LMV431/LMV431A/LMV431B Low-Voltage (1.24V) Adjustable Precision Shunt Regulators

Check for Samples: LMV431, LMV431A, LMV431B

FEATURES

- **Low Voltage Operation/Wide Adjust Range (1.24V/30V)**
- **0.5% Initial Tolerance (LMV431B)**
- **Temperature Compensated for Industrial Temperature Range (39 PPM/°C for the LMV431AI)**
- **Low Operation Current (55µA)**
- **Low Output Impedance (0.25Ω)**
- **Fast Turn-On Response**
- **Low Cost**

APPLICATIONS

- **Shunt Regulator**
- **Series Regulator**
- **Current Source or Sink**
- **Voltage Monitor**
- **Error Amplifier**
- **3V Off-Line Switching Regulator**
- **Low Dropout N-Channel Series Regulator**

DESCRIPTION

The LMV431, LMV431A and LMV431B are precision 1.24V shunt regulators capable of adjustment to 30V. Negative feedback from the cathode to the adjust pin controls the cathode voltage, much like a non-inverting op amp configuration (Refer to Symbol and Functional diagrams). A two resistor voltage divider terminated at the adjust pin controls the gain of a 1.24V band-gap reference. Shorting the cathode to the adjust pin (voltage follower) provides a cathode voltage of a 1.24V.

The LMV431, LMV431A and LMV431B have respective initial tolerances of 1.5%, 1% and 0.5%, and functionally lends themselves to several applications that require zener diode type performance at low voltages. Applications include a 3V to 2.7V low drop-out regulator, an error amplifier in a 3V off-line switching regulator and even as a voltage detector. These parts are typically stable with capacitive loads greater than 10nF and less than 50pF.

The LMV431, LMV431A and LMV431B provide performance at a competitive price.

Connection Diagram

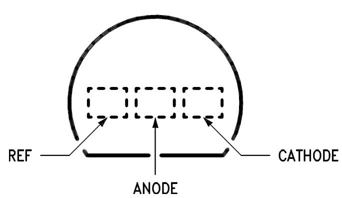
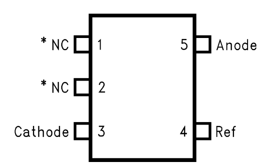


Figure 1. TO-92: Plastic Package Top View



*Pin 1 is not internally connected.
*Pin 2 is internally connected to Anode pin. Pin 2 should be either floating or connected to Anode pin.

Figure 2. SOT-23-5 Top View

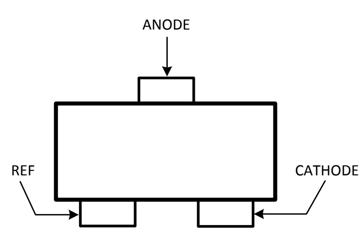
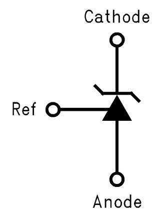
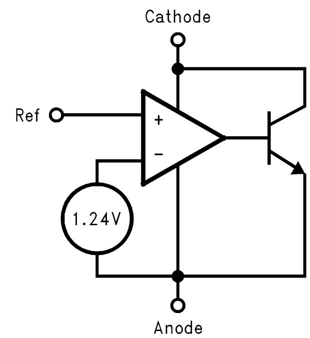


Figure 3. SOT-23-3 Top View

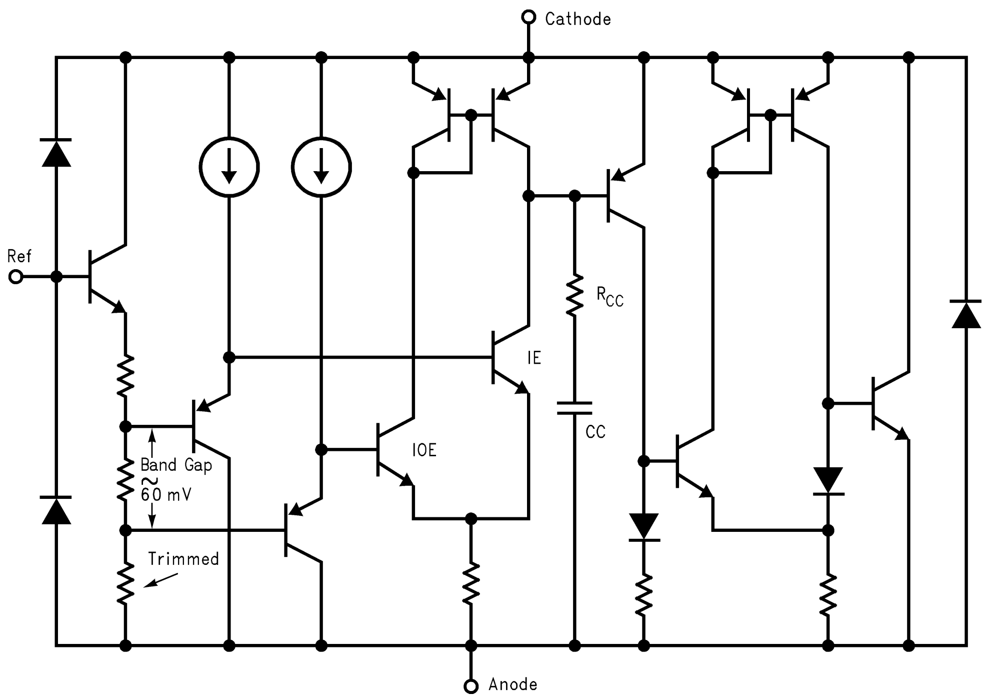
Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

Symbol and Functional Diagrams





Simplified Schematic



DC/AC Test Circuits for Table and Curves

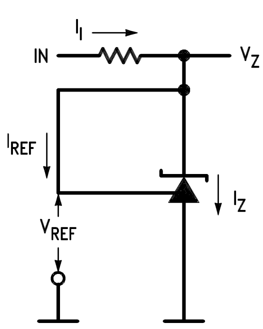
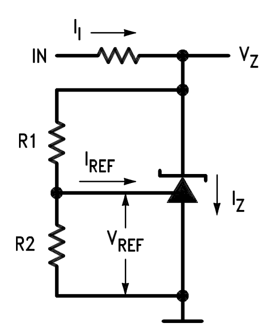


Figure 4. Test Circuit for $V_Z = V_{REF}$



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

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

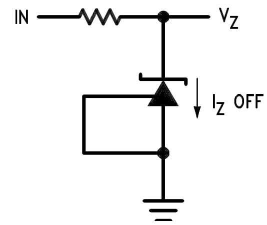


Figure 6. Test Circuit for Off-State Current

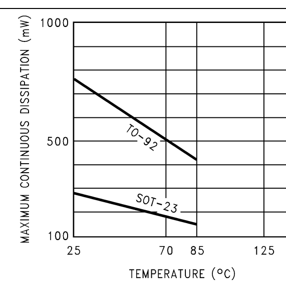
These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

ABSOLUTE MAXIMUM RATINGS [1][2]

Storage Temperature Range		−65°C to +150°C
Operating Temperature Range	Industrial (LMV431AI, LMV431I)	−40°C to +85°C
	Commercial (LMV431AC, LMV431C, LMV431BC)	0°C to +70°C
Lead Temperature	TO-92 Package/SOT-23 -5,-3 Package (Soldering, 10 sec.)	265°C
Internal Power Dissipation [3]	TO-92	0.78W
	SOT-23-5, -3 Package	0.28W
Cathode Voltage		35V
Continuous Cathode Current		−30 mA to +30mA
Reference Input Current range		−.05mA to 3mA

(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 Texas Instruments Sales Office/ Distributors for availability and specifications.
(3) Ratings apply to ambient temperature at 25°C. Above this temperature, derate the TO-92 at 6.2 mW/°C, and the SOT-23-5 at 2.2 mW/°C. See derating curve in Operating Condition section..

OPERATING CONDITIONS

Cathode Voltage		V_{REF} to 30V
Cathode Current		0.1 mA to 15mA
Temperature range	LMV431AI	$-40°C \le T_A \le 85°C$
Thermal Resistance (θ_{JA}) [1]	SOT-23-5, -3 Package	455 °C/W
	TO-92 Package	161 °C/W
Derating Curve (Slope = $-1/\theta_{JA}$)		

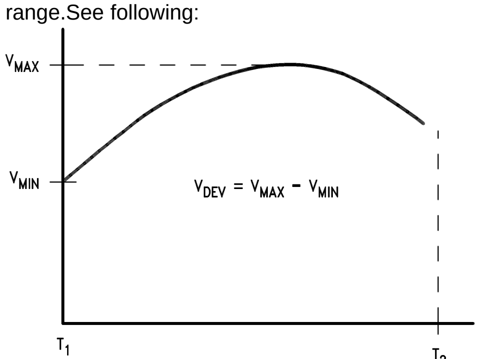
(1) $T_{J\ Max}$ = 150°C, $T_J = T_A + (\theta_{JA}\ P_D)$, where P_D is the operating power of the device.

LMV431C ELECTRICAL CHARACTERISTICS

T_A = 25°C unless otherwise specified

Symbol	Parameter	Conditions		Min	Typ	Max	Units
V_{REF}	Reference Voltage	$V_Z = V_{REF}$, I_Z = 10mA *(See Figure 4)*	T_A = 25°C	1.222	1.24	1.258	
			T_A = Full Range	1.21		1.27	V
V_{DEV}	Deviation of Reference Input Voltage Over Temperature (1)	$V_Z = V_{REF}$, I_Z = 10mA, T_A = Full Range *(See Figure 4)*			4	12	mV
$\Delta V_{REF}/\Delta V_Z$	Ratio of the Change in Reference Voltage to the Change in Cathode Voltage	I_Z = 10mA *(see Figure 5)* V_Z from V_{REF} to 6V R_1 = 10k, R_2 = ∞ and 2.6k			−1.5	−2.7	mV/V
I_{REF}	Reference Input Current	R_1 = 10kΩ, R_2 = ∞ I_I = 10mA *(see Figure 5)*			0.15	0.5	µA
$\propto I_{REF}$	Deviation of Reference Input Current over Temperature	R_1 = 10kΩ, R_2 = ∞, I_I = 10mA, T_A = Full Range *(see Figure 5)*			0.05	0.3	µA
$I_{Z(MIN)}$	Minimum Cathode Current for Regulation	$V_Z = V_{REF}$*(see Figure 4)*			55	80	µA
$I_{Z(OFF)}$	Off-State Current	V_Z=6V, V_{REF} = 0V *(see Figure 6)*			0.001	0.1	µA
r_Z	Dynamic Output Impedance (2)	$V_Z = V_{REF}$, I_Z = 0.1mA to 15mA Frequency = 0Hz *(see Figure 4)*			0.25	0.4	Ω

(1) Deviation of reference input voltage, V_{DEV}, is defined as the maximum variation of the reference input voltage over the full temperature range.See following:



The average temperature coefficient of the reference input voltage, $\propto V_{REF}$, is defined as:

$$\propto V_{REF}\frac{ppm}{°C} = \frac{\pm\left[\frac{V_{Max} - V_{Min}}{V_{REF}\ (at\ 25°C)}\right]10^6}{T_2 - T_1} = \frac{\pm\left[\frac{V_{DEV}}{V_{REF}\ (at\ 25°C)}\right]10^6}{T_2 - T_1}$$

Where:$T_2 - T_1$ = full temperature change.$\propto V_{REF}$ can be positive or negative depending on whether the slope is positive or negative.Example: V_{DEV} = 6.0mV, $_{REF}$ = 1240mV, $T_2 - T_1$ = 125°C.

$$\propto V_{REF} = \frac{\left[\frac{6.0\ mV}{1240\ mV}\right]10^6}{125°C} = +39\ ppm/°C$$

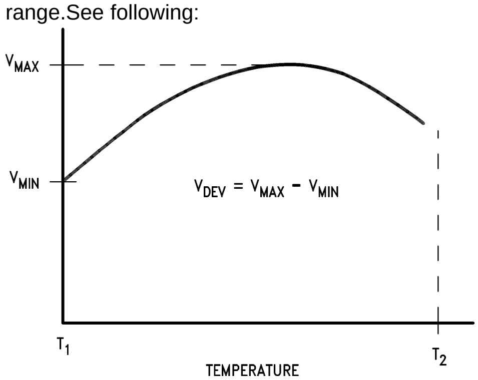
(2) The dynamic output impedance, r_Z, is defined as: $r_Z = \frac{\Delta V_Z}{\Delta I_Z}$ When the device is programmed with two external resistors, R1 and R2, (see *Figure 5*), the dynamic output impedance of the overall circuit, r_Z, is defined as: $r_Z = \frac{\Delta V_Z}{\Delta I_Z} \cong \left[r_Z\left(1 + \frac{R1}{R2}\right)\right]$

LMV431I ELECTRICAL CHARACTERISTICS

T_A = 25°C unless otherwise specified

Symbol	Parameter	Conditions		Min	Typ	Max	Units
V_{REF}	Reference Voltage	$V_Z = V_{REF}$, I_Z = 10mA *(See Figure 4)*	T_A = 25°C	1.222	1.24	1.258	V
			T_A = Full Range	1.202		1.278	
V_{DEV}	Deviation of Reference Input Voltage Over Temperature (1)	$V_Z = V_{REF}$, I_Z = 10mA, T_A = Full Range *(See Figure 4)*			6	20	mV
$\Delta V_{REF}/\Delta V_Z$	Ratio of the Change in Reference Voltage to the Change in Cathode Voltage	I_Z = 10mA *(see Figure 5)* V_Z from V_{REF} to 6V R_1 = 10k, $R_2 = \infty$ and 2.6k			−1.5	−2.7	mV/V
I_{REF}	Reference Input Current	R_1 = 10kΩ, $R_2 = \infty$ I_I = 10mA *(see Figure 5)*			0.15	0.5	μA
$\propto I_{REF}$	Deviation of Reference Input Current over Temperature	R_1 = 10kΩ, $R_2 = \infty$, I_I = 10mA, T_A = Full Range *(see Figure 5)*			0.1	0.4	μA
$I_{Z(MIN)}$	Minimum Cathode Current for Regulation	$V_Z = V_{REF}$*(see Figure 4)*			55	80	μA
$I_{Z(OFF)}$	Off-State Current	V_Z = 6V, V_{REF} = 0V *(see Figure 6)*			0.001	0.1	μA
r_Z	Dynamic Output Impedance (2)	$V_Z = V_{REF}$, I_Z = 0.1mA to 15mA Frequency = 0Hz *(see Figure 4)*			0.25	0.4	Ω

(1) Deviation of reference input voltage, V_{DEV}, is defined as the maximum variation of the reference input voltage over the full temperature range.See following:



The average temperature coefficient of the reference input voltage, $\propto V_{REF}$, is defined as:

$$\propto V_{REF}\ \frac{ppm}{°C} = \frac{\pm\left[\frac{V_{Max} - V_{Min}}{V_{REF}\ (at\ 25°C)}\right]10^6}{T_2 - T_1} = \frac{\pm\left[\frac{V_{DEV}}{V_{REF}\ (at\ 25°C)}\right]10^6}{T_2 - T_1}$$

Where:$T_2 - T_1$ = full temperature change.$\propto V_{REF}$ can be positive or negative depending on whether the slope is positive or negative.Example: V_{DEV} = 6.0mV, $_{REF}$ = 1240mV, $T_2 - T_1$ = 125°C.

$$\propto V_{REF} = \frac{\left[\frac{6.0\ mV}{1240\ mV}\right]10^6}{125°C} = +39\ ppm/°C$$

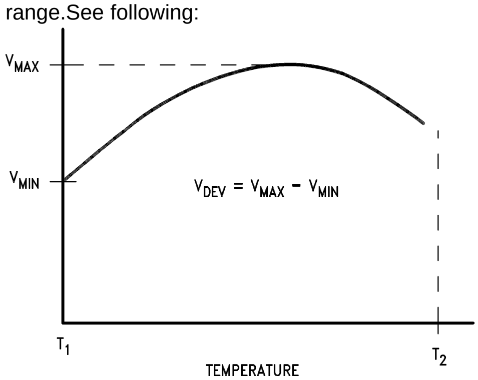
(2) The dynamic output impedance, r_Z, is defined as: $r_Z = \frac{\Delta V_Z}{\Delta I_Z}$ When the device is programmed with two external resistors, R1 and R2, (see *Figure 5*), the dynamic output impedance of the overall circuit, r_Z, is defined as: $r_Z = \frac{\Delta V_Z}{\Delta I_Z} \cong \left[r_Z\left(1 + \frac{R1}{R2}\right)\right]$

LMV431AC ELECTRICAL CHARACTERISTICS

T_A = 25°C unless otherwise specified

Symbol	Parameter	Conditions		Min	Typ	Max	Units
V_{REF}	Reference Voltage	$V_Z = V_{REF}$, I_Z = 10 mA *(See Figure 4)*	T_A = 25°C	1.228	1.24	1.252	V
			T_A = Full Range	1.221		1.259	
V_{DEV}	Deviation of Reference Input Voltage Over Temperature (1)	$V_Z = V_{REF}$, I_Z = 10mA, T_A = Full Range *(See Figure 4)*			4	12	mV
$\Delta V_{REF}/\Delta V_Z$	Ratio of the Change in Reference Voltage to the Change in Cathode Voltage	I_Z = 10 mA *(see Figure 5)* V_Z from V_{REF} to 6V R_1 = 10k, R_2 = ∞ and 2.6k			−1.5	−2.7	mV/V
I_{REF}	Reference Input Current	R_1 = 1 kΩ, R_2 = ∞ I_I = 10 mA *(see Figure 5)*			0.15	0.50	µA
$\propto I_{REF}$	Deviation of Reference Input Current over Temperature	R_1 = 10 kΩ, R_2 = ∞, I_I = 10 mA, T_A = Full Range *(see Figure 5)*			0.05	0.3	µA
$I_{Z(MIN)}$	Minimum Cathode Current for Regulation	$V_Z = V_{REF}$*(see Figure 4)*			55	80	µA
$I_{Z(OFF)}$	Off-State Current	V_Z = 6V, V_{REF} = 0V *(see Figure 6)*			0.001	0.1	µA
r_Z	Dynamic Output Impedance (2)	$V_Z = V_{REF}$, I_Z = 0.1mA to 15mA Frequency = 0 Hz *(see Figure 4)*			0.25	0.4	Ω

(1) Deviation of reference input voltage, V_{DEV}, is defined as the maximum variation of the reference input voltage over the full temperature range.See following:



The average temperature coefficient of the reference input voltage, $\propto V_{REF}$, is defined as:

$$\propto V_{REF}\,\frac{ppm}{°C} = \frac{\pm\left[\frac{V_{Max}-V_{Min}}{V_{REF}\,(at\ 25°C)}\right]10^6}{T_2-T_1} = \frac{\pm\left[\frac{V_{DEV}}{V_{REF}\,(at\ 25°C)}\right]10^6}{T_2-T_1}$$

Where:$T_2 - T_1$ = full temperature change.$\propto V_{REF}$ can be positive or negative depending on whether the slope is positive or negative.Example: V_{DEV} = 6.0mV, $_{REF}$ = 1240mV, $T_2 - T_1$ = 125°C.

$$\propto V_{REF} = \frac{\left[\frac{6.0\ mV}{1240\ mV}\right]10^6}{125°C} = +39\ ppm/°C$$

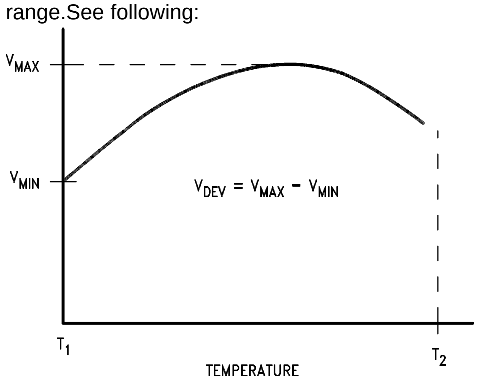
(2) The dynamic output impedance, r_Z, is defined as: $r_Z = \frac{\Delta V_Z}{\Delta I_Z}$ When the device is programmed with two external resistors, R1 and R2, (see *Figure 5*), the dynamic output impedance of the overall circuit, r_Z, is defined as: $r_Z = \frac{\Delta V_Z}{\Delta I_Z} \cong \left[r_Z\left(1 + \frac{R1}{R2}\right)\right]$

LMV431AI ELECTRICAL CHARACTERISTICS

T_A = 25°C unless otherwise specified

Symbol	Parameter	Conditions		Min	Typ	Max	Units
V_{REF}	Reference Voltage	$V_Z = V_{REF}$, I_Z = 10mA *(See Figure 4)*	T_A = 25°C	1.228	1.24	1.252	
			T_A = Full Range	1.215		1.265	V
V_{DEV}	Deviation of Reference Input Voltage Over Temperature (1)	$V_Z = V_{REF}$, I_Z = 10mA, T_A = Full Range *(See Figure 4)*			6	20	mV
$\Delta V_{REF}/\Delta V_Z$	Ratio of the Change in Reference Voltage to the Change in Cathode Voltage	I_Z = 10mA *(see Figure 5)* V_Z from V_{REF} to 6V R_1 = 10k, R_2 = ∞ and 2.6k			−1.5	−2.7	mV/V
I_{REF}	Reference Input Current	R_1 = 10kΩ, R_2 = ∞ I_I = 10mA *(see Figure 5)*			0.15	0.5	µA
$\propto I_{REF}$	Deviation of Reference Input Current over Temperature	R_1 = 10kΩ, R_2 = ∞, I_I = 10mA, T_A = Full Range *(see Figure 5)*			0.1	0.4	µA
$I_{Z(MIN)}$	Minimum Cathode Current for Regulation	$V_Z = V_{REF}$*(see Figure 4)*			55	80	µA
$I_{Z(OFF)}$	Off-State Current	V_Z = 6V, V_{REF} = 0V *(see Figure 6)*			0.001	0.1	µA
r_Z	Dynamic Output Impedance (2)	$V_Z = V_{REF}$, I_Z = 0.1mA to 15mA Frequency = 0Hz *(see Figure 4)*			0.25	0.4	Ω

(1) Deviation of reference input voltage, V_{DEV}, is defined as the maximum variation of the reference input voltage over the full temperature range.See following:



The average temperature coefficient of the reference input voltage, $\propto V_{REF}$, is defined as:

$$\propto V_{REF}\,\frac{ppm}{°C} = \frac{\pm\left[\frac{V_{Max}-V_{Min}}{V_{REF}\,(at\ 25°C)}\right]10^6}{T_2-T_1} = \frac{\pm\left[\frac{V_{DEV}}{V_{REF}\,(at\ 25°C)}\right]10^6}{T_2-T_1}$$

Where:$T_2 - T_1$ = full temperature change.$\propto V_{REF}$ can be positive or negative depending on whether the slope is positive or negative.Example: V_{DEV} = 6.0mV, $_{REF}$ = 1240mV, $T_2 - T_1$ = 125°C.

$$\propto V_{REF} = \frac{\left[\frac{6.0\ mV}{1240\ mV}\right]10^6}{125°C} = +39\ ppm/°C$$

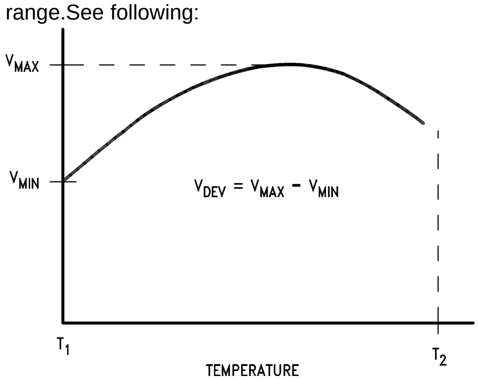
(2) The dynamic output impedance, r_Z, is defined as: $r_Z = \frac{\Delta V_Z}{\Delta I_Z}$ When the device is programmed with two external resistors, R1 and R2, (see *Figure 5*), the dynamic output impedance of the overall circuit, r_Z, is defined as: $r_Z = \frac{\Delta V_Z}{\Delta I_Z} \cong \left[r_Z\left(1+\frac{R1}{R2}\right)\right]$

LMV431BC ELECTRICAL CHARACTERISTICS

T_A = 25°C unless otherwise specified

Symbol	Parameter	Conditions		Min	Typ	Max	Units
V_{REF}	Reference Voltage	$V_Z = V_{REF}$, I_Z = 10mA *(See Figure 4)*	T_A = 25°C	1.234	1.24	1.246	
			T_A = Full Range	1.227		1.253	V
V_{DEV}	Deviation of Reference Input Voltage Over Temperature [(1)]	$V_Z = V_{REF}$, I_Z = 10mA, T_A = Full Range *(See Figure 4)*			4	12	mV
$\Delta V_{REF}/\Delta V_Z$	Ratio of the Change in Reference Voltage to the Change in Cathode Voltage	I_Z = 10mA *(see Figure 5)* V_Z from V_{REF} to 6V R_1 = 10k, $R_2 = \infty$ and 2.6k			−1.5	−2.7	mV/V
I_{REF}	Reference Input Current	R_1 = 10kΩ, $R_2 = \infty$ I_I = 10mA *(see Figure 5)*			0.15	0.50	μA
$\propto I_{REF}$	Deviation of Reference Input Current over Temperature	R_1 = 10kΩ, $R_2 = \infty$, I_I = 10mA, T_A = Full Range *(see Figure 5)*			0.05	0.3	μA
$I_{Z(MIN)}$	Minimum Cathode Current for Regulation	$V_Z = V_{REF}$*(see Figure 4)*			55	80	μA
$I_{Z(OFF)}$	Off-State Current	V_Z = 6V, V_{REF} = 0V *(see Figure 6)*			0.001	0.1	μA
r_Z	Dynamic Output Impedance [(2)]	$V_Z = V_{REF}$, I_Z = 0.1mA to 15mA Frequency = 0Hz *(see Figure 4)*			0.25	0.4	Ω

(1) Deviation of reference input voltage, V_{DEV}, is defined as the maximum variation of the reference input voltage over the full temperature range.See following:



The average temperature coefficient of the reference input voltage, $\propto V_{REF}$, is defined as:

$$\propto V_{REF}\ \frac{ppm}{°C} = \frac{\pm\left[\frac{V_{Max} - V_{Min}}{V_{REF}\ (at\ 25°C)}\right]10^6}{T_2 - T_1} = \frac{\pm\left[\frac{V_{DEV}}{V_{REF}\ (at\ 25°C)}\right]10^6}{T_2 - T_1}$$

Where:$T_2 - T_1$ = full temperature change.$\propto V_{REF}$ can be positive or negative depending on whether the slope is positive or negative.Example: V_{DEV} = 6.0mV, $_{REF}$ = 1240mV, $T_2 - T_1$ = 125°C.

$$\propto V_{REF} = \frac{\left[\frac{6.0\ mV}{1240\ mV}\right]10^6}{125°C} = +39\ ppm/°C$$

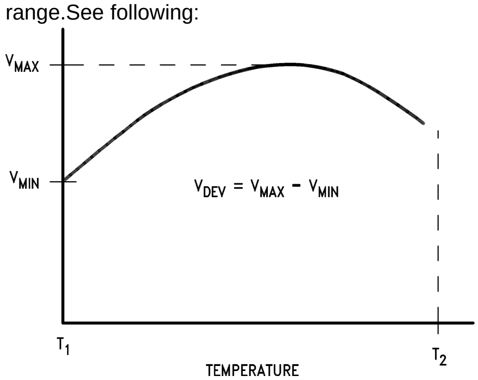
(2) The dynamic output impedance, r_Z, is defined as: $r_Z = \frac{\Delta V_Z}{\Delta I_Z}$ When the device is programmed with two external resistors, R1 and R2, (see *Figure 5*), the dynamic output impedance of the overall circuit, r_Z, is defined as: $r_Z = \frac{\Delta V_Z}{\Delta I_Z} \cong \left[r_Z\left(1 + \frac{R1}{R2}\right)\right]$

LMV431BI ELECTRICAL CHARACTERISTICS

T_A = 25°C unless otherwise specified

Symbol	Parameter	Conditions		Min	Typ	Max	Units
V_{REF}	Reference Voltage	$V_Z = V_{REF}$, I_Z = 10mA *(See Figure 4)*	T_A = 25°C	1.234	1.24	1.246	
			T_A = Full Range	1.224		1.259	V
V_{DEV}	Deviation of Reference Input Voltage Over Temperature [(1)]	$V_Z = V_{REF}$, I_Z = 10mA, T_A = Full Range *(See Figure 4)*			6	20	mV
$\Delta V_{REF}/\Delta V_Z$	Ratio of the Change in Reference Voltage to the Change in Cathode Voltage	I_Z = 10mA *(see Figure 5)* V_Z from V_{REF} to 6V R_1 = 10k, R_2 = ∞ and 2.6k			−1.5	−2.7	mV/V
I_{REF}	Reference Input Current	R_1 = 10kΩ, R_2 = ∞ I_I = 10mA *(see Figure 5)*			0.15	0.50	µA
$\propto I_{REF}$	Deviation of Reference Input Current over Temperature	R_1 = 10kΩ, R_2 = ∞, I_I = 10mA, T_A = Full Range *(see Figure 5)*			0.1	0.4	µA
$I_{Z(MIN)}$	Minimum Cathode Current for Regulation	$V_Z = V_{REF}$*(see Figure 4)*			55	80	µA
$I_{Z(OFF)}$	Off-State Current	V_Z = 6V, V_{REF} = 0V *(see Figure 6)*			0.001	0.1	µA
r_Z	Dynamic Output Impedance [(2)]	$V_Z = V_{REF}$, I_Z = 0.1mA to 15mA Frequency = 0Hz *(see Figure 4)*			0.25	0.4	Ω

(1) Deviation of reference input voltage, V_{DEV}, is defined as the maximum variation of the reference input voltage over the full temperature range.See following:



The average temperature coefficient of the reference input voltage, $\propto V_{REF}$, is defined as:

$$\propto V_{REF} \frac{ppm}{°C} = \frac{\pm\left[\frac{V_{Max} - V_{Min}}{V_{REF}\ (at\ 25°C)}\right]10^6}{T_2 - T_1} = \frac{\pm\left[\frac{V_{DEV}}{V_{REF}\ (at\ 25°C)}\right]10^6}{T_2 - T_1}$$

Where:$T_2 - T_1$ = full temperature change.$\propto V_{REF}$ can be positive or negative depending on whether the slope is positive or negative.Example: V_{DEV} = 6.0mV, $_{REF}$ = 1240mV, $T_2 - T_1$ = 125°C.

$$\propto V_{REF} = \frac{\left[\frac{6.0\ mV}{1240\ mV}\right]10^6}{125°C} = +39\ ppm/°C$$

(2) The dynamic output impedance, r_Z, is defined as: $r_Z = \frac{\Delta V_Z}{\Delta I_Z}$ When the device is programmed with two external resistors, R1 and R2, (see *Figure 5*), the dynamic output impedance of the overall circuit, r_Z, is defined as: $r_Z = \frac{\Delta V_Z}{\Delta I_Z} \cong \left[r_Z\left(1 + \frac{R1}{R2}\right)\right]$

TYPICAL PERFORMANCE CHARACTERISTICS

Reference Voltage vs. Junction Temperature

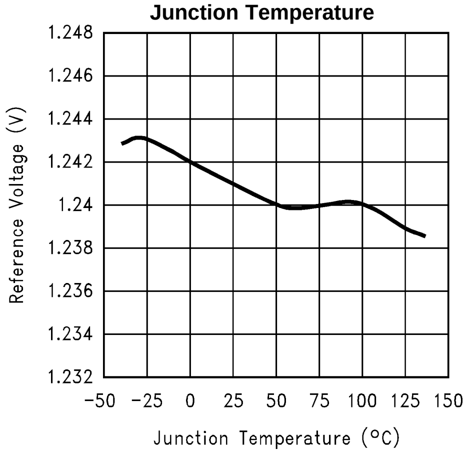


Figure 7.

Reference Input Current vs. Junction Temperature

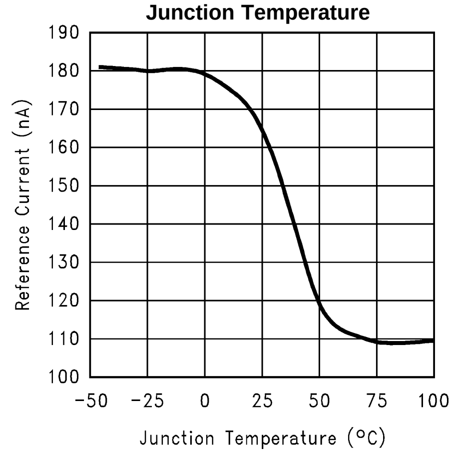


Figure 8.

Cathode Current vs. Cathode Voltage 1

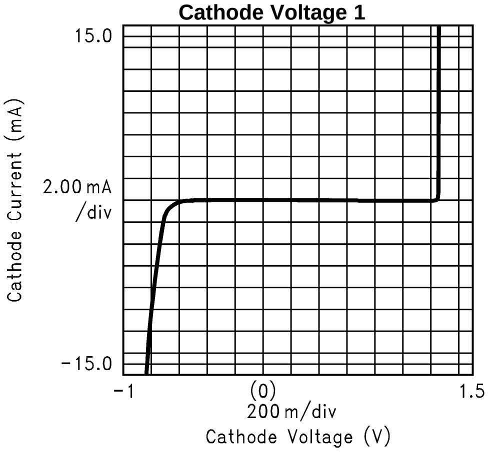


Figure 9.

Cathode Current vs. Cathode Voltage 2

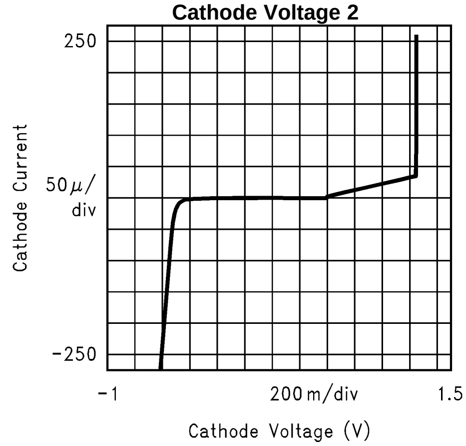


Figure 10.

Off-State Cathode Current vs. Junction Temperature

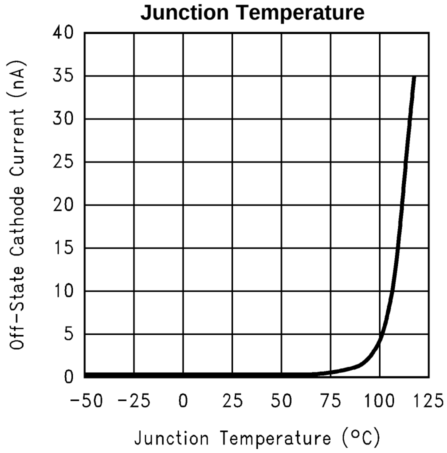


Figure 11.

Delta Reference Voltage Per Delta Cathode Voltage vs. Junction Temperature

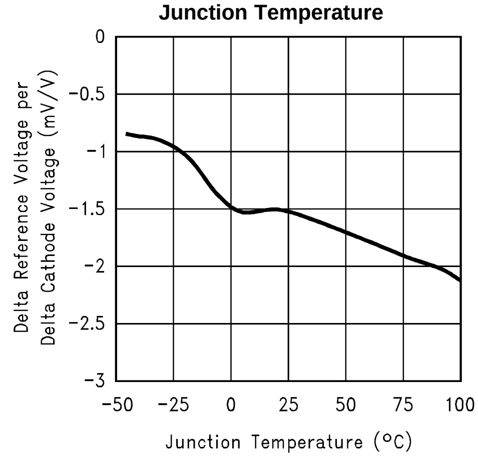


Figure 12.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Input Voltage Noise vs. Frequency

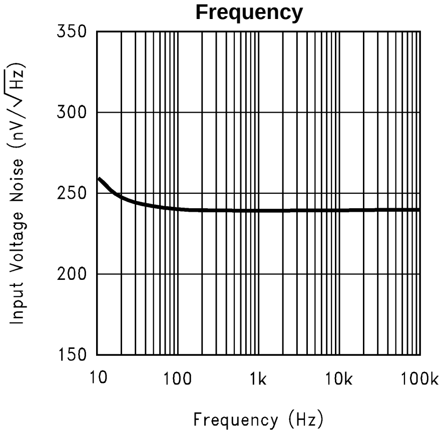


Figure 13.

Test Circuit for Input Voltage Noise vs. Frequency

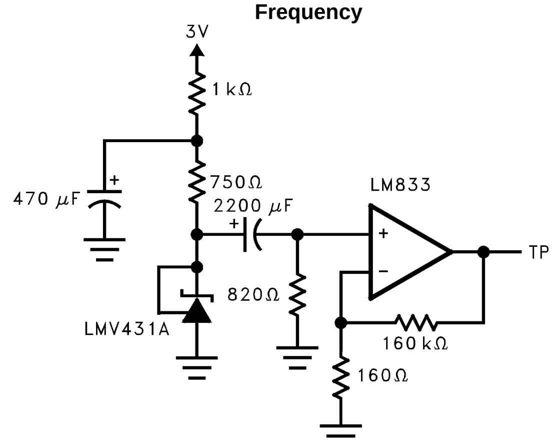


Figure 14.

Low Frequency Peak to Peak Noise

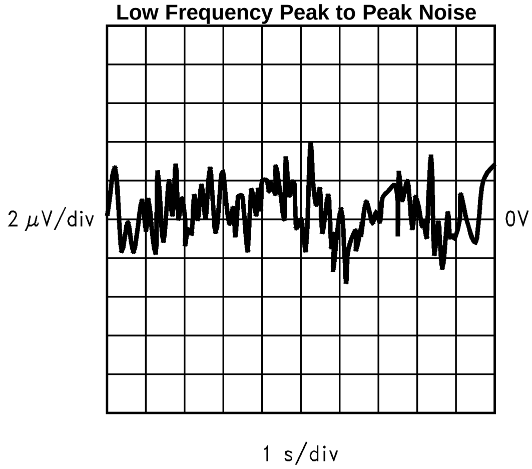


Figure 15.

Test Circuit for Peak to Peak Noise (BW= 0.1Hz to 10Hz)

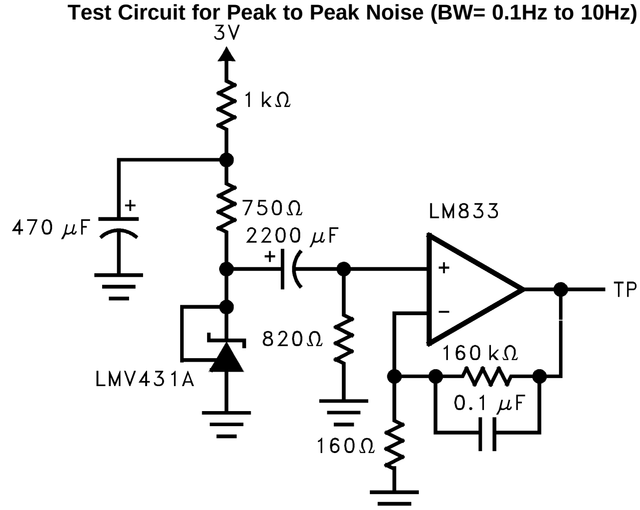


Figure 16.

Small Signal Voltage Gain and Phase Shift vs. Frequency

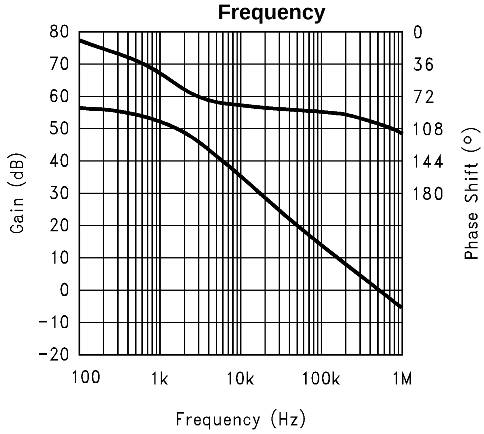


Figure 17.

Test Circuit For Voltage Gain and Phase Shift vs. Frequency

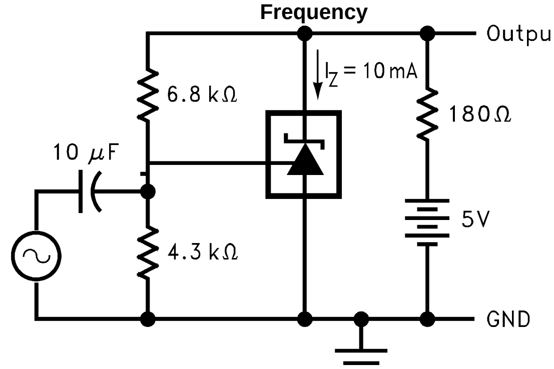


Figure 18.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Reference Impedance vs. Frequency

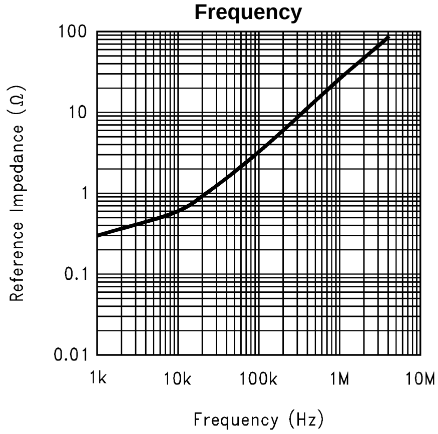


Figure 19.

Test Circuit for Reference Impedance vs. Frequency

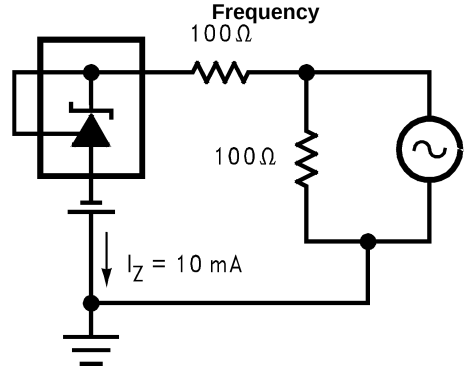


Figure 20.

Pulse Response 1

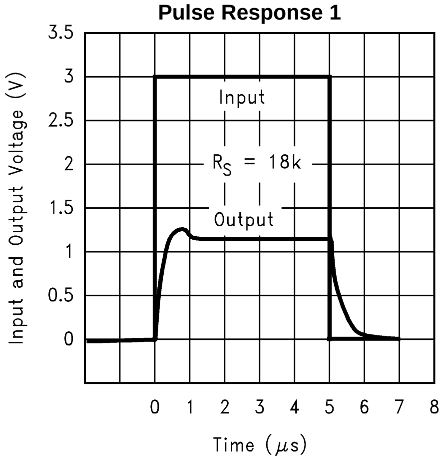


Figure 21.

Test Circuit for Pulse Response 1

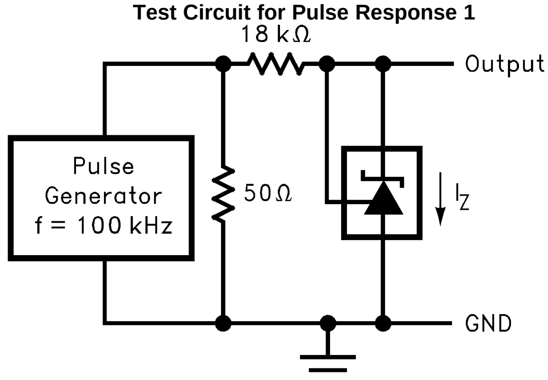


Figure 22.

Pulse Response 2

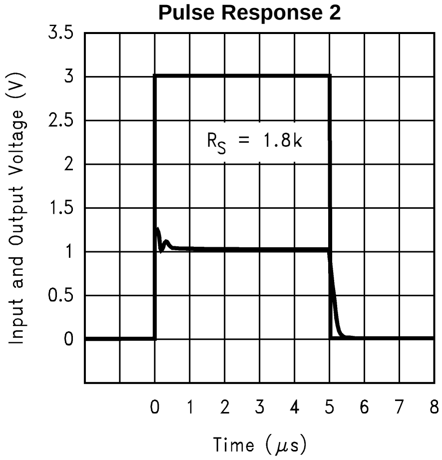


Figure 23.

Test Circuit for Pulse Response 2

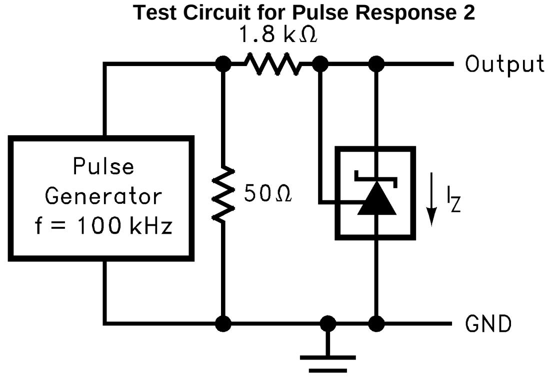


Figure 24.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

LMV431 Stability Boundary Condition

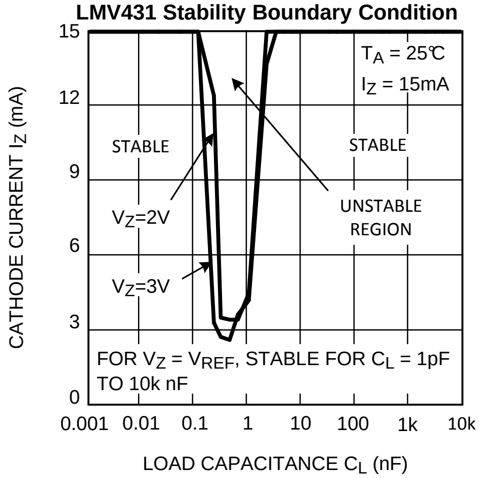


Figure 25.

Test circuit for $V_Z = V_{REF}$

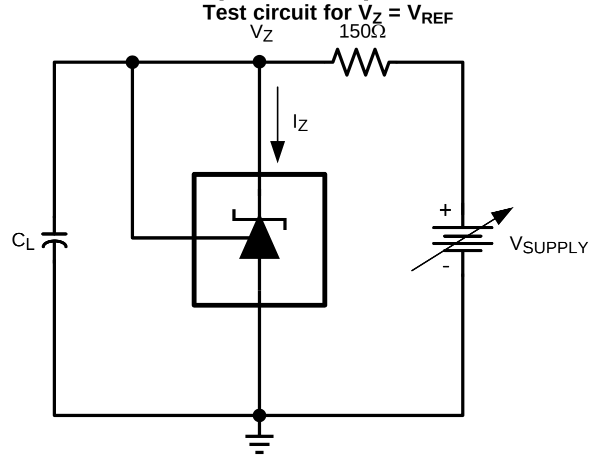


Figure 26.

Test Circuit for V_Z = 2V, 3V

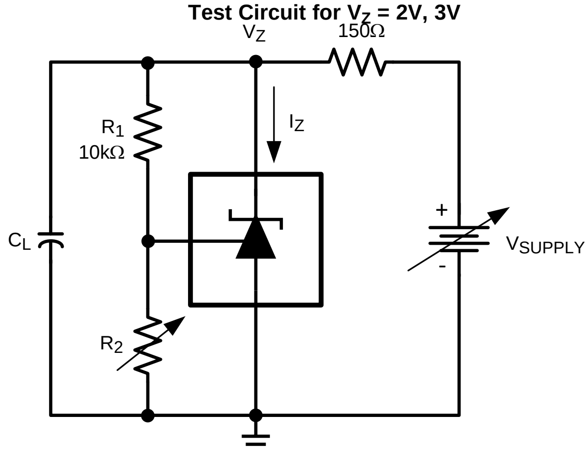
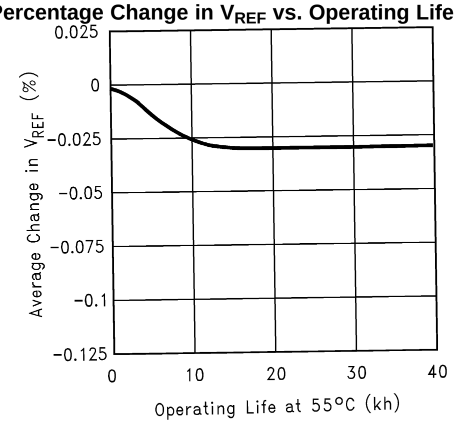


Figure 27.

Percentage Change in V_{REF} vs. Operating Life at 55°C

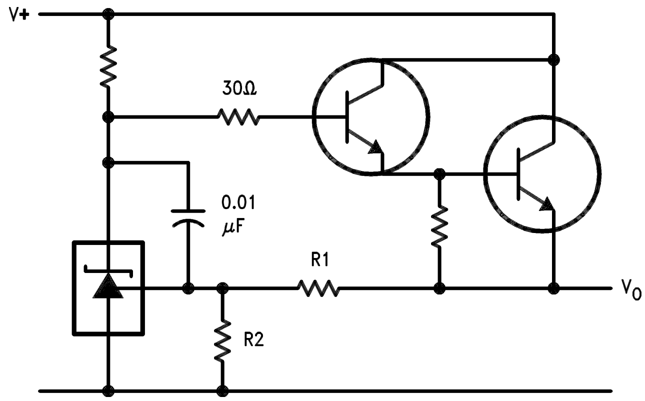


Extrapolated from life-test data taken at 125°C; the activation energy assumed is 0.7eV.

Figure 28.

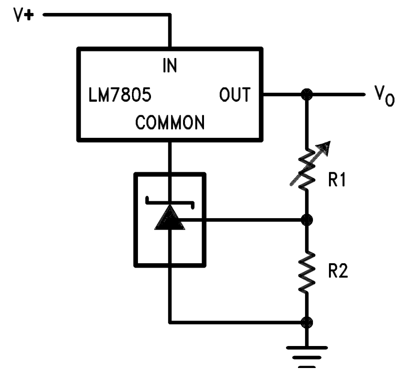
TYPICAL APPLICATIONS

Series Regulator



$$V_O \approx \left(1 + \frac{R1}{R2}\right) V_{REF}$$

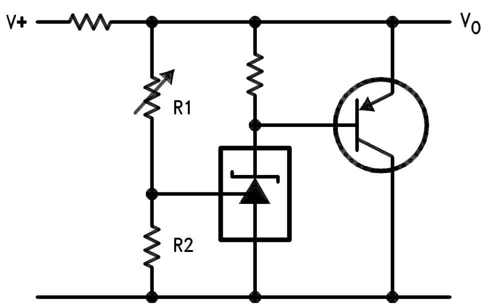
Output Control of a Three Terminal Fixed Regulator



$$V_O = \left(1 + \frac{R1}{R2}\right) V_{REF}$$

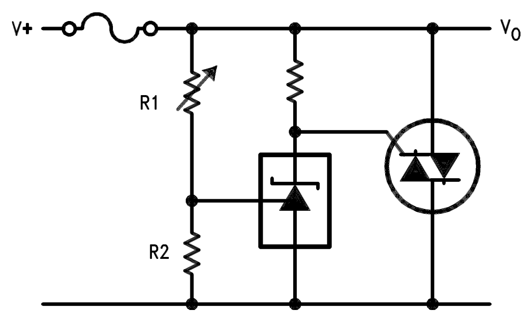
$$V_{O\ MIN} = V_{REF} + 5V$$

Higher Current Shunt Regulator



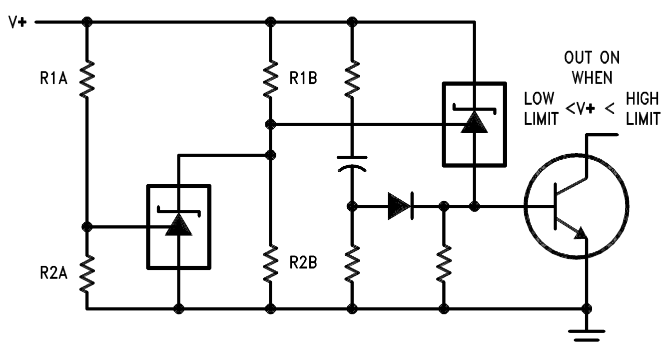
$$V_O \approx \left(1 + \frac{R1}{R2}\right) V_{REF}$$

Crow Bar



$$V_{LIMIT} \approx \left(1 + \frac{R1}{R2}\right) V_{REF}$$

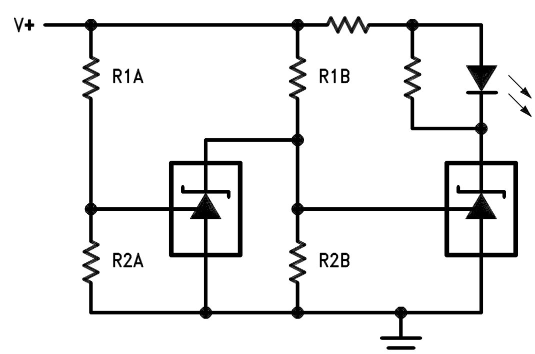
Over Voltage/Under VoltageProtection Circuit



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

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

Voltage Monitor

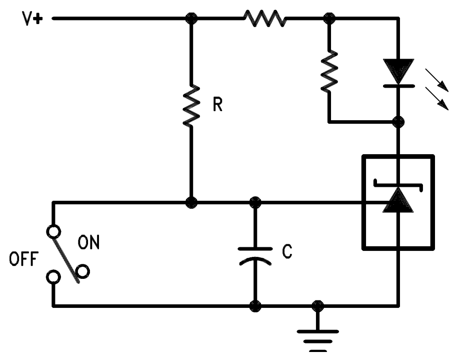


$$\text{LOW LIMIT} \approx V_{REF} \left(1 + \frac{R1B}{R2B}\right)$$

LED ON WHEN
LOW LIMIT $< V^+ <$ HIGH LIMIT

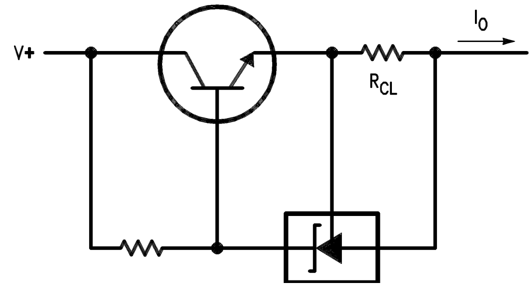
$$\text{HIGH LIMIT} \approx V_{REF} \left(1 + \frac{R1A}{R2A}\right)$$

Delay Timer



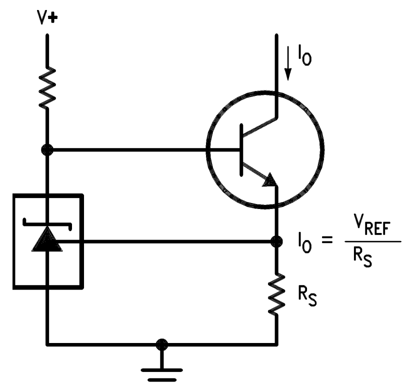
$$DELAY = R \bullet C \bullet \ell n \frac{V+}{(V^+) - V_{REF}}$$

Current Limiter or Current Source



$$I_O = \frac{V_{REF}}{R_{CL}}$$

Constant Current Sink



PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LMV431ACM5	ACTIVE	SOT-23	DBV	5	1000	TBD	Call TI	Call TI	-40 to 85	N09A	Samples
LMV431ACM5/NOPB	ACTIVE	SOT-23	DBV	5	1000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	N09A	Samples
LMV431ACM5X	ACTIVE	SOT-23	DBV	5	3000	TBD	Call TI	Call TI	-40 to 85	N09A	Samples
LMV431ACM5X/NOPB	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	N09A	Samples
LMV431AIM5	ACTIVE	SOT-23	DBV	5	1000	TBD	Call TI	Call TI	-40 to 85	N08A	Samples
LMV431AIM5/NOPB	ACTIVE	SOT-23	DBV	5	1000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	N08A	Samples
LMV431AIM5X	ACTIVE	SOT-23	DBV	5	3000	TBD	Call TI	Call TI	-40 to 85	N08A	Samples
LMV431AIM5X/NOPB	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	N08A	Samples
LMV431AIMF	ACTIVE	SOT-23	DBZ	3	1000	TBD	Call TI	Call TI	-40 to 85	RLA	Samples
LMV431AIMF/NOPB	ACTIVE	SOT-23	DBZ	3	1000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	RLA	Samples
LMV431AIMFX	ACTIVE	SOT-23	DBZ	3	3000	TBD	Call TI	Call TI	-40 to 85	RLA	Samples
LMV431AIMFX/NOPB	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	RLA	Samples
LMV431AIZ/LFT3	ACTIVE	TO-92	LP	3	2000	Green (RoHS & no Sb/Br)	SNCU	Level-1-NA-UNLIM		LMV431 AIZ	Samples
LMV431AIZ/NOPB	ACTIVE	TO-92	LP	3	1800	Green (RoHS & no Sb/Br)	SNCU	Level-1-NA-UNLIM	-40 to 85	LMV431 AIZ	Samples
LMV431BCM5	ACTIVE	SOT-23	DBV	5	1000	TBD	Call TI	Call TI		N09C	Samples
LMV431BCM5/NOPB	ACTIVE	SOT-23	DBV	5	1000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM		N09C	Samples
LMV431BCM5X	ACTIVE	SOT-23	DBV	5	3000	TBD	Call TI	Call TI		N09C	Samples
LMV431BCM5X/NOPB	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM		N09C	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LMV431BIMF	ACTIVE	SOT-23	DBZ	3	1000	TBD	Call TI	Call TI	-40 to 85	RLB	Samples
LMV431BIMF/NOPB	ACTIVE	SOT-23	DBZ	3	1000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	RLB	Samples
LMV431BIMFX	ACTIVE	SOT-23	DBZ	3	3000	TBD	Call TI	Call TI	-40 to 85	RLB	Samples
LMV431BIMFX/NOPB	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	RLB	Samples
LMV431CM5	ACTIVE	SOT-23	DBV	5	1000	TBD	Call TI	Call TI	0 to 70	N09B	Samples
LMV431CM5/NOPB	ACTIVE	SOT-23	DBV	5	1000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	0 to 70	N09B	Samples
LMV431CM5X	ACTIVE	SOT-23	DBV	5	3000	TBD	Call TI	Call TI	0 to 70	N09B	Samples
LMV431CM5X/NOPB	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	0 to 70	N09B	Samples
LMV431CZ/NOPB	ACTIVE	TO-92	LP	3	1800	Green (RoHS & no Sb/Br)	SNCU	Level-1-NA-UNLIM	0 to 70	LMV431 CZ	Samples
LMV431IM5	ACTIVE	SOT-23	DBV	5	1000	TBD	Call TI	Call TI	-40 to 85	N08B	Samples
LMV431IM5/NOPB	ACTIVE	SOT-23	DBV	5	1000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	N08B	Samples
LMV431IM5X	ACTIVE	SOT-23	DBV	5	3000	TBD	Call TI	Call TI	-40 to 85	N08B	Samples
LMV431IM5X/NOPB	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	N08B	Samples
LMV431IZ/NOPB	ACTIVE	TO-92	LP	3	1800	Green (RoHS & no Sb/Br)	SNCU	Level-1-NA-UNLIM	-40 to 85	LMV431 IZ	Samples

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

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

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

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

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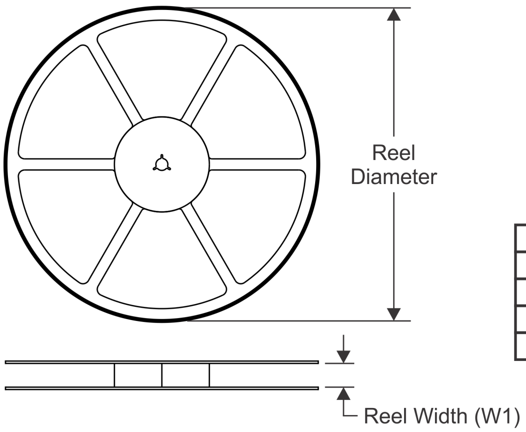
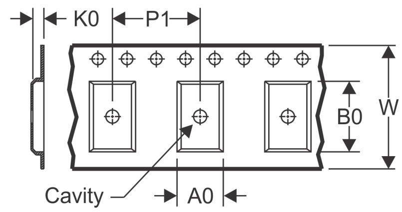
TAPE AND REEL INFORMATION

REEL DIMENSIONS

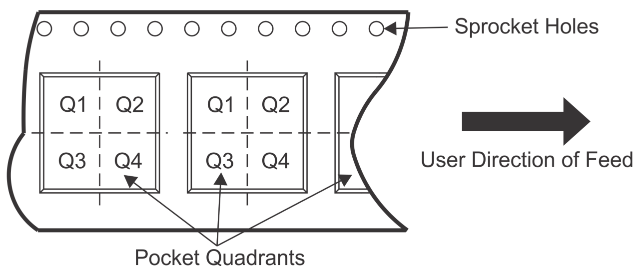


TAPE DIMENSIONS



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

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE

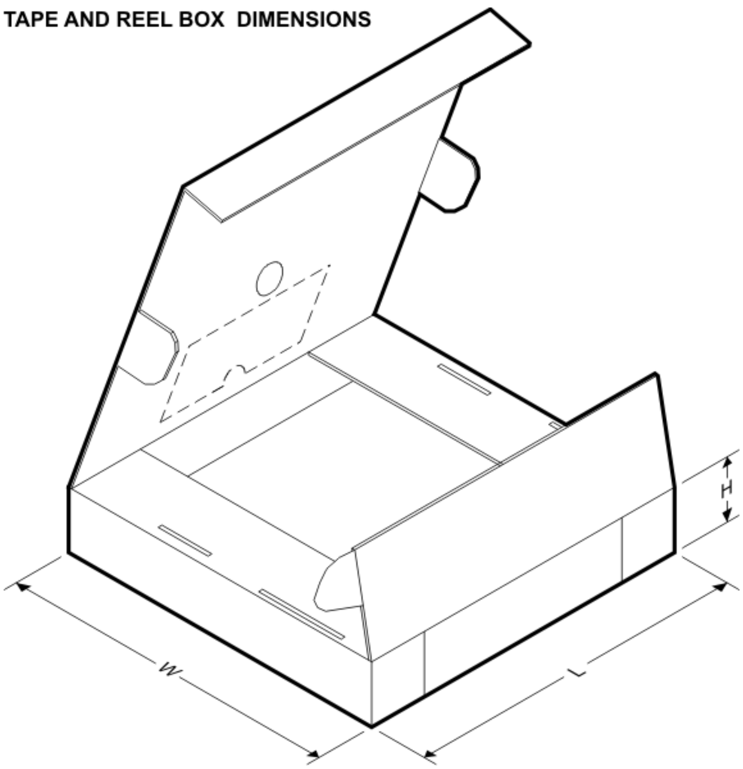


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LMV431ACM5	SOT-23	DBV	5	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV431ACM5/NOPB	SOT-23	DBV	5	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV431ACM5X	SOT-23	DBV	5	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV431ACM5X/NOPB	SOT-23	DBV	5	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV431AIM5	SOT-23	DBV	5	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV431AIM5/NOPB	SOT-23	DBV	5	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV431AIM5X	SOT-23	DBV	5	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV431AIM5X/NOPB	SOT-23	DBV	5	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV431AIMF	SOT-23	DBZ	3	1000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LMV431AIMF/NOPB	SOT-23	DBZ	3	1000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LMV431AIMFX	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LMV431AIMFX/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LMV431BCM5	SOT-23	DBV	5	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV431BCM5/NOPB	SOT-23	DBV	5	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV431BCM5X	SOT-23	DBV	5	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV431BCM5X/NOPB	SOT-23	DBV	5	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV431BIMF	SOT-23	DBZ	3	1000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LMV431BIMF/NOPB	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
LMV431BIMFX	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LMV431BIMFX/NOPB	SOT-23	DBZ	3	3000	178.0	8.4	3.3	2.9	1.22	4.0	8.0	Q3
LMV431CM5	SOT-23	DBV	5	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV431CM5/NOPB	SOT-23	DBV	5	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV431CM5X	SOT-23	DBV	5	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV431CM5X/NOPB	SOT-23	DBV	5	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV431IM5	SOT-23	DBV	5	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV431IM5/NOPB	SOT-23	DBV	5	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV431IM5X	SOT-23	DBV	5	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV431IM5X/NOPB	SOT-23	DBV	5	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS

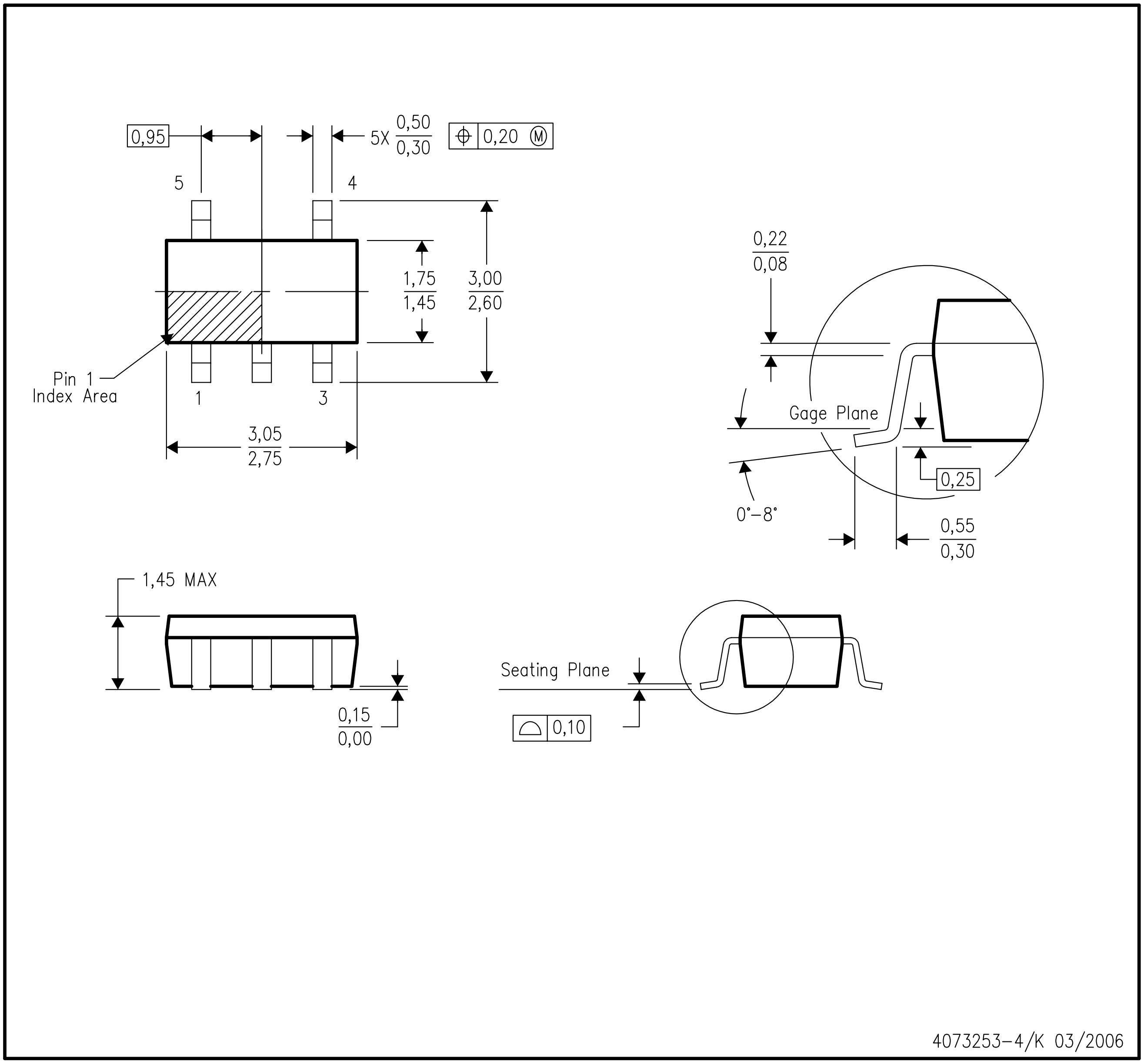


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LMV431ACM5	SOT-23	DBV	5	1000	210.0	185.0	35.0
LMV431ACM5/NOPB	SOT-23	DBV	5	1000	210.0	185.0	35.0
LMV431ACM5X	SOT-23	DBV	5	3000	210.0	185.0	35.0
LMV431ACM5X/NOPB	SOT-23	DBV	5	3000	210.0	185.0	35.0
LMV431AIM5	SOT-23	DBV	5	1000	210.0	185.0	35.0
LMV431AIM5/NOPB	SOT-23	DBV	5	1000	210.0	185.0	35.0
LMV431AIM5X	SOT-23	DBV	5	3000	210.0	185.0	35.0

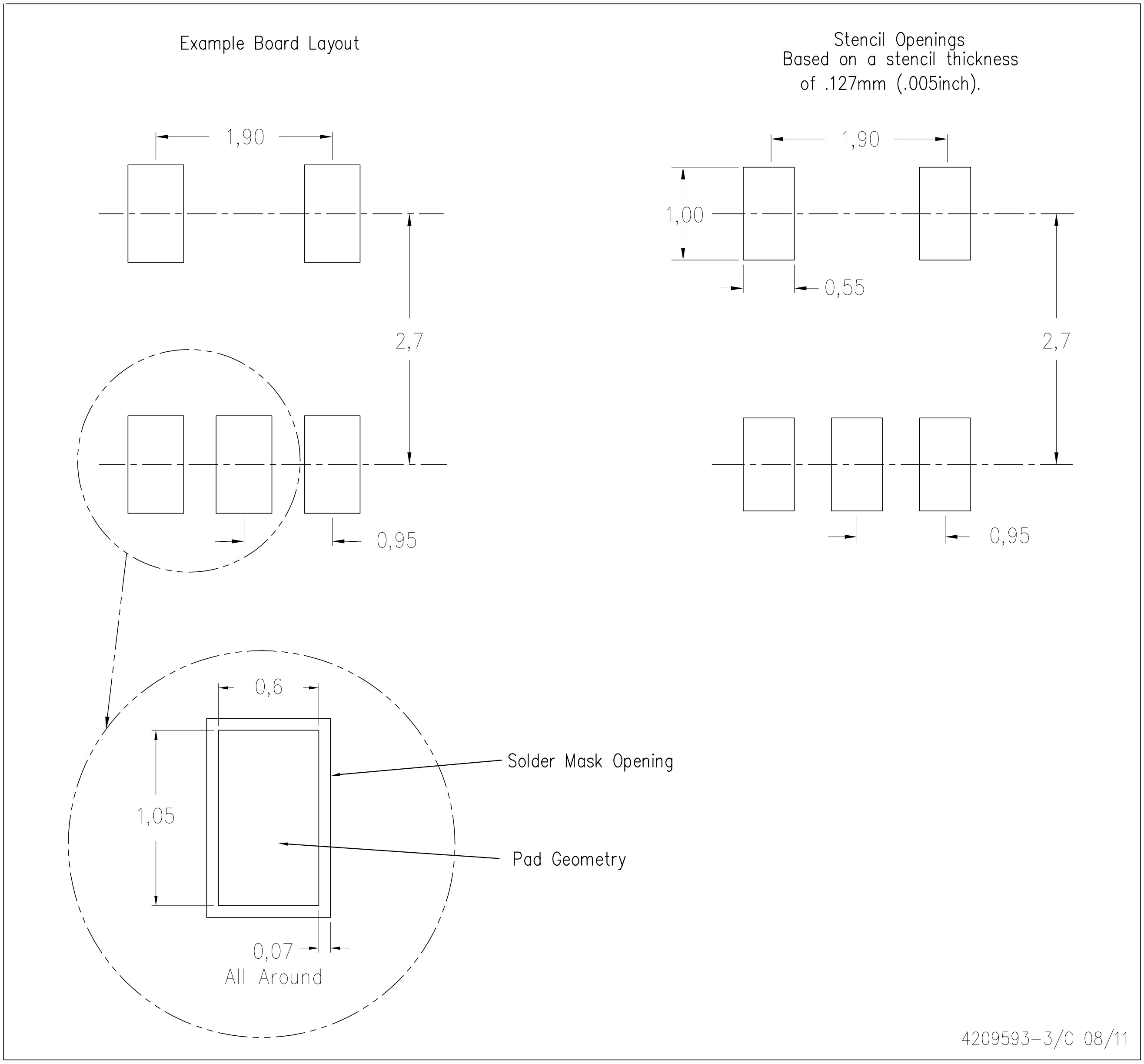
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LMV431AIM5X/NOPB	SOT-23	DBV	5	3000	210.0	185.0	35.0
LMV431AIMF	SOT-23	DBZ	3	1000	210.0	185.0	35.0
LMV431AIMF/NOPB	SOT-23	DBZ	3	1000	210.0	185.0	35.0
LMV431AIMFX	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LMV431AIMFX/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LMV431BCM5	SOT-23	DBV	5	1000	210.0	185.0	35.0
LMV431BCM5/NOPB	SOT-23	DBV	5	1000	210.0	185.0	35.0
LMV431BCM5X	SOT-23	DBV	5	3000	210.0	185.0	35.0
LMV431BCM5X/NOPB	SOT-23	DBV	5	3000	210.0	185.0	35.0
LMV431BIMF	SOT-23	DBZ	3	1000	210.0	185.0	35.0
LMV431BIMF/NOPB	SOT-23	DBZ	3	1000	210.0	185.0	35.0
LMV431BIMFX	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LMV431BIMFX/NOPB	SOT-23	DBZ	3	3000	210.0	185.0	35.0
LMV431CM5	SOT-23	DBV	5	1000	210.0	185.0	35.0
LMV431CM5/NOPB	SOT-23	DBV	5	1000	210.0	185.0	35.0
LMV431CM5X	SOT-23	DBV	5	3000	210.0	185.0	35.0
LMV431CM5X/NOPB	SOT-23	DBV	5	3000	210.0	185.0	35.0
LMV431IM5	SOT-23	DBV	5	1000	210.0	185.0	35.0
LMV431IM5/NOPB	SOT-23	DBV	5	1000	210.0	185.0	35.0
LMV431IM5X	SOT-23	DBV	5	3000	210.0	185.0	35.0
LMV431IM5X/NOPB	SOT-23	DBV	5	3000	210.0	185.0	35.0

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



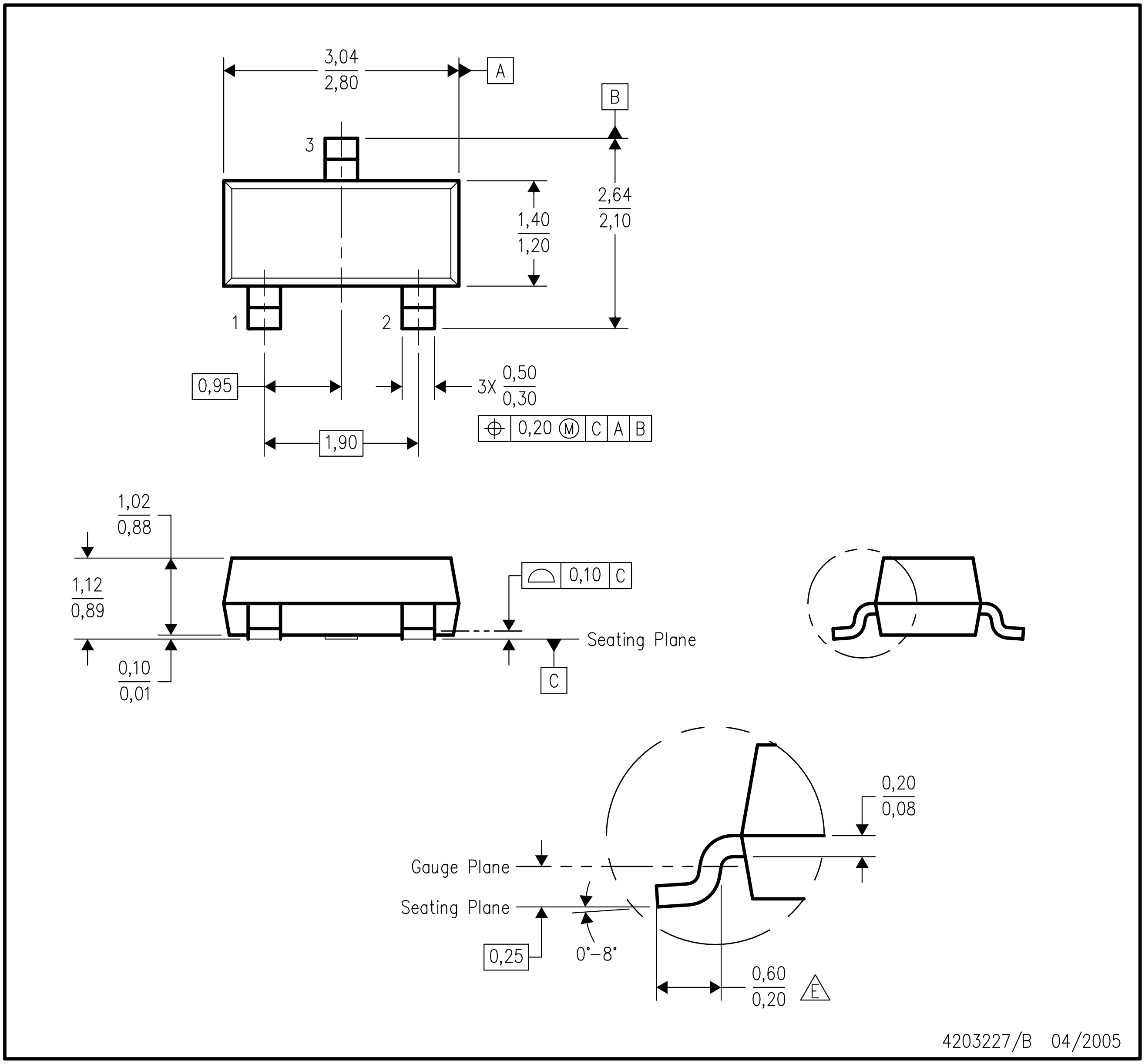
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
D. Falls within JEDEC MO-178 Variation AA.

DBV (R–PDSO–G5) PLASTIC SMALL OUTLINE



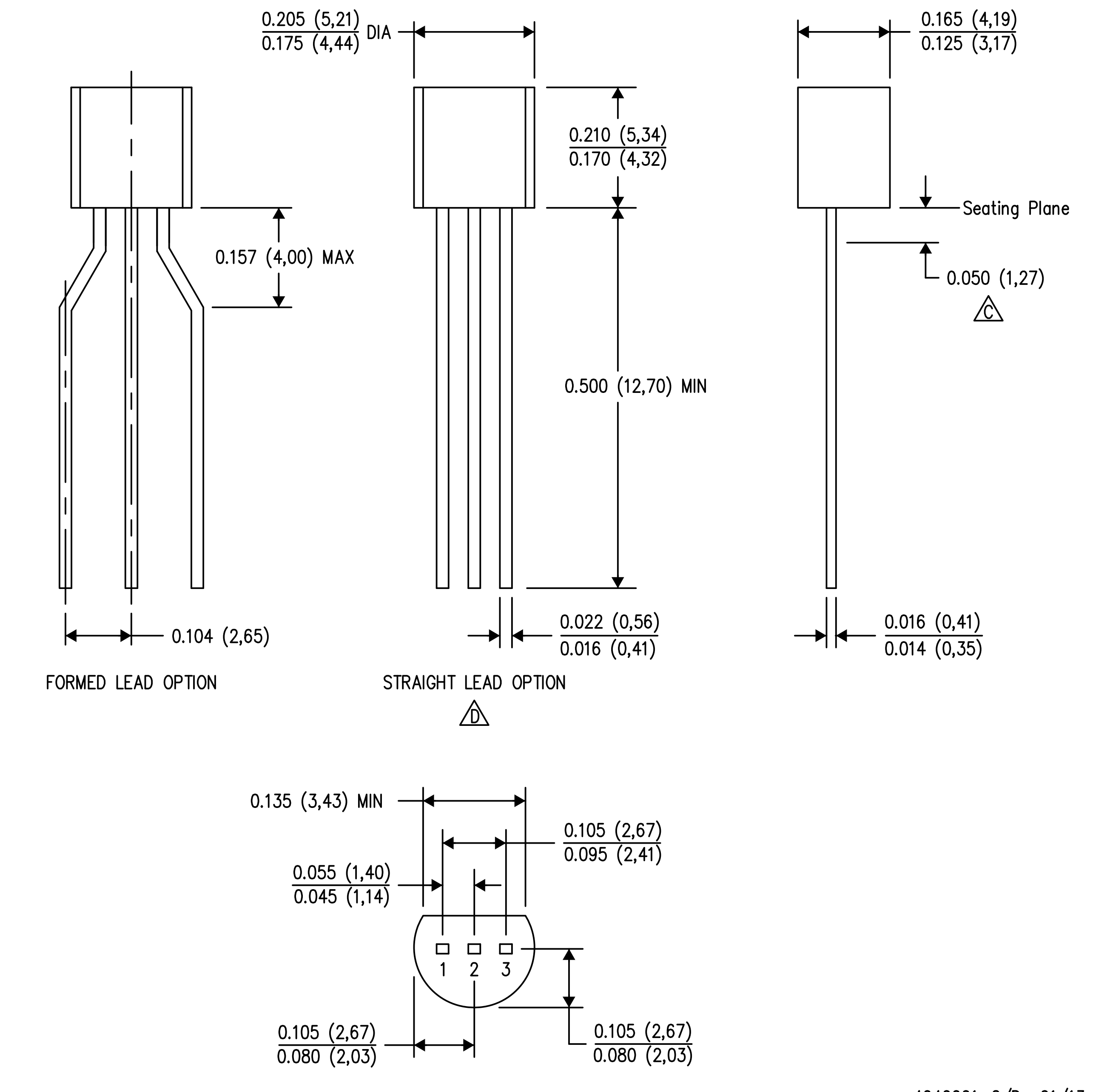
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
D. Publication IPC–7351 is recommended for alternate designs.
E. Laser cutting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

DBZ (R-PDSO-G3) PLASTIC SMALL-OUTLINE



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

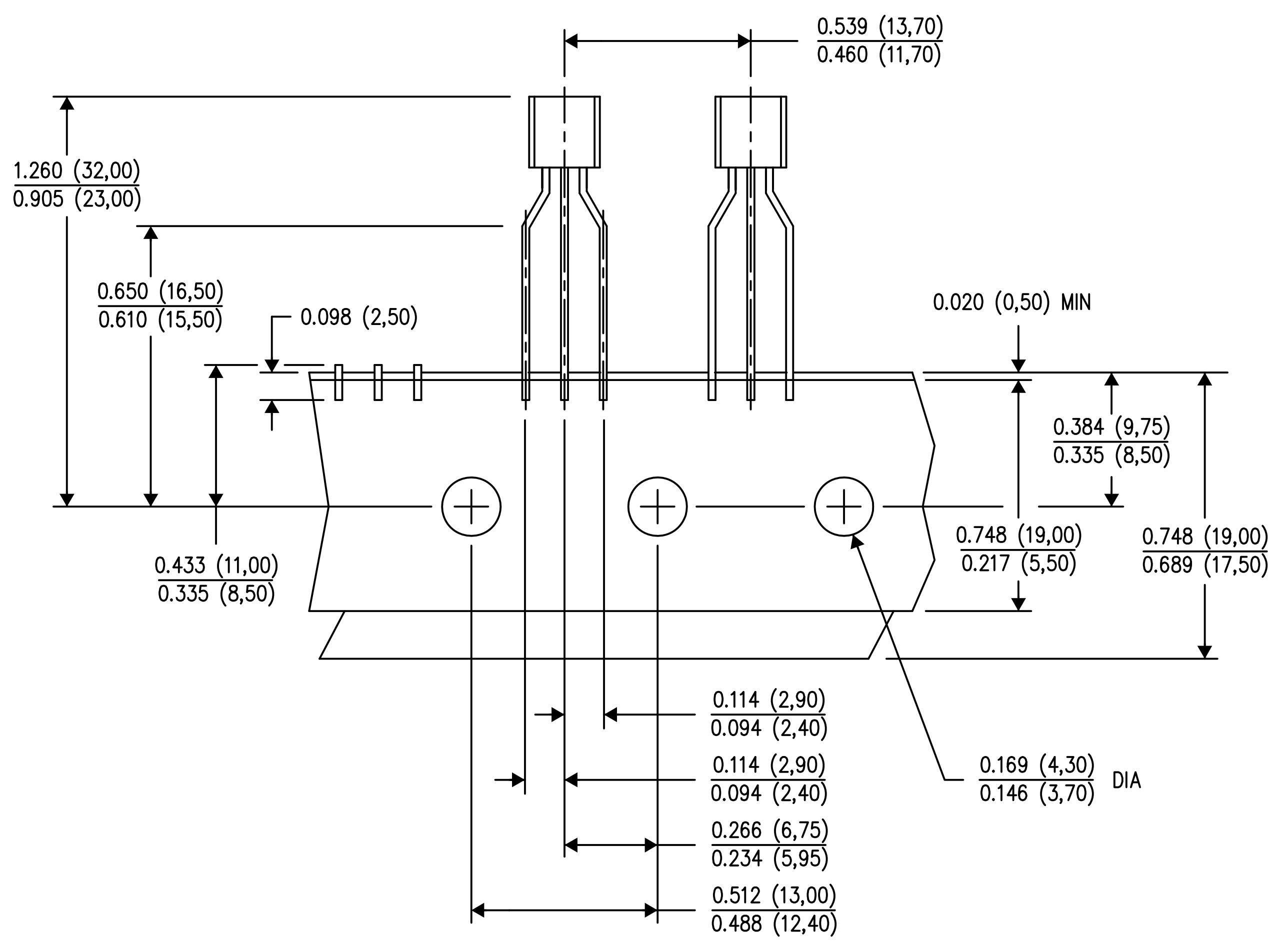
LP (O-PBCY-W3) PLASTIC CYLINDRICAL PACKAGE



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



TAPE & REEL

4040001-3/D 01/13

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

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