

## LM431 Adjustable Precision Zener Shunt Regulator

Check for Samples: [LM431](#)

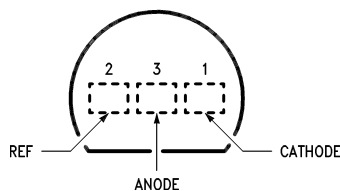
### FEATURES

- Average Temperature Coefficient 50 ppm/°C
- Temperature Compensated for Operation Over the Full Temperature Range
- Programmable Output Voltage
- Fast Turn-On Response
- Low Output Noise

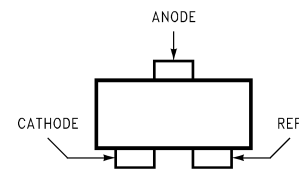
### DESCRIPTION

The LM431 is a 3-terminal adjustable shunt regulator with ensured temperature stability over the entire temperature range of operation. The output voltage may be set at any level greater than 2.5V ( $V_{REF}$ ) up to 36V merely by selecting two external resistors that act as a voltage divided network. Due to the sharp turn-on characteristics this device is an excellent replacement for many zener diode applications.

### Connection Diagram

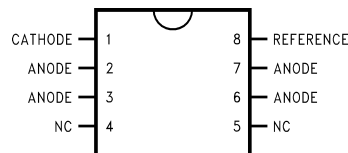


**Figure 1. TO-92: Plastic Package Top View**



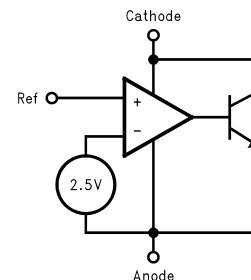
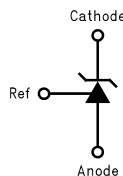
**Figure 2. SOT-23: 3-Lead Small Outline Top View**

A. Note: NC = Not internally connected.



**Figure 3. SOIC: 8-Pin Surface Mount Top view**

### Symbol and Functional Diagrams



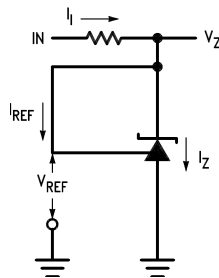
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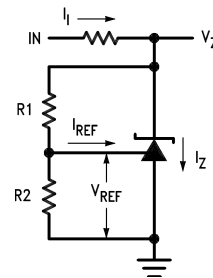
PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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## DC Test Circuits

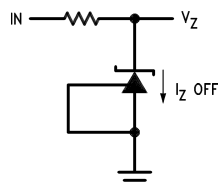


**Figure 4. Test Circuit for  $V_Z = V_{REF}$**



**Figure 5. Test Circuit for  $V_Z > V_{REF}$**

**Note:**  $V_Z = V_{REF} (1 + R1/R2) + I_{REF} \cdot R1$



**Figure 6. Test Circuit for Off-State Current**



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## Absolute Maximum Ratings<sup>(1)(2)</sup>

|                                              |                                  |                    |
|----------------------------------------------|----------------------------------|--------------------|
| Storage Temperature Range                    |                                  | -65°C to +150°C    |
| Operating Temperature Range                  | Industrial (LM431xI)             | -40°C to +85°C     |
|                                              | Commercial (LM431xC)             | 0°C to +70°C       |
| Soldering Information                        | Infrared or Convection (20 sec.) | 235°C              |
|                                              | Wave Soldering (10 sec.)         | 260°C (lead temp.) |
| Cathode Voltage                              |                                  | 37V                |
| Continuous Cathode Current                   |                                  | -10 mA to +150 mA  |
| Reference Voltage                            |                                  | -0.5V              |
| Reference Input Current                      |                                  | 10 mA              |
| Internal Power Dissipation <sup>(3)(4)</sup> | TO-92 Package                    | 0.78W              |
|                                              | SOIC Package                     | 0.81W              |
|                                              | SOT-23 Package                   | 0.28W              |

- (1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Electrical specifications do not apply when operating the device beyond its rated operating conditions.
- (2) If Military/Aerospace specified devices are required, please contact the TI Sales Office/ Distributors for availability and specifications.
- (3)  $T_J \text{ Max} = 150^\circ\text{C}$ .
- (4) Ratings apply to ambient temperature at 25°C. Above this temperature, derate the TO-92 at 6.2 mW/°C, the SOIC at 6.5 mW/°C, the SOT-23 at 2.2 mW/°C.

## Operating Conditions

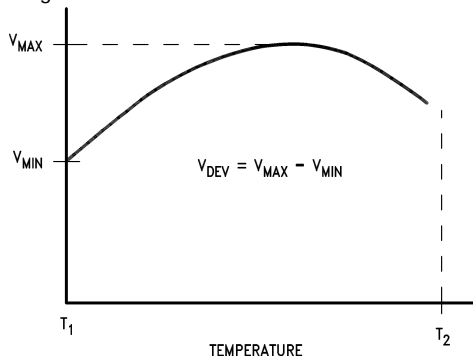
|                 | Min       | Max    |
|-----------------|-----------|--------|
| Cathode Voltage | $V_{REF}$ | 37V    |
| Cathode Current | 1.0 mA    | 100 mA |

## LM431 Electrical Characteristics

T<sub>A</sub> = 25°C unless otherwise specified

| Symbol                             | Parameter                                                                 | Conditions                                                                                                         | Min   | Typ          | Max          | Units |
|------------------------------------|---------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|-------|--------------|--------------|-------|
| V <sub>REF</sub>                   | Reference Voltage                                                         | V <sub>Z</sub> = V <sub>REF</sub> , I <sub>I</sub> = 10 mA<br>LM431A (Figure 4)                                    | 2.440 | 2.495        | 2.550        | V     |
|                                    |                                                                           | V <sub>Z</sub> = V <sub>REF</sub> , I <sub>I</sub> = 10 mA<br>LM431B (Figure 4)                                    | 2.470 | 2.495        | 2.520        | V     |
|                                    |                                                                           | V <sub>Z</sub> = V <sub>REF</sub> , I <sub>I</sub> = 10 mA<br>LM431C (Figure 4)                                    | 2.485 | 2.500        | 2.510        | V     |
| V <sub>DEV</sub>                   | Deviation of Reference Input Voltage Over Temperature <sup>(1)</sup>      | V <sub>Z</sub> = V <sub>REF</sub> , I <sub>I</sub> = 10 mA,<br>T <sub>A</sub> = Full Range (Figure 4)              |       | 8.0          | 17           | mV    |
| ΔV <sub>REF</sub> /ΔV <sub>Z</sub> | Ratio of the Change in Reference Voltage to the Change in Cathode Voltage | I <sub>Z</sub> = 10 mA (Figure 5)<br>V <sub>Z</sub> from V <sub>REF</sub> to 10V<br>V <sub>Z</sub> from 10V to 36V |       | -1.4<br>-1.0 | -2.7<br>-2.0 | mV/V  |
| I <sub>REF</sub>                   | Reference Input Current                                                   | R <sub>1</sub> = 10 kΩ, R <sub>2</sub> = ∞, I <sub>I</sub> = 10 mA<br>(Figure 5)                                   |       | 2.0          | 4.0          | μA    |
| αI <sub>REF</sub>                  | Deviation of Reference Input Current over Temperature                     | R <sub>1</sub> = 10 kΩ, R <sub>2</sub> = ∞, I <sub>I</sub> = 10 mA,<br>T <sub>A</sub> = Full Range (Figure 5)      |       | 0.4          | 1.2          | μA    |
| I <sub>Z(MIN)</sub>                | Minimum Cathode Current for Regulation                                    | V <sub>Z</sub> = V <sub>REF</sub> (Figure 4)                                                                       |       | 0.4          | 1.0          | mA    |
| I <sub>Z(OFF)</sub>                | Off-State Current                                                         | V <sub>Z</sub> = 36V, V <sub>REF</sub> = 0V (Figure 6)                                                             |       | 0.3          | 1.0          | μA    |
| r <sub>Z</sub>                     | Dynamic Output Impedance <sup>(2)</sup>                                   | V <sub>Z</sub> = V <sub>REF</sub> , LM431A,<br>Frequency = 0 Hz (Figure 4)                                         |       |              | 0.75         | Ω     |
|                                    |                                                                           | V <sub>Z</sub> = V <sub>REF</sub> , LM431B, LM431C<br>Frequency = 0 Hz (Figure 4)                                  |       |              | 0.50         | Ω     |

- (1) Deviation of reference input voltage, V<sub>DEV</sub>, is defined as the maximum variation of the reference input voltage over the full temperature range.



The average temperature coefficient of the reference input voltage, αV<sub>REF</sub>, is defined as:

$$\alpha V_{REF} \frac{\text{ppm}}{^{\circ}\text{C}} = \frac{\pm \left[ \frac{V_{MAX} - V_{MIN}}{V_{REF} \text{ (at } 25^{\circ}\text{C)}} \right] 10^6}{T_2 - T_1} = \frac{\pm \left[ \frac{V_{DEV}}{V_{REF} \text{ (at } 25^{\circ}\text{C)}} \right] 10^6}{T_2 - T_1}$$

Where:

T<sub>2</sub> - T<sub>1</sub> = full temperature change (0-70°C).

V<sub>REF</sub> can be positive or negative depending on whether the slope is positive or negative.

Example: V<sub>DEV</sub> = 8.0 mV, V<sub>REF</sub> = 2495 mV, T<sub>2</sub> - T<sub>1</sub> = 70°C, slope is positive.

$$\alpha V_{REF} = \frac{\left[ \frac{8.0 \text{ mV}}{2495 \text{ mV}} \right] 10^6}{70^{\circ}\text{C}} = +46 \text{ ppm}/^{\circ}\text{C}$$

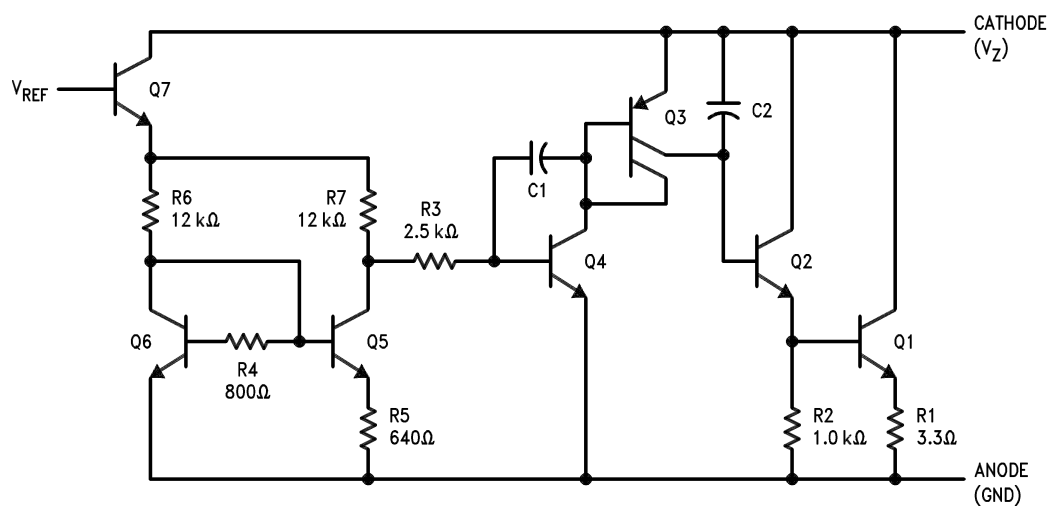
- (2) The dynamic output impedance, r<sub>Z</sub>, is defined as:

$$r_Z = \frac{\Delta V_Z}{\Delta I_Z}$$

When the device is programmed with two external resistors, R<sub>1</sub> and R<sub>2</sub>, (see Figure 5), the dynamic output impedance of the overall circuit, r<sub>Z</sub>, is defined as:

$$r_Z = \frac{\Delta V_Z}{\Delta I_Z} \approx \left[ r_Z \left( 1 + \frac{R_1}{R_2} \right) \right]$$

## Equivalent Circuit



## Typical Performance Characteristics

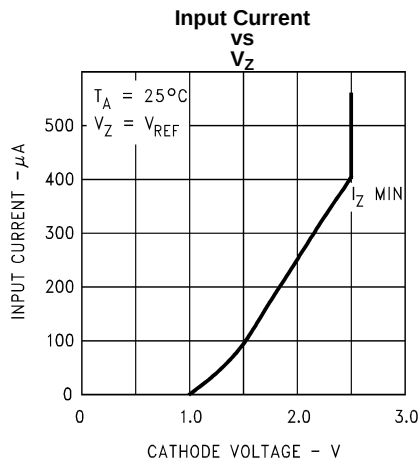


Figure 7.

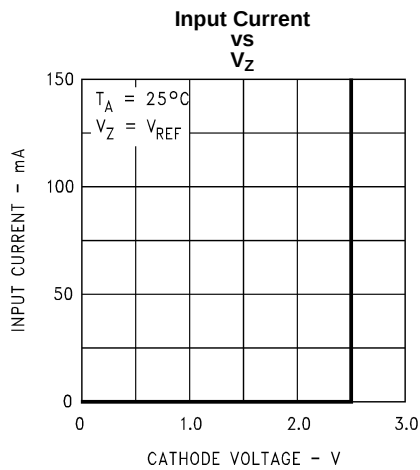


Figure 9.

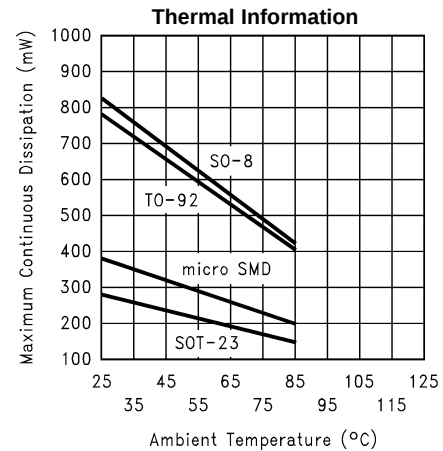


Figure 8.

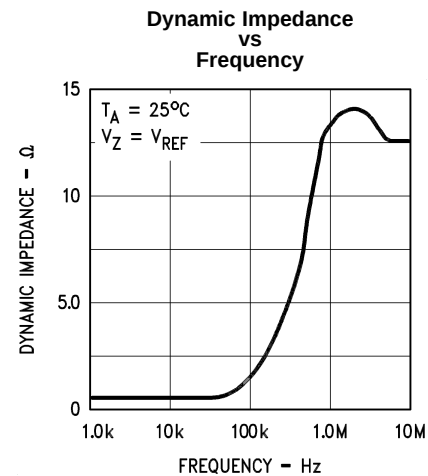
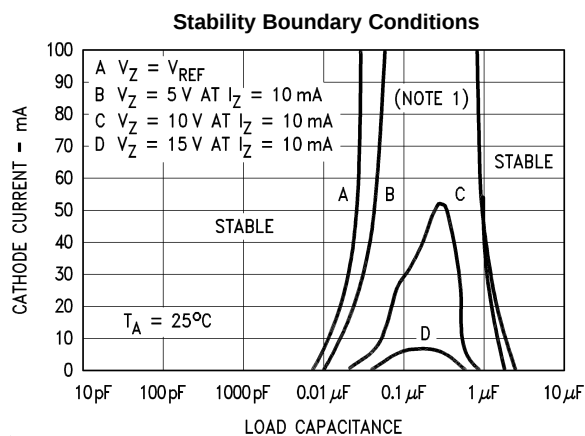


Figure 10.



**Note:** The areas under the curves represent conditions that may cause the device to oscillate. For curves B, C, and D, R2 and V<sup>+</sup> were adjusted to establish the initial V<sub>Z</sub> and I<sub>Z</sub> conditions with C<sub>L</sub> = 0. V<sup>+</sup> and C<sub>L</sub> were then adjusted to determine the ranges of stability.

Figure 11.

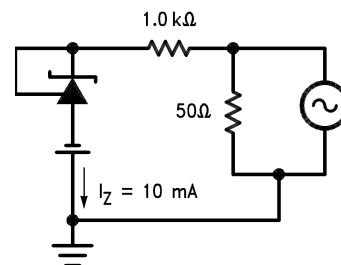


Figure 12.

### Typical Performance Characteristics (continued)

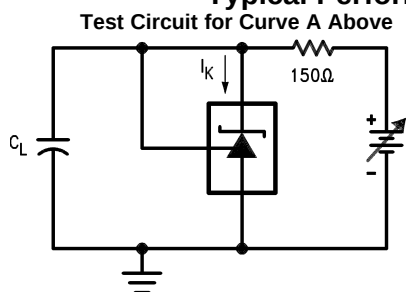


Figure 13.

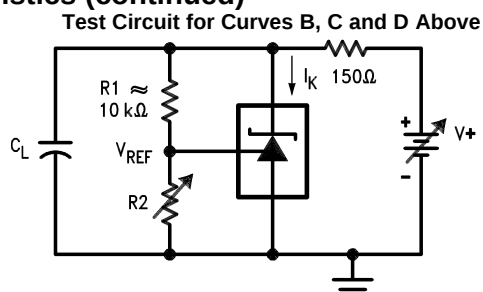


Figure 14.

## Typical Applications

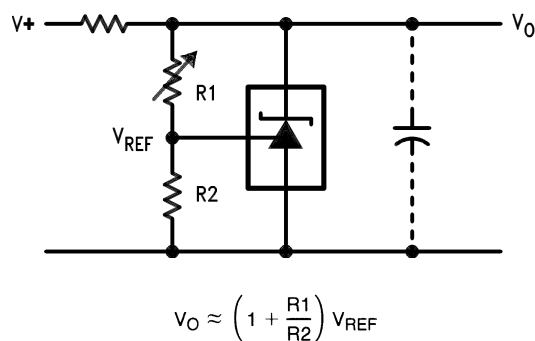


Figure 15. Shunt Regulator

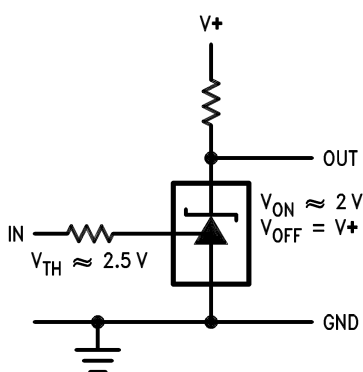


Figure 16. Single Supply Comparator with Temperature Compensated Threshold

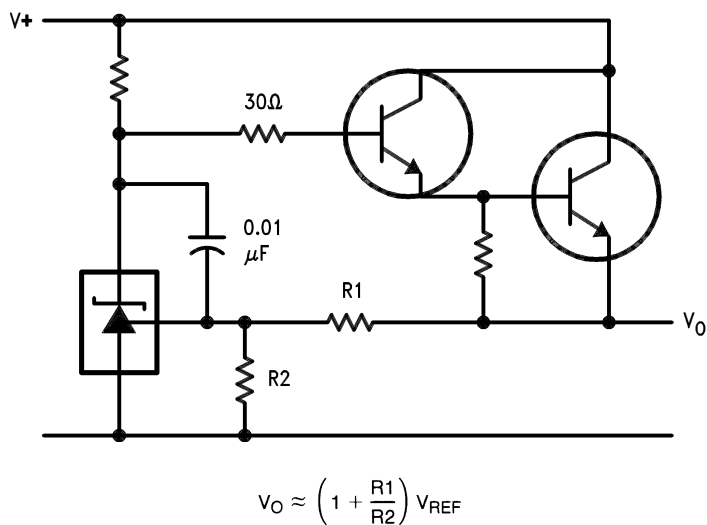
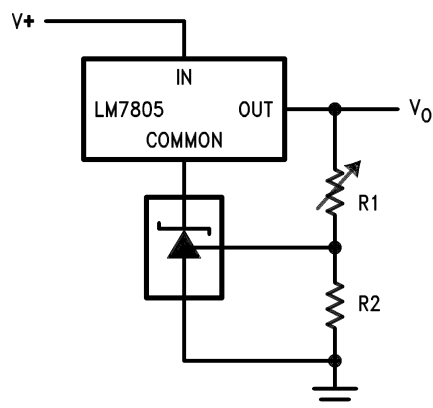


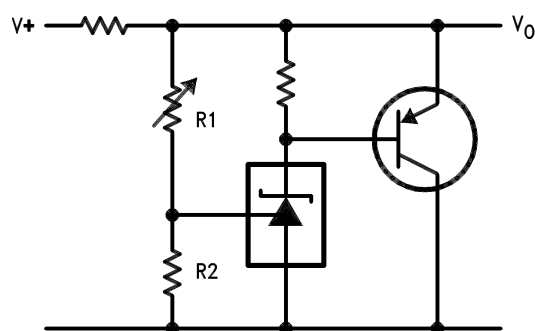
Figure 17. Series Regulator



$$V_O = \left(1 + \frac{R_1}{R_2}\right) V_{REF}$$

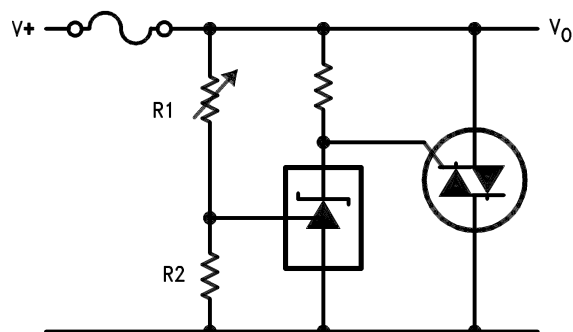
$$V_{O\ MIN} = V_{REF} + 5V$$

Figure 18. Output Control of a Three Terminal Fixed Regulator



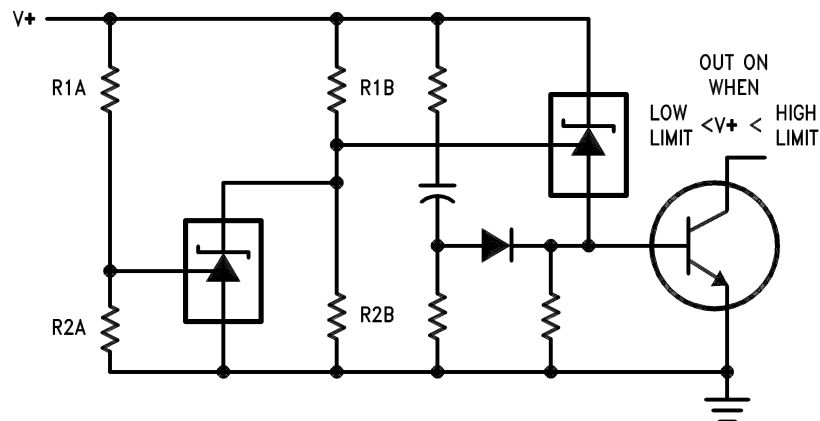
$$V_O \approx \left(1 + \frac{R_1}{R_2}\right) V_{REF}$$

Figure 19. Higher Current Shunt Regulator



$$V_{LIMIT} \approx \left(1 + \frac{R_1}{R_2}\right) V_{REF}$$

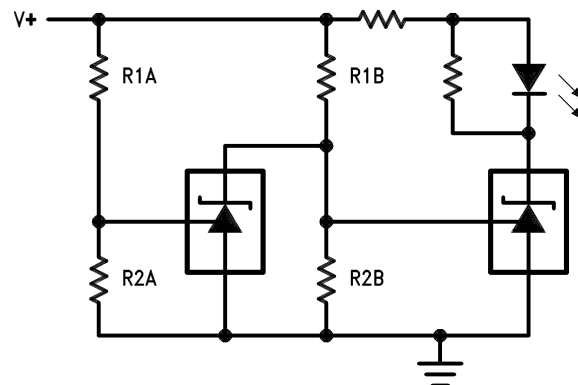
Figure 20. Crow Bar



$$\text{LOW LIMIT} \approx V_{\text{REF}} \left( 1 + \frac{R1B}{R2B} \right) + V_{\text{BE}}$$

$$\text{HIGH LIMIT} \approx V_{\text{REF}} \left( 1 + \frac{R1A}{R2A} \right)$$

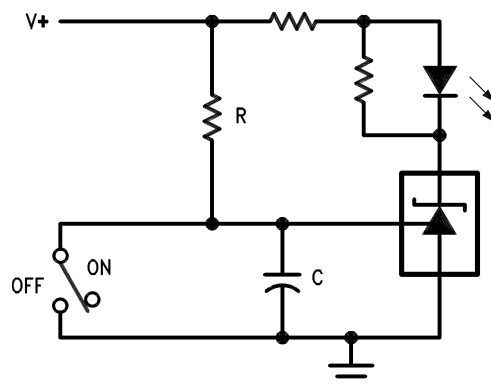
**Figure 21. Over Voltage/Under Voltage Protection Circuit**



$$\text{LOW LIMIT} \approx V_{\text{REF}} \left( 1 + \frac{R1B}{R2B} \right) \quad \text{LED ON WHEN} \quad \text{LOW LIMIT} < V^+ < \text{HIGH LIMIT}$$

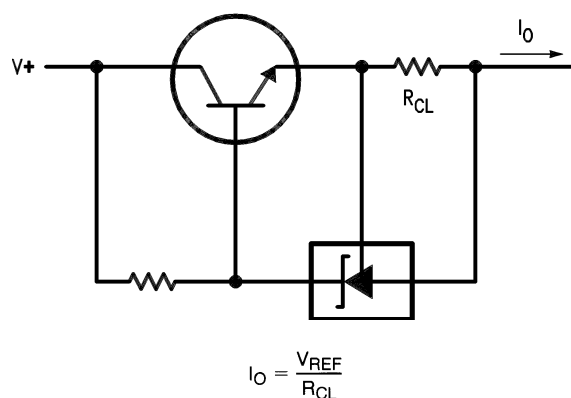
$$\text{HIGH LIMIT} \approx V_{\text{REF}} \left( 1 + \frac{R1A}{R2A} \right)$$

**Figure 22. Voltage Monitor**



$$\text{DELAY} = R \cdot C \cdot \ln \frac{V+}{(V+) - V_{\text{REF}}}$$

Figure 23. Delay Timer



$$I_0 = \frac{V_{\text{REF}}}{R_{\text{CL}}}$$

Figure 24. Current Limiter or Current Source

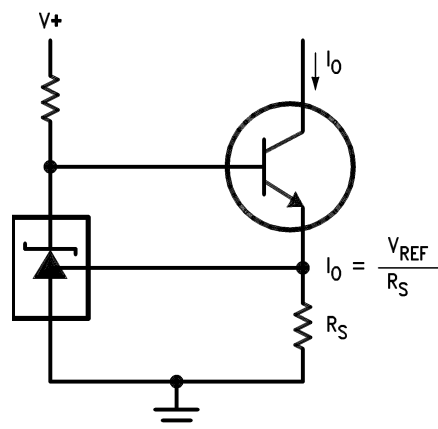


Figure 25. Constant Current Sink

## REVISION HISTORY

### Changes from Revision F (April 2013) to Revision G

### Page

- Changed layout of National Data Sheet to TI format ..... [10](#)

**PACKAGING INFORMATION**

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|------------------|----------------------|--------------|-------------------------|-------------------------|
| LM431ACM         | ACTIVE        | SOIC         | D                  | 8    | 95             | TBD                        | Call TI          | Call TI              | -40 to 85    | LM431<br>ACM            | <a href="#">Samples</a> |
| LM431ACM/NOPB    | ACTIVE        | SOIC         | D                  | 8    | 95             | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 85    | LM431<br>ACM            | <a href="#">Samples</a> |
| LM431ACM3        | ACTIVE        | SOT-23       | DBZ                | 3    | 1000           | TBD                        | Call TI          | Call TI              | -40 to 85    | N1F                     | <a href="#">Samples</a> |
| LM431ACM3/NOPB   | ACTIVE        | SOT-23       | DBZ                | 3    | 1000           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 85    | N1F                     | <a href="#">Samples</a> |
| LM431ACM3X       | ACTIVE        | SOT-23       | DBZ                | 3    | 3000           | TBD                        | Call TI          | Call TI              | -40 to 85    | N1F                     | <a href="#">Samples</a> |
| LM431ACM3X/NOPB  | ACTIVE        | SOT-23       | DBZ                | 3    | 3000           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 85    | N1F                     | <a href="#">Samples</a> |
| LM431ACMX        | ACTIVE        | SOIC         | D                  | 8    | 2500           | TBD                        | Call TI          | Call TI              | -40 to 85    | LM431<br>ACM            | <a href="#">Samples</a> |
| LM431ACMX/NOPB   | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 85    | LM431<br>ACM            | <a href="#">Samples</a> |
| LM431ACZ/LFT3    | ACTIVE        | TO-92        | LP                 | 3    | 2000           | Green (RoHS<br>& no Sb/Br) | SNCU             | Level-1-NA-UNLIM     |              | LM431<br>ACZ            | <a href="#">Samples</a> |
| LM431ACZ/LFT4    | ACTIVE        | TO-92        | LP                 | 3    | 2000           | Green (RoHS<br>& no Sb/Br) | SNCU             | Level-1-NA-UNLIM     |              | LM431<br>ACZ            | <a href="#">Samples</a> |
| LM431ACZ/NOPB    | ACTIVE        | TO-92        | LP                 | 3    | 1800           | Green (RoHS<br>& no Sb/Br) | SNCU             | Level-1-NA-UNLIM     | -40 to 85    | LM431<br>ACZ            | <a href="#">Samples</a> |
| LM431AIM         | ACTIVE        | SOIC         | D                  | 8    | 95             | TBD                        | Call TI          | Call TI              | -40 to 85    | LM431<br>AIM            | <a href="#">Samples</a> |
| LM431AIM/NOPB    | ACTIVE        | SOIC         | D                  | 8    | 95             | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 85    | LM431<br>AIM            | <a href="#">Samples</a> |
| LM431AIM3        | ACTIVE        | SOT-23       | DBZ                | 3    | 1000           | TBD                        | Call TI          | Call TI              | -40 to 85    | N1E                     | <a href="#">Samples</a> |
| LM431AIM3/NOPB   | ACTIVE        | SOT-23       | DBZ                | 3    | 1000           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 85    | N1E                     | <a href="#">Samples</a> |
| LM431AIM3X       | ACTIVE        | SOT-23       | DBZ                | 3    | 3000           | TBD                        | Call TI          | Call TI              | -40 to 85    | N1E                     | <a href="#">Samples</a> |
| LM431AIM3X/NOPB  | ACTIVE        | SOT-23       | DBZ                | 3    | 3000           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 85    | N1E                     | <a href="#">Samples</a> |
| LM431AIMX        | ACTIVE        | SOIC         | D                  | 8    | 2500           | TBD                        | Call TI          | Call TI              | -40 to 85    | LM431<br>AIM            | <a href="#">Samples</a> |

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|------------------|----------------------|--------------|-------------------------|-------------------------|
| LM431AIMX/NOPB   | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 85    | LM431<br>AIM            | <a href="#">Samples</a> |
| LM431AIZ/LFT1    | ACTIVE        | TO-92        | LP                 | 3    | 2000           | Green (RoHS<br>& no Sb/Br) | SNCU             | Level-1-NA-UNLIM     |              | LM431<br>AIZ            | <a href="#">Samples</a> |
| LM431AIZ/NOPB    | ACTIVE        | TO-92        | LP                 | 3    | 1800           | Green (RoHS<br>& no Sb/Br) | SNCU             | Level-1-NA-UNLIM     | -40 to 85    | LM431<br>AIZ            | <a href="#">Samples</a> |
| LM431BCM         | ACTIVE        | SOIC         | D                  | 8    | 95             | TBD                        | Call TI          | Call TI              | -40 to 85    | 431<br>BCM              | <a href="#">Samples</a> |
| LM431BCM/NOPB    | ACTIVE        | SOIC         | D                  | 8    | 95             | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 85    | 431<br>BCM              | <a href="#">Samples</a> |
| LM431BCM3        | ACTIVE        | SOT-23       | DBZ                | 3    | 1000           | TBD                        | Call TI          | Call TI              | -40 to 85    | N1D                     | <a href="#">Samples</a> |
| LM431BCM3/NOPB   | ACTIVE        | SOT-23       | DBZ                | 3    | 1000           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 85    | N1D                     | <a href="#">Samples</a> |
| LM431BCM3X/NOPB  | ACTIVE        | SOT-23       | DBZ                | 3    | 3000           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 85    | N1D                     | <a href="#">Samples</a> |
| LM431BCMx        | ACTIVE        | SOIC         | D                  | 8    | 2500           | TBD                        | Call TI          | Call TI              | -40 to 85    | 431<br>BCM              | <a href="#">Samples</a> |
| LM431BCMx/NOPB   | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 85    | 431<br>BCM              | <a href="#">Samples</a> |
| LM431BCZ/NOPB    | ACTIVE        | TO-92        | LP                 | 3    | 1800           | Green (RoHS<br>& no Sb/Br) | SNCU             | Level-1-NA-UNLIM     | -40 to 85    | LM431<br>BCZ            | <a href="#">Samples</a> |
| LM431BIM         | ACTIVE        | SOIC         | D                  | 8    | 95             | TBD                        | Call TI          | Call TI              | -40 to 85    | 431<br>BIM              | <a href="#">Samples</a> |
| LM431BIM/NOPB    | ACTIVE        | SOIC         | D                  | 8    | 95             | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 85    | 431<br>BIM              | <a href="#">Samples</a> |
| LM431BIM3        | ACTIVE        | SOT-23       | DBZ                | 3    | 1000           | TBD                        | Call TI          | Call TI              | -40 to 85    | N1C                     | <a href="#">Samples</a> |
| LM431BIM3/NOPB   | ACTIVE        | SOT-23       | DBZ                | 3    | 1000           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 85    | N1C                     | <a href="#">Samples</a> |
| LM431BIM3X       | ACTIVE        | SOT-23       | DBZ                | 3    | 3000           | TBD                        | Call TI          | Call TI              | -40 to 85    | N1C                     | <a href="#">Samples</a> |
| LM431BIM3X/NOPB  | ACTIVE        | SOT-23       | DBZ                | 3    | 3000           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 85    | N1C                     | <a href="#">Samples</a> |
| LM431BIMx/NOPB   | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 85    | 431<br>BIM              | <a href="#">Samples</a> |

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|------------------|----------------------|--------------|-------------------------|-------------------------|
| LM431CCM/NOPB    | ACTIVE        | SOIC         | D                  | 8    | 95             | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 85    | 431<br>CCM              | <a href="#">Samples</a> |
| LM431CCM3        | ACTIVE        | SOT-23       | DBZ                | 3    | 1000           | TBD                        | Call TI          | Call TI              | -40 to 85    | N1B                     | <a href="#">Samples</a> |
| LM431CCM3/NOPB   | ACTIVE        | SOT-23       | DBZ                | 3    | 1000           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 85    | N1B                     | <a href="#">Samples</a> |
| LM431CCM3X       | ACTIVE        | SOT-23       | DBZ                | 3    | 3000           | TBD                        | Call TI          | Call TI              | -40 to 85    | N1B                     | <a href="#">Samples</a> |
| LM431CCM3X/NOPB  | ACTIVE        | SOT-23       | DBZ                | 3    | 3000           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 85    | N1B                     | <a href="#">Samples</a> |
| LM431CCZ/NOPB    | ACTIVE        | TO-92        | LP                 | 3    | 1800           | Green (RoHS<br>& no Sb/Br) | SNCU             | Level-1-NA-UNLIM     | -40 to 85    | LM431<br>CCZ            | <a href="#">Samples</a> |
| LM431CIM         | ACTIVE        | SOIC         | D                  | 8    | 95             | TBD                        | Call TI          | Call TI              | -40 to 85    | 431<br>CIM              | <a href="#">Samples</a> |
| LM431CIM/NOPB    | ACTIVE        | SOIC         | D                  | 8    | 95             | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 85    | 431<br>CIM              | <a href="#">Samples</a> |
| LM431CIM3        | ACTIVE        | SOT-23       | DBZ                | 3    | 1000           | TBD                        | Call TI          | Call TI              | -40 to 85    | N1A                     | <a href="#">Samples</a> |
| LM431CIM3/NOPB   | ACTIVE        | SOT-23       | DBZ                | 3    | 1000           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 85    | N1A                     | <a href="#">Samples</a> |
| LM431CIM3X       | ACTIVE        | SOT-23       | DBZ                | 3    | 3000           | TBD                        | Call TI          | Call TI              | -40 to 85    | N1A                     | <a href="#">Samples</a> |
| LM431CIM3X/NOPB  | ACTIVE        | SOT-23       | DBZ                | 3    | 3000           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 85    | N1A                     | <a href="#">Samples</a> |
| LM431CIZ/LFT1    | ACTIVE        | TO-92        | LP                 | 3    | 2000           | Green (RoHS<br>& no Sb/Br) | SNCU             | Level-1-NA-UNLIM     |              | LM431<br>CIZ            | <a href="#">Samples</a> |
| LM431CIZ/NOPB    | ACTIVE        | TO-92        | LP                 | 3    | 1800           | Green (RoHS<br>& no Sb/Br) | SNCU             | Level-1-NA-UNLIM     | -40 to 85    | LM431<br>CIZ            | <a href="#">Samples</a> |

(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.

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**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)

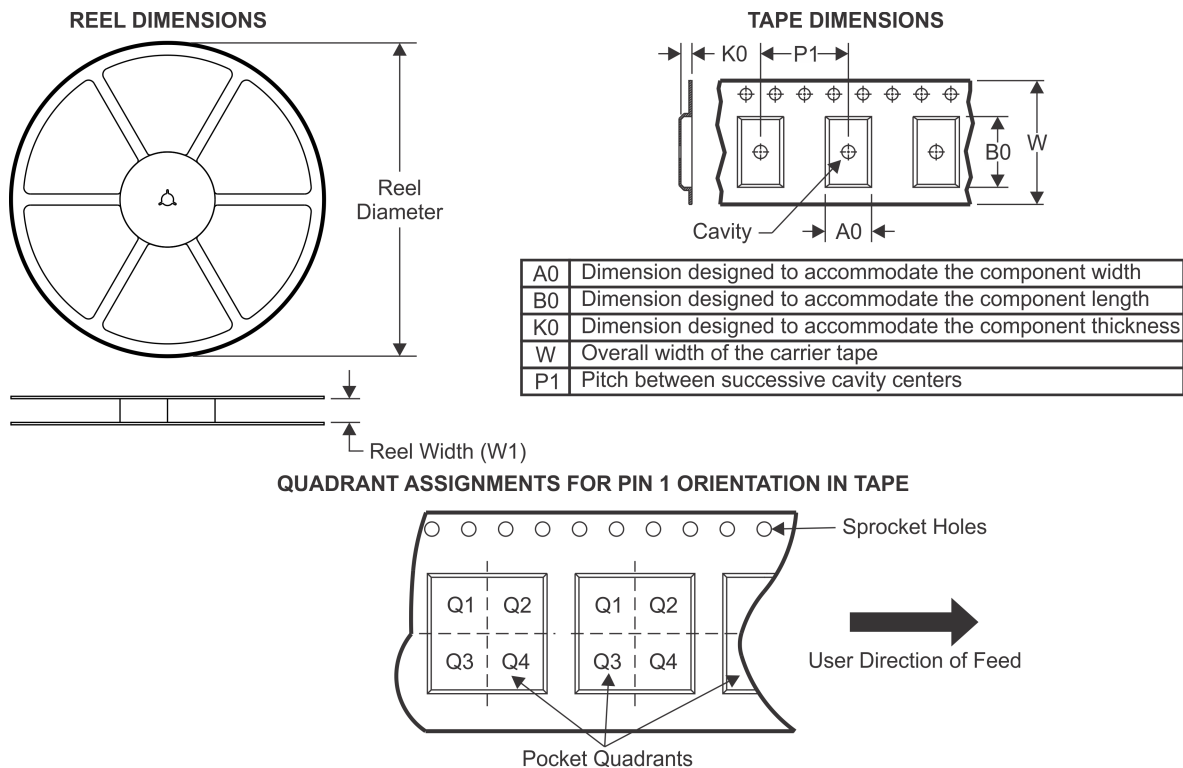
<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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

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

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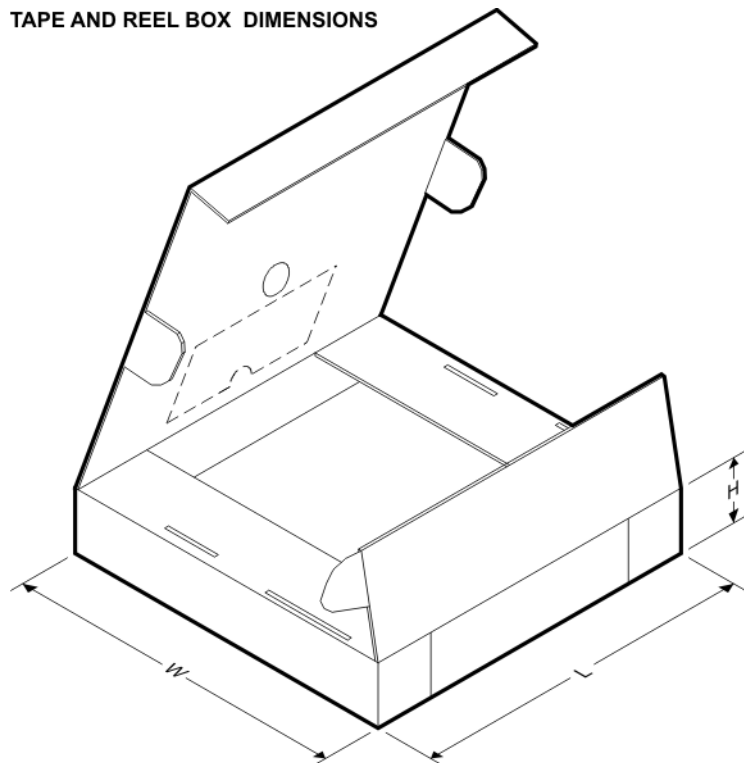
**TAPE AND REEL INFORMATION**


\*All dimensions are nominal

| Device          | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|-----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| LM431ACM3       | SOT-23       | DBZ             | 3    | 1000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM431ACM3/NOPB  | SOT-23       | DBZ             | 3    | 1000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM431ACM3X      | SOT-23       | DBZ             | 3    | 3000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM431ACM3X/NOPB | SOT-23       | DBZ             | 3    | 3000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM431ACMX       | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| LM431ACMX/NOPB  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| LM431AIM3       | SOT-23       | DBZ             | 3    | 1000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM431AIM3/NOPB  | SOT-23       | DBZ             | 3    | 1000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM431AIM3X      | SOT-23       | DBZ             | 3    | 3000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM431AIM3X/NOPB | SOT-23       | DBZ             | 3    | 3000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM431AIMX       | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| LM431AIMX/NOPB  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| LM431BCM3       | SOT-23       | DBZ             | 3    | 1000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM431BCM3/NOPB  | SOT-23       | DBZ             | 3    | 1000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM431BCM3X/NOPB | SOT-23       | DBZ             | 3    | 3000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM431BCM3X      | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| LM431BCM3X/NOPB | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| LM431BIM3       | SOT-23       | DBZ             | 3    | 1000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |

| Device          | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|-----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| LM431BIM3/NOPB  | SOT-23       | DBZ             | 3    | 1000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM431BIM3X      | SOT-23       | DBZ             | 3    | 3000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM431BIM3X/NOPB | SOT-23       | DBZ             | 3    | 3000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM431BIMX/NOPB  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| LM431CCM3       | SOT-23       | DBZ             | 3    | 1000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM431CCM3/NOPB  | SOT-23       | DBZ             | 3    | 1000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM431CCM3X      | SOT-23       | DBZ             | 3    | 3000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM431CCM3X/NOPB | SOT-23       | DBZ             | 3    | 3000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM431CIM3       | SOT-23       | DBZ             | 3    | 1000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM431CIM3/NOPB  | SOT-23       | DBZ             | 3    | 1000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM431CIM3X      | SOT-23       | DBZ             | 3    | 3000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM431CIM3X/NOPB | SOT-23       | DBZ             | 3    | 3000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |

## TAPE AND REEL BOX DIMENSIONS



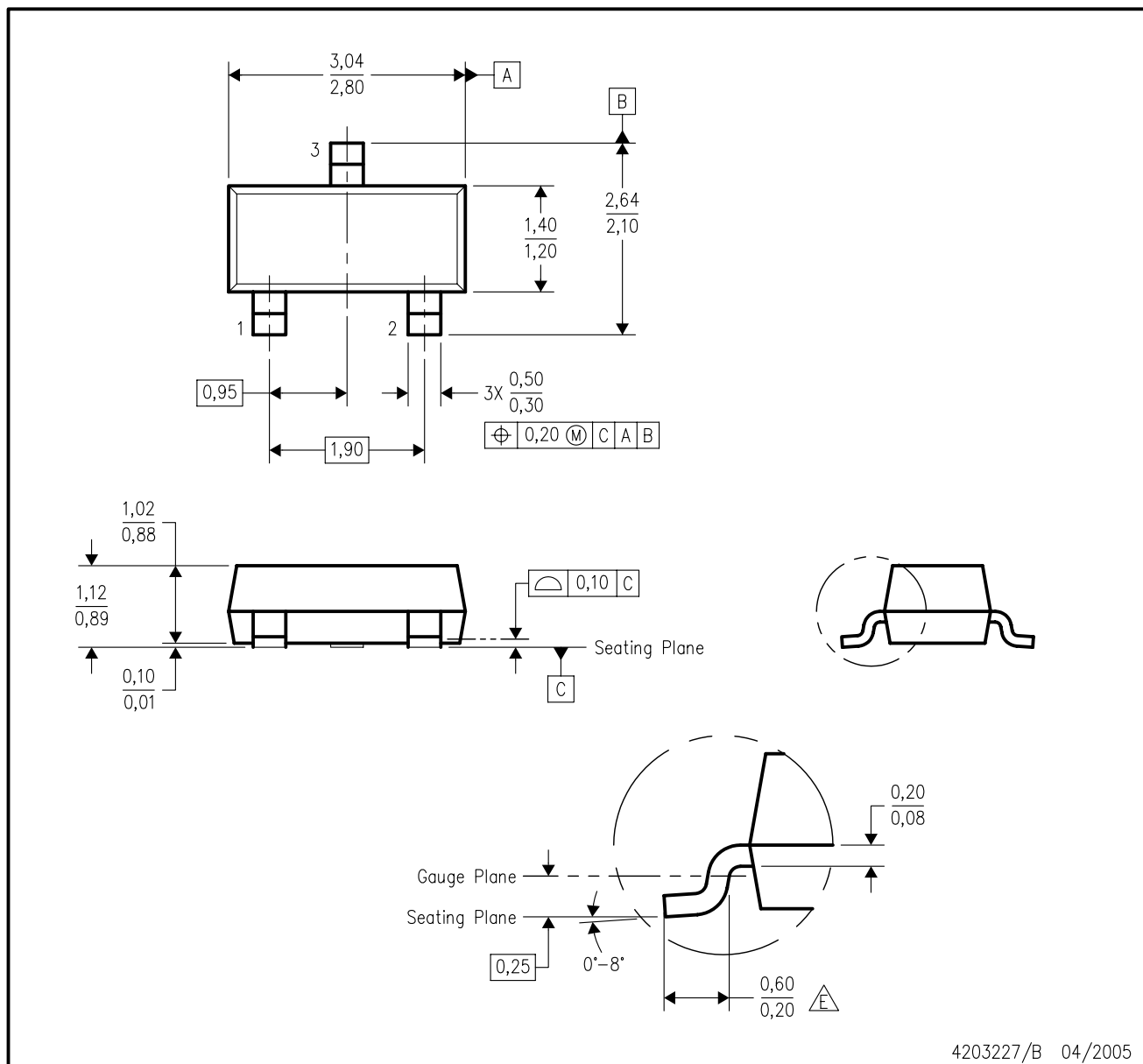
\*All dimensions are nominal

| Device          | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|-----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| LM431ACM3       | SOT-23       | DBZ             | 3    | 1000 | 210.0       | 185.0      | 35.0        |
| LM431ACM3/NOPB  | SOT-23       | DBZ             | 3    | 1000 | 210.0       | 185.0      | 35.0        |
| LM431ACM3X      | SOT-23       | DBZ             | 3    | 3000 | 210.0       | 185.0      | 35.0        |
| LM431ACM3X/NOPB | SOT-23       | DBZ             | 3    | 3000 | 210.0       | 185.0      | 35.0        |
| LM431ACMX       | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |

| Device          | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|-----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| LM431ACMX/NOPB  | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM431AIM3       | SOT-23       | DBZ             | 3    | 1000 | 210.0       | 185.0      | 35.0        |
| LM431AIM3/NOPB  | SOT-23       | DBZ             | 3    | 1000 | 210.0       | 185.0      | 35.0        |
| LM431AIM3X      | SOT-23       | DBZ             | 3    | 3000 | 210.0       | 185.0      | 35.0        |
| LM431AIM3X/NOPB | SOT-23       | DBZ             | 3    | 3000 | 210.0       | 185.0      | 35.0        |
| LM431AIMX       | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM431AIMX/NOPB  | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM431BCM3       | SOT-23       | DBZ             | 3    | 1000 | 210.0       | 185.0      | 35.0        |
| LM431BCM3/NOPB  | SOT-23       | DBZ             | 3    | 1000 | 210.0       | 185.0      | 35.0        |
| LM431BCM3X/NOPB | SOT-23       | DBZ             | 3    | 3000 | 210.0       | 185.0      | 35.0        |
| LM431BCM3X      | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM431BCM3X/NOPB | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM431BIM3       | SOT-23       | DBZ             | 3    | 1000 | 210.0       | 185.0      | 35.0        |
| LM431BIM3/NOPB  | SOT-23       | DBZ             | 3    | 1000 | 210.0       | 185.0      | 35.0        |
| LM431BIM3X      | SOT-23       | DBZ             | 3    | 3000 | 210.0       | 185.0      | 35.0        |
| LM431BIM3X/NOPB | SOT-23       | DBZ             | 3    | 3000 | 210.0       | 185.0      | 35.0        |
| LM431BIMX/NOPB  | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM431CCM3       | SOT-23       | DBZ             | 3    | 1000 | 210.0       | 185.0      | 35.0        |
| LM431CCM3/NOPB  | SOT-23       | DBZ             | 3    | 1000 | 210.0       | 185.0      | 35.0        |
| LM431CCM3X      | SOT-23       | DBZ             | 3    | 3000 | 210.0       | 185.0      | 35.0        |
| LM431CCM3X/NOPB | SOT-23       | DBZ             | 3    | 3000 | 210.0       | 185.0      | 35.0        |
| LM431CIM3       | SOT-23       | DBZ             | 3    | 1000 | 210.0       | 185.0      | 35.0        |
| LM431CIM3/NOPB  | SOT-23       | DBZ             | 3    | 1000 | 210.0       | 185.0      | 35.0        |
| LM431CIM3X      | SOT-23       | DBZ             | 3    | 3000 | 210.0       | 185.0      | 35.0        |
| LM431CIM3X/NOPB | SOT-23       | DBZ             | 3    | 3000 | 210.0       | 185.0      | 35.0        |

DBZ (R-PDSO-G3)

PLASTIC SMALL-OUTLINE



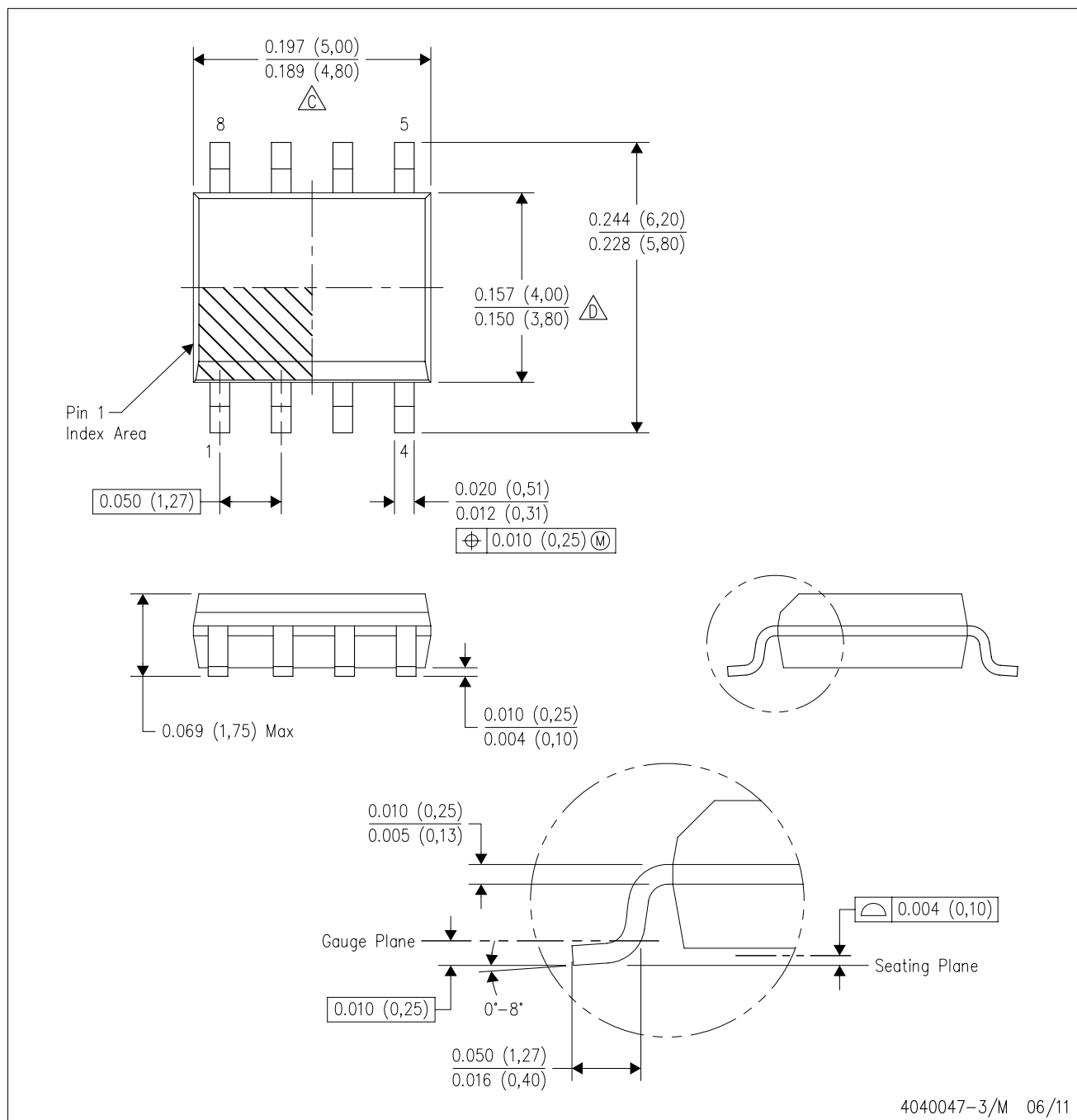
4203227/B 04/2005

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.

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE

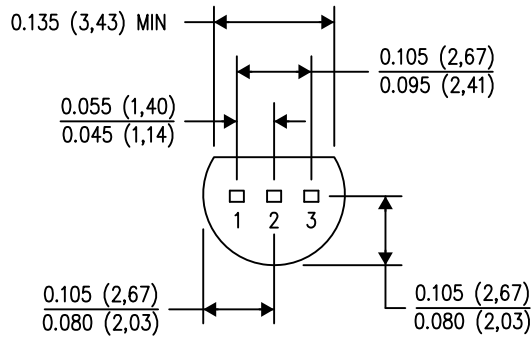
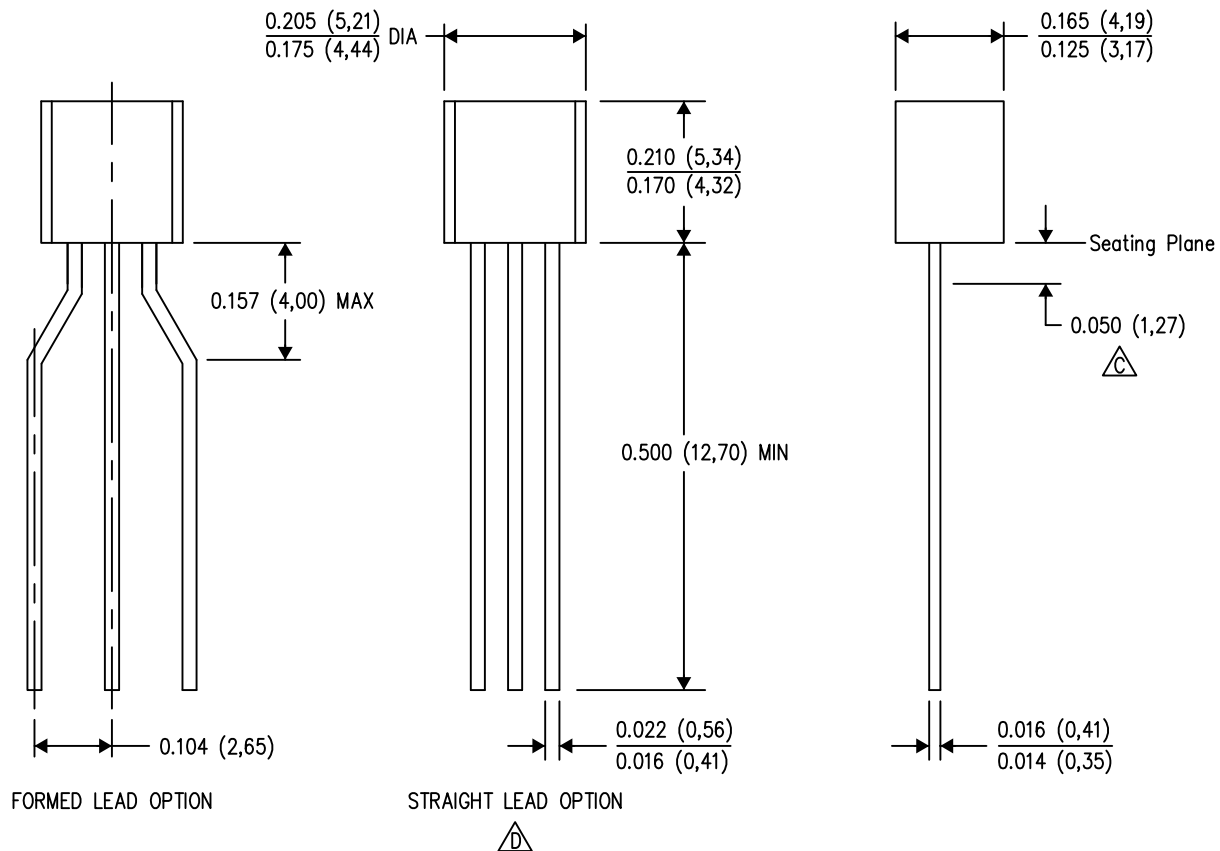


## NOTES:

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

LP (O-PBCY-W3)

PLASTIC CYLINDRICAL PACKAGE

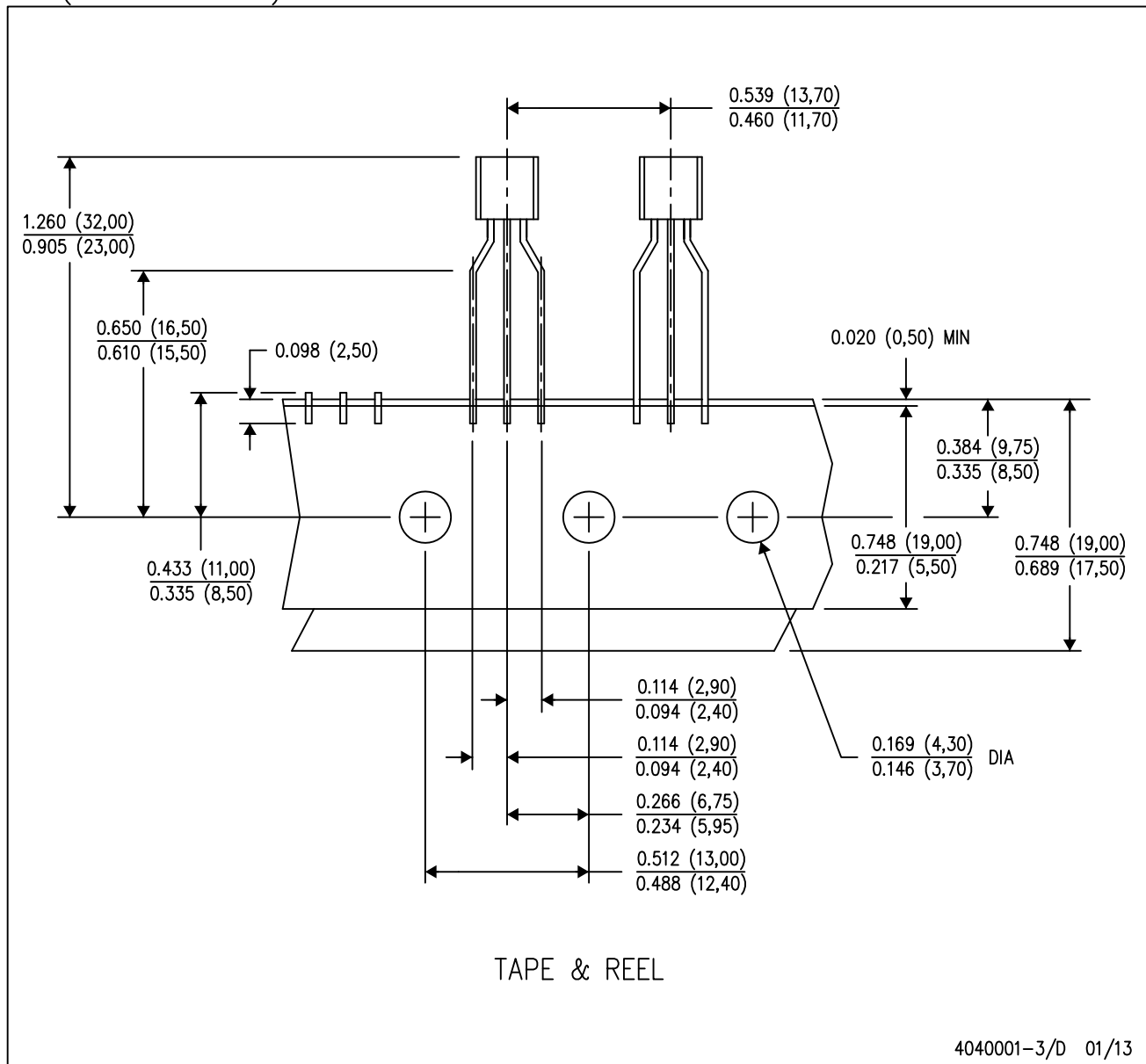


4040001-2/D 01/13

- 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 either bulk pack or tape & reel.
    - Formed lead option available in tape & reel or ammo pack.
    - Specific products can be offered in limited combinations of shipping mediums and lead options.
    - Consult product folder for more information on available options.

LP (O-PBCY-W3)

PLASTIC CYLINDRICAL PACKAGE



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

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|                              |                                                                                      |
|------------------------------|--------------------------------------------------------------------------------------|
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| Amplifiers                   | <a href="http://amplifier.ti.com">amplifier.ti.com</a>                               |
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| DLP® Products                | <a href="http://www.dlp.com">www.dlp.com</a>                                         |
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| RFID                         | <a href="http://www.ti-rfid.com">www.ti-rfid.com</a>                                 |
| OMAP Applications Processors | <a href="http://www.ti.com/omap">www.ti.com/omap</a>                                 |
| Wireless Connectivity        | <a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a> |

### Applications

|                               |                                                                                          |
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| Energy and Lighting           | <a href="http://www.ti.com/energy">www.ti.com/energy</a>                                 |
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