LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

TL431/TL431A/TL431B

PRECISION PROGRAMMABLE REFERENCES

PRODUCTION DATA SHEET

DESCRIPTION

The TL431/TL431A/TL431B series precision adjustable three terminal shunt voltage regulators are pin-to-pin compatible with the industry standard TL431. The output voltage of this reference is programmable by using two external resistors from 2.5V to 36V.

These devices offer low output impedance for improved load regulation. The typical output impedance of these devices is 200mΩ. These devices find application in the feedback path of switching power supplies, OVP crowbar circuits, reference for A/D, D/A, and as zener diodes with improved turn-on characteristics.

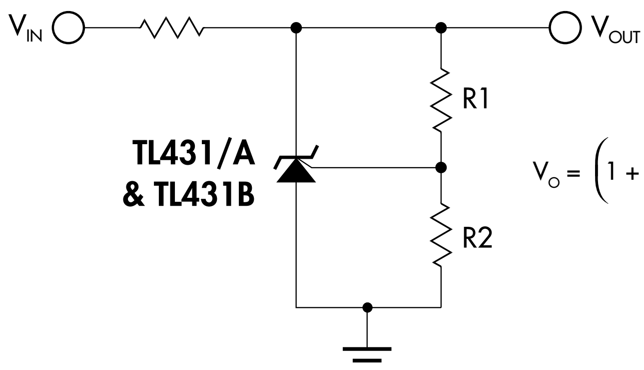
NOTE: For current data & package dimensions, visit our web site: **http://www.linfinity.com**.

KEY FEATURES

- INITIAL VOLTAGE REFERENCE ACCURACY OF 0.4% (TL431B)
- SINK CURRENT CAPABILITY 1mA to 100mA
- TYPICAL OUTPUT DYNAMIC IMPEDANCE LESS THAN 200mΩ;
  TYPICAL OUTPUT IMPEDANCE OF THE TL431B LESS THAN 100mΩ
- ADJUSTABLE OUTPUT VOLTAGE FROM 2.5V TO 36V
- AVAILABLE IN SURFACE-MOUNT PACKAGES
- LOW OUTPUT NOISE
- TYPICAL EQUIVALENT FULL RANGE TEMPERATURE COEFFICIENT OF 30ppm/°C
- DIRECT PIN-TO-PIN REPLACEMENT FOR INDUSTRY STANDARD TL431 AND TL1431

PRODUCT HIGHLIGHT

PRECISION PROGRAMMABLE REFERENCES



$$V_O = \left(1 + \frac{R1}{R2}\right) * V_{REF}$$

PACKAGE ORDER INFORMATION

T_A (°C)	Initial Tolerance	DM Plastic SOIC 8-pin	LP Plastic TO-92 3-pin
0 to 70	2%	TL431CDM	TL431CLP
	1%	TL431ACDM	TL431ACLP
	0.4%	TL431BCDM	TL431BCLP
-40 to 85	2%	TL431IDM	TL431ILP
	1%	TL431AIDM	TL431AILP
	0.4%	TL431BIDM	TL431BILP

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. TL431CDMT)
TO-92 (LP) package also available in ammo-pack.

TL431/TL431A/TL431B

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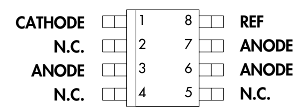
ABSOLUTE MAXIMUM RATINGS (Note 1)

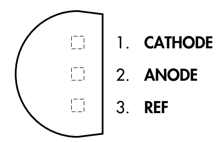
Cathode to Anode Voltage (V_{KA}) (Note 2) .... -0.3V to 37V
Reference Input Current (I_{REF}) .... -50µA to 10mA
Continuous Cathode Current (I_K) .... -100mA to 150mA
Operating Junction Temperature
  Plastic (DM, LP Packages) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature .... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal. Pin numbers refer to DIL packages only.
Note 2. Voltage values are with respect to the anode terminal unless otherwise noted.

PACKAGE PIN OUTS



DM PACKAGE
(Top View)



LP PACKAGE
(Top View)

THERMAL DATA

DM PACKAGE:

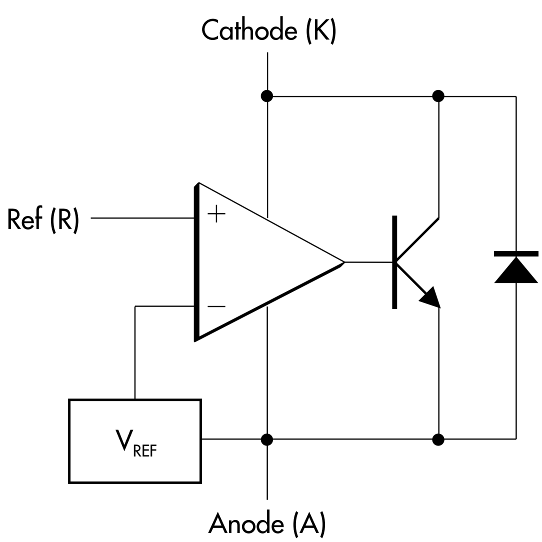
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	165°C/W

LP PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	156°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow

BLOCK DIAGRAM



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ELECTRICAL CHARACTERISTICS (Note 3)

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for TL431C/TL431AC/TL431BC with 0°C ≤ T_A ≤ 70°C, TL431I/TL431AI/TL431BI with -40°C ≤ T_A ≤ 85°C.)

Parameter		Symbol	Test Conditions	TL431/431A/431B Min.	Typ.	Max.	Units
Reference Input Voltage	TL431	V_{REF}	I_K = 10mA, $V_{KA} = V_{REF}$, T_A = 25°C	2440	2495	2550	mV
	TL431A		I_K = 10mA, $V_{KA} = V_{REF}$, T_A = 25°C	2470	2495	2520	mV
	TL431B		I_K = 10mA, $V_{KA} = V_{REF}$, T_A = 25°C	2490	2500	2510	mV
Reference Drift	TL431C	$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	I_K = 10mA, $V_{KA} = V_{REF}$		4	17	mV
	TL431I		I_K = 10mA, $V_{KA} = V_{REF}$		5	30	mV
	TL431AC		I_K = 10mA, $V_{KA} = V_{REF}$		4	17	mV
	TL431AI		I_K = 10mA, $V_{KA} = V_{REF}$		5	30	mV
	TL431BC		I_K = 10mA, $V_{KA} = V_{REF}$		4	15	mV
	TL431BI		I_K = 10mA, $V_{KA} = V_{REF}$		5	20	mV
Voltage Ratio, Ref to Cathode	TL431, TL431A		I_K = 10mA, V_{KA} = 2.5V to 36V		-1.4	-2.7	mV/V
(Note 4)	TL431B		I_K = 10mA, V_{KA} = 2.5V to 36V		-1.1	-2	mV/V
Reference Input Current	TL431,TL431A	I_{REF}	$V_{KA} = V_{REF}$, T_A = 25°C		2	4	µA
	TL431B		$V_{KA} = V_{REF}$, T_A = 25°C		1.5	1.9	µA
			$V_{KA} = V_{REF}$, T_A = Operating Range			2.3	µA
Minimum Operating Current		I_{MIN}	$V_{KA} = V_{REF}$ to 36V		0.4	1	mA
Off-State Cathode Current	TL431	I_{OFF}	$V_{KA} = V_{REF}$ to 36V, T_A = 25°C		0.1	1	µA
	TL431A		$V_{KA} = V_{REF}$ to 36V, T_A = 25°C		0.1	1	µA
	TL431B		$V_{KA} = V_{REF}$ to 36V, T_A = Operating Range			2	µA
			V_{KA} = 36V, V_{REF} = 0V, T_A = 25°C		0.18	0.5	µA
Dynamic Impedance	TL431	$\vert Z_{KA}\vert$	$V_{KA} = V_{REF}$, I_K = 1mA to 100mA, f ≤ 1kHz, T_A = 25°C		0.2	0.5	Ω
	TL431B		$V_{KA} = V_{REF}$, I_K = 1mA to 100mA, f ≤ 1kHz, T_A = 25°C		0.1	0.2	Ω

Note 3. These parameters are guaranteed by design.

Note 4. $\frac{\Delta V_{REF}}{\Delta V_{KA}}$ Ratio of change in reference input voltage to the change in cathode voltage.

GRAPH / CURVE INDEX

Characteristic Curves

FIGURE INDEX

Parameter Measurement Information

Typical Characteristics

Application Information

CHARACTERISTIC CURVES

FIGURE 1. — REFERENCE VOLTAGE vs. FREE-AIR TEMPERATURE

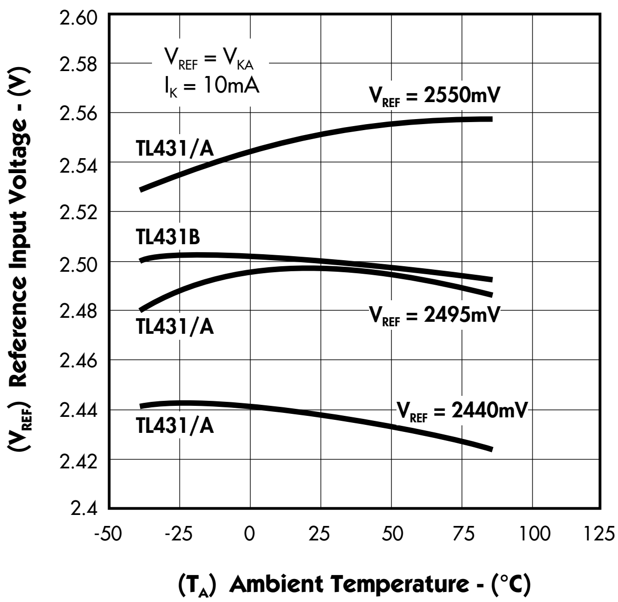


FIGURE 2. — REFERENCE CURRENT vs. FREE-AIR TEMPERATURE

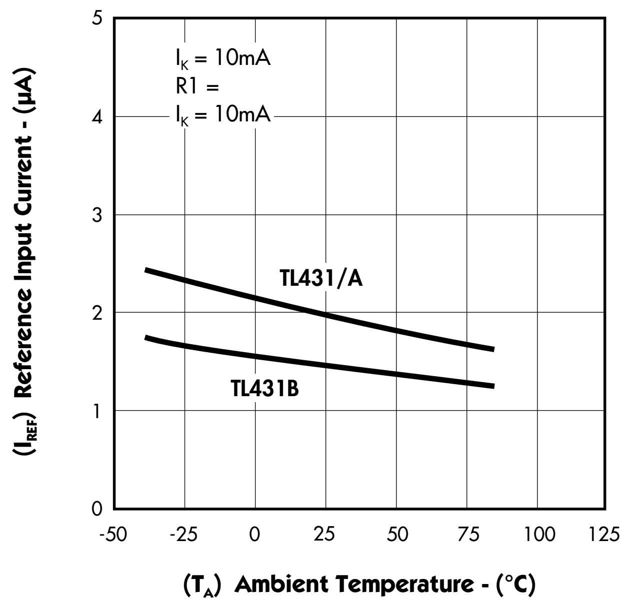


FIGURE 3. — CATHODE CURRENT vs. CATHODE VOLTAGE

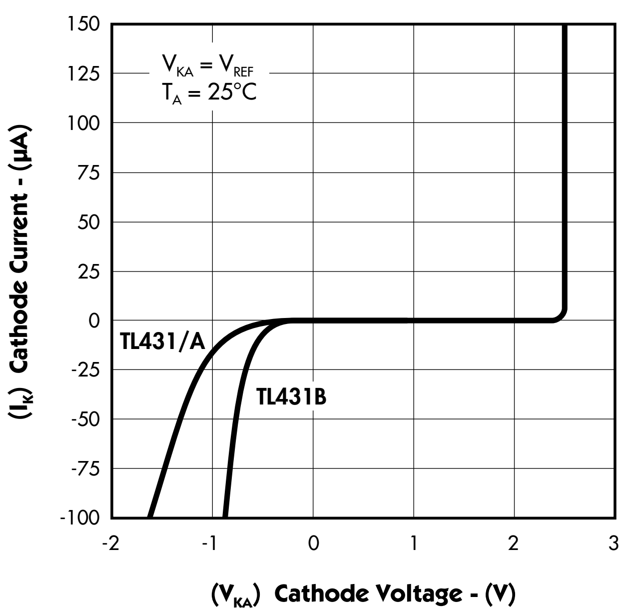
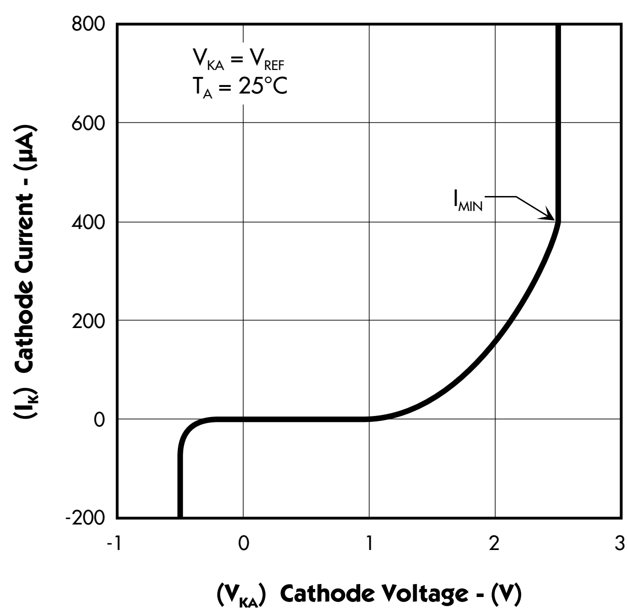


FIGURE 4. — CATHODE CURRENT vs. CATHODE VOLTAGE



CHARACTERISTIC CURVES

FIGURE 5. — OFF-STATE CATHODE CURRENT vs. FREE-AIR TEMPERATURE

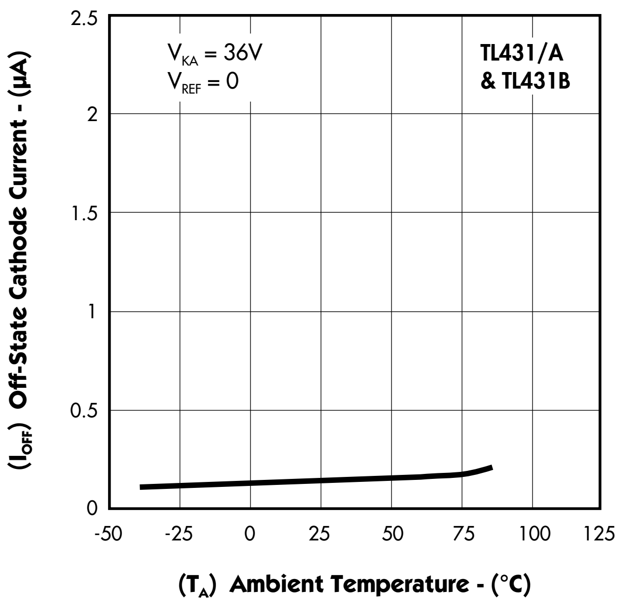


FIGURE 6. — RATIO OF DELTA REFERENCE VOLTAGE TO DELTA CATHODE VOLTAGE vs. FREE-AIR TEMPERATURE

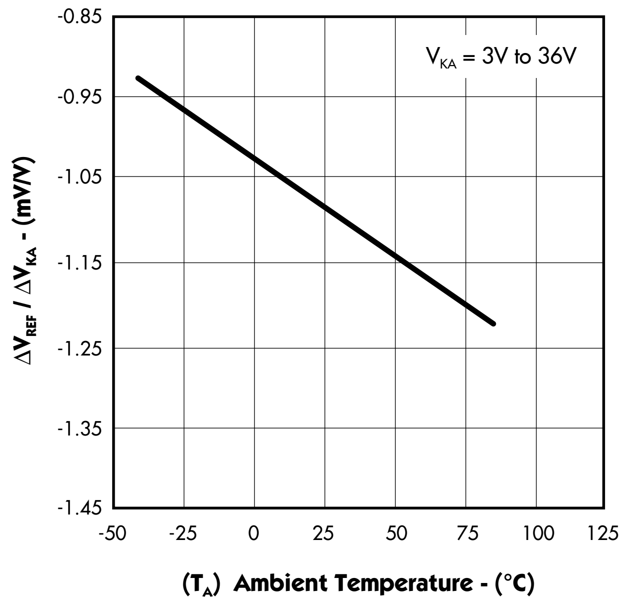
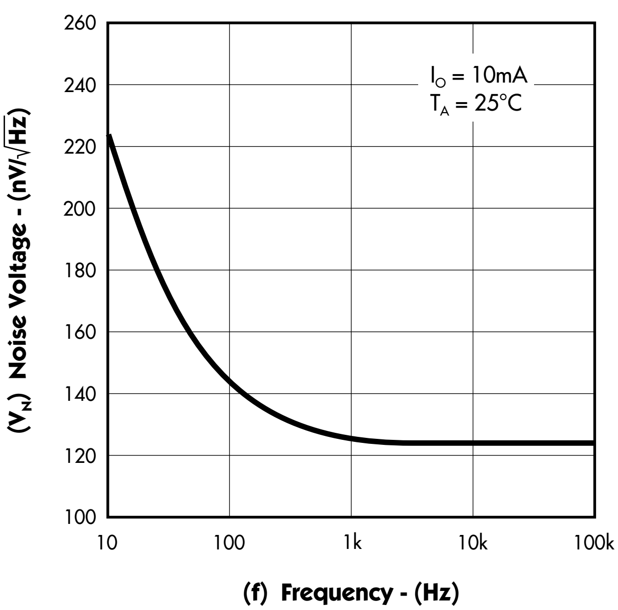


FIGURE 7. — EQUIVALENT INPUT NOISE VOLTAGE vs. FREQUENCY



PARAMETER MEASUREMENT INFORMATION

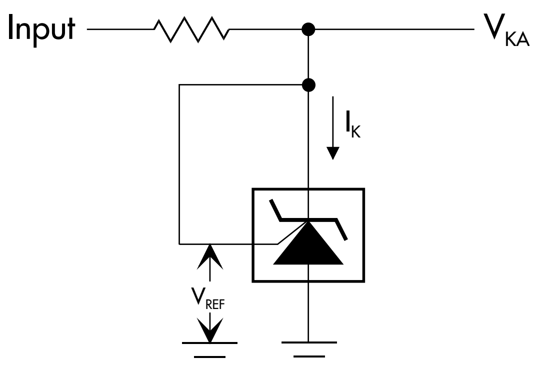


FIGURE 8 — TEST CIRCUIT FOR $V_{KA} = V_{REF}$

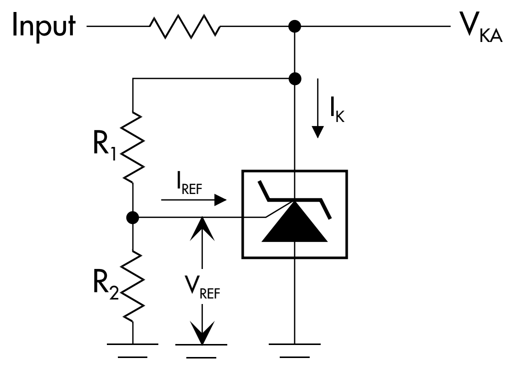


FIGURE 9 — TEST CIRCUIT FOR $V_{KA} > V_{REF}$

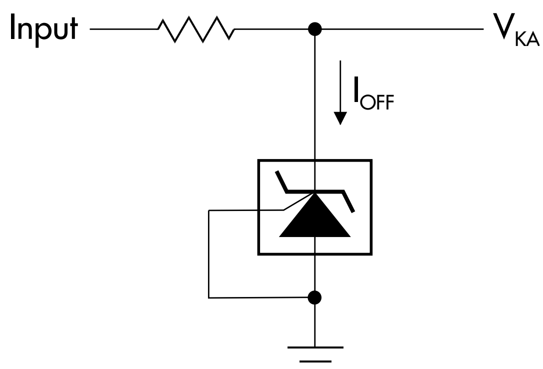


FIGURE 10 — TEST CIRCUIT FOR I_{OFF}

TYPICAL CHARACTERISTICS

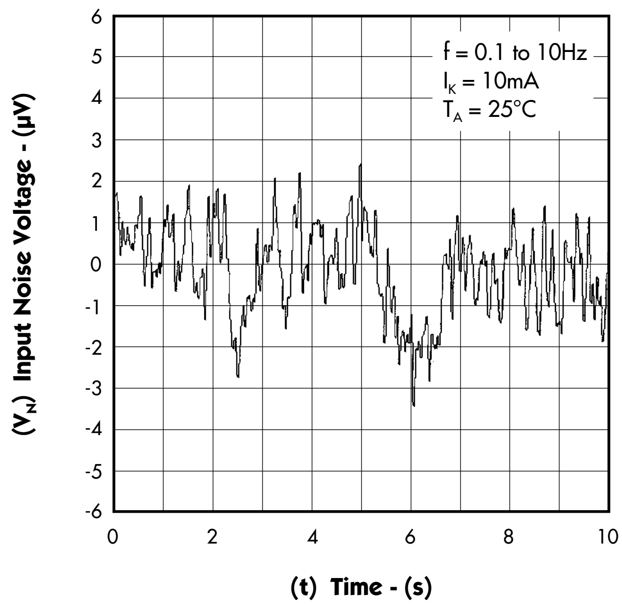
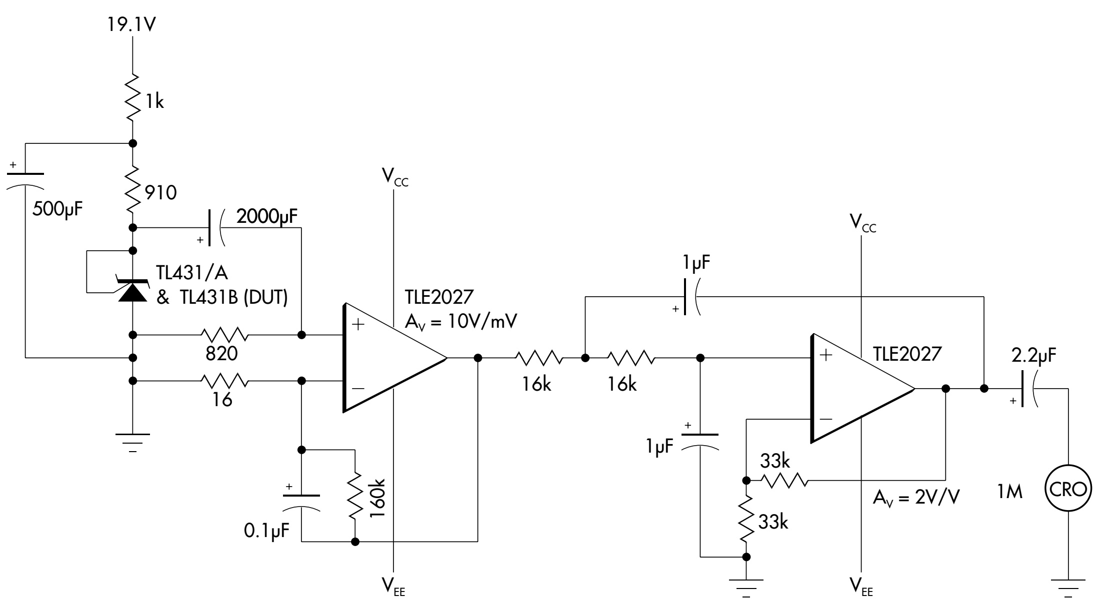


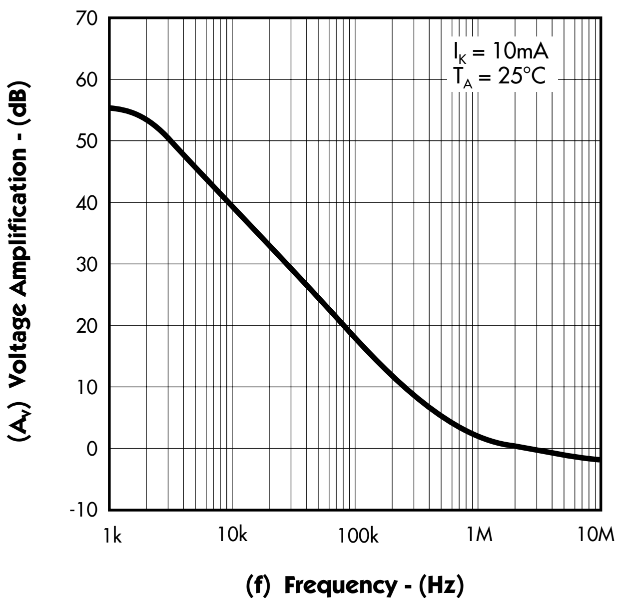
FIGURE 11. — EQUIVALENT INPUT NOISE VOLTAGE OVER A 10-SECOND PERIOD

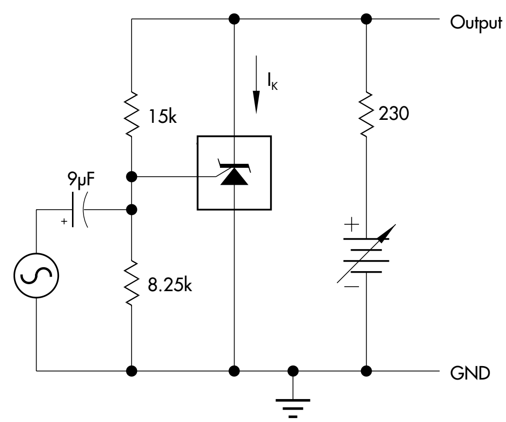


Test Circuit for 0.1Hz to 10Hz Equivalent Input Noise Voltage

TYPICAL CHARACTERISTICS

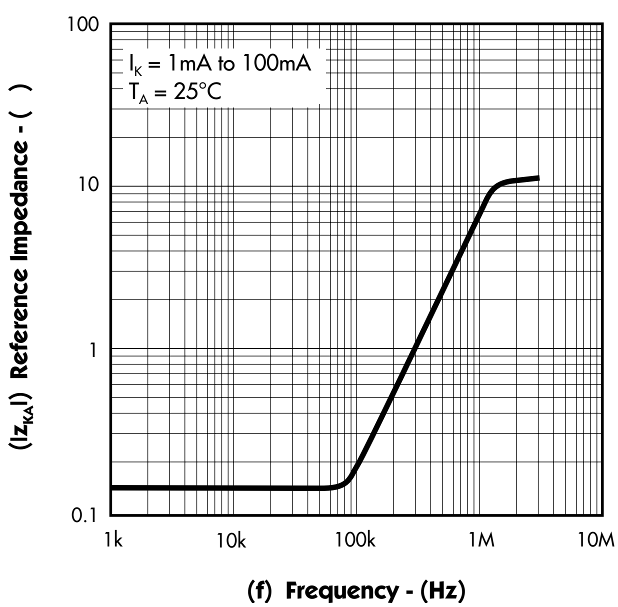
FIGURE 12. — SMALL-SIGNAL VOLTAGE AMPLIFICATION vs. FREQUENCY

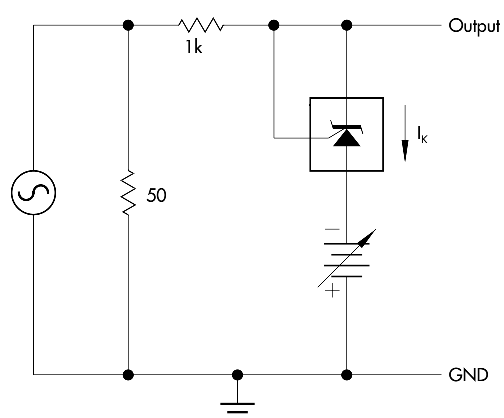




Test Circuit for Voltage Amplification

FIGURE 13. — REFERENCE IMPEDANCE vs. FREQUENCY

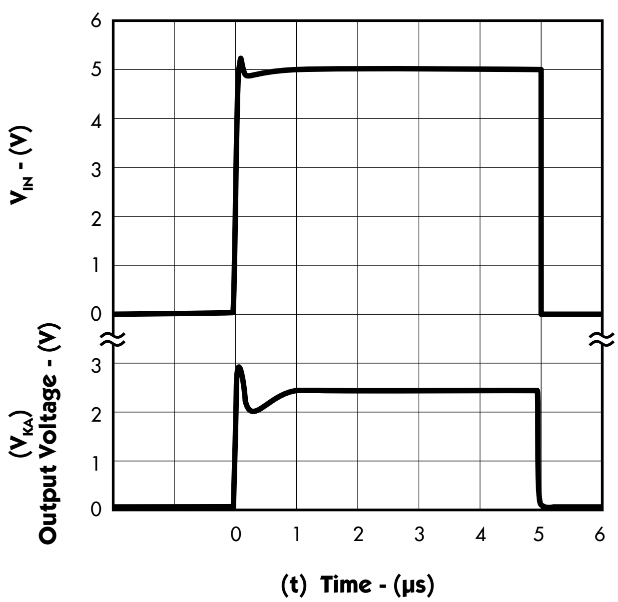


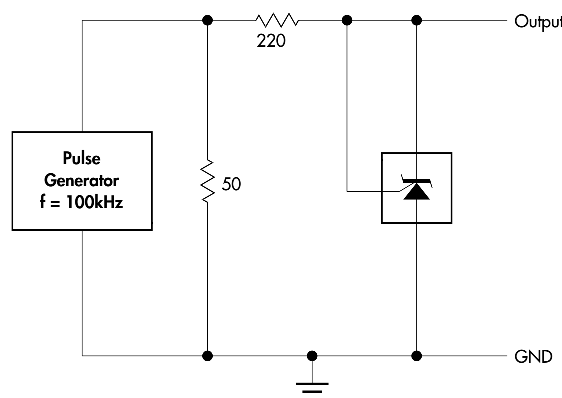


Test Circuit for Reference Impedance

TYPICAL CHARACTERISTICS

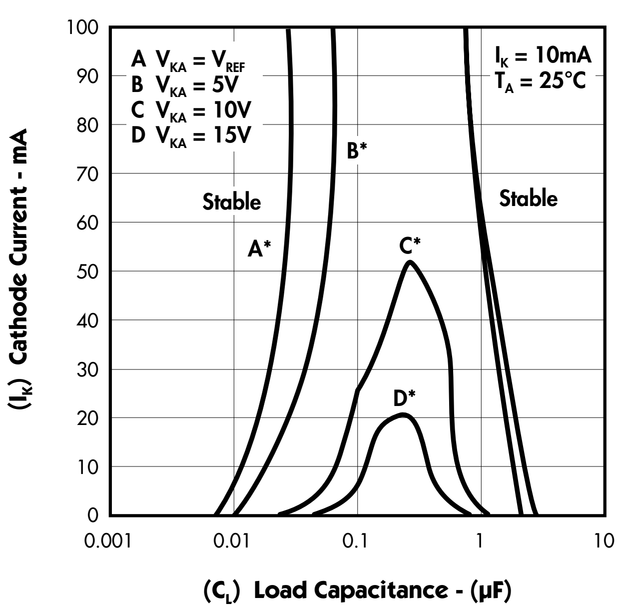
FIGURE 14. — PULSE RESPONSE



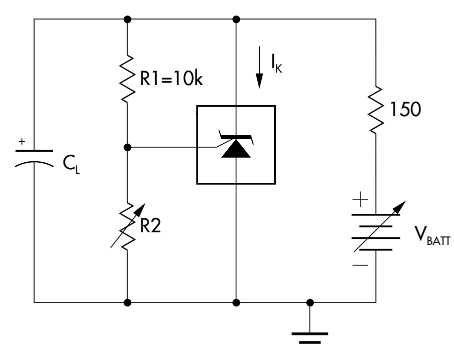


Test Circuit for Pulse Response

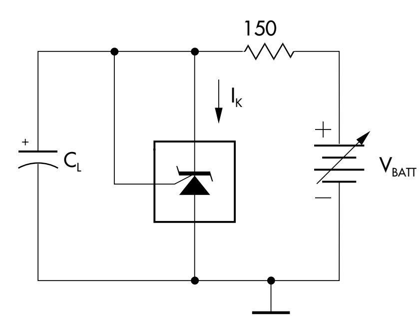
FIGURE 15. — STABILITY BOUNDARY CONDITIONS



* The areas under the curves represent conditions that may cause the device to oscillate. For curves B, C, and D, R2 and V+ were adjusted to establish the initial V_{KA} and I_K conditions with C_L = 0. V_{BATT} and C_L were then adjusted to determine the ranges of stability.



Test Circuit for Curve A



Test Circuit for Curves B, C, and D

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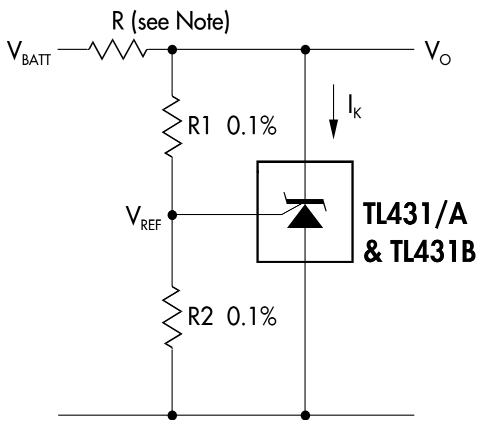
APPLICATION INFORMATION



$$V_O = \left(1 + \frac{R1}{R2}\right) * V_{REF}$$

Note: R should provide ≥ 1mA cathode current to the TL431/A & TL1431 at minimum V_{BATT}.

FIGURE 16 — SHUNT REGULATOR

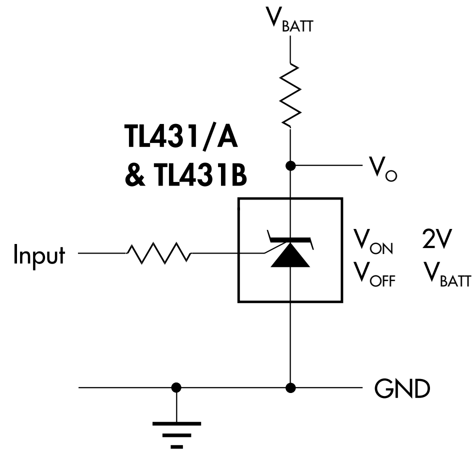
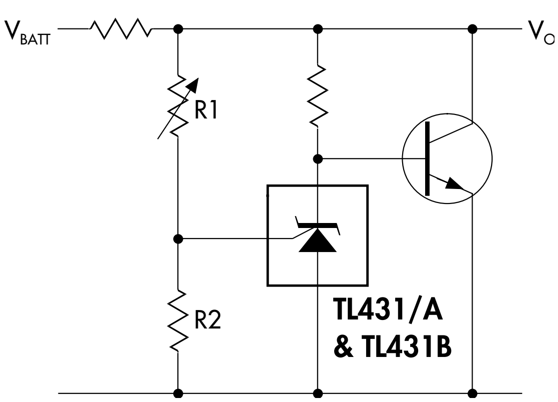
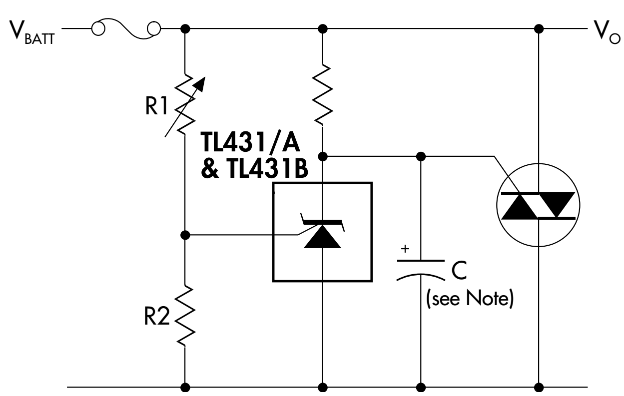


FIGURE 17 — SINGLE-SUPPLY COMPARATOR WITH TEMPERATURE-COMPENSATED THRESHOLD



$$V_O = \left(1 + \frac{R1}{R2}\right) * V_{REF}$$

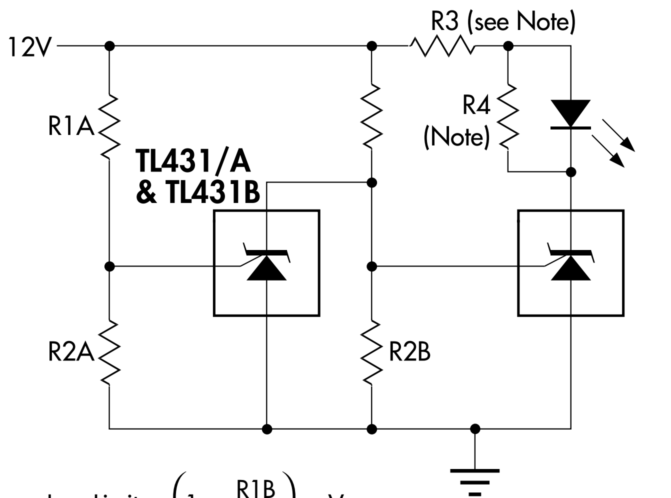
FIGURE 18 — HIGH CURRENT SHUNT REGULATOR



Note: Refer to the stability boundary conditions in Figure 15 to determine allowable values for C.

FIGURE 19 — CROWBAR CIRCUIT

APPLICATION INFORMATION



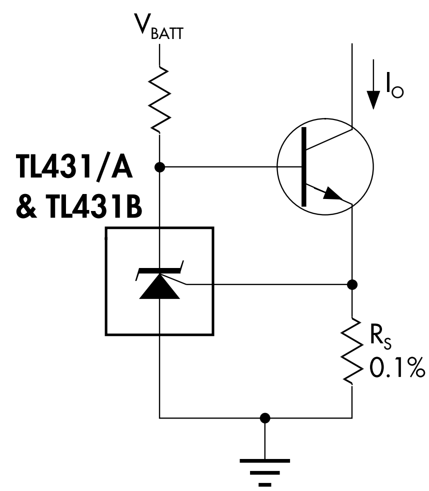
$$\text{Low Limit} = \left(1 + \frac{R1B}{R2B}\right) * V_{REF}$$

$$\text{High Limit} = \left(1 + \frac{R1B}{R2B}\right) * V_{REF}$$

LED On when
Low Limit < V_{BATT} < High Limit

Note: R3 and R4 are selected to provide the desired LED intensity and ≥ 1mA cathode current to the TL431/A & TL431B at the available V+.

FIGURE 20 — VOLTAGE MONITOR



$$I_O = \left(\frac{V_{REF}}{R_S}\right)$$

FIGURE 21 — PRECISION CONTANT-CURRENT SINK

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