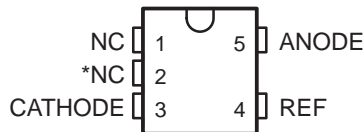


# TLVH431, TLVH431A, TLVH431B TLVH432, TLVH432A, TLVH432B LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATOR

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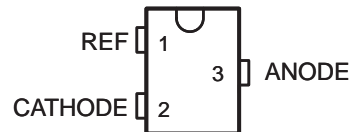
- Low-Voltage Operation . . . Down to 1.24 V
- Reference Voltage Tolerances at 25°C
  - 0.5% for B Grade
  - 1% for A Grade
  - 1.5% for Standard Grade
- Adjustable Output Voltage,  $V_O = V_{REF}$  to 18 V
- Wide Operating Cathode Current Range . . . 55  $\mu$ A to 80 mA
- 0.25- $\Omega$  Typical Output Impedance
- –40°C to 125°C Specifications
- TLVH432 Provides Alternative Pinouts for SOT-23-3 and SOT-89 Packages
- Ultra-Small SC-70 Package Offers 40% Smaller Footprint Than SOT-23-3

TLVH431  
DBV (SOT23-5) PACKAGE  
(TOP VIEW)

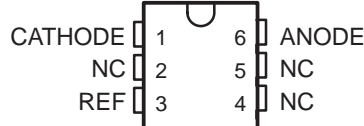


NC - No internal connection  
\* Pin 2 is connected internally to ANODE (die substrate). Pin 2 should be connected to ANODE or left floating.

TLVH431  
DBZ (SOT23-3) PACKAGE  
(TOP VIEW)



TLVH431  
DCK (SC-70) PACKAGE  
(TOP VIEW)

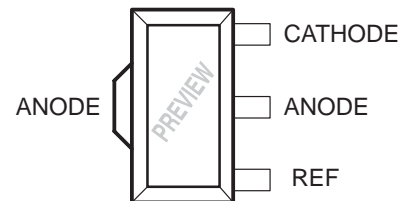


NC - No internal connection

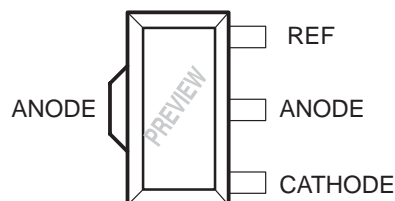
TLVH431  
LP (TO-92/TO-226) PACKAGE  
(TOP VIEW)



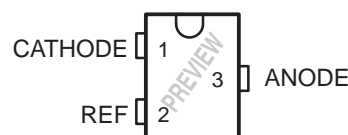
TLVH431  
PK (SOT-89) PACKAGE  
(TOP VIEW)



TLVH432  
PK (SOT-89) PACKAGE  
(TOP VIEW)



TLVH432  
DBZ (SOT23-3) PACKAGE  
(TOP VIEW)



## description/ordering information

The TLVH431 and TLVH432 are low-voltage 3-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 18 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.



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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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**TLVH431, TLVH431A, TLVH431B**  
**TLVH432, TLVH432A, TLVH432B**  
**LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATOR**

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**description/ordering information (continued)**

When used with an optocoupler, the TLVH431 and TLVH432 are ideal voltage references in isolated feedback circuits for 3-V to 3.3-V switching-mode power supplies. They have a typical output impedance of 0.25  $\Omega$ . Active output circuitry provides a very sharp turn-on characteristic, making the TLVH431 and TLVH432 excellent replacements for low-voltage Zener diodes in many applications, including on-board regulation and adjustable power supplies.

The TLVH432 is identical to the TLVH431, but is offered with different pinouts for the SOT23-3 and SOT-89 packages.



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**TLVH431, TLVH431A, TLVH431B**  
**TLVH432, TLVH432A, TLVH432B**  
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**ORDERING INFORMATION**

T <sub>J</sub>	V <sub>REF</sub> TOLERANCE	PACKAGE†	ORDERABLE PART NUMBER	TOP-SIDE MARKING‡	
0°C to 70°C	0.5%	SC-70 (DCK)	Reel of 3000	TLVH431BCDCKR	YH_
			Reel of 250	TLVH431BCDCKT	
		SOT-23-5 (DBV)	Reel of 3000	TLVH431BCDBVR	Y3J_
			Reel of 250	TLVH431BCDBVT	PREVIEW
		SOT-23-3 (DBZ)	Reel of 3000	TLVH431BCDBZR	Y3J_
				TLVH432BCDBZR	PREVIEW
			Reel of 250	TLVH431BCDBZT	
		SOT-89 (PK)	Reel of 1000	TLVH431BCPK	PREVIEW
				TLVH432BCPK	
		TO-92 (LP)	Bulk of 1000	TLVH431BCLP	ZA431B
			Reel of 2000	TLVH431BCLPR	
		1%	SC-70 (DCK)	Reel of 3000	TLVH431ACDCKR
	Reel of 250			TLVH431ACDCKT	
	SOT-23-5 (DBV)		Reel of 3000	TLVH431ACDBVR	PREVIEW
			Reel of 250	TLVH431ACDBVT	
	SOT-23-3 (DBZ)		Reel of 3000	TLVH431ACDBZR	PREVIEW
				TLVH432ACDBZR	
			Reel of 250	TLVH431ACDBZT	
	SOT-89 (PK)		Reel of 1000	TLVH431ACPK	PREVIEW
				TLVH432ACPK	
	TO-92 (LP)		Bulk of 1000	TLVH431ACL	PREVIEW
			Reel of 2000	TLVH431ACLPR	
	1.5%		SC-70 (DCK)	Reel of 3000	TLVH431CDCKR
		Reel of 250		TLVH431CDCKT	
		SOT-23-5 (DBV)	Reel of 3000	TLVH431CDBVR	PREVIEW
			Reel of 250	TLVH431CDBVT	
		SOT-23-3 (DBZ)	Reel of 3000	TLVH431CDBZR	PREVIEW
TLVH432CDBZR					
Reel of 250			TLVH431CDBZT		
SOT-89 (PK)		Reel of 1000	TLVH431CPK	PREVIEW	
			TLVH432CPK		
TO-92 (LP)		Bulk of 1000	TLVH431CLP	PREVIEW	
		Reel of 2000	TLVH431CLPR		

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

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



**TLVH431, TLVH431A, TLVH431B**  
**TLVH432, TLVH432A, TLVH432B**  
**LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATOR**

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**ORDERING INFORMATION (continued)**

T <sub>J</sub>	V <sub>REF</sub> TOLERANCE	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING‡
-40°C to 85°C	0.5%	SC-70 (DCK)	Reel of 3000	TLVH431BIDCKR	YJ_
			Reel of 250	TLVH431BIDCKT	
		SOT-23-5 (DBV)	Reel of 3000	TLVH431BIDBVR	Y3K_
			Reel of 250	TLVH431BIDBVT	PREVIEW
		SOT-23-3 (DBZ)	Reel of 3000	TLVH431BIDBZR	Y3K_
				TLVH432BIDBZR	PREVIEW
			Reel of 250	TLVH431BIDBZT	
		SOT-89 (PK)	Reel of 1000	TLVH431BIPK	PREVIEW
				TLVH432BIPK	
		TO-92 (LP)	Bulk of 1000	TLVH431BILP	ZB431B
				Reel of 2000	
		1%	SC-70 (DCK)	Reel of 3000	TLVH431AIDCKR
	Reel of 250			TLVH431AIDCKT	
	SOT-23-5 (DBV)		Reel of 3000	TLVH431AIDBVR	PREVIEW
			Reel of 250	TLVH431AIDBVT	
	SOT-23-3 (DBZ)		Reel of 3000	TLVH431AIDBZR	PREVIEW
				TLVH432AIDBZR	
			Reel of 250	TLVH431AIDBZT	
	SOT-89 (PK)		Reel of 1000	TLVH431AQPK	PREVIEW
				TLVH432AQPK	
	TO-92 (LP)		Bulk of 1000	TLVH431AILP	PREVIEW
				Reel of 2000	
	1.5%		SC-70 (DCK)	Reel of 3000	TLVH431IDCKR
		Reel of 250		TLVH431IDCKT	
		SOT-23-5 (DBV)	Reel of 3000	TLVH431IDBVR	PREVIEW
			Reel of 250	TLVH431IDBVT	
		SOT-23-3 (DBZ)	Reel of 3000	TLVH431IDBZR	PREVIEW
				TLVH432IDBZR	
			Reel of 250	TLVH431IDBZT	
		SOT-89 (PK)	Reel of 1000	TLVH431QPK	PREVIEW
TLVH432IPK					
TO-92 (LP)		Bulk of 1000	TLVH431ILP	PREVIEW	
			Reel of 2000		TLVH431ILPR

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

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**TLVH431, TLVH431A, TLVH431B**  
**TLVH432, TLVH432A, TLVH432B**  
**LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATOR**

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**ORDERING INFORMATION (continued)**

T <sub>J</sub>	V <sub>REF</sub> TOLERANCE	PACKAGE†	ORDERABLE PART NUMBER	TOP-SIDE MARKING‡	
-40°C to 125°C	0.5%	SC-70 (DCK)	Reel of 3000	TLVH431BQDCKR	YK_
			Reel of 250	TLVH431BQDCKT	
		SOT-23-5 (DBV)	Reel of 3000	TLVH431BQDBVR	Y3L_
			Reel of 250	TLVH431BQDBVT	PREVIEW
		SOT-23-3 (DBZ)	Reel of 3000	TLVH431BQDBZR	Y3L_
				TLVH432BQDBZR	PREVIEW
			Reel of 250	TLVH431BQDBZT	
		SOT-89 (PK)	Reel of 1000	TLVH431BQPK	PREVIEW
				TLVH432BQPK	
		TO-92 (LP)	Bulk of 1000	TLVH431BQLP	ZD431B
			Reel of 2000	TLVH431BQLPR	
		1%	SC-70 (DCK)	Reel of 3000	TLVH431AQDCKR
	Reel of 250			TLVH431AQDCKT	
	SOT-23-5 (DBV)		Reel of 3000	TLVH431AQDBVR	PREVIEW
			Reel of 250	TLVH431AQDBVT	
	SOT-23-3 (DBZ)		Reel of 3000	TLVH431AQDBZR	PREVIEW
				TLVH432AQDBZR	
			Reel of 250	TLVH431AQDBZT	
	SOT-89 (PK)		Reel of 1000	TLVH431AQPK	PREVIEW
				TLVH432AQPK	
	TO-92 (LP)		Bulk of 1000	TLVH431AQLP	PREVIEW
			Reel of 2000	TLVH431AQLPR	
	1.5%		SC-70 (DCK)	Reel of 3000	TLVH431QDCKR
		Reel of 250		TLVH431QDCKT	
		SOT-23-5 (DBV)	Reel of 3000	TLVH431QDBVR	PREVIEW
			Reel of 250	TLVH431QDBVT	
		SOT-23-3 (DBZ)	Reel of 3000	TLVH431QDBZR	PREVIEW
				TLVH432QDBZR	
			Reel of 250	TLVH431QDBZT	
		SOT-89 (PK)	Reel of 1000	TLVH431QPK	PREVIEW
TLVH432QPK					
TO-92 (LP)		Bulk of 1000	TLVH431QLP	PREVIEW	
		Reel of 2000	TLVH431QLPR		

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

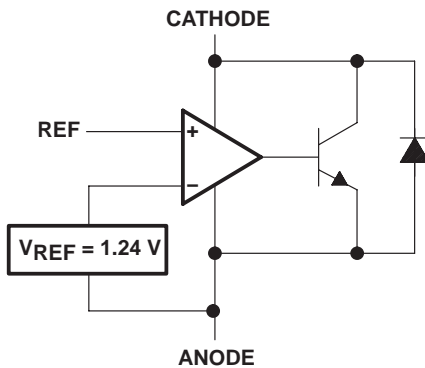
‡ DBV/DBZ/DCK: The actual top-side marking has one additional character that designates the assembly/test site.



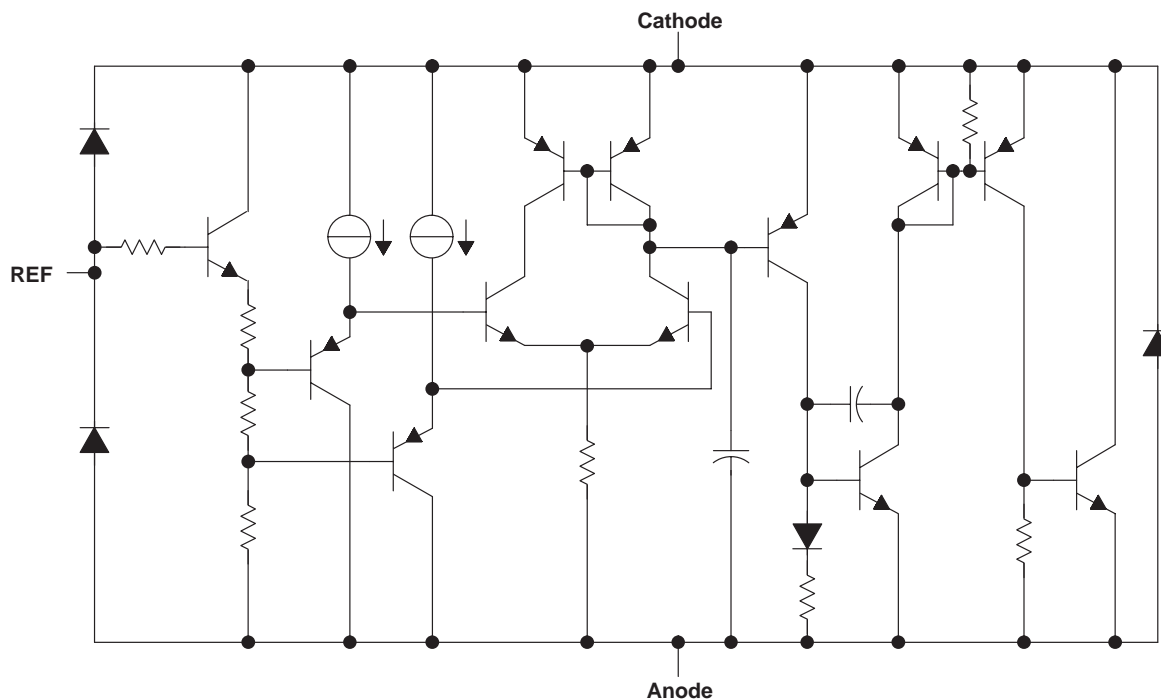
# TLVH431, TLVH431A, TLVH431B TLVH432, TLVH432A, TLVH432B LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATOR

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## logic block diagram



## equivalent schematic



**TLVH431, TLVH431A, TLVH431B**  
**TLVH432, TLVH432A, TLVH432B**  
**LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATOR**

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

Cathode voltage, $V_{KA}$ (see Note 1) .....	20 V	
Cathode current range, $I_K$ .....	–25 mA to 80 mA	
Reference current range, $I_{ref}$ .....	–0.05 mA to 3 mA	
Package thermal impedance, $\theta_{JA}$ (see Notes 2 and 3):	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  $T_J(max)$ ,  $\theta_{JA}$ , 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	$V_{REF}$	18	V	
$I_K$	Cathode current (continuous)	0.1	80	mA	
$T_A$	Operating free-air temperature range	TLVH43X_C	0	70	°C
		TLVH43X_I	–40	85	
		TLVH43X_Q	–40	125	



# TLVH431, TLVH431A, TLVH431B TLVH432, TLVH432A, TLVH432B LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATOR

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## TLVH431 electrical characteristics at 25°C free-air temperature (unless otherwise noted)

PARAMETER	TEST CONDITIONS	TLVH431, TLVH432			UNIT	
		MIN	TYP	MAX		
V <sub>REF</sub> Reference voltage	V <sub>KA</sub> = V <sub>REF</sub> , I <sub>K</sub> = 10 mA	T <sub>A</sub> = 25°C	1.222	1.24	1.258	V
		T <sub>A</sub> = full range (see Note 4 and Figure 1)	TLVH431C	1.21	1.27	
		TLVH431I	1.202	1.278		
		TLVH431Q	1.194	1.286		
V <sub>REF(dev)</sub> V <sub>REF</sub> deviation over full temperature range (see Note 5)	V <sub>KA</sub> = V <sub>REF</sub> , I <sub>K</sub> = 10 mA (see Note 4 and Figure 1)	TLVH431C	4	12	mV	
		TLVH431I	6	20		
		TLVH431Q	11	31		
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$ Ratio of V <sub>REF</sub> change to cathode voltage change	I <sub>K</sub> = 10 mA (see Figure 2)	V <sub>KA</sub> = V <sub>REF</sub> to 18 V	-1.5	-2.7	mV/V	
I <sub>ref</sub> Reference terminal current	I <sub>K</sub> = 10 mA, R1 = 10 kΩ, R2 = open (see Figure 2)		0.1	0.5	μA	
I <sub>ref(dev)</sub> I <sub>ref</sub> deviation over full temperature range (see Note 5)	I <sub>K</sub> = 10 mA, R1 = 10 kΩ, R2 = open (see Note 4 and Figure 2)		TLVH431C	0.05	0.3	μA
			TLVH431I	0.1	0.4	
			TLVH431Q	0.15	0.5	
I <sub>K(min)</sub> Minimum cathode current for regulation	V <sub>KA</sub> = V <sub>REF</sub> (see Figure 1)		60	100	μA	
I <sub>K(off)</sub> Off-state cathode current	V <sub>REF</sub> = 0, V <sub>KA</sub> = 18 V (see Figure 3)		0.02	0.1	μA	
z <sub>KA</sub>   Dynamic impedance (see Note 6)	V <sub>KA</sub> = V <sub>REF</sub> , f ≤ 1 kHz, I <sub>K</sub> = 0.1 mA to 80 mA (see Figure 1)		0.25	0.4	Ω	

- NOTES: 4. Full temperature ranges are: -40°C to 125°C for TLVH431Q, -40°C to 85°C for TLVH431I, and 0°C to 70°C for the TLVH431C.  
5. The deviation parameters V<sub>REF(dev)</sub> and I<sub>ref(dev)</sub> 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<sub>REF</sub>, is defined as:

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

where ΔT<sub>A</sub> is the rated operating free-air temperature range of the device.

αV<sub>REF</sub> can be positive or negative, depending on whether minimum V<sub>REF</sub> or maximum V<sub>REF</sub>, 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:

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



**TLVH431, TLVH431A, TLVH431B**  
**TLVH432, TLVH432A, TLVH432B**  
**LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATOR**

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**TLVH431A electrical characteristics at 25°C free-air temperature (unless otherwise noted)**

PARAMETER	TEST CONDITIONS	TLVH431A TLVH432A			UNIT	
		MIN	TYP	MAX		
V <sub>REF</sub> Reference voltage	V <sub>KA</sub> = V <sub>REF</sub> , I <sub>K</sub> = 10 mA	T <sub>A</sub> = 25°C	1.228	1.24	1.252	V
		T <sub>A</sub> = full range (see Note 4 and Figure 1)	TLVH431AC	1.221	1.259	
	TLVH431AI		1.215	1.265		
	TLVH431AQ		1.209	1.271		
V <sub>REF(dev)</sub> V <sub>REF</sub> deviation over full temperature range (see Note 5)	V <sub>KA</sub> = V <sub>REF</sub> , I <sub>K</sub> = 10 mA (see Note 4 and Figure 1)	TLVH431AC	4	12	mV	
		TLVH431AI	6	20		
		TLVH431AQ	11	31		
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$ Ratio of V <sub>REF</sub> change to cathode voltage change	I <sub>K</sub> = 10 mA (see Figure 2)	V <sub>KA</sub> = V <sub>REF</sub> to 18 V	-1.5	-2.7	mV/V	
I <sub>ref</sub> Reference terminal current	I <sub>K</sub> = 10 mA, R1 = 10 kΩ, R2 = open (see Figure 2)		0.1	0.5	μA	
I <sub>ref(dev)</sub> I <sub>ref</sub> deviation over full temperature range (see Note 5)	I <sub>K</sub> = 10 mA, R1 = 10 kΩ, R2 = open (see Note 4 and Figure 2)		TLVH431AC	0.05	0.3	μA
			TLVH431AI	0.1	0.4	
			TLVH431AQ	0.15	0.5	
I <sub>K(min)</sub> Minimum cathode current for regulation	V <sub>KA</sub> = V <sub>REF</sub> (see Figure 1)		60	100	μA	
I <sub>K(off)</sub> Off-state cathode current	V <sub>REF</sub> = 0, V <sub>KA</sub> = 18 V (see Figure 3)		0.02	0.1	μA	
z <sub>KA</sub>   Dynamic impedance (see Note 6)	V <sub>KA</sub> = V <sub>REF</sub> , f ≤ 1 kHz, I <sub>K</sub> = 0.1 mA to 80 mA (see Figure 1)		0.25	0.4	Ω	

- NOTES: 4. Full temperature ranges are: -40°C to 125°C for TLVH431AQ, -40°C to 85°C for TLVH431AI, and 0°C to 70°C for the TLVH431AC.  
5. The deviation parameters V<sub>REF(dev)</sub> and I<sub>ref(dev)</sub> 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<sub>REF</sub>, is defined as:

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

where ΔT<sub>A</sub> is the rated operating free-air temperature range of the device.

αV<sub>REF</sub> can be positive or negative, depending on whether minimum V<sub>REF</sub> or maximum V<sub>REF</sub>, 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:

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

# TLVH431, TLVH431A, TLVH431B TLVH432, TLVH432A, TLVH432B LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATOR

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## TLVH431B electrical characteristics at 25°C free-air temperature (unless otherwise noted)

PARAMETER	TEST CONDITIONS	TLVH431B TLVH432B			UNIT	
		MIN	TYP	MAX		
V <sub>REF</sub> Reference voltage	V <sub>KA</sub> = V <sub>REF</sub> , I <sub>K</sub> = 10 mA	T <sub>A</sub> = 25°C	1.234	1.24	1.246	V
		T <sub>A</sub> = full range (see Note 4 and Figure 1)	TLVH431BC	1.227	1.253	
	TLVH431BI		1.224	1.259		
	TLVH431BQ		1.221	1.265		
V <sub>REF(dev)</sub> V <sub>REF</sub> deviation over full temperature range (see Note 5)	V <sub>KA</sub> = V <sub>REF</sub> , I <sub>K</sub> = 10 mA (see Note 4 and Figure 1)	TLVH431BC	4	12	mV	
		TLVH431BI	6	20		
		TLVH431BQ	11	31		
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$ Ratio of V <sub>REF</sub> change to cathode voltage change	I <sub>K</sub> = 10 mA (see Figure 2)	V <sub>KA</sub> = V <sub>REF</sub> to 18 V		-1.5	-2.7	mV/V
I <sub>ref</sub> Reference terminal current	I <sub>K</sub> = 10 mA, R1 = 10 kΩ (see Figure 2)			0.1	0.5	μA
I <sub>ref(dev)</sub> I <sub>ref</sub> deviation over full temperature range (see Note 5)	I <sub>K</sub> = 10 mA, R1 = 10 kΩ, R2 = open (see Note 4 and Figure 2)	TLVH431BC	0.05	0.3	μA	
		TLVH431BI	0.1	0.4		
		TLVH431BQ	0.15	0.5		
I <sub>K(min)</sub> Minimum cathode current for regulation	V <sub>KA</sub> = V <sub>REF</sub> (see Figure 1)			60	100	μA
I <sub>K(off)</sub> Off-state cathode current	V <sub>REF</sub> = 0, V <sub>KA</sub> = 18 V (see Figure 3)			0.02	0.1	μA
z <sub>KA</sub>   Dynamic impedance (see Note 6)	V <sub>KA</sub> = V <sub>REF</sub> , f ≤ 1 kHz, I <sub>K</sub> = 0.1 mA to 80 mA (see Figure 1)			0.25	0.4	Ω

- NOTES: 4. Full temperature ranges are: -40°C to 125°C for TLVH431BQ, -40°C to 85°C for TLVH431BI, and 0°C to 70°C for the TLVH431BC.  
5. The deviation parameters V<sub>REF(dev)</sub> and I<sub>ref(dev)</sub> 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<sub>REF</sub>, is defined as:

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

where ΔT<sub>A</sub> is the rated operating free-air temperature range of the device.

αV<sub>REF</sub> can be positive or negative, depending on whether minimum V<sub>REF</sub> or maximum V<sub>REF</sub>, 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:

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

PARAMETER MEASUREMENT INFORMATION

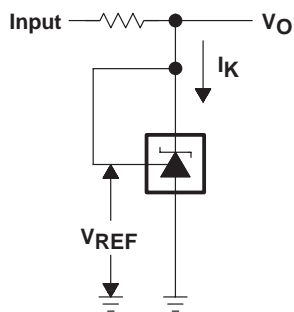


Figure 1. Test Circuit for  $V_{KA} = V_{REF}$   
 $V_O = V_{KA} = V_{REF}$

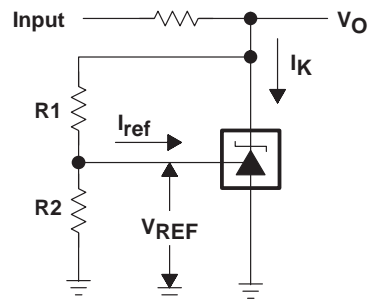


Figure 2. Test Circuit for  $V_{KA} > V_{REF}$   
 $V_O = V_{KA} = V_{REF} \times (1 + R1/R2) + I_{ref} \times R1$

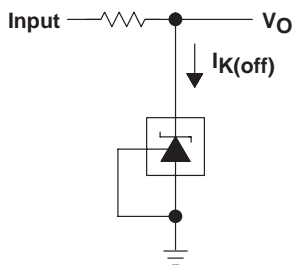


Figure 3. Test Circuit for  $I_{K(off)}$

PARAMETER MEASUREMENT INFORMATION

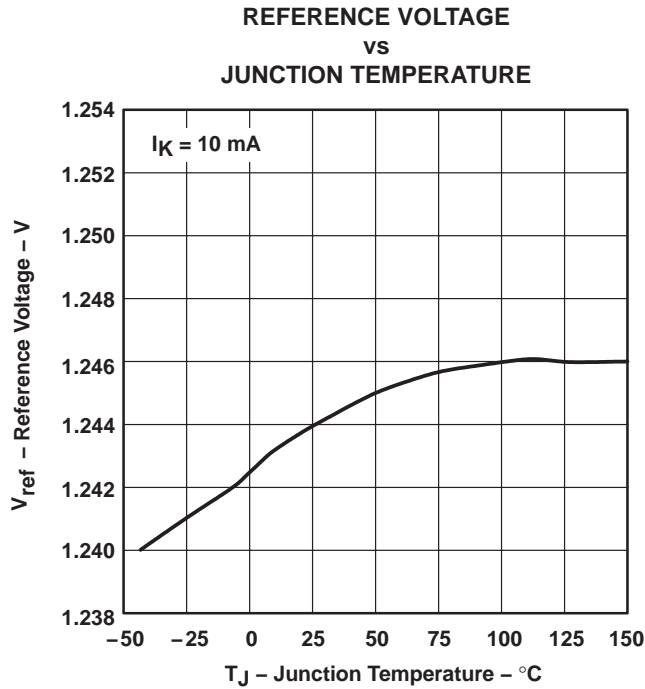


Figure 4

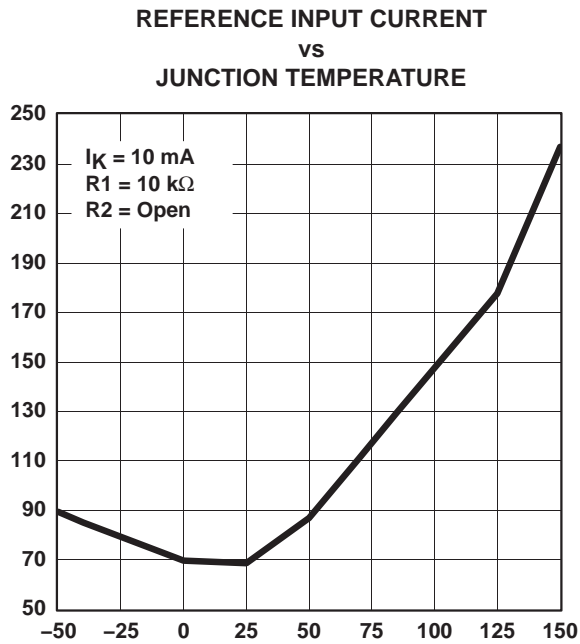


Figure 5

TLVH431, TLVH431A, TLVH431B  
 TLVH432, TLVH432A, TLVH432B  
**LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATOR**

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**PARAMETER MEASUREMENT INFORMATION†**

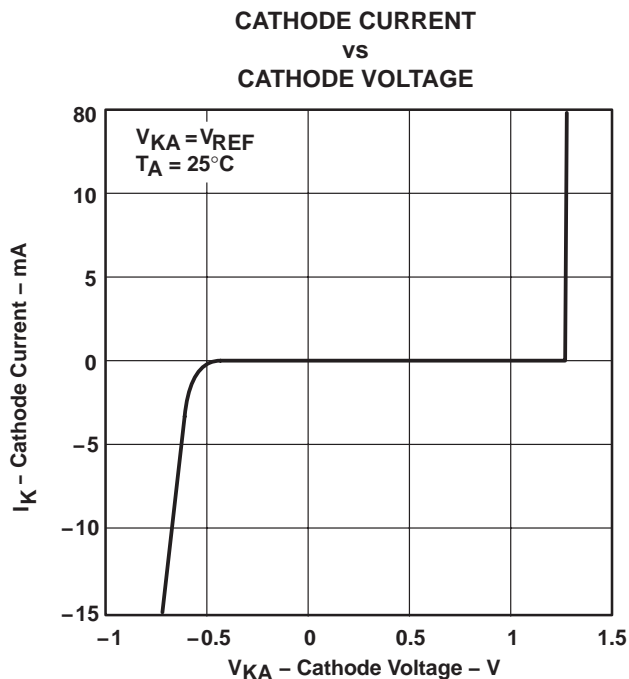


Figure 6

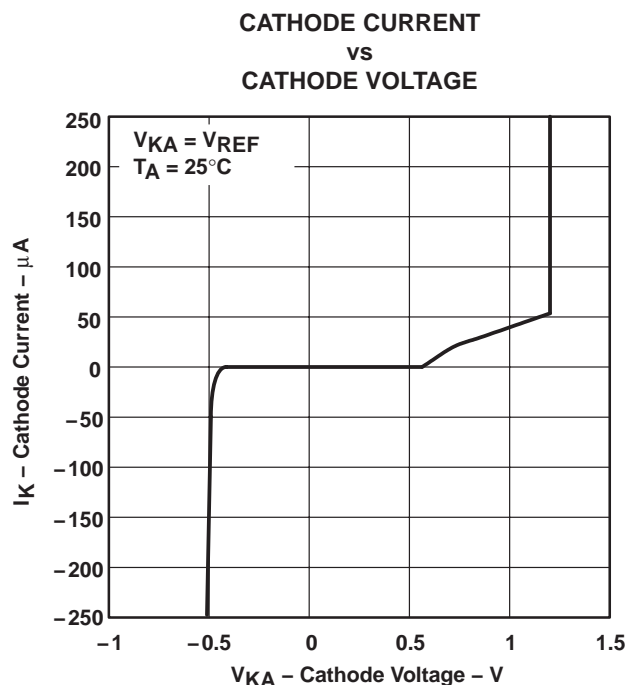


Figure 7

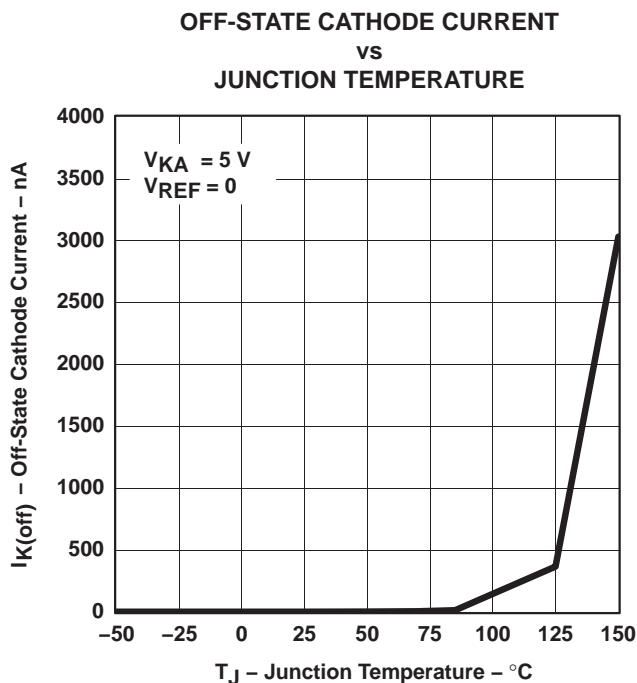
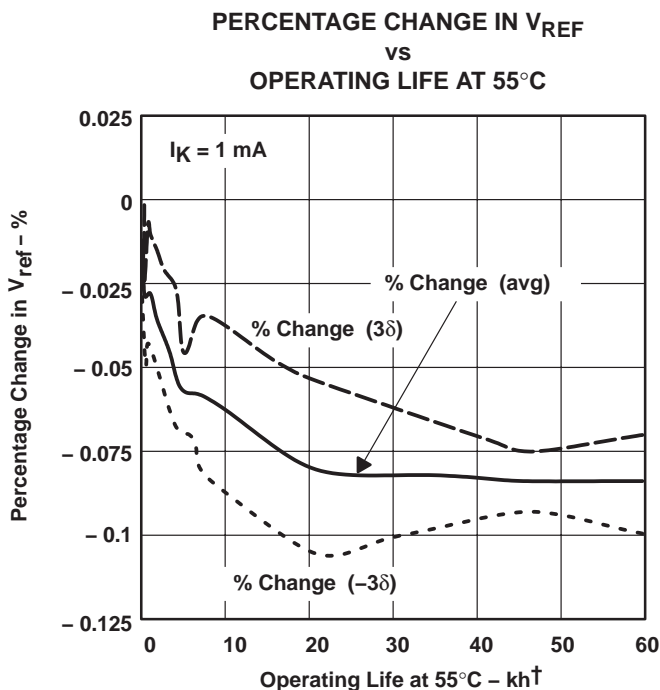
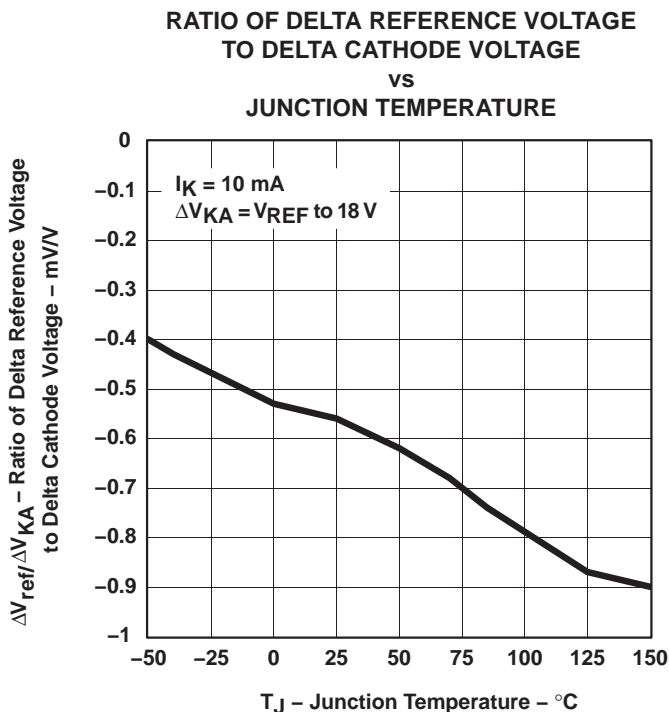


Figure 8

**TLVH431, TLVH431A, TLVH431B  
 TLVH432, TLVH432A, TLVH432B  
 LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATOR**

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**PARAMETER MEASUREMENT INFORMATION†**



† 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.



TLVH431, TLVH431A, TLVH431B  
 TLVH432, TLVH432A, TLVH432B  
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**PARAMETER MEASUREMENT INFORMATION**

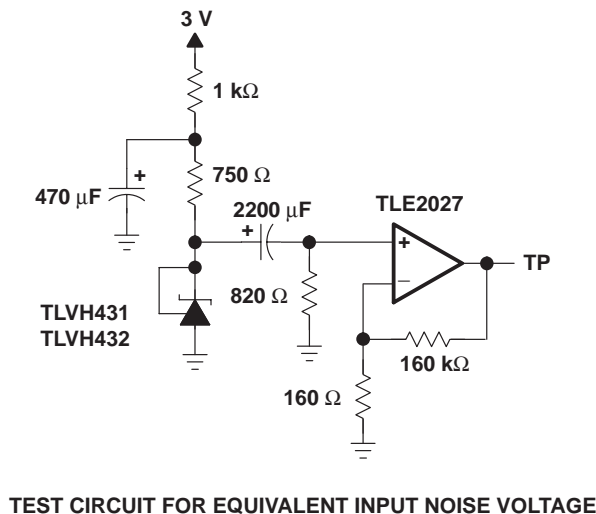
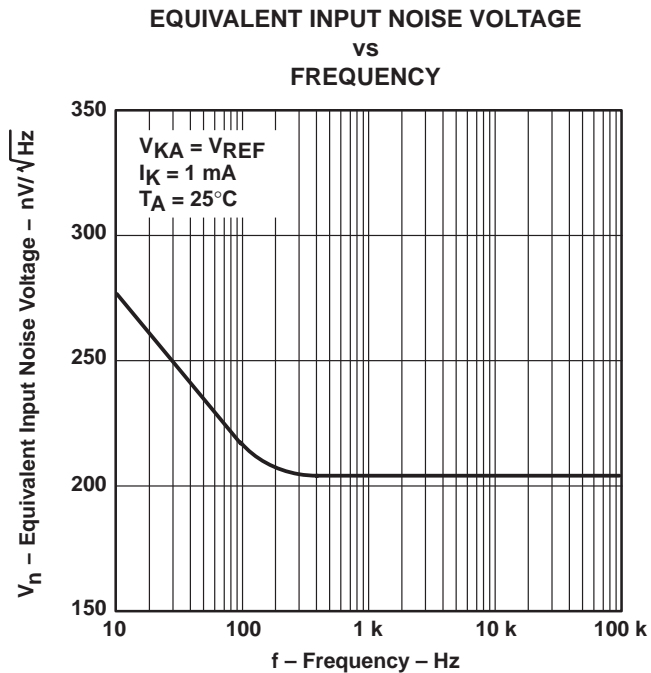


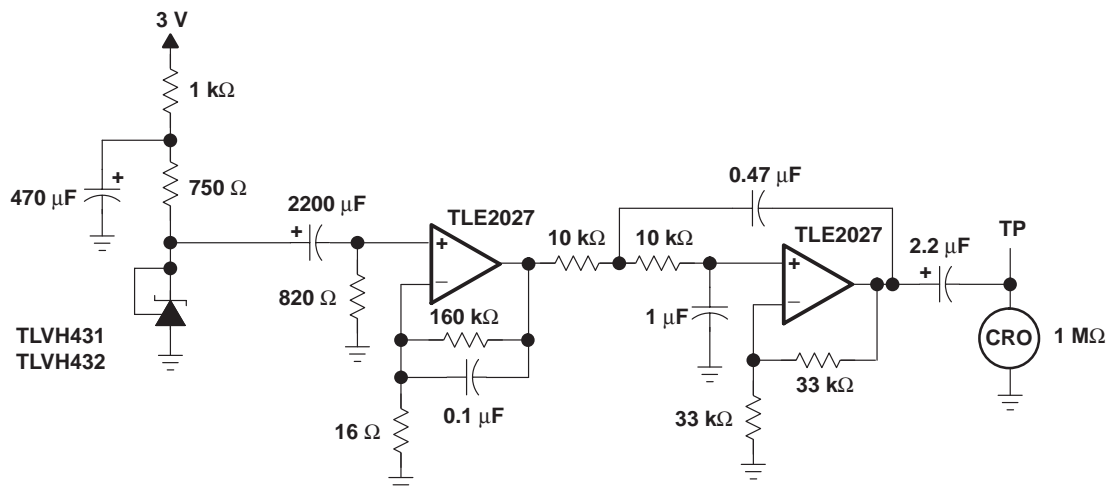
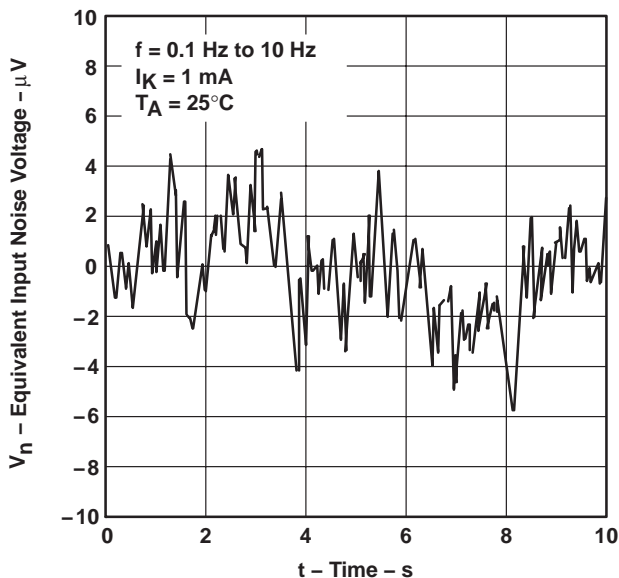
Figure 11

**TLVH431, TLVH431A, TLVH431B**  
**TLVH432, TLVH432A, TLVH432B**  
**LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATOR**

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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**



TLVH431, TLVH431A, TLVH431B  
 TLVH432, TLVH432A, TLVH432B  
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**PARAMETER MEASUREMENT INFORMATION**

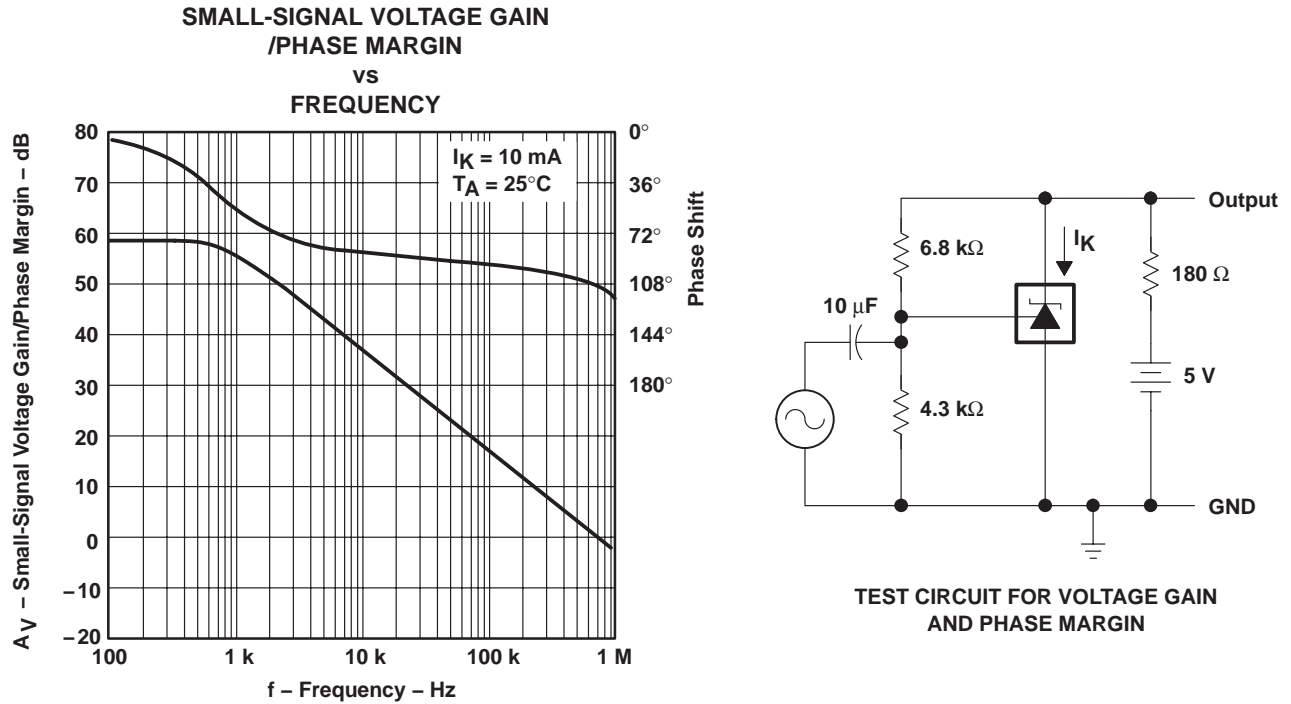


Figure 13

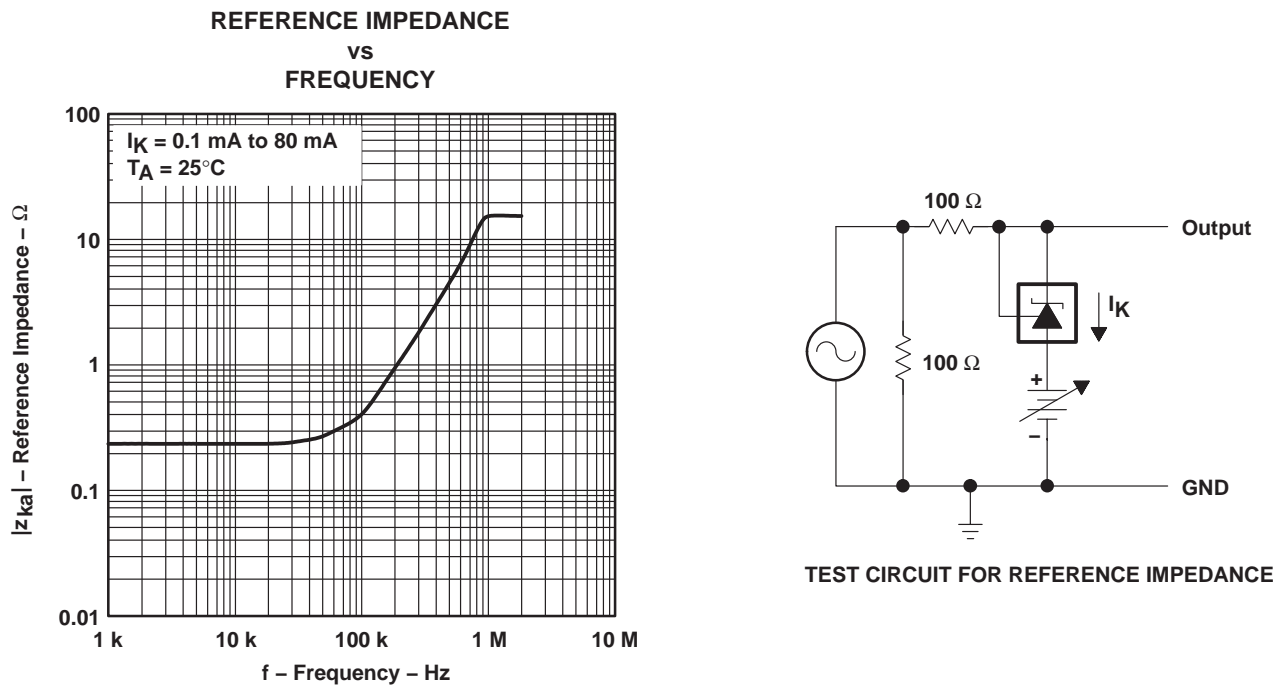


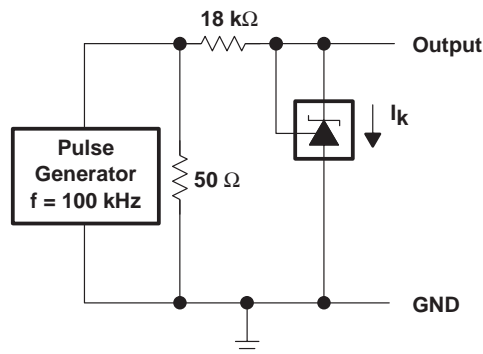
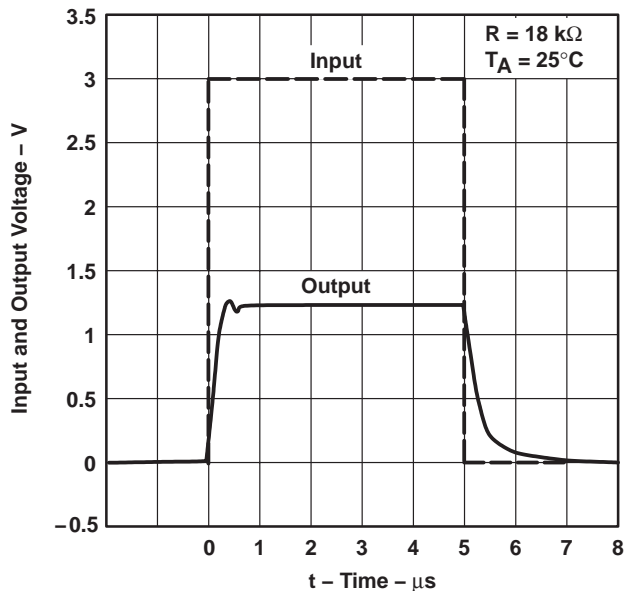
Figure 14

**TLVH431, TLVH431A, TLVH431B**  
**TLVH432, TLVH432A, TLVH432B**  
**LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATOR**

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**PARAMETER MEASUREMENT INFORMATION**

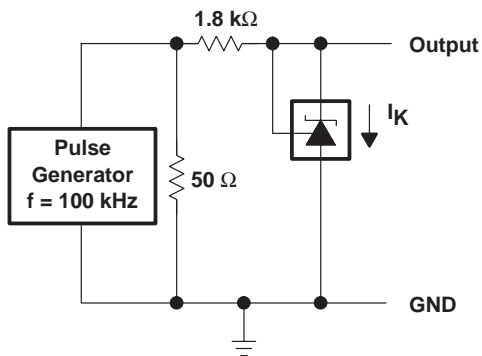
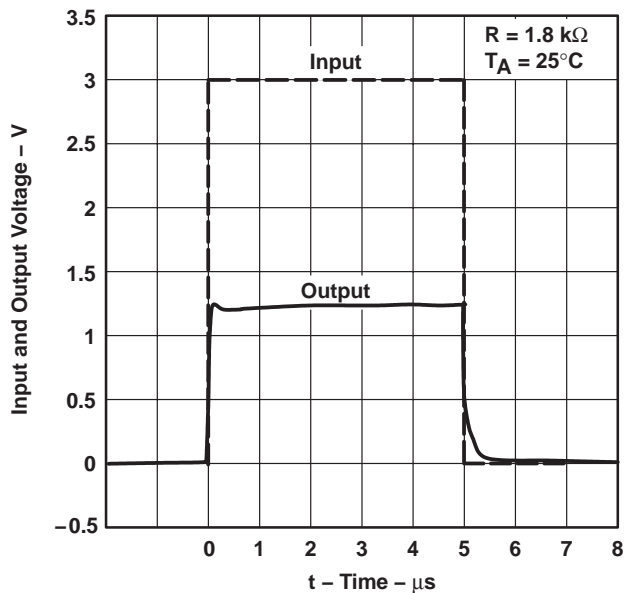
**PULSE RESPONSE 1**



**TEST CIRCUIT FOR PULSE RESPONSE 1**

**Figure 15**

**PULSE RESPONSE 2**



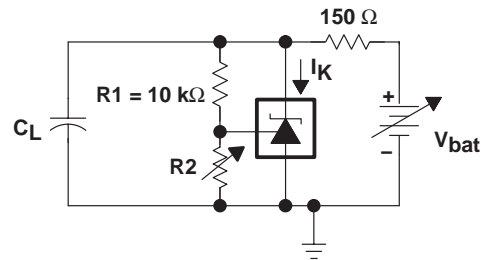
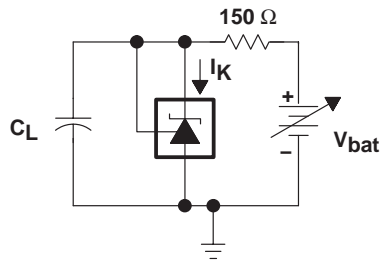
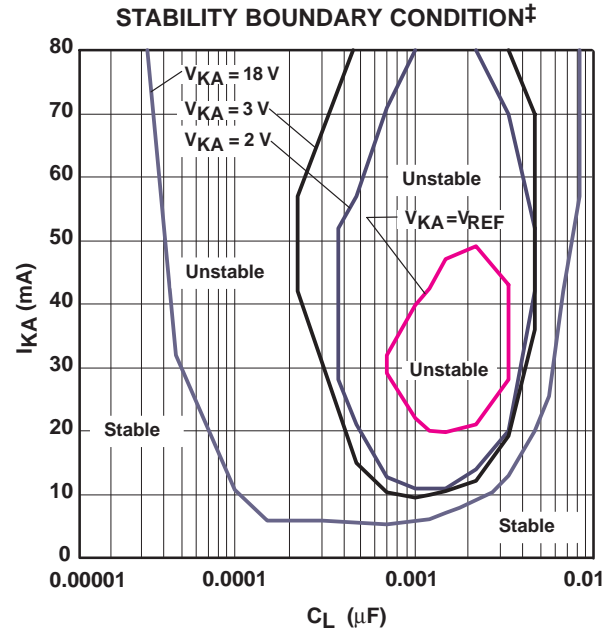
**TEST CIRCUIT FOR PULSE RESPONSE 2**

**Figure 16**

TLVH431, TLVH431A, TLVH431B  
TLVH432, TLVH432A, TLVH432B  
**LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATOR**

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**PARAMETER MEASUREMENT INFORMATION†**



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

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

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

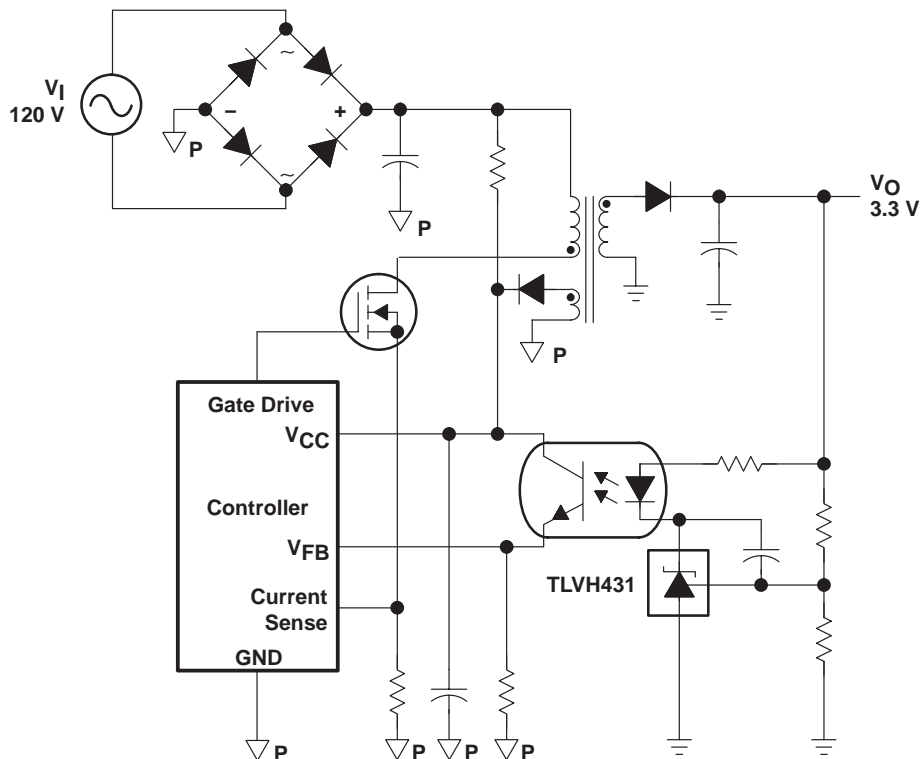
‡ The areas enclosed by the curves represent conditions that may cause the device to oscillate. For  $V_{KA} = 2\text{-V}, 3\text{-V}$ , and  $18\text{-V}$  curves,  $R_2$  and  $V_{bat}$  were adjusted to establish the initial  $V_{KA}$  and  $I_K$  conditions with  $C_L = 0$ .  $V_{bat}$  and  $C_L$  then were adjusted to determine the ranges of stability.

**Figure 17**

**TLVH431, TLVH431A, TLVH431B**  
**TLVH432, TLVH432A, TLVH432B**  
**LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATOR**

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**APPLICATION INFORMATION**



**Figure 18. Flyback With Isolation Using TLVH431 and TLVH432 as Voltage Reference and Error Amplifier**

Figure 18 shows the TLVH431 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). 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 <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
TLVH431ACDBVR	PREVIEW	SOT-23	DBV	5	3000	None	Call TI	Call TI
TLVH431ACDBVT	PREVIEW	SOT-23	DBV	5	250	None	Call TI	Call TI
TLVH431ACDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
TLVH431ACDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
TLVH431ACDCKR	PREVIEW	SC70	DCK	6	3000	None	Call TI	Call TI
TLVH431ACDCKT	PREVIEW	SC70	DCK	6	250	None	Call TI	Call TI
TLVH431ACLCP	PREVIEW	TO-92	LP	3	1000	None	Call TI	Call TI
TLVH431ACLPR	PREVIEW	TO-92	LP	3	2000	None	Call TI	Call TI
TLVH431ACPK	PREVIEW	SOT-89	PK	3	1000	None	Call TI	Call TI
TLVH431AIDBVR	PREVIEW	SOT-23	DBV	5	3000	None	Call TI	Call TI
TLVH431AIDBVT	PREVIEW	SOT-23	DBV	5	250	None	Call TI	Call TI
TLVH431AIDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
TLVH431AIDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
TLVH431AIDCKR	PREVIEW	SC70	DCK	6	3000	None	Call TI	Call TI
TLVH431AILP	PREVIEW	TO-92	LP	3	1000	None	Call TI	Call TI
TLVH431AILPR	PREVIEW	TO-92	LP	3	2000	None	Call TI	Call TI
TLVH431AIPK	PREVIEW	SOT-89	PK	3	1000	None	Call TI	Call TI
TLVH431AQDBVR	PREVIEW	SOT-23	DBV	5	3000	None	Call TI	Call TI
TLVH431AQDBVT	PREVIEW	SOT-23	DBV	5	250	None	Call TI	Call TI
TLVH431AQDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
TLVH431AQDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
TLVH431AQDCKR	PREVIEW	SC70	DCK	6	3000	None	Call TI	Call TI
TLVH431AQDCKT	PREVIEW	SC70	DCK	6	250	None	Call TI	Call TI
TLVH431AQLP	PREVIEW	TO-92	LP	3	1000	None	Call TI	Call TI
TLVH431AQLPR	PREVIEW	TO-92	LP	3	2000	None	Call TI	Call TI
TLVH431AQPCK	PREVIEW	SOT-89	PK	3	1000	None	Call TI	Call TI
TLVH431BCDBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLVH431BCDBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLVH431BCDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLVH431BCDBZT	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLVH431BCDCKR	ACTIVE	SC70	DCK	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLVH431BCDCKT	ACTIVE	SC70	DCK	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLVH431BCLP	ACTIVE	TO-92	LP	3	1000	None	CU SNPB	Level-NC-NC-NC
TLVH431BCLPR	ACTIVE	TO-92	LP	3	2000	None	CU SNPB	Level-NC-NC-NC
TLVH431BIDBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLVH431BIDBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
TLVH431BIDBZR	PREVIEW	SOT-23	DBZ	3		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLVH431BIDBZT	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLVH431BIDCKR	ACTIVE	SC70	DCK	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLVH431BIDCKT	ACTIVE	SC70	DCK	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLVH431BILP	ACTIVE	TO-92	LP	3	1000	None	CU SNPB	Level-NC-NC-NC
TLVH431BILPR	ACTIVE	TO-92	LP	3	2000	None	CU SNPB	Level-NC-NC-NC
TLVH431BQDBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLVH431BQDBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLVH431BQDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLVH431BQDBZT	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLVH431BQDCKR	ACTIVE	SC70	DCK	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLVH431BQDCKT	ACTIVE	SC70	DCK	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLVH431BQLP	ACTIVE	TO-92	LP	3	1000	None	CU SNPB	Level-NC-NC-NC
TLVH431BQLPR	ACTIVE	TO-92	LP	3	2000	None	CU SNPB	Level-NC-NC-NC
TLVH431CDBVR	PREVIEW	SOT-23	DBV	5	3000	None	Call TI	Call TI
TLVH431CDBVT	PREVIEW	SOT-23	DBV	5	250	None	Call TI	Call TI
TLVH431CDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
TLVH431CDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
TLVH431CDCKR	PREVIEW	SC70	DCK	6	3000	None	Call TI	Call TI
TLVH431CDCKT	PREVIEW	SC70	DCK	6	250	None	Call TI	Call TI
TLVH431CLP	PREVIEW	TO-92	LP	3	1000	None	Call TI	Call TI
TLVH431CLPR	PREVIEW	TO-92	LP	3	2000	None	Call TI	Call TI
TLVH431CPK	PREVIEW	SOT-89	PK	3	1000	None	Call TI	Call TI
TLVH431BQDBZR	PREVIEW	SOT-23	DBZ	3		None	Call TI	Call TI
TLVH431IDBVR	PREVIEW	SOT-23	DBV	5	3000	None	Call TI	Call TI
TLVH431IDBVT	PREVIEW	SOT-23	DBV	5	250	None	Call TI	Call TI
TLVH431IDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
TLVH431IDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
TLVH431IDCKR	PREVIEW	SC70	DCK	6	3000	None	Call TI	Call TI
TLVH431IDCKT	PREVIEW	SC70	DCK	6	250	None	Call TI	Call TI
TLVH431ILP	PREVIEW	TO-92	LP	3	1000	None	Call TI	Call TI
TLVH431ILPR	PREVIEW	TO-92	LP	3	2000	None	Call TI	Call TI
TLVH431IPK	PREVIEW	SOT-89	PK	3	1000	None	Call TI	Call TI
TLVH431QDBVR	PREVIEW	SOT-23	DBV	5	3000	None	Call TI	Call TI
TLVH431QDBVT	PREVIEW	SOT-23	DBV	5	250	None	Call TI	Call TI
TLVH431QDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
TLVH431QDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
TLVH431QDCKR	PREVIEW	SC70	DCK	6	3000	None	Call TI	Call TI
TLVH431QDCKT	PREVIEW	SC70	DCK	6	250	None	Call TI	Call TI
TLVH431QLP	PREVIEW	TO-92	LP	3	1000	None	Call TI	Call TI
TLVH431QLPR	PREVIEW	TO-92	LP	3	2000	None	Call TI	Call TI
TLVH431QPK	PREVIEW	SOT-89	PK	3	1000	None	Call TI	Call TI
TLVH432ACDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
TLVH432ACDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
TLVH432ACPK	PREVIEW	SOT-89	PK	3	1000	None	Call TI	Call TI
TLVH432AIDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
TLVH432AIDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
TLVH432AIPK	PREVIEW	SOT-89	PK	3	1000	None	Call TI	Call TI
TLVH432AQDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
TLVH432AQDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
TLVH432AQPK	PREVIEW	SOT-89	PK	3	1000	None	Call TI	Call TI
TLVH432BCDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
TLVH432BCDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
TLVH432BCPK	PREVIEW	SOT-89	PK	3	1000	None	Call TI	Call TI
TLVH432BIDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
TLVH432BIDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
TLVH432BIPK	PREVIEW	SOT-89	PK	3	1000	None	Call TI	Call TI
TLVH432BQDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
TLVH432BQDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
TLVH432BQPK	PREVIEW	SOT-89	PK	3	1000	None	Call TI	Call TI
TLVH432CDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
TLVH432CDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
TLVH432CPK	PREVIEW	SOT-89	PK	3	1000	None	Call TI	Call TI
TLVH432IDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
TLVH432IDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
TLVH432IPK	PREVIEW	SOT-89	PK	3	1000	None	Call TI	Call TI
TLVH432QDBZR	PREVIEW	SOT-23	DBZ	3	3000	None	Call TI	Call TI
TLVH432QDBZT	PREVIEW	SOT-23	DBZ	3	250	None	Call TI	Call TI
TLVH432QPK	PREVIEW	SOT-89	PK	3	1000	None	Call TI	Call TI

<sup>(1)</sup> 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.

<sup>(2)</sup> Eco Plan - May not be currently available - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**None:** Not yet available Lead (Pb-Free).

**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.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean "Pb-Free" and in addition, uses package materials that do not contain halogens, including bromine (Br) or antimony (Sb) above 0.1% of total product weight.

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

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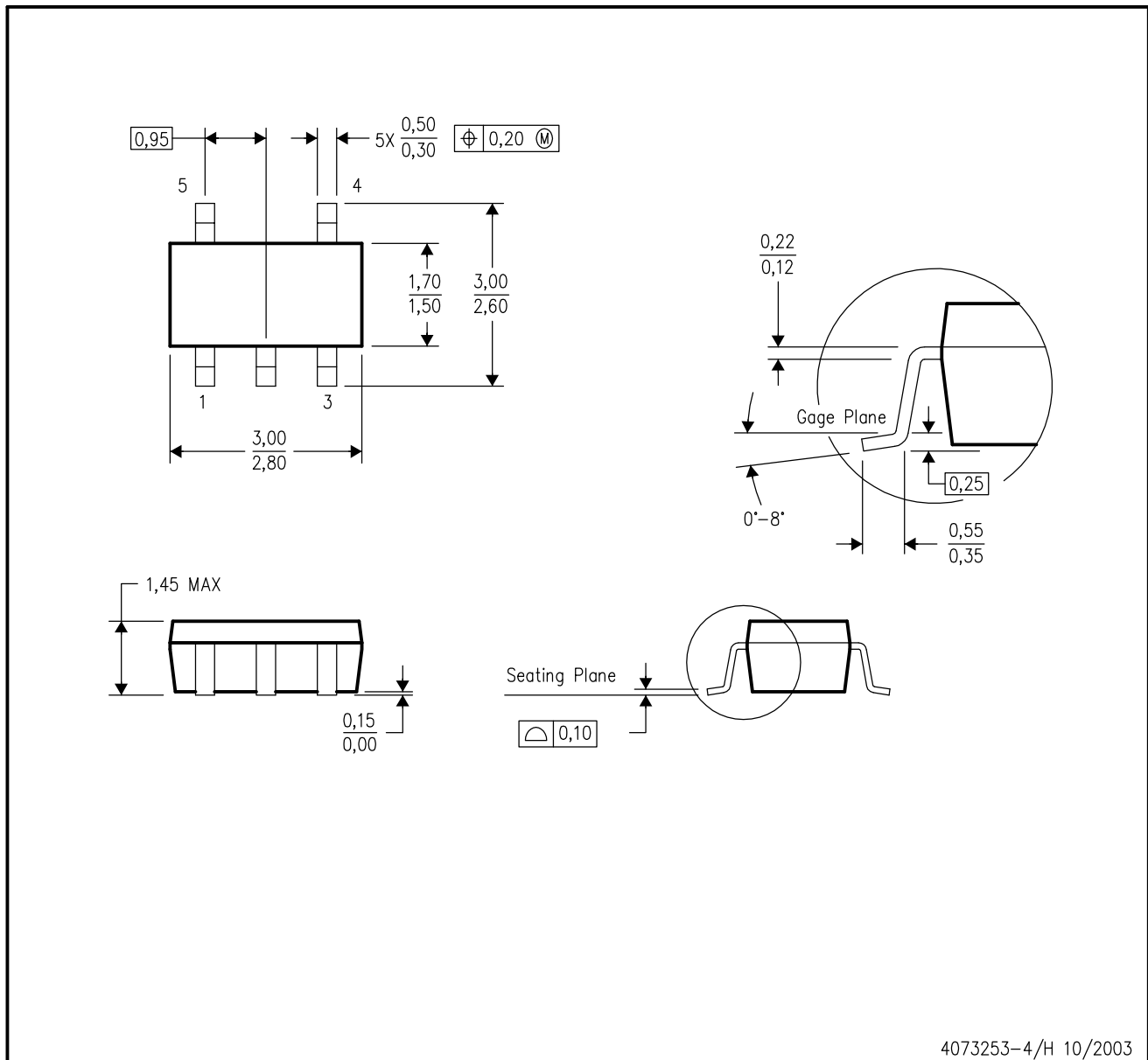
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.





DBV (R-PDSO-G5)

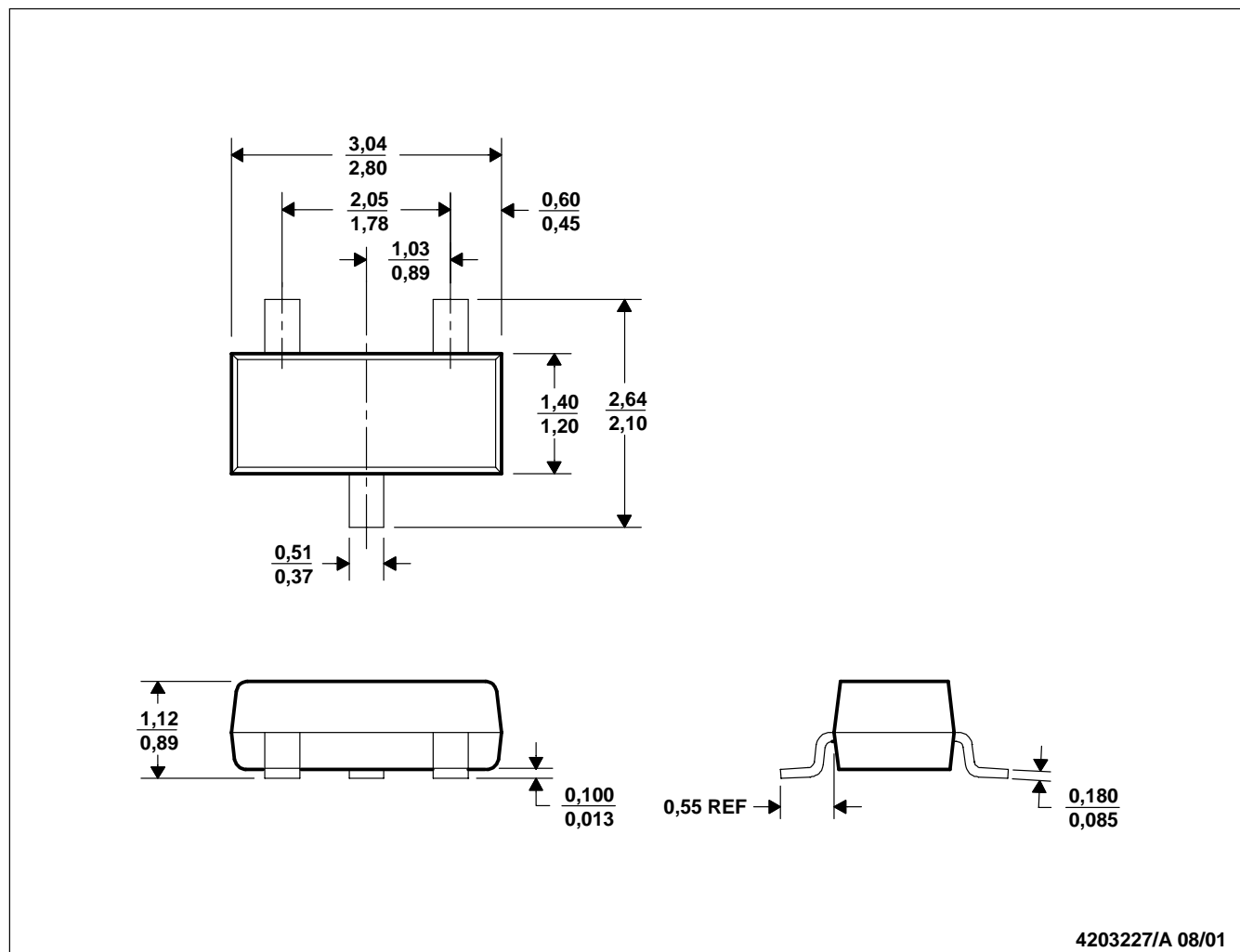
PLASTIC SMALL-OUTLINE PACKAGE



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

DBZ (R-PDSO-G3)

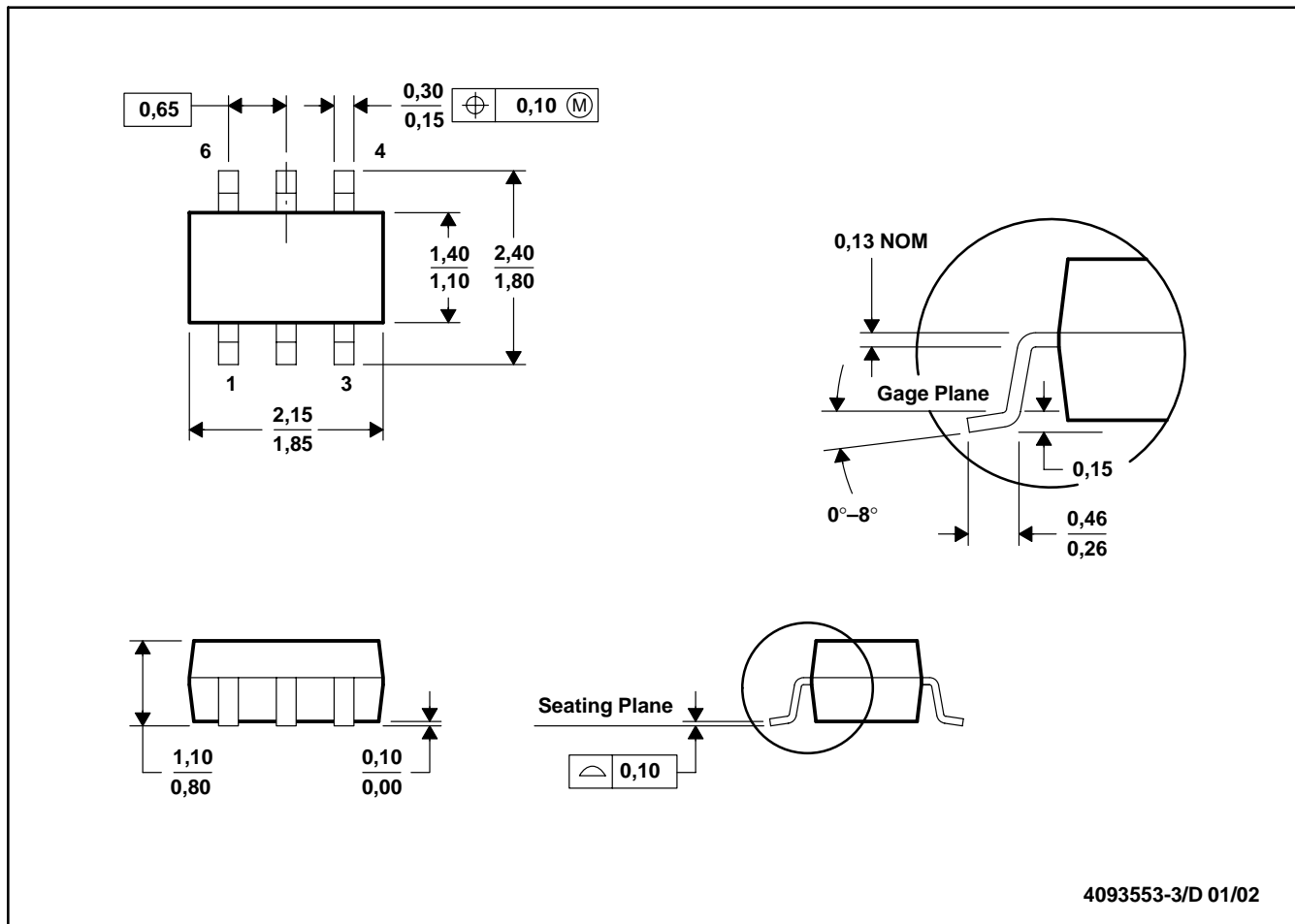
PLASTIC SMALL-OUTLINE



- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Dimensions are inclusive of plating.  
 D. Dimensions are exclusive of mold flash and metal burr.

DCK (R-PDSO-G6)

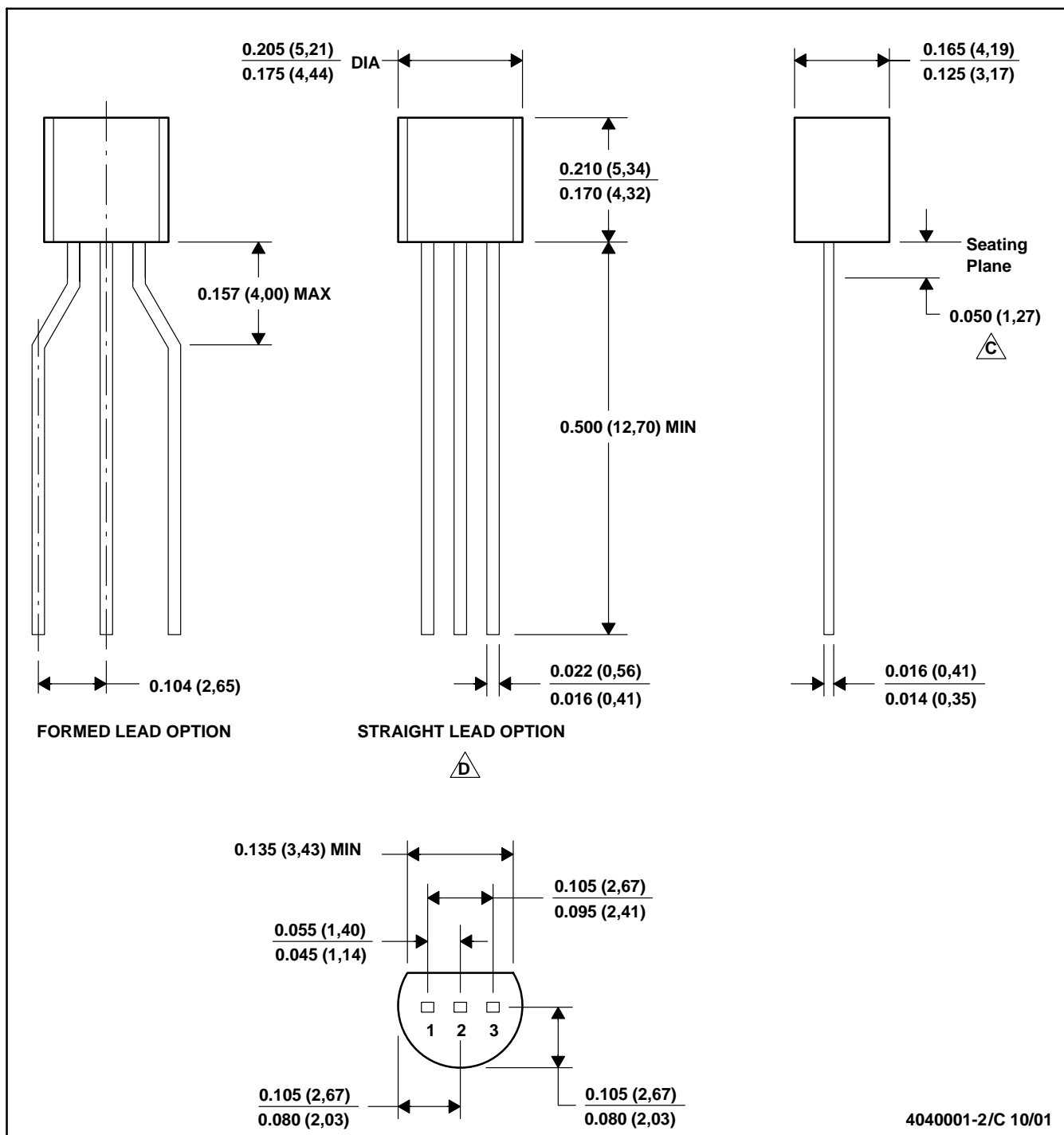
PLASTIC SMALL-OUTLINE PACKAGE



- 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-203

LP (O-PBCY-W3)

PLASTIC CYLINDRICAL PACKAGE



4040001-2/C 10/01

- 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.

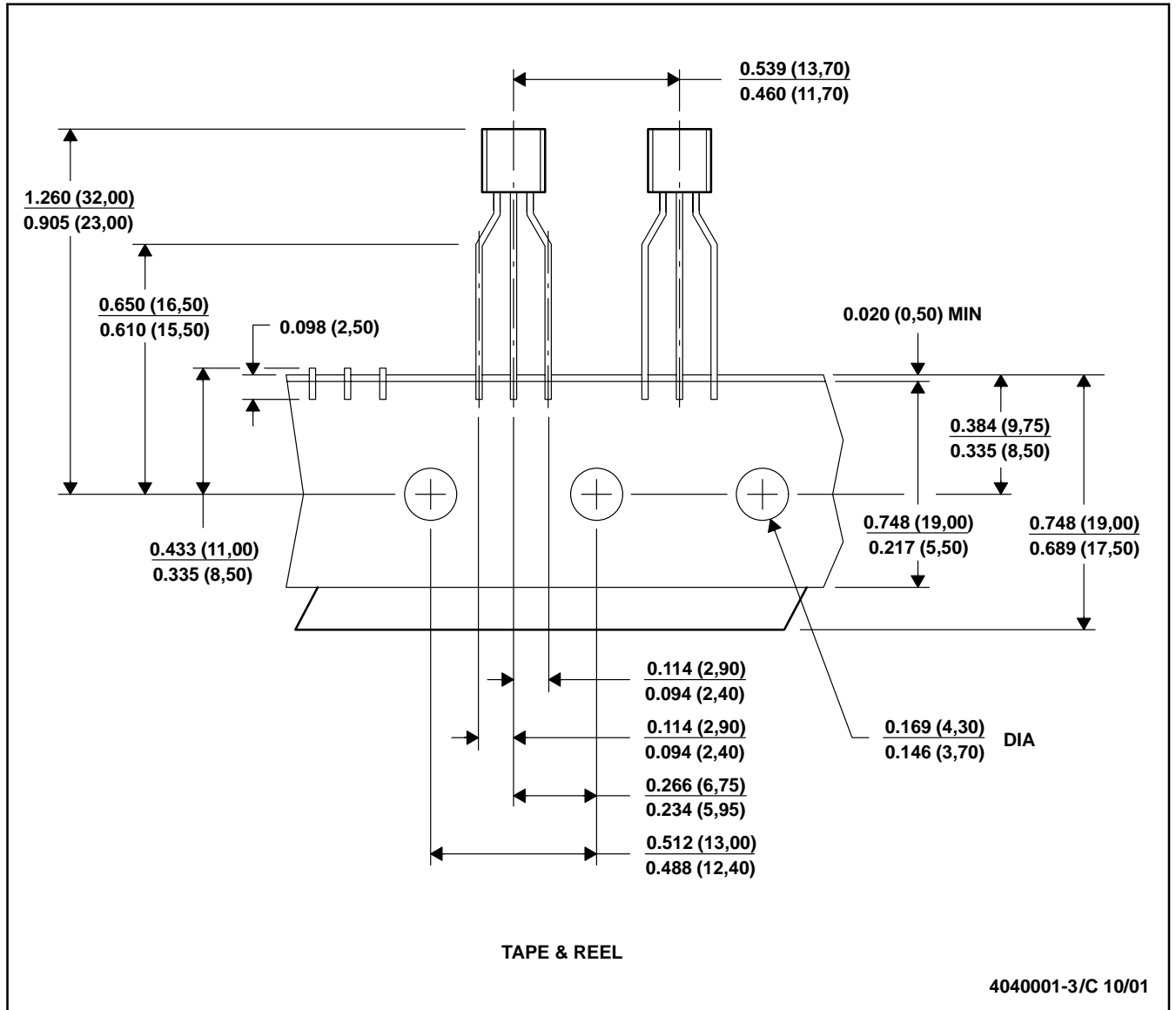


# MECHANICAL DATA

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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