

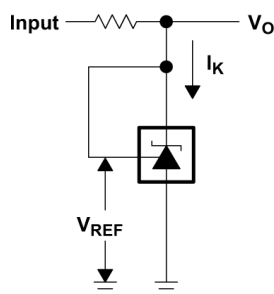
TLV431x 低電圧、可変、高精度シャントレギュレータ

1 特長

- 低電圧動作、 $V_{REF} = 1.24V$
- 可変出力電圧、 $V_O = V_{REF} \sim 6V$
- 25°Cでのリファレンス電圧の公差
 - TLV431B: 0.5%
 - TLV431A: 1%
 - TLV431: 1.5%
- 温度ドリフト (標準値)
 - 4mV (0°C~70°C)
 - 6mV (-40°C~85°C)
 - 11mV (-40°C~125°C)
- 低い動作カソード電流: 80μA (標準値)
- 出力インピーダンス: 0.25Ω (標準値)
- 超小型の SC-70 パッケージで、SOT-23-3 よりも 40% 小さい占有面積
- TLVH431 および TLVH432 の特長
 - 広い V_{KA} (1.24V~18V) と I_K (80mA)
 - SOT-89 パッケージでも供給
 - SOT-23-3 および SOT-89 パッケージで複数のピン配置を選択可能
- MIL-PRF-38535 準拠の製品については、特に記述のない限り、すべてのパラメータはテスト済みです。その他のすべての製品については、量産プロセスにすべてのパラメータのテストが含まれているとは限りません。

2 アプリケーション

- 調整可能な基準電圧および電流
- フライバック SMPS の 2 次側レギュレーション
- ツェナーの代替品
- 電圧監視
- リファレンス電圧内蔵のコンパレータ



概略回路図

3 概要

TLV431 デバイスは低電圧、3 端子の可変電圧リファレンスであり、該当する産業用および民生用温度範囲全体にわたって規定の熱的安定性を維持します。出力電圧は、2 つの外付け抵抗により V_{REF} (1.24V) と 6V の間の任意の値に設定できます (「パラメータ測定情報」セクションを参照)。これらのデバイスは、広く使用されている TL431 および TL1431 シャントレギュレータ基準電圧よりも低い電圧 (1.24V) で動作します。

オプトカプラとともに使用すると、TLV431 は 3V~3.3V のスイッチングモード電源用の絶縁フィードバック回路における理想的な基準電圧です。これらのデバイスの出力インピーダンスは 0.25Ω (標準値) です。アクティブ出力回路により、非常に鋭いターンオン特性を持つことから、オンボードレギュレーションや可変電源など多くのアプリケーションにおいて、低電圧ツェナーダイオードの非常に優れた代替品となります。

パッケージ情報

部品番号	パッケージ (1)	パッケージサイズ (2)
TLV431	DBZ (SOT-23, 3)	2.92mm × 2.37mm
	DBV (SOT-23, 5)	2.90mm × 2.8mm
	LP (TO-92, 3)	5.2mm × 3.68mm
	PK (SOT-89, 3)	4.5mm × 4.095mm
TLV431A	DBV (SOT-23, 5)	2.90mm × 2.8mm
	DBZ (SOT-23, 3)	2.92mm × 2.37mm
	PK (SOT-89, 3)	4.5mm × 4.095mm
	LP (TO-92, 3)	5.2mm × 3.68mm
	D (SOIC, 8)	4.9mm × 6mm
TLV431B	DBV (SOT-23, 5)	2.90mm × 2.8mm
	DBZ (SOT-23, 3)	2.92mm × 2.37mm
	PK (SOT-89, 3)	4.5mm × 4.095mm
	LP (TO-92, 3)	5.2mm × 3.68mm
	DCK (SOT-SC70, 6)	2mm × 1.5mm

- 利用可能なすべてのパッケージについては、データシートの末尾にある注文情報を参照してください。
- パッケージサイズ (長さ×幅) は公称値であり、該当する場合はピンも含まれます



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4 Pin Configuration and Functions

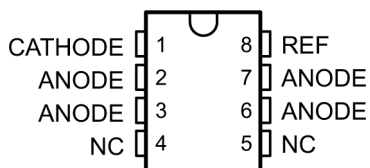
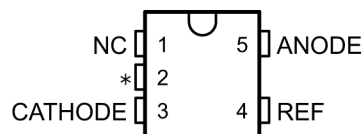


図 4-1. D (SOIC) Package
(Top View)



NC – No internal connection

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

図 4-2. DBV (SOT-23-5) Package
(Top View)

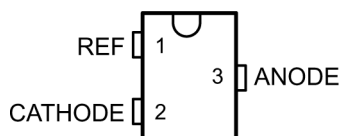


図 4-3. DBZ (SOT-23-3) Package
(Top View)

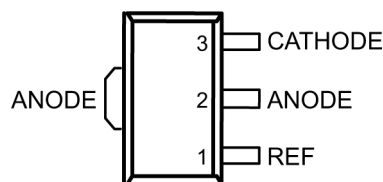
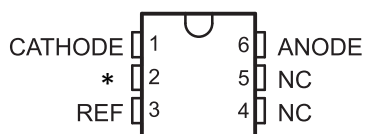


図 4-4. PK (SOT-89) Package
(Top View)



NC – No internal connection

* - Must be connected to ANODE or left open

図 4-5. DCK (SC-70) Package
(Top View)

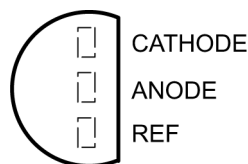


図 4-6. LP (TO-92/TO-226) Package
(Top View)

表 4-1. Pin Functions

NAME	PIN						TYPE	DESCRIPTION
	DBZ	DBV	PK	D	LP	DCK		
CATHODE	2	3	3	1	1	1	I/O	Shunt Current/Voltage input
REF	1	4	1	8	3	3	I	Threshold relative to common anode
ANODE	3	5	2	2, 3, 6, 7	2	6	O	Common pin, normally connected to ground
NC	—	1	—	4, 5	—	4, 5	I	No Internal Connection
*	—	2	—	—	—	2	I	Substrate Connection. Must be connected to ANODE or left open.

5 Specifications

5.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
V_{KA}	Cathode voltage ⁽²⁾		7	V
I_K	Continuous cathode current	–20	20	mA
I_{ref}	Reference current	–0.05	3	mA
	Operating virtual junction temperature		150	°C
T_{stg}	Storage temperature	–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) Voltage values are with respect to the anode terminal, unless otherwise noted.

5.2 ESD Ratings

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

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

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

5.3 Recommended Operating Conditions

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

			MIN	MAX	UNIT
V_{KA}	Cathode voltage		V_{REF}	6	V
I_K	Cathode current		0.1	15	mA
T_A	Operating free-air temperature	TLV431_C	0	70	°C
		TLV431_I	–40	85	
		TLV431_Q	–40	125	

5.4 Thermal Information

THERMAL METRIC ⁽¹⁾		TLV431x						UNIT
		DCK	D	PK	DBV	DBZ	LP	
		6 PINS	8 PINS	3 PINS	5 PINS	3 PINS	3 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	87	97	52	206	206	140	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	259	39	9	131	76	55	°C/W

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

5.5 Electrical Characteristics for TLV431

at 25°C free-air temperature (unless otherwise noted)

PARAMETER	TEST CONDITIONS	TLV431			UNIT
		MIN	TYP	MAX	
V_{REF} Reference voltage	$V_{KA} = V_{REF}$, $I_K = 10\text{mA}$	$T_A = 25^\circ\text{C}$		1.222 1.24 1.258	V
		$T_A = \text{full range}^{(1)}$ (see 6-1)			
		TLV431C		1.21 1.27	
		TLV431Q		1.202 1.278	
$V_{REF(\text{dev})}$ V_{REF} deviation over full temperature range ⁽²⁾	$V_{KA} = V_{REF}$, $I_K = 10\text{mA}$ ⁽¹⁾ (see 6-1)		TLV431C	4 12	mV
			TLV431I	6 20	
			TLV431Q	11 31	
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$ Ratio of V_{REF} change in cathode voltage change	$V_{KA} = V_{REF}$ to 6V, $I_K = 10\text{mA}$ (see 6-2)			-1.5 -2.7	mV/V
I_{ref} Reference terminal current	$I_K = 10\text{mA}$, $R1 = 10\text{k}\Omega$, $R2 = \text{open}$ (see 6-2)			0.15 0.5	μA
$I_{ref(\text{dev})}$ I_{ref} deviation over full temperature range ⁽²⁾	$I_K = 10\text{mA}$, $R1 = 10\text{k}\Omega$, $R2 = \text{open}$ ⁽¹⁾ (see 6-2)		TLV431C	0.05 0.3	μA
			TLV431I	0.1 0.4	
			TLV431Q	0.15 0.5	
$I_{K(\text{min})}$ Minimum cathode current for regulation	$V_{KA} = V_{REF}$ (see 6-1)		TLV431C/I	55 80	μA
			TLV431Q	55 100	
$I_{K(\text{off})}$ Off-state cathode current	$V_{REF} = 0$, $V_{KA} = 6\text{V}$ (see 6-3)			0.001 0.1	μA
$ z_{KA} $ Dynamic impedance ⁽³⁾	$V_{KA} = V_{REF}$, $f \leq 1\text{kHz}$, $I_K = 0.1\text{mA}$ to 15mA (see 6-1)			0.25 0.4	Ω

(1) Full temperature ranges are -40°C to 125°C for TLV431Q, -40°C to 85°C for TLV431I, and 0°C to 70°C for TLV431C.

(2) The deviation parameters $V_{REF(\text{dev})}$ and $I_{ref(\text{dev})}$ 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, αV_{REF} , is defined as:

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

where ΔT_A is the rated operating free-air temperature range of the device. αV_{REF} can be positive or negative, depending on whether minimum V_{REF} or maximum V_{REF} , respectively, occurs at the lower temperature.

$$|z_{ka}| = \frac{\Delta V_{KA}}{\Delta I_K}$$

(3) The dynamic impedance is defined as $|z_{ka}|$. When the device is operating with two external resistors (see [6-2](#)), the total

dynamic impedance of the circuit is defined as:

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

5.6 Electrical Characteristics for TLV431A

at 25°C free-air temperature (unless otherwise noted)

PARAMETER	TEST CONDITIONS		TLV431A			UNIT
			MIN	TYP	MAX	
V_{REF} Reference voltage	$V_{KA} = V_{REF}$, $I_K = 10\text{mA}$	$T_A = 25^\circ\text{C}$	1.228	1.24	1.252	V
		$T_A = \text{full range}^{(1)}$ (see Figure 6-1)	1.221		1.259	
			1.215		1.265	
			1.209		1.271	
$V_{REF(\text{dev})}$ V_{REF} deviation over full temperature range ⁽²⁾	$V_{KA} = V_{REF}$, $I_K = 10\text{mA}$ ⁽¹⁾ (see Figure 6-1)	TLV431AC		4	12	mV
		TLV431AI		6	20	
		TLV431AQ		11	31	
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$ Ratio of V_{REF} change in cathode voltage change	$V_{KA} = V_{REF}$ to 6V, $I_K = 10\text{mA}$ (see Figure 6-2)			-1.5	-2.7	mV/V
I_{ref} Reference terminal current	$I_K = 10\text{mA}$, $R_1 = 10\text{k}\Omega$, $R_2 = \text{open}$ (see Figure 6-2)			0.15	0.5	μA
$I_{ref(\text{dev})}$ I_{ref} deviation over full temperature range ⁽²⁾	$I_K = 10\text{mA}$, $R_1 = 10\text{k}\Omega$, $R_2 = \text{open}$ ⁽¹⁾ (see Figure 6-2)	TLV431AC		0.05	0.3	μA
		TLV431AI		0.1	0.4	
		TLV431AQ		0.15	0.5	
$I_{K(\text{min})}$ Minimum cathode current for regulation	$V_{KA} = V_{REF}$ (see Figure 6-1)	TLV431AC/AI		55	80	μA
		TLV431AQ		55	100	
$I_{K(\text{off})}$ Off-state cathode current	$V_{REF} = 0$, $V_{KA} = 6\text{V}$ (see Figure 6-3)			0.001	0.1	μA
$ z_{KA} $ Dynamic impedance ⁽³⁾	$V_{KA} = V_{REF}$, $f \leq 1\text{kHz}$, $I_K = 0.1\text{mA}$ to 15mA (see Figure 6-1)			0.25	0.4	Ω

(1) Full temperature ranges are -40°C to 125°C for TLV431Q, -40°C to 85°C for TLV431I, and 0°C to 70°C for TLV431C.

(2) The deviation parameters $V_{REF(\text{dev})}$ and $I_{ref(\text{dev})}$ 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, αV_{REF} , is defined as:

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

where ΔT_A is the rated operating free-air temperature range of the device. αV_{REF} can be positive or negative, depending on whether minimum V_{REF} or maximum V_{REF} , respectively, occurs at the lower temperature.

$$|z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_K}$$

(3) The dynamic impedance is defined as $|z_{KA}|$. When the device is operating with two external resistors (see [Figure 6-2](#)), the total

dynamic impedance of the circuit is defined as:

$$|z_{KA}|' = \frac{\Delta V}{\Delta I} \approx |z_{KA}| \times \left(1 + \frac{R_1}{R_2} \right)$$

5.7 Electrical Characteristics for TLV431B

at 25°C free-air temperature (unless otherwise noted)

PARAMETER	TEST CONDITIONS		TLV431B			UNIT
			MIN	TYP	MAX	
V_{REF} Reference voltage	$V_{KA} = V_{REF}$, $I_K = 10\text{mA}$	$T_A = 25^\circ\text{C}$	1.234	1.24	1.246	V
		$T_A = \text{full range}^{(1)}$ (see 6-1)	1.227		1.253	
			1.224		1.259	
			1.221		1.265	
$V_{REF(\text{dev})}$ V_{REF} deviation over full temperature range ⁽²⁾	$V_{KA} = V_{REF}$, $I_K = 10\text{mA}^{(1)}$ (see 6-1)	TLV431BC		4	12	mV
		TLV431BI		6	20	
		TLV431BQ		11	31	
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$ Ratio of V_{REF} change in cathode voltage change	$V_{KA} = V_{REF}$ to 6V, $I_K = 10\text{mA}$ (see 6-2)			-1.5	-2.7	mV/V
I_{ref} Reference terminal current	$I_K = 10\text{mA}$, $R1 = 10\text{k}\Omega$, $R2 = \text{open}$ (see 6-2)			0.1	0.5	μA
$I_{ref(\text{dev})}$ I_{ref} deviation over full temperature range ⁽²⁾	$I_K = 10\text{mA}$, $R1 = 10\text{k}\Omega$, $R2 = \text{open}^{(3)}$ (see 6-2)	TLV431BC		0.05	0.3	μA
		TLV431BI		0.1	0.4	
		TLV431BQ		0.15	0.5	
$I_{K(\text{min})}$ Minimum cathode current for regulation	$V_{KA} = V_{REF}$ (see 6-1)			55	100	μA
$I_{K(\text{off})}$ Off-state cathode current	$V_{REF} = 0$, $V_{KA} = 6\text{V}$ (see 6-3)			0.001	0.1	μA
$ z_{KA} $ Dynamic impedance ⁽⁴⁾	$V_{KA} = V_{REF}$, $f \leq 1\text{kHz}$, $I_K = 0.1\text{mA}$ to 15mA (see 6-1)			0.25	0.4	Ω

- (1) Full temperature ranges are -40°C to 125°C for TLV431Q, -40°C to 85°C for TLV431I, and 0°C to 70°C for TLV431C.
(2) The deviation parameters $V_{REF(\text{dev})}$ and $I_{ref(\text{dev})}$ 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, αV_{REF} , is defined as:

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

where ΔT_A is the rated operating free-air temperature range of the device. αV_{REF} can be positive or negative, depending on whether minimum V_{REF} or maximum V_{REF} , respectively, occurs at the lower temperature.

- (3) Full temperature ranges are -40°C to 125°C for TLV431Q, -40°C to 85°C for TLV431I, and 0°C to 70°C for TLV431C.

- (4) dynamic impedance is defined as $|z_{ka}| = \frac{\Delta V_{KA}}{\Delta I_K}$. When the device is operating with two external resistors (see [6-2](#)), the total

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

dynamic impedance of the circuit is defined as:

5.8 Typical Characteristics

Operation of the device at these or any other conditions beyond those indicated in the *Recommended Operating Conditions* table are not implied.

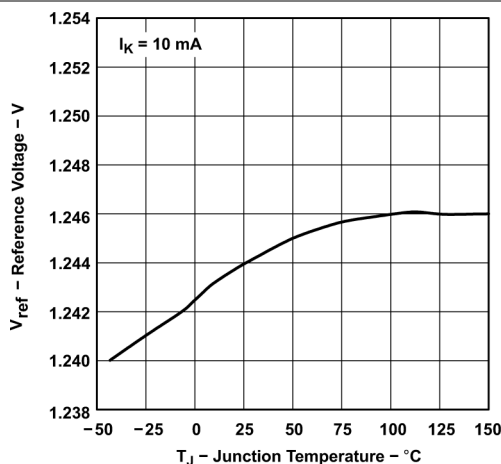


Figure 5-1. Reference Voltage vs Junction Temperature

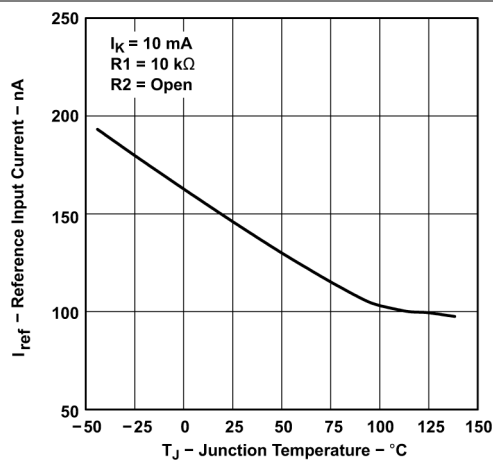


Figure 5-2. Reference Input Current vs Junction Temperature (for TLV431 and TLV431A)

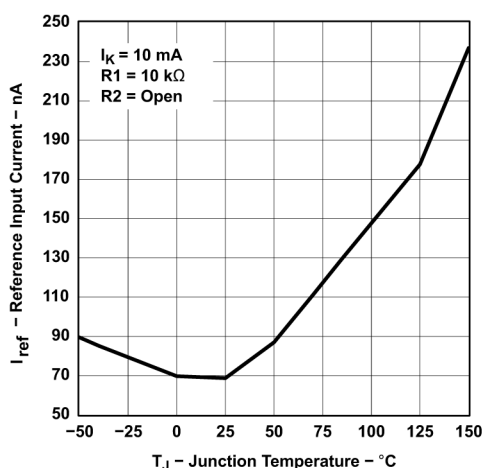


Figure 5-3. Reference Input Current vs Junction Temperature (for TLV431B)

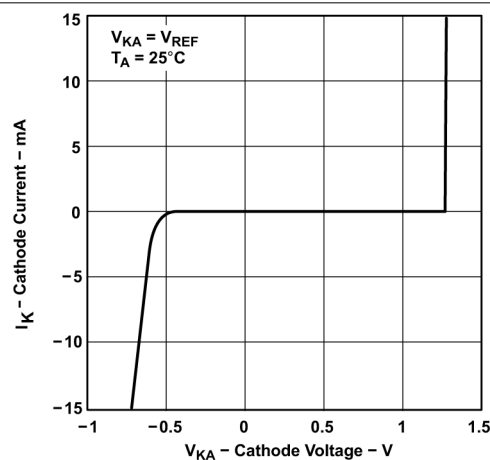


Figure 5-4. Cathode Current vs Cathode Voltage

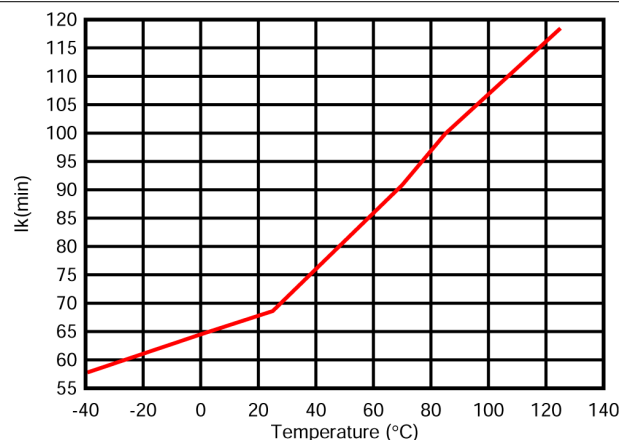


Figure 5-5. Minimum Cathode Current vs Temperature

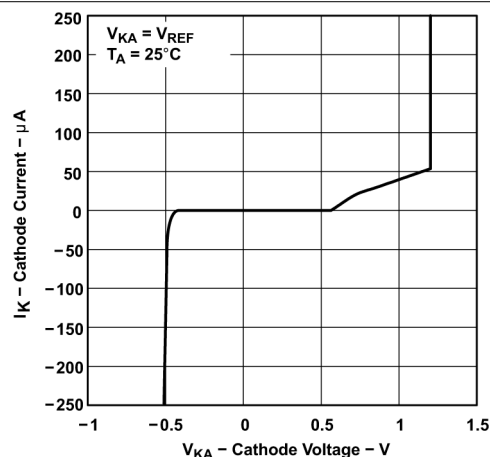


Figure 5-6. Cathode Current vs Cathode Voltage

5.8 Typical Characteristics (continued)

Operation of the device at these or any other conditions beyond those indicated in the *Recommended Operating Conditions* table are not implied.

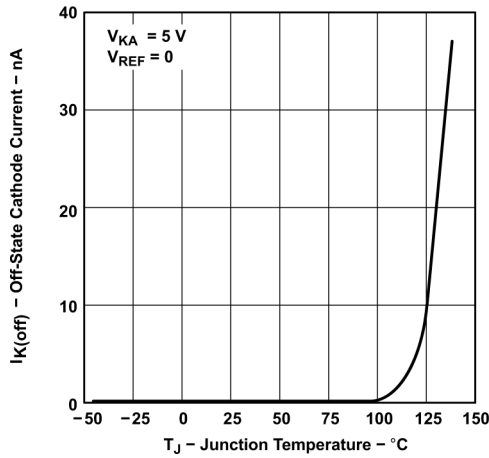


図 5-7. Off-State Cathode Current vs Junction Temperature (for TLV431 and TLV431A)

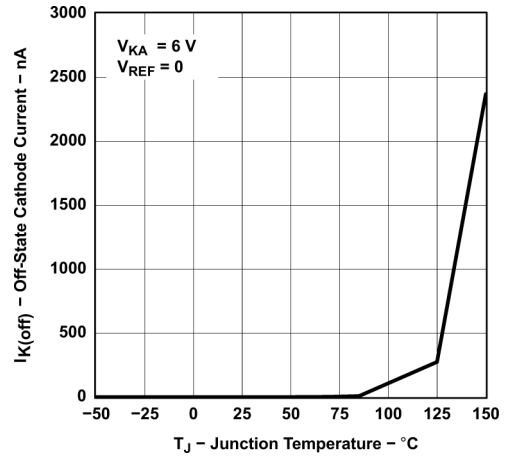


図 5-8. Off-State Cathode Current vs Junction Temperature (for TLV431B)

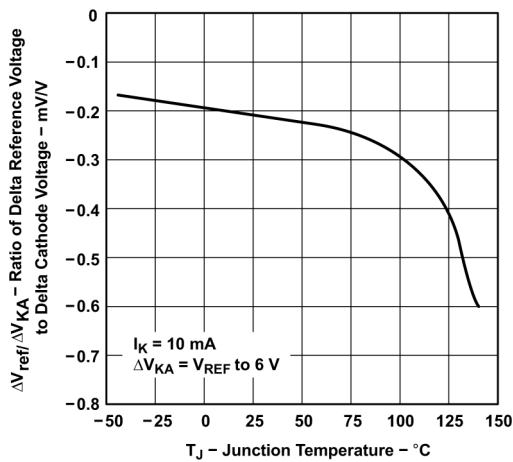


図 5-9. Ratio of Delta Reference Voltage to Delta Cathode Voltage vs Junction Temperature (for TLV431 and TLV431A)

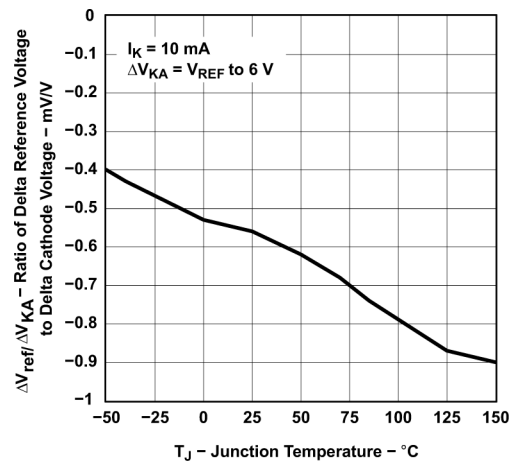


図 5-10. Ratio of Delta Reference Voltage to Delta Cathode Voltage vs Junction Temperature (for TLV431B)

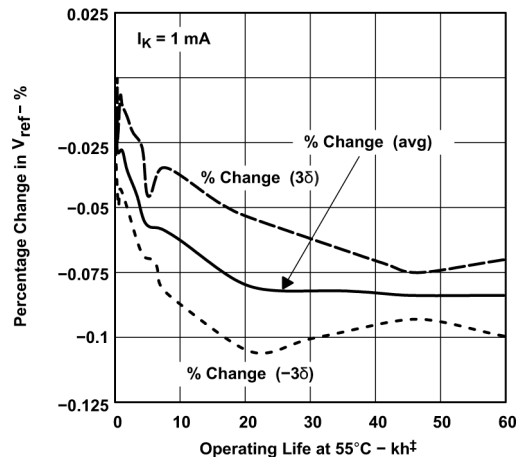
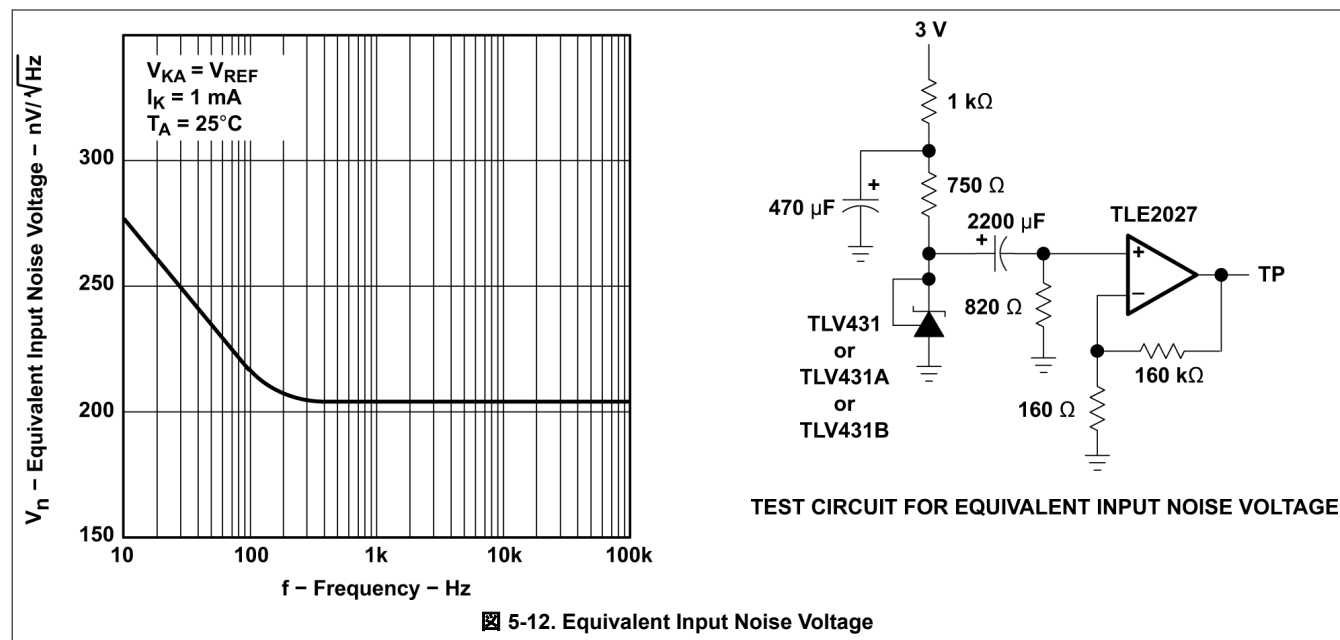


図 5-11. Percentage Change in v_{REF} vs Operating Life at 55°C

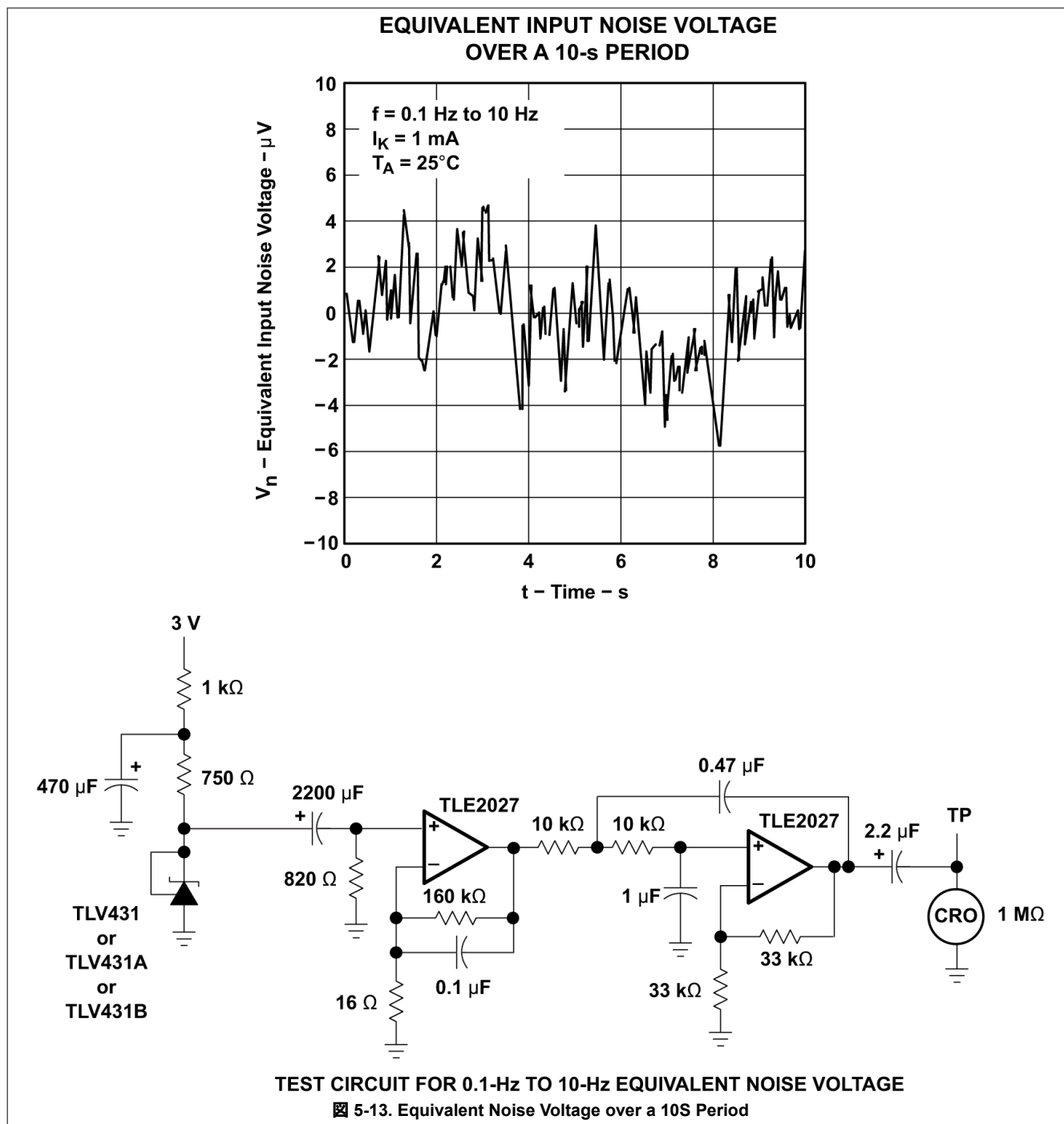
5.8 Typical Characteristics (continued)

Operation of the device at these or any other conditions beyond those indicated in the *Recommended Operating Conditions* table are not implied.



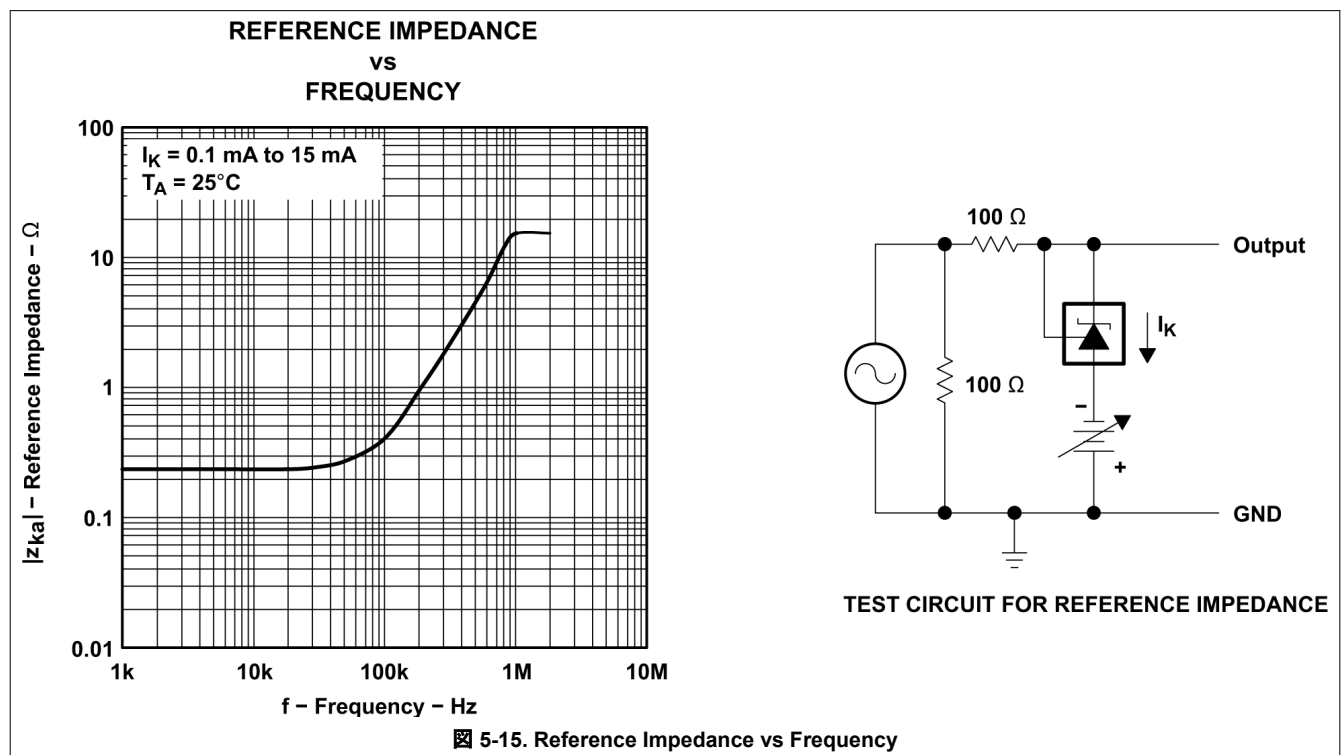
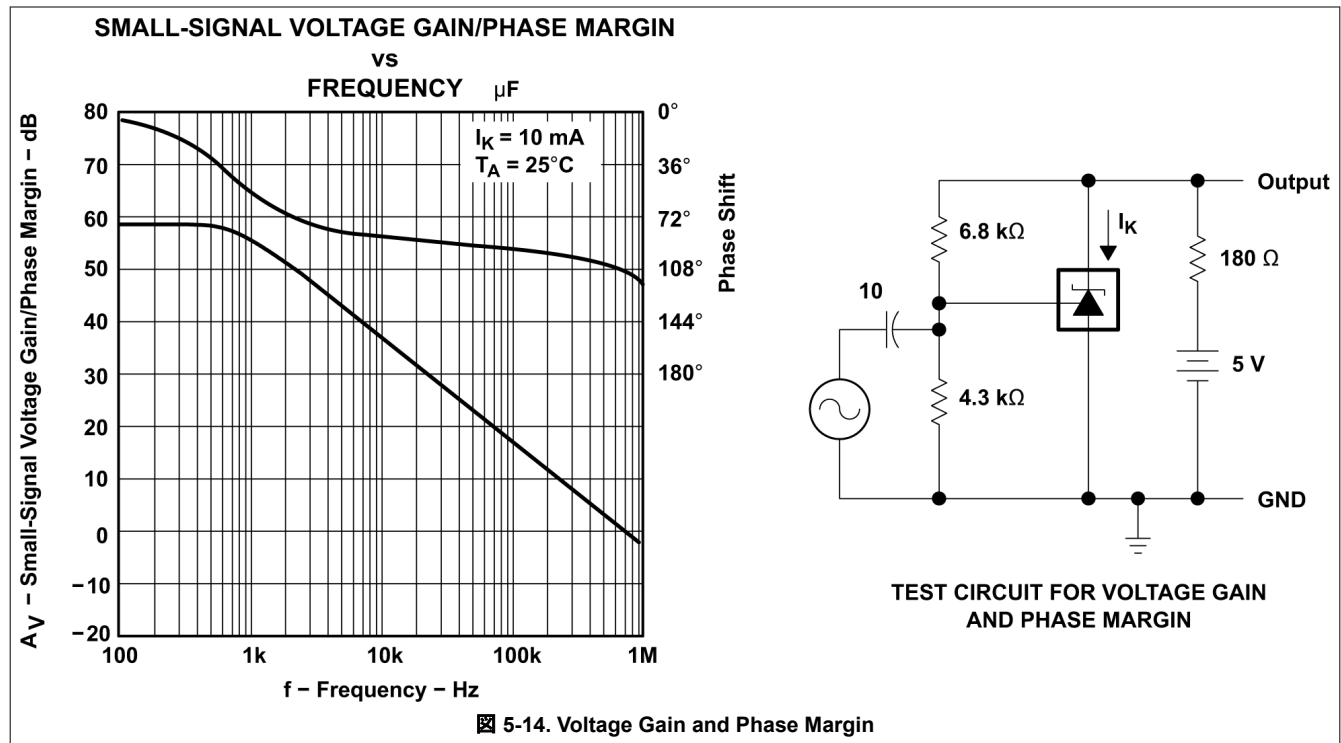
5.8 Typical Characteristics (continued)

Operation of the device at these or any other conditions beyond those indicated in the *Recommended Operating Conditions* table are not implied.



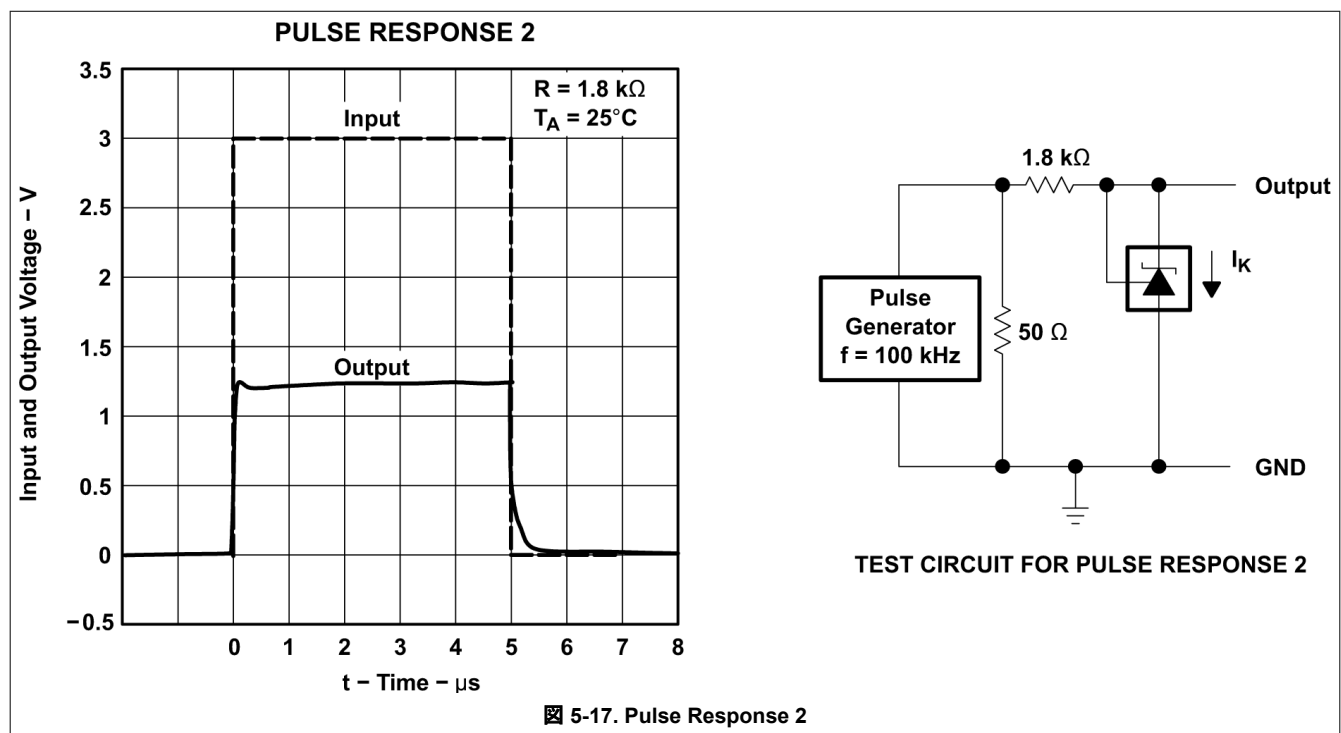
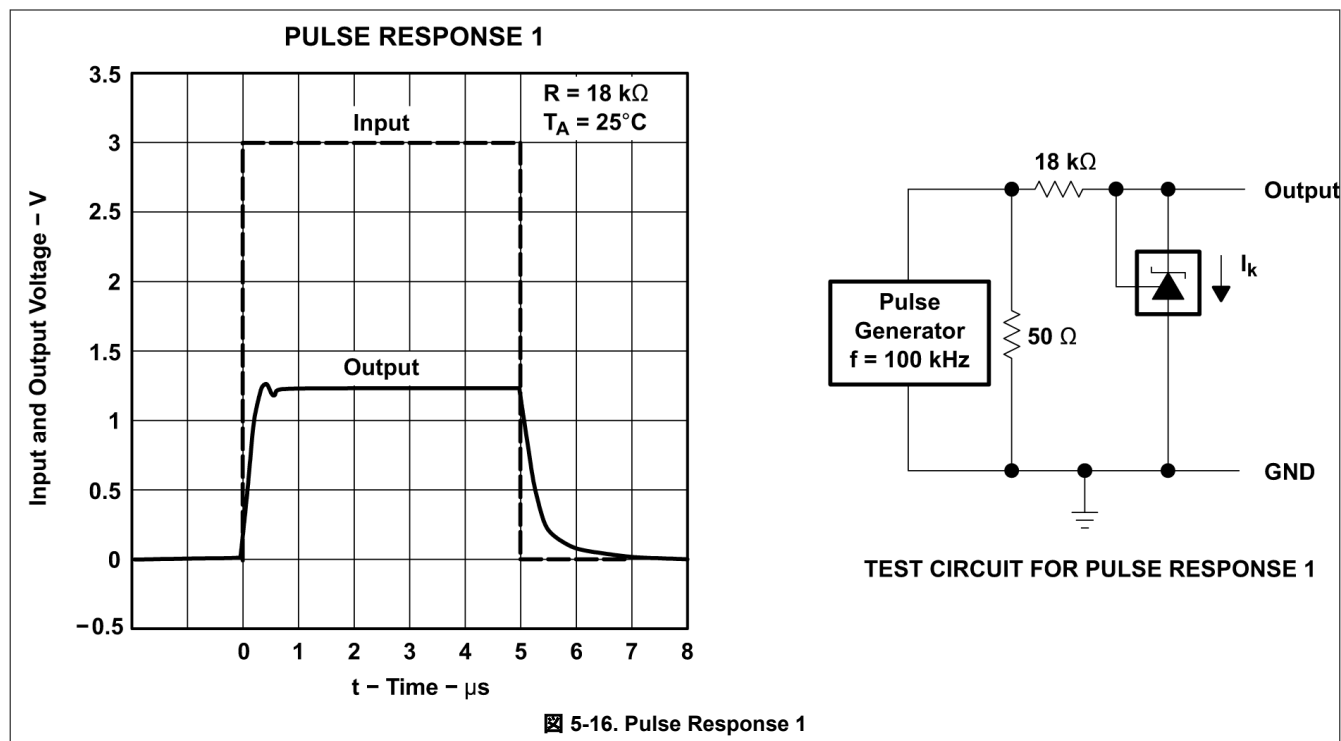
5.8 Typical Characteristics (continued)

Operation of the device at these or any other conditions beyond those indicated in the *Recommended Operating Conditions* table are not implied.



5.8 Typical Characteristics (continued)

Operation of the device at these or any other conditions beyond those indicated in the *Recommended Operating Conditions* table are not implied.



5.8 Typical Characteristics (continued)

Operation of the device at these or any other conditions beyond those indicated in the *Recommended Operating Conditions* table are not implied.

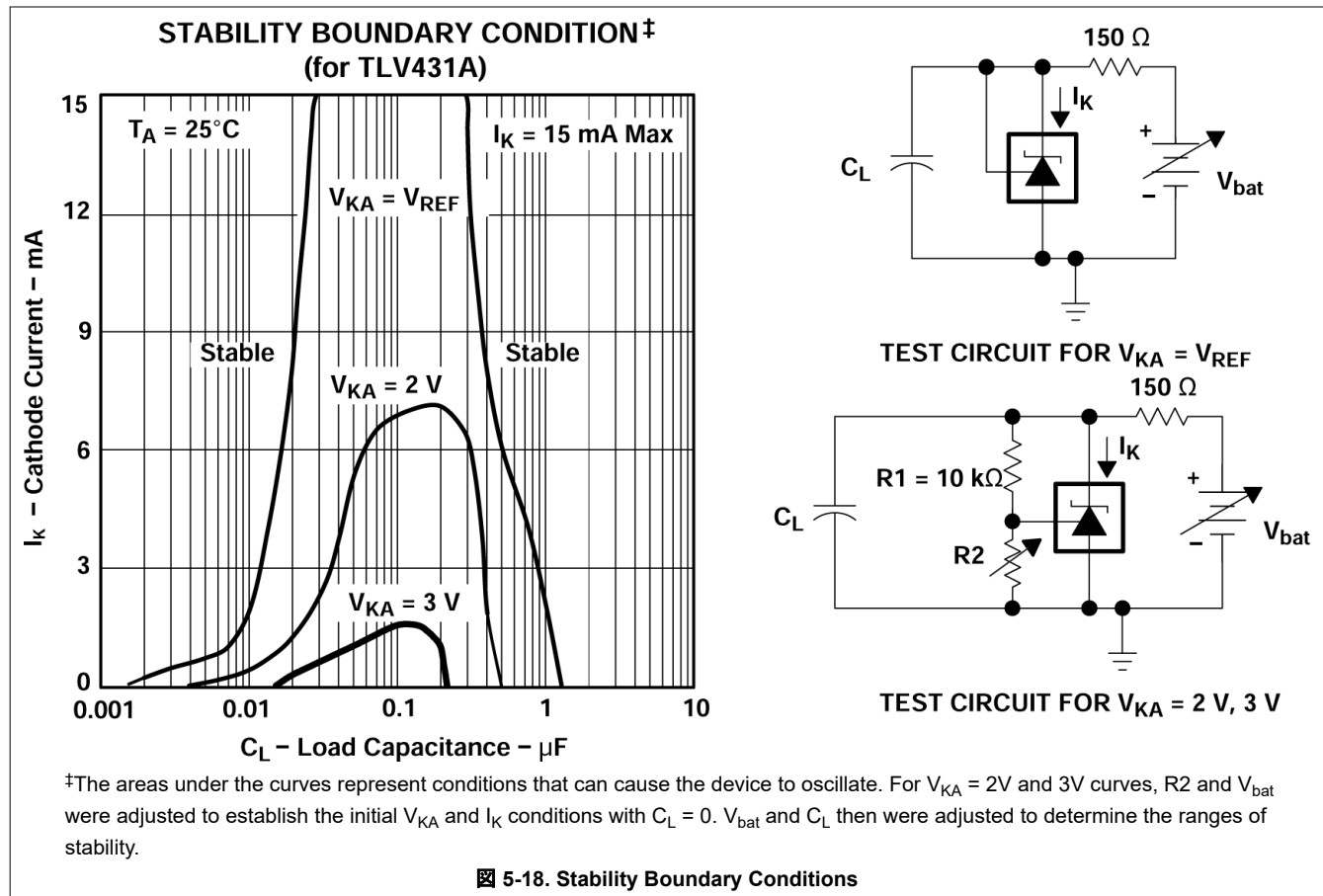
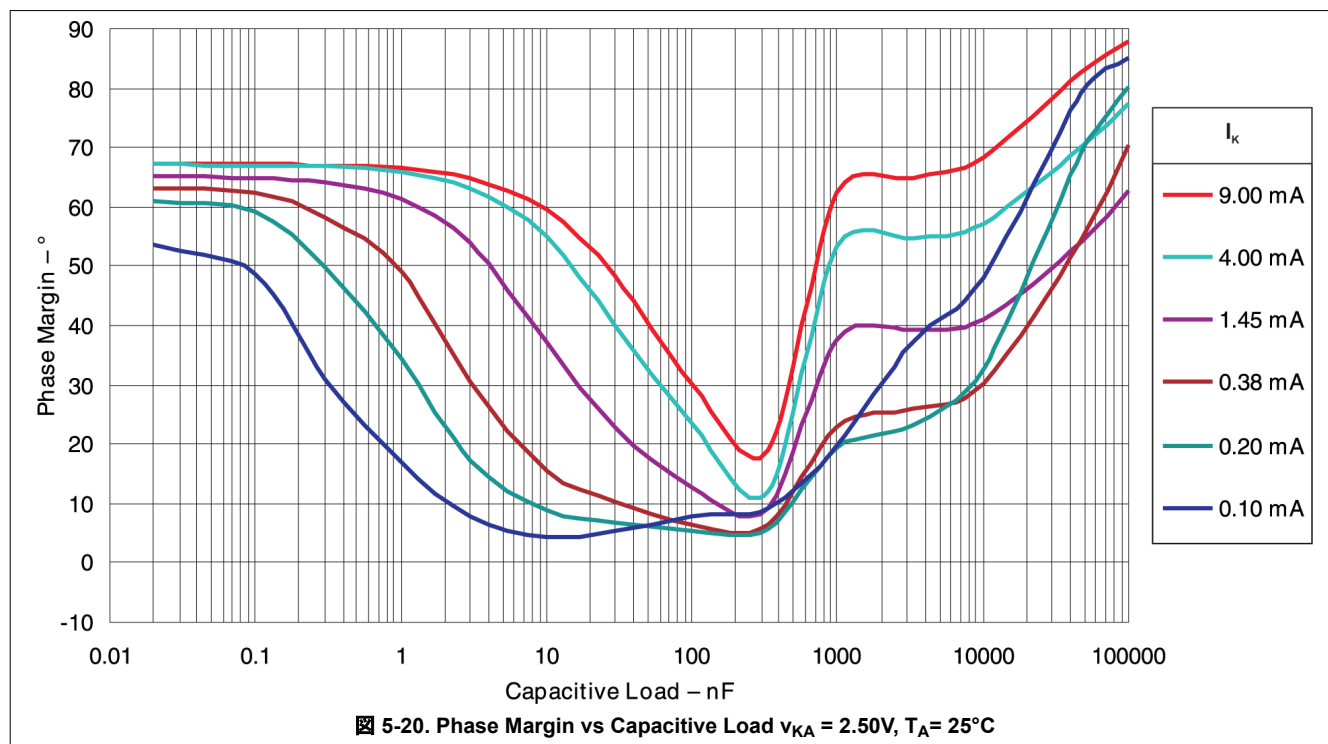
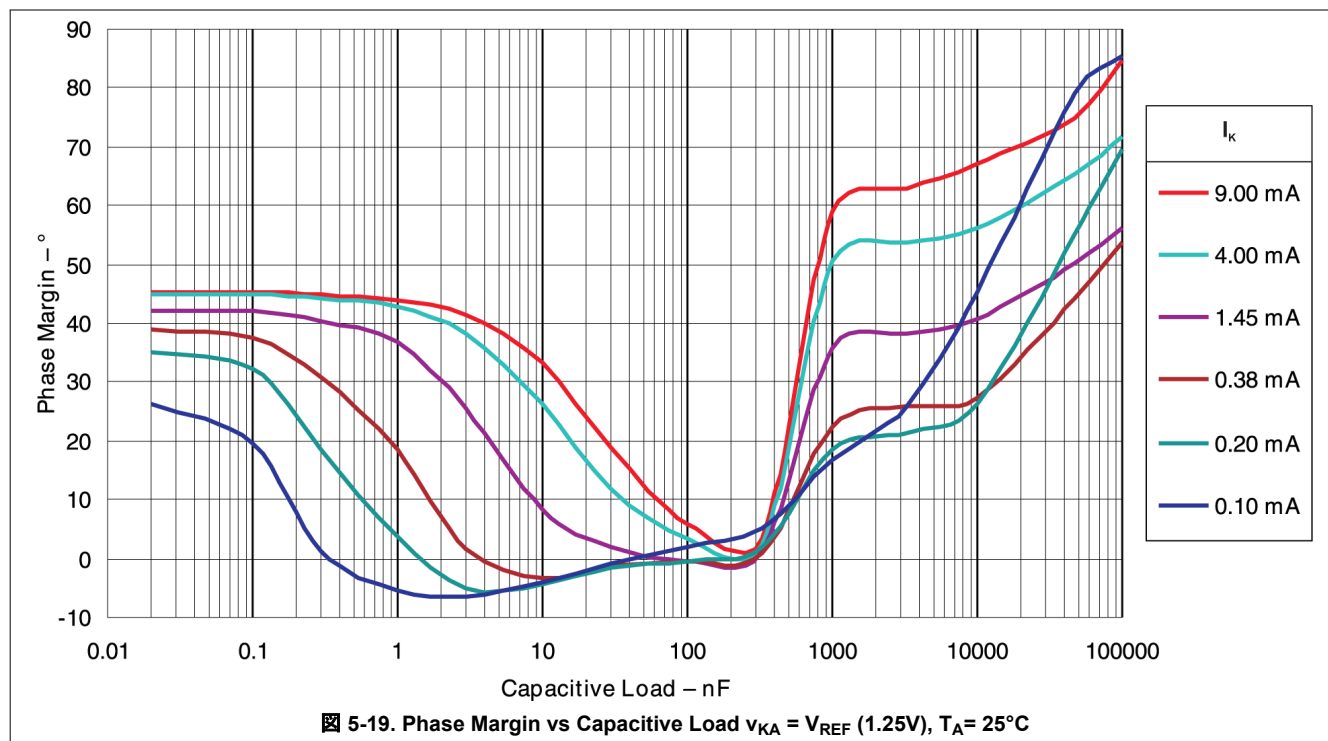


图 5-18. Stability Boundary Conditions

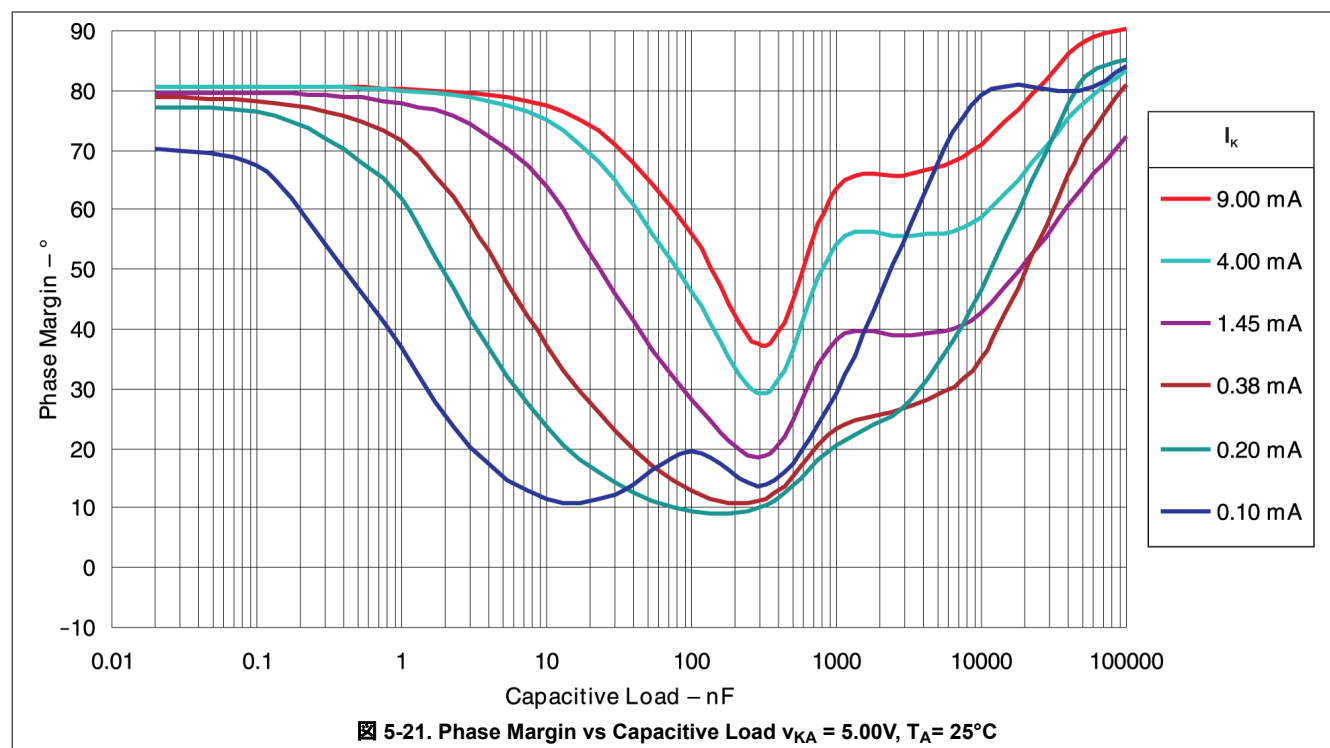
5.8 Typical Characteristics (continued)

Operation of the device at these or any other conditions beyond those indicated in the *Recommended Operating Conditions* table are not implied.

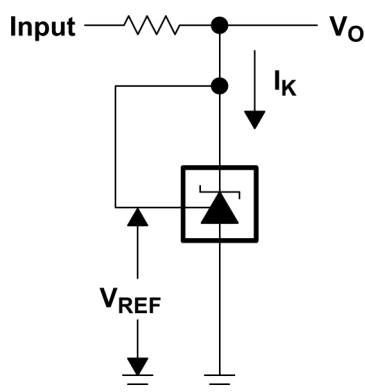


5.8 Typical Characteristics (continued)

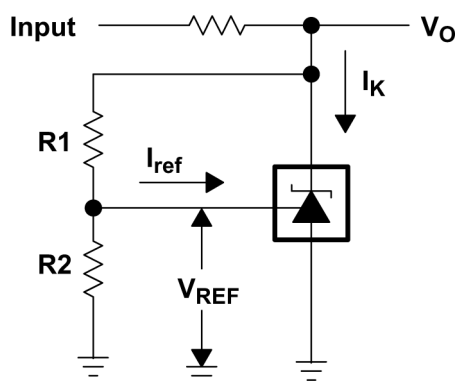
Operation of the device at these or any other conditions beyond those indicated in the *Recommended Operating Conditions* table are not implied.



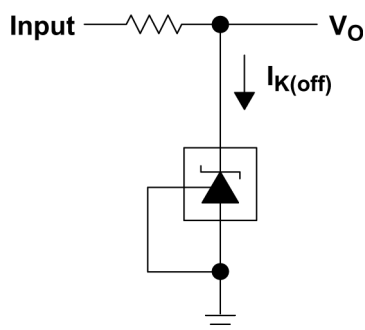
6 Parameter Measurement Information



6-1. Test Circuit for $v_{KA} = V_{REF}$, $V_O = V_{KA} = V_{REF}$



6-2. Test Circuit for $v_{KA} > V_{REF}$, $V_O = V_{KA} = V_{REF} \times (1 + R1/R2) + I_{ref} \times R1$



6-3. Test Circuit for $I_{K(off)}$

7 Detailed Description

7.1 Overview

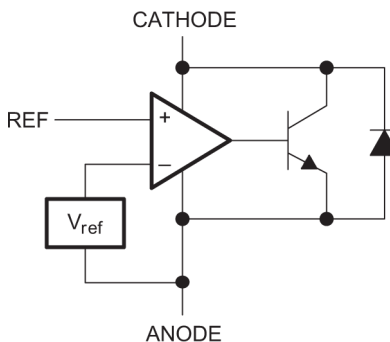
TLV431 is a low power counterpart to TL431, having lower reference voltage (1.24V vs 2.5 V) for lower voltage adjustability and lower minimum cathode current ($I_{k(min)} = 100\mu A$ vs 1mA). Like TL431, TLV431 is used in conjunction with its key components to behave as a single voltage reference, error amplifier, voltage clamp, or comparator with integrated reference.

TLV431 can be operated and adjusted to cathode voltages from 1.24V to 6V, making this part optimum for a wide range of end equipments in industrial, auto, telecom, and computing. For this device to behave as a shunt regulator or error amplifier, $> 100\mu A$ ($I_{min(max)}$) must be supplied in to the cathode pin. Under this condition, feedback can be applied from the Cathode and Ref pins to create a replica of the internal reference voltage.

Various reference voltage options can be purchased with initial tolerances (at 25°C) of 0.5%, 1%, and 1.5%. These reference options are denoted by B (0.5%), A (1.0%), and blank (1.5%) after the TLV431.

The TLV431xC devices are characterized for operation from 0°C to 70°C, the TLV431xI devices are characterized for operation from –40°C to 85°C, and the TLV431xQ devices are characterized for operation from –40°C to 125°C.

7.2 Functional Block Diagram



7.3 Feature Description

TLV431 consists of an internal reference and amplifier that outputs a sink current based on the difference between the reference pin and the virtual internal pin. The sink current is produced by an internal darlington pair.

When operated with enough voltage headroom ($\geq 1.24V$) and cathode current (I_{ka}), TLV431 forces the reference pin to 1.24V. However, the reference pin can not be left floating, as it requires $I_{ref} \geq 0.5\mu A$ (see the *Functional Block Diagram*). This is because the reference pin is driven into an NPN, which requires a base current to operate properly.

When feedback is applied from the Cathode and Reference pins, TLV431 behaves as a Zener diode, regulating to a constant voltage dependent on current being supplied into the cathode. This is due to the internal amplifier and reference entering the proper operating regions. The same amount of current required in the above feedback situation must be applied to this device in open-loop, servo, or error-amplifying implementations for it to be in the proper linear region giving TLV431 enough gain.

Unlike many linear regulators, TLV431 is internally compensated to be stable without an output capacitor between the cathode and anode. However, if it is desired to use an output capacitor [Figure 5-19](#) can be used as a guide to assist in choosing the correct capacitor to maintain stability.

7.4 Device Functional Modes

7.4.1 Open Loop (Comparator)

When the cathode/output voltage or current of TLV431 is not being fed back to the reference/input pin in any form, this device is operating in open loop. With proper cathode current (I_{ka}) applied to this device, TLV431 will have the characteristics shown in [Figure 5-6](#). With such high gain in this configuration, TLV431 is typically used as a comparator. With the reference integrated makes TLV431 the preferred choice when users are trying to monitor a certain level of a single signal.

7.4.2 Closed Loop

When the cathode/output voltage or current of TLV431 is being fed back to the reference/input pin in any form, this device is operating in closed loop. The majority of applications involving TLV431 use it in this manner to regulate a fixed voltage or current. The feedback enables this device to behave as an error amplifier, computing a portion of the output voltage and adjusting it to maintain the desired regulation. This is done by relating the output voltage back to the reference pin in a manner to make it equal to the internal reference voltage, which can be accomplished through resistive or direct feedback.

8.2 Typical Applications

8.2.1 Comparator with Integrated Reference (Open Loop)

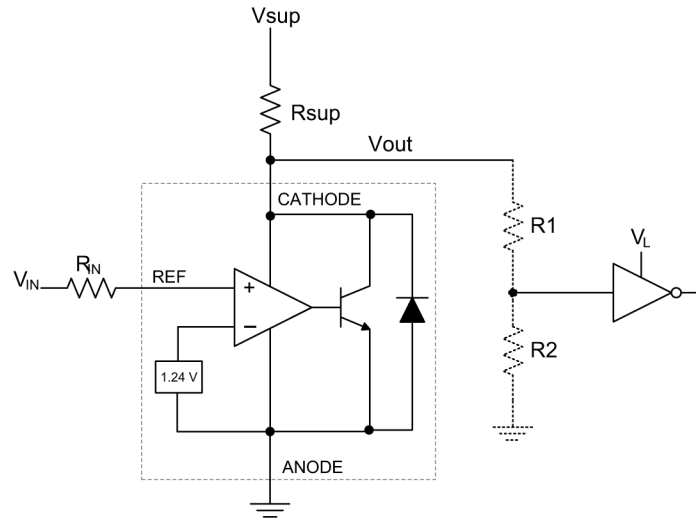


図 8-2. Comparator Application Schematic

8.2.1.1 Design Requirements

For this design example, use the parameters listed in 表 8-1 as the input parameters.

表 8-1. Design Parameters

DESIGN PARAMETER	EXAMPLE VALUE
Input Voltage Range	0V to 5V
Input Resistance	10kΩ
Supply Voltage	5V
Cathode Current (I_k)	500μA
Output Voltage Level	~1V - V_{sup}
Logic Input Thresholds V_{IH}/V_{IL}	V_L

8.2.1.2 Detailed Design Procedure

When using TLV431 as a comparator with reference, determine the following:

- Input voltage range
- Reference voltage accuracy
- Output logic input high and low level thresholds
- Current source resistance

8.2.1.2.1 Basic Operation

In the configuration shown in 図 8-2 TLV431 will behave as a comparator, comparing the V_{ref} pin voltage to the internal virtual reference voltage. When provided a proper cathode current (I_k), TLV431 will have enough open-loop gain to provide a quick response. With the TLV431's maximum operating current ($I_{min(max)}$) being 100μA and up to 150μA over temperature, operation below that could result in low gain, leading to a slow response.

8.2.1.2.2 Overdrive

Slow or inaccurate responses can also occur when the reference pin is not provided enough overdrive voltage. This is the amount of voltage that is higher than the internal virtual reference. The internal virtual reference voltage will be within the range of $1.24V \pm (0.5\%, 1.0\%, \text{ or } 1.5\%)$ depending on which version is being used.

The more overdrive voltage provided, the faster the TLV431 will respond. This can be seen in [Figure 8-3](#) and [Figure 8-4](#) where it displays the output responses to various input voltages.

For applications where TLV431 is being used as a comparator, it is best to set the trip point to greater than the positive expected error (that is, +1.0% for the A version). For fast response, setting the trip point to > 10% of the internal V_{ref} should suffice.

For minimal voltage drop or difference from V_{in} to the ref pin, TI recommends using an input resistor < 10k Ω to provide I_{ref} .

8.2.1.2.3 Output Voltage and Logic Input Level

For the TLV431 to properly be used as a comparator, the logic output must be readable by the receiving logic device. This is accomplished by knowing the input high and low level threshold voltage levels, typically denoted by V_{IH} and V_{IL} .

As seen in [Figure 8-3](#), TLV431's output low level voltage in open-loop/comparator mode is approximately 1V, which is sufficient for some 3.3V supplied logic. However, this does not work for 2.5V or 1.8V supplied logic. To accommodate this a resistive divider can be tied to the output to attenuate the output voltage to a voltage legible to the receiving low voltage logic device.

TLV431's output high voltage is approximately V_{sup} due to TLV431 being open-collector. If V_{sup} is much higher than the receiving logic's maximum input voltage tolerance, the output must be attenuated to accommodate the outgoing logic's reliability.

When using a resistive divider on the output, be sure to make the sum of the resistive divider (R_1 and R_2 in [Figure 8-2](#)) is much greater than R_{sup} to not interfere with TLV431's ability to pull close to V_{sup} when turning off.

8.2.1.2.3.1 Input Resistance

TLV431 requires an input resistance in this application to source the reference current (I_{ref}) needed from this device to be in the proper operating regions while turning on. The actual voltage seen at the ref pin will be $V_{ref} = V_{in} - I_{ref} \times R_{in}$. Because the I_{ref} can be as high as 0.5 μ A, TI recommends using a resistance small enough that will mitigate the error that I_{ref} creates from V_{in} .

8.2.1.3 Application Curves

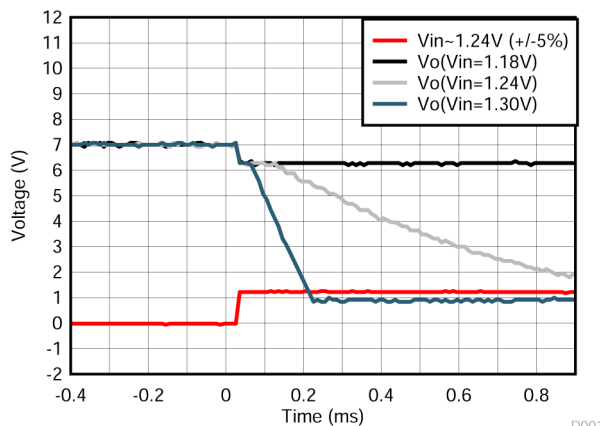


Figure 8-3. Output Response with Small Overdrive Voltages

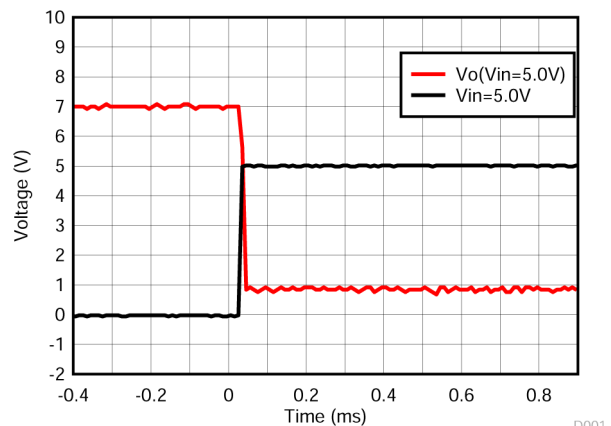


Figure 8-4. Output Response with Large Overdrive Voltage

8.2.2 Shunt Regulator/Reference

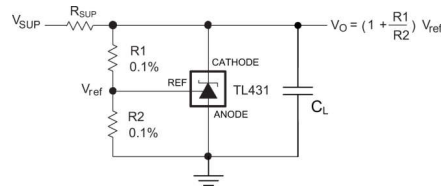


図 8-5. Shunt Regulator Schematic

8.2.2.1 Design Requirements

For this design example, use the parameters listed in 表 8-2 as the input parameters.

表 8-2. Design Parameters

DESIGN PARAMETER	EXAMPLE VALUE
Reference Initial Accuracy	1.0%
Supply Voltage	6V
Cathode Current (I _k)	1mA
Output Voltage Level	1.24V - 6V
Load Capacitance	100pF
Feedback Resistor Values and Accuracy (R1 and R2)	10kΩ

8.2.2.2 Detailed Design Procedure

When using TLV431 as a Shunt Regulator, determine the following:

- Input voltage range
- Temperature range
- Total accuracy
- Cathode current
- Reference initial accuracy
- Output capacitance

8.2.2.2.1 Programming Output/Cathode Voltage

To program the cathode voltage to a regulated voltage a resistive bridge must be shunted between the cathode and anode pins with the mid point tied to the reference pin. This can be seen in 図 8-5, with R1 and R2 being the resistive bridge. The cathode/output voltage in the shunt regulator configuration can be approximated by the equation shown in 図 8-5. The cathode voltage can be more accurately determined by taking the cathode current in to account

$$V_O = (1 + R1 / R2) \times V_{ref} - I_{ref} \times R1 \quad (1)$$

For Equation 1 to be valid, TLV431 must be fully biased so that it has enough open-loop gain to mitigate any gain error. This can be done by meeting the I_{min} spec denoted in *Recommended Operating Conditions* table.

8.2.2.2.2 Total Accuracy

When programming the output above unity gain (V_{ka} = V_{ref}), TLV431 is susceptible to other errors that may effect the overall accuracy beyond V_{ref}. These errors include:

- R1 and R2 accuracies
- V_{I(dev)} – Change in reference voltage over temperature
- ΔV_{ref} / ΔV_{KA} – Change in reference voltage to the change in cathode voltage
- |Z_{KA}| – Dynamic impedance, causing a change in cathode voltage with cathode current

Worst-case cathode voltage can be determined taking all of the variables in to account. Application note Setting the Shunt Voltage on an Adjustable Shunt Regulator (SLVA445) assists designers in setting the shunt voltage to achieve optimum accuracy for this device.

8.2.2.2.3 Stability

Though TLV431 is stable with no capacitive load, the device that receives the shunt regulator's output voltage could present a capacitive load that is within the TLV431 region of stability, shown in [Figure 5-18](#). Also, designers may use capacitive loads to improve the transient response or for power supply decoupling.

8.2.2.3 Application Curve

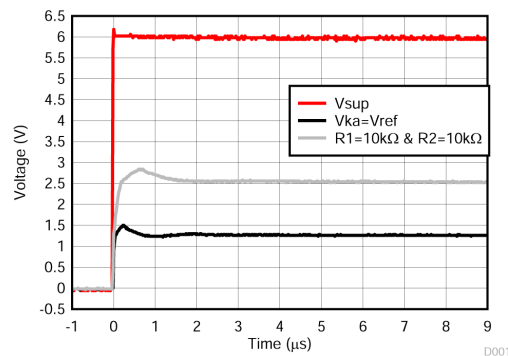


Figure 8-6. TLV431 Start-Up Response

8.3 Power Supply Recommendations

When using TLV431 as a Linear Regulator to supply a load, designers will typically use a bypass capacitor on the output/cathode pin. When doing this, be sure that the capacitance is within the stability criteria shown in [Figure 5-18](#).

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

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

8.4 Layout

8.4.1 Layout Guidelines

Place decoupling capacitors as close to the device as possible. Use appropriate widths for traces when shunting high currents to avoid excessive voltage drops.

8.4.2 Layout Example

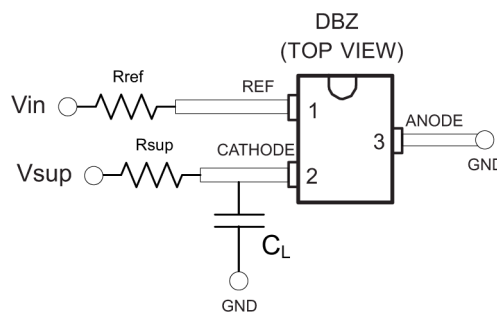


Figure 8-7. DBZ Layout Example

9 Device and Documentation Support

9.1 Documentation Support

9.1.1 Related Documentation

For related documentation, see the following:

- [Compensation Design With TL431 for UCC28600](#) (SLUA671)
- [Setting the Shunt Voltage on an Adjustable Shunt Regulator](#) (SLVA445)

9.2 ドキュメントの更新通知を受け取る方法

ドキュメントの更新についての通知を受け取るには、www.tij.co.jp のデバイス製品フォルダを開いてください。[通知] をクリックして登録すると、変更されたすべての製品情報に関するダイジェストを毎週受け取ることができます。変更の詳細については、改訂されたドキュメントに含まれている改訂履歴をご覧ください。

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9.6 用語集

[テキサス・インスツルメンツ用語集](#) この用語集には、用語や略語の一覧および定義が記載されています。

10 Revision History

資料番号末尾の英字は改訂を表しています。その改訂履歴は英語版に準じています。

Changes from Revision Y (March 2024) to Revision Z (June 2024)	Page
• Updated pinout diagrams.....	3

Changes from Revision X (May 2018) to Revision Y (March 2024)	Page
• ドキュメント全体にわたって表、図、相互参照の採番方法を更新.....	1
• 概略回路図を「概要」から「アプリケーション」に移動.....	1
• Updated pinout diagrams.....	3
• Updated <i>Typical Applications Design Requiements</i>	23

Changes from Revision W (March 2018) to Revision X (May 2018)**Page**

- Changed  5-18 **8**

11 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 part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
TLV431ACDBVR	Active	Production	SOT-23 (DBV) 5	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	(YAC6, YACC, YACI, YACN) (YACG, YACL, YACS)
TLV431ACDBVR1G4	Active	Production	SOT-23 (DBV) 5	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	(YAC6, YACC, YACI) (YACG, YACL, YACS)
TLV431ACDBVRG4	Obsolete	Production	SOT-23 (DBV) 5	-	-	Call TI	Call TI	0 to 70	YACI
TLV431ACDBVT	Active	Production	SOT-23 (DBV) 5	250 SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	(YAC6, YACC, YACI) (YACG, YACL, YACS)
TLV431ACDBZR	Active	Production	SOT-23 (DBZ) 3	3000 LARGE T&R	Yes	NIPDAU SN NIPDAUAG NIPDAU	Level-1-260C-UNLIM	0 to 70	(YAC6, YAC8, YACB, YACS) (YAC3, YACS, YACU)
TLV431ACDBZRG4	Active	Production	SOT-23 (DBZ) 3	3000 LARGE T&R	Yes	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	0 to 70	YAC6 YACS
TLV431ACLP	Active	Production	TO-92 (LP) 3	1000 BULK	Yes	SN	N/A for Pkg Type	0 to 70	V431AC
TLV431ACLPR	Active	Production	TO-92 (LP) 3	2000 LARGE T&R	Yes	SN	N/A for Pkg Type	0 to 70	V431AC
TLV431AID	Obsolete	Production	SOIC (D) 8	-	-	Call TI	Call TI	-40 to 85	TY431A
TLV431AIDBVR	Active	Production	SOT-23 (DBV) 5	3000 LARGE T&R	Yes	NIPDAU SN	Level-1-260C-UNLIM	-40 to 85	(YAI6, YAI6, YAI6, YAI6) (YAI6, YAI6, YAI6, YAI6)
TLV431AIDBVR1G4	Active	Production	SOT-23 (DBV) 5	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(YAI6, YAI6) (YAIL, YAI6)
TLV431AIDBVRG4	Obsolete	Production	SOT-23 (DBV) 5	-	-	Call TI	Call TI	-40 to 85	YAI6
TLV431AIDBVT	Active	Production	SOT-23 (DBV) 5	250 SMALL T&R	Yes	NIPDAU SN	Level-1-260C-UNLIM	-40 to 85	(YAI6, YAI6, YAI6) (YAI6, YAI6, YAI6)

Orderable part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
TLV431AIDBZR	Active	Production	SOT-23 (DBZ) 3	3000 LARGE T&R	Yes	NIPDAU SN NIPDAUAG NIPDAU	Level-1-260C-UNLIM	-40 to 85	(YAI6, YAI8, YAIB, Y AIS) (YAI3, Y AIS, YAIU)
TLV431AIDBZRG4	Active	Production	SOT-23 (DBZ) 3	3000 LARGE T&R	Yes	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	-40 to 85	YAI6 Y AIS
TLV431AIDR	Active	Production	SOIC (D) 8	2500 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TY431A
TLV431AILP	Obsolete	Production	TO-92 (LP) 3	-	-	Call TI	Call TI	-40 to 85	V431AI
TLV431AILPM	Active	Production	TO-92 (LP) 3	2000 AMMO	Yes	SN	N/A for Pkg Type	-40 to 85	V431AI
TLV431AILPR	Active	Production	TO-92 (LP) 3	2000 LARGE T&R	Yes	SN	N/A for Pkg Type	-40 to 85	V431AI
TLV431AQPK	Active	Production	SOT-89 (PK) 3	1000 LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	VA
TLV431BCDBVR	Active	Production	SOT-23 (DBV) 5	3000 LARGE T&R	Yes	NIPDAU SN	Level-1-260C-UNLIM	0 to 70	(Y3GG, Y3GJ, Y3GU)
TLV431BCDBVT	Active	Production	SOT-23 (DBV) 5	250 SMALL T&R	Yes	NIPDAU SN	Level-1-260C-UNLIM	0 to 70	(Y3GG, Y3GJ, Y3GU)
TLV431BCDBZR	Active	Production	SOT-23 (DBZ) 3	3000 LARGE T&R	Yes	NIPDAU SN NIPDAUAG NIPDAU	Level-1-260C-UNLIM	0 to 70	(Y3G3, Y3GS, Y3GU)
TLV431BCDBZT	Active	Production	SOT-23 (DBZ) 3	250 SMALL T&R	Yes	NIPDAU SN NIPDAUAG	Level-1-260C-UNLIM	0 to 70	(Y3GS, Y3GU)
TLV431BCDBZTG4	Active	Production	SOT-23 (DBZ) 3	250 SMALL T&R	Yes	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	0 to 70	Y3GS
TLV431BCDCKR	Active	Production	SC70 (DCK) 6	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	YEU
TLV431BCDCKT	Active	Production	SC70 (DCK) 6	250 SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	YEU
TLV431BCLP	Obsolete	Production	TO-92 (LP) 3	-	-	Call TI	Call TI	0 to 70	TV431B
TLV431BCLPR	Active	Production	TO-92 (LP) 3	2000 LARGE T&R	Yes	SN	N/A for Pkg Type	0 to 70	TV431B
TLV431BCPK	Active	Production	SOT-89 (PK) 3	1000 LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	0 to 70	VE
TLV431BIDBVR	Active	Production	SOT-23 (DBV) 5	3000 LARGE T&R	Yes	NIPDAU SN	Level-1-260C-UNLIM	-40 to 85	(Y3FJ, Y3FU)
TLV431BIDBVT	Active	Production	SOT-23 (DBV) 5	250 SMALL T&R	Yes	NIPDAU SN	Level-1-260C-UNLIM	-40 to 85	(Y3FJ, Y3FU)
TLV431BIDBZR	Active	Production	SOT-23 (DBZ) 3	3000 LARGE T&R	Yes	NIPDAU SN NIPDAUAG NIPDAU	Level-1-260C-UNLIM	-40 to 85	(Y3F3, Y3FS, Y3FU)
TLV431BIDBZRG4	Active	Production	SOT-23 (DBZ) 3	3000 LARGE T&R	Yes	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	-40 to 85	(Y3F3, Y3FS)
TLV431BIDBZT	Active	Production	SOT-23 (DBZ) 3	250 SMALL T&R	Yes	NIPDAU SN NIPDAUAG	Level-1-260C-UNLIM	-40 to 85	(Y3FS, Y3FU)
TLV431BIDCKR	Active	Production	SC70 (DCK) 6	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	YFU

Orderable part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
TLV431BIDCKRG4	Active	Production	SC70 (DCK) 6	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	YFU
TLV431BIDCKT	Active	Production	SC70 (DCK) 6	250 SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	YFU
TLV431BILP	Obsolete	Production	TO-92 (LP) 3	-	-	Call TI	Call TI	-40 to 85	TY431B
TLV431BILPR	Active	Production	TO-92 (LP) 3	2000 LARGE T&R	Yes	SN	N/A for Pkg Type	-40 to 85	TY431B
TLV431BIPK	Active	Production	SOT-89 (PK) 3	1000 LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 85	VF
TLV431BQDBVR	Active	Production	SOT-23 (DBV) 5	3000 LARGE T&R	Yes	NIPDAU SN	Level-1-260C-UNLIM	-40 to 125	(Y3HJ, Y3HU)
TLV431BQDBVRG4	Active	Production	SOT-23 (DBV) 5	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	Y3HU
TLV431BQDBVT	Active	Production	SOT-23 (DBV) 5	250 SMALL T&R	Yes	NIPDAU SN	Level-1-260C-UNLIM	-40 to 125	(Y3HJ, Y3HU)
TLV431BQDBZR	Active	Production	SOT-23 (DBZ) 3	3000 LARGE T&R	Yes	NIPDAU SN NIPDAUAG NIPDAU	Level-1-260C-UNLIM	-40 to 125	(Y3H3, Y3HS, Y3HU)
TLV431BQDBZRG4	Active	Production	SOT-23 (DBZ) 3	3000 LARGE T&R	Yes	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	-40 to 125	Y3HS
TLV431BQDBZT	Active	Production	SOT-23 (DBZ) 3	250 SMALL T&R	Yes	NIPDAU SN NIPDAUAG	Level-1-260C-UNLIM	-40 to 125	(Y3HS, Y3HU)
TLV431BQDCKR	Active	Production	SC70 (DCK) 6	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	YGU
TLV431BQDCKT	Active	Production	SC70 (DCK) 6	250 SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	YGU
TLV431BQLP	Obsolete	Production	TO-92 (LP) 3	-	-	Call TI	Call TI	-40 to 125	TQ431B
TLV431BQLPR	Active	Production	TO-92 (LP) 3	2000 LARGE T&R	Yes	SN	N/A for Pkg Type	-40 to 125	TQ431B
TLV431BQPK	Active	Production	SOT-89 (PK) 3	1000 LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	V6
TLV431CDBVR	Active	Production	SOT-23 (DBV) 5	3000 LARGE T&R	Yes	NIPDAU SN	Level-1-260C-UNLIM	0 to 70	(Y3C6, Y3CI) (Y3CG, Y3CS)
TLV431CDBVRG4	Obsolete	Production	SOT-23 (DBV) 5	-	-	Call TI	Call TI	0 to 70	Y3CI
TLV431CDBVT	Active	Production	SOT-23 (DBV) 5	250 SMALL T&R	Yes	NIPDAU SN	Level-1-260C-UNLIM	0 to 70	(Y3C6, Y3CI) (Y3CG, Y3CS)
TLV431CDBZR	Active	Production	SOT-23 (DBZ) 3	3000 LARGE T&R	Yes	NIPDAU SN NIPDAUAG NIPDAU	Level-1-260C-UNLIM	0 to 70	(Y3C6, Y3C8, Y3CB, Y3CS) (Y3C3, Y3CS, Y3CU)
TLV431CLP	Obsolete	Production	TO-92 (LP) 3	-	-	Call TI	Call TI	0 to 70	V431C
TLV431CLPR	Active	Production	TO-92 (LP) 3	2000 LARGE T&R	Yes	SN	N/A for Pkg Type	0 to 70	V431C
TLV431IDBVR	Active	Production	SOT-23 (DBV) 5	3000 LARGE T&R	Yes	NIPDAU SN	Level-1-260C-UNLIM	-40 to 85	(Y3I6, Y3II) (Y3IG, Y3IS)
TLV431IDBVR1G4	Active	Production	SOT-23 (DBV) 5	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	Y3I6 Y3IS

Orderable part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
TLV431IDBVRG4	Obsolete	Production	SOT-23 (DBV) 5	-	-	Call TI	Call TI	-40 to 85	Y3II
TLV431IDBVT	Active	Production	SOT-23 (DBV) 5	250 SMALL T&R	Yes	NIPDAU SN	Level-1-260C-UNLIM	-40 to 85	(Y3I6, Y3II) (Y3IG, Y3IS)
TLV431IDBZR	Active	Production	SOT-23 (DBZ) 3	3000 LARGE T&R	Yes	NIPDAU SN NIPDAUAG	Level-1-260C-UNLIM	-40 to 85	(Y3I6, Y3IB, Y3IS) (Y3IU, Y3IU)
TLV431IDBZRG4	Active	Production	SOT-23 (DBZ) 3	3000 LARGE T&R	Yes	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	-40 to 85	Y3I6 Y3IS
TLV431ILP	Obsolete	Production	TO-92 (LP) 3	-	-	Call TI	Call TI	-40 to 85	V431I
TLV431ILPR	Active	Production	TO-92 (LP) 3	2000 LARGE T&R	Yes	SN	N/A for Pkg Type	-40 to 85	V431I
TLV431QPK	Active	Production	SOT-89 (PK) 3	1000 LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	VB

⁽¹⁾ **Status:** For more details on status, see our [product life cycle](#).

⁽²⁾ **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

⁽³⁾ **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

⁽⁴⁾ **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

⁽⁵⁾ **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

⁽⁶⁾ **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "-" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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OTHER QUALIFIED VERSIONS OF TLV431A, TLV431B :

- Automotive : [TLV431A-Q1](#), [TLV431B-Q1](#)

NOTE: Qualified Version Definitions:

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

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
TLV431ACDBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TLV431ACDBVR1G4	SOT-23	DBV	5	3000	180.0	8.4	3.23	3.17	1.37	4.0	8.0	Q3
TLV431ACDBVR1G4	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TLV431ACDBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TLV431ACDBZR	SOT-23	DBZ	3	3000	178.0	9.0	3.15	2.77	1.22	4.0	8.0	Q3
TLV431ACDBZRG4	SOT-23	DBZ	3	3000	180.0	8.4	2.9	3.35	1.35	4.0	8.0	Q3
TLV431ACDBZRG4	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
TLV431AIDBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TLV431AIDBVR1G4	SOT-23	DBV	5	3000	180.0	8.4	3.23	3.17	1.37	4.0	8.0	Q3
TLV431AIDBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TLV431AIDBZR	SOT-23	DBZ	3	3000	178.0	9.0	3.15	2.77	1.22	4.0	8.0	Q3
TLV431AIDBZRG4	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
TLV431AIDBZRG4	SOT-23	DBZ	3	3000	180.0	8.4	2.9	3.35	1.35	4.0	8.0	Q3
TLV431AIDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TLV431AQPK	SOT-89	PK	3	1000	180.0	12.4	4.91	4.52	1.9	8.0	12.0	Q3
TLV431AQPK	SOT-89	PK	3	1000	180.0	12.4	4.91	4.52	1.9	8.0	12.0	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
TLV431BCDBVR	SOT-23	DBV	5	3000	178.0	9.0	3.3	3.2	1.4	4.0	8.0	Q3
TLV431BCDBVT	SOT-23	DBV	5	250	178.0	9.0	3.3	3.2	1.4	4.0	8.0	Q3
TLV431BCDBZR	SOT-23	DBZ	3	3000	178.0	9.0	3.15	2.77	1.22	4.0	8.0	Q3
TLV431BCDBZT	SOT-23	DBZ	3	250	178.0	9.0	3.15	2.77	1.22	4.0	8.0	Q3
TLV431BCDBZTG4	SOT-23	DBZ	3	250	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
TLV431BCDBZTG4	SOT-23	DBZ	3	250	180.0	8.4	2.9	3.35	1.35	4.0	8.0	Q3
TLV431BCDCKR	SC70	DCK	6	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
TLV431BCDCKT	SC70	DCK	6	250	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
TLV431BCPK	SOT-89	PK	3	1000	180.0	12.4	4.91	4.52	1.9	8.0	12.0	Q3
TLV431BCPK	SOT-89	PK	3	1000	180.0	12.4	4.91	4.52	1.9	8.0	12.0	Q3
TLV431BIDBVR	SOT-23	DBV	5	3000	178.0	9.0	3.3	3.2	1.4	4.0	8.0	Q3
TLV431BIDBVT	SOT-23	DBV	5	250	180.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
TLV431BIDBVT	SOT-23	DBV	5	250	178.0	9.0	3.3	3.2	1.4	4.0	8.0	Q3
TLV431BIDBZR	SOT-23	DBZ	3	3000	178.0	9.0	3.15	2.77	1.22	4.0	8.0	Q3
TLV431BIDBZRG4	SOT-23	DBZ	3	3000	180.0	8.4	2.9	3.35	1.35	4.0	8.0	Q3
TLV431BIDBZRG4	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
TLV431BIDBZT	SOT-23	DBZ	3	250	178.0	9.0	3.15	2.77	1.22	4.0	8.0	Q3
TLV431BIDCKR	SC70	DCK	6	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
TLV431BIDCKRG4	SC70	DCK	6	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
TLV431BIDCKT	SC70	DCK	6	250	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
TLV431BIPK	SOT-89	PK	3	1000	180.0	12.4	4.91	4.52	1.9	8.0	12.0	Q3
TLV431BIPK	SOT-89	PK	3	1000	180.0	12.4	4.91	4.52	1.9	8.0	12.0	Q3
TLV431BQDBVR	SOT-23	DBV	5	3000	179.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
TLV431BQDBVR	SOT-23	DBV	5	3000	178.0	9.0	3.3	3.2	1.4	4.0	8.0	Q3
TLV431BQDBVRG4	SOT-23	DBV	5	3000	179.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
TLV431BQDBVT	SOT-23	DBV	5	250	180.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
TLV431BQDBVT	SOT-23	DBV	5	250	178.0	9.0	3.3	3.2	1.4	4.0	8.0	Q3
TLV431BQDBZR	SOT-23	DBZ	3	3000	178.0	9.0	3.15	2.77	1.22	4.0	8.0	Q3
TLV431BQDBZRG4	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
TLV431BQDBZRG4	SOT-23	DBZ	3	3000	180.0	8.4	2.9	3.35	1.35	4.0	8.0	Q3
TLV431BQDBZT	SOT-23	DBZ	3	250	178.0	9.0	3.15	2.77	1.22	4.0	8.0	Q3
TLV431BQDCKR	SC70	DCK	6	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
TLV431BQDCKT	SC70	DCK	6	250	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
TLV431BQPK	SOT-89	PK	3	1000	180.0	12.4	4.91	4.52	1.9	8.0	12.0	Q3
TLV431BQPK	SOT-89	PK	3	1000	180.0	12.4	4.91	4.52	1.9	8.0	12.0	Q3
TLV431CDBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TLV431CDBVT	SOT-23	DBV	5	250	180.0	8.4	3.23	3.17	1.37	4.0	8.0	Q3
TLV431CDBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TLV431CDBZR	SOT-23	DBZ	3	3000	178.0	9.0	3.15	2.77	1.22	4.0	8.0	Q3
TLV431IDBVR	SOT-23	DBV	5	3000	178.0	9.0	3.3	3.2	1.4	4.0	8.0	Q3
TLV431IDBVR1G4	SOT-23	DBV	5	3000	180.0	8.4	3.23	3.17	1.37	4.0	8.0	Q3

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TLV431IDBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TLV431IDBZR	SOT-23	DBZ	3	3000	178.0	9.0	3.15	2.77	1.22	4.0	8.0	Q3
TLV431IDBZRG4	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
TLV431IDBZRG4	SOT-23	DBZ	3	3000	180.0	8.4	2.9	3.35	1.35	4.0	8.0	Q3
TLV431QPK	SOT-89	PK	3	1000	180.0	12.4	4.91	4.52	1.9	8.0	12.0	Q3
TLV431QPK	SOT-89	PK	3	1000	180.0	12.4	4.91	4.52	1.9	8.0	12.0	Q3

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

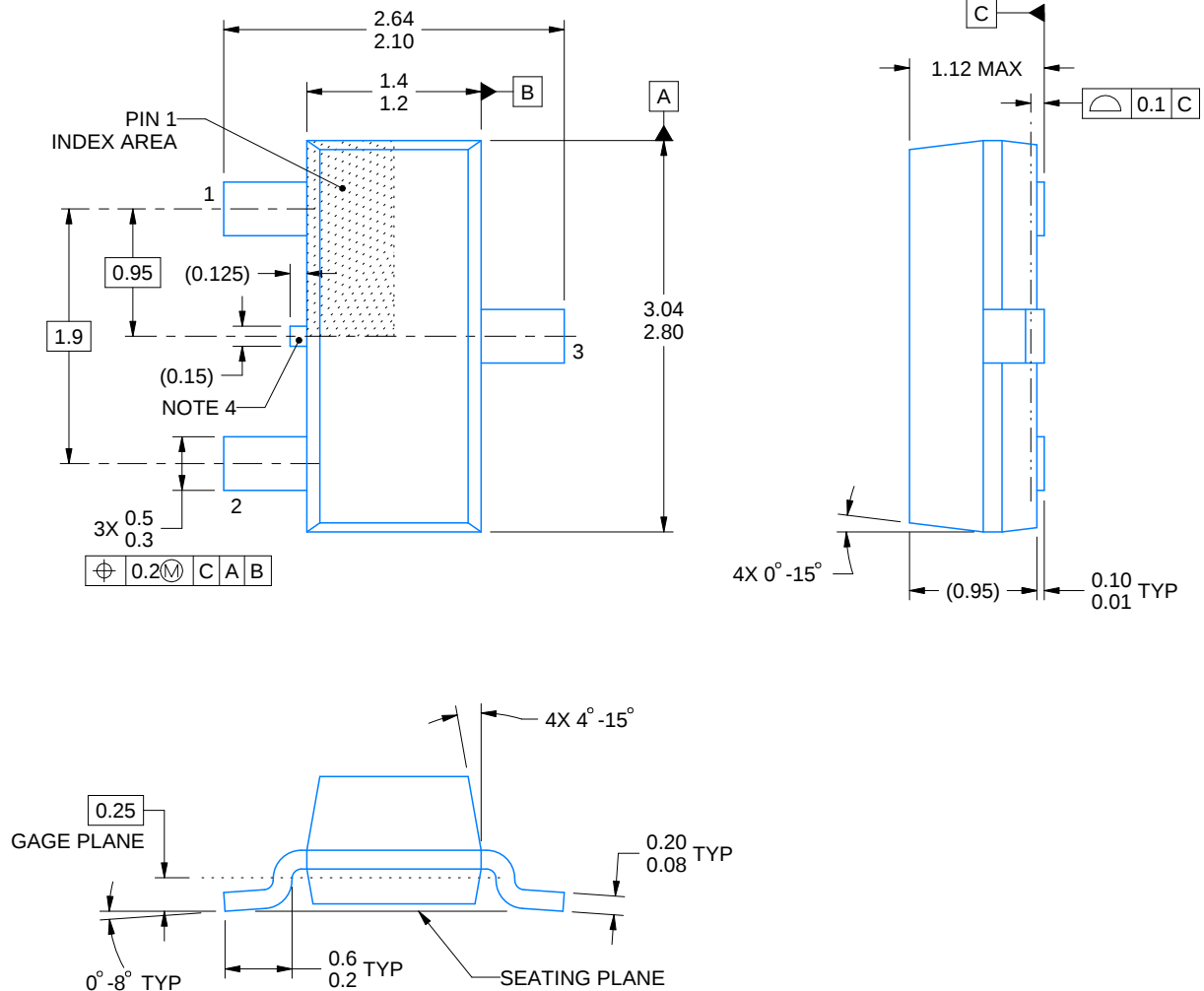
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TLV431ACDBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TLV431ACDBVR1G4	SOT-23	DBV	5	3000	183.0	183.0	20.0
TLV431ACDBVR1G4	SOT-23	DBV	5	3000	180.0	180.0	18.0
TLV431ACDBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TLV431ACDBZR	SOT-23	DBZ	3	3000	180.0	180.0	18.0
TLV431ACDBZRG4	SOT-23	DBZ	3	3000	210.0	185.0	35.0
TLV431ACDBZRG4	SOT-23	DBZ	3	3000	183.0	183.0	20.0
TLV431AIDBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TLV431AIDBVR1G4	SOT-23	DBV	5	3000	183.0	183.0	20.0
TLV431AIDBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TLV431AIDBZR	SOT-23	DBZ	3	3000	180.0	180.0	18.0
TLV431AIDBZRG4	SOT-23	DBZ	3	3000	183.0	183.0	20.0
TLV431AIDBZRG4	SOT-23	DBZ	3	3000	210.0	185.0	35.0
TLV431AIDR	SOIC	D	8	2500	353.0	353.0	32.0
TLV431AQPK	SOT-89	PK	3	1000	190.0	190.0	30.0
TLV431AQPK	SOT-89	PK	3	1000	340.0	340.0	38.0
TLV431BCDBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TLV431BCDBVT	SOT-23	DBV	5	250	180.0	180.0	18.0

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TLV431BCDBZR	SOT-23	DBZ	3	3000	180.0	180.0	18.0
TLV431BCDBZT	SOT-23	DBZ	3	250	180.0	180.0	18.0
TLV431BCDBZTG4	SOT-23	DBZ	3	250	183.0	183.0	20.0
TLV431BCDBZTG4	SOT-23	DBZ	3	250	210.0	185.0	35.0
TLV431BCDCKR	SC70	DCK	6	3000	203.0	203.0	35.0
TLV431BCDCKT	SC70	DCK	6	250	203.0	203.0	35.0
TLV431BCPK	SOT-89	PK	3	1000	190.0	190.0	30.0
TLV431BCPK	SOT-89	PK	3	1000	340.0	340.0	38.0
TLV431BIDBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TLV431BIDBVT	SOT-23	DBV	5	250	203.0	203.0	35.0
TLV431BIDBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TLV431BIDBZR	SOT-23	DBZ	3	3000	180.0	180.0	18.0
TLV431BIDBZRG4	SOT-23	DBZ	3	3000	210.0	185.0	35.0
TLV431BIDBZRG4	SOT-23	DBZ	3	3000	183.0	183.0	20.0
TLV431BIDBZT	SOT-23	DBZ	3	250	180.0	180.0	18.0
TLV431BIDCKR	SC70	DCK	6	3000	203.0	203.0	35.0
TLV431BIDCKRG4	SC70	DCK	6	3000	203.0	203.0	35.0
TLV431BIDCKT	SC70	DCK	6	250	203.0	203.0	35.0
TLV431BIPK	SOT-89	PK	3	1000	340.0	340.0	38.0
TLV431BIPK	SOT-89	PK	3	1000	190.0	190.0	30.0
TLV431BQDBVR	SOT-23	DBV	5	3000	200.0	183.0	25.0
TLV431BQDBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TLV431BQDBVRG4	SOT-23	DBV	5	3000	200.0	183.0	25.0
TLV431BQDBVT	SOT-23	DBV	5	250	203.0	203.0	35.0
TLV431BQDBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TLV431BQDBZR	SOT-23	DBZ	3	3000	180.0	180.0	18.0
TLV431BQDBZRG4	SOT-23	DBZ	3	3000	183.0	183.0	20.0
TLV431BQDBZRG4	SOT-23	DBZ	3	3000	210.0	185.0	35.0
TLV431BQDBZT	SOT-23	DBZ	3	250	180.0	180.0	18.0
TLV431BQDCKR	SC70	DCK	6	3000	200.0	183.0	25.0
TLV431BQDCKT	SC70	DCK	6	250	200.0	183.0	25.0
TLV431BQPK	SOT-89	PK	3	1000	340.0	340.0	38.0
TLV431BQPK	SOT-89	PK	3	1000	190.0	190.0	30.0
TLV431CDBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TLV431CDBVT	SOT-23	DBV	5	250	183.0	183.0	20.0
TLV431CDBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TLV431CDBZR	SOT-23	DBZ	3	3000	180.0	180.0	18.0
TLV431IDBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
TLV431IDBVR1G4	SOT-23	DBV	5	3000	183.0	183.0	20.0
TLV431IDBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
TLV431IDBZR	SOT-23	DBZ	3	3000	180.0	180.0	18.0
TLV431IDBZRG4	SOT-23	DBZ	3	3000	183.0	183.0	20.0
TLV431IDBZRG4	SOT-23	DBZ	3	3000	210.0	185.0	35.0

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TLV431QPK	SOT-89	PK	3	1000	340.0	340.0	38.0
TLV431QPK	SOT-89	PK	3	1000	190.0	190.0	30.0

DBZ0003A**PACKAGE OUTLINE****SOT-23 - 1.12 mm max height**

SMALL OUTLINE TRANSISTOR



4214838/F 08/2024

NOTES:

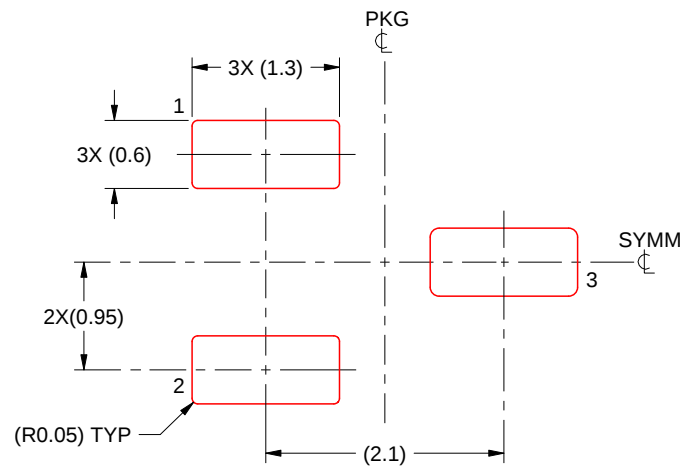
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Reference JEDEC registration TO-236, except minimum foot length.
4. Support pin may differ or may not be present.
5. Body dimensions do not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.25mm per side

EXAMPLE STENCIL DESIGN

DBZ0003A

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



SOLDER PASTE EXAMPLE
BASED ON 0.125 THICK STENCIL
SCALE:15X

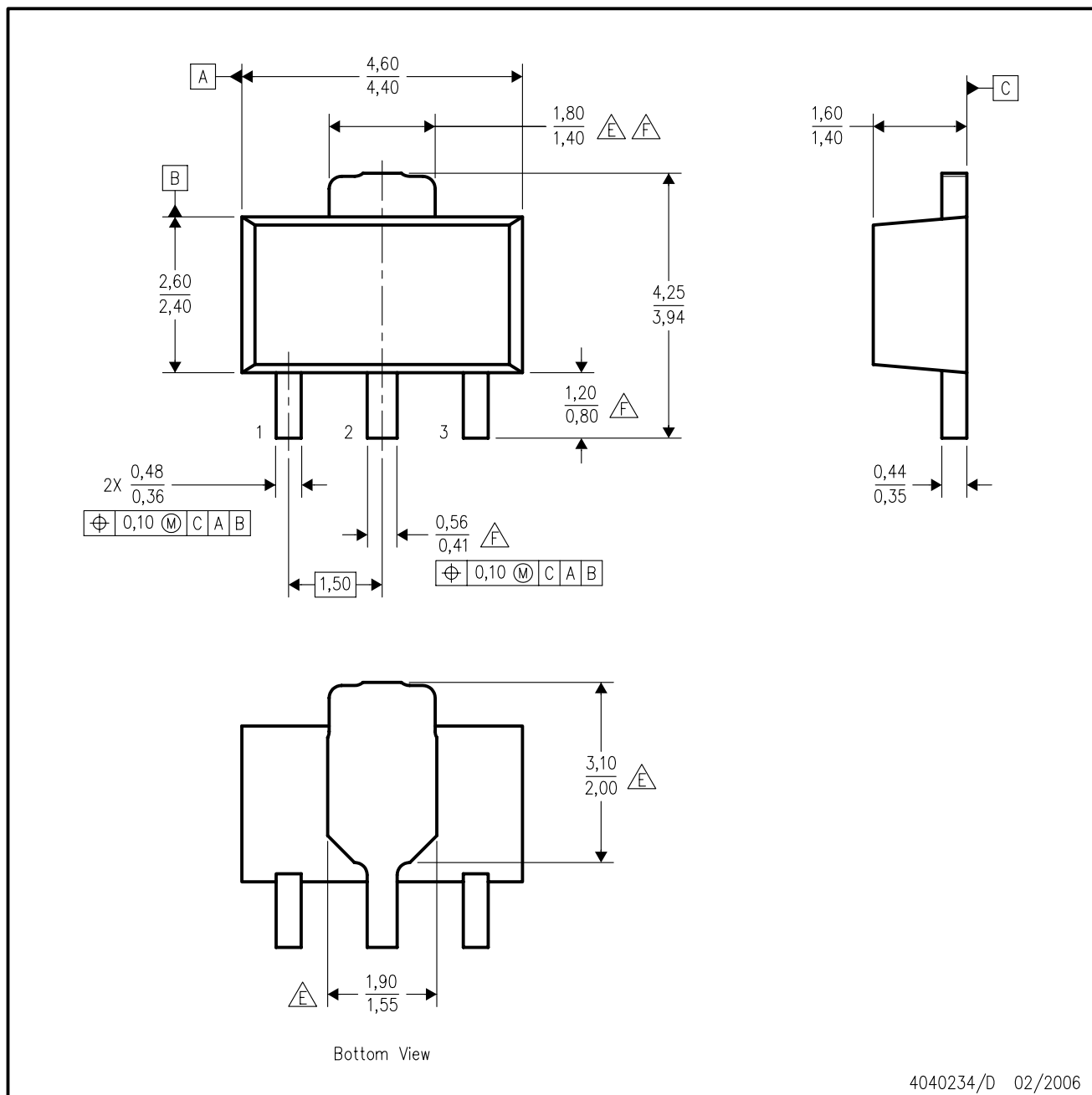
4214838/F 08/2024

NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

PK (R-PSSO-F3)

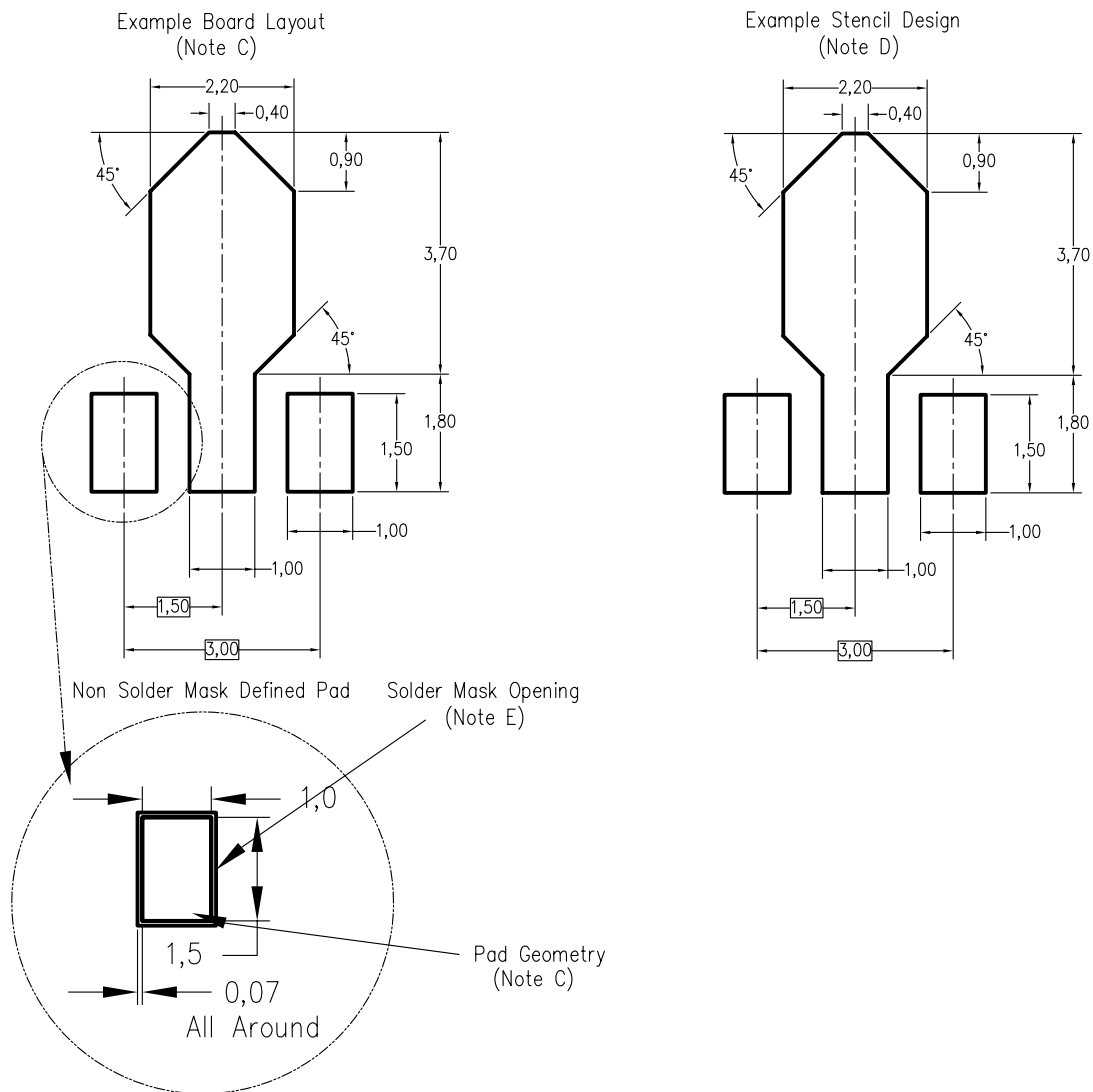
PLASTIC SINGLE-IN-LINE PACKAGE



4040234/D 02/2006

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

PK (R-PDSO-G3)



4208221/A 09/06

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



SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Reference JEDEC MO-178.
4. Body dimensions do not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.25 mm per side.
5. Support pin may differ or may not be present.

EXAMPLE BOARD LAYOUT

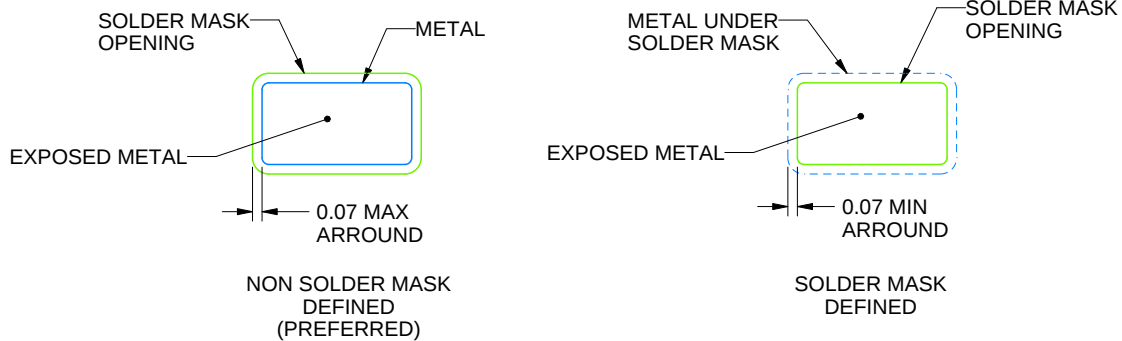
DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X



SOLDER MASK DETAILS

4214839/K 08/2024

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR

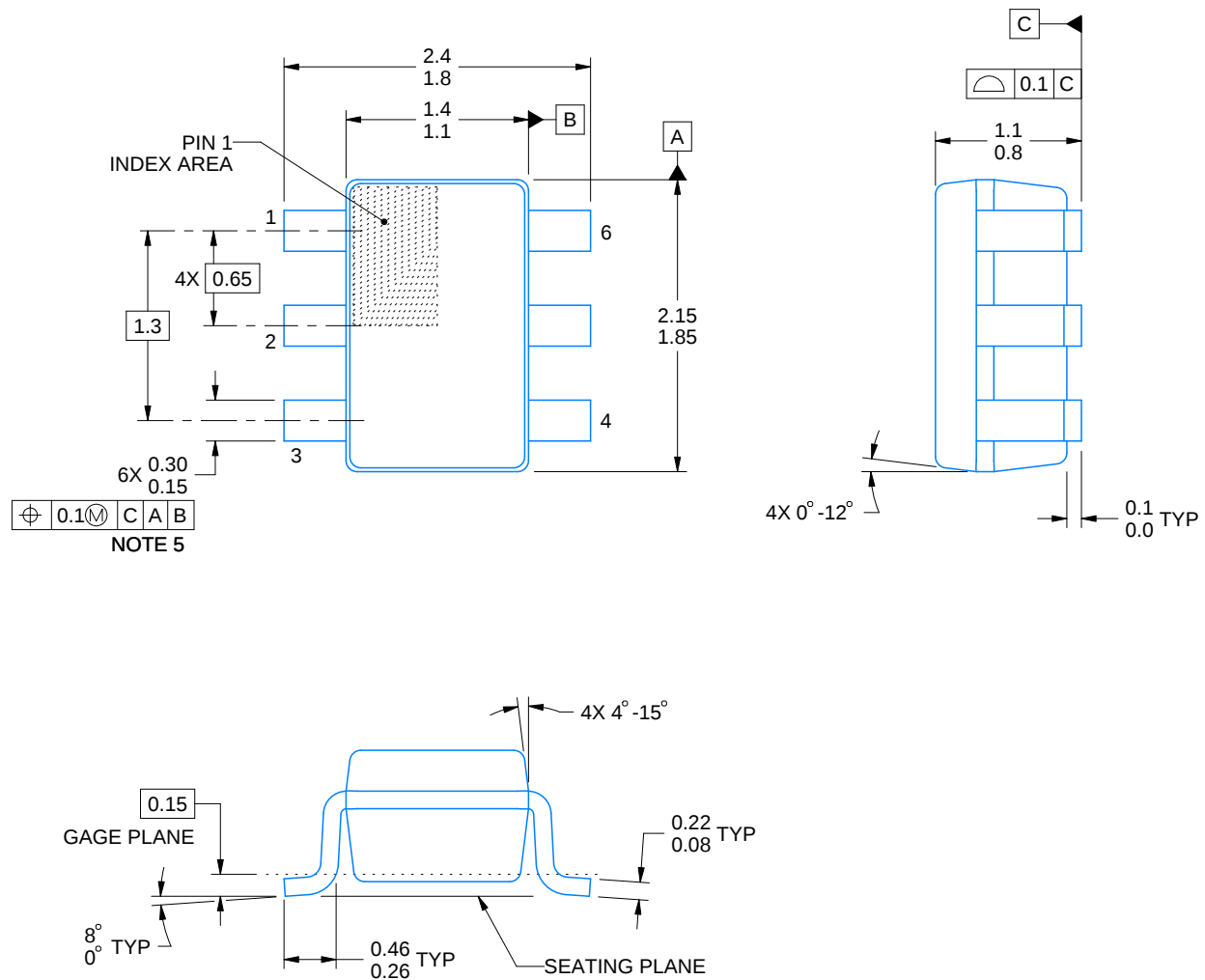


SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:15X

4214839/K 08/2024

NOTES: (continued)

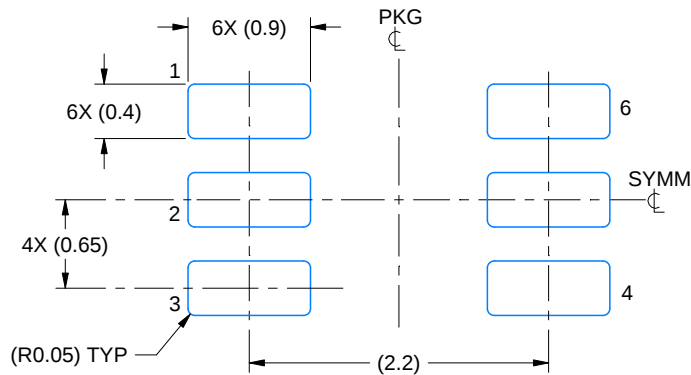
8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.



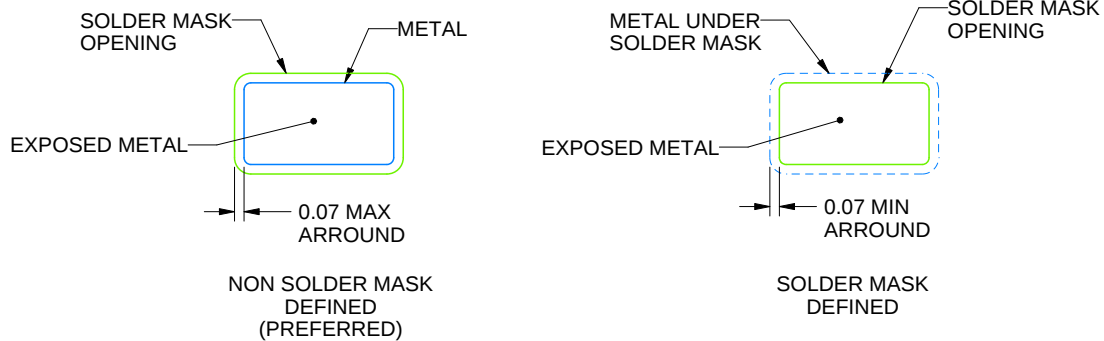
4214835/D 11/2024

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
4. Falls within JEDEC MO-203 variation AB.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:18X

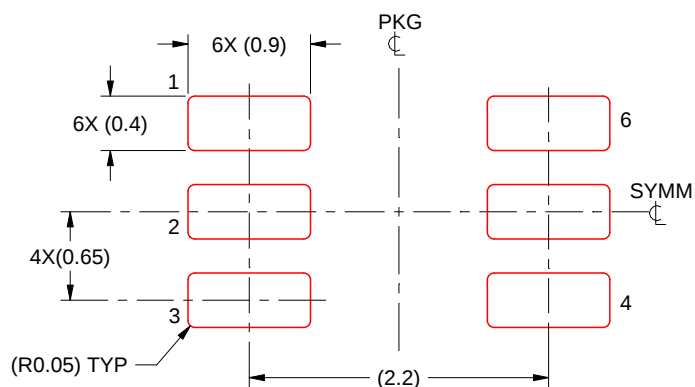


SOLDER MASK DETAILS

4214835/D 11/2024

NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 THICK STENCIL
SCALE:18X

4214835/D 11/2024

NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.



PACKAGE OUTLINE

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X



SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

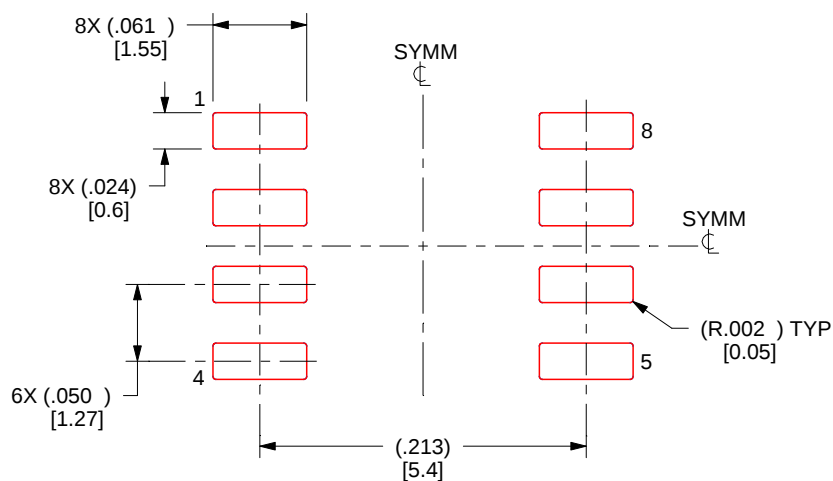
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



SOLDER PASTE EXAMPLE
BASED ON .005 INCH [0.125 MM] THICK STENCIL
SCALE:8X

4214825/C 02/2019

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.



TO-92 - 5.34 mm max height

Technical drawing of a 12-pin connector showing two views: a side view on the left and a front view on the right.

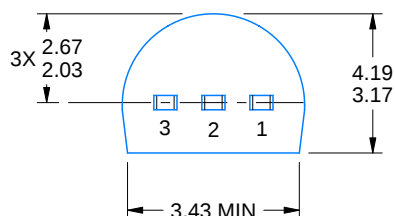
Side View (Left):

- Body width: 2X 2.9 / 2.4
- Body height: 2X 4 MAX
- Seating Plane: Indicated by a horizontal line.

Front View (Right):

- Body width: 5.21 / 4.44
- Body height: 5.34 / 4.32
- Ejector Pin: OPTIONAL (indicated by a circle and arrow)
- Pin height: (1.5) TYP
- Pin diameter: (0.51) TYP
- Pin pitch: 6X 0.076 MAX
- Pin length: 3X 12.7 MIN
- Pin width: 3X 0.55 / 0.38
- Pin spacing: 2X 1.27 ± 0.13
- Seating Plane: Indicated by a horizontal line.
- Note 3: (2.54) (indicated by a dashed line and arrow)

STRAIGHT LEAD OPTION



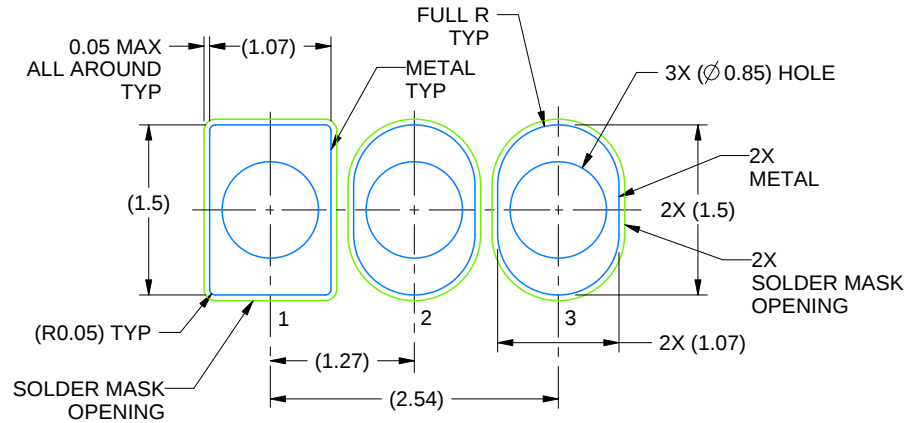
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Lead dimensions are not controlled within this area.
4. Reference JEDEC TO-226, variation AA.
5. Shipping method:
 - a. Straight lead option available in bulk pack only.
 - b. Formed lead option available in tape and reel or ammo pack.
 - c. Specific products can be offered in limited combinations of shipping medium and lead options.
 - d. Consult product folder for more information on available options.

EXAMPLE BOARD LAYOUT

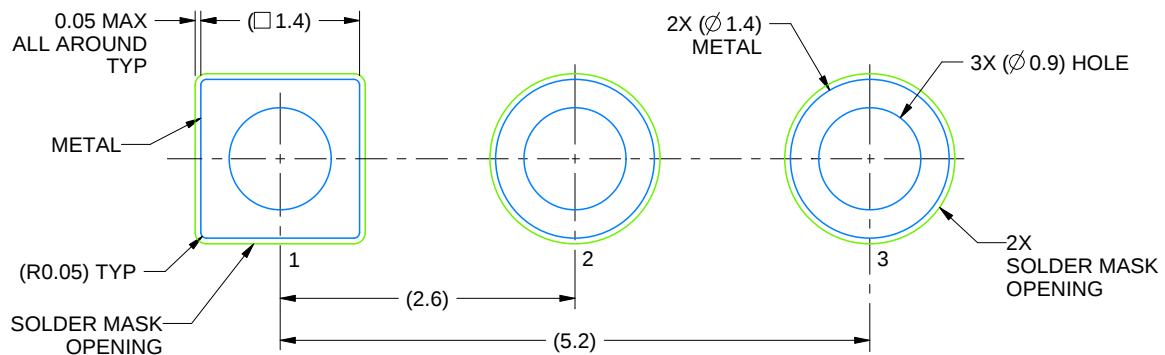
LP0003A

TO-92 - 5.34 mm max height

TO-92



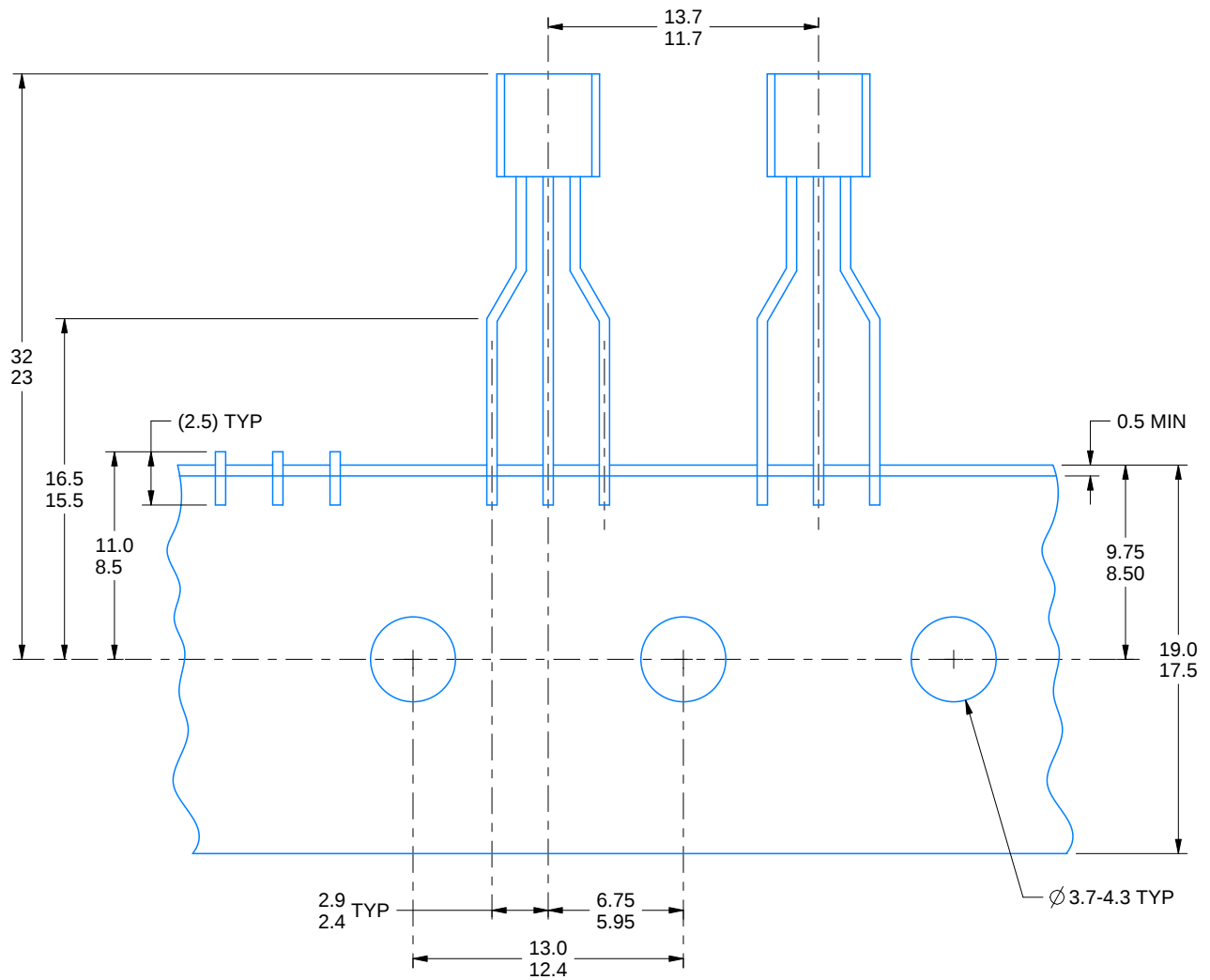
LAND PATTERN EXAMPLE
STRAIGHT LEAD OPTION
NON-SOLDER MASK DEFINED
SCALE:15X



LAND PATTERN EXAMPLE
FORMED LEAD OPTION
NON-SOLDER MASK DEFINED
SCALE:15X

4215214/C 04/2025

TO-92



FOR FORMED LEAD OPTION PACKAGE

4215214/C 04/2025

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