TL1431-EP Precision-Programmable Reference

1 Features

- 0.4% Initial Voltage Tolerance
- 0.2-Ω Typical Output Impedance
- Fast Turnon: 500 ns
- Sink Current Capability: 1 to 100 mA
- Low Reference Current (REF)
- Adjustable Output Voltage: $V_{I(ref)}$ to 36 V
- Supports Defense, Aerospace, and Medical Applications
  - Controlled Baseline
  - One Assembly and Test Site
  - One Fabrication Site
  - Available in Military (–55°C to 125°C) Temperature Range
  - Extended Product Life Cycle
  - Extended Product-Change Notification
  - Product Traceability

2 Applications

- Shunt Regulators
- Temperature-Compensated Comparators
- PWM Converter Reference
- Photodiode Reference Drivers
- Precision Current Limiters
- Precision Current Sink

3 Description

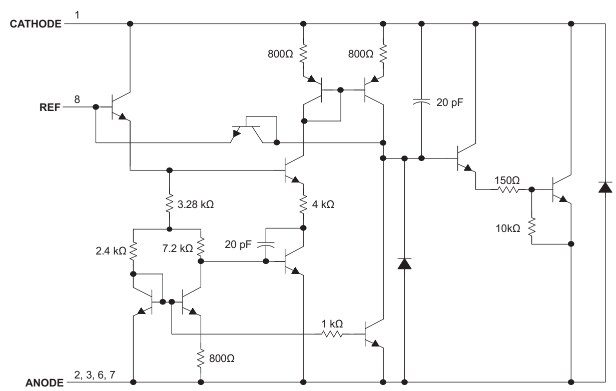
The TL1431-EP device is a precision-programmable reference with specified thermal stability over the military temperature range. The output voltage can be set to any value from $V_{I(ref)}$ (approximately 2.5 V) to 36 V with two external resistors (see Figure 21). This device has a typical output impedance of 0.2 Ω. Active output circuitry provides a very sharp turnon characteristic, making the device an excellent replacement for Zener diodes and other types of references in applications such as onboard regulation, adjustable power supplies, and switching power supplies.

Device Information(1)

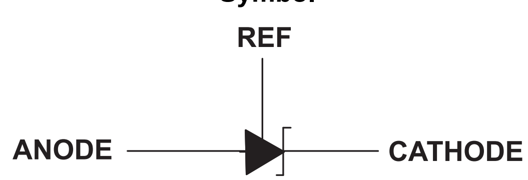
PART NUMBER	PACKAGE	BODY SIZE (NOM)
TL1431-EP	SOIC (8)	3.91 mm × 4.90 mm

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

4 Simplified Schematic



Symbol



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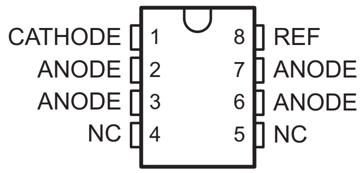
5 Revision History

Changes from Revision C (December 2006) to Revision D **Page**

- Added *ESD Ratings* table, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section 1
- Changed pinout title from JG to D Package 3

6 Pin Configuration and Functions

D Package
8-Pin SOIC
(Top View)



NC − No internal connection

Pin Functions

<table>
<tr><th colspan="2">PIN</th><th rowspan="2">I/O</th><th rowspan="2">DESCRIPTION</th></tr>
<tr><th>NO.</th><th>NAME</th></tr>
<tr><td>1</td><td>CATHODE</td><td>I/O</td><td>Cathode</td></tr>
<tr><td>2</td><td rowspan="4">ANODE</td><td>I/O</td><td rowspan="4">ANODE pins are connected internally</td></tr>
<tr><td>3</td><td>I/O</td></tr>
<tr><td>6</td><td>I/O</td></tr>
<tr><td>7</td><td>I/O</td></tr>
<tr><td>4</td><td rowspan="2">NC</td><td rowspan="2">—</td><td rowspan="2">No internal connection</td></tr>
<tr><td>5</td></tr>
<tr><td>8</td><td>REF</td><td>I</td><td>Reference</td></tr>
</table>

7 Specifications

7.1 Absolute Maximum Ratings[1]

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

	MIN	MAX	UNIT
Cathode voltage[2], V_{KA}		37	V
Continuous cathode current, I_{KA}	–100	150	mA
Reference input current, $I_{I(ref)}$	–0.00005	10	mA
Operating virtual junction temperature[3], T_J		150	°C
Lead temperature 1.6 mm (1/16 inch) from case for 10 s		260	°C
Storage temperature, T_{stg}	–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) All voltage values are with respect to ANODE, unless otherwise noted.
(3) Long-term high-temperature storage and/or use at the absolute maximum ratings may result in a reduction of overall device life. See www.ti.com/ep_quality for additional information on enhanced plastic packaging.

7.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins[1]	±4000	V
		Charged device model (CDM), per JEDEC specification JESD22-C101, all pins[2]	±2000	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

7.3 Recommended Operating Conditions

		MIN	MAX	UNIT
V_{KA}	Cathode voltage	$V_{I(ref)}$	36	V
I_{KA}	Cathode current	1	100	mA
T_A	Operating free-air temperature	–55	125	°C

7.4 Thermal Information

THERMAL METRIC[1]		TL1431-EP	UNIT
		D	
		8 PINS	
$R_{\theta JA(high)}$	Junction-to-ambient thermal resistance (high K board)	97	°C/W
$R_{\theta JA(low)}$	Junction-to-ambient thermal resistance (low K board)	165	

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

7.5 Dissipation Rating Table

PACKAGE	$T_A \leq 25°C$ POWER RATING	PACKAGE THERMAL IMPEDANCE	DERATING FACTOR ABOVE T_A = 25°C	T_A = 70°C ABSOLUTE MAXIMUM POWER RATING	T_A = 85°C ABSOLUTE MAXIMUM POWER RATING	T_A = 125°C ABSOLUTE MAXIMUM POWER RATING
D	1102 mW	97°C/W (High K board)	10 mW/°C	824 mW	670 mW	257 mW
		165°C/W (Low K board)	6 mW/°C	484 mW	393 mW	151 mW

7.6 Electrical Characteristics

at specified free-air temperature, I_{KA} = 10 mA (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A (1)	TEST CIRCUIT	MIN	TYP	MAX	UNIT
$V_{I(ref)}$	Reference input voltage	$V_{KA} = V_{I(ref)}$	25°C	Figure 8	2490	2500	2510	mV
			Full range		2470		2530	
$V_{I(dev)}$	Deviation of reference input voltage over full temperature range (2)	$V_{KA} = V_{I(ref)}$	Full range	Figure 8		17		mV
$\frac{\Delta V_{I(ref)}}{\Delta V_{KA}}$	Ratio of change in reference input voltage to the change in cathode voltage	ΔV_{KA} = 3 to 36 V	Full range	Figure 9		–1.1	–2	mV/V
$I_{I(ref)}$	Reference input current	R1 = 10 kΩ, R2 = ∞	25°C	Figure 9		1.5	2.5	µA
			Full range				4	
$I_{I(dev)}$	Deviation of reference input current over full temperature range (2)	R1 = 10 kΩ, R2 = ∞	Full range	Figure 9		0.5		µA
I_{min}	Minimum cathode current for regulation	$V_{KA} = V_{I(ref)}$	25°C	Figure 8		0.45	1	mA
I_{off}	Off-state cathode current	V_{KA} = 36 V, $V_{I(ref)}$ = 0	25°C	Figure 10		0.18	0.5	µA
			Full range				2	
$\lvert z_{KA} \rvert$	Output impedance (3)	$V_{KA} = V_{I(ref)}$, $f \le$ 1 kHz, I_{KA} = 1 to 100 mA	25°C	Figure 8		0.2	0.4	Ω

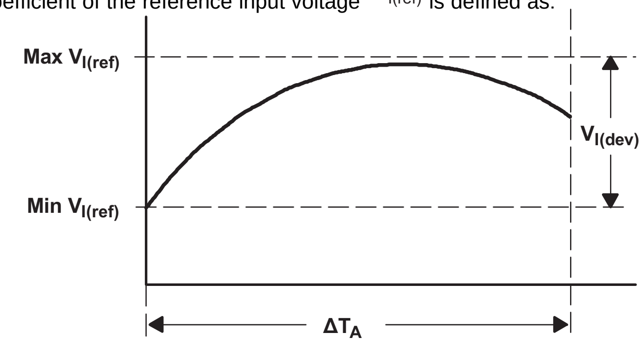
(1) Full range is –40°C to 125°C for Q-suffix devices; –55°C to 125°C for M-suffix devices.

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

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

where:

ΔT_A is the rated operating temperature range of the device.



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

(3) The output impedance is defined as: $z_{KA} = \frac{\Delta V_{KA}}{\Delta I_{KA}}$

When the device is operating with two external resistors (see Figure 9), the total dynamic impedance of the circuit is given by:

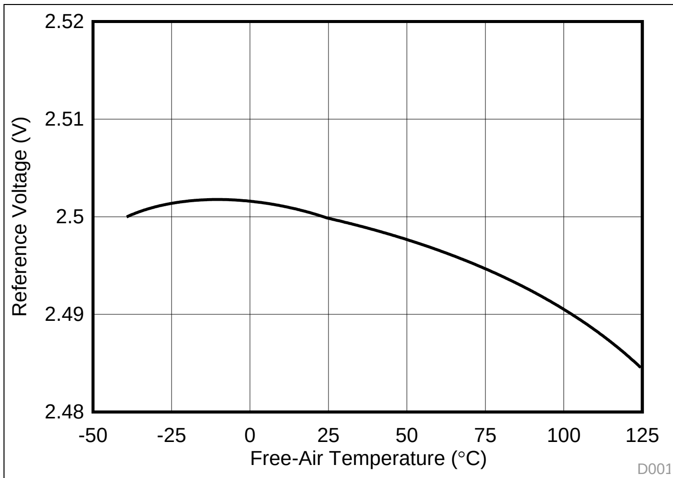
$|z'| = \frac{\Delta V}{\Delta I}$, which is approximately equal to $z_{KA} = \left(1 + \frac{R1}{R2}\right)$.

7.7 Typical Characteristics

Data at high and low temperatures are applicable only within the recommended operating free-air temperature range.

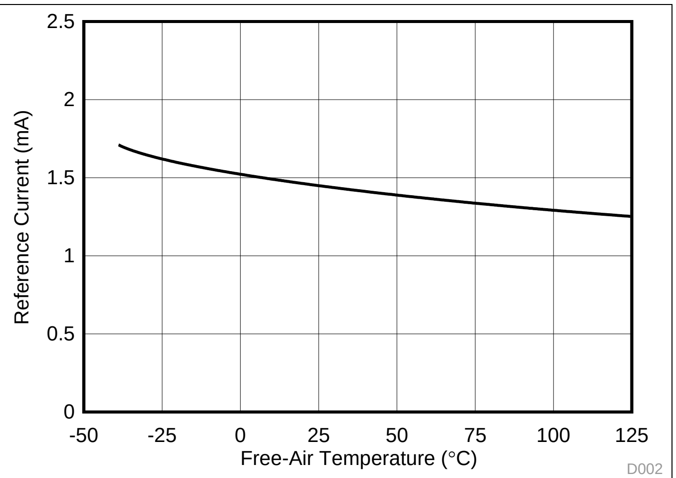
Table 1. Table of Graphs

GRAPH TITLE	FIGURE
Reference voltage vs Free-Air Temperature	Figure 1
Reference current vs Free-Air Temperature	Figure 2
Cathode Current vs Cathode Voltage	Figure 3, Figure 4
Off-State Cathode Current vs Free-Air Temperature	Figure 5
Ratio of Delta Reference Voltage to Delta Cathode Voltage vs Free-Air Temperature	Figure 6
Equivalent Input-Noise Voltage vs Frequency	Figure 7
Equivalent Input-Noise Voltage Over a 10-s Period	Figure 11
Small-Signal Voltage Amplification vs Frequency	Figure 13
Reference Impedance vs Frequency	Figure 15
Pulse Response	Figure 17
Stability Boundary Conditions	Figure 19



$V_{I(ref)} = V_{KA}$ I_{KA} = 10 mA

Figure 1. Reference Voltage vs Free-Air Temperature



I_{KA} = 10 mA   R1 = 10 kΩ   R2 = ∞

Figure 2. Reference Current vs Free-Air Temperature

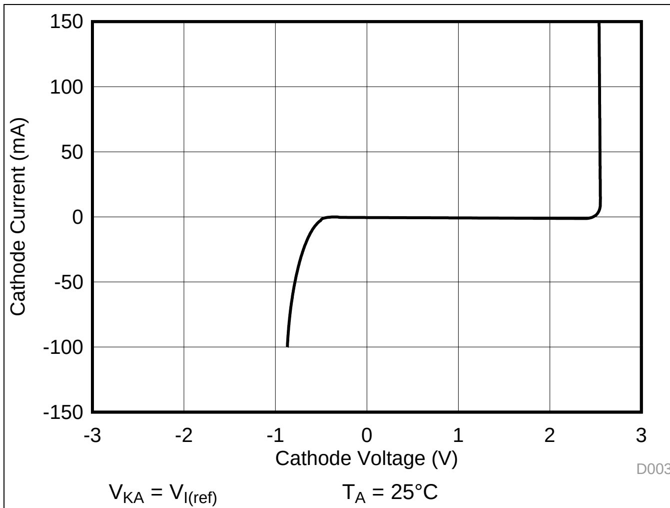


Figure 3. Cathode Current vs Cathode Voltage

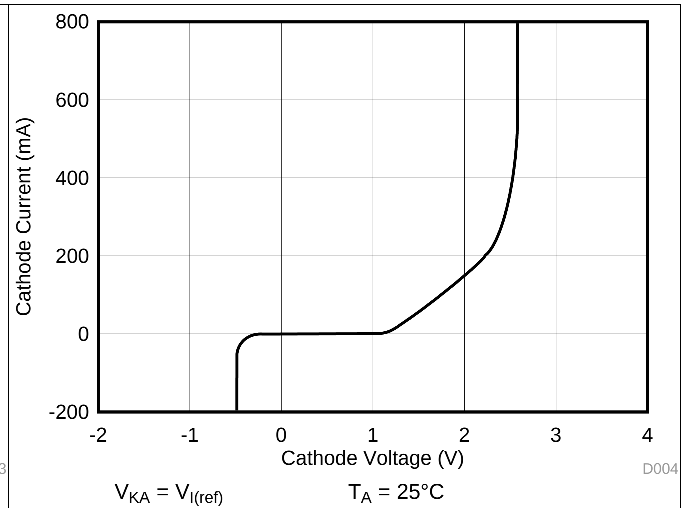


Figure 4. Cathode Current vs Cathode Voltage

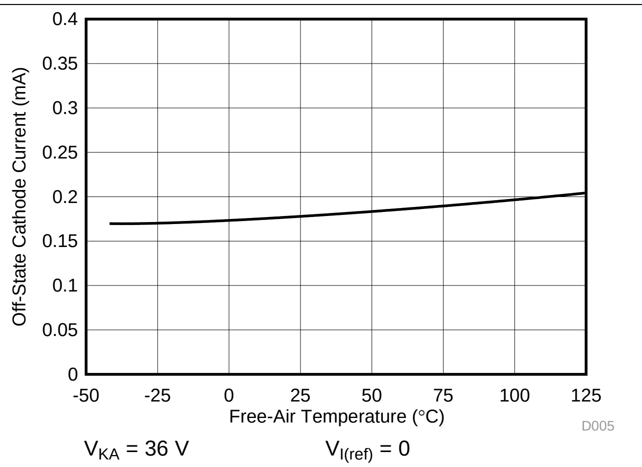


Figure 5. Off-State Cathode Current vs Free-Air Temperature

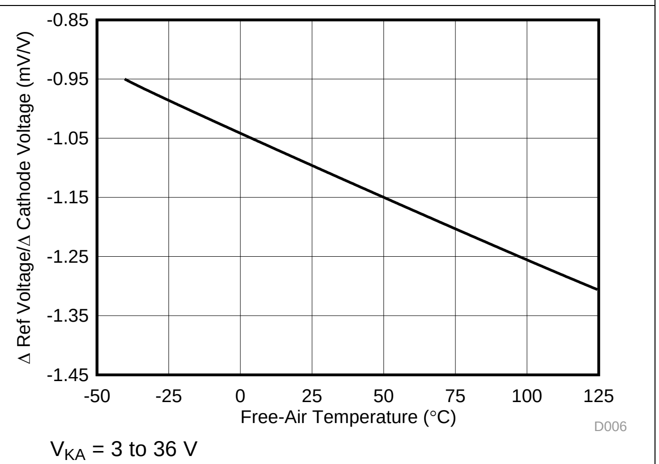


Figure 6. Ratio of Delta Reference Voltage to Delta Cathode Voltage vs Free-Air Temperature

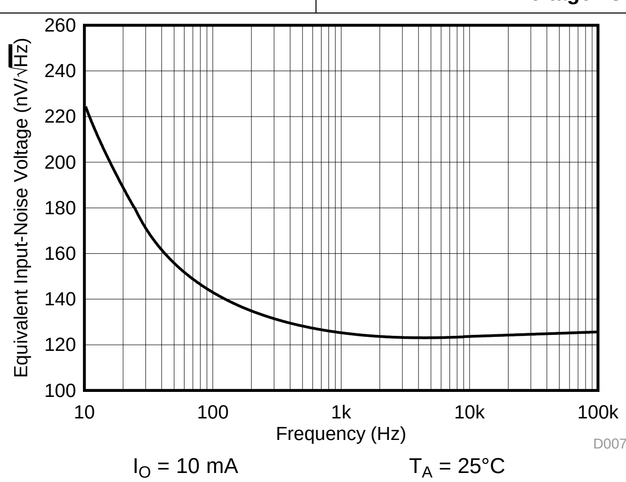


Figure 7. Equivalent Input-Noise Voltage vs Frequency

8 Parameter Measurement Information

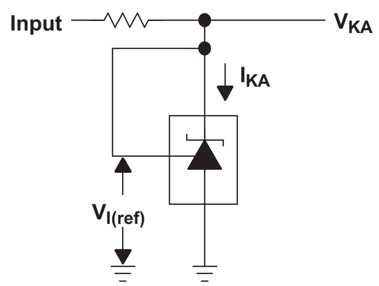


Figure 8. Test Circuit for $V_{(KA)} = V_{ref}$

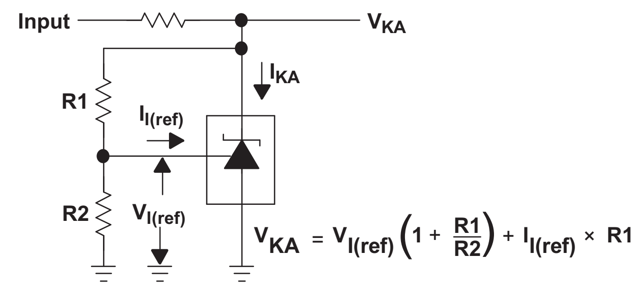


Figure 9. Test Circuit for $V_{(KA)} > V_{ref}$

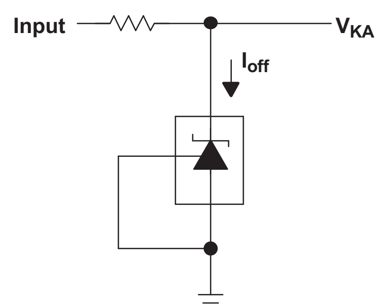


Figure 10. Test Circuit for I_{off}

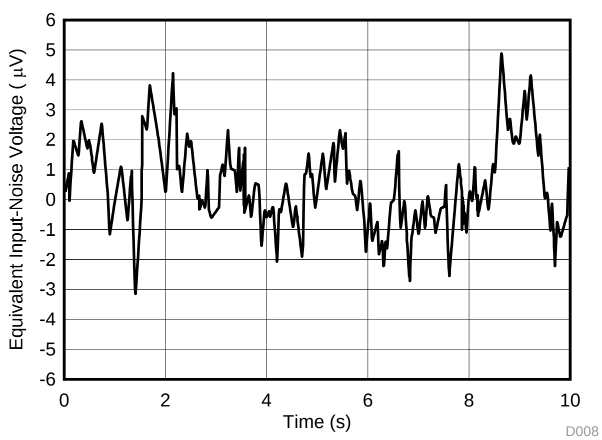


Figure 11. Equivalent Input-Noise Voltage Over a 10-s Period

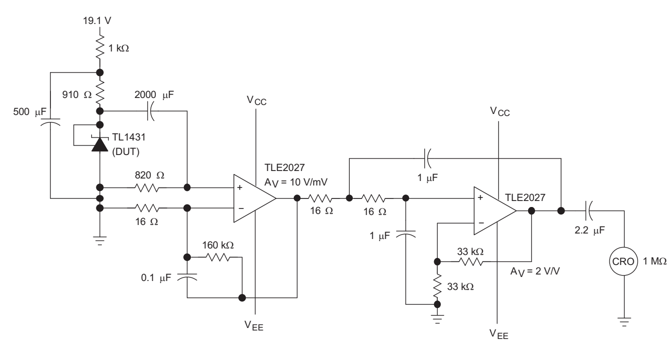


Figure 12. Test Circuit for 0.1- to 10-Hz Equivalent Input-Noise Voltage

Parameter Measurement Information (continued)

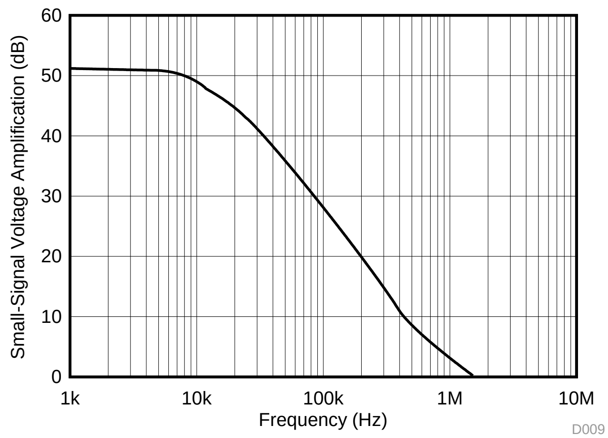


Figure 13. Small-Signal Voltage Amplification vs Frequency

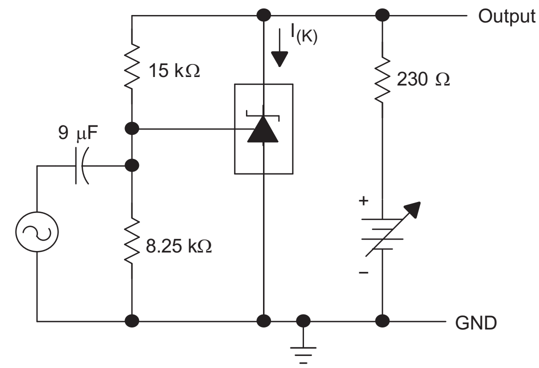


Figure 14. Test Circuit for Voltage Amplification

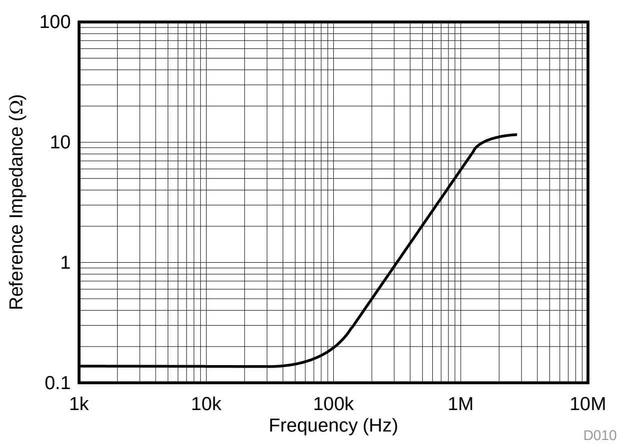


Figure 15. Reference Impedance vs Frequency

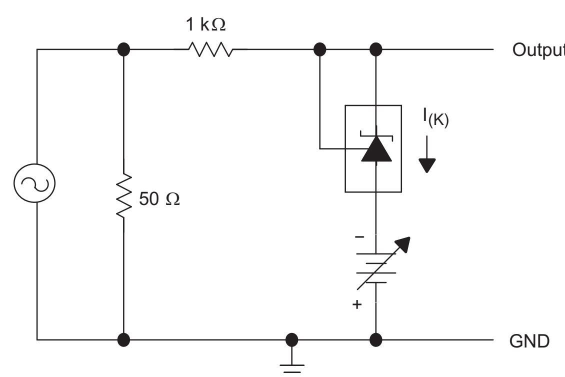


Figure 16. Test Circuit for Reference Impedance

Parameter Measurement Information (continued)

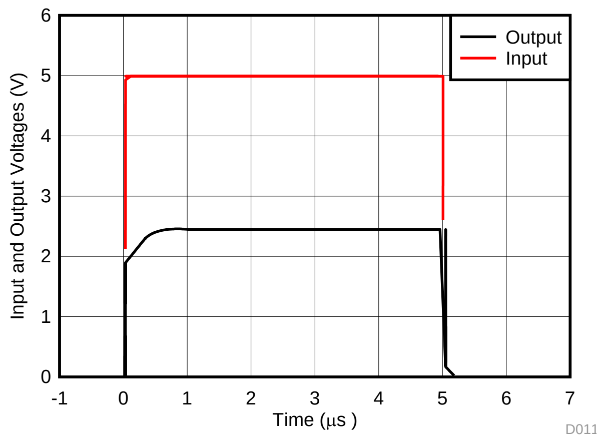


Figure 17. Pulse Response

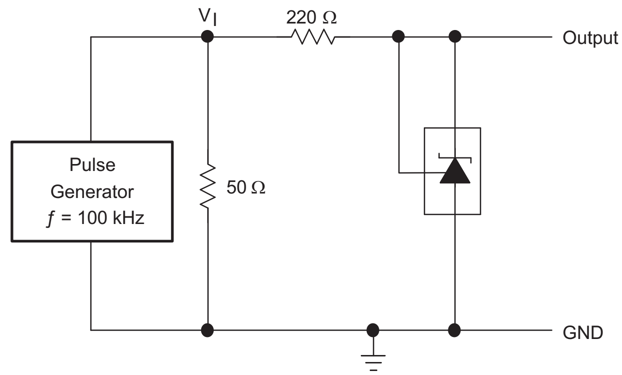


Figure 18. Test Circuit for Pulse Response

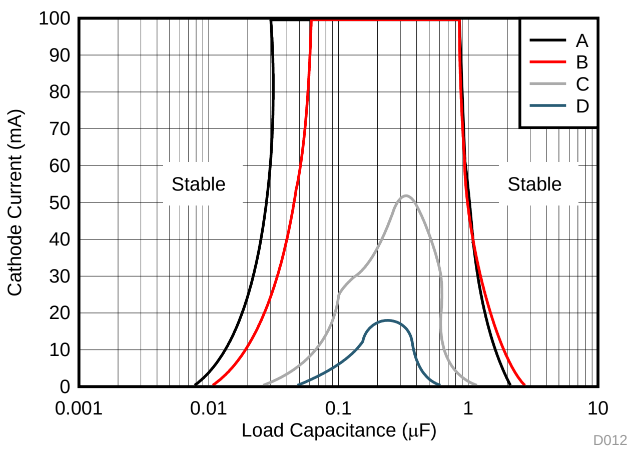


Figure 19. Stability Boundary Conditions

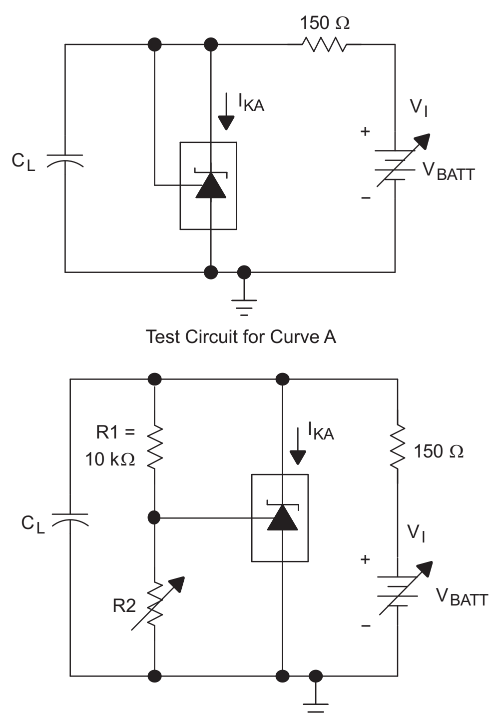


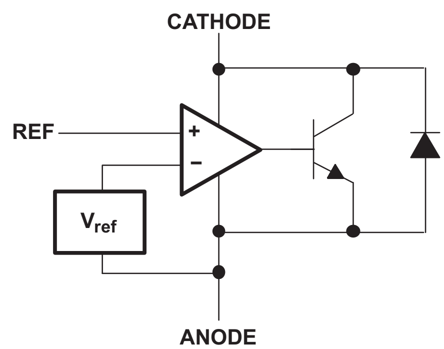
Figure 20. Test Circuits for Curves A through D

9 Detailed Description

9.1 Overview

The TL1431-EP is a precision-programmable reference with specified thermal stability over the military temperature range. The device can be used in a very wide array of applications, and can enter operational mode with as little as two external resistors.

9.2 Functional Block Diagram



9.3 Feature Description

The output voltage can be set to any value between $V_{I(ref)}$ and 36 V. Active output circuitry provides a very sharp turnon characteristic, making the device an excellent replacement for Zener diodes and other types of references in applications such as onboard regulation, adjustable power supplies, and switching power supplies.

TI's EP line is certified to the Aerospace Qualified Electronic Component (AQEC) Standard (ANSI/GEIA STD-0002-1). The AQEC Standard was jointly developed by the aerospace and semiconductor industries to define the minimum requirements for commercial-off-the-shelf (COTS) components used in military, avionic, aerospace, medical and other rugged operating environments where high-reliability and long service life are required.

9.4 Device Functional Modes

The device only has one functional mode, which is enabled at power up. Operation of the device is determined by external parameters described *Application and Implementation*.

10 Application and Implementation

NOTE

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

10.1 Application Information

The ability to set the shunt voltage, V_{KA}, to any voltage between V_{REF} and the maximum rated voltage for the shunt regulator provides a lot of flexibility. It takes two resistors to set the shunt voltage. In an ideal common anode shunt regulator, the shunt voltage would be $V_{REF} \times (R_1/R_2 + 1)$.

Real world shunt regulators have limited gain, non-zero reference input current, and suffer from cathode voltage modulation. This application report derives comprehensive formulas that accurately represent the relationship between the shunt voltage and feedback resistors. It also shows a practical example.

10.1.1 Shunt Regulator Limitations

Real world shunt regulators have three parameters that should be considered.

- Dynamic impedance, Z_{KA}
- Reference pin current, I_{REF}
- Ratio of change in reference voltage to the change in cathode voltage, $\Delta V_{REF}/\Delta V_{KA}$.

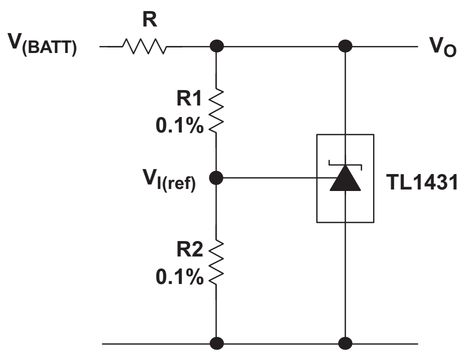
The first parameter will cause a V_{REF} shift for all V_{KA} values and the last two only apply when V_{KA}, is set greater than V_{REF}.

Z_{KA} offsets the V_{REF} in direct proportion to the cathode current. The data sheet generally specifies V_{REF} at a specific current. At any other current Z_{KA} impacts V_{REF}.

I_{REF} causes an inequality in the feedback resistor currents which changes the effective DC feedback ratio. This factor is often included in data sheet formulas.

$\Delta V_{REF}/\Delta V_{KA}$ specifies how much the V_{REF} voltage changes when the cathode voltage changes. This is a frequently ignored factor although the effect can be significant.

10.2 Typical Application



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

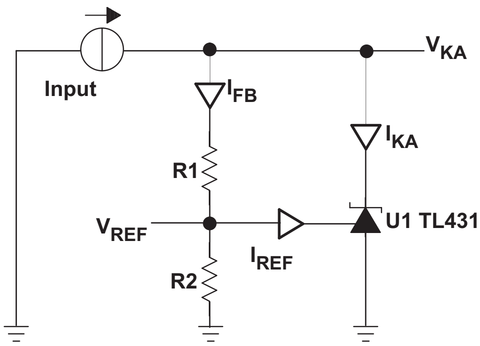
NOTE: R should provide cathode current ≥1 mA to the TL1431-EP at minimum $V_{(BATT)}$.

Figure 21. Shunt Regulator

Typical Application (continued)

10.2.1 Design Requirements

To calculate the values for resistors R_1 and R_2, the values of the following parameters must be known: the feedback current, (I_{FB}), cathode current, (I_{KA}), and desired shunt voltage, (V_{KA}).



The *Electrical Characteristics* table specifies when $V_{KA} = V_{REF}$ and I_{KA} is 10 mA the nominal V_{REF}, (labeled V_{NOM}) is 2.5 V. The reference voltage varies with cathode voltage at two different rates. The reference voltage is –1.1 mV/V from V_{REF} to 10 V then –1.5 mV/V above 10 V. The reference pin current is 4 µA.

The Z_{KA} parameter offsets V_{REF} by $(I_{KA} - I_{NOM}) \times Z_{KA}$.

In addition, the $\Delta V_{REF} / \Delta V_{KA}$ parameter offsets V_{REF} by either –1.1 mV × (V_{KA} – 2.5 V) if $V_{KA} \leq 10$ V or –8.25 mV –1.5 mV/V × (V_{KA} – 10 V) if V_{KA}>10 V. The –8.25-mV constant is the V_{REF} offset as V_{KA} changes from V_{NOM} to 10 V, (10 V – 2.5 V) × –1.1 mV/V.

Therefore:

If $V_{KA} \leq 10$ V then;

$$V_{REF} = V_{NOM} + (I_{KA} - I_{NOM}) \text{ x } Z_{KA} + (V_{KA} - V_{NOM}) \times -1.1 \text{ mV/V} \quad (1)$$

If $V_{KA} > 10$ then;

$$V_{REF} = V_{NOM} + (I_{KA} - I_{NOM}) \times Z_{KA} + (V_{KA} - 10 \text{ V}) \text{ x } -1.5 \text{ mV/V } -8.25 \text{ mV} \quad (2)$$

Now that the value of V_{REF} is calculated, use Equation 1 and Equation 2 to calculate the value of R_1 and R_2.

$$R_1 = (V_{KA} - V_{REF}) / I_{FB} \quad (3)$$

$$R_2 = V_{REF} / (I_{FB} - I_{REF}) \quad (4)$$

NOTE

R_2 has less current than R_1.

10.2.2 Detailed Design Procedure

The goal of the design is: the TL1431 cathode set to 12 V, the cathode current at 2 mA, and a feedback current of 0.2 mA.

Using the formula derived in the general example for V_{KA}>10 V.

$$V_{REF} = V_{NOM} + (I_{KA} - I_{NOM}) \times Z_{KA} + (V_{KA} - 10 \text{ V}) \times -1.1 \text{ mV} - 8.25 \text{ mV} \quad (5)$$

$$V_{REF} = 2.500 \text{ V} + (2 \text{ mA} - 10 \text{ mA}) \text{ x } 2\ \Omega + (12 \text{ V} - 10 \text{ V}) \times -1.1 \text{ mV} - 8.25 \text{ mV} \quad (6)$$

Using Equation 5 and Equation 6, the value of V_{REF} = 2.473 V

$$R_1 = (V_{KA} - V_{REF}) / I_{FB} \quad (7)$$

$$R_1 = (12 \text{ V} - 2.473 \text{ V}) / 0.2 \text{ mA} \quad (8)$$

Using Equation 7 and Equation 8, the value of R_1 = 46.285 kΩ

Typical Application (continued)

$$R_2 = V_{REF} / (I_{FB} - I_{REF}) \quad (9)$$
$$R_2 = 2.473\ V / (0.2\ mA - 4\ \mu A) \quad (10)$$

Using Equation 9 and Equation 10, the value of R_2 = 12.617 kΩ

The closest standard 1% resistor values are R_1 = 46.4 kΩ and R_2 = 12.7 kΩ. Other resistor combinations may provide a shunt voltage that is centered better. A formula to test for R_1 values that may be closer to standard values using standard R_2 resistors is $R_1 = (V_{KA} - V_{REF}) / (V_{REF} / R_2 + I_{REF})$.

10.2.3 Application Curves

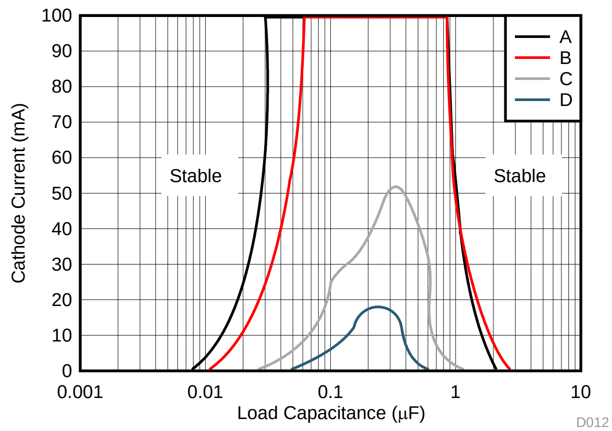


Figure 22. Stability Bounderies for load capacitance on Shunt Regulator

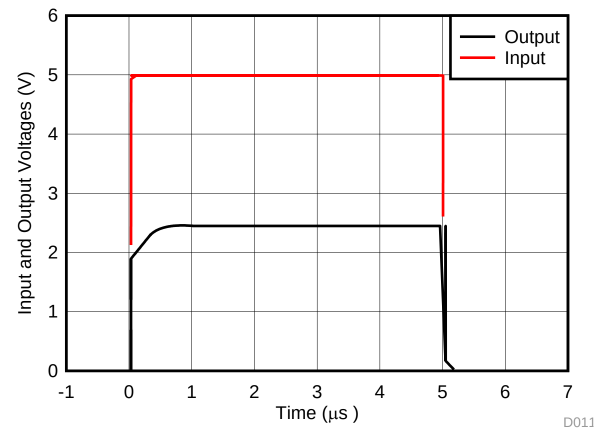


Figure 23. Pulse Response at Startup of Shunt Regulator

11 Power Supply Recommendations

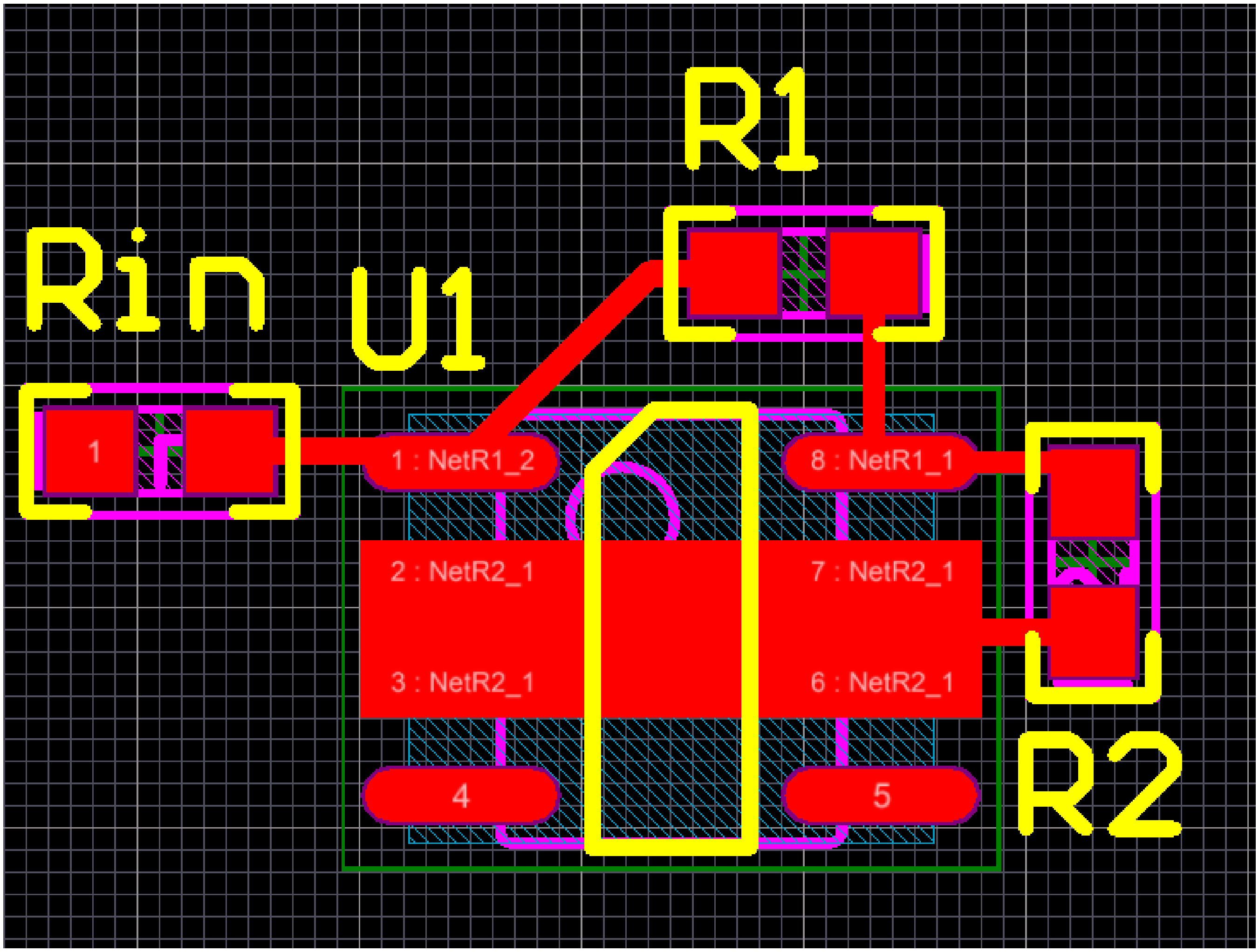
Do not exceed the values listed in the *Recommended Operating Conditions* and *Electrical Characteristics*. To ensure proper operation, deliver a minimum of 1 mA of current to the cathode. Ensure that the power source can provide at least 1 mA of current across the entire voltage range.

12 Layout

12.1 Layout Guidelines

Pins 2, 3, 6, and 7 are connected internally to the anode. For the most precision, tie these pins together externally as well. Resistors should be placed as close as possible to the device.

12.2 Layout Example



13 Device and Documentation Support

13.1 Trademarks

All trademarks are the property of their respective owners.

13.2 Electrostatic Discharge Caution

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.

13.3 Glossary

SLYZ022 — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

14 Mechanical, Packaging, and Orderable Information

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

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TL1431MDREP	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	1431ME	Samples
TL1431MDREPG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	1431ME	Samples
TL1431QDREP	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	1431QE	Samples
V62/04756-01XE	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	1431QE	Samples
V62/04756-02XE	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	1431ME	Samples

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

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

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

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

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

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

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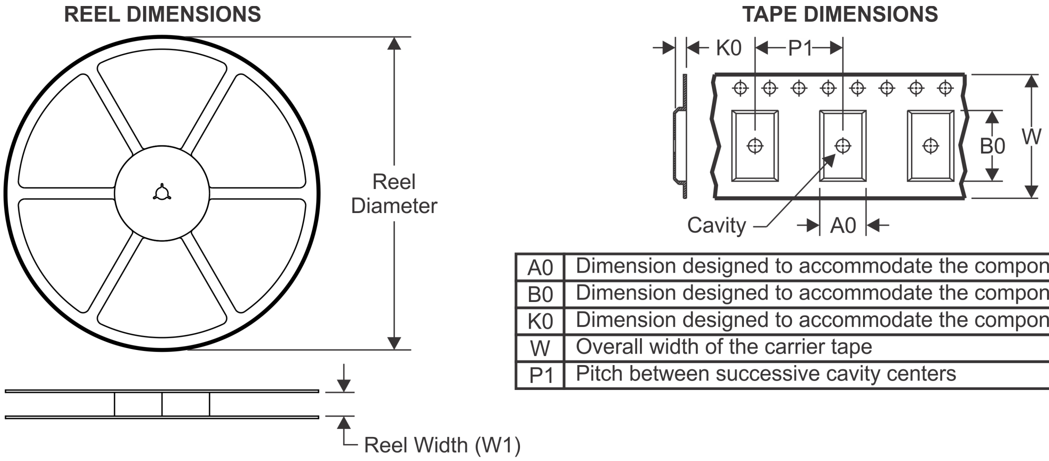
OTHER QUALIFIED VERSIONS OF TL1431-EP :

- Catalog: TL1431
- Automotive: TL1431-Q1
- Military: TL1431M
- Space: TL1431-SP

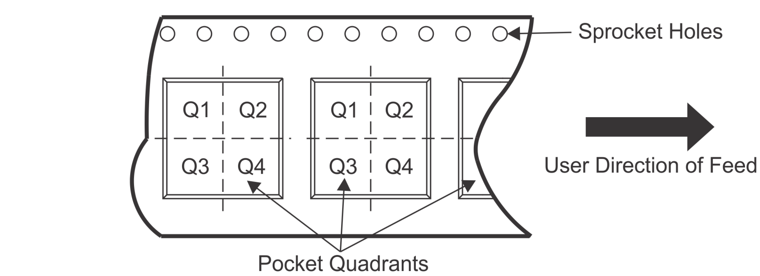
NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects
- Military - QML certified for Military and Defense Applications
- Space - Radiation tolerant, ceramic packaging and qualified for use in Space-based application

TAPE AND REEL INFORMATION



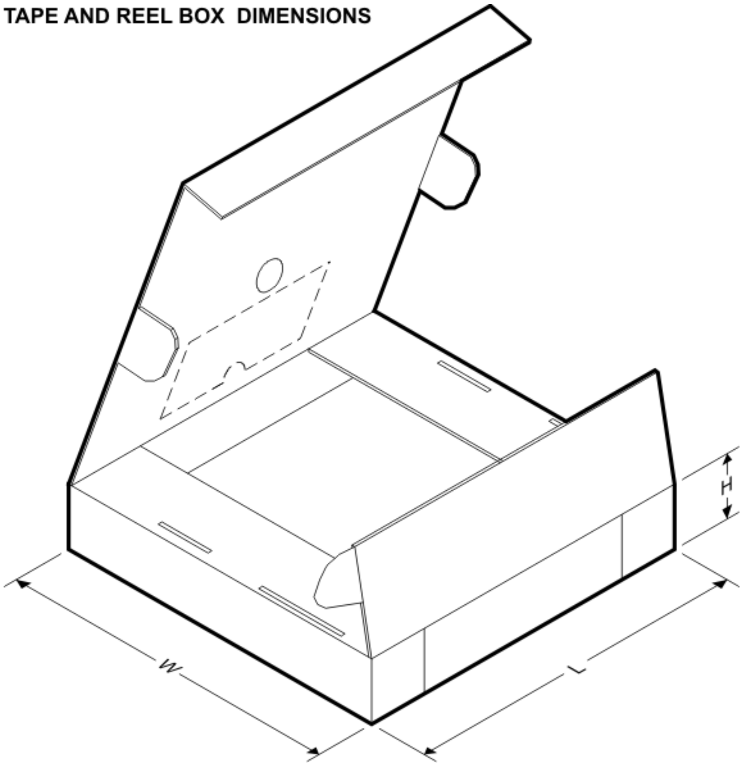
A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers



*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
TL1431MDREP	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL1431QDREP	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1

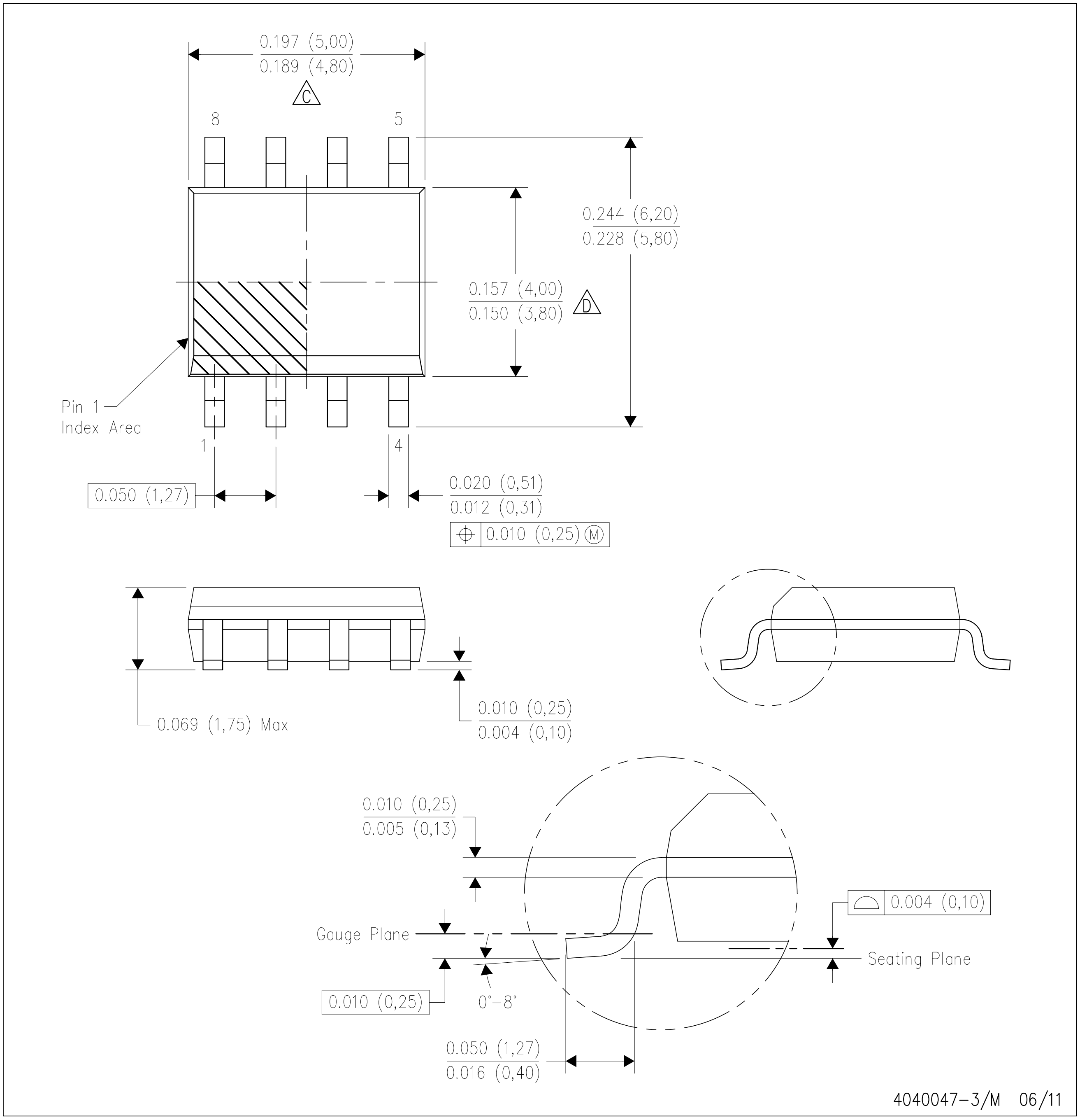
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

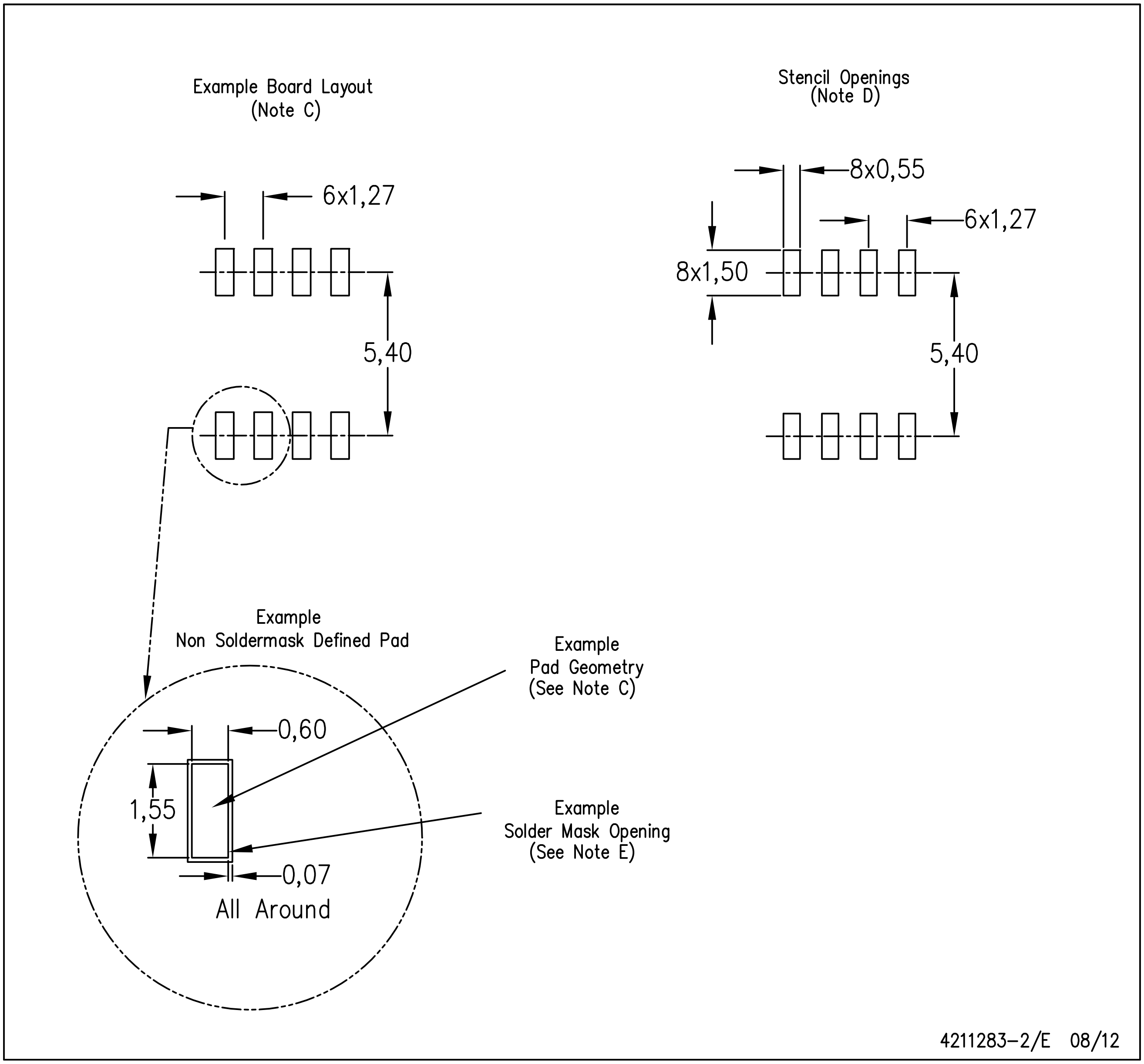
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TL1431MDREP	SOIC	D	8	2500	367.0	367.0	35.0
TL1431QDREP	SOIC	D	8	2500	367.0	367.0	35.0

D (R–PDSO–G8) PLASTIC SMALL OUTLINE



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

D (R-PDSO-G8) PLASTIC SMALL OUTLINE



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

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