

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

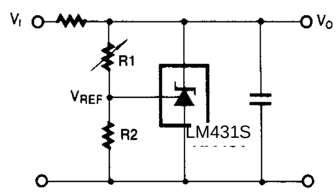


Figure 13. Shunt Regulator

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

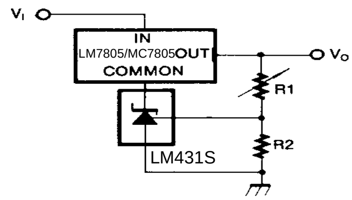


Figure 14. Output Control for Three-Termianl Fixed Regulator

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

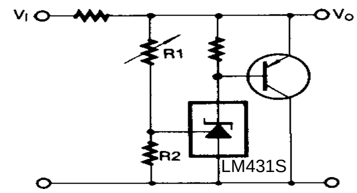


Figure 15. High Current Shunt Regulator

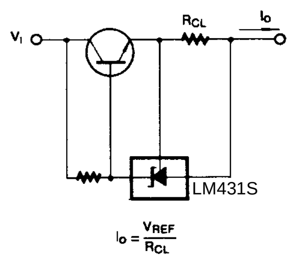


Figure 16. Current Limit or Current Source

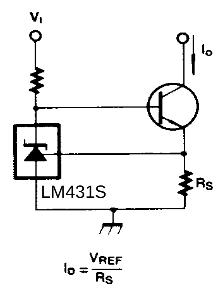


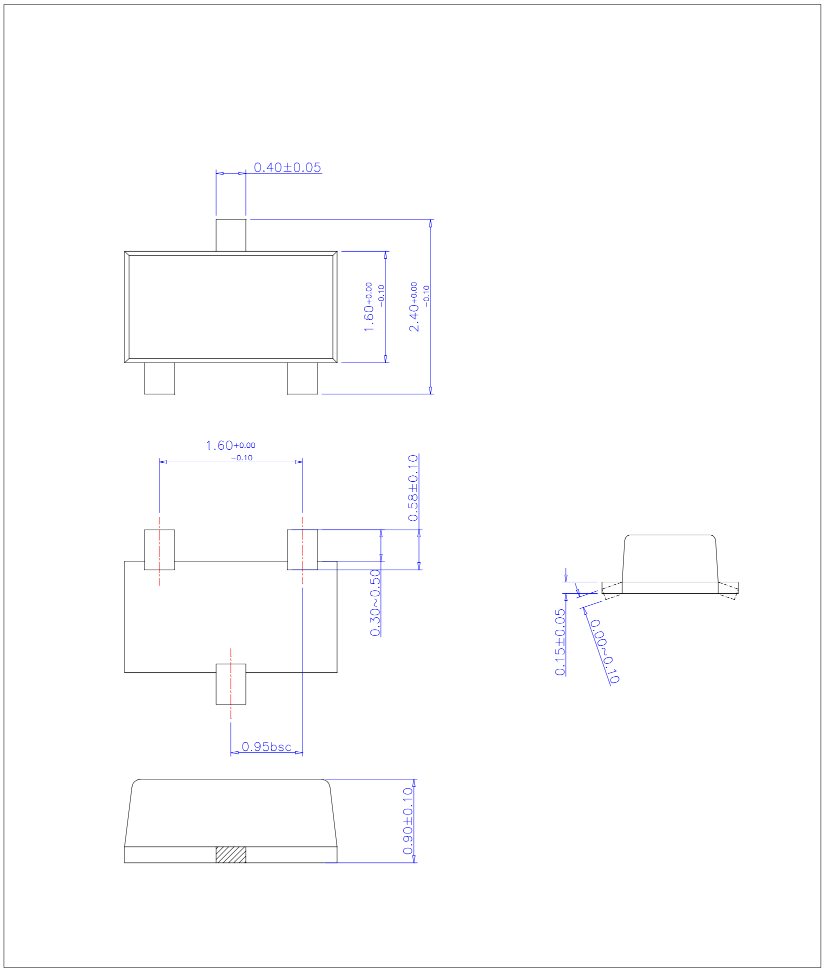
Figure 17. Constant-Current Sink

Mechanical Dimensions

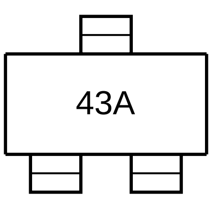
Package

Dimensions in millimeters

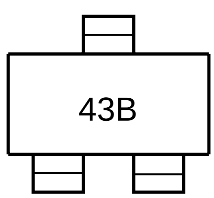
SOT-23F



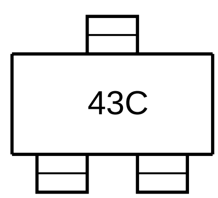
Marking



2% tolerance



1% tolerance



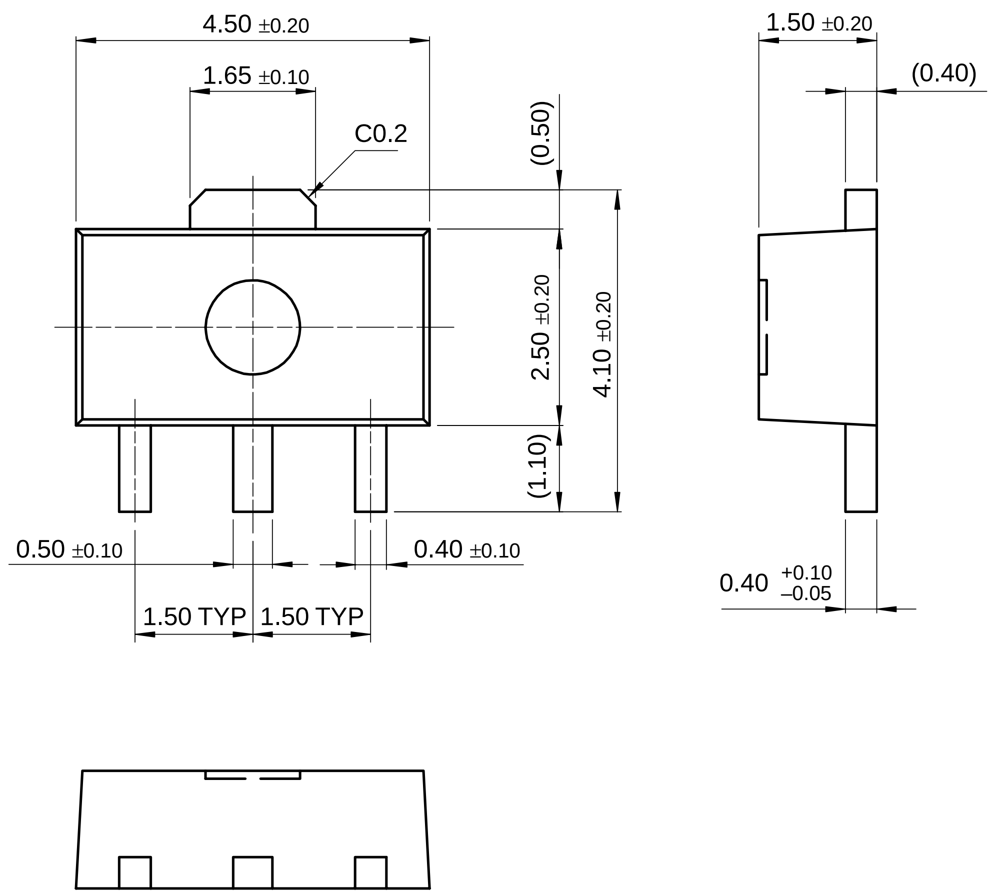
0.5% tolerance

Mechanical Dimensions (Continued)

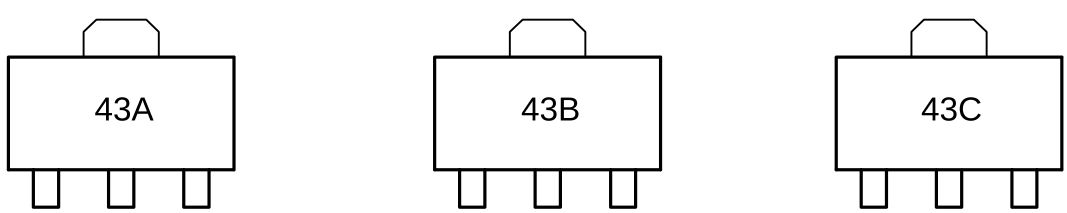
Package

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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2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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