TEXAS INSTRUMENTS

TL431, TL431A, TL431B
TL432, TL432A, TL432B

SLVS543O – AUGUST 2004 – REVISED JANUARY 2015

# TL43xx Precision Programmable Reference

## 1 Features

- Reference Voltage Tolerance at 25°C
  - 0.5% (B Grade)
  - 1% (A Grade)
  - 2% (Standard Grade)
- Adjustable Output Voltage: $V_{ref}$ to 36 V
- Operation From −40°C to 125°C
- Typical Temperature Drift (TL431B)
  - 6 mV (C Temp)
  - 14 mV (I Temp, Q Temp)
- Low Output Noise
- 0.2-Ω Typical Output Impedance
- Sink-Current Capability: 1 mA to 100 mA
-

## 2 Applications

- Adjustable Voltage and Current Referencing
- Secondary Side Regulation in Flyback SMPSs
- Zener Replacement
- Voltage Monitoring
- Comparator with Integrated Reference

## 3 Description

The TL431 and TL432 devices are three-terminal adjustable shunt regulators, with specified thermal stability over applicable automotive, commercial, and military temperature ranges. The output voltage can be set to any value between $V_{ref}$ (approximately 2.5 V) and 36 V, with two external resistors. These devices have a typical output impedance of 0.2 Ω. Active output circuitry provides a very sharp turn-on characteristic, making these devices excellent replacements for Zener diodes in many applications, such as onboard regulation, adjustable power supplies, and switching power supplies. The TL432 device has exactly the same functionality and electrical specifications as the TL431 device, but has different pinouts for the DBV, DBZ, and PK packages.

Both the TL431 and TL432 devices are offered in three grades, with initial tolerances (at 25°C) of 0.5%, 1%, and 2%, for the B, A, and standard grade, respectively. In addition, low output drift versus temperature ensures good stability over the entire temperature range.

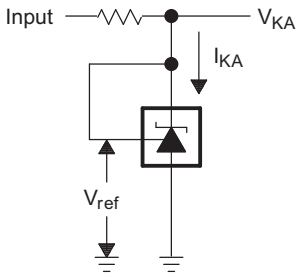
The TL43xxC devices are characterized for operation from 0°C to 70°C, the TL43xxI devices are characterized for operation from –40°C to 85°C, and the TL43xxQ devices are characterized for operation from –40°C to 125°C.

**Device Information(1)**

| PART NUMBER | PACKAGE (PIN) | BODY SIZE (NOM) |
|---|---|---|
| TL43xx | SOT-23-3 (3) | 2.90 mm x 1.30 mm |
| | SOT-23-5 (5) | 2.90 mm x 1.60 mm |
| | SOIC (8) | 4.90 mm x 3.90 mm |
| | PDIP (8) | 9.50 mm x 6.35 mm |
| | SOP (8) | 6.20 mm x 5.30 mm |

(1) For all available packages, see the orderable addendum at the end of the data sheet.

## 4 Simplified Schematic




An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

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## 5 Revision History

**Changes from Revision N (January 2014) to Revision O** — **Page**

- Added *Applications*, *Device Information* table, *Pin Functions* table, *ESD Ratings* table, *Thermal Information* table, , *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section. ... 1
- Added Applications. ... 1
- Moved *Typical Characteristics* into *Specifications* section. ... 14

**Changes from Revision M (July 2012) to Revision N** — **Page**

- Updated document formatting ... 1
- Removed *Ordering Information* table. ... 3
- Added Application Note links. ... 21

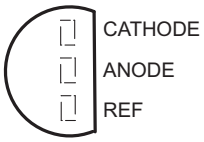
**Changes from Revision K (June 2010) to Revision L** — **Page**

- Deleted $T_A$ values under TEST CONDITIONS for $V_{I(dev)}$ and $I_{I(dev)}$ PARAMETERS in the *Electrical Characteristics* table. .. 5

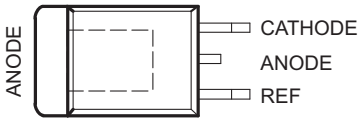

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# 6 Pin Configuration and Functions

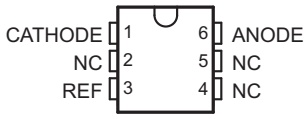
TL431, TL431A, TL431B . . . LP (TO-92/TO-226) PACKAGE
(TOP VIEW)




TL431 . . . KTP (PowerFLEX /TO-252) PACKAGE
(TOP VIEW)

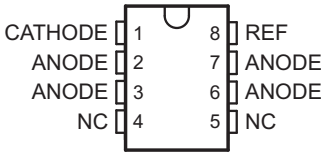



TL431A, TL431B . . . DCK (SC-70) PACKAGE
(TOP VIEW)



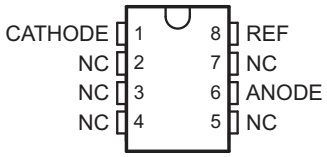

NC − No internal connection

TL431, TL431A, TL431B . . . D (SOIC) PACKAGE
(TOP VIEW)



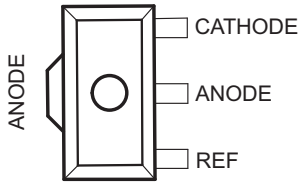

NC − No internal connection

TL431, TL431A, TL431B . . . P (PDIP), PS (SOP),
OR PW (TSSOP) PACKAGE
(TOP VIEW)

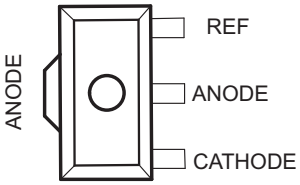



NC − No internal connection

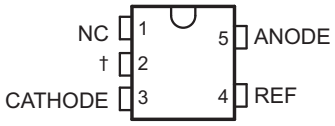
TL431, TL431A, TL431B . . . PK (SOT-89) PACKAGE
(TOP VIEW)




TL432, TL432A, TL432B . . . PK (SOT-89) PACKAGE
(TOP VIEW)

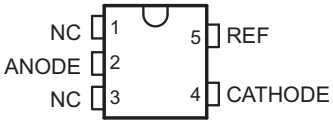



TL431, TL431A, TL431B . . . DBV (SOT-23-5) PACKAGE
(TOP VIEW)



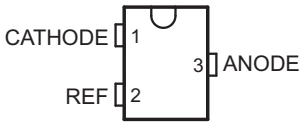

NC − No internal connection
† Pin 2 is attached to Substrate and must be connected to ANODE or left open.

TL432, TL432A, TL432B . . . DBV (SOT-23-5) PACKAGE
(TOP VIEW)

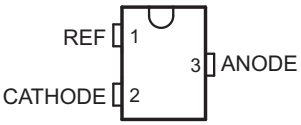



NC − No internal connection

TL431, TL431A, TL431B . . . DBZ (SOT-23-3) PACKAGE
(TOP VIEW)




TL432, TL432A, TL432B . . . DBZ (SOT-23-3) PACKAGE
(TOP VIEW)




## Pin Functions

| PIN | | | | | | | | | | | | TYPE | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NAME | TLV431x | | | | | | | | TLV432x | | | | |
| | DBZ | DBV | PK | D | P, PS PW | LP | KTP | DCK | DBZ | DBV | PK | | |
| CATHODE | 1 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 2 | 4 | 1 | I/O | Shunt Current/Voltage input |
| REF | 2 | 4 | 1 | 8 | 8 | 3 | 3 | 3 | 1 | 5 | 3 | I | Threshold relative to common anode |
| ANODE | 3 | 5 | 2 | 2, 3, 6, 7 | 6 | 2 | 2 | 6 | 3 | 2 | 2 | O | Common pin, normally connected to ground |

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# 7 Specifications

## 7.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| $V_{KA}$ | Cathode voltage(2) | | 37 | V |
| $I_{KA}$ | Continuous cathode current range | –100 | 150 | mA |
| $I_{I(ref)}$ | Reference input current range | –0.05 | 10 | mA |
| $T_J$ | 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) All voltage values are with respect to ANODE, unless otherwise noted.

## 7.2 ESD Ratings

| | | | VALUE | UNIT |
|---|---|---|---|---|
| $V_{(ESD)}$ | Electrostatic discharge | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1) | ±2000 | V |
| | | Charged-device model (CDM), per JEDEC specification JESD22-C101(2) | ±1000 | |

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 500-V HBM is possible with the necessary precautions.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 250-V CDM is possible with the necessary precautions.

## 7.3 Thermal Information

| THERMAL METRIC(1) | | TL43xx | | | | | | | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | P | PW | D | PS | DCK | DBV | DBZ | LP | PK | |
| | | 8 PINS | | | | 6 PINS | 5 PINS | 3 PINS | | | |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 85 | 149 | 97 | 95 | 259 | 206 | 206 | 140 | 52 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 57 | 65 | 39 | 46 | 87 | 131 | 76 | 55 | 9 | |

(1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report (SPRA953).

## 7.4 Recommended Operating Conditions

See(1)

| | | | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| $V_{KA}$ | Cathode voltage | | $V_{ref}$ | 36 | V |
| $I_{KA}$ | Cathode current | | 1 | 100 | mA |
| $T_A$ | Operating free-air temperature | TL43xxC | 0 | 70 | °C |
| | | TL43xxI | –40 | 85 | |
| | | TL43xxQ | –40 | 125 | |

(1) Maximum power dissipation is a function of $T_{J(max)}$, $\theta_{JA}$, and $T_A$. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_{J(max)} – T_A)/\theta_{JA}$. Operating at the absolute maximum $T_J$ of 150°C can affect reliability.


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## 7.5 Electrical Characteristics, TL431C, TL432C

over recommended operating conditions, $T_A$ = 25°C (unless otherwise noted)

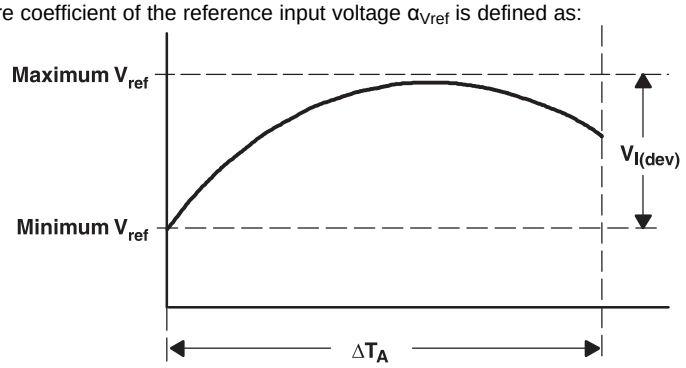
| PARAMETER | | TEST CIRCUIT | TEST CONDITIONS | | TL431C, TL432C | | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | |
| $V_{ref}$ | Reference voltage | See Figure 20 | $V_{KA}$ = $V_{ref}$, $I_{KA}$ = 10 mA | | 2440 | 2495 | 2550 | mV |
| $V_{I(dev)}$ | Deviation of reference input voltage over full temperature range(1) | See Figure 20 | $V_{KA}$ = $V_{ref}$, $I_{KA}$ = 10 mA, | SOT23-3 and TL432 devices | | 6 | 16 | mV |
| | | | | All other devices | | 4 | 25 | |
| $\Delta V_{ref}$ / $\Delta V_{KA}$ | Ratio of change in reference voltage to the change in cathode voltage | See Figure 21 | $I_{KA}$ = 10 mA | $\Delta V_{KA}$ = 10 V – $V_{ref}$ | | –1.4 | –2.7 | mV/V |
| | | | | $\Delta V_{KA}$ = 36 V – 10 V | | –1 | –2 | |
| $I_{ref}$ | Reference input current | See Figure 21 | $I_{KA}$ = 10 mA, R1 = 10 kΩ, R2 = ∞ | | | 2 | 4 | µA |
| $I_{I(dev)}$ | Deviation of reference input current over full temperature range(1) | See Figure 21 | $I_{KA}$ = 10 mA, R1 = 10 kΩ, R2 = ∞ | | | 0.4 | 1.2 | µA |
| $I_{min}$ | Minimum cathode current for regulation | See Figure 20 | $V_{KA}$ = $V_{ref}$ | | | 0.4 | 1 | mA |
| $I_{off}$ | Off-state cathode current | See Figure 22 | $V_{KA}$ = 36 V, $V_{ref}$ = 0 | | | 0.1 | 1 | µA |
| $\lvert z_{KA} \rvert$ | Dynamic impedance(2) | See Figure 20 | $V_{KA}$ = $V_{ref}$, f ≤ 1 kHz, $I_{KA}$ = 1 mA to 100 mA | | | 0.2 | 0.5 | Ω |

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

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

where:

$\Delta T_A$ is the rated operating temperature range of the device.




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

(2) The dynamic impedance is defined as: $\lvert z_{KA} \rvert = \frac{\Delta V_{KA}}{\Delta I_{KA}}$

When the device is operating with two external resistors (see Figure 21), the total dynamic impedance of the circuit is given by: $\lvert z' \rvert = \frac{\Delta V}{\Delta I}$ which is approximately equal to $\lvert z_{KA} \rvert \left(1 + \frac{R1}{R2}\right)$.

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## 7.6 Electrical Characteristics, TL431I, TL432I

over recommended operating conditions, $T_A$ = 25°C (unless otherwise noted)

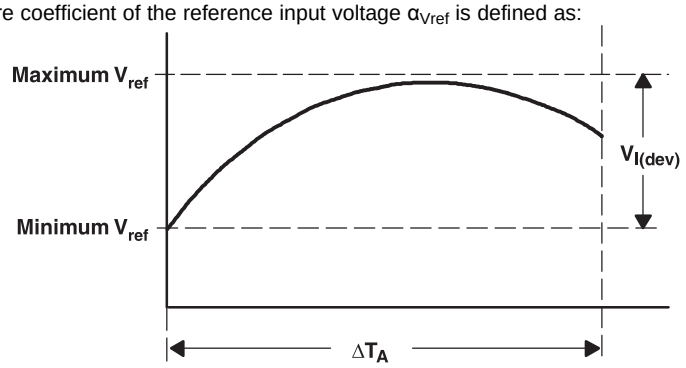
| PARAMETER | | TEST CIRCUIT | TEST CONDITIONS | | TL431I, TL432I | | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | |
| $V_{ref}$ | Reference voltage | See Figure 20 | $V_{KA}$ = $V_{ref}$, $I_{KA}$ = 10 mA | | 2440 | 2495 | 2550 | mV |
| $V_{I(dev)}$ | Deviation of reference input voltage over full temperature range(1) | See Figure 20 | $V_{KA}$ = $V_{ref}$, $I_{KA}$ = 10 mA | SOT23-3 and TL432 devices | | 14 | 34 | mV |
| | | | | All other devices | | 5 | 50 | |
| $\Delta V_{ref}$ / $\Delta V_{KA}$ | Ratio of change in reference voltage to the change in cathode voltage | See Figure 21 | $I_{KA}$ = 10 mA | $\Delta V_{KA}$ = 10 V – $V_{ref}$ | | –1.4 | –2.7 | mV/V |
| | | | | $\Delta V_{KA}$ = 36 V – 10 V | | –1 | –2 | |
| $I_{ref}$ | Reference input current | See Figure 21 | $I_{KA}$ = 10 mA, R1 = 10 kΩ, R2 = ∞ | | | 2 | 4 | µA |
| $I_{I(dev)}$ | Deviation of reference input current over full temperature range(1) | See Figure 21 | $I_{KA}$ = 10 mA, R1 = 10 kΩ, R2 = ∞ | | | 0.8 | 2.5 | µA |
| $I_{min}$ | Minimum cathode current for regulation | See Figure 20 | $V_{KA}$ = $V_{ref}$ | | | 0.4 | 1 | mA |
| $I_{off}$ | Off-state cathode current | See Figure 22 | $V_{KA}$ = 36 V, $V_{ref}$ = 0 | | | 0.1 | 1 | µA |
| $\|z_{KA}\|$ | Dynamic impedance(2) | See Figure 20 | $V_{KA}$ = $V_{ref}$, f ≤ 1 kHz, $I_{KA}$ = 1 mA to 100 mA | | | 0.2 | 0.5 | Ω |

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

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

where:

$\Delta T_A$ is the rated operating temperature range of the device.




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

(2) The dynamic impedance is defined as: $|z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_{KA}}$

When the device is operating with two external resistors (see Figure 21), the total dynamic impedance of the circuit is given by: $|z'| = \frac{\Delta V}{\Delta I}$ which is approximately equal to $|z_{KA}|\left(1 + \frac{R1}{R2}\right)$.


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## 7.7 Electrical Characteristics, TL431Q, TL432Q

over recommended operating conditions, $T_A$ = 25°C (unless otherwise noted)

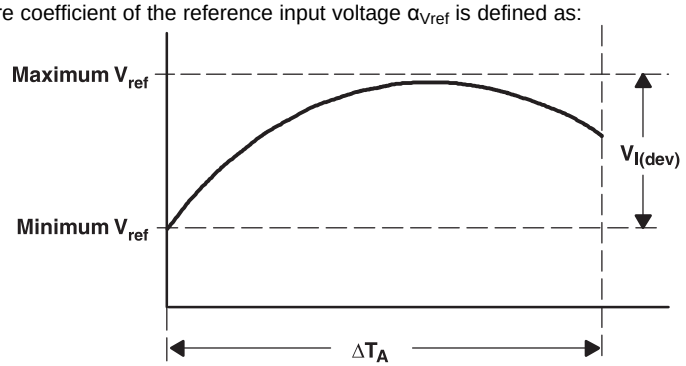
| PARAMETER | | TEST CIRCUIT | TEST CONDITIONS | | TL431Q, TL432Q | | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | |
| $V_{ref}$ | Reference voltage | See Figure 20 | $V_{KA}$ = $V_{ref}$, $I_{KA}$ = 10 mA | | 2440 | 2495 | 2550 | mV |
| $V_{I(dev)}$ | Deviation of reference input voltage over full temperature range(1) | See Figure 20 | $V_{KA}$ = $V_{ref}$, $I_{KA}$ = 10 mA | | | 14 | 34 | mV |
| $\Delta V_{ref}$ / $\Delta V_{KA}$ | Ratio of change in reference voltage to the change in cathode voltage | See Figure 21 | $I_{KA}$ = 10 mA | $\Delta V_{KA}$ = 10 V – $V_{ref}$ | | –1.4 | –2.7 | mV/V |
| | | | | $\Delta V_{KA}$ = 36 V – 10 V | | –1 | –2 | |
| $I_{ref}$ | Reference input current | See Figure 21 | $I_{KA}$ = 10 mA, R1 = 10 kΩ, R2 = ∞ | | | 2 | 4 | µA |
| $I_{I(dev)}$ | Deviation of reference input current over full temperature range(1) | See Figure 21 | $I_{KA}$ = 10 mA, R1 = 10 kΩ, R2 = ∞ | | | 0.8 | 2.5 | µA |
| $I_{min}$ | Minimum cathode current for regulation | See Figure 20 | $V_{KA}$ = $V_{ref}$ | | | 0.4 | 1 | mA |
| $I_{off}$ | Off-state cathode current | See Figure 22 | $V_{KA}$ = 36 V, $V_{ref}$ = 0 | | | 0.1 | 1 | µA |
| $\|z_{KA}\|$ | Dynamic impedance(2) | See Figure 20 | $V_{KA}$ = $V_{ref}$, f ≤ 1 kHz, $I_{KA}$ = 1 mA to 100 mA | | | 0.2 | 0.5 | Ω |

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

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

where:

$\Delta T_A$ is the rated operating temperature range of the device.




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

(2) The dynamic impedance is defined as: $|z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_{KA}}$

When the device is operating with two external resistors (see Figure 21), the total dynamic impedance of the circuit is given by: $|z'| = \frac{\Delta V}{\Delta I}$ which is approximately equal to $|z_{KA}|\left(1 + \frac{R1}{R2}\right)$.

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## 7.8 Electrical Characteristics, TL431AC, TL432AC

over recommended operating conditions, $T_A$ = 25°C (unless otherwise noted)

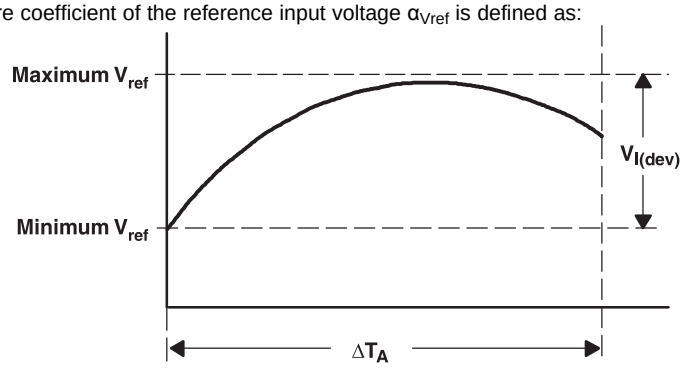
| PARAMETER | | TEST CIRCUIT | TEST CONDITIONS | | TL431AC, TL432AC | | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | |
| $V_{ref}$ | Reference voltage | See Figure 20 | $V_{KA}$ = $V_{ref}$, $I_{KA}$ = 10 mA | | 2470 | 2495 | 2520 | mV |
| $V_{I(dev)}$ | Deviation of reference input voltage over full temperature range(1) | See Figure 20 | $V_{KA}$ = $V_{ref}$, $I_{KA}$ = 10 mA | SOT23-3 and TL432 devices | | 6 | 16 | mV |
| | | | | All other devices | | 4 | 25 | |
| $\Delta V_{ref}$ / $\Delta V_{KA}$ | Ratio of change in reference voltage to the change in cathode voltage | See Figure 21 | $I_{KA}$ = 10 mA | $\Delta V_{KA}$ = 10 V – $V_{ref}$ | | –1.4 | –2.7 | mV/V |
| | | | | $\Delta V_{KA}$ = 36 V – 10 V | | –1 | –2 | |
| $I_{ref}$ | Reference input current | See Figure 21 | $I_{KA}$ = 10 mA, R1 = 10 kΩ, R2 = ∞ | | | 2 | 4 | µA |
| $I_{I(dev)}$ | Deviation of reference input current over full temperature range(1) | See Figure 21 | $I_{KA}$ = 10 mA, R1 = 10 kΩ, R2 = ∞ | | | 0.8 | 1.2 | µA |
| $I_{min}$ | Minimum cathode current for regulation | See Figure 20 | $V_{KA}$ = $V_{ref}$ | | | 0.4 | 0.6 | mA |
| $I_{off}$ | Off-state cathode current | See Figure 22 | $V_{KA}$ = 36 V, $V_{ref}$ = 0 | | | 0.1 | 0.5 | µA |
| $\|z_{KA}\|$ | Dynamic impedance(2) | See Figure 20 | $V_{KA}$ = $V_{ref}$, f ≤ 1 kHz, $I_{KA}$ = 1 mA to 100 mA | | | 0.2 | 0.5 | Ω |

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

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

where:

$\Delta T_A$ is the rated operating temperature range of the device.




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

(2) The dynamic impedance is defined as: $|z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_{KA}}$

When the device is operating with two external resistors (see Figure 21), the total dynamic impedance of the circuit is given by: $|z'| = \frac{\Delta V}{\Delta I}$

which is approximately equal to $|z_{KA}|\left(1 + \frac{R1}{R2}\right)$.


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## 7.9 Electrical Characteristics, TL431AI, TL432AI

over recommended operating conditions, $T_A$ = 25°C (unless otherwise noted)

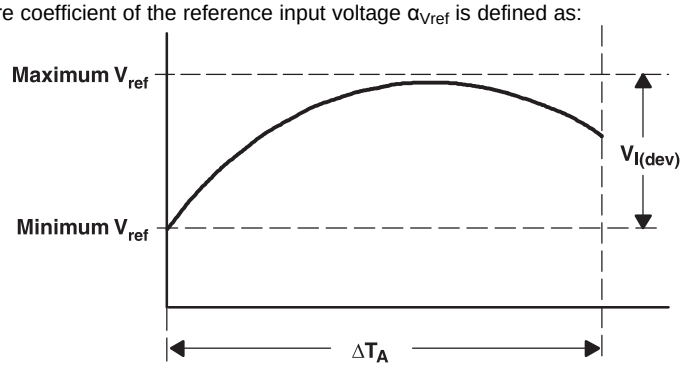
| PARAMETER | | TEST CIRCUIT | TEST CONDITIONS | | TL431AI, TL432AI | | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | |
| $V_{ref}$ | Reference voltage | See Figure 20 | $V_{KA}$ = $V_{ref}$, $I_{KA}$ = 10 mA | | 2470 | 2495 | 2520 | mV |
| $V_{I(dev)}$ | Deviation of reference input voltage over full temperature range(1) | See Figure 20 | $V_{KA}$ = $V_{ref}$, $I_{KA}$ = 10 mA | SOT23-3 and TL432 devices | | 14 | 34 | mV |
| | | | | All other devices | | 5 | 50 | |
| $\Delta V_{ref}$ / $\Delta V_{KA}$ | Ratio of change in reference voltage to the change in cathode voltage | See Figure 21 | $I_{KA}$ = 10 mA | $\Delta V_{KA}$ = 10 V – $V_{ref}$ | | –1.4 | –2.7 | mV/V |
| | | | | $\Delta V_{KA}$ = 36 V – 10 V | | –1 | –2 | |
| $I_{ref}$ | Reference input current | See Figure 21 | $I_{KA}$ = 10 mA, R1 = 10 kΩ, R2 = ∞ | | | 2 | 4 | µA |
| $I_{I(dev)}$ | Deviation of reference input current over full temperature range(1) | See Figure 21 | $I_{KA}$ = 10 mA, R1 = 10 kΩ, R2 = ∞ | | | 0.8 | 2.5 | µA |
| $I_{min}$ | Minimum cathode current for regulation | See Figure 20 | $V_{KA}$ = $V_{ref}$ | | | 0.4 | 0.7 | mA |
| $I_{off}$ | Off-state cathode current | See Figure 22 | $V_{KA}$ = 36 V, $V_{ref}$ = 0 | | | 0.1 | 0.5 | µA |
| $\lvert z_{KA} \rvert$ | Dynamic impedance(2) | See Figure 20 | $V_{KA}$ = $V_{ref}$, f ≤ 1 kHz, $I_{KA}$ = 1 mA to 100 mA | | | 0.2 | 0.5 | Ω |

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

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

where:

$\Delta T_A$ is the rated operating temperature range of the device.




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

(2) The dynamic impedance is defined as: $\lvert z_{KA} \rvert = \frac{\Delta V_{KA}}{\Delta I_{KA}}$

When the device is operating with two external resistors (see Figure 21), the total dynamic impedance of the circuit is given by: $\lvert z' \rvert = \frac{\Delta V}{\Delta I}$ which is approximately equal to $\lvert z_{KA} \rvert \left(1 + \frac{R1}{R2}\right)$.

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## 7.10 Electrical Characteristics, TL431AQ, TL432AQ

over recommended operating conditions, $T_A$ = 25°C (unless otherwise noted)

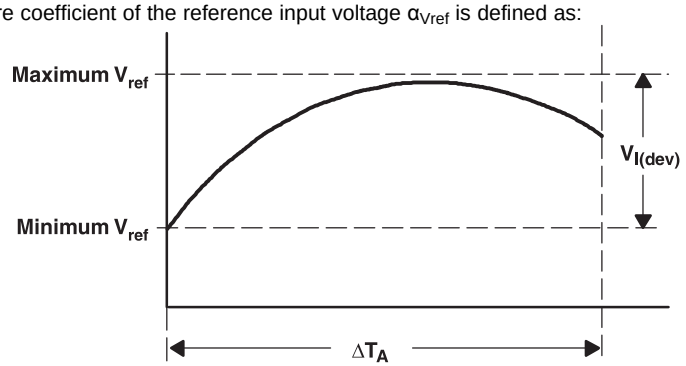
| PARAMETER | | TEST CIRCUIT | TEST CONDITIONS | | TL431AQ, TL432AQ | | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | |
| $V_{ref}$ | Reference voltage | See Figure 20 | $V_{KA}$ = $V_{ref}$, $I_{KA}$ = 10 mA | | 2470 | 2495 | 2520 | mV |
| $V_{I(dev)}$ | Deviation of reference input voltage over full temperature range(1) | See Figure 20 | $V_{KA}$ = $V_{ref}$, $I_{KA}$ = 10 mA | | | 14 | 34 | mV |
| $\Delta V_{ref}$ / $\Delta V_{KA}$ | Ratio of change in reference voltage to the change in cathode voltage | See Figure 21 | $I_{KA}$ = 10 mA | $\Delta V_{KA}$ = 10 V – $V_{ref}$ | | –1.4 | –2.7 | mV/V |
| | | | | $\Delta V_{KA}$ = 36 V – 10 V | | –1 | –2 | |
| $I_{ref}$ | Reference input current | See Figure 21 | $I_{KA}$ = 10 mA, R1 = 10 kΩ, R2 = ∞ | | | 2 | 4 | µA |
| $I_{I(dev)}$ | Deviation of reference input current over full temperature range(1) | See Figure 21 | $I_{KA}$ = 10 mA, R1 = 10 kΩ, R2 = ∞ | | | 0.8 | 2.5 | µA |
| $I_{min}$ | Minimum cathode current for regulation | See Figure 20 | $V_{KA}$ = $V_{ref}$ | | | 0.4 | 0.7 | mA |
| $I_{off}$ | Off-state cathode current | See Figure 22 | $V_{KA}$ = 36 V, $V_{ref}$ = 0 | | | 0.1 | 0.5 | µA |
| $\lvert z_{KA} \rvert$ | Dynamic impedance(2) | See Figure 20 | $V_{KA}$ = $V_{ref}$, f ≤ 1 kHz, $I_{KA}$ = 1 mA to 100 mA | | | 0.2 | 0.5 | Ω |

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

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

where:

$\Delta T_A$ is the rated operating temperature range of the device.




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

(2) The dynamic impedance is defined as: $\lvert z_{KA} \rvert = \frac{\Delta V_{KA}}{\Delta I_{KA}}$

When the device is operating with two external resistors (see Figure 21), the total dynamic impedance of the circuit is given by: $\lvert z' \rvert = \frac{\Delta V}{\Delta I}$ which is approximately equal to $\lvert z_{KA} \rvert \left(1 + \frac{R1}{R2}\right)$.


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## 7.11 Electrical Characteristics, TL431BC, TL432BC

over recommended operating conditions, $T_A$ = 25°C (unless otherwise noted)

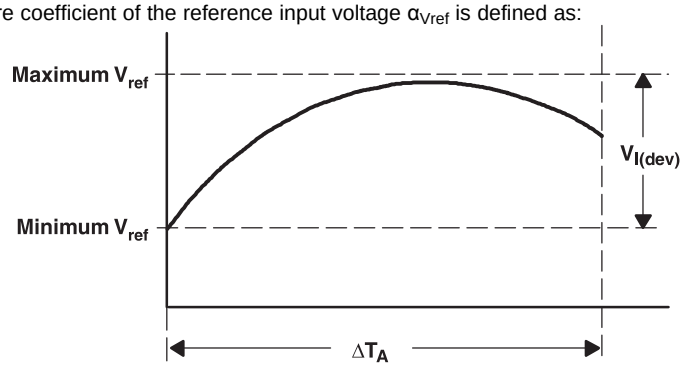
| PARAMETER | | TEST CIRCUIT | TEST CONDITIONS | | TL431BC, TL432BC | | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | |
| $V_{ref}$ | Reference voltage | See Figure 20 | $V_{KA}$ = $V_{ref}$, $I_{KA}$ = 10 mA | | 2483 | 2495 | 2507 | mV |
| $V_{I(dev)}$ | Deviation of reference input voltage over full temperature range(1) | See Figure 20 | $V_{KA}$ = $V_{ref}$, $I_{KA}$ = 10 mA | | | 6 | 16 | mV |
| $\Delta V_{ref}$ / $\Delta V_{KA}$ | Ratio of change in reference voltage to the change in cathode voltage | See Figure 21 | $I_{KA}$ = 10 mA | $\Delta V_{KA}$ = 10 V – $V_{ref}$ | | –1.4 | –2.7 | mV/V |
| | | | | $\Delta V_{KA}$ = 36 V – 10 V | | – | –2 | |
| $I_{ref}$ | Reference input current | See Figure 21 | $I_{KA}$ = 10 mA, R1 = 10 kΩ, R2 = ∞ | | | 2 | 4 | µA |
| $I_{I(dev)}$ | Deviation of reference input current over full temperature range(1) | See Figure 21 | $I_{KA}$ = 10 mA, R1 = 10 kΩ, R2 = ∞ | | | 0.8 | 1.2 | µA |
| $I_{min}$ | Minimum cathode current for regulation | See Figure 20 | $V_{KA}$ = $V_{ref}$ | | | 0.4 | 0.6 | mA |
| $I_{off}$ | Off-state cathode current | See Figure 22 | $V_{KA}$ = 36 V, $V_{ref}$ = 0 | | | 0.1 | 0.5 | µA |
| $\|z_{KA}\|$ | Dynamic impedance(2) | See Figure 20 | $V_{KA}$ = $V_{ref}$, f ≤ 1 kHz, $I_{KA}$ = 1 mA to 100 mA | | | 0.2 | 0.5 | Ω |

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

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

where:

$\Delta T_A$ is the rated operating temperature range of the device.




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

(2) The dynamic impedance is defined as: $|z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_{KA}}$

When the device is operating with two external resistors (see Figure 21), the total dynamic impedance of the circuit is given by: $|z'| = \frac{\Delta V}{\Delta I}$ which is approximately equal to $|z_{KA}|\left(1 + \frac{R1}{R2}\right)$.

## 7.12 Electrical Characteristics, TL431BI, TL432BI

over recommended operating conditions, $T_A$ = 25°C (unless otherwise noted)

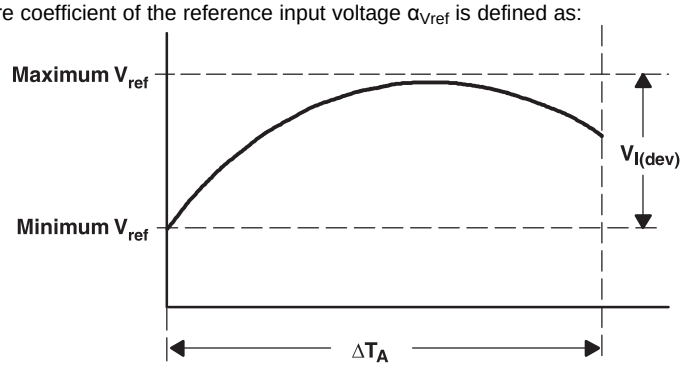
| PARAMETER | | TEST CIRCUIT | TEST CONDITIONS | | TL431BI, TL432BI | | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | |
| $V_{ref}$ | Reference voltage | See Figure 20 | $V_{KA}$ = $V_{ref}$, $I_{KA}$ = 10 mA | | 2483 | 2495 | 2507 | mV |
| $V_{I(dev)}$ | Deviation of reference input voltage over full temperature range(1) | See Figure 20 | $V_{KA}$ = $V_{ref}$, $I_{KA}$ = 10 mA | | | 14 | 34 | mV |
| $\Delta V_{ref}$ / $\Delta V_{KA}$ | Ratio of change in reference voltage to the change in cathode voltage | See Figure 21 | $I_{KA}$ = 10 mA | $\Delta V_{KA}$ = 10 V – $V_{ref}$ | | –1.4 | –2.7 | mV/V |
| | | | | $\Delta V_{KA}$ = 36 V – 10 V | | –1 | –2 | |
| $I_{ref}$ | Reference input current | See Figure 21 | $I_{KA}$ = 10 mA, R1 = 10 kΩ, R2 = ∞ | | | 2 | 4 | µA |
| $I_{I(dev)}$ | Deviation of reference input current over full temperature range(1) | See Figure 21 | $I_{KA}$ = 10 mA, R1 = 10 kΩ, R2 = ∞ | | | 0.8 | 2.5 | µA |
| $I_{min}$ | Minimum cathode current for regulation | See Figure 20 | $V_{KA}$ = $V_{ref}$ | | | 0.4 | 0.7 | mA |
| $I_{off}$ | Off-state cathode current | See Figure 22 | $V_{KA}$ = 36 V, $V_{ref}$ = 0 | | | 0.1 | 0.5 | µA |
| $\|z_{KA}\|$ | Dynamic impedance(2) | See Figure 20 | $V_{KA}$ = $V_{ref}$, f ≤ 1 kHz, $I_{KA}$ = 1 mA to 100 mA | | | 0.2 | 0.5 | Ω |

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

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

where:

$\Delta T_A$ is the rated operating temperature range of the device.




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

(2) The dynamic impedance is defined as: $|z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_{KA}}$

When the device is operating with two external resistors (see Figure 21), the total dynamic impedance of the circuit is given by: $|z'| = \frac{\Delta V}{\Delta I}$ which is approximately equal to $|z_{KA}|\left(1 + \frac{R1}{R2}\right)$.


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## 7.13 Electrical Characteristics, TL431BQ, TL432BQ

over recommended operating conditions, $T_A$ = 25°C (unless otherwise noted)

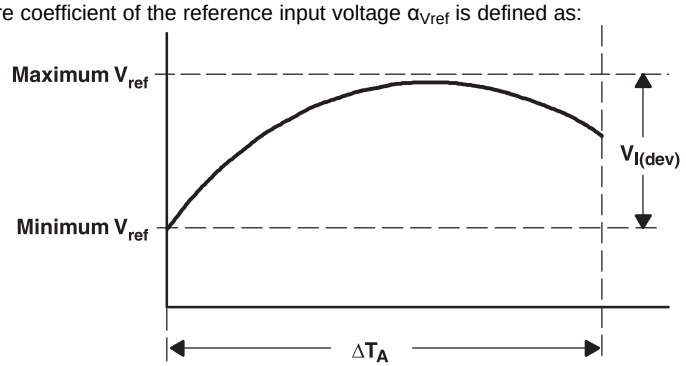
| PARAMETER | | TEST CIRCUIT | TEST CONDITIONS | | TL431BQ, TL432BQ | | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | |
| $V_{ref}$ | Reference voltage | See Figure 20 | $V_{KA}$ = $V_{ref}$, $I_{KA}$ = 10 mA | | 2483 | 2495 | 2507 | mV |
| $V_{I(dev)}$ | Deviation of reference input voltage over full temperature range(1) | See Figure 20 | $V_{KA}$ = $V_{ref}$, $I_{KA}$ = 10 mA | | | 14 | 34 | mV |
| $\Delta V_{ref}$ / $\Delta V_{KA}$ | Ratio of change in reference voltage to the change in cathode voltage | See Figure 21 | $I_{KA}$ = 10 mA | $\Delta V_{KA}$ = 10 V – $V_{ref}$ | | –1.4 | –2.7 | mV/V |
| | | | | $\Delta V_{KA}$ = 36 V – 10 V | | –1 | –2 | |
| $I_{ref}$ | Reference input current | See Figure 21 | $I_{KA}$ = 10 mA, R1 = 10 kΩ, R2 = ∞ | | | 2 | 4 | µA |
| $I_{I(dev)}$ | Deviation of reference input current over full temperature range(1) | See Figure 21 | $I_{KA}$ = 10 mA, R1 = 10 kΩ, R2 = ∞ | | | 0.8 | 2.5 | µA |
| $I_{min}$ | Minimum cathode current for regulation | See Figure 20 | $V_{KA}$ = $V_{ref}$ | | | 0.4 | 0.7 | mA |
| $I_{off}$ | Off-state cathode current | See Figure 22 | $V_{KA}$ = 36 V, $V_{ref}$ = 0 | | | 0.1 | 0.5 | µA |
| $\|z_{KA}\|$ | Dynamic impedance(2) | See Figure 20 | $V_{KA}$ = $V_{ref}$, f ≤ 1 kHz, $I_{KA}$ = 1 mA to 100 mA | | | 0.2 | 0.5 | Ω |

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

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

where:

$\Delta T_A$ is the rated operating temperature range of the device.




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

(2) The dynamic impedance is defined as: $|z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_{KA}}$

When the device is operating with two external resistors (see Figure 21), the total dynamic impedance of the circuit is given by: $|z'| = \frac{\Delta V}{\Delta I}$ which is approximately equal to $|z_{KA}|\left(1 + \frac{R1}{R2}\right)$.

## 7.14 Typical Characteristics

Data at high and low temperatures are applicable only within the recommended operating free-air temperature ranges of the various devices.

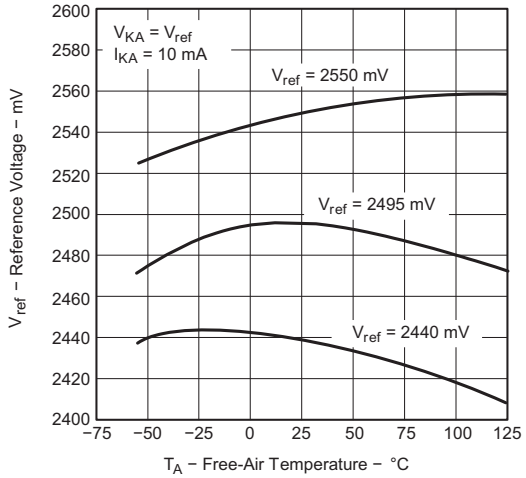



**Figure 1. Reference Voltage vs Free-Air Temperature**

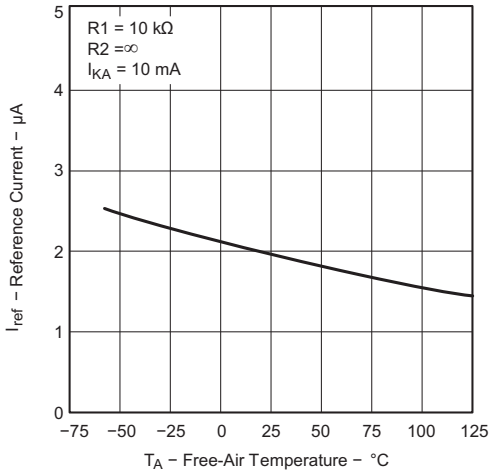



**Figure 2. Reference Current vs Free-Air Temperature**

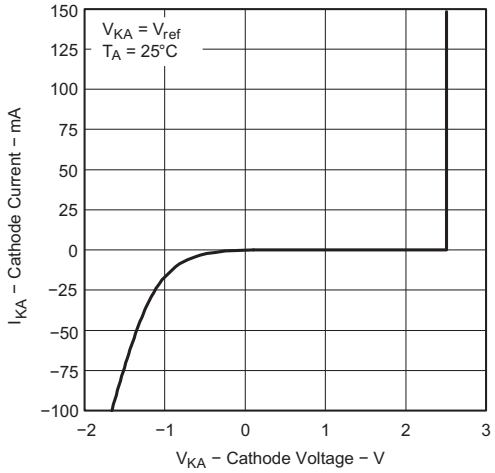



**Figure 3. Cathode Current vs Cathode Voltage**

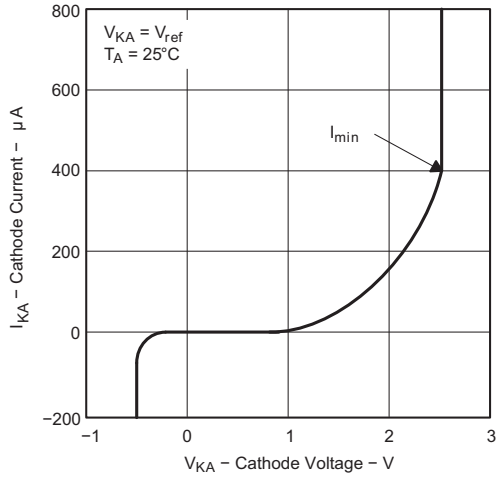



**Figure 4. Cathode Current vs Cathode Voltage**

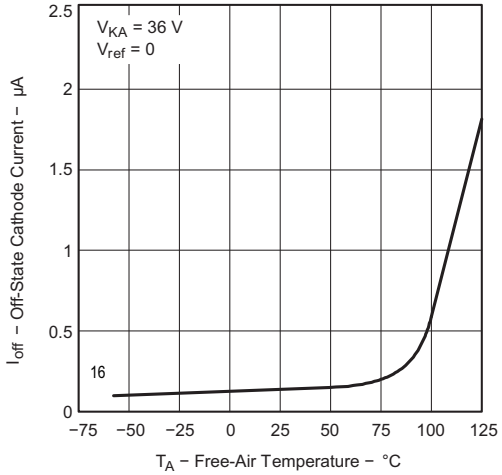



**Figure 5. Off-State Cathode Current vs Free-Air Temperature**

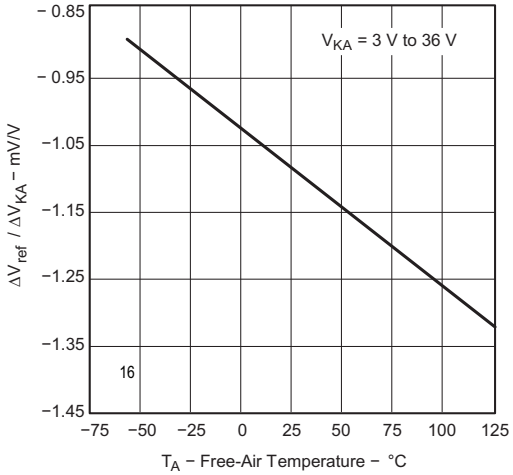



**Figure 6. Ratio of Delta Reference Voltage to Delta Cathode Voltage vs Free-Air Temperature**


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## Typical Characteristics (continued)

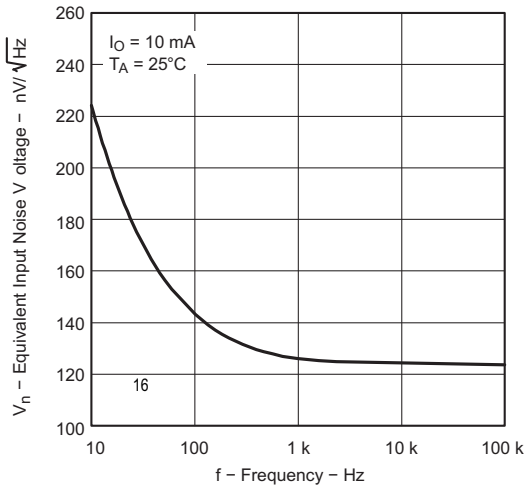



**Figure 7. Equivalent Input Noise Voltage vs Frequency**

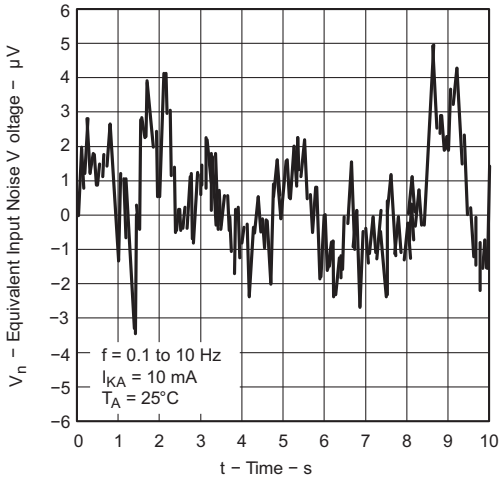



**Figure 8. Equivalent Input Noise Voltage Over a 10-S Period**

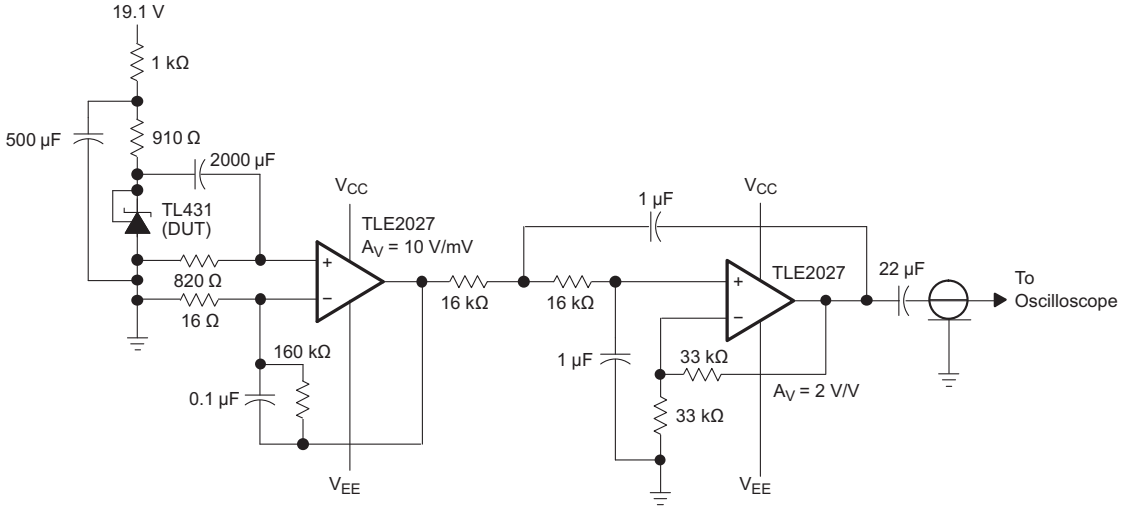



**Figure 9. Test Circuit for Equivalent Input Noise Voltage Over a 10-S Period**

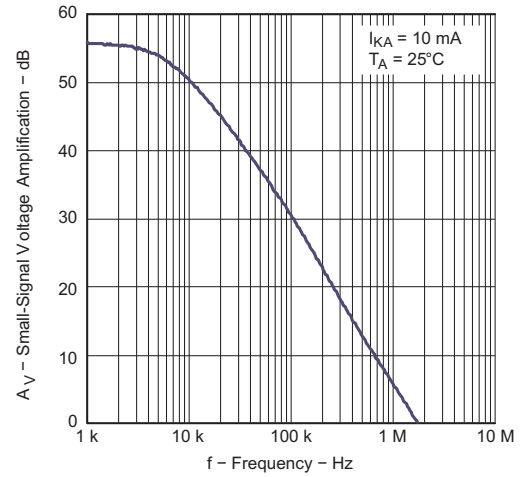



**Figure 10. Small-Signal Voltage Amplification vs Frequency**

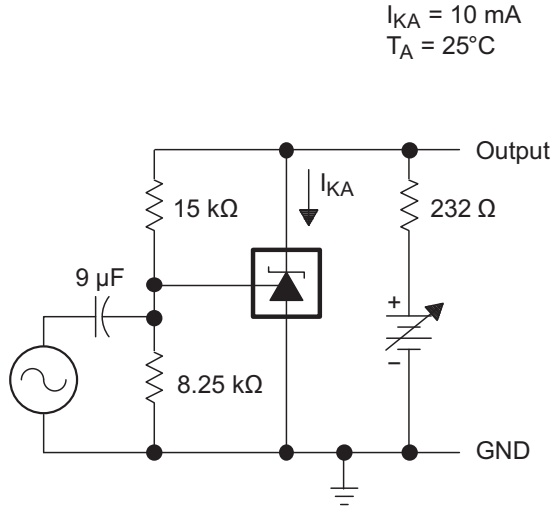



**Figure 11. Test Circuit for Voltage Amplification**

## Typical Characteristics (continued)

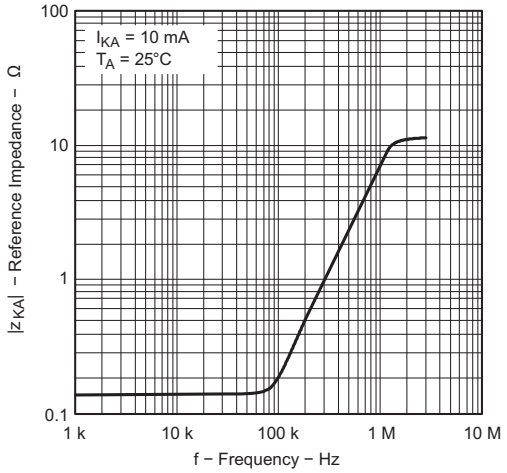



**Figure 12. Reference Impedance vs Frequency**

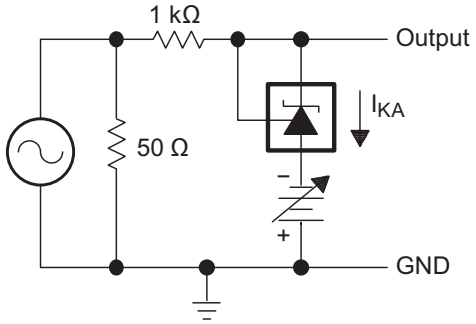



**Figure 13. Test Circuit for Reference Impedance**

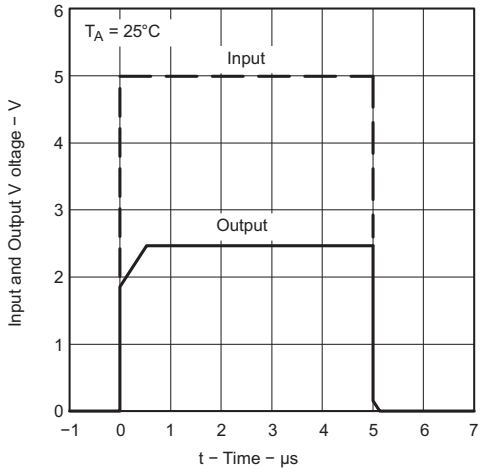



**Figure 14. Pulse Response**

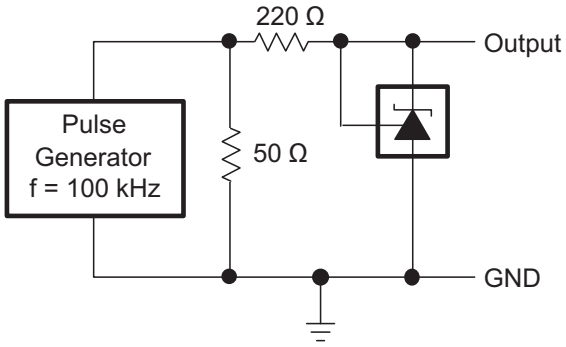
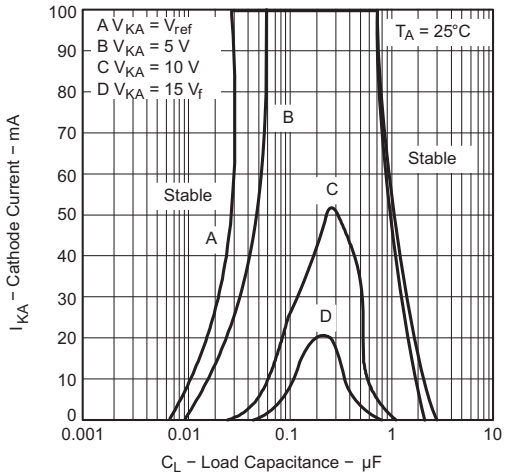



**Figure 15. Test Circuit for Pulse Response**




The areas under the curves represent conditions that may cause the device to oscillate. For curves B, C, and D, R2 and V+ are adjusted to establish the initial $V_{KA}$ and $I_{KA}$ conditions, with $C_L$ = 0. $V_{BATT}$ and $C_L$ then are adjusted to determine the ranges of stability.

**Figure 16. Stability Boundary Conditions for All TL431 and TL431A Devices**
**(Except for SOT23-3, SC-70, and Q-Temp Devices)**

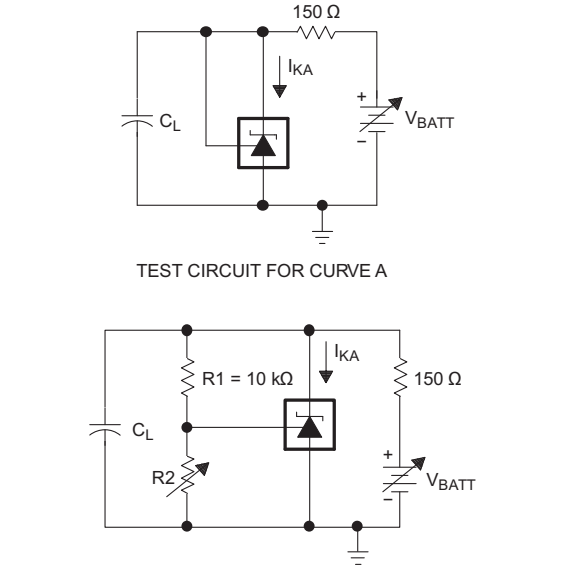
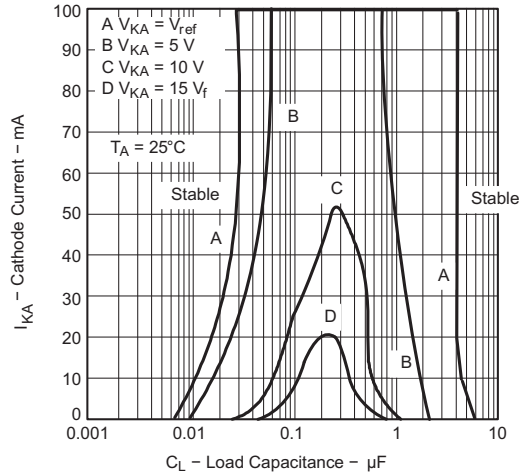



**Figure 17. Test Circuits for Stability Boundary Conditions**

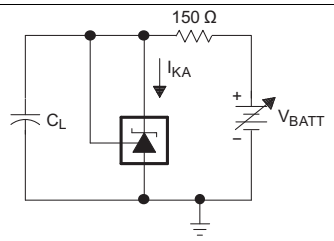

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## Typical Characteristics (continued)

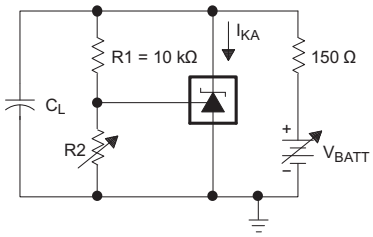



The areas under the curves represent conditions that may cause the device to oscillate. For curves B, C, and D, R2 and V+ are adjusted to establish the initial $V_{KA}$ and $I_{KA}$ conditions, with $C_L$ = 0. $V_{BATT}$ and $C_L$ then are adjusted to determine the ranges of stability.

**Figure 18. Stability Boundary Conditions for All TL431B, TL432, SOT-23, SC-70, and Q-Temp Devices**




TEST CIRCUIT FOR CURVE A




TEST CIRCUIT FOR CURVES B, C, AND D

**Figure 19. Test Circuit for Stability Boundary Conditions**

# 8 Parameter Measurement Information

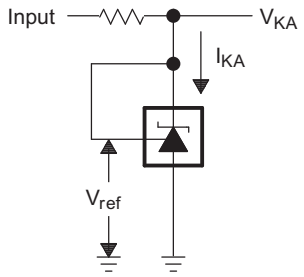



**Figure 20. Test Circuit for $V_{KA} = V_{ref}$**

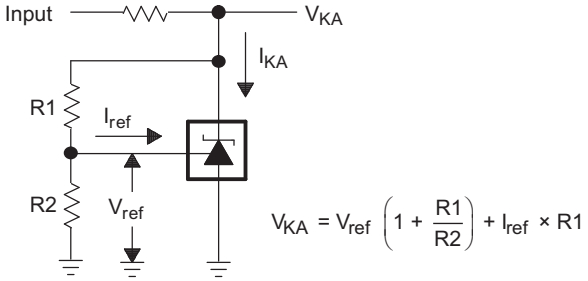



**Figure 21. Test Circuit for $V_{KA} > V_{ref}$**

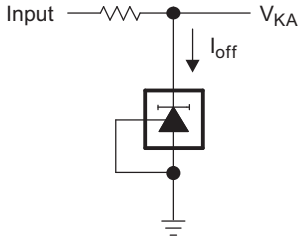



**Figure 22. Test Circuit for $I_{off}$**


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# 9 Detailed Description

## 9.1 Overview

This standard device has proven ubiquity and versatility across a wide range of applications, ranging from power to signal path. This is due to it's key components containing an accurate voltage reference & opamp, which are very fundamental analog building blocks. TL43xx is used in conjunction with it's key components to behave as a single voltage reference, error amplifier, voltage clamp or comparator with integrated reference.

TL43xx can be operated and adjusted to cathode voltages from 2.5V to 36V, making this part optimum for a wide range of end equipments in industrial, auto, telecom & computing. In order for this device to behave as a shunt regulator or error amplifier, >1mA ($I_{min}$(max)) must be supplied in to the cathode pin. Under this condition, feedback can be applied from the Cathode and Ref pins to create a replica of the internal reference voltage.

Various reference voltage options can be purchased with initial tolerances (at 25°C) of 0.5%, 1%, and 2%. These reference options are denoted by B (0.5%), A (1.0%) and blank (2.0%) after the TL431 or TL432. TL431 & TL432 are both functionaly, but have separate pinout options.

The TL43xxC devices are characterized for operation from 0°C to 70°C, the TL43xxI devices are characterized for operation from –40°C to 85°C, and the TL43xxQ devices are characterized for operation from –40°C to 125°C.

## 9.2 Functional Block Diagram

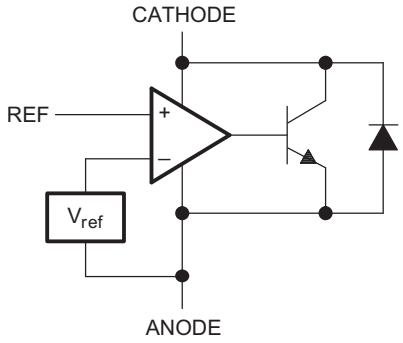



**Figure 23. Equivalent Schematic**

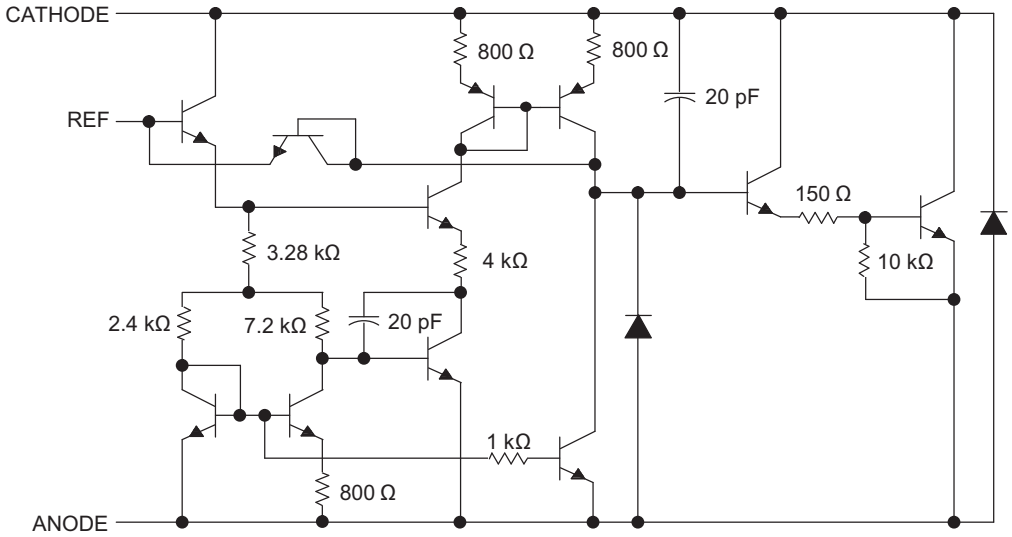



**Figure 24. Detailed Schematic**

## 9.3 Feature Description

TL43xx consists of an internal reference and amplifier that outputs a sink current base on the difference between the reference pin and the virtual internal pin. The sink current is produced by the internal Darlington pair, shown in the above schematic (Figure 24). A Darlington pair is used in order for this device to be able to sink a maximum current of 100 mA.

When operated with enough voltage headroom (≥ 2.5 V) and cathode current ($I_{KA}$), TL431 forces the reference pin to 2.5 V. However, the reference pin can not be left floating, as it needs $I_{REF}$ ≥ 4 µA (please see *Electrical Characteristics, TL431C, TL432C*). This is because the reference pin is driven into an npn, which needs base current in order operate properly.

When feedback is applied from the Cathode and Reference pins, TL43xx behaves as a Zener diode, regulating to a constant voltage dependent on current being supplied into the cathode. This is due to the internal amplifier and reference entering the proper operating regions. The same amount of current needed in the above feedback situation must be applied to this device in open loop, servo or error amplifying implementations in order for it to be in the proper linear region giving TL43xx enough gain.

Unlike many linear regulators, TL43xx is internally compensated to be stable without an output capacitor between the cathode and anode. However, if it is desired to use an output capacitor Figure 24 can be used as a guide to assist in choosing the correct capacitor to maintain stability.

## 9.4 Device Functional Modes

### 9.4.1 Open Loop (Comparator)

When the cathode/output voltage or current of TL43xx is not being fed back to the reference/input pin in any form, this device is operating in open loop. With proper cathode current (Ika) applied to this device, TL43xx will have the characteristics shown in Figure 23. With such high gain in this configuration, TL43xx is typically used as a comparator. With the reference integrated makes TL43xx the prefered choice when users are trying to monitor a certain level of a single signal.

### 9.4.2 Closed Loop

When the cathode/output voltage or current of TL43xx is being fed back to the reference/input pin in any form, this device is operating in closed loop. The majority of applications involving TL43xx use it in this manner to regulate a fixed voltage or current. The feedback enables this device to behave as an error amplifier, computing a portion of the output voltage and adjusting it to maintain the desired regulation. This is done by relating the output voltage back to the reference pin in a manner to make it equal to the internal reference voltage, which can be accomplished via resistive or direct feedback.


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# 10 Applications and Implementation

**NOTE**

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

## 10.1 Application Information

As this device has many applications and setups, there are many situations that this datasheet can not characterize in detail. The linked application notes will help the designer make the best choices when using this part.

Application note SLVA482 will provide a deeper understanding of this devices stability characteristics and aid the user in making the right choices when choosing a load capacitor. Application note SLVA445 assists designers in setting the shunt voltage to achieve optimum accuracy for this device.

## 10.2 Typical Applications

### 10.2.1 Comparator With Integrated Reference

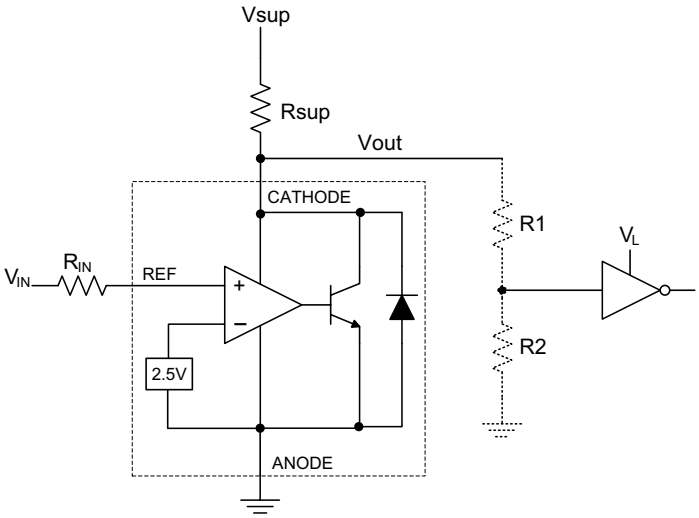



**Figure 25. Comparator Application Schematic**

## Typical Applications (continued)

### 10.2.1.1 Design Requirements

For this design example, use the parameters listed in *Table 1* as the input parameters.

**Table 1. Design Parameters**

| DESIGN PARAMETER | EXAMPLE VALUE |
|---|---|
| Input Voltage Range | 0 V to 5 V |
| Input Resistance | 10 kΩ |
| Supply Voltage | 24 V |
| Cathode Current (Ik) | 5 mA |
| Output Voltage Level | ~2 V – $V_{SUP}$ |
| Logic Input Thresholds VIH/VIL | $V_L$ |

### 10.2.1.2 Detailed Design Procedure

When using TL431 as a comparator with reference, determine the following:

- Input Voltage Range
- Reference Voltage Accuracy
- Output logic input high and low level thresholds
- Current Source resistance

#### 10.2.1.2.1 Basic Operation

In the configuration shown in Figure 25 TL431 will behave as a comparator, comparing the $V_{REF}$ pin voltage to the internal virtual reference voltage. When provided a proper cathode current ($I_K$), TL43xx will have enough open loop gain to provide a quick response. This can be seen in Figure 26, where the $R_{SUP}$=10 kΩ ($I_{KA}$=500 µA) situation responds much slower than $R_{SUP}$=1 kΩ ($I_{KA}$=5 mA). With the TL43xx's max Operating Current ($I_{MIN}$) being 1 mA, operation below that could result in low gain, leading to a slow response.

##### 10.2.1.2.1.1 Overdrive

Slow or inaccurate responses can also occur when the reference pin is not provided enough overdrive voltage. This is the amount of voltage that is higher than the internal virtual reference. The internal virtual reference voltage will be within the range of 2.5 V ±(0.5%, 1.0% or 1.5%) depending on which version is being used. The more overdrive voltage provided, the faster the TL431 will respond.

For applications where TL431 is being used as a comparator, it is best to set the trip point to greater than the positive expected error (i.e. +1.0% for the A version). For fast response, setting the trip point to >10% of the internal $V_{REF}$ should suffice.

For minimal voltage drop or difference from Vin to the ref pin, it is recommended to use an input resistor <10kΩ to provide Iref.


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#### 10.2.1.2.2 Output Voltage and Logic Input Level

In order for TL431 to properly be used as a comparator, the logic output must be readable by the receiving logic device. This is accomplished by knowing the input high and low level threshold voltage levels, typically denoted by $V_{IH}$ & $V_{IL}$.

As seen in Figure 26, TL431's output low level voltage in open-loop/comparator mode is ~2 V, which is typically sufficient for 5V supplied logic. However, would not work for 3.3 V & 1.8 V supplied logic. In order to accomodate this a resistive divider can be tied to the output to attenuate the output voltage to a voltage legible to the receiving low voltage logic device.

TL431's output high voltage is equal to $V_{SUP}$ due to TL431 being open-collector. If $V_{SUP}$ is much higher than the receiving logic's maximum input voltage tolerance, the output must be attenuated to accomadate the outgoing logic's reliability.

When using a resistive divider on the output, be sure to make the sum of the resistive divider (R1 & R2 in Figure 25) is much greater than $R_{SUP}$ in order to not interfere with TL431's ability to pull close to $V_{SUP}$ when turning off.

##### *10.2.1.2.2.1 Input Resistance*

TL431 requires an input resistance in this application in order to source the reference current ($I_{REF}$) needed from this device to be in the proper operating regions while turing on. The actual voltage seen at the ref pin will be $V_{REF}=V_{IN}-I_{REF}*R_{IN}$. Since $I_{REF}$ can be as high as 4 µA it is recommended to use a resistance small enough that will mitigate the error that $I_{REF}$ creates from $V_{IN}$.

### *10.2.1.3 Application Curves*

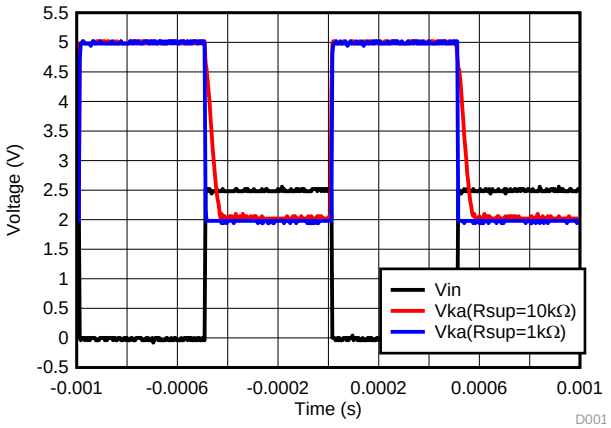



**Figure 26. Output Response With Various Cathode Currents**

### 10.2.2 Shunt Regulator/Reference

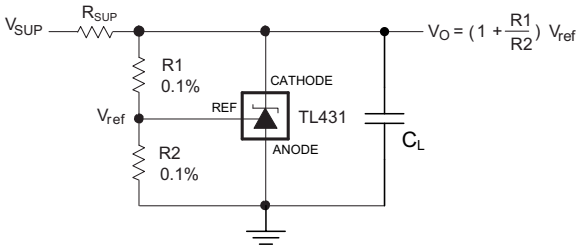



**Figure 27. Shunt Regulator Schematic**

#### *10.2.2.1 Design Requirements*

For this design example, use the parameters listed in Table 1 as the input parameters.

**Table 2. Design Parameters**

| DESIGN PARAMETER | EXAMPLE VALUE |
|---|---|
| Reference Initial Accuracy | 1.0 % |
| Supply Voltage | 24 V |
| Cathode Current (Ik) | 5 mA |
| Output Voltage Level | 2.5 V - 36 V |
| Load Capacitance | 100 nF |
| Feedback Resistor Values and Accuracy (R1 & R2) | 10 kΩ |

#### *10.2.2.2 Detailed Design Procedure*

When using TL431 as a Shunt Regulator, determine the following:

- Input Voltage Range
- Temperature Range
- Total Accuracy
- Cathode Current
- Reference Initial Accuracy
- Output Capacitance

##### 10.2.2.2.1 Programming Output/Cathode Voltage

In order to program the cathode voltage to a regulated voltage a resistive bridge must be shunted between the cathode and anode pins with the mid point tied to the reference pin. This can be seen in Figure 27, with R1 & R2 being the resistive bridge. The cathode/output voltage in the shunt regulator configuration can be approximated by the equation shown in Figure 27. The cathode voltage can be more accuratel determined by taking in to account the cathode current:

$Vo=(1+R1/R2)*V_{REF}-I_{REF}*R1$

In order for this equation to be valid, TL43xx must be fully biased so that it has enough open loop gain to mitigate any gain error. This can be done by meeting the Imin spec denoted in *Electrical Characteristics, TL431C, TL432C*.


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#### 10.2.2.2.2 Total Accuracy

When programming the output above unity gain ($V_{KA}$=$V_{REF}$), TL43xx is susceptible to other errors that may effect the overall accuracy beyond $V_{REF}$. These errors include:

- R1 and R2 accuracies
- $V_{I(dev)}$ - Change in reference voltage over temperature
- $\Delta V_{REF}$ / $\Delta V_{KA}$ - Change in reference voltage to the change in cathode voltage
- $|z_{KA}|$ - Dynamic impedance, causing a change in cathode voltage with cathode current

Worst case cathode voltage can be determined taking all of the variables in to account. Application note SLVA445 assists designers in setting the shunt voltage to achieve optimum accuracy for this device.

#### 10.2.2.2.3 Stability

Though TL43xx is stable with no capacitive load, the device that receives the shunt regulator's output voltage could present a capacitive load that is within the TL43xx region of stability, shown inFigure 16 and Figure 18. Also, designers may use capacitive loads to improve the transient response or for power supply decoupling. When using additional capacitance between Cathode and Anode, refer to Figure 16 and Figure 18. Also, application note SLVA482 will provide a deeper understanding of this devices stability characteristics and aid the user in making the right choices when choosing a load capacitor.

#### 10.2.2.2.4 Start-up Time

As shown in Figure 28, TL43xx has a fast response up to ~2 V and then slowly charges to it's programmed value. This is due to the compensation capacitance (shown in Figure 24) the TL43xx has to meet it's stability criteria. Despite the secondary delay, TL43xx still has a fast response suitable for many clamp applications.

### *10.2.2.3 Application Curves*

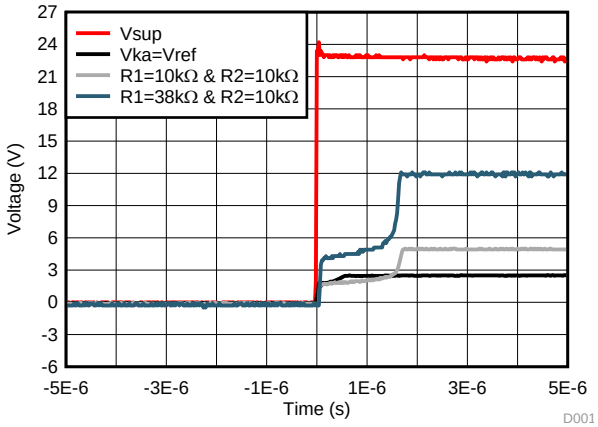
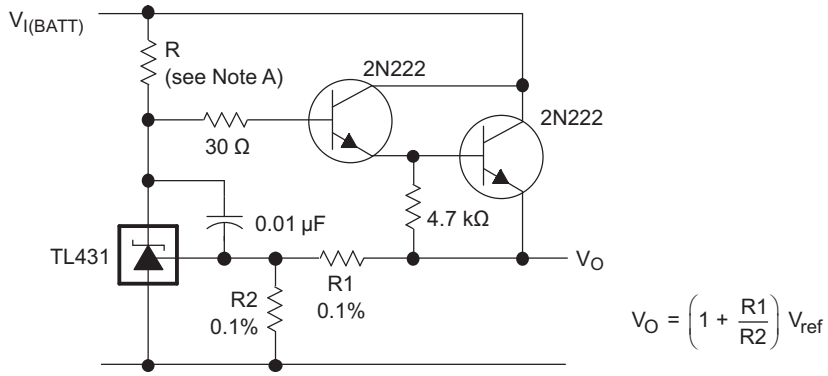



**Figure 28. TL43xx Start-up Response**

## 10.3 System Examples




A. R should provide cathode current ≥1 mA to the TL431 at minimum $V_{(BATT)}$.

**Figure 29. Precision High-Current Series Regulator**

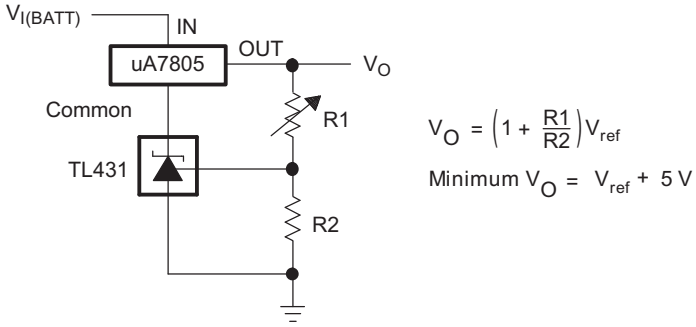



**Figure 30. Output Control of a Three-Terminal Fixed Regulator**

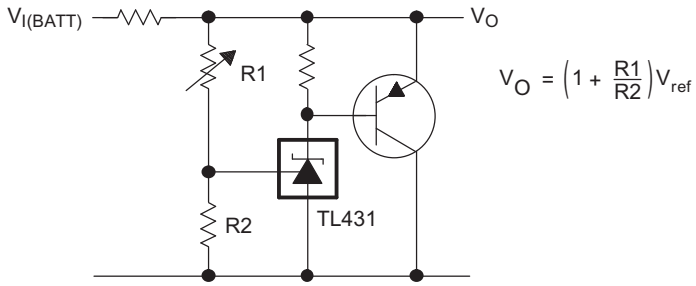
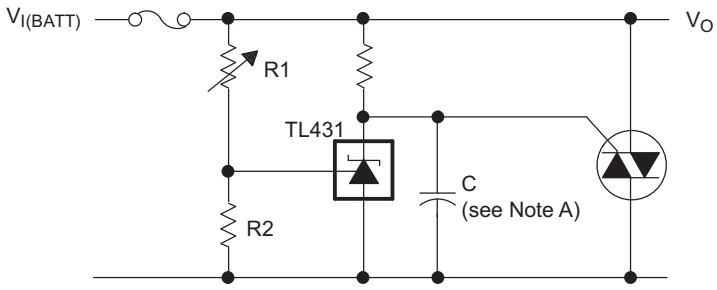



**Figure 31. High-Current Shunt Regulator**




A. Refer to the stability boundary conditions in Figure 16 and Figure 18 to determine allowable values for C.

**Figure 32. Crowbar Circuit**


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## System Examples (continued)

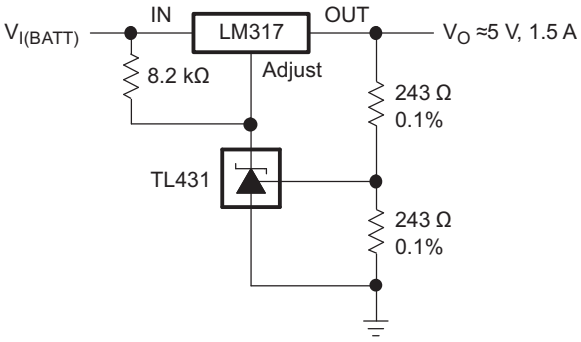
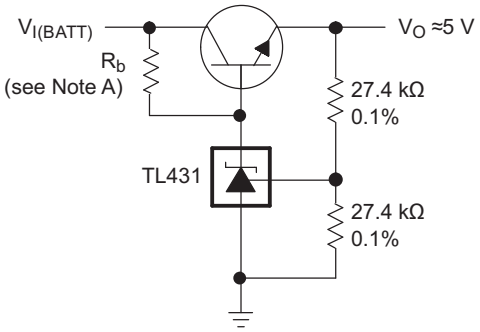



**Figure 33. Precision 5-V, 1.5-A Regulator**




A. $R_b$ should provide cathode current ≥1 mA to the TL431.

**Figure 34. Efficient 5-V Precision Regulator**

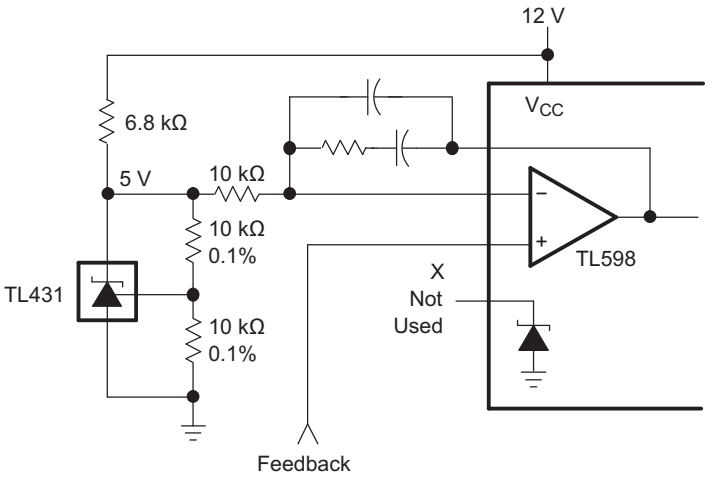
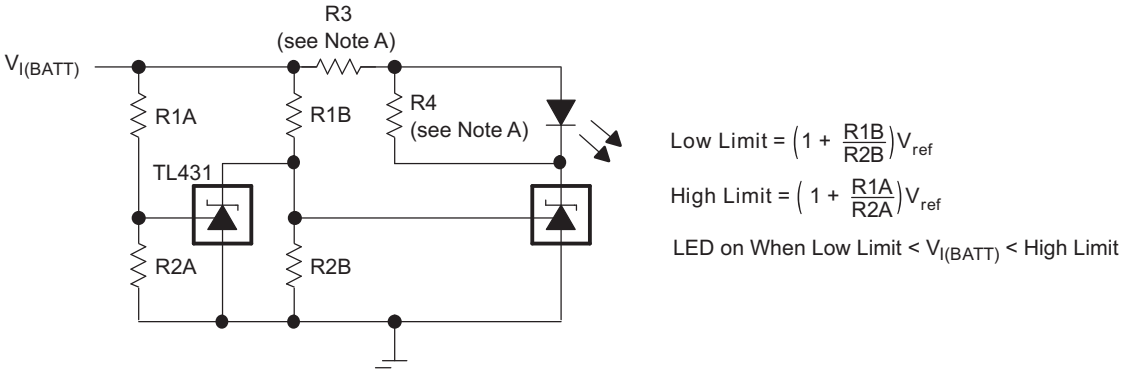



**Figure 35. PWM Converter With Reference**

## System Examples (continued)




A. Select R3 and R4 to provide the desired LED intensity and cathode current ≥1 mA to the TL431 at the available $V_{I(BATT)}$.

**Figure 36. Voltage Monitor**

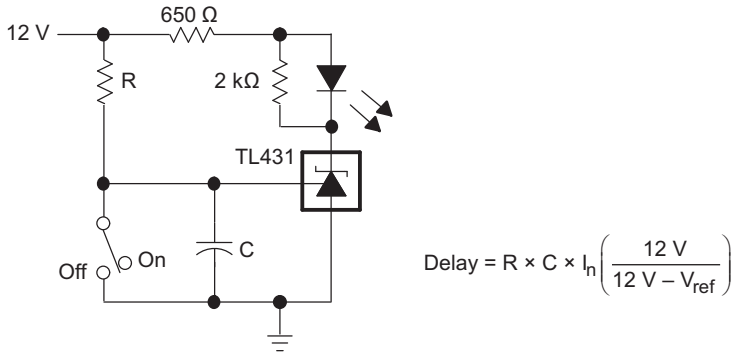



**Figure 37. Delay Timer**

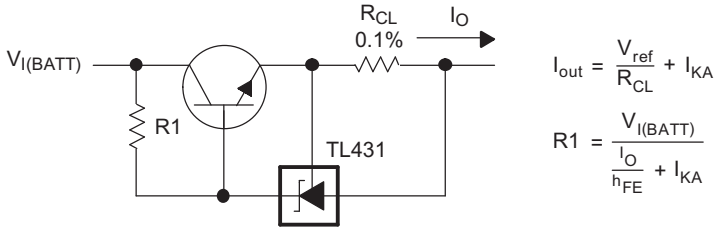



**Figure 38. Precision Current Limiter**


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### System Examples (continued)

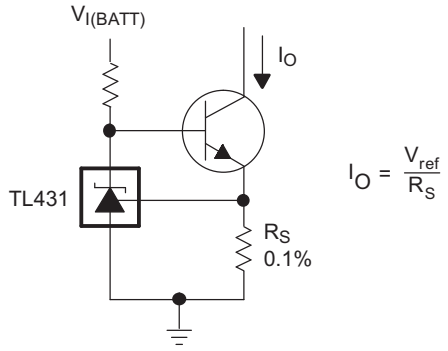



**Figure 39. Precision Constant-Current Sink**

## 11 Power Supply Recommendations

When using TL43xx as a Linear Regulator to supply a load, designers will typically use a bypass capacitor on the output/cathode pin. When doing this, be sure that the capacitance is within the stability criteria shown in Figure 16 and Figure 18.

In order to not exceed the maximum cathode current, be sure that the supply voltage is current limited. Also, be sure to limit the current being driven into the Ref pin, as not to exceed it's absolute maximum rating.

For applications shunting high currents, pay attention to the cathode and anode trace lengths, adjusting the width of the traces to have the proper current density.

## 12 Layout

### 12.1 Layout Guidelines

Bypass capacitors should be placed as close to the part as possible. Current-carrying traces need to have widths appropriate for the amount of current they are carrying; in the case of the TL43xx, these currents will be low.

### 12.2 Layout Example

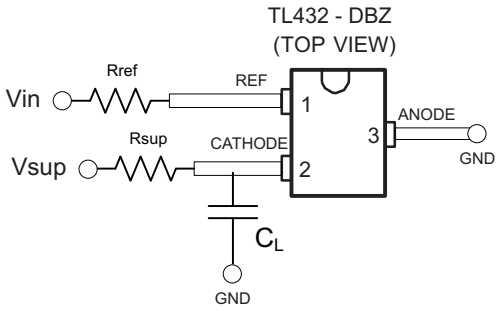



**Figure 40. DBZ Layout example**

# 13 Device and Documentation Support

## 13.1 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

**Table 3. Related Links**

| PARTS | PRODUCT FOLDER | SAMPLE & BUY | TECHNICAL DOCUMENTS | TOOLS & SOFTWARE | SUPPORT & COMMUNITY |
|---|---|---|---|---|---|
| TL431 | Click here | Click here | Click here | Click here | Click here |
| TL431A | Click here | Click here | Click here | Click here | Click here |
| TL431B | Click here | Click here | Click here | Click here | Click here |
| TL432 | Click here | Click here | Click here | Click here | Click here |
| TL432A | Click here | Click here | Click here | Click here | Click here |
| TL432B | Click here | Click here | Click here | Click here | Click here |

## 13.2 Trademarks

All trademarks are the property of their respective owners.

## 13.3 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

## 13.4 Glossary

SLYZ022 — *TI Glossary.*

This glossary lists and explains terms, acronyms and definitions.

# 14 Mechanical, Packaging, and Orderable Information

The following pages include mechanical packaging and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser based versions of this data sheet, refer to the left hand navigation.


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## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TL431ACD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | 431AC | Samples |
| TL431ACDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (TAC3 ~ TACG ~ TACS) | Samples |
| TL431ACDBVRG4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | TACG | Samples |
| TL431ACDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (TAC3 ~ TACG ~ TACU) | Samples |
| TL431ACDBVTE4 | ACTIVE | SOT-23 | DBV | 5 | | TBD | Call TI | Call TI | 0 to 70 | | Samples |
| TL431ACDBVTG4 | ACTIVE | SOT-23 | DBV | 5 | | TBD | Call TI | Call TI | 0 to 70 | | Samples |
| TL431ACDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (TAC3 ~ TACS ~ TACU) | Samples |
| TL431ACDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (TAC3 ~ TACS ~ TACU) | Samples |
| TL431ACDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (TAC3 ~ TACS ~ TACU) | Samples |
| TL431ACDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (TAC3 ~ TACS ~ TACU) | Samples |
| TL431ACDCKR | ACTIVE | SC70 | DCK | 6 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (T4S ~ T4U) | Samples |
| TL431ACDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | 431AC | Samples |
| TL431ACDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU \| CU SN | Level-1-260C-UNLIM | 0 to 70 | 431AC | Samples |
| TL431ACDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | 431AC | Samples |
| TL431ACLP | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | 0 to 70 | TL431AC | Samples |
| TL431ACLPE3 | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | 0 to 70 | TL431AC | Samples |
| TL431ACLPM | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | 0 to 70 | TL431AC | Samples |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TL431ACLPR | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | 0 to 70 | TL431AC | Samples |
| TL431ACP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type | 0 to 70 | TL431ACP | Samples |
| TL431ACPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | 0 to 70 | 4A | Samples |
| TL431ACPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | 0 to 70 | 4A | Samples |
| TL431ACPSR | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | T431A | Samples |
| TL431ACPW | ACTIVE | TSSOP | PW | 8 | 150 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | T431A | Samples |
| TL431ACPWE4 | ACTIVE | TSSOP | PW | 8 | 150 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | T431A | Samples |
| TL431ACPWR | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | T431A | Samples |
| TL431ACPWRG4 | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | T431A | Samples |
| TL431AID | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | 431AI | Samples |
| TL431AIDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (TAI3 ~ TAIG ~ TAIS) | Samples |
| TL431AIDBVRE4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TAIG | Samples |
| TL431AIDBVRG4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TAIG | Samples |
| TL431AIDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (TAI3 ~ TAIG ~ TAIU) | Samples |
| TL431AIDBVTE4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TAIG | Samples |
| TL431AIDBVTG4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TAIG | Samples |
| TL431AIDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (TAI3 ~ TAIS ~ TAIU) | Samples |
| TL431AIDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (TAI3 ~ TAIS ~ TAIU) | Samples |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TL431AIDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (TAI3 ~ TAIS ~ TAIU) | Samples |
| TL431AIDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (TAI3 ~ TAIS ~ TAIU) | Samples |
| TL431AIDCKR | ACTIVE | SC70 | DCK | 6 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | T5U | Samples |
| TL431AIDCKRE4 | ACTIVE | SC70 | DCK | 6 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | T5U | Samples |
| TL431AIDCKRG4 | ACTIVE | SC70 | DCK | 6 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | T5U | Samples |
| TL431AIDCKT | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | T5U | Samples |
| TL431AIDCKTG4 | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | T5U | Samples |
| TL431AIDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | 431AI | Samples |
| TL431AIDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU \| CU SN | Level-1-260C-UNLIM | -40 to 85 | 431AI | Samples |
| TL431AIDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | 431AI | Samples |
| TL431AILP | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | -40 to 85 | TL431AI | Samples |
| TL431AILPM | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | -40 to 85 | TL431AI | Samples |
| TL431AILPME3 | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | -40 to 85 | TL431AI | Samples |
| TL431AILPR | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | -40 to 85 | TL431AI | Samples |
| TL431AIP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type | -40 to 85 | TL431AIP | Samples |
| TL431AIPE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type | -40 to 85 | TL431AIP | Samples |
| TL431AIPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | -40 to 85 | 4B | Samples |
| TL431AIPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | -40 to 85 | 4B | Samples |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TL431AQDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (TAQG ~ TAQU) | Samples |
| TL431AQDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (TAQG ~ TAQU) | Samples |
| TL431AQDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (TAQ3 ~ TAQS ~ TAQU) | Samples |
| TL431AQDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (TAQ3 ~ TAQS ~ TAQU) | Samples |
| TL431AQDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (TAQS ~ TAQU) | Samples |
| TL431AQDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (TAQS ~ TAQU) | Samples |
| TL431AQDCKR | ACTIVE | SC70 | DCK | 6 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | T7U | Samples |
| TL431AQDCKT | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | T7U | Samples |
| TL431AQPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | -40 to 125 | 4D | Samples |
| TL431AQPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | -40 to 125 | 4D | Samples |
| TL431BCD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | T431B | Samples |
| TL431BCDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU \| CU SN | Level-1-260C-UNLIM | 0 to 70 | (T3G3 ~ T3GG ~ T3GU) | Samples |
| TL431BCDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU \| CU SN | Level-1-260C-UNLIM | 0 to 70 | (T3G3 ~ T3GG ~ T3GU) | Samples |
| TL431BCDBVTE4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | T3GG | Samples |
| TL431BCDBVTG4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | T3GG | Samples |
| TL431BCDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (T3G3 ~ T3GS ~ T3GU) | Samples |
| TL431BCDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (T3G3 ~ T3GS ~ T3GU) | Samples |
| TL431BCDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (T3G3 ~ T3GS ~ T3GU) | Samples |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TL431BCDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (T3G3 ~ T3GS ~ T3GU) | Samples |
| TL431BCDCKR | ACTIVE | SC70 | DCK | 6 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | T2U | Samples |
| TL431BCDCKT | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | T2U | Samples |
| TL431BCDE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | T431B | Samples |
| TL431BCDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | T431B | Samples |
| TL431BCDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | T431B | Samples |
| TL431BCDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | T431B | Samples |
| TL431BCLP | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | 0 to 70 | T431B | Samples |
| TL431BCLPE3 | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | 0 to 70 | T431B | Samples |
| TL431BCLPR | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | 0 to 70 | T431B | Samples |
| TL431BCP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type | 0 to 70 | TL431BCP | Samples |
| TL431BCPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | 0 to 70 | 4C | Samples |
| TL431BCPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | 0 to 70 | 4C | Samples |
| TL431BCPSR | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | T431B | Samples |
| TL431BCPSRE4 | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | T431B | Samples |
| TL431BCPWR | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | T431B | Samples |
| TL431BID | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | Z431B | Samples |
| TL431BIDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU \| CU SN | Level-1-260C-UNLIM | -40 to 85 | (T3F3 ~ T3FG ~ T3FU) | Samples |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TL431BIDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU \| CU SN | Level-1-260C-UNLIM | -40 to 85 | (T3F3 ~ T3FG ~ T3FU) | Samples |
| TL431BIDBVTE4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | T3FG | Samples |
| TL431BIDBVTG4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | T3FG | Samples |
| TL431BIDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (T3F3 ~ T3FS ~ T3FU) | Samples |
| TL431BIDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (T3F3 ~ T3FS ~ T3FU) | Samples |
| TL431BIDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (T3F3 ~ T3FS ~ T3FU) | Samples |
| TL431BIDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (T3F3 ~ T3FS ~ T3FU) | Samples |
| TL431BIDCKR | ACTIVE | SC70 | DCK | 6 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | T3U | Samples |
| TL431BIDCKT | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | T3U | Samples |
| TL431BIDCKTE4 | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | T3U | Samples |
| TL431BIDCKTG4 | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | T3U | Samples |
| TL431BIDE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | Z431B | Samples |
| TL431BIDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | Z431B | Samples |
| TL431BIDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU \| CU SN | Level-1-260C-UNLIM | -40 to 85 | Z431B | Samples |
| TL431BIDRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | Z431B | Samples |
| TL431BIDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | Z431B | Samples |
| TL431BILP | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | -40 to 85 | Z431B | Samples |
| TL431BILPE3 | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | -40 to 85 | Z431B | Samples |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TL431BILPR | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | -40 to 85 | Z431B | Samples |
| TL431BILPRE3 | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | -40 to 85 | Z431B | Samples |
| TL431BIP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type | -40 to 85 | TL431BIP | Samples |
| TL431BIPE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type | -40 to 85 | TL431BIP | Samples |
| TL431BIPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | -40 to 85 | 4I | Samples |
| TL431BIPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | -40 to 85 | 4I | Samples |
| TL431BQD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | T431BQ | Samples |
| TL431BQDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (T3H3 ~ T3HU) | Samples |
| TL431BQDBVRG4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (T3H3 ~ T3HU) | Samples |
| TL431BQDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (T3H3 ~ T3HU) | Samples |
| TL431BQDBVTE4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (T3H3 ~ T3HU) | Samples |
| TL431BQDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (T3H3 ~ T3HS ~ T3HU) | Samples |
| TL431BQDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (T3H3 ~ T3HS ~ T3HU) | Samples |
| TL431BQDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (T3HS ~ T3HU) | Samples |
| TL431BQDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (T3HS ~ T3HU) | Samples |
| TL431BQDCKR | ACTIVE | SC70 | DCK | 6 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | T8U | Samples |
| TL431BQDCKT | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | T8U | Samples |
| TL431BQDCKTE4 | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | T8U | Samples |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TL431BQDCKTG4 | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | T8U | Samples |
| TL431BQDE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | T431BQ | Samples |
| TL431BQDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | T431BQ | Samples |
| TL431BQDRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | T431BQ | Samples |
| TL431BQDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | T431BQ | Samples |
| TL431BQLP | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | -40 to 125 | T431BQ | Samples |
| TL431BQLPE3 | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | -40 to 125 | T431BQ | Samples |
| TL431BQLPM | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | -40 to 125 | T431BQ | Samples |
| TL431BQLPME3 | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | -40 to 125 | T431BQ | Samples |
| TL431BQLPR | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | -40 to 125 | T431BQ | Samples |
| TL431BQLPRE3 | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | -40 to 125 | T431BQ | Samples |
| TL431BQPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | -40 to 125 | 3H | Samples |
| TL431BQPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | -40 to 125 | 3H | Samples |
| TL431BQPSR | PREVIEW | SO | PS | 8 | 2000 | TBD | Call TI | Call TI | -40 to 125 | T431BQ | |
| TL431CD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | TL431C | Samples |
| TL431CDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU \| CU SN | Level-1-260C-UNLIM | 0 to 70 | (T3C3 ~ T3CG ~ T3CS) | Samples |
| TL431CDBVRE4 | ACTIVE | SOT-23 | DBV | 5 | | TBD | Call TI | Call TI | 0 to 70 | | Samples |
| TL431CDBVRG4 | ACTIVE | SOT-23 | DBV | 5 | | TBD | Call TI | Call TI | 0 to 70 | | Samples |
| TL431CDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU \| CU SN | Level-1-260C-UNLIM | 0 to 70 | (T3C3 ~ T3CG ~ T3CS) | Samples |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TL431CDBVTG4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | T3CG | Samples |
| TL431CDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (T3C3 ~ T3CS ~ T3CU) | Samples |
| TL431CDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (T3C3 ~ T3CS ~ T3CU) | Samples |
| TL431CDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (T3CS ~ T3CU) | Samples |
| TL431CDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (T3CS ~ T3CU) | Samples |
| TL431CDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | TL431C | Samples |
| TL431CDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU \| CU SN | Level-1-260C-UNLIM | 0 to 70 | TL431C | Samples |
| TL431CDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | TL431C | Samples |
| TL431CKTPR | OBSOLETE | PFM | KTP | 2 | | TBD | Call TI | Call TI | 0 to 70 | | |
| TL431CLP | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | 0 to 70 | TL431C | Samples |
| TL431CLPB-TDJ | OBSOLETE | TO-92 | LP | 3 | | TBD | Call TI | Call TI | 0 to 75 | | |
| TL431CLPM | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | 0 to 70 | TL431C | Samples |
| TL431CLPR | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | 0 to 70 | TL431C | Samples |
| TL431CP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type | 0 to 70 | TL431CP | Samples |
| TL431CPE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type | 0 to 70 | TL431CP | Samples |
| TL431CPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | 0 to 70 | 43 | Samples |
| TL431CPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | 0 to 70 | 43 | Samples |
| TL431CPSLE | OBSOLETE | SO | PS | 8 | | TBD | Call TI | Call TI | 0 to 70 | | |
| TL431CPSR | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | T431 | Samples |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TL431CPSRG4 | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | T431 | Samples |
| TL431CPW | OBSOLETE | TSSOP | PW | 8 | | TBD | Call TI | Call TI | 0 to 70 | | |
| TL431CPWE4 | OBSOLETE | TSSOP | PW | 8 | | TBD | Call TI | Call TI | 0 to 70 | | |
| TL431CPWG4 | OBSOLETE | TSSOP | PW | 8 | | TBD | Call TI | Call TI | 0 to 70 | | |
| TL431CPWLE | OBSOLETE | TSSOP | PW | 8 | | TBD | Call TI | Call TI | 0 to 70 | | |
| TL431CPWR | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | T431 | Samples |
| TL431ID | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TL431I | Samples |
| TL431IDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (T3I3 ~ T3IG ~ T3IS) | Samples |
| TL431IDBVRE4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | T3IG | Samples |
| TL431IDBVRG4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | T3IG | Samples |
| TL431IDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (T3I3 ~ T3IG ~ T3IU) | Samples |
| TL431IDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (T3I3 ~ T3IS ~ T3IU) | Samples |
| TL431IDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (T3I3 ~ T3IS ~ T3IU) | Samples |
| TL431IDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (T3IS ~ T3IU) | Samples |
| TL431IDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (T3IS ~ T3IU) | Samples |
| TL431IDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TL431I | Samples |
| TL431IDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU \| CU SN | Level-1-260C-UNLIM | -40 to 85 | TL431I | Samples |
| TL431IDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | TL431I | Samples |
| TL431ILP | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | -40 to 85 | TL431I | Samples |
| TL431ILPM | OBSOLETE | TO-92 | LP | 3 | | TBD | Call TI | Call TI | -40 to 85 | | |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TL431ILPR | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type | -40 to 85 | TL431I | Samples |
| TL431IP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type | -40 to 85 | TL431IP | Samples |
| TL431IPE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type | -40 to 85 | TL431IP | Samples |
| TL431IPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | -40 to 85 | 3I | Samples |
| TL431IPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | -40 to 85 | 3I | Samples |
| TL431MFKB | OBSOLETE | LCCC | FK | 20 | | TBD | Call TI | Call TI | -55 to 125 | | |
| TL431MJG | OBSOLETE | CDIP | JG | 8 | | TBD | Call TI | Call TI | -55 to 125 | | |
| TL431MJGB | OBSOLETE | CDIP | JG | 8 | | TBD | Call TI | Call TI | -55 to 125 | | |
| TL431QD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | T431Q | Samples |
| TL431QDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU \| CU SN | Level-1-260C-UNLIM | -40 to 125 | (T3QG ~ T3QU) | Samples |
| TL431QDBVRG4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | T3QG | Samples |
| TL431QDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU \| CU SN | Level-1-260C-UNLIM | -40 to 125 | (T3QG ~ T3QU) | Samples |
| TL431QDBVTE4 | ACTIVE | SOT-23 | DBV | 5 | | TBD | Call TI | Call TI | -40 to 125 | | Samples |
| TL431QDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (T3Q3 ~ T3QS ~ T3QU) | Samples |
| TL431QDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (T3Q3 ~ T3QS ~ T3QU) | Samples |
| TL431QDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (T3QS ~ T3QU) | Samples |
| TL431QDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (T3QS ~ T3QU) | Samples |
| TL431QDCKR | ACTIVE | SC70 | DCK | 6 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | T6U | Samples |
| TL431QDCKRG4 | ACTIVE | SC70 | DCK | 6 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | T6U | Samples |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TL431QDCKT | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | T6U | Samples |
| TL431QDCKTG4 | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | T6U | Samples |
| TL431QDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | T431Q | Samples |
| TL431QPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | -40 to 125 | 3Q | Samples |
| TL431QPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | -40 to 125 | 3Q | Samples |
| TL432ACDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU \| CU SN | Level-1-260C-UNLIM | 0 to 70 | (T4BG ~ T4BU) | Samples |
| TL432ACDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (T4B3 ~ T4BS ~ T4BU) | Samples |
| TL432ACDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (T4B3 ~ T4BS ~ T4BU) | Samples |
| TL432ACDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (T4BS ~ T4BU) | Samples |
| TL432ACDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (T4BS ~ T4BU) | Samples |
| TL432AIDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU \| CU SN | Level-1-260C-UNLIM | -40 to 85 | (T4AG ~ T4AU) | Samples |
| TL432AIDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (T4A3 ~ T4AS ~ T4AU) | Samples |
| TL432AIDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (T4A3 ~ T4AS ~ T4AU) | Samples |
| TL432AIDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (T4A3 ~ T4AS ~ T4AU) | Samples |
| TL432AIDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (T4A3 ~ T4AS ~ T4AU) | Samples |
| TL432AIPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | -40 to 85 | 2E | Samples |
| TL432AQDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | T4DU | Samples |
| TL432AQDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | T4DU | Samples |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TL432AQDBVTG4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | T4DU | Samples |
| TL432AQDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (T4D3 ~ T4DS ~ T4DU) | Samples |
| TL432AQDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (T4D3 ~ T4DS ~ T4DU) | Samples |
| TL432AQDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (T4DS ~ T4DU) | Samples |
| TL432AQDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (T4DS ~ T4DU) | Samples |
| TL432AQPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | -40 to 125 | 2F | Samples |
| TL432AQPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | -40 to 125 | 2F | Samples |
| TL432BCDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (TBC3 ~ TBCU) | Samples |
| TL432BCDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (TBCS ~ TBCU) | Samples |
| TL432BCDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (TBCS ~ TBCU) | Samples |
| TL432BCDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (TBCS ~ TBCU) | Samples |
| TL432BCPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | 0 to 70 | 2G | Samples |
| TL432BIDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (T4F3 ~ T4FS ~ T4FU) | Samples |
| TL432BIDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (T4F3 ~ T4FS ~ T4FU) | Samples |
| TL432BIDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (T4F3 ~ T4FS ~ T4FU) | Samples |
| TL432BIDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (T4F3 ~ T4FS ~ T4FU) | Samples |
| TL432BIPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | -40 to 85 | 2H | Samples |
| TL432BQDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (T4H3 ~ T4HS ~ T4HU) | Samples |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TL432BQDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (T4H3 ~ T4HS ~ T4HU) | Samples |
| TL432BQDBZT | PREVIEW | SOT-23 | DBZ | 3 | | TBD | Call TI | Call TI | -40 to 125 | | |
| TL432BQPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | -40 to 125 | 2J | Samples |
| TL432CDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU \| CU SN | Level-1-260C-UNLIM | 0 to 70 | (T4CG ~ T4CU) | Samples |
| TL432CDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (T4CS ~ T4CU) | Samples |
| TL432CDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (T4CS ~ T4CU) | Samples |
| TL432CDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | 0 to 70 | (T4CS ~ T4CU) | Samples |
| TL432CPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | 0 to 70 | 2A | Samples |
| TL432IDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU \| CU SN | Level-1-260C-UNLIM | -40 to 85 | (T4IG ~ T4IU) | Samples |
| TL432IDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (T4IS ~ T4IU) | Samples |
| TL432IDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (T4IS ~ T4IU) | Samples |
| TL432IPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | -40 to 85 | 2B | Samples |
| TL432QDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (T4QS ~ T4QU) | Samples |
| TL432QPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | -40 to 125 | 2C | Samples |
| TL432QPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1 YEAR | -40 to 125 | 2C | Samples |

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

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

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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

**OTHER QUALIFIED VERSIONS OF TL431A, TL431B, TL432A, TL432B :**

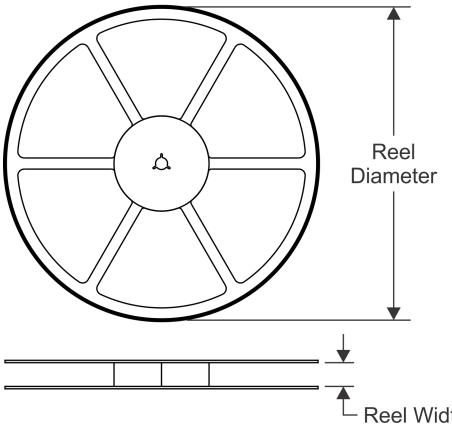
- Automotive: TL431A-Q1, TL431B-Q1, TL432A-Q1, TL432B-Q1

NOTE: Qualified Version Definitions:

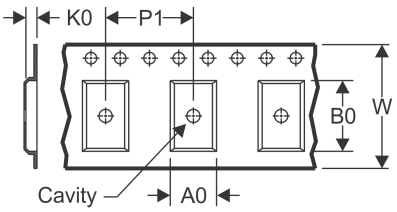
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

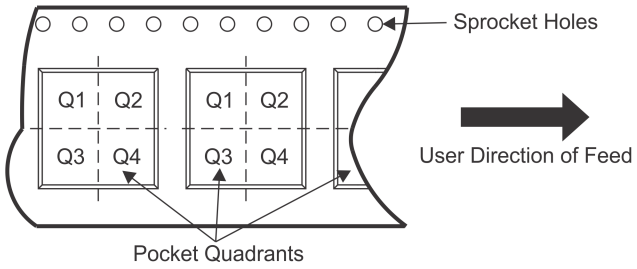



**TAPE DIMENSIONS**




| | |
|---|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*All dimensions are nominal

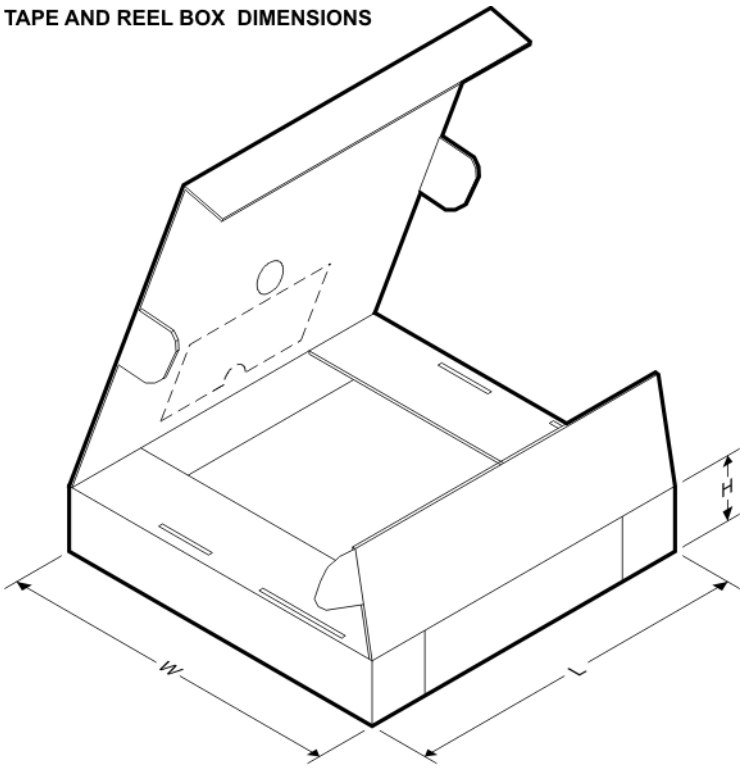
| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TL431ACDBVR | SOT-23 | DBV | 5 | 3000 | 178.0 | 9.0 | 3.3 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TL431ACDBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 8.4 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL431ACDBVRG4 | SOT-23 | DBV | 5 | 3000 | 178.0 | 9.0 | 3.3 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TL431ACDBVT | SOT-23 | DBV | 5 | 250 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL431ACDBZR | SOT-23 | DBZ | 3 | 3000 | 178.0 | 9.2 | 3.08 | 2.8 | 1.27 | 4.0 | 8.0 | Q3 |
| TL431ACDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL431ACDBZT | SOT-23 | DBZ | 3 | 250 | 178.0 | 9.2 | 3.08 | 2.8 | 1.27 | 4.0 | 8.0 | Q3 |
| TL431ACDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL431ACDCKR | SC70 | DCK | 6 | 3000 | 180.0 | 8.4 | 2.41 | 2.41 | 1.2 | 4.0 | 8.0 | Q3 |
| TL431ACDR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TL431ACDRG4 | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TL431ACPK | SOT-89 | PK | 3 | 1000 | 180.0 | 12.4 | 4.91 | 4.52 | 1.9 | 8.0 | 12.0 | Q3 |
| TL431ACPSR | SO | PS | 8 | 2000 | 330.0 | 16.4 | 8.2 | 6.6 | 2.5 | 12.0 | 16.0 | Q1 |
| TL431AIDBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 8.4 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL431AIDBVR | SOT-23 | DBV | 5 | 3000 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL431AIDBVRG4 | SOT-23 | DBV | 5 | 3000 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL431AIDBVT | SOT-23 | DBV | 5 | 250 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL431AIDBVTG4 | SOT-23 | DBV | 5 | 250 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TL431AIDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL431AIDBZR | SOT-23 | DBZ | 3 | 3000 | 178.0 | 9.2 | 3.08 | 2.8 | 1.27 | 4.0 | 8.0 | Q3 |
| TL431AIDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL431AIDBZT | SOT-23 | DBZ | 3 | 250 | 178.0 | 9.2 | 3.08 | 2.8 | 1.27 | 4.0 | 8.0 | Q3 |
| TL431AIDCKR | SC70 | DCK | 6 | 3000 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| TL431AIDCKT | SC70 | DCK | 6 | 250 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| TL431AIDR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TL431AIDRG4 | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TL431AIPK | SOT-89 | PK | 3 | 1000 | 180.0 | 12.4 | 4.91 | 4.52 | 1.9 | 8.0 | 12.0 | Q3 |
| TL431AQDBVR | SOT-23 | DBV | 5 | 3000 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL431AQDBVT | SOT-23 | DBV | 5 | 250 | 178.0 | 9.0 | 3.3 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TL431AQDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL431AQDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL431AQDCKR | SC70 | DCK | 6 | 3000 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| TL431AQDCKT | SC70 | DCK | 6 | 250 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| TL431BCDBVR | SOT-23 | DBV | 5 | 3000 | 179.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TL431BCDBVT | SOT-23 | DBV | 5 | 250 | 179.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TL431BCDBVTG4 | SOT-23 | DBV | 5 | 250 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL431BCDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL431BCDBZR | SOT-23 | DBZ | 3 | 3000 | 178.0 | 9.2 | 3.08 | 2.8 | 1.27 | 4.0 | 8.0 | Q3 |
| TL431BCDBZT | SOT-23 | DBZ | 3 | 250 | 178.0 | 9.2 | 3.08 | 2.8 | 1.27 | 4.0 | 8.0 | Q3 |
| TL431BCDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL431BCDCKR | SC70 | DCK | 6 | 3000 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| TL431BCDCKT | SC70 | DCK | 6 | 250 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| TL431BCDR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TL431BCPK | SOT-89 | PK | 3 | 1000 | 180.0 | 12.4 | 4.91 | 4.52 | 1.9 | 8.0 | 12.0 | Q3 |
| TL431BCPSR | SO | PS | 8 | 2000 | 330.0 | 16.4 | 8.2 | 6.6 | 2.5 | 12.0 | 16.0 | Q1 |
| TL431BIDBVR | SOT-23 | DBV | 5 | 3000 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL431BIDBVR | SOT-23 | DBV | 5 | 3000 | 179.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TL431BIDBVT | SOT-23 | DBV | 5 | 250 | 179.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TL431BIDBVT | SOT-23 | DBV | 5 | 250 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL431BIDBVTG4 | SOT-23 | DBV | 5 | 250 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL431BIDBZR | SOT-23 | DBZ | 3 | 3000 | 178.0 | 9.2 | 3.08 | 2.8 | 1.27 | 4.0 | 8.0 | Q3 |
| TL431BIDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL431BIDBZT | SOT-23 | DBZ | 3 | 250 | 178.0 | 9.2 | 3.08 | 2.8 | 1.27 | 4.0 | 8.0 | Q3 |
| TL431BIDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL431BIDCKR | SC70 | DCK | 6 | 3000 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| TL431BIDCKT | SC70 | DCK | 6 | 250 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| TL431BIDR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TL431BIDR | SOIC | D | 8 | 2500 | 330.0 | 12.8 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TL431BIDRG4 | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TL431BIPK | SOT-89 | PK | 3 | 1000 | 180.0 | 12.4 | 4.91 | 4.52 | 1.9 | 8.0 | 12.0 | Q3 |
| TL431BQDBVR | SOT-23 | DBV | 5 | 3000 | 179.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TL431BQDBVT | SOT-23 | DBV | 5 | 250 | 179.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TL431BQDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL431BQDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL431BQDCKR | SC70 | DCK | 6 | 3000 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| TL431BQDCKT | SC70 | DCK | 6 | 250 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| TL431BQDR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TL431CDBVR | SOT-23 | DBV | 5 | 3000 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL431CDBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 8.4 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL431CDBVT | SOT-23 | DBV | 5 | 250 | 180.0 | 8.4 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL431CDBVTG4 | SOT-23 | DBV | 5 | 250 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL431CDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL431CDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL431CDR | SOIC | D | 8 | 2500 | 330.0 | 12.8 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TL431CDR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TL431CDRG4 | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TL431CPK | SOT-89 | PK | 3 | 1000 | 180.0 | 12.4 | 4.91 | 4.52 | 1.9 | 8.0 | 12.0 | Q3 |
| TL431CPSR | SO | PS | 8 | 2000 | 330.0 | 16.4 | 8.2 | 6.6 | 2.5 | 12.0 | 16.0 | Q1 |
| TL431IDBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 8.4 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL431IDBVR | SOT-23 | DBV | 5 | 3000 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL431IDBVRG4 | SOT-23 | DBV | 5 | 3000 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL431IDBVT | SOT-23 | DBV | 5 | 250 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL431IDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL431IDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL431IDR | SOIC | D | 8 | 2500 | 330.0 | 12.8 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TL431IDR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TL431IDRG4 | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TL431IPK | SOT-89 | PK | 3 | 1000 | 180.0 | 12.4 | 4.91 | 4.52 | 1.9 | 8.0 | 12.0 | Q3 |
| TL431QDBVR | SOT-23 | DBV | 5 | 3000 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL431QDBVRG4 | SOT-23 | DBV | 5 | 3000 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL431QDBVT | SOT-23 | DBV | 5 | 250 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL431QDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL431QDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL431QDCKR | SC70 | DCK | 6 | 3000 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| TL431QDCKT | SC70 | DCK | 6 | 250 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| TL431QDR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TL432ACDBVR | SOT-23 | DBV | 5 | 3000 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL432ACDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL432ACDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL432AIDBVR | SOT-23 | DBV | 5 | 3000 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL432AIDBZR | SOT-23 | DBZ | 3 | 3000 | 178.0 | 9.2 | 3.08 | 2.8 | 1.27 | 4.0 | 8.0 | Q3 |
| TL432AIDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL432AIDBZT | SOT-23 | DBZ | 3 | 250 | 178.0 | 9.2 | 3.08 | 2.8 | 1.27 | 4.0 | 8.0 | Q3 |
| TL432AIDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TL432AIPK | SOT-89 | PK | 3 | 1000 | 180.0 | 12.4 | 4.91 | 4.52 | 1.9 | 8.0 | 12.0 | Q3 |
| TL432AQDBVR | SOT-23 | DBV | 5 | 3000 | 179.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TL432AQDBVT | SOT-23 | DBV | 5 | 250 | 179.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TL432AQDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL432AQDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL432AQPK | SOT-89 | PK | 3 | 1000 | 180.0 | 12.4 | 4.91 | 4.52 | 1.9 | 8.0 | 12.0 | Q3 |
| TL432BCDBVR | SOT-23 | DBV | 5 | 3000 | 179.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TL432BCDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL432BCDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL432BCPK | SOT-89 | PK | 3 | 1000 | 180.0 | 12.4 | 4.91 | 4.52 | 1.9 | 8.0 | 12.0 | Q3 |
| TL432BIDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL432BIDBZR | SOT-23 | DBZ | 3 | 3000 | 178.0 | 9.2 | 3.08 | 2.8 | 1.27 | 4.0 | 8.0 | Q3 |
| TL432BIDBZT | SOT-23 | DBZ | 3 | 250 | 178.0 | 9.2 | 3.08 | 2.8 | 1.27 | 4.0 | 8.0 | Q3 |
| TL432BIDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL432BIPK | SOT-89 | PK | 3 | 1000 | 180.0 | 12.4 | 4.91 | 4.52 | 1.9 | 8.0 | 12.0 | Q3 |
| TL432BQDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL432BQDBZR | SOT-23 | DBZ | 3 | 3000 | 178.0 | 9.2 | 3.08 | 2.8 | 1.27 | 4.0 | 8.0 | Q3 |
| TL432BQPK | SOT-89 | PK | 3 | 1000 | 180.0 | 12.4 | 4.91 | 4.52 | 1.9 | 8.0 | 12.0 | Q3 |
| TL432CDBVR | SOT-23 | DBV | 5 | 3000 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL432CDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL432CDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL432CPK | SOT-89 | PK | 3 | 1000 | 180.0 | 12.4 | 4.91 | 4.52 | 1.9 | 8.0 | 12.0 | Q3 |
| TL432IDBVR | SOT-23 | DBV | 5 | 3000 | 179.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TL432IDBVR | SOT-23 | DBV | 5 | 3000 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TL432IDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL432IDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL432IPK | SOT-89 | PK | 3 | 1000 | 180.0 | 12.4 | 4.91 | 4.52 | 1.9 | 8.0 | 12.0 | Q3 |
| TL432QDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 8.4 | 3.15 | 2.77 | 1.22 | 4.0 | 8.0 | Q3 |
| TL432QPK | SOT-89 | PK | 3 | 1000 | 180.0 | 12.4 | 4.91 | 4.52 | 1.9 | 8.0 | 12.0 | Q3 |

**TAPE AND REEL BOX DIMENSIONS**




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| TL431ACDBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 180.0 | 18.0 |
| TL431ACDBVR | SOT-23 | DBV | 5 | 3000 | 202.0 | 201.0 | 28.0 |
| TL431ACDBVRG4 | SOT-23 | DBV | 5 | 3000 | 180.0 | 180.0 | 18.0 |
| TL431ACDBVT | SOT-23 | DBV | 5 | 250 | 180.0 | 180.0 | 18.0 |
| TL431ACDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 180.0 | 18.0 |
| TL431ACDBZR | SOT-23 | DBZ | 3 | 3000 | 202.0 | 201.0 | 28.0 |
| TL431ACDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 180.0 | 18.0 |
| TL431ACDBZT | SOT-23 | DBZ | 3 | 250 | 202.0 | 201.0 | 28.0 |
| TL431ACDCKR | SC70 | DCK | 6 | 3000 | 202.0 | 201.0 | 28.0 |
| TL431ACDR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| TL431ACDRG4 | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| TL431ACPK | SOT-89 | PK | 3 | 1000 | 340.0 | 340.0 | 38.0 |
| TL431ACPSR | SO | PS | 8 | 2000 | 367.0 | 367.0 | 38.0 |
| TL431AIDBVR | SOT-23 | DBV | 5 | 3000 | 202.0 | 201.0 | 28.0 |
| TL431AIDBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 180.0 | 18.0 |
| TL431AIDBVRG4 | SOT-23 | DBV | 5 | 3000 | 180.0 | 180.0 | 18.0 |
| TL431AIDBVT | SOT-23 | DBV | 5 | 250 | 180.0 | 180.0 | 18.0 |
| TL431AIDBVTG4 | SOT-23 | DBV | 5 | 250 | 180.0 | 180.0 | 18.0 |
| TL431AIDBZR | SOT-23 | DBZ | 3 | 3000 | 202.0 | 201.0 | 28.0 |
| TL431AIDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 180.0 | 18.0 |

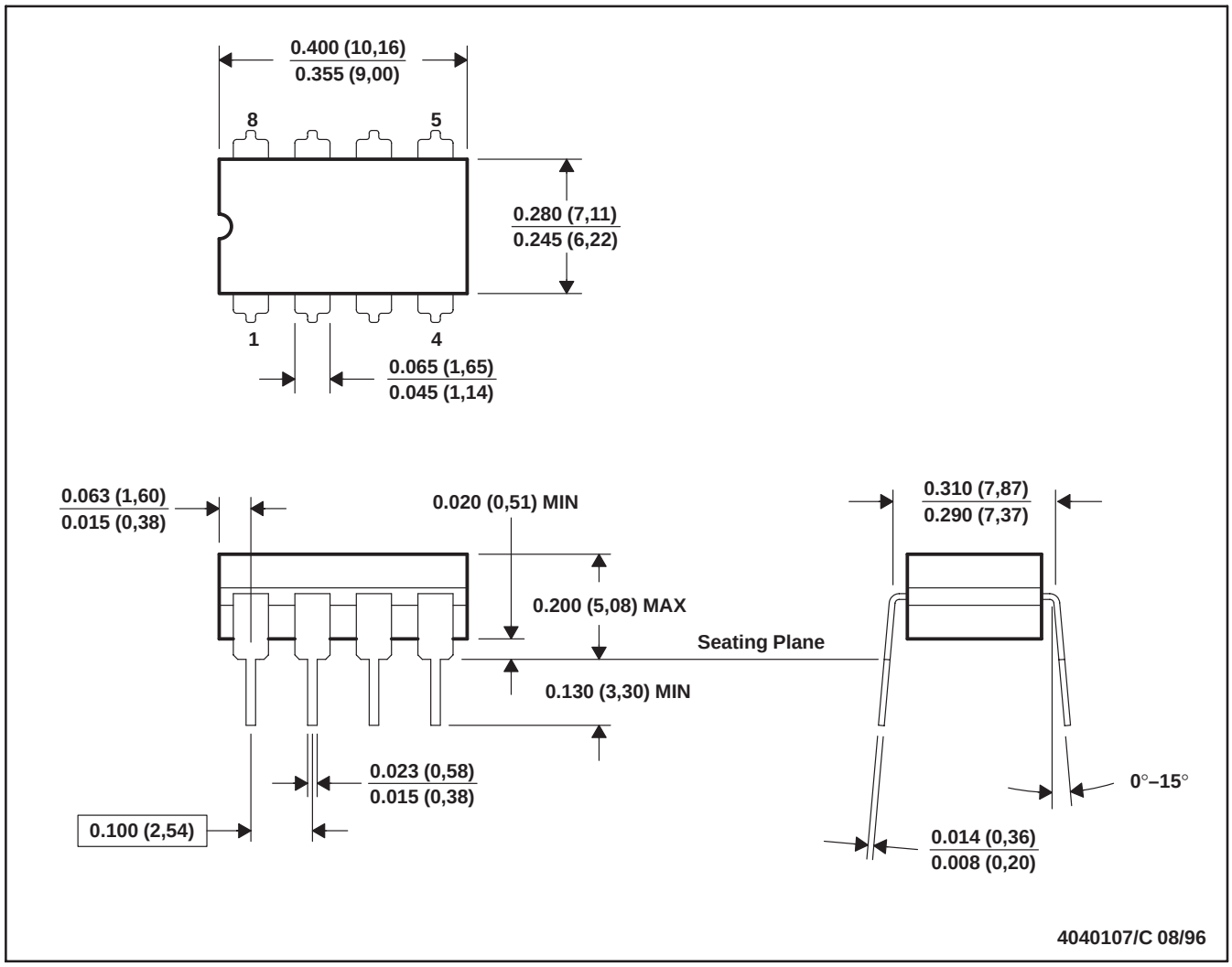
| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| TL431AIDBZT | SOT-23 | DBZ | 3 | 250 | 202.0 | 201.0 | 28.0 |
| TL431AIDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 180.0 | 18.0 |
| TL431AIDCKR | SC70 | DCK | 6 | 3000 | 203.0 | 203.0 | 35.0 |
| TL431AIDCKT | SC70 | DCK | 6 | 250 | 203.0 | 203.0 | 35.0 |
| TL431AIDR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| TL431AIDRG4 | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| TL431AIPK | SOT-89 | PK | 3 | 1000 | 340.0 | 340.0 | 38.0 |
| TL431AQDBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 180.0 | 18.0 |
| TL431AQDBVT | SOT-23 | DBV | 5 | 250 | 180.0 | 180.0 | 18.0 |
| TL431AQDBZR | SOT-23 | DBZ | 3 | 3000 | 202.0 | 201.0 | 28.0 |
| TL431AQDBZT | SOT-23 | DBZ | 3 | 250 | 202.0 | 201.0 | 28.0 |
| TL431AQDCKR | SC70 | DCK | 6 | 3000 | 203.0 | 203.0 | 35.0 |
| TL431AQDCKT | SC70 | DCK | 6 | 250 | 203.0 | 203.0 | 35.0 |
| TL431BCDBVR | SOT-23 | DBV | 5 | 3000 | 203.0 | 203.0 | 35.0 |
| TL431BCDBVT | SOT-23 | DBV | 5 | 250 | 203.0 | 203.0 | 35.0 |
| TL431BCDBVTG4 | SOT-23 | DBV | 5 | 250 | 180.0 | 180.0 | 18.0 |
| TL431BCDBZR | SOT-23 | DBZ | 3 | 3000 | 202.0 | 201.0 | 28.0 |
| TL431BCDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 180.0 | 18.0 |
| TL431BCDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 180.0 | 18.0 |
| TL431BCDBZT | SOT-23 | DBZ | 3 | 250 | 202.0 | 201.0 | 28.0 |
| TL431BCDCKR | SC70 | DCK | 6 | 3000 | 203.0 | 203.0 | 35.0 |
| TL431BCDCKT | SC70 | DCK | 6 | 250 | 203.0 | 203.0 | 35.0 |
| TL431BCDR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| TL431BCPK | SOT-89 | PK | 3 | 1000 | 340.0 | 340.0 | 38.0 |
| TL431BCPSR | SO | PS | 8 | 2000 | 367.0 | 367.0 | 38.0 |
| TL431BIDBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 180.0 | 18.0 |
| TL431BIDBVR | SOT-23 | DBV | 5 | 3000 | 203.0 | 203.0 | 35.0 |
| TL431BIDBVT | SOT-23 | DBV | 5 | 250 | 203.0 | 203.0 | 35.0 |
| TL431BIDBVT | SOT-23 | DBV | 5 | 250 | 180.0 | 180.0 | 18.0 |
| TL431BIDBVTG4 | SOT-23 | DBV | 5 | 250 | 180.0 | 180.0 | 18.0 |
| TL431BIDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 180.0 | 18.0 |
| TL431BIDBZR | SOT-23 | DBZ | 3 | 3000 | 202.0 | 201.0 | 28.0 |
| TL431BIDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 180.0 | 18.0 |
| TL431BIDBZT | SOT-23 | DBZ | 3 | 250 | 202.0 | 201.0 | 28.0 |
| TL431BIDCKR | SC70 | DCK | 6 | 3000 | 203.0 | 203.0 | 35.0 |
| TL431BIDCKT | SC70 | DCK | 6 | 250 | 203.0 | 203.0 | 35.0 |
| TL431BIDR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| TL431BIDR | SOIC | D | 8 | 2500 | 364.0 | 364.0 | 27.0 |
| TL431BIDRG4 | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| TL431BIPK | SOT-89 | PK | 3 | 1000 | 340.0 | 340.0 | 38.0 |
| TL431BQDBVR | SOT-23 | DBV | 5 | 3000 | 203.0 | 203.0 | 35.0 |
| TL431BQDBVT | SOT-23 | DBV | 5 | 250 | 203.0 | 203.0 | 35.0 |
| TL431BQDBZR | SOT-23 | DBZ | 3 | 3000 | 202.0 | 201.0 | 28.0 |
| TL431BQDBZT | SOT-23 | DBZ | 3 | 250 | 202.0 | 201.0 | 28.0 |

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| TL431BQDCKR | SC70 | DCK | 6 | 3000 | 203.0 | 203.0 | 35.0 |
| TL431BQDCKT | SC70 | DCK | 6 | 250 | 203.0 | 203.0 | 35.0 |
| TL431BQDR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| TL431CDBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 180.0 | 18.0 |
| TL431CDBVR | SOT-23 | DBV | 5 | 3000 | 202.0 | 201.0 | 28.0 |
| TL431CDBVT | SOT-23 | DBV | 5 | 250 | 202.0 | 201.0 | 28.0 |
| TL431CDBVTG4 | SOT-23 | DBV | 5 | 250 | 180.0 | 180.0 | 18.0 |
| TL431CDBZR | SOT-23 | DBZ | 3 | 3000 | 202.0 | 201.0 | 28.0 |
| TL431CDBZT | SOT-23 | DBZ | 3 | 250 | 202.0 | 201.0 | 28.0 |
| TL431CDR | SOIC | D | 8 | 2500 | 364.0 | 364.0 | 27.0 |
| TL431CDR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| TL431CDRG4 | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| TL431CPK | SOT-89 | PK | 3 | 1000 | 340.0 | 340.0 | 38.0 |
| TL431CPSR | SO | PS | 8 | 2000 | 367.0 | 367.0 | 38.0 |
| TL431IDBVR | SOT-23 | DBV | 5 | 3000 | 202.0 | 201.0 | 28.0 |
| TL431IDBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 180.0 | 18.0 |
| TL431IDBVRG4 | SOT-23 | DBV | 5 | 3000 | 180.0 | 180.0 | 18.0 |
| TL431IDBVT | SOT-23 | DBV | 5 | 250 | 180.0 | 180.0 | 18.0 |
| TL431IDBZR | SOT-23 | DBZ | 3 | 3000 | 202.0 | 201.0 | 28.0 |
| TL431IDBZT | SOT-23 | DBZ | 3 | 250 | 202.0 | 201.0 | 28.0 |
| TL431IDR | SOIC | D | 8 | 2500 | 364.0 | 364.0 | 27.0 |
| TL431IDR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| TL431IDRG4 | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| TL431IPK | SOT-89 | PK | 3 | 1000 | 340.0 | 340.0 | 38.0 |
| TL431QDBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 180.0 | 18.0 |
| TL431QDBVRG4 | SOT-23 | DBV | 5 | 3000 | 180.0 | 180.0 | 18.0 |
| TL431QDBVT | SOT-23 | DBV | 5 | 250 | 180.0 | 180.0 | 18.0 |
| TL431QDBZR | SOT-23 | DBZ | 3 | 3000 | 202.0 | 201.0 | 28.0 |
| TL431QDBZT | SOT-23 | DBZ | 3 | 250 | 202.0 | 201.0 | 28.0 |
| TL431QDCKR | SC70 | DCK | 6 | 3000 | 203.0 | 203.0 | 35.0 |
| TL431QDCKT | SC70 | DCK | 6 | 250 | 203.0 | 203.0 | 35.0 |
| TL431QDR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| TL432ACDBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 180.0 | 18.0 |
| TL432ACDBZR | SOT-23 | DBZ | 3 | 3000 | 202.0 | 201.0 | 28.0 |
| TL432ACDBZT | SOT-23 | DBZ | 3 | 250 | 202.0 | 201.0 | 28.0 |
| TL432AIDBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 180.0 | 18.0 |
| TL432AIDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 180.0 | 18.0 |
| TL432AIDBZR | SOT-23 | DBZ | 3 | 3000 | 202.0 | 201.0 | 28.0 |
| TL432AIDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 180.0 | 18.0 |
| TL432AIDBZT | SOT-23 | DBZ | 3 | 250 | 202.0 | 201.0 | 28.0 |
| TL432AIPK | SOT-89 | PK | 3 | 1000 | 340.0 | 340.0 | 38.0 |
| TL432AQDBVR | SOT-23 | DBV | 5 | 3000 | 203.0 | 203.0 | 35.0 |
| TL432AQDBVT | SOT-23 | DBV | 5 | 250 | 203.0 | 203.0 | 35.0 |
| TL432AQDBZR | SOT-23 | DBZ | 3 | 3000 | 202.0 | 201.0 | 28.0 |

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| TL432AQDBZT | SOT-23 | DBZ | 3 | 250 | 202.0 | 201.0 | 28.0 |
| TL432AQPK | SOT-89 | PK | 3 | 1000 | 340.0 | 340.0 | 38.0 |
| TL432BCDBVR | SOT-23 | DBV | 5 | 3000 | 203.0 | 203.0 | 35.0 |
| TL432BCDBZR | SOT-23 | DBZ | 3 | 3000 | 202.0 | 201.0 | 28.0 |
| TL432BCDBZT | SOT-23 | DBZ | 3 | 250 | 202.0 | 201.0 | 28.0 |
| TL432BCPK | SOT-89 | PK | 3 | 1000 | 340.0 | 340.0 | 38.0 |
| TL432BIDBZR | SOT-23 | DBZ | 3 | 3000 | 202.0 | 201.0 | 28.0 |
| TL432BIDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 180.0 | 18.0 |
| TL432BIDBZT | SOT-23 | DBZ | 3 | 250 | 180.0 | 180.0 | 18.0 |
| TL432BIDBZT | SOT-23 | DBZ | 3 | 250 | 202.0 | 201.0 | 28.0 |
| TL432BIPK | SOT-89 | PK | 3 | 1000 | 340.0 | 340.0 | 38.0 |
| TL432BQDBZR | SOT-23 | DBZ | 3 | 3000 | 202.0 | 201.0 | 28.0 |
| TL432BQDBZR | SOT-23 | DBZ | 3 | 3000 | 180.0 | 180.0 | 18.0 |
| TL432BQPK | SOT-89 | PK | 3 | 1000 | 340.0 | 340.0 | 38.0 |
| TL432CDBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 180.0 | 18.0 |
| TL432CDBZR | SOT-23 | DBZ | 3 | 3000 | 202.0 | 201.0 | 28.0 |
| TL432CDBZT | SOT-23 | DBZ | 3 | 250 | 202.0 | 201.0 | 28.0 |
| TL432CPK | SOT-89 | PK | 3 | 1000 | 340.0 | 340.0 | 38.0 |
| TL432IDBVR | SOT-23 | DBV | 5 | 3000 | 203.0 | 203.0 | 35.0 |
| TL432IDBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 180.0 | 18.0 |
| TL432IDBZR | SOT-23 | DBZ | 3 | 3000 | 202.0 | 201.0 | 28.0 |
| TL432IDBZT | SOT-23 | DBZ | 3 | 250 | 202.0 | 201.0 | 28.0 |
| TL432IPK | SOT-89 | PK | 3 | 1000 | 340.0 | 340.0 | 38.0 |
| TL432QDBZR | SOT-23 | DBZ | 3 | 3000 | 202.0 | 201.0 | 28.0 |
| TL432QPK | SOT-89 | PK | 3 | 1000 | 340.0 | 340.0 | 38.0 |

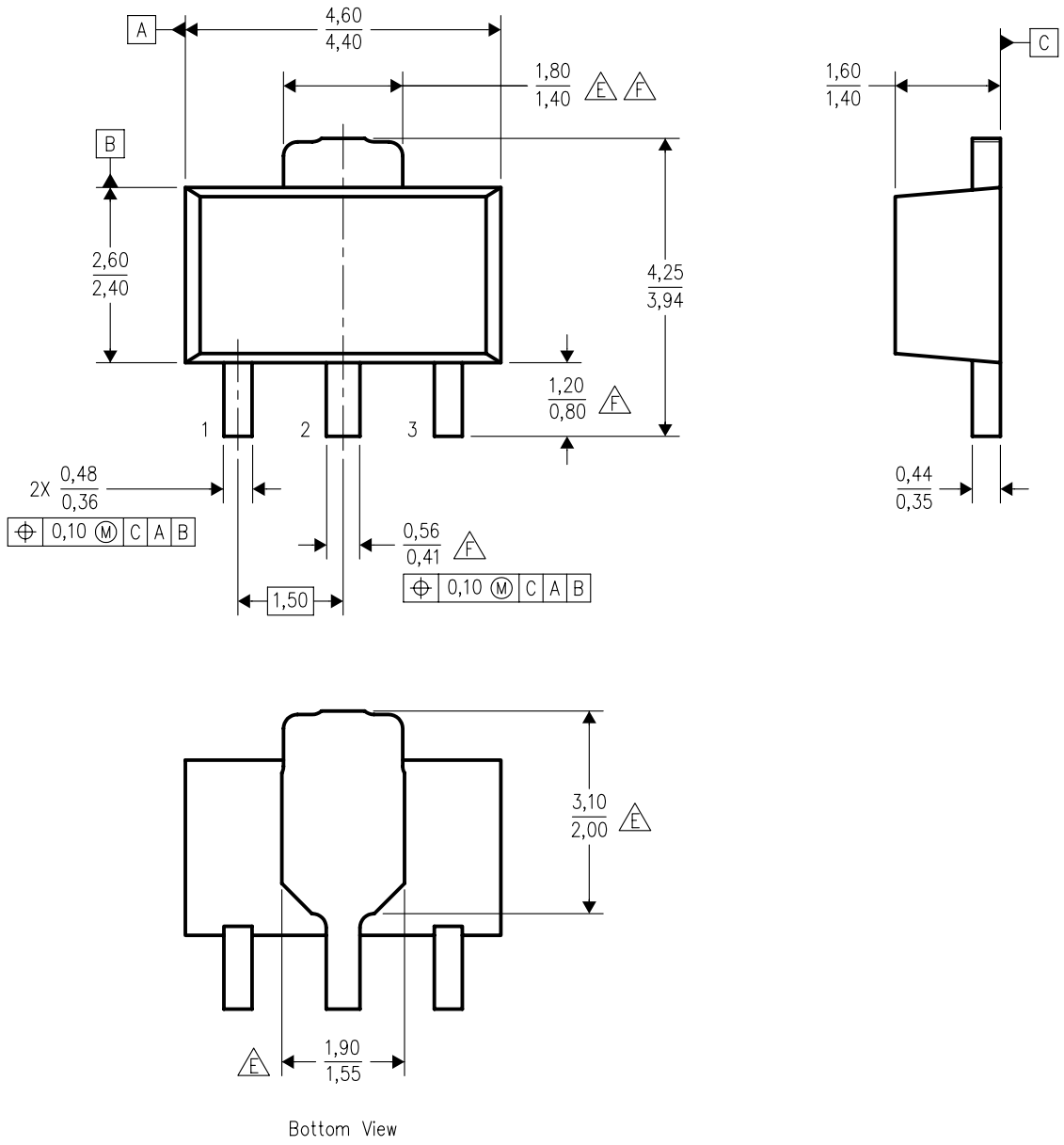
MCER001A – JANUARY 1995 – REVISED JANUARY 1997

**JG (R-GDIP-T8)** **CERAMIC DUAL-IN-LINE**




NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification.
E. Falls within MIL STD 1835 GDIP1-T8

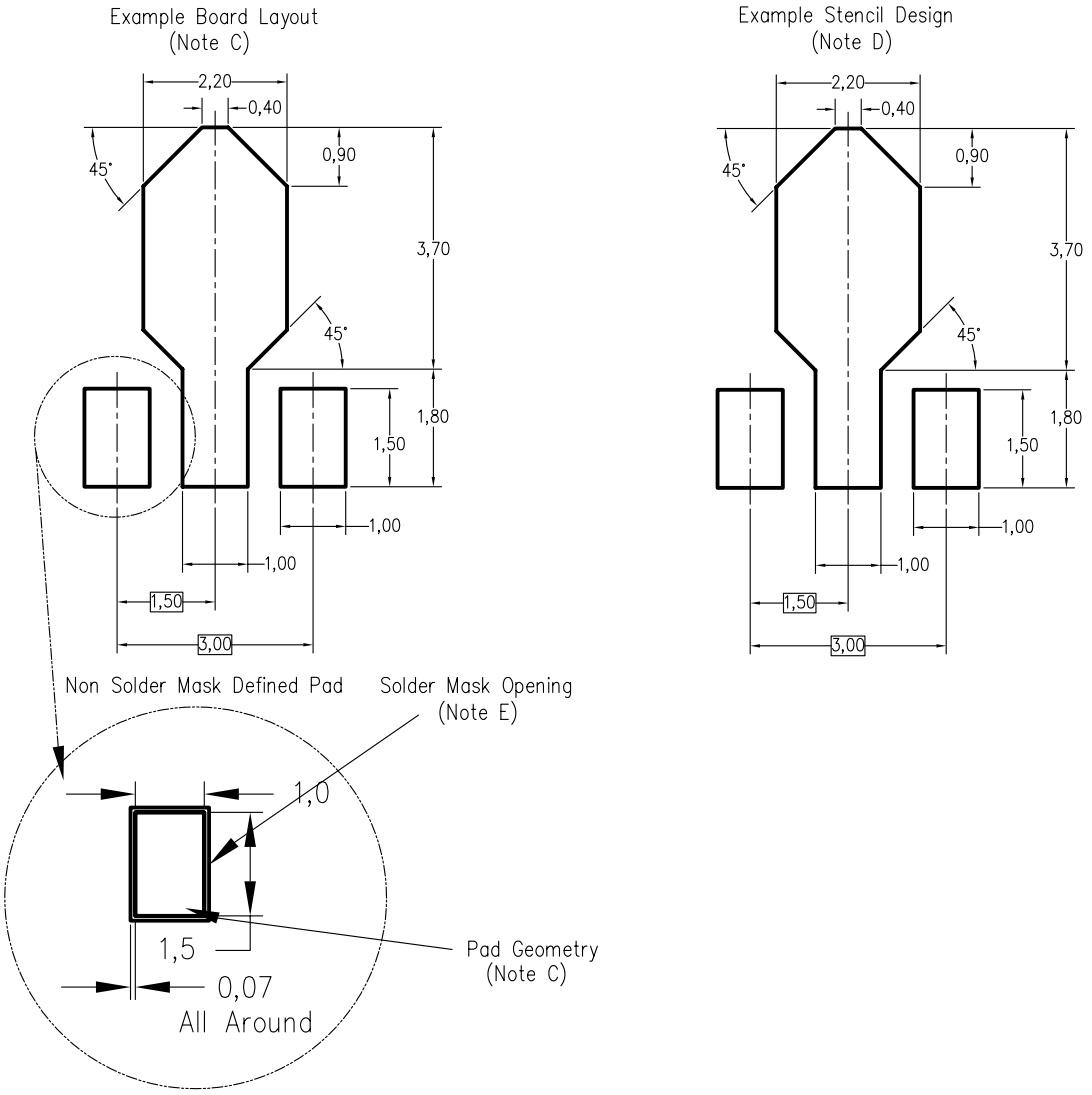
## PK (R–PSSO–F3) PLASTIC SINGLE–IN–LINE PACKAGE




4040234/D 02/2006

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

# PK (R–PDSO–G3)

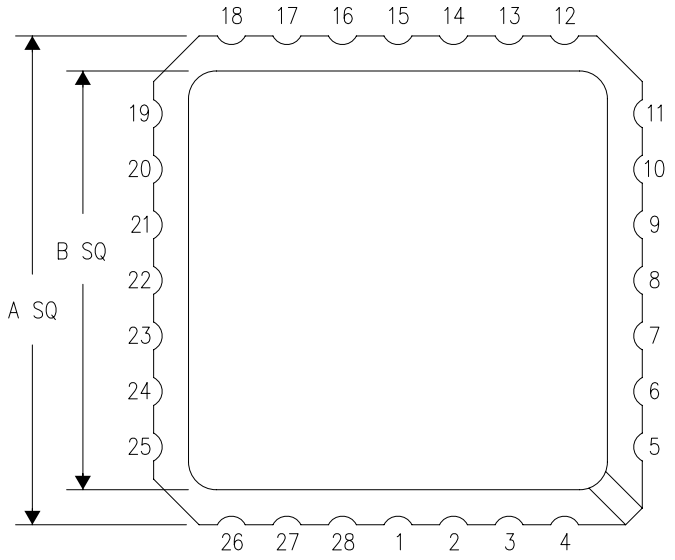



4208221/A 09/06

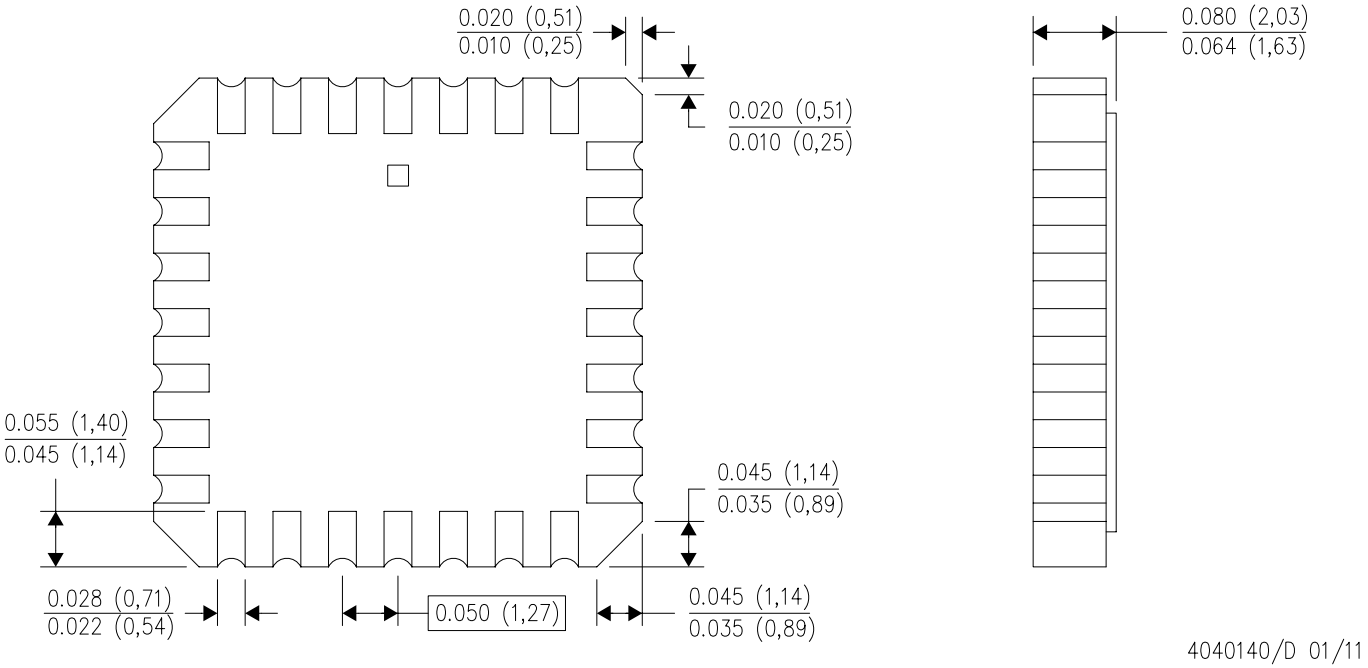
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact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

FK (S–CQCC–N**) LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



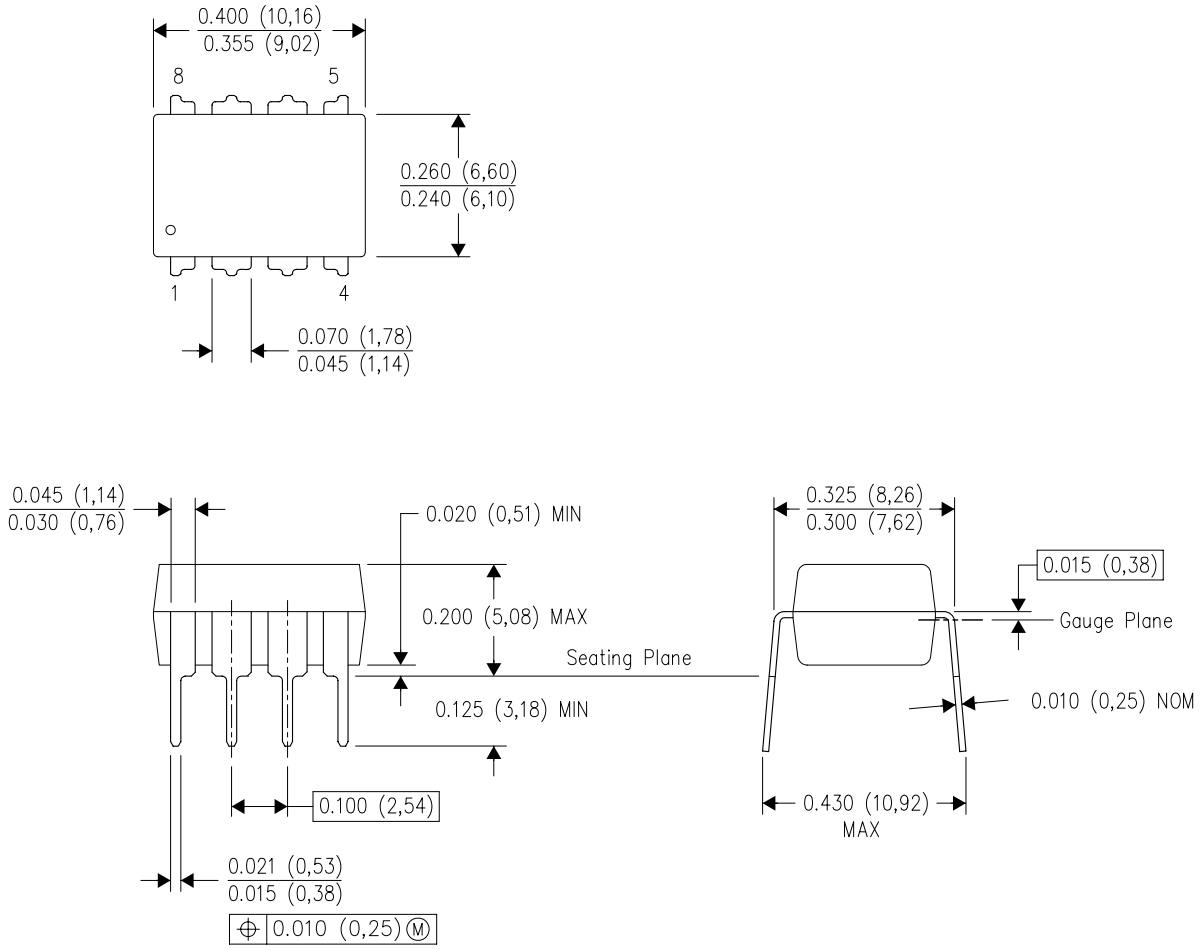

| NO. OF TERMINALS ** | A | | B | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| 20 | 0.342 (8,69) | 0.358 (9,09) | 0.307 (7,80) | 0.358 (9,09) |
| 28 | 0.442 (11,23) | 0.458 (11,63) | 0.406 (10,31) | 0.458 (11,63) |
| 44 | 0.640 (16,26) | 0.660 (16,76) | 0.495 (12,58) | 0.560 (14,22) |
| 52 | 0.740 (18,78) | 0.761 (19,32) | 0.495 (12,58) | 0.560 (14,22) |
| 68 | 0.938 (23,83) | 0.962 (24,43) | 0.850 (21,6) | 0.858 (21,8) |
| 84 | 1.141 (28,99) | 1.165 (29,59) | 1.047 (26,6) | 1.063 (27,0) |




4040140/D 01/11

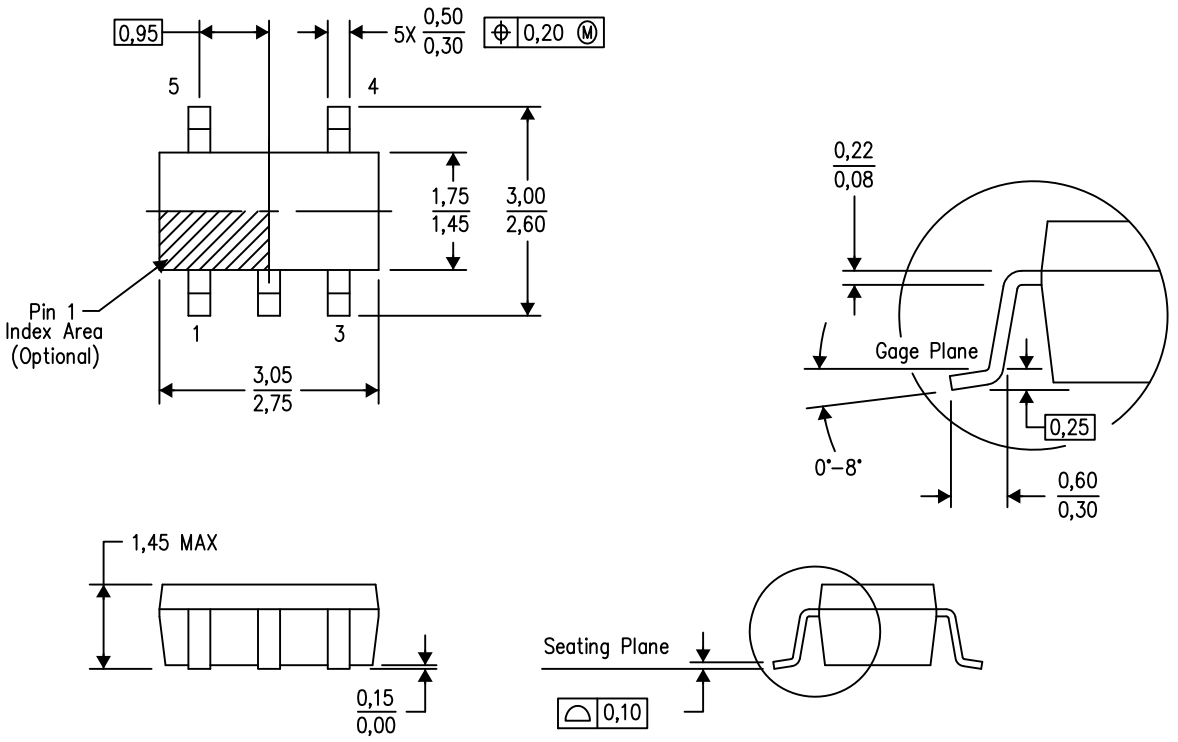
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a metal lid.
D. Falls within JEDEC MS–004

P (R–PDIP–T8) PLASTIC DUAL–IN–LINE PACKAGE




NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001 variation BA.

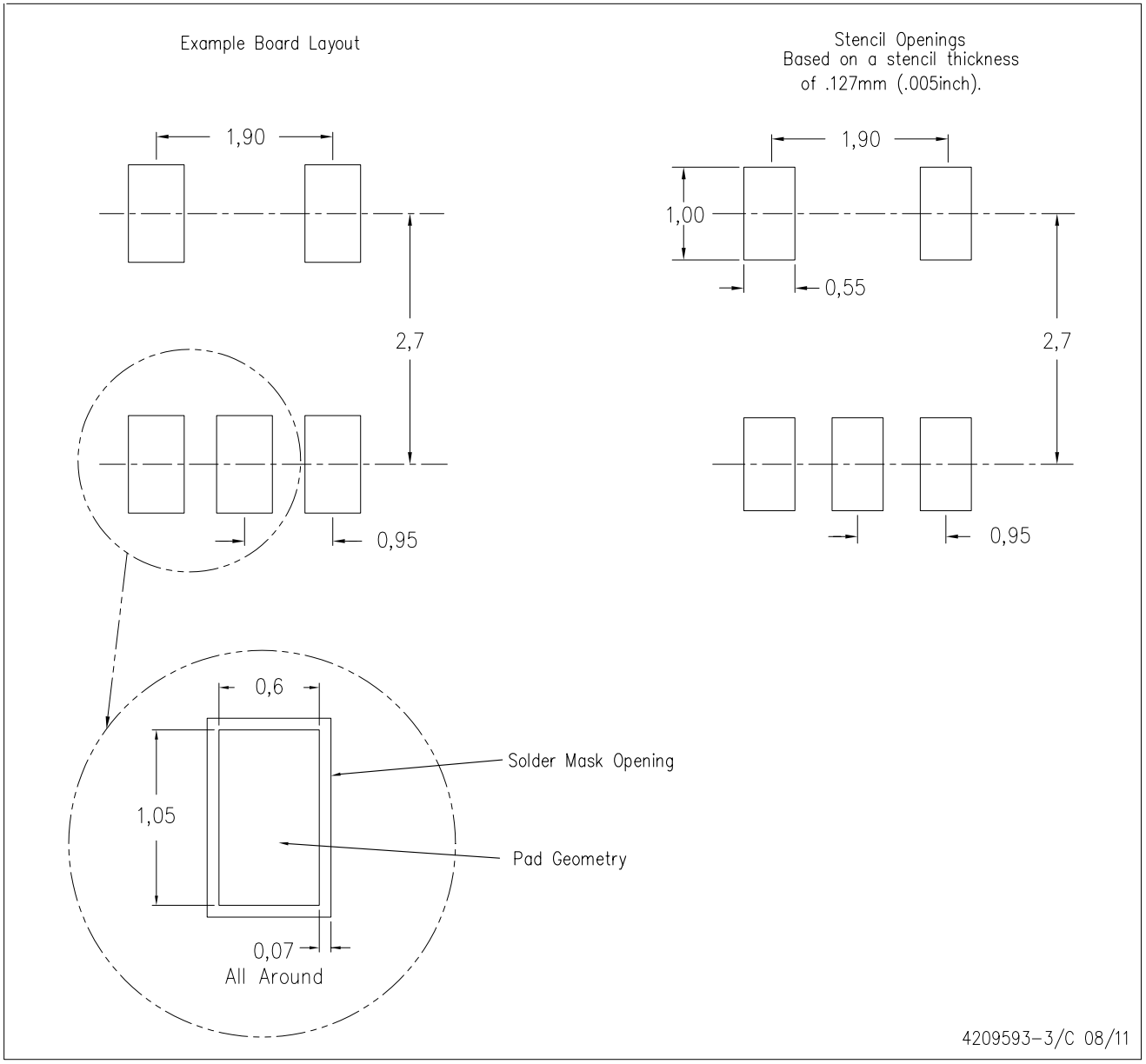
DBV (R–PDSO–G5) PLASTIC SMALL–OUTLINE PACKAGE




4073253–4/N 12/14

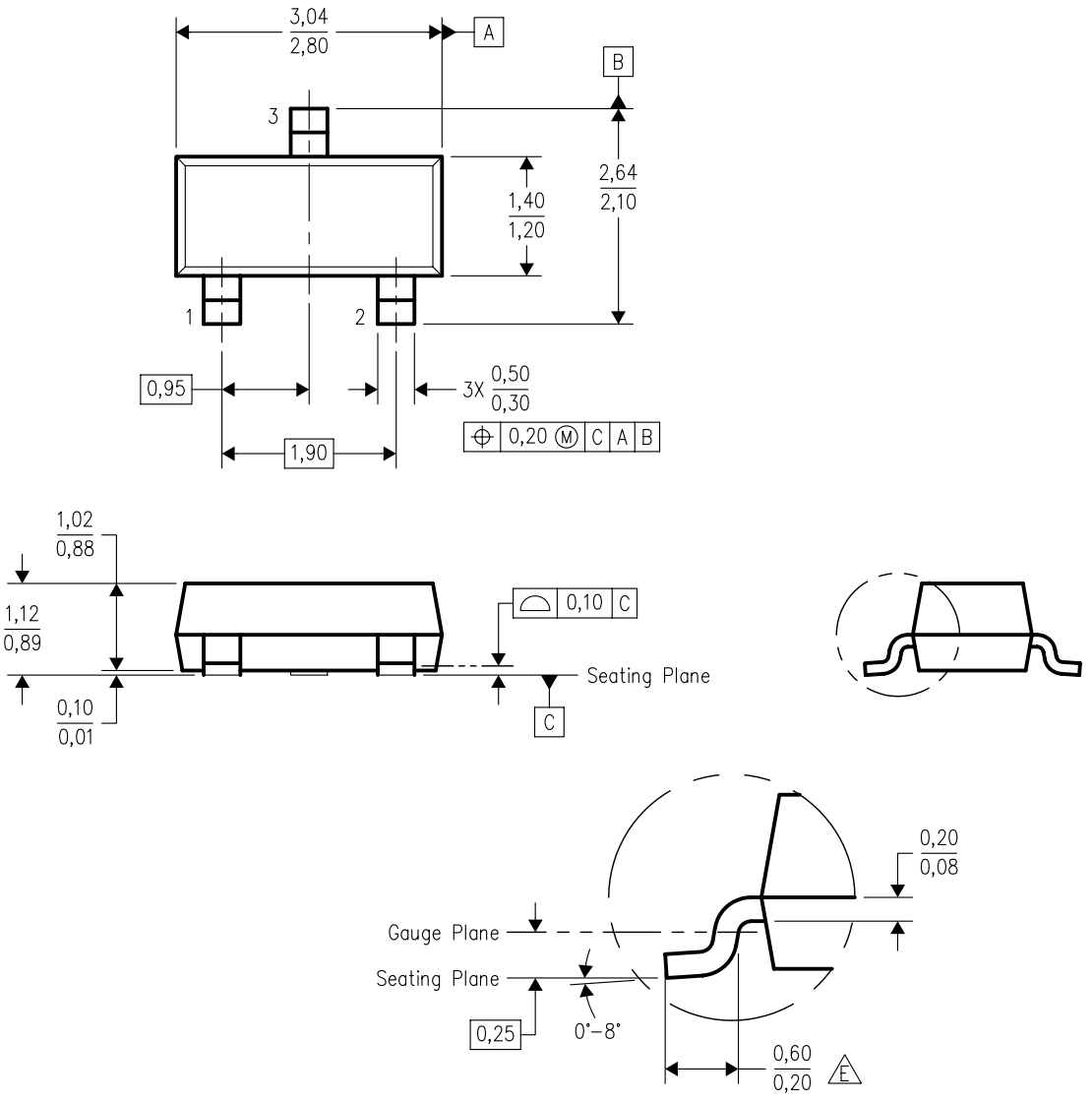
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
D. Falls within JEDEC MO–178 Variation AA.

DBV (R–PDSO–G5) PLASTIC SMALL OUTLINE



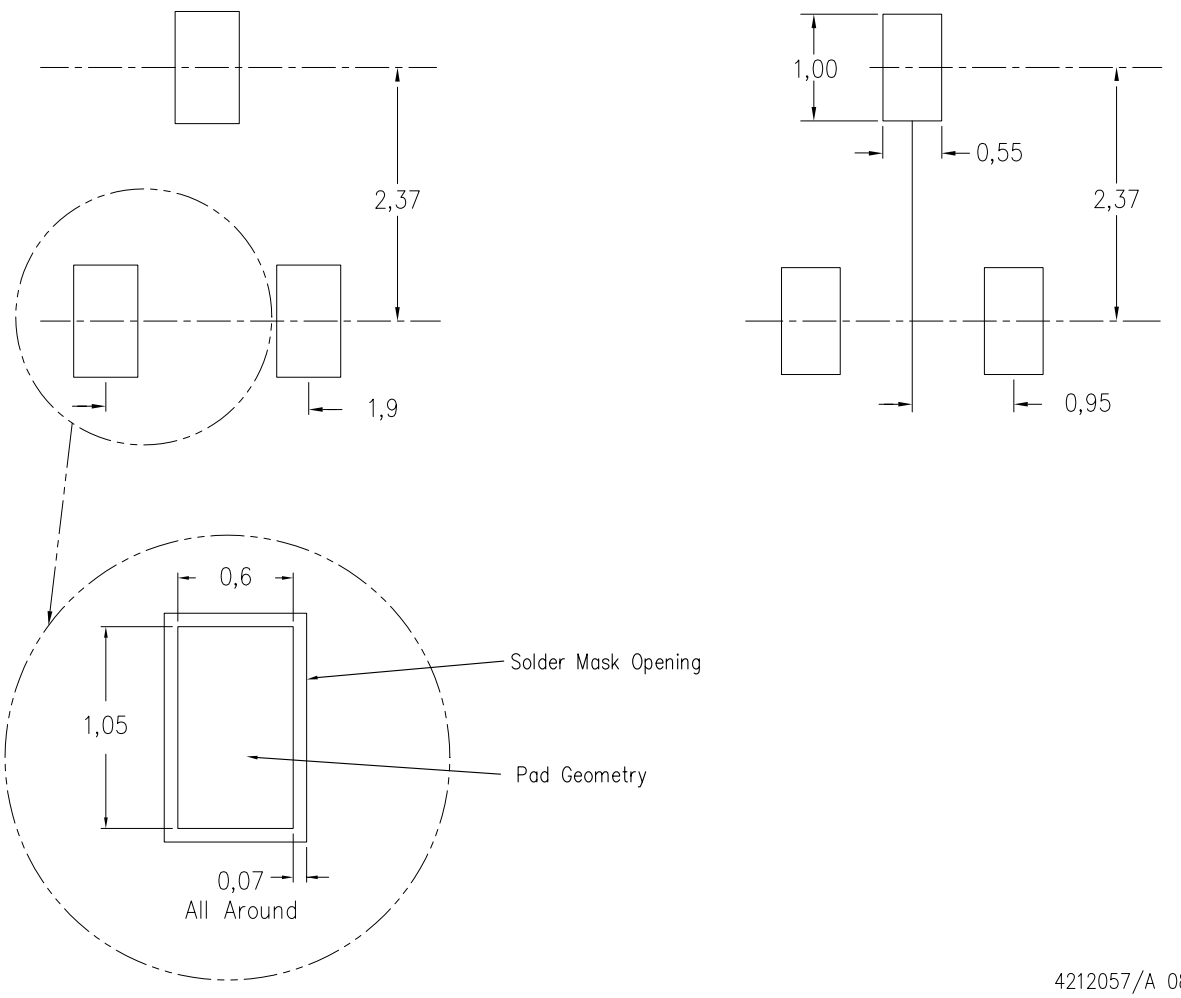

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
D. Publication IPC–7351 is recommended for alternate designs.
E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC–7525 for other stencil recommendations.

## DBZ (R–PDSO–G3) PLASTIC SMALL–OUTLINE



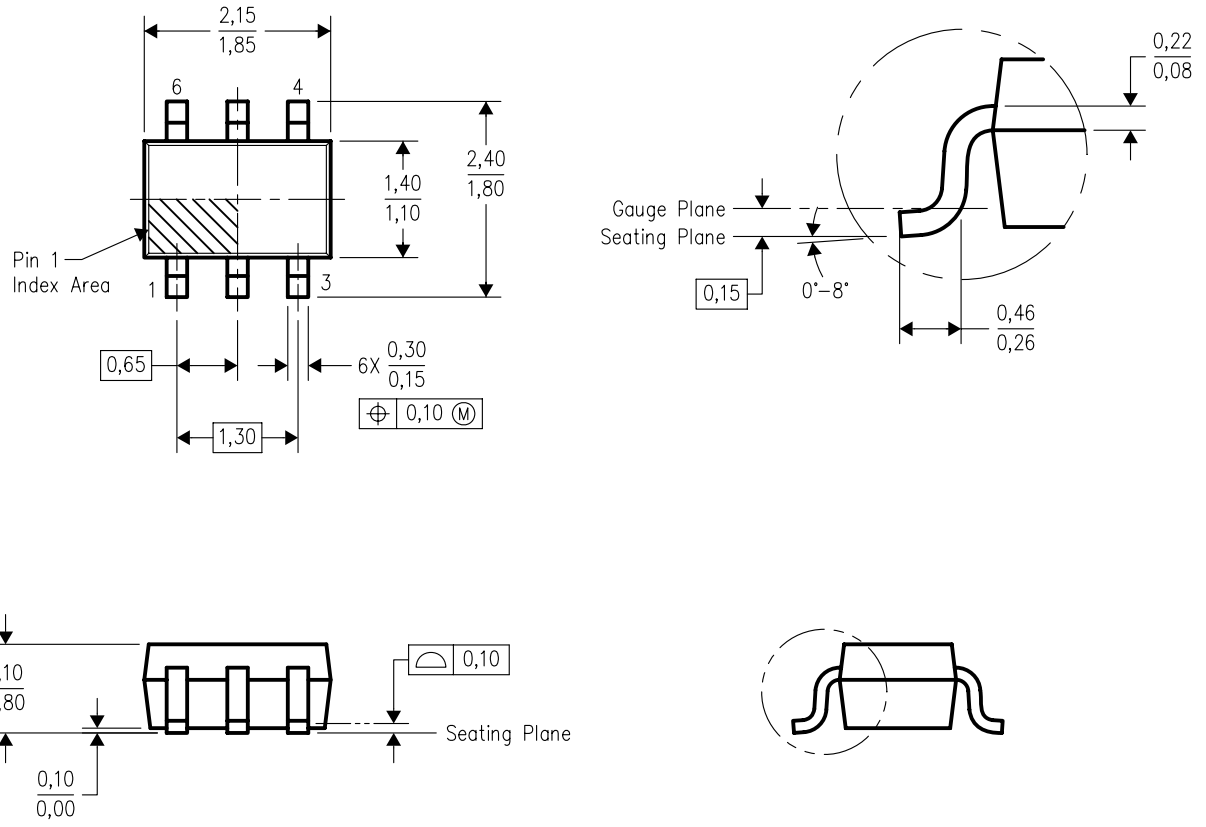

NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Lead dimensions are inclusive of plating.
D. Body dimensions are exclusive of mold flash and protrusion. Mold flash and protrusion not to exceed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

DBZ (R–PDSO–G3) PLASTIC SMALL OUTLINE




NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
D. Publication IPC–7351 is recommended for alternate designs.
E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC–7525 for other stencil recommendations.

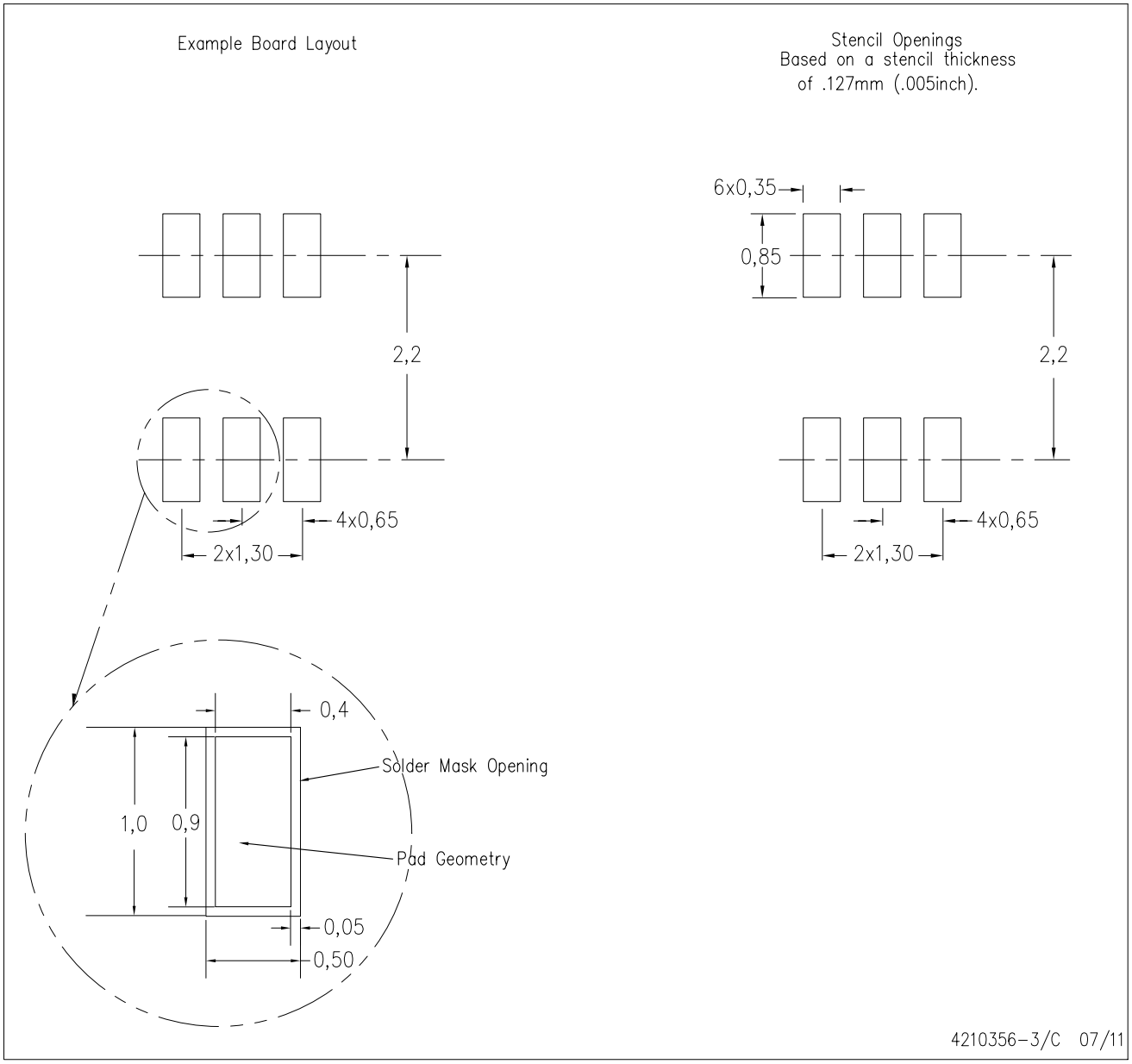
## DCK (R–PDSO–G6) PLASTIC SMALL–OUTLINE PACKAGE




4093553–4/G 01/2007

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

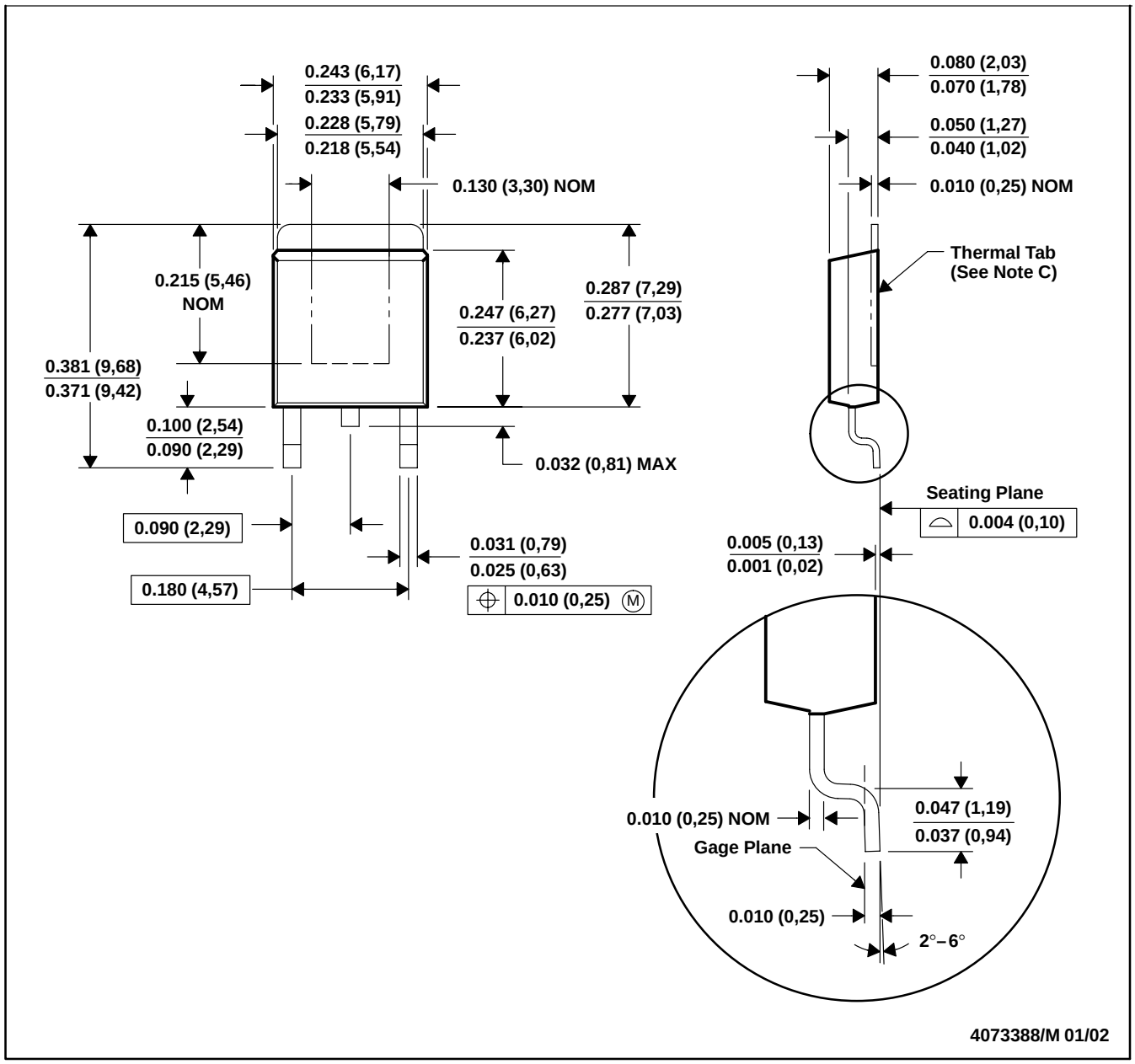
DCK (R–PDSO–G6) PLASTIC SMALL OUTLINE




NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
D. Publication IPC–7351 is recommended for alternate designs.
E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC–7525 for other stencil recommendations.

MPSF001F – JANUARY 1996 – REVISED JANUARY 2002

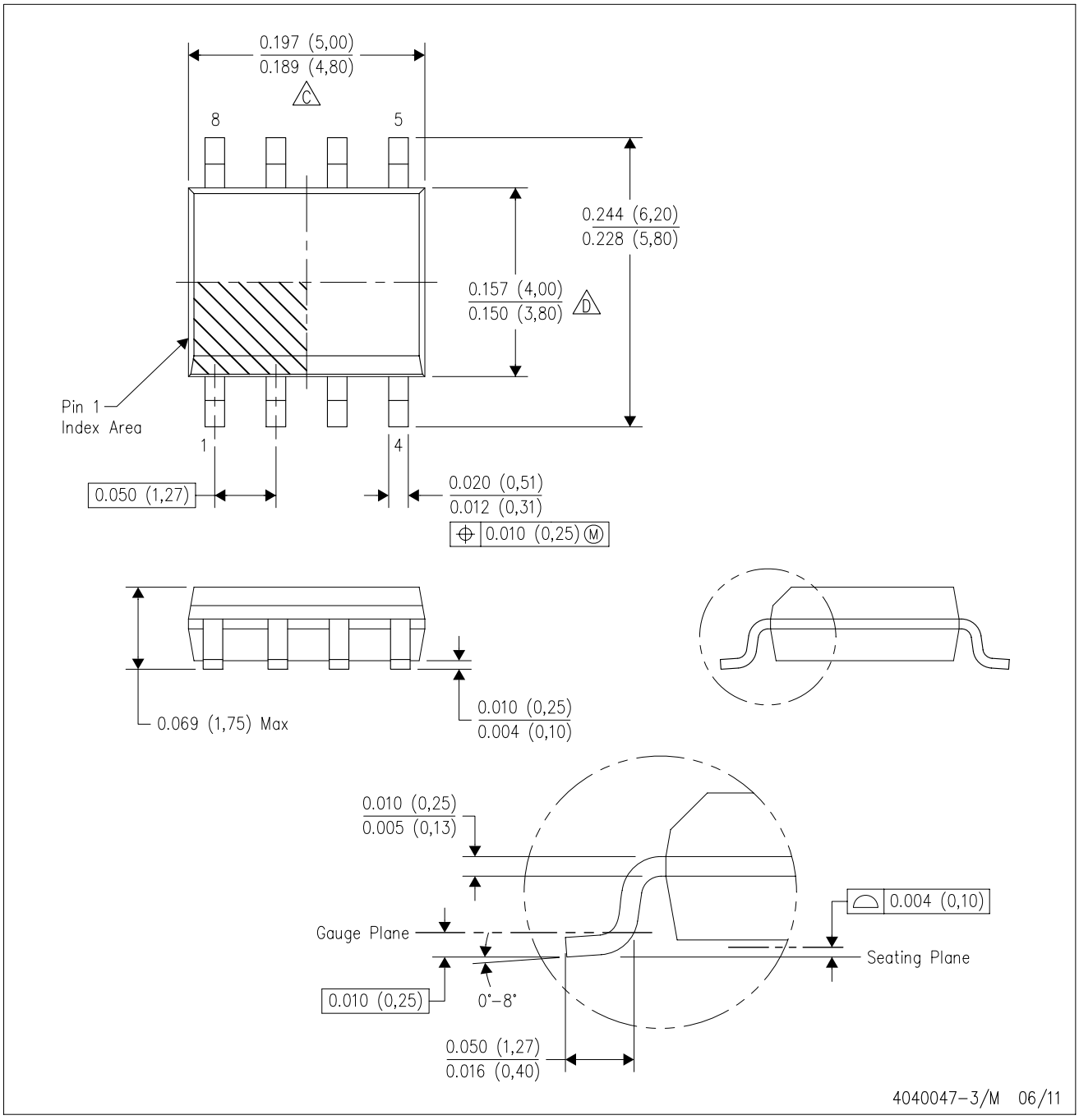
**KTP (R-PSFM-G2)** **PowerFLEX™ PLASTIC FLANGE-MOUNT PACKAGE**




NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. The center lead is in electrical contact with the thermal tab.
D. Dimensions do not include mold protrusions, not to exceed 0.006 (0,15).
E. Falls within JEDEC TO-252 variation AC.

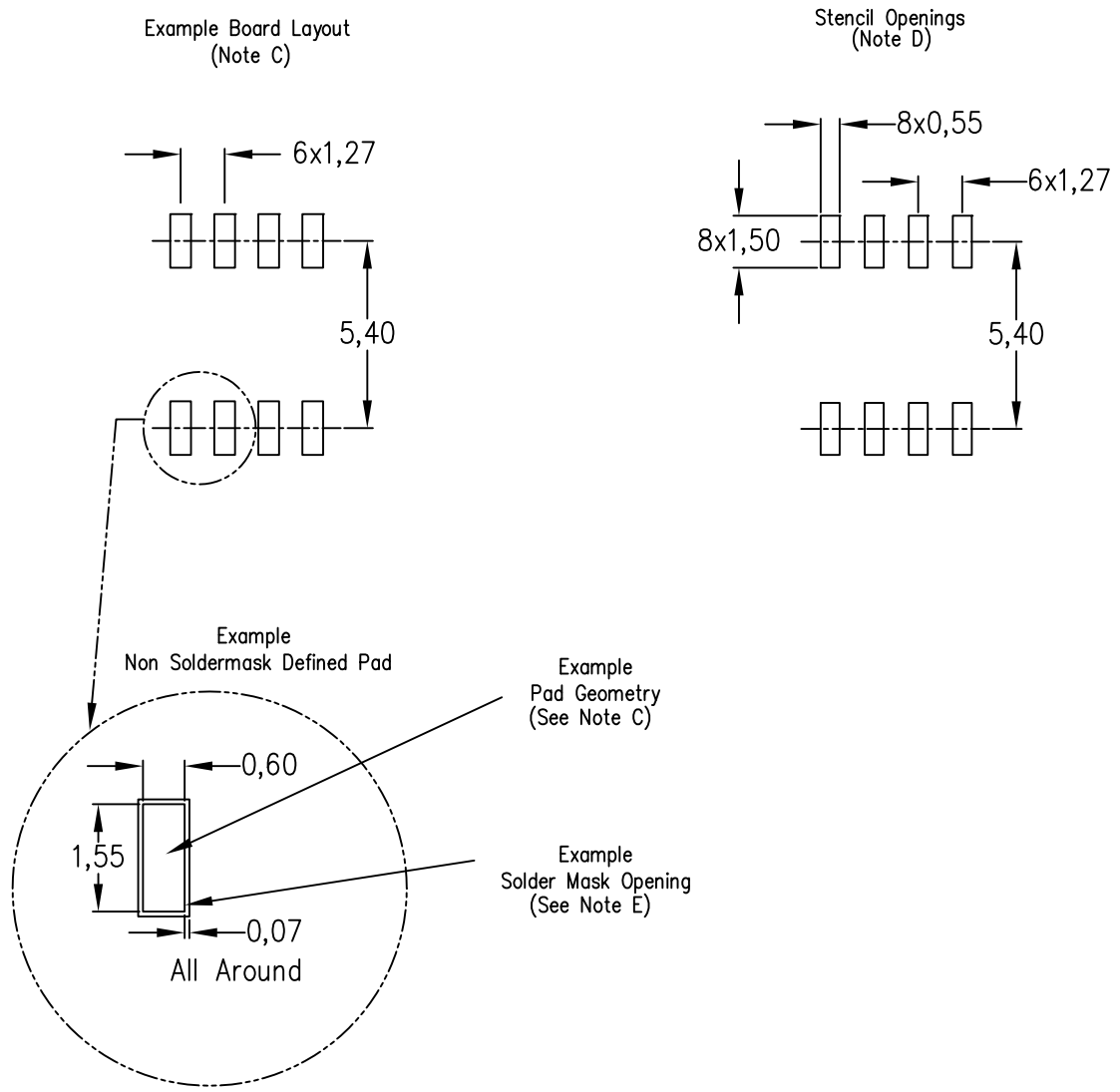
PowerFLEX is a trademark of Texas Instruments.

D (R–PDSO–G8) PLASTIC SMALL OUTLINE




NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
E. Reference JEDEC MS–012 variation AA.

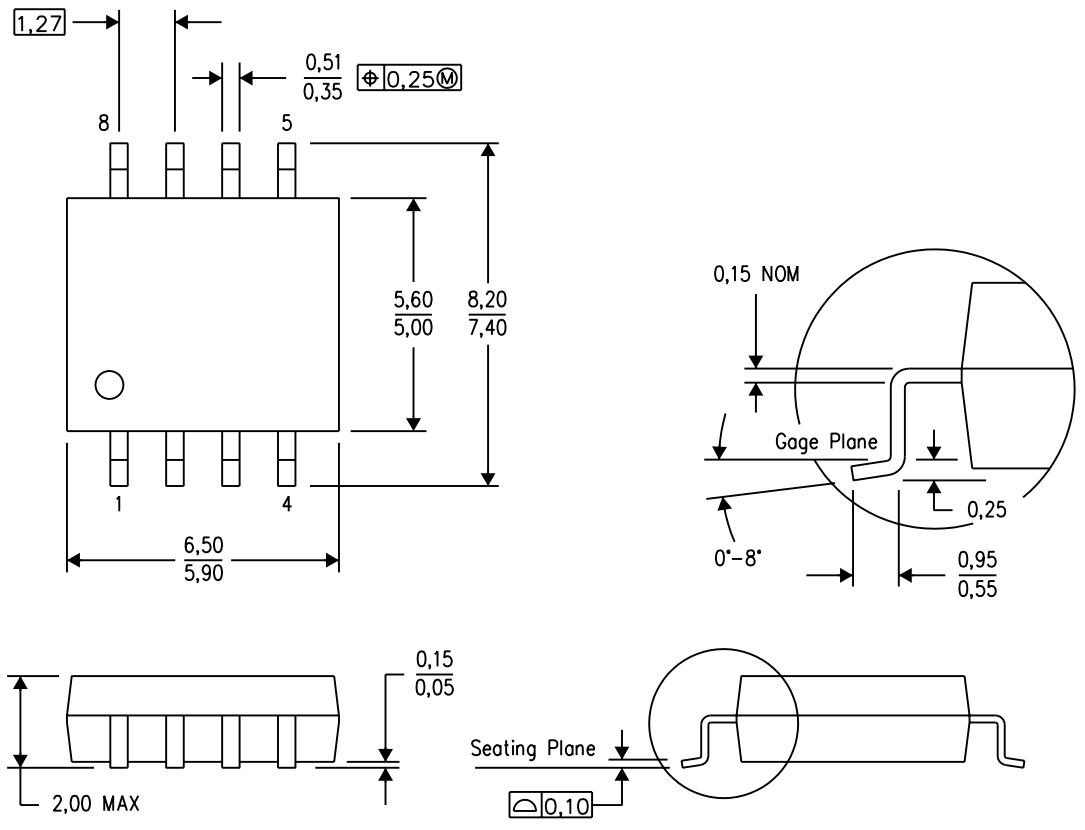
D (R–PDSO–G8) PLASTIC SMALL OUTLINE




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

## MECHANICAL DATA

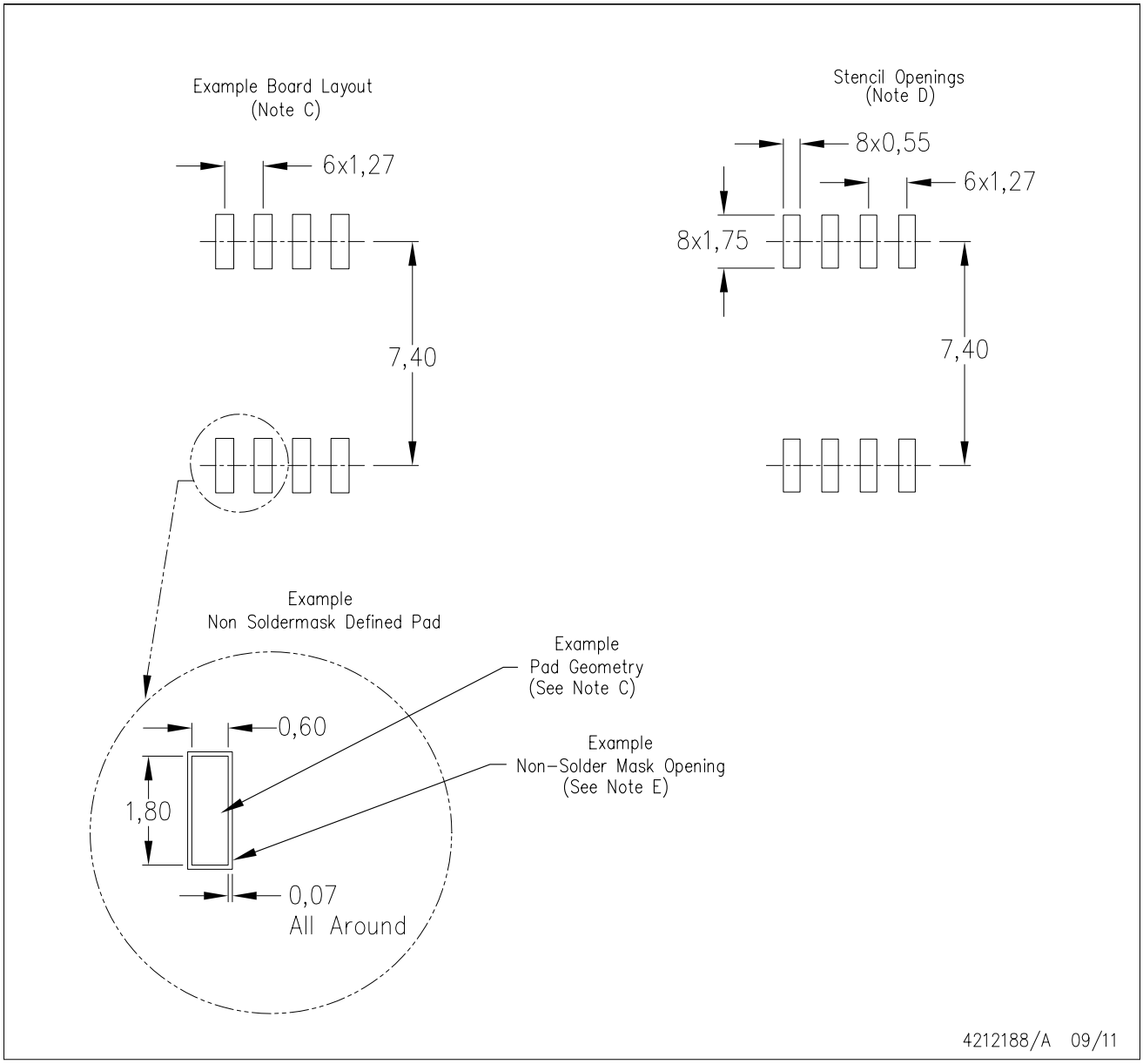
**PS (R-PDSO-G8)** **PLASTIC SMALL-OUTLINE PACKAGE**




4040063/C 03/03

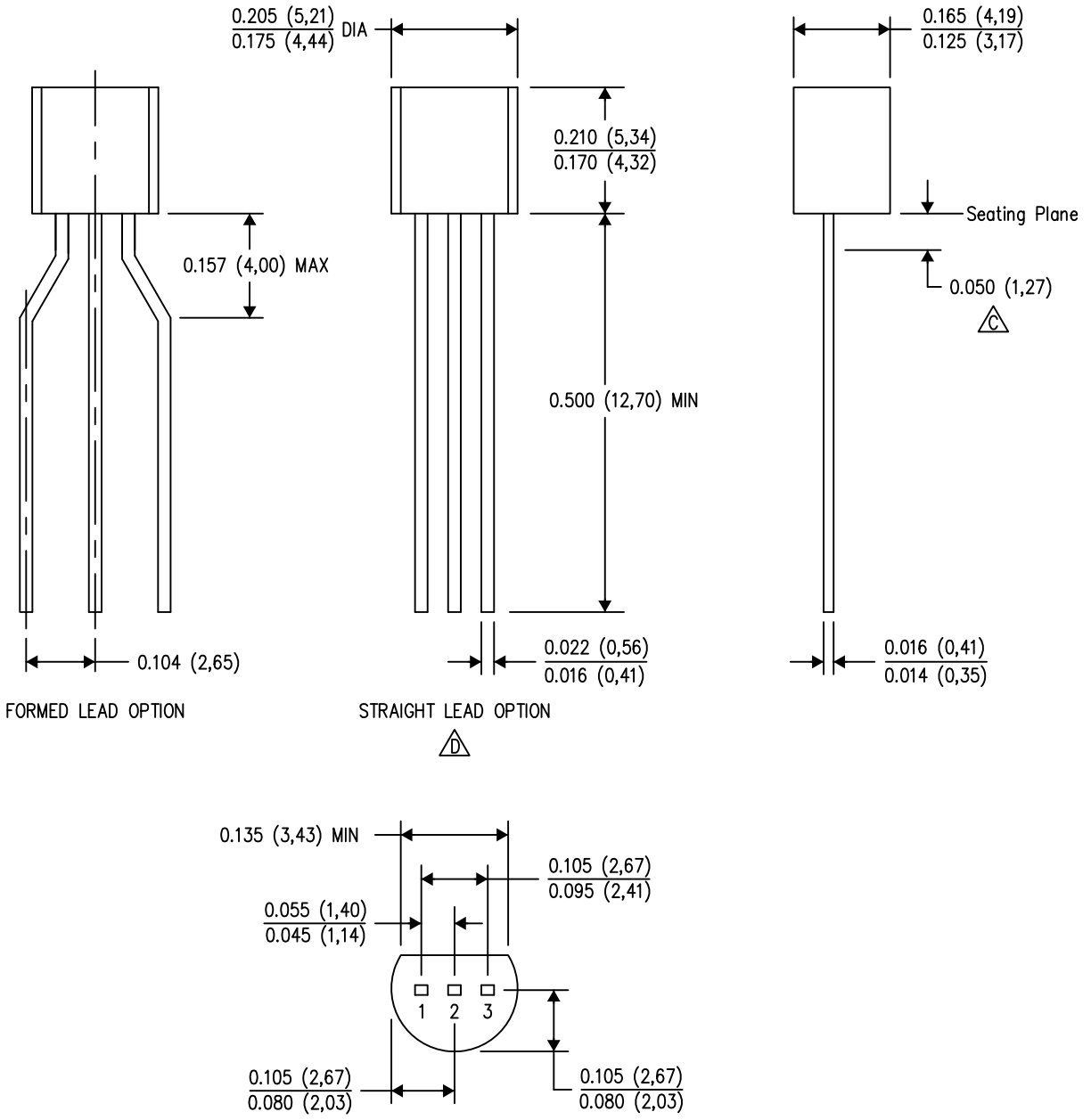
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

PS (R–PDSO–G8) PLASTIC SMALL OUTLINE



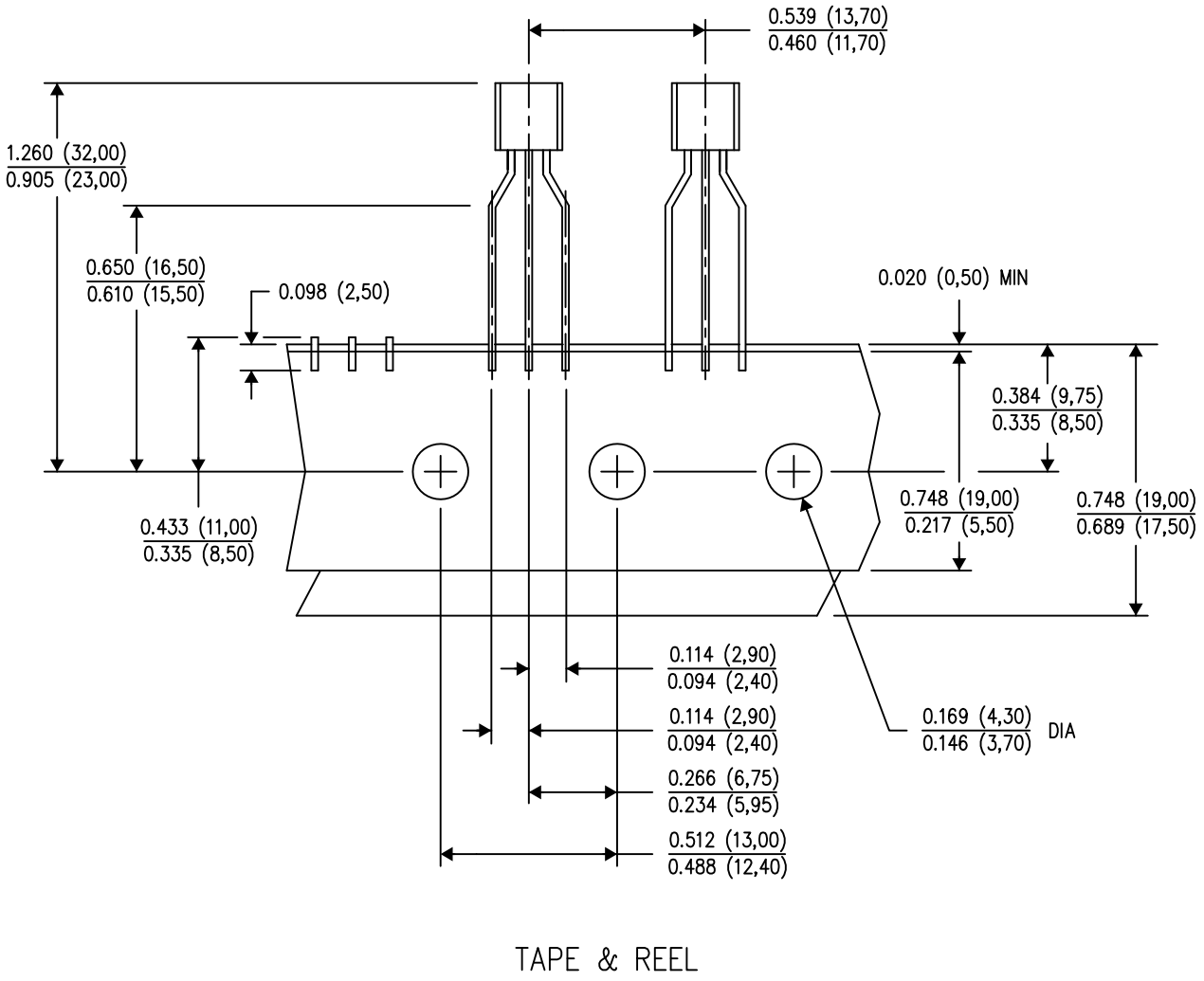

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact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

LP (O–PBCY–W3) PLASTIC CYLINDRICAL PACKAGE



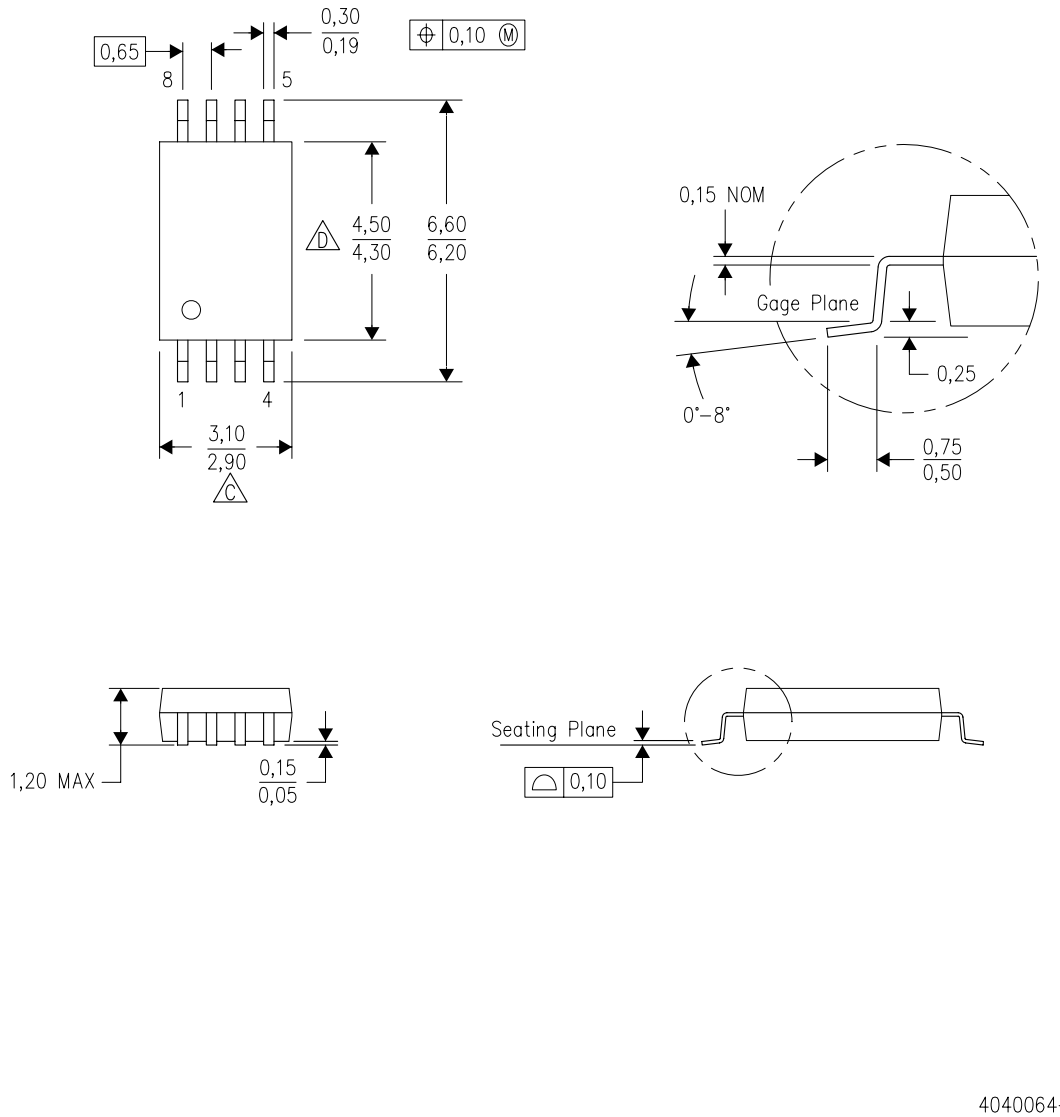

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Lead dimensions are not controlled within this area.
D. Falls within JEDEC TO–226 Variation AA (TO–226 replaces TO–92).
E. Shipping Method:
Straight lead option available in bulk pack only.
Formed lead option available in tape & reel or ammo pack.
Specific products can be offered in limited combinations of shipping mediums and lead options.
Consult product folder for more information on available options.

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 Formed Lead Option package.

PW (R–PDSO–G8) PLASTIC SMALL OUTLINE




4040064–2/G 02/11

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. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
E. Falls within JEDEC MO–153

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