

# **Programmable Shunt Regulator**

## LM431A, LM431B, LM431C

#### Description

The LM431A/LM431B/LM431C are three–terminal output adjustable regulators with thermal stability over the full operating temperature range. The output voltage can be set to any value between  $V_{REF}$  (approximately 2.5 V) and 36 V 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 replacements for Zener diodes in many applications.

#### **Features**

- Programmable Output Voltage to 36 V
- Low Dynamic Output Impedance: 0.2 Ω (Typical)
- Sink Current Capability: 1.0 to 100 mA
- Equivalent Full-Range Temperature Coefficient of 50 ppm/°C (Typical)
- Temperature Compensated for Operation Over Full Rated Operating Temperature Range
- Low Output Noise Voltage
- Fast Turn-on Response

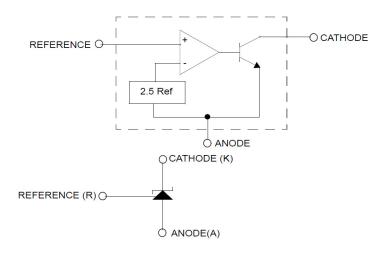
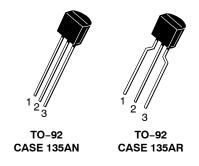
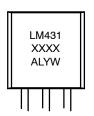


Figure 1. Block Diagram

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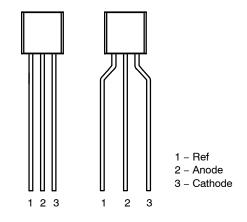


#### MARKING DIAGRAM



LM431XXXX = Specific Device Code
A = Assembly Location
L = Wafer Lot
YW = Assembly Start Week

#### **PIN CONNECTIONS**



#### **ORDERING INFORMATION**

See detailed ordering and shipping information in the package dimensions section on page 7 of this data sheet.

NOTE: Some of the devices on this data sheet have been **DISCONTINUED**. Please refer to the table on page 7.

#### **ABSOLUTE MAXIMUM RATINGS**

Symbol	Parameter	Value	Unit
$V_{KA}$	Cathode Voltage	37	V
I <sub>KA</sub>	Cathode Current Range (Continuous)	-100 to +150	mA
I <sub>REF</sub>	Reference Input Current Range	−0.05 to +10	mA
$P_{D}$	Power Dissipation	770	mW
$R_{\theta jA}$	Thermal Resistance, Junction to Ambient	160	°C/W
T <sub>OPR</sub>	Operating Temperature Range – LM431xC	-25 to +85	°C
	Operating Temperature Range – LM431xI	-40 to +85	°C
$T_J$	Junction Temperature	150	°C
T <sub>STG</sub>	Storage Temperature Range	−65 to +150	°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

#### RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Max	Unit
V <sub>KA</sub>	Cathode Voltage	$V_{REF}$	36	V
I <sub>KA</sub>	Cathode Current	1.0	100	mA

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

## **ELECTRICAL CHARACTERISTICS** (Values are at T<sub>A</sub> = 25°C unless otherwise noted)

				ı	_M431A	1	ı	_M431E	3	ı	_M431C	;	
Symbol	Parameter	Condi	tions	Min	Тур	Max	Min	Тур	Max	Min	Тур	Max	Unit
V <sub>REF</sub>	Reference Input Voltage	V <sub>KA</sub> = V <sub>REF</sub> , I <sub>KA</sub> = 10 mA		2.450	2.500	2.550	2.470	2.495	2.520	2.482	2.495	2.508	V
$\Delta V_{REF}/\Delta T$	Deviation of Reference Input Voltage Over– Temperature	$V_{KA} = V_{REF}$ , $I_{KA} = 10 \text{ mA}$ $T_{MIN} \le T_A \le T_{MAX}$ (Note 1)		-	4.5	17.0	-	4.5	17.0	-	4.5	17.0	mV
ΔV <sub>REF</sub> / ΔV <sub>KA</sub>	Ratio of Change in Reference Input Voltage to the	I <sub>KA</sub> = 10 mA	$\Delta V_{KA} =$ 10 V-V <sub>REF</sub>	-	-1.0	-2.7	-	-1.0	-2.7	-	-1.0	-2.7	mV/V
	Change in Cathode Voltage		ΔV <sub>KA</sub> = 36 V–10 V	-	-0.5	-2.0	-	-0.5	-2.0	-	-0.5	-2.0	
I <sub>REF</sub>	Reference Input Current	I <sub>KA</sub> = 10 mA, F R2 = ∞	$R1 = 10 \text{ k}\Omega$ ,	-	1.5	4.0	_	1.5	4.0	_	1.5	4.0	μΑ
ΔI <sub>REF</sub> /ΔΤ	Deviation of Reference Input Current Over Full Temperature Range	$I_{KA} = 10 \text{ mA, F}$ R2 = $\infty$ , T <sub>A</sub> = F		-	0.4	1.2	-	0.4	1.2	-	0.4	1.2	μΑ
I <sub>KA(MIN)</sub>	Minimum Cathode Current for Regulation	V <sub>KA</sub> = V <sub>REF</sub>		-	0.45	1.00	-	0.45	1.00	-	0.45	1.00	mA
I <sub>KA(OFF)</sub>	Off - Stage Cathode Current	V <sub>KA</sub> = 36 V, V <sub>REF</sub> = 0		_	0.05	1.00	_	0.05	1.00	_	0.05	1.00	μΑ
Z <sub>KA</sub>	Dynamic Impedance	$V_{KA} = V_{REF}, I_{KA} = 1 \text{ to } 100$ mA, f $\geq$ 1.0 kHz		-	0.15	0.50	-	0.15	0.50	-	0.15	0.50	Ω

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

1. 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 CIRCUIT**

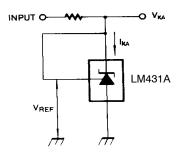


Figure 2. Test Circuit for  $V_{KA} = V_{REF}$ 

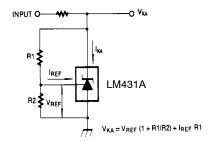


Figure 3. Test Circuit for  $V_{KA} \ge V_{REF}$ 

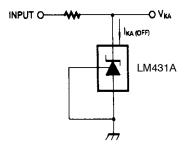


Figure 4. Test Circuit for I<sub>KA(OFF)</sub>

## **TYPICAL PERFORMANCE CHARACTERISTICS**

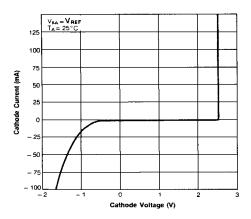


Figure 5. Cathode Current vs. Cathode Voltage

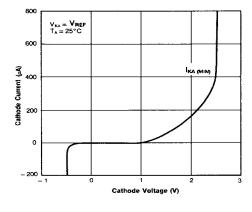


Figure 6. Cathode Current vs. Cathode Voltage

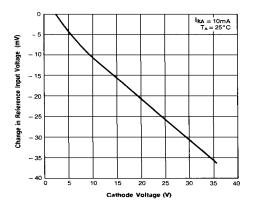


Figure 7. Change in Reference Input Voltage vs. Cathode Voltage

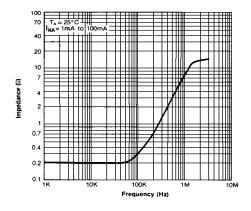


Figure 8. Dynamic Impedance Frequency

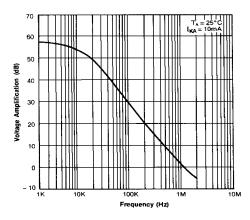


Figure 9. Small Signal Voltage Amplification vs. Frequency

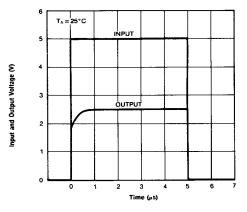


Figure 10. Pulse Response

## TYPICAL PERFORMANCE CHARACTERISTICS (CONTINUED)

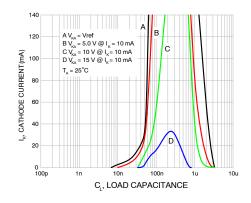


Figure 11. Stability Boundary Conditions

## **TYPICAL APPLICATION**

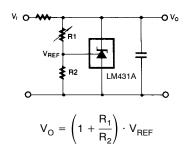


Figure 12. Shunt Regulator

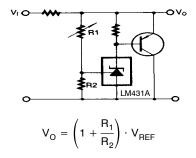


Figure 14. High-Current Shunt Regulator

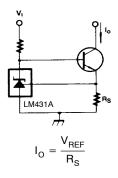


Figure 16. Constant-Current Sink

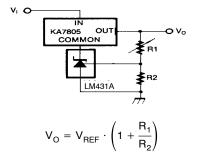


Figure 13. Output Control for Three-Terminal Fixed Regulator

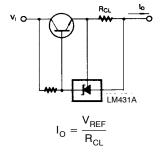


Figure 15. Current Limit or Current Source

## **ORDERING INFORMATION**

Part Number	Operating Temperature Range	Output Voltage Tolerance	Tom Mark	Package	Packing Method <sup>†</sup>
LM431AIZ	−40 ~ +85°C	2%	LM431AIZ	TO-92	Bulk

## **DISCONTINUED** (Note 2)

LM431CCZ	−25 ~ +85°C	0.5%	LM431CCZ	TO-92	Bulk
LM431BCZX		1%	LM431BCZ	TO-92	Tape and Reel
LM431BCZXA			LM431BCZ	TO-92	Ammo
LM431ACZ		2%	LM431ACZ	TO-92	Bulk
LM431ACZX			LM431ACZ	TO-92	Tape and Reel
LM431BIZX	−40 ~ +85°C	1%	LM431BIZ	TO-92	Tape and Reel

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

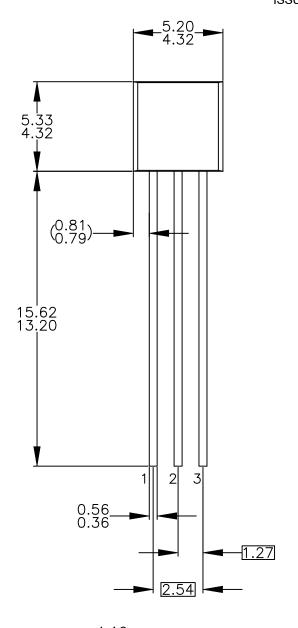
2. **DISCONTINUED:** These devices are not recommended for new design. Please contact your **onsemi** representative for information. The

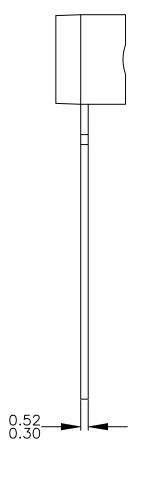
most current information on these devices may be available on www.onsemi.com.



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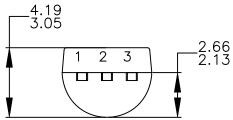
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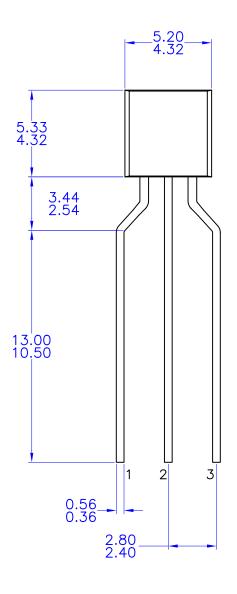


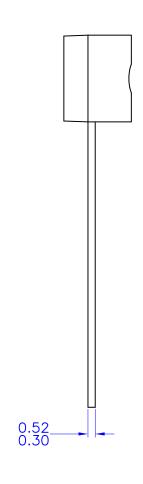


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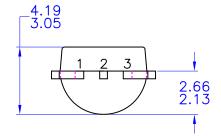
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