Microsemi™

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.

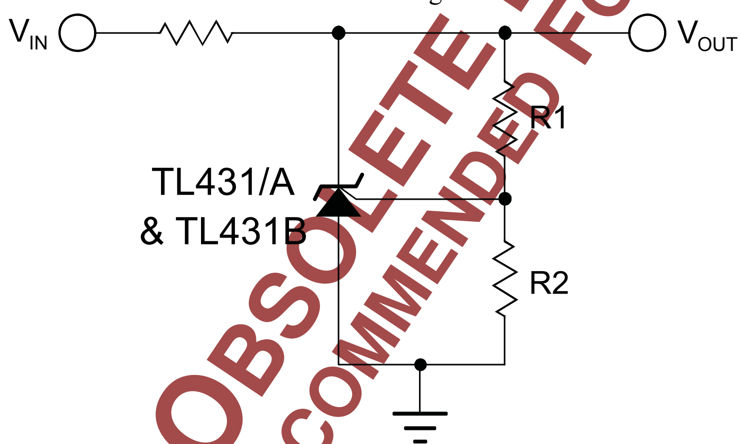
IMPORTANT: For the most current data, consult *MICROSEMI*'s website: http://www.microsemi.com

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



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

PACKAGE ORDER INFO

T_A (°C)	Initial Tolerance	DM Plastic SOIC 8-Pin RoHS Compliant / Pb-free Transition DC: 0440	LP Plastic TO-92 3-Pin RoHS Compliant / Pb-free Transition DC: 0509	PK Plastic TO-89 3 - Pin RoHS Compliant / Pb-free Transition DC: 0518
0 to 70	2%	TL431CDM	TL431CLP	TL431CPK
	1%	TL431ACDM	TL431ACLP	TL431ACPK
	0.4%	TL431BCDM	TL431BCLP	TL431BCPK
-40 to 85	2%	TL431IDM	TL431ILP	TL431IPK
	1%	TL431AIDM	TL431AILP	TL431AIPK
	0.4%	TL431BIDM	TL431BILP	TL461BIPK

Note: All surface mount packages are available in Tape & Reel. Append the letters "TR" to the part number. (i.e. LTL431AIDM-TR). The TO-92 (LP) package is available in ammo-pack.

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Precision programmable References

PRODUCTION DATA SHEET

ABSOLUTE MAXIMUM RATINGS

Cathode to Anode Voltage (VKA)(Note 2) .... -0.3 to 37V
Reference Input Current (IREF) .... -50µA to 10mA
Continuous Cathode Current (IK) .... -100mA to 150mA
Operating Junction Temperature .... 150°C
Storage Temperature Range .... -65°C to 150°C
Package Peak Temp. for Solder Reflow (40 seconds maximum exposure) ... 260°C (+0 -5)

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

THERMAL DATA

DM **Plastic SOIC 8-Pin**

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

PK **Plastic TO-89 3-Pin**

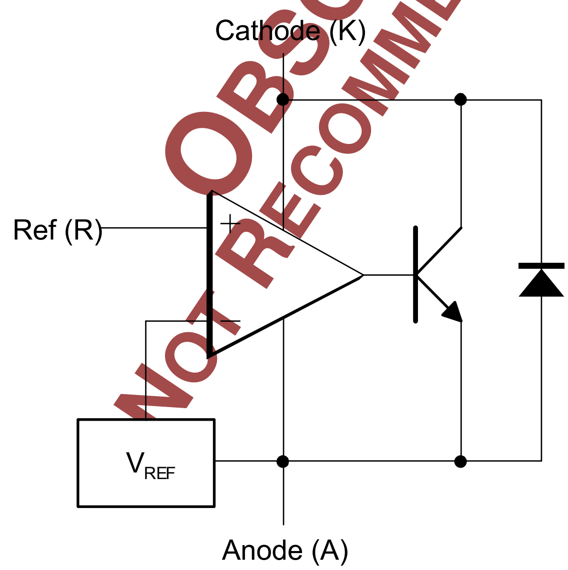
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA} — **71°C/W**

LP **Plastic TO-92 3-Pin**

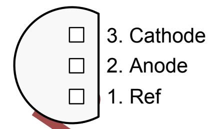
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA} — **156°C/W**

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.

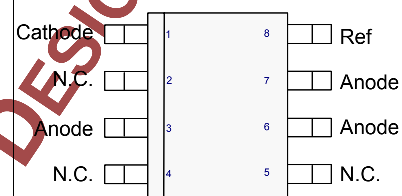
BLOCK DIAGRAM



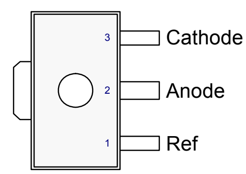
PACKAGE PIN OUT



LP PACKAGE
(Top View)



DM PACKAGE
(Top View)



PK PACKAGE
(Top View)

RoHS / Pb-free 100% Matte Tin Lead Finish

ELECTRICAL CHARACTERISTICS

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

Parameter		Symbol	Test Conditions	TL431/A/B 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	
	TL431B		I_K = 10mA, V_{KA} = V_{REF}, T_A = 25°C	2490	2500	2510	
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	
	TL431AC		I_K = 10mA, V_{KA} = V_{REF}		4	17	
	TL431AI		I_K = 10mA, V_{KA} = V_{REF}		5	30	
	TL431BC		I_K = 10mA, V_{KA} = V_{REF}		4	15	
	TL431BI		I_K = 10mA, V_{KA} = V_{REF}		5	20	
Voltage Ratio, Ref to Cathode (Note 4)	TL431, TL431A		I_K = 10mA, V_{KA} = 2.5V to 36V		-1.4	-2.7	mV/V
	TL431B		I_K = 10mA, V_{KA} = 2.5V to 36V		-1.1	-2.0	
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	
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	
	TL431B		V_{KA} = V_{REF} to 36V, T_A= Operating Range			2	
			V_{KA} = 36V, V_{REF} = 0V, T_A= 25°C		0.18	0.5	
Dynamic Impedance	TL431	$\lvert Z_{KA} \rvert$	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	

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.

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18. High Current Shunt Regulator
19. Crowbar Circuit
20. Voltage Monitor
21. Precision Constant-Current Sink

CHARACTERISTIC CURVES

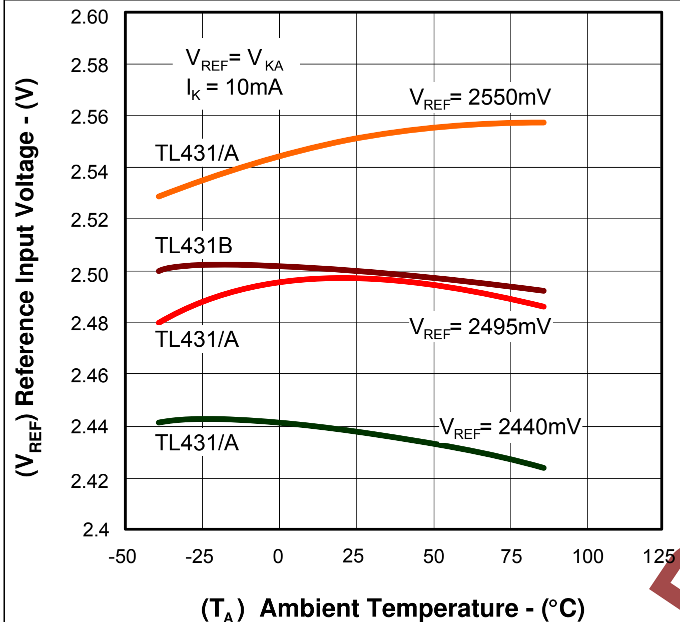


Figure 1 – Reference Voltage vs. Free-Air Temperature

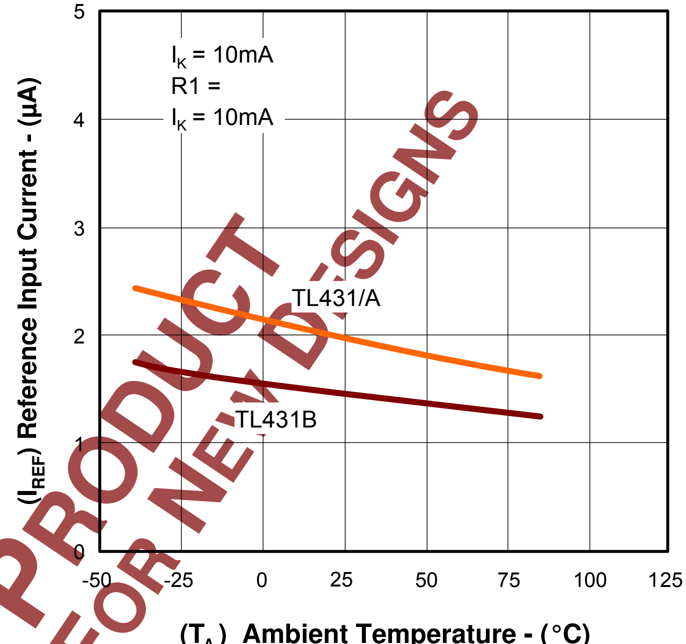


Figure 2 – Reference Current vs. Free-Air Temperature

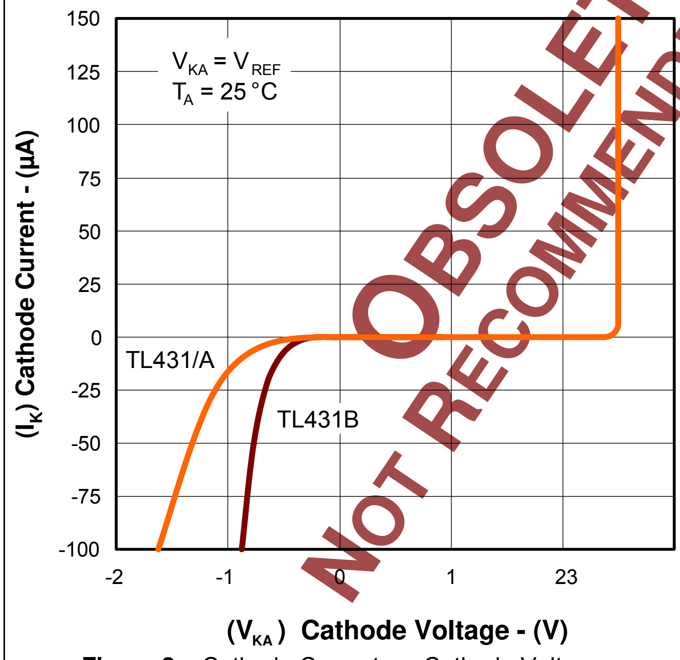


Figure 3 – Cathode Current vs. Cathode Voltage

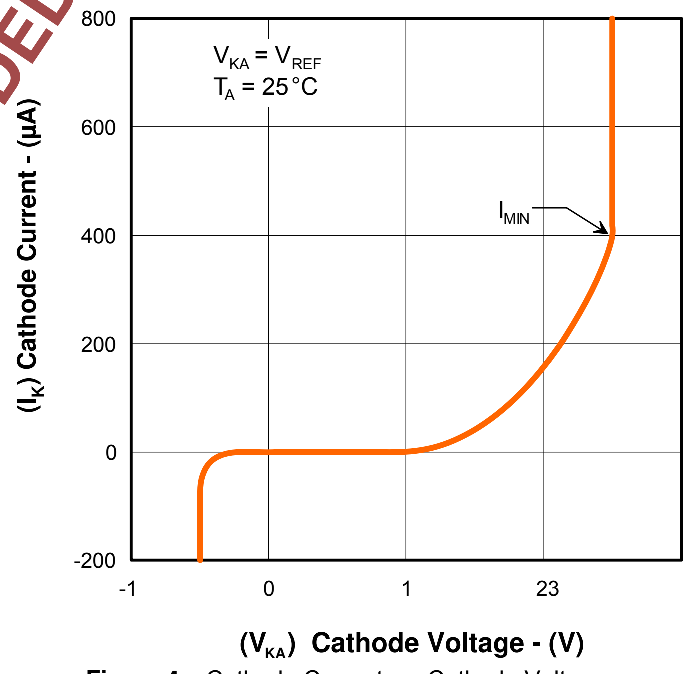


Figure 4 – Cathode Current vs. Cathode Voltage

CHARACTERISTIC CURVES

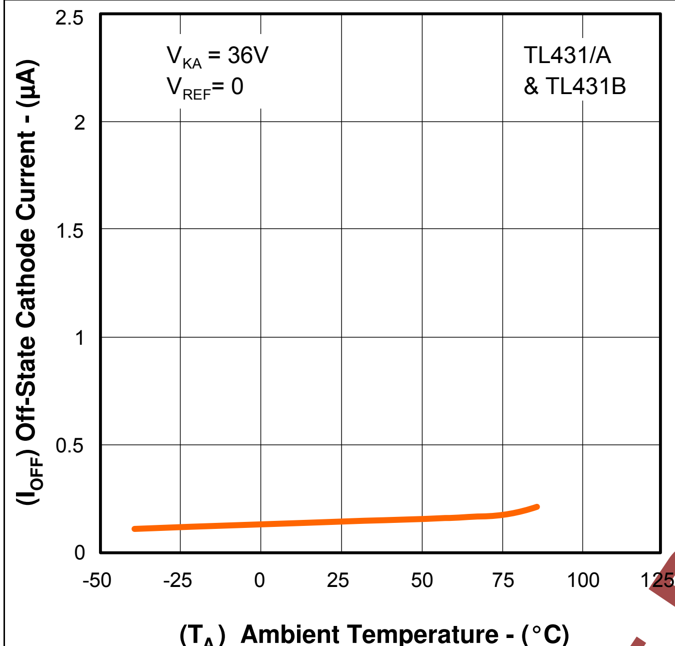


Figure 5 – Off-State Cathode Current vs Free-Air Temperature

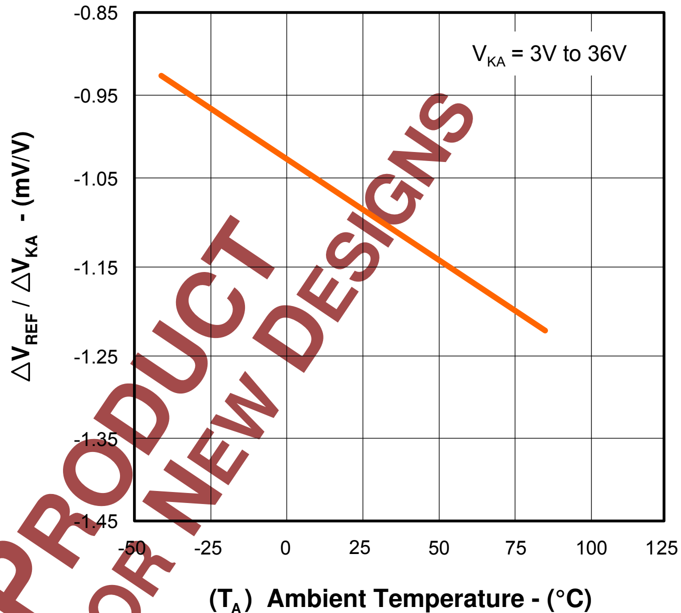


Figure 6 – Ratio of Delta Reference Voltage to Delta Cathode Voltage vs. Free-Air Temperature

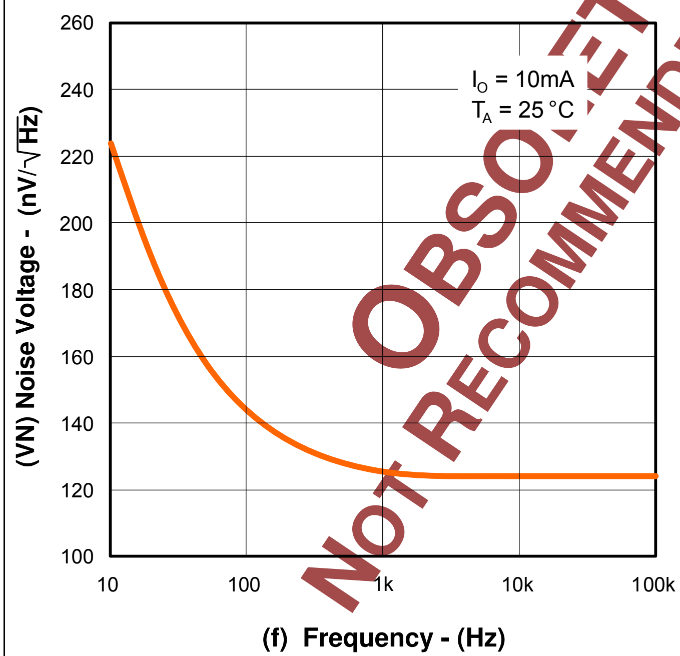


Figure 7 – Equivalent Input Noise Voltage vs. Frequency

PARAMETER MEASUREMENT INFORMATION

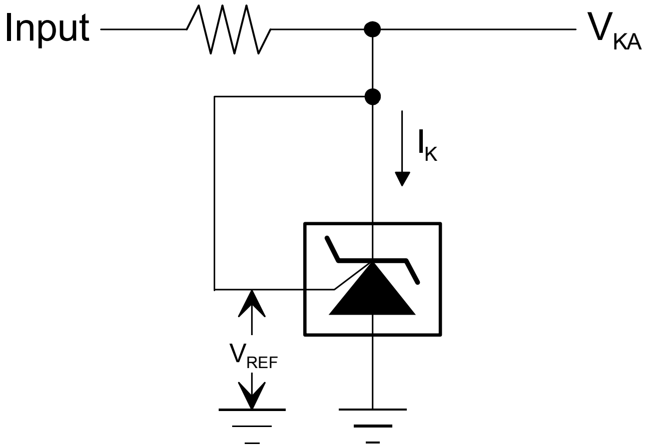


Figure 8 – Test Circuit for $V_{KA} = V_{REF}$

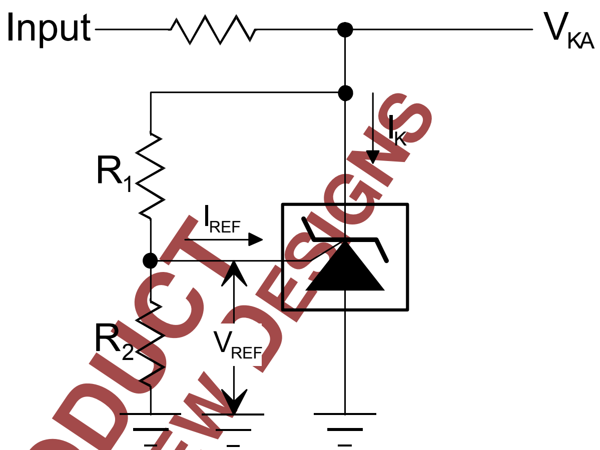


Figure 9 – Test Circuit for $V_{KA} > V_{REF}$

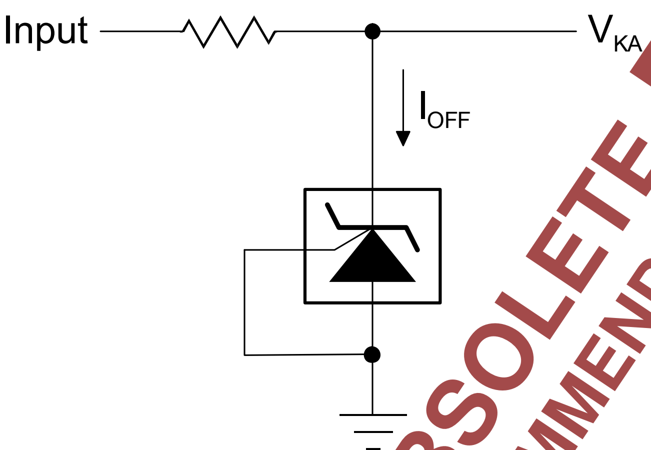


Figure 10 – Test Circuit for I_{OFF}

TYPICAL CHARACTERISTICS

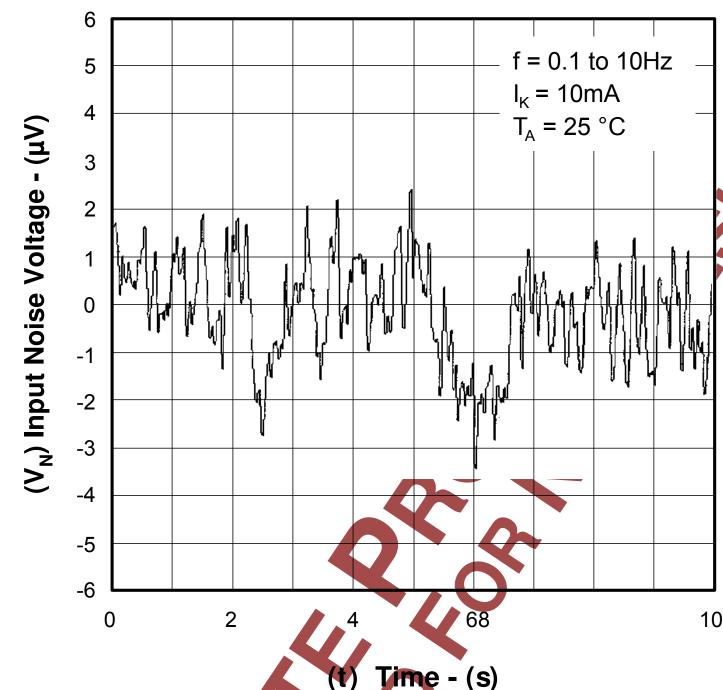
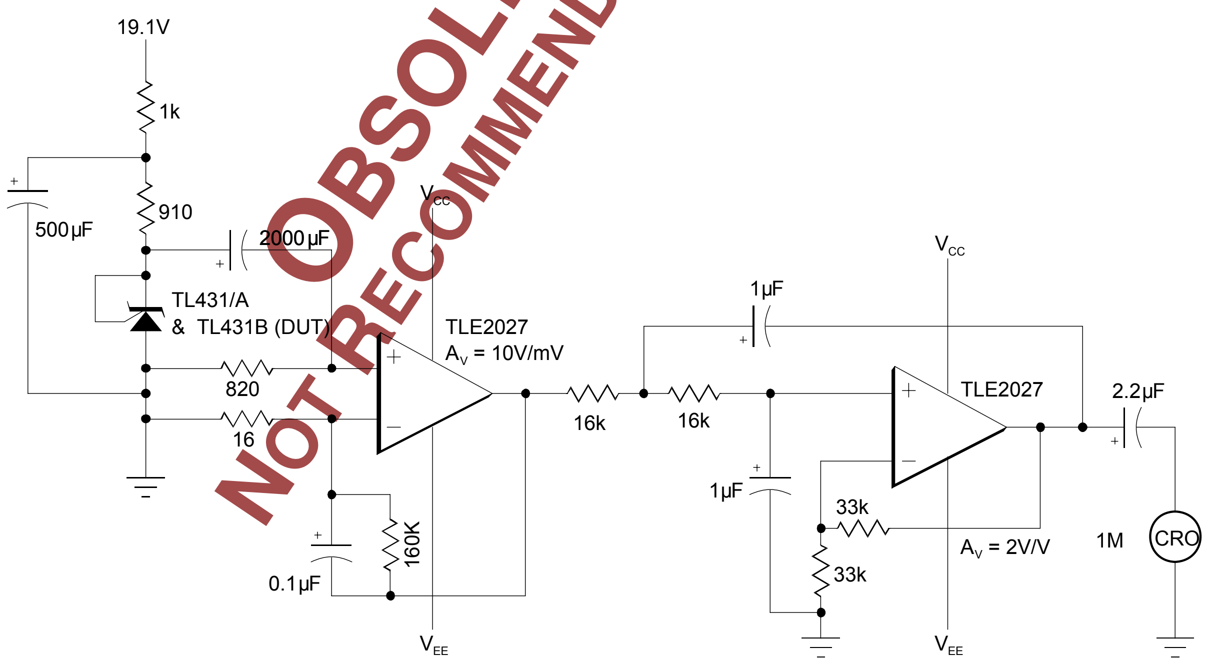


Figure 11 – Equivalent Input Noise Voltage over a 10 – Second Period



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

APPLICATIONS

TYPICAL CHARACTERISTICS

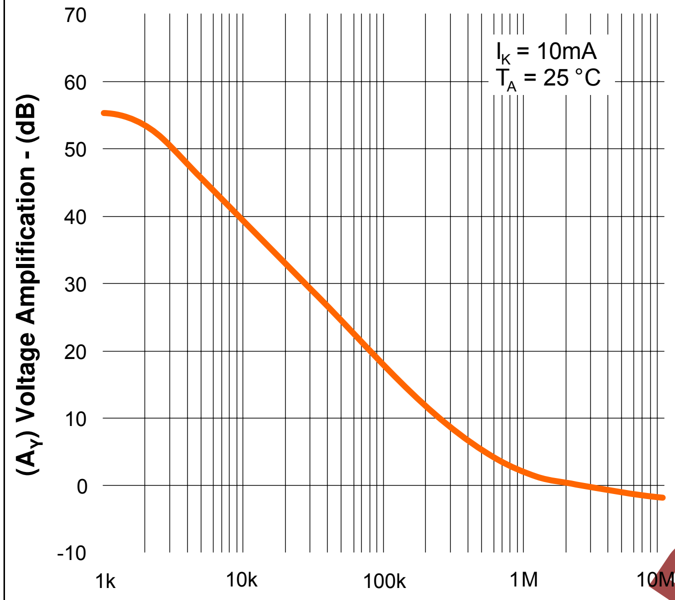
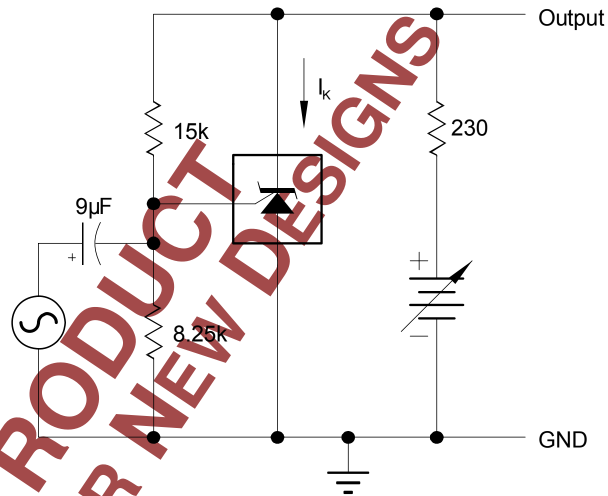


Figure 12 – Reference Impedance vs. Frequency



Test Circuit for Voltage Amplification

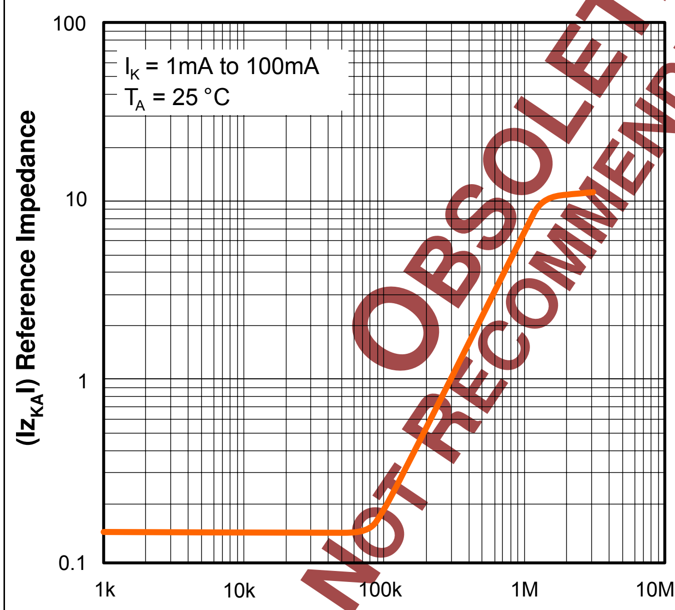
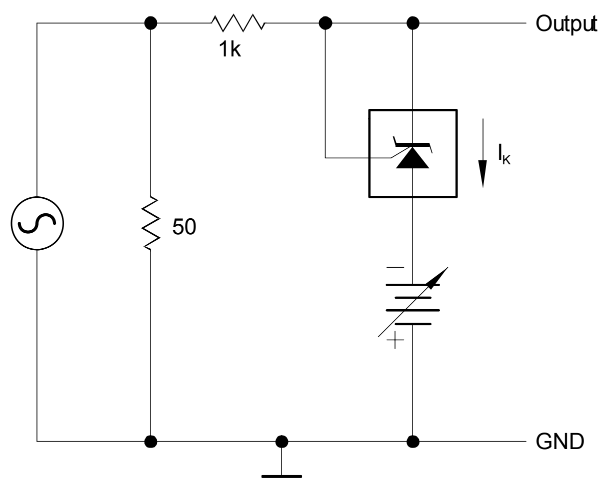


Figure 13 – Reference Impedance vs. Frequency



Test Circuit for Reference Impedance

TYPICAL CHARACTERISTICS

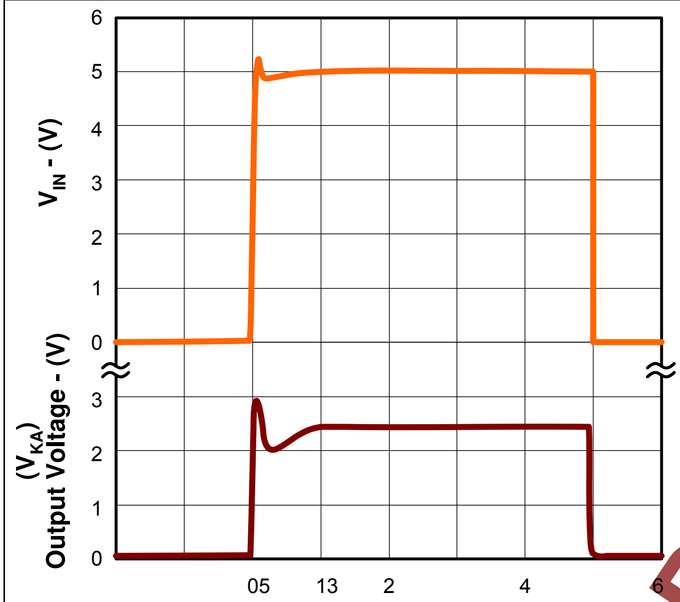
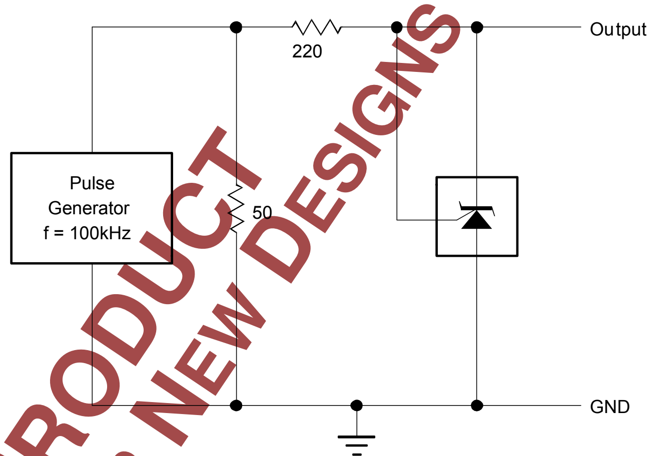


Figure 14 – Pulse Response



Test Circuit for Pulse Response

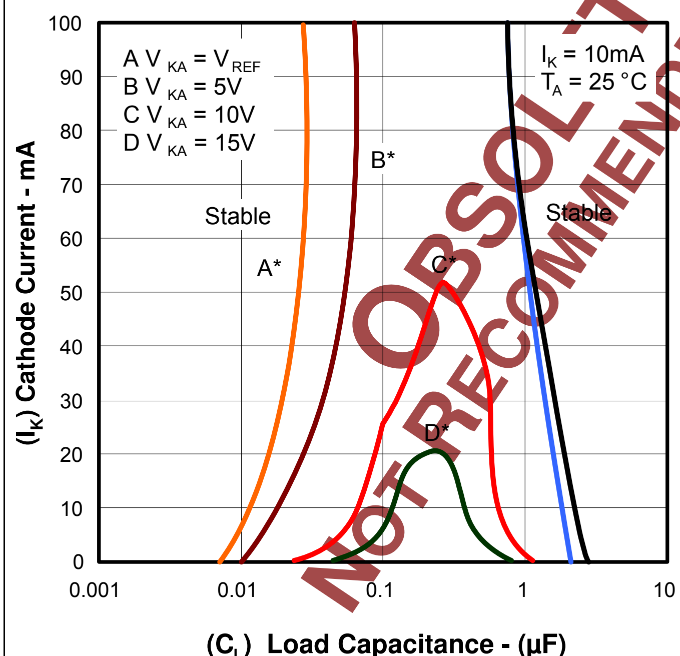
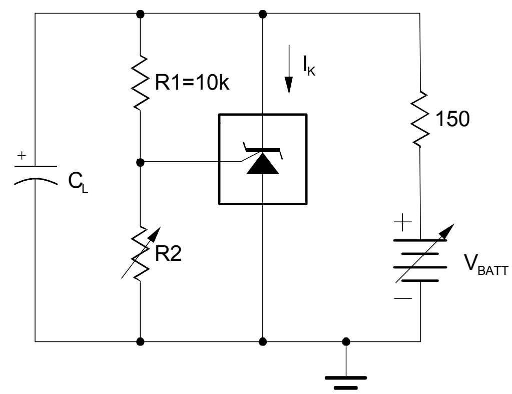
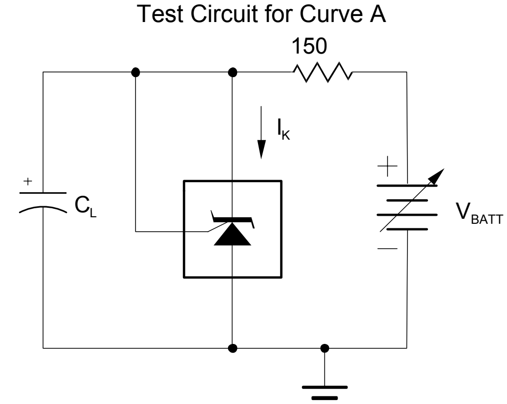


Figure 15 – Stability Boundary Conditions

*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.

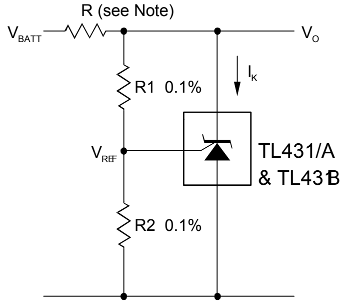


Test Circuit for Curve A



Test Circuit for Curve B, C, D

APPLICATION INFORMATION



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

Figure 16 – Shunt Regulator

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

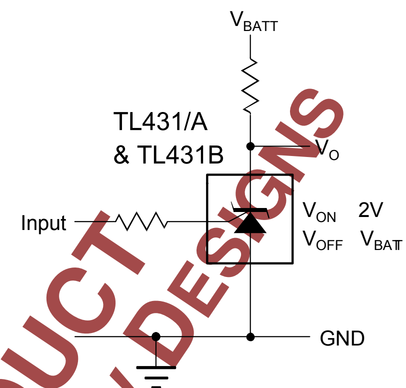
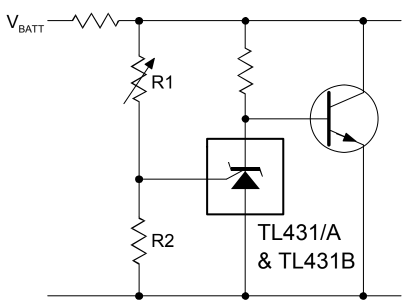


Figure 17 – Single-Supply Comparator with Temperature-Compensated Threshold



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

Figure 18 – High Current Shunt Regulator

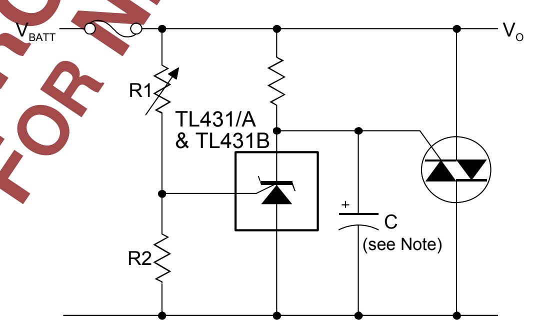
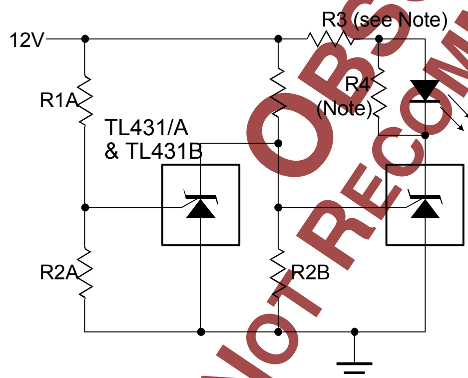


Figure 19 – Crowbar Circuit

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



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

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

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

Figure 20 – Voltage Monitor

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+

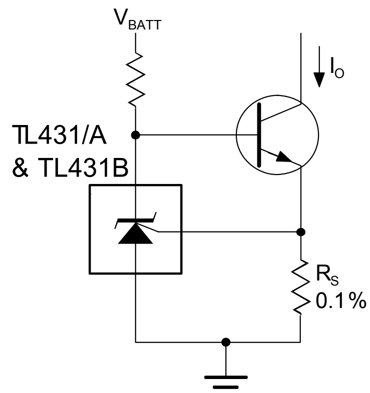


Figure 21 – Precision Contact – Current Sink