

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.

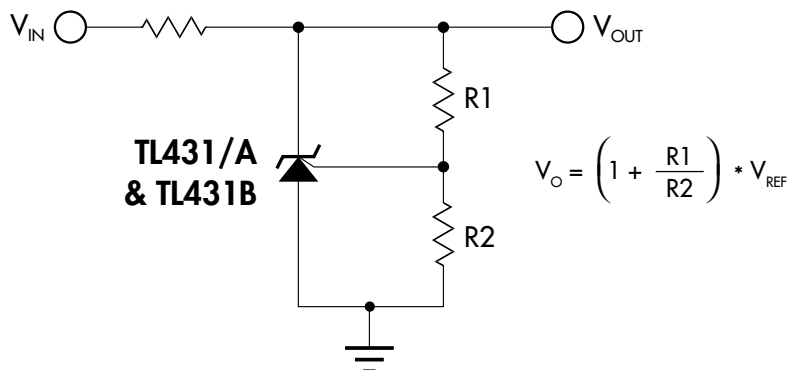
NOTE: For current data & package dimensions, visit our web site: <http://www.linfinity.com>.

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



PACKAGE ORDER INFORMATION

| T _A (°C) | Initial Tolerance | DM | LP |
|---------------------|-------------------|--------------------|---------------------|
| | | Plastic SOIC 8-pin | 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}) | -50 μ A 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.

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 |
|---|---------|

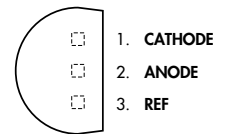
Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.

The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow

PACKAGE PIN OUTS

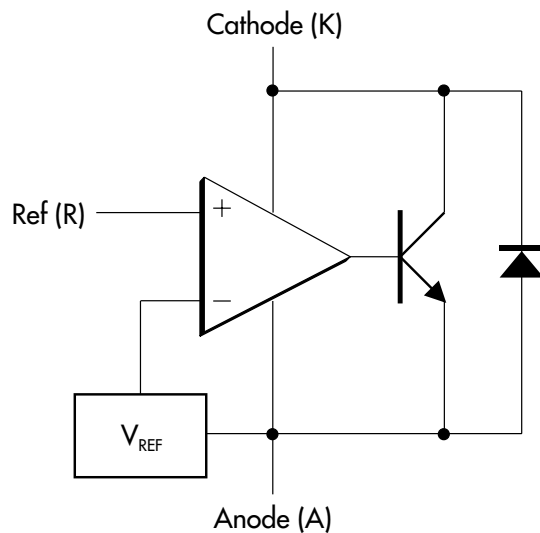
| | | | | | |
|---------|---|---|---|---|-------|
| CATHODE | □ | 1 | 8 | □ | REF |
| N.C. | □ | 2 | 7 | □ | ANODE |
| ANODE | □ | 3 | 6 | □ | ANODE |
| N.C. | □ | 4 | 5 | □ | N.C. |

DM PACKAGE
(Top View)



LP PACKAGE
(Top View)

BLOCK DIAGRAM



TL431/TL431A/TL431B

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ELECTRICAL CHARACTERISTICS (Note 3)

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for TL431C/TL431AC/TL431BC with $0^{\circ}\text{C} \leq T_A \leq 70^{\circ}\text{C}$, TL431I/TL431AI/TL431BI with $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$.)

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

TL431/TL431A/TL431B

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6. RATIO OF DELTA REFERENCE VOLTAGE TO DELTA CATHODE VOLTAGE vs. FREE-AIR TEMPERATURE
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CHARACTERISTIC CURVES

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

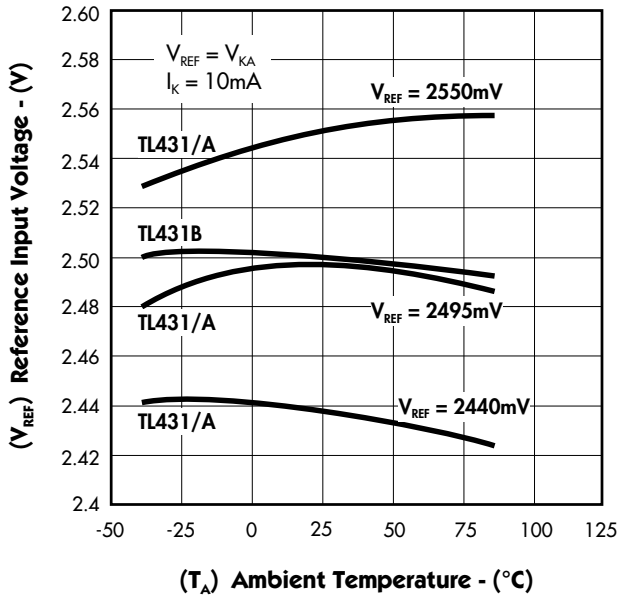


FIGURE 2. — REFERENCE CURRENT vs. FREE-AIR TEMPERATURE

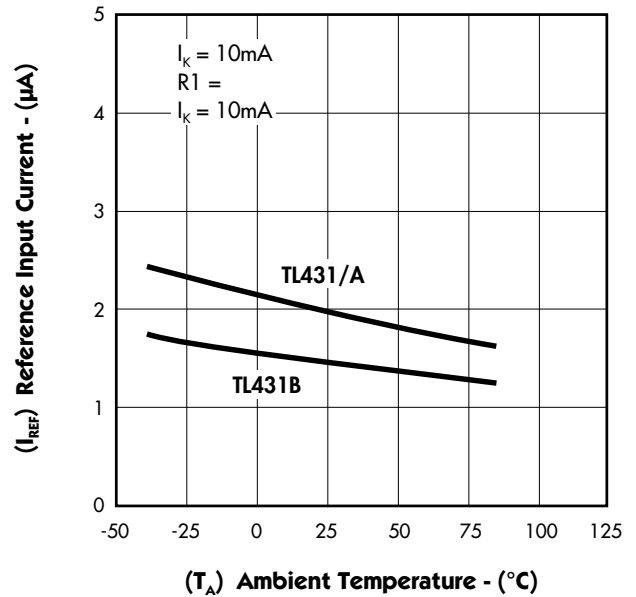


FIGURE 3. — CATHODE CURRENT vs. CATHODE VOLTAGE

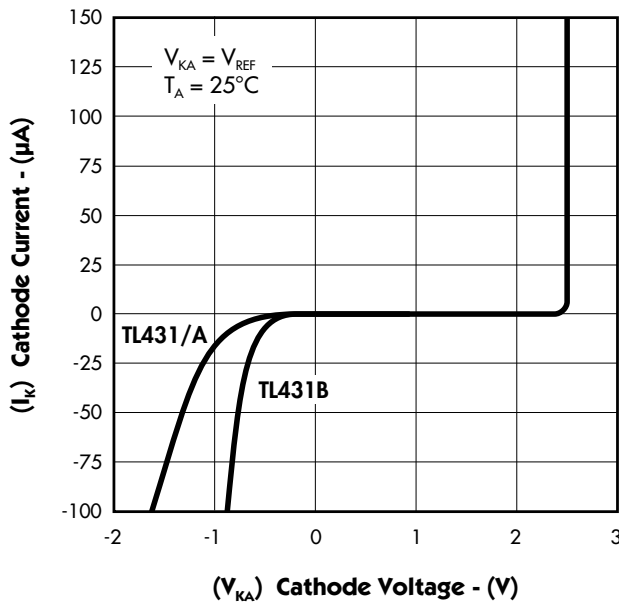
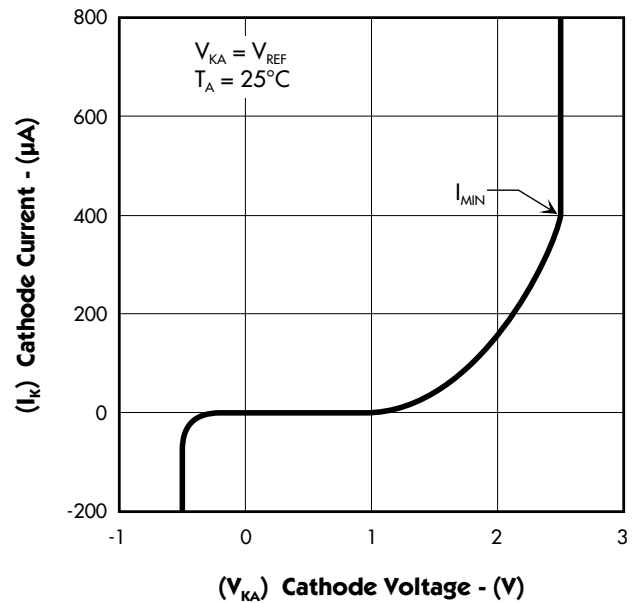


FIGURE 4. — CATHODE CURRENT vs. CATHODE VOLTAGE



TL431/TL431A/TL431B

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CHARACTERISTIC CURVES

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

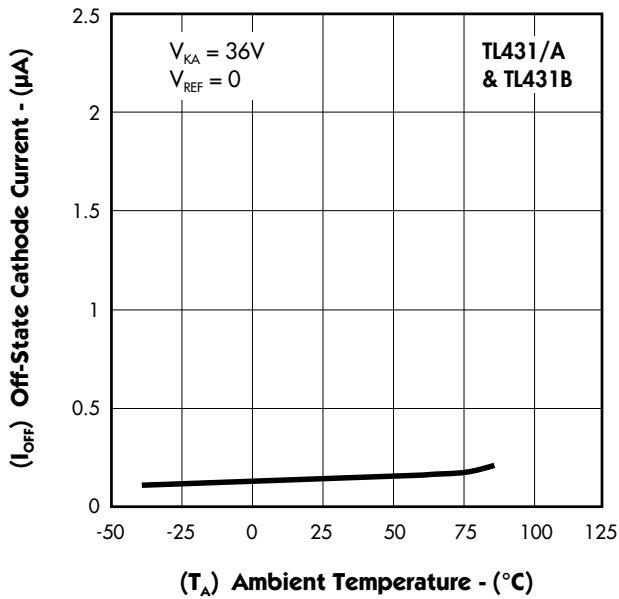


FIGURE 6. — RATIO OF DELTA REFERENCE VOLTAGE TO DELTA CATHODE VOLTAGE vs. FREE-AIR TEMPERATURE

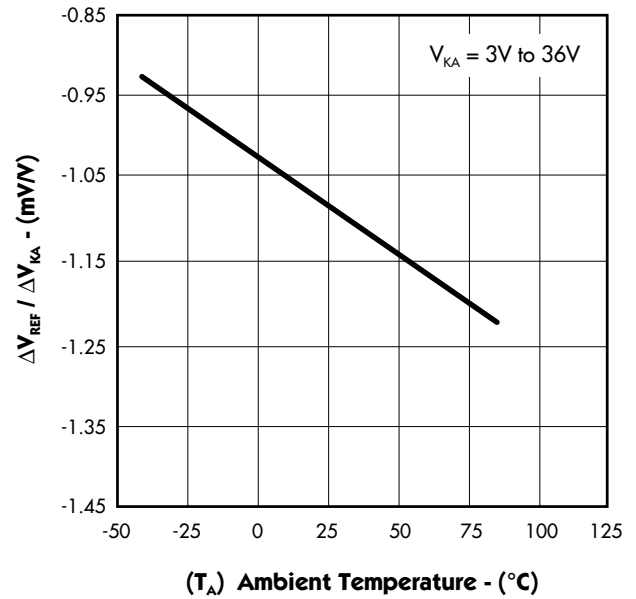
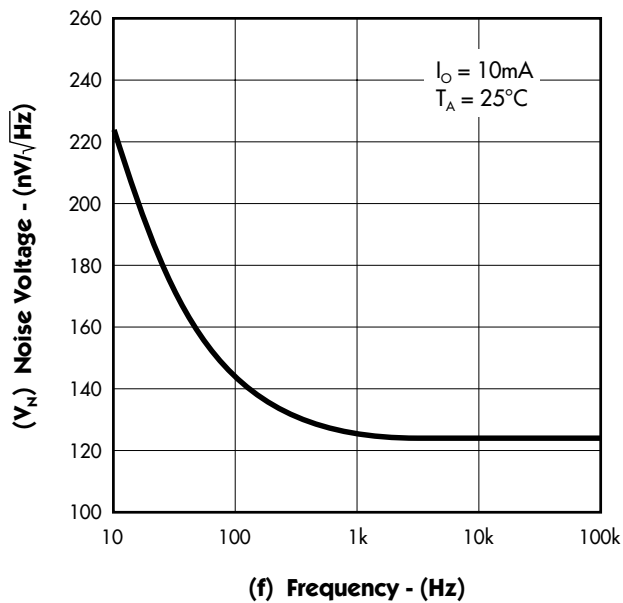


FIGURE 7. — EQUIVALENT INPUT NOISE VOLTAGE vs. FREQUENCY



PARAMETER MEASUREMENT INFORMATION

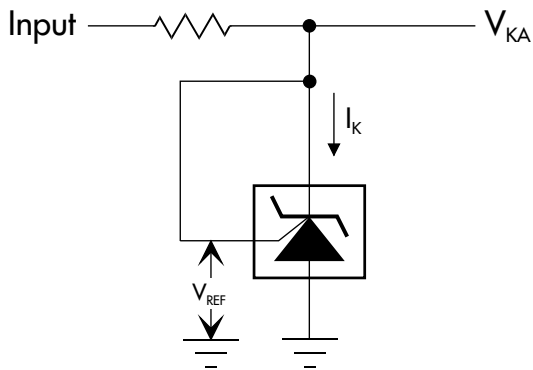


FIGURE 8 — TEST CIRCUIT FOR $V_{KA} = V_{REF}$

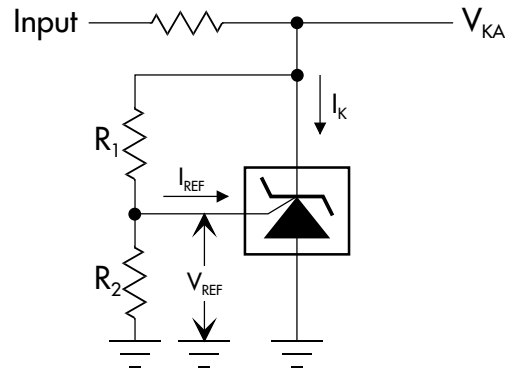


FIGURE 9 — TEST CIRCUIT FOR $V_{KA} > V_{REF}$

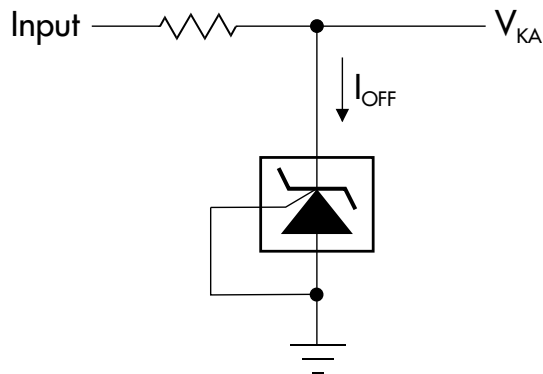


FIGURE 10 — TEST CIRCUIT FOR I_{OFF}

TL431/TL431A/TL431B

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TYPICAL CHARACTERISTICS

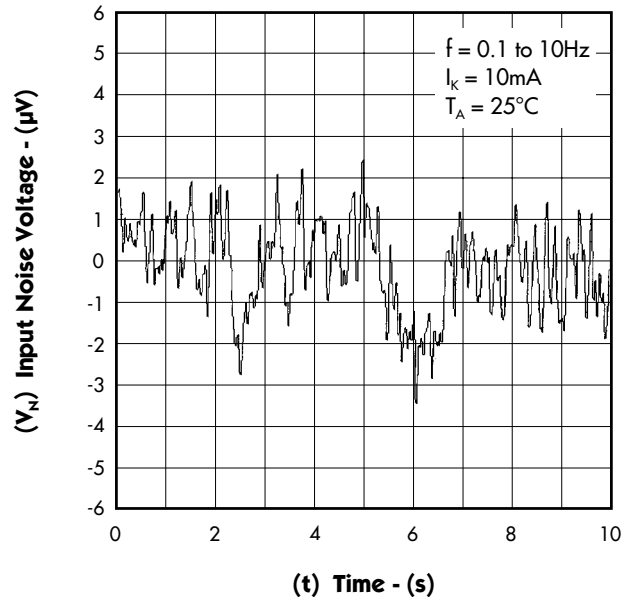
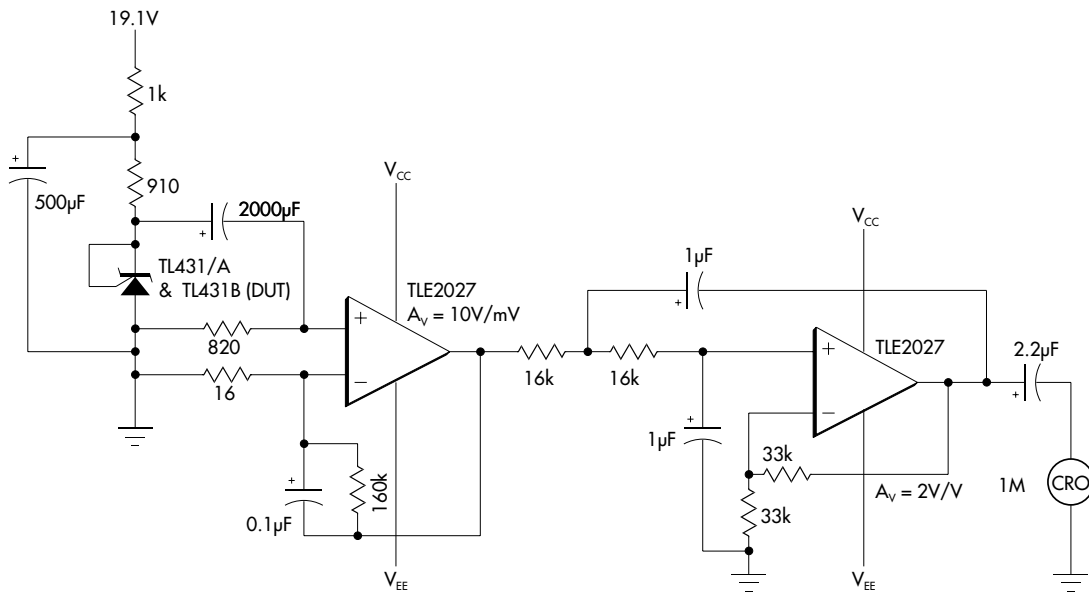


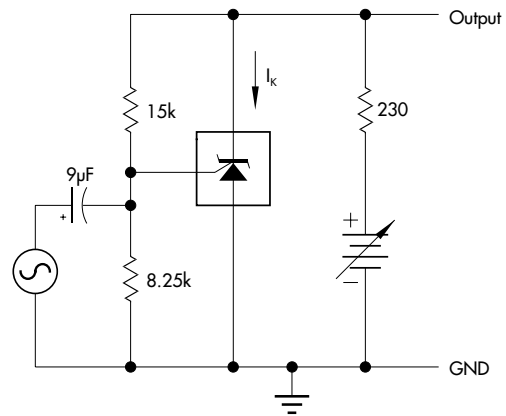
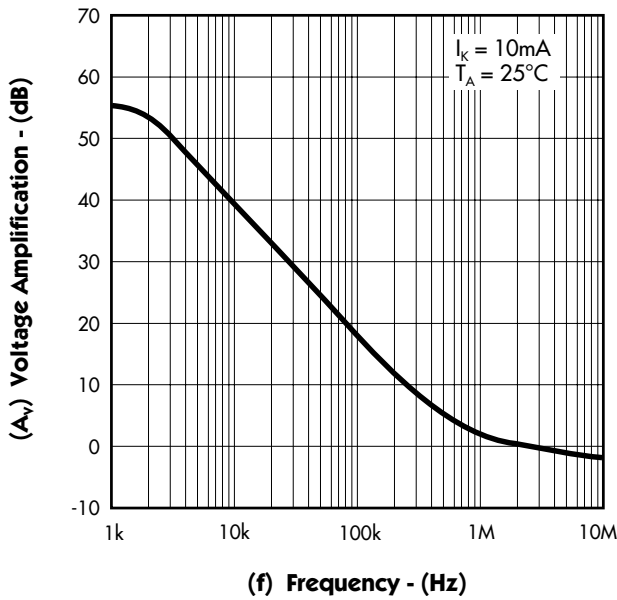
FIGURE 11. — EQUIVALENT INPUT NOISE VOLTAGE OVER A 10-SECOND PERIOD



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

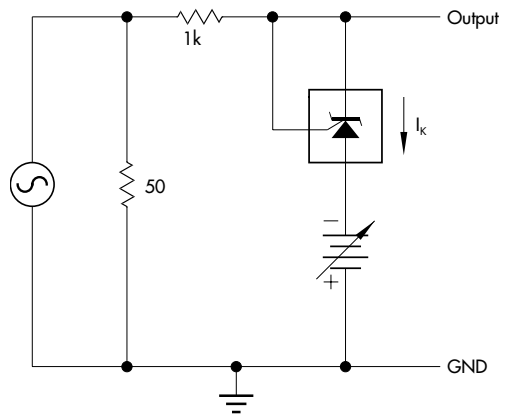
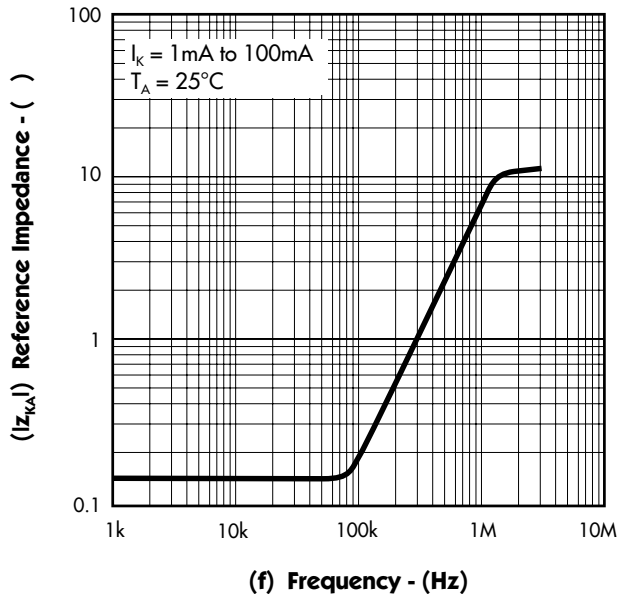
TYPICAL CHARACTERISTICS

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



Test Circuit for Voltage Amplification

FIGURE 13. — REFERENCE IMPEDANCE vs. FREQUENCY



Test Circuit for Reference Impedance

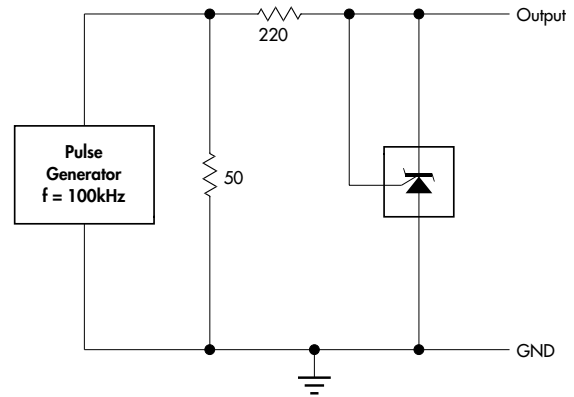
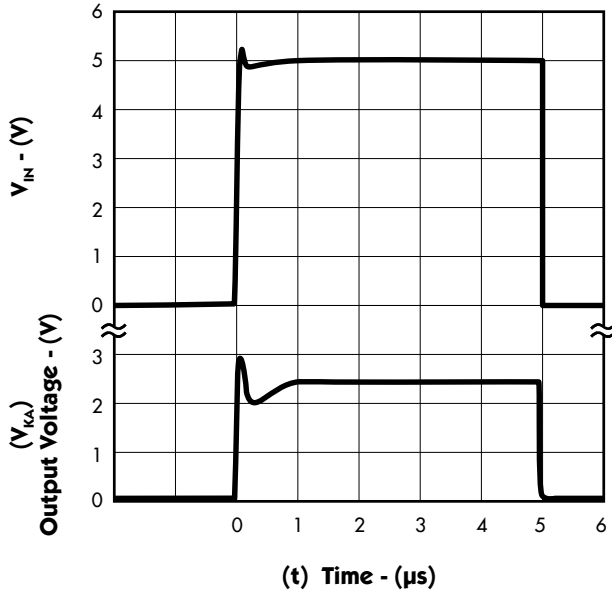
TL431/TL431A/TL431B

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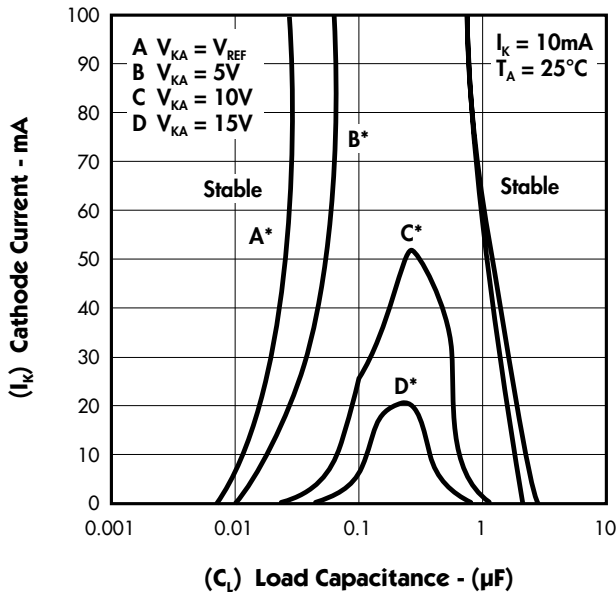
TYPICAL CHARACTERISTICS

FIGURE 14. — PULSE RESPONSE

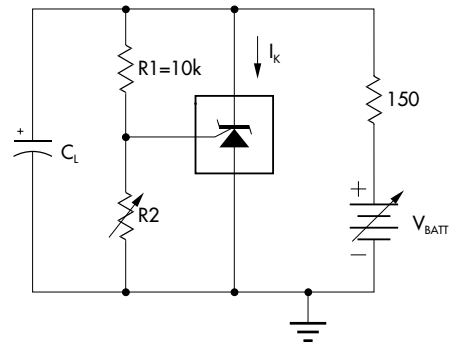


Test Circuit for Pulse Response

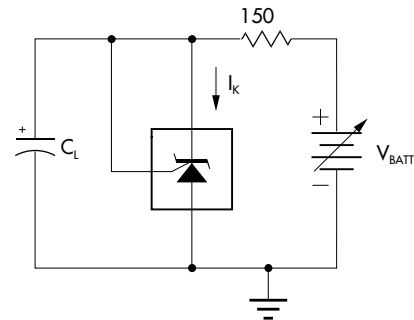
FIGURE 15. — STABILITY BOUNDARY CONDITIONS



* 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



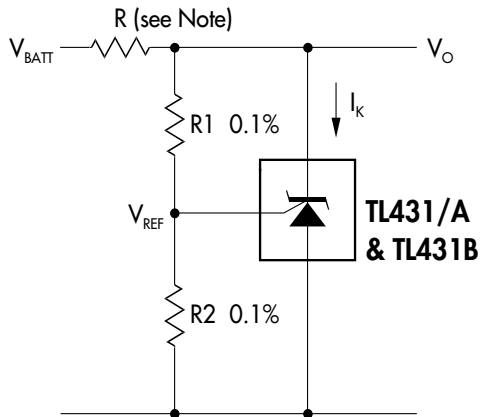
Test Circuit for Curves B, C, and D

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APPLICATION INFORMATION



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

Note: R should provide ≥ 1 mA cathode current to the TL431/A & TL431B at minimum V_{BATT} .

FIGURE 16 — SHUNT REGULATOR

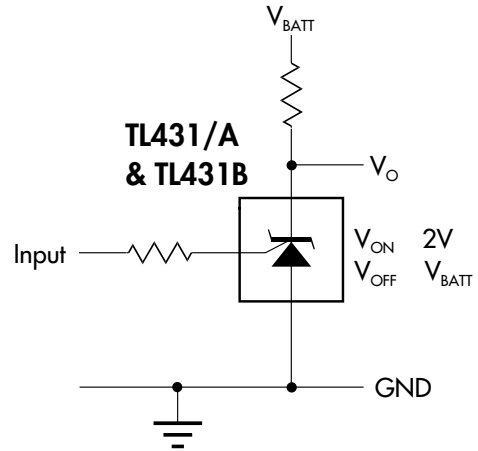
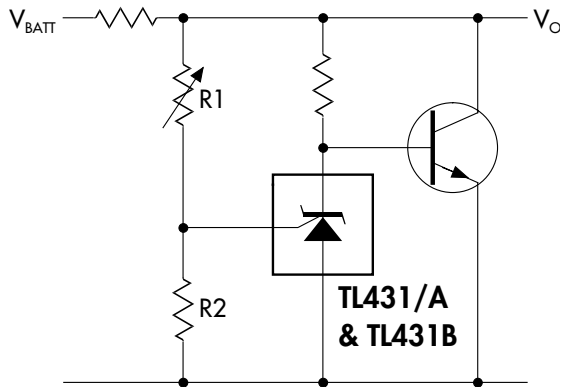
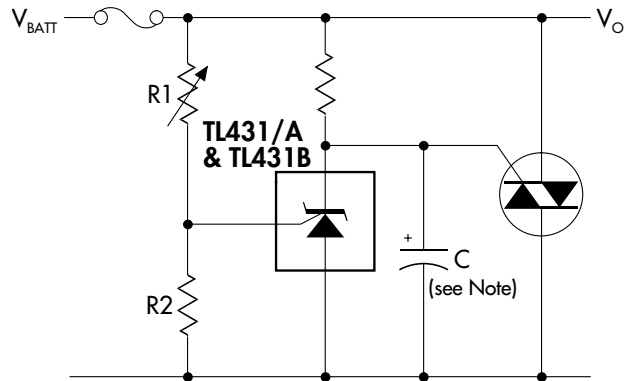


FIGURE 17 — SINGLE-SUPPLY COMPARATOR WITH TEMPERATURE-COMPENSATED THRESHOLD



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

FIGURE 18 — HIGH CURRENT SHUNT REGULATOR



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

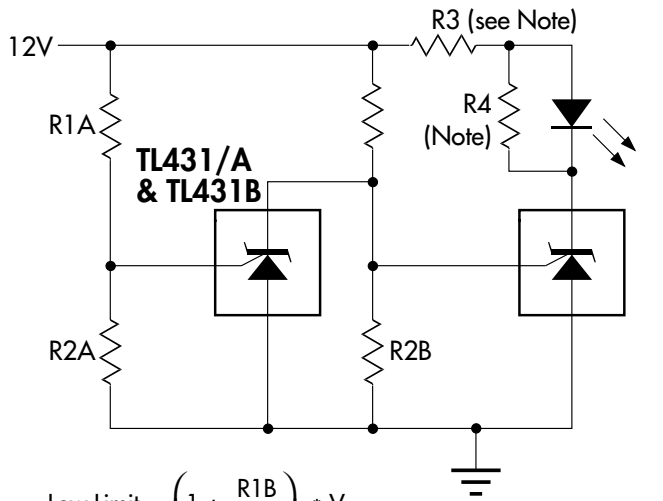
FIGURE 19 — CROWBAR CIRCUIT

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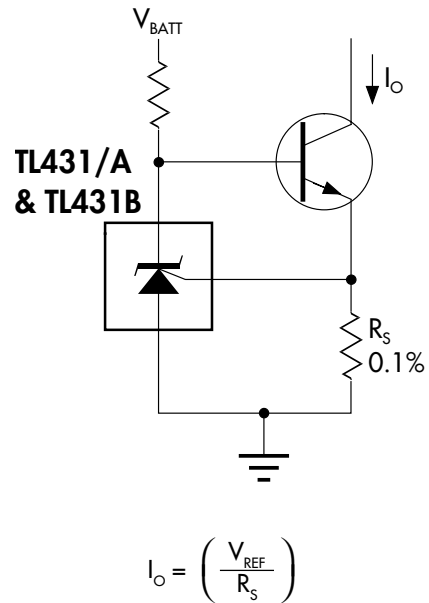
$$\text{Low Limit} = \left(1 + \frac{R1B}{R2B}\right) * V_{REF}$$

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

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

Note: R3 and R4 are selected to provide the desired LED intensity and ≥ 1 mA 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 CONSTANT-CURRENT SINK

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