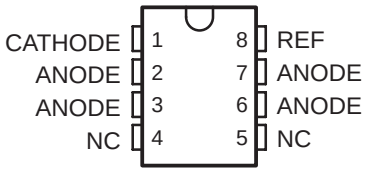
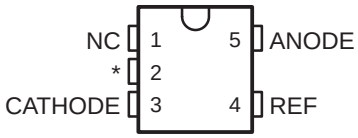
- **Low-Voltage Operation . . . V_{REF} = 1.24 V**
- **Adjustable Output Voltage, V_O = V_{REF} to 6 V**
- **Reference Voltage Tolerances at 25°C**
  - **0.5% for TLV431B**
  - **1% for TLV431A**
  - **1.5% for TLV431**
- **Typical Temperature Drift**
  - **4 mV (0°C to 70°C)**
  - **6 mV (–40°C to 85°C)**
  - **11 mV (–40°C to 125°C)**
- **Low Operational Cathode Current . . . 80 μA Typ**
- **0.25-Ω Typical Output Impedance**
- **Ultra-Small SC-70 Package Offers 40% Smaller Footprint Than SOT-23-3**
- **See TLVH431 and TLVH432 for**
  - **Wider V_{KA} (1.24 V to 18 V) and I_K (80 mA)**
  - **Additional SOT-89 Package**
  - **Multiple Pinouts for SOT-23-3 and SOT-89 Packages**

D (SOIC) PACKAGE
(TOP VIEW)

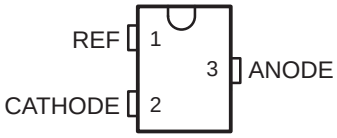


DBV (SOT-23-5) PACKAGE
(TOP VIEW)

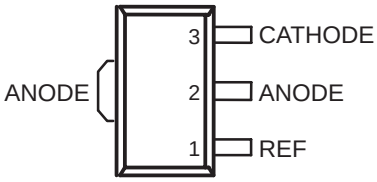


NC − No internal connection
* For TLV431, TLV431A: NC − No internal connection
* For TLV431B: Pin 2 is attached to Substrate and must be connected to ANODE or left open.

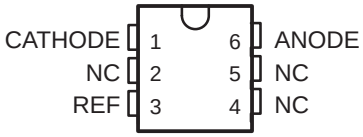
DBZ (SOT-23-3) PACKAGE
(TOP VIEW)



PK (SOT-89) PACKAGE
(TOP VIEW)

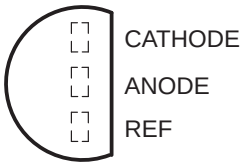


DCK (SC-70) PACKAGE
(TOP VIEW)



NC − No internal connection

LP (TO-92/TO-226) PACKAGE
(TOP VIEW)



description/ordering information

The TLV431 is a low-voltage 3-terminal adjustable voltage reference 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). These devices 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 is an ideal voltage reference 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 them excellent replacements for low-voltage Zener diodes in many applications, including on-board regulation and adjustable power supplies.

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.

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ORDERING INFORMATION

T_J	25°C V_{REF} TOLERANCE	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	0.5%	SC-70 (DCK)	Reel of 3000	TLV431BCDCKR	YE_
			Reel of 250	TLV431BCDCKT	
		SOT-23-5 (DBV)	Reel of 3000	TLV431BCDBVR	Y3GU
			Reel of 250	TLV431BCDBVT	
		SOT-23-3 (DBZ)	Reel of 3000	TLV431BCDBZR	Y3GU
			Reel of 250	TLV431BCDBZT	
		SOT-89 (PK)	Reel of 1000	TLV431BCPK	VE
		TO-92 (LP)	Bulk of 1000	TLV431BCLP	TV431B
			Reel of 2000	TLV431BCLPR	
	1%	SOT-23-5 (DBV)	Reel of 3000	TLV431ACDBVR	VAHC‡, YAC_§
			Reel of 250	TLV431ACDBVT	
		SOT-23-3 (DBZ)	Reel of 3000	TLV431ACDBZR	YAC_§
		TO-92 (LP)	Bulk of 1000	TLV431ACLP	V431AC
			Reel of 2000	TLV431ACLPR	
	1.5%	SOT-23-5 (DBV)	Reel of 3000	TLV431CDBVR	VAII‡, Y3I_§
			Reel of 250	TLV431CDBVT	
		SOT-23-3 (DBZ)	Reel of 3000	TLV431CDBZR	Y3I_§
		TO-92 (LP)	Bulk of 1000	TLV431CLP	V431C
			Reel of 2000	TLV431CLPR	

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.
‡ Possible top-side marking on units prior to August 16, 2004
§ DBV/DBZ/DCK: The actual top-side marking has one additional character that designates the assembly/test site.

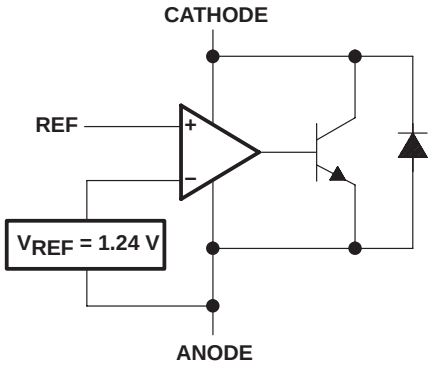
ORDERING INFORMATION (continued)

T_J	25°C V_{REF} TOLERANCE	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING‡
−40°C to 85°C	0.5%	SC-70 (DCK)	Reel of 3000	TLV431BIDCKR	YF_
			Reel of 250	TLV431BIDCKT	
		SOT-23-5 (DBV)	Reel of 3000	TLV431BIDBVR	Y3FU
			Reel of 250	TLV431BIDBVT	
		SOT-23-3 (DBZ)	Reel of 3000	TLV431BIDBZR	Y3FU
			Reel of 250	TLV431BIDBZT	
		TO-92 (LP)	Bulk of 1000	TLV431BILP	TY431B
			Reel of 2000	TLV431BILPR	
	1%	SOIC (D)	Tube of 75	TLV431AID	TY431A
			Reel of 2500	TLV431AIDR	
		SOT-23-5 (DBV)	Reel of 3000	TLV431AIDBVR	VAHI‡, YAI_§
			Reel of 250	TLV431AIDBVT	
		SOT-23-3 (DBZ)	Reel of 3000	TLV431AIDBZR	YAI_§
		SOT-89 (PK)	Reel of 1000	TLV431BIPK	VF
		TO-92 (LP)	Bulk of 1000	TLV431AILP	V431AI
			Ammo of 2000	TLV431AILPM	
			Reel of 2000	TLV431AILPR	
	1.5%	SOT-23-5 (DBV)	Reel of 3000	TLV431IDBVR	VAII‡, Y3I_§
			Reel of 250	TLV431IDBVT	
		SOT-23-3 (DBZ)	Reel of 3000	TLV431IDBZR	Y3I_§
		TO-92 (LP)	Bulk of 1000	TLV431ILP	V431I
			Reel of 2000	TLV431ILPR	
−40°C to 125°C	0.5%	SC-70 (DCK)	Reel of 3000	TLV431BQDCKR	YG_
			Reel of 250	TLV431BQDCKT	
		SOT-23-5 (DBV)	Reel of 3000	TLV431BQDBVR	Y3HU
			Reel of 250	TLV431BQDBVT	
		SOT-23-3 (DBZ)	Reel of 3000	TLV431BQDBZR	Y3HU
			Reel of 250	TLV431BQDBZT	
		SOT-89 (PK)	Reel of 1000	TLV431BQPK	V6
		TO-92 (LP)	Bulk of 1000	TLV431BQLP	TQ431B
			Reel of 2000	TLV431BQLPR	
	1%	SOT-89 (PK)	Reel of 1000	TLV431AQPK	VA
	1.5%	SOT-89 (PK)	Reel of 1000	TLV431QPK	VB

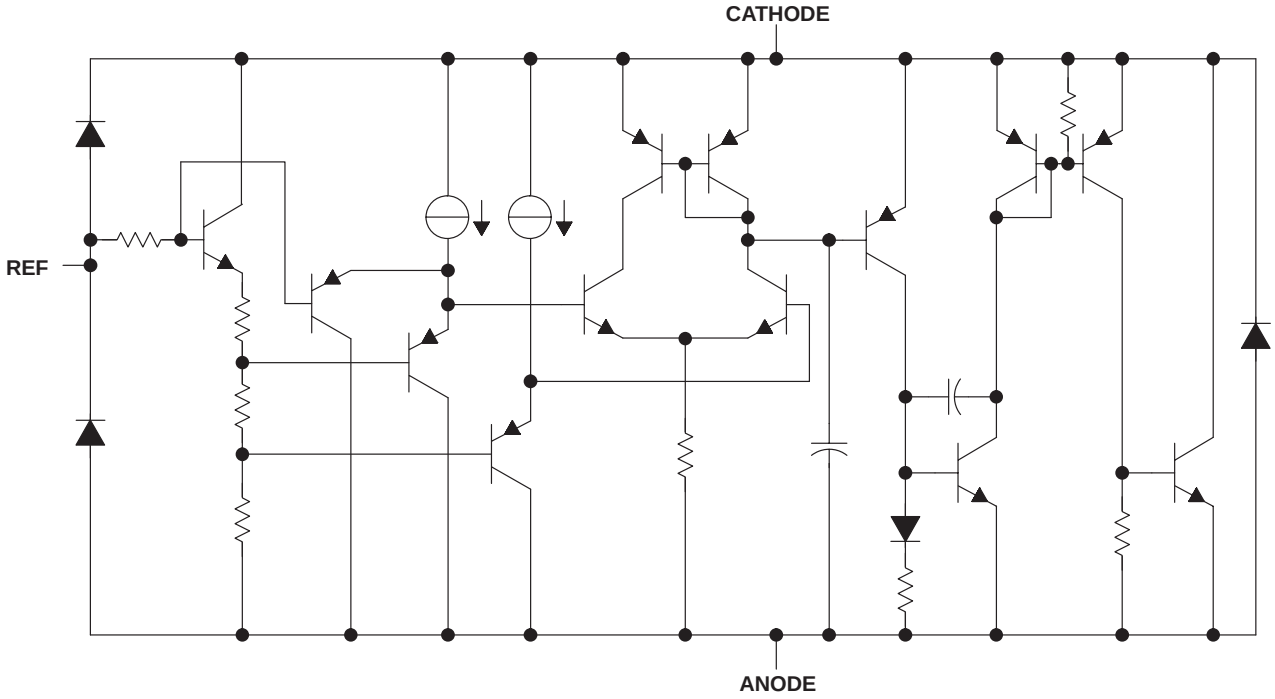
† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

‡ DBV/DBZ/DCK: The actual top-side marking has one additional character that designates the assembly/test site.

logic block diagram



equivalent schematic



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
DBZ package . . . . . 206°C/W
DCK package . . . . . 252°C/W
LP package . . . . . 140°C/W
PK package . . . . . 52°C/W
Operating virtual junction temperature . . . . . 150°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
V_{KA}	Cathode voltage		V_{REF}	6	V
I_K	Cathode current		0.1	15	mA
T_A	Operating free-air temperature range	TLV431_C	0	70	°C
		TLV431_I	−40	85	
		TLV431_Q	−40	125	

TLV431 electrical characteristics at 25°C free-air temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			TLV431			UNIT
					MIN	TYP	MAX	
V_{REF}	Reference voltage	$V_{KA} = V_{REF}$, I_K = 10 mA	T_A = 25°C		1.222	1.24	1.258	V
			T_A = full range (see Note 4 and Figure 1)	TLV431C	1.21		1.27	
				TLV431I	1.202		1.278	
				TLV431Q	1.194		1.286	
$V_{REF(dev)}$	V_{REF} deviation over full temperature range (see Note 4)	$V_{KA} = V_{REF}$, I_K = 10 mA (see Note 4 and Figure 1)		TLV431C		4	12	mV
				TLV431I		6	20	
				TLV431Q		11	31	
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	Ratio of V_{REF} change in cathode voltage change	$V_{KA} = V_{REF}$ to 6 V, I_K = 10 mA (see Figure 2)				−1.5	−2.7	mV/V
I_{ref}	Reference terminal current	I_K = 10 mA, R1 = 10 kΩ, R2 = open (see Figure 2)				0.15	0.5	µA
$I_{ref(dev)}$	I_{ref} deviation over full temperature range (see Note 4)	I_K = 10 mA, R1 = 10 kΩ, R2 = open (see Note 4 and Figure 2)		TLV431C		0.05	0.3	µA
				TLV431I		0.1	0.4	
				TLV431Q		0.15	0.5	
$I_{K(min)}$	Minimum cathode current for regulation	$V_{KA} = V_{REF}$ (see Figure 1)		TLV431C/I		55	80	µA
				TLV431Q		55	100	
$I_{K(off)}$	Off-state cathode current	V_{REF} = 0, V_{KA} = 6 V (see Figure 3)				0.001	0.1	µA
$\lvert z_{KA} \rvert$	Dynamic impedance (see Note 5)	$V_{KA} = V_{REF}$, f ≤ 1 kHz, I_K = 0.1 mA to 15 mA (see Figure 1)				0.25	0.4	Ω

NOTES: 4. Full temperature ranges are −40°C to 125°C for TLV431Q, −40°C to 85°C for TLV431I, and 0°C to 70°C for TLV431C.

5. 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:

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

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

αV_{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 $|z_{ka}| = \frac{\Delta V_{KA}}{\Delta I_K}$

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

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

TLV431A electrical characteristics at 25°C free-air temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			TLV431A			UNIT
					MIN	TYP	MAX	
V_{REF}	Reference voltage	$V_{KA} = V_{REF}$, I_K = 10 mA	T_A = 25°C		1.228	1.24	1.252	V
			T_A = full range (see Note 3 and Figure 1)	TLV431AC	1.221		1.259	
				TLV431AI	1.215		1.265	
				TLV431AQ	1.209		1.271	
$V_{REF(dev)}$	V_{REF} deviation over full temperature range (see Note 4)	$V_{KA} = V_{REF}$, I_K = 10 mA (see Note 3 and Figure 1)		TLV431AC		4	12	mV
				TLV431AI		6	20	
				TLV431AQ		11	31	
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	Ratio of V_{REF} change in cathode voltage change	$V_{KA} = V_{REF}$ to 6 V, I_K = 10 mA (see Figure 2)				−1.5	−2.7	mV/V
I_{ref}	Reference terminal current	I_K = 10 mA, R1 = 10 kΩ, R2 = open (see Figure 2)				0.15	0.5	µA
$I_{ref(dev)}$	I_{ref} deviation over full temperature range (see Note 4)	I_K = 10 mA, R1 = 10 kΩ, R2 = open (see Note 3 and Figure 2)		TLV431AC		0.05	0.3	µA
				TLV431AI		0.1	0.4	
				TLV431AQ		0.15	0.5	
$I_{K(min)}$	Minimum cathode current for regulation	$V_{KA} = V_{REF}$ (see Figure 1)		TLV431AC/AI		55	80	µA
				TLV431AQ		55	100	
$I_{K(off)}$	Off-state cathode current	V_{REF} = 0, V_{KA} = 6 V (see Figure 3)				0.001	0.1	µA
$\|z_{KA}\|$	Dynamic impedance (see Note 5)	$V_{KA} = V_{REF}$, f ≤ 1 kHz, I_K = 0.1 mA to 15 mA (see Figure 1)				0.25	0.4	Ω

NOTES: 3. Full temperature ranges are −40°C to 125°C for TLV431AQ, −40°C to 85°C for TLV431AI, and 0°C to 70°C for TLV431AC.

4. 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:

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

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

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

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

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

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

TLV431B electrical characteristics at 25°C free-air temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			TLV431B			UNIT
					MIN	TYP	MAX	
V_{REF}	Reference voltage	$V_{KA} = V_{REF}$, I_K = 10 mA	T_A = 25°C		1.234	1.24	1.246	V
			T_A = full range (see Note 3 and Figure 1)	TLV431BC	1.227		1.253	
				TLV431BI	1.224		1.259	
				TLV431BQ	1.221		1.265	
$V_{REF(dev)}$	V_{REF} deviation over full temperature range (see Note 4)	$V_{KA} = V_{REF}$, I_K = 10 mA (see Note 3 and Figure 1)		TLV431BC		4	12	mV
				TLV431BI		6	20	
				TLV431BQ		11	31	
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	Ratio of V_{REF} change in cathode voltage change	$V_{KA} = V_{REF}$ to 6 V, I_K = 10 mA (see Figure 2)				−1.5	−2.7	mV/V
I_{ref}	Reference terminal current	I_K = 10 mA, R1 = 10 kΩ, R2 = open (see Figure 2)				0.1	0.5	µA
$I_{ref(dev)}$	I_{ref} deviation over full temperature range (see Note 4)	I_K = 10 mA, R1 = 10 kΩ, R2 = open (see Note 3 and Figure 2)		TLV431BC		0.05	0.3	µA
				TLV431BI		0.1	0.4	
				TLV431BQ		0.15	0.5	
$I_{K(min)}$	Minimum cathode current for regulation	$V_{KA} = V_{REF}$ (see Figure 1)				55	100	µA
$I_{K(off)}$	Off-state cathode current	V_{REF} = 0, V_{KA} = 6 V (see Figure 3)				0.001	0.1	µA
$\|z_{KA}\|$	Dynamic impedance (see Note 5)	$V_{KA} = V_{REF}$, f ≤ 1 kHz, I_K = 0.1 mA to 15 mA (see Figure 1)				0.25	0.4	Ω

NOTES: 3. Full temperature ranges are −40°C to 125°C for TLV431BQ, −40°C to 85°C for TLV431BI, and 0°C to 70°C for TLV431BC.

4. 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:

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

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

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

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

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

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

PARAMETER MEASUREMENT INFORMATION

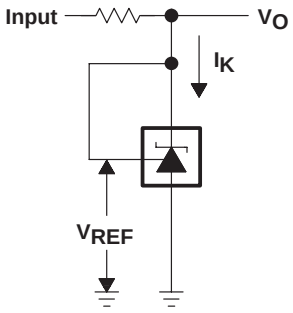


Figure 1. Test Circuit for $V_{KA} = V_{REF}$, $V_O = V_{KA} = V_{REF}$

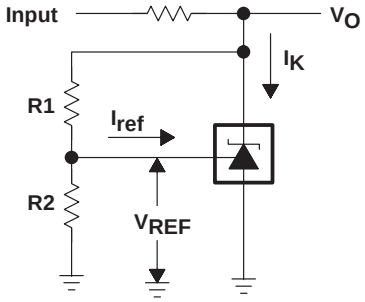


Figure 2. Test Circuit for $V_{KA} > V_{REF}$, $V_O = V_{KA} = V_{REF} \times (1 + R1/R2) + I_{ref} \times R1$

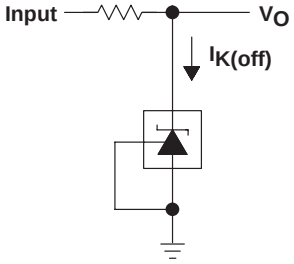


Figure 3. Test Circuit for $I_{K(off)}$

PARAMETER MEASUREMENT INFORMATION†

REFERENCE VOLTAGE vs JUNCTION TEMPERATURE

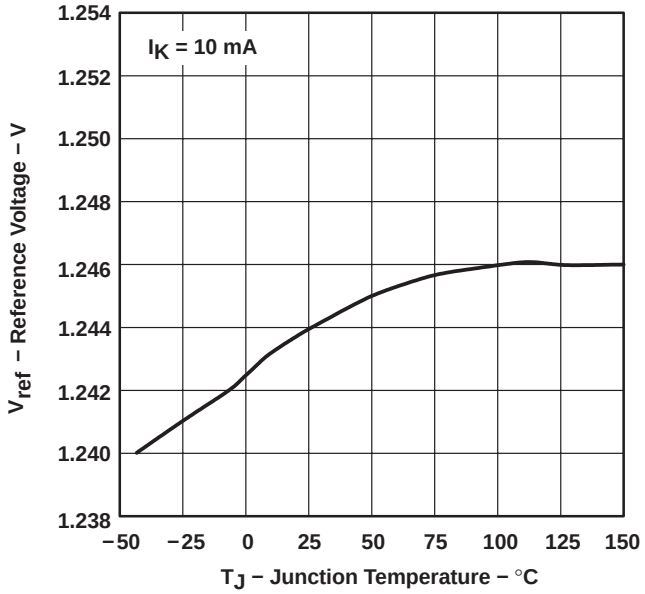


Figure 4

REFERENCE INPUT CURRENT vs JUNCTION TEMPERATURE (for TLV431 and TLV431A)

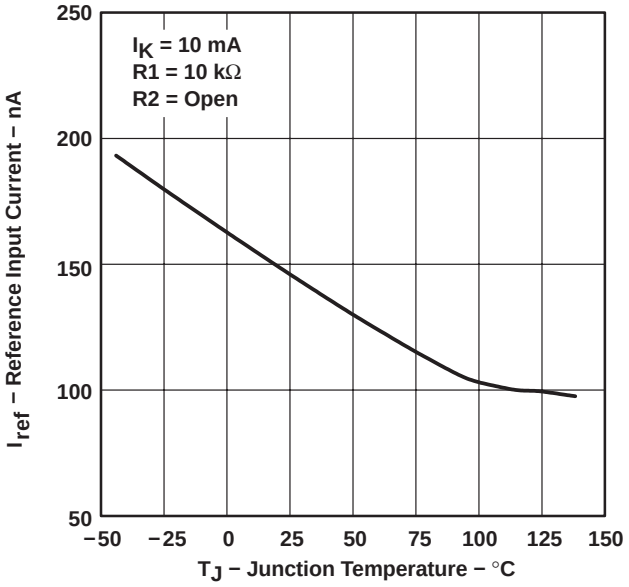


Figure 5A

REFERENCE INPUT CURRENT vs JUNCTION TEMPERATURE (for TLV431B)

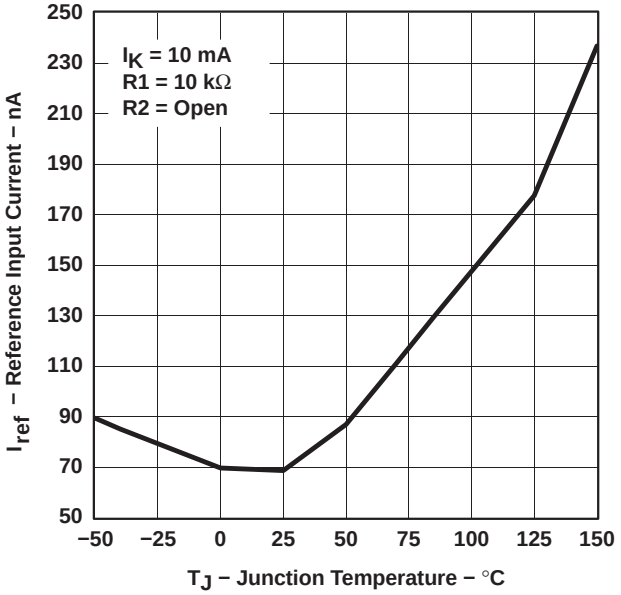


Figure 5B

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

PARAMETER MEASUREMENT INFORMATION†

CATHODE CURRENT vs CATHODE VOLTAGE

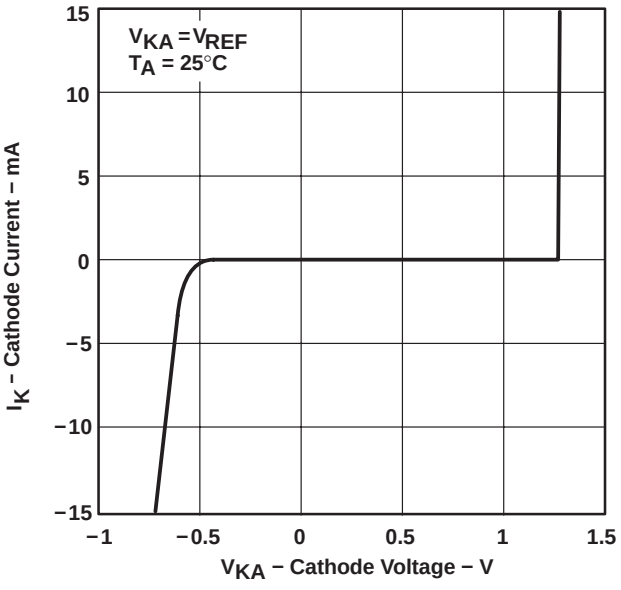


Figure 6

CATHODE CURRENT vs CATHODE VOLTAGE

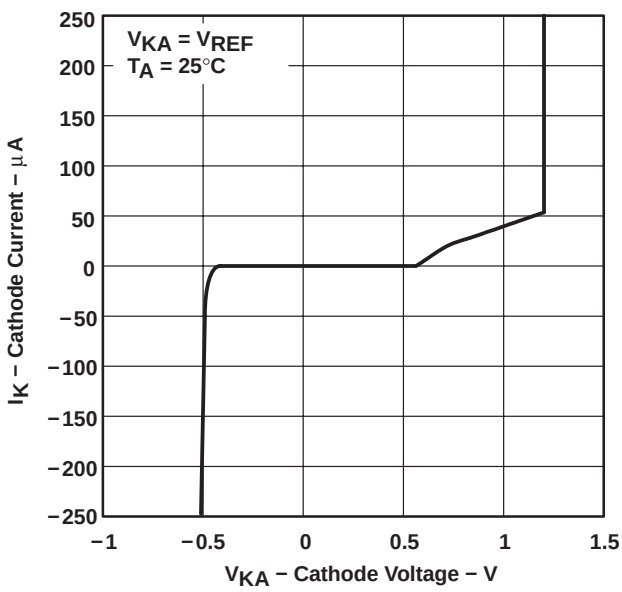


Figure 7

OFF-STATE CATHODE CURRENT vs JUNCTION TEMPERATURE (for TLV431 and TLV431A)

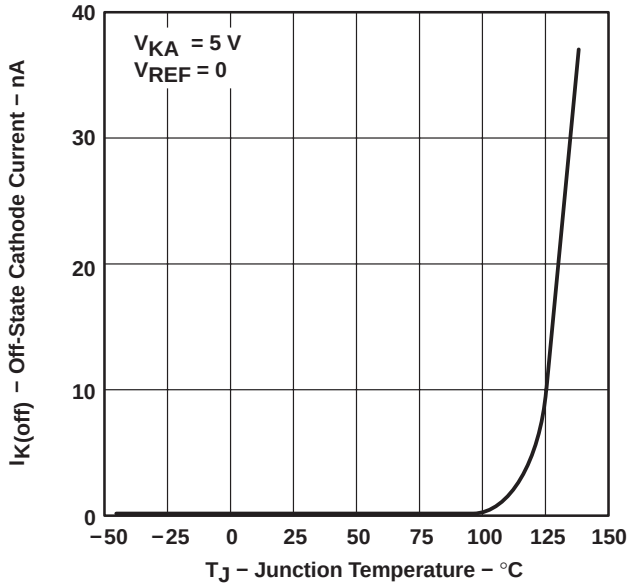


Figure 8A

OFF-STATE CATHODE CURRENT vs JUNCTION TEMPERATURE (for TLV431B)

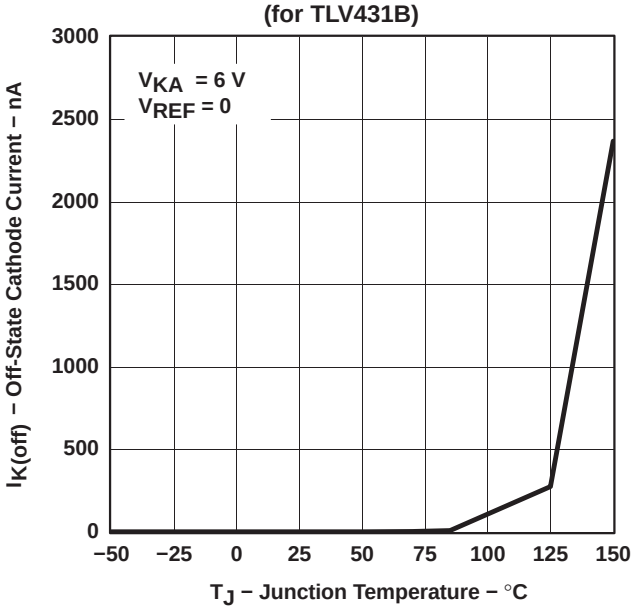


Figure 8B

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

PARAMETER MEASUREMENT INFORMATION†

RATIO OF DELTA REFERENCE VOLTAGE TO DELTA CATHODE VOLTAGE vs JUNCTION TEMPERATURE (for TLV431 and TLV431A)

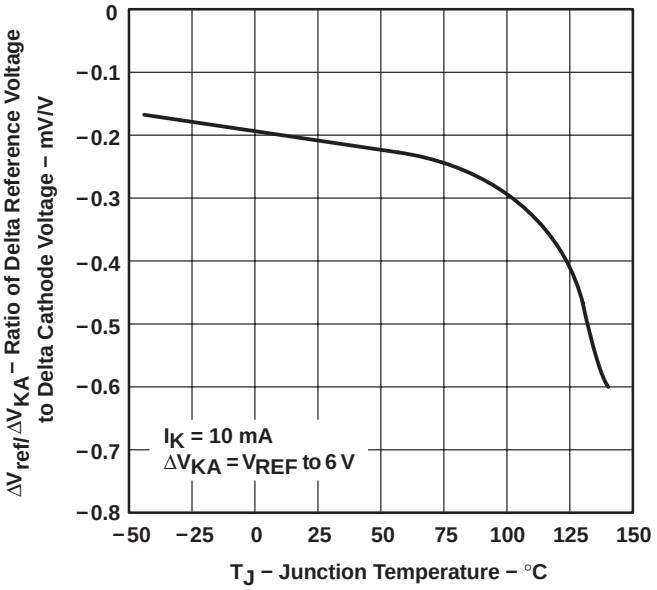


Figure 9A

RATIO OF DELTA REFERENCE VOLTAGE TO DELTA CATHODE VOLTAGE vs JUNCTION TEMPERATURE (for TLV431B)

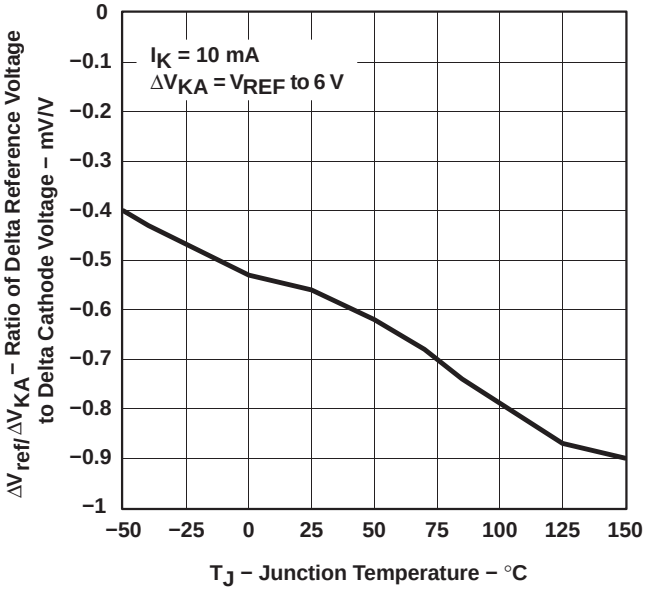
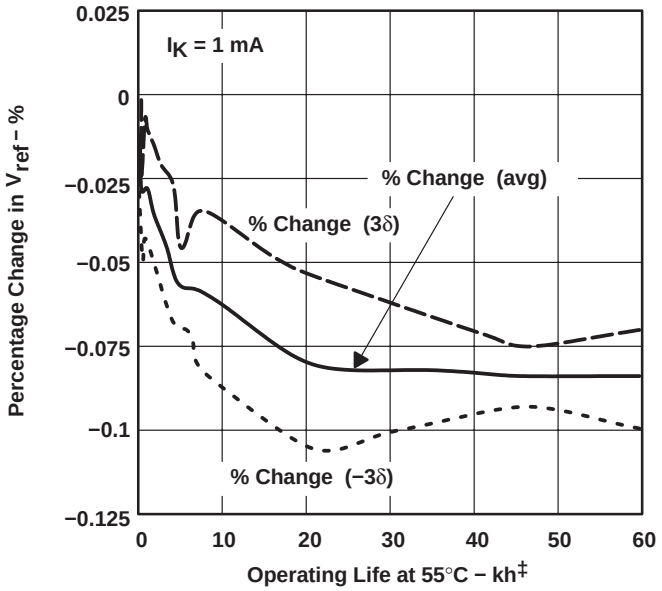


Figure 9B

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



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

Figure 10

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

PARAMETER MEASUREMENT INFORMATION

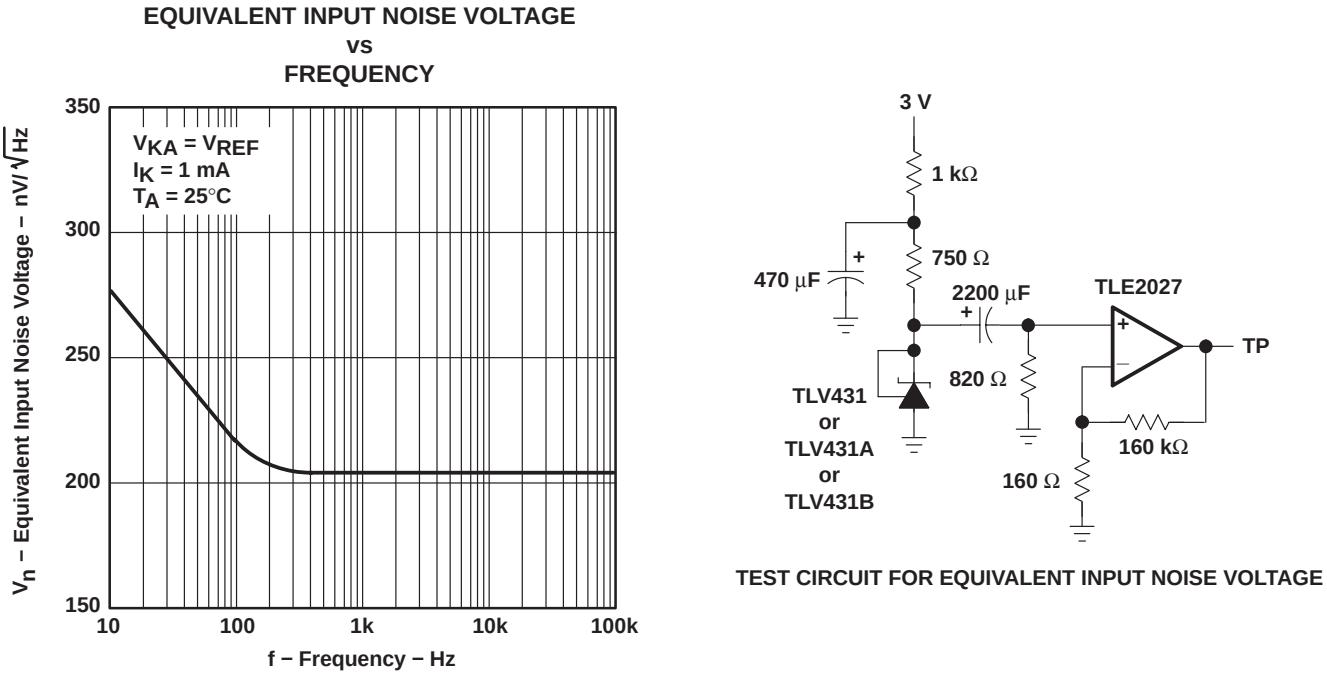
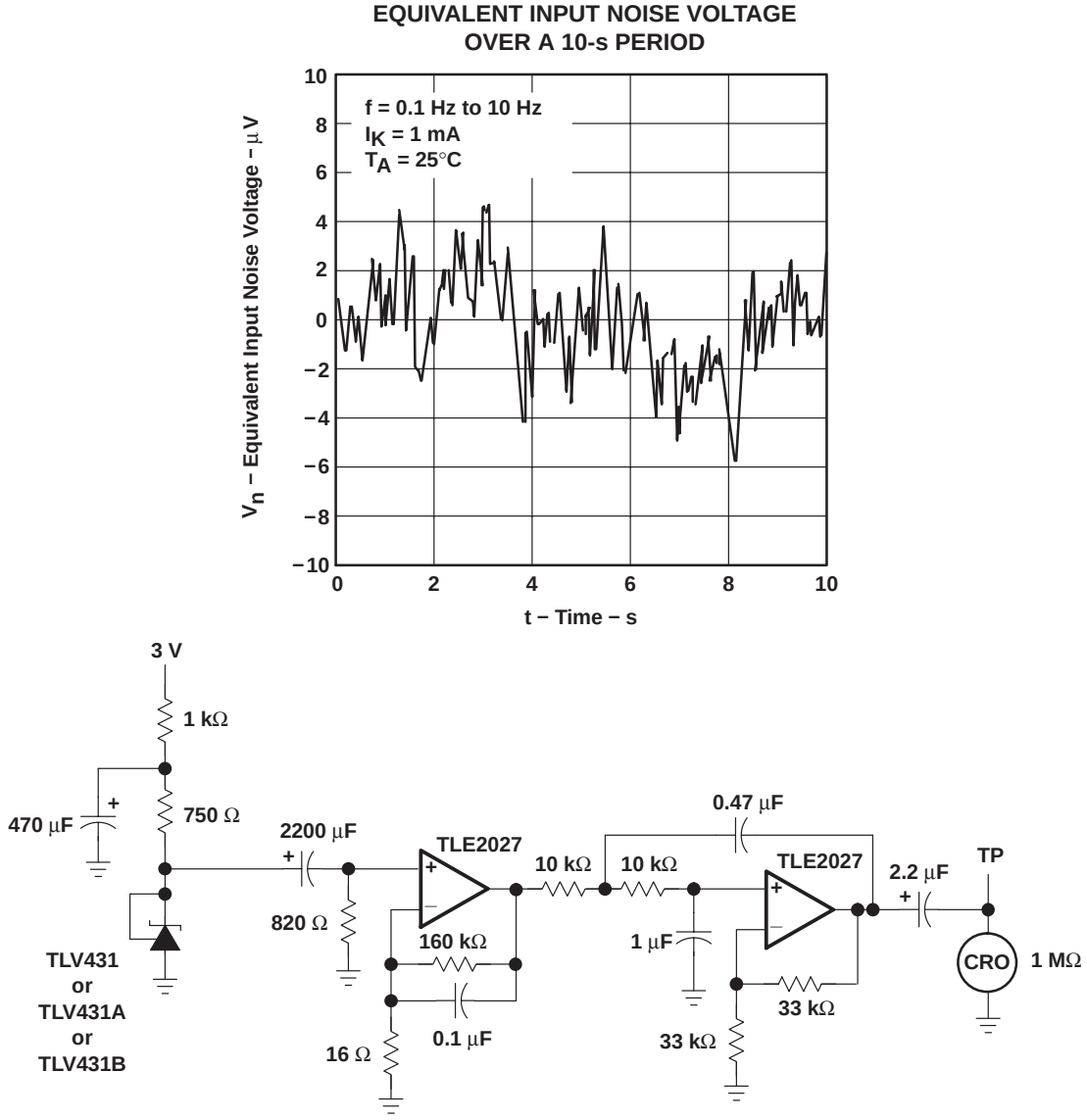


Figure 11

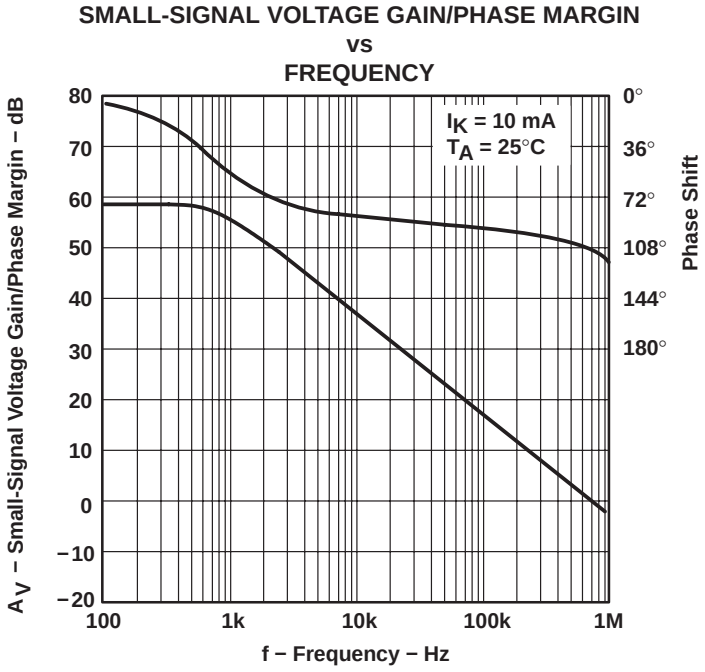
PARAMETER MEASUREMENT INFORMATION

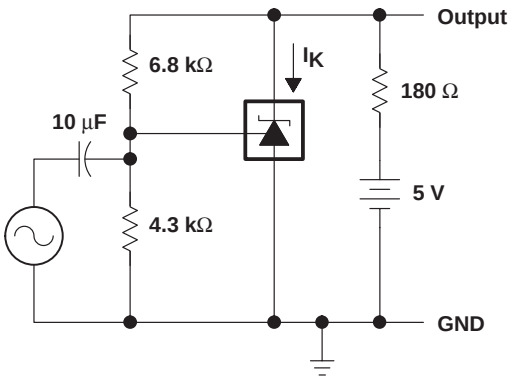


TEST CIRCUIT FOR 0.1-Hz TO 10-Hz EQUIVALENT NOISE VOLTAGE

Figure 12

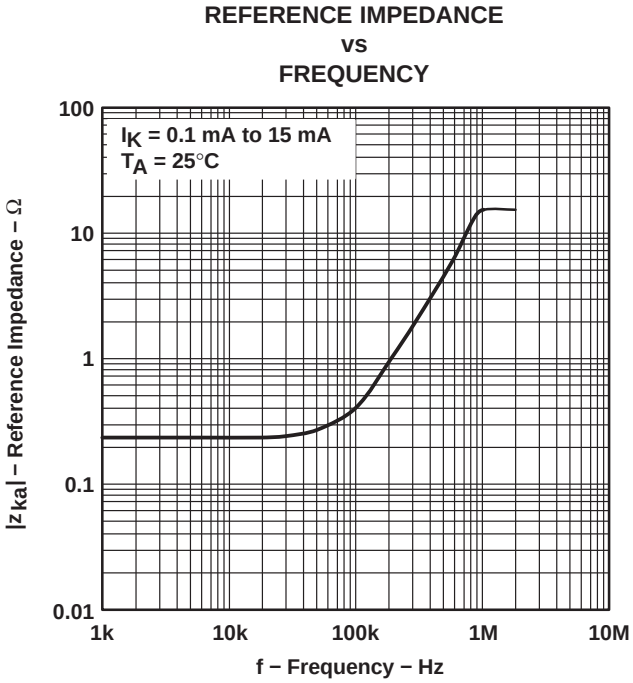
PARAMETER MEASUREMENT INFORMATION

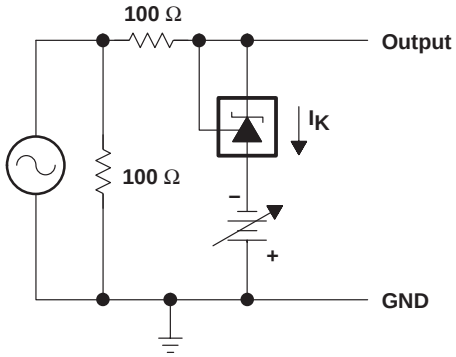




TEST CIRCUIT FOR VOLTAGE GAIN
AND PHASE MARGIN

Figure 13





TEST CIRCUIT FOR REFERENCE IMPEDANCE

Figure 14

PARAMETER MEASUREMENT INFORMATION

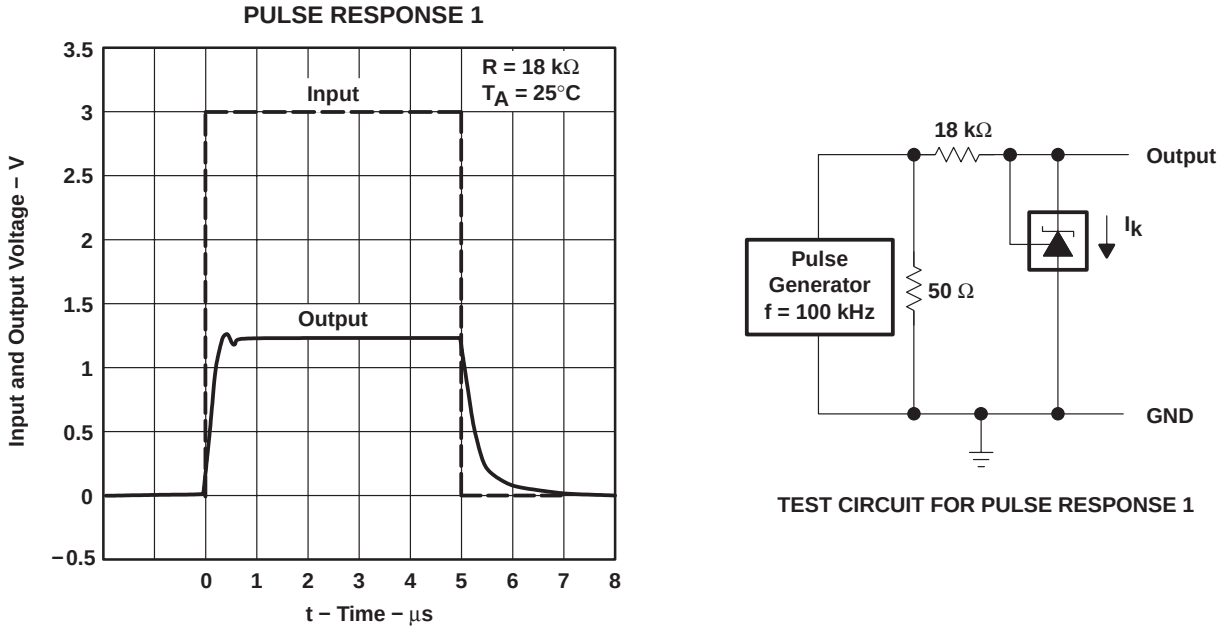


Figure 15

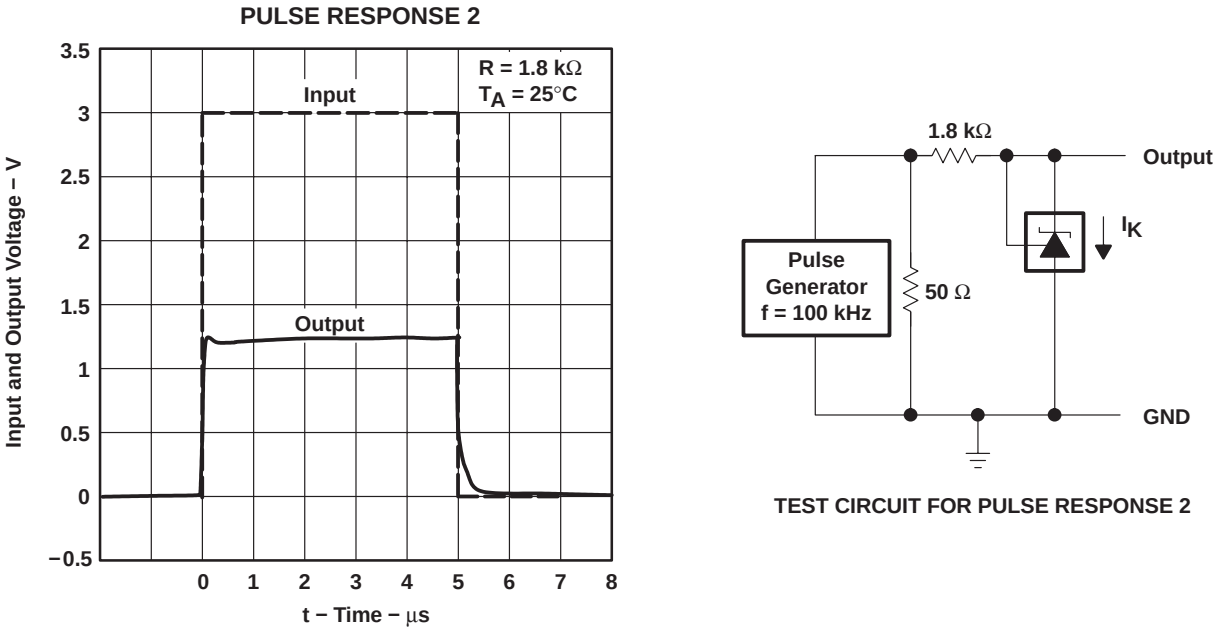
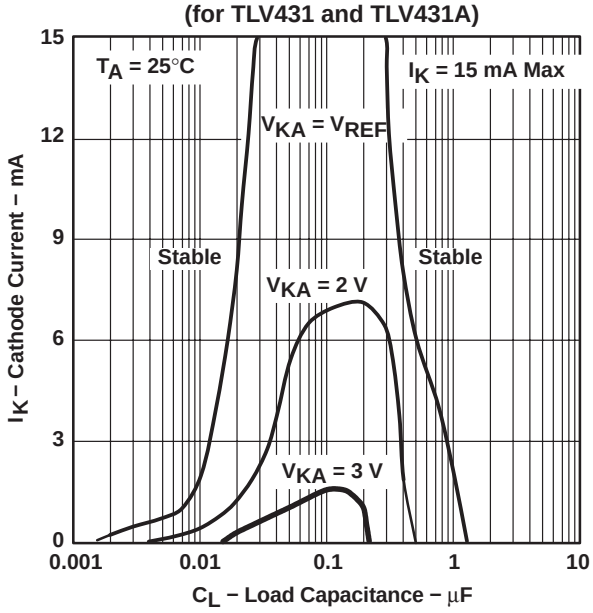


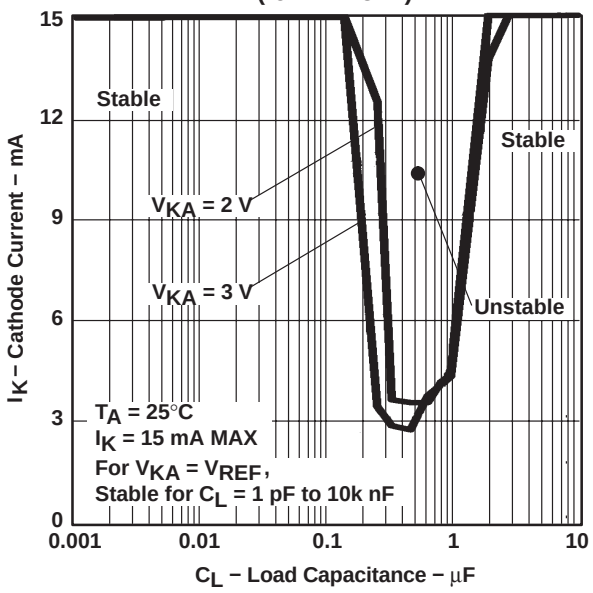
Figure 16

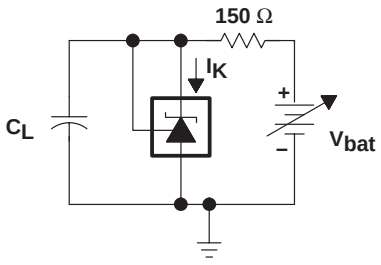
PARAMETER MEASUREMENT INFORMATION†

STABILITY BOUNDARY CONDITION‡ (for TLV431 and TLV431A)

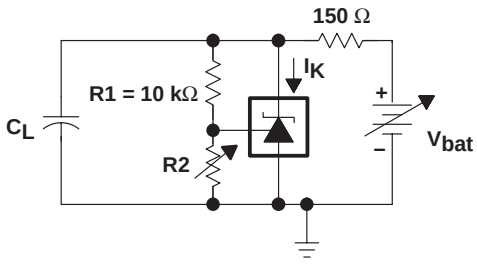


STABILITY BOUNDARY CONDITION‡ (for TLV431B)





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 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.

APPLICATION INFORMATION

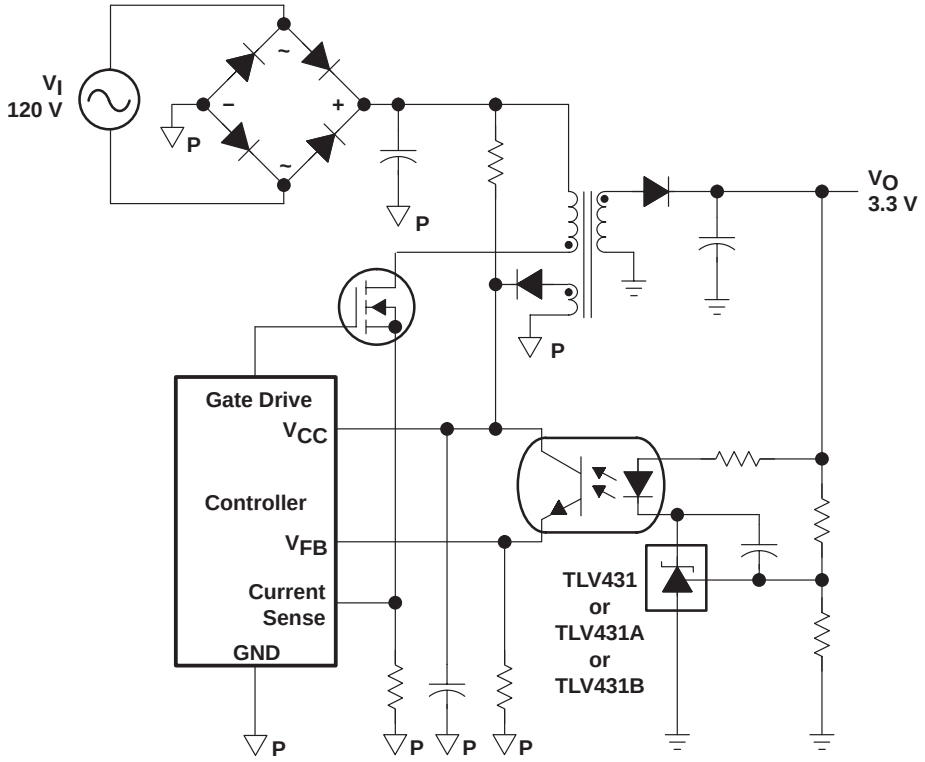


Figure 18. Flyback With Isolation Using TLV431, TLV431A, or TLV431B as Voltage Reference and Error Amplifier

Figure 18 shows the TLV431, TLV431A, or TLV431B used in a 3.3-V isolated flyback supply. Output voltage V_O can be as low as reference voltage V_{REF} (1.24 V ± 1%). The output of the regulator, plus the forward voltage drop of the optocoupler LED (1.24 + 1.4 = 2.64 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 topology shown in Figure 18.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
TLV431ACDBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431ACDBVRE4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431ACDBVRG4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431ACDBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431ACDBVTE4	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431ACDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431ACDBZRG4	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431ACLP	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431ACLPE3	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431ACLPR	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431ACLPRE3	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431AID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431AIDBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431AIDBVRE4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431AIDBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431AIDBVTE4	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431AIDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431AIDBZRG4	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431AIDE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431AIDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431AIDRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431AILP	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431AILPE3	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431AILPM	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431AILPME3	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
TLV431AILPR	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431AILPRE3	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431AQPK	ACTIVE	SOT-89	PK	3	1000	Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1YEAR
TLV431AQPKG3	ACTIVE	SOT-89	PK	3	1000	Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1YEAR
TLV431BCDBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BCDBVRE4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BCDBVRG4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BCDBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BCDBVTE4	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BCDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BCDBZRG4	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BCDBZT	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BCDBZTG4	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BCDCKR	ACTIVE	SC70	DCK	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BCDCKRE4	ACTIVE	SC70	DCK	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BCDCKT	ACTIVE	SC70	DCK	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BCDCKTE4	ACTIVE	SC70	DCK	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BCLP	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431BCLPE3	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431BCLPR	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431BCLPRE3	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431BCPK	ACTIVE	SOT-89	PK	3	1000	Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1YEAR
TLV431BCPKG3	ACTIVE	SOT-89	PK	3	1000	Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1YEAR
TLV431BIDBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BIDBVRE4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BIDBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
TLV431BIDBVTE4	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BIDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BIDBZRG4	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BIDBZT	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BIDBZTG4	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BIDCKR	ACTIVE	SC70	DCK	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BIDCKRE4	ACTIVE	SC70	DCK	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BIDCKT	ACTIVE	SC70	DCK	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BIDCKTE4	ACTIVE	SC70	DCK	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BILP	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431BILPE3	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431BILPR	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431BILPRE3	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431BIPK	ACTIVE	SOT-89	PK	3	1000	Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1YEAR
TLV431BIPKG3	ACTIVE	SOT-89	PK	3	1000	Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1YEAR
TLV431BQDBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BQDBVRE4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BQDBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BQDBVTE4	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BQDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BQDBZRG4	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BQDBZT	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BQDBZTG4	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BQDCKR	ACTIVE	SC70	DCK	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BQDCKRE4	ACTIVE	SC70	DCK	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BQDCKT	ACTIVE	SC70	DCK	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
TLV431BQDCKTE4	ACTIVE	SC70	DCK	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431BQLP	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431BQLPE3	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431BQLPR	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431BQLPRE3	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431BQPK	ACTIVE	SOT-89	PK	3	1000	Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1YEAR
TLV431BQPKG3	ACTIVE	SOT-89	PK	3	1000	Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1YEAR
TLV431CDBV	OBSOLETE	SOT-23	DBV	5		TBD	Call TI	Call TI
TLV431CDBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431CDBVRE4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431CDBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431CDBVTE4	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431CDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431CDBZRG4	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431CLP	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431CLPE3	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431CLPM	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431CLPME3	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431CLPR	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431CLPRE3	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431IDBV	OBSOLETE	SOT-23	DBV	5		TBD	Call TI	Call TI
TLV431IDBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431IDBVRE4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431IDBVRG4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431IDBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431IDBVTE4	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431IDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS &	CU NIPDAU	Level-1-260C-UNLIM

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
						no Sb/Br)		
TLV431IDBZRG4	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV431ILP	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431ILPE3	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431ILPR	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431ILPRE3	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type
TLV431QPK	ACTIVE	SOT-89	PK	3	1000	Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1YEAR
TLV431QPKG3	ACTIVE	SOT-89	PK	3	1000	Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1YEAR

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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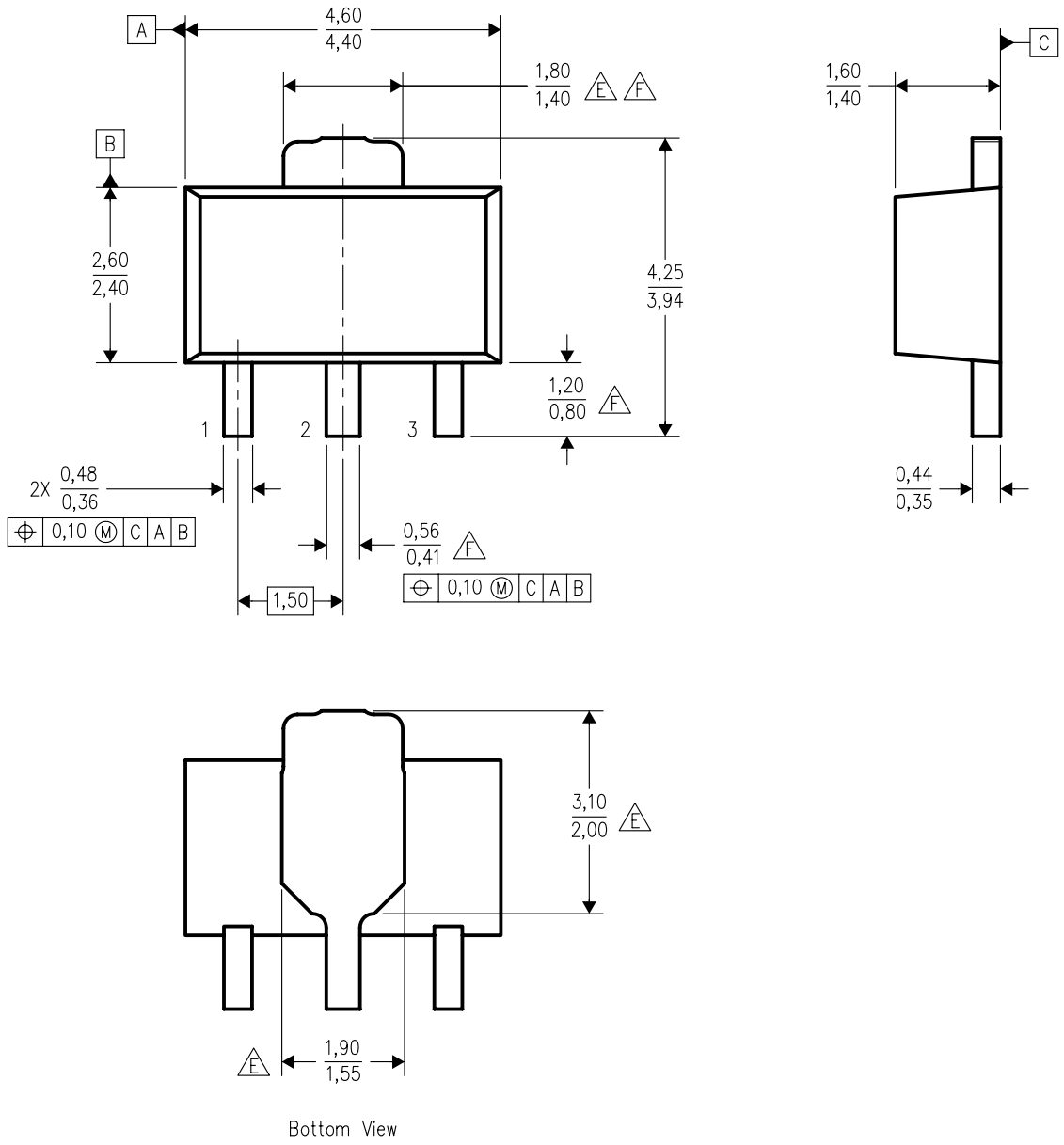
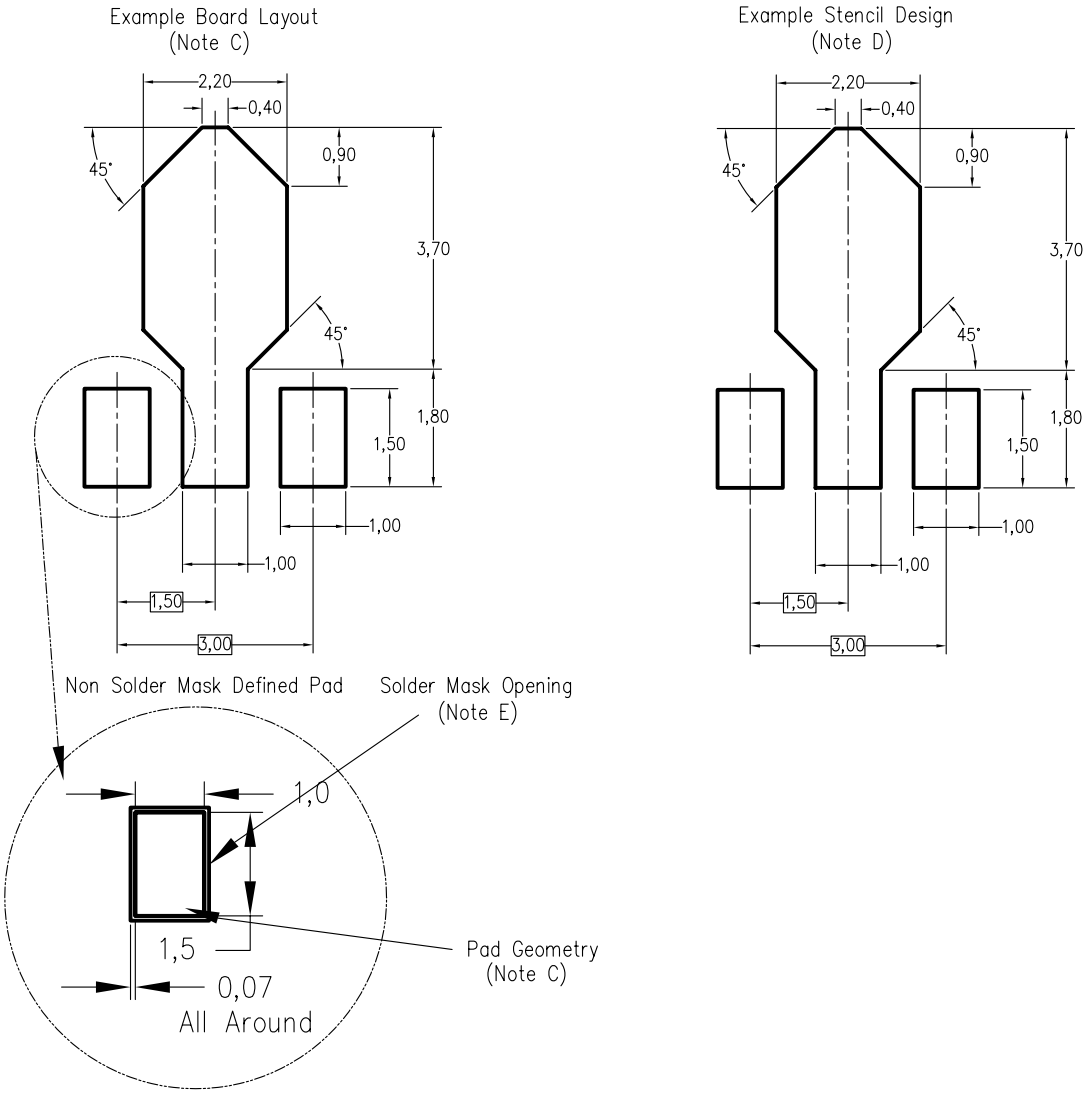
PK (R–PSSO–F3) PLASTIC SINGLE–IN–LINE PACKAGE



4040234/D 02/2006

NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. The center lead is in electrical contact with the tab.
D. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion not to exceed 0.15 per side.
E. Thermal pad contour optional within these dimensions.
F. Falls within JEDEC TO–243 variation AA, except minimum lead length, pin 2 minimum lead width, minimum tab width.

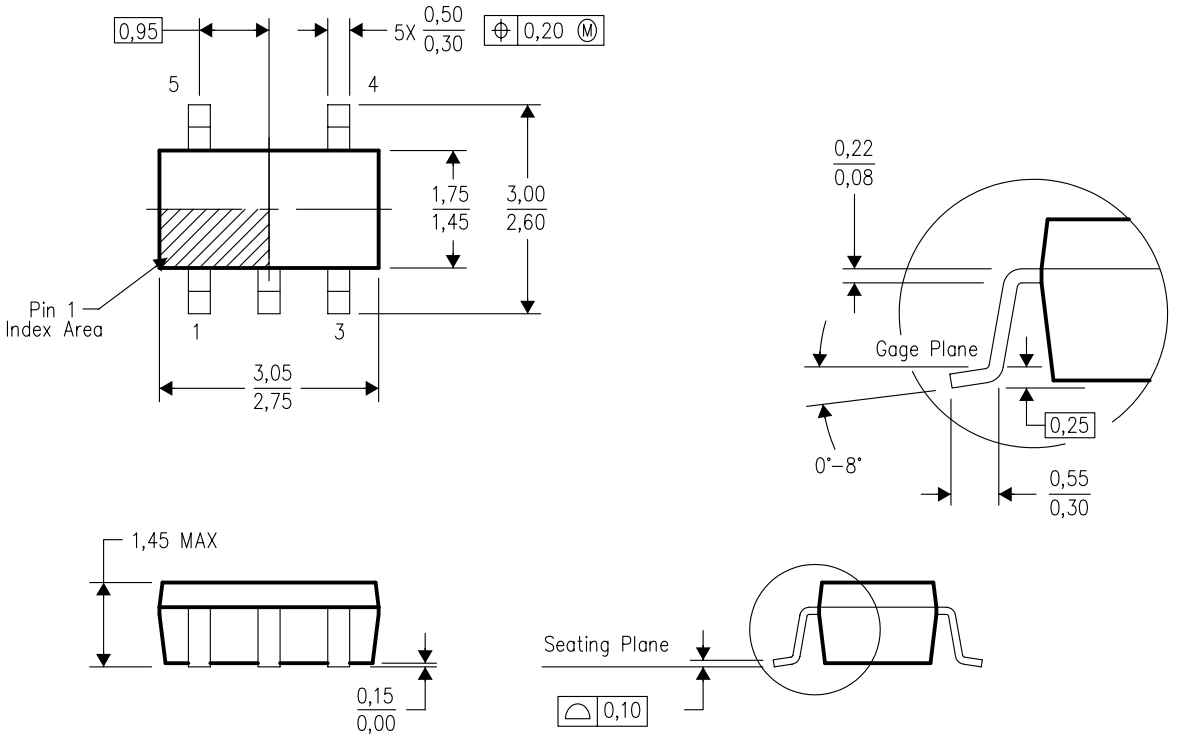
PK (R–PDSO–G3)



4208221/A 09/06

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC–7525.
E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

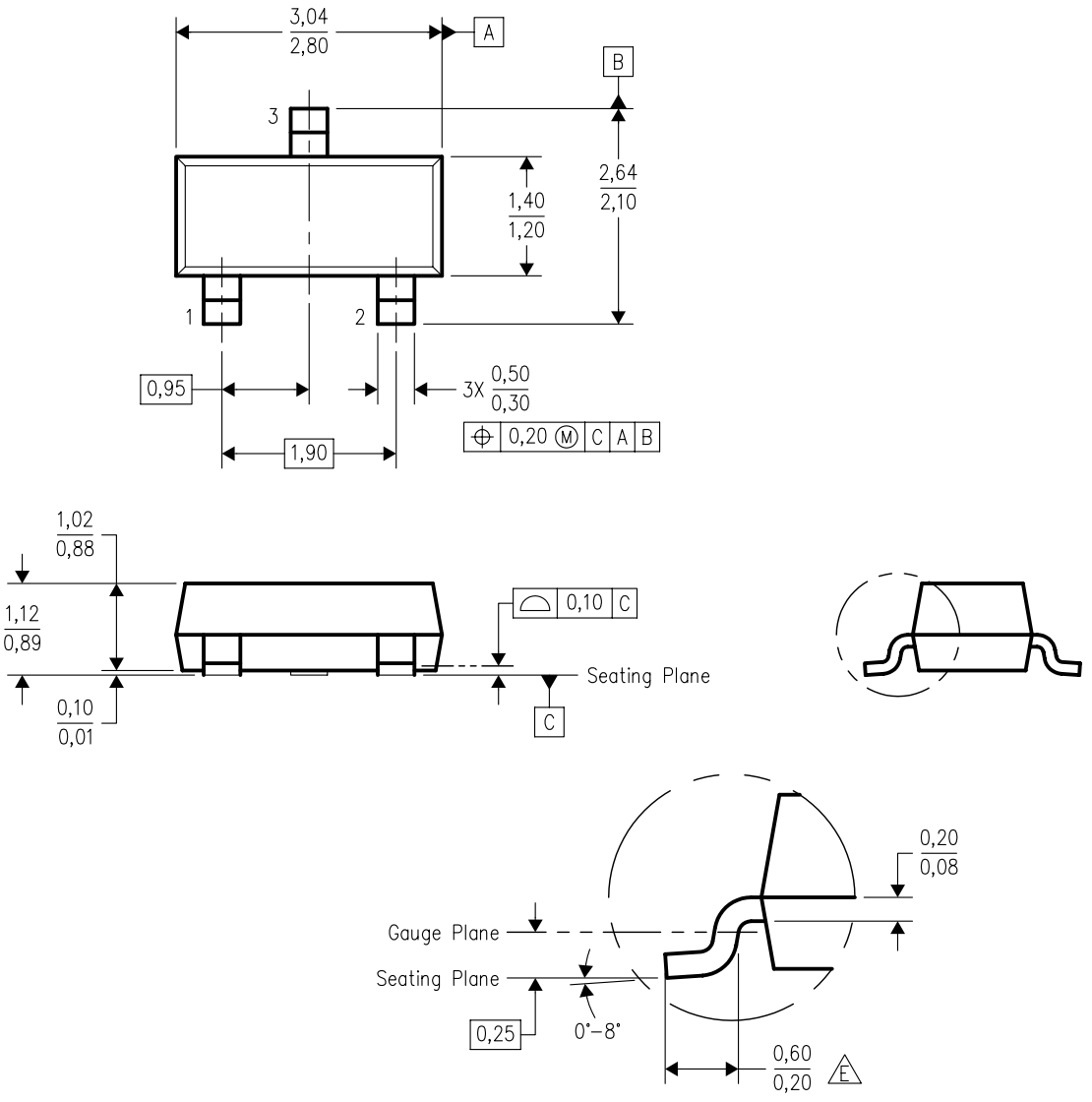
DBV (R–PDSO–G5) PLASTIC SMALL–OUTLINE PACKAGE



4073253–4/K 03/2006

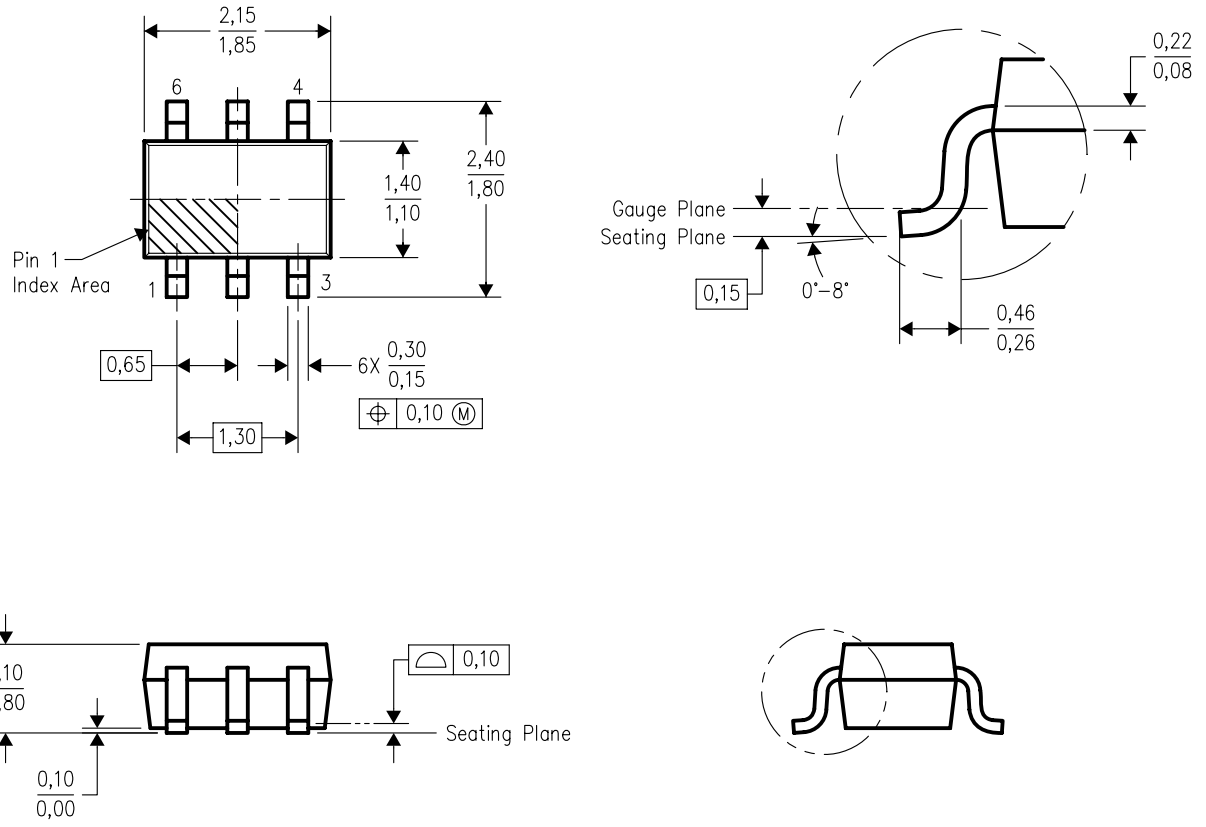
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
D. Falls within JEDEC MO–178 Variation AA.

DBZ (R–PDSO–G3) PLASTIC SMALL–OUTLINE



NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Lead dimensions are inclusive of plating.
D. Body dimensions are exclusive of mold flash and protrusion. Mold flash and protrusion not to exceed 0.25 per side.
E. Falls within JEDEC TO–236 variation AB, except minimum foot length.

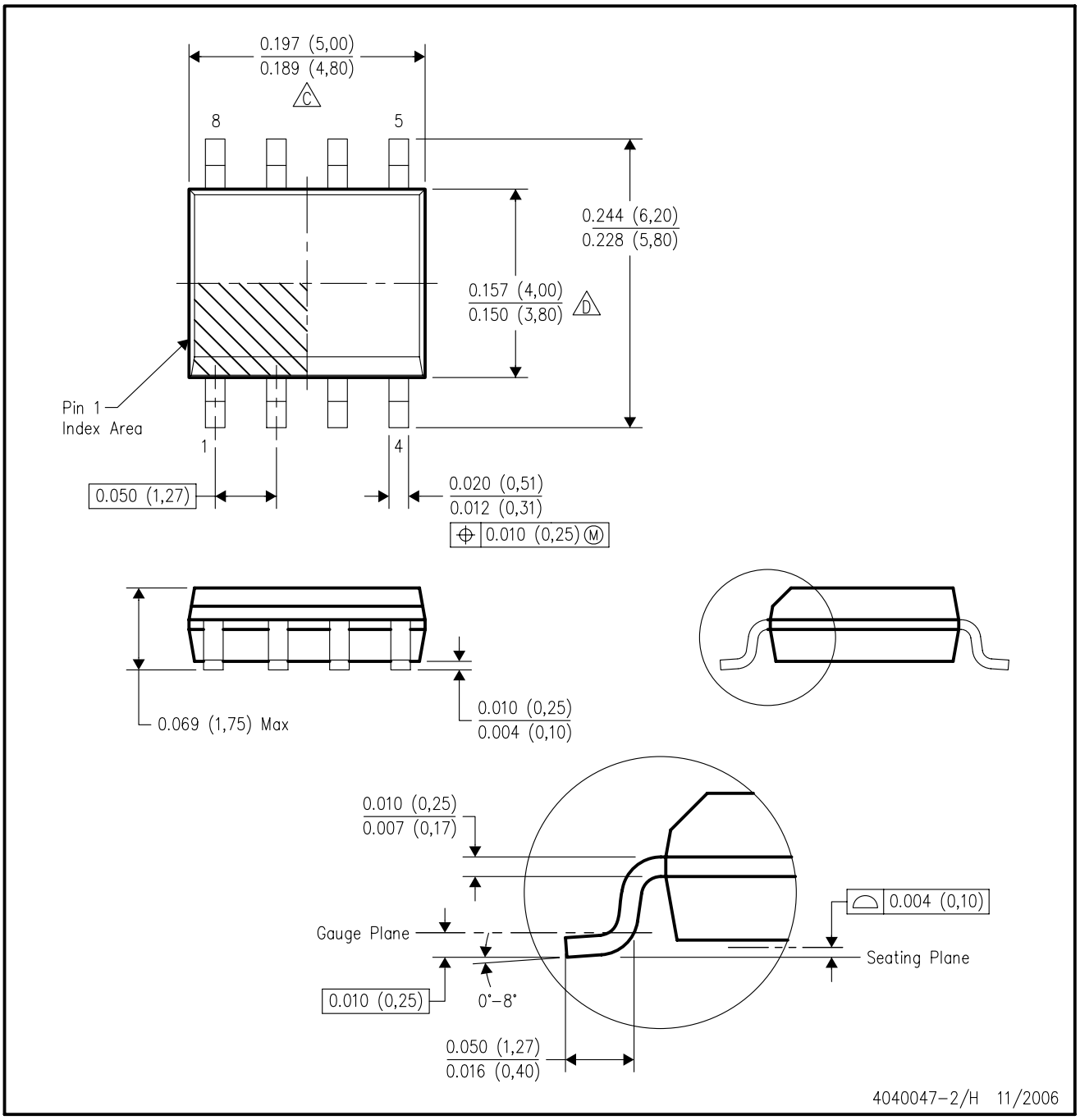
DCK (R–PDSO–G6) PLASTIC SMALL–OUTLINE PACKAGE



4093553–4/G 01/2007

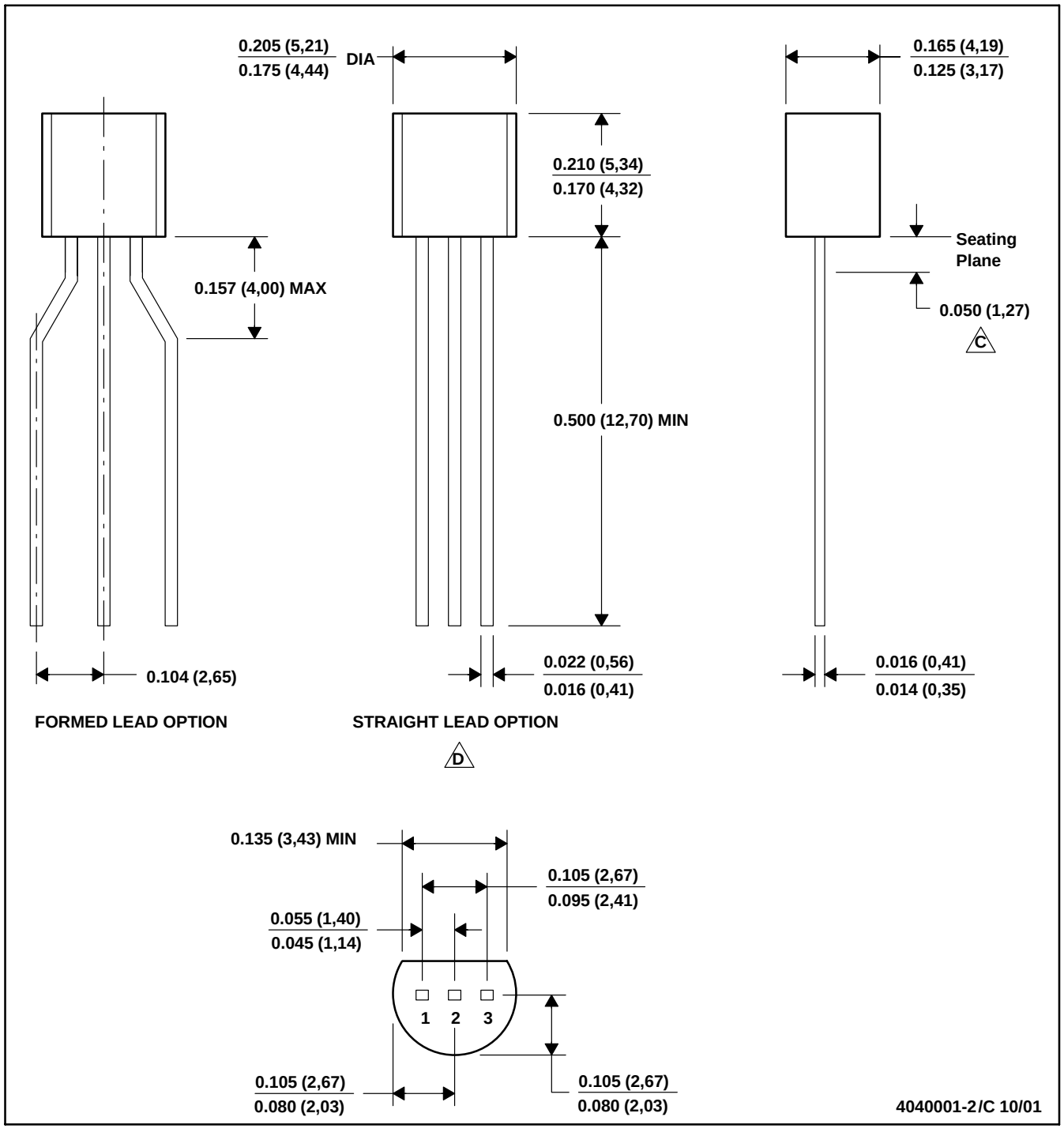
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
D. Falls within JEDEC MO–203 variation AB.

D (R–PDSO–G8) PLASTIC SMALL–OUTLINE PACKAGE



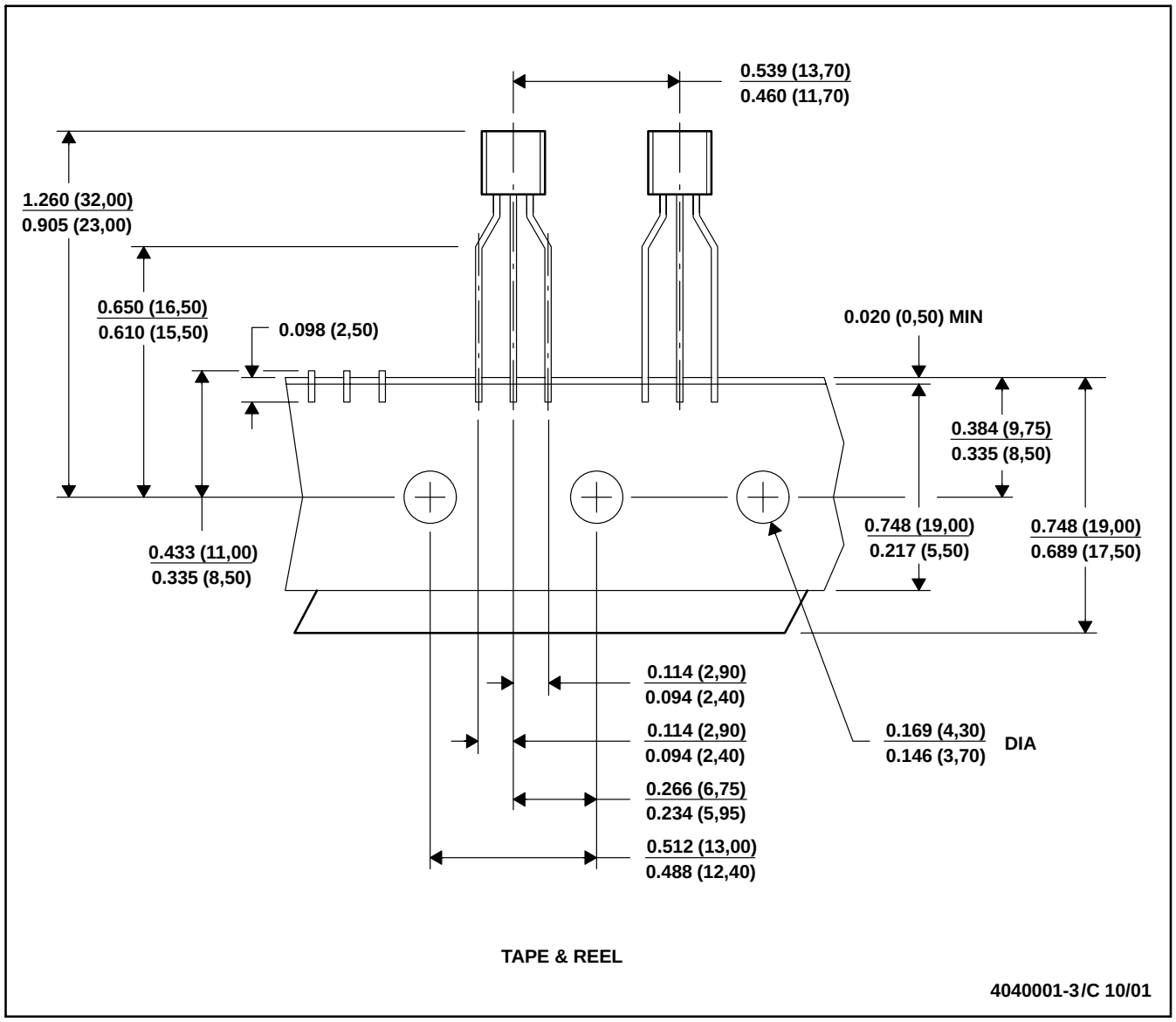
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
D. Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
E. Reference JEDEC MS–012 variation AA.

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.

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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