INA27x Voltage Output, Unidirectional Measurement Current-Shunt Monitor

1 Features

- Wide Common-Mode Range: –16 V to +80 V
- CMRR: 120 dB
- Accuracy:
  ±0.5-mV Offset (typ)
  ±0.2% Gain Error (typ)
  2.5 μV/°C Offset Drift (typ)
  50 ppm/°C Gain Drift (max)
- Bandwidth: Up to 130 kHz
- Two Gain Options Available:
  14 V/V (INA270)
  20 V/V (INA271)
- Quiescent Current: 700 μA (typ)
- Power Supply: +2.7 V to +18 V
- Provision for Filtering

2 Applications

- Power Management
- Automotive
- Telecom Equipment
- Notebook Computers
- Battery Chargers
- Cell Phones
- Welding Equipment

3 Description

The INA270 and INA271 family of voltage-output, current-sense amplifiers can sense drops across shunt resistors at common-mode voltages from –16 V to +80 V, independent of the supply voltage. The INA270 and INA271 pinouts readily enable filtering.

The INA270 and INA271 are available with two gain options: 14 V/V and 20 V/V. The 130-kHz bandwidth simplifies use in current-control loops.

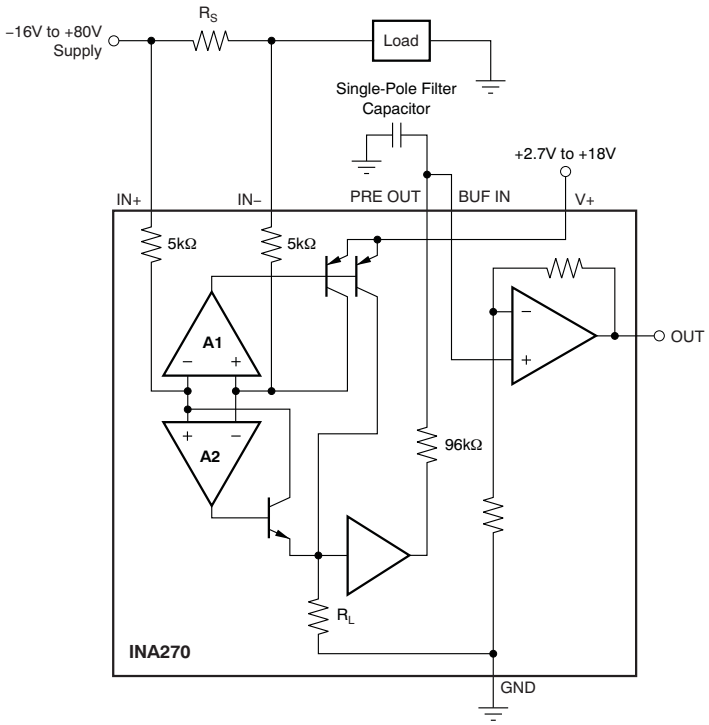
The INA270 and INA271 operate from a single +2.7-V to +18-V supply, drawing 700 μA (typical) of supply current. The devices are specified over the extended operating temperature range of –40°C to +125°C and are offered in an SOIC-8 package.

Device Information[1]

PART NUMBER	PACKAGE	BODY SIZE (NOM)
INA27x	SOIC (8)	4.90 mm × 3.91 mm

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

Simplified Schematic



An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

Table of Contents

1 Features ... 1
2 Applications ... 1
3 Description ... 1
4 Revision History ... 2
5 Device Comparison Table ... 3
6 Pin Configuration and Functions ... 3
7 Specifications ... 3
7.1 Absolute Maximum Ratings ... 3
7.2 ESD Ratings ... 4
7.3 Recommended Operating Conditions ... 4
7.4 Thermal Information ... 4
7.5 Electrical Characteristics ... 5
7.6 Typical Characteristics ... 7
8 Detailed Description ... 10
8.1 Overview ... 10
8.2 Functional Block Diagram ... 10
8.3 Feature Description ... 11
8.4 Device Functional Modes ... 12
9 Application and Implementation ... 15
9.1 Application Information ... 15
9.2 Typical Application ... 15
10 Power Supply Recommendations ... 17
10.1 Shutdown ... 17
11 Layout ... 18
11.1 Layout Guidelines ... 18
11.2 Layout Example ... 18
12 Device and Documentation Support ... 19
12.1 Documentation Support ... 19
12.2 Related Links ... 19
12.3 Community Resources ... 19
12.4 Trademarks ... 19
12.5 Electrostatic Discharge Caution ... 19
12.6 Glossary ... 19
13 Mechanical, Packaging, and Orderable Information ... 19

4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision D (November 2014) to Revision E — **Page**

- Added title to page 1 figure ... 1
- Updated *ESD Ratings* table to current standards ... 4
- Changed Figure 16: changed op amp input to BUF IN pin from negative to positive ... 12
- Added *Community Resources* section ... 19

Changes from Revision C (May 2010) to Revision D — **Page**

- Changed format to meet latest data sheet standards ... 1
- Added *Handling Rating*, *Pin Descriptions*, and *Recommended Operating Conditions* tables and *Feature Description*, *Device Functional Modes*, *Application and Implementation*, *Power Supply Recommendations*, *Layout*, *Device and Documentation Support*, and *Mechanical, Packaging, and Orderable Information* sections ... 1
- Changed *Accuracy* and *Quiescent Current* Features bullets: changed from max specifications and values to typical ... 1
- Changed wording in *Two Gain Options Available* Features bullet ... 1
- Changed *Description* section for clarification ... 1
- Added Device Information table ... 1
- Deleted Ordering Information table ... 3
- Changed Input, *Full-Scale Input Voltage* parameter conditions in Electrical Characteristics table ... 5
- Changed title of *First- or Second-Order Filtering* section ... 12
- Changed title of *Power Supply Recommendations* section ... 17

Changes from Revision B (July 2008) to Revision C — **Page**

- Corrected Figure 17 y-axis ... 14
- Corrected Figure 18 y-axis ... 14

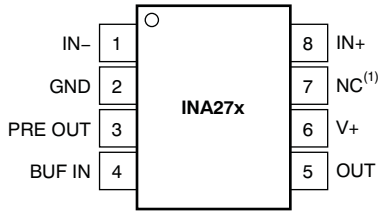
Copyright © 2007–2018, Texas Instruments Incorporated

5 Device Comparison Table

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

6 Pin Configuration and Functions

D Package
SOIC-8
Top View



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(1)

		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.

Copyright © 2007–2018, Texas Instruments Incorporated

7.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 (1)	±3000	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101 (2)	±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 (1)		INA27x D (SOIC) 8 PINS	UNIT
$R_{\theta JA}$	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
ψ_{JT}	Junction-to-top characterization parameter	22.0	°C/W
ψ_{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.

Copyright © 2007–2018, Texas Instruments Incorporated

7.5 Electrical Characteristics

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

PARAMETER			TEST CONDITIONS	MIN	TYP	MAX	UNIT
INPUT							
V_{SENSE}	Full-scale input voltage		$V_{SENSE} = (V_{IN+}) - (V_{IN-})$		0.15	(V_S – 0.2) / Gain	V
V_{CM}	Common-mode input range		T_A = –40°C to +125°C	–16		+80	V
CMRR	Common-mode rejection ratio		V_{IN+} = –16 V to +80 V	80	120		dB
	CMRR over temperature		V_{IN+} = +12 V to +80 V, T_A = –40°C to +125°C	100	120		dB
V_{OS}	Offset voltage, RTI(1)				±0.5	2.5	mV
	V_{OS} over temperature		T_A = –40°C to +125°C			±3	mV
dV_{OS}/dT	V_{OS} vs temperature		T_A = –40°C to +125°C		2.5	20	µV/°C
PSR	V_{OS} vs power-supply		V_S = +2.7 V to +18 V, V_{CM} = +18 V, T_A = –40°C to +125°C		5	100	µV/V
I_B	Input bias current, V_{IN-} pin		T_A = –40°C to +125°C		±8	±16	µA
	PRE OUT output impedance(2)				96		kΩ
	Buffer input bias current				–50		nA
	Buffer input bias current temperature coefficient				±0.03		nA/°C
OUTPUT (V_{SENSE} ≥ 20mV)(3)							
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 mV to 100 mV		±0.2%	±1%	
	Total gain error Over temperature		T_A = –40°C to +125°C			±2%	
	Total gain error vs temperature		T_A = –40°C to +125°C			50	ppm/°C
	Total output error(4)				±0.75%	±2.2%	
	Total output error		T_A = –40°C to +125°C		±1.0%	±3.0%	
	Nonlinearity error		V_{SENSE} = 20 mV to 100 mV		±0.002%		
R_O	Output impedance, pin 5				1.5		Ω
	Maximum capacitive load		No sustained oscillation		10		nF
VOLTAGE OUTPUT(5) (R_L = 10 kΩ to GND)							
	Swing to V+ power-supply rail		T_A = –40°C to +125°C		(V+) – 0.05	(V+) – 0.2	V
	Swing to GND(6)		T_A = –40°C to +125°C		V_{GND} + 0.003	V_{GND} + 0.05	V
FREQUENCY RESPONSE							
BW	Bandwidth		C_{LOAD} = 5 pF		130		kHz
	Phase margin		C_{LOAD} < 10 nF		40		Degrees
SR	Slew rate				1		V/µs
t_S	Settling time (1%)		V_{SENSE} = 10 mV to 100 mV_{PP}, C_{LOAD} = 5 pF		2		µs

(1) RTI means *Referred-to-Input*.
(2) Initial resistor variation is ±30% with an additional –2200-ppm/°C temperature coefficient.
(3) For output behavior when V_{SENSE} < 20 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.

Copyright © 2007–2018, Texas Instruments Incorporated

Electrical Characteristics (continued)

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
NOISE, RTI(1)						
e_n	Voltage noise density			40		nV/√Hz
POWER SUPPLY						
V_S	Operating range	T_A = –40°C to +125°C	+2.7		+18	V
I_Q	Quiescent current	V_{OUT} = 2 V		700	900	µA
	I_Q over temperature	V_{SENSE} = 0 mV, T_A = –40°C to +125°C		350	950	µA
TEMPERATURE RANGE						
	Specified temperature range		–40		+125	°C
	Operating temperature range		–55		+150	°C
θ_{JA}	Thermal resistance, SO-8			150		°C/W

Copyright © 2007–2018, Texas Instruments Incorporated

7.6 Typical Characteristics

At T_A = +25°C, V_S = +12 V, V_{CM} = 12 V, and V_{SENSE} = 100 mV, unless otherwise noted.

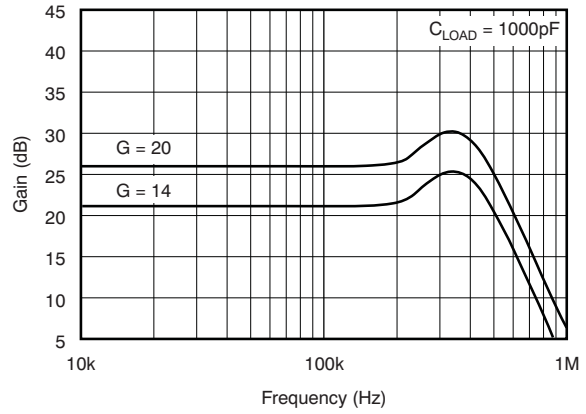


Figure 1. Gain vs Frequency

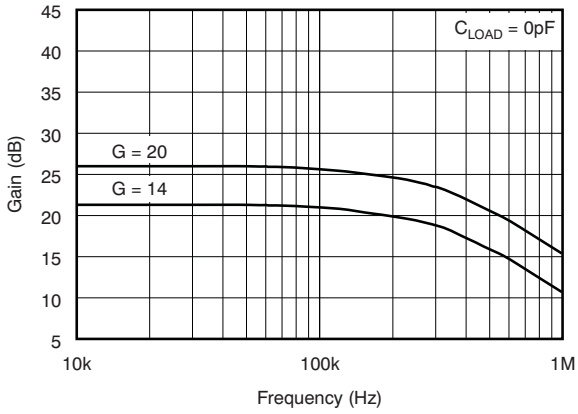


Figure 2. Gain vs Frequency

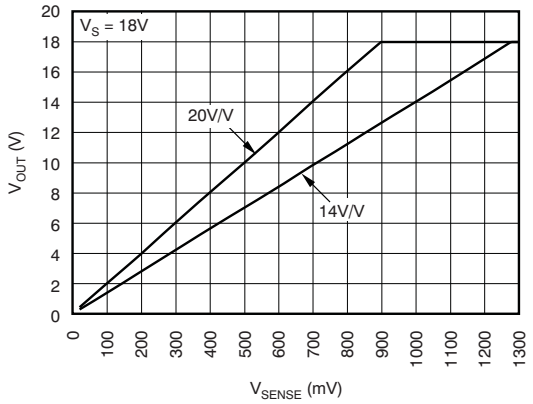


Figure 3. Gain Plot

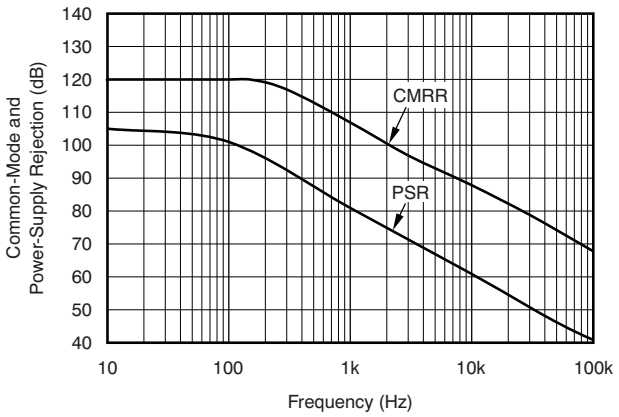


Figure 4. Common-Mode and Power-Supply Rejection vs Frequency

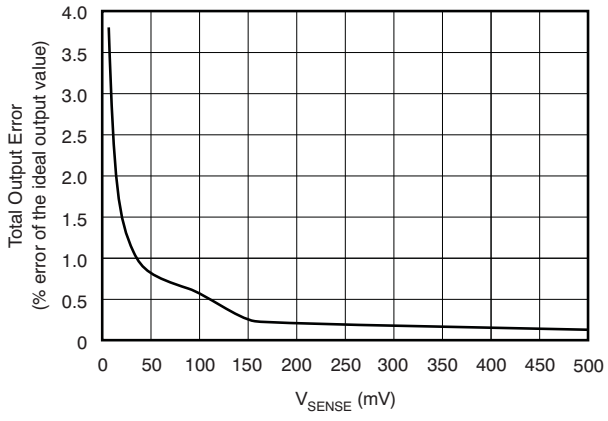


Figure 5. Total Output Error vs V_{SENSE}

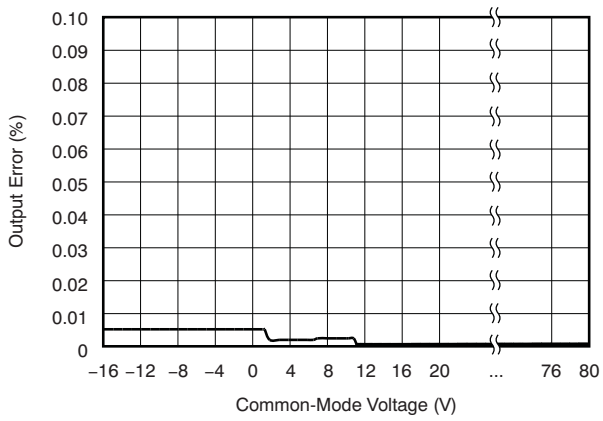


Figure 6. Output Error vs Common-Mode Voltage

Typical Characteristics (continued)

At T_A = +25°C, V_S = +12 V, V_{CM} = 12 V, and V_{SENSE} = 100 mV, unless otherwise noted.

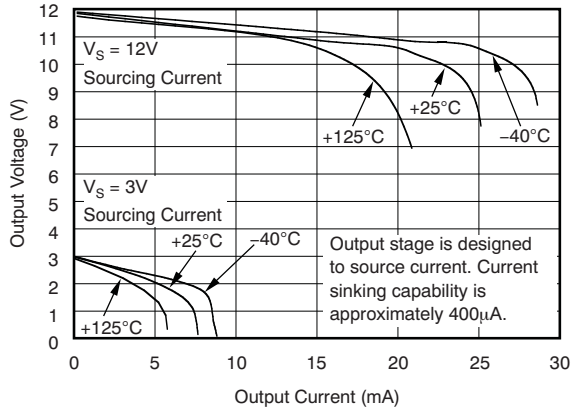


Figure 7. Positive Output Voltage Swing vs Output Current

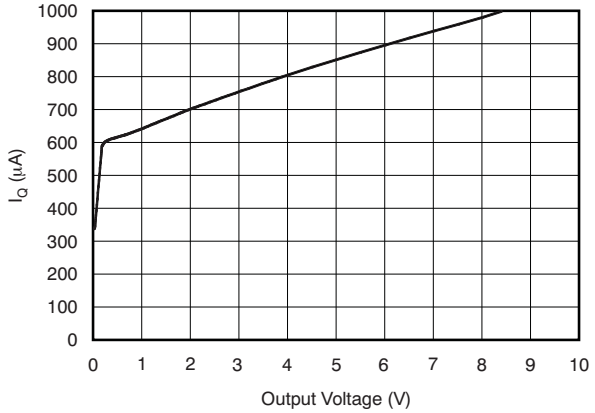


Figure 8. Quiescent Current vs Output Voltage

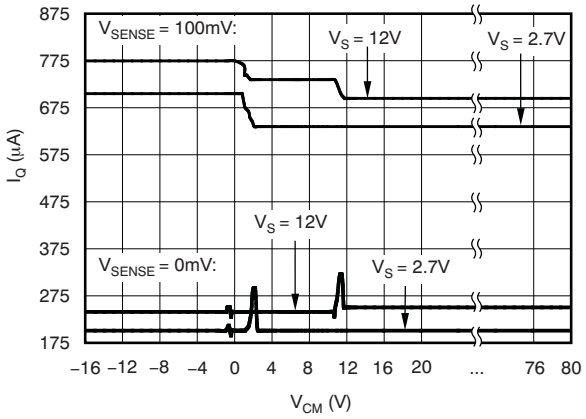


Figure 9. Quiescent Current vs Common-Mode Voltage

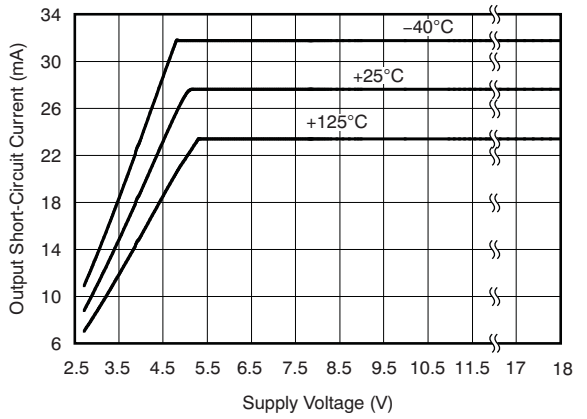


Figure 10. Output Short-Circuit Current vs Supply Voltage

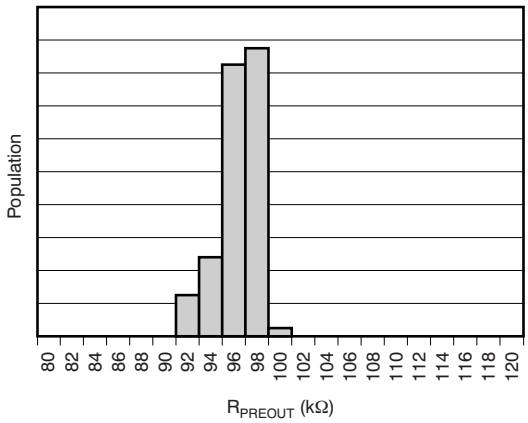


Figure 11. PRE OUT Output Resistance Production Distribution

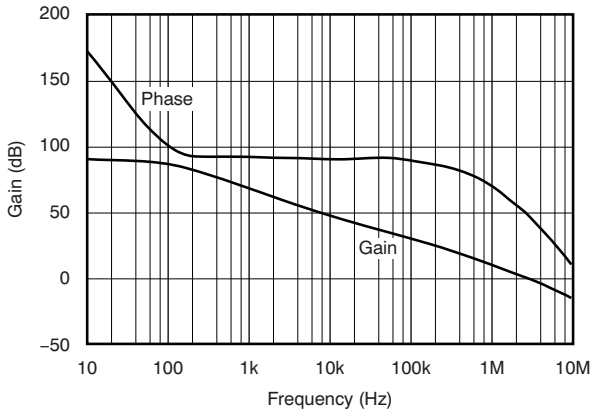


Figure 12. Buffer Gain vs Frequency

Copyright © 2007–2018, Texas Instruments Incorporated

Typical Characteristics (continued)

At T_A = +25°C, V_S = +12 V, V_{CM} = 12 V, and V_{SENSE} = 100 mV, unless otherwise noted.

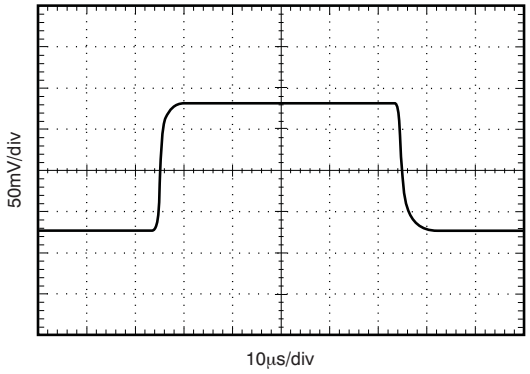


Figure 13. Small-Signal Step Response (10-mV to 20-mV Input)

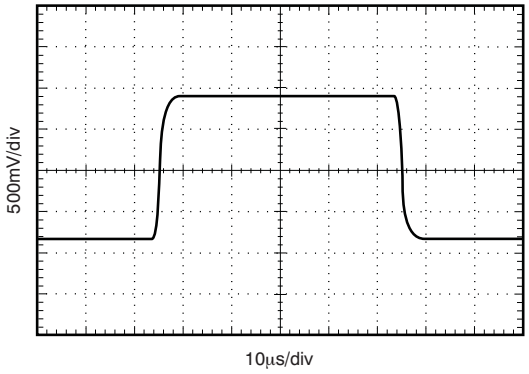


Figure 14. Large-Signal Step Response (10-mV to 100-mV Input)

Copyright © 2007–2018, Texas Instruments Incorporated

8 Detailed Description

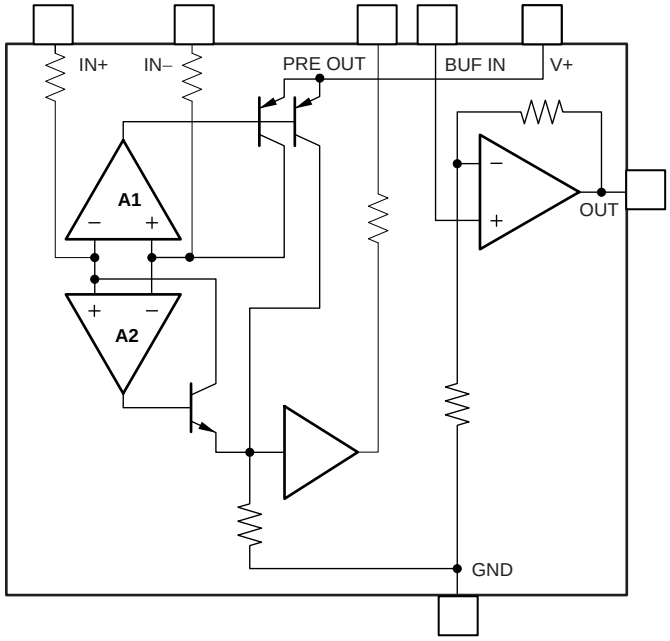
8.1 Overview

The INA270 and INA271 family of current-shunt monitors with voltage output can sense drops across current shunts at common-mode voltages from –16 V to +80 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 V/V and 20 V/V. The 130-kHz bandwidth simplifies use in current-control loops.

The INA270 and INA271 operate from a single +2.7-V to +18-V supply, drawing a maximum of 900 μA of supply current. The devices are specified over the extended operating temperature range of –40°C to +125°C and are offered in an SOIC-8 package.

8.2 Functional Block Diagram



Copyright © 2007–2018, Texas Instruments Incorporated

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 μF and 0.1 μF 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.

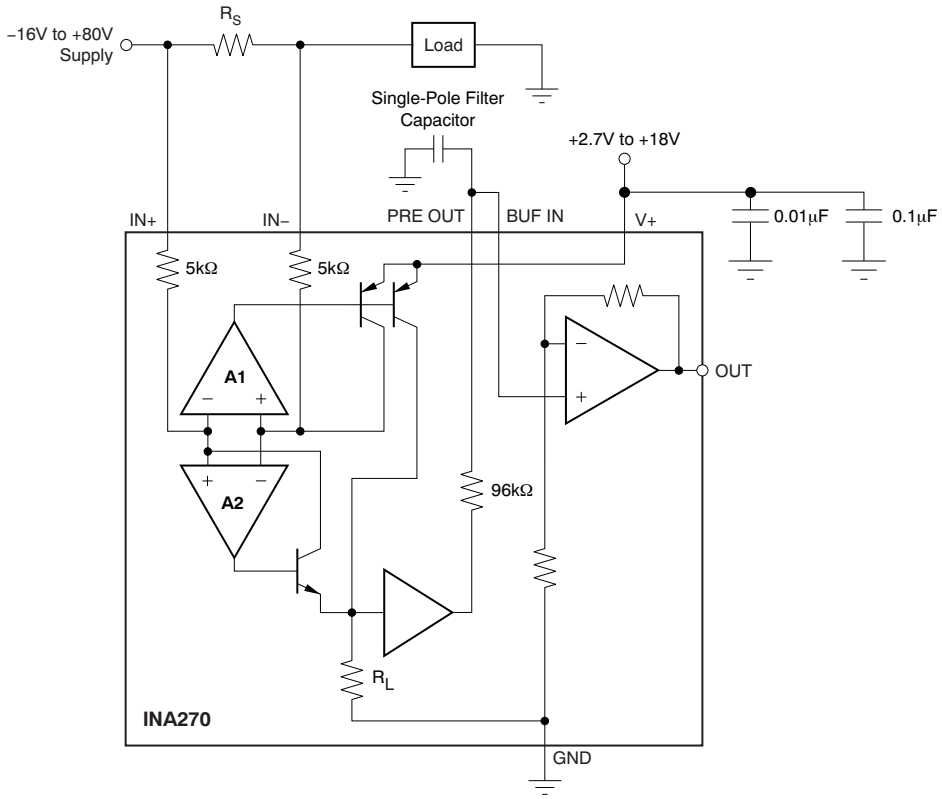


Figure 15. INA270 Basic Connections

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) / Gain.

8.3.3 Transient Protection

The –16-V to +80-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-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.

Copyright © 2007–2018, Texas Instruments Incorporated

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 ±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).

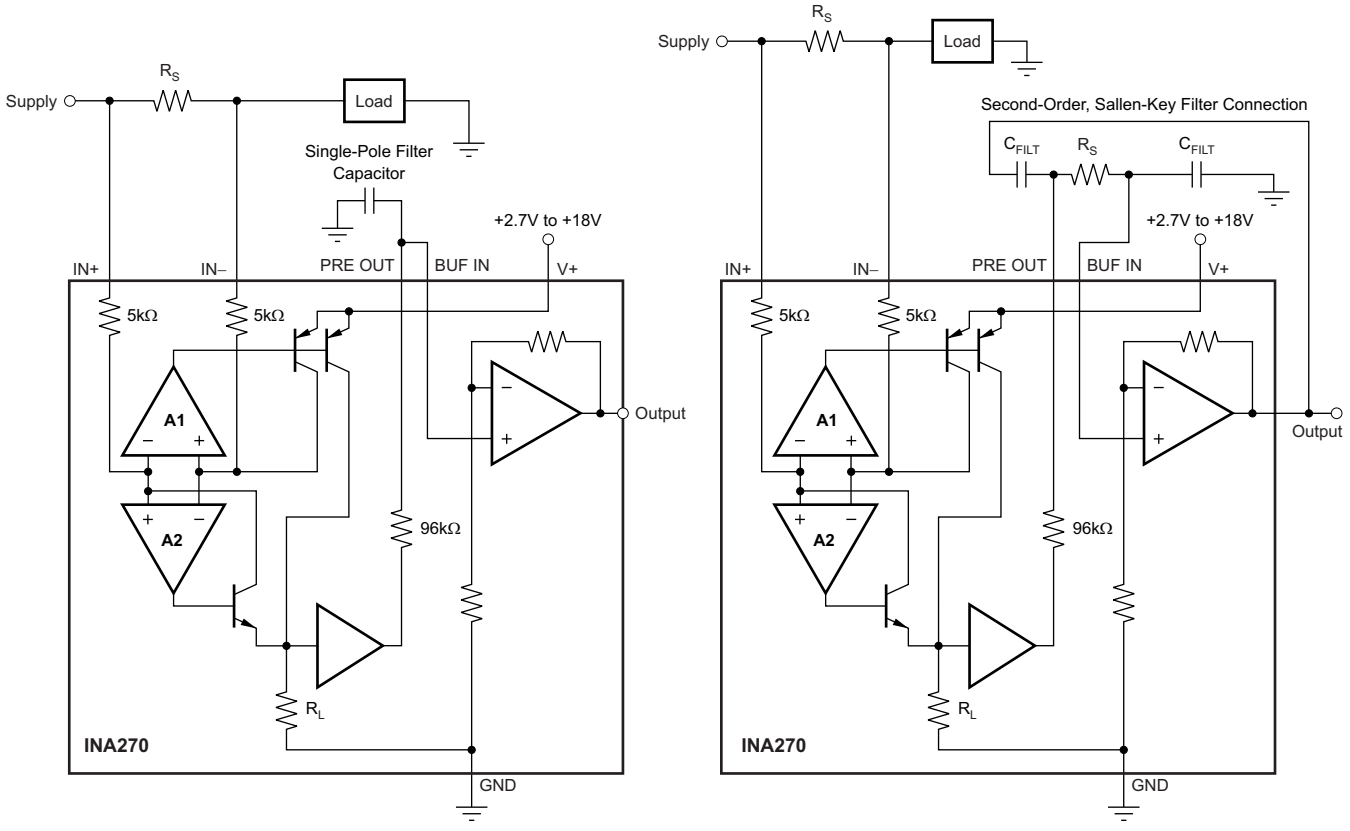
8.4 Device Functional Modes

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-kΩ 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-kΩ output impedance exhibits an initial variation of ±30% with the addition of a –2200-ppm/°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

Copyright © 2007–2018, Texas Instruments Incorporated

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: $V_{SENSE} \geq 20$ mV, $V_{CM} \geq V_S$
Normal Case 2: $V_{SENSE} \geq 20$ mV, $V_{CM} < V_S$
Low V_{SENSE} Case 1:
$V_{SENSE} < 20$ mV, $–16 \text{ V} \leq V_{CM} < 0$
Low V_{SENSE} Case 2:
$V_{SENSE} < 20$ mV, $0 \text{ V} \leq V_{CM} \leq V_S$
Low V_{SENSE} Case 3:
$V_{SENSE} < 20$ mV, $V_S < V_{CM} \leq 80$ V

8.4.2.1 Normal Case 1: $V_{SENSE} \geq 20$ 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 mV and
- V_{OUT2} = Output voltage with V_{SENSE} = 20 mV. (1)

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

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

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 V; for $V_{CM} \geq 12$ V, the output error is at its minimum. This case is also used to create the $V_{SENSE} \geq 20$ mV output specifications in the *Electrical Characteristics* table.

8.4.2.2 Normal Case 2: $V_{SENSE} \geq 20$ 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 V; for $V_{CM} < 12$ V, the output error increases when V_{CM} becomes less than 12 V, with a typical maximum error of 0.005% at the most negative $V_{CM} = –16$ V.

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

Copyright © 2007–2018, Texas Instruments Incorporated

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).

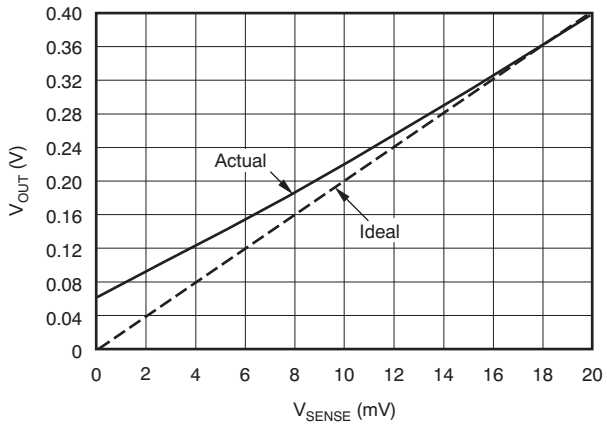
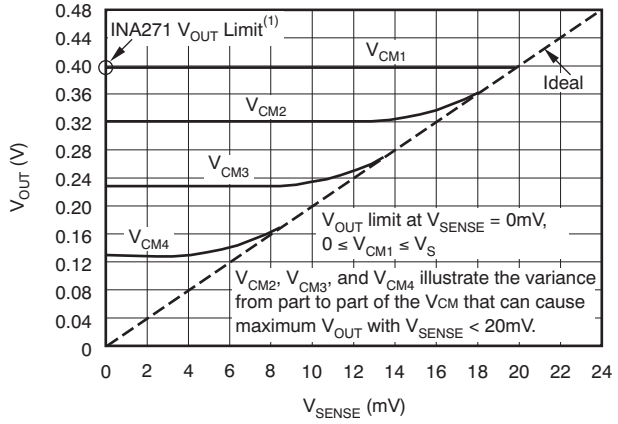


Figure 17. Example For Low V_{SENSE} Cases 1 and 3 (INA271, Gain = 20)

8.4.2.4 Low V_{SENSE} Case 2: V_{SENSE} < 20 mV, 0 V ≤ V_{CM} ≤ 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)

Copyright © 2007–2018, Texas Instruments Incorporated

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

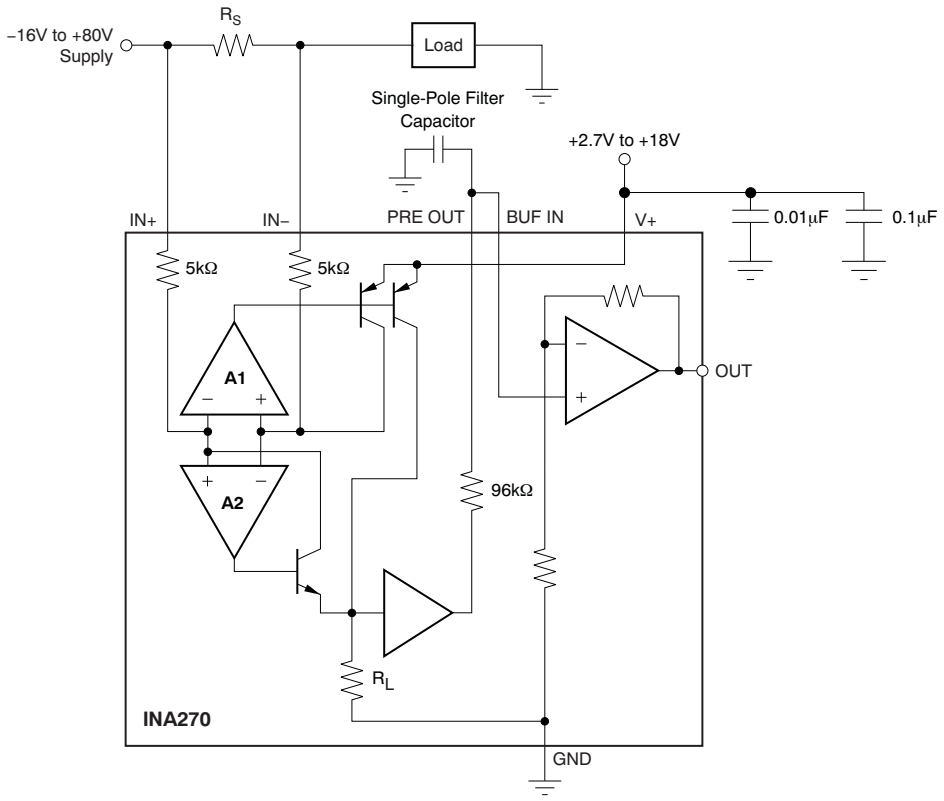


Figure 19. Filtering Configuration

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.

Copyright © 2007–2018, Texas Instruments Incorporated

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.

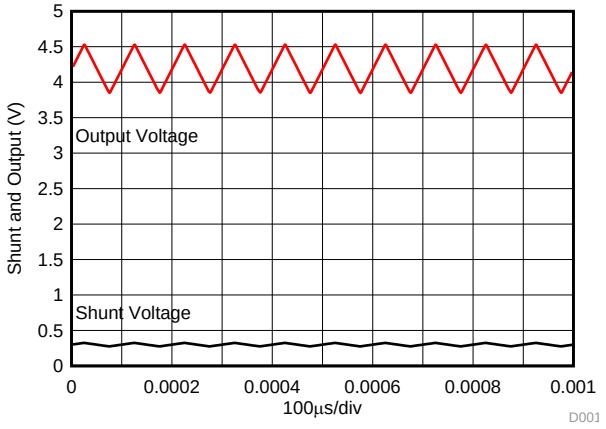


Figure 20. Without Filtering

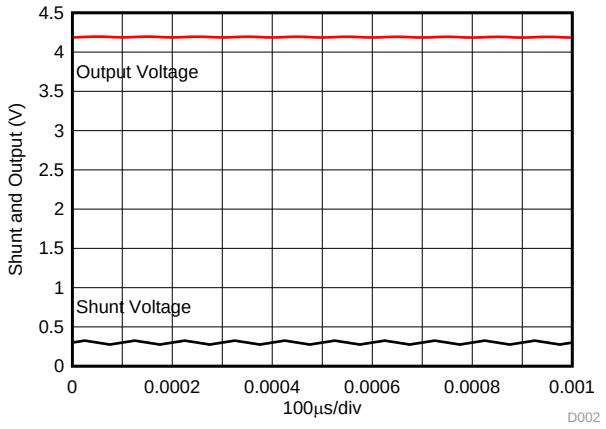


Figure 21. With Filtering

Copyright © 2007–2018, Texas Instruments Incorporated

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-μF 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-μA 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.

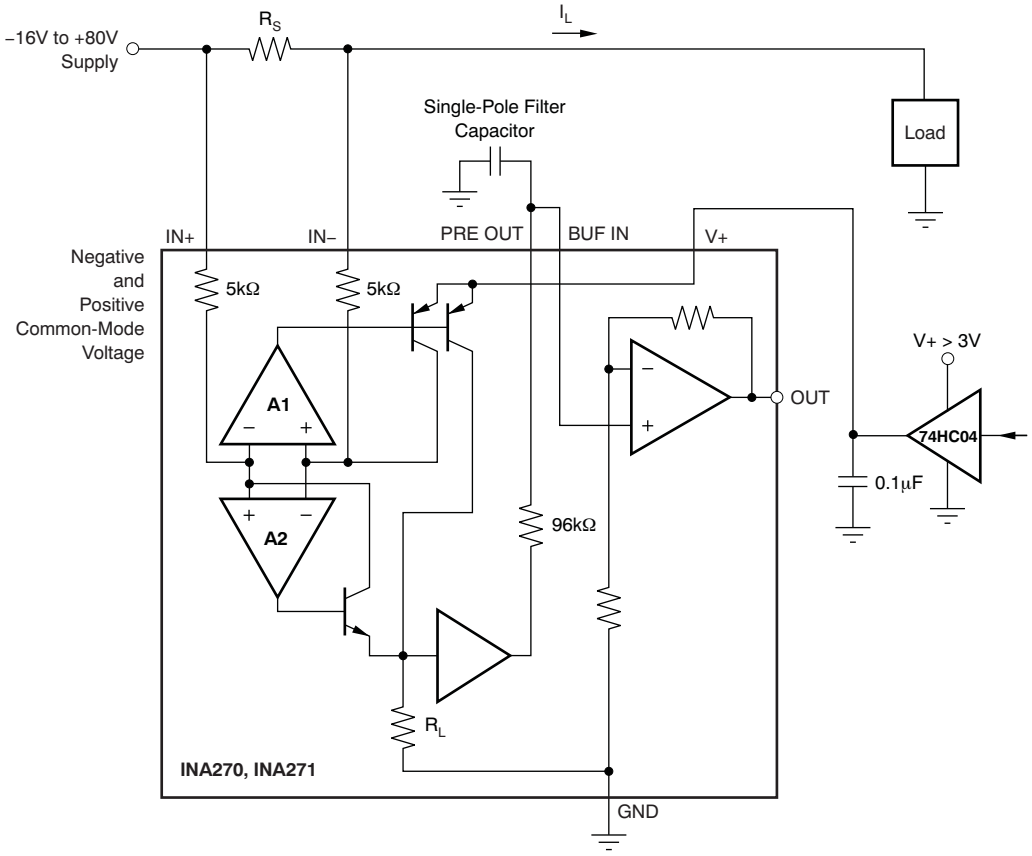


Figure 22. INA270–INA271 Example Shutdown Circuit

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 μF. 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

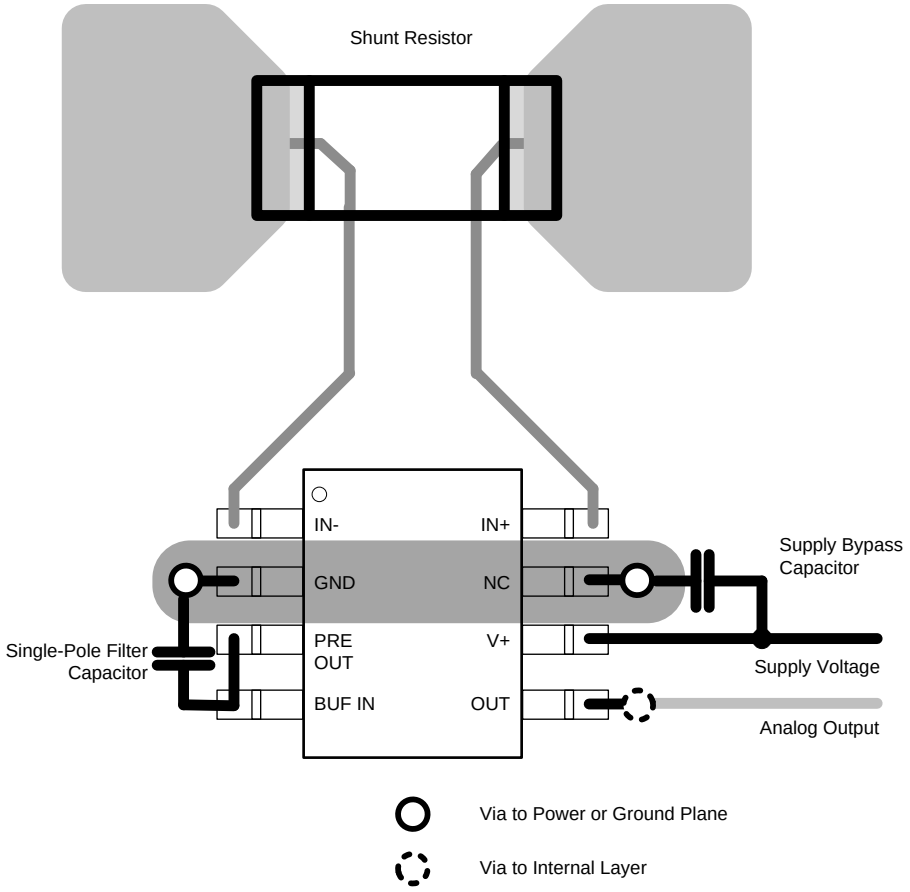


Figure 23. Example Layout

Copyright © 2007–2018, Texas Instruments Incorporated

12 Device and Documentation Support

12.1 Documentation Support

12.1.1 Related Documentation

For related documentation see the following:

INA270 TINA-TI Spice Model, SBOM306

INA270 PSpice Model, SBOM485

INA270 TINA-TI Reference Design, SBOC246

12.2 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to order now.

Table 1. Related Links

PARTS	PRODUCT FOLDER	ORDER NOW	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
INA270	Click here	Click here	Click here	Click here	Click here
INA271	Click here	Click here	Click here	Click here	Click here

12.3 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

TI E2E™ Online Community ***TI's Engineer-to-Engineer (E2E) Community.*** Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support ***TI's Design Support*** Quickly find helpful E2E forums along with design support tools and contact information for technical support.

12.4 Trademarks

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

12.5 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

12.6 Glossary

SLYZ022 — *TI Glossary*.

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

13 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.

Copyright © 2007–2018, Texas Instruments Incorporated

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)
INA270AID	Obsolete	Production	SOIC (D) | 8	-	-	Call TI	Call TI	-40 to 125	I270A
INA270AIDR	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	I270A
INA270AIDR.A	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	I270A
INA270AIDRG4	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	I270A
INA270AIDRG4.A	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	I270A
INA271AID	Active	Production	SOIC (D) | 8	75 | TUBE	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	I271A
INA271AID.A	Active	Production	SOIC (D) | 8	75 | TUBE	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	I271A
INA271AIDR	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	I271A
INA271AIDR.A	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	I271A
INA271AIDRG4	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	I271A
INA271AIDRG4.A	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	I271A

(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.

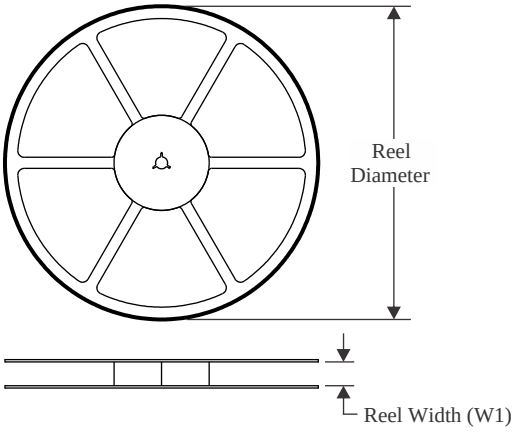
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

OTHER QUALIFIED VERSIONS OF INA271 :

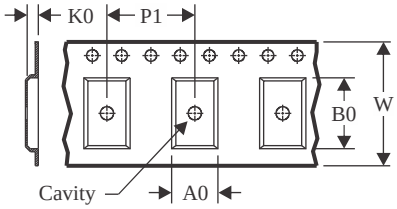
NOTE: Qualified Version Definitions:

TAPE AND REEL INFORMATION

REEL DIMENSIONS

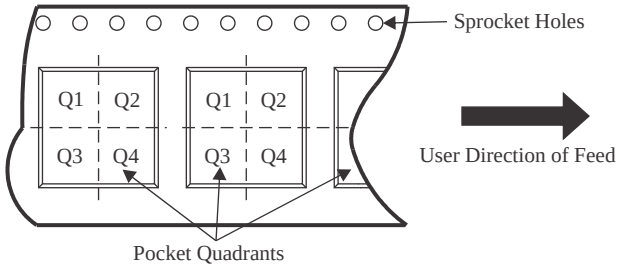


TAPE DIMENSIONS



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

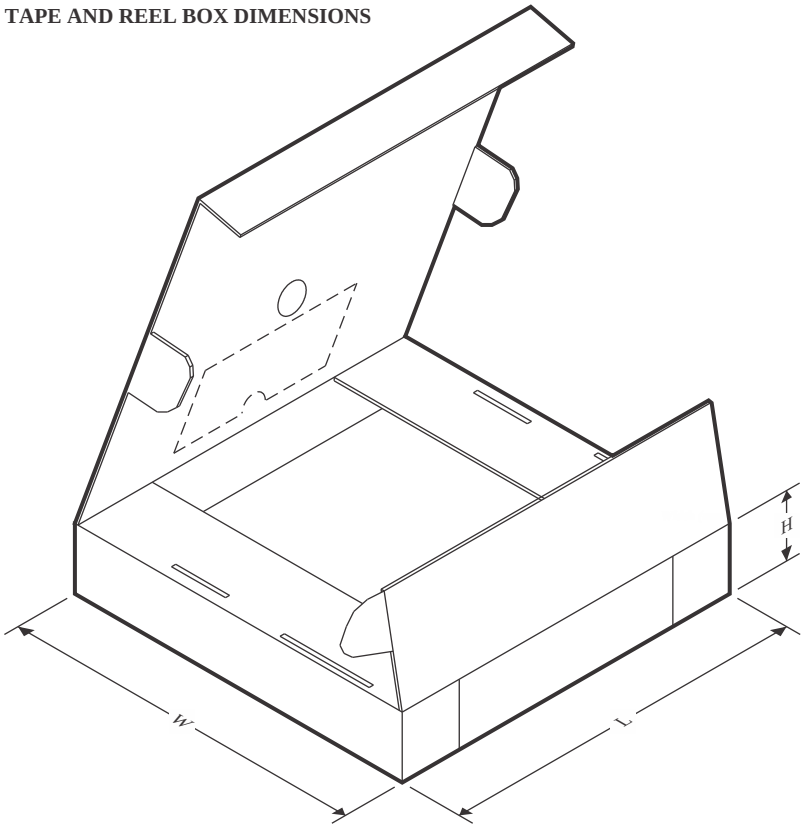
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
INA270AIDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
INA270AIDRG4	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
INA271AIDRG4	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1

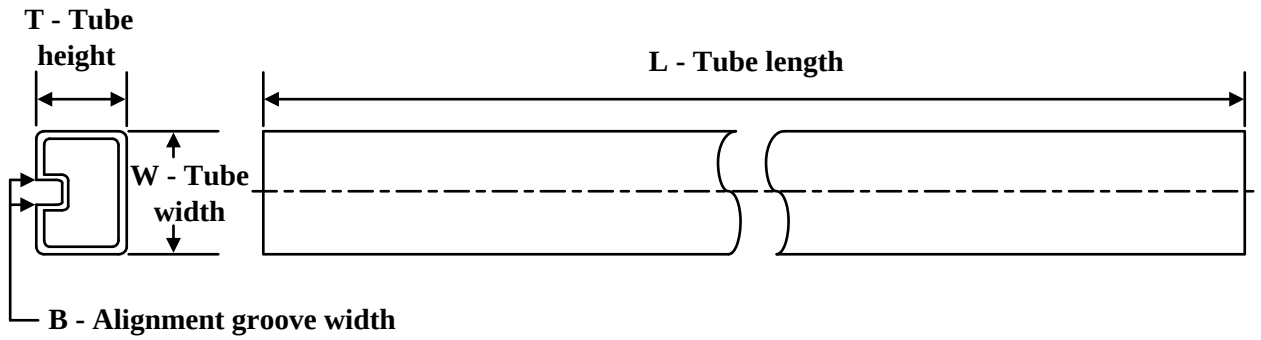
TAPE AND REEL BOX DIMENSIONS



*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
INA270AIDRG4	SOIC	D	8	2500	350.0	350.0	43.0
INA271AIDR	SOIC	D	8	2500	350.0	350.0	43.0
INA271AIDRG4	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)
INA271AID	D	SOIC	8	75	505.46	6.76	3810	4
INA271AID.A	D	SOIC	8	75	505.46	6.76	3810	4

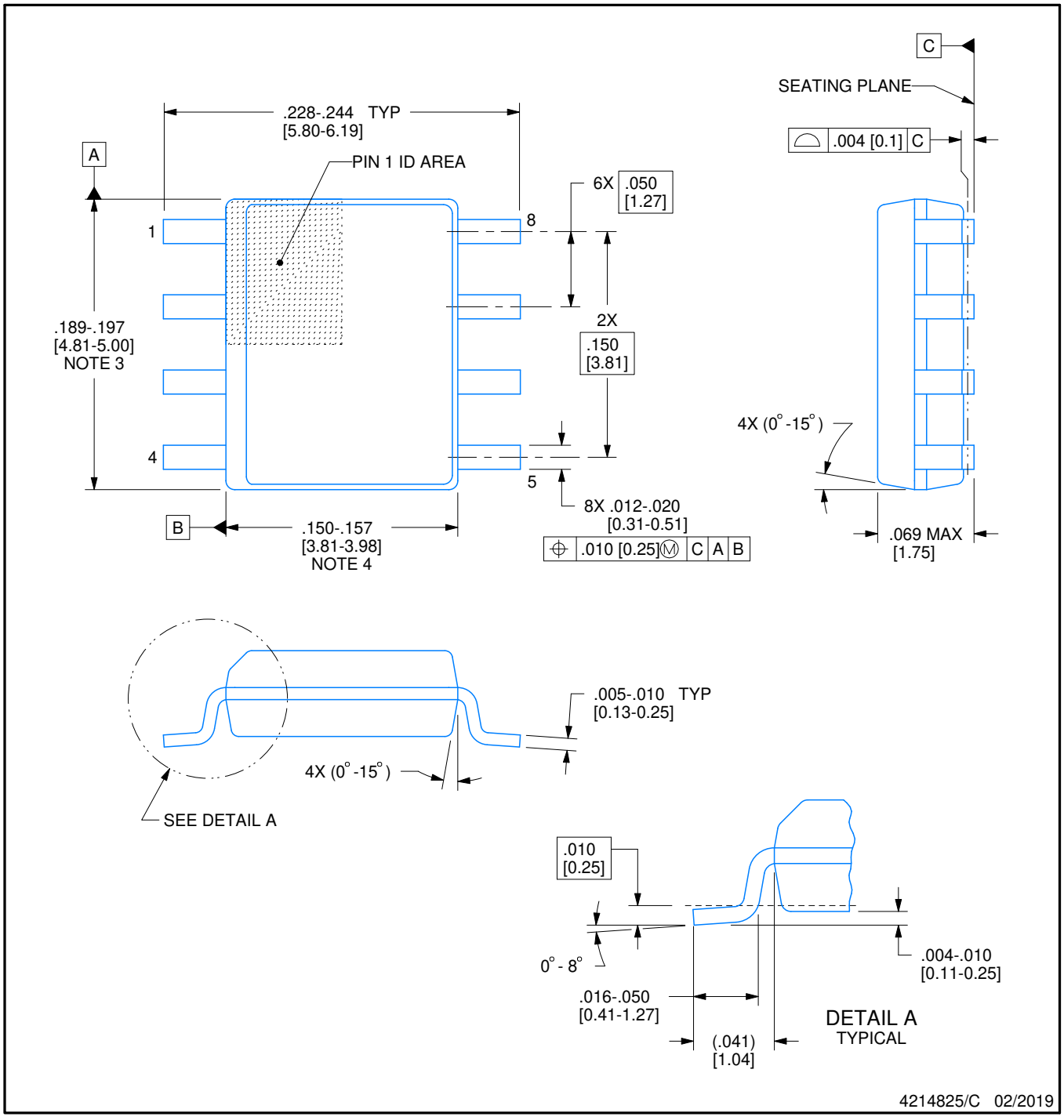


PACKAGE OUTLINE

D0008A

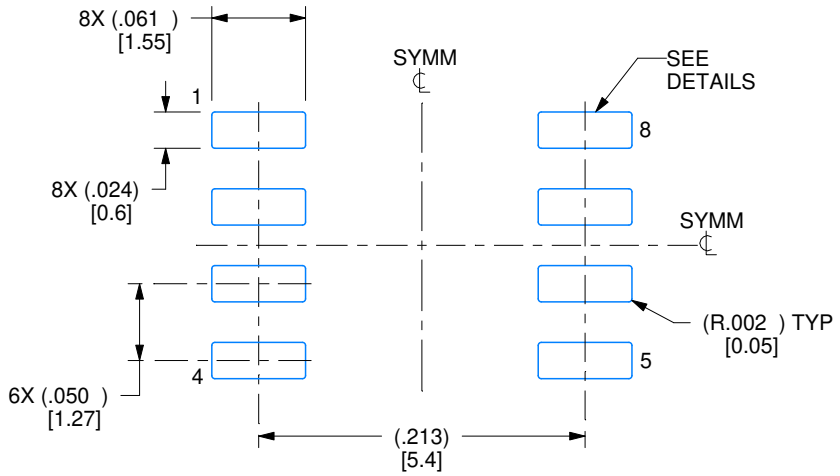
SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT

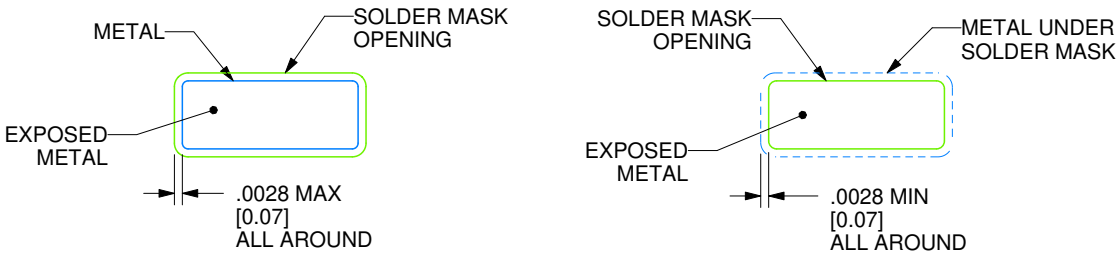


NOTES:

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.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X



SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

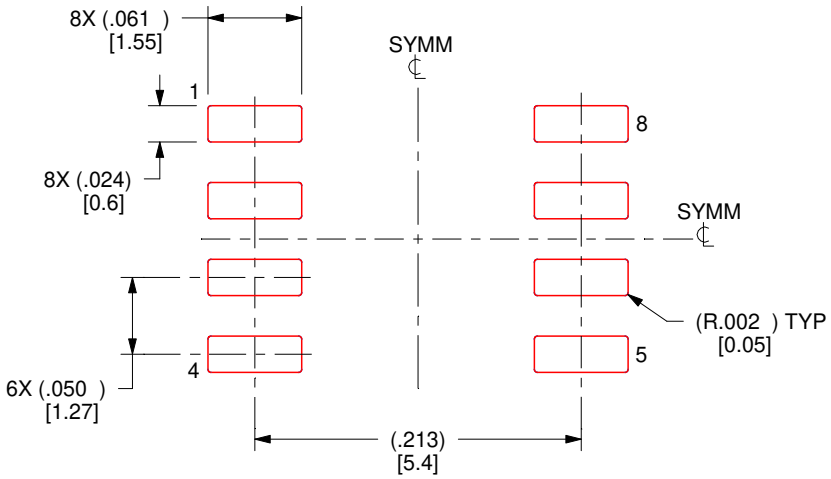
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

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.

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you fully indemnify TI and its representatives against any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale, TI’s General Quality Guidelines, or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products. Unless TI explicitly designates a product as custom or customer-specified, TI products are standard, catalog, general purpose devices.

TI objects to and rejects any additional or different terms you may propose.

Copyright © 2026, Texas Instruments Incorporated

Last updated 10/2025