

## INA27x 电压输出、单向测量电流分流监控器

### 1 特性

- 宽共模范围:  $-16\text{V}$  至  $+80\text{V}$
- CMRR: 120dB
- 精度:
  - $\pm 0.5\text{mV}$  失调电压 (典型值)
  - $\pm 0.2\%$  增益误差 (典型值)
  - $2.5\ \mu\text{V}/^\circ\text{C}$  温漂 (典型值)
  - $50\ \text{ppm}/^\circ\text{C}$  增益漂移 (最大值)
- 带宽: 高达 130kHz
- 两种可用增益选项:
  - 14 V/V (INA270)
  - 20 V/V (INA271)
- 静态电流:  $700\ \mu\text{A}$  (典型值)
- 电源:  $+2.7\text{V}$  至  $+18\text{V}$
- 可用于滤波

### 2 应用

- 电源管理
- 汽车
- 电信设备
- 笔记本电脑
- 电池充电器
- 手机
- 焊接设备

### 3 说明

INA270 和 INA271 系列器件电压输出、电流感应放大器可在独立于电源电压的  $-16\text{V}$  至  $+80\text{V}$  共模电压中检测分流电阻上的压降。INA270 和 INA271 引脚排列可随时用于滤波。

INA270 和 INA271 具有两种增益选项: 14 V/V 和 20 V/V。130kHz 带宽简化了在电流控制环路中的使用。

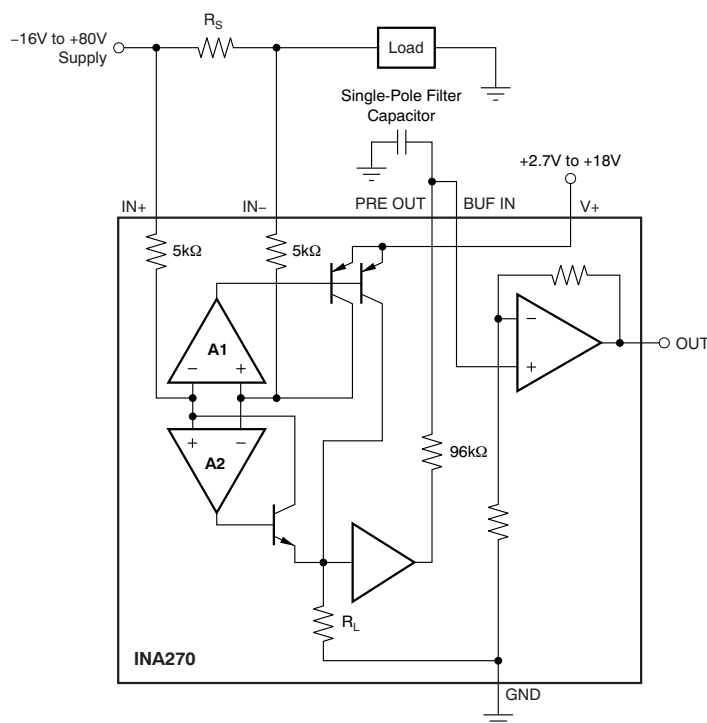
INA270 和 INA271 由一个  $+2.7\text{V}$  至  $+18\text{V}$  单电源供电, 消耗的电源电流为  $700\ \mu\text{A}$  (典型值)。器件具有  $-40^\circ\text{C}$  至  $+125^\circ\text{C}$  扩展额定工作温度范围, 采用 SOIC-8 封装。

#### Device Information<sup>(1)</sup>

PART NUMBER	PACKAGE	BODY SIZE (NOM)
INA27x	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。

简化原理图



## 目录

1 特性 .....	1	8.4 Device Functional Modes .....	12
2 应用 .....	1	<b>9 Application and Implementation</b> .....	<b>15</b>
3 说明 .....	1	9.1 Application Information .....	15
4 修订历史记录 .....	2	9.2 Typical Application .....	15
<b>5 Device Comparison Table</b> .....	<b>3</b>	<b>10 Power Supply Recommendations</b> .....	<b>17</b>
<b>6 Pin Configuration and Functions</b> .....	<b>3</b>	10.1 Shutdown .....	17
<b>7 Specifications</b> .....	<b>3</b>	<b>11 Layout</b> .....	<b>18</b>
7.1 Absolute Maximum Ratings .....	3	11.1 Layout Guidelines .....	18
7.2 ESD Ratings .....	4	11.2 Layout Example .....	18
7.3 Recommended Operating Conditions .....	4	<b>12 器件和文档支持</b> .....	<b>19</b>
7.4 Thermal Information .....	4	12.1 Documentation Support .....	19
7.5 Electrical Characteristics .....	5	12.2 相关链接 .....	19
7.6 Typical Characteristics .....	7	12.3 社区资源 .....	19
<b>8 Detailed Description</b> .....	<b>10</b>	12.4 商标 .....	19
8.1 Overview .....	10	12.5 静电放电警告 .....	19
8.2 Functional Block Diagram .....	10	12.6 Glossary .....	19
8.3 Feature Description .....	11	<b>13 机械、封装和可订购信息</b> .....	<b>19</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 Revision D (November 2014) to Revision E	Page
• 为第 1 页的图添加了标题 .....	1
• Updated <i>ESD Ratings</i> table to current standards .....	4
• Changed <a href="#">Figure 16</a> : changed op amp input to BUF IN pin from negative to positive .....	12
• 添加了社区资源部分 .....	19

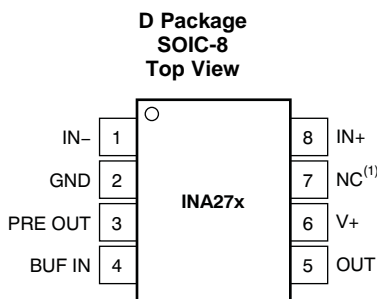
Changes from Revision C (May 2010) to Revision D	Page
• 更改了格式以符合最新数据表标准 .....	1
• 添加了处理额定值、引脚说明与建议运行条件表和特性说明、器件功能模式、应用和实施、电源相关建议、布局、器件和文档支持以及机械、封装和可订购信息部分 .....	1
• 更改了精度和静态电流特性项目符号：从规格和值的最大值更改成了典型值 .....	1
• 更改了两种可用增益选项特性项目符号中的措辞 .....	1
• 更改了说明部分用于澄清说明 .....	1
• 添加了器件信息表 .....	1
• Deleted Ordering Information table .....	3
• Changed Input, <i>Full-Scale Input Voltage</i> parameter conditions in Electrical Characteristics table .....	5
• Changed title of <i>First- or Second-Order Filtering</i> section .....	12
• Changed title of <i>Power Supply Recommendations</i> section .....	17

Changes from Revision B (July 2008) to Revision C	Page
• Corrected <a href="#">Figure 17</a> y-axis .....	14
• Corrected <a href="#">Figure 18</a> y-axis .....	14

## 5 Device Comparison Table

DEVICE	GAIN
INA270	14 V/V
INA271	20 V/V

## 6 Pin Configuration and Functions



NOTE (1): NC denotes no internal connection.

### Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
BUF IN	4	Analog input	Connect to output of filter from PRE OUT
GND	2	Analog	Ground
IN-	1	Analog input	Connect to load side of shunt resistor
IN+	8	Analog input	Connect to supply side of shunt resistor
NC	7	—	Connect to ground
OUT	5	Analog output	Output voltage
PRE OUT	3	Analog output	Connect to input of filter to BUF IN
V+	6	Analog input	Power supply, +2.7 V to +18 V

## 7 Specifications

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

	MIN	MAX	UNIT	
Supply voltage ( $V_S$ )		+18	V	
Analog inputs, $V_{IN+}$ , $V_{IN-}$ :	Differential, $(V_{IN+}) - (V_{IN-})$	-18	+18	V
	Common-mode	-16	+80	V
Analog output: OUT and PRE OUT pins	GND - 0.3	(V+) + 0.3	V	
Input current into any pin		5	mA	
Operating temperature	-55	+150	°C	
Junction temperature		+150	°C	
Storage temperature, $T_{stg}$	-65	+150	°C	

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, 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.

## 7.2 ESD Ratings

		VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>	±3000
		Charged-device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup>	±750

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

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

## 7.3 Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
$V_{CM}$	Common-mode input voltage	–16	12	80	V
$V_S$	Operating supply voltage	2.7	5	18	V
$T_A$	Operating free-air temperature	–40		125	°C

## 7.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>		INA27x	UNIT
		D (SOIC)	
		8 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	78.8	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	71.6	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	68.2	°C/W
$\Psi_{JT}$	Junction-to-top characterization parameter	22.0	°C/W
$\Psi_{JB}$	Junction-to-board characterization parameter	67.6	°C/W
$R_{\theta JC(bot)}$	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.

## 7.5 Electrical Characteristics

At  $T_A = +25^\circ\text{C}$ ,  $V_S = +5\text{ V}$ ,  $V_{CM} = +12\text{ V}$ ,  $V_{SENSE} = 100\text{ mV}$ , and PRE OUT connected to BUF IN, unless otherwise noted.

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>INPUT</b>						
$V_{SENSE}$	Full-scale input voltage	$V_{SENSE} = (V_{IN+}) - (V_{IN-})$		0.15	$(V_S - 0.2) / \text{Gain}$	V
$V_{CM}$	Common-mode input range	$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$	-16		+80	V
CMRR	Common-mode rejection ratio	$V_{IN+} = -16\text{ V}$ to $+80\text{ V}$	80	120		dB
	CMRR over temperature	$V_{IN+} = +12\text{ V}$ to $+80\text{ V}$ , $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$	100	120		dB
$V_{OS}$	Offset voltage, RTI <sup>(1)</sup>			$\pm 0.5$	2.5	mV
	$V_{OS}$ over temperature	$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$			$\pm 3$	mV
$dV_{OS}/dT$	$V_{OS}$ vs temperature	$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$		2.5	20	$\mu\text{V}/^\circ\text{C}$
PSR	$V_{OS}$ vs power-supply	$V_S = +2.7\text{ V}$ to $+18\text{ V}$ , $V_{CM} = +18\text{ V}$ , $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$		5	100	$\mu\text{V}/\text{V}$
$I_B$	Input bias current, $V_{IN-}$ pin	$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$		$\pm 8$	$\pm 16$	$\mu\text{A}$
	PRE OUT output impedance <sup>(2)</sup>			96		k $\Omega$
	Buffer input bias current			-50		nA
	Buffer input bias current temperature coefficient			$\pm 0.03$		nA/ $^\circ\text{C}$
<b>OUTPUT (<math>V_{SENSE} \geq 20\text{ mV}</math>)<sup>(3)</sup></b>						
G	Gain	INA270 total gain		14		V/V
		INA271 total gain		20		V/V
$G_{BUF}$	Output buffer gain			2		V/V
	Total gain error	$V_{SENSE} = 20\text{ mV}$ to $100\text{ mV}$		$\pm 0.2\%$	$\pm 1\%$	
	Total gain error Over temperature	$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$			$\pm 2\%$	
	Total gain error vs temperature	$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$			50	ppm/ $^\circ\text{C}$
	Total output error <sup>(4)</sup>			$\pm 0.75\%$	$\pm 2.2\%$	
	Total output error	$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$		$\pm 1.0\%$	$\pm 3.0\%$	
	Nonlinearity error	$V_{SENSE} = 20\text{ mV}$ to $100\text{ mV}$		$\pm 0.002\%$		
$R_O$	Output impedance, pin 5			1.5		$\Omega$
	Maximum capacitive load	No sustained oscillation		10		nF
<b>VOLTAGE OUTPUT<sup>(5)</sup> (<math>R_L = 10\text{ k}\Omega</math> to GND)</b>						
	Swing to $V_+$ power-supply rail	$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$		$(V_+) - 0.05$	$(V_+) - 0.2$	V
	Swing to GND <sup>(6)</sup>	$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$		$V_{GND} + 0.003$	$V_{GND} + 0.05$	V
<b>FREQUENCY RESPONSE</b>						
BW	Bandwidth	$C_{LOAD} = 5\text{ pF}$		130		kHz
	Phase margin	$C_{LOAD} < 10\text{ nF}$		40		Degrees
SR	Slew rate			1		V/ $\mu\text{s}$
$t_s$	Settling time (1%)	$V_{SENSE} = 10\text{ mV}$ to $100\text{ mV}_{PP}$ , $C_{LOAD} = 5\text{ pF}$		2		$\mu\text{s}$

(1) RTI means *Referred-to-Input*.

(2) Initial resistor variation is  $\pm 30\%$  with an additional  $-2200\text{-ppm}/^\circ\text{C}$  temperature coefficient.

(3) For output behavior when  $V_{SENSE} < 20\text{ mV}$ , see the [Accuracy Variations as a Result of  \$V\_{SENSE}\$  and Common-Mode Voltage](#) section.

(4) Total output error includes effects of gain error and  $V_{OS}$ .

(5) See typical characteristic curve [Output Swing vs Output Current](#) and the [Accuracy Variations as a Result of  \$V\_{SENSE}\$  and Common-Mode Voltage](#) section.

(6) Ensured by design; not production tested.

**INA270, INA271**

ZHCSHF9E – FEBRUARY 2007 – REVISED JANUARY 2018

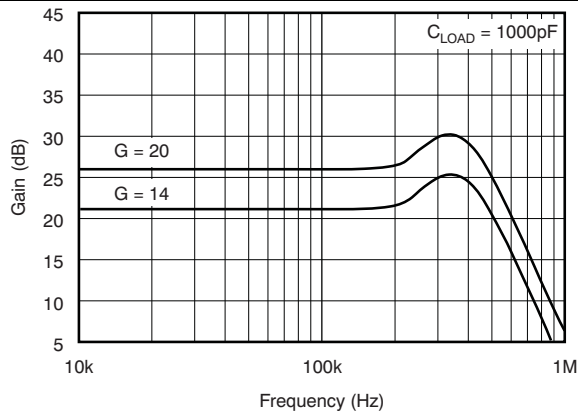
[www.ti.com.cn](http://www.ti.com.cn)
**Electrical Characteristics (continued)**

 At  $T_A = +25^\circ\text{C}$ ,  $V_S = +5\text{ V}$ ,  $V_{CM} = +12\text{ V}$ ,  $V_{SENSE} = 100\text{ mV}$ , and PRE OUT connected to BUF IN, unless otherwise noted.

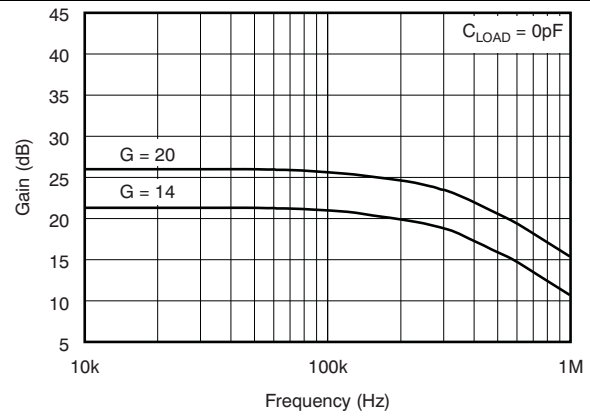
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>NOISE, RTI<sup>(1)</sup></b>						
$e_n$	Voltage noise density			40		nV/ $\sqrt{\text{Hz}}$
<b>POWER SUPPLY</b>						
$V_S$	Operating range	$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$	+2.7		+18	V
$I_Q$	Quiescent current	$V_{OUT} = 2\text{ V}$		700	900	$\mu\text{A}$
	$I_Q$ over temperature	$V_{SENSE} = 0\text{ mV}$ , $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$		350	950	$\mu\text{A}$
<b>TEMPERATURE RANGE</b>						
	Specified temperature range		-40		+125	$^\circ\text{C}$
	Operating temperature range		-55		+150	$^\circ\text{C}$
$\theta_{JA}$	Thermal resistance, SO-8			150		$^\circ\text{C/W}$

## 7.6 Typical Characteristics

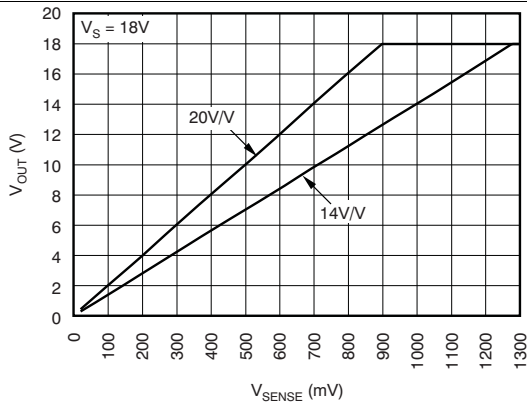
At  $T_A = +25^\circ\text{C}$ ,  $V_S = +12\text{ V}$ ,  $V_{CM} = 12\text{ V}$ , and  $V_{SENSE} = 100\text{ mV}$ , unless otherwise noted.



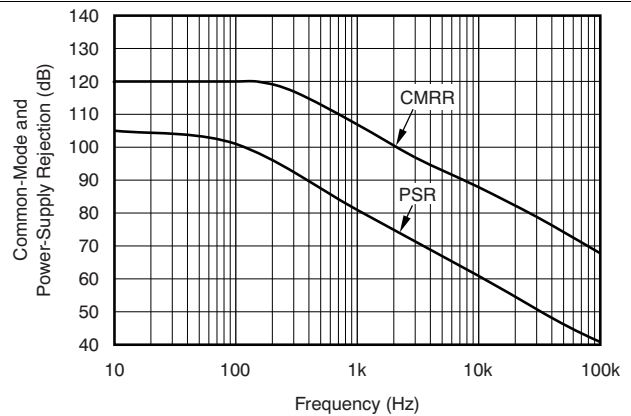
**Figure 1. Gain vs Frequency**



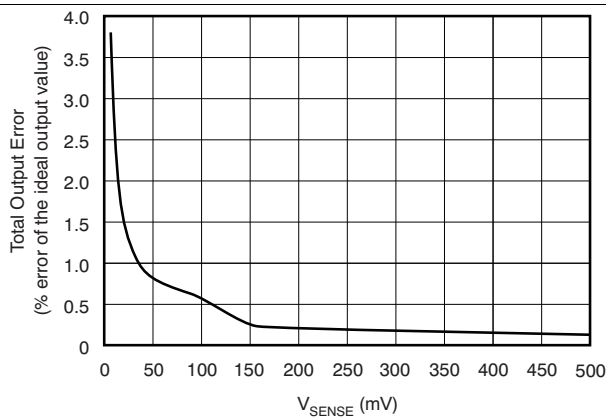
**Figure 2. Gain vs Frequency**



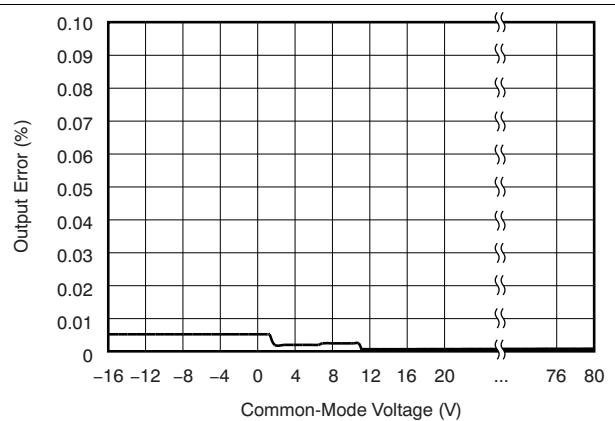
**Figure 3. Gain Plot**



**Figure 4. Common-Mode and Power-Supply Rejection vs Frequency**



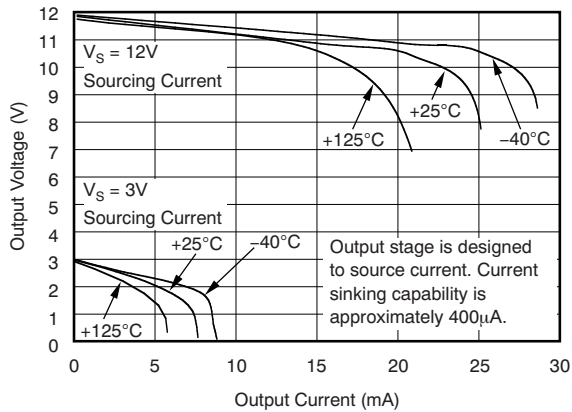
**Figure 5. Total Output Error vs  $V_{SENSE}$**



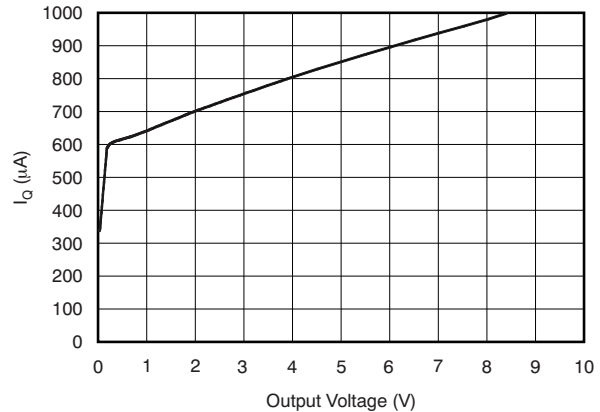
**Figure 6. Output Error vs Common-Mode Voltage**

**Typical Characteristics (continued)**

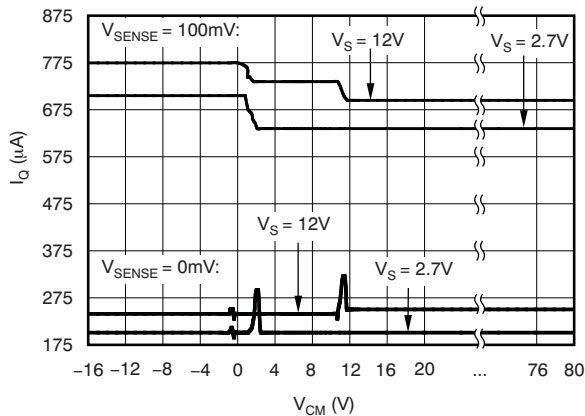
At  $T_A = +25^\circ\text{C}$ ,  $V_S = +12\text{ V}$ ,  $V_{CM} = 12\text{ V}$ , and  $V_{SENSE} = 100\text{ mV}$ , unless otherwise noted.



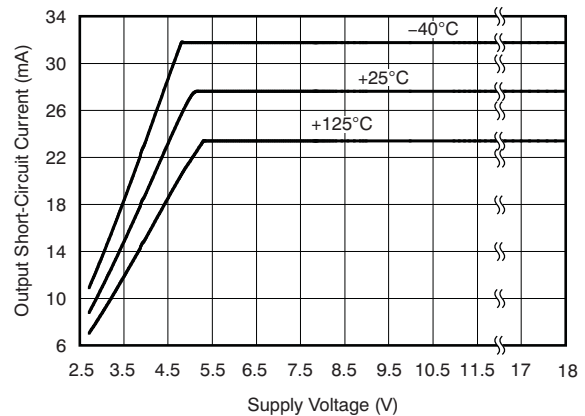
**Figure 7. Positive Output Voltage Swing vs Output Current**



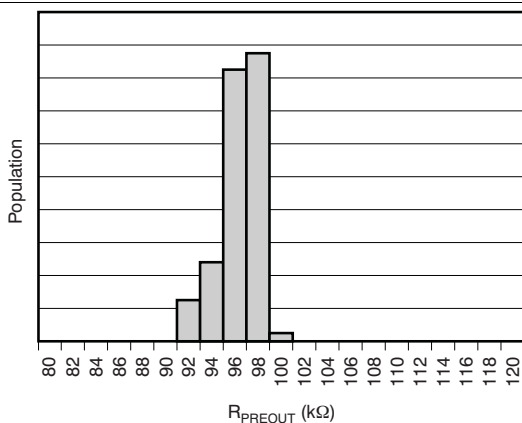
**Figure 8. Quiescent Current vs Output Voltage**



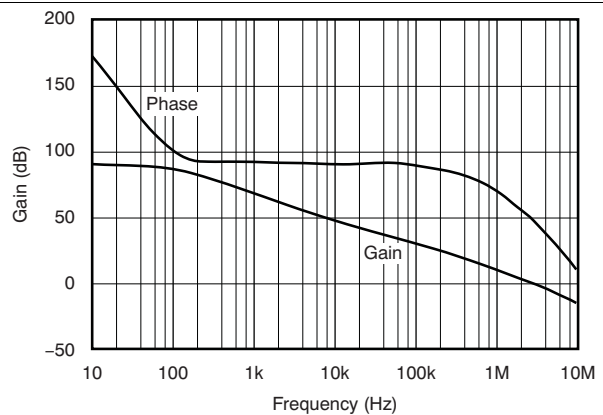
**Figure 9. Quiescent Current vs Common-Mode Voltage**



**Figure 10. Output Short-Circuit Current vs Supply Voltage**



**Figure 11. PRE OUT Output Resistance Production Distribution**

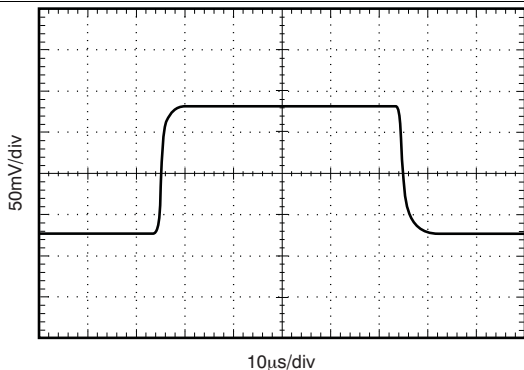


**Figure 12. Buffer Gain vs Frequency**

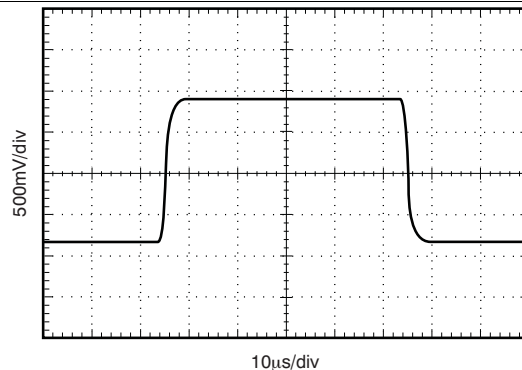


**Typical Characteristics (continued)**

At  $T_A = +25^\circ\text{C}$ ,  $V_S = +12\text{ V}$ ,  $V_{CM} = 12\text{ V}$ , and  $V_{SENSE} = 100\text{ mV}$ , unless otherwise noted.



**Figure 13. Small-Signal Step Response  
(10-mV to 20-mV Input)**



**Figure 14. Large-Signal Step Response  
(10-mV to 100-mV Input)**

## 8 Detailed Description

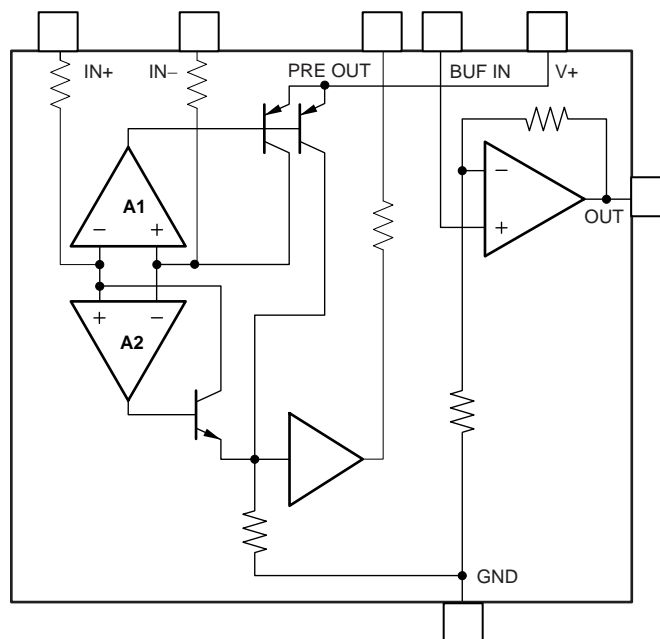
### 8.1 Overview

The INA270 and INA271 family of current-shunt monitors with voltage output can sense drops across current shunts at common-mode voltages from  $-16\text{ V}$  to  $+80\text{ V}$ , independent of the supply voltage. The INA270 and INA271 pinouts readily enable filtering.

The INA270 and INA271 are available with two output voltage scales:  $14\text{ V/V}$  and  $20\text{ V/V}$ . The  $130\text{-kHz}$  bandwidth simplifies use in current-control loops.

The INA270 and INA271 operate from a single  $+2.7\text{-V}$  to  $+18\text{-V}$  supply, drawing a maximum of  $900\text{ }\mu\text{A}$  of supply current. The devices are specified over the extended operating temperature range of  $-40^\circ\text{C}$  to  $+125^\circ\text{C}$  and are offered in an SOIC-8 package.

### 8.2 Functional Block Diagram



## 8.3 Feature Description

### 8.3.1 Basic Connection

Figure 15 shows the basic connection of the INA270 and INA271. Connect the input pins (IN+ and IN–) as closely as possible to the shunt resistor to minimize any resistance in series with the shunt resistance.

Power-supply bypass capacitors are required for stability. Applications with noisy or high-impedance power supplies may require additional decoupling capacitors to reject power-supply noise. Place minimum bypass capacitors of 0.01  $\mu\text{F}$  and 0.1  $\mu\text{F}$  in value close to the supply pins. Although not mandatory, an additional 10-mF electrolytic capacitor placed in parallel with the other bypass capacitors may be useful in applications with particularly noisy supplies.

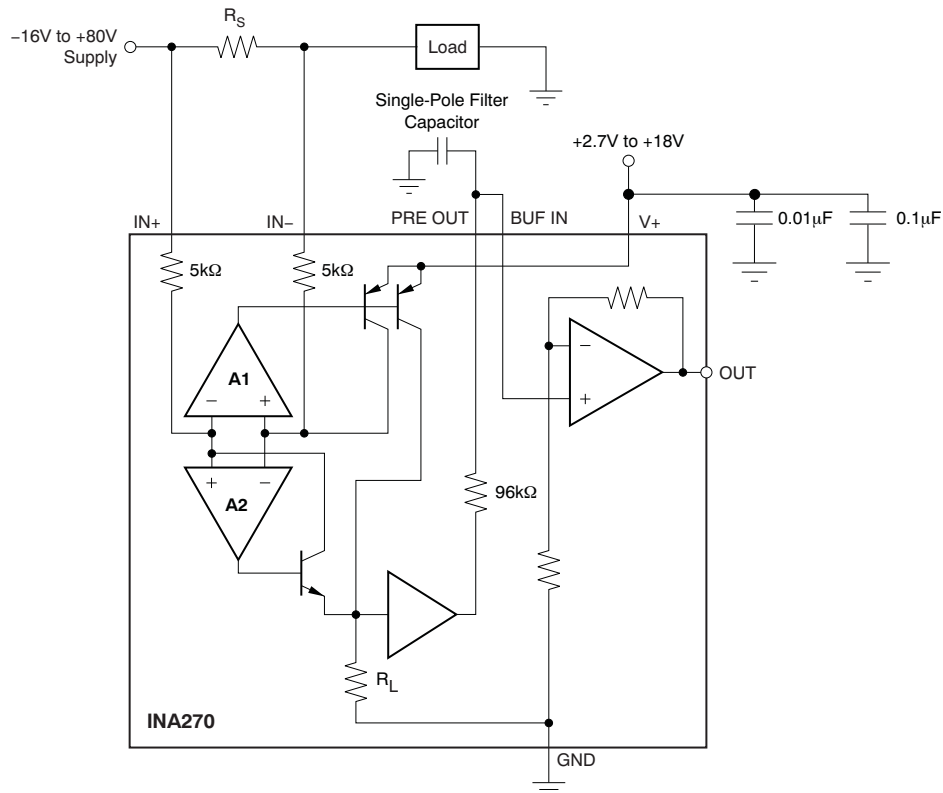


Figure 15. INA270 Basic Connections

### 8.3.2 Selecting $R_S$

The value chosen for the shunt resistor,  $R_S$ , depends on the application and is a compromise between small-signal accuracy and maximum permissible voltage loss in the measurement line. High values of  $R_S$  provide better accuracy at lower currents by minimizing the effects of offset, while low values of  $R_S$  minimize voltage loss in the supply line. For most applications, best performance is attained with an  $R_S$  value that provides a full-scale shunt voltage range of 50 mV to 100 mV. Maximum input voltage for accurate measurements is  $(V_S - 0.2) / \text{Gain}$ .

### 8.3.3 Transient Protection

The  $-16\text{-V}$  to  $+80\text{-V}$  common-mode range of the INA270 and INA271 is ideal for withstanding automotive fault conditions ranging from 12-V battery reversal up to  $+80\text{-V}$  transients because no additional protective components are needed up to those levels. In the event that the INA270 and INA271 are exposed to transients on the inputs in excess of their ratings, external transient absorption with semiconductor transient absorbers (zeners or Transzorbs) are necessary.

## Feature Description (continued)

Use of MOVs or VDRs is not recommended except when they are used in addition to a semiconductor transient absorber. Select the transient absorber such that it never allows the INA270 and INA271 to be exposed to transients greater than 80 V (that is, allow for transient absorber tolerance, as well as additional voltage because of transient absorber dynamic impedance). Despite the use of internal zener-type ESD protection, the INA270 and INA271 are not suited to using external resistors in series with the inputs because the internal gain resistors can vary up to  $\pm 30\%$ , but are tightly matched (if gain accuracy is not important, then resistors can be added in series with the INA270 and INA271 inputs with two equal resistors on each input).

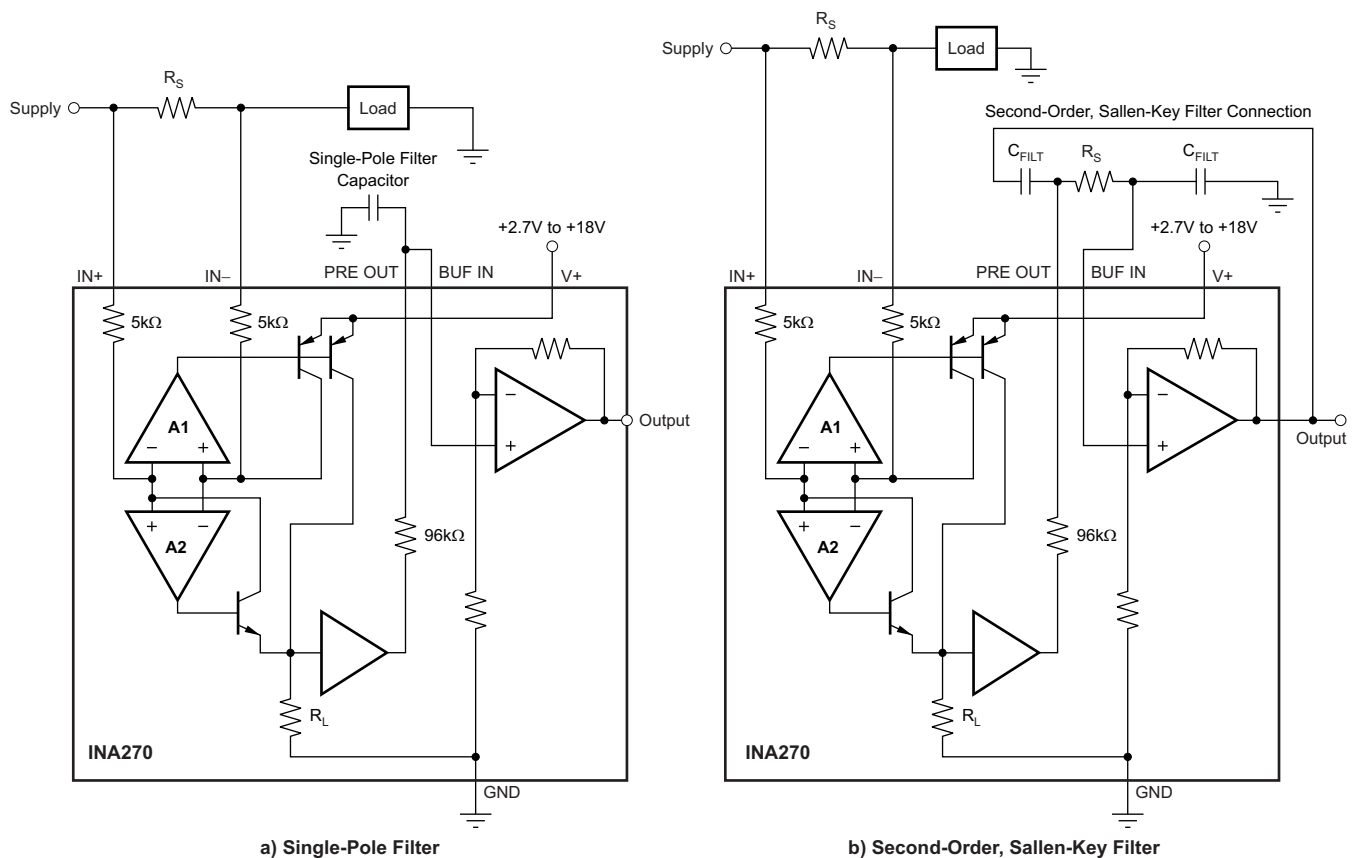
## 8.4 Device Functional Modes

### 8.4.1 First- or Second-Order Filtering

The output of the INA270 and INA271 is accurate within the output voltage swing range set by the power-supply pin, V+.

The INA270 and INA271 readily enable the inclusion of filtering between the preamp output and buffer input. Single-pole filtering can be accomplished with a single capacitor because of the 96-k $\Omega$  output impedance at PRE OUT on pin 3, as shown in Figure 16a.

The INA270 and INA271 readily lend themselves to second-order Sallen-Key configurations, as shown in Figure 16b. When designing these configurations consider that the PRE OUT 96-k $\Omega$  output impedance exhibits an initial variation of  $\pm 30\%$  with the addition of a  $-2200\text{-ppm}/^\circ\text{C}$  temperature coefficient.



NOTE: Remember to use the appropriate buffer gain (INA270 = 1.4, INA271 = 2) when designing Sallen-Key configurations.

**Figure 16. The INA270–INA271 can be Easily Connected for First- or Second-Order Filtering**

## Device Functional Modes (continued)

### 8.4.2 Accuracy Variations as a Result of $V_{SENSE}$ and Common-Mode Voltage

The accuracy of the INA270 and INA271 current shunt monitors is a function of two main variables:  $V_{SENSE}$  ( $V_{IN+} - V_{IN-}$ ) and common-mode voltage ( $V_{CM}$ ) relative to the supply voltage,  $V_S$ .  $V_{CM}$  is expressed as  $(V_{IN+} + V_{IN-}) / 2$ ; however, in practice,  $V_{CM}$  is used as the voltage at  $V_{IN+}$  because the voltage drop across  $V_{SENSE}$  is usually small.

This section addresses the accuracy of these specific operating regions:

Normal Case 1:  $V_{SENSE} \geq 20 \text{ mV}$ ,  $V_{CM} \geq V_S$

Normal Case 2:  $V_{SENSE} \geq 20 \text{ mV}$ ,  $V_{CM} < V_S$

Low  $V_{SENSE}$  Case 1:

$V_{SENSE} < 20 \text{ mV}$ ,  $-16 \text{ V} \leq V_{CM} < 0$

Low  $V_{SENSE}$  Case 2:

$V_{SENSE} < 20 \text{ mV}$ ,  $0 \text{ V} \leq V_{CM} \leq V_S$

Low  $V_{SENSE}$  Case 3:

$V_{SENSE} < 20 \text{ mV}$ ,  $V_S < V_{CM} \leq 80 \text{ V}$

#### 8.4.2.1 Normal Case 1: $V_{SENSE} \geq 20 \text{ mV}$ , $V_{CM} \geq V_S$

This region of operation provides the highest accuracy. Here, the input offset voltage is characterized and measured using a two-step method. First, the gain is determined by [Equation 1](#).

$$G = \frac{V_{OUT1} - V_{OUT2}}{100\text{mV} - 20\text{mV}}$$

where

- $V_{OUT1}$  = Output voltage with  $V_{SENSE} = 100 \text{ mV}$  and
- $V_{OUT2}$  = Output voltage with  $V_{SENSE} = 20 \text{ mV}$ . (1)

Then the offset voltage is measured at  $V_{SENSE} = 100 \text{ mV}$  and referred to the input (RTI) of the current shunt monitor, as shown in [Equation 2](#).

$$V_{OS\text{RTI}} (\text{Referred-To-Input}) = \left[ \frac{V_{OUT1}}{G} \right] - 100\text{mV} \quad (2)$$

In the [Typical Characteristics](#), the *Output Error vs Common-Mode Voltage* curve ([Figure 6](#)) shows the highest accuracy for the this region of operation. In this plot,  $V_S = 12 \text{ V}$ ; for  $V_{CM} \geq 12 \text{ V}$ , the output error is at its minimum. This case is also used to create the  $V_{SENSE} \geq 20 \text{ mV}$  output specifications in the [Electrical Characteristics](#) table.

#### 8.4.2.2 Normal Case 2: $V_{SENSE} \geq 20 \text{ mV}$ , $V_{CM} < V_S$

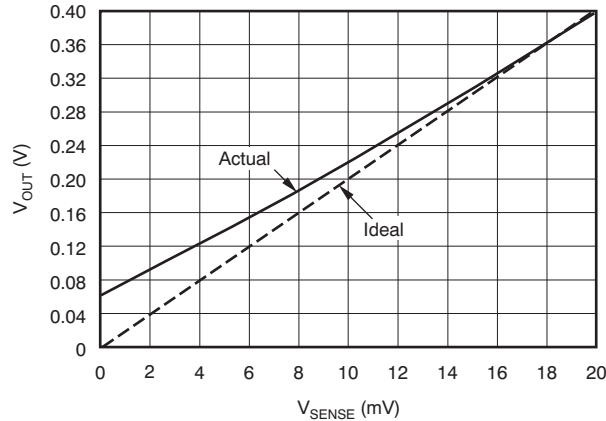
This region of operation has slightly less accuracy than [Normal Case 1](#) as a result of the common-mode operating area in which the device functions, as illustrated in the *Output Error vs Common-Mode Voltage* curve ([Figure 6](#)). As noted, for this graph  $V_S = 12 \text{ V}$ ; for  $V_{CM} < 12 \text{ V}$ , the output error increases when  $V_{CM}$  becomes less than  $12 \text{ V}$ , with a typical maximum error of 0.005% at the most negative  $V_{CM} = -16 \text{ V}$ .

#### 8.4.2.3 Low $V_{SENSE}$ Case 1: $V_{SENSE} < 20 \text{ mV}$ , $-16 \text{ V} \leq V_{CM} < 0$ ; and Low $V_{SENSE}$ Case 3: $V_{SENSE} < 20 \text{ mV}$ , $V_S < V_{CM} \leq 80 \text{ V}$

Although the INA270 family of devices are not designed for accurate operation in either of these regions, some applications are exposed to these conditions. For example, when monitoring power supplies that are switched on and off while  $V_S$  is still applied to the INA270 or INA271, knowing what the behavior of the devices is in these regions is important.

**Device Functional Modes (continued)**

When  $V_{SENSE}$  approaches 0 mV, in these  $V_{CM}$  regions, the device output accuracy degrades. A larger-than-normal offset can appear at the current shunt monitor output with a typical maximum value of  $V_{OUT} = 60$  mV for  $V_{SENSE} = 0$  mV. When  $V_{SENSE}$  approaches 20 mV,  $V_{OUT}$  returns to the expected output value with accuracy as specified in the [Electrical Characteristics](#). Figure 17 shows this effect using the INA271 (gain = 20).

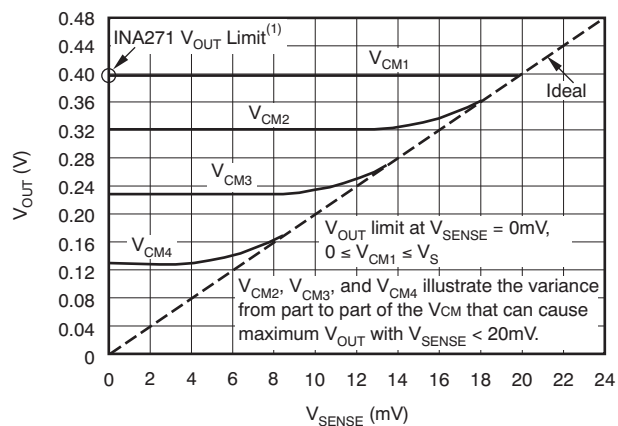


**Figure 17. Example For Low  $V_{SENSE}$  Cases 1 and 3 (INA271, Gain = 20)**

**8.4.2.4 Low  $V_{SENSE}$  Case 2:  $V_{SENSE} < 20$  mV,  $0$  V  $\leq V_{CM} \leq V_S$** 

This region of operation is the least accurate for the INA270 family. To achieve the wide input common-mode voltage range, these devices use two op amp front ends in parallel. One op amp front end operates in the positive input common-mode voltage range, and the other in the negative input region. For this case, neither of these two internal amplifiers dominates and overall loop gain is very low. Within this region,  $V_{OUT}$  approaches voltages close to linear operation levels for [Normal Case 2](#).

This deviation from linear operation becomes greatest the closer  $V_{SENSE}$  approaches 0 V. Within this region, when  $V_{SENSE}$  approaches 20 mV, device operation is closer to that described by [Normal Case 2](#). Figure 18 shows this behavior for the INA271. The  $V_{OUT}$  maximum peak for this case is determined by maintaining a constant  $V_S$ , setting  $V_{SENSE} = 0$  mV, and sweeping  $V_{CM}$  from 0 V to  $V_S$ . The exact  $V_{CM}$  at which  $V_{OUT}$  peaks during this case varies from device to device. The maximum peak voltage for the INA270 is 0.28 V; for the INA271, the maximum peak voltage is 0.4 V.



NOTE: (1) INA271  $V_{OUT}$  Limit = 0.4V. INA270  $V_{OUT}$  Limit = 0.28V.

**Figure 18. Example for Low  $V_{SENSE}$  Case 2 (INA271, Gain = 20)**

## 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

The INA270 and INA271 measures the voltage developed across a current-sensing resistor when current passes through it. The ability to drive the reference terminal to adjust the functionality of the output signal offers multiple configurations discussed throughout this section. There is also a filtering feature to remove unwanted transients and smooth the output voltage.

### 9.2 Typical Application

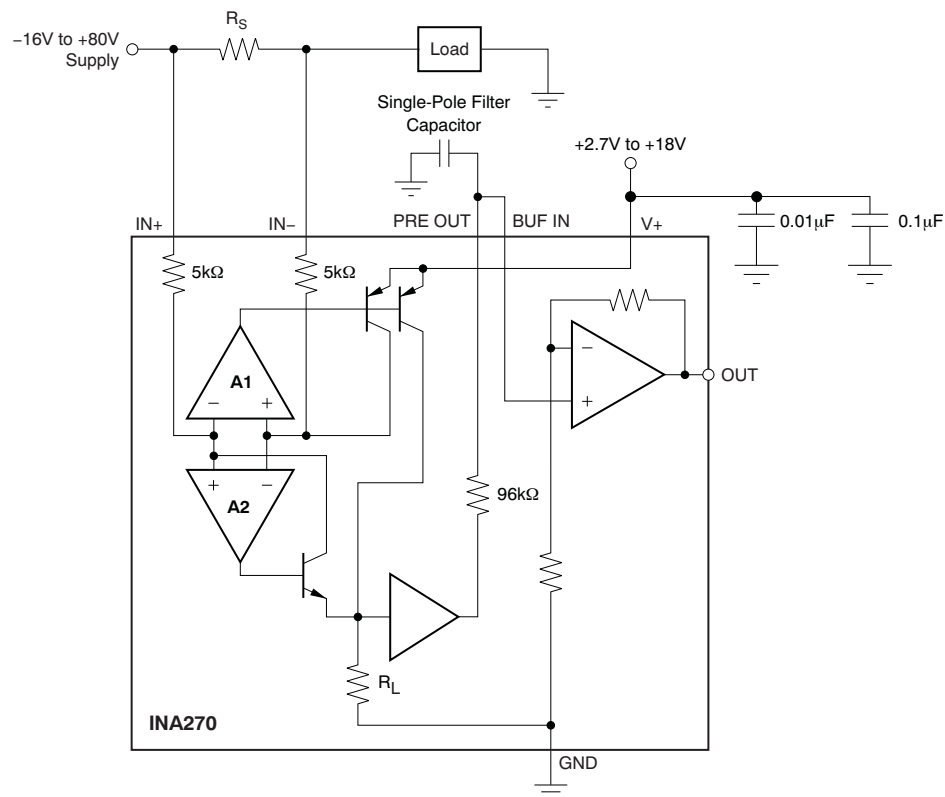


Figure 19. Filtering Configuration

#### 9.2.1 Design Requirements

In this application, the device is configured to measure a triangular periodic current at 10 kHz with filtering. The average current through the shunt is the information that is desired. This current can be either solenoid current or inductor current where current is being pulsed through.

Selecting the capacitor size is based on the lowest frequency component to be filtered out. The amount of signal that is filtered out is dependant on this cutoff frequency. From the cutoff frequency, the attention is 20 dB per decade.

## Typical Application (continued)

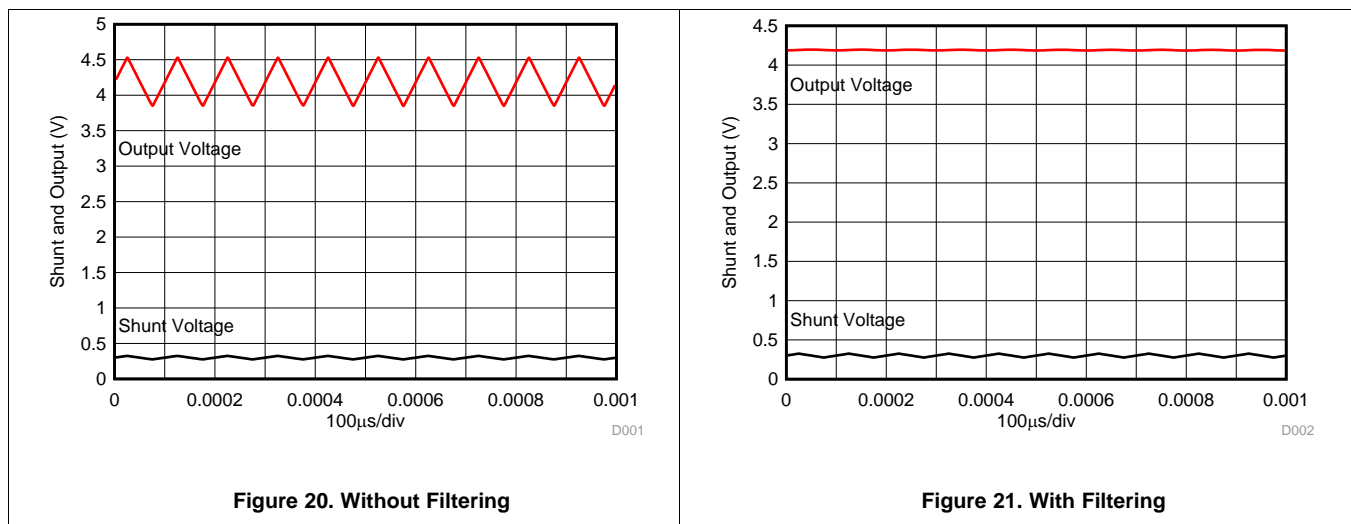
### 9.2.2 Detailed Design Procedure

Without this filtering capability, an input filter must be used. When series resistance is added to the input, large errors also come into play because the resistance must be large to create a low cutoff frequency. By using a 10-nF capacitor for the single-pole filter capacitor, the 10-kHz signal is averaged. The cutoff frequency made by the capacitor is set at 166 Hz frequency. This frequency is well below the periodic frequency and reduces the ripple on the output and the average current can easily be measured.

### 9.2.3 Application Curves

**Figure 20** shows the output waveform without filtering. The output signal tracks the input signal with a large ripple. If this current is sampled by an ADC, many samples must be taken to average the current digitally. This process takes additional time to sample and average and is very time consuming, thus is unwanted for this application.

**Figure 21** shows the output waveform with filtering. The output signal is filtered and the average can easily be measured with a small ripple. If this current is sampled by an ADC, only a few samples must be taken to average. Digital averaging is now not required and the time required is significantly reduced.





## 10 Power Supply Recommendations

The input circuitry of the INA270 and INA271 can accurately measure beyond its power-supply voltage,  $V+$ . For example, the  $V+$  power supply can be 5 V, whereas the load power-supply voltage is up to +80 V. The output voltage range of the OUT terminal, however, is limited by the voltages on the power-supply pin.

### 10.1 Shutdown

The INA270 and INA271 do not provide a shutdown pin; however, because these devices consume a quiescent current less than 1 mA, they can be powered by either the output of logic gates or by transistor switches to supply power. Driving the gate low shuts down the INA270 and INA271. Use a totem-pole output buffer or gate that can provide sufficient drive along with a 0.1- $\mu\text{F}$  bypass capacitor, preferably ceramic with good high-frequency characteristics. This gate must have a supply voltage of 3 V or greater because the INA270 and INA271 require a minimum supply greater than 2.7 V. In addition to eliminating quiescent current, this gate also turns off the 10- $\mu\text{A}$  bias current present at each of the inputs. Note that the IN+ and IN- inputs are able to withstand full common-mode voltage under all powered and under-powered conditions. An example shutdown circuit is shown in Figure 22.

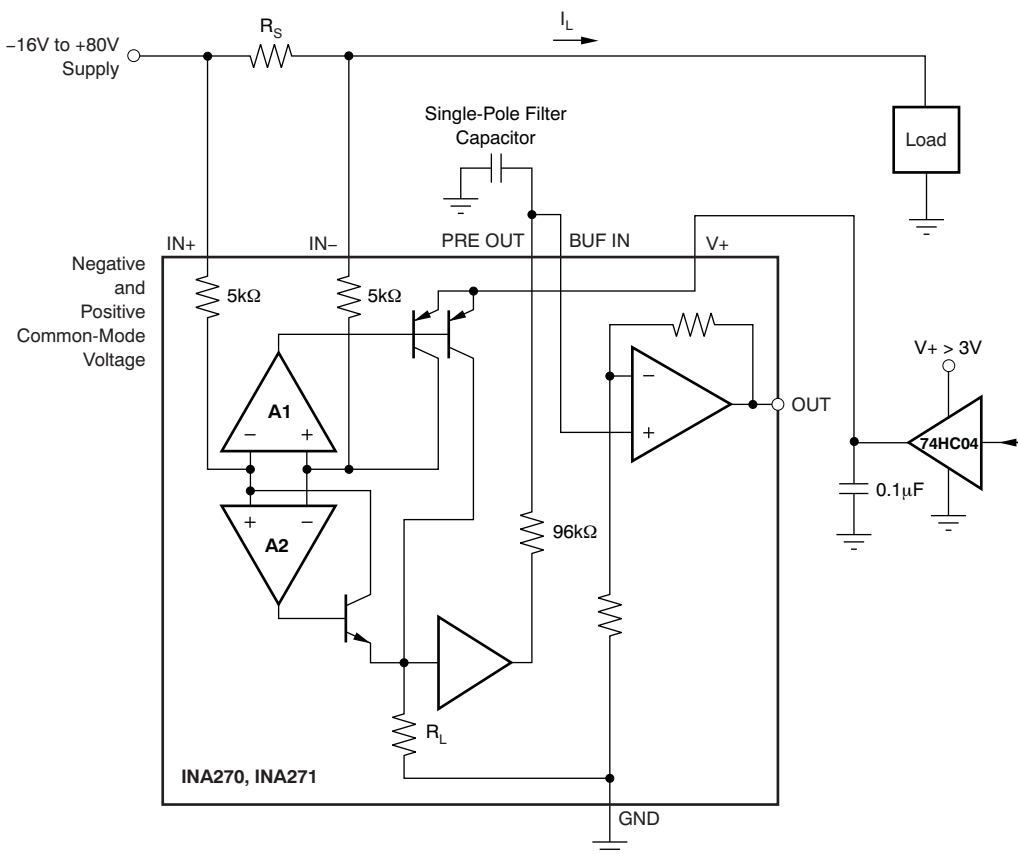


Figure 22. INA270–INA271 Example Shutdown Circuit

## 11 Layout

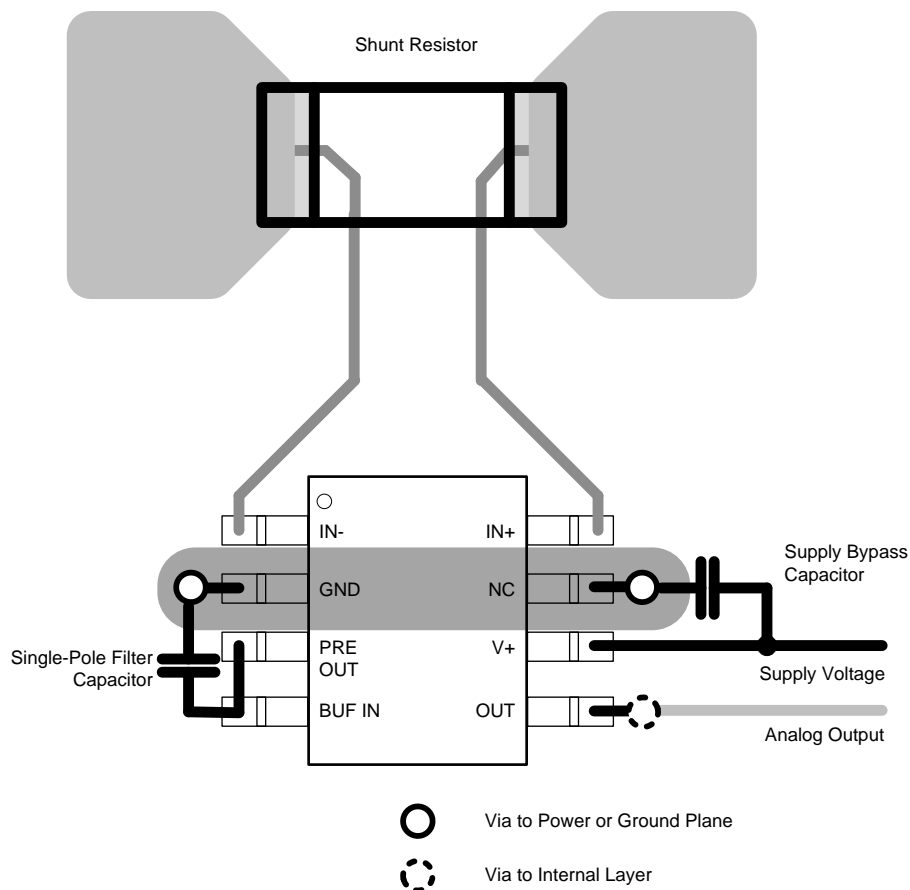
### 11.1 Layout Guidelines

- Connect the input pins to the sensing resistor using a Kelvin or 4-wire connection. This connection technique ensures that only the current-sensing resistor impedance is detected between the input pins. Poor routing of the current-sensing resistor commonly results in additional resistance present between the input pins. Given the very low ohmic value of the current resistor, any additional high-current carrying impedance can cause significant measurement errors.
- Place the power-supply bypass capacitor as closely as possible to the supply and ground pins. The recommended value of this bypass capacitor is 0.1  $\mu\text{F}$ . Additional decoupling capacitance can be added to compensate for noisy or high-impedance power supplies.

#### 11.1.1 RFI and EMI

Attention to good layout practices is always recommended. Keep traces short and, when possible, use a printed circuit board (PCB) ground plane with surface-mount components placed as close to the device pins as possible. Small ceramic capacitors placed directly across amplifier inputs can reduce RFI and EMI sensitivity. PCB layout must locate the amplifier as far away as possible from RFI sources. Sources can include other components in the same system as the amplifier itself, such as inductors (particularly switched inductors handling a lot of current and at high frequencies). RFI can generally be identified as a variation in offset voltage or dc signal levels with changes in the interfering RF signal. If the amplifier cannot be located away from sources of radiation, shielding may be needed. Twisting wire input leads makes them more resistant to RF fields. The difference in input pin location of the INA270 and INA271 versus the [INA193 to INA198](#) may provide different EMI performance.

### 11.2 Layout Example



**Figure 23. Example Layout**

## 12 器件和文档支持

### 12.1 Documentation Support

#### 12.1.1 相关文档

如需相关文档，请参阅：

INA270 TINA-TI Spice 模型，[SBOM306](#)

INA270 PSpice 模型，[SBOM485](#)

INA270 TINA-TI 参考设计，[SBOC246](#)

#### 12.2 相关链接

下表列出了快速访问链接。类别包括技术文档、支持和社区资源、工具和软件，以及立即购买的快速链接。

表 1. 相关链接

器件	产品文件夹	立即订购	技术文档	工具和软件	支持和社区
INA270	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>
INA271	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>

#### 12.3 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](http://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。

#### 12.4 商标

E2E is a trademark of Texas Instruments.

All other trademarks are the property of their respective owners.

#### 12.5 静电放电警告



ESD 可能会损坏该集成电路。德州仪器 (TI) 建议通过适当的预防措施处理所有集成电路。如果不遵守正确的处理措施和安装程序，可能会损坏集成电路。

ESD 的损坏小至导致微小的性能降级，大至整个器件故障。精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

#### 12.6 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。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 Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
INA270AID	ACTIVE	SOIC	D	8	75	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	I270A	<a href="#">Samples</a>
INA270AIDR	ACTIVE	SOIC	D	8	2500	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	I270A	<a href="#">Samples</a>
INA271AID	ACTIVE	SOIC	D	8	75	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	I271A	<a href="#">Samples</a>
INA271AIDR	ACTIVE	SOIC	D	8	2500	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	I271A	<a href="#">Samples</a>

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSELETE:** TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

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

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

(6) Lead finish/Ball material - Orderable Devices 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.

**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 INA271 :**

NOTE: Qualified Version Definitions:

**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
INA270AIDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
INA271AIDR	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)
INA270AIDR	SOIC	D	8	2500	350.0	350.0	43.0
INA271AIDR	SOIC	D	8	2500	350.0	350.0	43.0

**TUBE**


\*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
INA270AID	D	SOIC	8	75	505.46	6.76	3810	4
INA271AID	D	SOIC	8	75	505.46	6.76	3810	4





D0008A

# PACKAGE OUTLINE

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



4214825/C 02/2019

NOTES:

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.

# EXAMPLE BOARD LAYOUT

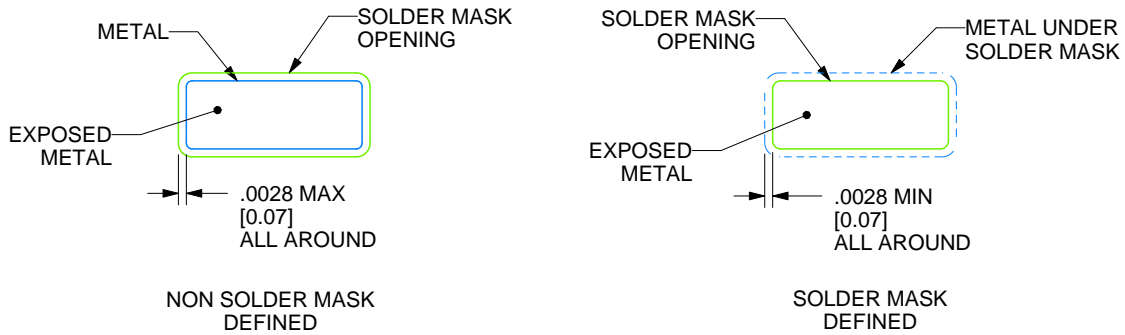
D0008A

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.

## 重要声明和免责声明

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、某特定用途方面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功能安全、信息安全、监管或其他要求。

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 产品的应用。严禁对这些资源进行其他复制或展示。您无权使用任何其他 TI 知识产权或任何第三方知识产权。您应全额赔偿因在这些资源的使用中对 TI 及其代表造成的任何索赔、损害、成本、损失和债务，TI 对此概不负责。

TI 提供的产品受 [TI 的销售条款](#) 或 [ti.com](#) 上其他适用条款/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。

TI 反对并拒绝您可能提出的任何其他或不同的条款。

邮寄地址：Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2024，德州仪器 (TI) 公司