

# TLV27L2-Q1 汽车类低功耗轨到轨输出运算放大器

## 1 特性

- 符合汽车应用 要求
- 具有符合 AEC-Q100 标准的下列结果：
  - 器件温度 1 级：-40°C 至 +125°C 的环境运行温度范围
  - 器件人体放电模式 (HBM) 分类等级 2
  - 器件组件充电模式 (CDM) 分类等级 C6
- 双极金属氧化物半导体 (BiMOS) 轨到轨输出
- 输入偏置电流：1pA
- 高带宽 160kHz
- 高转换率：0.1V/μs
- 电源电流：7μA（每通道）
- 输入噪声电压：89nV/√Hz
- 电源电压范围：2.7V 至 16V

## 2 应用

- 便携式医疗设备
- 功率监视
- 低功耗安全检测系统
- 烟雾探测器

## 3 说明

TLV27L2-Q1 单电源运算放大器具有轨到轨输出能力。TLV27L2-Q1 器件在扩展级工业温度范围内的最小工作电源电压低至 2.7V，同时还增添了轨到轨输出摆幅特性。TLV27L2-Q1 器件仅使用 7μA 的超低电流即可提供 160kHz 带宽。建议的最大电源电压为 16V，这使得器件可以由 (±1.35V 至 ±8V 电源) 两个可充电电池供电。

轨到轨输出使得 TLV27L2-Q1 器件成为 TLC27Lx 系列器件的良好升级版，能够以更低的静态电流提供更高的带宽。TLV27L2-Q1 的偏移电压与 TLC27Lx 型号相同。这些器件还具有经济高效的优点，在偏移和噪声问题不太重要的情况下，它们是 TLC225x 和 TLV225x 系列器件不错的替代产品。

TLV27L2-Q1 器件支持商业级温度范围，以便于实现从等效 TLC27Lx 的轻松迁移。

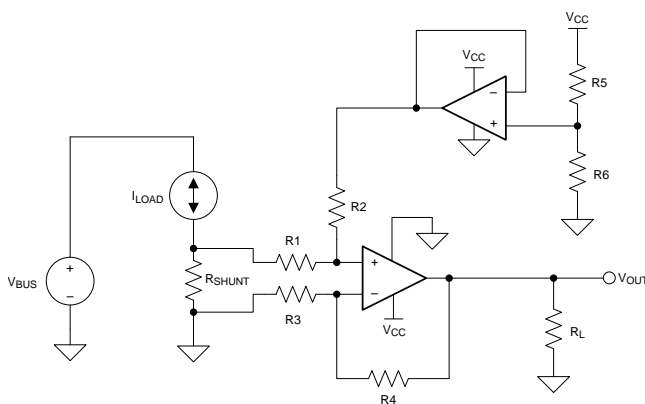
TLV27L2-Q1 器件采用 8 引脚 SOIC (D) 封装。

器件信息<sup>(1)</sup>

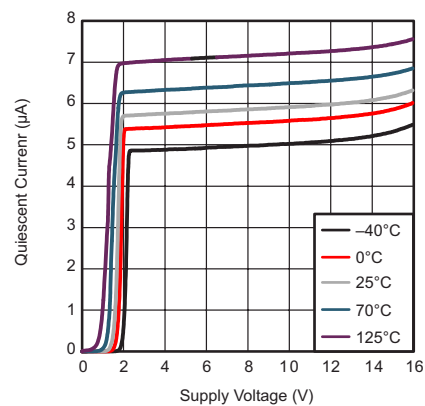
器件型号	封装	封装尺寸 (标称值)
TLV27L2-Q1	SOIC (8)	4.90mm x 3.91mm

(1) 如需了解所有可用封装，请参阅数据表末尾的可订购产品附录。

应用电路原理图



稳定的低静态电流



## 目录

<b>1</b>	特性 .....	<b>1</b>	8.4	Device Functional Modes .....	<b>11</b>
<b>2</b>	应用 .....	<b>1</b>	<b>9</b>	<b>Application and Implementation</b> .....	<b>12</b>
<b>3</b>	说明 .....	<b>1</b>	9.1	Application Information .....	<b>12</b>
<b>4</b>	修订历史记录 .....	<b>2</b>	9.2	Typical Application .....	<b>12</b>
<b>5</b>	<b>Selection Guide</b> .....	<b>3</b>	<b>10</b>	<b>Power Supply Recommendations</b> .....	<b>15</b>
<b>6</b>	<b>Pin Configuration and Functions</b> .....	<b>3</b>	<b>11</b>	<b>Layout</b> .....	<b>15</b>
<b>7</b>	<b>Specifications</b> .....	<b>4</b>	11.1	Layout Guidelines .....	<b>15</b>
7.1	Absolute Maximum Ratings .....	<b>4</b>	11.2	Layout Example .....	<b>16</b>
7.2	ESD Ratings .....	<b>4</b>	11.3	General Power Dissipation Considerations .....	<b>16</b>
7.3	Recommended Operating Conditions .....	<b>4</b>	<b>12</b>	器件和文档支持 .....	<b>17</b>
7.4	Thermal Information .....	<b>4</b>	12.1	文档支持 .....	<b>17</b>
7.5	Electrical Characteristics .....	<b>5</b>	12.2	社区资源 .....	<b>17</b>
7.6	Typical Characteristics .....	<b>6</b>	12.3	商标 .....	<b>18</b>
<b>8</b>	<b>Detailed Description</b> .....	<b>11</b>	12.4	静电放电警告 .....	<b>18</b>
8.1	Overview .....	<b>11</b>	12.5	Glossary .....	<b>18</b>
8.2	Functional Block Diagram .....	<b>11</b>	<b>13</b>	机械、封装和可订购信息 .....	<b>18</b>
8.3	Feature Description .....	<b>11</b>			

## 4 修订历史记录

注：之前版本的页码可能与当前版本有所不同。

### Changes from Original (September 2015) to Revision A

Page

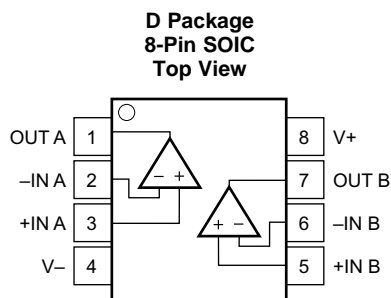
•	本数据表的第一个公开发布版本。 .....	<b>1</b>
---	-----------------------	----------

## 5 Selection Guide

All DC specifications are maximum values while AC specifications are typical values.

PART NUMBER	V <sub>S</sub> (V)	I <sub>Q</sub> /ch (μA)	V <sub>ICR</sub> (V)	V <sub>IO</sub> (mV)	I <sub>IB</sub> (pA)	GBW (MHz)	SLEW RATE (V/μs)	V <sub>n</sub> , 1 kHz (nV/√Hz)
TLV27L2-Q1	2.7 to 16	11	-0.2 to V <sub>S</sub> + 1.2	5	60	0.18	0.06	89
OPAx348-Q1	2.1 to 5.5	65	-0.2 to V <sub>S</sub> + 0.2	5	10	1	0.5	35
OPAx333-Q1	1.8 to 5.5	25	-0.1 to V <sub>S</sub> + 0.1	0.01	200	0.35	0.16	55
OPA2314-Q1	1.8 to 5.5	180	-0.2 to V <sub>S</sub> + 0.2	2.5	10	2.7	1.5	14
OPAx376-Q1	2.2 to 5.5	950	-0.1 to V <sub>S</sub> + 0.1	0.025	10	5.5	2	7.5
TLV226x-Q1	2.7 to 8	500	-0.3 to V <sub>S</sub> - 0.8	0.95	60	0.67	0.55	12

## 6 Pin Configuration and Functions



**Pin Functions**

PIN		I/O <sup>(1)</sup>	DESCRIPTION
NAME	NO.		
+IN A	3	I	Noninverting input, channel A
+IN B	5	I	Noninverting input, channel B
-IN A	2	I	Inverting input, channel A
-IN B	6	I	Inverting input, channel B
OUT A	1	O	Output, channel A
OUT B	7	O	Output, channel B
V+	8	—	Positive (highest) power supply
V-	4	—	Negative (lowest) power supply

(1) I = input, O = output

## 7 Specifications

### 7.1 Absolute Maximum Ratings

 over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

		MIN	MAX	UNIT
V <sub>S</sub>	Supply voltage		16.5	V
V <sub>I</sub>	Input voltage <sup>(2)</sup>		V <sub>S</sub>	V
V <sub>ID</sub>	Differential input voltage		V <sub>S</sub>	V
I <sub>O</sub>	Output current		100	mA
	Continuous total power dissipation	See the <a href="#">Thermal Information</a> Table		
T <sub>J</sub>	Maximum junction temperature		150	°C
T <sub>A</sub>	Operating free-air temperature	–40	125	°C
	Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds		300	°C
T <sub>stg</sub>	Storage temperature	–65	125	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) Relative to the V–.

### 7.2 ESD Ratings

		VALUE	UNIT
V <sub>(ESD)</sub>	Electrostatic discharge	Human-body model (HBM), per AEC Q100-002 <sup>(1)</sup>	±2000
		Charged-device model (CDM), per AEC Q100-011	±1000

- (1) AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

### 7.3 Recommended Operating Conditions

		MIN	MAX	UNIT
V <sub>S</sub>	Supply voltage	Dual supply	±1.35	±8
		Single supply	2.7	16
	Input common-mode voltage	–0.2	V <sub>S</sub> – 1.2	V
T <sub>A</sub>	Operating free-air temperature	–40	125	°C

### 7.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>	TLV27L2-Q1		UNIT
	D (SOIC)		
	8 PINS		
R <sub>θJA</sub>	Junction-to-ambient thermal resistance	122.2	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance	70.5	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance	62.5	°C/W
ψ <sub>JT</sub>	Junction-to-top characterization parameter	22.3	°C/W
ψ <sub>JB</sub>	Junction-to-board characterization parameter	62.0	°C/W
R <sub>θJC(bot)</sub>	Junction-to-case (bottom) thermal resistance	N/A	°C/W

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

## 7.5 Electrical Characteristics

at recommended operating conditions,  $V_S = 2.7\text{ V}$ ,  $5\text{ V}$ , and  $10\text{ V}$  (unless otherwise noted)

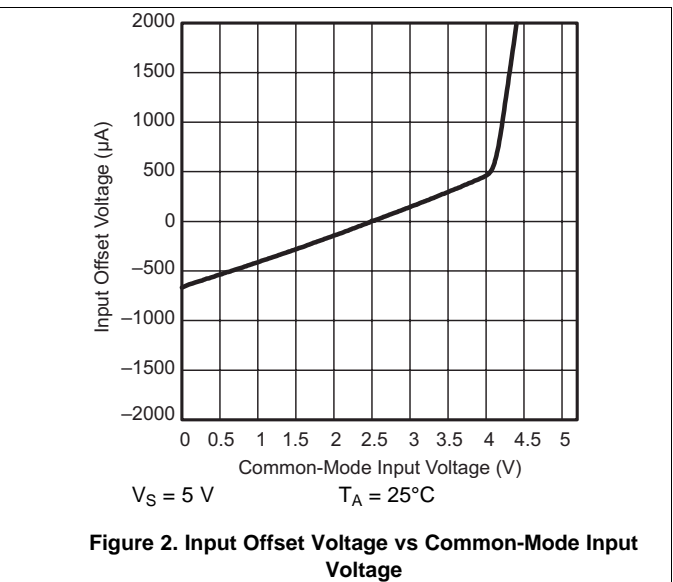
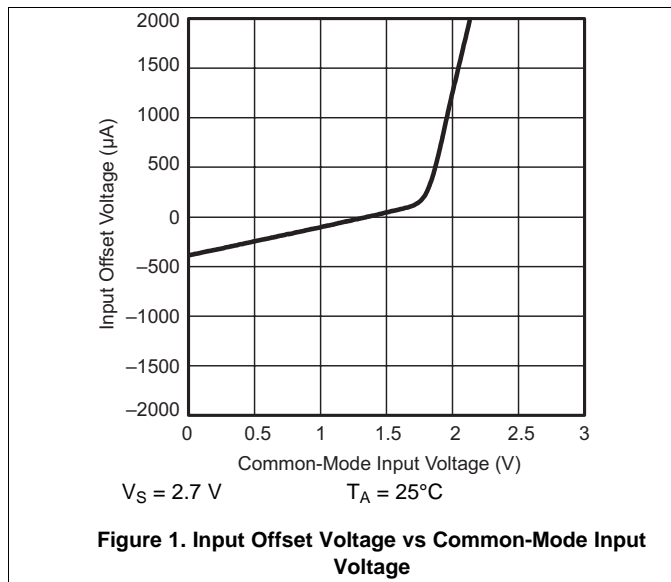
PARAMETER		TEST CONDITIONS		$T_A^{(1)}$	MIN	TYP	MAX	UNIT
<b>DC PERFORMANCE</b>								
$V_{IO}$	Input offset voltage	$V_{IC} = V_S / 2$ , $V_O = V_S / 2$ , $R_L = 100\text{ k}\Omega$ , $R_S = 50\ \Omega$		25°C		0.5	5	mV
				Full range			7	
$\alpha_{VIO}$	Offset voltage drift	$V_{IC} = V_S / 2$ , $V_O = V_S / 2$ , $R_L = 100\text{ k}\Omega$ , $R_S = 50\ \Omega$		25°C		1.1		$\mu\text{V}/^\circ\text{C}$
CMRR	Common-mode rejection ratio	$V_{IC} = 0\text{ V}$ to $V_S - 1.2\text{ V}$ , $R_S = 50\ \Omega$		25°C	71	86		dB
				Full range	70			
$A_{VD}$	Large-signal differential voltage amplification	$V_{O(PP)} = V_S / 2$ , $R_L = 100\text{ k}\Omega$ ,	$V_S = 2.7\text{ V}, 5\text{ V}$	25°C	80	100		dB
				Full range	77			
			$V_S = \pm 5\text{ V}$	25°C	77	82		
				Full range	74			
<b>INPUT CHARACTERISTICS</b>								
$I_{IO}$	Input offset current	$V_{IC} = V_S / 2$ , $V_O = V_S / 2$ , $R_L = 100\text{ k}\Omega$ , $R_S = 50\ \Omega$		$\leq 25^\circ\text{C}$		1	60	pA
				$\leq 70^\circ\text{C}$			100	
				$\leq 125^\circ\text{C}$			1000	
$I_{IB}$	Input bias current	$V_{IC} = V_S / 2$ , $V_O = V_S / 2$ , $R_L = 100\text{ k}\Omega$ , $R_S = 50\ \Omega$		$\leq 25^\circ\text{C}$		1	60	pA
				$\leq 70^\circ\text{C}$			200	
				$\leq 125^\circ\text{C}$			1000	
$r_{i(d)}$	Differential input resistance			$\leq 25^\circ\text{C}$		1000		G $\Omega$
$C_{IC}$	Common-mode input capacitance	$f = 1\text{ kHz}$		$\leq 25^\circ\text{C}$		8		pF
<b>POWER SUPPLY</b>								
$I_Q$	Quiescent current (per channel)	$V_O = V_S / 2$		25°C		7	11	$\mu\text{A}$
				Full range			16	
PSRR	Power supply rejection ratio ( $\Delta V_S / \Delta V_{IO}$ )	No load, $V_S = 2.7\text{ V}$ to $16\text{ V}$ , $V_{IC} = V_S / 2\text{ V}$		25°C	74	82		dB
				Full range	70			
<b>OUTPUT CHARACTERISTICS</b>								
$V_O$	Output voltage swing from rail	$V_{IC} = V_S / 2$ , $I_{OL} = 100\ \mu\text{A}$		$V_S = 2.7\text{ V}$	25°C	160	200	mV
					Full range			
				$V_S = 5\text{ V}$	25°C	85	120	
					Full range			
		$V_S = \pm 5\text{ V}$	25°C	50	120			
			Full range			150		
			$V_S = 5\text{ V}$	25°C	420	800		
				Full range			900	
$V_S = \pm 5\text{ V}$	25°C	200	400					
	Full range			500				
$I_O$	Output current	$V_O = 0.5\text{ V}$ from rail, $V_S = 2.7\text{ V}$		25°C		400		$\mu\text{A}$
<b>DYNAMIC PERFORMANCE</b>								
GBP	Gain bandwidth product	$R_L = 100\text{ k}\Omega$ , $C_L = 10\text{ pF}$ , $f = 1\text{ kHz}$		25°C		160		kHz
SR	Slew rate at unity gain	$V_{O(PP)} = 1\text{ V}$ , $R_L = 100\text{ k}\Omega$ , $C_L = 50\text{ pF}$		25°C		0.06		V/ $\mu\text{s}$
				-40°C		0.05		
				125°C		0.8		
$\phi_M$	Phase margin	$R_L = 100\text{ k}\Omega$ , $C_L = 50\text{ pF}$		25°C		62		°
$t_s$	Settling time (0.1%)	$V_{(STEP)pp} = 1\text{ V}$ , $A_V = -1$ , rise $C_L = 50\text{ pF}$ , $R_L = 100\text{ k}\Omega$ , fall		25°C		62		$\mu\text{s}$
							44	
<b>NOISE AND DISTORTION PERFORMANCE</b>								
$V_n$	Equivalent input noise voltage	$f = 1\text{ kHz}$		25°C		89		nV/ $\sqrt{\text{Hz}}$
$I_n$	Equivalent input noise current	$f = 1\text{ kHz}$		25°C		0.6		nV/ $\sqrt{\text{Hz}}$

(1) Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$  for I suffix.

## 7.6 Typical Characteristics

Table 1. Table of Graphs

		FIGURE
Input offset voltage ( $V_{IO}$ )	vs Common-mode input voltage ( $V_{IC}$ )	Figure 1, Figure 2, Figure 3
Input bias and offset current ( $I_{IB}$ and $I_{IO}$ )	vs Free-air temperature ( $T_A$ )	Figure 4
High-level output voltage ( $V_{OH}$ )	vs High-level output current ( $I_{OH}$ )	Figure 5, Figure 7, Figure 9
Low-level output voltage ( $V_{OL}$ )	vs Low-level output current ( $I_{OL}$ )	Figure 6, Figure 8, Figure 10
Quiescent current ( $I_Q$ )	vs Supply voltage ( $V_S$ )	Figure 11
	vs Free-air temperature ( $T_A$ )	Figure 12
Supply voltage and supply current ramp up		Figure 13
Differential voltage gain and phase shift ( $A_{VD}$ )	vs Frequency (f)	Figure 14
Gain-bandwidth product (GBP)	vs Free-air temperature ( $T_A$ )	Figure 15
Phase margin ( $\phi_m$ )	vs Load capacitance ( $C_L$ )	Figure 16
Common-mode rejection ratio (CMRR)	vs Frequency (f)	Figure 17
Power supply rejection ratio (PSRR)	vs Frequency (f)	Figure 18
Input referred noise voltage	vs Frequency (f)	Figure 19
Slew rate (SR)	vs Free-air temperature ( $T_A$ )	Figure 20
Peak-to-peak output voltage ( $V_{O(PP)}$ )	vs Frequency (f)	Figure 21
Inverting small-signal response		Figure 22
Inverting large-signal response		Figure 23
Crosstalk	vs Frequency (f)	Figure 24



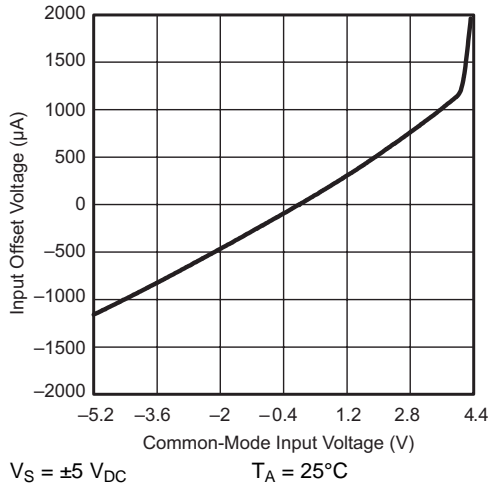


Figure 3. Input Offset Voltage vs Common-Mode Input Voltage

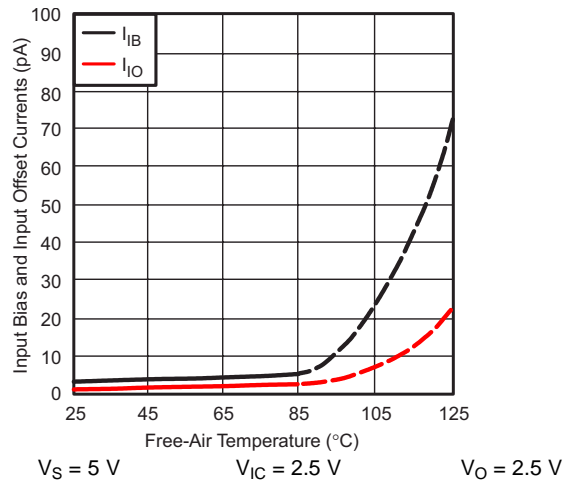


Figure 4. Input Bias And Input Offset Current vs Free-Air Temperature

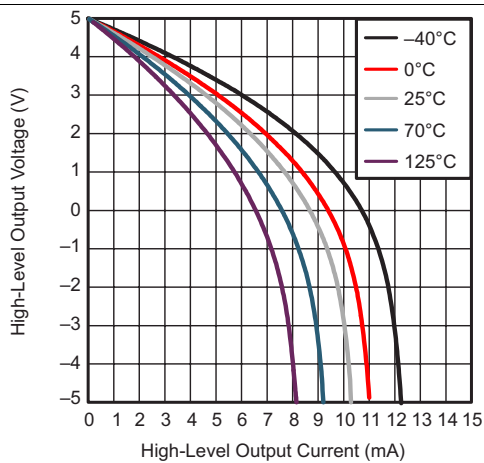


Figure 5. High-Level Output Voltage vs High-Level Output Current

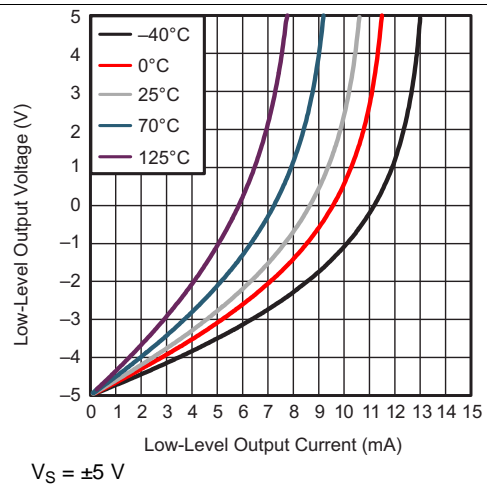


Figure 6. Low-Level Output Voltage vs Low-Level Output Current

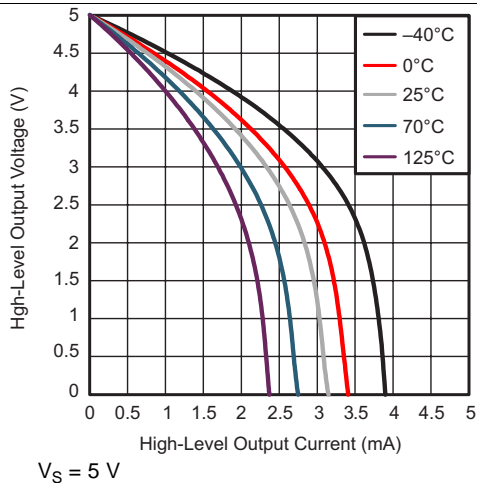


Figure 7. High-Level Output Voltage vs High-Level Output Current

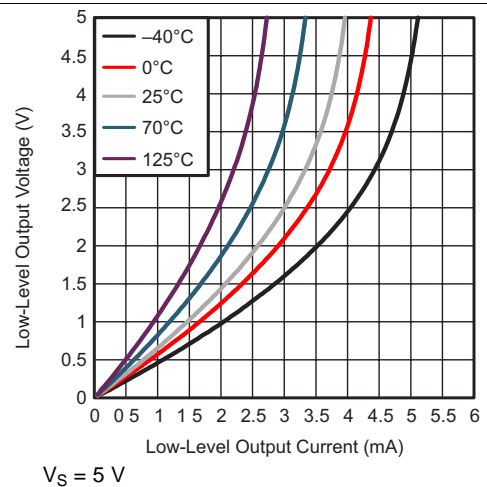


Figure 8. Low-Level Output Voltage vs Low-Level Output Current

TLV27L2-Q1

ZHCSEH4A – SEPTEMBER 2015 – REVISED DECEMBER 2015

www.ti.com.cn

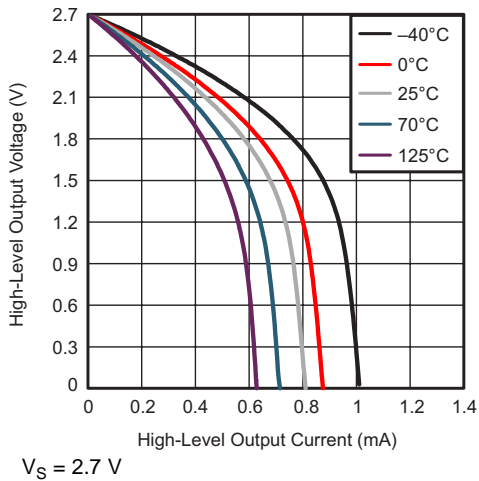


Figure 9. High-Level Output Voltage vs High-Level Output Current

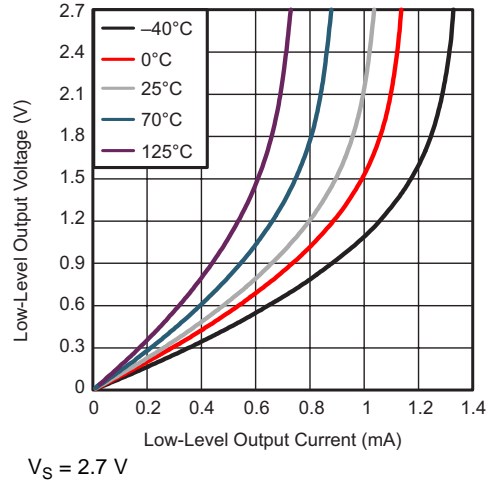


Figure 10. Low-Level Output Voltage vs Low-Level Output Current

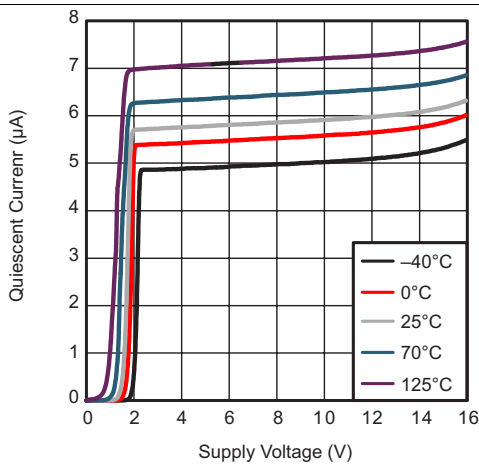


Figure 11. Quiescent Current vs Supply Voltage

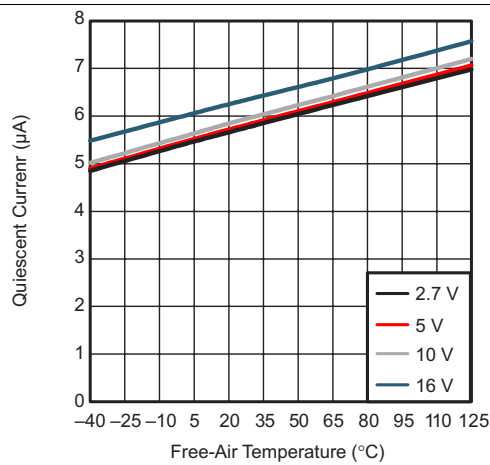


Figure 12. Quiescent Current vs Free-Air Temperature

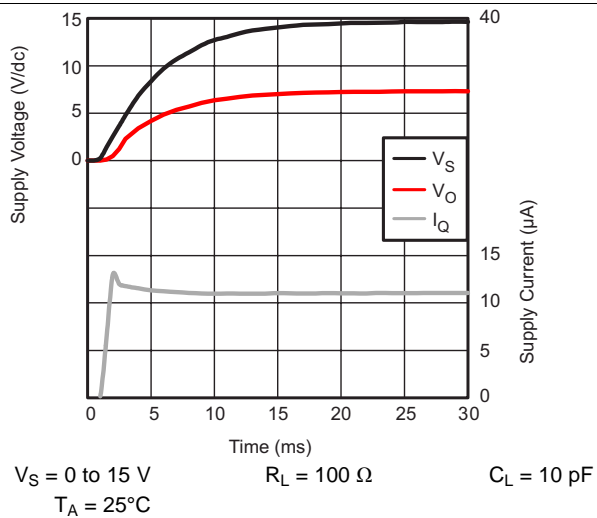


Figure 13. Supply Voltage and Supply Current Ramp Up

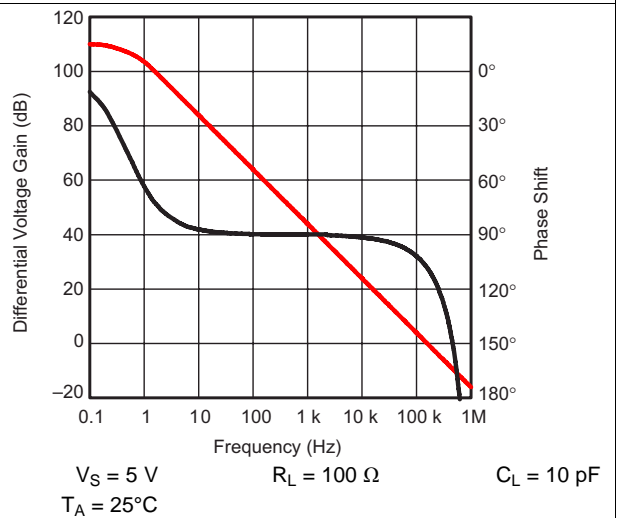


Figure 14. Differential Voltage Gain and Phase Shift vs Frequency



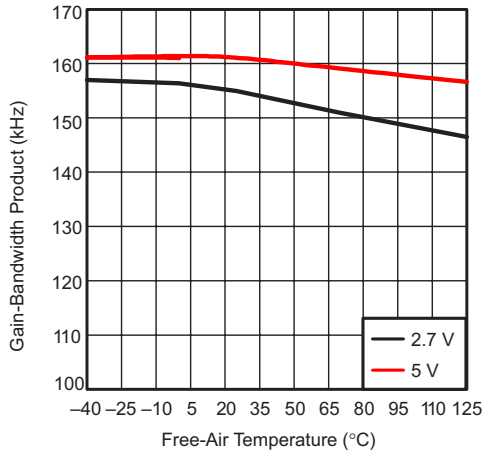


Figure 15. Gain-Bandwidth Product vs Free-Air Temperature

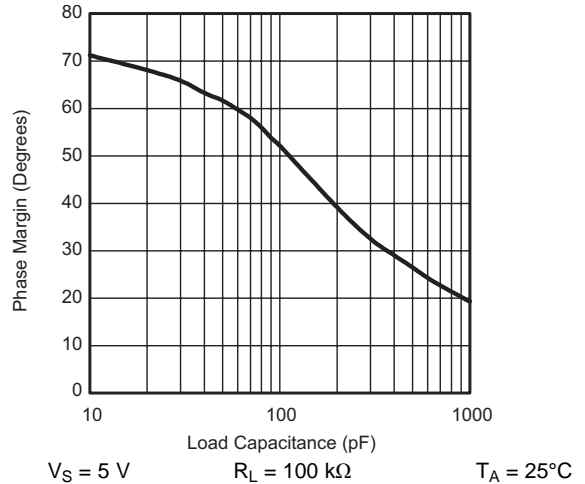


Figure 16. Phase Margin vs Load Capacitance

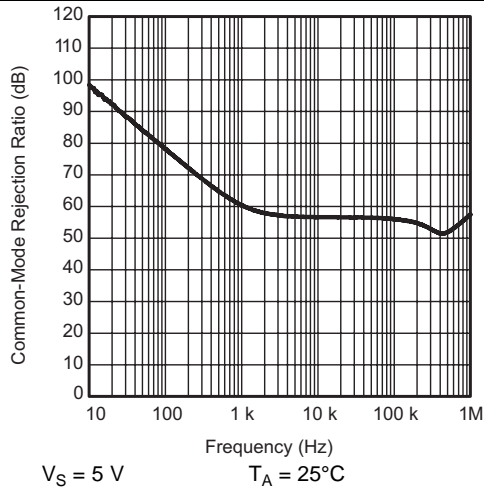


Figure 17. Common-Mode Rejection Ratio vs Frequency

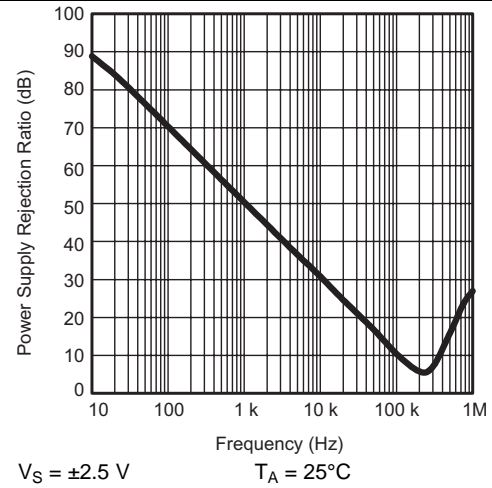


Figure 18. Power Supply Rejection Ratio vs Frequency

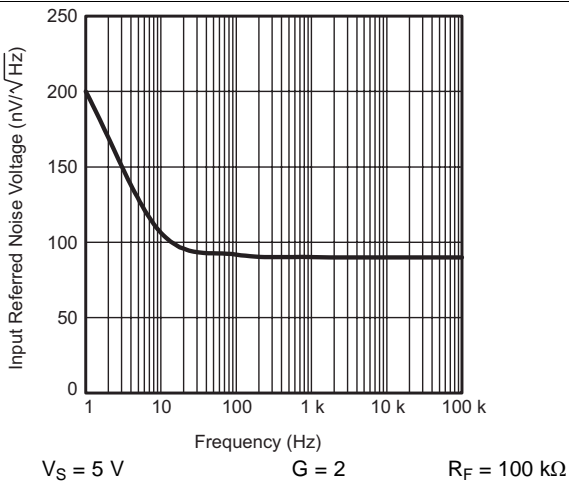


Figure 19. Input Referred Noise Voltage vs Frequency

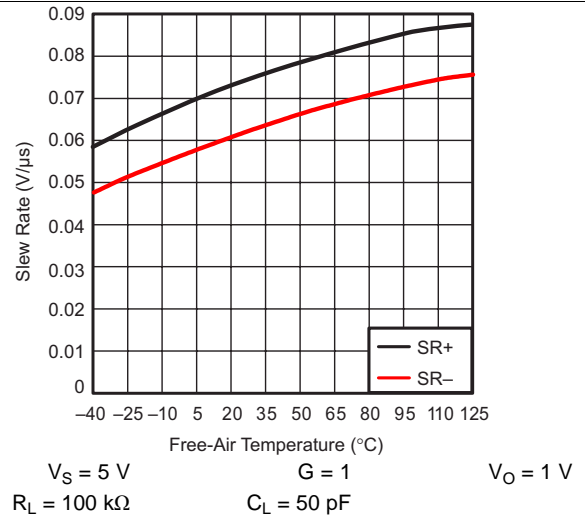


Figure 20. Slew Rate vs Free-Air Temperature

TLV27L2-Q1

ZHCSEH4A – SEPTEMBER 2015 – REVISED DECEMBER 2015

www.ti.com.cn

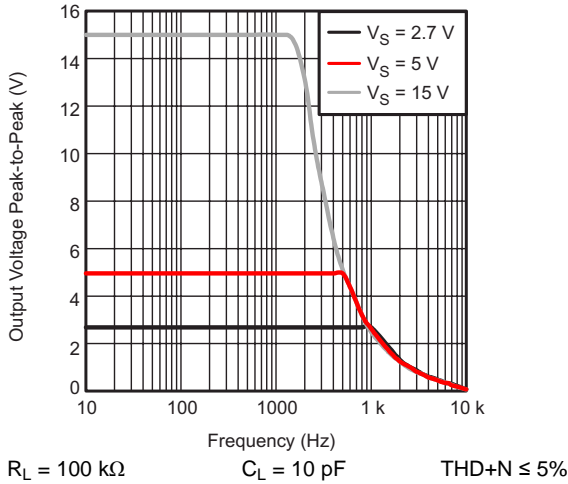


Figure 21. Peak-to-Peak Output Voltage vs Frequency

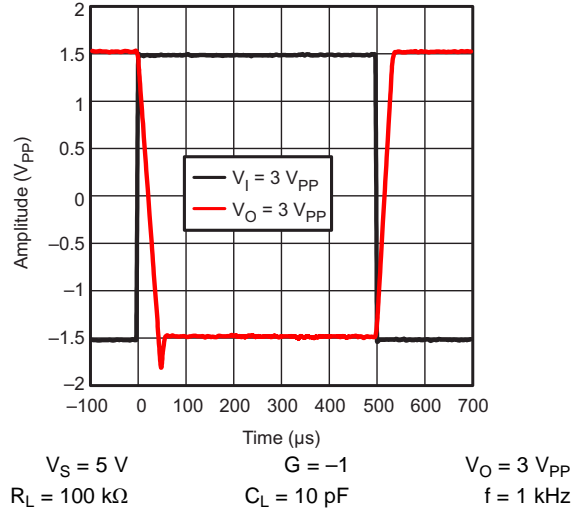


Figure 22. Inverting Small-Signal Response

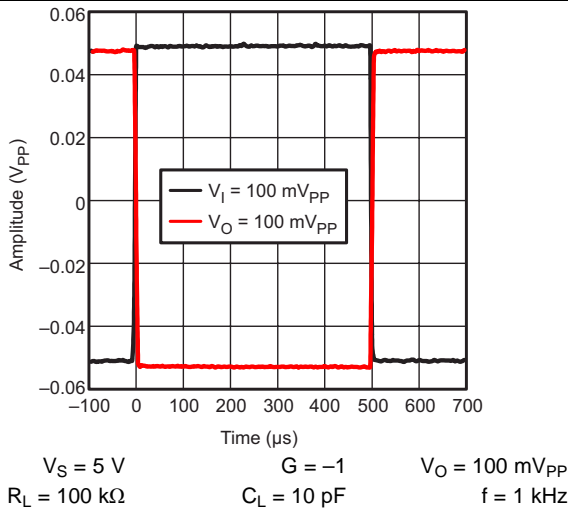


Figure 23. Inverting Large-Signal Response

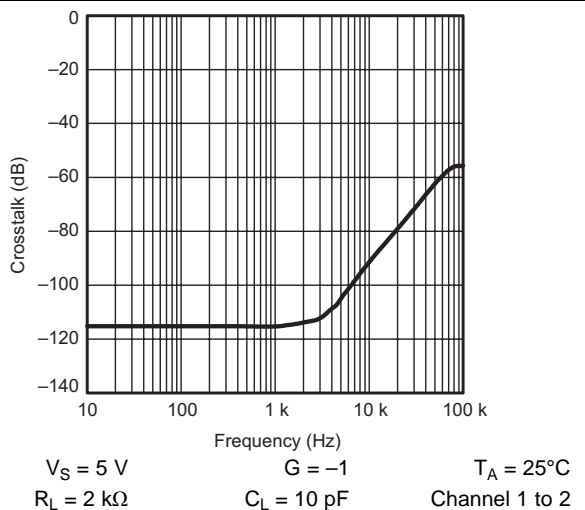


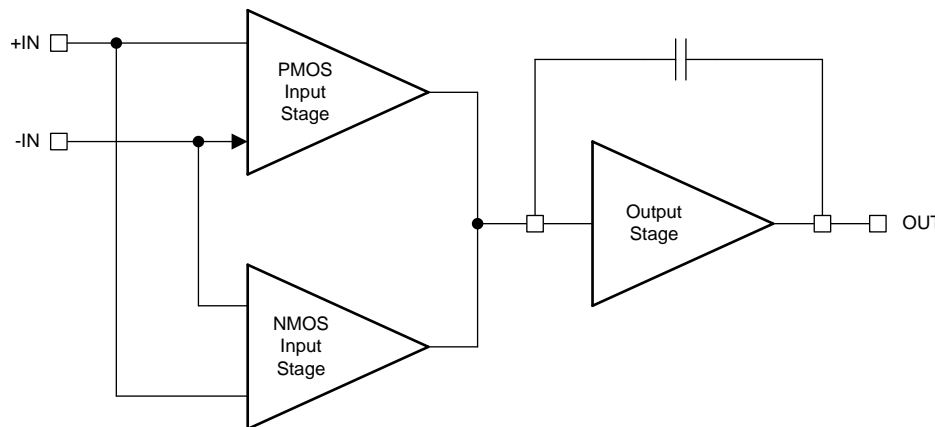
Figure 24. Crosstalk vs Frequency

## 8 Detailed Description

### 8.1 Overview

The TLV27L2-Q1 device is a micropower, rail-to-rail output, operational amplifier. This device operates from 2.7 V to 16 V, is unity-gain stable, and is suitable for a wide range of general-purpose applications. The class AB output stage is capable of driving  $\leq 10\text{-k}\Omega$  loads connected to any point between  $V+$  and ground. The input common-mode voltage range includes the negative rail and allows the TLV27L2-Q1 device to be used in virtually any single-supply application from 2.7 V to 16 V. The typical supply current of 7  $\mu\text{A}$  makes the TLV27L2-Q1 device an excellent choice for battery operated systems.

### 8.2 Functional Block Diagram



### 8.3 Feature Description

#### 8.3.1 Offset Voltage

The output offset voltage ( $V_{OO}$ ) is the sum of the input offset voltage ( $V_{IO}$ ) and both input bias currents ( $I_{IB}$ ) times the corresponding gains. Use the schematic and formula in Figure 25 to calculate the output offset voltage.

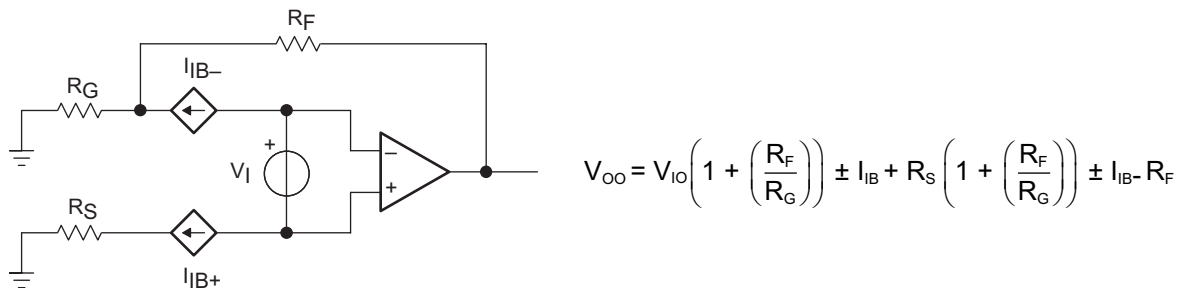


Figure 25. Output Offset Voltage Model

### 8.4 Device Functional Modes

The TLV27L2-Q1 device is powered on when the supply is connected. The device can be operated as a single-supply operational amplifier or a dual-supply amplifier, depending on the application. The TLV27L2-Q1 device operates from power supplies as low as 2.7 V or as high as 16 V.

## 9 Application and Implementation

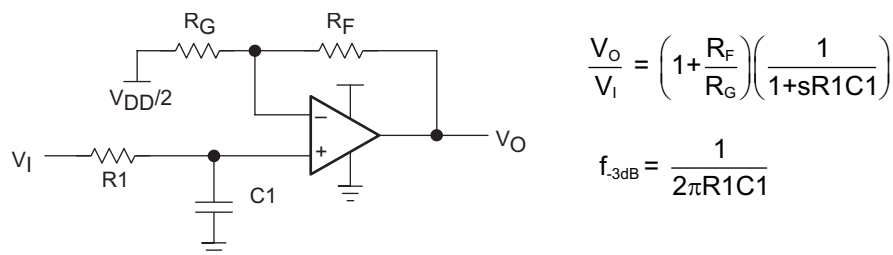
### NOTE

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.

### 9.1 Application Information

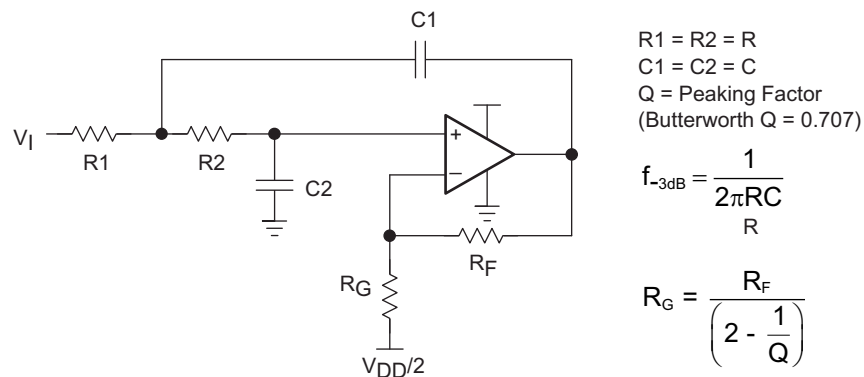
#### 9.1.1 General Configurations

When receiving low-level signals, limiting the bandwidth of the incoming signals into the system is often required. The simplest way limit the bandwidth is to place an RC filter at the noninverting terminal of the amplifier as shown in [Figure 26](#).



**Figure 26. Single-Pole Low-Pass Filter**

If even more attenuation is required, a multiple pole filter is required. The Sallen-Key filter can be used for this task. For best results, the amplifier should have a bandwidth that is 8 to 10 times the filter frequency bandwidth. Failure to do select an amplifier with an appropriate bandwidth can result in phase shift of the amplifier.



**Figure 27. 2-Pole Low-Pass Sallen-Key Filter**

### 9.2 Typical Application

This single-supply low-side, bi-directional current sensing solution can accurately detect load currents from  $-1$  A to  $+1$  A. The linear range of the output is from 110 mV to 3.19 V. The design uses the TLV27L2-Q1 device configured as a difference amplifier and reference voltage buffer.

Low-side current sensing is desirable because the common-mode voltage is near ground. Therefore the current sensing solution is independent of the bus voltage,  $V_{BUS}$ . When sensing bidirectional currents, a reference voltage must be added to differentiate between positive and negative currents. [Figure 28](#) shows a general circuit topology for a low-side, bidirectional current-sensing solution. This topology is particularly useful when cost is a priority at the expense of accuracy and printed circuit board (PCB) space. The shunt voltage ( $V_{SHUNT}$ ) is created

## Typical Application (continued)

by the load current ( $I_{LOAD}$ ) flowing through the shunt resistor ( $R_{SHUNT}$ ). The  $V_{SHUNT}$  voltage is amplified by an op amp (U1A) according to the gain set by the ratio of R4 to R3. To achieve the transfer function in Equation 1 and to minimize errors, set R4 equal to R2 and R3 equal to R1. To provide the reference voltage in this design, divide down the supply voltage ( $V_{CC}$ ) using R5 and R6. The reference voltage is then buffered using an additional op amp (U1B).

$$V_{OUT} = V_{SHUNT} \times \text{Gain}_{\text{Diff\_Amp}} + V_{ref} \quad (1)$$

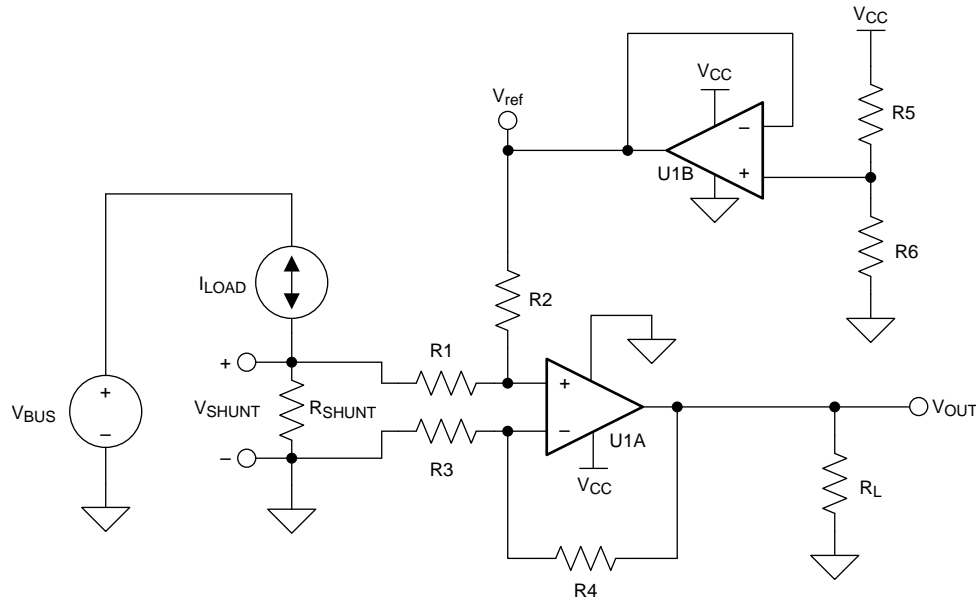


Figure 28. Application Schematic ±1-A Single-Supply Low-Side Current Sensing Solution

### 9.2.1 Design Requirements

The design requirements are as follows:

Supply voltage: 3.3 V

Input: -1 A to +1 A

Output: 110 mV to 3.19 V

Maximum shunt voltage: ±100 mV

### 9.2.2 Detailed Design Procedure

#### 9.2.2.1 Shunt Resistor ( $R_{SHUNT}$ )

As shown in Figure 28, the value of  $V_{SHUNT}$  is the ground potential for the system load. If the value of  $V_{SHUNT}$  is too large, it can cause issues when interfacing with systems with a true ground potential of 0 V. If the value of  $V_{SHUNT}$  is too negative, it can violate the input common-mode voltage of the differential amplifier in addition to potential interfacing issues. Therefore, limit the voltage across the shunt resistor. Use Equation 2 to calculate the maximum value of  $R_{SHUNT}$  given a maximum shunt voltage of 100 mV.

$$R_{SHUNT(MAX)} = \frac{|V_{SHUNT(MAX)}|}{|I_{LOAD(MAX)}|} = \frac{100 \text{ mV}}{1 \text{ A}} = 100 \text{ m}\Omega \quad (2)$$

Because cost is a priority in this design, a shunt resistor with a 0.5% tolerance was selected.

## Typical Application (continued)

### 9.2.2.2 Operational Amplifiers

The shunt voltage in this design can range from  $-100\text{ mV}$  to  $+100\text{ mV}$ . The shunt voltage is divided down by the resistors, R1 and R2. The op amp configured as a difference amplifier (U1A) must have an input common-mode that includes this voltage range. Therefore an op amp with rail-to-rail input (RRI) that extends below  $V_-$  is recommended. The output swing of the amplifier should also be rail-to-rail output (RRO) to maximize the dynamic range of the system. Use of a CMOS op amp is recommended because the supply voltage is  $3.3\text{ V}$ . The supply-splitter op amp (U1B) should have low offset voltage. Because this design includes two op amps, a dual package minimizes the required area. This design uses the TLV27L2-Q1 device because it is a RRO CMOS device. In addition, the cost versus performance of the device is excellent.

### 9.2.2.3 Reference Voltage Resistors (R5-R6)

Because the load current range is symmetric ( $-1\text{ A}$  to  $+1\text{ A}$ ), the resistors that divide down the supply voltage should be equal so that the reference voltage is the mid supply ( $[(V_+) - (V_-)] / 2$  or, for this example,  $(3.3\text{ V} - 0\text{ V}) / 2 = 1.65\text{ V}$ ). Because cost is a priority in this design, the tolerance should be consistent with the shunt resistor tolerance (0.5%). Finally, select resistors that are large enough to meet the power consumption requirement of the system. For this design,  $10\text{-k}\Omega$  resistors were selected.

### 9.2.2.4 Difference Amplifier Gain Setting Resistors (R1-R4)

Equation 3 and Equation 4 show the input common-mode ( $V_{CM}$ ) and output voltage range ( $V_{OUT}$ ) of the TLV27L2-Q1 device given a  $3.3\text{-V}$  supply.

$$-200\text{ mV} < V_{CM} < 2.1\text{ V} \quad (3)$$

$$100\text{ mV} < V_{OUT} < 3.2\text{ V} \quad (4)$$

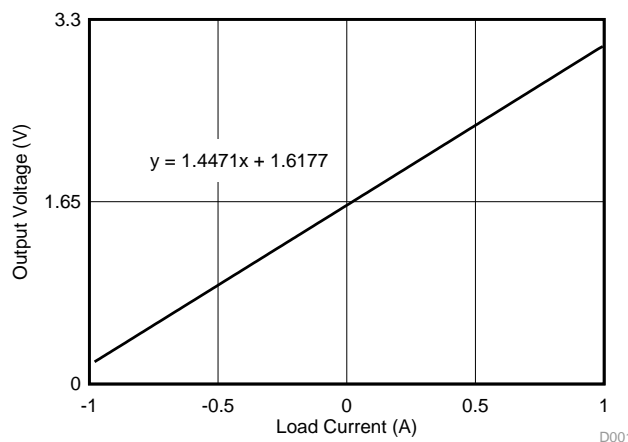
Use Equation 5 to calculate the gain.

$$\text{Gain}_{\text{Diff\_Amp}} = \frac{V_{OUT\_MAX} - V_{OUT\_MIN}}{R_{SHUNT} \times (I_{MAX} - I_{MIN})} = \frac{3.2\text{ V} - 100\text{ mV}}{100\text{ m}\Omega \times (1\text{ A} - (-1\text{ A}))} = 15.5 \frac{\text{V}}{\text{V}} \quad (5)$$

The selected value for the R1 and R3 resistors was  $1\text{ k}\Omega$ . The selected value for the R2 and R4 resistors was  $15.4\text{ k}\Omega$ , which is the nearest 0.1% value to the ideal value of  $15.5\text{ k}\Omega$ . Therefore, the ideal gain of the difference amplifier is  $15.4\text{ V/V}$ .

## 9.2.3 Application Curve

Figure 29 shows the measured transfer function of the design.



**Figure 29. Measured Output Voltage vs Load Current (Board 1)**

## 10 Power Supply Recommendations

The TLV27L2-Q1 device is specified for operation from 2.7 V to 16 V ( $\pm 1.35$  V to  $\pm 8$  V); many specifications apply from  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ . The [Typical Characteristics](#) presents parameters that can exhibit significant variance with regard to operating voltage or temperature.

### CAUTION

Supply voltages larger than 16.5 V can permanently damage the device (see the [Absolute Maximum Ratings](#) table).

Place 0.1- $\mu\text{F}$  bypass capacitors close to the power-supply pins to reduce errors coupling in from noisy or high-impedance power supplies. For more detailed information on bypass capacitor placement, refer to the [Layout Guidelines](#) section.

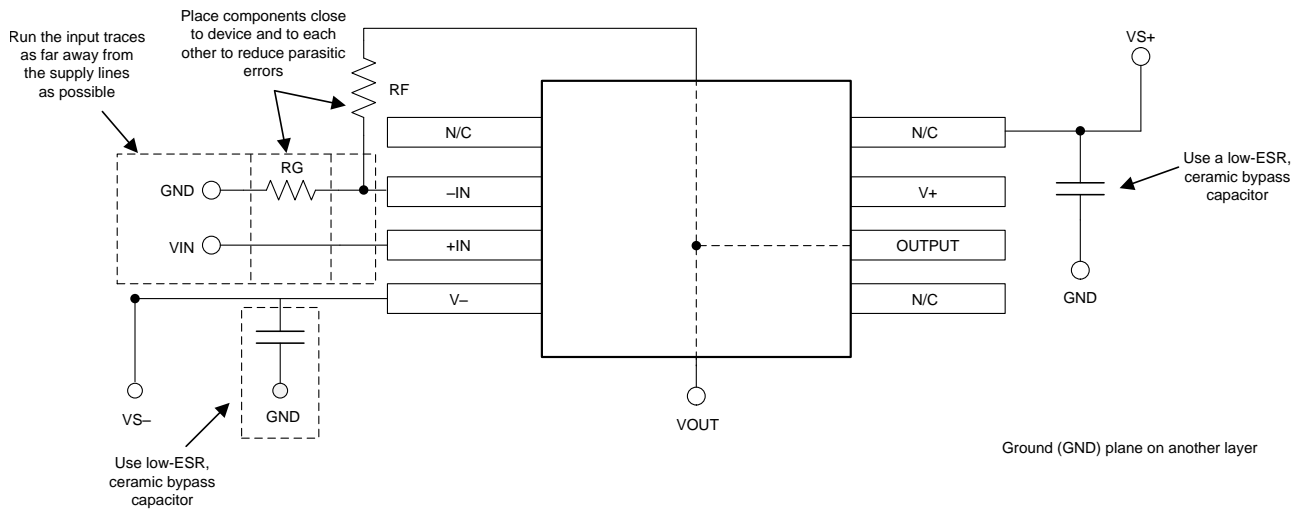
## 11 Layout

### 11.1 Layout Guidelines

To achieve the levels of high performance of the TLV27L2-Q1 device, follow proper printed-circuit board design techniques. The following list is a general set of guidelines:

- Ground planes—Using a ground plane on the board is highly recommended to provide all components with a low inductive-ground connection. However, in the areas of the amplifier inputs and output, the ground plane can be removed to minimize the stray capacitance.
- Proper power supply decoupling—Use a 6.8- $\mu\text{F}$  tantalum capacitor in parallel with a 0.1- $\mu\text{F}$  ceramic capacitor on each supply terminal. Sharing the tantalum capacitor among several amplifiers is possible depending on the application, but a 0.1- $\mu\text{F}$  ceramic capacitor should always be used on the supply terminal of every amplifier. In addition, the 0.1- $\mu\text{F}$  capacitor should be placed as close as possible to the supply terminal. As this distance increases, the inductance in the connecting trace makes the capacitor less effective. The designer should strive for distances of less than 0.1 inches between the device power terminals and the ceramic capacitors.
- Sockets—Sockets can be used but are not recommended. The additional lead inductance in the socket pins will often lead to stability problems. Surface-mount packages soldered directly to the printed-circuit board are the best implementation.
- Short trace runs and compact part placements—Optimum high performance is achieved when stray series inductance has been minimized. To achieve this performance, the circuit layout should be as compact as possible, thereby minimizing the length of all trace runs. Particular attention should be paid to the inverting input of the amplifier. The length should be kept as short as possible which helps minimize stray capacitance at the input of the amplifier.
- Surface-mount passive components—Using surface-mount passive components is recommended for high performance amplifier circuits for several reasons. First, because of the extremely low lead inductance of surface-mount components, the problem with stray series inductance is greatly reduced. Second, the small size of surface-mount components naturally leads to a more compact layout thereby minimizing both stray inductance and capacitance. If leaded components are used, keep the lead lengths as short as possible.

## 11.2 Layout Example



Copyright © 2017, Texas Instruments Incorporated

**Figure 30. TLV27L2-Q1 Layout Example**

## 11.3 General Power Dissipation Considerations

Use to calculate the maximum power dissipation for a given  $\theta_{JA}$ .

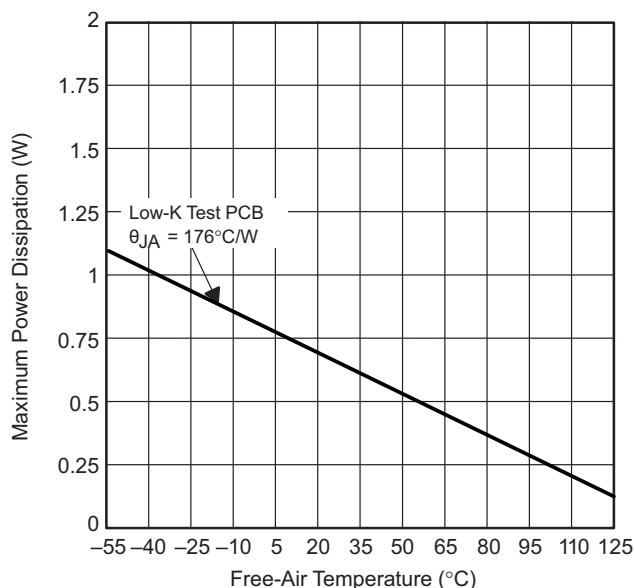
$$P_D = \left( \frac{T_{MAX} - T_A}{\theta_{JA}} \right)$$

where

- $P_D$  = Maximum power dissipation of TLV27L2-Q1 IC (watts)
- $T_{MAX}$  = Absolute maximum junction temperature (150°C)
- $T_A$  = Free-ambient air temperature (°C)
- $\theta_{JA} = \theta_{JC} + \theta_{CA}$ 
  - $\theta_{JC}$  = Thermal coefficient from junction to case
  - $\theta_{CA}$  = Thermal coefficient from case to ambient air (°C/W)



## General Power Dissipation Considerations (continued)



$$T_J = 150^{\circ}\text{C}$$

Results are with no air flow and using JEDEC Standard Low-K test PCB.

Figure 31. Maximum Power Dissipation vs Free-Air Temperature

## 12 器件和文档支持

### 12.1 文档支持

#### 12.1.1 相关文档

请参阅如下相关文档:

- 《OPA348-Q1 1MHz 45 $\mu$ A CMOS 轨到轨运算放大器》，[SBOS465](#)
- 《OPA333-Q1 1.8V 低功耗 CMOS 运算放大器零漂移系列》，[SBOS522](#)
- 《OPA2314-Q1 3MHz、低功耗、低噪声、RRIO、1.8V CMOS 运算放大器》，[SLOS896](#)
- 《OPA376-Q1 低噪声、低静态电流、高精度运算放大器 e-trim™ 系列》，[SBOS549](#)
- 《TLV226x-Q1 高级 LinCMOS™ CMOS 运算放大器》，[SGLS193](#)

### 12.2 社区资源

下列链接提供到 TI 社区资源的连接。链接的内容由各个分销商“按照原样”提供。这些内容并不构成 TI 技术规范，并且不一定反映 TI 的观点；请参阅 TI 的《使用条款》。

**TI E2E™ 在线社区** TI 的工程师对工程师 (E2E) 社区。此社区的创建目的在于促进工程师之间的协作。在 e2e.ti.com 中，您可以咨询问题、分享知识、拓展思路并与同行工程师一道帮助解决问题。

**设计支持** TI 参考设计支持 可帮助您快速查找有帮助的 E2E 论坛、设计支持工具以及技术支持的联系信息。

### 12.3 商标

E2E is a trademark of Texas Instruments.  
All other trademarks are the property of their respective owners.

### 12.4 静电放电警告



这些装置包含有限的内置 ESD 保护。存储或装卸时，应将导线一起截短或将装置放置于导电泡棉中，以防止 MOS 门极遭受静电损伤。

### 12.5 Glossary

[SLYZ022](#) — *TI Glossary*.

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

## 13 机械、封装和可订购信息

以下页面包含机械、封装和可订购信息。这些信息是指定器件的最新可用数据。这些数据如有变更，恕不另行通知和修订此文档。如欲获取此数据表的浏览器版本，请参阅左侧的导航。

**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)
<a href="#">TLV27L2QDRQ1</a>	Active	Production	SOIC (D)   8	2500   LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 125	27L2Q1
TLV27L2QDRQ1.A	Active	Production	SOIC (D)   8	2500   LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 125	27L2Q1

(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.

**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF TLV27L2-Q1 :**

- Catalog : [TLV27L2](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

**TAPE AND REEL INFORMATION**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**

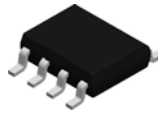

\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TLV27L2QDRQ1	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)
TLV27L2QDRQ1	SOIC	D	8	2500	340.5	336.1	25.0

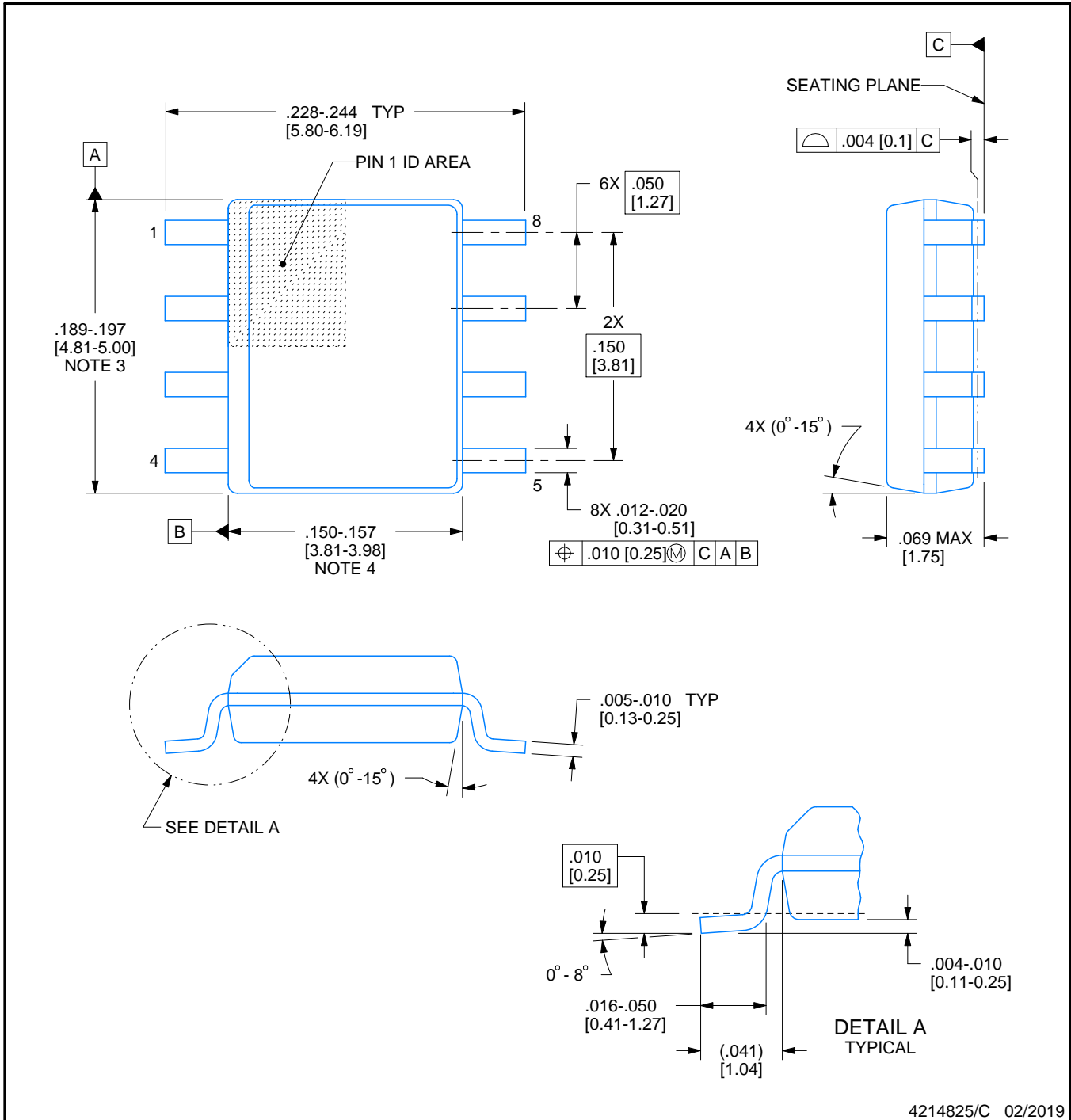


D0008A

# PACKAGE OUTLINE

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



NOTES:

- 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.
- This drawing is subject to change without notice.
- 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.
- This dimension does not include interlead flash.
- Reference JEDEC registration MS-012, variation AA.

# EXAMPLE BOARD LAYOUT

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.

## 重要通知和免责声明

TI“按原样”提供技术和可靠性数据（包括数据表）、设计资源（包括参考设计）、应用或其他设计建议、网络工具、安全信息和其他资源，不保证没有瑕疵且不做任何明示或暗示的担保，包括但不限于对适销性、与某特定用途的适用性或不侵犯任何第三方知识产权的暗示担保。

这些资源可供使用 TI 产品进行设计的熟练开发人员使用。您将自行承担以下全部责任：(1) 针对您的应用选择合适的 TI 产品，(2) 设计、验证并测试您的应用，(3) 确保您的应用满足相应标准以及任何其他安全、安保法规或其他要求。

这些资源如有变更，恕不另行通知。TI 授权您仅可将这些资源用于研发本资源所述的 TI 产品的相关应用。严禁以其他方式对这些资源进行复制或展示。您无权使用任何其他 TI 知识产权或任何第三方知识产权。对于因您对这些资源的使用而对 TI 及其代表造成的任何索赔、损害、成本、损失和债务，您将全额赔偿，TI 对此概不负责。

TI 提供的产品受 [TI 销售条款](#)、[TI 通用质量指南](#) 或 [ti.com](#) 上其他适用条款或 TI 产品随附的其他适用条款的约束。TI 提供这些资源并不会扩展或以其他方式更改 TI 针对 TI 产品发布的适用的担保或担保免责声明。除非德州仪器 (TI) 明确将某产品指定为定制产品或客户特定产品，否则其产品均为按确定价格收入目录的标准通用器件。

TI 反对并拒绝您可能提出的任何其他或不同的条款。

版权所有 © 2025，德州仪器 (TI) 公司

最后更新日期：2025 年 10 月