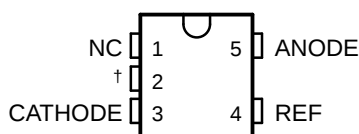


## FEATURES

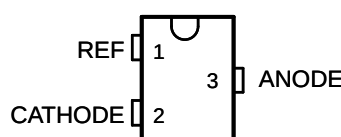
- **Low-Voltage Operation . . . Down to 1.24 V**
- **Reference Voltage Tolerances at 25°C**
  - 0.5% for B Grade
  - 1% for A Grade
  - 1.5% for Standard Grade
- **Adjustable Output Voltage,  $V_O = V_{REF}$  to 18 V**
- **Wide Operating Cathode Current Range . . . 55  $\mu$ A to 80 mA**
- **0.25- $\Omega$  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 (SOT-23-5) PACKAGE  
(TOP VIEW)**

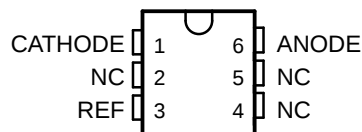


NC - No internal connection  
† Pin 2 must be connected to ANODE or left open.

**TLVH431  
DBZ (SOT-23-3) PACKAGE  
(TOP VIEW)**

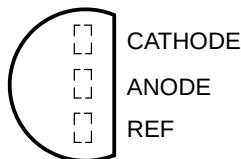


**TLVH431  
DCK (SC-70) PACKAGE  
(TOP VIEW)**

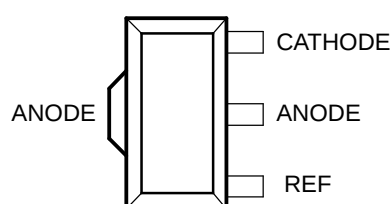


NC - No internal connection

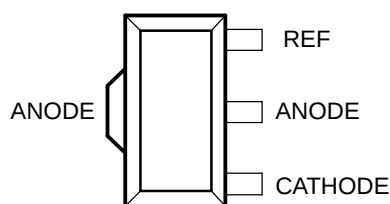
**TLVH431  
LP (TO-92/TO-226) PACKAGE  
(TOP VIEW)**



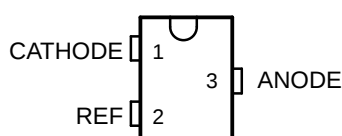
**TLVH431  
PK (SOT-89) PACKAGE  
(TOP VIEW)**



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



**TLVH432  
DBZ (SOT-23-3) 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.



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.

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

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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 SOT-23-3 and SOT-89 packages.

**ORDERING INFORMATION**

| $T_A$       | $V_{REF}$<br>TOLERANCE | PACKAGE <sup>(1)</sup> |              | ORDERABLE PART NUMBER | TOP-SIDE MARKING <sup>(2)</sup> |
|-------------|------------------------|------------------------|--------------|-----------------------|---------------------------------|
| 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         |                                 |
|             |                        | SOT-23-3 – DBZ         | Reel of 3000 | TLVH431BCDBZR         | Y3J_                            |
|             |                        |                        |              | TLVH432BCDBZR         | Y2H_                            |
|             |                        |                        | Reel of 250  | TLVH431BCDBZT         | Y3J_                            |
|             |                        |                        |              | TLVH432BCDBZT         | Y2H_                            |
|             |                        | SOT-89 – PK            | Reel of 1000 | TLVH431BCPK           | V7                              |
|             |                        |                        |              | TLVH432BCPK           | VN                              |
|             |                        | TO-92 – LP             | Bulk of 1000 | TLVH431BCLP           | ZA431B                          |
|             |                        |                        | Reel of 2000 | TLVH431BCLPR          |                                 |
|             | 1%                     | SC-70 – DCK            | Reel of 3000 | TLVH431ACDCKR         | YP_                             |
|             |                        |                        | Reel of 250  | TLVH431ACDCKT         |                                 |
|             |                        | SOT-23-5 – DBV         | Reel of 3000 | TLVH431ACDBVR         | Y3P_                            |
|             |                        |                        | Reel of 250  | TLVH431ACDBVT         |                                 |
|             |                        | SOT-23-3 – DBZ         | Reel of 3000 | TLVH431ACDBZR         | Y3P_                            |
|             |                        |                        |              | TLVH432ACDBZR         | Y2E_                            |
|             |                        |                        | Reel of 250  | TLVH431ACDBZT         | Y3P_                            |
|             |                        |                        |              | TLVH432ACDBZT         | Y2E_                            |
|             |                        | SOT-89 – PK            | Reel of 1000 | TLVH431ACPK           | W2                              |
|             |                        |                        |              | TLVH432ACPK           | VK                              |
|             |                        | TO-92 – LP             | Bulk of 1000 | TLVH431ACL            | ZA431A                          |
|             |                        |                        | Reel of 2000 | TLVH431ACLPR          |                                 |
|             | 1.5%                   | SC-70 – DCK            | Reel of 3000 | TLVH431CDCKR          | YU_                             |
|             |                        |                        | Reel of 250  | TLVH431CDCKT          |                                 |
|             |                        | SOT-23-5 – DBV         | Reel of 3000 | TLVH431CDBVR          | Y3U_                            |
|             |                        |                        | Reel of 250  | TLVH431CDBVT          |                                 |
|             |                        | SOT-23-3 – DBZ         | Reel of 3000 | TLVH431CDBZR          | Y3U_                            |
|             |                        |                        |              | TLVH432CDBZR          | Y2A_                            |
|             |                        |                        | Reel of 250  | TLVH431CDBZT          | Y3U_                            |
|             |                        |                        |              | TLVH432CDBZT          | Y2A_                            |
|             |                        | SOT-89 – PK            | Reel of 1000 | TLVH431CPK            | W4                              |
|             |                        |                        |              | TLVH432CPK            | VG                              |
|             |                        | TO-92 – LP             | Bulk of 1000 | TLVH431CLP            | ZA431                           |
|             |                        |                        | Reel of 2000 | TLVH431CLPR           |                                 |

(1) 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).

(2) 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 REGULATORS

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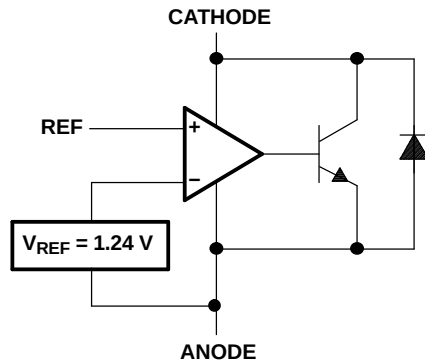
ORDERING INFORMATION (continued)

| $T_A$         | $V_{REF}$<br>TOLERANCE | PACKAGE <sup>(1)</sup> |              | ORDERABLE PART NUMBER | TOP-SIDE MARKING <sup>(2)</sup> |
|---------------|------------------------|------------------------|--------------|-----------------------|---------------------------------|
| –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         |                                 |
|               |                        | SOT-23-3 – DBZ         | Reel of 3000 | TLVH431BIDBZR         | Y3K_                            |
|               |                        |                        |              | TLVH432BIDBZR         | Y2J_                            |
|               |                        |                        | Reel of 250  | TLVH431BIDBZT         | Y3K_                            |
|               |                        |                        |              | TLVH432BIDBZT         | Y2J_                            |
|               |                        | SOT-89 – PK            | Reel of 1000 | TLVH431BIPK           | V8                              |
|               |                        |                        |              | TLVH432BIPK           | VP                              |
|               |                        | TO-92 – LP             | Bulk of 1000 | TLVH431BILP           | ZB431B                          |
|               |                        |                        | Reel of 2000 | TLVH431BILPR          |                                 |
|               | 1%                     | SC-70 – DCK            | Reel of 3000 | TLVH431AIDCKR         | YT_                             |
|               |                        |                        | Reel of 250  | TLVH431AIDCKT         |                                 |
|               |                        | SOT-23-5 – DBV         | Reel of 3000 | TLVH431AIDBVR         | Y3T_                            |
|               |                        |                        | Reel of 250  | TLVH431AIDBVT         |                                 |
|               |                        | SOT-23-3 – DBZ         | Reel of 3000 | TLVH431AIDBZR         | Y3T_                            |
|               |                        |                        |              | TLVH432AIDBZR         | Y2F_                            |
|               |                        |                        | Reel of 250  | TLVH431AIDBZT         | Y3T_                            |
|               |                        |                        |              | TLVH432AIDBZT         | Y2F_                            |
|               |                        | SOT-89 – PK            | Reel of 1000 | TLVH431AIPK           | W3                              |
|               |                        |                        |              | TLVH432AIPK           | VL                              |
|               |                        | TO-92 – LP             | Bulk of 1000 | TLVH431AILP           | ZB431A                          |
|               |                        |                        | Reel of 2000 | TLVH431AILPR          |                                 |
|               | 1.5%                   | SC-70 – DCK            | Reel of 3000 | TLVH431IDCKR          | YV_                             |
|               |                        |                        | Reel of 250  | TLVH431IDCKT          |                                 |
|               |                        | SOT-23-5 – DBV         | Reel of 3000 | TLVH431IDBVR          | Y3V_                            |
|               |                        |                        | Reel of 250  | TLVH431IDBVT          |                                 |
|               |                        | SOT-23-3 – DBZ         | Reel of 3000 | TLVH431IDBZR          | Y3V_                            |
|               |                        |                        |              | TLVH432IDBZR          | Y2B_                            |
|               |                        |                        | Reel of 250  | TLVH431IDBZT          | Y3V_                            |
|               |                        |                        |              | TLVH432IDBZT          | Y2B_                            |
|               |                        | SOT-89 – PK            | Reel of 1000 | TLVH431IPK            | W5                              |
|               |                        |                        |              | TLVH432IPK            | VH                              |
|               |                        | TO-92 – LP             | Bulk of 1000 | TLVH431ILP            | ZB431                           |
|               |                        |                        | Reel of 2000 | TLVH431ILPR           |                                 |

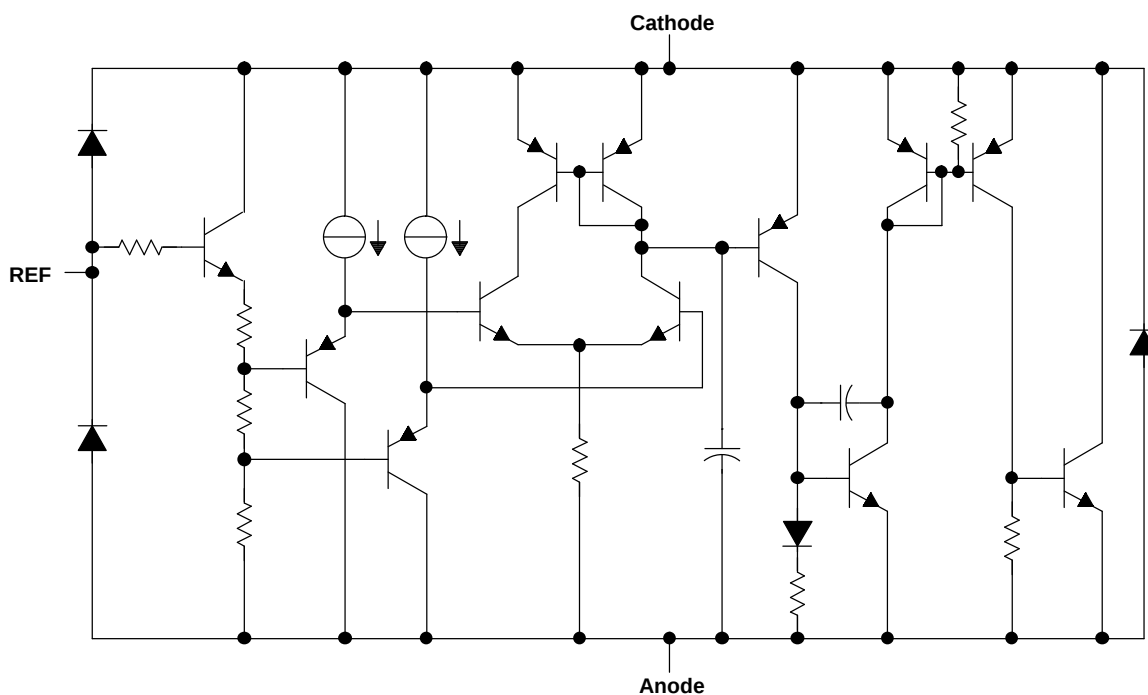
**ORDERING INFORMATION (continued)**

| $T_A$          | $V_{REF}$<br>TOLERANCE | PACKAGE <sup>(1)</sup> |              | ORDERABLE PART NUMBER | TOP-SIDE MARKING <sup>(2)</sup> |
|----------------|------------------------|------------------------|--------------|-----------------------|---------------------------------|
| –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         |                                 |
|                |                        | SOT-23-3 – DBZ         | Reel of 3000 | TLVH431BQDBZR         | Y3L_                            |
|                |                        |                        |              | TLVH432BQDBZR         | Y2K_                            |
|                |                        |                        | Reel of 250  | TLVH431BQDBZT         | Y3L_                            |
|                |                        |                        |              | TLVH432BQDBZT         | Y2K_                            |
|                |                        | SOT-89 – PK            | Reel of 1000 | TLVH431BQPK           | V9                              |
|                |                        |                        |              | TLVH432BQPK           | VQ                              |
|                |                        | TO-92 – LP             | Bulk of 1000 | TLVH431BQLP           | ZD431B                          |
|                |                        |                        | Reel of 2000 | TLVH431BQLPR          |                                 |
|                | 1%                     | SC-70 – DCK            | Reel of 3000 | TLVH431AQDCKR         | YN_                             |
|                |                        |                        | Reel of 250  | TLVH431AQDCKT         |                                 |
|                |                        | SOT-23-5 – DBV         | Reel of 3000 | TLVH431AQDBVR         | Y3N_                            |
|                |                        |                        | Reel of 250  | TLVH431AQDBVT         |                                 |
|                |                        | SOT-23-3 – DBZ         | Reel of 3000 | TLVH431AQDBZR         | Y3N_                            |
|                |                        |                        |              | TLVH432AQDBZR         | Y2G_                            |
|                |                        |                        | Reel of 250  | TLVH431AQDBZT         | Y3N_                            |
|                |                        |                        |              | TLVH432AQDBZT         | Y2G_                            |
|                |                        | SOT-89 – PK            | Reel of 1000 | TLVH431AQPK           | VD                              |
|                |                        |                        |              | TLVH432AQPK           | VM                              |
|                |                        | TO-92 – LP             | Bulk of 1000 | TLVH431AQLP           | ZD431A                          |
|                |                        |                        | Reel of 2000 | TLVH431AQLPR          |                                 |
|                | 1.5%                   | SC-70 – DCK            | Reel of 3000 | TLVH431QDCKR          | YM_                             |
|                |                        |                        | Reel of 250  | TLVH431QDCKT          |                                 |
|                |                        | SOT-23-5 – DBV         | Reel of 3000 | TLVH431QDBVR          | Y3M_                            |
|                |                        |                        | Reel of 250  | TLVH431QDBVT          |                                 |
|                |                        | SOT-23-3 – DBZ         | Reel of 3000 | TLVH431QDBZR          | Y3M_                            |
|                |                        |                        |              | TLVH432QDBZR          | Y2D_                            |
|                |                        |                        | Reel of 250  | TLVH431QDBZT          | Y3M_                            |
|                |                        |                        |              | TLVH432QDBZT          | Y2D_                            |
|                |                        | SOT-89 – PK            | Reel of 1000 | TLVH431QPK            | VC                              |
|                |                        |                        |              | TLVH432QPK            | VJ                              |
|                |                        | TO-92 – LP             | Bulk of 1000 | TLVH431QLP            | ZD431                           |
|                |                        |                        | Reel of 2000 | TLVH431QLPR           |                                 |

### LOGIC BLOCK DIAGRAM



### EQUIVALENT SCHEMATIC



## Absolute Maximum Ratings<sup>(1)</sup>

over operating free-air temperature range (unless otherwise noted)

|               |                                             | MIN         | MAX | UNIT |
|---------------|---------------------------------------------|-------------|-----|------|
| $V_{KA}$      | Cathode voltage <sup>(2)</sup>              |             | 20  | V    |
| $I_K$         | Cathode current range                       | –25         | 80  | mA   |
| $I_{ref}$     | Reference current range                     | –0.05       | 3   | mA   |
| $\theta_{JA}$ | Package thermal impedance <sup>(3)(4)</sup> | DBV package |     | 206  |
|               |                                             | DBZ package |     | 206  |
|               |                                             | DCK package |     | 252  |
|               |                                             | LP package  |     | 140  |
|               |                                             | PK package  |     | 52   |
| $T_J$         | Operating virtual junction temperature      |             | 150 | °C   |
| $T_{stg}$     | Storage temperature range                   | –65         | 150 | °C   |

- (1) 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.
- (2) Voltage values are with respect to the anode terminal, unless otherwise noted.
- (3) Maximum power dissipation is a function of  $T_J(\text{max})$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\text{max}) - T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of 150°C can affect reliability.
- (4) 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 | TLVH43X_C | 0   | 70   |
|          |                                | TLVH43X_I | –40 | 85   |
|          |                                | TLVH43X_Q | –40 | 125  |

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

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## TLVH431 Electrical Characteristics

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

| PARAMETER                              |                                                                       | TEST CONDITIONS                                                                                                |                                                                             | TLVH431<br>TLVH432 |       |       | UNIT |
|----------------------------------------|-----------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|--------------------|-------|-------|------|
|                                        |                                                                       |                                                                                                                |                                                                             | MIN                | TYP   | MAX   |      |
| V <sub>REF</sub>                       | Reference voltage                                                     | V <sub>KA</sub> = V <sub>REF</sub> ,<br>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,<br>See <a href="#">Figure 1</a> <sup>(1)</sup> | 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 <sup>(2)</sup> | V <sub>KA</sub> = V <sub>REF</sub> , I <sub>K</sub> = 10 mA, See <a href="#">Figure 1</a> <sup>(1)</sup>       | 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, V <sub>K</sub> = V <sub>REF</sub> to 18 V, See <a href="#">Figure 2</a>                |                                                                             |                    | –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 <a href="#">Figure 2</a>                                    |                                                                             |                    | 0.1   | 0.5   | μA   |
| I <sub>ref(dev)</sub>                  | I <sub>ref</sub> deviation over full temperature range <sup>(2)</sup> | I <sub>K</sub> = 10 mA, R1 = 10 kΩ, R2 = open, See <a href="#">Figure 2</a> <sup>(1)</sup>                     | 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 <a href="#">Figure 1</a>                                              |                                                                             |                    | 60    | 100   | μA   |
| I <sub>K(off)</sub>                    | Off-state cathode current                                             | V <sub>REF</sub> = 0, V <sub>KA</sub> = 18 V, See <a href="#">Figure 3</a>                                     |                                                                             |                    | 0.02  | 0.1   | μA   |
| z <sub>KA</sub>                        | Dynamic impedance <sup>(3)</sup>                                      | V <sub>KA</sub> = V <sub>REF</sub> , f ≤ 1 kHz, I <sub>K</sub> = 0.1 mA to 80 mA, See <a href="#">Figure 1</a> |                                                                             |                    | 0.25  | 0.4   | Ω    |

(1) Full temperature ranges are  $-40^\circ\text{C}$  to  $125^\circ\text{C}$  for TLVH431Q,  $-40^\circ\text{C}$  to  $85^\circ\text{C}$  for TLVH431I, and  $0^\circ\text{C}$  to  $70^\circ\text{C}$  for TLVH431C.

(2) The deviation parameters  $V_{REF(\text{dev})}$  and  $I_{ref(\text{dev})}$  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,  $\alpha V_{REF}$ , is defined as:

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

where  $\Delta T_A$  is the rated operating free-air temperature range of the device.

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

(3) 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:

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

## TLVH431A Electrical Characteristics

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

| PARAMETER                              |                                                                       | TEST CONDITIONS                                                                                                |                                                                             |           | TLVH431A<br>TLVH432A |      |       | UNIT |
|----------------------------------------|-----------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------|----------------------|------|-------|------|
|                                        |                                                                       |                                                                                                                |                                                                             |           | MIN                  | TYP  | MAX   |      |
| V <sub>REF</sub>                       | Reference voltage                                                     | V <sub>KA</sub> = V <sub>REF</sub> ,<br>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,<br>See <a href="#">Figure 1</a> <sup>(1)</sup> | 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 <sup>(2)</sup> | V <sub>KA</sub> = V <sub>REF</sub> , I <sub>K</sub> = 10 mA, See <a href="#">Figure 1</a> <sup>(1)</sup>       | 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            | V <sub>K</sub> = V <sub>REF</sub> to 18 V, I <sub>K</sub> = 10 mA, See <a href="#">Figure 2</a>                |                                                                             |           |                      | –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 <a href="#">Figure 2</a>                                    |                                                                             |           |                      | 0.1  | 0.5   | μA   |
| I <sub>ref(dev)</sub>                  | I <sub>ref</sub> deviation over full temperature range <sup>(2)</sup> | I <sub>K</sub> = 10 mA, R1 = 10 kΩ, R2 = open, See <a href="#">Figure 2</a> <sup>(1)</sup>                     | 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 <a href="#">Figure 1</a>                                              |                                                                             |           |                      | 60   | 100   | μA   |
| I <sub>K(off)</sub>                    | Off-state cathode current                                             | V <sub>REF</sub> = 0, V <sub>KA</sub> = 18 V, See <a href="#">Figure 3</a>                                     |                                                                             |           |                      | 0.02 | 0.1   | μA   |
| z <sub>KA</sub>                        | Dynamic impedance <sup>(3)</sup>                                      | V <sub>KA</sub> = V <sub>REF</sub> , f ≤ 1 kHz, I <sub>K</sub> = 0.1 mA to 80 mA, See <a href="#">Figure 1</a> |                                                                             |           |                      | 0.25 | 0.4   | Ω    |

(1) Full temperature ranges are  $-40^\circ\text{C}$  to  $125^\circ\text{C}$  for TLVH431Q,  $-40^\circ\text{C}$  to  $85^\circ\text{C}$  for TLVH431I, and  $0^\circ\text{C}$  to  $70^\circ\text{C}$  for TLVH431C.

(2) The deviation parameters  $V_{REF(\text{dev})}$  and  $I_{ref(\text{dev})}$  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,  $\alpha V_{REF}$ , is defined as:

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

where  $\Delta T_A$  is the rated operating free-air temperature range of the device.

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

(3) 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:

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

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

SLVS555F–NOVEMBER 2004–REVISED OCTOBER 2005

## TLVH431B Electrical Characteristics

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

| PARAMETER                              |                                                                       | TEST CONDITIONS                                                                                                |                                                                             | TLVH431B<br>TLVH432B |       |       | UNIT |
|----------------------------------------|-----------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|----------------------|-------|-------|------|
|                                        |                                                                       |                                                                                                                |                                                                             | MIN                  | TYP   | MAX   |      |
| V <sub>REF</sub>                       | Reference voltage                                                     | V <sub>KA</sub> = V <sub>REF</sub> ,<br>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,<br>See <a href="#">Figure 1</a> <sup>(1)</sup> | 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 <sup>(2)</sup> | V <sub>KA</sub> = V <sub>REF</sub> , I <sub>K</sub> = 10 mA, See <a href="#">Figure 1</a> <sup>(1)</sup>       | 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, V <sub>K</sub> = V <sub>REF</sub> to 18 V, See <a href="#">Figure 2</a>                |                                                                             |                      | –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 <a href="#">Figure 2</a>                                    |                                                                             |                      | 0.1   | 0.5   | μA   |
| I <sub>ref(dev)</sub>                  | I <sub>ref</sub> deviation over full temperature range <sup>(2)</sup> | I <sub>K</sub> = 10 mA, R1 = 10 kΩ, R2 = open, See <a href="#">Figure 2</a> <sup>(1)</sup>                     | 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 <a href="#">Figure 1</a>                                              |                                                                             |                      | 60    | 100   | μA   |
| I <sub>K(off)</sub>                    | Off-state cathode current                                             | V <sub>REF</sub> = 0, V <sub>KA</sub> = 18 V, See <a href="#">Figure 3</a>                                     |                                                                             |                      | 0.02  | 0.1   | μA   |
| z <sub>KA</sub>                        | Dynamic impedance <sup>(3)</sup>                                      | V <sub>KA</sub> = V <sub>REF</sub> , f ≤ 1 kHz, I <sub>K</sub> = 0.1 mA to 80 mA, See <a href="#">Figure 1</a> |                                                                             |                      | 0.25  | 0.4   | Ω    |

(1) Full temperature ranges are  $-40^\circ\text{C}$  to  $125^\circ\text{C}$  for TLVH431Q,  $-40^\circ\text{C}$  to  $85^\circ\text{C}$  for TLVH431I, and  $0^\circ\text{C}$  to  $70^\circ\text{C}$  for TLVH431C.

(2) The deviation parameters  $V_{REF(\text{dev})}$  and  $I_{ref(\text{dev})}$  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,  $\alpha V_{REF}$ , is defined as:

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

where  $\Delta T_A$  is the rated operating free-air temperature range of the device.

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

(3) 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:

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

## PARAMETER MEASUREMENT INFORMATION

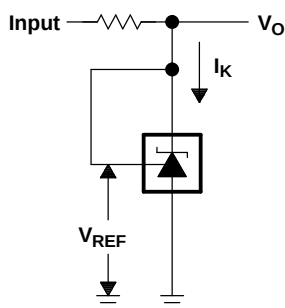


Figure 1. Test Circuit for  $V_{KA} = V_{REF}$ ,  $V_O = V_{KA} = V_{REF}$

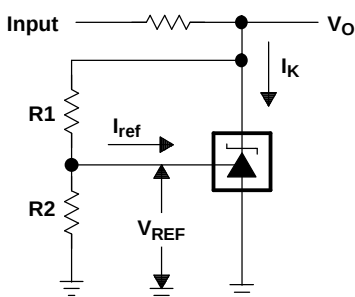


Figure 2. Test Circuit for  $V_{KA} > V_{REF}$ ,  $V_O = V_{KA} = V_{REF} \times (1 + R1/R2) + I_{ref} \times R1$

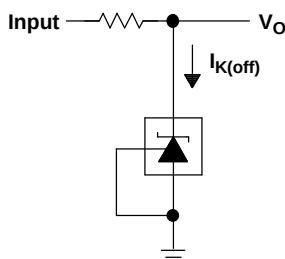


Figure 3. Test Circuit for  $I_{K(off)}$

PARAMETER MEASUREMENT INFORMATION (continued)

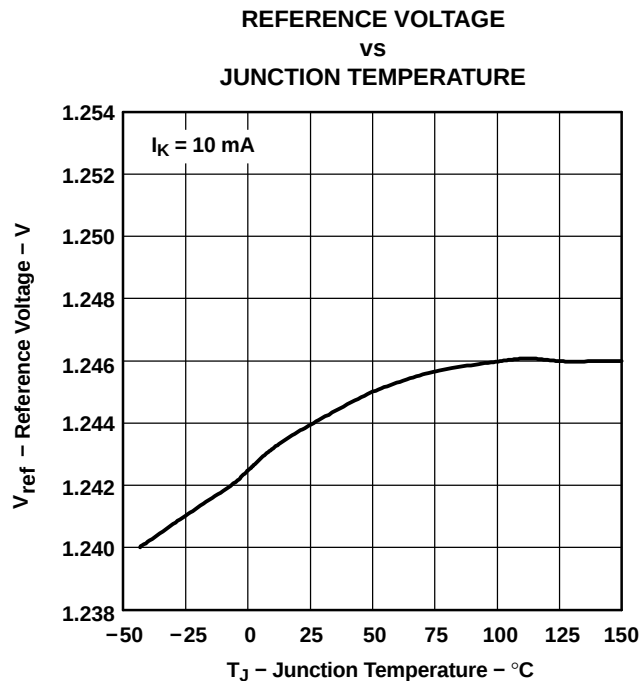


Figure 4.

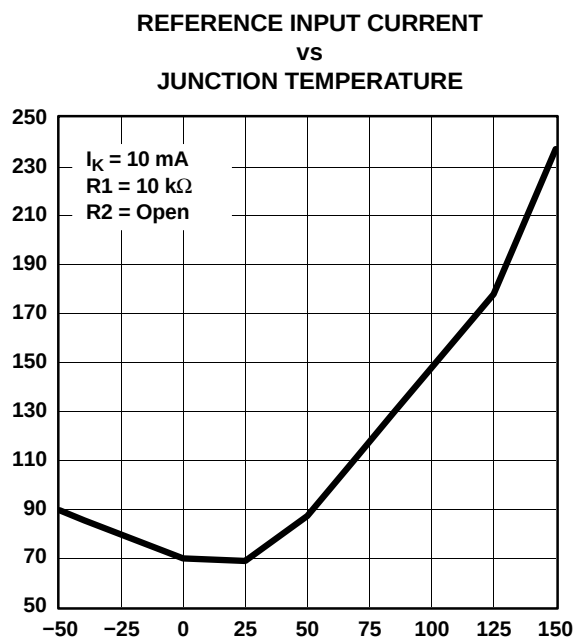


Figure 5.

PARAMETER MEASUREMENT INFORMATION (continued)

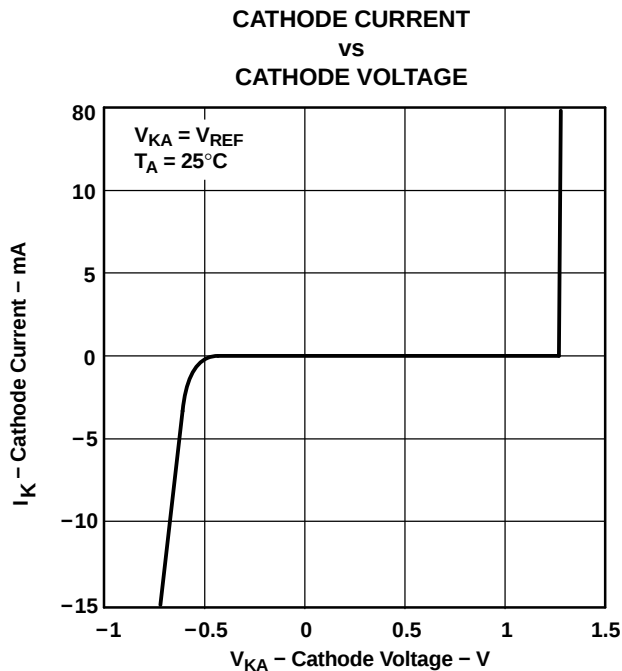


Figure 6.

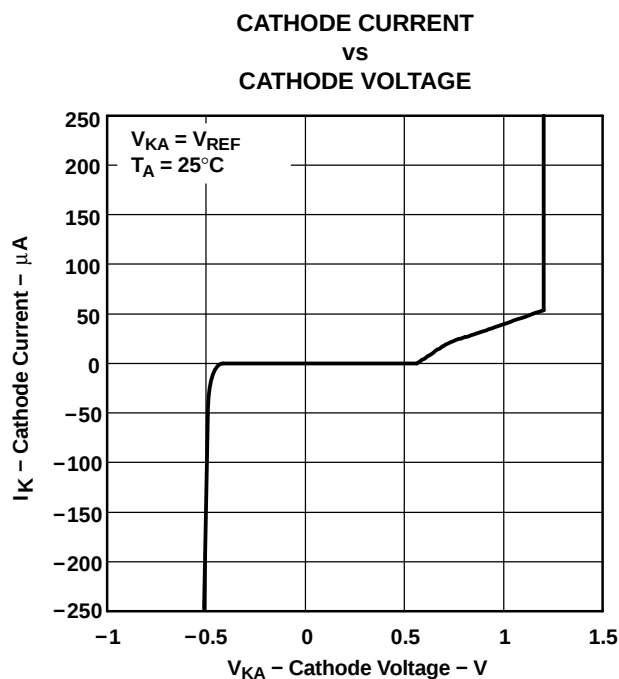


Figure 7.

PARAMETER MEASUREMENT INFORMATION (continued)

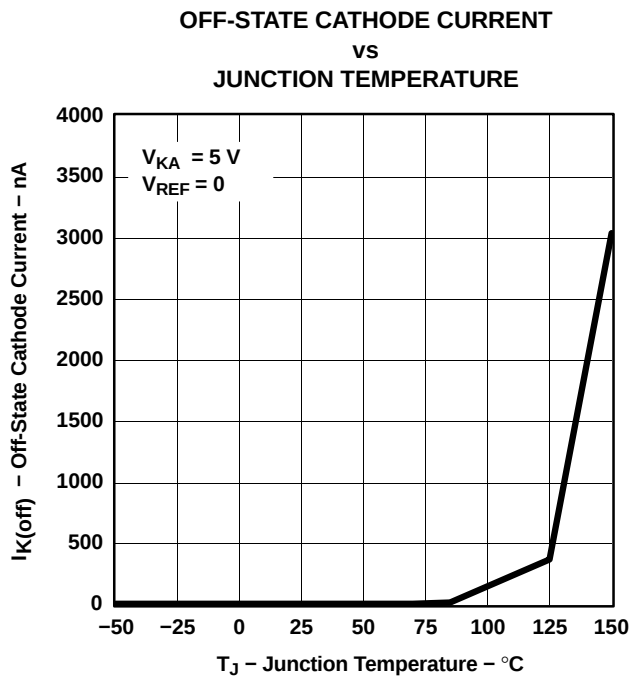


Figure 8.

## PARAMETER MEASUREMENT INFORMATION (continued)

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

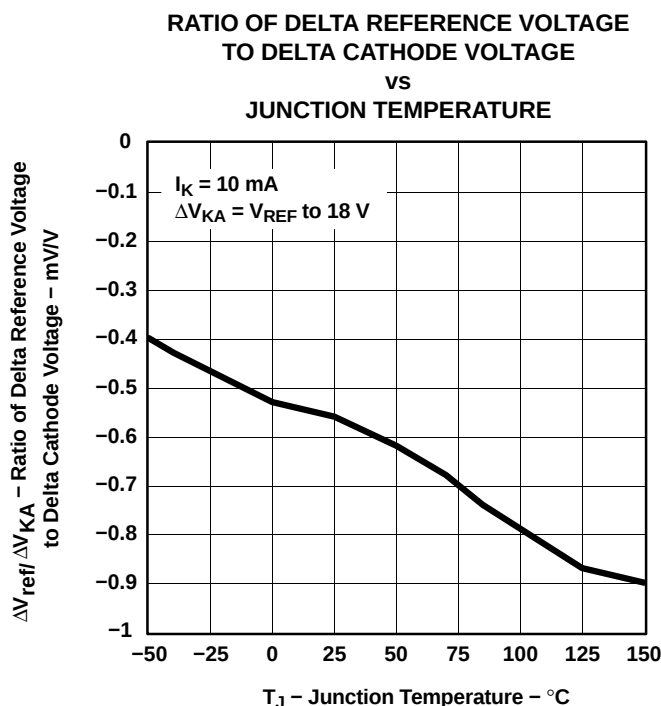
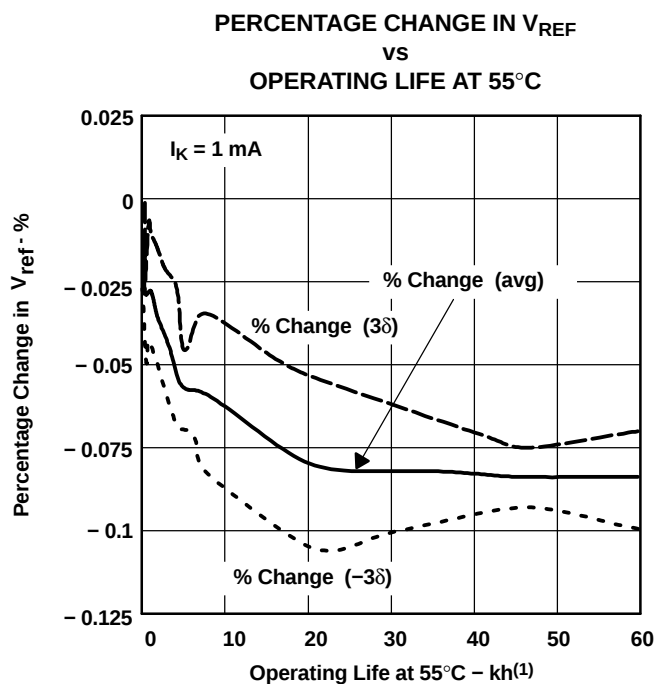


Figure 9.



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

Figure 10.

## PARAMETER MEASUREMENT INFORMATION (continued)

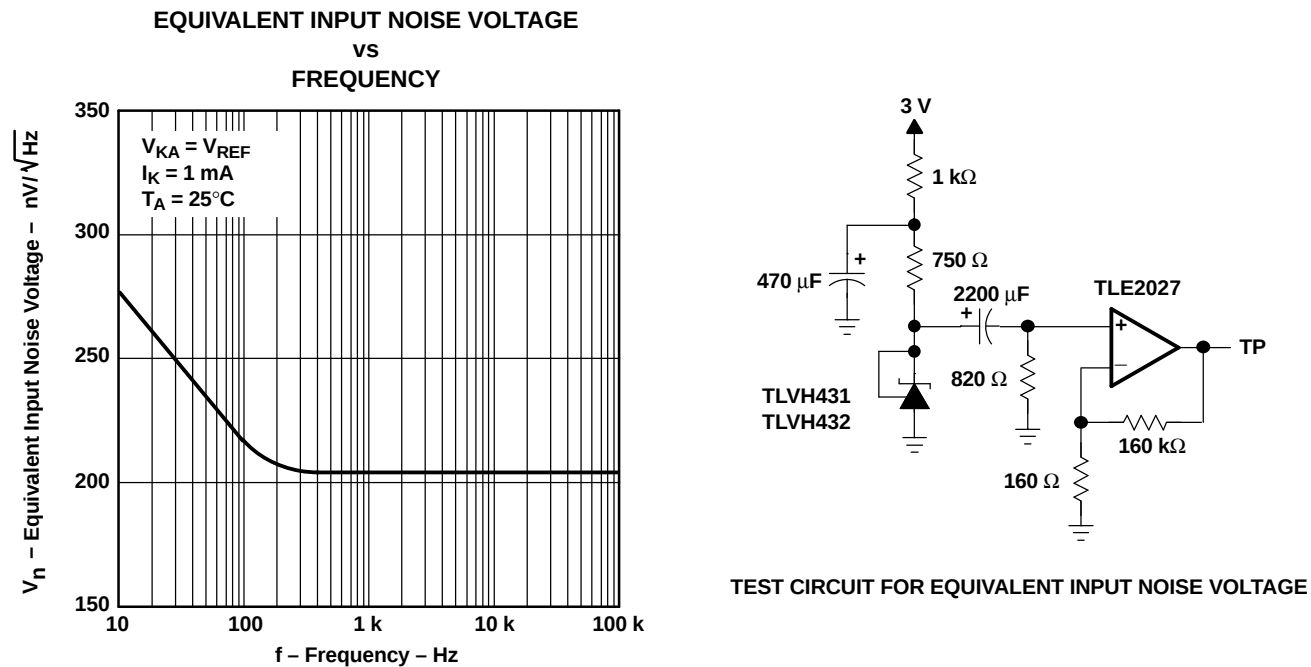
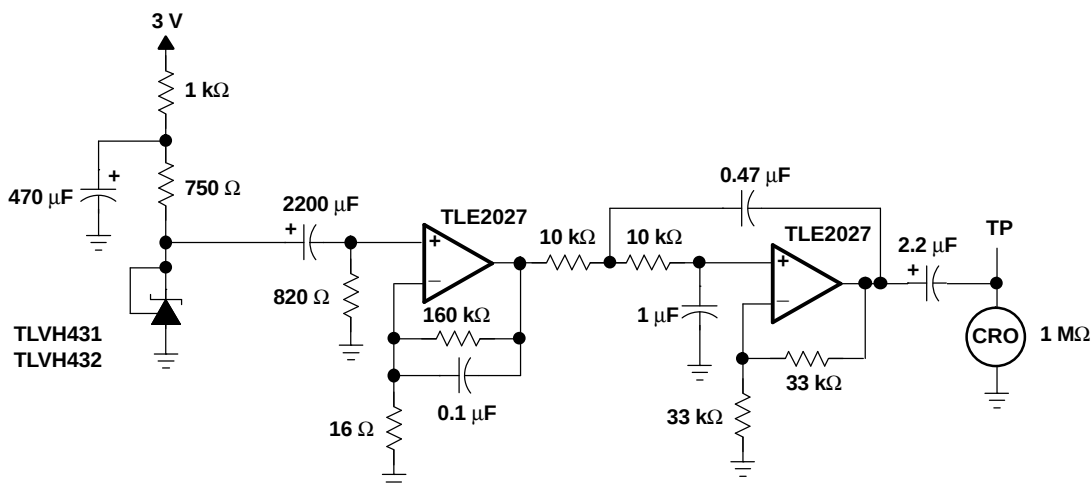
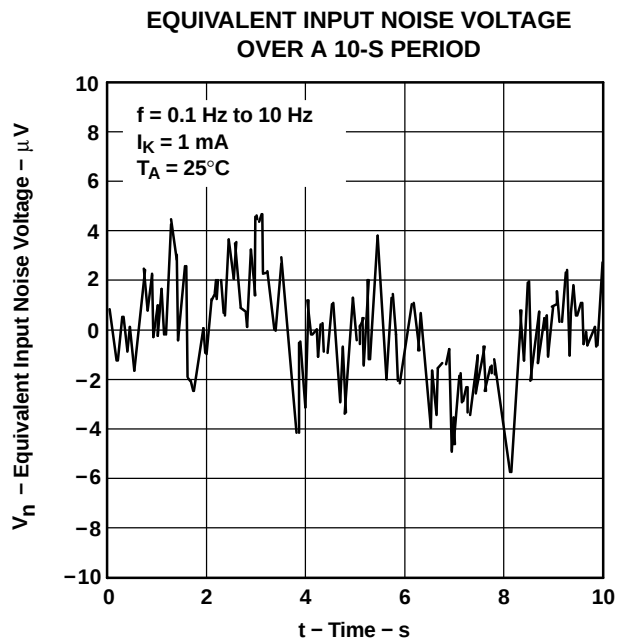


Figure 11.

PARAMETER MEASUREMENT INFORMATION (continued)



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

Figure 12.

PARAMETER MEASUREMENT INFORMATION (continued)

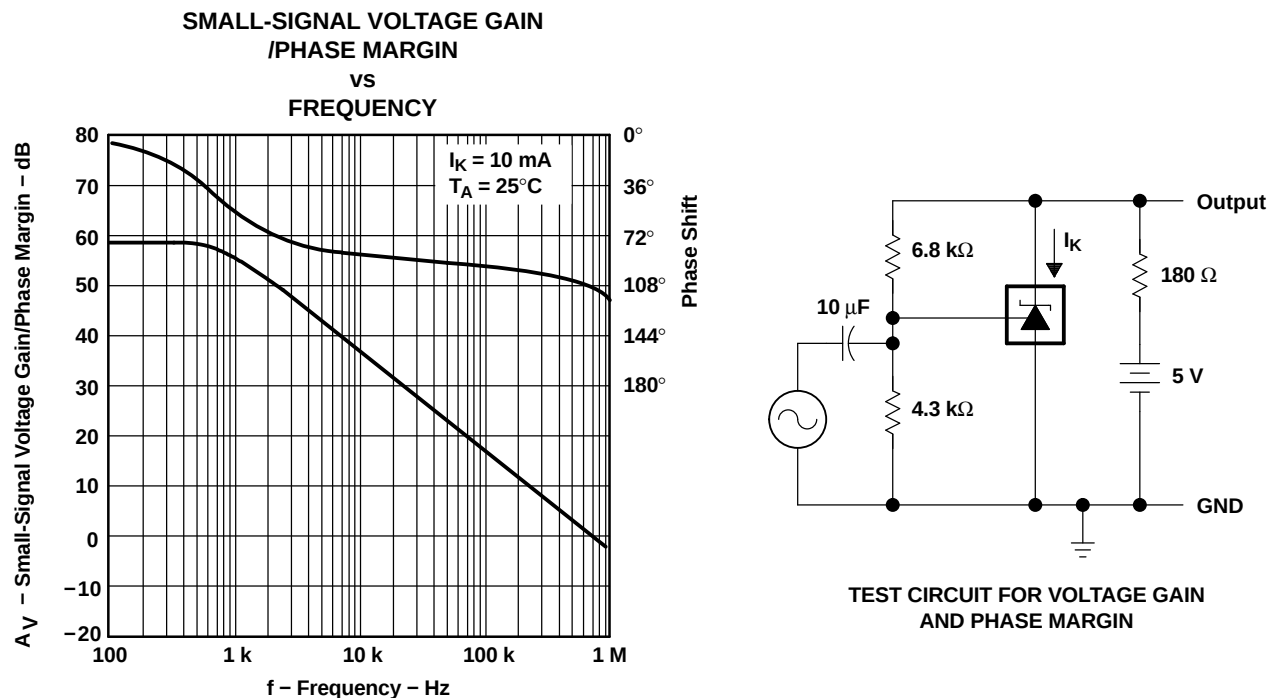


Figure 13.

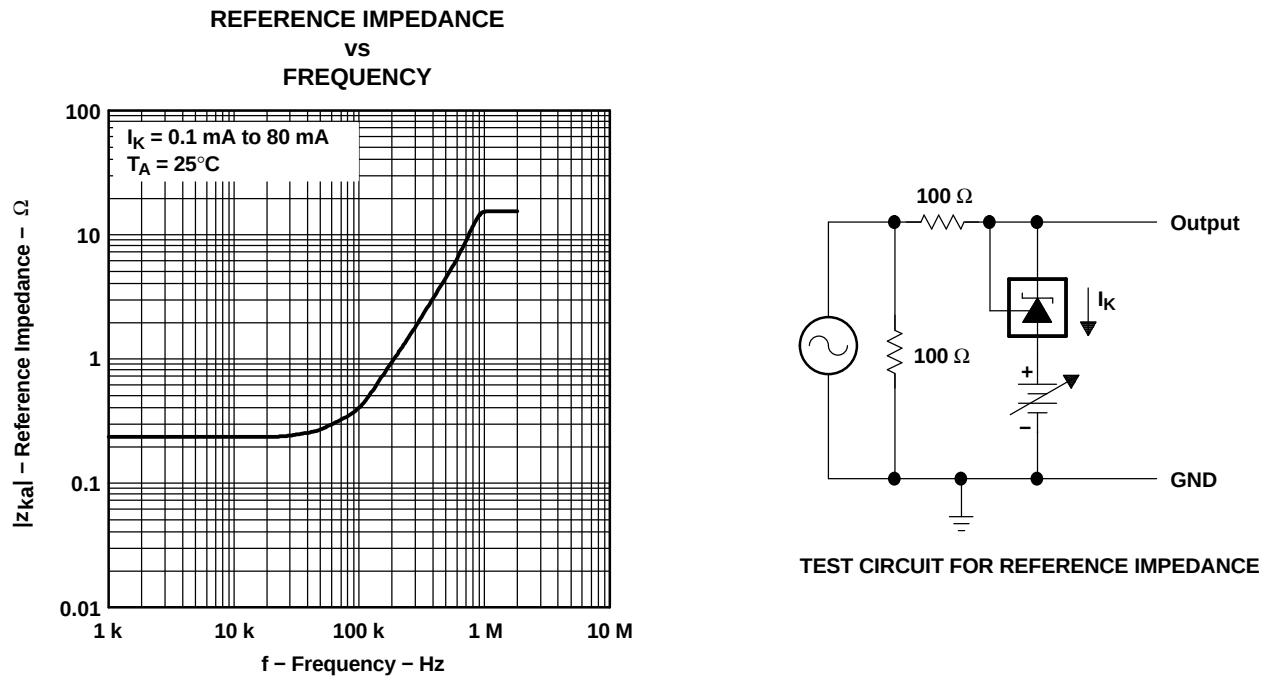
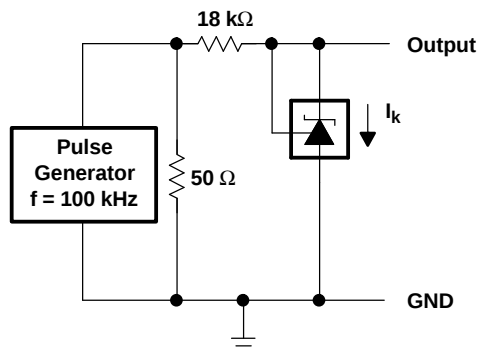
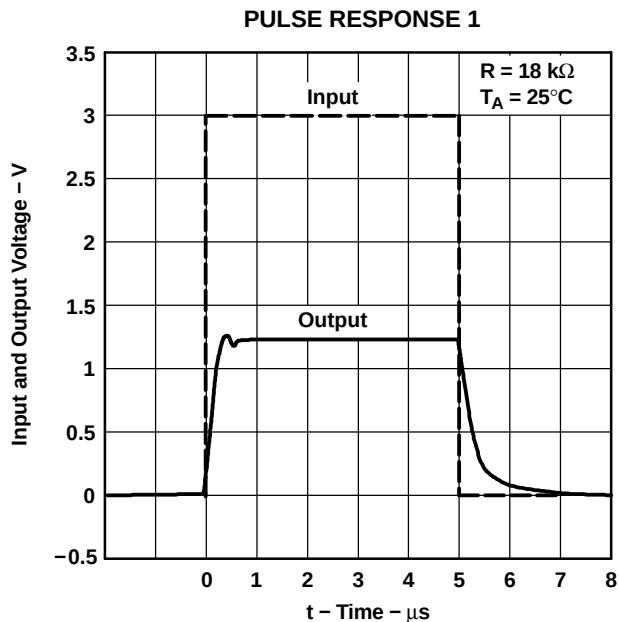


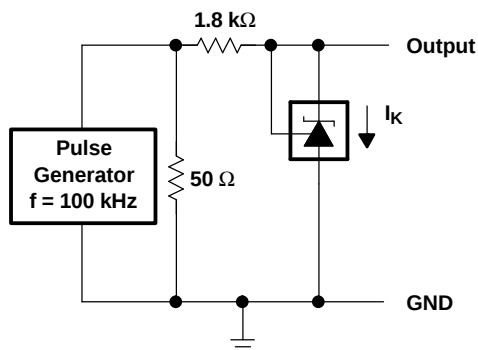
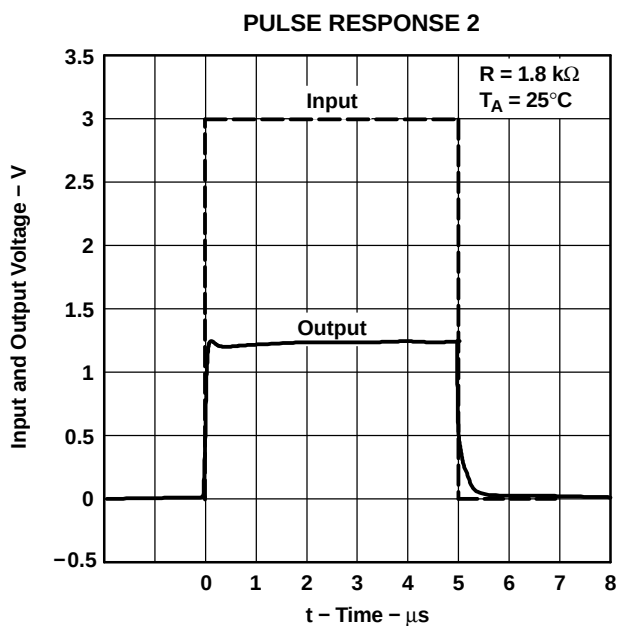
Figure 14.

PARAMETER MEASUREMENT INFORMATION (continued)



TEST CIRCUIT FOR PULSE RESPONSE 1

Figure 15.

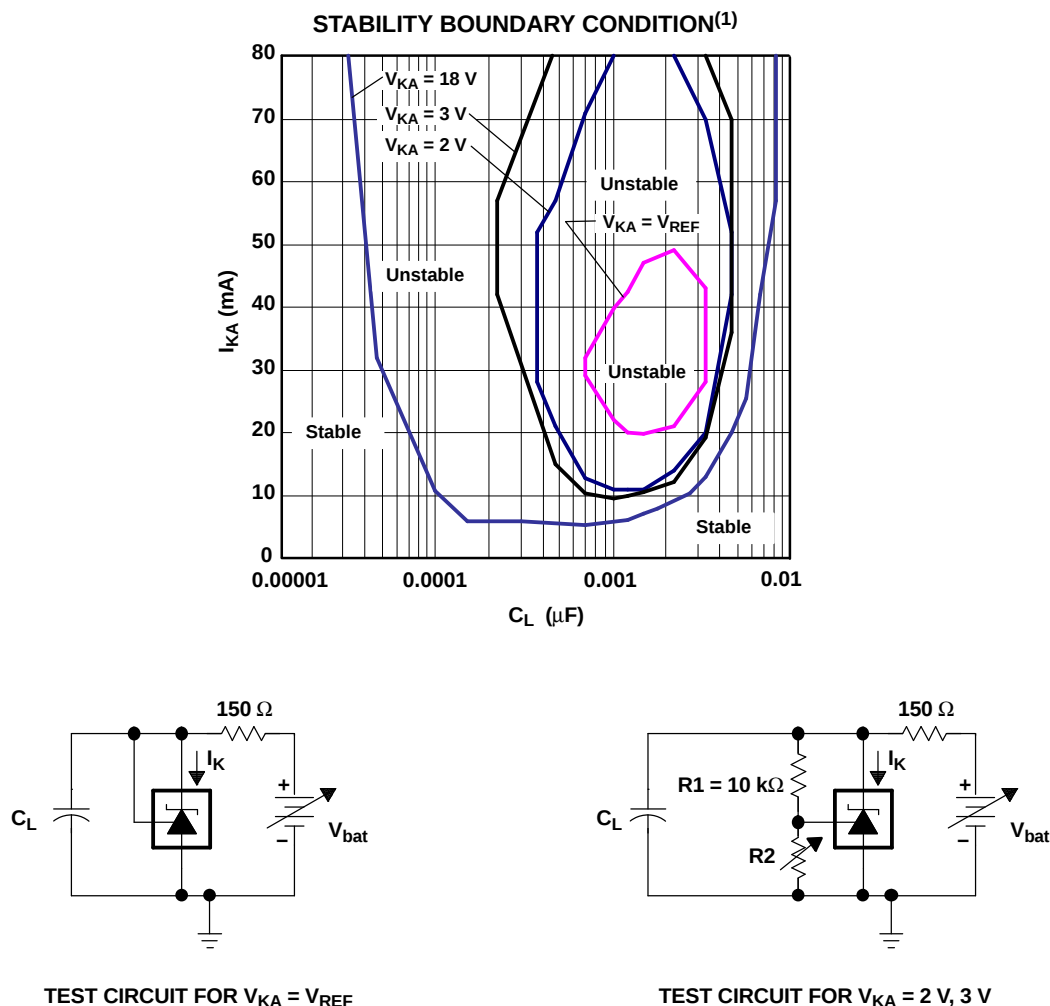


TEST CIRCUIT FOR PULSE RESPONSE 2

Figure 16.

## PARAMETER MEASUREMENT INFORMATION (continued)

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



(1) 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.**



**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    | ACTIVE                | SOT-23       | DBV             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431ACDBVRE4  | ACTIVE                | SOT-23       | DBV             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431ACDBVRG4  | ACTIVE                | SOT-23       | DBV             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431ACDBVT    | ACTIVE                | SOT-23       | DBV             | 5    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431ACDBVTE4  | ACTIVE                | SOT-23       | DBV             | 5    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431ACDBVTG4  | ACTIVE                | SOT-23       | DBV             | 5    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431ACDBZR    | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431ACDBZRG4  | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431ACDBZT    | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431ACDBZTG4  | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431ACDCKR    | ACTIVE                | SC70         | DCK             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431ACDCKRE4  | ACTIVE                | SC70         | DCK             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431ACDCKT    | ACTIVE                | SC70         | DCK             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431ACDCKTE4  | ACTIVE                | SC70         | DCK             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431ACLCP     | ACTIVE                | TO-92        | LP              | 3    | 1000        | TBD                     | CU SNPB          | Level-NC-NC-NC               |
| TLVH431ACLPE3    | ACTIVE                | TO-92        | LP              | 3    | 1000        | Pb-Free (RoHS)          | CU SN            | Level-NC-NC-NC               |
| TLVH431ACLPR     | ACTIVE                | TO-92        | LP              | 3    | 2000        | TBD                     | CU SNPB          | Level-NC-NC-NC               |
| TLVH431ACLPRE3   | ACTIVE                | TO-92        | LP              | 3    | 2000        | Pb-Free (RoHS)          | CU SN            | Level-NC-NC-NC               |
| TLVH431ACPK      | ACTIVE                | SOT-89       | PK              | 3    | 1000        | TBD                     | CU SNPB          | Level-1-220C-UNLIM           |
| TLVH431ACPKG3    | ACTIVE                | SOT-89       | PK              | 3    | 1000        | Green (RoHS & no Sb/Br) | CU SN            | Level-2-260C-1YEAR           |
| TLVH431AIDBVR    | ACTIVE                | SOT-23       | DBV             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431AIDBVRE4  | ACTIVE                | SOT-23       | DBV             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431AIDBVT    | ACTIVE                | SOT-23       | DBV             | 5    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431AIDBVTE4  | ACTIVE                | SOT-23       | DBV             | 5    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431AIDBZR    | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431AIDBZRG4  | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | 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> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TLVH431AIDBZT    | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431AIDBZTG4  | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431AIDCKR    | ACTIVE                | SC70         | DCK             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431AIDCKRE4  | ACTIVE                | SC70         | DCK             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431AIDCKT    | ACTIVE                | SC70         | DCK             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431AIDCKTE4  | ACTIVE                | SC70         | DCK             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431AILP      | ACTIVE                | TO-92        | LP              | 3    | 1000        | TBD                     | CU SNPB          | Level-NC-NC-NC               |
| TLVH431AILPE3    | ACTIVE                | TO-92        | LP              | 3    | 1000        | Pb-Free (RoHS)          | CU SN            | Level-NC-NC-NC               |
| TLVH431AILPR     | ACTIVE                | TO-92        | LP              | 3    | 2000        | TBD                     | CU SNPB          | Level-NC-NC-NC               |
| TLVH431AILPRE3   | ACTIVE                | TO-92        | LP              | 3    | 2000        | Pb-Free (RoHS)          | CU SN            | Level-NC-NC-NC               |
| TLVH431AIPK      | ACTIVE                | SOT-89       | PK              | 3    | 1000        | TBD                     | CU SNPB          | Level-1-220C-UNLIM           |
| TLVH431AIPKG3    | ACTIVE                | SOT-89       | PK              | 3    | 1000        | Green (RoHS & no Sb/Br) | CU SN            | Level-2-260C-1YEAR           |
| TLVH431AQDBVR    | ACTIVE                | SOT-23       | DBV             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431AQDBVRE4  | ACTIVE                | SOT-23       | DBV             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431AQDBVT    | ACTIVE                | SOT-23       | DBV             | 5    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431AQDBVTE4  | ACTIVE                | SOT-23       | DBV             | 5    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431AQDBZR    | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431AQDBZRG4  | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431AQDBZT    | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431AQDBZTG4  | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431AQDCKR    | ACTIVE                | SC70         | DCK             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431AQDCKRE4  | ACTIVE                | SC70         | DCK             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431AQDCKT    | ACTIVE                | SC70         | DCK             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431AQDCKTE4  | ACTIVE                | SC70         | DCK             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431AQLP      | ACTIVE                | TO-92        | LP              | 3    | 1000        | TBD                     | CU SNPB          | Level-NC-NC-NC               |
| TLVH431AQLPR     | ACTIVE                | TO-92        | LP              | 3    | 2000        | TBD                     | CU SNPB          | Level-NC-NC-NC               |
| TLVH431AQP       | ACTIVE                | SOT-89       | PK              | 3    | 1000        | TBD                     | CU SNPB          | Level-1-220C-UNLIM           |
| TLVH431AQPKG3    | ACTIVE                | SOT-89       | PK              | 3    | 1000        | Green (RoHS & no Sb/Br) | CU SN            | Level-2-260C-1YEAR           |

| 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> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TLVH431BCDBVR    | ACTIVE                | SOT-23       | DBV             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431BCDBVRE4  | 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           |
| TLVH431BCDBVTE4  | 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           |
| TLVH431BCDBZRG4  | 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           |
| TLVH431BCDBZTG4  | 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           |
| TLVH431BCDCKRE4  | 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           |
| TLVH431BCDCKTE4  | ACTIVE                | SC70         | DCK             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431BCLP      | ACTIVE                | TO-92        | LP              | 3    | 1000        | TBD                     | CU SNPB          | Level-NC-NC-NC               |
| TLVH431BCLPR     | ACTIVE                | TO-92        | LP              | 3    | 2000        | TBD                     | CU SNPB          | Level-NC-NC-NC               |
| TLVH431BCPK      | ACTIVE                | SOT-89       | PK              | 3    | 1000        | TBD                     | CU SNPB          | Level-1-220C-UNLIM           |
| TLVH431BCPKG3    | ACTIVE                | SOT-89       | PK              | 3    | 1000        | Green (RoHS & no Sb/Br) | CU SN            | Level-2-260C-1YEAR           |
| TLVH431BIDBVR    | ACTIVE                | SOT-23       | DBV             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431BIDBVRE4  | 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           |
| TLVH431BIDBVTE4  | ACTIVE                | SOT-23       | DBV             | 5    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431BIDBZR    | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431BIDBZRG4  | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | 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           |
| TLVH431BIDBZTG4  | 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           |
| TLVH431BIDCKRE4  | 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           |

| 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> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TLVH431BIDCKTE4  | ACTIVE                | SC70         | DCK             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431BILP      | ACTIVE                | TO-92        | LP              | 3    | 1000        | TBD                     | CU SNPB          | Level-NC-NC-NC               |
| TLVH431BILPR     | ACTIVE                | TO-92        | LP              | 3    | 2000        | TBD                     | CU SNPB          | Level-NC-NC-NC               |
| TLVH431BIPK      | ACTIVE                | SOT-89       | PK              | 3    | 1000        | TBD                     | CU SNPB          | Level-1-220C-UNLIM           |
| TLVH431BIPKG3    | ACTIVE                | SOT-89       | PK              | 3    | 1000        | Green (RoHS & no Sb/Br) | CU SN            | Level-2-260C-1YEAR           |
| TLVH431BQDBVR    | ACTIVE                | SOT-23       | DBV             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431BQDBVRE4  | 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           |
| TLVH431BQDBVTE4  | 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           |
| TLVH431BQDBZRG4  | 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           |
| TLVH431BQDBZTG4  | 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           |
| TLVH431BQDCKRE4  | 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           |
| TLVH431BQDCKTE4  | ACTIVE                | SC70         | DCK             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431BQLP      | ACTIVE                | TO-92        | LP              | 3    | 1000        | TBD                     | CU SNPB          | Level-NC-NC-NC               |
| TLVH431BQLPR     | ACTIVE                | TO-92        | LP              | 3    | 2000        | TBD                     | CU SNPB          | Level-NC-NC-NC               |
| TLVH431BQPK      | ACTIVE                | SOT-89       | PK              | 3    | 1000        | TBD                     | CU SNPB          | Level-1-220C-UNLIM           |
| TLVH431BQPKG3    | ACTIVE                | SOT-89       | PK              | 3    | 1000        | Green (RoHS & no Sb/Br) | CU SN            | Level-2-260C-1YEAR           |
| TLVH431CDBVR     | ACTIVE                | SOT-23       | DBV             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431CDBVRE4   | ACTIVE                | SOT-23       | DBV             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431CDBVT     | ACTIVE                | SOT-23       | DBV             | 5    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431CDBVTE4   | ACTIVE                | SOT-23       | DBV             | 5    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431CDBZR     | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431CDBZRG4   | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431CDBZT     | ACTIVE                | SOT-23       | DBZ             | 3    | 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> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TLVH431CDBZTG4   | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431CDCKR     | ACTIVE                | SC70         | DCK             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431CDCKRE4   | ACTIVE                | SC70         | DCK             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431CDCKT     | ACTIVE                | SC70         | DCK             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431CDCKTE4   | ACTIVE                | SC70         | DCK             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431CLP       | ACTIVE                | TO-92        | LP              | 3    | 1000        | TBD                     | CU SNPB          | Level-NC-NC-NC               |
| TLVH431CLPE3     | ACTIVE                | TO-92        | LP              | 3    | 1000        | Pb-Free (RoHS)          | CU SN            | Level-NC-NC-NC               |
| TLVH431CLPR      | ACTIVE                | TO-92        | LP              | 3    | 2000        | TBD                     | CU SNPB          | Level-NC-NC-NC               |
| TLVH431CLPRE3    | ACTIVE                | TO-92        | LP              | 3    | 2000        | Pb-Free (RoHS)          | CU SN            | Level-NC-NC-NC               |
| TLVH431CPK       | ACTIVE                | SOT-89       | PK              | 3    | 1000        | TBD                     | CU SNPB          | Level-1-220C-UNLIM           |
| TLVH431CPKG3     | ACTIVE                | SOT-89       | PK              | 3    | 1000        | Green (RoHS & no Sb/Br) | CU SN            | Level-2-260C-1YEAR           |
| TLVH431IBQDBZR   | PREVIEW               | SOT-23       | DBZ             | 3    |             | TBD                     | Call TI          | Call TI                      |
| TLVH431IDBVR     | ACTIVE                | SOT-23       | DBV             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431IDBVRE4   | ACTIVE                | SOT-23       | DBV             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431IDBVT     | ACTIVE                | SOT-23       | DBV             | 5    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431IDBVTE4   | ACTIVE                | SOT-23       | DBV             | 5    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431IDBZR     | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431IDBZRG4   | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431IDBZT     | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431IDBZTG4   | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431IDCKR     | ACTIVE                | SC70         | DCK             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431IDCKRE4   | ACTIVE                | SC70         | DCK             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431IDCKT     | ACTIVE                | SC70         | DCK             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431IDCKTE4   | ACTIVE                | SC70         | DCK             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431ILP       | ACTIVE                | TO-92        | LP              | 3    | 1000        | TBD                     | CU SNPB          | Level-NC-NC-NC               |
| TLVH431ILPE3     | ACTIVE                | TO-92        | LP              | 3    | 1000        | Pb-Free (RoHS)          | CU SN            | Level-NC-NC-NC               |
| TLVH431ILPR      | ACTIVE                | TO-92        | LP              | 3    | 2000        | TBD                     | CU SNPB          | Level-NC-NC-NC               |
| TLVH431ILPRE3    | ACTIVE                | TO-92        | LP              | 3    | 2000        | Pb-Free (RoHS)          | CU SN            | Level-NC-NC-NC               |

| 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> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TLVH431IPK       | ACTIVE                | SOT-89       | PK              | 3    | 1000        | TBD                     | CU SNPB          | Level-1-220C-UNLIM           |
| TLVH431IPKG3     | ACTIVE                | SOT-89       | PK              | 3    | 1000        | Green (RoHS & no Sb/Br) | CU SN            | Level-2-260C-1YEAR           |
| TLVH431QDBVR     | ACTIVE                | SOT-23       | DBV             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431QDBVRE4   | ACTIVE                | SOT-23       | DBV             | 5    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431QDBVT     | ACTIVE                | SOT-23       | DBV             | 5    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431QDBVTE4   | ACTIVE                | SOT-23       | DBV             | 5    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431QDBZR     | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431QDBZRG4   | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431QDBZT     | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431QDBZTG4   | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431QDCKR     | ACTIVE                | SC70         | DCK             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431QDCKRE4   | ACTIVE                | SC70         | DCK             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431QDCKT     | ACTIVE                | SC70         | DCK             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431QDCKTE4   | ACTIVE                | SC70         | DCK             | 6    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH431QLP       | ACTIVE                | TO-92        | LP              | 3    | 1000        | TBD                     | CU SNPB          | Level-NC-NC-NC               |
| TLVH431QLPR      | ACTIVE                | TO-92        | LP              | 3    | 2000        | TBD                     | CU SNPB          | Level-NC-NC-NC               |
| TLVH431QPK       | ACTIVE                | SOT-89       | PK              | 3    | 1000        | TBD                     | CU SNPB          | Level-1-220C-UNLIM           |
| TLVH431QPKG3     | ACTIVE                | SOT-89       | PK              | 3    | 1000        | Green (RoHS & no Sb/Br) | CU SN            | Level-2-260C-1YEAR           |
| TLVH432ACDBZR    | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432ACDBZRG4  | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432ACDBZT    | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432ACDBZTG4  | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432ACPK      | ACTIVE                | SOT-89       | PK              | 3    | 1000        | TBD                     | CU SNPB          | Level-1-220C-UNLIM           |
| TLVH432ACPKG3    | ACTIVE                | SOT-89       | PK              | 3    | 1000        | Green (RoHS & no Sb/Br) | CU SN            | Level-2-260C-1YEAR           |
| TLVH432AIDBZR    | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432AIDBZRG4  | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432AIDBZT    | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432AIDBZTG4  | ACTIVE                | SOT-23       | DBZ             | 3    | 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> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TLVH432AIPK      | ACTIVE                | SOT-89       | PK              | 3    | 1000        | TBD                     | CU SNPB          | Level-1-220C-UNLIM           |
| TLVH432AIPKG3    | ACTIVE                | SOT-89       | PK              | 3    | 1000        | Green (RoHS & no Sb/Br) | CU SN            | Level-2-260C-1YEAR           |
| TLVH432AQDBZR    | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432AQDBZRG4  | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432AQDBZT    | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432AQDBZTG4  | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432AQP       | ACTIVE                | SOT-89       | PK              | 3    | 1000        | TBD                     | CU SNPB          | Level-1-220C-UNLIM           |
| TLVH432AQPKG3    | ACTIVE                | SOT-89       | PK              | 3    | 1000        | Green (RoHS & no Sb/Br) | CU SN            | Level-2-260C-1YEAR           |
| TLVH432BCDBZR    | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432BCDBZRG4  | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432BCDBZT    | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432BCDBZTG4  | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432BCPK      | ACTIVE                | SOT-89       | PK              | 3    | 1000        | TBD                     | CU SNPB          | Level-1-220C-UNLIM           |
| TLVH432BCPKG3    | ACTIVE                | SOT-89       | PK              | 3    | 1000        | Green (RoHS & no Sb/Br) | CU SN            | Level-2-260C-1YEAR           |
| TLVH432BIDBZR    | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432BIDBZRG4  | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432BIDBZT    | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432BIDBZTG4  | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432BIPK      | ACTIVE                | SOT-89       | PK              | 3    | 1000        | TBD                     | CU SNPB          | Level-1-220C-UNLIM           |
| TLVH432BIPKG3    | ACTIVE                | SOT-89       | PK              | 3    | 1000        | Green (RoHS & no Sb/Br) | CU SN            | Level-2-260C-1YEAR           |
| TLVH432BQDBZR    | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432BQDBZRG4  | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432BQDBZT    | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432BQDBZTG4  | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432BQPK      | ACTIVE                | SOT-89       | PK              | 3    | 1000        | TBD                     | CU SNPB          | Level-1-220C-UNLIM           |
| TLVH432BQPKG3    | ACTIVE                | SOT-89       | PK              | 3    | 1000        | Green (RoHS & no Sb/Br) | CU SN            | Level-2-260C-1YEAR           |
| TLVH432CDBZR     | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432CDBZRG4   | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | 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> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TLVH432CDBZT     | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432CDBZTG4   | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432CPK       | ACTIVE                | SOT-89       | PK              | 3    | 1000        | TBD                     | CU SNPB          | Level-1-220C-UNLIM           |
| TLVH432CPKG3     | ACTIVE                | SOT-89       | PK              | 3    | 1000        | Green (RoHS & no Sb/Br) | CU SN            | Level-2-260C-1YEAR           |
| TLVH432IDBZR     | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432IDBZRG4   | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432IDBZT     | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432IDBZTG4   | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432IPK       | ACTIVE                | SOT-89       | PK              | 3    | 1000        | TBD                     | CU SNPB          | Level-1-220C-UNLIM           |
| TLVH432IPKG3     | ACTIVE                | SOT-89       | PK              | 3    | 1000        | Green (RoHS & no Sb/Br) | CU SN            | Level-2-260C-1YEAR           |
| TLVH432QDBZR     | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432QDBZRG4   | ACTIVE                | SOT-23       | DBZ             | 3    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432QDBZT     | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432QDBZTG4   | ACTIVE                | SOT-23       | DBZ             | 3    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TLVH432QPK       | ACTIVE                | SOT-89       | PK              | 3    | 1000        | TBD                     | CU SNPB          | Level-1-220C-UNLIM           |
| TLVH432QPKG3     | ACTIVE                | SOT-89       | PK              | 3    | 1000        | Green (RoHS & no Sb/Br) | CU SN            | Level-2-260C-1YEAR           |

<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 - The planned eco-friendly classification: Pb-Free (RoHS) 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.

**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)

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

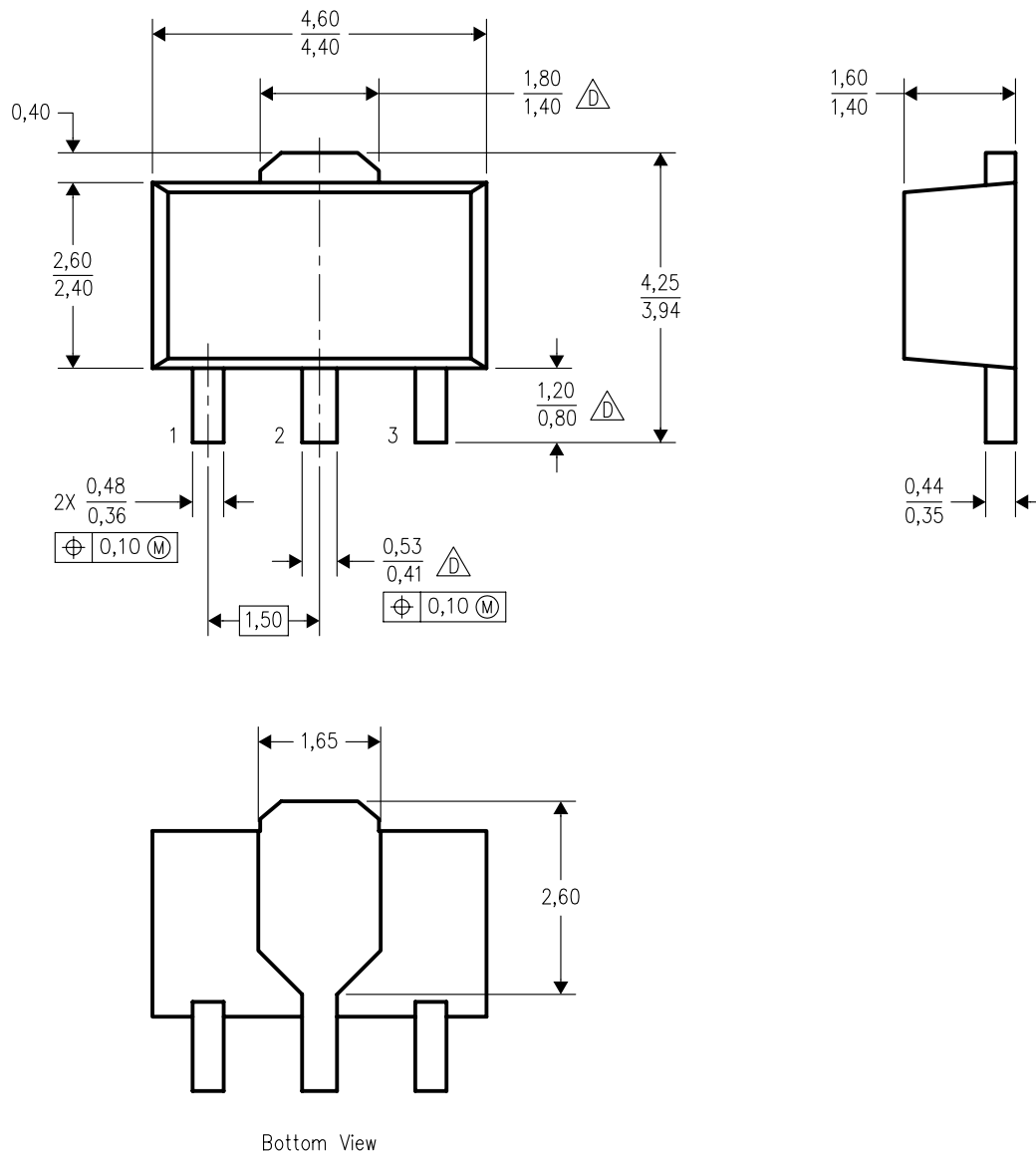
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PK (R-PSSO-F3)

PLASTIC SINGLE-IN-LINE PACKAGE

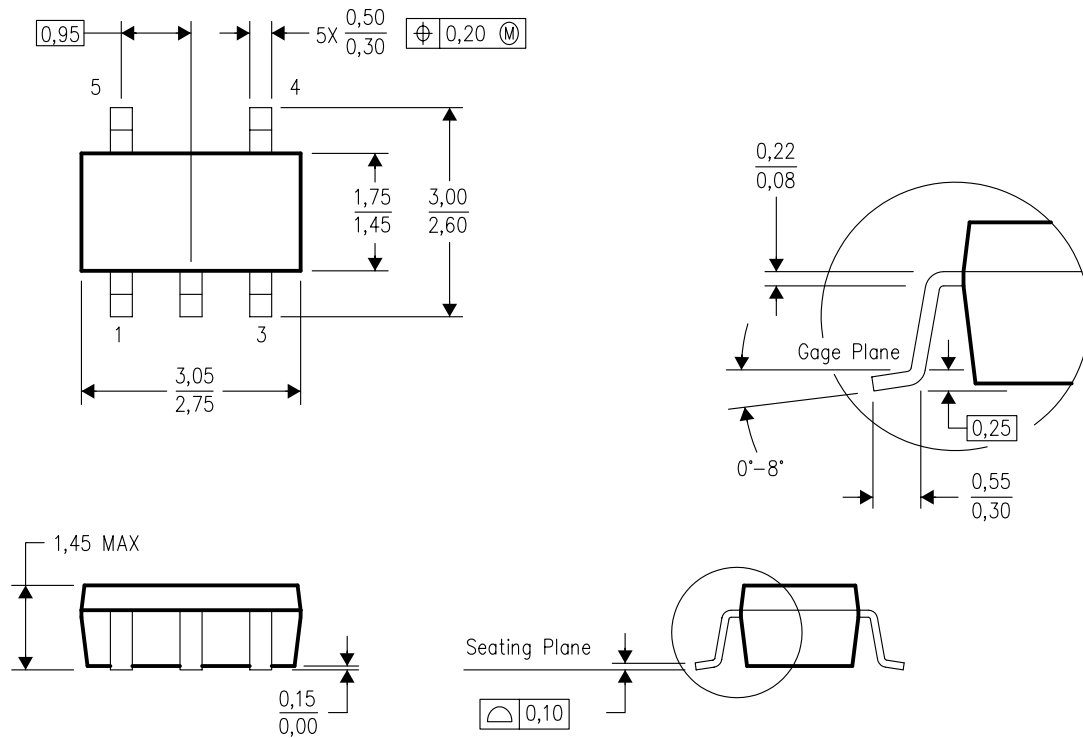


4040234/C 07/2004

- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5-1994.
  - B. This drawing is subject to change without notice.
  - C. The center lead is in electrical contact with the tab.
- $\triangle$  Falls within JEDEC TO-243 variation AA, except minimum lead length, pin 2 minimum lead width, and minimum tab width.

## DBV (R-PDSO-G5)

## PLASTIC SMALL-OUTLINE PACKAGE

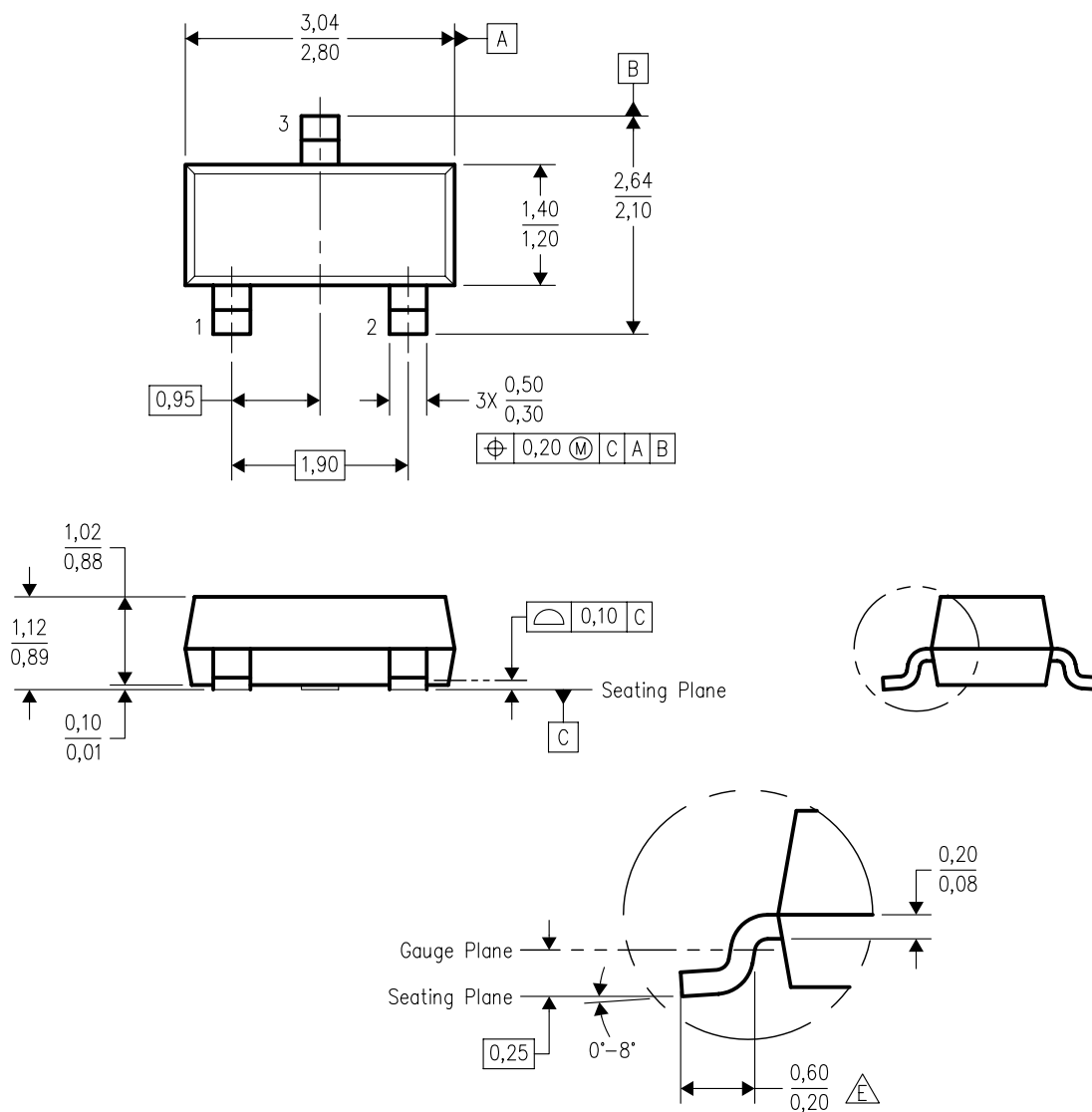


4073253-4/J 10/2005

- 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

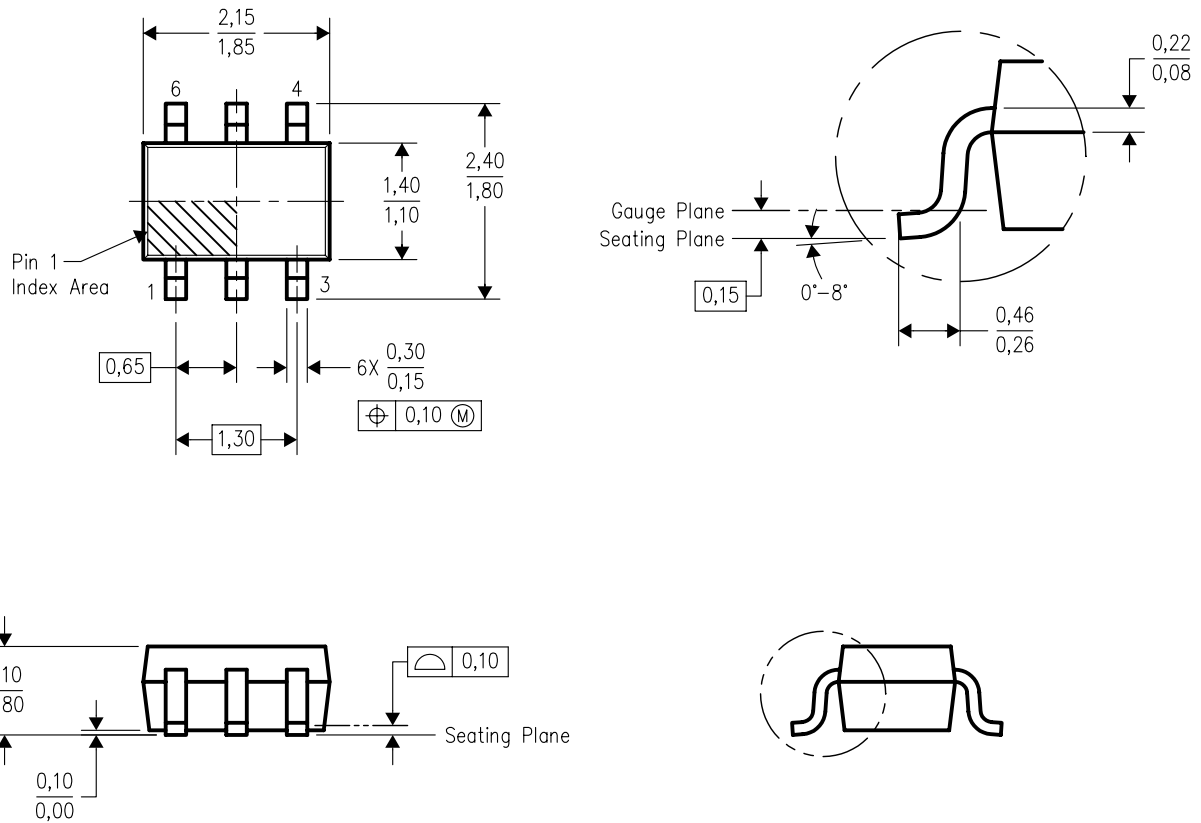


4203227/B 04/2005

- 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.
  - $\triangle E$  Falls within JEDEC TO-236 variation AB, except minimum foot length.

## DCK (R-PDSO-G6)

## PLASTIC SMALL-OUTLINE PACKAGE

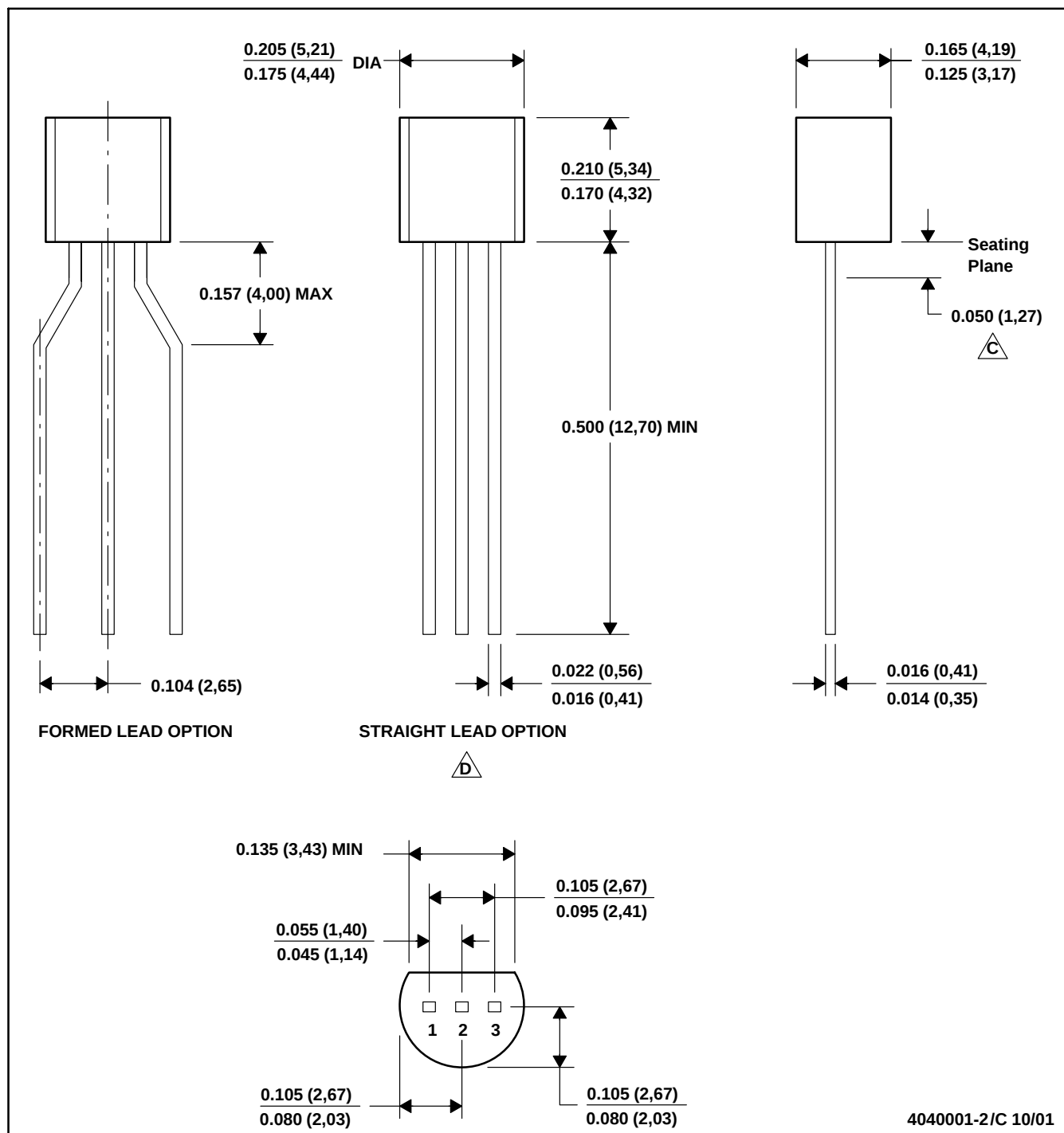


4093553-3/E 10/2005

- 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.

## LP (O-PBCY-W3)

## PLASTIC CYLINDRICAL PACKAGE



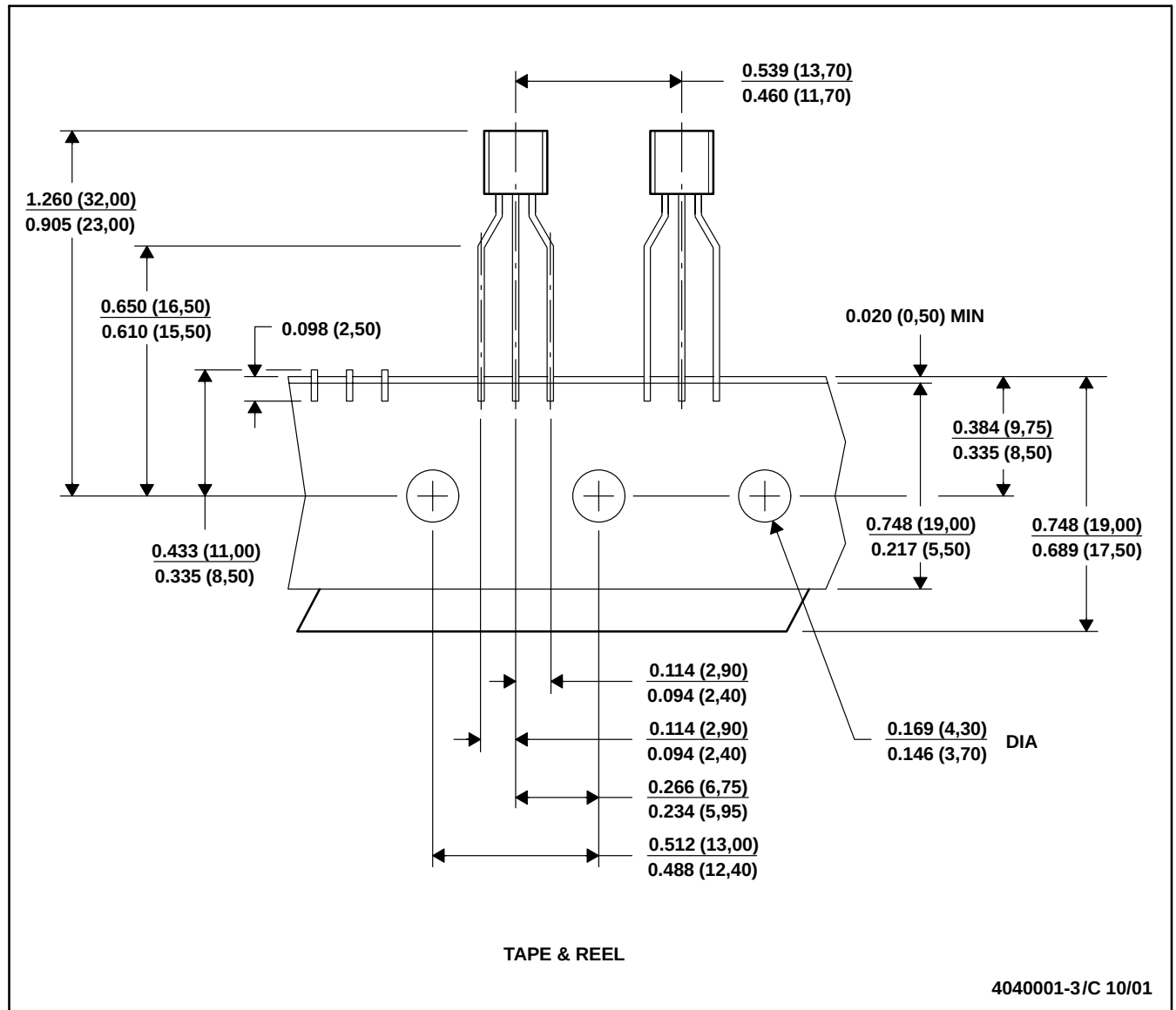
- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Lead dimensions are not controlled within this area.  
 D. Falls within JEDEC TO -226 Variation AA (TO-226 replaces TO-92).  
 E. Shipping Method:  
     Straight lead option available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