

## INA1x8 高侧测量分流监测计

### 1 特性

- 完整的单极高侧电流测量电路
- 宽电源和共模范围
- INA138: 2.7V 至 36V
- INA168: 2.7V 至 60V
- 独立电源和输入共模电压
- 单电阻增益设定
- 低静态电流: 25 $\mu$ A (典型值)
- 宽温度范围: -40 $^{\circ}$ C 至 +125 $^{\circ}$ C
- 5 引脚小外形尺寸晶体管 (SOT)-23 封装

### 2 应用

- 分流测量:
  - 汽车、电话、计算机
- 便携式和备用电池系统
- 电池充电器
- 电源管理
- 手机
- 精密电流源

### 3 说明

INA138 和 INA168 均为高侧单极分流监测计。此类器件兼具宽输入共模电压范围和低静态电流，并且采用小型 SOT-23 封装，广泛适用于各类应用。

输入共模和电源电压相互独立，INA138 的电压范围为 2.7V 至 36V，INA168 的电压范围为 2.7V 至 60V。静态电流仅为 25 $\mu$ A，允许电源连接到电流测量分流器的任一侧，同时误差非常小。

该器件可将一个差分输入电压转换为电流输出。此电流使用外部负载电阻转换回电压，该电阻可设置的增益范围为 1 至 100 以上。尽管该电路专为分流测量而设计，但同时也非常适用于创造性应用中的测量和电平转换。

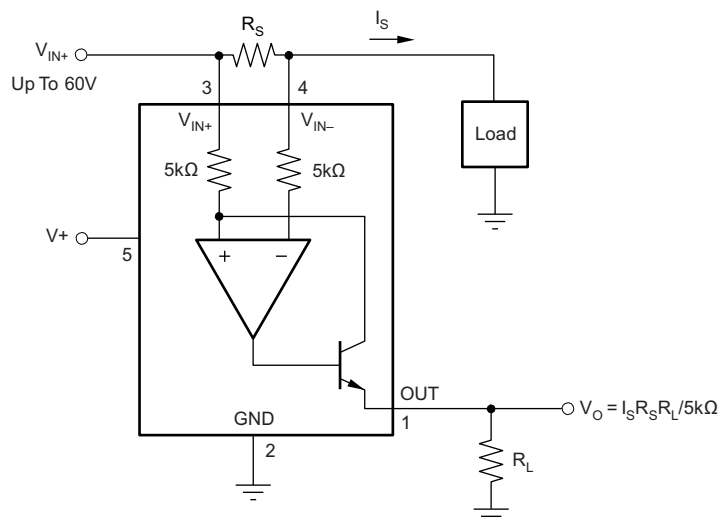
INA138 和 INA168 均采用 SOT23-5 封装，额定温度范围为 -40 $^{\circ}$ C 至 125 $^{\circ}$ C。

#### 器件信息(1)

器件型号	封装	封装尺寸 (标称值)
INA138	SOT-23 (5)	18.00mm x 18.00mm
INA168	SOT-23 (5)	18.00mm x 18.00mm

(1) 如需了解所有可用封装，请见数据表末尾的可订购产品附录。

#### 典型应用电路



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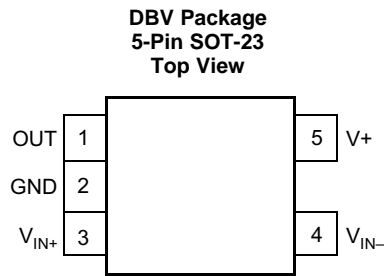
## 4 修订历史记录

### Changes from Revision C (November 2005) to Revision D

**Page**

- 已添加 ESD 额定值表，特性描述部分，器件功能模式，应用和实施部分，电源相关建议部分，布局部分，器件和文档支持部分以及机械、封装和可订购信息部分。 ..... **1**

## 5 Pin Configuration and Functions



### Pin Functions

PIN		I/O	DESCRIPTION
NO.	NAME		
1	OUT	O	Output current
2	GND	—	Ground
3	VIN+	I	Positive input voltage
4	V+	I	Power supply voltage
5	VIN-	I	Negative input voltage

## 6 Specifications

### 6.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT	
V+	Supply voltage	INA138	-0.3	60	V
		INA168	-0.3	75	V
V <sub>IN+</sub> , V <sub>IN-</sub>	Analog inputs, INA138	Common mode <sup>(2)</sup>	-0.3	60	V
		Differential (V <sub>IN+</sub> ) – (V <sub>IN-</sub> )	-40	2	V
	Analog inputs, INA168	Common mode <sup>(2)</sup>	-0.3	75	V
		Differential (V <sub>IN+</sub> ) – (V <sub>IN-</sub> )	-40	2	V
Analog output, Out <sup>(2)</sup>		-0.3	40	V	
Input current into any pin			10	mA	
Operating temperature		-55	150	°C	
Junction temperature			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) The input voltage at any pin may exceed the voltage shown if the current at that pin is limited to 10mA.

### 6.2 ESD Ratings

		VALUE	UNIT
V <sub>(ESD)</sub>	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins <sup>(1)</sup>	±1000
		Charged device model (CDM), per JEDEC specification JESD22-C101, all pins <sup>(2)</sup>	±500
			V

- (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	NOM	MAX	UNIT
<b>INA138</b>					
V+		2.7	5	36	V
Common Mode Voltage		2.7	12	36	V
<b>INA168</b>					
V+		2.7	5	60	V
Common Mode Voltage		2.7	12	60	V

### 6.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>		INA1x8	UNIT
		DBV	
		5 PINS	
R <sub>θJA</sub>	Junction-to-ambient thermal resistance	209.6	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance	196.8	
R <sub>θJB</sub>	Junction-to-board thermal resistance	107.5	
ψ <sub>JT</sub>	Junction-to-top characterization parameter	36.2	
ψ <sub>JB</sub>	Junction-to-board characterization parameter	104.5	

- (1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, [SPRA953](http://www.ti.com/lit/an/spra953).

## 6.5 Electrical Characteristics

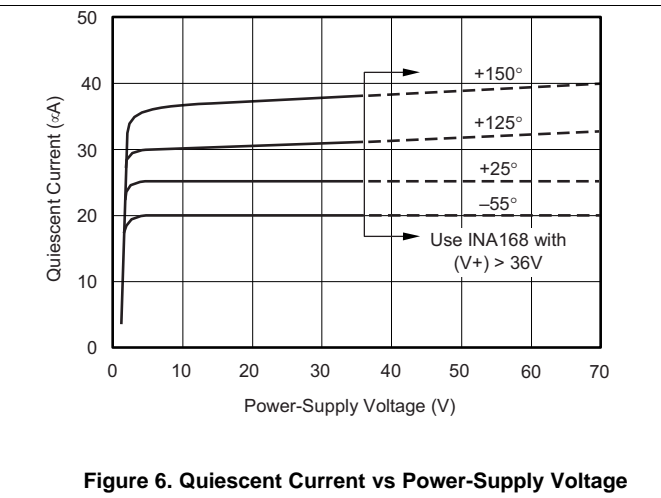
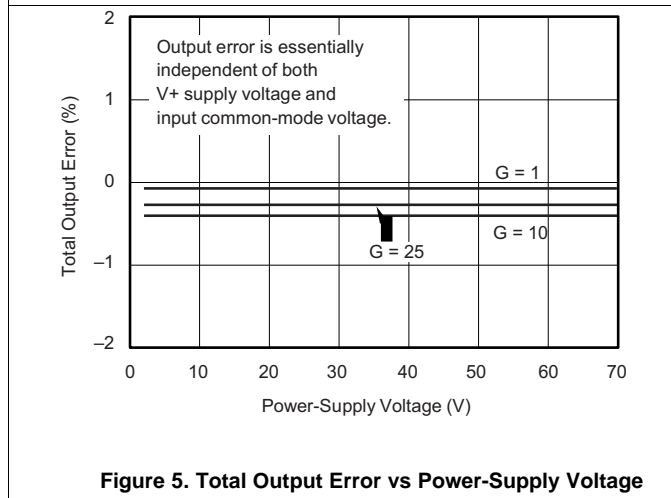
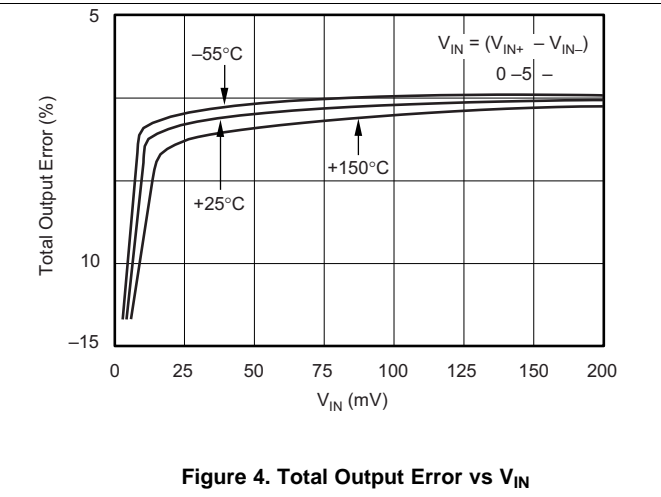
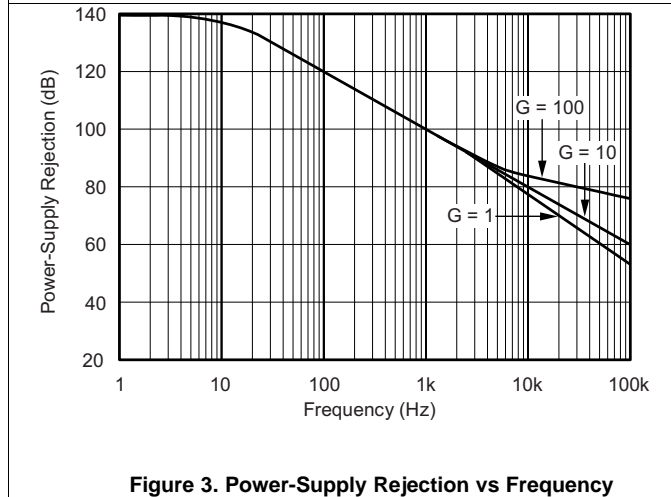
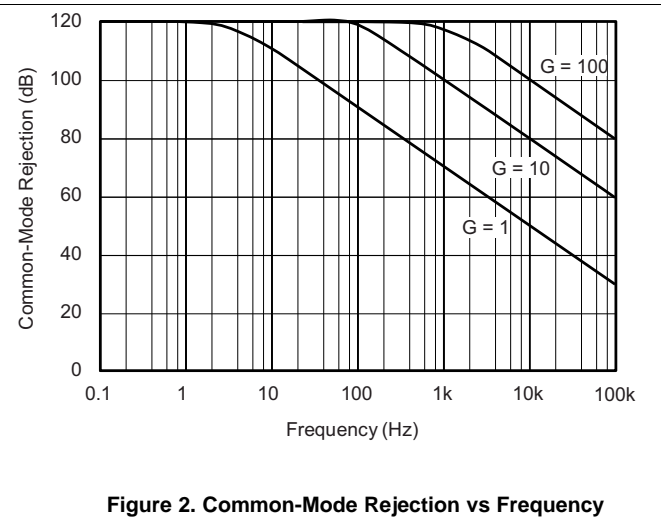
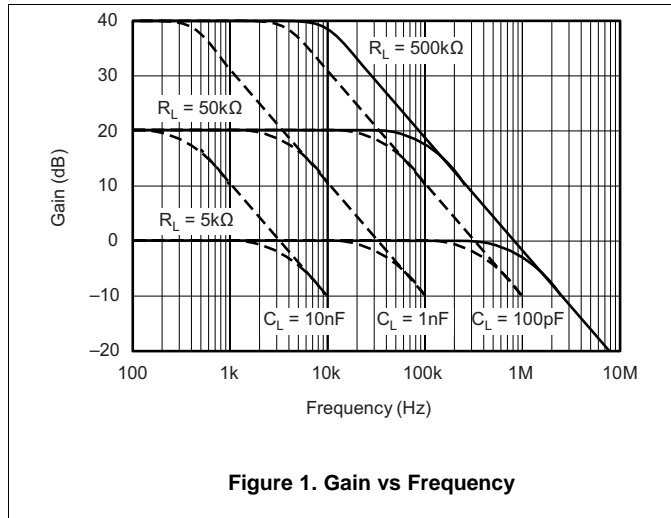
All other characteristics at  $T_A = +25^\circ\text{C}$ ,  $V_S = 5\text{V}$ ,  $V_{IN+} = 12\text{V}$ , and  $R_{OUT} = 125\text{k}\Omega$ , unless otherwise noted.

PARAMETER	TEST CONDITIONS	INA138			INA168			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
<b>INPUT</b>								
Full-Scale Sense Voltage	$V_{SENSE} = V_{IN+} - V_{IN-}$		100	500		100	500	mV
Common-Mode Input Range		2.7		36	2.7		60	V
Common-Mode Rejection	$V_{IN+} = 2.7\text{V to } 40\text{V}$ , $V_{SENSE} = 50\text{mV}$	100	120					dB
					100	120		dB
Offset Voltage			$\pm 0.2$	$\pm 1$		$\pm 0.2$	$\pm 1$	mV
Offset Voltage Over Temperature <sup>(1)</sup>	$T_A = -40^\circ\text{C to } +125^\circ\text{C}$			$\pm 2$			$\pm 2$	mV
Offset Voltage vs Temperature <sup>(1)</sup>	$T_A = -40^\circ\text{C to } +125^\circ\text{C}$		1			1		$\mu\text{V}/^\circ\text{C}$
Offset Voltage	$V_- = 2.7\text{V to } 40\text{V}$ , $V_{SENSE} = 50\text{mV}$		0.1	10		1		$\mu\text{V}/\text{V}$
Offset Voltage vs Power Supply, $V_+$	$V_- = 2.7\text{V to } 60\text{V}$ , $V_{SENSE} = 50\text{mV}$					0.1	10	$\mu\text{V}/\text{V}$
Input Bias Current			2			2		$\mu\text{A}$
Input Bias Current vs Temperature	$T_A = -40^\circ\text{C to } +125^\circ\text{C}$			10				$\mu\text{A}$
<b>OUTPUT</b>								
Transconductance	$T_A = +25^\circ\text{C}$ , $V_{SENSE} = 10\text{mV} - 150\text{mV}$	198	200	202	198	200	202	$\mu\text{A}/\text{V}$
Transconductance vs Temperature	$V_{SENSE} = 100\text{mV}$ , $T_A = -40^\circ\text{C to } +125^\circ\text{C}$	196		204	196		204	$\mu\text{A}/\text{V}$
Transconductance Over Temperature	$T_A = -40^\circ\text{C to } +125^\circ\text{C}$		10			10		$\text{nA}/^\circ\text{C}$
Nonlinearity Error	$V_{SENSE} = 10\text{mV to } 150\text{mV}$		$\pm 0.01\%$	$\pm 0.1\%$		$\pm 0.0\%$	$\pm 0.1\%$	
Total Output Error	$V_{SENSE} = 100\text{mV}$		$\pm 0.5\%$	$\pm 2\%$		$\pm 0.5\%$	$\pm 2\%$	
Total Output Error Over Temperature	$T_A = -40^\circ\text{C to } +125^\circ\text{C}$		$\pm 2.5\%$			$\pm 2.5\%$		
Output Impedance			1    5			1    5		$\text{G}\Omega$    $\text{pF}$
Voltage Output Swing to Power Supply, $V_+$			( $V_+$ ) – 0.8	( $V_+$ ) – 1.0		( $V_+$ ) – 0.8	( $V_+$ ) – 1.0	V
Voltage Output Swing to Common Mode, $V_{CM}$			$V_{CM} - 0.5$	$V_{CM} - 0.8$		$V_{CM} - 0.5$	$V_{CM} - 0.8$	V
<b>FREQUENCY RESPONSE</b>								
Bandwidth	$R_{OUT} = 5\text{k}\Omega$		800			800		kHz
	$R_{OUT} = 125\text{k}\Omega$		32			32		kHz
Settling Time (0.1%)	5V Step, $R_{OUT} = 5\text{k}\Omega$		1.8			1.8		$\mu\text{s}$
	5V Step, $R_{OUT} = 125\text{k}\Omega$		30			30		$\mu\text{s}$
<b>NOISE</b>								
Output-Current Noise Density			9			9		$\text{pA}/\sqrt{\text{Hz}}$
Total Output-Current Noise	$\text{BW} = 100\text{kHz}$		3			3		nA RMS
<b>POWER SUPPLY</b>								
Operating Range, $V_+$		2.7		36	2.7		60	V
Quiescent Current	$T_A = +25^\circ\text{C}$ , $V_{SENSE} = 0$ , $I_O = 0$		25	45		25	45	$\mu\text{A}$
Quiescent Current Over Temperature	$T_A = -40^\circ\text{C to } +125^\circ\text{C}$			60			60	$\mu\text{A}$
<b>TEMPERATURE RANGE</b>								
Specification, $T_{MIN}$ to $T_{MAX}$		-40		125	-40		125	$^\circ\text{C}$
Operating		-55		150	-55		150	$^\circ\text{C}$
Storage		-65		150	-65		150	$^\circ\text{C}$
Thermal Resistance, $\theta_{JA}$			200			200		$^\circ\text{C}/\text{W}$

(1) Defined as the amount of input voltage,  $V_{SENSE}$ , to drive the output to zero.

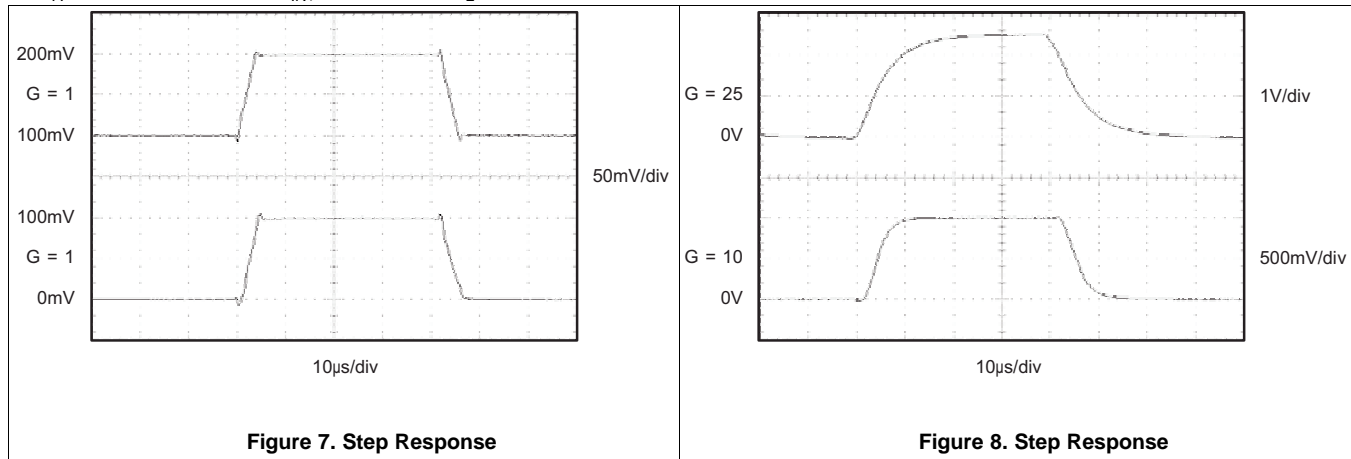
### 6.6 Typical Characteristics

At  $T_A = +25^\circ\text{C}$ ,  $V_+ = 5\text{V}$ ,  $V_{IN+} = 12\text{V}$ , and  $R_L = 125\text{k}\Omega$ , unless otherwise noted.



**Typical Characteristics (continued)**

At  $T_A = +25^\circ\text{C}$ ,  $V_+ = 5\text{V}$ ,  $V_{IN+} = 12\text{V}$ , and  $R_L = 125\text{k}\Omega$ , unless otherwise noted.



**Figure 7. Step Response**

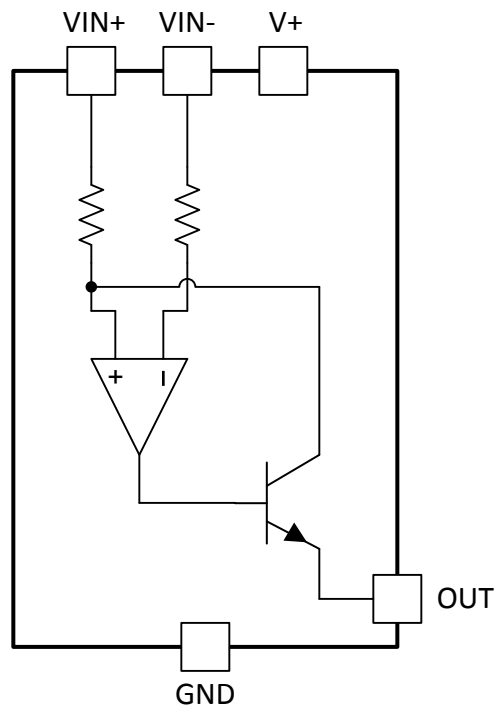
**Figure 8. Step Response**

## 7 Detailed Description

### 7.1 Overview

The INA138 and INA168 devices are comprised of a high voltage, precision operational amplifier, precision thin film resistors trimmed in production to an absolute tolerance and a low noise output transistor. The INA138 and INA168 devices can be powered from a single power supply and their input voltages can exceed the power supply voltage. The INA138 and INA168 devices are ideal for measuring small differential voltages, such as those generated across a shunt resistor, in the presence of large common-mode voltages. Refer to [Functional Block Diagram](#) which illustrates the functional components within both INA138 and INA168 devices.

### 7.2 Functional Block Diagram



### 7.3 Feature Description

#### 7.3.1 Output Voltage Range

The output of the INA138 device is a current, which is converted to a voltage by the load resistor,  $R_L$ . The output current remains accurate within the compliance voltage range of the output circuitry. The shunt voltage and the input common-mode and power-supply voltages limit the maximum possible output swing. The maximum output voltage compliance is limited by the lower of the following two equations:

$$V_{out\ max} = (V+) - 0.7\ V - (V_{IN+} - V_{IN-}) \quad (1)$$

or

$$V_{out\ max} = V_{IN-} - 0.5\ V \quad (2)$$

(whichever is lower)



## Feature Description (continued)

### 7.3.2 Bandwidth

Measurement bandwidth is affected by the value of the load resistor,  $R_L$ . High gain produced by high values of  $R_L$  will yield a narrower measurement bandwidth (see [Typical Characteristics](#)). For widest possible bandwidth, keep the capacitive load on the output to a minimum. Reduction in bandwidth due to capacitive load is shown in the [Typical Characteristics](#).

If bandwidth limiting (filtering) is desired, a capacitor can be added to the output (see [Figure 12](#)). This will not cause instability.

## 7.4 Device Functional Modes

For proper operation the INA138 and INA168 devices must operate within their specified limits. Operating either device outside of their specified power supply voltage range or their specified common-mode range will result in unexpected behavior and is not recommended. Additionally operating the output beyond their specified limits with respect to power supply voltage and input common-mode voltage will also produce unexpected results. Refer to [Electrical Characteristics](#) for the device specifications.

## 8 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.

### 8.1 Application Information

#### 8.1.1 Operation

Figure 9 illustrates the basic circuit diagram for both the INA138 and INA168 devices. Load current  $I_S$  is drawn from supply  $V_S$  through shunt resistor  $R_S$ . The voltage drop in shunt resistor  $V_S$  is forced across  $R_{G1}$  by the internal op amp, causing current to flow into the collector of Q1. External resistor  $R_L$  converts the output current to a voltage,  $V_{OUT}$ , at the OUT pin. The transfer function for the INA138 device is:

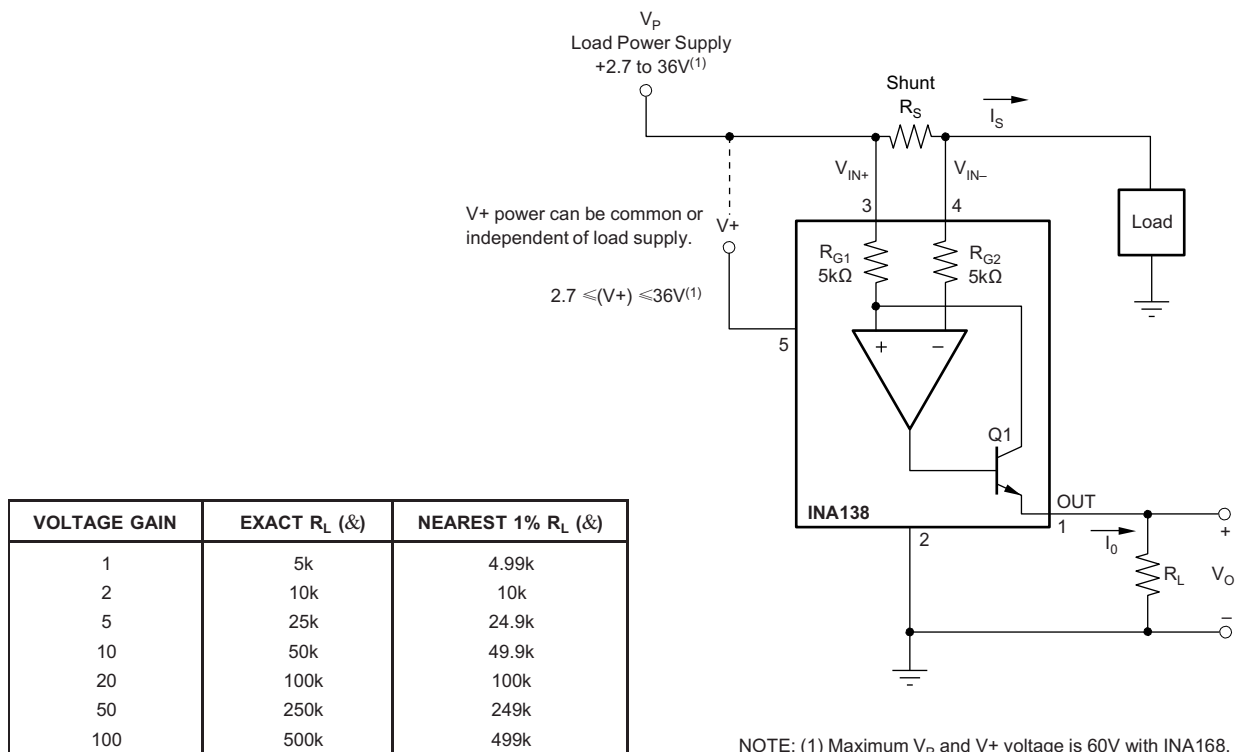
$$I_O = g_m(V_{IN+} - V_{IN-}) \quad (3)$$

where  $g_m = 200 \mu A/V$ .

In the circuit of Figure 9, the input voltage,  $(V_{IN+} - V_{IN-})$ , is equal to  $I_S \times R_S$  and the output voltage,  $V_{OUT}$ , is equal to  $I_O \times R_L$ . The transconductance,  $g_m$ , of the INA138 device is  $200 \mu A/V$ . The complete transfer function for the current measurement amplifier in this application is:

$$V_{OUT} = (I_S) (R_S) (200 \mu A/V) (R_L) \quad (4)$$

The maximum differential input voltage for accurate measurements is 0.5 V, which produces a 100- $\mu A$  output current. A differential input voltage of up to 2 V will not cause damage. Differential measurements (pins 3 and 4) must be unipolar with a more-positive voltage applied to pin 3. If a more-negative voltage is applied to pin 3, the output current,  $I_O$ , will be zero, but it will not cause damage.



**Figure 9. Basic Circuit Connections**

## 8.2 Typical Applications

The INA138 device is designed for current shunt measurement circuits, as shown in Figure 9, but its basic function is useful in a wide range of circuitry. A creative engineer will find many unforeseen uses in measurement and level shifting circuits. A few ideas are illustrated in Figure 10 through Figure 18.

### 8.2.1 Buffering Output to Drive an ADC

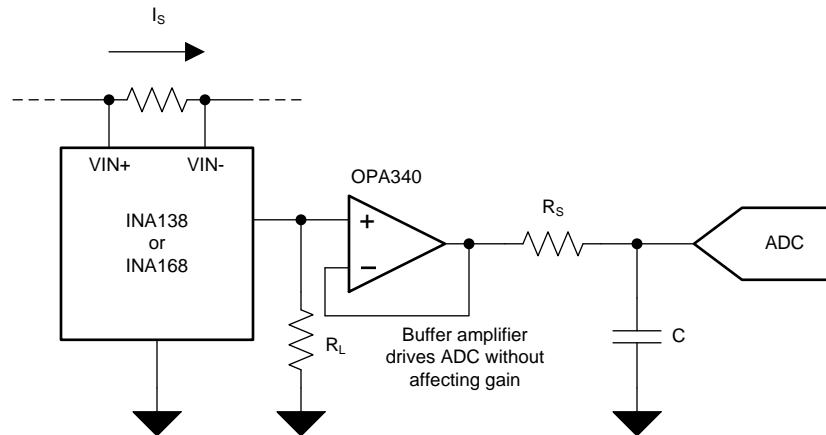


Figure 10. Buffering Output to Drive an A/D Converter

#### 8.2.1.1 Design Requirements

Digitize the output of the INA138 or INA168 devices using a 1-MSPS analog-to-digital converter (ADC).

#### 8.2.1.2 Detailed Design Procedure

##### 8.2.1.2.1 Selecting the Shunt Resistor and $R_L$

In Figure 9 the value chosen for the shunt resistor depends on the application and is a compromise between small-signal accuracy and maximum permissible voltage loss in the measurement line. High values of shunt resistor provide better accuracy at lower currents by minimizing the effects of offset, while low values of shunt resistor minimize voltage loss in the supply line. For most applications, best performance is attained with a shunt resistor value that provides a full-scale shunt voltage range of 50 mV to 100 mV. Maximum input voltage for accurate measurements is 500 mV.

The load resistor,  $R_L$ , is chosen to provide the desired full-scale output voltage. The output impedance of the INA138 and INA168 OUT terminal is very high which permits using values of  $R_L$  up to 500 k $\Omega$  with excellent accuracy. The input impedance of any additional circuitry at the output should be much higher than the value of  $R_L$  to avoid degrading accuracy.

Some Analog-to-Digital (A/D) converters have input impedances that will significantly affect measurement gain. The input impedance of the A/D converter can be included as part of the effective  $R_L$  if its input can be modeled as a resistor to ground. Alternatively, an op amp can be used to buffer the A/D converter input. The INA138 and INA168 are current output devices, and as such have an inherently large output impedance. The output currents from the amplifier are converted to an output voltage via the load resistor,  $R_L$ , connected from the amplifier output to ground. The ratio of the load resistor value to that of the internal resistor value determines the voltage gain of the system.

In many applications digitizing the output of the INA138 or INA168 devices is required. This can be accomplished by connecting the output of the amplifier to an ADC. It is very common for an ADC to have a dynamic input impedance. If the INA138 or INA168 output is connected directly to an ADC input, the input impedance of the ADC is effectively connected in parallel with the gain setting resistor  $R_L$ . This parallel impedance combination will affect the gain of the system and the impact on the gain is difficult to estimate accurately. A simple solution that eliminates the paralleling of impedances, simplifying the gain of the circuit is to place a buffer amplifier, such as the OPA340, between the output of the INA138 or INA168 devices and the input to the ADC.

## Typical Applications (continued)

Figure 10 illustrates this concept. Notice that a low pass filter is placed between the OPA340 output and the input to the ADC. The filter capacitor is required to provide any instantaneous demand for current required by the input stage of the ADC. The filter resistor is required to isolate the OPA340 output from the filter capacitor to maintain circuit stability. The values for the filter components will vary according to the operational amplifier used for the buffer and the particular ADC selected. More information can be found regarding the design of the low pass filter in the TI Precision Design *16 bit 1MSPS Data Acquisition Reference Design for Single-Ended Multiplexed Applications*, T1PD173.

Figure 10 shows the expected results when driving an analog-to-digital converter at 1MSPS with and without buffering the INA138 or INA168 output. Without the buffer, the high impedance of the INA138 or INA168 will react with the input capacitance and sample and hold (S/H) capacitance of the analog-to-digital converter and will not allow the S/H to reach the correct final value before it is reset and the next conversion starts. Adding the buffer amplifier significantly reduces the output impedance driving the S/H and allows for higher conversion rates than can be achieved without adding the buffer.

### 8.2.1.3 Application Curve

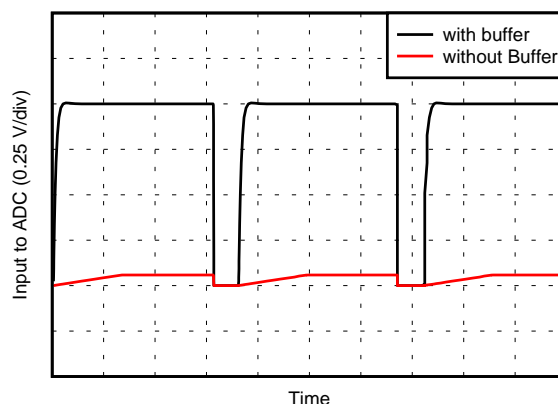


Figure 11. Driving an A/D with and without a Buffer

## 8.2.2 Output Filter

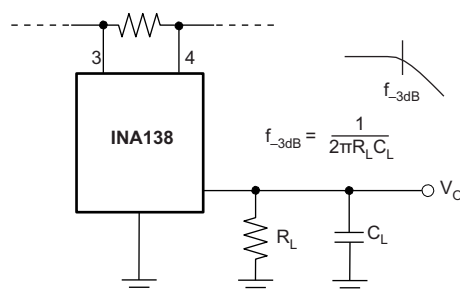


Figure 12. Output Filter

### 8.2.2.1 Design Requirements

Filter the output of the INA138 or INA168 devices.

## Typical Applications (continued)

### 8.2.2.2 Detailed Design Procedure

A low-pass filter can be formed at the output of the INA138 or INA168 devices simply by placing a capacitor of the desired value in parallel with the load resistor. First determine the value of the load resistor needed to achieve the desired gain. Refer to the table in Figure 9. Next, determine the capacitor value that will result in the desired cutoff frequency according to the equation shown in Figure 12. Figure 13 illustrates various combinations of gain settings (determined by  $R_L$ ) and filter capacitors.

### 8.2.2.3 Application Curve

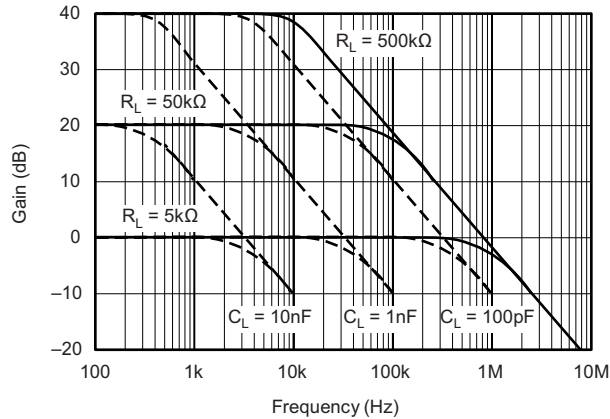
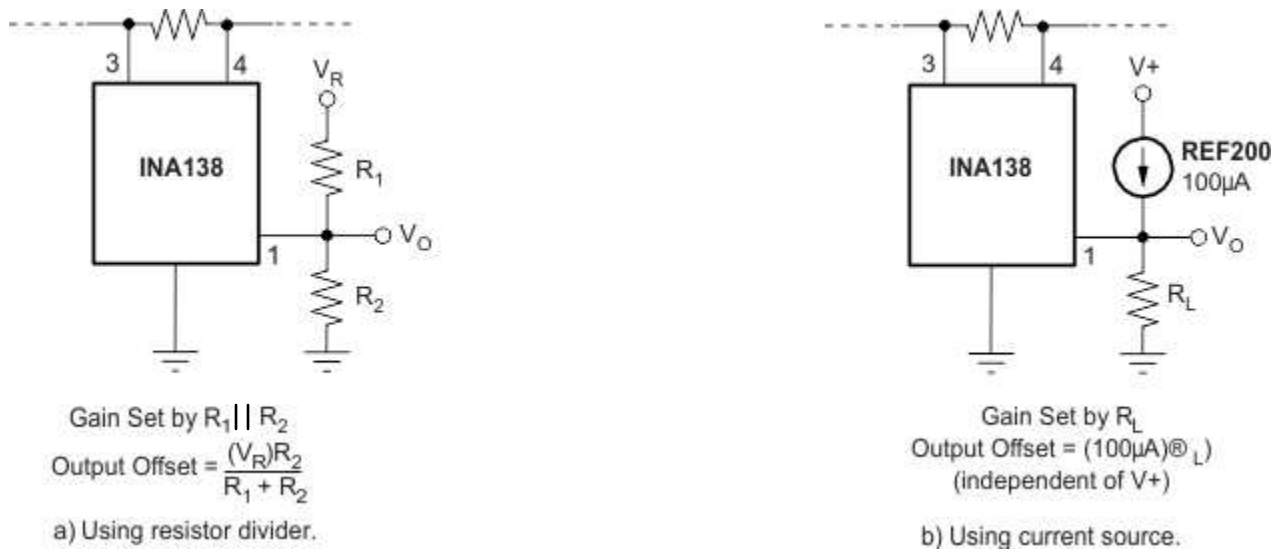


Figure 13. Gain vs Frequency

### 8.2.3 Offsetting the Output Voltage

For many applications using only a single power supply it may be required to level shift the output voltage away from ground when there is no load current flowing in the shunt resistor. Level shifting the output of the INA138 or INA168 devices is easily accomplished by one of two simple methods shown in Figure 14. The method on the left hand side of Figure 14 illustrates a simple voltage divider method. This method is useful for applications that require the output of the INA138 or INA168 devices to remain centered with respect to the power supply at zero load current through the shunt resistor. Using this method the gain is determined by the parallel combination of  $R_1$  and  $R_2$  while the output offset is determined by the voltage divider ratio  $R_1$  and  $R_2$ . For applications that may require a fixed value of output offset, independent of the power supply voltage, the current source method shown on the right-hand side of Figure 14 is recommended. With this method a REF200 constant current source is used to generate a constant output offset. Using this method the gain is determined by  $R_L$  and the offset is determined by the product of the value of the current source and  $R_L$ .

**Typical Applications (continued)**

**Figure 14. Offsetting the Output Voltage**
**8.2.4 Bipolar Current Measurement**

The INA138 or INA168 devices can be configured as shown in [Figure 15](#) in applications where measuring current bi-directionally is required. Two INA devices are required connecting their inputs across the shunt resistor as shown in [Figure 15](#). A comparator, such as the [TLV3201](#), is used to detect the polarity of the load current. The magnitude of the load current is monitored across the resistor connected between ground and the connection labeled *Output*. In this example the 100-k $\Omega$  resistor results in a gain of 20 V/V. The 10-k $\Omega$  resistors connected in series with the INA138 or INA168 output current are used to develop a voltage across the comparator inputs. Two diodes are required to prevent current flow into the INA138 or INA168 output, as only one device at a time is providing current to the *Output* connection of the circuit. The circuit functionality is illustrated in [Figure 16](#).

Typical Applications (continued)

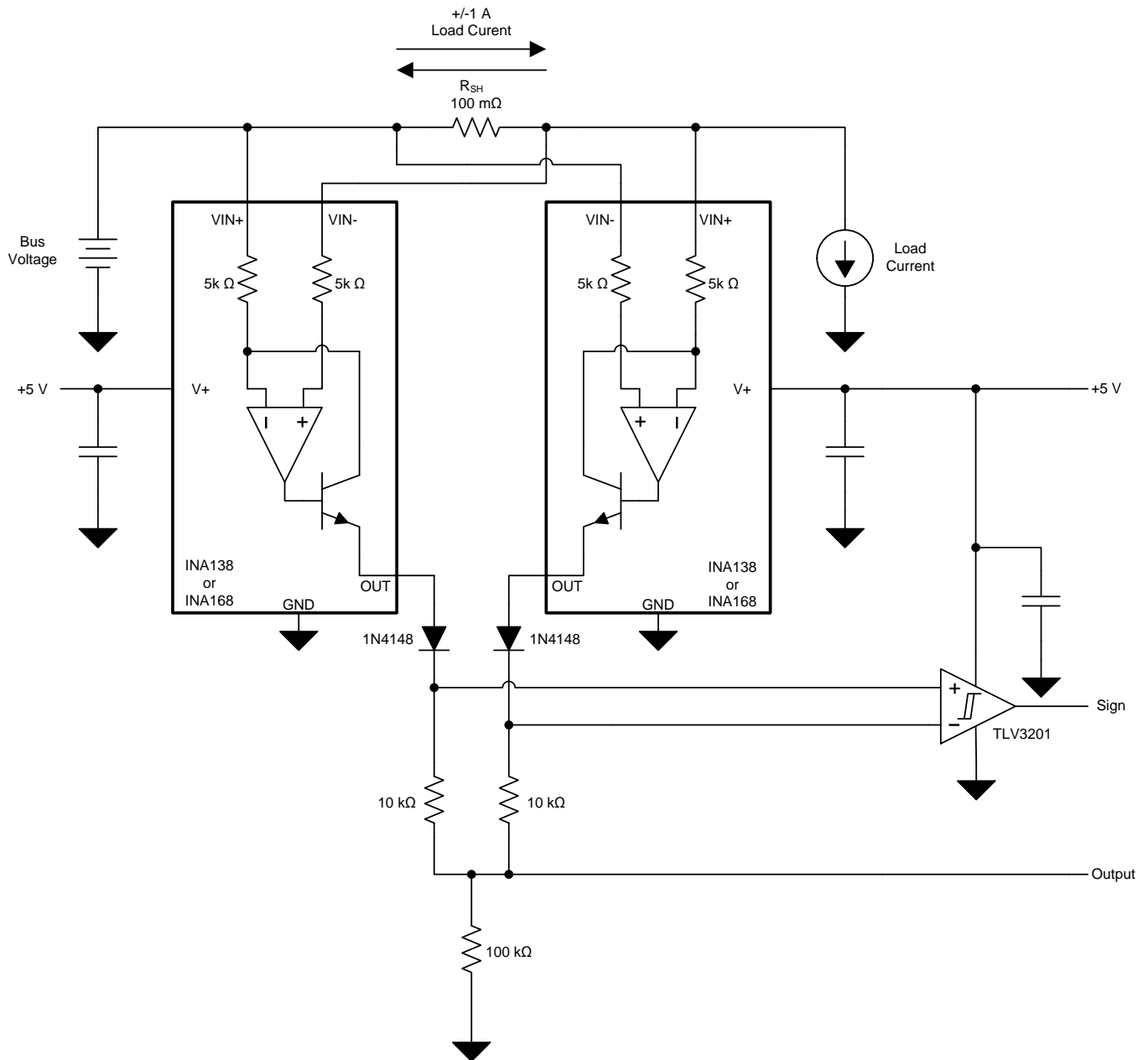
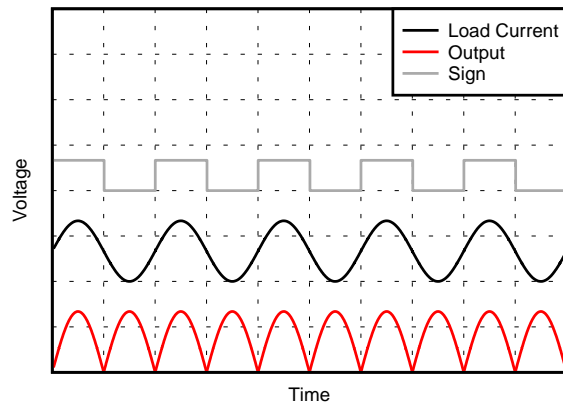
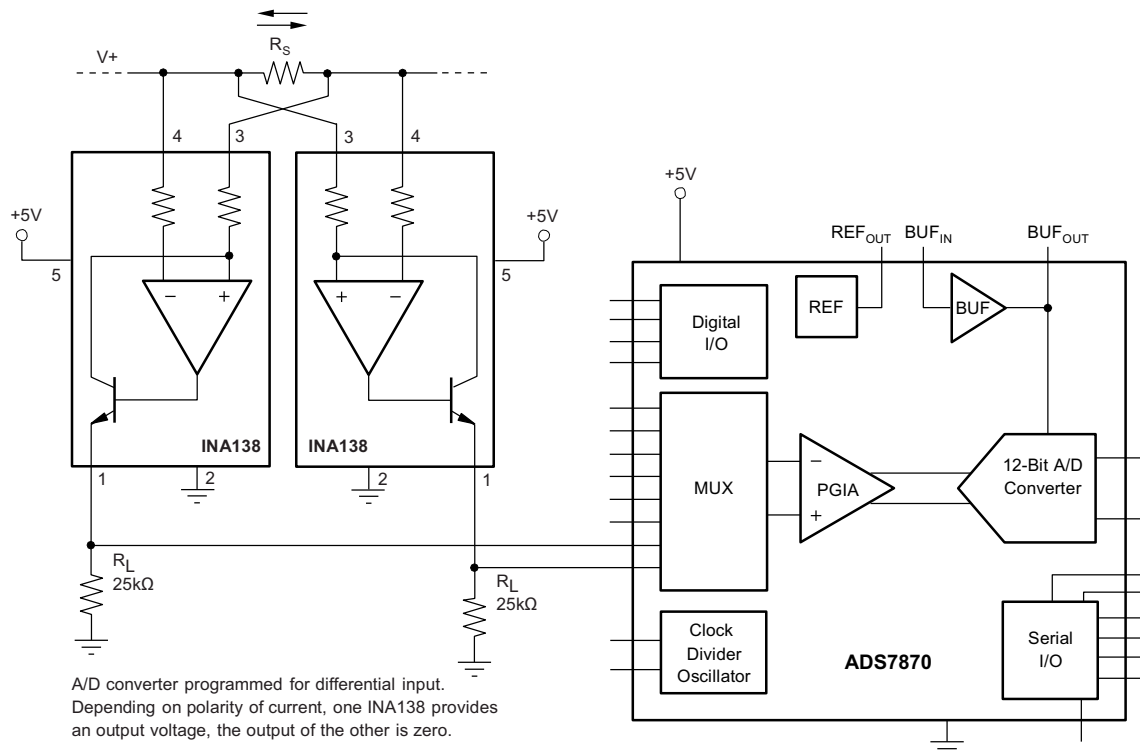


Figure 15. Bipolar Current Measurement

**Typical Applications (continued)**

**Figure 16. Bipolar Current Measurements Results (arbitrary scale)**
**8.2.5 Bipolar Current Measurement Using Differential Input of A/D Converter**

The INA138 or INA168 devices can be used with an A/D Converter such as the [ADS7870](#) programmed for differential mode operation. [Figure 17](#) illustrates this configuration. In this configuration the use of two INA's allows for bi-directional current measurement. Depending upon the polarity of the current, one of the INA's will provide an output voltage while the other output is zero. In this way the A/D converter will read the polarity of current directly, without the need for additional circuitry.


**Figure 17. Bipolar Current Measurement Using Differential Input of A/D Converter**



## Typical Applications (continued)

### 8.2.6 Multiplexed Measurement Using Logic Signal for Power

Multiple loads can be measured as illustrated in Figure 18. In this configuration each INA138 or INA168 device is powered by the Digital I/O from the ADS7870. Multiplexing is achieved by switching on or off each the desired I/O.

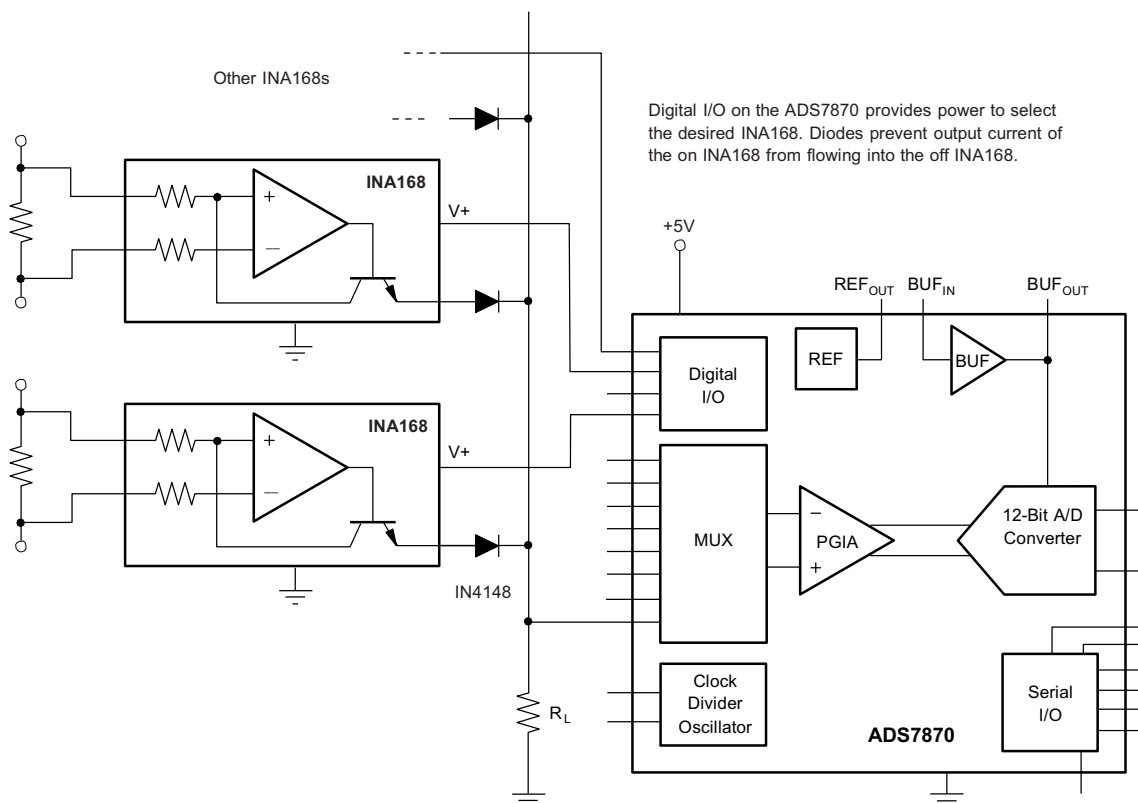


Figure 18. Multiplexed Measurement Using Logic Signal for Power

## 9 Power Supply Recommendations

The input circuitry of the INA138 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 36 V (or 60 V with the INA168). The output voltage range of the OUT terminal, however, is limited by the lesser of the two voltages (see [Output Voltage Range](#)). A 0.1- $\mu$ F capacitor is recommended to be placed near the power supply pin on the INA138 or INA168. Additional capacitance may be required for applications with noisy power supply voltages.

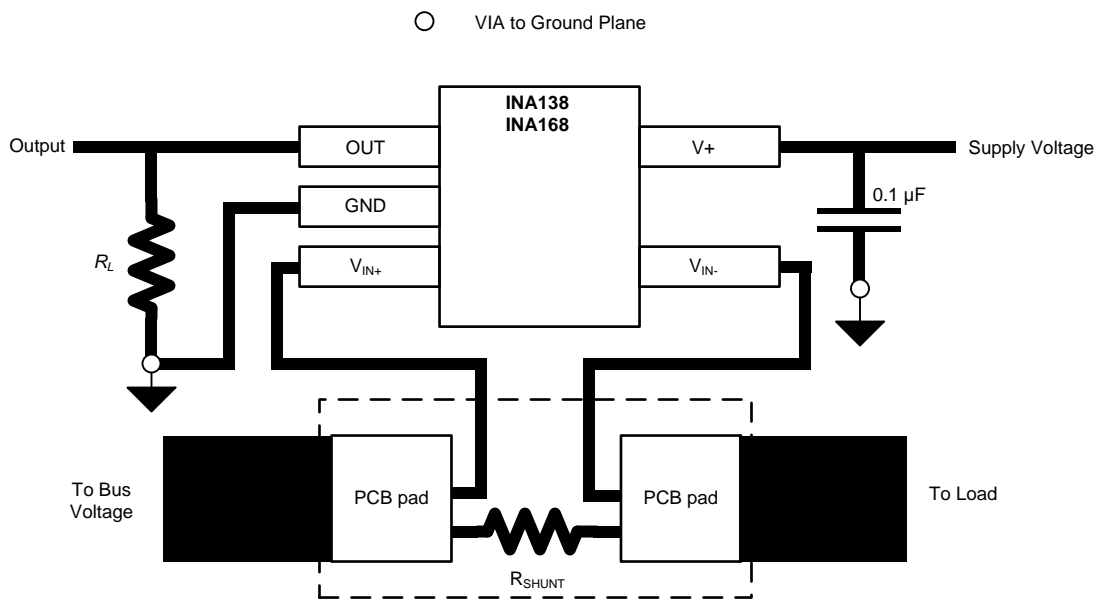
## 10 Layout

### 10.1 Layout Guidelines

Figure 19 shows the basic connection of the INA138 device. The input pins,  $V_{IN+}$  and  $V_{IN-}$ , should be connected as closely as possible to the shunt resistor to minimize any resistance in series with the shunt resistance. The output resistor,  $R_L$ , is shown connected between pin 1 and ground. Best accuracy is achieved with the output voltage measured directly across  $R_L$ . This is especially important in high-current systems where load current could flow in the ground connections, affecting the measurement accuracy.

No power-supply bypass capacitors are required for stability of the INA138. However, applications with noisy or high-impedance power supplies may require decoupling capacitors to reject power-supply noise. Connect bypass capacitors close to the device pins.

### 10.2 Layout Example



**Figure 19. Typical Layout Example**

## 11 器件和文档支持

### 11.1 文档支持

#### 11.1.1 相关文档

相关文档请参见以下部分：

- 《用于单端多路复用应用的 16 位 1MSPS 数据采集 参考设计》，[TIDU504](#)
- 《ADS7870 12 位 ADC、MUX、PGA 和内部基准数据采集系统》（文献编号：[SBAS124](#)）
- 《TLV3201、TLV3202 40ns 低功耗推挽式输出比较器》（文献编号：[SBOS561](#)）
- 《REF200 双路电流源/灌电流阱》（文献编号：[SBVS020](#)）

#### 11.2 相关链接

下面的表格列出了快速访问链接。范围包括技术文档、支持和社区资源、工具和软件，以及样片或购买的快速访问。

表 1. 相关链接

器件	产品文件夹	样片与购买	技术文档	工具与软件	支持与社区
INA138	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>
INA168	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>

#### 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

以下页中包括机械、封装和可订购信息。这些信息是针对指定器件可提供的最新数据。这些数据会在无通知且不对本文档进行修订的情况下发生改变。欲获得该数据表的浏览器版本，请查阅左侧的导航栏。

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
INA138NA/250	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	B38	<a href="#">Samples</a>
INA138NA/3KG4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	B38	<a href="#">Samples</a>
INA168NA/250	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR		A68	<a href="#">Samples</a>
INA168NA/3K	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 125	A68	<a href="#">Samples</a>

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

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

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

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

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

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

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

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

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

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

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

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

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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**OTHER QUALIFIED VERSIONS OF INA138, INA168 :**

- Automotive: [INA138-Q1](#), [INA168-Q1](#)

**NOTE: Qualified Version Definitions:**

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

## 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
INA138NA/250	SOT-23	DBV	5	250	178.0	9.0	3.3	3.2	1.4	4.0	8.0	Q3
INA168NA/250	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
INA168NA/3K	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3

**TAPE AND REEL BOX DIMENSIONS**

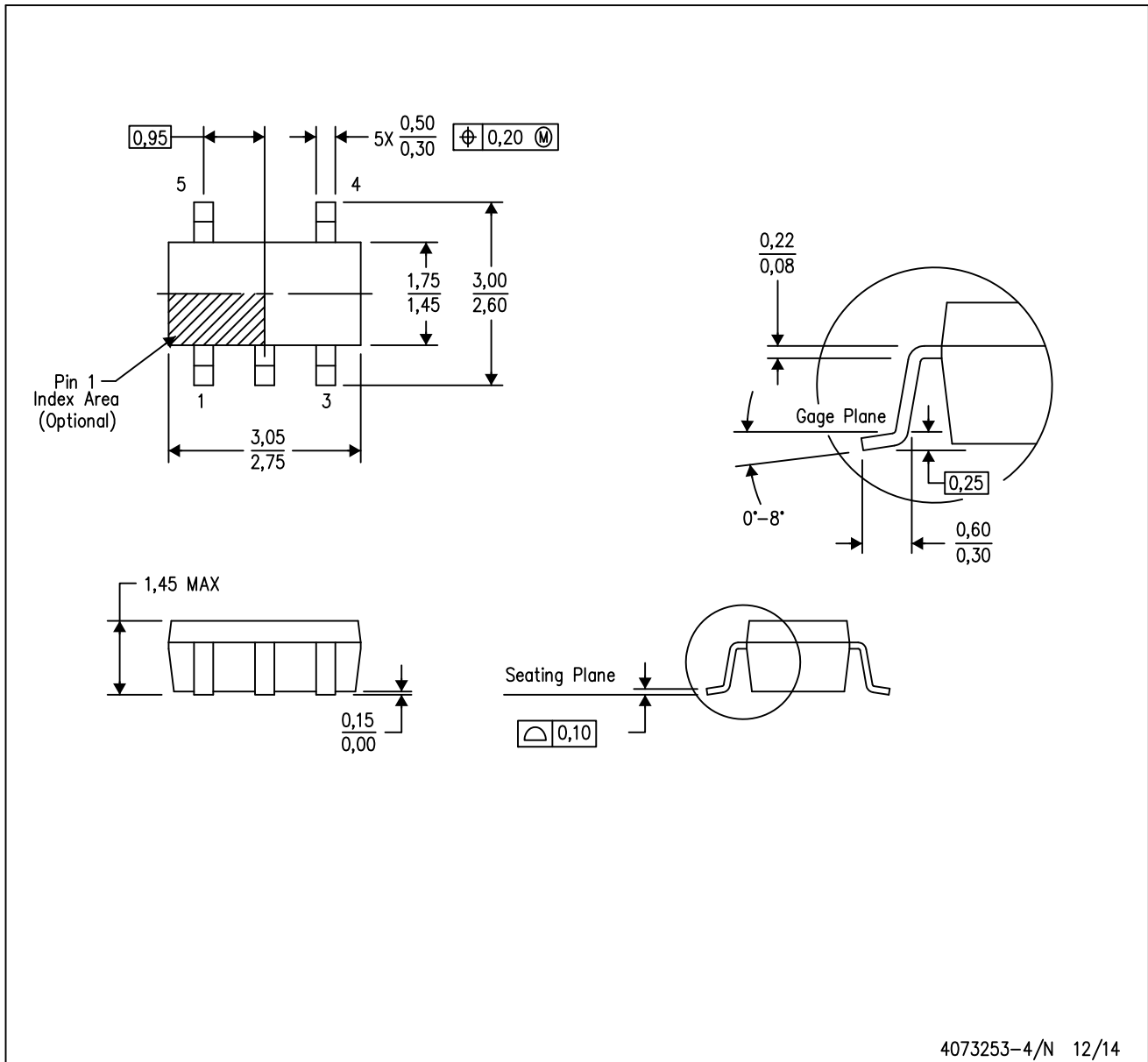

\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
INA138NA/250	SOT-23	DBV	5	250	180.0	180.0	18.0
INA168NA/250	SOT-23	DBV	5	250	180.0	180.0	18.0
INA168NA/3K	SOT-23	DBV	5	3000	180.0	180.0	18.0



DBV (R-PDSO-G5)

PLASTIC SMALL-OUTLINE PACKAGE



4073253-4/N 12/14

- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
  - Falls within JEDEC MO-178 Variation AA.

DBV (R-PDSO-G5)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
  - D. Publication IPC-7351 is recommended for alternate designs.
  - E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.

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