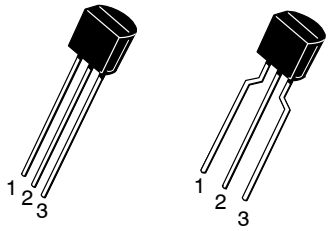
Programmable Shunt Regulator

LM431A, LM431B, LM431C



TO−92
CASE 135AN

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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 Ω. 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

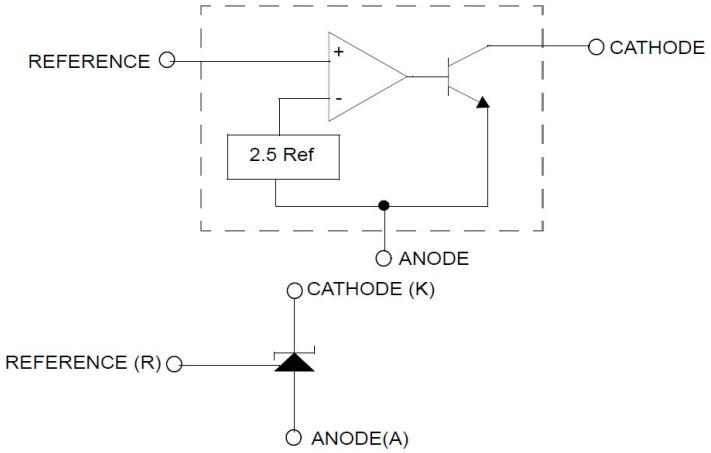
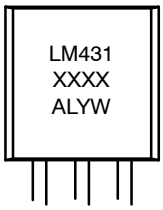


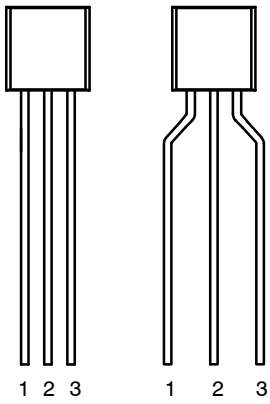
Figure 1. Block Diagram

MARKING DIAGRAM



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

PIN CONNECTIONS



1 – Ref
2 – Anode
3 – Cathode

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 6 of this data sheet.

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ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{KA}	Cathode Voltage	37	V
I_{KA}	Cathode Current Range (Continuous)	−100 to +150	mA
I_{REF}	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_{OPR}	Operating Temperature Range − LM431xC	−25 to +85	°C
	Operating Temperature Range − LM431xI	−40 to +85	°C
T_J	Junction Temperature	150	°C
T_{STG}	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_{KA}	Cathode Voltage	V_{REF}	36	V
I_{KA}	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_A = 25°C unless otherwise noted)

Symbol	Parameter	Conditions		LM431A			LM431B			LM431C			Unit
				Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
V_{REF}	Reference Input Voltage	$V_{KA} = V_{REF}$, I_{KA} = 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 mA $T_{MIN} \le T_A \le T_{MAX}$ (Note 1)		–	4.5	17.0	–	4.5	17.0	–	4.5	17.0	mV
$\Delta V_{REF}/\Delta V_{KA}$	Ratio of Change in Reference Input Voltage to the Change in Cathode Voltage	I_{KA} = 10 mA	ΔV_{KA} = 10 V−V_{REF}	–	−1.0	−2.7	–	−1.0	−2.7	–	−1.0	−2.7	mV/V
			ΔV_{KA} = 36 V−10 V	–	−0.5	−2.0	–	−0.5	−2.0	–	−0.5	−2.0	
I_{REF}	Reference Input Current	I_{KA} = 10 mA, R1 = 10 kΩ, R2 = ∞		–	1.5	4.0	–	1.5	4.0	–	1.5	4.0	μA
$\Delta I_{REF}/\Delta T$	Deviation of Reference Input Current Over Full Temperature Range	I_{KA} = 10 mA, R1 = 10 kΩ, R2 = ∞, T_A = Full Range		–	0.4	1.2	–	0.4	1.2	–	0.4	1.2	μA
$I_{KA(MIN)}$	Minimum Cathode Current for Regulation	$V_{KA} = V_{REF}$		–	0.45	1.00	–	0.45	1.00	–	0.45	1.00	mA
$I_{KA(OFF)}$	Off − Stage Cathode Current	V_{KA} = 36 V, V_{REF} = 0		–	0.05	1.00	–	0.05	1.00	–	0.05	1.00	μA
Z_{KA}	Dynamic Impedance	$V_{KA} = V_{REF}$, I_{KA} = 1 to 100 mA, f ≥ 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_{MIN} = −25°C, T_{MAX} = +85°C
   LM431xI: T_{MIN} = −40°C, T_{MAX} = +85°C

TEST CIRCUIT

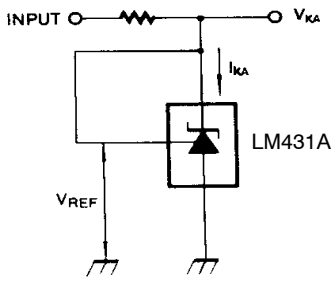


Figure 2. Test Circuit for V_{KA}= V_{REF}

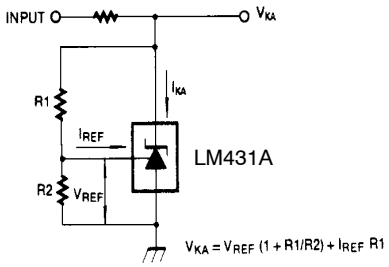


Figure 3. Test Circuit for $V_{KA} \geq V_{REF}$

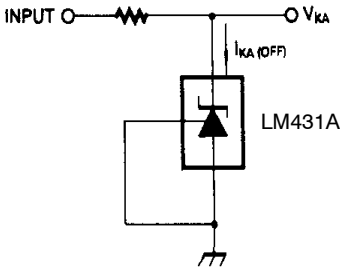


Figure 4. Test Circuit for $I_{KA(OFF)}$

TYPICAL PERFORMANCE CHARACTERISTICS

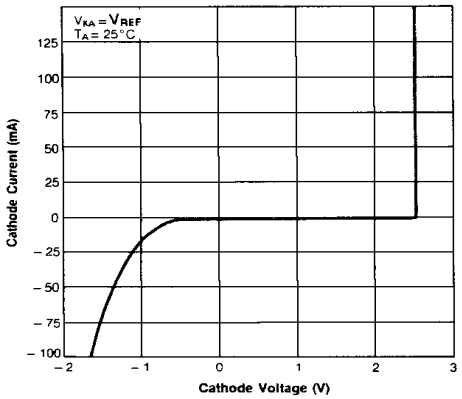


Figure 5. Cathode Current vs. Cathode Voltage

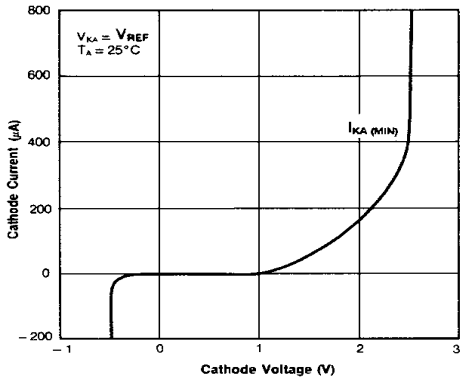


Figure 6. Cathode Current vs. Cathode Voltage

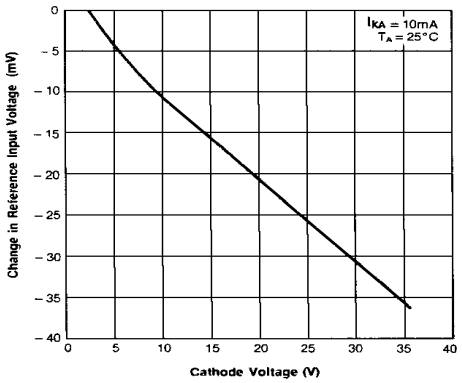


Figure 7. Change in Reference Input Voltage vs. Cathode Voltage

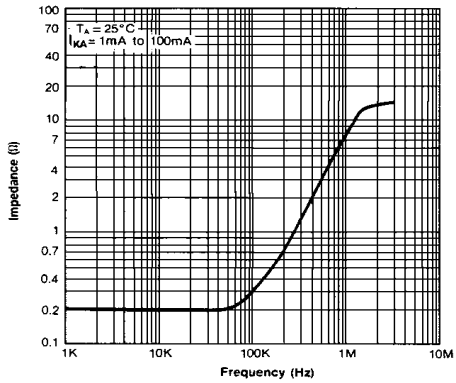


Figure 8. Dynamic Impedance Frequency

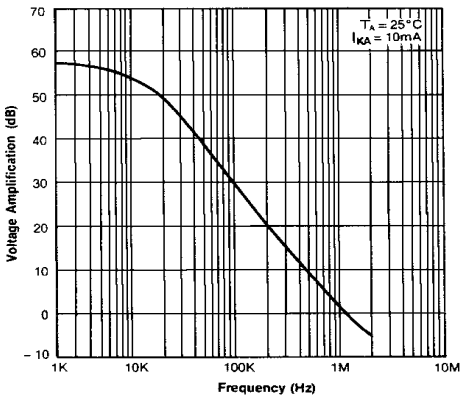


Figure 9. Small Signal Voltage Amplification vs. Frequency

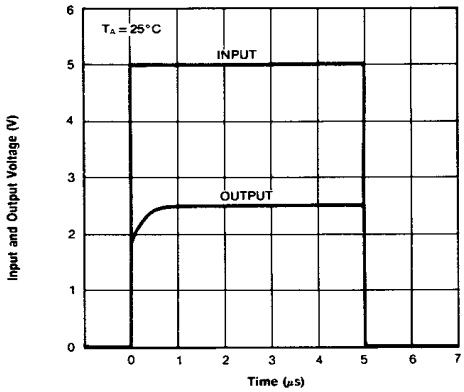


Figure 10. Pulse Response

TYPICAL PERFORMANCE CHARACTERISTICS (CONTINUED)

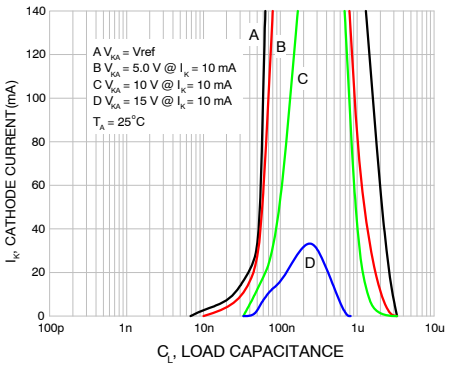
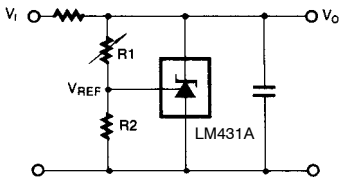


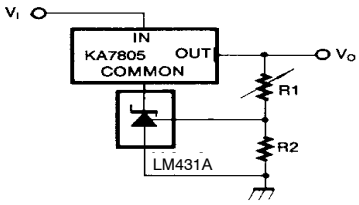
Figure 11. Stability Boundary Conditions

TYPICAL APPLICATION



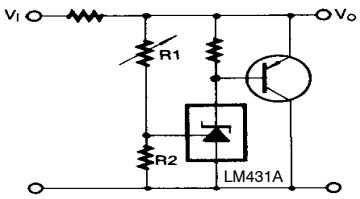
$$V_O = \left(1 + \frac{R_1}{R_2}\right) \cdot V_{REF}$$

Figure 12. Shunt Regulator



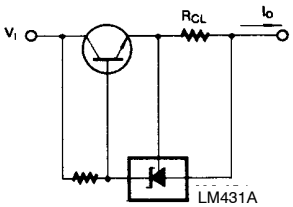
$$V_O = V_{REF} \cdot \left(1 + \frac{R_1}{R_2}\right)$$

Figure 13. Output Control for Three−Terminal Fixed Regulator



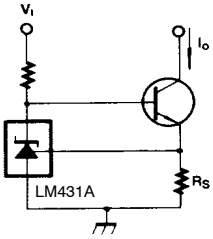
$$V_O = \left(1 + \frac{R_1}{R_2}\right) \cdot V_{REF}$$

Figure 14. High−Current Shunt Regulator



$$I_O = \frac{V_{REF}}{R_{CL}}$$

Figure 15. Current Limit or Current Source



$$I_O = \frac{V_{REF}}{R_S}$$

Figure 16. Constant−Current Sink

ORDERING INFORMATION

Part Number	Operating Temperature Range	Output Voltage Tolerance	Tom Mark	Package	Packing Method†
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
LM431AIZ		2%	LM431AIZ	TO−92	Bulk

†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.

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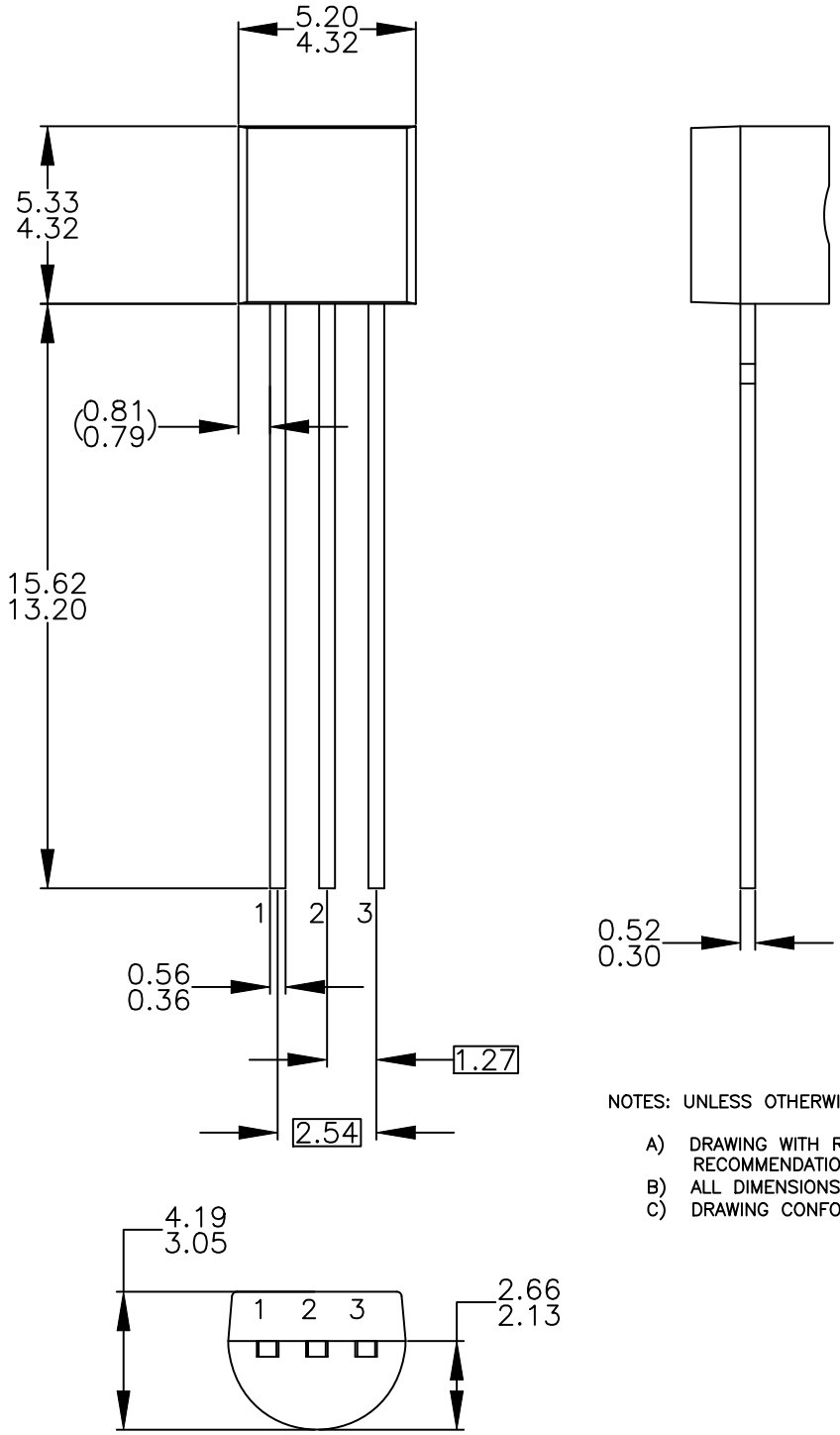
ISSUE O

DATE 31 JUL 2016



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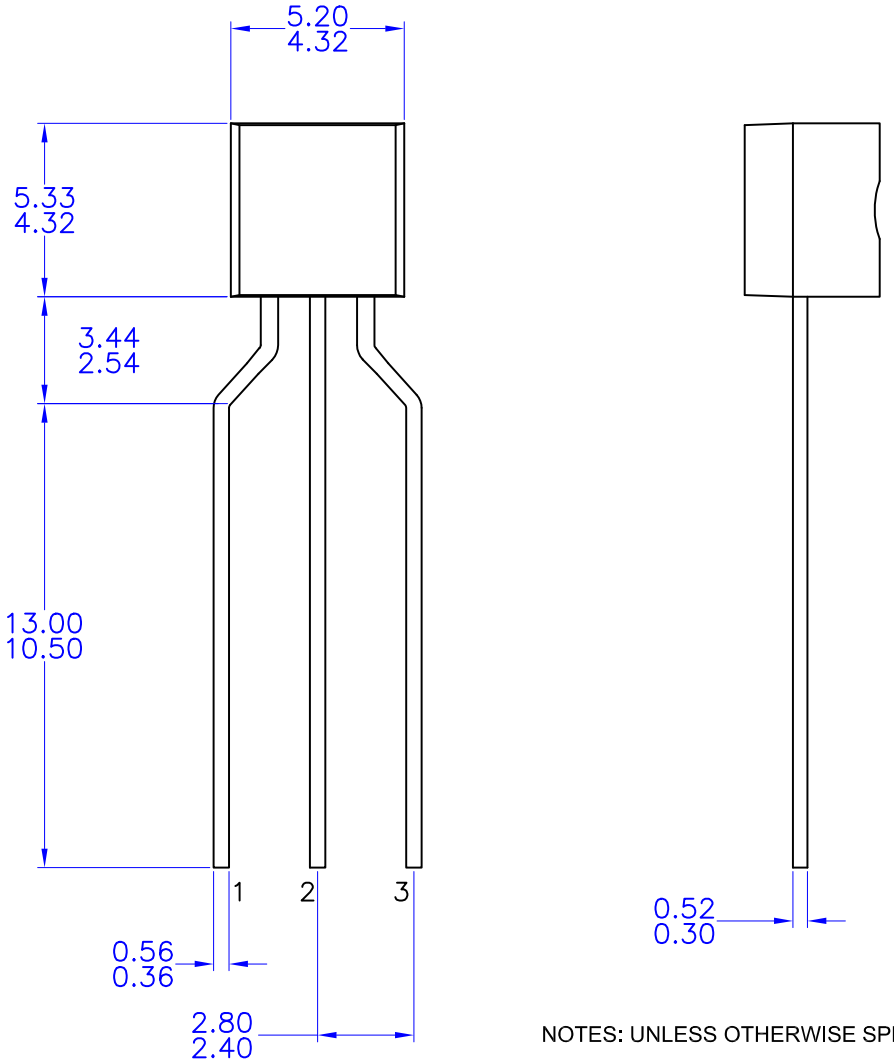

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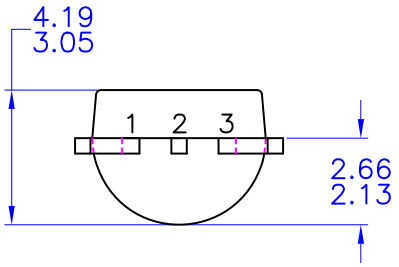

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