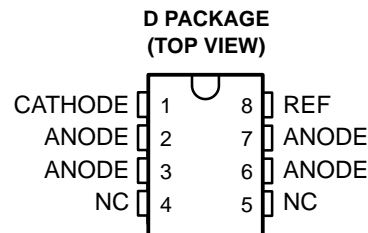


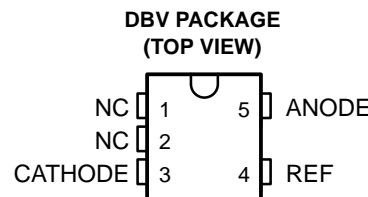
TLV431, TLV431A LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATORS

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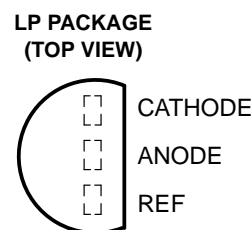
- Low-Voltage Operation . . . Down to 1.24 V
- 1% Reference-Voltage Tolerance (TLV431A)
- Adjustable Output Voltage, $V_O = V_{ref}$ to 6 V
- Low Operational Cathode Current . . . 80 μ A Typ
- 0.25- Ω Typical Output Impedance
- Package Options Include Plastic Small-Outline (D), Small-Outline Transistor (DBV), and Cylindrical (LP) Packages



NC – No internal connection



NC – No internal connection



description

The TLV431 and TLV431A are low-voltage three-terminal adjustable voltage references with specified thermal stability over applicable industrial and commercial temperature ranges. Output voltage can be set to any value between V_{ref} (1.24 V) and 6 V with two external resistors (see Figure 2). The TLV431 and TLV431A operate from a lower voltage (1.24 V) than the widely used TL431 and TL1431 shunt-regulator references.

When used with an optocoupler, the TLV431 and TLV431A are ideal voltage references in isolated feedback circuits for 3-V to 3.3-V switching-mode power supplies. These devices have a typical output impedance of 0.25 Ω . Active output circuitry provides a very sharp turn-on characteristic, making the TLV431 and TLV431A excellent replacements for low-voltage Zener diodes in many applications, including onboard regulation and adjustable power supplies.

The TLV431C and TLV431AC devices are characterized for operation from 0°C to 70°C. The TLV431I and TLV431AI devices are characterized for operation from –40°C to 85°C.

AVAILABLE OPTIONS

T_A	PACKAGE		
	TO-92 (LP)	SOIC (D)	5-PIN SOT-23 (DBV)
0°C to 70°C	TLV431CLP TLV431ACL	— —	TLV431CDBVR TLV431ACDBVR
–40°C to 85°C	TLV431ILP TLV431AILP	— TLV431AID	TLV431IDBVR TLV431AIDBVR

The D and LP packages are available taped and reeled. Add the suffix R to the device type (e.g., TLV431ACLPR). The DBV package is available only taped and reeled.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

**TEXAS
INSTRUMENTS**

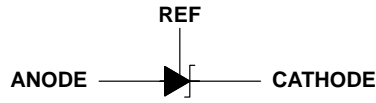
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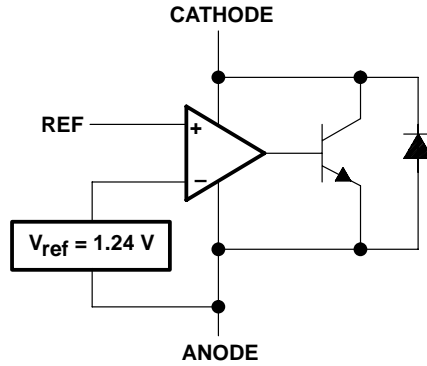
TLV431, TLV431A LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATORS

SLVS139E – JULY 1996 – REVISED JUNE 2002

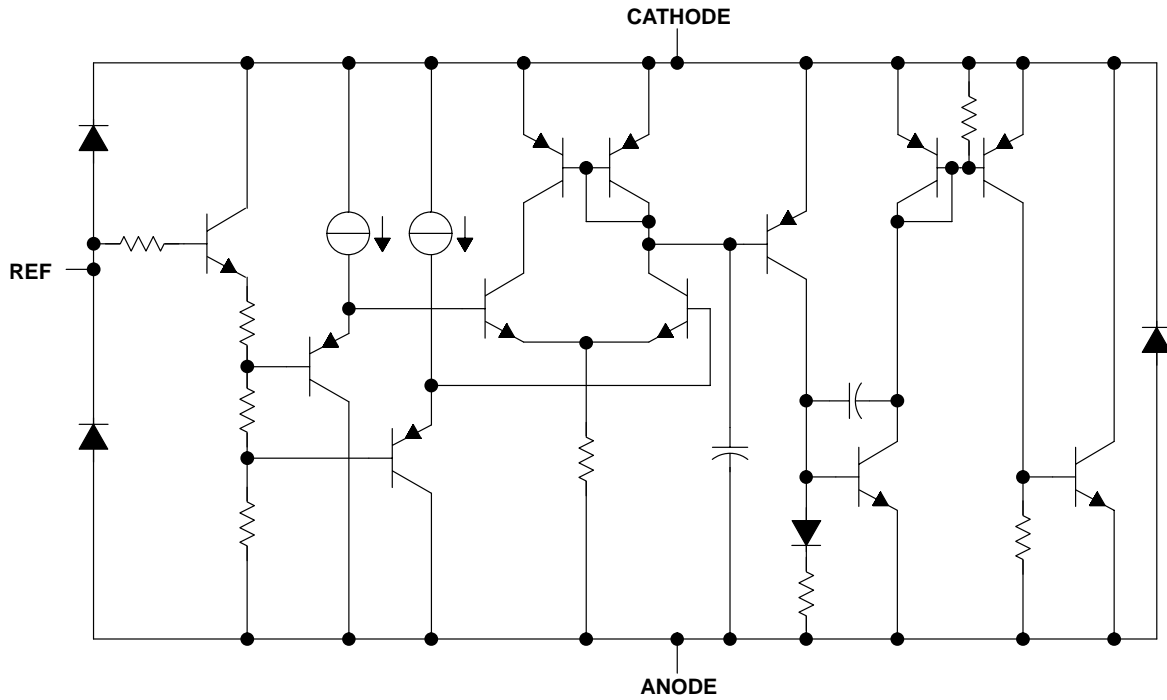
logic symbol



logic diagram (positive logic)



equivalent schematic



TLV431, TLV431A

LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATORS

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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
Package thermal impedance, θ_{JA} (see Notes 2 and 3): D package	97°C/W
DBV package	206°C/W
LP package	156°C/W
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260°C
Storage temperature range, T_{stg}	–65°C to 150°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.

- NOTES:
1. Voltage values are with respect to the anode terminal unless otherwise noted.
 2. Maximum power dissipation is a function of $T_J(max)$, θ_{JA} , and T_A . The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) - T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.
 3. The package thermal impedance is calculated in accordance with JESD 51-7.

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	TLV431C, TLV431AC		°C
	TLV431I, TLV431AI		



TLV431, TLV431A

LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATORS

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electrical characteristics, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS		TLV431C			TLV431I			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{ref} Reference voltage	$V_{\text{KA}} = V_{\text{ref}}$, $I_{\text{K}} = 10 \text{ mA}$	$T_A = 25^\circ\text{C}$	1.222	1.24	1.258	1.222	1.24	1.258	V
		$T_A = \text{full range}$ (see Note 4 and Figure 1)	1.21		1.27	1.202		1.278	
$V_{\text{ref(dev)}}$ V_{ref} deviation over full temperature range (see Note 5)	$V_{\text{KA}} = V_{\text{ref}}$, $I_{\text{K}} = 10 \text{ mA}$, (see Note 4 and Figure 1)			4	12		6	20	mV
$\frac{\Delta V_{\text{ref}}}{\Delta V_{\text{KA}}}$ Ratio of V_{ref} change in cathode voltage change	$I_{\text{K}} = 10 \text{ mA}$, $V_{\text{KA}} = V_{\text{ref}}$ to 6 V, (see Figure 2)			-1.5	-2.7		-1.5	-2.7	mV/V
I_{ref} Reference terminal current	$I_{\text{K}} = 10 \text{ mA}$, $R_1 = 10 \text{ k}\Omega$, $R_2 = \text{open}$ (see Figure 2)			0.15	0.5		0.15	0.5	μA
$I_{\text{ref(dev)}}$ I_{ref} deviation over full temperature range (see Note 5)	$I_{\text{K}} = 10 \text{ mA}$, $R_1 = 10 \text{ k}\Omega$, $R_2 = \text{open}$ (see Note 4 and Figure 2)			0.05	0.3		0.1	0.4	μA
$I_{\text{K(min)}}$ Minimum cathode current for regulation	$V_{\text{KA}} = V_{\text{ref}}$ (see Figure 1)			55	80		55	80	μA
$I_{\text{K(off)}}$ Off-state cathode current	$V_{\text{KA}} = 6 \text{ V}$, $V_{\text{ref}} = 0$ (see Figure 3)			0.001	0.1		0.001	0.1	μA
$ z_{\text{KA}} $ Dynamic impedance (see Note 6)	$V_{\text{KA}} = V_{\text{ref}}$, $f \leq 1 \text{ kHz}$, $I_{\text{K}} = 0.1 \text{ mA}$ to 15 mA (see Figure 1)			0.25	0.4		0.25	0.4	Ω

NOTES: 4. Full range is -40°C to 85°C for the TLV431I, and 0°C to 70°C for the TLV431C.

5. The deviation parameters $V_{\text{ref(dev)}}$ and $I_{\text{ref(dev)}}$ 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, $\alpha_{V_{\text{ref}}}$, is defined as:

$$|\alpha_{V_{\text{ref}}}| \left(\frac{\text{ppm}}{^\circ\text{C}} \right) = \frac{\left(\frac{V_{\text{ref(dev)}}}{V_{\text{ref at } 25^\circ\text{C}}} \right) \times 10^6}{\Delta T_A}$$

where:

ΔT_A is the rated operating temperature range of the device.

$\alpha_{V_{\text{ref}}}$ can be positive or negative, depending on whether minimum V_{ref} or maximum V_{ref} , respectively, occurs at the lower temperature.

6. The dynamic impedance is defined as: $|z_{\text{KA}}| = \frac{\Delta V_{\text{KA}}}{\Delta I_{\text{KA}}}$

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

$$|z_{\text{KA}}| = \frac{\Delta V}{\Delta I} \approx |z_{\text{KA}}| \times \left(1 + \frac{R_1}{R_2} \right)$$

TLV431, TLV431A

LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATORS

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electrical characteristics, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	TLV431AC			TLV431AI			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
V_{ref} Reference voltage	$V_{\text{KA}} = V_{\text{ref}}$, $I_{\text{K}} = 10\text{ mA}$, $T_A = 25^\circ\text{C}$ $T_A = \text{full range}$, (see Note 4 and Figure 1)	1.228	1.24	1.252	1.228	1.24	1.252	V
		1.221		1.259	1.215		1.265	
$V_{\text{ref(dev)}}$	V_{ref} deviation over full temperature range (see Note 5)		4	12		6	20	mV
$\frac{\Delta V_{\text{ref}}}{\Delta V_{\text{KA}}}$	Ratio of V_{ref} change in cathode voltage change		-1.5	-2.7		-1.5	-2.7	mV/V
I_{ref}	Reference terminal current		0.15	0.5		0.15	0.5	μA
$I_{\text{ref(dev)}}$	I_{ref} deviation over full temperature range (see Note 5)		0.05	0.3		0.1	0.4	μA
$I_{\text{K(min)}}$	Minimum cathode current for regulation		55	80		55	80	μA
$I_{\text{K(off)}}$	Off-state cathode current		0.001	0.1		0.001	0.1	μA
$ z_{\text{KA}} $	Dynamic impedance (see Note 6)		0.25	0.4		0.25	0.4	Ω

- NOTES: 7. Full range is -40°C to 85°C for the TLV4311, and 0°C to 70°C for the TLV431C.
8. The deviation parameters $V_{\text{ref(dev)}}$ and $I_{\text{ref(dev)}}$ 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, $\alpha_{V_{\text{ref}}}$, is defined as:

$$|\alpha_{V_{\text{ref}}}| \left(\frac{\text{ppm}}{^\circ\text{C}} \right) = \frac{\left(\frac{V_{\text{ref(dev)}}}{V_{\text{ref at } 25^\circ\text{C}}} \right) \times 10^6}{\Delta T_A}$$

where:

ΔT_A is the rated operating temperature range of the device.

$\alpha_{V_{\text{ref}}}$ can be positive or negative, depending on whether minimum V_{ref} or maximum V_{ref} , respectively, occurs at the lower temperature.

9. The dynamic impedance is defined as: $|z_{\text{KA}}| = \frac{\Delta V_{\text{KA}}}{\Delta I_{\text{KA}}}$

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

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

TLV431, TLV431A

LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATORS

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PARAMETER MEASUREMENT INFORMATION

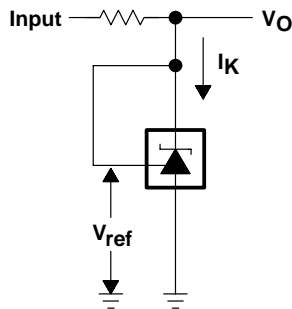


Figure 1. Test Circuit for $V_{KA} = V_{ref}$,
 $V_O = V_{KA} = V_{ref}$

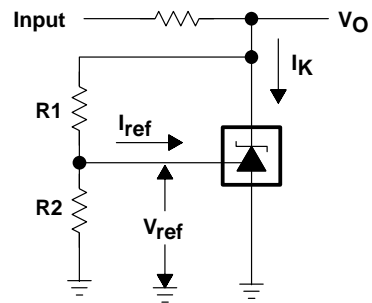


Figure 2. Test Circuit for $V_{KA} > V_{ref}$,
 $V_O = V_{KA} = V_{ref} \times (1 + R1/R2) + I_{ref} \times R1$

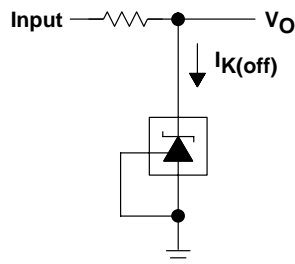


Figure 3. Test Circuit for $I_{K(off)}$

PARAMETER MEASUREMENT INFORMATION†

**REFERENCE VOLTAGE
 vs
 JUNCTION TEMPERATURE**

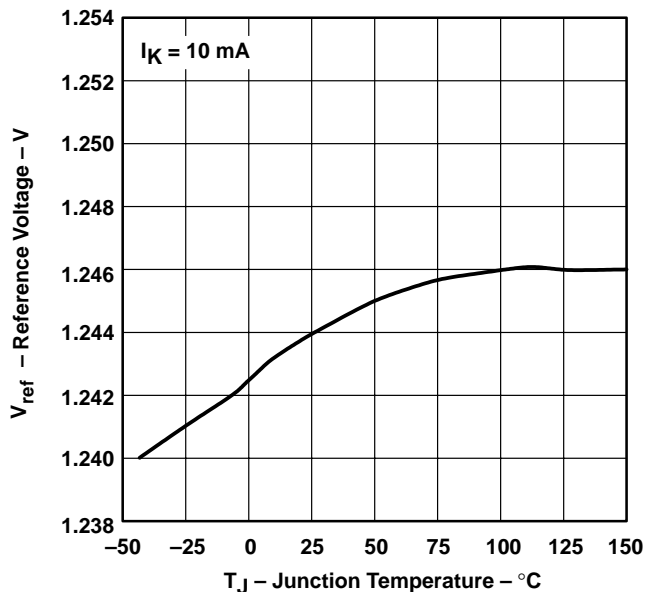


Figure 4

**REFERENCE INPUT CURRENT
 vs
 JUNCTION TEMPERATURE**

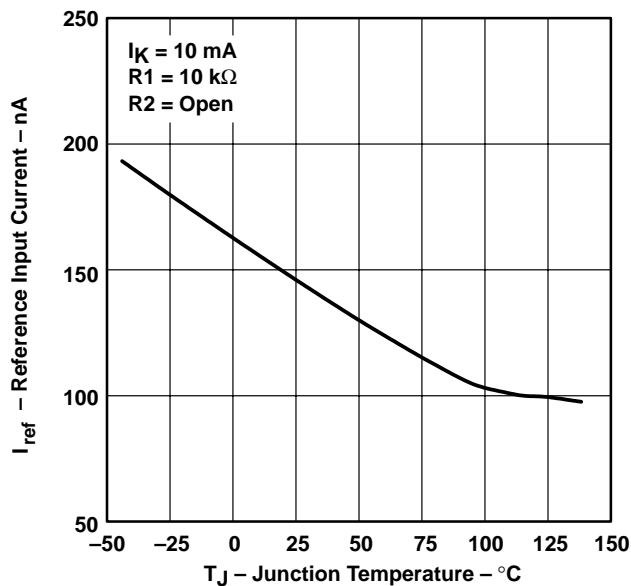


Figure 5

**CATHODE CURRENT
 vs
 CATHODE VOLTAGE**

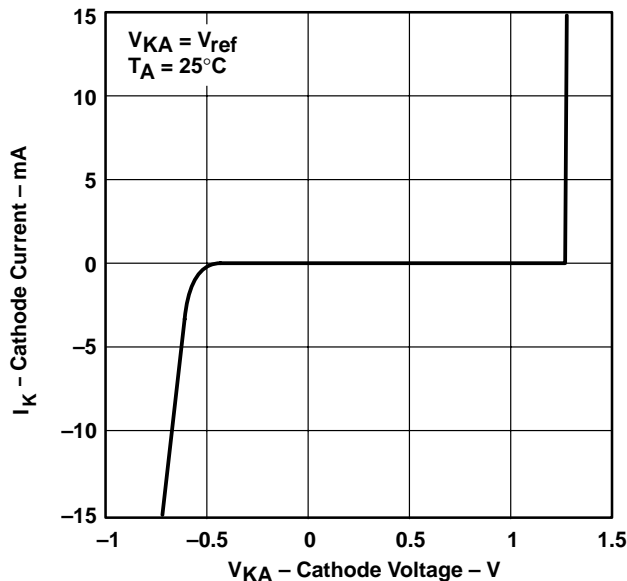


Figure 6

**CATHODE CURRENT
 vs
 CATHODE VOLTAGE**

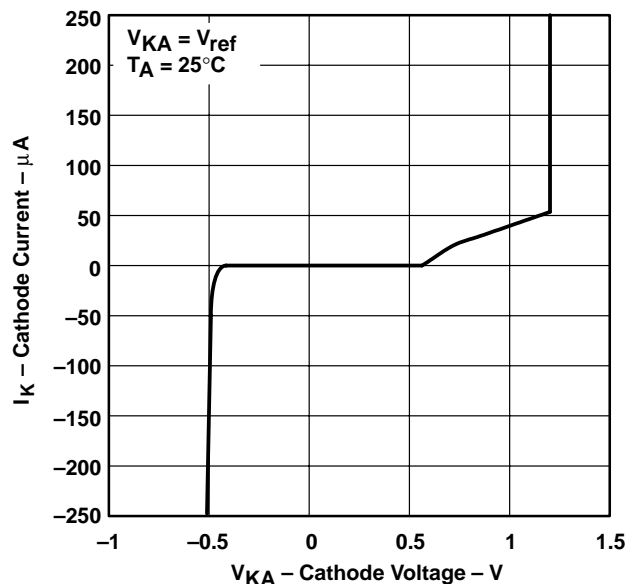


Figure 7

† Operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied.

TLV431, TLV431A

LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATORS

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PARAMETER MEASUREMENT INFORMATION†

OFF-STATE CATHODE CURRENT
vs
JUNCTION TEMPERATURE

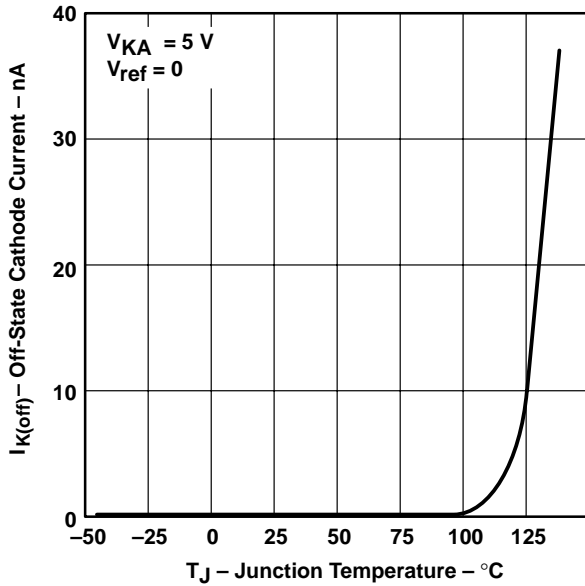


Figure 8

RATIO OF DELTA REFERENCE VOLTAGE
TO DELTA CATHODE VOLTAGE
vs
JUNCTION TEMPERATURE

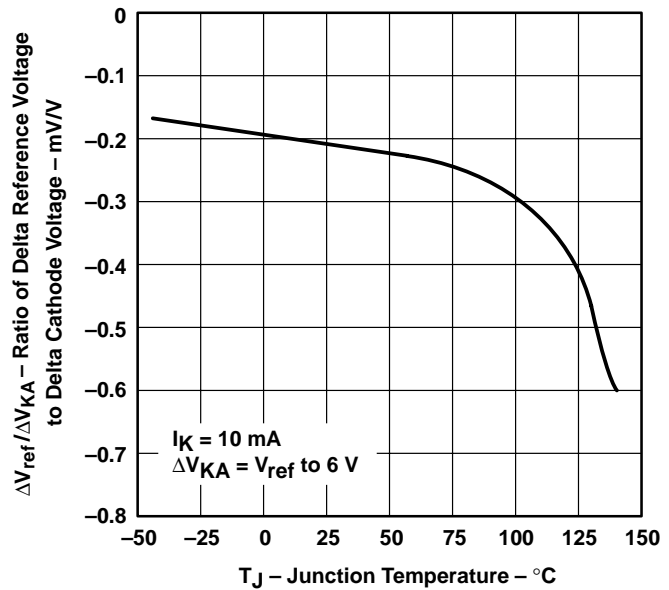


Figure 9

PERCENTAGE CHANGE IN V_{ref}
vs
OPERATING LIFE AT 55°C

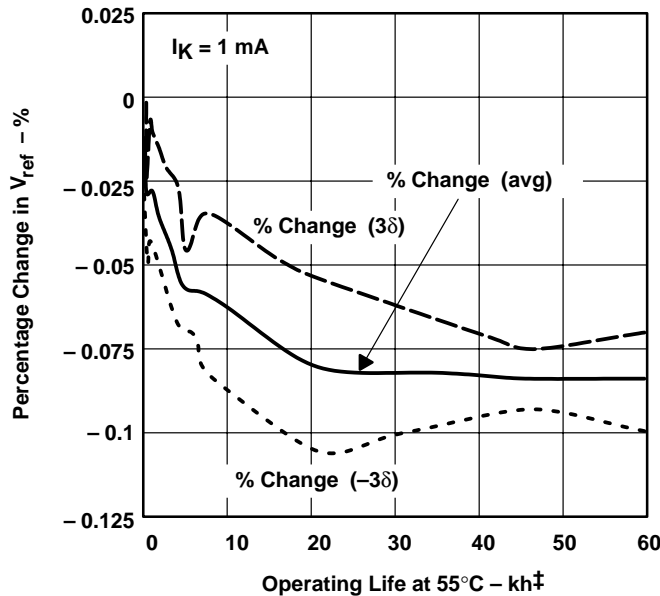


Figure 10

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

† Operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied.



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PARAMETER MEASUREMENT INFORMATION

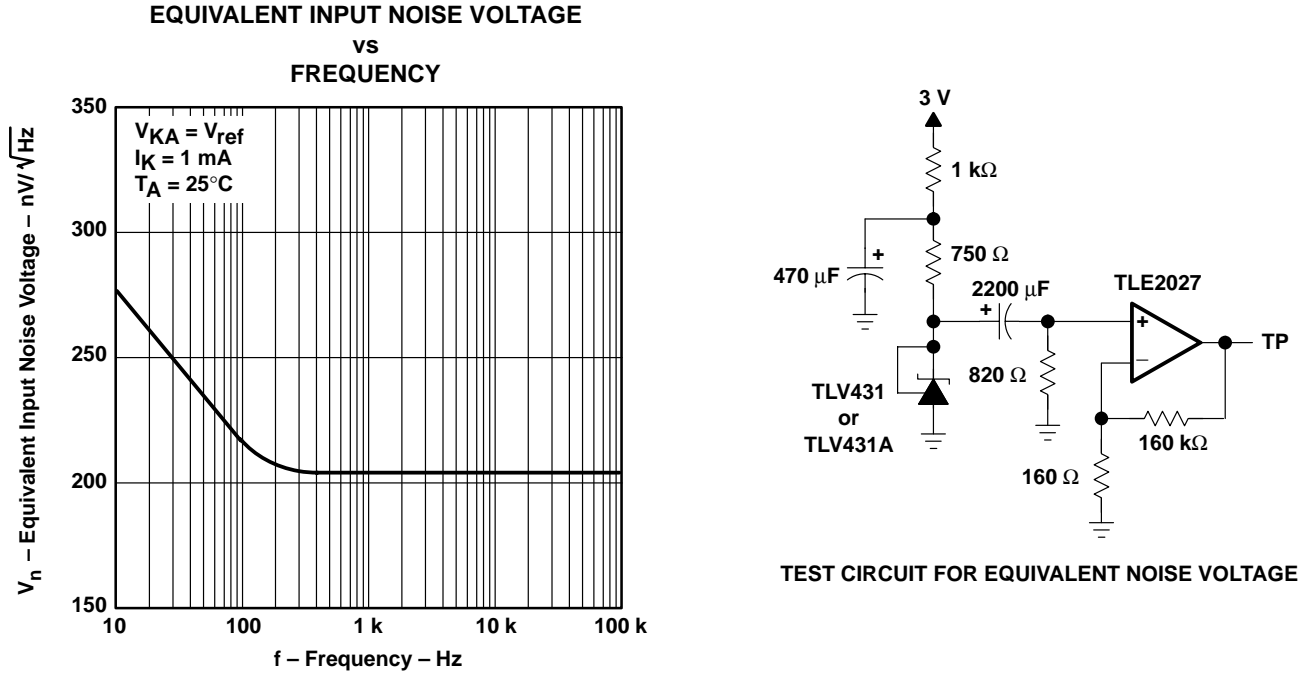


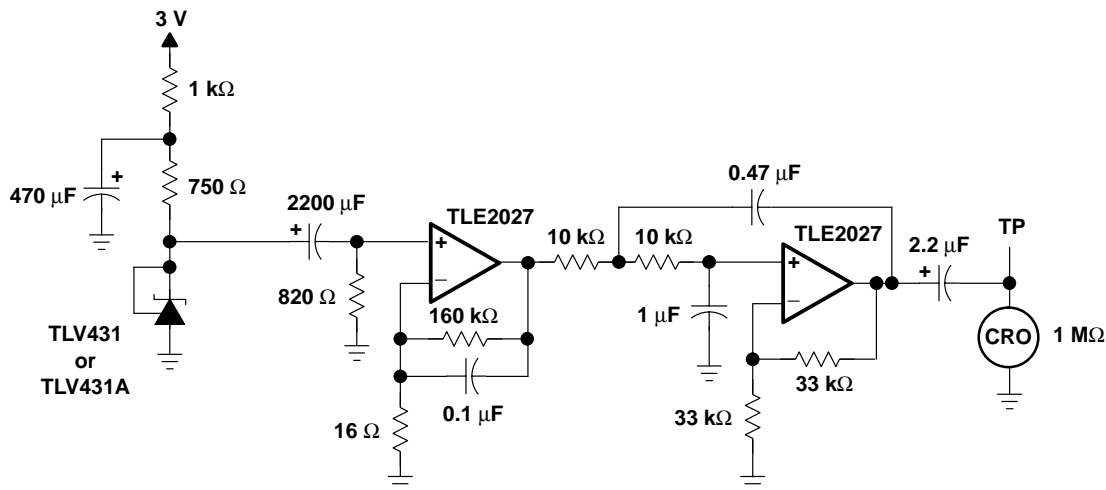
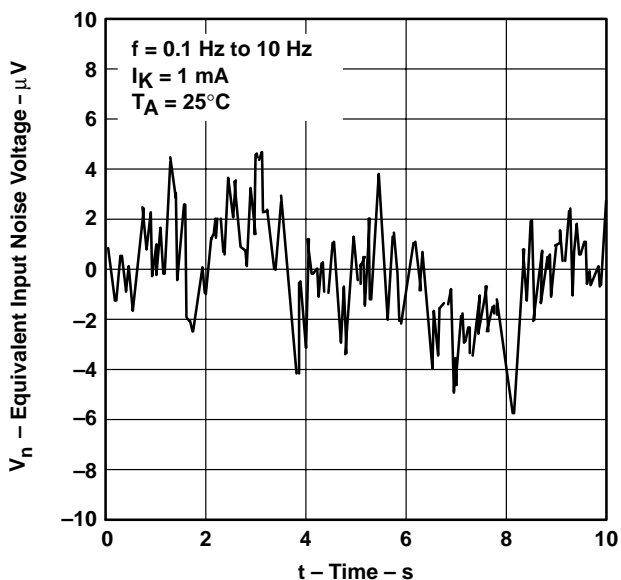
Figure 11

TLV431, TLV431A LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATORS

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PARAMETER MEASUREMENT INFORMATION

EQUIVALENT INPUT NOISE VOLTAGE OVER A 10-SECOND PERIOD



TEST CIRCUIT FOR 0.1-Hz TO 10-Hz EQUIVALENT NOISE VOLTAGE

Figure 12

PARAMETER MEASUREMENT INFORMATION

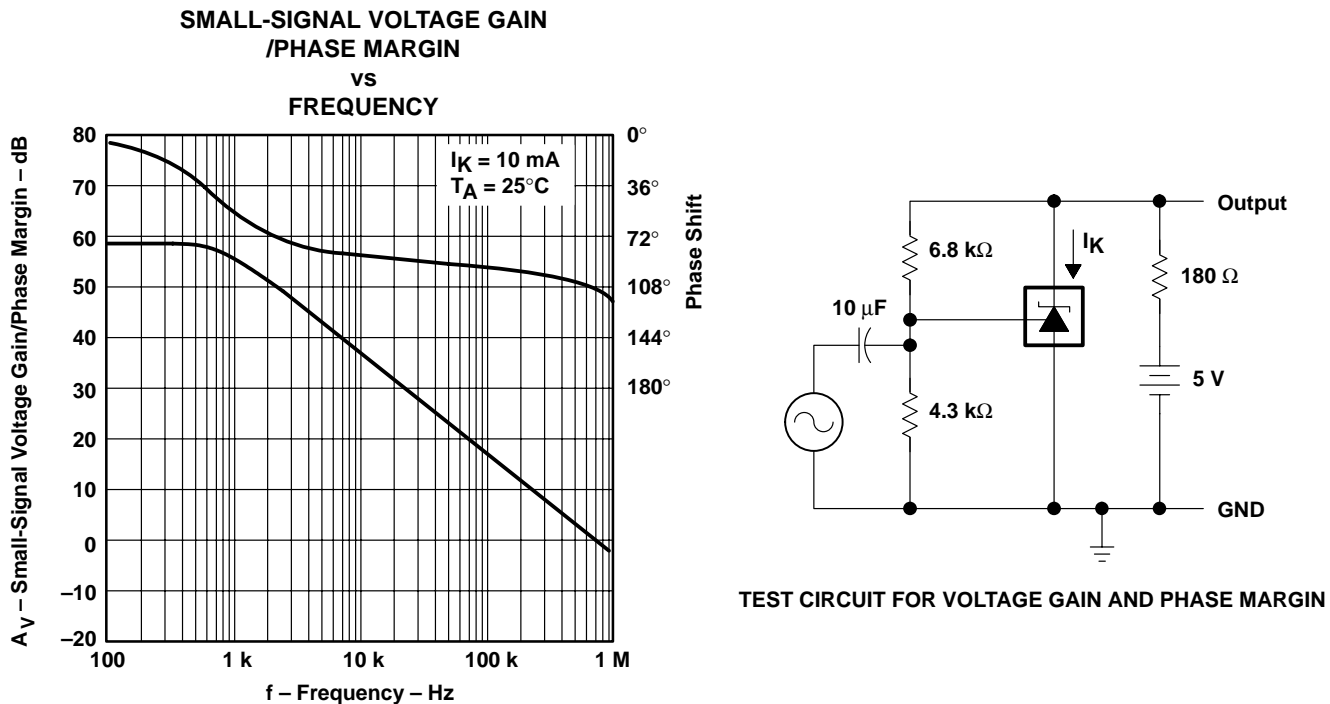


Figure 13

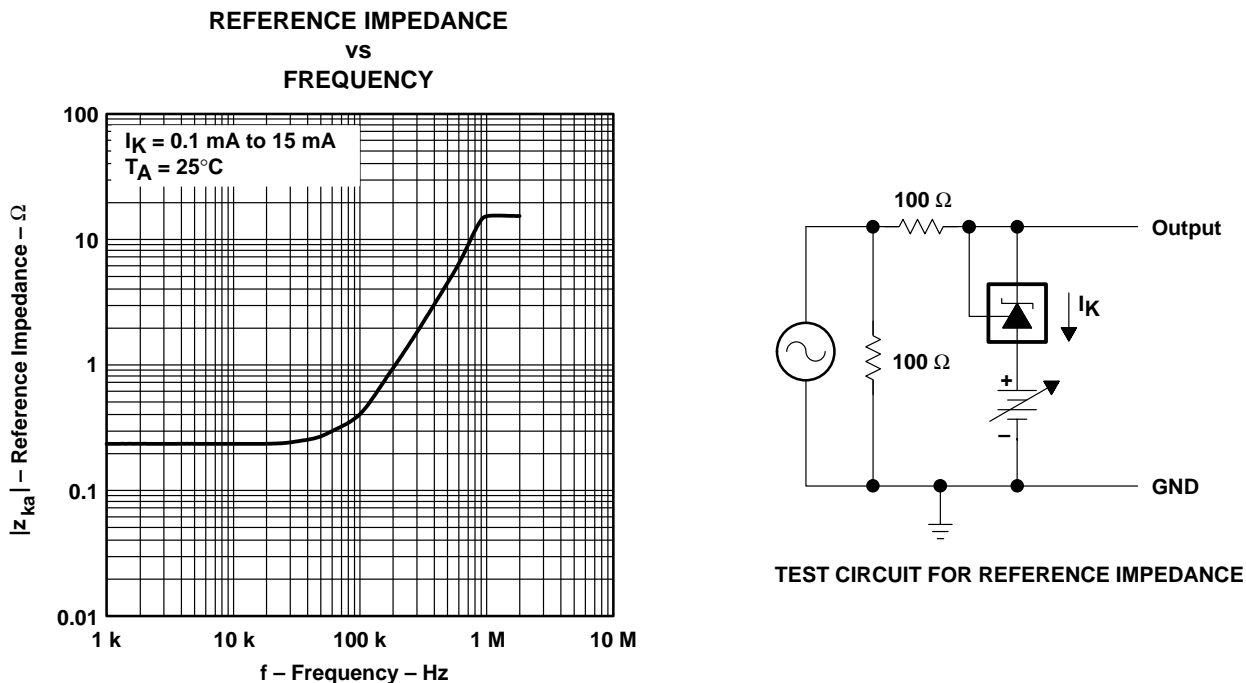


Figure 14

TLV431, TLV431A

LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATORS

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PARAMETER MEASUREMENT INFORMATION

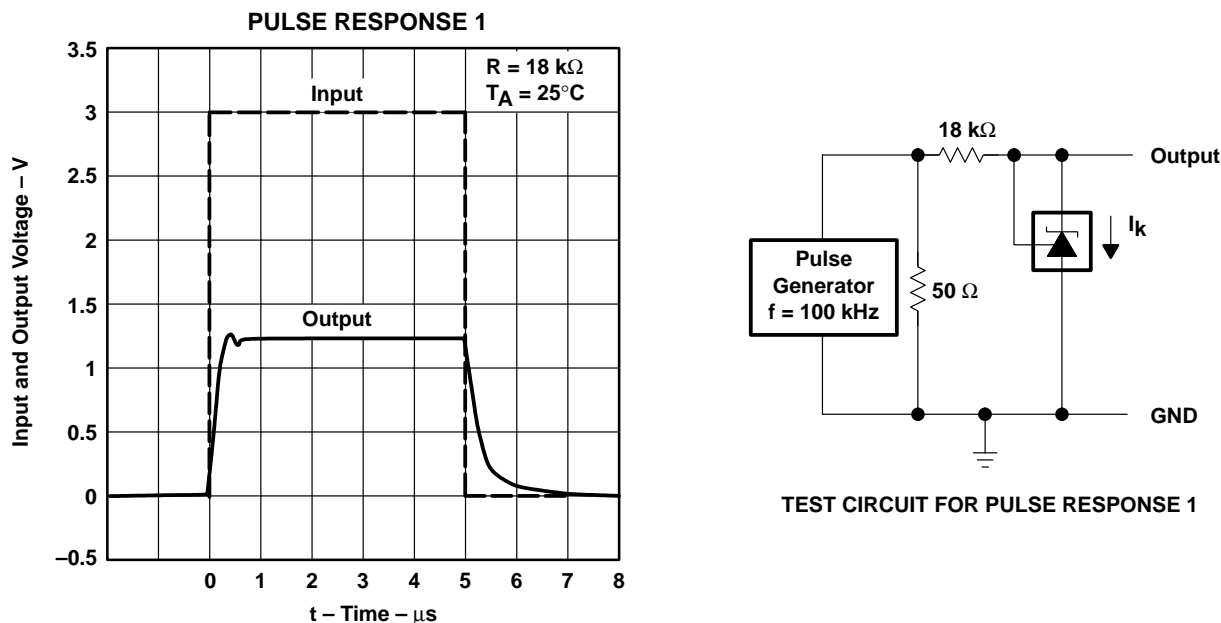


Figure 15

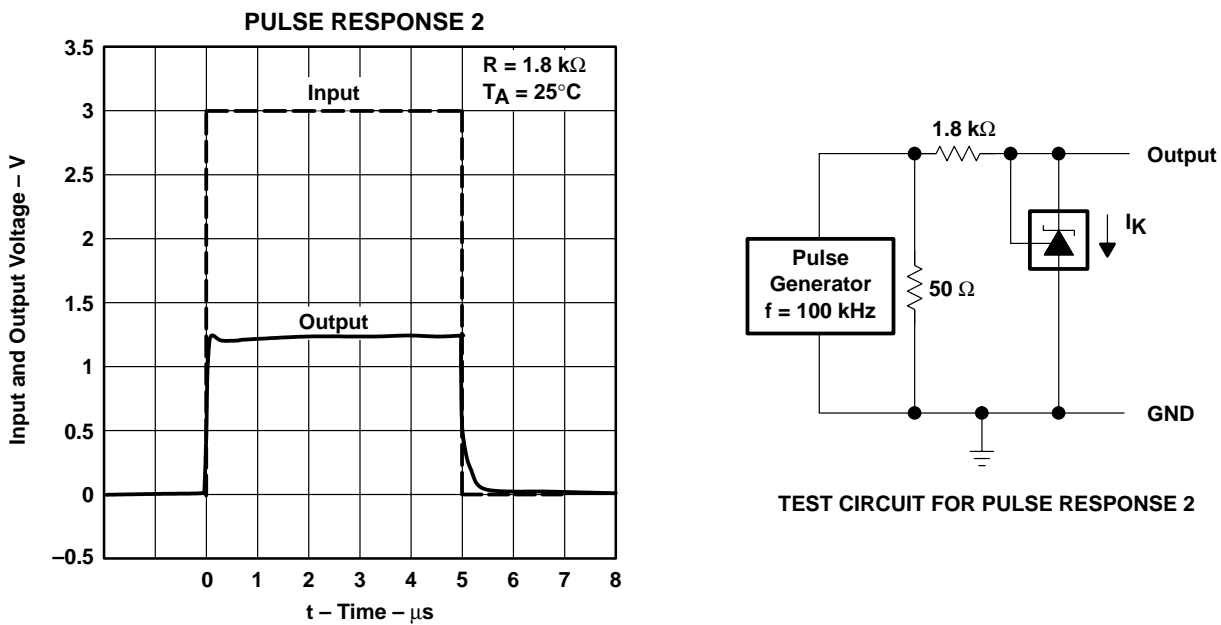
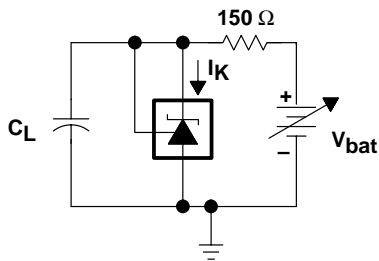
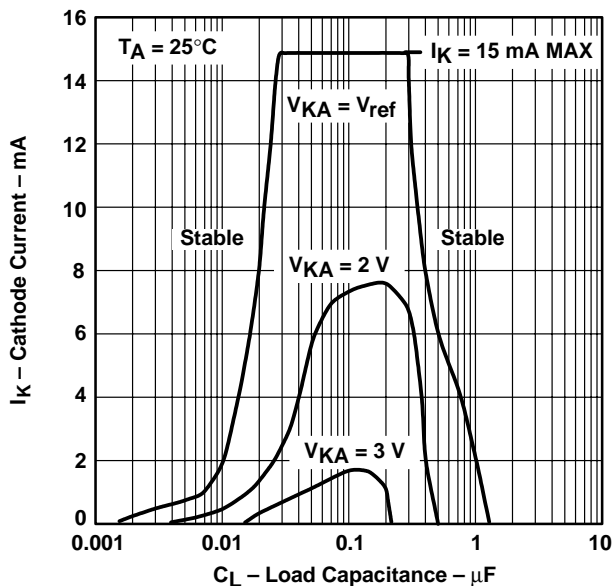


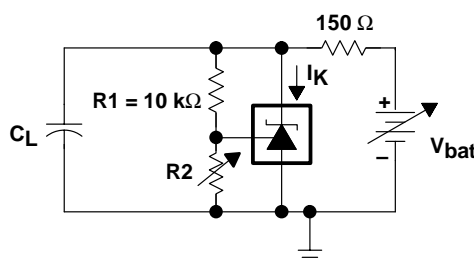
Figure 16

PARAMETER MEASUREMENT INFORMATION†

STABILITY BOUNDARY CONDITION‡



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



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

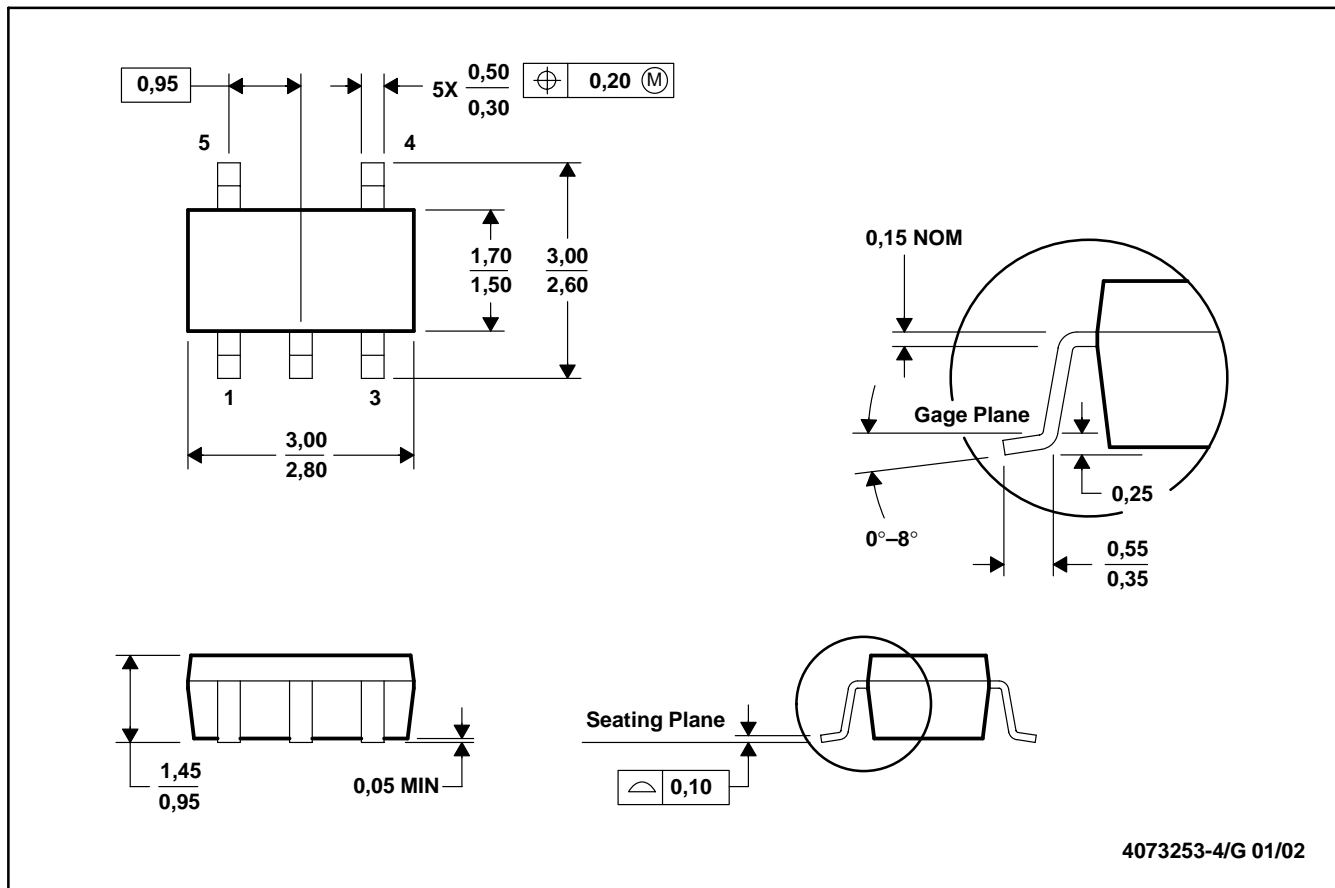
‡ The areas under the curves represent conditions that may cause the device to oscillate. For $V_{KA} = 2\text{-V}$ and 3-V curves, R_2 and V_{bat} were adjusted to establish the initial V_{KA} and I_K conditions with $C_L = 0$. V_{bat} and C_L then were adjusted to determine the ranges of stability.

Figure 17

† Operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied.

DBV (R-PDSO-G5)

PLASTIC SMALL-OUTLINE

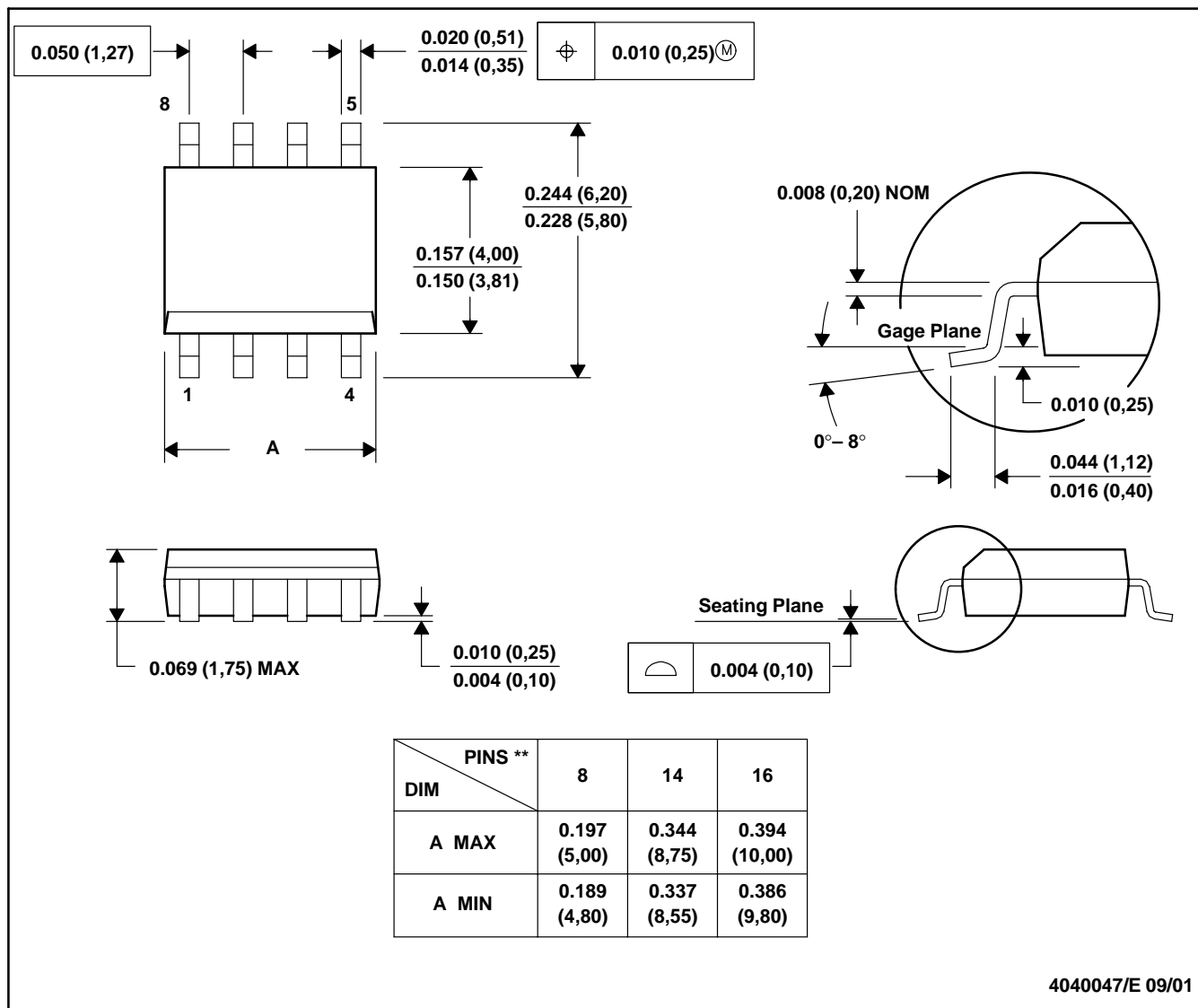


- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion.
 D. Falls within JEDEC MO-178

D (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

8 PINS SHOWN

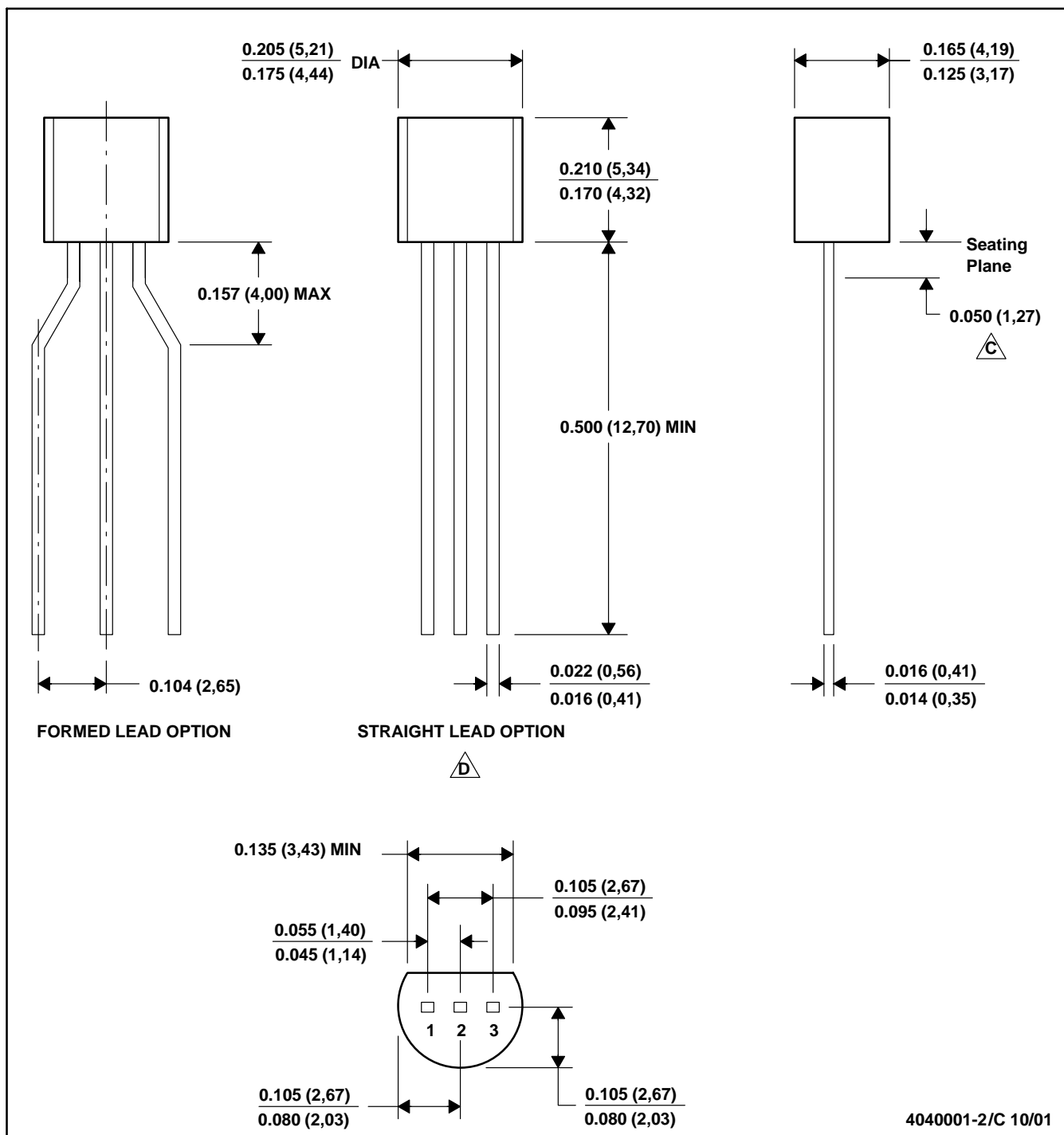


4040047/E 09/01

- NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion, not to exceed 0.006 (0,15).
 D. Falls within JEDEC MS-012

LP (O-PBCY-W3)

PLASTIC CYLINDRICAL PACKAGE



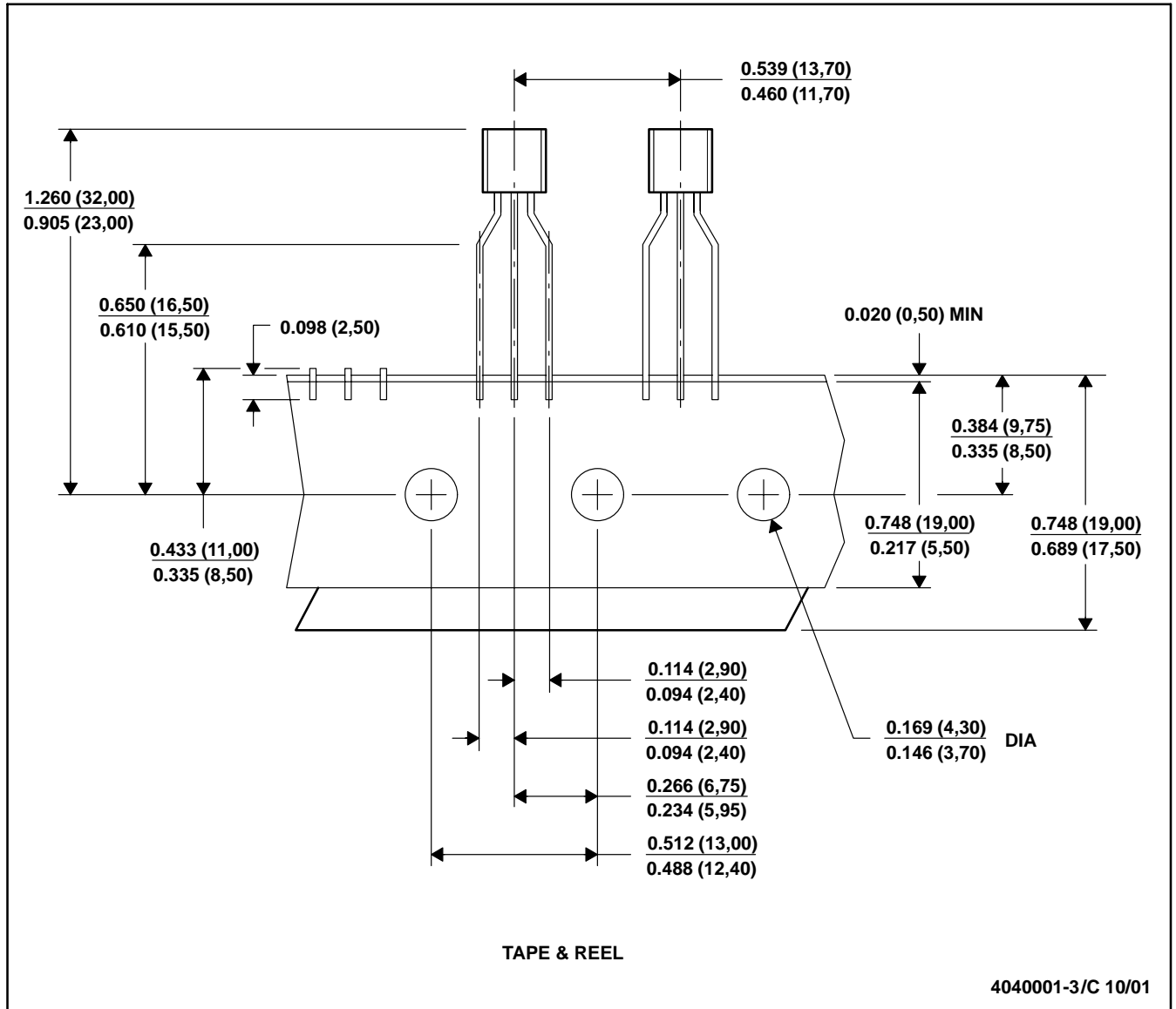
- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Lead dimensions are not controlled within this area
 - D. Falls within JEDEC TO-226 Variation AA (TO-226 replaces TO-92)
 - E. Shipping Method:
 Straight lead option available in bulk pack only.
 Formed lead option available in tape & reel or ammo pack.

MECHANICAL DATA

MSOT002A – OCTOBER 1994 – REVISED NOVEMBER 2001

LP (O-PBCY-W3)

PLASTIC CYLINDRICAL PACKAGE



- NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Tape and Reel information for the Format Lead Option package.

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