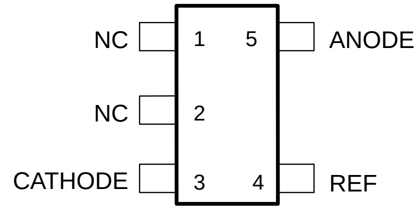
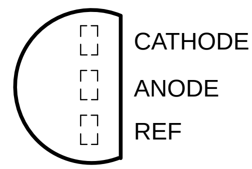
- **Low-Voltage Operation . . . to 1.24 V**
- **1% Reference Voltage Tolerance**
- **Adjustable Output Voltage, $V_O = V_{ref}$ to 6 V**
- **Low Operational Cathode Current . . . 80 μA**
- **0.25 Ω Typical Output Impedance**
- **SOT-23 Package**

DBV PACKAGE
(TOP VIEW)



NC - No internal connection

LP PACKAGE
(TOP VIEW)



description

The TLV431A is a low-voltage three-terminal adjustable voltage reference with specified thermal stability over applicable industrial and commercial temperature ranges. Output voltage may be set to any value between V_{ref} (1.24 V) and 6 V with two external resistors (see Figure 2). The TLV431A operates from a lower voltage (1.24 V) than the widely used TL431 and TL1431 shunt regulator references.

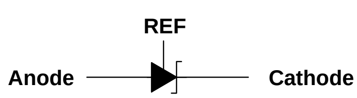
When used with an optocoupler, the TLV431A is an ideal voltage reference in an isolated feedback circuit for 3-V to 3.3-V switching-mode power supplies. This device has a typical output impedance of 0.25 Ω. Active output circuitry provides a very sharp turn-on characteristic, making the TLV431A an excellent replacement for low-voltage zener diodes in many applications, including on-board regulation and adjustable power supplies.

AVAILABLE OPTIONS

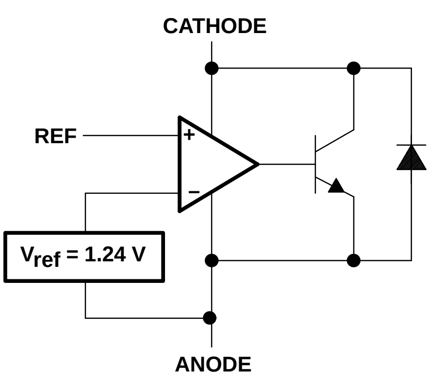
T_A	PACKAGED DEVICES		CHIP FORM (Y)
	TO-92 (LP)	SOT-23 (DBV)	
0°C to 70°C	TLV431ACLP	TLV431ACDBV	TLV431AY
–40°C to 85°C	TLV431AILP	TLV431AIDBV	

The LP package is available taped and reeled. Add R suffix to device type (e.g., TLV431ACLPR).
The DBV is only available taped and reeled (no R suffix is required).

symbol



functional block diagram



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TEXAS INSTRUMENTS
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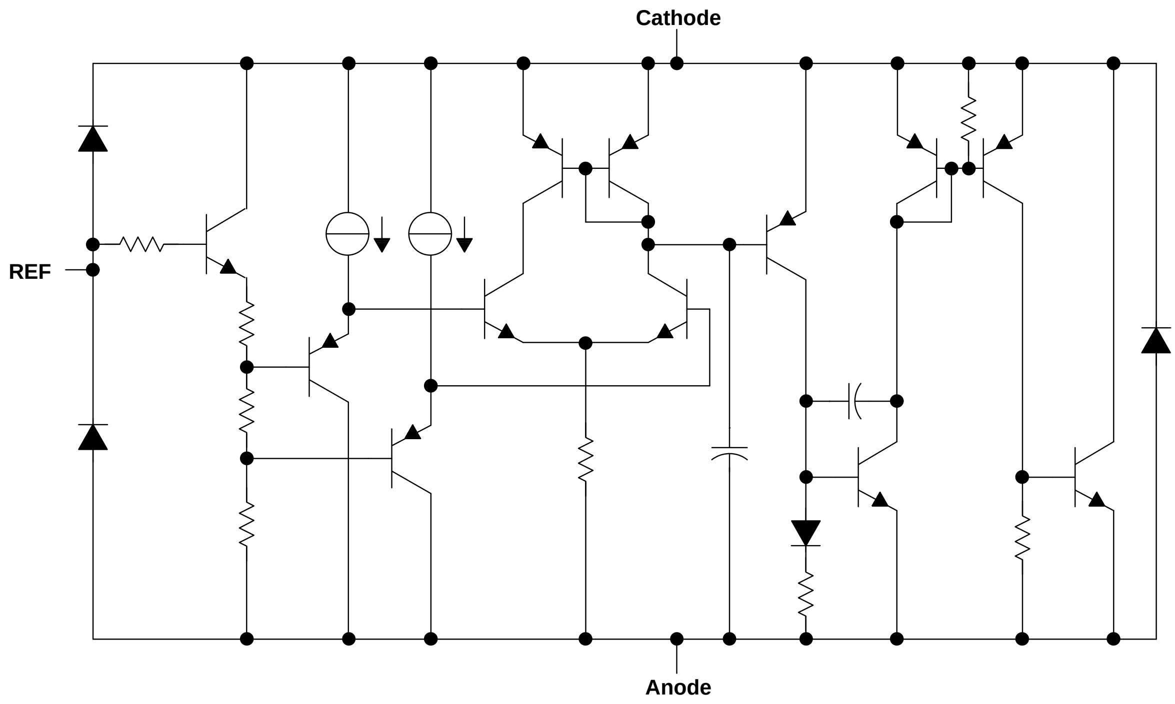
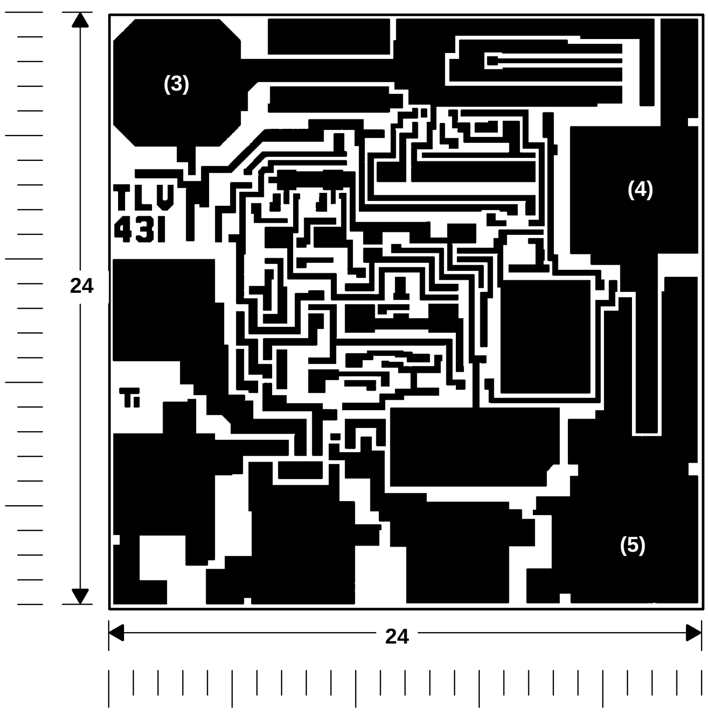
equivalent schematic



TLV431AY chip information

This chip, when properly assembled, displays characteristics similar to the TLV431A. Thermal compression or ultrasonic bonding may be used on the doped aluminum bonding pads. Chips may be mounted with conductive epoxy or a gold-silicon preform.

BONDING PAD ASSIGNMENTS



CHIP THICKNESS: 10 TYPICAL

BONDING PADS: 4 × 4 MINIMUM

T_J max = 150°C

TOLERANCES ARE ±10%.

ALL DIMENSIONS ARE IN MILS.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Cathode voltage, V_{KA} (see Note 1) . . . . 7 V
Continuous cathode current range, I_K . . . . –20 mA to 20 mA
Reference current range, I_{ref} . . . . –0.05 mA to 3 mA
Power dissipation, P_D . . . . See Dissipation Rating Table
Operating free-air temperature range, T_A: C-suffix . . . . 0°C to 70°C
I-suffix . . . . –40°C to 85°C
Storage temperature range, T_{stg} . . . . –65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds . . . . 260°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: Voltage values are with respect to the anode terminal, unless otherwise noted.

DISSIPATION RATING TABLE

PACKAGE	$T_A \le 25°C$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25°C$	$T_A = 70°C$ POWER RATING	$T_A = 85°C$ POWER RATING
LP	775 mW	6.2 mW/°C	496 mW	403 mW
DBV	150 mW	1.2 mW/°C	96 mW	78 mW

recommended operating conditions

		MIN	MAX	UNIT
Cathode voltage, V_{KA}		V_{ref}	6	V
Cathode current, I_K		0.1	15	mA
Operating free-air temperature range, T_A	TLV431AC	0	70	°C
	TLV431AI	–40	85	

electrical characteristics at 25°C free-air temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS		TLV431AC			TLV431AI			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{ref}	Reference voltage	$V_{KA} = V_{ref}$, I_K = 10 mA, See Figure 1	T_A = 25°C	1.228	1.240	1.252	1.228	1.240	1.252	V
			T_A = full range	1.221		1.259	1.215		1.265	
$V_{ref(dev)}$	V_{ref} deviation over full temperature range (see Note 3)	$V_{KA} = V_{ref}$, I_K = 10 mA, See Note 2 and Figure 1			4	12		6	20	mV
$\frac{\Delta V_{ref}}{\Delta V_{KA}}$	Ratio of V_{ref} change in cathode voltage change	I_K = 10 mA, $\Delta V_{KA} = V_{ref}$ to 6 V, See Figure 2			–1.5	–2.7		–1.5	–2.7	$\frac{mV}{V}$
I_{ref}	Reference terminal current	I_K = 10 mA, R1 = 10 kΩ, R2 = ∞, See Figure 2			0.15	0.5		0.15	0.5	µA
$I_{ref(dev)}$	$I_{I(ref)}$ deviation over full temperature range (see Note 3)	I_K = 10 mA, R1 = 10 kΩ, R2 = ∞, See Note 2 and Figure 2			0.05	0.3		0.1	0.4	µA
$I_{K(min)}$	Minimum cathode current for regulation	$V_{KA} = V_{ref}$, See Figure 1			55	80		55	80	µA
I_{off}	Off-state cathode current	V_{KA} = 6 V, V_{ref} = 0, See Figure 3			0.001	0.1		0.001	0.1	µA
$\lvert z_{ka} \rvert$	Dynamic impedance (see Note 4)	$V_{KA} = V_{ref}$, f ≤ 1 kHz, I_K = 0.1 mA to 15 mA See Figure 1			0.25	0.4		0.25	0.4	Ω

NOTES: 2. Full temperature range is –40°C to 85°C for TLV431AI, and 0°C to 70°C for the TLV431AC.

3. The deviation parameters $V_{ref(dev)}$ and $I_{ref(dev)}$ are defined as the differences between the maximum and minimum values obtained over the rated temperature range. The average full-range temperature coefficient of the reference input voltage, αV_{ref}, is defined as:

$$\left|\alpha V_{ref}\right|\left(\frac{ppm}{°C}\right) = \frac{\left(\frac{V_{ref(dev)}}{V_{ref}\ (T_A = 25°C)}\right) \times 10^6}{\Delta T_A}$$

where ΔT_A is the rated operating free-air temperature range of the device.

α_{Vref} can be positive or negative depending on whether minimum V_{ref} or maximum V_{ref}, respectively, occurs at the lower temperature.

4. The dynamic impedance is defined as: $\left|z_{ka}\right| = \frac{\Delta V_{KA}}{\Delta I_K}$

When the device is operating with two external resistors (see Figure 2), the total dynamic impedance of the circuit is given by:

$$\left|z_{ka}\right| = \frac{\Delta V}{\Delta I} \approx \left|z_{ka}\right| \times \left(1 + \frac{R1}{R2}\right)$$

PARAMETER MEASUREMENT INFORMATION

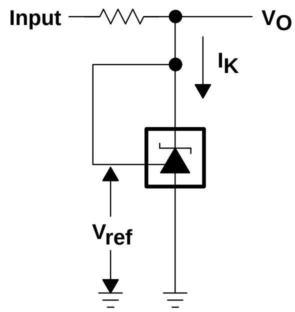


Figure 1. Test Circuit for $V_{KA} = V_{ref}$
$V_O = V_{KA} = V_{ref}$

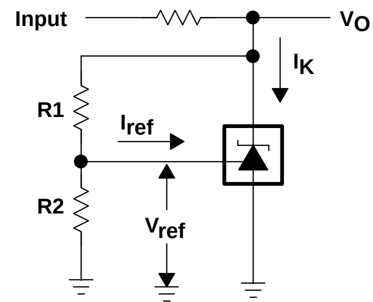


Figure 2. Test Circuit for $V_{KA} > V_{ref}$
$V_O = V_{KA} = V_{ref} \times (1 + R1/R2) + I_{ref} \times R1$

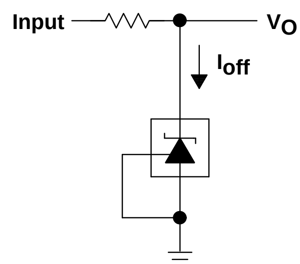


Figure 3. Test Circuit for I_{off}

PARAMETER MEASUREMENT INFORMATION

REFERENCE VOLTAGE vs JUNCTION TEMPERATURE

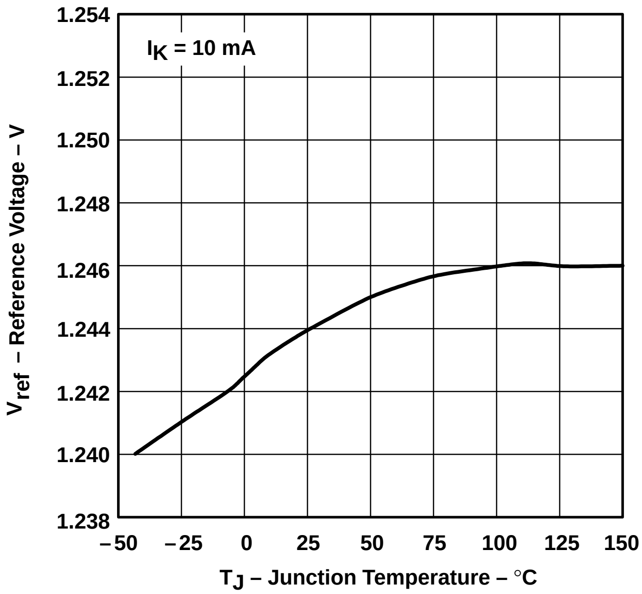


Figure 4

REFERENCE INPUT CURRENT vs JUNCTION TEMPERATURE

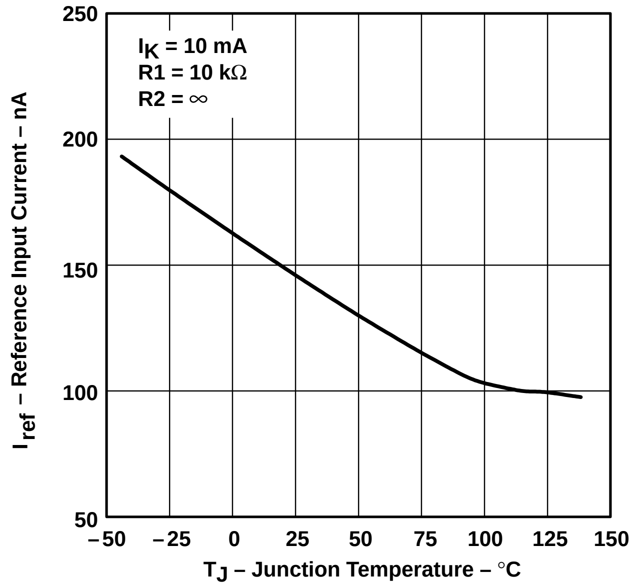


Figure 5

CATHODE CURRENT vs CATHODE VOLTAGE

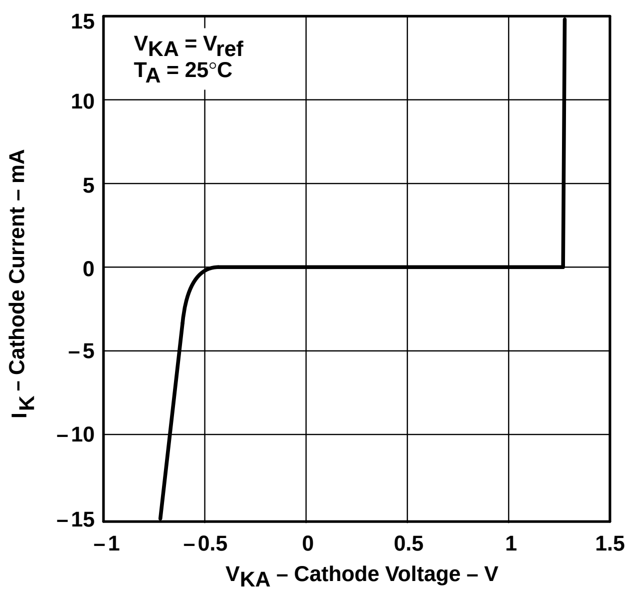


Figure 6

CATHODE CURRENT vs CATHODE VOLTAGE

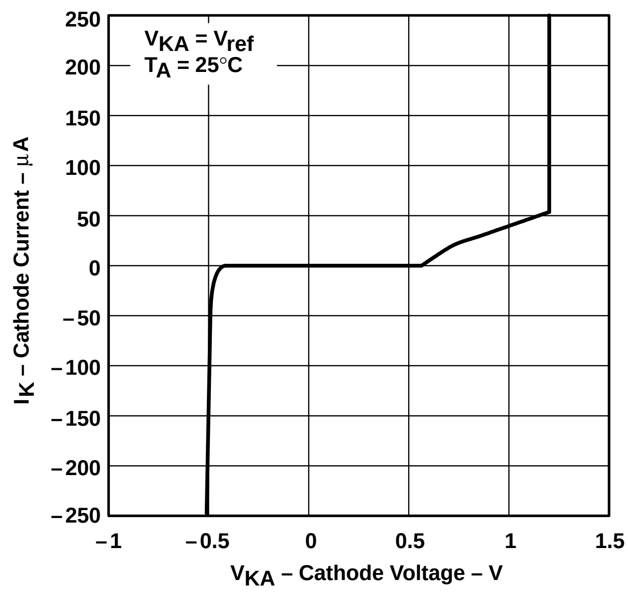


Figure 7

PARAMETER MEASUREMENT INFORMATION

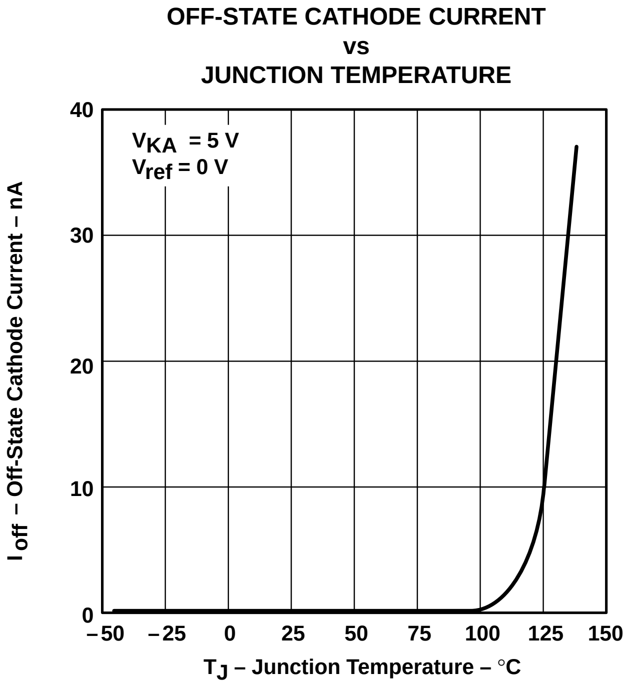


Figure 8

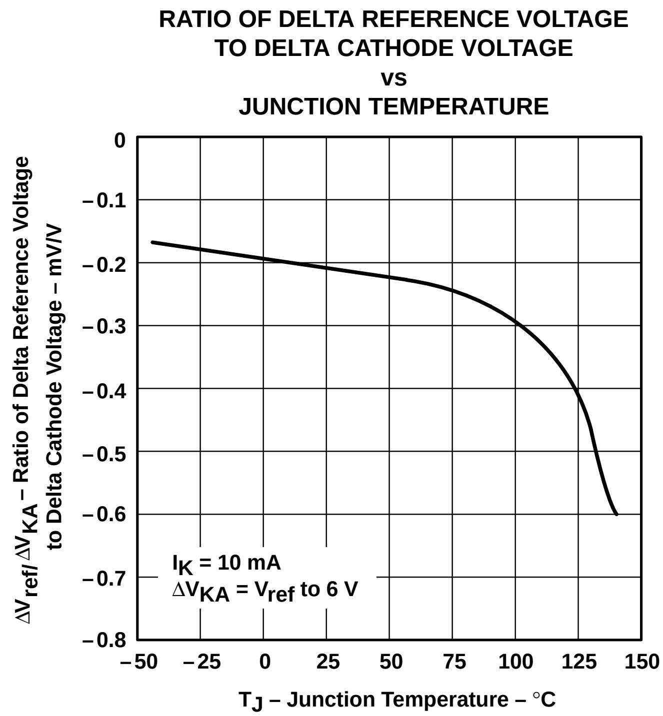


Figure 9

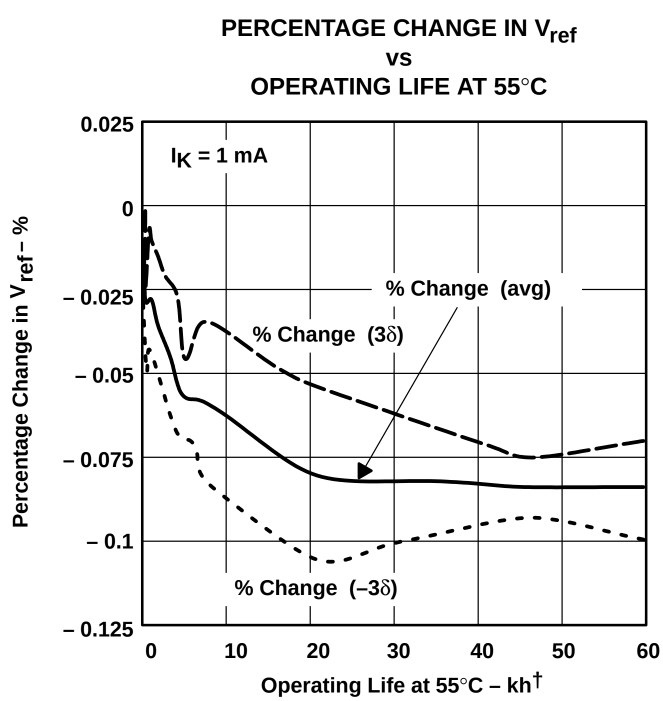
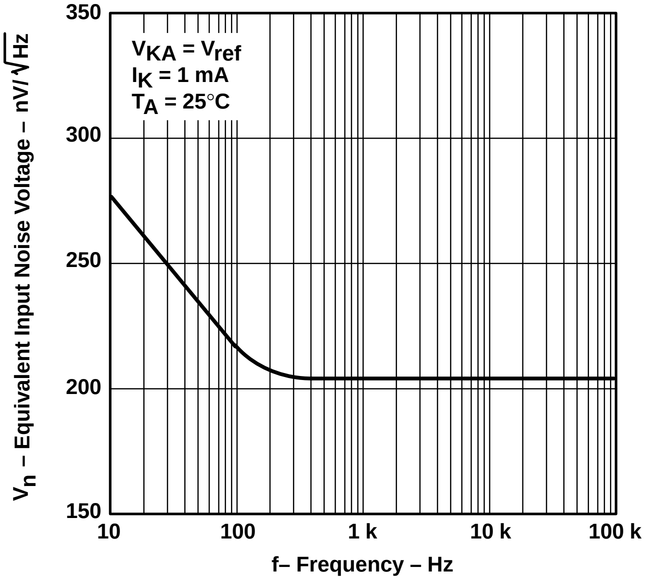


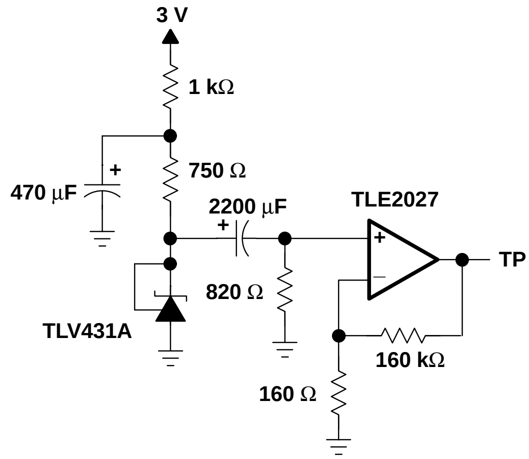
Figure 10

† Extrapolated from lifetest data taken at 125°C; the activation energy assumed is 0.7 eV.

PARAMETER MEASUREMENT INFORMATION

EQUIVALENT INPUT NOISE VOLTAGE
vs
FREQUENCY

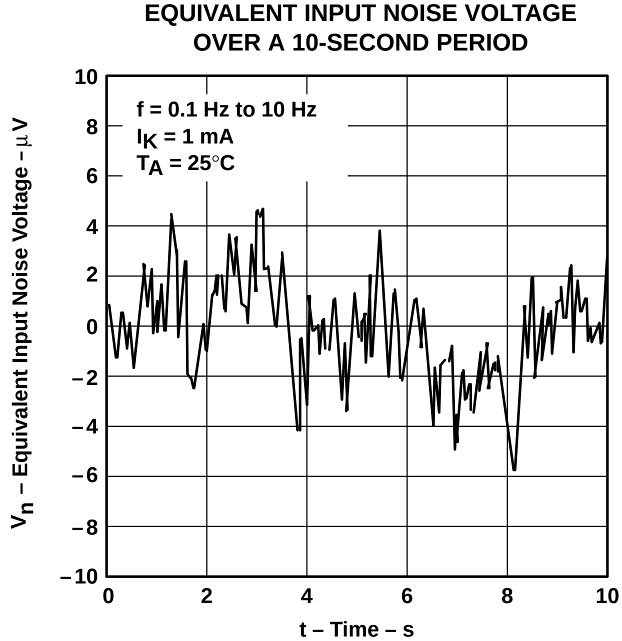


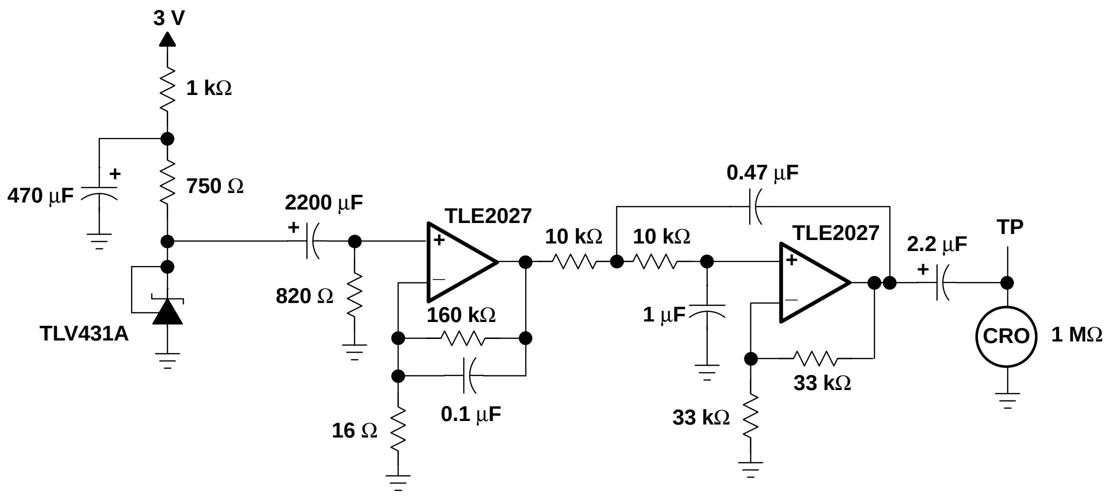


Test circuit for equivalent noise voltage

Figure 11

PARAMETER MEASUREMENT INFORMATION



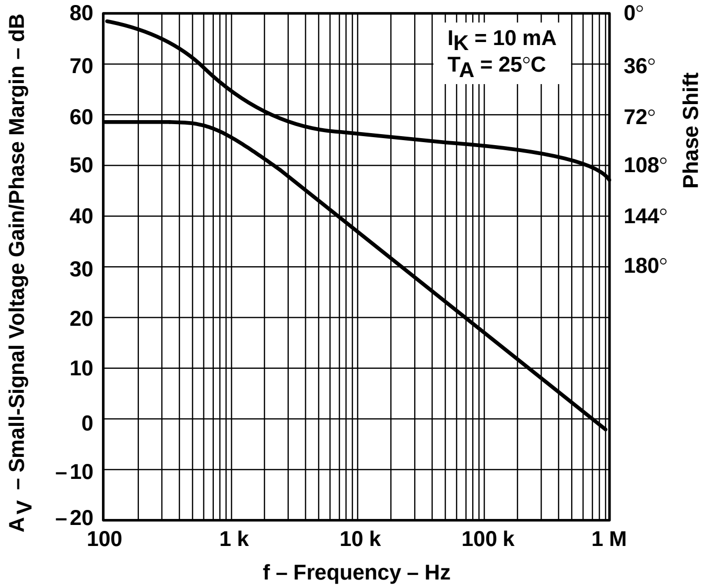


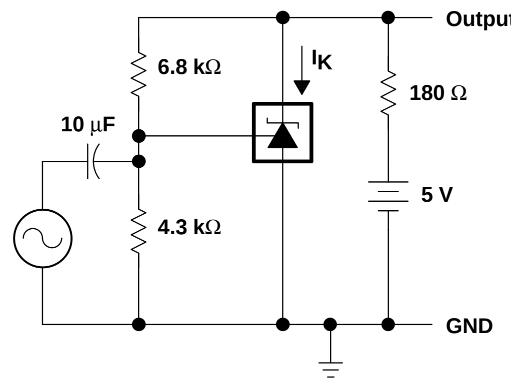
Test circuit for 0.1-Hz to 10-Hz equivalent noise voltage

Figure 12

PARAMETER MEASUREMENT INFORMATION

SMALL-SIGNAL VOLTAGE GAIN /PHASE MARGIN vs FREQUENCY

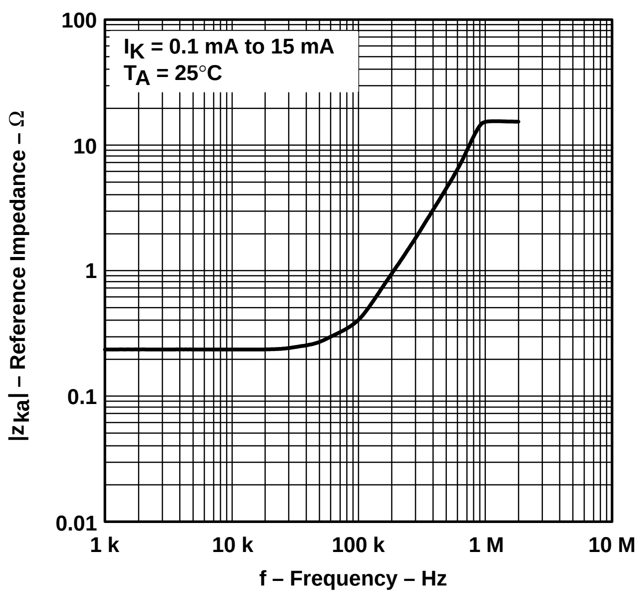


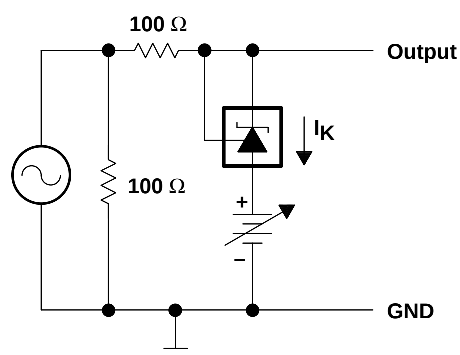


TEST CIRCUIT FOR VOLTAGE GAIN AND PHASE MARGIN

Figure 13

REFERENCE IMPEDANCE vs FREQUENCY

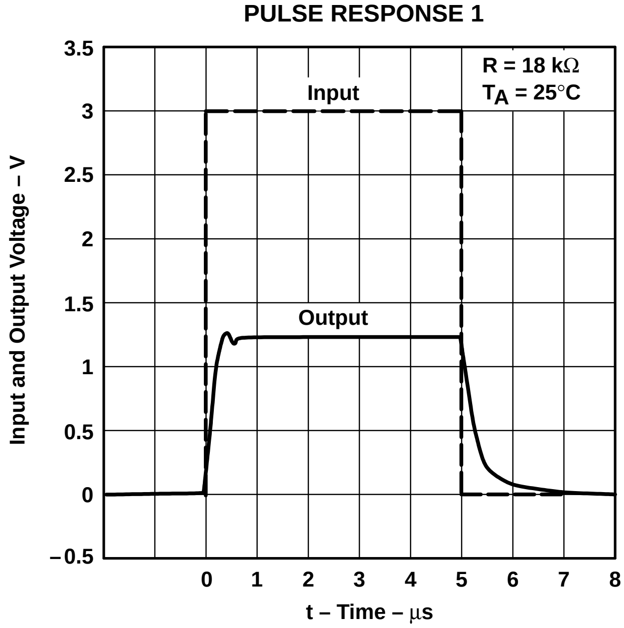


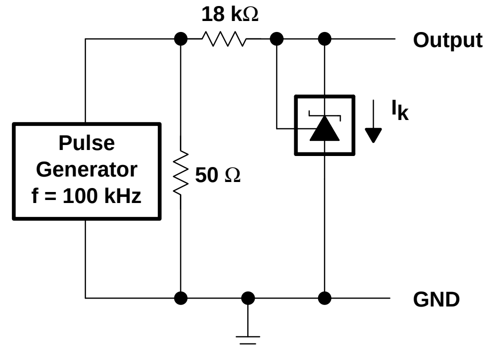


TEST CIRCUIT FOR REFERENCE IMPEDANCE

Figure 14

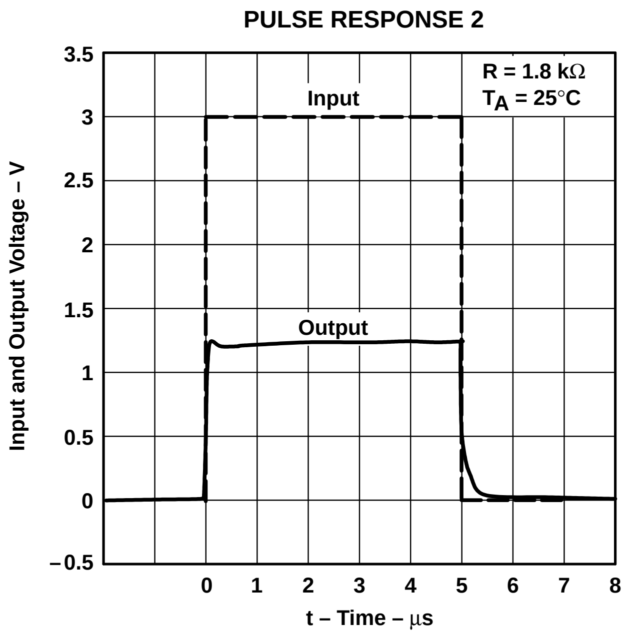
PARAMETER MEASUREMENT INFORMATION

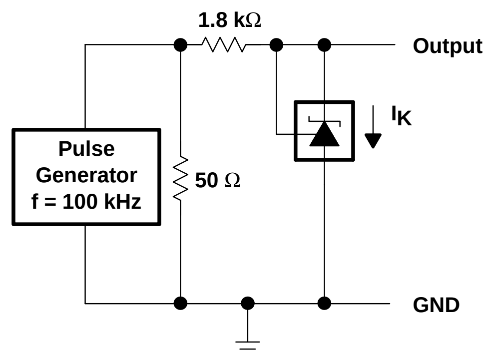




TEST CIRCUIT FOR PULSE RESPONSE 1

Figure 15



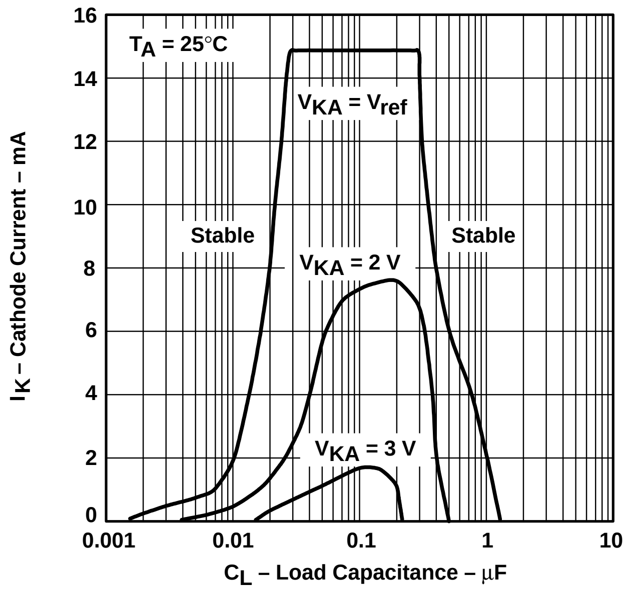


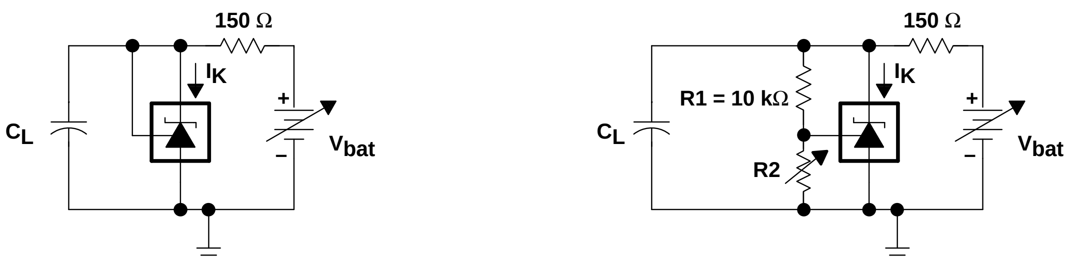
TEST CIRCUIT FOR PULSE RESPONSE 2

Figure 16

PARAMETER MEASUREMENT INFORMATION

STABILITY BOUNDARY CONDITION†





TEST CIRCUIT FOR $V_{KA} = V_{ref}$

TEST CIRCUIT FOR V_{KA} = 2 V, 3 V

† The areas under the curves represent conditions that may cause the device to oscillate. For V_{KA} = 2 V and 3 V curves, R2 and V_{bat} were adjusted to establish the initial V_{KA} and I_K conditions with C_L = 0. V_{bat} and C_L were then adjusted to determine the ranges of stability.

Figure 17

APPLICATION INFORMATION

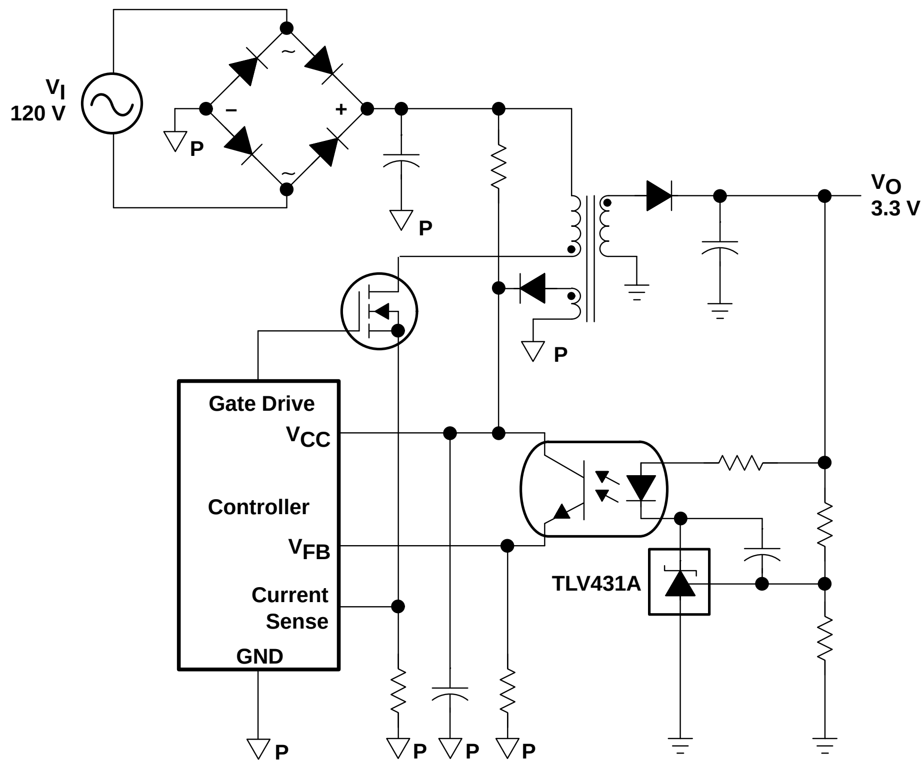
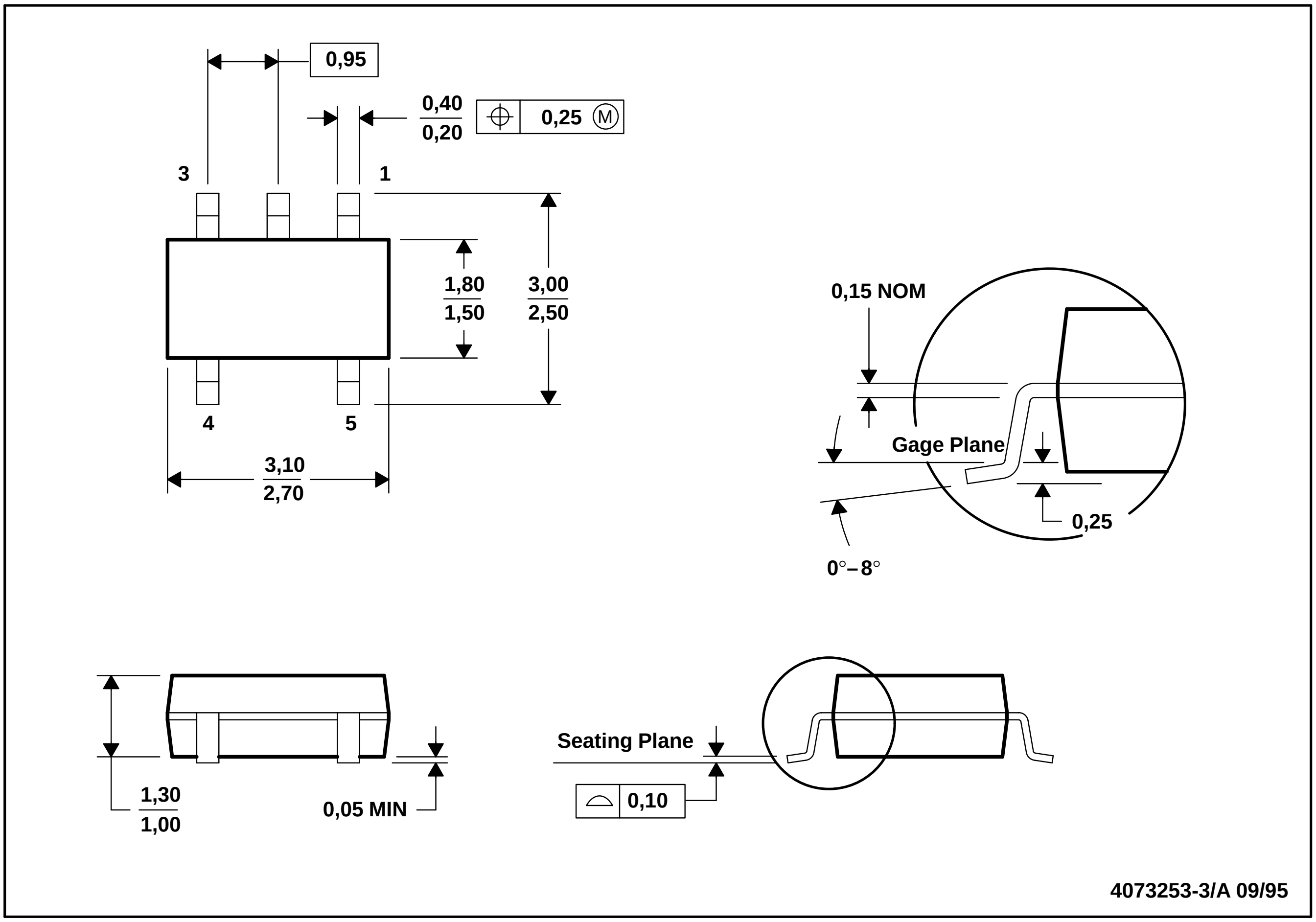


Figure 18. Flyback with Isolation using TLV431A as Voltage Reference and Error Amplifier.

Figure 18 shows the TLV431A used in a 3.3-V isolated flyback supply. V_O of the TLV431A can be as low as V_{ref} (1.244 V ± 1%). The output of the regulator plus the forward voltage drop of the optocoupler LED (1.244 + 1.4 = 2.644 V) determine the minimum voltage that can be regulated in an isolated supply configuration. Regulated voltage as low as 2.7 Vdc is possible in the above topology.

MECHANICAL DATA

DBV (R-PDSO-G5) **PLASTIC SMALL-OUTLINE PACKAGE**



NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions include mold flash or protrusion.

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