

## INA317 低功耗 (50 $\mu$ A)、零漂移、轨至轨输出仪表放大器

### 1 特性

- 低失调电压: 75 $\mu$ V (最大值),  $G \geq 100$
- 低温漂: 0.3 $\mu$ V/ $^{\circ}$ C,  $G \geq 100$
- 低噪声: 50nV/ $\sqrt{\text{Hz}}$ ,  $G \geq 100$
- 高共模抑制比 (CMRR): 100dB (最小值),  $G \geq 10$
- 低输入偏置电流: 200pA (最大值)
- 电源范围: 1.8V 至 5.5V
- 输入电压: (V-) 0.1V 至 (V+) -0.1V
- 电压范围: (V-) 0.05V 至 (V+) -0.05V
- 低静态电流: 50 $\mu$ A
- 工作温度范围: -40 $^{\circ}$ C 至 +125 $^{\circ}$ C
- 已过滤射频干扰 (RFI) 的输入
- 8 引脚 VSSOP 封装

### 2 应用

- 桥式放大器
- 心电图 (ECG) 放大器
- 压力传感器
- 医疗仪表
- 便携式仪表
- 衡器
- 热电偶放大器
- 电阻式温度检测器 (RTD) 传感器放大器
- 数据采集

### 3 说明

INA317 是一款具备出色精度的低功耗精密仪表放大器。INA317 采用 3 种多功能运算放大器设计, 尺寸小巧, 功耗较低, 适用于各种便携式应用。

单个外部电阻器可根据行业标准增益等式  $G = 1 + (100 \text{ k}\Omega / R_G)$  的定义, 设置 1 至 1000 范围内的任意增益。

该仪表放大器提供低失调电压 (75 $\mu$ V,  $G \geq 100$ )、出色的失调电压漂移

(0.3  $\mu$ V/ $^{\circ}$ C,  $G \geq 100$ ) 和高共模抑制 ( $G \geq 10$  时为 100dB)。INA317 采用低至 1.8V ( $\pm 0.9$ V) 电压和 50 $\mu$ A 静态电流的电源供电, 因而该器件适用于电池供电系统。INA317 器件采用自动校准技术确保广泛工业温度范围内的精度, 可提供可扩展到直流的低噪声密度 (50nV/ $\sqrt{\text{Hz}}$ )。

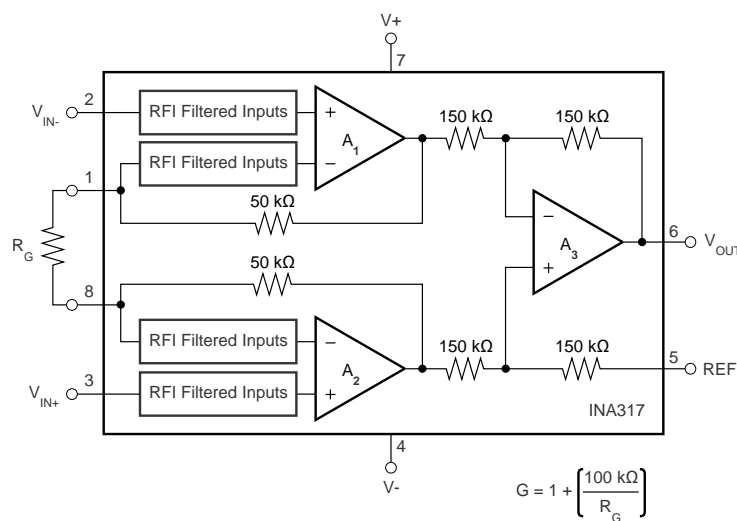
INA317 采用 8 引脚 VSSOP 表面贴装式封装, 额定温度范围为  $T_A = -40^{\circ}\text{C}$  至 +125 $^{\circ}\text{C}$ 。

#### 器件信息<sup>(1)</sup>

器件型号	封装	封装尺寸 (标称值)
INA317	VSSOP (8)	3.00mm x 3.00mm

(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



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## 目录

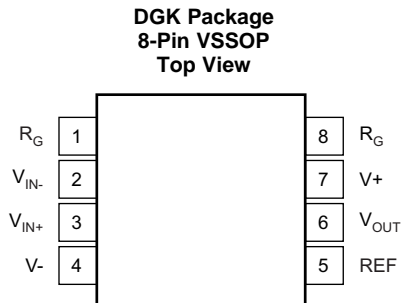
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## 4 修订历史记录

注：之前版本的页码可能与当前版本有所不同。

日期	修订版本	说明
2017 年 11 月	*	初始发行版

## 5 Pin Configuration and Functions



### Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
REF	5	I	Reference input. This pin must be driven by low impedance or connected to ground.
R <sub>G</sub>	1, 8	—	Gain setting pins. For gains greater than 1, place a gain resistor between pins 1 and 8.
V <sub>+</sub>	7	—	Positive supply
V <sub>-</sub>	4	—	Negative supply
V <sub>IN+</sub>	3	I	Positive input
V <sub>IN-</sub>	2	I	Negative input
V <sub>OUT</sub>	6	O	Output

## 6 Specifications

### 6.1 Absolute Maximum Ratings

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

	MIN	MAX	UNIT
Supply voltage	7		V
Analog input voltage <sup>(2)</sup>	(V <sub>-</sub> ) - 0.3	(V <sub>+</sub> ) + 0.3	V
Output short-circuit <sup>(3)</sup>	Continuous		
Operating temperature, T <sub>A</sub>	-40	150	°C
Junction temperature, T <sub>J</sub>		150	°C
Storage temperature, T <sub>stg</sub>	-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.
- (2) Input pins are diode-clamped to the power-supply rails. Input signals that can swing more than 0.3 V beyond the supply rails must be current limited to 10 mA or less.
- (3) Short-circuit to ground.

### 6.2 ESD Ratings

		VALUE	UNIT
V <sub>(ESD)</sub> Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>	±4000	V
	Charged-device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup>	±1000	
	Machine model (MM)	±200	

- (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.

### 6.3 Recommended Operating Conditions

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

		MIN	MAX	UNIT
V <sub>S</sub>	Supply voltage	1.8	5.5	V
	Specified temperature	-40	125	°C

### 6.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>		INA317	UNIT
		DGK (VSSOP)	
		8 PINS	
R <sub>θJA</sub>	Junction-to-ambient thermal resistance	169.5	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance	62.7	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance	90.3	°C/W
ψ <sub>JT</sub>	Junction-to-top characterization parameter	7.6	°C/W
ψ <sub>JB</sub>	Junction-to-board characterization parameter	88.7	°C/W
R <sub>θJC(bot)</sub>	Junction-to-case (bottom) thermal resistance	—	°C/W

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

## 6.5 Electrical Characteristics

for  $V_S = 1.8\text{ V to }5.5\text{ V}$  at  $T_A = 25^\circ\text{C}$ ,  $R_L = 10\text{ k}\Omega$ ,  $V_{REF} = V_S / 2$ , and  $G = 1$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>INPUT<sup>(1)</sup></b>						
$V_{OSI}$	Offset voltage, RTI <sup>(2)</sup>			$\pm 10 \pm 25 / G$	$\pm 75 \pm 75 / G$	$\mu\text{V}$
PSR		vs temperature, $T_A = -40^\circ\text{C to }125^\circ\text{C}$			$\pm 0.3 \pm 0.5 / G$	$\mu\text{V}/^\circ\text{C}$
		vs power supply, $1.8\text{ V} \leq V_S \leq 5.5\text{ V}$		$\pm 1 \pm 5 / G$	$\pm 5 \pm 15 / G$	$\mu\text{V}/\text{V}$
		Long-term stability		See <sup>(3)</sup>		
	Turnon time to specified $V_{OSI}$	$T_A = -40^\circ\text{C to }125^\circ\text{C}$	See <a href="#">Typical Characteristics</a>			
	Impedance					
$Z_{IN}$	Differential			$100 \parallel 3$		$\text{G}\Omega \parallel \text{pF}$
$Z_{IN}$	Common-mode			$100 \parallel 3$		$\text{G}\Omega \parallel \text{pF}$
$V_{CM}$	Common-mode voltage range	$V_O = 0\text{ V}$	$(V-) + 0.1$		$(V+) - 0.1$	V
CMR	Common-mode rejection	DC to 60 Hz				
		$V_{CM} = (V-) + 0.1\text{ V}$ to $(V+) - 0.1\text{ V}$ , $G = 1$	80	90		dB
		$V_{CM} = (V-) + 0.1\text{ V}$ to $(V+) - 0.1\text{ V}$ , $G = 10$	100	110		dB
		$V_{CM} = (V-) + 0.1\text{ V}$ to $(V+) - 0.1\text{ V}$ , $G = 100$ ,	100	115		dB
	$V_{CM} = (V-) + 0.1\text{ V}$ to $(V+) - 0.1\text{ V}$ , $G = 1000$	100	115		dB	
<b>INPUT BIAS CURRENT</b>						
$I_B$	Input bias current			$\pm 70$	$\pm 200$	pA
	vs temperature	$T_A = -40^\circ\text{C to }125^\circ\text{C}$		See <a href="#">Figure 26</a>		$\text{pA}/^\circ\text{C}$
$I_{OS}$	Input offset current			$\pm 50$	$\pm 200$	pA
	vs temperature	$T_A = -40^\circ\text{C to }125^\circ\text{C}$		See <a href="#">Figure 28</a>		$\text{pA}/^\circ\text{C}$
<b>INPUT VOLTAGE NOISE</b>						
$e_{NI}$	Input voltage noise	$G = 100$ , $R_S = 0\ \Omega$ , $f = 10\text{ Hz}$		50		$\text{nV}/\sqrt{\text{Hz}}$
		$G = 100$ , $R_S = 0\ \Omega$ , $f = 100\text{ Hz}$		50		$\text{nV}/\sqrt{\text{Hz}}$
		$G = 100$ , $R_S = 0\ \Omega$ , $f = 1\text{ kHz}$		50		$\text{nV}/\sqrt{\text{Hz}}$
		$G = 100$ , $R_S = 0\ \Omega$ , $f = 0.1\text{ Hz to }10\text{ Hz}$		1		$\mu\text{V}_{PP}$
$i_N$	Input current noise	$f = 10\text{ Hz}$		100		$\text{fA}/\sqrt{\text{Hz}}$
		$f = 0.1\text{ Hz to }10\text{ Hz}$		2		$\text{pA}_{PP}$
<b>GAIN</b>						
G	Gain equation			$1 + (100\text{ k}\Omega / R_G)$		V/V
	Range of gain		1		1000	V/V
Gain error		$V_S = 5.5\text{ V}$ , $(V-) + 100\text{ mV}$ $\leq V_O \leq (V+) - 100\text{ mV}$				
		$G = 1$		$\pm 0.01\%$	$\pm 0.1\%$	
		$G = 10$		$\pm 0.05\%$	$\pm 0.25\%$	
		$G = 100$		$\pm 0.07\%$	$\pm 0.25\%$	
	$G = 1000$		$\pm 0.25\%$	$\pm 0.5\%$		
	Gain vs temperature, $G = 1$	$T_A = -40^\circ\text{C to }125^\circ\text{C}$		$\pm 1$	$\pm 5$	$\text{ppm}/^\circ\text{C}$
	Gain vs temperature, $G > 1$ <sup>(4)</sup>	$T_A = -40^\circ\text{C to }125^\circ\text{C}$		$\pm 15$	$\pm 50$	$\text{ppm}/^\circ\text{C}$
	Gain nonlinearity	$V_S = 5.5\text{ V}$ , $(V-) + 100\text{ mV}$ $\leq V_O \leq (V+) - 100\text{ mV}$				
	Gain nonlinearity, $G = 1$ to 1000	$R_L = 10\text{ k}\Omega$		10		ppm
<b>OUTPUT</b>						
	Output voltage swing from rail	$V_S = 5.5\text{ V}$ $R_L = 10\text{ k}\Omega$		See <a href="#">Figure 29</a>		50 mV
	Capacitive load drive			500		pF

(1) Total  $V_{OS}$ , referred-to-input =  $(V_{OSI}) + (V_{OSO} / G)$ 

(2) RTI = Referred-to-input

(3) 300-hour life test at  $150^\circ\text{C}$  demonstrated randomly distributed variation of approximately  $1\ \mu\text{V}$ 

(4) Does not include effects of external resistor  $R_G$

**Electrical Characteristics (continued)**

 for  $V_S = 1.8\text{ V}$  to  $5.5\text{ V}$  at  $T_A = 25^\circ\text{C}$ ,  $R_L = 10\text{ k}\Omega$ ,  $V_{REF} = V_S / 2$ , and  $G = 1$  (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$I_{SC}$ Short-circuit current	Continuous to common		-40, 5		mA
<b>FREQUENCY RESPONSE</b>					
Bandwidth, -3 dB	$G = 1$		150		kHz
	$G = 10$		35		kHz
	$G = 100$		3.5		kHz
	$G = 1000$		350		Hz
SR Slew rate	$V_S = 5\text{ V}$ , $V_O = 4\text{-V step}$ , $G = 1$		0.16		V/ $\mu\text{s}$
	$V_S = 5\text{ V}$ , $V_O = 4\text{-V step}$ , $G = 100$		0.05		V/ $\mu\text{s}$
$t_S$ Settling time to 0.01%	$V_{STEP} = 4\text{ V}$ , $G = 1$		50		$\mu\text{s}$
	$V_{STEP} = 4\text{ V}$ , $G = 100$		400		$\mu\text{s}$
$t_S$ Settling time to 0.001%	$V_{STEP} = 4\text{ V}$ , $G = 1$		60		$\mu\text{s}$
	$V_{STEP} = 4\text{ V}$ , $G = 100$		500		$\mu\text{s}$
Overload recovery	50% overdrive		75		$\mu\text{s}$
<b>REFERENCE INPUT</b>					
$R_{IN}$			300		k $\Omega$
Voltage range		V-		V+	V
<b>POWER SUPPLY</b>					
Voltage range	Single voltage range	1.8		5.5	V
	Dual voltage range	$\pm 0.9$		$\pm 2.75$	V
$I_Q$ Quiescent current vs temperature	$V_{IN} = V_S / 2$		50	75	$\mu\text{A}$
	$T_A = -40^\circ\text{C}$ to $125^\circ\text{C}$			80	$\mu\text{A}$
<b>TEMPERATURE RANGE</b>					
Specified temperature range		-40		125	$^\circ\text{C}$
Operating temperature range		-40		150	$^\circ\text{C}$

### 6.6 Typical Characteristics

at  $T_A = 25^\circ\text{C}$ ,  $V_S = 5\text{ V}$ ,  $R_L = 10\text{ k}\Omega$ ,  $V_{REF} = \text{midsupply}$ , and  $G = 1$ , (unless otherwise noted)

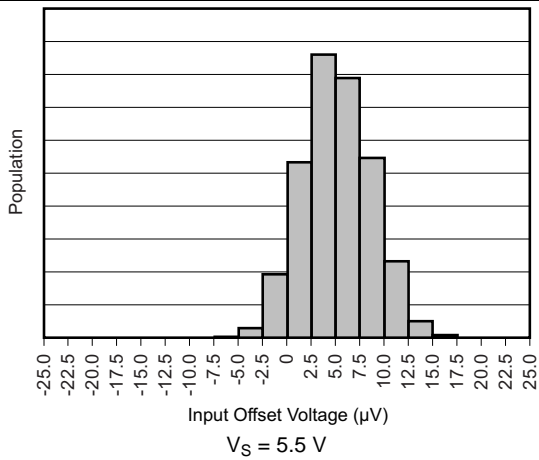


图 1. Input Offset Voltage

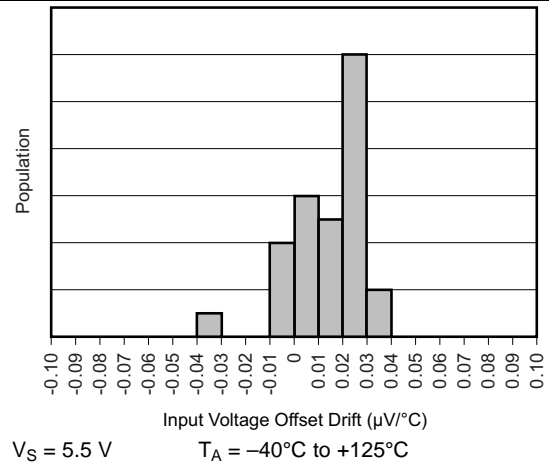


图 2. Input Voltage Offset Drift

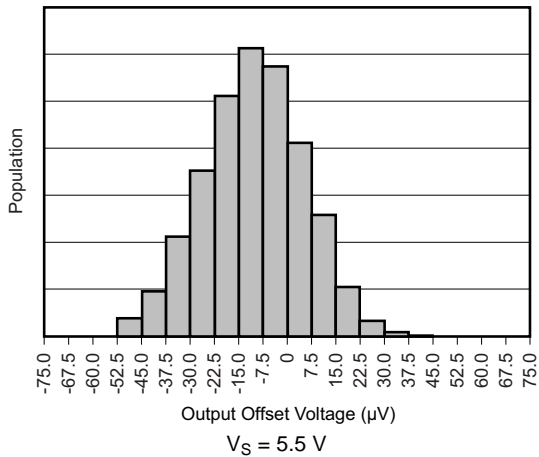


图 3. Output Offset Voltage

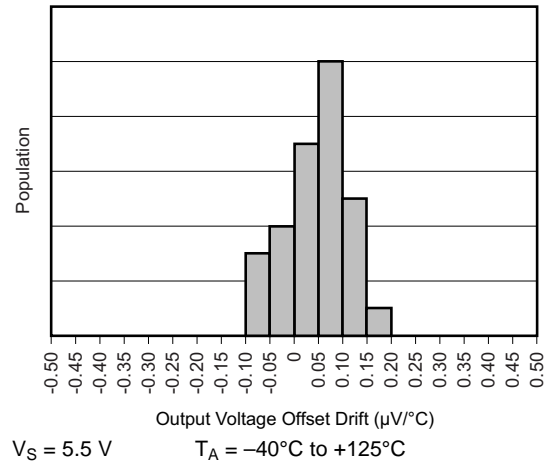


图 4. Output Voltage Offset Drift

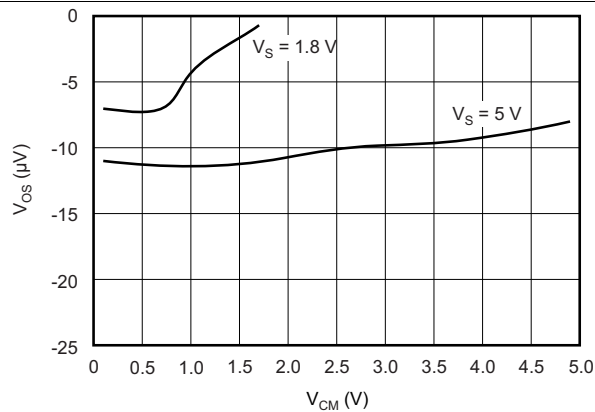


图 5. Offset Voltage vs Common-Mode Voltage

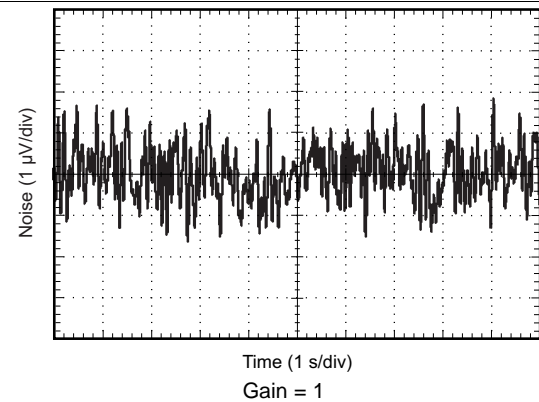
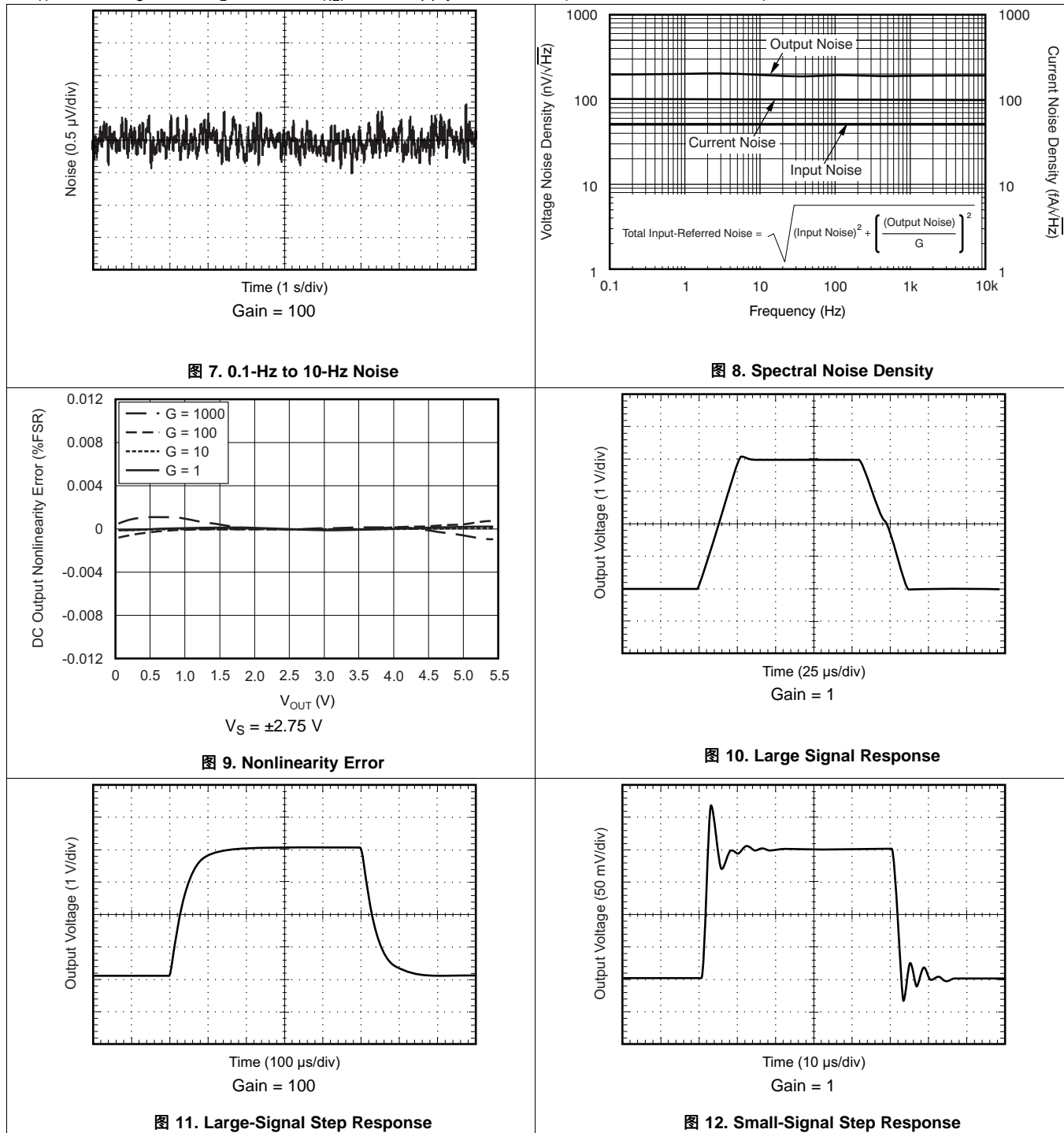


图 6. 0.1-Hz to 10-Hz Noise

Typical Characteristics (接下页)

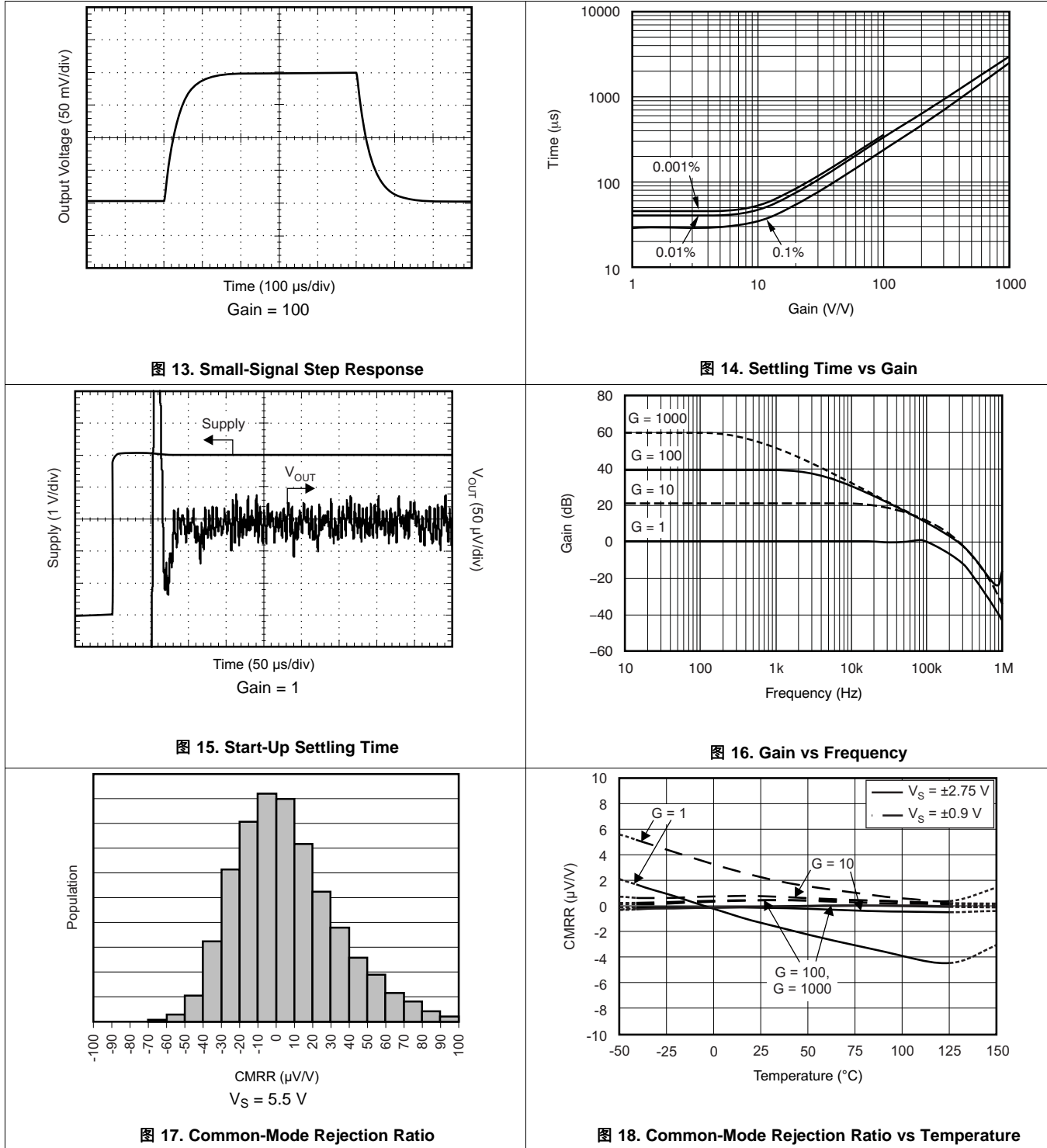
at  $T_A = 25^\circ\text{C}$ ,  $V_S = 5\text{ V}$ ,  $R_L = 10\text{ k}\Omega$ ,  $V_{REF} = \text{midsupply}$ , and  $G = 1$ , (unless otherwise noted)





Typical Characteristics (接下页)

at  $T_A = 25^\circ\text{C}$ ,  $V_S = 5\text{ V}$ ,  $R_L = 10\text{ k}\Omega$ ,  $V_{REF} = \text{mid supply}$ , and  $G = 1$ , (unless otherwise noted)



Typical Characteristics (接下页)

at  $T_A = 25^\circ\text{C}$ ,  $V_S = 5\text{ V}$ ,  $R_L = 10\text{ k}\Omega$ ,  $V_{REF} = \text{midsupply}$ , and  $G = 1$ , (unless otherwise noted)

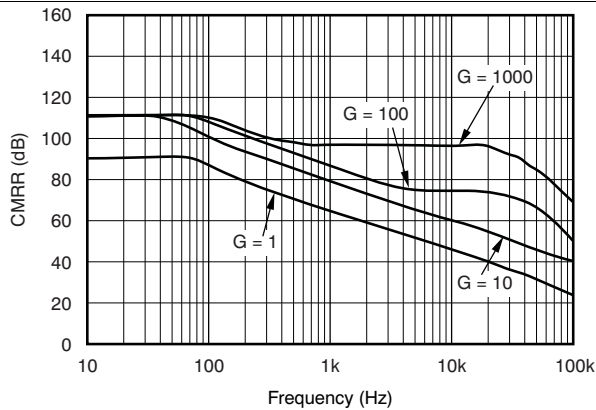


图 19. Common-Mode Rejection Ratio vs Frequency

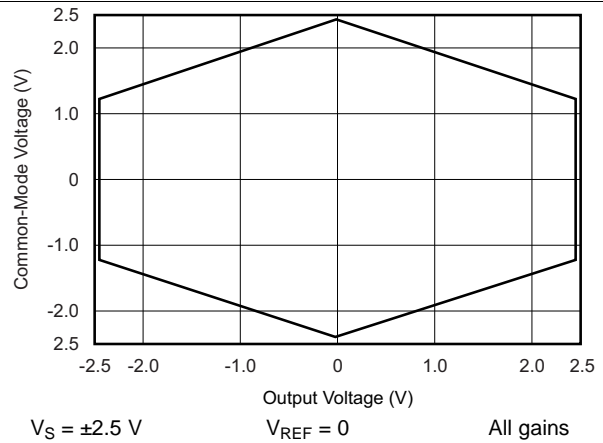


图 20. Typical Common-Mode Range vs Output Voltage

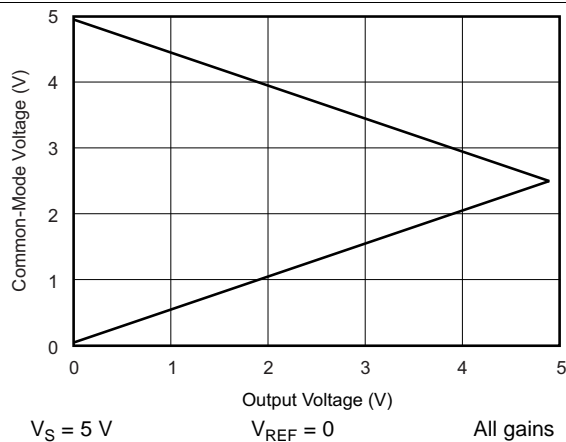


图 21. Typical Common-Mode Range vs Output Voltage

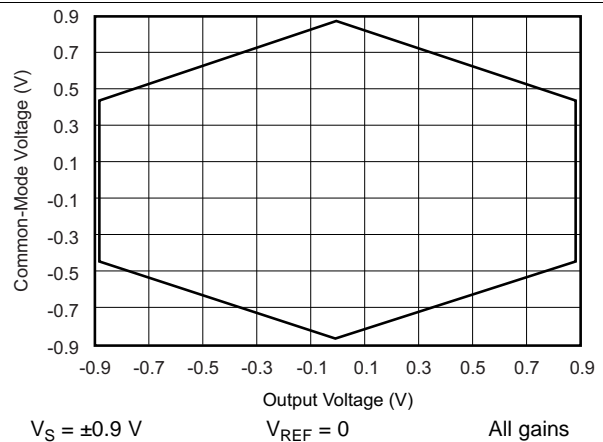


图 22. Typical Common-Mode Range vs Output Voltage

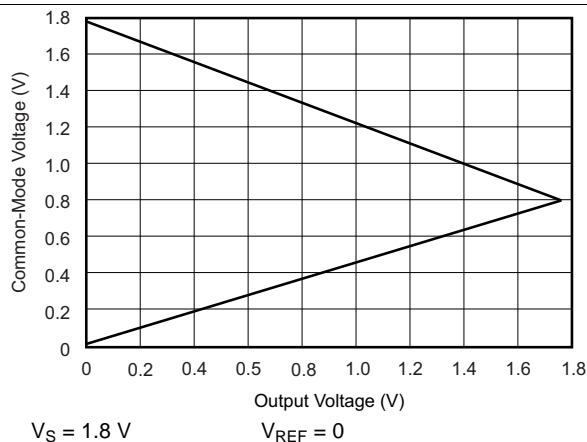


图 23. Typical Common-Mode Range vs Output Voltage

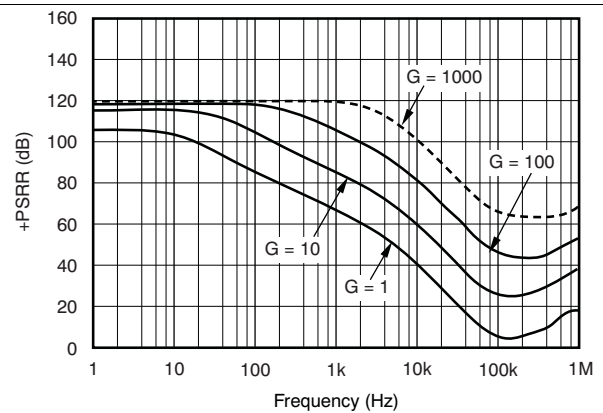


图 24. Positive Power-Supply Rejection Ratio

Typical Characteristics (接下页)

at  $T_A = 25^\circ\text{C}$ ,  $V_S = 5\text{ V}$ ,  $R_L = 10\text{ k}\Omega$ ,  $V_{REF} = \text{mid supply}$ , and  $G = 1$ , (unless otherwise noted)

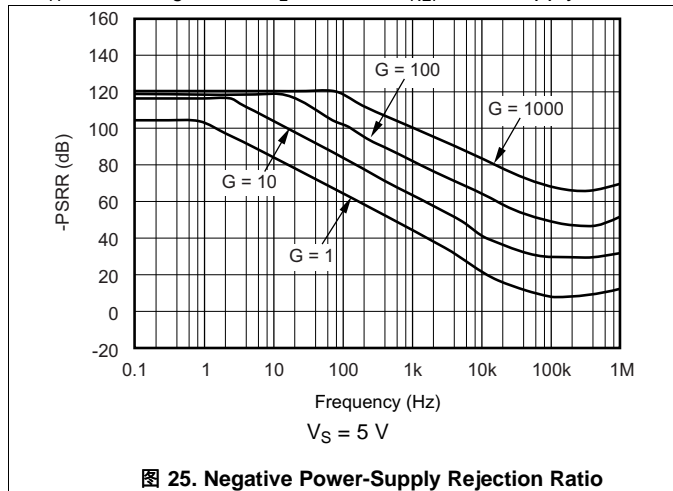


图 25. Negative Power-Supply Rejection Ratio

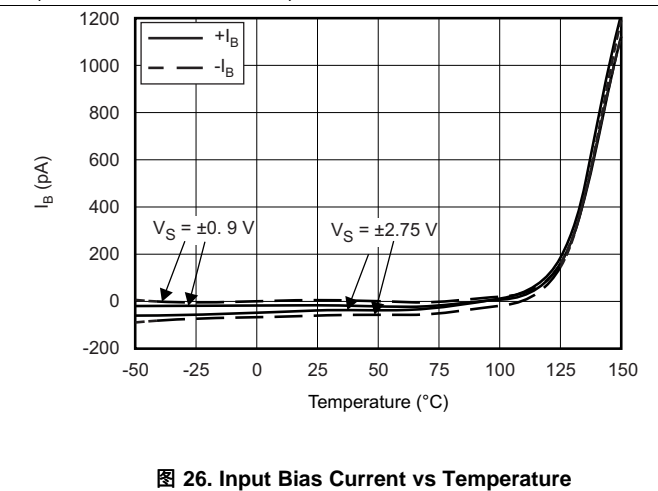


图 26. Input Bias Current vs Temperature

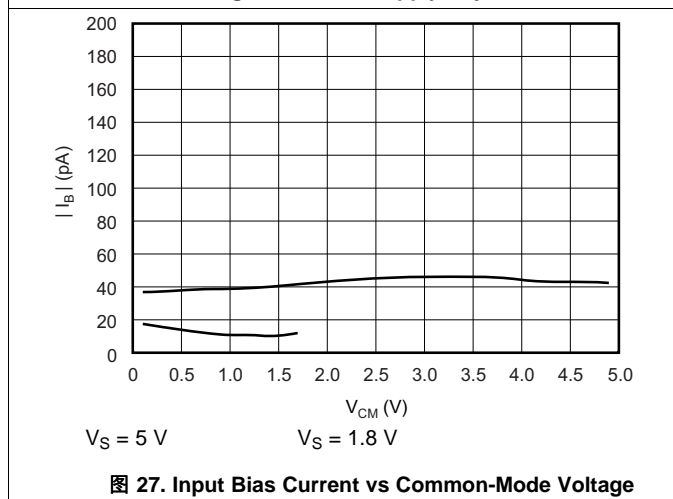


图 27. Input Bias Current vs Common-Mode Voltage

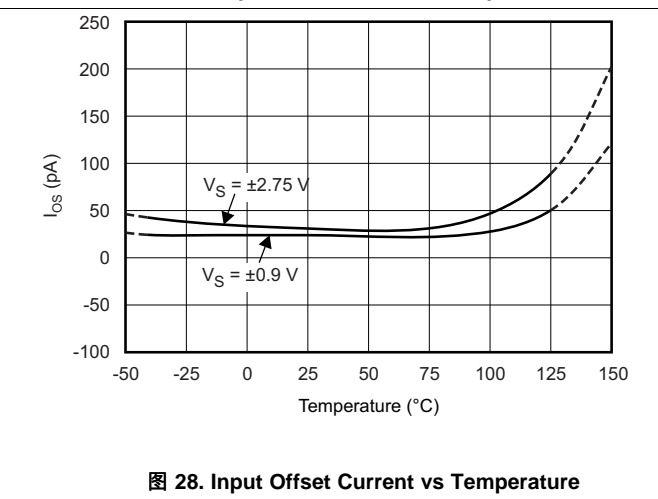


图 28. Input Offset Current vs Temperature

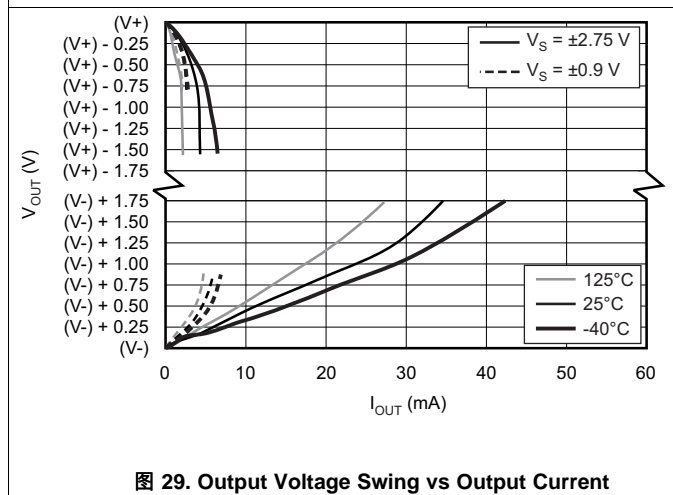


图 29. Output Voltage Swing vs Output Current

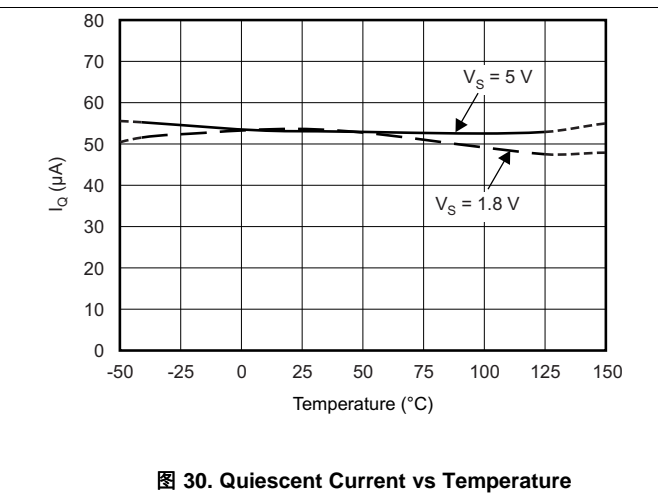
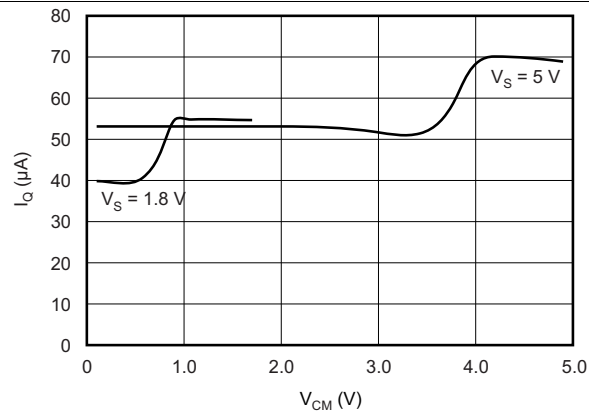


图 30. Quiescent Current vs Temperature

**Typical Characteristics (接下页)**

at  $T_A = 25^\circ\text{C}$ ,  $V_S = 5\text{ V}$ ,  $R_L = 10\text{ k}\Omega$ ,  $V_{\text{REF}} = \text{midsupply}$ , and  $G = 1$ , (unless otherwise noted)



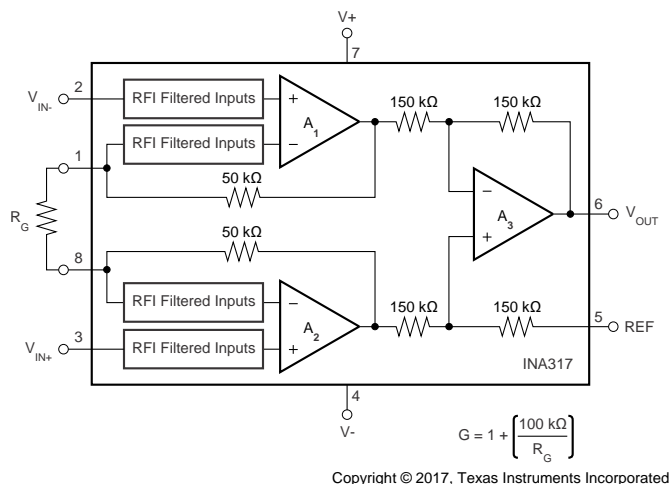
**图 31. Quiescent Current vs Common-Mode Voltage**

## 7 Detailed Description

### 7.1 Overview

The INA317 is a monolithic instrumentation amplifier (INA) based on the precision zero-drift OPA333 (operational amplifier) core. The INA317 integrates laser-trimmed resistors to ensure excellent common-mode rejection and low gain error. The combination of the zero-drift amplifier core and the precision resistors allows this device to achieve outstanding DC precision and is designed for 3.3-V and 5-V industrial applications.

### 7.2 Functional Block Diagram



### 7.3 Feature Description

The INA317 is a low-power, zero-drift instrumentation amplifier that offers accuracy. The versatile three-operational-amplifier design and small size makes the amplifier designed for a wide range of applications. Zero-drift chopper circuitry provides DC specifications. A single external resistor sets any gain from 1 to 10,000. The INA317 is laser trimmed for high common-mode rejection (100 dB at  $G \geq 100$ ). Typically, the INA317 operates with power supplies as low as 1.8 V and quiescent current of 50  $\mu$ A.

### 7.4 Device Functional Modes

#### 7.4.1 Internal Offset Correction

INA317 internal operational amplifiers use an autocalibration technique with a time-continuous 350-kHz operational amplifier in the signal path. The amplifier is zero-corrected every 8  $\mu$ s using a proprietary technique. Upon power up, the amplifier requires approximately 100  $\mu$ s to achieve specified VOS accuracy. This design has no aliasing or flicker noise.

#### 7.4.2 Input Common-Mode Range

The linear input voltage range of the input circuitry of the INA317 is from approximately 0.1 V below the positive supply voltage to 0.1 V above the negative supply. However, as a differential input voltage causes the output voltage to increase, the output voltage swing of amplifiers A1 and A2 limits the linear input range. As a result, the linear common-mode input range is related to the output voltage of the complete amplifier. This behavior depends on supply voltage; see [Figure 20](#).

Input overload conditions can produce an output voltage that appears normal. For example, if an input overload condition drives the input amplifiers to the respective positive output swing limit, the difference voltage measured by the output amplifier is approximately zero. The output of the INA317 is approximately 0 V even though the inputs are overloaded.

## 8 Application and Implementation

注

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.

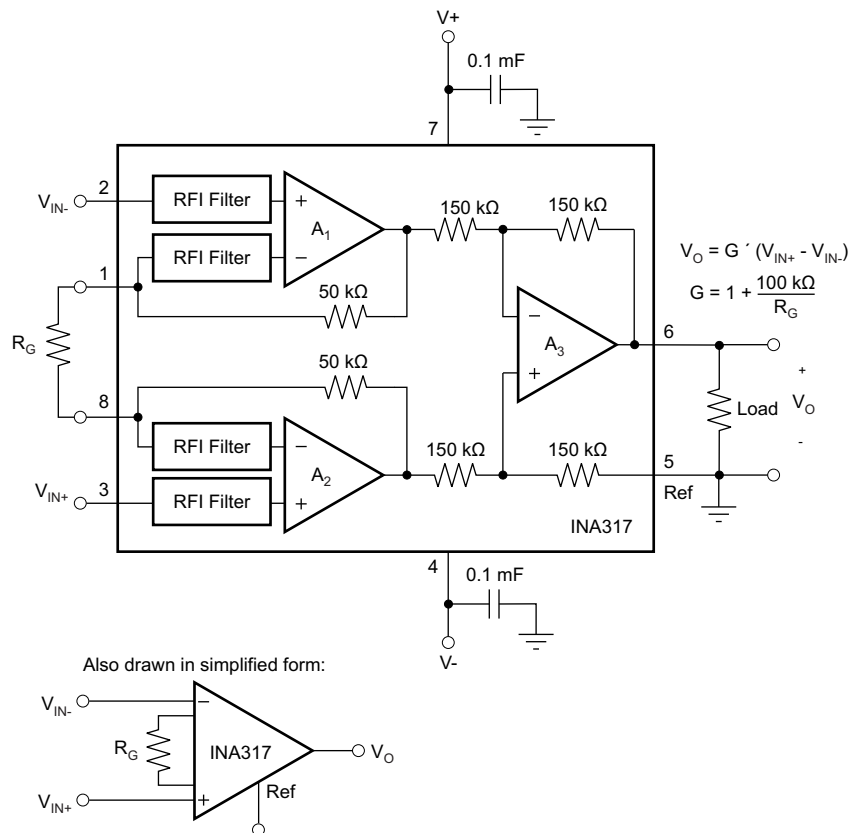
### 8.1 Application Information

The INA317 measures small differential voltage with high common-mode voltage that develops between the noninverting and inverting input. The high input impedance makes the INA317 designed for a wide range of applications. The ability to set the reference pin to adjust the functionality of the output signal offers additional flexibility that is practical for multiple configurations.

### 8.2 Typical Application

图 32 shows the basic connections required for operation of the INA317 device. Good layout practice mandates the use of bypass capacitors placed close to the device pins as shown.

The output of the INA317 device is referred to the output reference (REF) pin, which is normally grounded. This connection must be low-impedance to ensure good common-mode rejection. Although 15 Ω or less of stray resistance is tolerated while maintaining specified CMRR, small stray resistances of tens of ohms in series with the REF pin causes noticeable degradation in CMRR.



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图 32. Basic Connections

## Typical Application (接下页)

### 8.2.1 Design Requirements

The device is configured to monitor the input differential voltage when the gain of the external resistor  $R_G$  sets the input signal. The output signal references to the REF pin. The most common application is where the output is referenced to ground when no input signal is present by connecting the REF pin to ground. When the input signal increases, the output voltage at the OUT pin increases.

### 8.2.2 Detailed Design Procedure

#### 8.2.2.1 Setting the Gain

A single external resistor ( $R_G$ ) that is connected between pins 1 and 8 sets the gain of the INA317. The value of  $R_G$  is selected according to [公式 1](#):

$$G = 1 + (100 \text{ k}\Omega / R_G) \quad (1)$$

[表 1](#) lists several commonly-used gains and resistor values. The 100 k $\Omega$  in [公式 1](#) is a result of the sum of the two internal feedback resistors ( $A_1$  and  $A_2$ .) These on-chip resistors are laser trimmed to accurate absolute values. The accuracy and temperature coefficient of these resistors are included in the gain accuracy and drift specifications of the INA317 device.

The stability and temperature drift of the external gain setting resistor ( $R_G$ ) also affects gain. The contribution of  $R_G$  to gain accuracy and drift is inferred from the gain in [公式 1](#). Low resistor values required for high gain make wiring resistance important. Sockets add to the wiring resistance and contribute additional gain error (possibly an unstable gain error) in gains of approximately 100 or greater. To ensure stability, avoid parasitic capacitance of more than a few picofarads at the  $R_G$  connections. Careful matching of any parasitics on  $R_G$  pins maintains optimal CMRR over frequency.

**表 1. Commonly-Used Gains and Resistor Values**

DESIRED GAIN	$R_G$ ( $\Omega$ )	NEAREST 1% $R_G$ ( $\Omega$ )
1	NC <sup>(1)</sup>	NC
2	100 k	100 k
5	25 k	24.9 k
10	11.1 k	11 k
20	5.26 k	5.23 k
50	2.04 k	2.05
100	1.01 k	1 k
200	502.5	499
500	200.4	200
1000	100.1	100

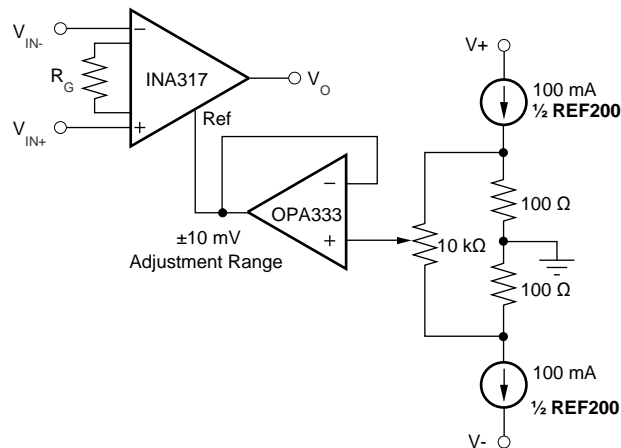
(1) NC denotes no connection. When using the SPICE model, the simulation does not converge unless a resistor is connected to the  $R_G$  pins; use a large resistor value.

#### 8.2.2.2 Internal Offset Correction

The INA317 device internal operational amplifiers use an autocalibration technique with a time-continuous 350-kHz operational amplifier in the signal path. The amplifier is zero-corrected every 8  $\mu$ s using a proprietary technique. At power-up, the amplifier requires approximately 100  $\mu$ s to achieve specified  $V_{OS}$  accuracy. This design has no aliasing or flicker noise.

#### 8.2.2.3 Offset Trimming

Most applications require no external offset adjustment. However, apply a voltage to the REF pin to make adjustments if necessary. [图 33](#) shows an optional circuit for trimming the output offset voltage. The voltage applied to REF pin is added at the output. The operational amplifier buffer provides low impedance at the REF pin to preserve good common-mode rejection.



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**图 33. Optional Trimming of Output Offset Voltage**

### 8.2.2.4 Noise Performance

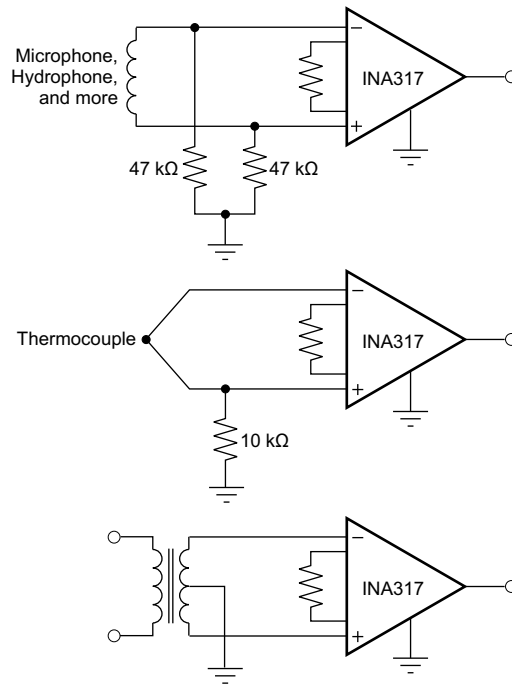
The autocalibration technique used by the INA317 device results in reduced low-frequency noise, typically only  $50 \text{ nV}/\sqrt{\text{Hz}}$  ( $G = 100$ ). The spectral noise density is shown in [图 8](#). Low-frequency noise of the INA317 device is approximately  $1 \mu\text{V}_{\text{PP}}$  measured from 0.1 Hz to 10 Hz ( $G = 100$ ).

### 8.2.2.5 Input Bias Current Return Path

The input impedance of the INA317 device is extremely high (approximately  $100 \text{ G}\Omega$ .) However, a path must be provided for the input bias current of the inputs. This input bias current is typically  $\pm 70 \text{ pA}$ . High-input impedance means that this input bias current changes very little with varying input voltage.

For proper operation, input circuitry must provide a path for the input bias current. [图 34](#) shows various provisions for an input bias current path. Without a bias current path, the inputs float to a potential that exceeds the common-mode range of the INA317 device, and the input amplifiers saturate. If the differential source resistance is low, the bias current return path connects to one input (see the thermocouple example in [图 34](#)). With higher source impedance, using two equal resistors provides a balanced input with possible advantages of lower input offset voltage as a result of bias current and better high-frequency common-mode rejection.





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**图 34. Providing an Input Common-Mode Current Path**

### 8.2.2.6 Input Common-Mode Range

The linear input voltage range of the input circuitry of the INA317 device is from approximately 0.1 V below the positive supply voltage to 0.1 V above the negative supply. As a differential input voltage causes the output voltage to increase, however, the linear input range is limited by the output voltage swing of amplifiers A<sub>1</sub> and A<sub>2</sub>. The linear common-mode input range is related to the output voltage of the complete amplifier. This behavior depends on supply voltage (see 图 20 to 图 23 in the *Typical Characteristics* section.)

Input overload conditions can produce an output voltage that appears normal. For example, if an input overload condition drives both input amplifiers to the respective positive output swing limit, the difference voltage measured by the output amplifier is near zero. The output of the INA317 is near 0 V even though both inputs are overloaded.

### 8.2.2.7 Operating Voltage

The INA317 operates over a power-supply range of 1.8 V to 5.5 V (±0.9 V to ±2.75 V). Supply voltages higher than 7 V (absolute maximum) can permanently damage the device. Parameters that vary over supply voltage or temperature are shown in the *Typical Characteristics* section of this data sheet.

### 8.2.2.8 Low Voltage Operation

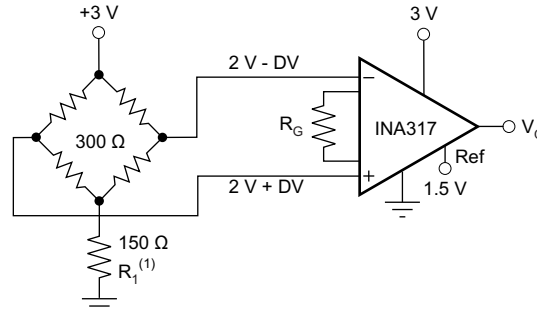
The INA317 device operates on power supplies as low as ±0.9 V. Most parameters vary only slightly throughout this supply voltage range; see the *Typical Characteristics* section. Operation at very low supply voltage requires careful attention to ensure that the input voltages remain within the linear range. Voltage swing requirements of internal nodes limit the input common-mode range with low power supply voltage. 图 20 to 图 23 show the range of linear operation for various supply voltages and gains.

### 8.2.2.9 Single-Supply Operation

The INA317 device can be used on single power supplies of 1.8 V to 5.5 V. 图 35 shows a basic single-supply circuit. The output REF pin is connected to midsupply. Zero differential input voltage demands an output voltage of midsupply. Actual output voltage swing is limited to approximately 50 mV more than ground when the load is referred to ground as shown. 图 29 shows how the output voltage swing varies with output current.

With single-supply operation,  $V_{IN+}$  and  $V_{IN-}$  must be 0.1 V more than ground for linear operation. For instance, the inverting input cannot connect to ground to measure a voltage that is connected to the noninverting input.

To show the issues affecting low voltage operation, see 图 35. 图 35 shows the INA317 device operating from a single 3-V supply. A resistor in series with the low side of the bridge ensures that the bridge output voltage is within the common-mode range of the amplifier inputs.



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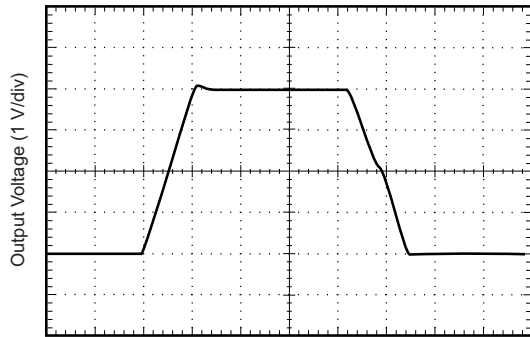
- (1)  $R_1$  creates proper common-mode voltage only for low-voltage operation; see [Single-Supply Operation](#).

**图 35. Single-Supply Bridge Amplifier**

### 8.2.2.10 Input Protection

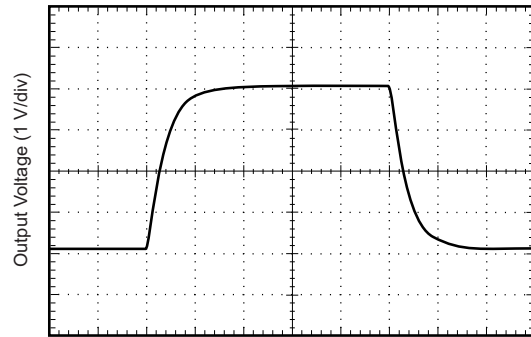
The input pins of the INA317 device are protected with internal diodes that are connected to the power-supply rails. These diodes clamp the applied signal to prevent the signal from damaging the input circuitry. If the input signal voltage exceeds the power supplies by more than 0.3 V, the input signal current must be limited to less than 10 mA to protect the internal clamp diodes. Limit the current with a series input resistor. Some signal sources are inherently current limited and do not require limiting resistors.

### 8.2.3 Application Curves



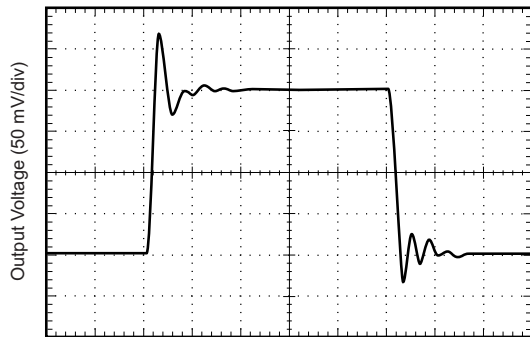
Time (25  $\mu$ s/div)  
Gain = 1

**图 36. Large Signal Response**



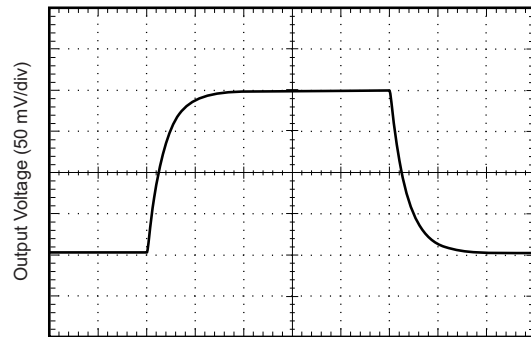
Time (100  $\mu$ s/div)  
Gain = 100

**图 37. Large-Signal Step Response**



Time (10  $\mu$ s/div)  
Gain = 1

**图 38. Small-Signal Step Response**



Time (100  $\mu$ s/div)  
Gain = 100

**图 39. Small-Signal Step Response**

## 9 Power Supply Recommendations

The minimum power supply voltage for INA317 is 1.8 V and the maximum power supply voltage is 5.5 V. For optimum performance, 3.3 V to 5 V is recommended. TI recommends adding a bypass capacitor at the input to compensate for the layout and power supply source impedance.

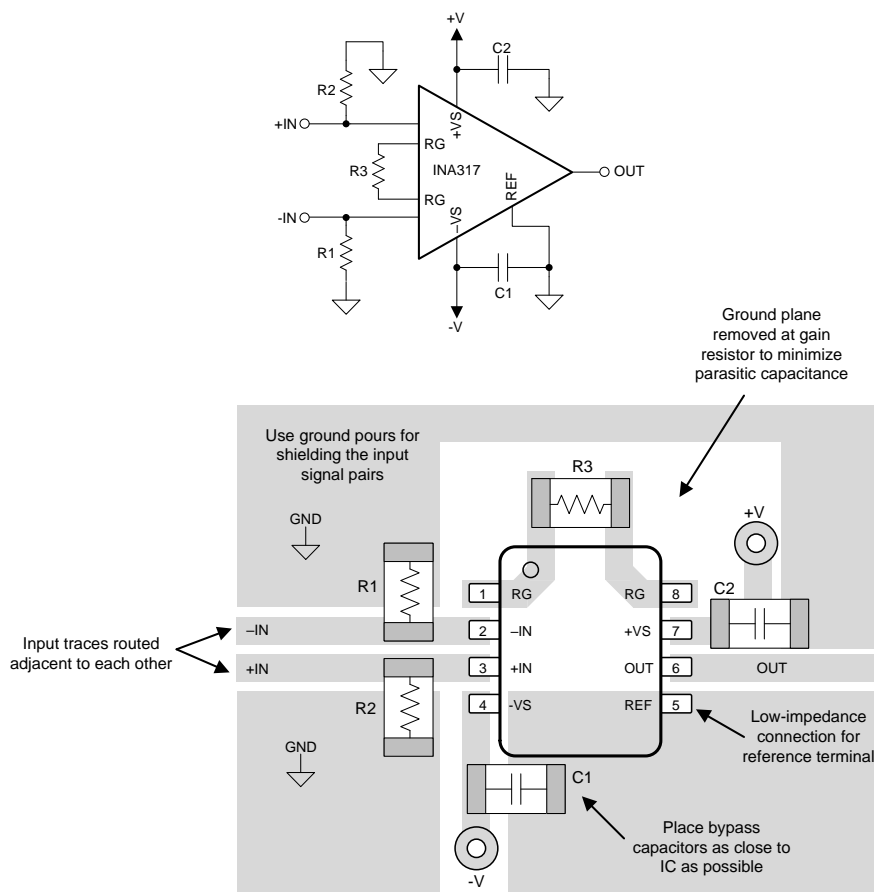
## 10 Layout

### 10.1 Layout Guidelines

TI recommends paying attention to good layout practices. Keep traces short and use a printed-circuit-board (PCB) ground plane with surface-mount components placed as close to the device pins as possible. Place a 0.1- $\mu$ F bypass capacitor as close as possible to the supply pins. Apply these guidelines throughout the analog circuit to improve performance and reduce electromagnetic interference (EMI) susceptibility.

Instrumentation amplifiers vary in the susceptibility to radio-frequency interference (RFI). RFI is identified as a variation in offset voltage or DC signal levels with changes in the interfering RF signal. The INA317 device is designed to minimize susceptibility to RFI by incorporating passive RC filters with an 8-MHz corner frequency at the  $V_{IN+}$  and  $V_{IN-}$  inputs. As a result, the INA317 device demonstrates low sensitivity compared to previous generation devices. However, strong RF fields can cause varied offset levels and may require additional shielding.

## 10.2 Layout Example



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图 40. INA317 Layout

## 11 器件和文档支持

### 11.1 器件支持

#### 11.1.1 开发支持

##### 11.1.1.1 TINA-TI (免费下载软件)

针对 INA317 使用基于 SPICE 的 TINA-TI 模拟仿真程序

TINA 是一款简单、功能强大且易于使用的电路仿真程序，此程序基于 SPICE 引擎。TINA-TI 是 TINA 软件的一款免费全功能版本，除了一系列无源和有源模型外，此版本软件还预先载入了一个宏模型库。它提供所有传统的 SPICE 直流 (DC)、瞬态和频域分析以及其他设计功能。

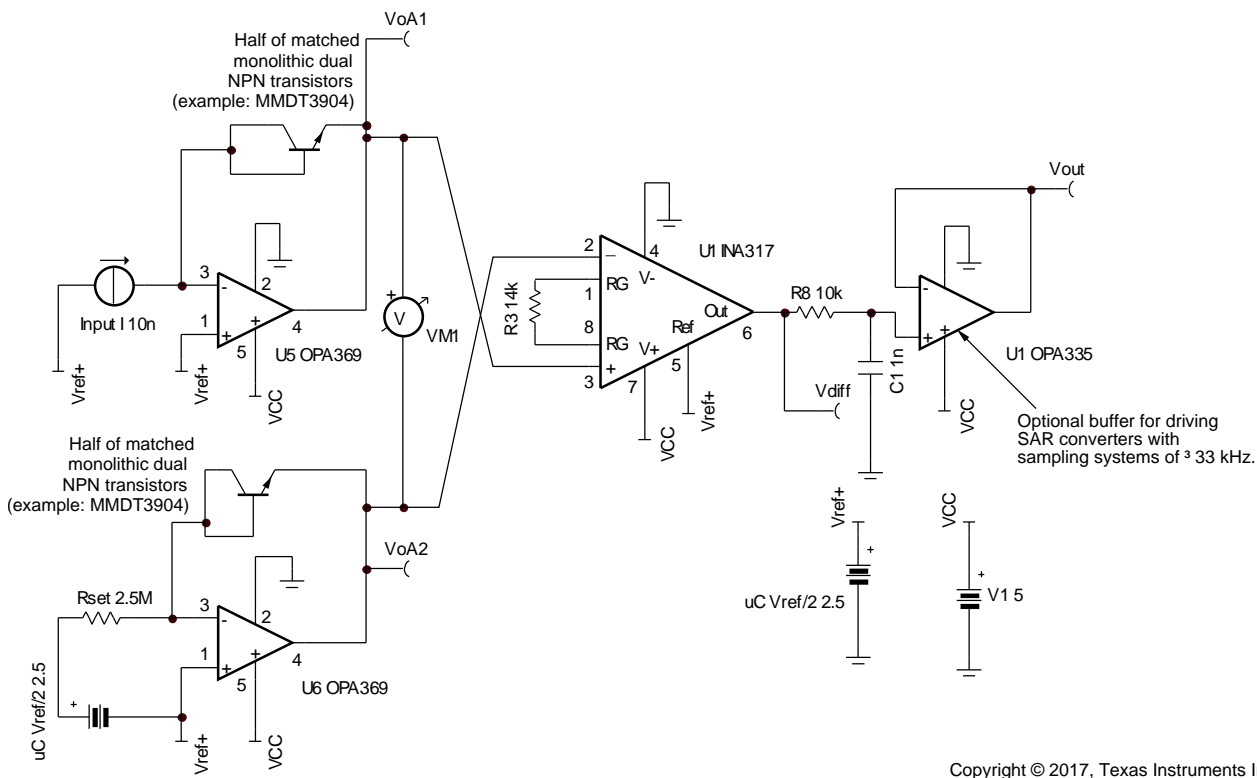
TINA-TI 可从 [Analog eLab Design Center \(模拟电子实验室设计中心\)](#) 免费下载，它提供全面的后续处理能力，使得用户能够以多种方式形成结果。

虚拟仪器为用户提供选择输入波形和探测电路节点、电压和波形的功能，从而创建一个动态的快速入门工具。

图 41 和图 42 给出了适用于 INA317 器件的 TINA-TI 电路示例，可用于开发、修改和评估特定应用的电路设计。。下面给出了这些仿真文件的下载链接。

**注**

必须安装 TINA 软件（从 DesignSoft）或者 TINA-TI 软件后才能使用这些文件。请从 TINA-TI 文件夹中下载免费的 TINA-TI 软件。



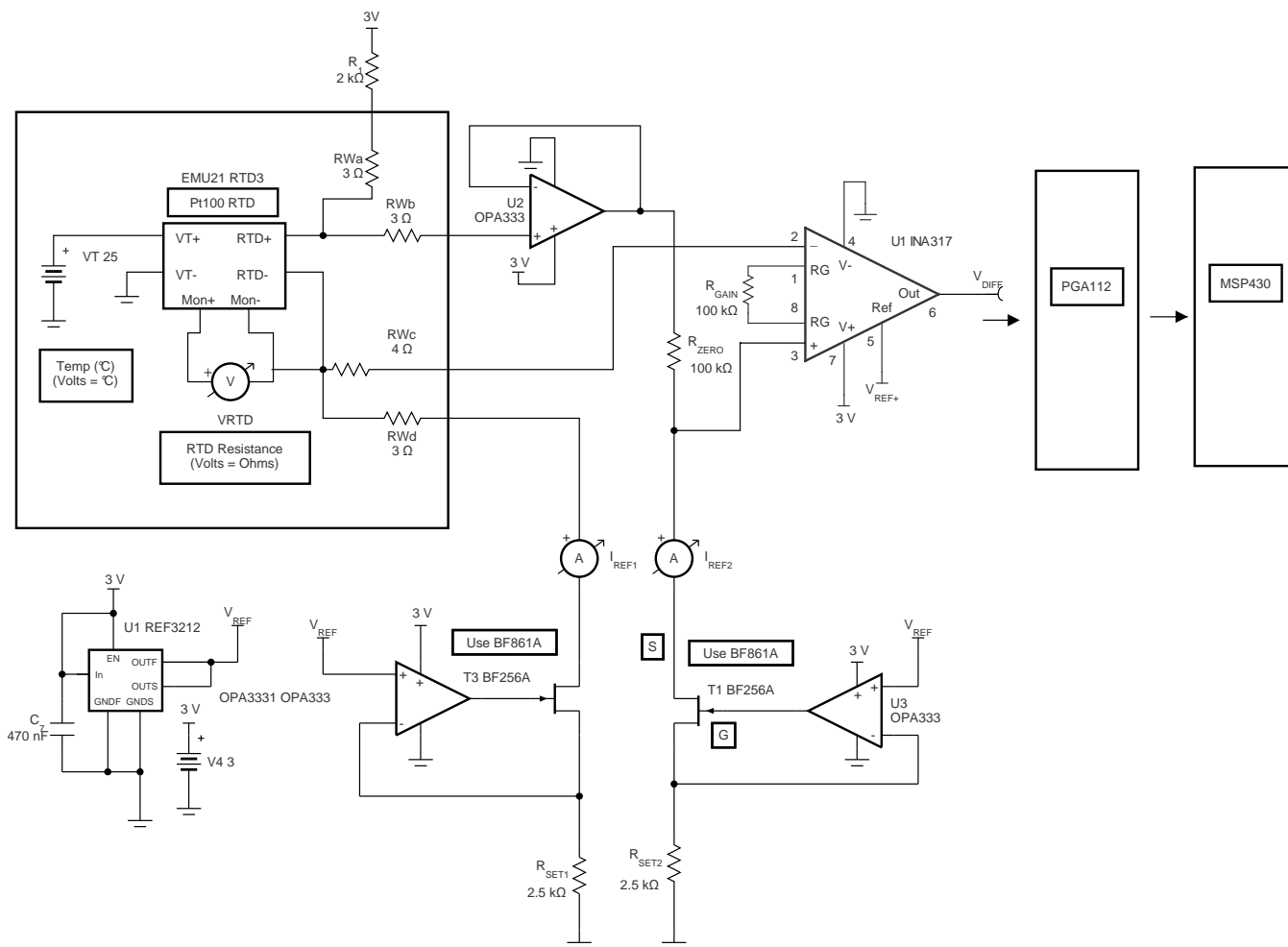
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- (1) 如下链接会打开 TI 对数放大器网页：对数放大器产品主页
- (2) 未显示对数晶体管的温度补偿。
- (3) 对于单片对数放大器（例如 LOG112 或 LOG114），请参阅注 1 中的链接。

**图 41. 便携式电池供电类系统的低功耗对数函数电路  
(例如血糖仪)**

要下载包含此电路 TINA-TI 仿真文件的压缩文件，请点击如下链接：[对数电路](#)。

器件支持 (接下页)



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RWa、RWb、RWc 和 RWd 用于仿真线电阻。包含这些电阻以展示 4 线感应技术对线路失配的抗扰性。这种方法假定使用 4 线 RTD。

图 42. 带有可编程增益采集系统的适用于 PT100 RTD 的 4 线、3V 调节器

要下载包含此电路 TINA-TI 仿真文件的压缩文件，请点击如下链接：[PT100 RTD](#)。

## 11.2 文档支持

### 11.2.1 相关文档

请参阅如下相关文档：

- [精密、低噪声、轨至轨输出，36V，零漂移运算放大器](#)
- [50μV VOS、0.25μV/°C、35μA CMOS 运算放大器零漂移系列](#)
- [4ppm/°C、100μA、SOT23-6 系列电压基准](#)
- [《电路板布局布线技巧》](#)

### 11.3 商标

All trademarks are the property of their respective owners.

## 11.4 静电放电警告



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

## 11.5 Glossary

[SLYZ022](#) — *TI Glossary*.

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



## 12 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。如欲获取此产品说明书的浏览器版本，请参阅左侧的导航。

**PACKAGING INFORMATION**

Orderable part number	Status (1)	Material type (2)	Package   Pins	Package qty   Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
<a href="#">INA317IDGKR</a>	Active	Production	VSSOP (DGK)   8	2500   LARGE T&R	Yes	NIPDAU   SN   NIPDAUAG	Level-2-260C-1 YEAR	-40 to 125	I317
INA317IDGKR.A	Active	Production	VSSOP (DGK)   8	2500   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	I317
<a href="#">INA317IDGKT</a>	Active	Production	VSSOP (DGK)   8	250   SMALL T&R	Yes	NIPDAU   SN   NIPDAUAG	Level-2-260C-1 YEAR	-40 to 125	I317
INA317IDGKT.A	Active	Production	VSSOP (DGK)   8	250   SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	I317

(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.

**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
INA317IDGKR	VSSOP	DGK	8	2500	330.0	12.4	5.25	3.35	1.25	8.0	12.0	Q1
INA317IDGKR	VSSOP	DGK	8	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
INA317IDGKR	VSSOP	DGK	8	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
INA317IDGKT	VSSOP	DGK	8	250	330.0	12.4	5.25	3.35	1.25	8.0	12.0	Q1
INA317IDGKT	VSSOP	DGK	8	250	330.0	12.4	5.3	3.4	1.4	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)
INA317IDGKR	VSSOP	DGK	8	2500	366.0	364.0	50.0
INA317IDGKR	VSSOP	DGK	8	2500	353.0	353.0	32.0
INA317IDGKR	VSSOP	DGK	8	2500	366.0	364.0	50.0
INA317IDGKT	VSSOP	DGK	8	250	366.0	364.0	50.0
INA317IDGKT	VSSOP	DGK	8	250	353.0	353.0	32.0

# DGK0008A



# PACKAGE OUTLINE

VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



4214862/A 04/2023

**NOTES:**

PowerPAD is a trademark of Texas Instruments.

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-187.

# EXAMPLE BOARD LAYOUT

DGK0008A

™ VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 15X



SOLDER MASK DETAILS

4214862/A 04/2023

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.
8. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.
9. Size of metal pad may vary due to creepage requirement.

# EXAMPLE STENCIL DESIGN

DGK0008A

™ VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
SCALE: 15X

4214862/A 04/2023

NOTES: (continued)

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

## 重要通知和免责声明

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