INA27xA-Q1 Automotive Grade, –16V to +80V, Low- or High-side, High-Speed, Voltage Output Current Sense Amplifier With Simplified Filter Inputs

1 Features

- Qualified for Automotive Applications
- AEC-Q100 Qualified With the Following Results:
  - Device Temperature Grade 1: –40°C to +125°C Ambient Operating Temperature Range
  - Device HBM ESD Classification Level 2
  - Device CDM ESD Classification Level C6
- Pinout Optimized for External Filtering
- Wide Common-Mode Range: –16 V to +80 V
- Accuracy:
  - CMRR: 120 dB
  - ±2.5-mV Offset (Maximum)
  - ±1% Gain Error (Maximum)
  - 20-μV/°C Offset Drift (Maximum)
  - 55-ppm/°C Gain Drift (Maximum)
- Bandwidth: Up to 130 kHz
- Two Gain Options Available:
  - 14 V/V (INA270A-Q1)
  - 20 V/V (INA271A-Q1)
- Quiescent Current: 900 μA (Maximum)
- Power Supply: 2.7 V to 18 V
- Packages: SOIC-8

2 Applications

- Electric Power Steering (EPS) Systems
- Body Control Modules
- Brake Systems
- Electronic Stability Control (ESC) Systems

3 Description

The INA270A-Q1 and INA271A-Q1 (INA27xA-Q1) family of current-shunt monitors with voltage output can sense voltage drops across current shunts at common-mode voltages from –16 V to +80 V, independent of the supply voltage. The INA27xA-Q1 pinouts readily enable filtering.

The INA27xA-Q1 devices 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 INA27xA-Q1 operates from a single 2.7-V to 18-V supply, drawing a maximum of 900 μA of supply current. They 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)
INA270A-Q1	SOIC (8)	4.90 mm × 3.91 mm
INA271A-Q1		

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

Simplified Schematic

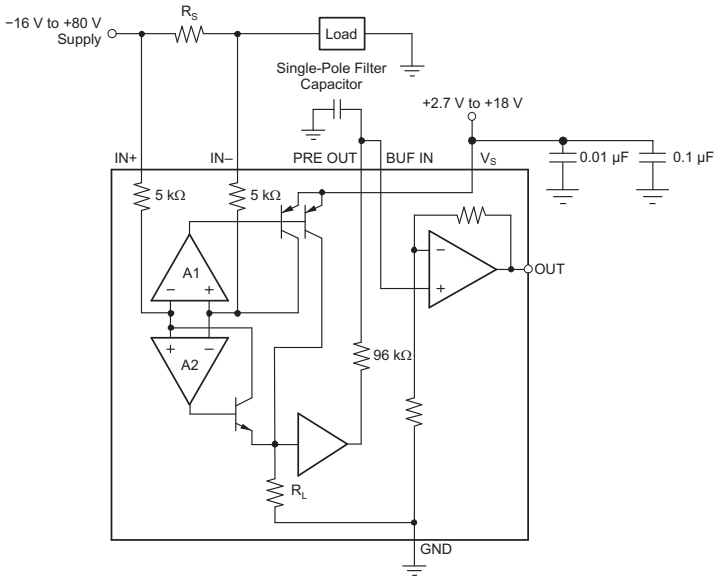


Table of Contents

4 Revision History

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

Changes from Revision B (February 2010) to Revision C **Page**

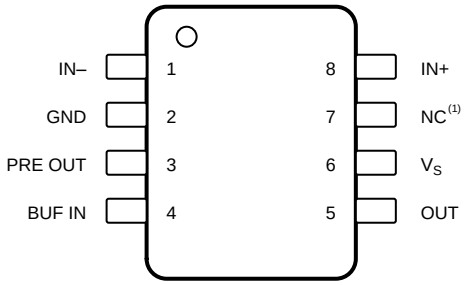
- Updated data sheet title, *Features*, and *Applications* ... 1
- Updated device name from INA270-Q1 and INA271-Q1 to INA270A-Q1 and INA271A-Q1 ... 1
- Added A-Q1 to INA270 and INA271 throughout document ... 1
- Added *Device Information* table, *ESD Ratings* table, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *First- or Second-Order Filtering* section *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section. ... 1
- Changed V+ to V_S throughout ... 3
- Added equation (V_{IN+} + $V_{IN–}$)/2 to common-mode in *Absolute Maximum Ratings* table ... 3
- Updated V_{SENSE} equation ... 4
- Changed Input offset voltage temperature coefficient symbol ... 4

5 Device Comparison Table

DEVICE	GAIN
INA270A-Q1	14 V/V
INA271A-Q1	20 V/V

6 Pin Configuration and Functions

D Package
8-Pin SOIC
Top View



(1) NC – No internal connection

Pin Functions

PIN		TYPE(1)	DESCRIPTION
NAME	NO.		
BUF IN	4	AI	Buffer Input. Connect to output of filter from PRE OUT
GND	2	A	Ground
IN–	1	AI	Negative input. Connect to load side of shunt resistor.
IN+	8	AI	Positive input. Connect to supply side of shunt resistor.
NC	7	—	Not internally connected. Connect to ground.
PRE OUT	3	AO	Pre Amplifier Output. Connect to input of filter to BUF IN.
OUT	5	AO	Output
V_S	6	AI	Power supply, 2.7 V to 18 V

(1) A = Analog, AI = Analog input, AO = Analog output

7 Specifications

7.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
V_S	Supply voltage		18	V
V_{SENSE}	Differential analog input voltage range (V_{IN+} – $V_{IN–}$)	–18	18	V
V_{CM}	Common-mode analog input voltage range (V_{IN+} + $V_{IN–}$)/2	–16	80	V
V_O	Analog output voltage range (OUT and PRE OUT)	(GND – 0.3)	(V_S) + 0.3	V
I_I	Input current (any pin)		5	mA
T_J	Maximum junction temperature		150	°C
T_A	Operating free-air temperature	–40	125	°C
T_{stg}	Storage temperature	–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, 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 AEC Q100-002 (1)	2000	V
		Machine Model (MM)	100	
		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	NOM	MAX	UNIT
V_S	Supply voltage	2.7	5	18	V
V_{CM}	Common mode input	–16	12	80	V
T_A	Operating free-air temperature	–40	25	125	°C

7.4 Thermal Information

THERMAL METRIC (1)		INA27xA-Q1 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	°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, SPRA953.

7.5 Electrical Characteristics

T_A = 25°C, V_S = 5 V, V_{CM} = 12 V, V_{SENSE} = 100 mV, 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 voltage	T_A = –40°C to +125°C	–16		80	V
CMRR	Common-mode rejection	V_{IN+} = –16 V to +80 V	80	120		dB
		V_{IN+} = 12 V to 80 V, T_A = –40°C to +125°C	100	120		
V_{OS}	Offset voltage, RTI (1)			±0.5	2.5	mV
		T_A = –40°C to +125°C			±3	
dV_{OS}/dT	Input offset voltage temperature coefficient	T_A = –40°C to +125°C		2.5	20	µV/°C
PSR	Offset voltage power-supply rejection	V_S = 2.7 V to 18 V, V_{CM} = 18 V, T_A = –40°C to +125°C		5	100	µV/V
I_{IB}	Input bias current	IN– pin, T_A = –40°C to +125°C full range		±8	±16	µA
Z_O	Output impedance (2)	PRE OUT pin		96		kΩ
	Buffer input bias current			–50		nA
	Buffer input bias current temperature coefficient			±0.3		nA/°C

(1) RTI = referred to input
(2) Initial resistor variation is ±30% with an additional –2200-ppm/°C temperature coefficient.

Electrical Characteristics (continued)

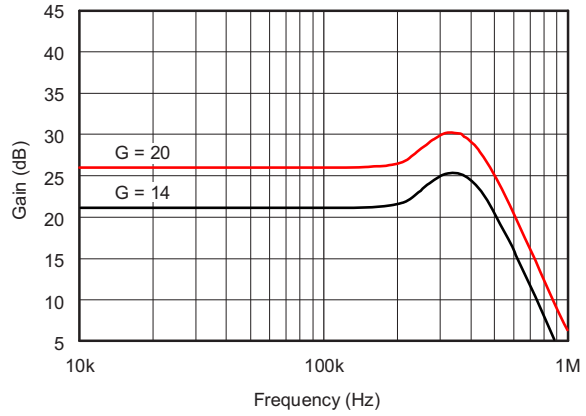
T_A = 25°C, V_S = 5 V, V_{CM} = 12 V, V_{SENSE} = 100 mV, PRE OUT connected to BUF IN (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
Output (V_{SENSE} ≥ 20 mV)(3)							
G	Gain	INA270A-Q1			14		V/V
		INA271A-Q1			20		
G_{BUF}	Output buffer gain				2		V/V
	Total gain error	V_{SENSE} = 20 mV to 100 mV			±0.2%	±1%	
			T_A = –40°C to +125°C			±2%	
	Total gain error temperature coefficient	T_A = –40°C to +125°C				50	ppm/°C
	Total output error(4)				±0.75%	±2.2%	
		T_A = –40°C to +125°C			±1%	±3%	
	Nonlinearity error	V_{SENSE} = 20 mV to 100 mV			±0.002%		
Z_O	Output impedance	OUT pin			1.5		Ω
	Maximum capacitive load	No sustained oscillation			10		nF
Voltage Output(5)							
	Swing to V_S power-supply rail	R_L = 10 kΩ to GND, T_A = –40°C to +125°C			V_S – 0.05	V_S – 0.2	V
	Swing to GND	R_L = 10 kΩ to GND, T_A = –40°C to +125°C			V_{GND} + 0.003	V_{GND} + 0.05	V
Frequency Response							
BW	Bandwidth	C_L = 5 pF			130		kHz
φ_m	Phase margin	C_L < 10 nF			40		degrees
SR	Slew rate				1		V/µs
t_s	Settling time (1%)	V_{SENSE} = 10 mV to 100 mV, C_L = 5 pF			2		µs
Noise, RTI(1)							
V_n	Voltage noise density				40		nV/√Hz
Power Supply							
I_Q	Quiescent current	V_{OUT} = 2 V			700	900	µA
		V_{SENSE} = 0 V, T_A = –40°C to +125°C			350	950	

(3) For output behavior when V_{SENSE} < 20 mV, see *Application Information*
(4) Total output error includes effects of gain error and V_{OS}.
(5) See *Typical Characteristics* curve Output Swing vs Output Current and *Accuracy Variations as a Result of VSENSE and Common-Mode Voltage* in the *Application Information* section.

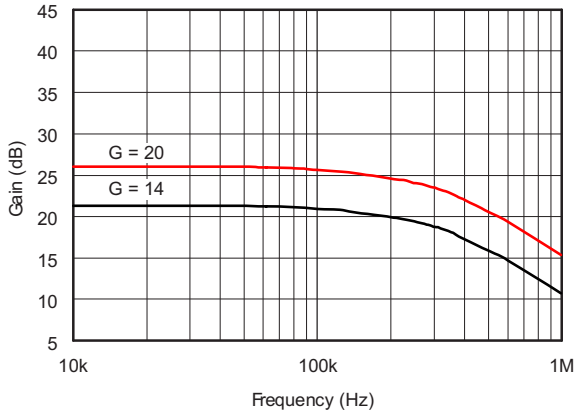
7.6 Typical Characteristics

T_A = 25°C, V_S = 12 V, V_{CM} = 12 V, V_{SENSE} = 100 mV (unless otherwise noted)



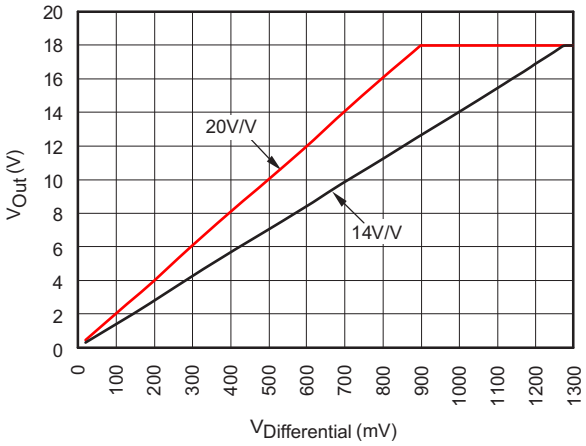
C_{LOAD} = 1000 pF

Figure 1. Gain vs Frequency



C_{LOAD} = 0 pF

Figure 2. Gain vs Frequency



V_S = 18 V

Figure 3. Gain Plot

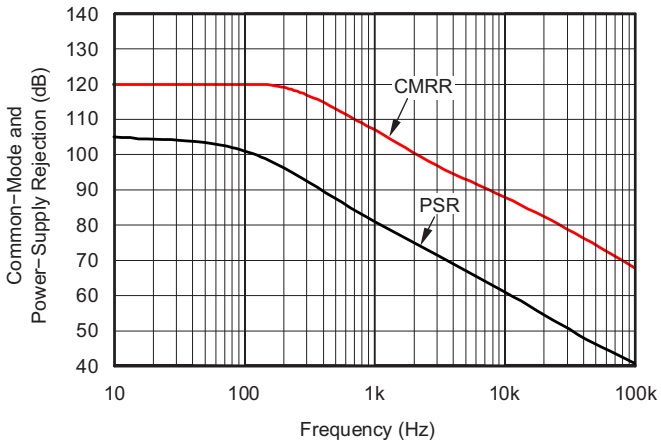


Figure 4. Common-Mode and Power-Supply Rejection vs Frequency

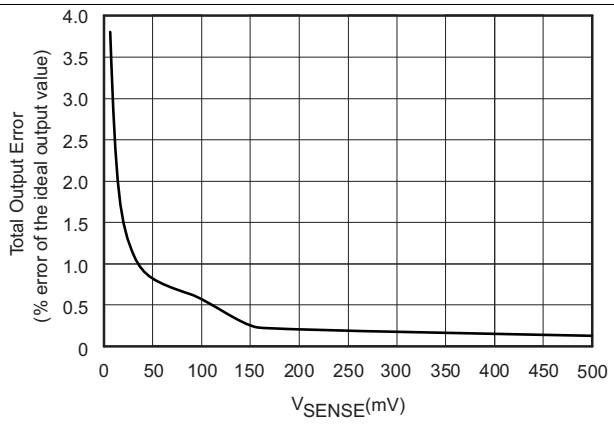


Figure 5. Total Output Error vs V_{SENSE}

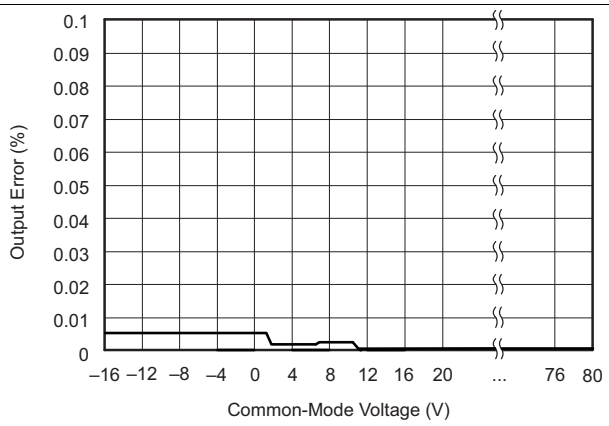
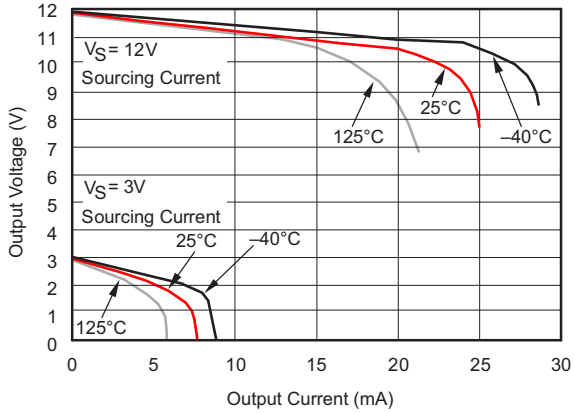


Figure 6. Output Error vs Common-Mode Voltage

Typical Characteristics (continued)

T_A = 25°C, V_S = 12 V, V_{CM} = 12 V, V_{SENSE} = 100 mV (unless otherwise noted)



Output stage is designed to source current.
Current sinking capability is approximately 400 µA.

Figure 7. Positive Output Voltage Swing vs Output Current

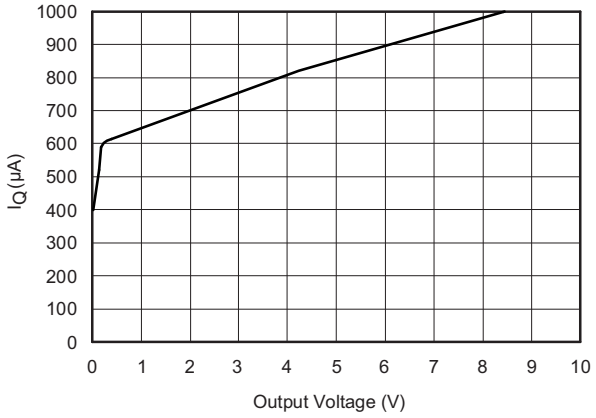


Figure 8. Quiescent Current vs Output Voltage

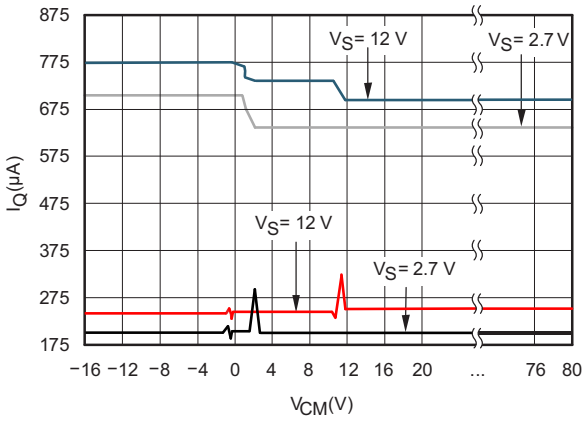


Figure 9. Quiescent Current vs Common-Mode Voltage

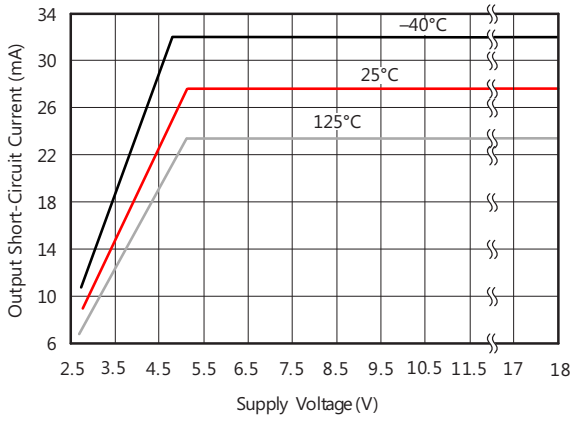


Figure 10. Output Short-Circuit Current vs Supply Voltage

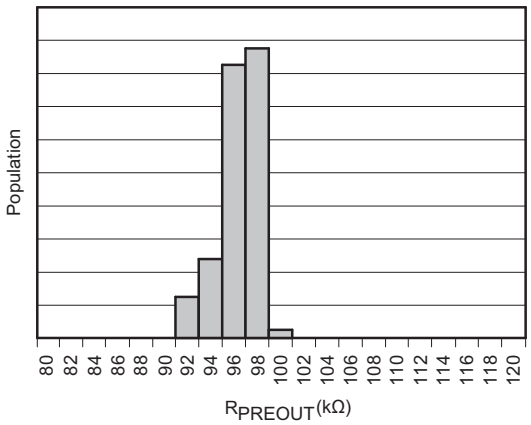


Figure 11. Preout Output Resistance Production Distribution

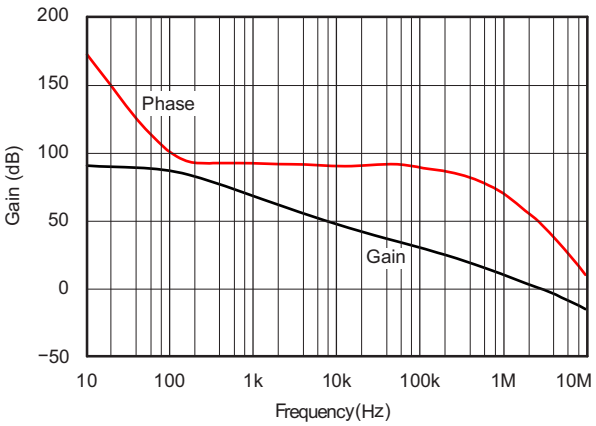


Figure 12. Buffer Gain vs Frequency

Typical Characteristics (continued)

T_A = 25°C, V_S = 12 V, V_{CM} = 12 V, V_{SENSE} = 100 mV (unless otherwise noted)

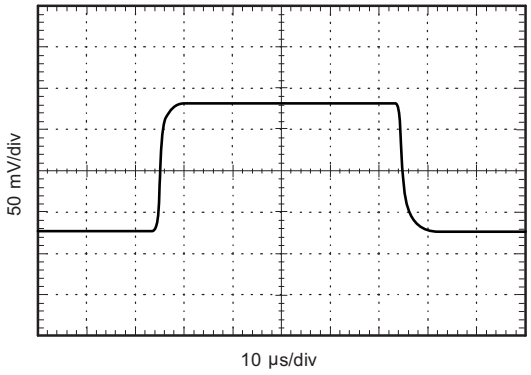


Figure 13. Small-Signal Step Response 10-mV to 20-mV Input

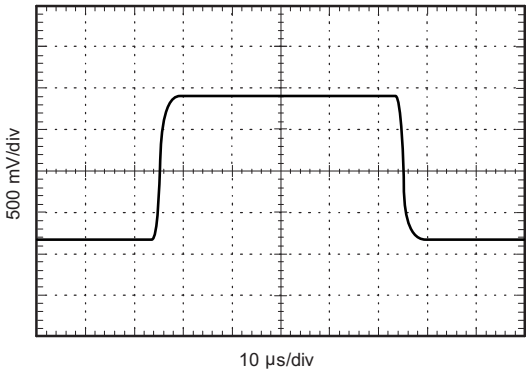


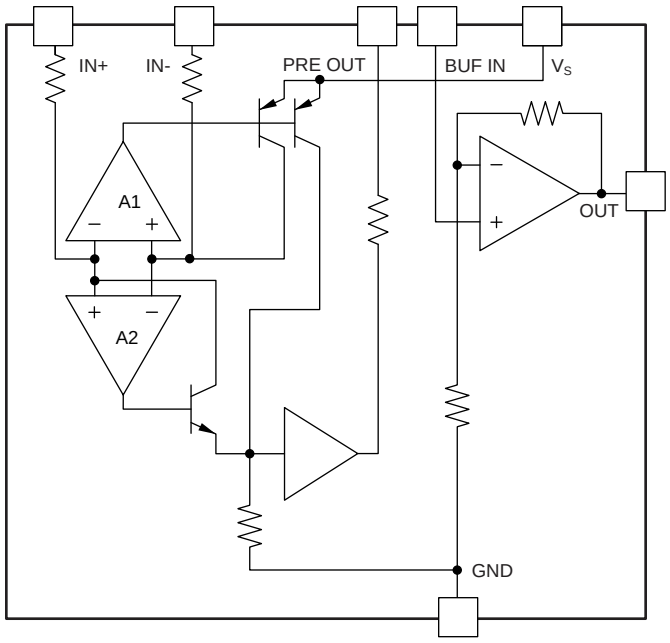
Figure 14. Large-Signal Step Response 10-mV to 100-mV Input

8 Detailed Description

8.1 Overview

The INA27xA-Q1 is a family of voltage output current-sense amplifiers. INA27xA-Q1 operates over a wide common-mode voltage range (–16 V to +80 V). The package brings out the output of the pre amplifier stage (PRE OUT) and the input to the output buffer stage (BUF IN). This pinout readily enables filtering, see *First- or Second-Order Filtering*.

8.2 Functional Block Diagram



8.3 Feature Description

8.3.1 Output Voltage Range

The output of the INA27xA-Q1 is accurate within the output voltage swing range set by the power-supply pin, V_S.

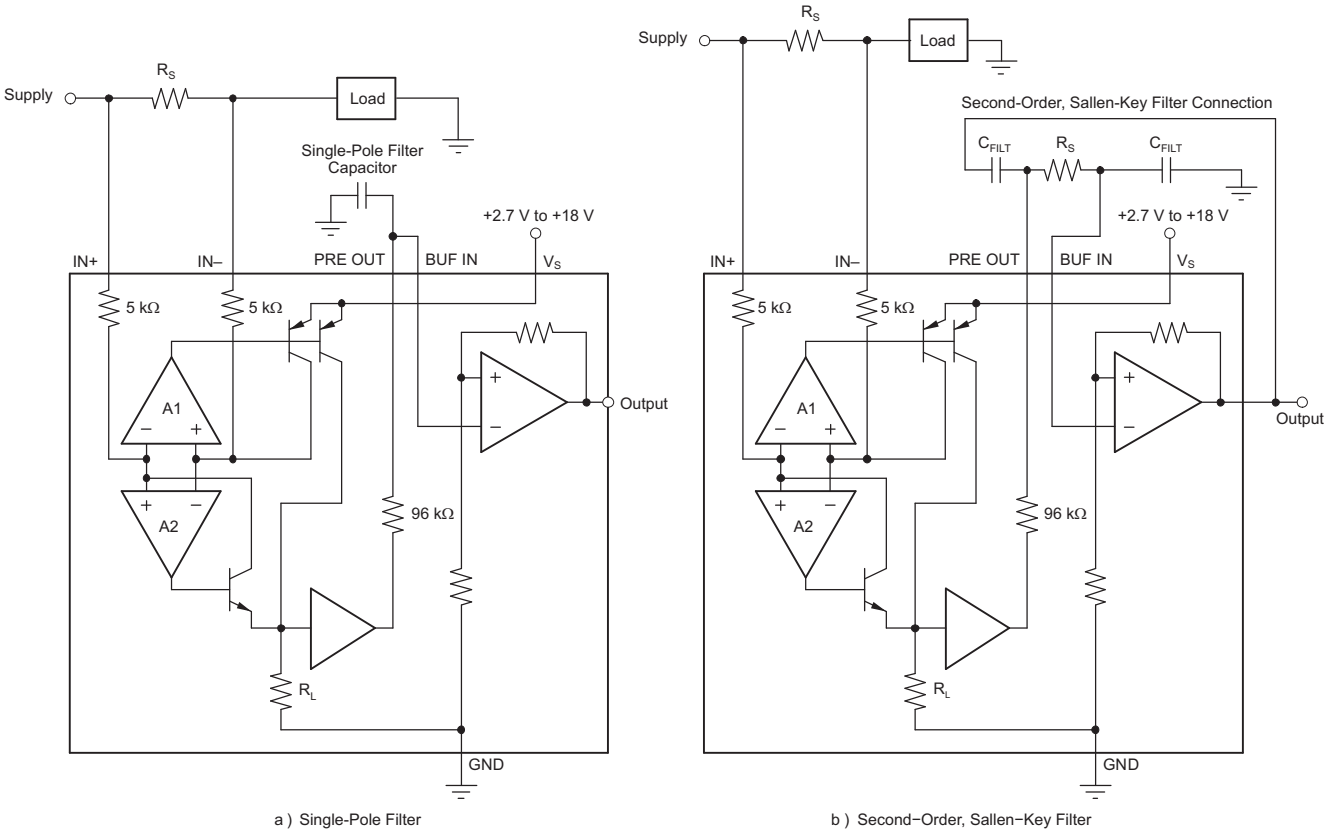
8.4 Device Functional Modes

8.4.1 First- or Second-Order Filtering

The INA27xA-Q1 devices 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 (see Figure 15a).

The INA27xA-Q1 devices readily lend themselves to second-order Sallen-Key configurations (see Figure 15b). 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.

Device Functional Modes (continued)



A. The INA27xA-Q1 can be easily connected for first-order or second-order filtering. Remember to use the appropriate buffer gain (INA270A-Q1 = 1.4, INA271A-Q1 = 2) when designing Sallen-Key configurations.

Figure 15. First-Order or Second-Order Filtering

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 INA27xA-Q1 measures the voltage developed across a current-sensing resistor when current passes through it. There is also a filtering feature to remove unwanted transients and smooth the output voltage.

9.1.1 Basic Connection

Figure 16 illustrates the basic connection of the INA27xA-Q1. The input pins, IN+ and IN–, should be connected 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. Minimum bypass capacitors of 0.01 μF and 0.1 μF in value should be placed close to the supply pins. Although not mandatory, an additional 10-μF electrolytic capacitor placed in parallel with the other bypass capacitors may be useful in applications with particularly noisy supplies.

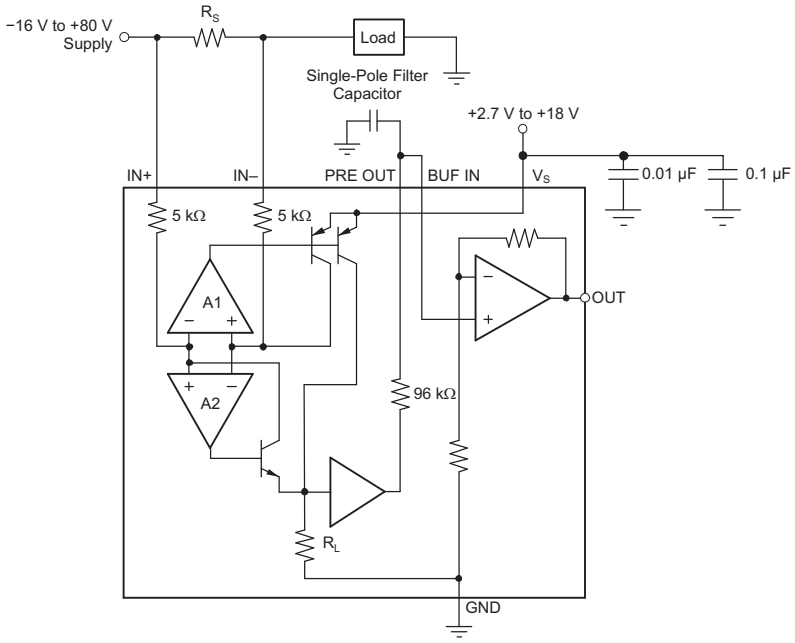


Figure 16. INA270A-Q1 Basic Connection

9.1.2 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.

Application Information (continued)

9.1.3 Accuracy Variations as a Result of V_{SENSE} and Common-Mode Voltage

The accuracy of the INA27xA-Q1 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 seen 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

9.1.3.1 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.

$$G = \frac{V_{OUT1} - V_{OUT2}}{100 \text{ mV} - 20 \text{ mV}} \quad (1)$$

where

- V_{OUT1} = Output voltage with V_{SENSE} = 100 mV
- V_{OUT2} = Output voltage with V_{SENSE} = 20 mV

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 *Typical Characteristics*, the Output Error vs Common-Mode Voltage curve 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 *Electrical Characteristics*.

9.1.3.2 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 INA270A-Q1 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 INA27xA-Q1 devices, it is important to know what the behavior of the devices is in these regions.

As 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. As V_{SENSE} approaches 20 mV, V_{OUT} returns to the expected output value with accuracy as specified in *Electrical Characteristics*. Figure 17 illustrates this effect using the INA271A-Q1 (Gain = 20).

Application Information (continued)

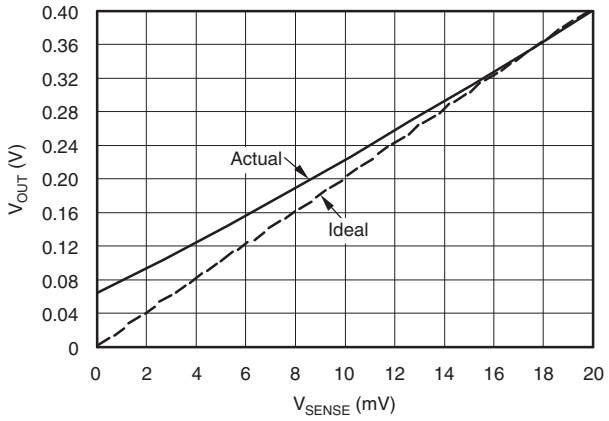


Figure 17. Example for Low V_{SENSE} Cases 1 and 3 (INA271A-Q1, Gain = 20)

9.1.3.3 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 INA27xA-Q1 family. To achieve the wide input common-mode voltage range, these devices use two operational amplifier (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, as V_{SENSE} approaches 20 mV, device operation is closer to that described by Normal Case 2. Figure 18 illustrates this behavior for the INA271A-Q1. 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 part to part. The maximum peak voltage for the INA270A-Q1 is 0.28 V; for the INA271A-Q1, the maximum peak voltage is 0.4 V.

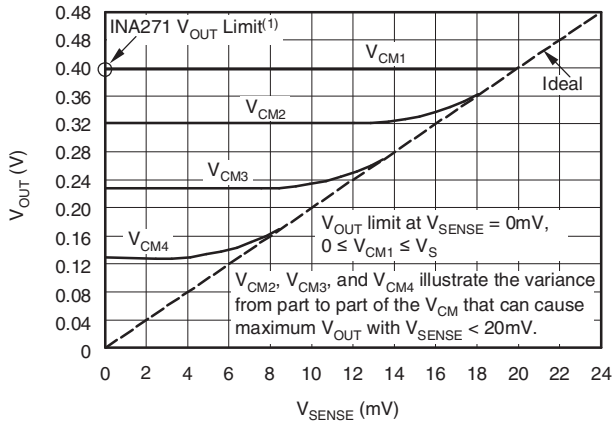


Figure 18. Example for Low V_{SENSE} Case 2 (INA271A-Q1, Gain = 20)

9.1.4 Transient Protection

The –16-V to 80-V common-mode range of the INA27xA-Q1 is ideal for withstanding automotive fault conditions ranging from 12-V battery reversal up to 80-V transients, since no additional protective components are needed up to those levels. In the event that the INA27xA-Q1 devices are exposed to transients on the inputs in excess of their ratings, external transient absorption with semiconductor transient absorbers (zeners or Transzorbs) are necessary.

Application Information (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 INA27xA-Q1 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 INA27xA-Q1 devices are not suited to using external resistors in series with the inputs, since the internal gain resistors can vary up to ±30%, but the internal resistors are tightly matched. If gain accuracy is not important, then resistors can be added in series with the INA27xA-Q1 inputs, with two equal resistors on each input.

9.2 Typical Application

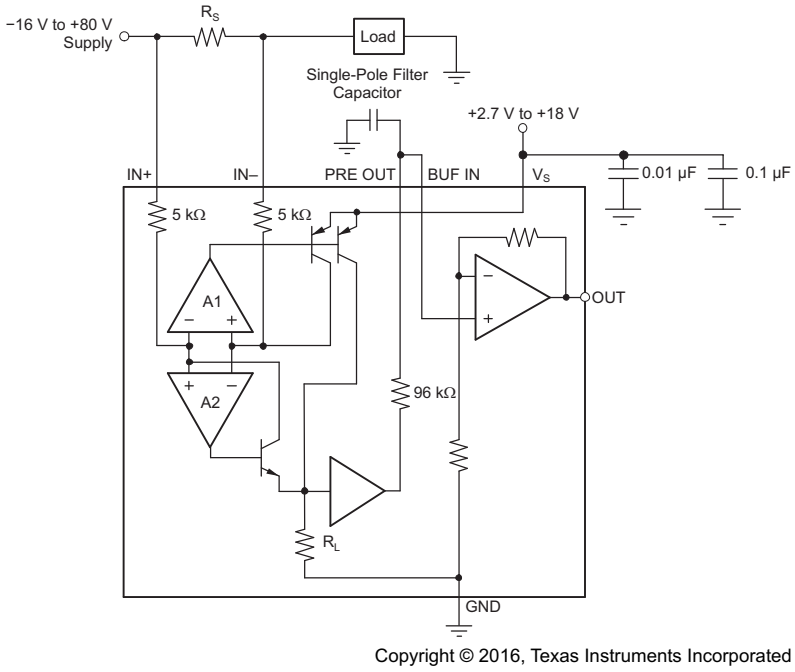


Figure 19. Filtering Configuration

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.

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.

Typical Application (continued)

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.

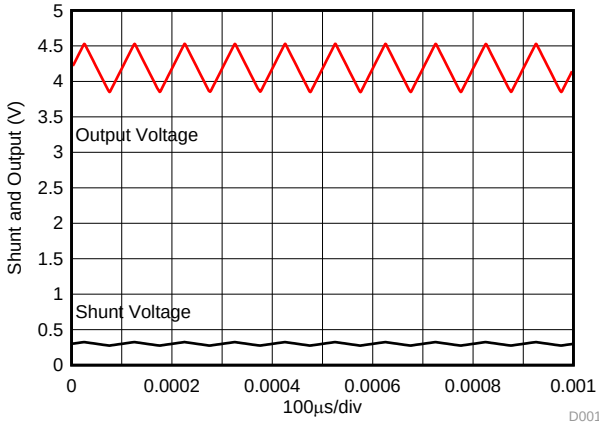


Figure 20. Without Filtering

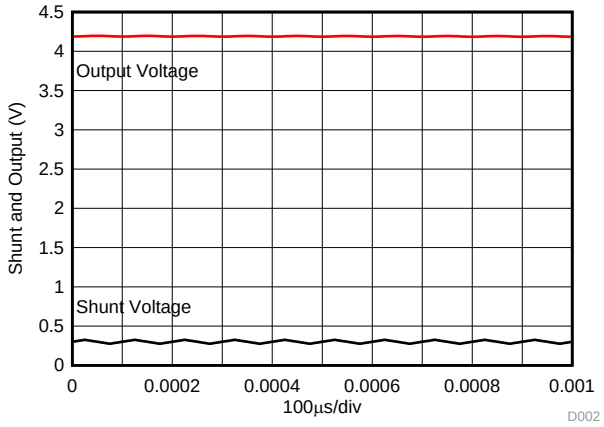


Figure 21. With Filtering

10 Power Supply Recommendations

The input circuitry of the INA27xA-Q1 can accurately measure beyond its power-supply voltage, V_S. For example, the V_S 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 INA27xA-Q1 devices do not provide a shutdown pin; however, because they 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 INA27xA-Q1. Use a totem-pole output buffer or gate that can provide sufficient drive along with 0.1-μF bypass capacitor, preferably ceramic with good high-frequency characteristics. This gate should have a supply voltage of 3 V or greater, because the INA27xA-Q1 requires 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

The IN+ and IN– inputs are able to withstand full common-mode voltage under all powered and under-powered conditions. Figure 22 shows an example of the shutdown circuit.

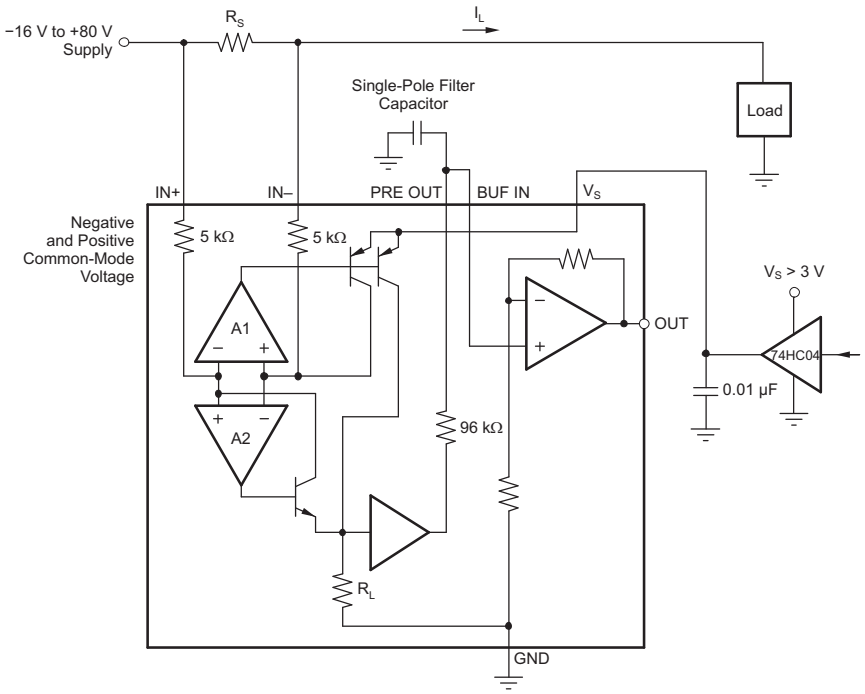


Figure 22. INA27xA-Q1 Example Shutdown Circuit Schematic

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 should 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 INA27xA-Q1 versus the INA193 through INA198 may provide different EMI performance.

11.2 Layout Example

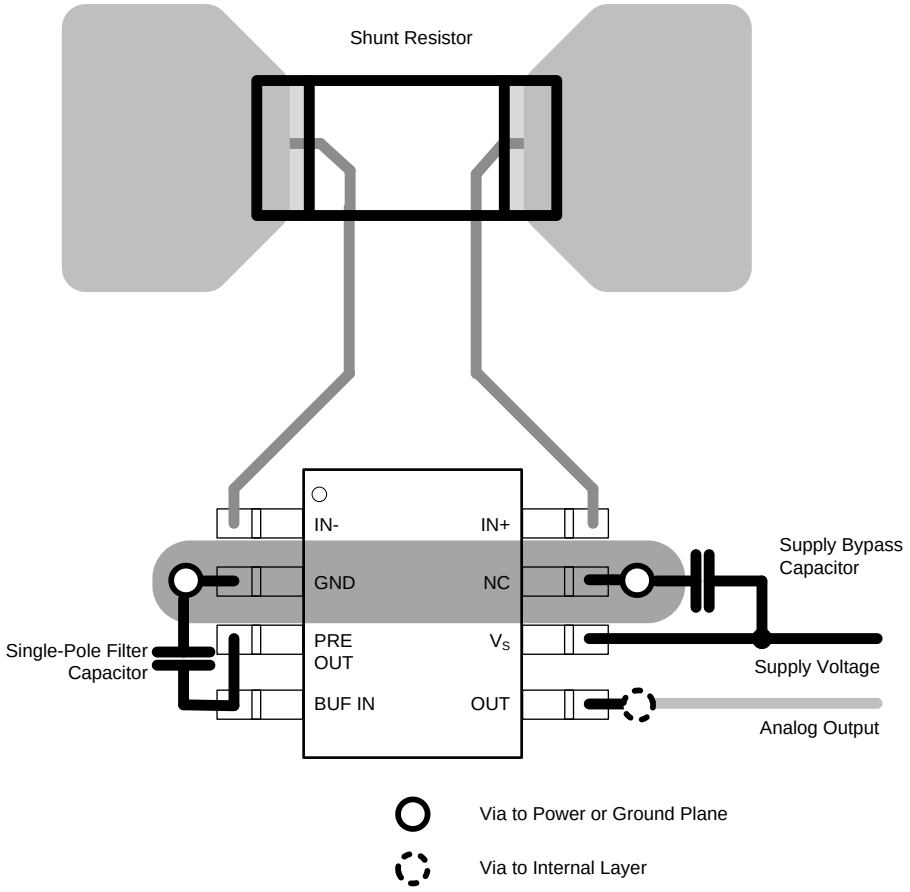


Figure 23. INA27xA-Q1 Example Layout

12 Device and Documentation Support

12.1 Related Links

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

Table 1. Related Links

PARTS	PRODUCT FOLDER	SAMPLE & BUY	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
INA270A-Q1	Click here	Click here	Click here	Click here	Click here
INA271A-Q1	Click here	Click here	Click here	Click here	Click here

12.2 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.

12.3 Trademarks

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

12.4 Electrostatic Discharge Caution

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

12.5 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.

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)
INA270AQDRQ1	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	INA270
INA270AQDRQ1.A	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	INA270
INA271AQDRQ1	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	INA271
INA271AQDRQ1.A	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	INA271

(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.

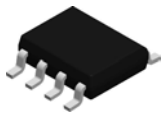
(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(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.

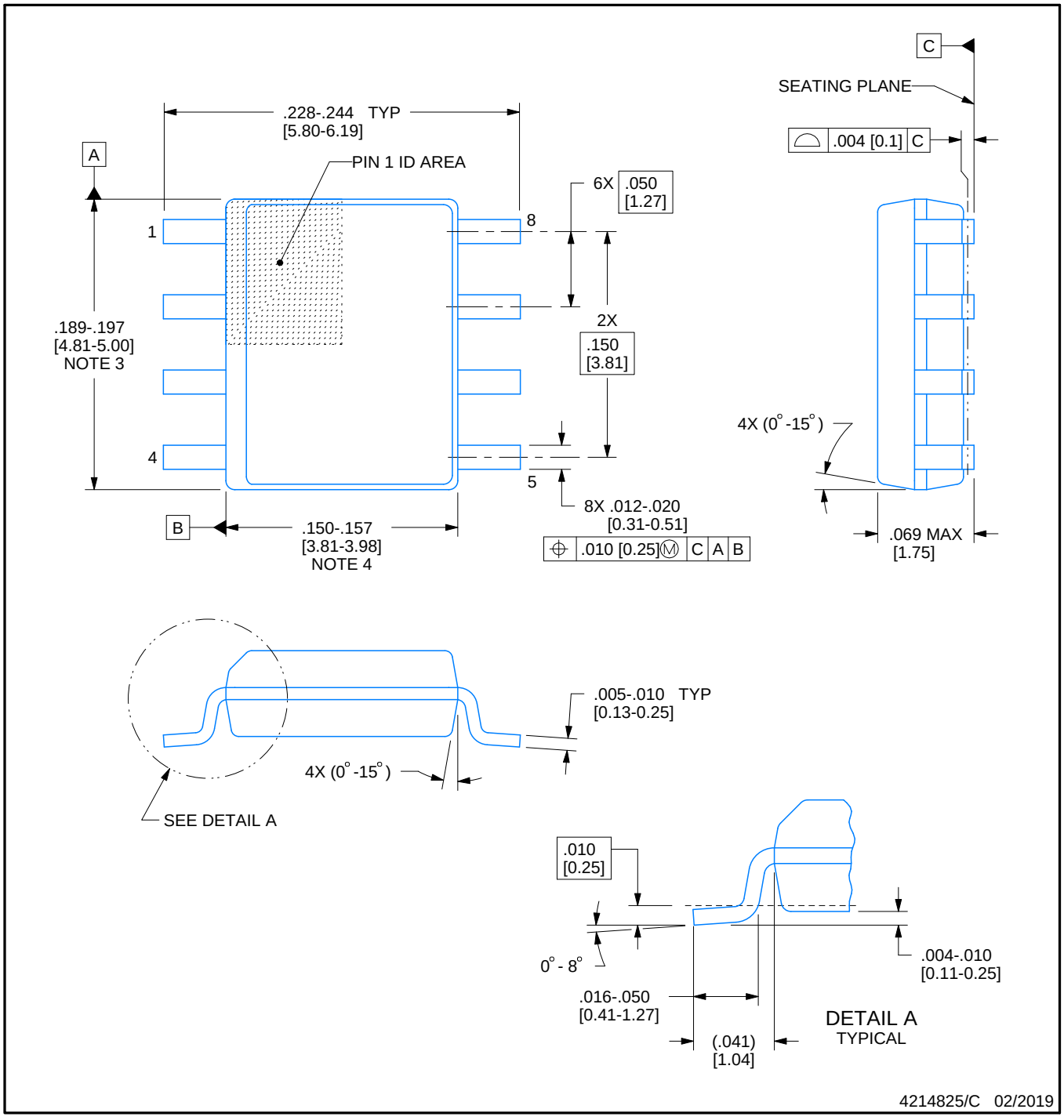


PACKAGE OUTLINE

D0008A

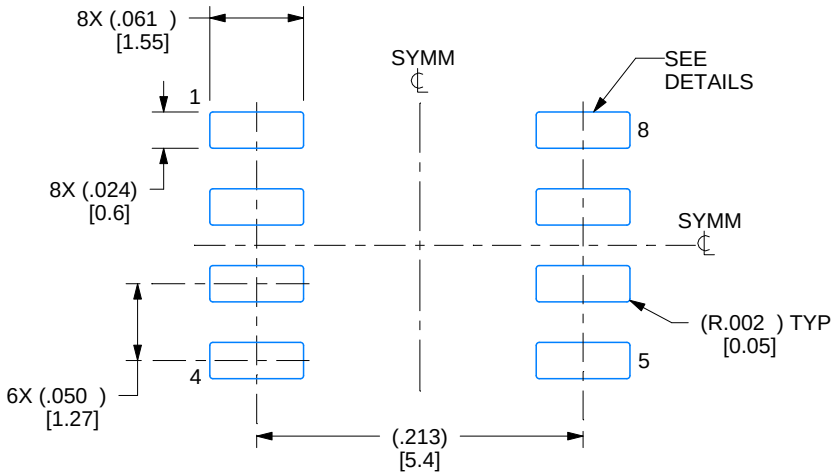
SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT

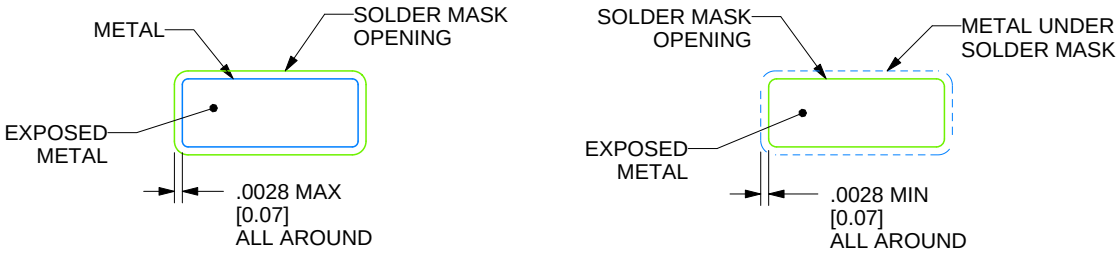


NOTES:

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)

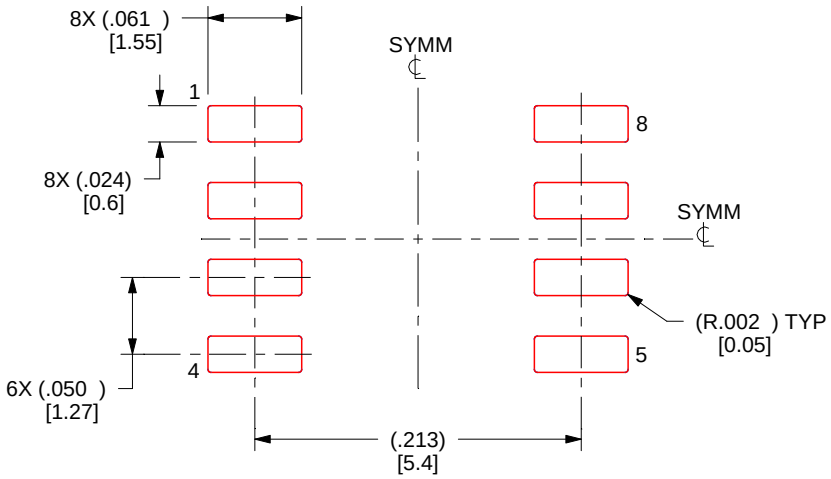
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

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.

Last updated 10/2025