

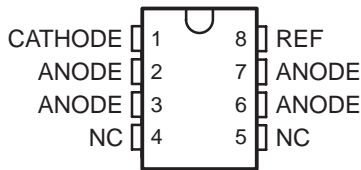
TL431, TL431A, TL431B TL432, TL432A, TL432B

ADJUSTABLE PRECISION SHUNT REGULATORS

SLVS543J – AUGUST 2004 – REVISED DECEMBER 2005

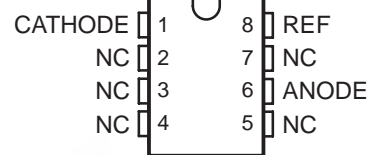
- Operation From -40°C to 125°C
- Reference Voltage Tolerance at 25°C
 - 0.5% . . . B Grade
 - 1% . . . A Grade
 - 2% . . . Standard Grade
- Typical Temperature Drift (TL431B)
 - 6 mV (C Temp)
 - 14 mV (I Temp, Q Temp)
- Low Output Noise
- 0.2- Ω Typical Output Impedance
- Sink-Current Capability . .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

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



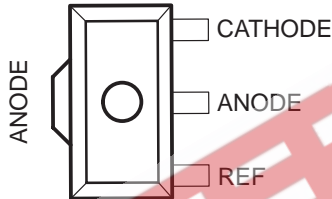
NC – No internal connection

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

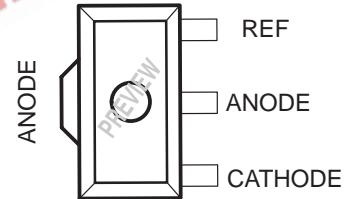


NC – No internal connection

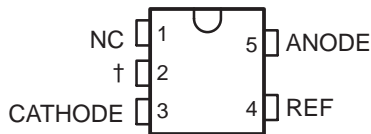
TL431, TL431A, TL431B . . . PK (SOT-89) PACKAGE
(TOP VIEW)



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



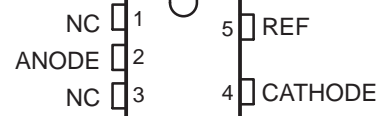
TL431, TL431A, TL431B . . . DBV (SOT-23-5) PACKAGE
(TOP VIEW)



NC – No internal connection

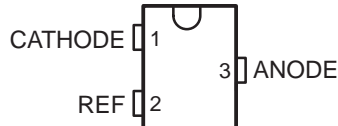
† Pin 2 is attached to Substrate and must be connected to ANODE or left open.

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

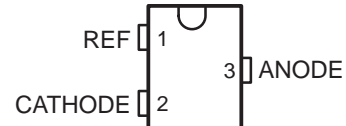


NC – No internal connection

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



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



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**TEXAS
INSTRUMENTS**

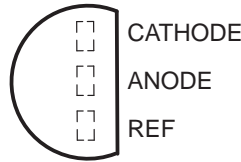
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TL431, TL431A, TL431B TL432, TL432A, TL432B ADJUSTABLE PRECISION SHUNT REGULATORS

SLVS543J – AUGUST 2004 – REVISED DECEMBER 2005

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

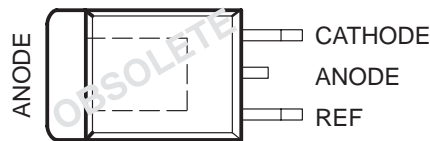


TL431A, TL431B . . . DCK (SC-70) PACKAGE
(TOP VIEW)



NC – No internal connection

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



description/ordering information

The TL431 and TL432 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 (see Figure 17). 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 has exactly the same functionality and electrical specifications as the TL431, 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 vs 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.

TL431, TL431A, TL431B
TL432, TL432A, TL432B
ADJUSTABLE PRECISION SHUNT REGULATORS
 SLVS543J – AUGUST 2004 – REVISED DECEMBER 2005

V_{ref} TOLERANCE (25°C) = 2%
TL431, TL432 ORDERING INFORMATION

| T _A | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING‡ |
|----------------|-------------------|-----------------------------|-----------------------|-------------------|
| 0°C to 70°C | PDIP (P) | Tube of 50 | TL431CP | TL431CP |
| | SOIC (D) | Tube of 75 | TL431CD | TL431C |
| | | Reel of 2500 | TL431CDR | |
| | SOP (PS) | Reel of 2000 | TL431CPSR | T431 |
| | SOT-23-5 (DBV) | Reel of 3000 | TL431CDBVR | T3C_ |
| | | Reel of 250 | TL431CDBVT | |
| | | Reel of 3000 | TL432CDBVR | T4C_ |
| | | Reel of 250 | TL432CDBVT | |
| | SOT-23-3 (DBZ) | Reel of 3000 | TL431CDBZR | T3C_ |
| | | Reel of 250 | TL431CDBZT | |
| | | Reel of 3000 | TL432CDBZR | T4C_ |
| | | Reel of 250 | TL432CDBZT | |
| | SOT-89 (PK) | Reel of 1000 | TL431CPK | 43 |
| | | | TL432CPK | 2A |
| | TO-226/TO-92 (LP) | Bulk of 1000, straight lead | TL431CLP | TL431C |
| | | Ammo of 2000, formed lead | TL431CLPM | |
| | | Reel of 2000, formed lead | TL431CLPR | |
| | TSSOP (PW) | Tube of 150 | TL431CPW | T431 |
| Reel of 2000 | | TL431CPWR | | |
| -40°C to 85°C | PDIP (P) | Tube of 50 | TL431IP | TL431IP |
| | SOIC (D) | Tube of 75 | TL431ID | TL431I |
| | | Reel of 2500 | TL431IDR | |
| | SOT-23-5 (DBV) | Reel of 3000 | TL431IDBVR | T3I_ |
| | | Reel of 250 | TL431IDBVT | |
| | | Reel of 3000 | TL432IDBVR | T4I_ |
| | | Reel of 250 | TL432IDBVT | |
| | SOT-23-3 (DBZ) | Reel of 3000 | TL431IDBZR | T3I_ |
| | | Reel of 250 | TL431IDBZT | |
| | | Reel of 3000 | TL432IDBZR | T4I_ |
| | | Reel of 250 | TL432IDBZT | |
| | SOT-89 (PK) | Reel of 1000 | TL431IPK | 3I |
| | | | TL432IPK | 2B |
| | TO-226/TO-92 (LP) | Bulk of 1000, straight lead | TL431ILP | TL431I |
| | | Ammo of 2000, formed lead | TL431ILPM | |
| | | Reel of 2000, formed lead | TL431ILPR | |

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

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

**TL431, TL431A, TL431B
TL432, TL432A, TL432B
ADJUSTABLE PRECISION SHUNT REGULATORS**

SLVS543J – AUGUST 2004 – REVISED DECEMBER 2005

**V_{ref} TOLERANCE (25°C) = 2%
TL431, TL432 ORDERING INFORMATION (CONTINUED)**

| TA | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING‡ |
|----------------|----------------|--------------|-----------------------|-------------------|
| -40°C to 125°C | SOT-23-5 (DBV) | Reel of 3000 | TL431QDBVR | T3Q_ |
| | | Reel of 250 | TL431QDBVT | |
| | | Reel of 3000 | TL432QDBVR | T4Q_ |
| | | Reel of 250 | TL432QDBVT | |
| | SOT-23-3 (DBZ) | Reel of 3000 | TL431QDBZR | T3Q_ |
| | | Reel of 250 | TL431QDBZT | |
| | | Reel of 3000 | TL432QDBZR | T4Q_ |
| | | Reel of 250 | TL432QDBZT | |
| | SOT-89 (PK) | Reel of 1000 | TL431QPK | 3Q |
| | | | TL432QPK | 2C |
| | SC-70 (DCK) | Reel of 1000 | TL431QDCKR | T6_ |
| | | | Reel of 250 | |

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

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



TL431, TL431A, TL431B
TL432, TL432A, TL432B
ADJUSTABLE PRECISION SHUNT REGULATORS
 SLVS543J – AUGUST 2004 – REVISED DECEMBER 2005

V_{ref} TOLERANCE (25°C) = 1%
TL431A, TL432A ORDERING INFORMATION

| TA | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING‡ |
|---------------------------|-------------------|-----------------------------|-----------------------|-------------------|
| 0°C to 70°C | PDIP (P) | Tube of 50 | TL431ACP | TL431ACP |
| | SC-70 (DCK) | Reel of 3000 | TL431ACDCKR | T4_ |
| | | Reel of 250 | TL431ACDCKT | |
| | SOIC (D) | Tube of 75 | TL431ACD | 431AC |
| | | Reel of 2500 | TL431ACDR | |
| | SOP (PS) | Reel of 2000 | TL431ACPSR | T431A |
| | SOT-23-5 (DBV) | Reel of 3000 | TL431ACDBVR | TAC_ |
| | | Reel of 250 | TL431ACDBVT | |
| | | Reel of 3000 | TL432ACDBVR | T4B_ |
| | | Reel of 250 | TL432ACDBVT | |
| | SOT-23-3 (DBZ) | Reel of 3000 | TL431ACDBZR | TAC_ |
| | | Reel of 250 | TL431ACDBZT | |
| | | Reel of 3000 | TL432ACDBZR | T4B_ |
| | | Reel of 250 | TL432ACDBZT | |
| | SOT-89 (PK) | Reel of 1000 | TL431ACPK | 4A |
| | | | TL432ACPK | 2D |
| | TO-226/TO-92 (LP) | Bulk of 1000, straight lead | TL431ACLP | TL431AC |
| Ammo of 2000, formed lead | | TL431ACLPM | | |
| Reel of 2000, formed lead | | TL431ACLPR | | |
| Reel of 2000, formed lead | | TL431ACLPRE3 | | |
| TSSOP (PW) | Tube of 150 | TL431ACPW | T431A | |
| | Reel of 2000 | TL431ACPWR | | |

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

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

**TL431, TL431A, TL431B
TL432, TL432A, TL432B
ADJUSTABLE PRECISION SHUNT REGULATORS**

SLVS543J – AUGUST 2004 – REVISED DECEMBER 2005

**V_{ref} TOLERANCE (25°C) = 1%
TL431A, TL432A ORDERING INFORMATION (CONTINUED)**

| T_A | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING‡ |
|----------------|-------------------|-----------------------------|-----------------------|-------------------|
| -40°C to 85°C | PDIP (P) | Tube of 50 | TL431AIP | TL431AIP |
| | SC-70 (DCK) | Reel of 3000 | TL431AIDCKR | T5_ |
| | | Reel of 250 | TL431AIDCKT | |
| | SOIC (D) | Tube of 75 | TL431AID | 431AI |
| | | Reel of 2500 | TL431AIDR | |
| | SOT-23-5 (DBV) | Reel of 3000 | TL431AIDBVR | TAI_ |
| | | Reel of 250 | TL431AIDBVT | |
| | | Reel of 3000 | TL432AIDBVR | T4A_ |
| | | Reel of 250 | TL432AIDBVT | |
| | SOT-23-3 (DBZ) | Reel of 3000 | TL431AIDBZR | TAI_ |
| | | Reel of 250 | TL431AIDBZT | |
| | | Reel of 3000 | TL432AIDBZR | T4A_ |
| | | Reel of 250 | TL432AIDBZT | |
| | SOT-89 (PK) | Reel of 1000 | TL431AIPK | 4B |
| | | | TL432AIPK | 2E |
| | TO-226/TO-92 (LP) | Bulk of 1000, straight lead | TL431AILP | TL431AI |
| | | Ammo of 2000, formed lead | TL431AILPM | |
| | | Reel of 2000, formed lead | TL431AILPR | |
| -40°C to 125°C | SOT-23-5 (DBV) | Reel of 3000 | TL431AQDBVR | TAQ_ |
| | | Reel of 250 | TL431AQDBVT | T4D_ |
| | | Reel of 3000 | TL432AQDBVR | |
| | | Reel of 250 | TL432AQDBVT | |
| | SOT-23-3 (DBZ) | Reel of 3000 | TL431AQDBZR | TAQ_ |
| | | Reel of 250 | TL431AQDBZT | T4D_ |
| | | Reel of 3000 | TL432AQDBZR | |
| | | Reel of 250 | TL432AQDBZT | |
| | SOT-89 (PK) | Reel of 1000 | TL431AQPK | 4D |
| | | | TL432AQPK | 2F |
| | SC-70 (PK) | Reel of 1000 | TL431AQDCKR | T7_ |
| | | Reel of 250 | TL431AQDCKT | |

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

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

TL431, TL431A, TL431B
TL432, TL432A, TL432B
ADJUSTABLE PRECISION SHUNT REGULATORS
 SLVS543J – AUGUST 2004 – REVISED DECEMBER 2005

V_{ref} TOLERANCE (25°C) = 0.5%
TL431B, TL432B ORDERING INFORMATION

| T _A | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING‡ |
|----------------|-------------------|-----------------------------|-----------------------|-------------------|
| 0°C to 70°C | PDIP (P) | Tube of 50 | TL431BCP | TL431BCP |
| | SC-70 (DCK) | Reel of 3000 | TL431BCDCKR | T2_ |
| | | Reel of 250 | TL431BCDCKT | |
| | SOIC (D) | Tube of 75 | TL431BCD | T431B |
| | | Reel of 2500 | TL431BCDR | |
| | SOP (PS) | Reel of 2000 | TL431BCPSR | TL431B |
| | SOT-23-5 (DBV) | Reel of 3000 | TL431BCDBVR | T3G_ |
| | | Reel of 250 | TL431BCDBVT | |
| | | Reel of 3000 | TL432BCDBVR | TBC_ |
| | | Reel of 250 | TL432BCDBVT | |
| | SOT-23-3 (DBZ) | Reel of 3000 | TL431BCDBZR | T3G_ |
| | | Reel of 250 | TL431BCDBZT | |
| | | Reel of 3000 | TL432BCDBZR | TBC_ |
| | | Reel of 250 | TL432BCDBZT | |
| | SOT-89 (PK) | Reel of 1000 | TL431BCPK | 4C |
| | | | TL432BCPK | 2G |
| | TO-226/TO-92 (LP) | Bulk of 1000, straight lead | TL431BCLP | TL431B |
| | | Ammo of 2000, formed lead | TL431BCLPM | |
| | | Reel of 2000, formed lead | TL431BCLPR | |
| | TSSOP (PW) | Tube of 150 | TL431BCPW | T431B |
| Reel of 2000 | | TL431BCPWR | | |

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

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

**TL431, TL431A, TL431B
TL432, TL432A, TL432B
ADJUSTABLE PRECISION SHUNT REGULATORS**

SLVS543J – AUGUST 2004 – REVISED DECEMBER 2005

**V_{ref} TOLERANCE (25°C) = 0.5%
TL431B, TL432B ORDERING INFORMATION (CONTINUED)**

| TA | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING‡ |
|---------------------------|-------------------|-----------------------------|-----------------------|-------------------|
| -40°C to 85°C | PDIP (P) | Tube of 50 | TL431BIP | TL431BIP |
| | SC-70 (DCK) | Reel of 3000 | TL431BIDCKR | T3_ |
| | | Reel of 250 | TL431BIDCKT | |
| | SOIC (D) | Tube of 75 | TL431BID | Z431B |
| | | Reel of 2500 | TL431BIDR | |
| | SOT-23-5 (DBV) | Reel of 3000 | TL431BIDBVR | T3F_ |
| | | Reel of 250 | TL431BIDBVT | |
| | | Reel of 3000 | TL432BIDBVR | T4F_ |
| | | Reel of 250 | TL432BIDBVT | |
| | SOT-23-3 (DBZ) | Reel of 3000 | TL431BIDBZR | T3F_ |
| | | Reel of 250 | TL431BIDBZT | |
| | | Reel of 3000 | TL432BIDBZR | T4F_ |
| | | Reel of 250 | TL432IBDBZT | |
| | SOT-89 (PK) | Reel of 1000 | TL431BIPK | 4I |
| | | | TL432BIPK | 2H |
| | TO-226/TO-92 (LP) | Bulk of 1000, straight lead | TL431BILP | Z431B |
| Ammo of 2000, formed lead | | TL431BILPM | | |
| Reel of 2000, formed lead | | TL431BILPR | | |

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

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

TL431, TL431A, TL431B
TL432, TL432A, TL432B
ADJUSTABLE PRECISION SHUNT REGULATORS
 SLVS543J – AUGUST 2004 – REVISED DECEMBER 2005

V_{ref} TOLERANCE (25°C) = 0.5%
TL431B, TL432B ORDERING INFORMATION (CONTINUED)

| T _A | PACKAGE† | ORDERABLE PART NUMBER | TOP-SIDE MARKING‡ | |
|---------------------------|-------------------|-----------------------------|-------------------|-------------|
| -40°C to 125°C | SOIC (D) | Tube of 75 | TL431BQD | T431BQ |
| | | Reel of 2500 | TL431BQDR | |
| | SOT-23-5 (DBV) | Reel of 3000 | TL431BQDBVR | T3H_ |
| | | | TL431BQDBVT | |
| | | Reel of 250 | TL432BQDBVR | T4H_ |
| | | | TL432BQDBVT | |
| | SOT-23-3 (DBZ) | Reel of 3000 | TL431BQDBZR | T3H_ |
| | | | TL431BQDBZT | |
| | | Reel of 250 | TL432BQDBZR | T4H_ |
| | | | TL432BQDBZT | |
| | SOT-89 (PK) | Reel of 1000 | TL431BQPK | 3H |
| | | | TL432BQPK | 2J |
| | TO-226/TO-92 (LP) | Bulk of 1000, straight lead | TL431BQLP | T431BQ |
| | | Ammo of 2000, formed lead | TL431BQLPM | |
| Reel of 2000, formed lead | | TL431BQLPR | | |
| SC-70 (DCK) | Reel of 1000 | TL431BQDCKR | T8_ | |
| | | Reel of 250 | | TL431BQDCKT |

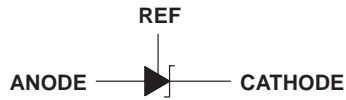
† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

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

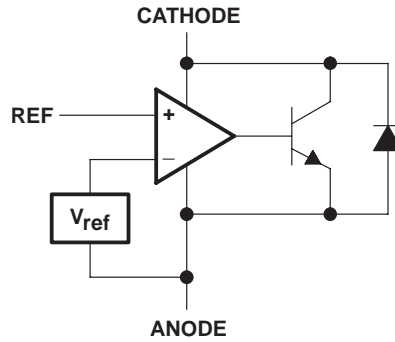
**TL431, TL431A, TL431B
TL432, TL432A, TL432B
ADJUSTABLE PRECISION SHUNT REGULATORS**

SLVS543J – AUGUST 2004 – REVISED DECEMBER 2005

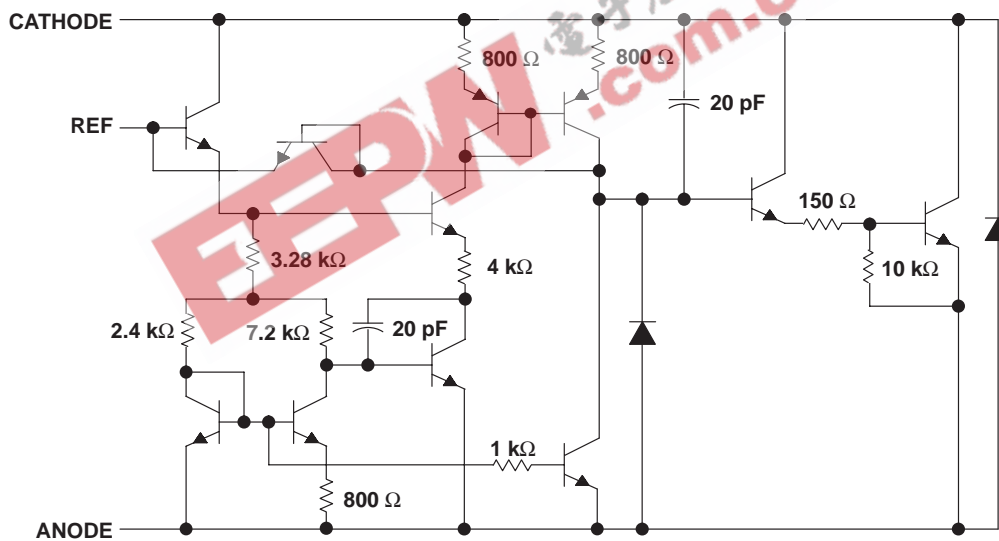
symbol



functional block diagram



equivalent schematic†



† All component values are nominal.

TL431, TL431A, TL431B
TL432, TL432A, TL432B
ADJUSTABLE PRECISION SHUNT REGULATORS
 SLVS543J – AUGUST 2004 – REVISED DECEMBER 2005

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

| | |
|---|----------------------|
| Cathode voltage, V_{KA} (see Note 1) | 37 V |
| Continuous cathode current range, I_{KA} | –100 mA to 150 mA |
| Reference input current range | –50 μ A to 10 mA |
| Operating virtual junction temperature, T_J | 150°C |
| Storage temperature range, T_{stg} | –65°C to 150°C |

‡ Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: Voltage values are with respect to the ANODE terminal, unless otherwise noted.

package thermal data (see Note 2)

| PACKAGE | BOARD | θ_{JC} | θ_{JA} |
|----------------|-------------------|---------------|---------------|
| PDIP (P) | High K, JESD 51-7 | 57°C/W | 85°C/W |
| SC-70 (DCK) | High K, JESD 51-7 | 259°C/W | 87°C/W |
| SOIC (D) | High K, JESD 51-7 | 39°C/W | 97°C/W |
| SOP (PS) | High K, JESD 51-7 | 46°C/W | 95°C/W |
| SOT-89 (PK) | High K, JESD 51-7 | 9°C/W | 52°C/W |
| SOT-23-5 (DBV) | High K, JESD 51-7 | 131°C/W | 206°C/W |
| SOT-23-3 (DBZ) | High K, JESD 51-7 | 76°C/W | 206°C/W |
| TO-92 (LP) | High K, JESD 51-7 | 55°C/W | 140°C/W |
| TSSOP (PW) | High K, JESD 51-7 | 65°C/W | 149°C/W |

NOTE 2: Maximum power dissipation is a function of $T_J(\text{max})$, θ_{JA} , and T_A . The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(\text{max}) - T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.

recommended operating conditions

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

TL431, TL431A, TL431B TL432, TL432A, TL432B ADJUSTABLE PRECISION SHUNT REGULATORS

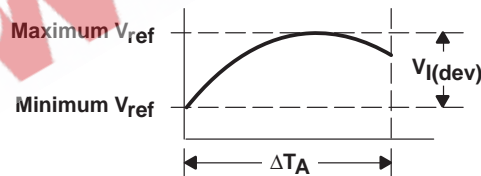
SLVS543J – AUGUST 2004 – REVISED DECEMBER 2005

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

| PARAMETER | TEST CIRCUIT | TEST CONDITIONS | TL431C TL432C | | | UNIT | |
|--|--------------|---|--|------|------|------|------------------------------|
| | | | MIN | TYP | MAX | | |
| V_{ref} Reference voltage | 2 | $V_{\text{KA}} = V_{\text{ref}}, I_{\text{KA}} = 10 \text{ mA}$ | 2440 | 2495 | 2550 | mV | |
| $V_{\text{I(dev)}}$ Deviation of reference voltage over full temperature range (see Figure 1) | 2 | $V_{\text{KA}} = V_{\text{ref}}, I_{\text{KA}} = 10 \text{ mA}, T_A = 0^\circ\text{C} \text{ to } 70^\circ\text{C}$ | SOT23-3 and TL432 devices | | 6 | 16 | mV |
| | | | All other devices | | 4 | 25 | |
| $\frac{\Delta V_{\text{ref}}}{\Delta V_{\text{KA}}}$ Ratio of change in reference voltage to the change in cathode voltage | 3 | $I_{\text{KA}} = 10 \text{ mA}$ | $\Delta V_{\text{KA}} = 10 \text{ V} - V_{\text{ref}}$ | | -1.4 | -2.7 | $\frac{\text{mV}}{\text{V}}$ |
| | | | $\Delta V_{\text{KA}} = 36 \text{ V} - 10 \text{ V}$ | | -1 | -2 | |
| I_{ref} Reference current | 3 | $I_{\text{KA}} = 10 \text{ mA}, R1 = 10 \text{ k}\Omega, R2 = \infty$ | | | 2 | 4 | μA |
| $I_{\text{I(dev)}}$ Deviation of reference current over full temperature range (see Figure 1) | 3 | $I_{\text{KA}} = 10 \text{ mA}, R1 = 10 \text{ k}\Omega, R2 = \infty, T_A = 0^\circ\text{C} \text{ to } 70^\circ\text{C}$ | | | 0.4 | 1.2 | μA |
| I_{min} Minimum cathode current for regulation | 2 | $V_{\text{KA}} = V_{\text{ref}}$ | | | 0.4 | 1 | mA |
| I_{off} Off-state cathode current | 4 | $V_{\text{KA}} = 36 \text{ V}, V_{\text{ref}} = 0$ | | | 0.1 | 1 | μA |
| $ z_{\text{KA}} $ Dynamic impedance (see Figure 1) | 1 | $I_{\text{KA}} = 1 \text{ mA to } 100 \text{ mA}, V_{\text{KA}} = V_{\text{ref}}, f \leq 1 \text{ kHz}$ | | | 0.2 | 0.5 | Ω |

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

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



where:

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

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

Example: maximum $V_{\text{ref}} = 2496 \text{ mV}$ at 30°C , minimum $V_{\text{ref}} = 2492 \text{ mV}$ at 0°C , $V_{\text{ref}} = 2495 \text{ mV}$ at 25°C , $\Delta T_A = 70^\circ\text{C}$ for TL431C

$$|\alpha_{V_{\text{ref}}}| = \frac{\left(\frac{4 \text{ mV}}{2495 \text{ mV}} \right) \times 10^6}{70^\circ\text{C}} \approx \frac{23 \text{ ppm}}{^\circ\text{C}}$$

Because minimum V_{ref} occurs at the lower temperature, the coefficient is positive.

Calculating Dynamic Impedance

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

When the device is operating with two external resistors (see Figure 3), the total dynamic impedance of the circuit is given by:

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

Figure 1. Calculating Deviation Parameters and Dynamic Impedance

TL431, TL431A, TL431B
TL432, TL432A, TL432B
ADJUSTABLE PRECISION SHUNT REGULATORS
 SLVS543J – AUGUST 2004 – REVISED DECEMBER 2005

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

| PARAMETER | TEST CIRCUIT | TEST CONDITIONS | TL431 TL432I | | | UNIT | |
|--|--------------|---|---|------|------|------|------------------------------|
| | | | MIN | TYP | MAX | | |
| V_{ref} Reference voltage | 2 | $V_{\text{KA}} = V_{\text{ref}}$, $I_{\text{KA}} = 10\text{ mA}$ | 2440 | 2495 | 2550 | mV | |
| $V_{\text{I(dev)}}$ Deviation of reference voltage over full temperature range (see Figure 1) | 2 | $V_{\text{KA}} = V_{\text{ref}}$, $I_{\text{KA}} = 10\text{ mA}$, $T_A = -40^\circ\text{C}$ to 85°C | SOT23-3 and TL432 devices | | 14 | 34 | mV |
| | | All other devices | | 5 | 50 | | |
| $\frac{\Delta V_{\text{ref}}}{\Delta V_{\text{KA}}}$ Ratio of change in reference voltage to the change in cathode voltage | 3 | $I_{\text{KA}} = 10\text{ mA}$ | $\Delta V_{\text{KA}} = 10\text{ V} - V_{\text{ref}}$ | | -1.4 | -2.7 | $\frac{\text{mV}}{\text{V}}$ |
| | | | $\Delta V_{\text{KA}} = 36\text{ V} - 10\text{ V}$ | | -1 | -2 | |
| I_{ref} Reference current | 3 | $I_{\text{KA}} = 10\text{ mA}$, $R_1 = 10\text{ k}\Omega$, $R_2 = \infty$ | | | 2 | 4 | μA |
| $I_{\text{I(dev)}}$ Deviation of reference current over full temperature range (see Figure 1) | 3 | $I_{\text{KA}} = 10\text{ mA}$, $R_1 = 10\text{ k}\Omega$, $R_2 = \infty$, $T_A = -40^\circ\text{C}$ to 85°C | | | 0.8 | 2.5 | μA |
| I_{min} Minimum cathode current for regulation | 2 | $V_{\text{KA}} = V_{\text{ref}}$ | | | 0.4 | 1 | mA |
| I_{off} Off-state cathode current | 4 | $V_{\text{KA}} = 36\text{ V}$, $V_{\text{ref}} = 0$ | | | 0.1 | 1 | μA |
| $ z_{\text{KA}} $ Dynamic impedance (see Figure 1) | 2 | $I_{\text{KA}} = 1\text{ mA}$ to 100 mA , $V_{\text{KA}} = V_{\text{ref}}$, $f \leq 1\text{ kHz}$ | | | 0.2 | 0.5 | Ω |

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

| PARAMETER | TEST CIRCUIT | TEST CONDITIONS | TL431Q TL432Q | | | UNIT | |
|--|--------------|--|---|------|------|------|------------------------------|
| | | | MIN | TYP | MAX | | |
| V_{ref} Reference voltage | 2 | $V_{\text{KA}} = V_{\text{ref}}$, $I_{\text{KA}} = 10\text{ mA}$ | 2440 | 2495 | 2550 | mV | |
| $V_{\text{I(dev)}}$ Deviation of reference voltage over full temperature range (see Figure 1) | 2 | $V_{\text{KA}} = V_{\text{ref}}$, $I_{\text{KA}} = 10\text{ mA}$, $T_A = -40^\circ\text{C}$ to 125°C | | | 14 | 34 | mV |
| | | | | | | | |
| $\frac{\Delta V_{\text{ref}}}{\Delta V_{\text{KA}}}$ Ratio of change in reference voltage to the change in cathode voltage | 3 | $I_{\text{KA}} = 10\text{ mA}$ | $\Delta V_{\text{KA}} = 10\text{ V} - V_{\text{ref}}$ | | -1.4 | -2.7 | $\frac{\text{mV}}{\text{V}}$ |
| | | | $\Delta V_{\text{KA}} = 36\text{ V} - 10\text{ V}$ | | -1 | -2 | |
| I_{ref} Reference current | 3 | $I_{\text{KA}} = 10\text{ mA}$, $R_1 = 10\text{ k}\Omega$, $R_2 = \infty$ | | | 2 | 4 | μA |
| $I_{\text{I(dev)}}$ Deviation of reference current over full temperature range (see Figure 1) | 3 | $I_{\text{KA}} = 10\text{ mA}$, $R_1 = 10\text{ k}\Omega$, $R_2 = \infty$, $T_A = -40^\circ\text{C}$ to 125°C | | | 0.8 | 2.5 | μA |
| I_{min} Minimum cathode current for regulation | 2 | $V_{\text{KA}} = V_{\text{ref}}$ | | | 0.4 | 1 | mA |
| I_{off} Off-state cathode current | 4 | $V_{\text{KA}} = 36\text{ V}$, $V_{\text{ref}} = 0$ | | | 0.1 | 1 | μA |
| $ z_{\text{KA}} $ Dynamic impedance (see Figure 1) | 2 | $I_{\text{KA}} = 1\text{ mA}$ to 100 mA , $V_{\text{KA}} = V_{\text{ref}}$, $f \leq 1\text{ kHz}$ | | | 0.2 | 0.5 | Ω |

**TL431, TL431A, TL431B
TL432, TL432A, TL432B
ADJUSTABLE PRECISION SHUNT REGULATORS**

SLVS543J – AUGUST 2004 – REVISED DECEMBER 2005

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

| PARAMETER | TEST CIRCUIT | TEST CONDITIONS | TL431AC TL432AC | | | UNIT | |
|--|--------------|---|---|------|------|------|------------------------------|
| | | | MIN | TYP | MAX | | |
| V_{ref} Reference voltage | 2 | $V_{\text{KA}} = V_{\text{ref}}$, $I_{\text{KA}} = 10\text{ mA}$ | 2470 | 2495 | 2520 | mV | |
| $V_{\text{I(dev)}}$ Deviation of reference voltage over full temperature range (see Figure 1) | 2 | $V_{\text{KA}} = V_{\text{ref}}$, $I_{\text{KA}} = 10\text{ mA}$, $T_A = 0^\circ\text{C}$ to 70°C | SOT23-3, SC-70, and TL432 devices | | 6 | 16 | mV |
| | | | All other devices | | 4 | 25 | |
| $\frac{\Delta V_{\text{ref}}}{\Delta V_{\text{KA}}}$ Ratio of change in reference voltage to the change in cathode voltage | 3 | $I_{\text{KA}} = 10\text{ mA}$ | $\Delta V_{\text{KA}} = 10\text{ V} - V_{\text{ref}}$ | | -1.4 | -2.7 | $\frac{\text{mV}}{\text{V}}$ |
| | | | $\Delta V_{\text{KA}} = 36\text{ V} - 10\text{ V}$ | | -1 | -2 | |
| I_{ref} Reference current | 3 | $I_{\text{KA}} = 10\text{ mA}$, $R_1 = 10\text{ k}\Omega$, $R_2 = \infty$ | | | 2 | 4 | μA |
| $I_{\text{I(dev)}}$ Deviation of reference current over full temperature range (see Figure 1) | 3 | $I_{\text{KA}} = 10\text{ mA}$, $R_1 = 10\text{ k}\Omega$, $R_2 = \infty$, $T_A = 0^\circ\text{C}$ to 70°C | | | 0.8 | 1.2 | μA |
| I_{min} Minimum cathode current for regulation | 2 | $V_{\text{KA}} = V_{\text{ref}}$ | | | 0.4 | 0.6 | mA |
| I_{off} Off-state cathode current | 4 | $V_{\text{KA}} = 36\text{ V}$, $V_{\text{ref}} = 0$ | | | 0.1 | 0.5 | μA |
| $ z_{\text{KA}} $ Dynamic impedance (see Figure 1) | 1 | $I_{\text{KA}} = 1\text{ mA}$ to 100 mA , $V_{\text{KA}} = V_{\text{ref}}$, $f \leq 1\text{ kHz}$ | | | 0.2 | 0.5 | Ω |

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

| PARAMETER | TEST CIRCUIT | TEST CONDITIONS | TL431AI TL432AI | | | UNIT | |
|--|--------------|---|---|------|------|------|------------------------------|
| | | | MIN | TYP | MAX | | |
| V_{ref} Reference voltage | 2 | $V_{\text{KA}} = V_{\text{ref}}$, $I_{\text{KA}} = 10\text{ mA}$ | 2470 | 2495 | 2520 | mV | |
| $V_{\text{I(dev)}}$ Deviation of reference voltage over full temperature range (see Figure 1) | 2 | $V_{\text{KA}} = V_{\text{ref}}$, $I_{\text{KA}} = 10\text{ mA}$, $T_A = -40^\circ\text{C}$ to 85°C | SOT23-3, SC-70, and TL432 devices | | 14 | 34 | mV |
| | | | All other packages | | 5 | 50 | |
| $\frac{\Delta V_{\text{ref}}}{\Delta V_{\text{KA}}}$ Ratio of change in reference voltage to the change in cathode voltage | 3 | $I_{\text{KA}} = 10\text{ mA}$ | $\Delta V_{\text{KA}} = 10\text{ V} - V_{\text{ref}}$ | | -1.4 | -2.7 | $\frac{\text{mV}}{\text{V}}$ |
| | | | $\Delta V_{\text{KA}} = 36\text{ V} - 10\text{ V}$ | | -1 | -2 | |
| I_{ref} Reference current | 3 | $I_{\text{KA}} = 10\text{ mA}$, $R_1 = 10\text{ k}\Omega$, $R_2 = \infty$ | | | 2 | 4 | μA |
| $I_{\text{I(dev)}}$ Deviation of reference current over full temperature range (see Figure 1) | 3 | $I_{\text{KA}} = 10\text{ mA}$, $R_1 = 10\text{ k}\Omega$, $R_2 = \infty$, $T_A = -40^\circ\text{C}$ to 85°C | | | 0.8 | 2.5 | μA |
| I_{min} Minimum cathode current for regulation | 2 | $V_{\text{KA}} = V_{\text{ref}}$ | | | 0.4 | 0.7 | mA |
| I_{off} Off-state cathode current | 4 | $V_{\text{KA}} = 36\text{ V}$, $V_{\text{ref}} = 0$ | | | 0.1 | 0.5 | μA |
| $ z_{\text{KA}} $ Dynamic impedance (see Figure 1) | 2 | $I_{\text{KA}} = 1\text{ mA}$ to 100 mA , $V_{\text{KA}} = V_{\text{ref}}$, $f \leq 1\text{ kHz}$ | | | 0.2 | 0.5 | Ω |

TL431, TL431A, TL431B
TL432, TL432A, TL432B
ADJUSTABLE PRECISION SHUNT REGULATORS
 SLVS543J – AUGUST 2004 – REVISED DECEMBER 2005

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

| PARAMETER | TEST CIRCUIT | TEST CONDITIONS | TL431AQ TL432AQ | | | UNIT |
|--|--------------|--|---|------|------|------------------------------|
| | | | MIN | TYP | MAX | |
| V_{ref} Reference voltage | 2 | $V_{\text{KA}} = V_{\text{ref}}$, $I_{\text{KA}} = 10\text{ mA}$ | 2470 | 2495 | 2520 | mV |
| $V_{\text{I(dev)}}$ Deviation of reference voltage over full temperature range (see Figure 1) | 2 | $V_{\text{KA}} = V_{\text{ref}}$, $I_{\text{KA}} = 10\text{ mA}$, $T_A = -40^\circ\text{C}$ to 125°C | | 14 | 34 | mV |
| $\frac{\Delta V_{\text{ref}}}{\Delta V_{\text{KA}}}$ Ratio of change in reference voltage to the change in cathode voltage | 3 | $I_{\text{KA}} = 10\text{ mA}$ | $\Delta V_{\text{KA}} = 10\text{ V} - V_{\text{ref}}$ | -1.4 | -2.7 | $\frac{\text{mV}}{\text{V}}$ |
| | | | $\Delta V_{\text{KA}} = 36\text{ V} - 10\text{ V}$ | -1 | -2 | |
| I_{ref} Reference current | 3 | $I_{\text{KA}} = 10\text{ mA}$, $R_1 = 10\text{ k}\Omega$, $R_2 = \infty$ | | 2 | 4 | μA |
| $I_{\text{I(dev)}}$ Deviation of reference current over full temperature range (see Figure 1) | 3 | $I_{\text{KA}} = 10\text{ mA}$, $R_1 = 10\text{ k}\Omega$, $R_2 = \infty$, $T_A = -40^\circ\text{C}$ to 125°C | | 0.8 | 2.5 | μA |
| I_{min} Minimum cathode current for regulation | 2 | $V_{\text{KA}} = V_{\text{ref}}$ | | 0.4 | 0.7 | mA |
| I_{off} Off-state cathode current | 4 | $V_{\text{KA}} = 36\text{ V}$, $V_{\text{ref}} = 0$ | | 0.1 | 0.5 | μA |
| $ z_{\text{KA}} $ Dynamic impedance (see Figure 1) | 2 | $I_{\text{KA}} = 1\text{ mA}$ to 100 mA , $V_{\text{KA}} = V_{\text{ref}}$, $f \leq 1\text{ kHz}$ | | 0.2 | 0.5 | Ω |

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

| PARAMETER | TEST CIRCUIT | TEST CONDITIONS | TL431BC TL432BC | | | UNIT |
|--|--------------|---|---|------|------|------------------------------|
| | | | MIN | TYP | MAX | |
| V_{ref} Reference voltage | 2 | $V_{\text{KA}} = V_{\text{ref}}$, $I_{\text{KA}} = 10\text{ mA}$ | 2483 | 2495 | 2507 | mV |
| $V_{\text{I(dev)}}$ Deviation of reference voltage over full temperature range (see Figure 1) | 2 | $V_{\text{KA}} = V_{\text{ref}}$, $I_{\text{KA}} = 10\text{ mA}$, $T_A = 0^\circ\text{C}$ to 70°C | | 6 | 16 | mV |
| $\frac{\Delta V_{\text{ref}}}{\Delta V_{\text{KA}}}$ Ratio of change in reference voltage to the change in cathode voltage | 3 | $I_{\text{KA}} = 10\text{ mA}$ | $\Delta V_{\text{KA}} = 10\text{ V} - V_{\text{ref}}$ | -1.4 | -2.7 | $\frac{\text{mV}}{\text{V}}$ |
| | | | $\Delta V_{\text{KA}} = 36\text{ V} - 10\text{ V}$ | -1 | -2 | |
| I_{ref} Reference current | 3 | $I_{\text{KA}} = 10\text{ mA}$, $R_1 = 10\text{ k}\Omega$, $R_2 = \infty$ | | 2 | 4 | μA |
| $I_{\text{I(dev)}}$ Deviation of reference current over full temperature range (see Figure 1) | 3 | $I_{\text{KA}} = 10\text{ mA}$, $R_1 = 10\text{ k}\Omega$, $R_2 = \infty$, $T_A = 0^\circ\text{C}$ to 70°C | | 0.8 | 1.2 | μA |
| I_{min} Minimum cathode current for regulation | 2 | $V_{\text{KA}} = V_{\text{ref}}$ | | 0.4 | 0.6 | mA |
| I_{off} Off-state cathode current | 4 | $V_{\text{KA}} = 36\text{ V}$, $V_{\text{ref}} = 0$ | | 0.1 | 0.5 | μA |
| $ z_{\text{KA}} $ Dynamic impedance (see Figure 1) | 1 | $I_{\text{KA}} = 1\text{ mA}$ to 100 mA , $V_{\text{KA}} = V_{\text{ref}}$, $f \leq 1\text{ kHz}$ | | 0.2 | 0.5 | Ω |

**TL431, TL431A, TL431B
TL432, TL432A, TL432B
ADJUSTABLE PRECISION SHUNT REGULATORS**

SLVS543J – AUGUST 2004 – REVISED DECEMBER 2005

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

| PARAMETER | TEST CIRCUIT | TEST CONDITIONS | TL431BI TL432BI | | | UNIT |
|--|--------------|---|--|------|------|------------------------------|
| | | | MIN | TYP | MAX | |
| V_{ref} Reference voltage | 2 | $V_{\text{KA}} = V_{\text{ref}}, I_{\text{KA}} = 10 \text{ mA}$ | 2483 | 2495 | 2507 | mV |
| $V_{\text{I(dev)}}$ Deviation of reference voltage over full temperature range (see Figure 1) | 2 | $V_{\text{KA}} = V_{\text{ref}}, I_{\text{KA}} = 10 \text{ mA}, T_A = -40^\circ\text{C} \text{ to } 85^\circ\text{C}$ | | 14 | 34 | mV |
| $\frac{\Delta V_{\text{ref}}}{\Delta V_{\text{KA}}}$ Ratio of change in reference voltage to the change in cathode voltage | 3 | $I_{\text{KA}} = 10 \text{ mA}$ | $\Delta V_{\text{KA}} = 10 \text{ V} - V_{\text{ref}}$ | -1.4 | -2.7 | $\frac{\text{mV}}{\text{V}}$ |
| | | | $\Delta V_{\text{KA}} = 36 \text{ V} - 10 \text{ V}$ | -1 | -2 | |
| I_{ref} Reference current | 3 | $I_{\text{KA}} = 10 \text{ mA}, R1 = 10 \text{ k}\Omega, R2 = \infty$ | | 2 | 4 | μA |
| $I_{\text{I(dev)}}$ Deviation of reference current over full temperature range (see Figure 1) | 3 | $I_{\text{KA}} = 10 \text{ mA}, R1 = 10 \text{ k}\Omega, R2 = \infty, T_A = -40^\circ\text{C} \text{ to } 85^\circ\text{C}$ | | 0.8 | 2.5 | μA |
| I_{min} Minimum cathode current for regulation | 2 | $V_{\text{KA}} = V_{\text{ref}}$ | | 0.4 | 0.7 | mA |
| I_{off} Off-state cathode current | 4 | $V_{\text{KA}} = 36 \text{ V}, V_{\text{ref}} = 0$ | | 0.1 | 0.5 | μA |
| $ z_{\text{KA}} $ Dynamic impedance (see Figure 1) | 2 | $I_{\text{KA}} = 1 \text{ mA} \text{ to } 100 \text{ mA}, V_{\text{KA}} = V_{\text{ref}}, f \leq 1 \text{ kHz}$ | | 0.2 | 0.5 | Ω |

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

| PARAMETER | TEST CIRCUIT | TEST CONDITIONS | TL431BQ TL432BQ | | | UNIT |
|--|--------------|--|--|------|------|------------------------------|
| | | | MIN | TYP | MAX | |
| V_{ref} Reference voltage | 2 | $V_{\text{KA}} = V_{\text{ref}}, I_{\text{KA}} = 10 \text{ mA}$ | 2483 | 2495 | 2507 | mV |
| $V_{\text{I(dev)}}$ Deviation of reference voltage over full temperature range (see Figure 1) | 2 | $V_{\text{KA}} = V_{\text{ref}}, I_{\text{KA}} = 10 \text{ mA}, T_A = -40^\circ\text{C} \text{ to } 125^\circ\text{C}$ | | 14 | 34 | mV |
| $\frac{\Delta V_{\text{ref}}}{\Delta V_{\text{KA}}}$ Ratio of change in reference voltage to the change in cathode voltage | 3 | $I_{\text{KA}} = 10 \text{ mA}$ | $\Delta V_{\text{KA}} = 10 \text{ V} - V_{\text{ref}}$ | -1.4 | -2.7 | $\frac{\text{mV}}{\text{V}}$ |
| | | | $\Delta V_{\text{KA}} = 36 \text{ V} - 10 \text{ V}$ | -1 | -2 | |
| I_{ref} Reference current | 3 | $I_{\text{KA}} = 10 \text{ mA}, R1 = 10 \text{ k}\Omega, R2 = \infty$ | | 2 | 4 | μA |
| $I_{\text{I(dev)}}$ Deviation of reference current over full temperature range (see Figure 1) | 3 | $I_{\text{KA}} = 10 \text{ mA}, R1 = 10 \text{ k}\Omega, R2 = \infty, T_A = -40^\circ\text{C} \text{ to } 125^\circ\text{C}$ | | 0.8 | 2.5 | μA |
| I_{min} Minimum cathode current for regulation | 2 | $V_{\text{KA}} = V_{\text{ref}}$ | | 0.4 | 0.7 | mA |
| I_{off} Off-state cathode current | 4 | $V_{\text{KA}} = 36 \text{ V}, V_{\text{ref}} = 0$ | | 0.1 | 0.5 | μA |
| $ z_{\text{KA}} $ Dynamic impedance (see Figure 1) | 1 | $I_{\text{KA}} = 1 \text{ mA} \text{ to } 100 \text{ mA}, V_{\text{KA}} = V_{\text{ref}}, f \leq 1 \text{ kHz}$ | | 0.2 | 0.5 | Ω |

PARAMETER MEASUREMENT INFORMATION

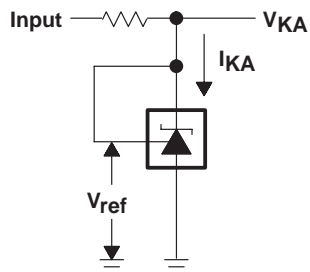


Figure 2. Test Circuit for $V_{KA} = V_{ref}$

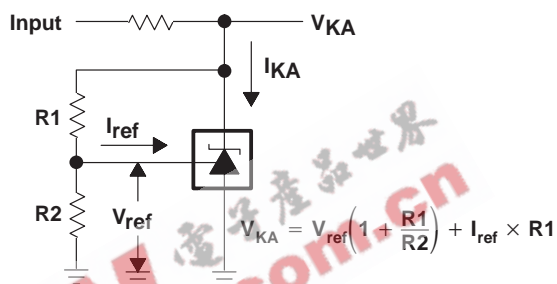


Figure 3. Test Circuit for $V_{KA} > V_{ref}$

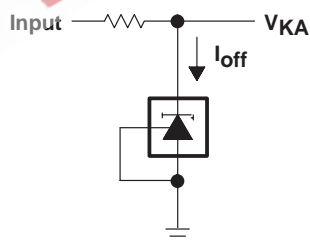


Figure 4. Test Circuit for I_{off}

TL431, TL431A, TL431B
TL432, TL432A, TL432B
ADJUSTABLE PRECISION SHUNT REGULATORS

SLVS543J – AUGUST 2004 – REVISED DECEMBER 2005

TYPICAL CHARACTERISTICS

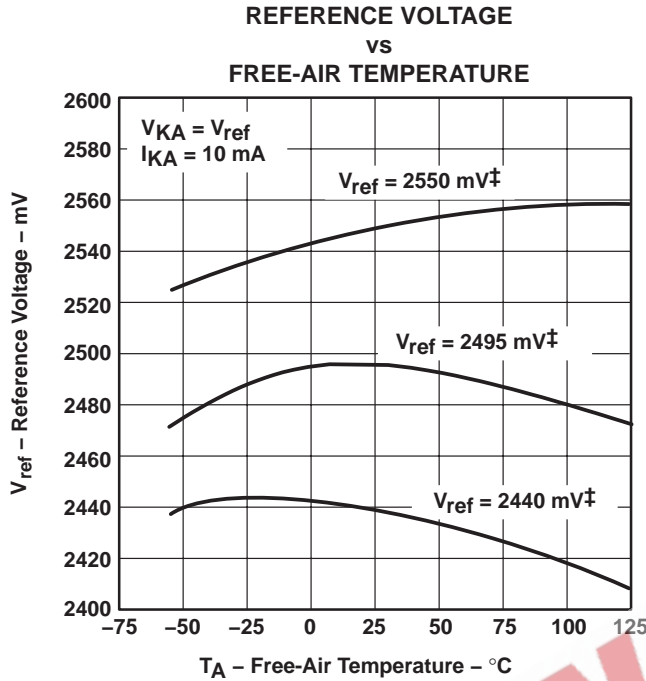
Table 1. Graphs

| | FIGURE |
|---|---------------|
| Reference voltage vs Free-air temperature | 5 |
| Reference current vs Free-air temperature | 6 |
| Cathode current vs Cathode voltage | 7, 8 |
| OFF-state cathode current vs Free-air temperature | 9 |
| Ratio of delta reference voltage to delta cathode voltage vs Free-air temperature | 10 |
| Equivalent input noise voltage vs Frequency | 11 |
| Equivalent input noise voltage over a 10-s period | 12 |
| Small-signal voltage amplification vs Frequency | 13 |
| Reference impedance vs Frequency | 14 |
| Pulse response | 15 |
| Stability boundary conditions | 16 |

Table 2. Application Circuits

| | FIGURE |
|---|---------------|
| Shunt regulator | 17 |
| Single-supply comparator with temperature-compensated threshold | 18 |
| Precision high-current series regulator | 19 |
| Output control of a three-terminal fixed regulator | 20 |
| High-current shunt regulator | 21 |
| Crowbar circuit | 22 |
| Precision 5-V 1.5-A regulator | 23 |
| Efficient 5-V precision regulator | 24 |
| PWM converter with reference | 25 |
| Voltage monitor | 26 |
| Delay timer | 27 |
| Precision current limiter | 28 |
| Precision constant-current sink | 29 |

TYPICAL CHARACTERISTICS†



† Data is for devices having the indicated value of V_{ref} at $I_{KA} = 10 \text{ mA}$, $T_A = 25^\circ\text{C}$.

Figure 5

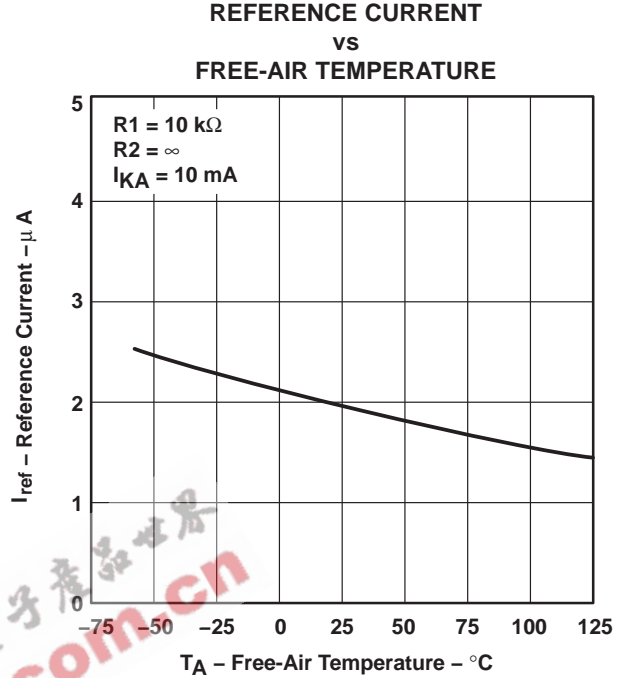


Figure 6

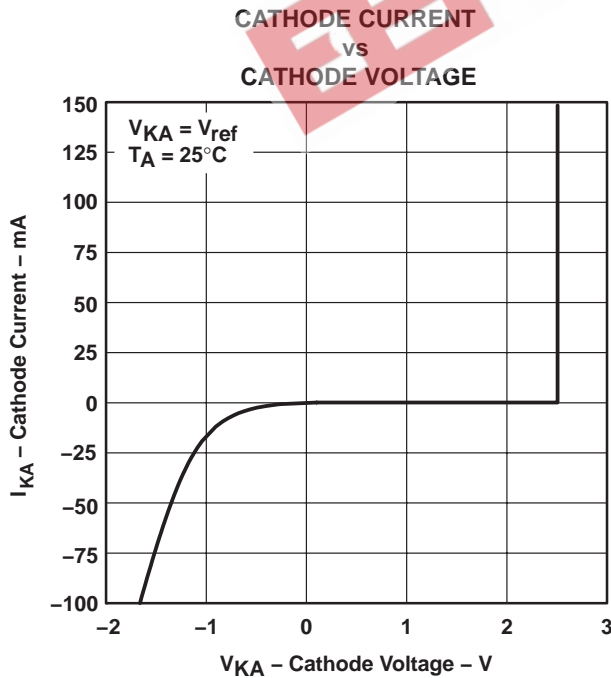


Figure 7

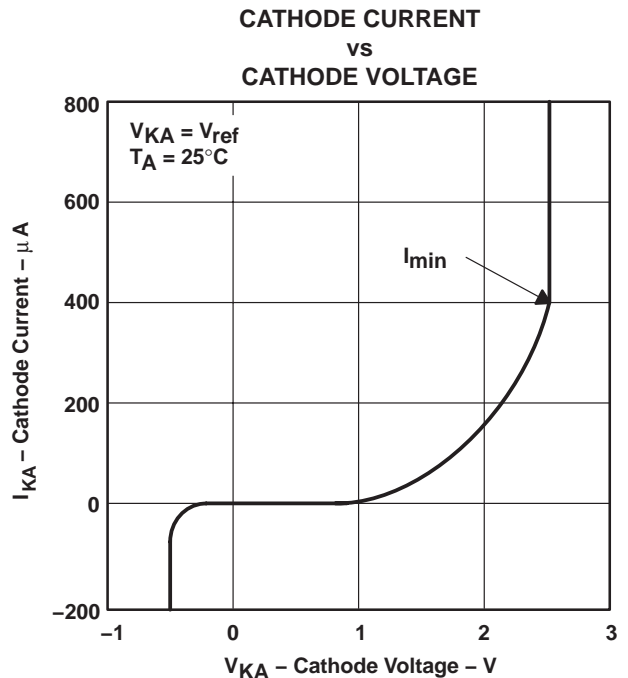


Figure 8

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

**TL431, TL431A, TL431B
TL432, TL432A, TL432B
ADJUSTABLE PRECISION SHUNT REGULATORS**

SLVS543J – AUGUST 2004 – REVISED DECEMBER 2005

TYPICAL CHARACTERISTICS†

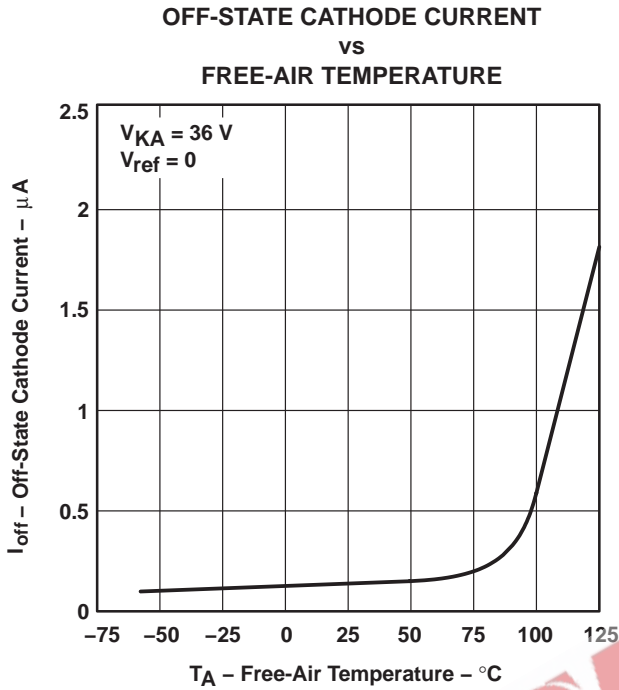


Figure 9

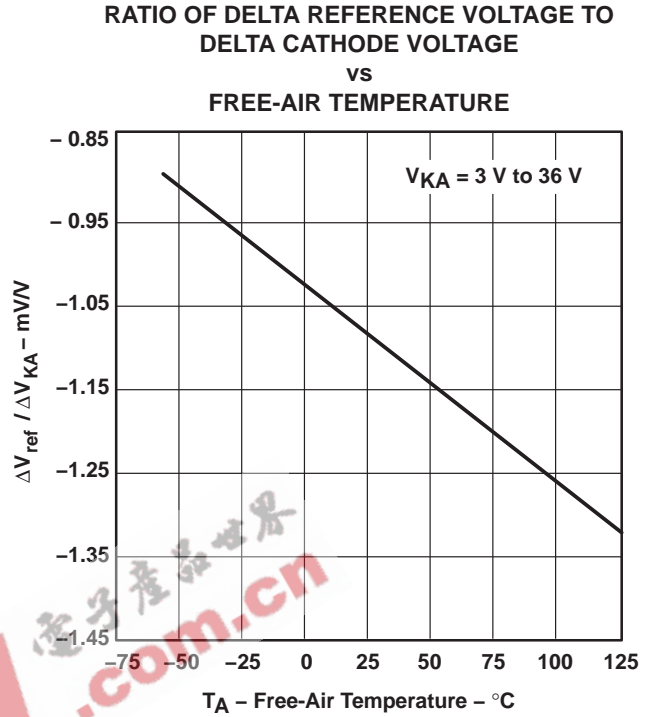


Figure 10

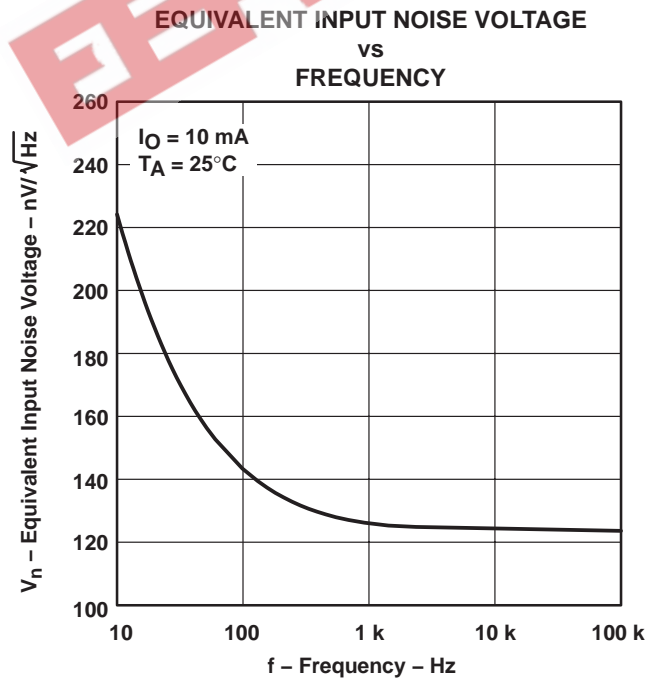


Figure 11

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

TYPICAL CHARACTERISTICS

EQUIVALENT INPUT NOISE VOLTAGE
 OVER A 10-S PERIOD

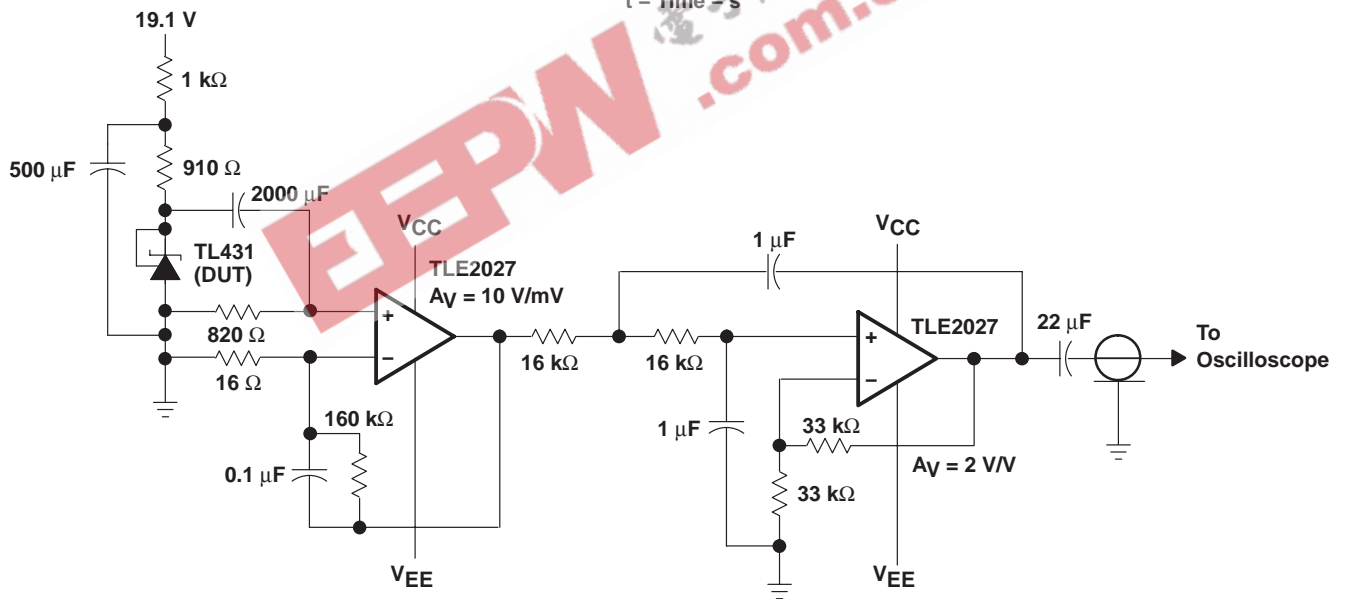


Figure 12. Test Circuit for Equivalent Input Noise Voltage

**TL431, TL431A, TL431B
TL432, TL432A, TL432B
ADJUSTABLE PRECISION SHUNT REGULATORS**

SLVS543J – AUGUST 2004 – REVISED DECEMBER 2005

TYPICAL CHARACTERISTICS



Figure 13

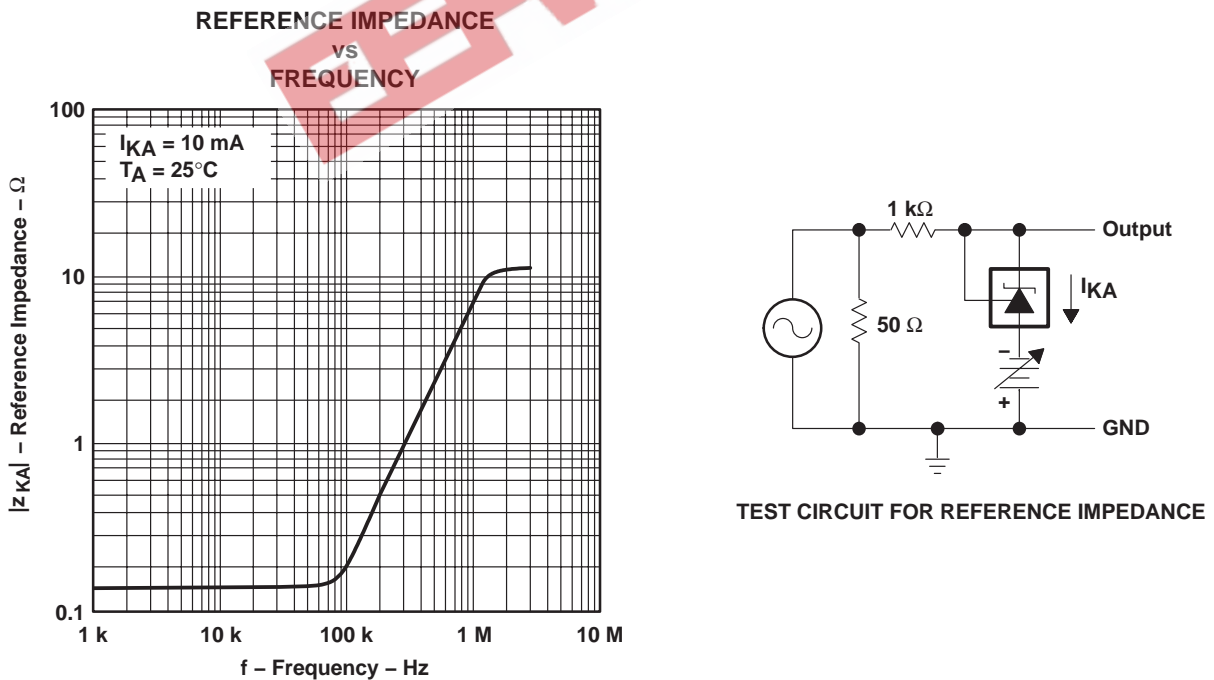


Figure 14

TYPICAL CHARACTERISTICS

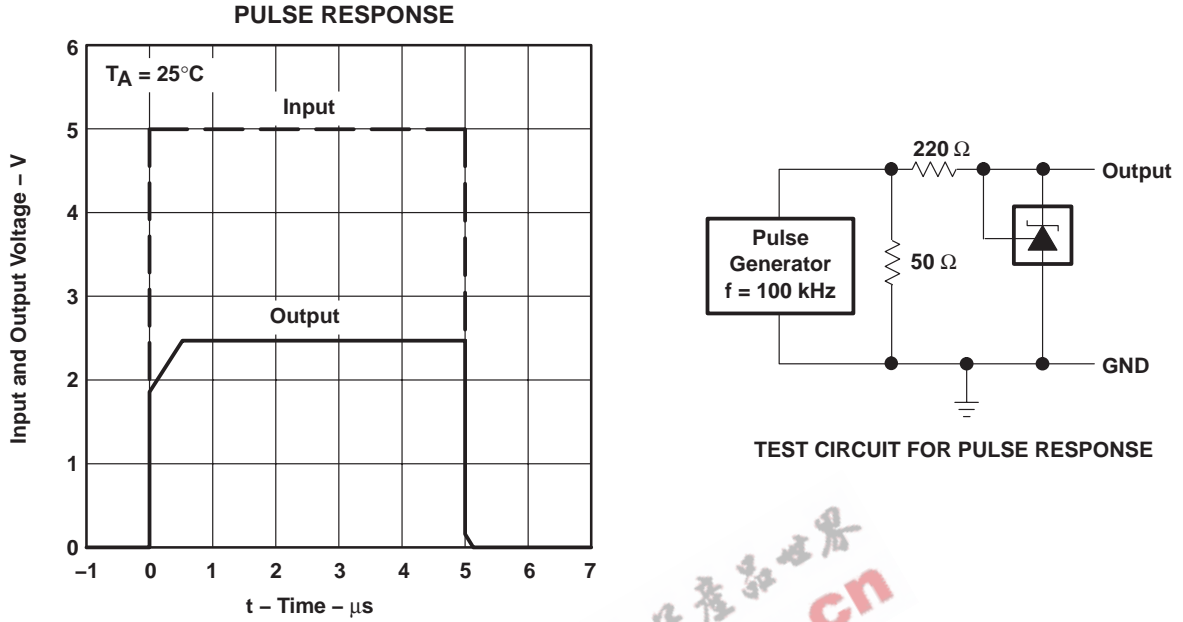


Figure 15

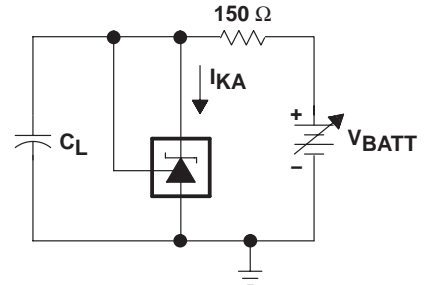
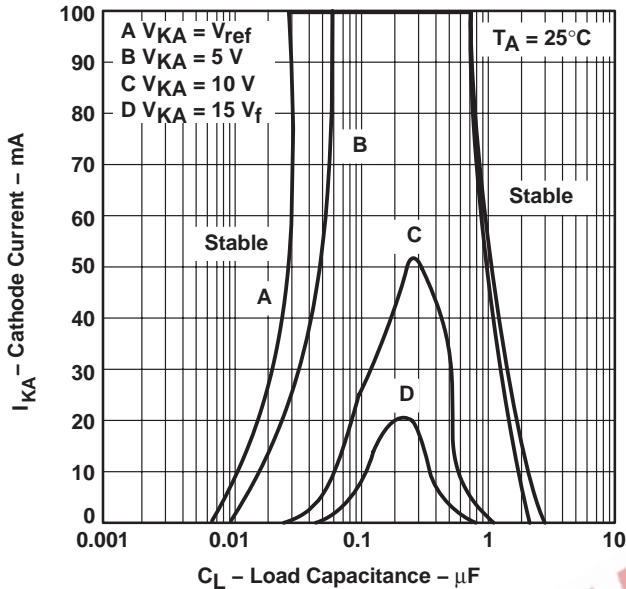
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**TL431, TL431A, TL431B
TL432, TL432A, TL432B
ADJUSTABLE PRECISION SHUNT REGULATORS**

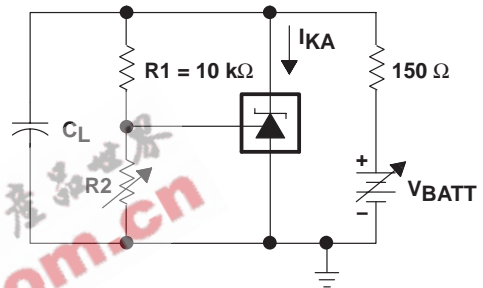
SLVS543J – AUGUST 2004 – REVISED DECEMBER 2005

TYPICAL CHARACTERISTICS

**STABILITY BOUNDARY CONDITIONS†
FOR ALL TL431 AND TL431A DEVICES
(EXCEPT FOR SOT23-3, SC-70, AND Q-TEMP DEVICES)**

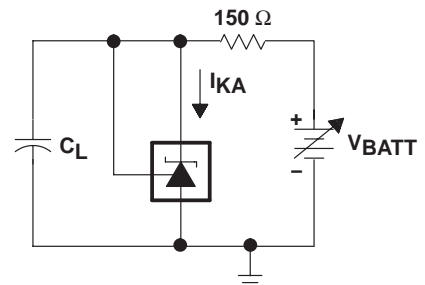
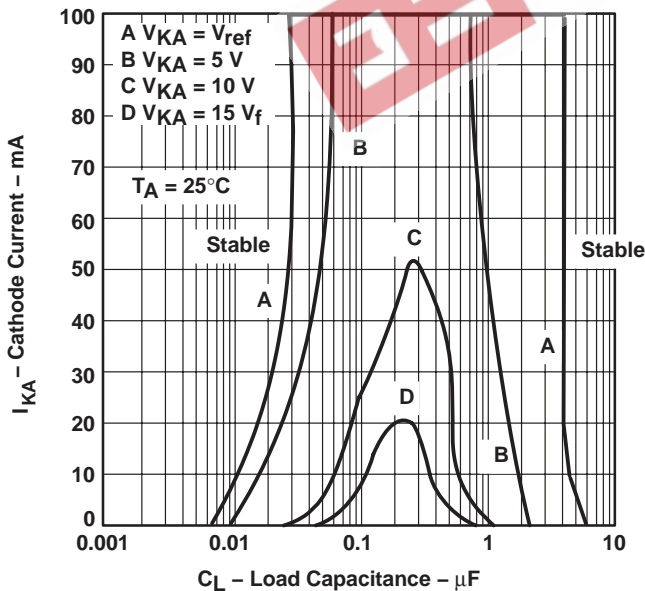


TEST CIRCUIT FOR CURVE A

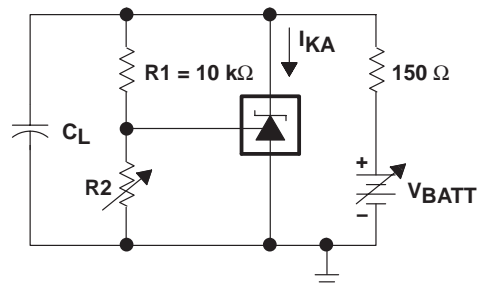


TEST CIRCUIT FOR CURVES B, C, AND D

**STABILITY BOUNDARY CONDITIONS†
FOR ALL TL431B, TL432, SOT-23, SC-70, AND Q-TEMP DEVICES**



TEST CIRCUIT FOR CURVE A

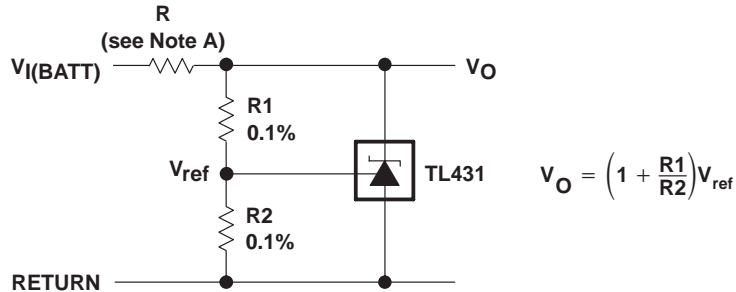


TEST CIRCUIT FOR CURVES B, C, AND D

† The areas under the curves represent conditions that may cause the device to oscillate. For curves B, C, and D, R2 and V+ were adjusted to establish the initial VKA and IKA conditions with CL = 0. VBATT and CL then were adjusted to determine the ranges of stability.

Figure 16

APPLICATION INFORMATION



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

Figure 17. Shunt Regulator

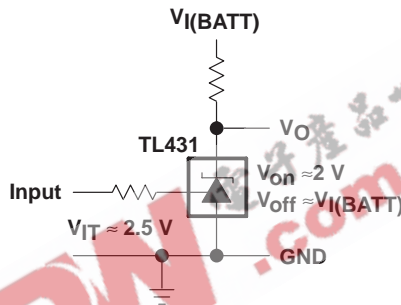
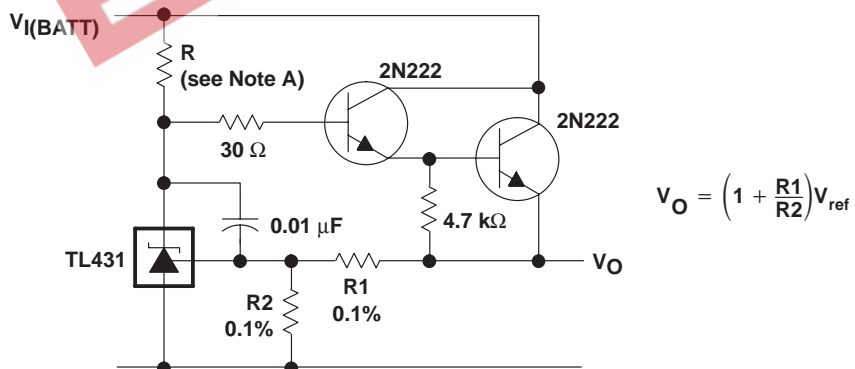


Figure 18. Single-Supply Comparator With Temperature-Compensated Threshold



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

Figure 19. Precision High-Current Series Regulator

**TL431, TL431A, TL431B
TL432, TL432A, TL432B
ADJUSTABLE PRECISION SHUNT REGULATORS**

SLVS543J – AUGUST 2004 – REVISED DECEMBER 2005

APPLICATION INFORMATION

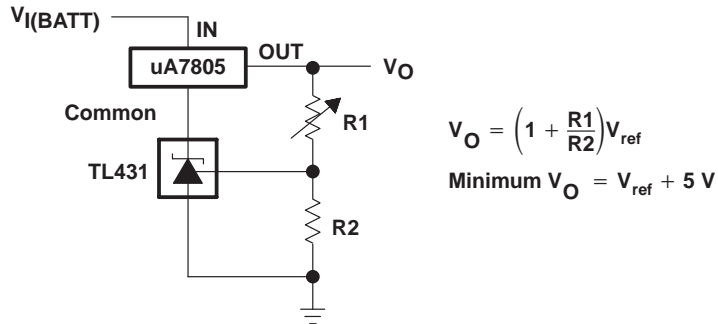


Figure 20. Output Control of a Three-Terminal Fixed Regulator

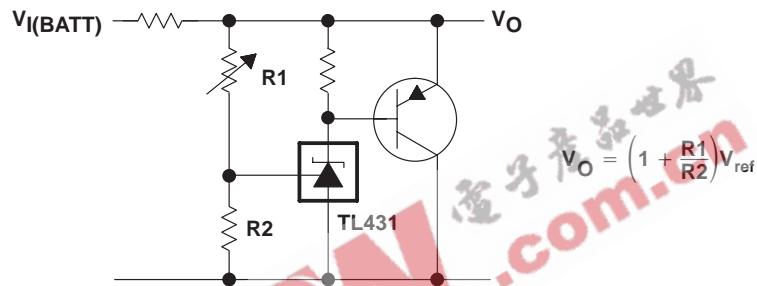
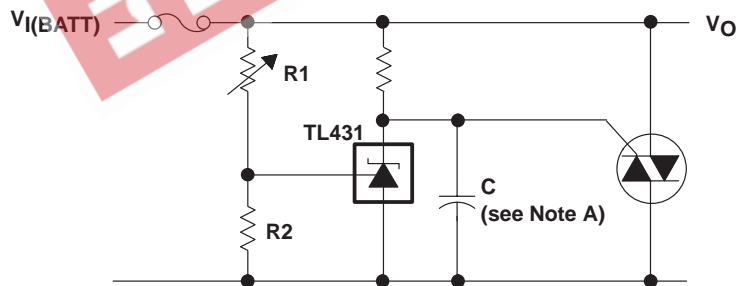


Figure 21. High-Current Shunt Regulator



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

Figure 22. Crowbar Circuit

APPLICATION INFORMATION

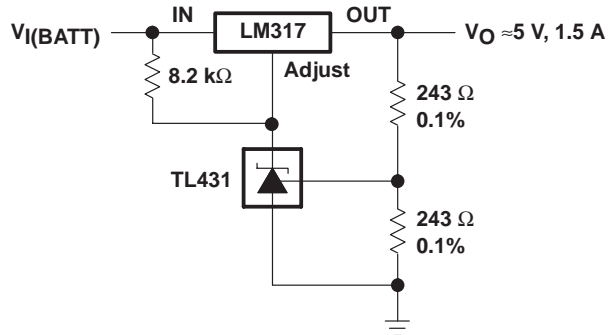
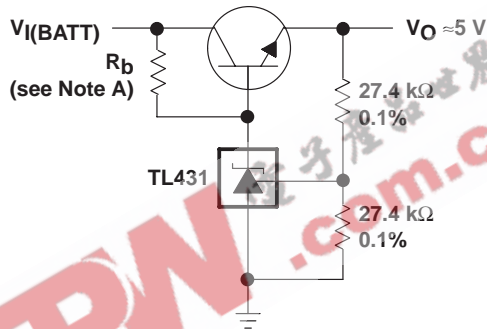


Figure 23. Precision 5-V 1.5-A Regulator



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

Figure 24. Efficient 5-V Precision Regulator

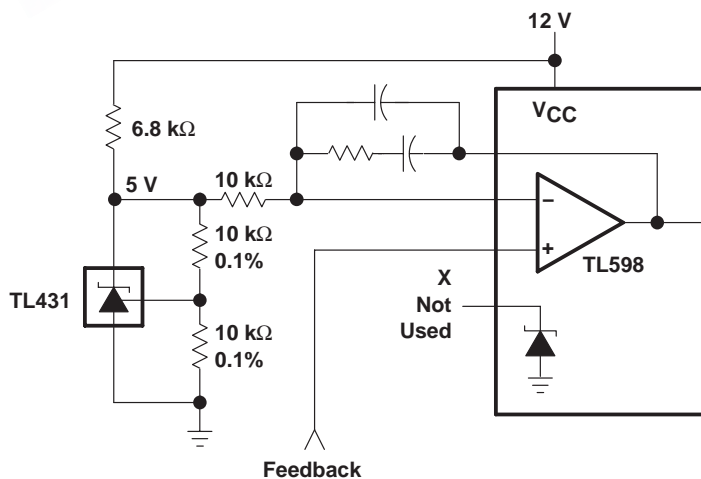
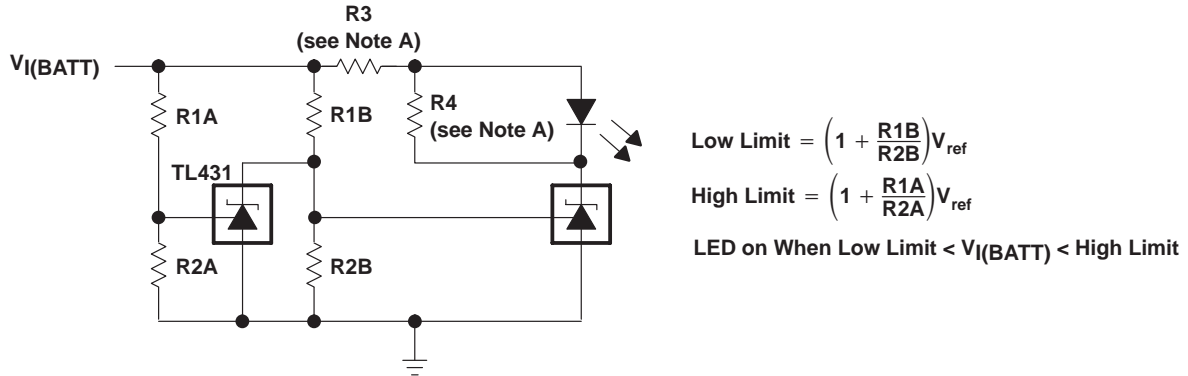


Figure 25. PWM Converter With Reference

**TL431, TL431A, TL431B
TL432, TL432A, TL432B
ADJUSTABLE PRECISION SHUNT REGULATORS**

SLVS543J – AUGUST 2004 – REVISED DECEMBER 2005

APPLICATION INFORMATION



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

Figure 26. Voltage Monitor

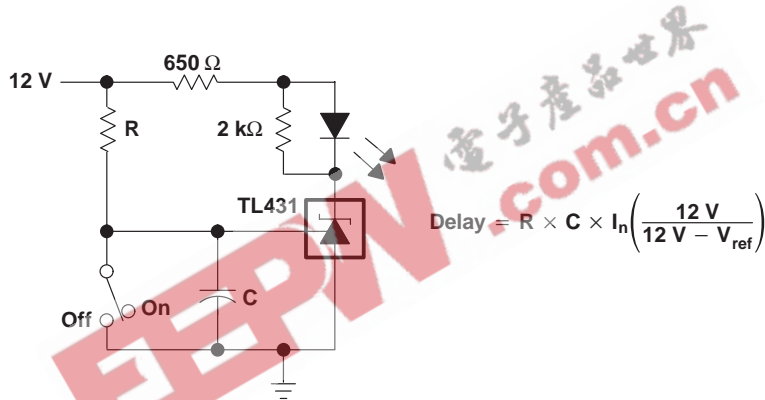


Figure 27. Delay Timer

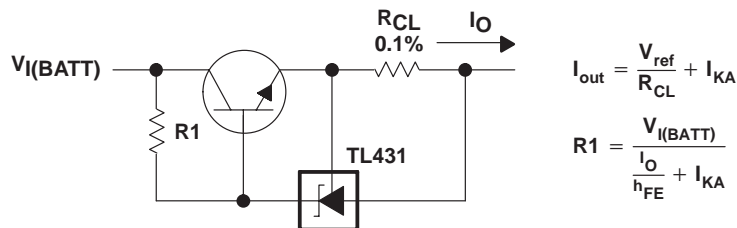


Figure 28. Precision Current Limiter

APPLICATION INFORMATION

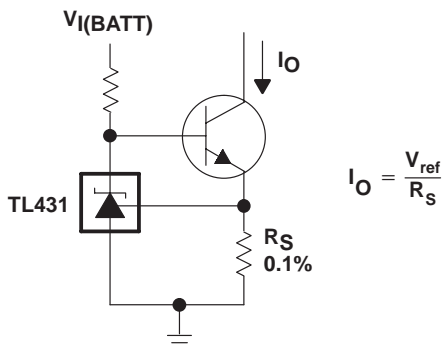


Figure 29. Precision Constant-Current Sink

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PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TL431ACD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ACDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ACDBVRE4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ACDBVRG4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ACDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ACDBVTE4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ACDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ACDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ACDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ACDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ACDCKR | ACTIVE | SC70 | DCK | 6 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ACDCKRE4 | ACTIVE | SC70 | DCK | 6 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ACDCKT | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ACDCKTE4 | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ACDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ACDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ACDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ACLCP | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431ACLPE3 | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431ACLPM | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431ACLPR | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431ACP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TL431ACPE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TL431ACPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL431ACPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TL431ACPSR | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ACPSRE4 | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ACPW | ACTIVE | TSSOP | PW | 8 | 150 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ACPWE4 | ACTIVE | TSSOP | PW | 8 | 150 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ACPWR | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ACPWRE4 | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ACPWRG4 | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AID | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AIDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AIDBVRE4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AIDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AIDBVTE4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AIDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AIDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AIDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AIDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AIDCKR | ACTIVE | SC70 | DCK | 6 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AIDCKRE4 | ACTIVE | SC70 | DCK | 6 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AIDCKT | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AIDCKTE4 | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AIDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AIDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AIDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AILP | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431AILPM | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431AILPME3 | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TL431AILPR | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431AIP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TL431AIPE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TL431AIPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL431AIPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL431AQDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AQDBVRE4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AQDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AQDBVTE4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AQDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AQDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AQDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AQDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AQDCKR | ACTIVE | SC70 | DCK | 6 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AQDCKRE4 | ACTIVE | SC70 | DCK | 6 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AQDCKT | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AQDCKTE4 | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431AQP | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL431AQPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL431BCD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BCDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BCDBVRE4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BCDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BCDBVTE4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BCDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BCDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TL431BCDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BCDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BCDCKR | ACTIVE | SC70 | DCK | 6 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BCDCKRE4 | ACTIVE | SC70 | DCK | 6 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BCDCKT | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BCDCKTE4 | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BCDE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BCDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BCDRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BCLP | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431BCLPE3 | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431BCLPM | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431BCLPME3 | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431BCLPR | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431BCLPRE3 | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431BCP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TL431BCPE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TL431BCPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL431BCPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL431BCPSR | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BCPSRE4 | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BCPW | ACTIVE | TSSOP | PW | 8 | 150 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BCPWE4 | ACTIVE | TSSOP | PW | 8 | 150 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BCPWR | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BCPWRE4 | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BID | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TL431BIDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BIDBVRE4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BIDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BIDBVTE4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BIDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BIDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BIDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BIDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BIDCKR | ACTIVE | SC70 | DCK | 6 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BIDCKRE4 | ACTIVE | SC70 | DCK | 6 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BIDCKT | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BIDCKTE4 | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BIDE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BIDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BIDRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BILP | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431BILPE3 | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431BILPR | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431BILPRE3 | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431BIP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TL431BIPE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TL431BIPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL431BIPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL431BQD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BQDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BQDBVRE4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TL431BQDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BQDBVTE4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BQDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BQDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BQDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BQDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BQDCKR | ACTIVE | SC70 | DCK | 6 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BQDCKRE4 | ACTIVE | SC70 | DCK | 6 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BQDCKT | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BQDCKTE4 | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BQDE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BQDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BQDRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431BQLP | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431BQLPE3 | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431BQLPM | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431BQLPME3 | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431BQLPR | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431BQLPRE3 | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431BQPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL431BQPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL431BQPSR | PREVIEW | SO | PS | 8 | 2000 | TBD | Call TI | Call TI |
| TL431CD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431CDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431CDBVRE4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431CDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TL431CDBVTE4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431CDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431CDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431CDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431CDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431CDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431CDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431CDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431CKTPR | OBSOLETE | PFM | KTP | 2 | | TBD | Call TI | Call TI |
| TL431CLP | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431CLPB-TDJ | OBSOLETE | TO-92 | LP | 3 | | TBD | Call TI | Call TI |
| TL431CLPM | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431CLPR | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431CP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TL431CPE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TL431CPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL431CPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL431CPSLE | OBSOLETE | SO | PS | 8 | | TBD | Call TI | Call TI |
| TL431CPSR | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431CPSRG4 | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431CPW | ACTIVE | TSSOP | PW | 8 | 150 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431CPWE4 | ACTIVE | TSSOP | PW | 8 | 150 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431CPWLE | OBSOLETE | TSSOP | PW | 8 | | TBD | Call TI | Call TI |
| TL431CPWR | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431CPWRE4 | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ID | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431IDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431IDBVRE4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| | | | | | | no Sb/Br) | | |
| TL431IDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431IDBVTE4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431IDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431IDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431IDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431IDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431IDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431IDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431IDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431ILP | ACTIVE | TO-92 | LP | 3 | 1000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431ILPM | OBSOLETE | TO-92 | LP | 3 | | TBD | Call TI | Call TI |
| TL431ILPR | ACTIVE | TO-92 | LP | 3 | 2000 | Pb-Free (RoHS) | CU SN | N / A for Pkg Type |
| TL431IP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TL431IPE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TL431IPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL431IPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL431MFKB | OBSOLETE | LCCC | FK | 20 | | TBD | Call TI | Call TI |
| TL431MJG | OBSOLETE | CDIP | JG | 8 | | TBD | Call TI | Call TI |
| TL431MJGB | OBSOLETE | CDIP | JG | 8 | | TBD | Call TI | Call TI |
| TL431QD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431QDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431QDBVRE4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431QDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431QDBVTE4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431QDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431QDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431QDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TL431QDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431QDCKR | ACTIVE | SC70 | DCK | 6 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431QDCKRE4 | ACTIVE | SC70 | DCK | 6 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431QDCKT | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431QDCKTE4 | ACTIVE | SC70 | DCK | 6 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431QDE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431QDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431QDRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL431QPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL431QPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL432ACDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432ACDBVRE4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432ACDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432ACDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432ACDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432ACDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432ACPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL432ACPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL432AIDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432AIDBVRE4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432AIDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432AIDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432AIDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432AIDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432AIPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL432AIPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TL432AQDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432AQDBVRE4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432AQDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432AQDBVTE4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432AQDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432AQDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432AQDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432AQDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432AQPCK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL432AQPCKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL432BCDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432BCDBVRE4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432BCDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432BCDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432BCDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432BCDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432BCPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL432BCPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL432BIDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432BIDBVRE4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432BIDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432BIDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432BIDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432BIDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432BIPCK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL432BIPCKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TL432BQDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432BQDBVRE4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432BQDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432BQDBVTE4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432BQDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432BQDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432BQDBZT | PREVIEW | SOT-23 | DBZ | 3 | 250 | TBD | Call TI | Call TI |
| TL432BQPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL432BQPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL432CDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432CDBVRE4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432CDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432CDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432CDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432CDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432CPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL432CPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL432IDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432IDBVRE4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432IDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432IDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432IDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432IDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432IPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL432IPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL432QDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TL432QDBVRE4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432QDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432QDBVTE4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432QDBZR | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432QDBZRG4 | ACTIVE | SOT-23 | DBZ | 3 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432QDBZT | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432QDBZTG4 | ACTIVE | SOT-23 | DBZ | 3 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL432QPK | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |
| TL432QPKG3 | ACTIVE | SOT-89 | PK | 3 | 1000 | Green (RoHS & no Sb/Br) | CU SN | Level-2-260C-1YEAR |

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

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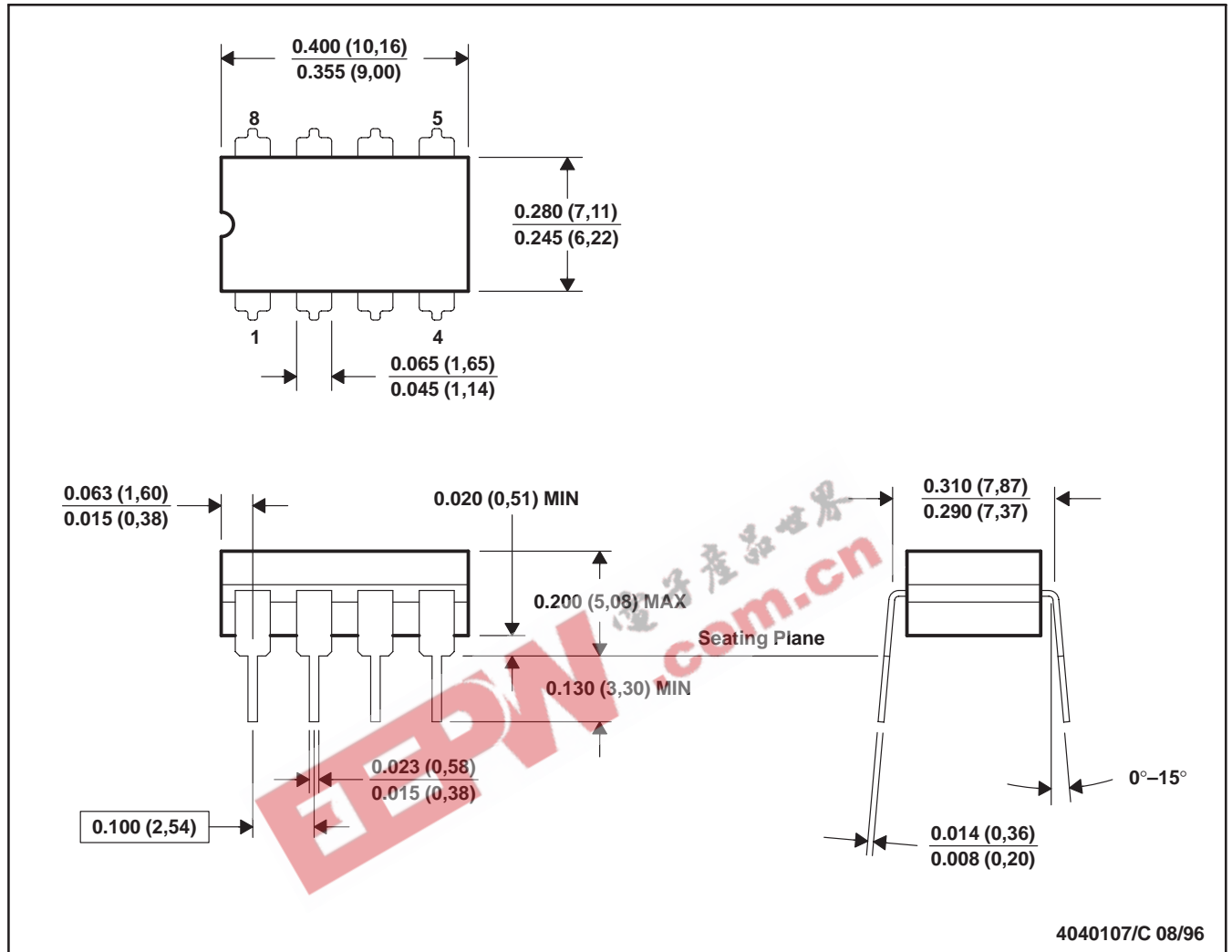
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MECHANICAL DATA

MCER001A – JANUARY 1995 – REVISED JANUARY 1997

JG (R-GDIP-T8)

CERAMIC DUAL-IN-LINE

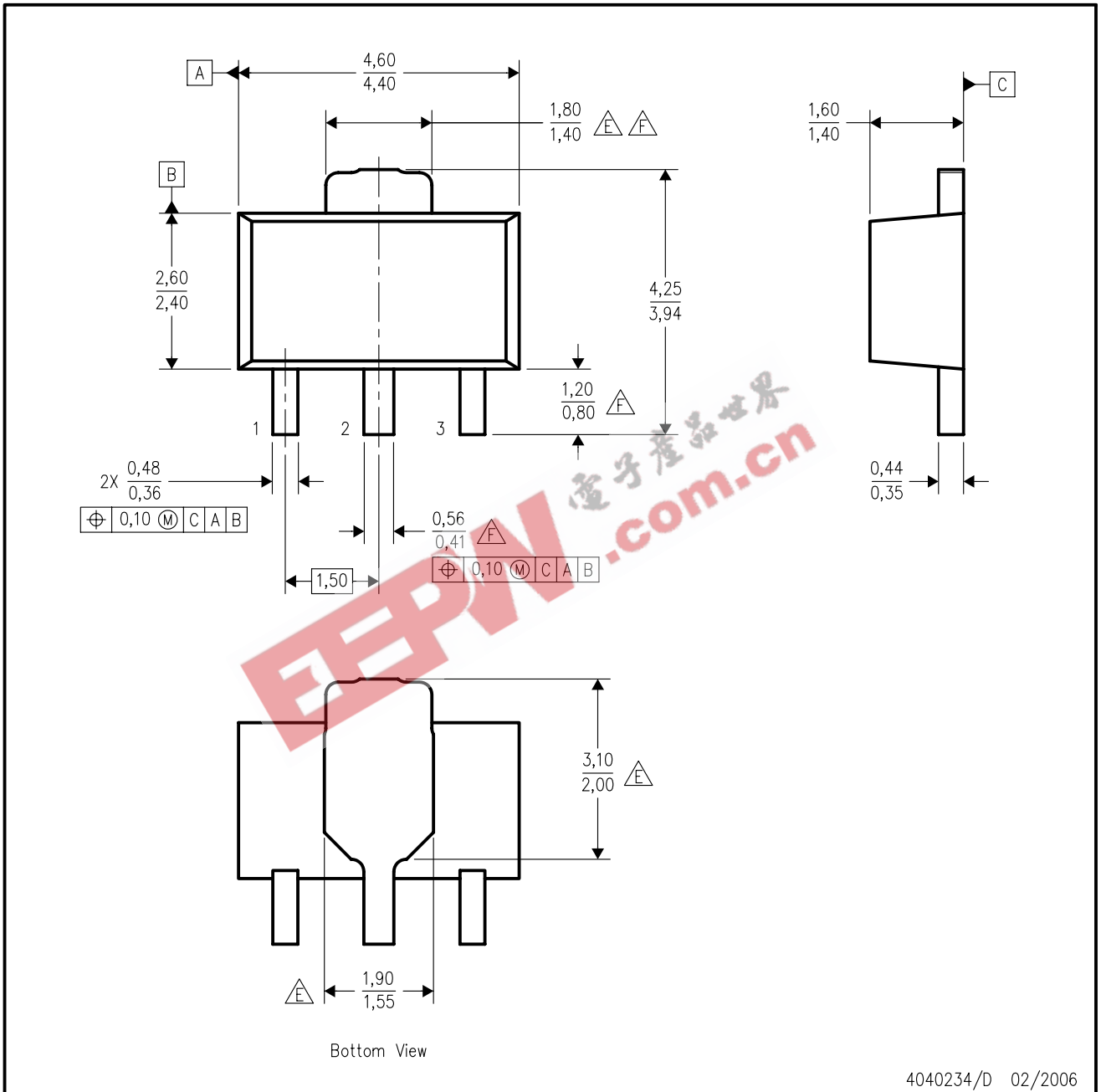


- NOTES:
- All linear dimensions are in inches (millimeters).
 - This drawing is subject to change without notice.
 - This package can be hermetically sealed with a ceramic lid using glass frit.
 - Index point is provided on cap for terminal identification.
 - Falls within MIL STD 1835 GDIP1-T8

MECHANICAL DATA

PK (R-PSS0-F3)

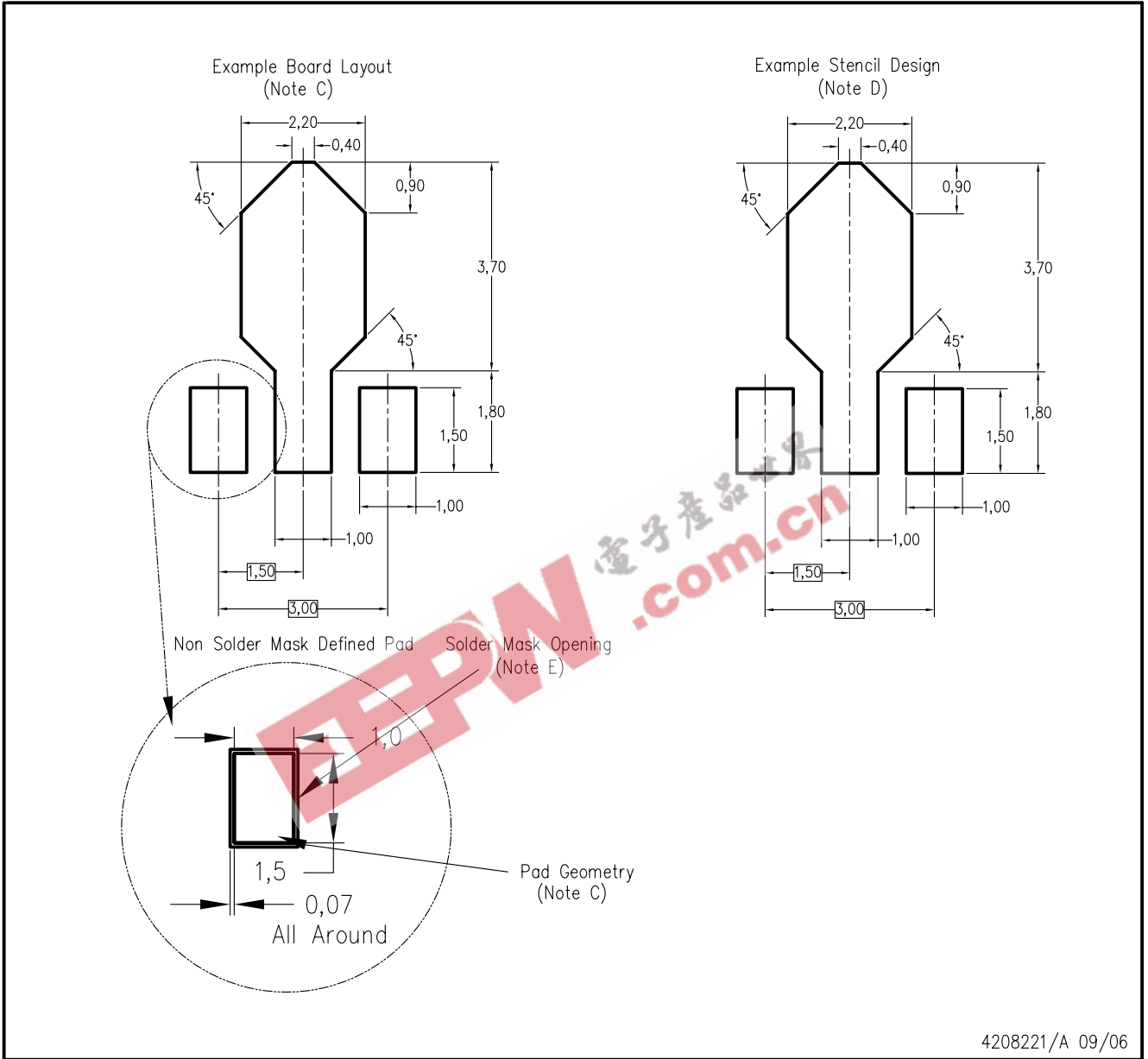
PLASTIC SINGLE-IN-LINE PACKAGE



4040234/D 02/2006

- NOTES:
- All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - This drawing is subject to change without notice.
 - The center lead is in electrical contact with the tab.
 - 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)



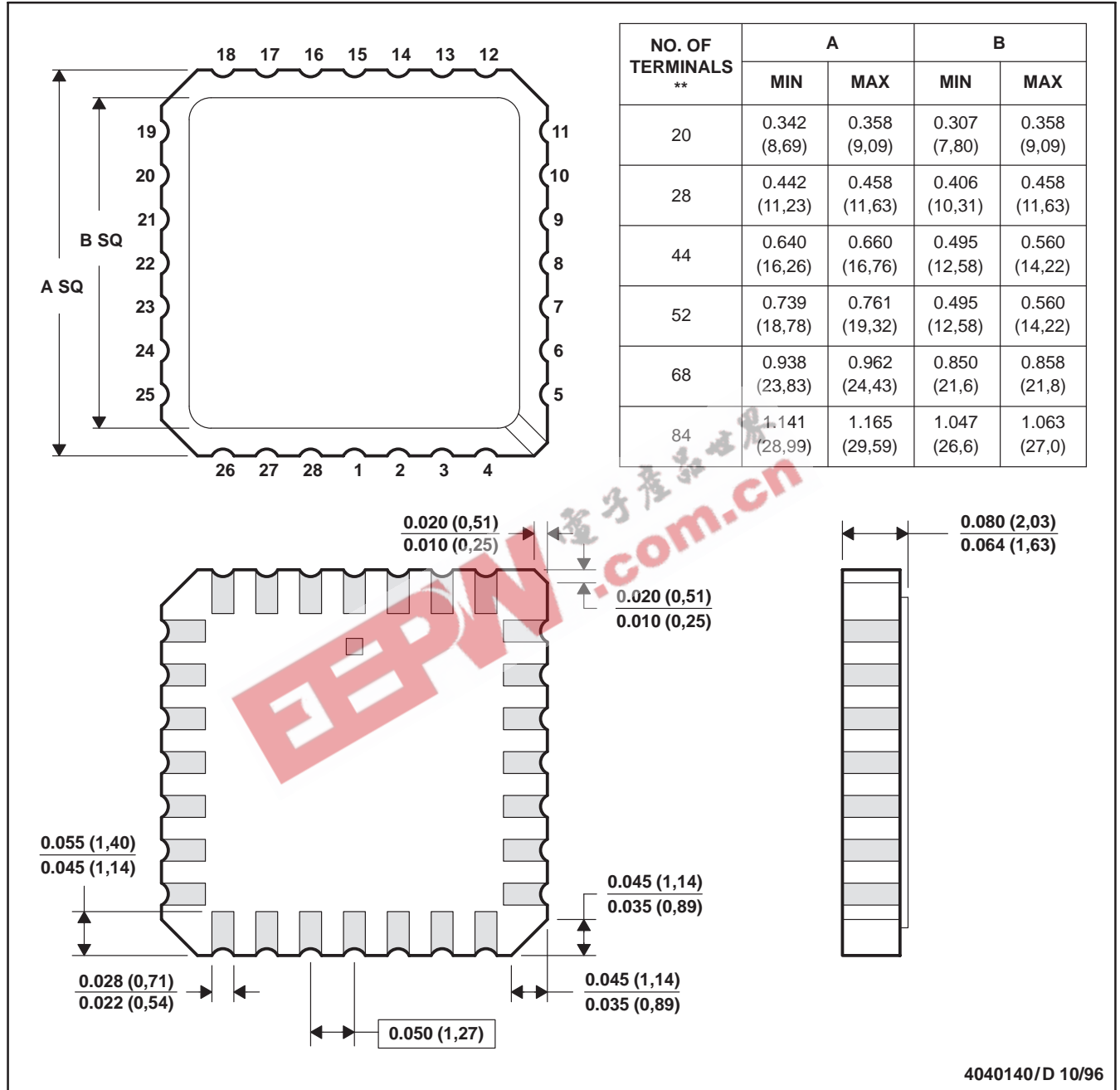
4208221/A 09/06

- 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



- 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. The terminals are gold plated.
 - E. Falls within JEDEC MS-004

MECHANICAL DATA

MPDI001A – JANUARY 1995 – REVISED JUNE 1999

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE



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

For the latest package information, go to http://www.ti.com/sc/docs/package/pkg_info.htm

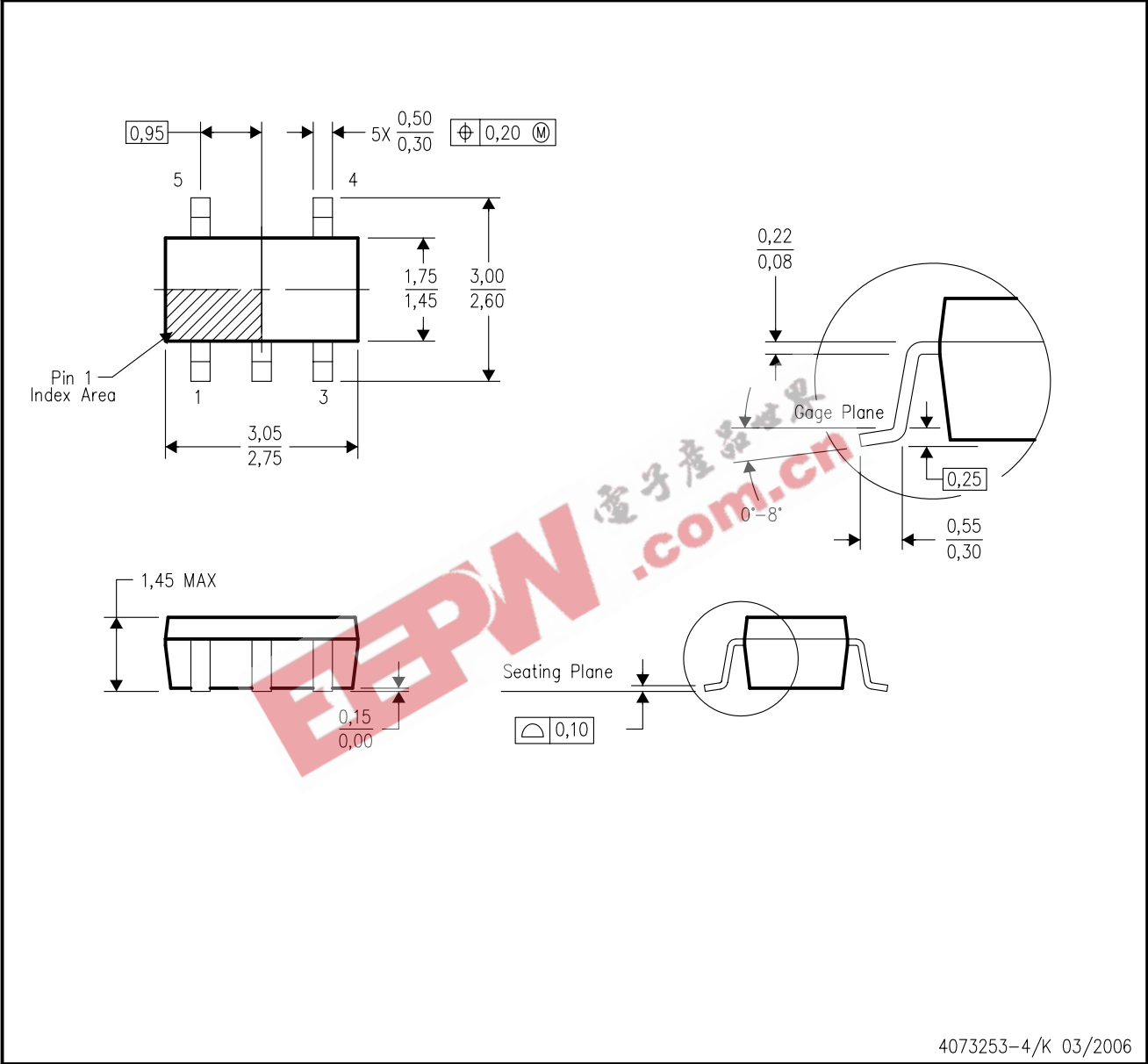


POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

MECHANICAL DATA

DBV (R-PDSO-G5)

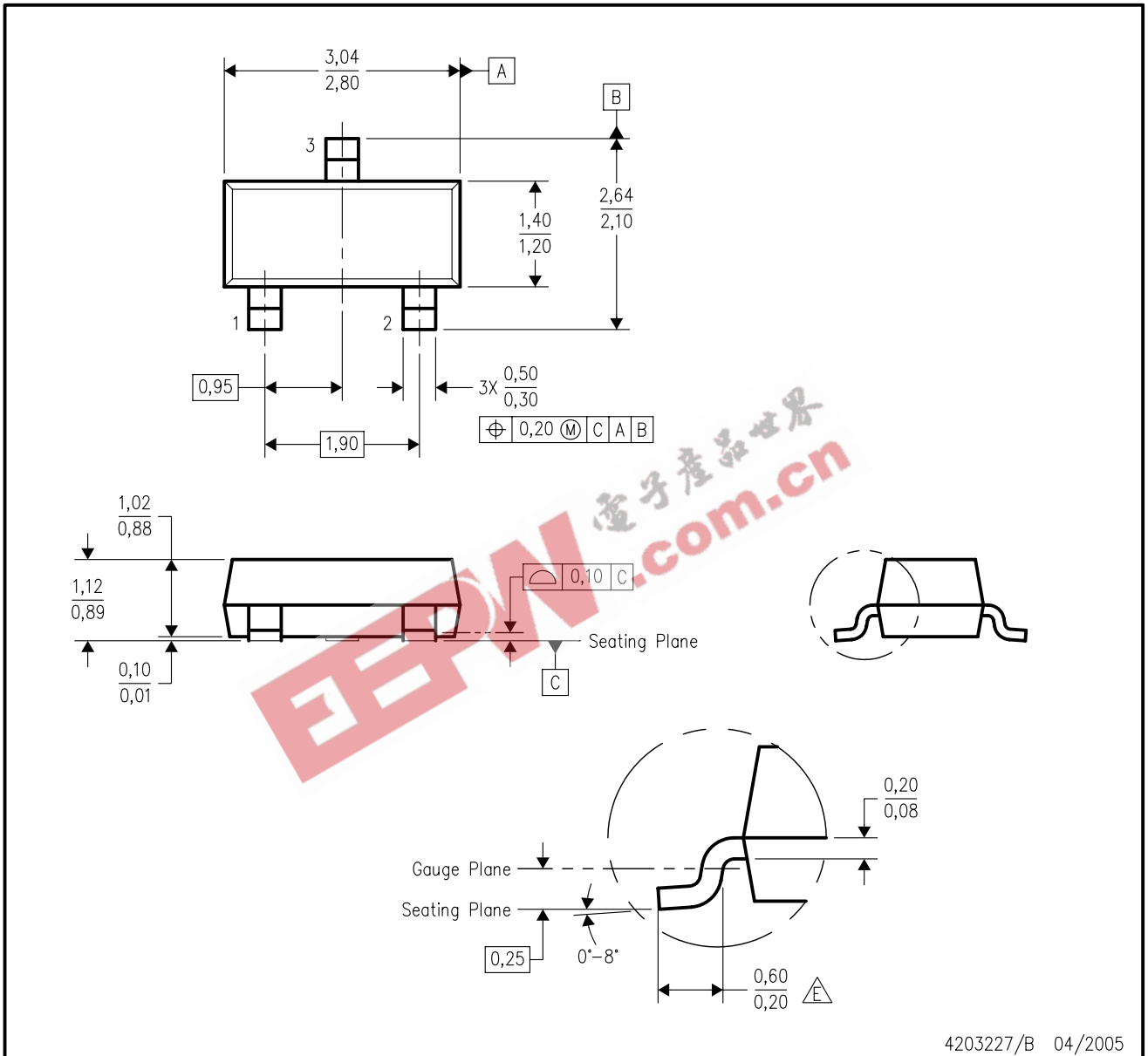
PLASTIC SMALL-OUTLINE PACKAGE



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

DBZ (R-PDSO-G3)

PLASTIC SMALL-OUTLINE



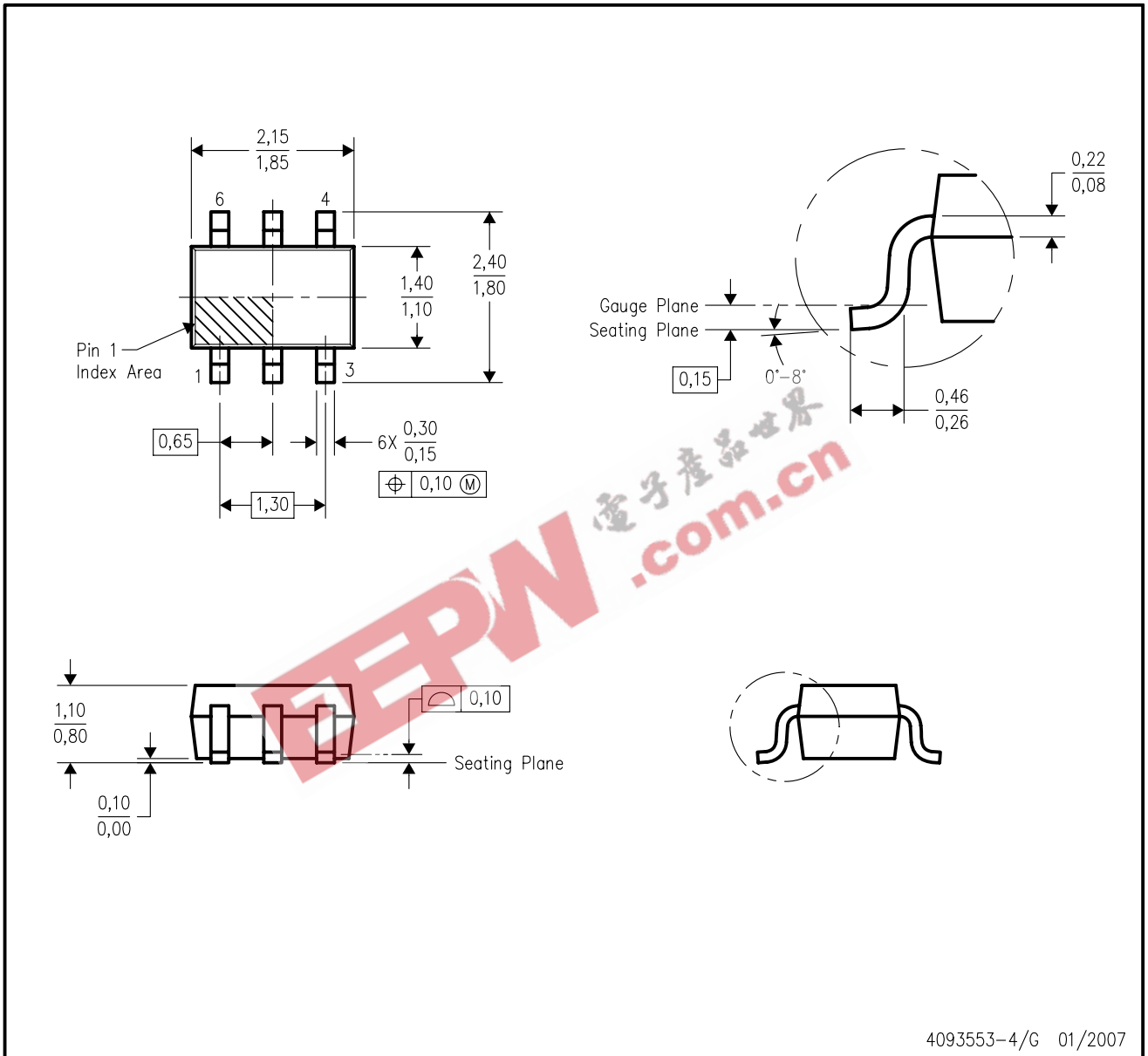
4203227/B 04/2005

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

MECHANICAL DATA

DCK (R-PDSO-G6)

PLASTIC SMALL-OUTLINE PACKAGE



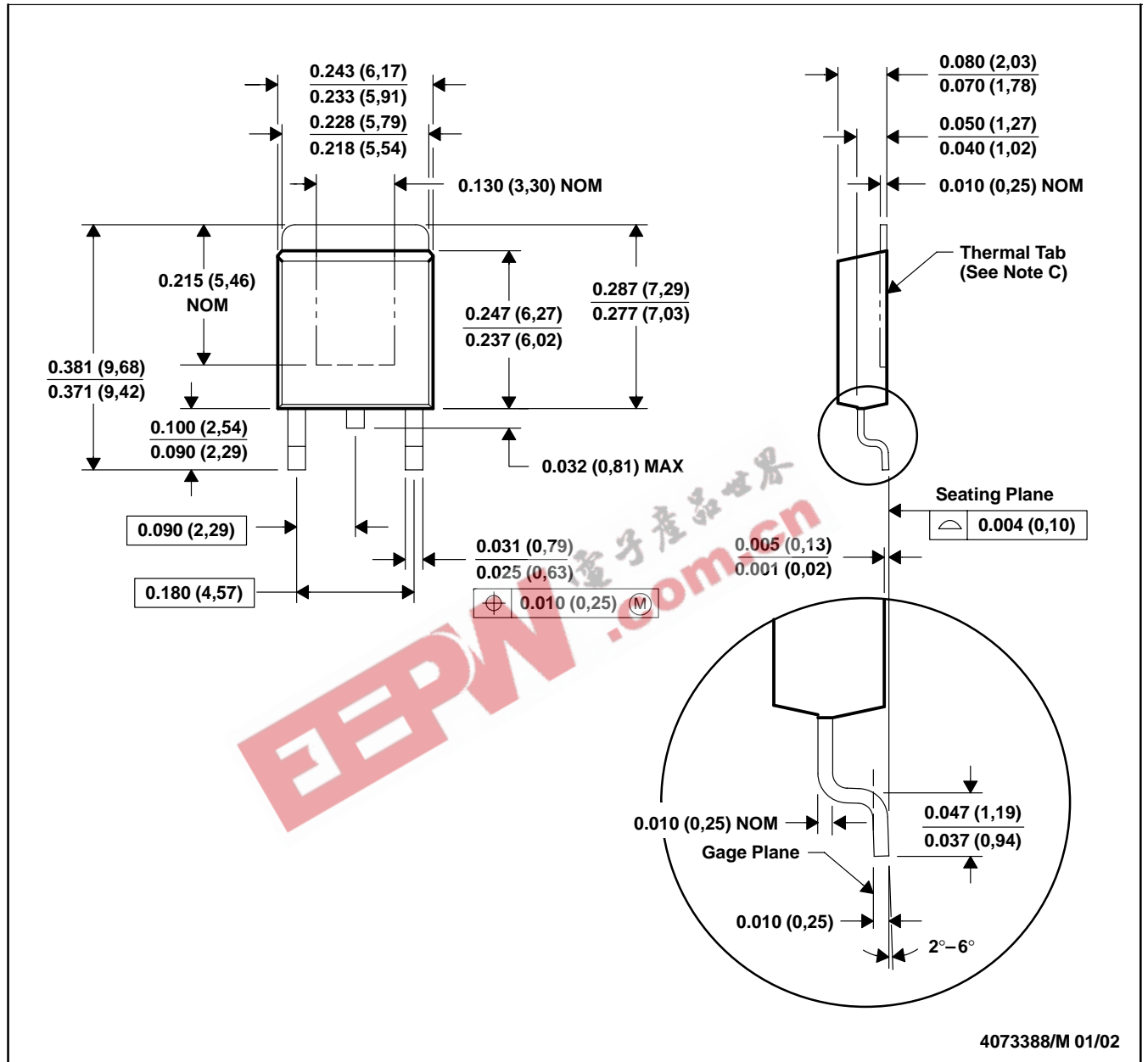
- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
 - D. Falls within JEDEC MO-203 variation AB.

MECHANICAL DATA

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.

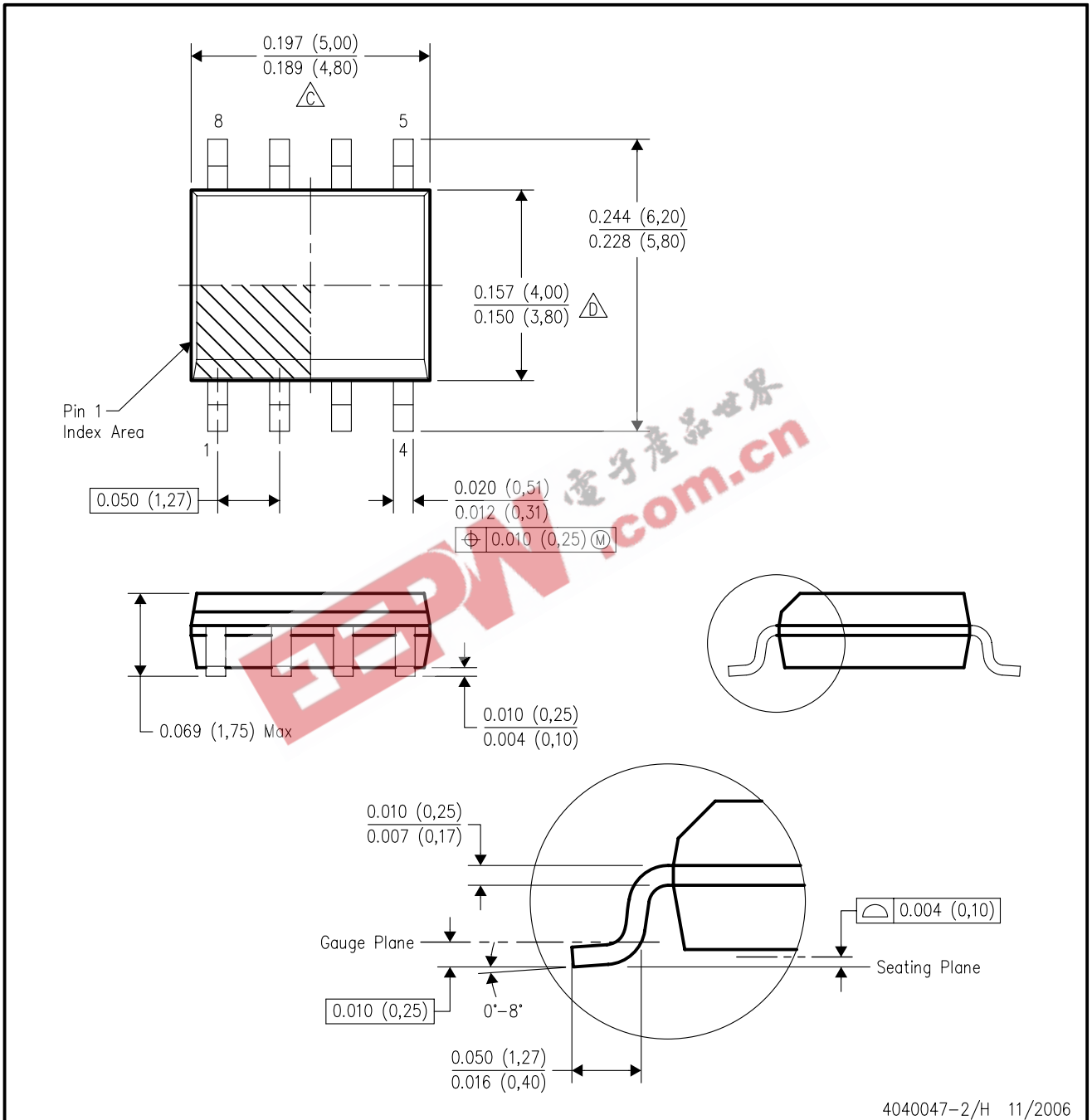
 **TEXAS
INSTRUMENTS**

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MECHANICAL DATA

D (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE

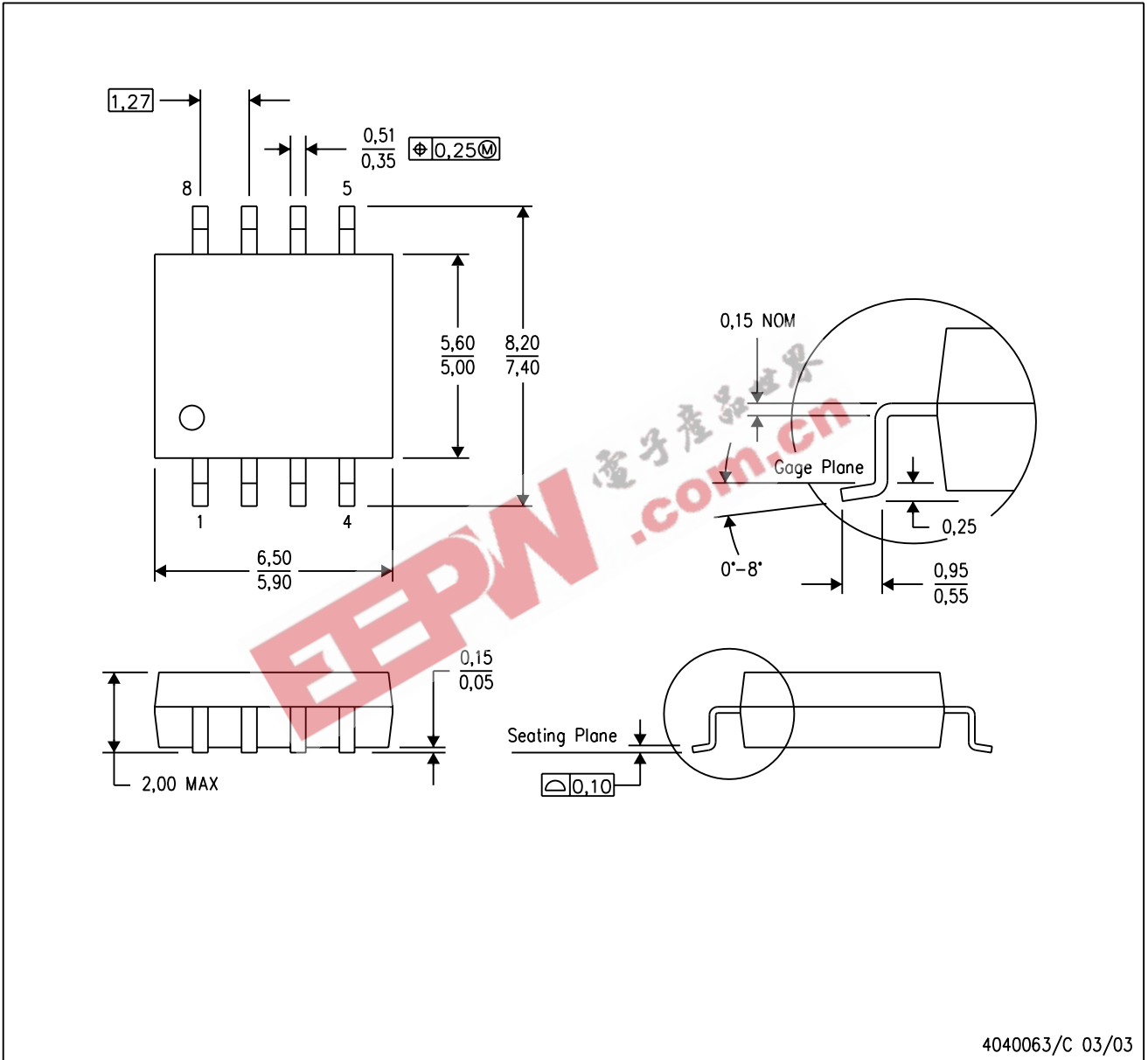


- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
 - D. Body width does not include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

MECHANICAL DATA

PS (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



4040063/C 03/03

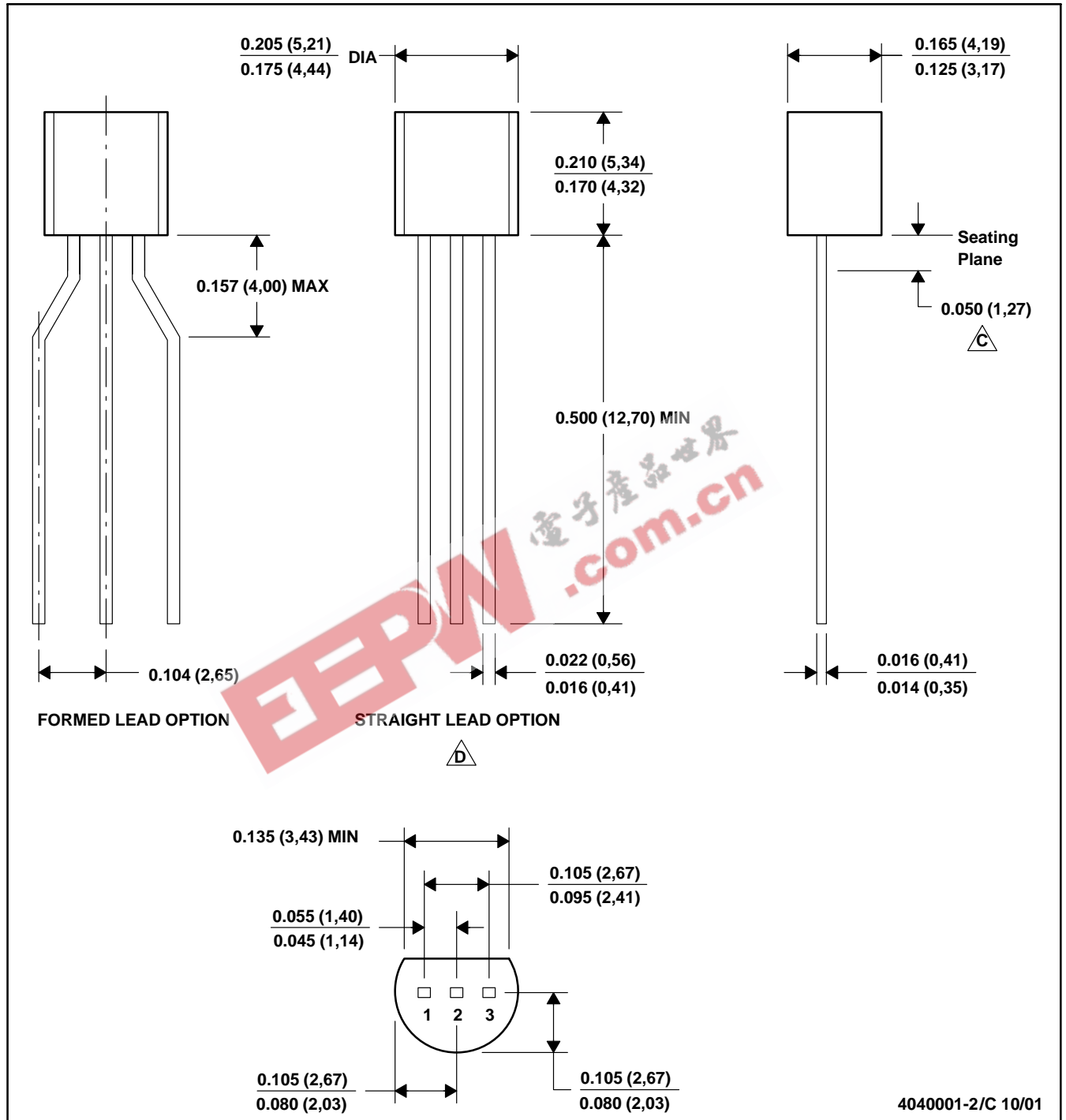
- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

MECHANICAL DATA

MSOT002A – OCTOBER 1994 – REVISED NOVEMBER 2001

LP (O-PBCY-W3)

PLASTIC CYLINDRICAL PACKAGE



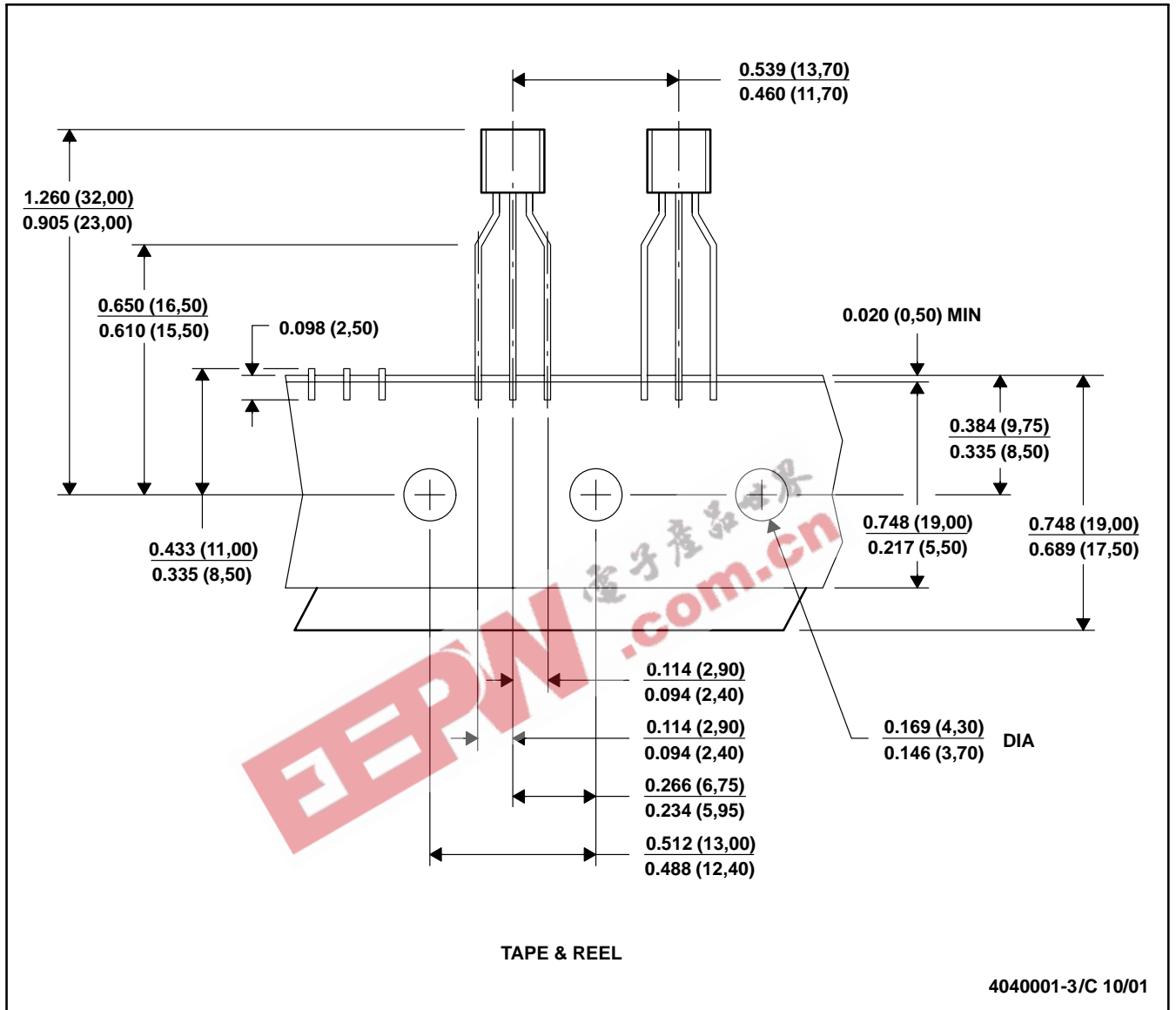
- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C** Lead dimensions are not controlled within this area
 - D** Falls within JEDEC TO -226 Variation AA (TO-226 replaces TO-92)
 - E. Shipping Method:
 - Straight lead option available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

MECHANICAL DATA

MSOT002A – OCTOBER 1994 – REVISED NOVEMBER 2001

LP (O-PBCY-W3)

PLASTIC CYLINDRICAL PACKAGE



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

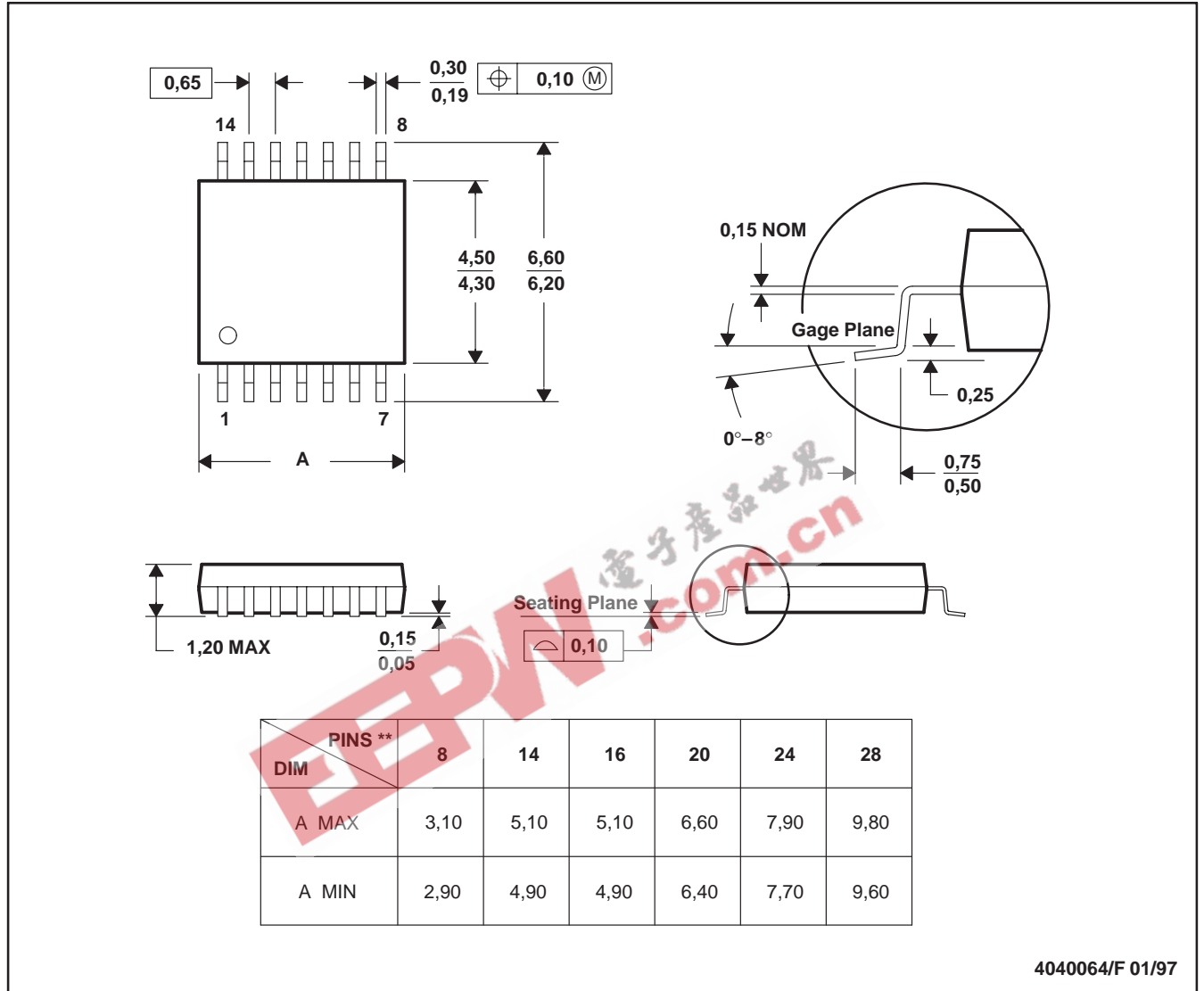
MECHANICAL DATA

MTSS001C – JANUARY 1995 – REVISED FEBRUARY 1999

PW (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



4040064/F 01/97

- 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.
 D. Falls within JEDEC MO-153

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