精密仪用放大器INA114

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一、概述

INA114是一种通用仪用放大器，尺寸小、精度高、价格低廉，可用于电桥、热电偶、数据采集、RTD传感器和医疗仪器等。INA114只需一个外部电阻就可以设置1至10000之间的任意增益值，内部输入保护能够长期耐受±40V，失调电压低（50μV），漂移小（0.25μV/℃），共模抑制比高（G=1000时为50dB），用激光进行调整，可以在±2.25V的电压下工作，使用电池（组）或5V单电源系统，静态电流最大为3mA。INA114采用8引脚塑料封装或SOL-16表面封装贴件，使用环境温度为-40℃～+85℃。

INA114的内部电路和引脚布局如图1和图2所示。

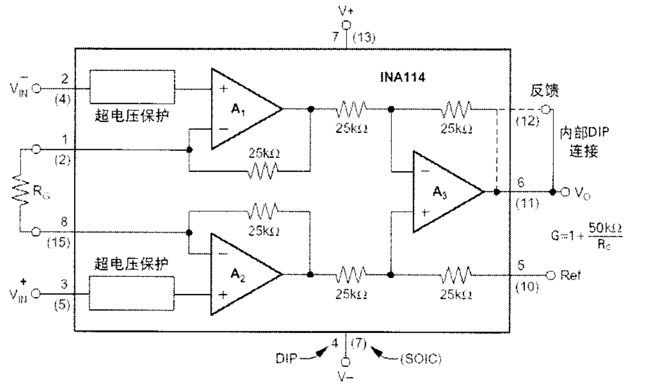

图1：INA114 的内部电路图

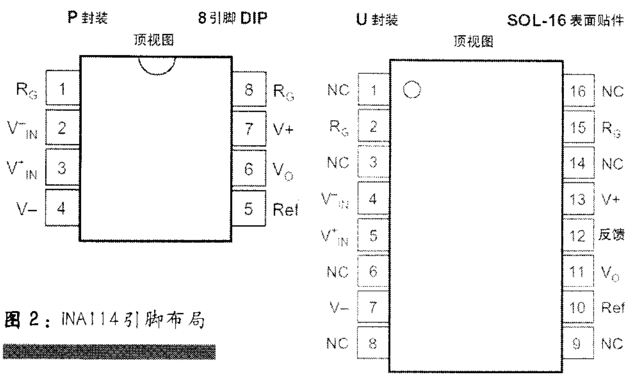

图2：INA114引脚布局

二、主要电气参数

表1给出了INA114的主要电气参数。

由于INA114的参数很多，这里只简单地列出了一些参数，更详细的资料可以去BB公司的主页下载。

下面给出INA114绝对最大使用限度。

电源电压：	±18V
输入电压范围：	±40V
工作温度：	-40℃～+125℃
储存温度：	-40℃～+125℃
节点温度：	+150℃
引脚温度(软焊，10s)：	+300℃

三、应用设计及举例

图3所示为INA114的基本连接要求。如用于噪声或高阻电源时，需要在靠近电源引脚处连接去耦合电容。

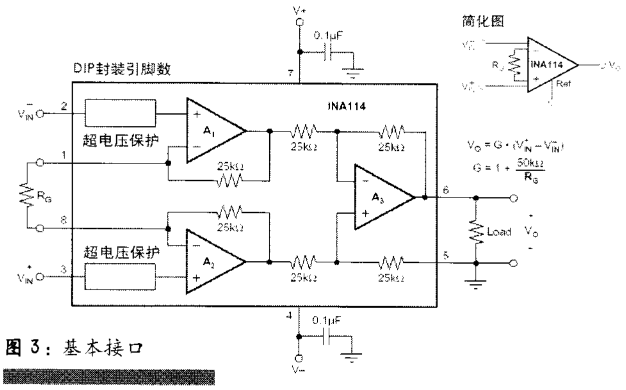

图3：基本接口

建立增益

INA114的增益值只用一个外部电阻R_G就可以设置，公式如下：

$$G=1+50k\Omega/R_G \qquad (1)$$

图3附有常用的增益值及相应阻值，表2列出了INA114的常用增益值和R_G近似阻值。

公式（1）中的“50kΩ”这一项是两个内部反馈电阻的和。这两个金属膜的电阻已经用激光调整到精确的值。INA114增益的精确度和漂移额定值中包含了这两个电阻的精确度和温度系数。

用来设置增益的外部电阻R_G的稳定性和温漂也对增益有影响。R_G对增益精度和增益漂移的影响，可以由公式（1）直接推导出来。高增益需要低阻值，所以接线电阻就很重要。

表1：INA114的主要电气参数（T_A=+25℃，V_S=±15V，R_L=2kΩ）

		INA114BP,BU			INA114AP,AU			单位
参数	条件	最小值	典型值	最大值	最小值	典型值	最大值	
输入共模范围		±11	±13.5		±11	±13.5		V
安全输入电压				±40			±40	V
共模抑制比	VCM =±10V,							
	△R_S=1kΩ							
	G=1	80	96		75	90		dB
	G=1000	115	120		106	110		dB
增益								
增益公式			1+(50kΩ/R_G)					
增益范围		1		10000	1		10000	V/V
增益误差	G=1		±0.01	±0.05		±0.01	±0.05	%
	G=1000		±0.5	±1		±0.5	±2	%
增益温漂	G=1		±2	±10		±2	±10	ppm/℃
5kΩ电阻			±2.5	±100		±2.5	±100	ppm/℃
非线性	G=1		±0.0001	±0.001		±0.0001	±0.002	%of FSR
	G=1000		±0.0002	±0.01		±0.0002	±0.02	%of FSR
频率响应								
带宽，-3dB	G=1		1			1		mHz
	G=1000		1			1		kHz
压摆率	VO=±10V,G=10	0.3	0.6		0.3	0.6		V/μs
建立时间，0.01%	G=1		18			18		μs
	G=1000		1100			1100		μs
过载恢复	激励过度50%		20			20		μs

线路上增加的插座会使增益误差额外地增加100甚至更多，并且很可能是不稳定的误差。

噪声特性

表2：INA114的常用增益值与R_G近似阻值

增益	R_G(Ω)	最近似1% R_G(Ω)
1	无	无
2	50.00k	49.9k
5	12.50k	12.4k
10	5.556k	5.62k
20	2.632k	2.61k
50	1.02k	1.02k
100	505.1	511
200	251.3	249
500	100.2	100
1000	50.03	49.9
2000	25.01	24.9
5000	10.00	10
10000	5.001	4.99

在大多数应用中，INA114产生的噪声都很小。对于小于1kΩ的差动信号源电阻，INA103产生的噪声更小；信号源电阻大于5kΩ时，INA111型FET输入仪用放大器产生的噪声更小一些。

INA114的低频噪声频率峰-峰值约为0.4μV(从0.1Hz到10Hz)。这大约是使用斩波稳零的“低噪声”放大器所产生的噪声的十分之一。

失调/偏移的修正

INA114用激光来修正微小的失调电压和漂移，在大多数应用中都不需要进行外部失调修正。图4所示为采用一个回路来修正输出偏离电压。在这个结点上必须使用低电阻来保证良好的共模抑制比，用一个运算放大器进行缓冲就可以达到这个目的。

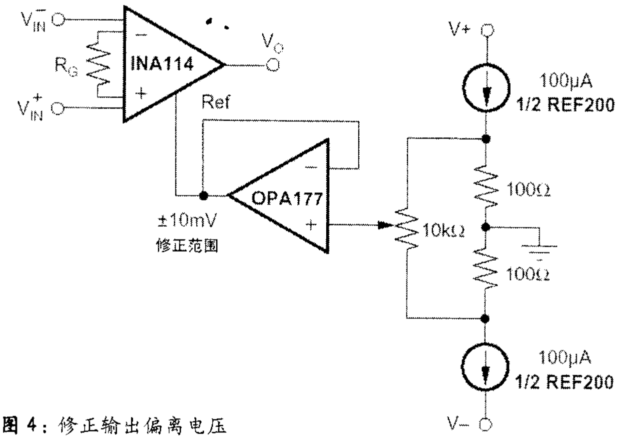

图4：修正输出偏离电压

偏置电压返回路径

INA114的输入电阻很大（约10^{10}Ω），但是必须为两个输入端的偏置电流都设置返回路径。偏置电流小于±1nA(由

于电路的影响，偏置电流可正可负)。由于输入电阻很大，使得输入电压变化时偏置电流的变化很小。

必须提供输入电流返回路径，INA114才能正常运行。图5所示为一些提供偏置电流返回路径的设计。没有偏置电流返回路径，输入的浮动将超出INA114的共模范围，放大器将达到饱和。如果差动信号源电阻很小，偏置电流路径可以接到一个引脚上(参看图5的热电偶)。信号源电阻大时，用两个相等电阻提供一个平衡输入，并且由于偏置电流和良好的共模抑制比，偏离电压也会变得较低。

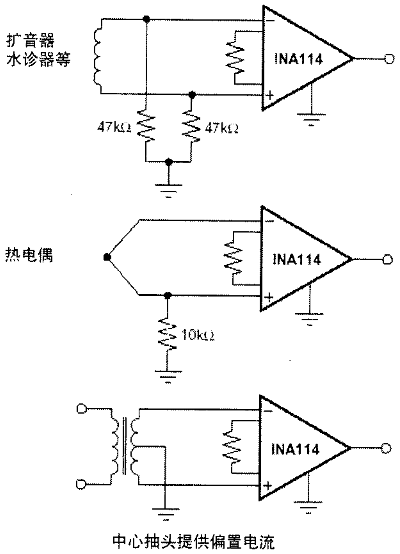

图 5：提供偏置电流返回路径

输入共模范围

INA114 的运算放大器的线性共模范围和整个放大器的输出电压有关，约为 ±13.75V(或偏离电源电压1.25V)。输出电压升高时，输入运算放大器 A1 和 A2的输出电压摆却限制着线性输出范围。

共模和差动输入信号联合会造成A1 或A2输出饱和。图6所示为A1和A2根据共模和差动输入电压表示的输出电压摆。这些内部放大器的输出摆动能力和外部放大器 A3一样。在输入共模需要达到最大范围的应用中，给INA114设置较小的增益，来限制输出电压摆。如果需要，在INA114后加大增益来提高输出电压摆。

输入过载时，输出常常表现正常。例如，当一个输入端电压为+20V，另一个为+40V时，显然这两个输入都超过了

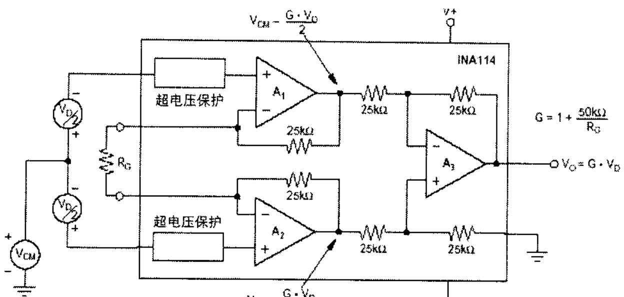

图 6：A1 和 A2 的电压摆

放大器的线性共模范围。由于这两个放大器都饱和，且接近于相同的输出电压极限，输出电压测到的差动电压接近零，所以如果两个输入端都过载，INA114 的输出却接近于零。

输入保护

INA114 两个输入端的保护各自可承受± 40V 电压。即使一个输入端电压为−40V，另一个为+40V，也不会有危险。每个输入端的内部电路在通常信号条件下提供串联小电阻。为提供等效的保护，串联输入电阻会产生过度噪声。如果输入端过载，保护电路把输入电流限制到安全值(约1.5mA)。即使没有电源电压存在，输入端仍然受到保护。

输出电压检测(仅用于SOL−16封装)

INA114 的表面贴装版本有一个独立的输出检测反馈接口—引脚12，该引脚必须接引脚11来进行操作，在INA114的DIP版本中这个接口则设在芯片内部。

输出检测接口在精度最好的负载条件下可直接用来检测输出电压。图7 所示是通过内部连接电阻驱动负载的方法。远距离定位反馈路径可能造成不稳定，可以用通过 C_1 的高频反馈路径来消除。

图7和图8是两个应用的典型电路，供读者参考。

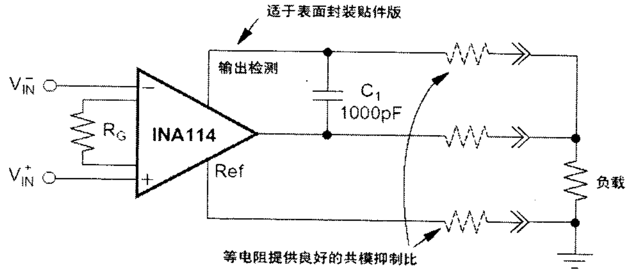

图 7：远距离负载和地面传感

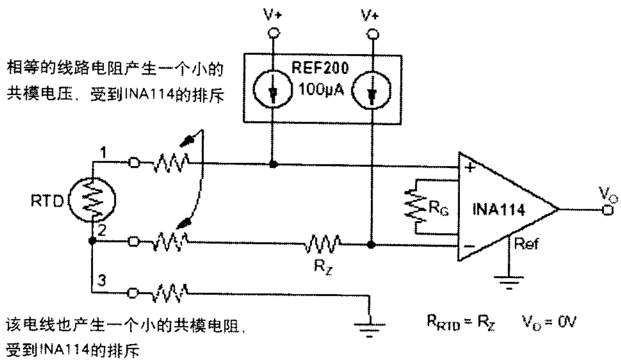

图 8：RTD温度测量电路

结束语

综上所述，INA114精密仪用放大器精度高、增益范围大、性能优良、价格低廉，非常适合于精密仪器的使用。 EPC

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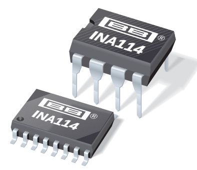


INA114

Precision INSTRUMENTATION AMPLIFIER

FEATURES

- LOW OFFSET VOLTAGE: 50µV max
- LOW DRIFT: 0.25µV/°C max
- LOW INPUT BIAS CURRENT: 2nA max
- HIGH COMMON-MODE REJECTION: 115dB min
- INPUT OVER-VOLTAGE PROTECTION: ±40V
- WIDE SUPPLY RANGE: ±2.25 to ±18V
- LOW QUIESCENT CURRENT: 3mA max
- 8-PIN PLASTIC AND SOL-16

APPLICATIONS

- BRIDGE AMPLIFIER
- THERMOCOUPLE AMPLIFIER
- RTD SENSOR AMPLIFIER
- MEDICAL INSTRUMENTATION
- DATA ACQUISITION

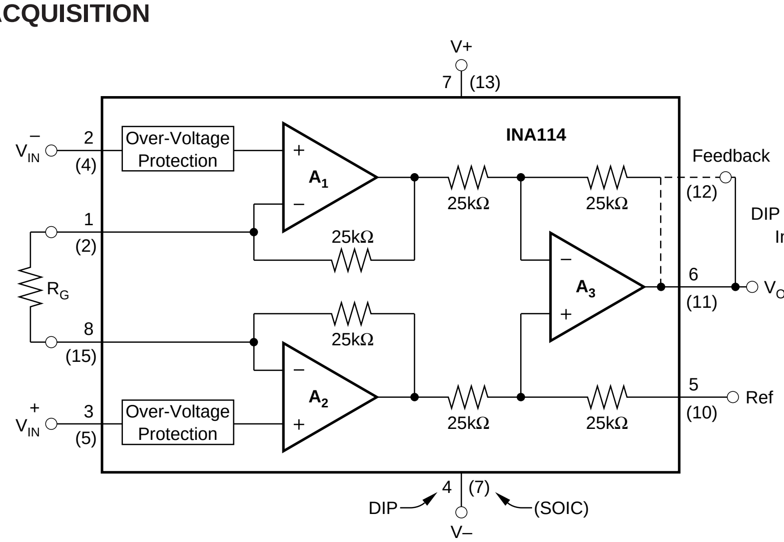
DESCRIPTION

The INA114 is a low cost, general purpose instrumentation amplifier offering excellent accuracy. Its versatile 3-op amp design and small size make it ideal for a wide range of applications.

A single external resistor sets any gain from 1 to 10,000. Internal input protection can withstand up to ±40V without damage.

The INA114 is laser trimmed for very low offset voltage (50µV), drift (0.25µV/°C) and high common-mode rejection (115dB at G = 1000). It operates with power supplies as low as ±2.25V, allowing use in battery operated and single 5V supply systems. Quiescent current is 3mA maximum.

The INA114 is available in 8-pin plastic and SOL-16 surface-mount packages. Both are specified for the –40°C to +85°C temperature range.



$$G = 1 + \frac{50k\Omega}{R_G}$$

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SBOS014

SPECIFICATIONS

ELECTRICAL

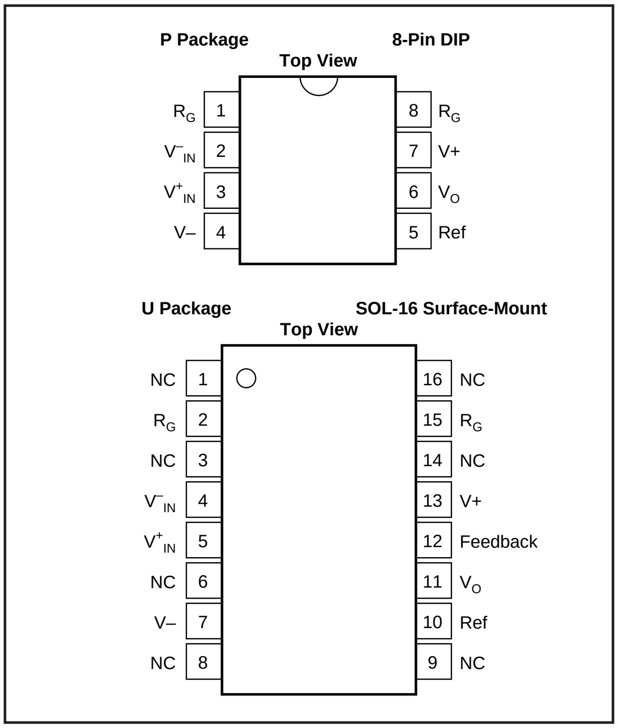
At T_A = +25°C, V_S = ±15V, R_L = 2kΩ, unless otherwise noted.

PARAMETER	CONDITIONS	INA114BP, BU			INA114AP, AU			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
INPUT								
Offset Voltage, RTI								
Initial	T_A = +25°C		±10 + 20/G	±50 + 100/G		±25 + 30/G	±125 + 500/G	μV
vs Temperature	$T_A = T_{MIN}$ to T_{MAX}		±0.1 + 0.5/G	±0.25 + 5/G		±0.25 + 5/G	±1 + 10/G	μV/°C
vs Power Supply	V_S = ±2.25V to ±18V		0.5 + 2/G	3 + 10/G		*	*	μV/V
Long-Term Stability			±0.2 + 0.5/G			*		μV/mo
Impedance, Differential			$10^{10} \parallel 6$			*		Ω ∥ pF
Common-Mode			$10^{10} \parallel 6$			*		Ω ∥ pF
Input Common-Mode Range		±11	±13.5		*	*		V
Safe Input Voltage				±40			*	V
Common-Mode Rejection	V_{CM} = ±10V, ΔR_S = 1kΩ							
	G = 1	80	96		75	90		dB
	G = 10	96	115		90	106		dB
	G = 100	110	120		106	110		dB
	G = 1000	115	120		106	110		dB
BIAS CURRENT			±0.5	±2		*	±5	nA
vs Temperature			±8			*		pA/°C
OFFSET CURRENT			±0.5	±2		*	±5	nA
vs Temperature			±8			*		pA/°C
NOISE VOLTAGE, RTI	G = 1000, R_S = 0Ω							
f = 10Hz			15			*		nV/√Hz
f = 100Hz			11			*		nV/√Hz
f = 1kHz			11			*		nV/√Hz
f_B = 0.1Hz to 10Hz			0.4			*		μVp-p
Noise Current								
f=10Hz			0.4			*		pA/√Hz
f=1kHz			0.2			*		pA/√Hz
f_B = 0.1Hz to 10Hz			18			*		pAp-p
GAIN								
Gain Equation			1 + (50kΩ/R_G)			*		V/V
Range of Gain		1		10000	*		*	V/V
Gain Error	G = 1		±0.01	±0.05		*	*	%
	G = 10		±0.02	±0.4		*	±0.5	%
	G = 100		±0.05	±0.5		*	±0.7	%
	G = 1000		±0.5	±1		*	±2	%
Gain vs Temperature	G = 1		±2	±10		*	±10	ppm/°C
50kΩ Resistance(1)			±25	±100		*	*	ppm/°C
Nonlinearity	G = 1		±0.0001	±0.001		*	±0.002	% of FSR
	G = 10		±0.0005	±0.002		*	±0.004	% of FSR
	G = 100		±0.0005	±0.002		*	±0.004	% of FSR
	G = 1000		±0.002	±0.01		*	±0.02	% of FSR
OUTPUT								
Voltage	I_O = 5mA, T_{MIN} to T_{MAX}	±13.5	±13.7		*	*		V
	V_S = ±11.4V, R_L = 2kΩ	±10	±10.5		*	*		V
	V_S = ±2.25V, R_L = 2kΩ	±1	±1.5		*	*		V
Load Capacitance Stability			1000			*		pF
Short Circuit Current			+20/–15			*		mA
FREQUENCY RESPONSE								
Bandwidth, –3dB	G = 1		1			*		MHz
	G = 10		100			*		kHz
	G = 100		10			*		kHz
	G = 1000		1			*		kHz
Slew Rate	V_O = ±10V, G = 10	0.3	0.6		*	*		V/μs
Settling Time, 0.01%	G = 1		18			*		μs
	G = 10		20			*		μs
	G = 100		120			*		μs
	G = 1000		1100			*		μs
Overload Recovery	50% Overdrive		20			*		μs
POWER SUPPLY								
Voltage Range		±2.25	±15	±18	*	*	*	V
Current	V_{IN} = 0V		±2.2	±3		*	*	mA
TEMPERATURE RANGE								
Specification		–40		85	*		*	°C
Operating		–40		125	*		*	°C
θ_{JA}			80			*		°C/W

* Specification same as INA114BP/BU.

NOTE: (1) Temperature coefficient of the "50kΩ" term in the gain equation.

PIN CONFIGURATIONS



ABSOLUTE MAXIMUM RATINGS(1)

Supply Voltage	±18V
Input Voltage Range	±40V
Output Short-Circuit (to ground)	Continuous
Operating Temperature	–40°C to +125°C
Storage Temperature	–40°C to +125°C
Junction Temperature	+150°C
Lead Temperature (soldering, 10s)	+300°C

NOTE: (1) Stresses above these ratings may cause permanent damage.

ELECTROSTATIC DISCHARGE SENSITIVITY

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

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

PACKAGE/ORDERING INFORMATION

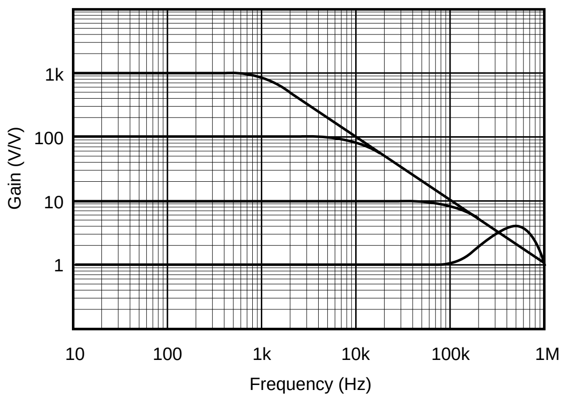
PRODUCT	PACKAGE	PACKAGE DRAWING NUMBER(1)	TEMPERATURE RANGE
INA114AP	8-Pin Plastic DIP	006	–40°C to +85°C
INA114BP	8-Pin Plastic DIP	006	–40°C to +85°C
INA114AU	SOL-16 Surface-Mount	211	–40°C to +85°C
INA114BU	SOL-16 Surface-Mount	211	–40°C to +85°C

NOTE: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix C of Burr-Brown IC Data Book.

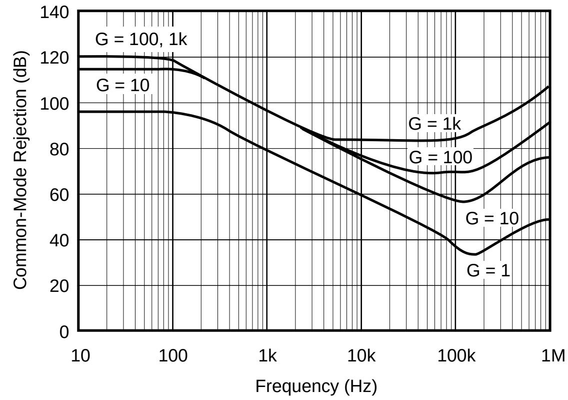
TYPICAL PERFORMANCE CURVES

At T_A = +25°C, V_S = ±15V, unless otherwise noted.

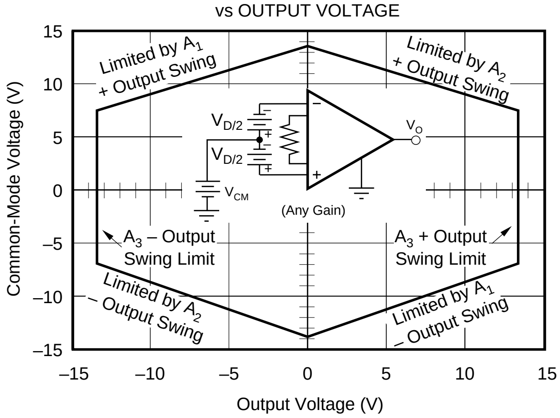
GAIN vs FREQUENCY



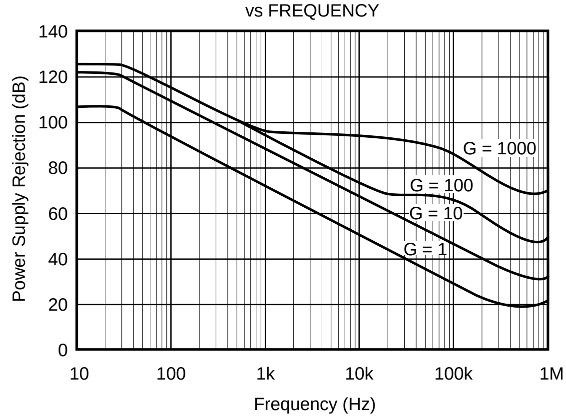
COMMON-MODE REJECTION vs FREQUENCY



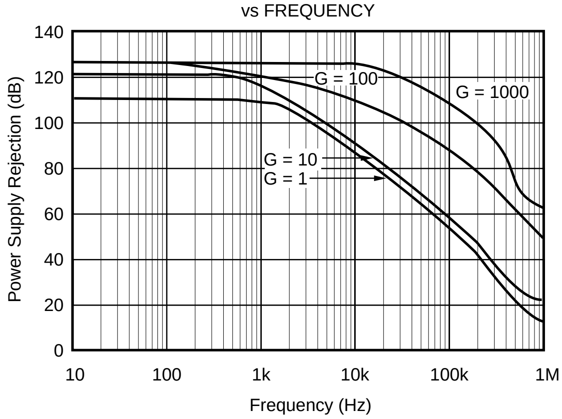
INPUT COMMON-MODE VOLTAGE RANGE
vs OUTPUT VOLTAGE



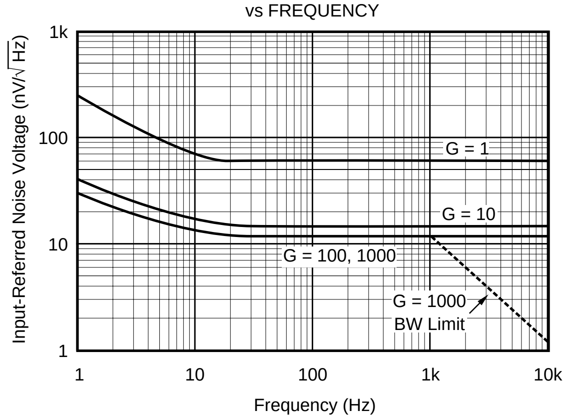
POSITIVE POWER SUPPLY REJECTION
vs FREQUENCY



NEGATIVE POWER SUPPLY REJECTION
vs FREQUENCY



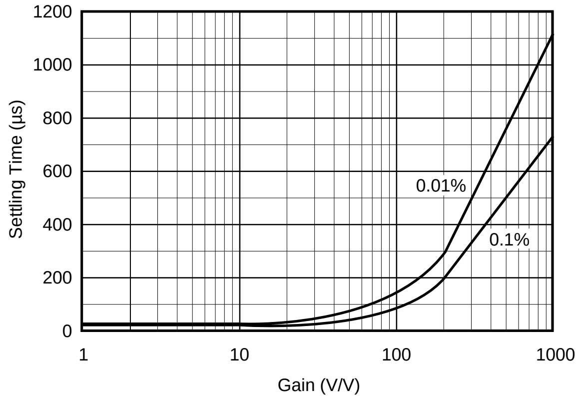
INPUT-REFERRED NOISE VOLTAGE
vs FREQUENCY



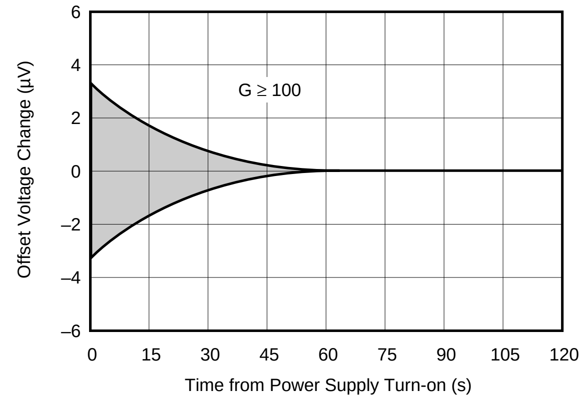
TYPICAL PERFORMANCE CURVES (CONT)

At $T_A = +25°C$, $V_S = ±15V$, unless otherwise noted.

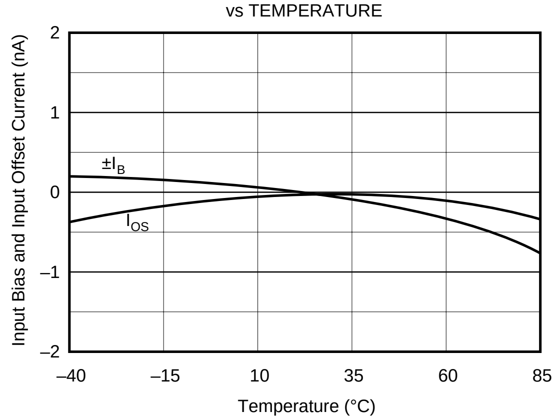
SETTLING TIME vs GAIN



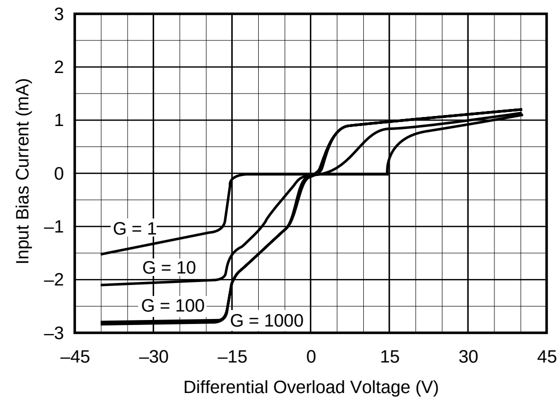
OFFSET VOLTAGE WARM-UP vs TIME



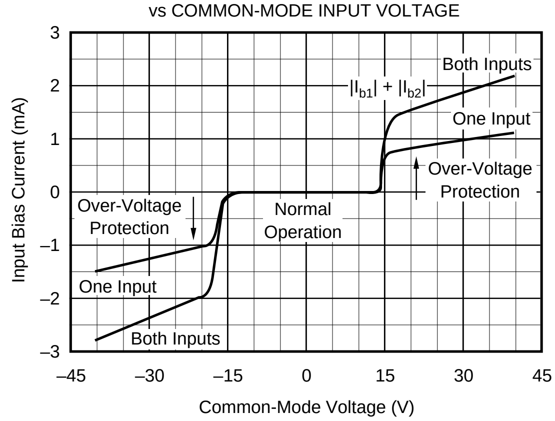
INPUT BIAS AND INPUT OFFSET CURRENT
vs TEMPERATURE



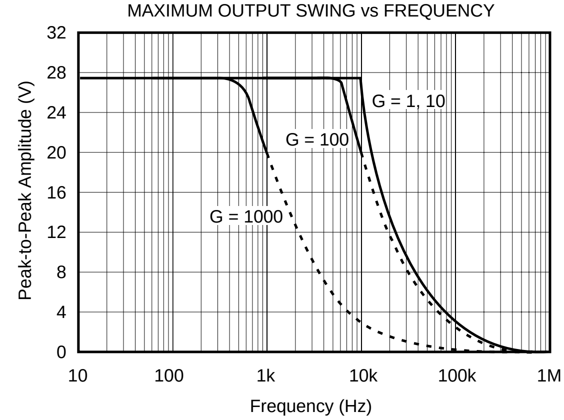
INPUT BIAS CURRENT
vs DIFFERENTIAL INPUT VOLTAGE



INPUT BIAS CURRENT
vs COMMON-MODE INPUT VOLTAGE

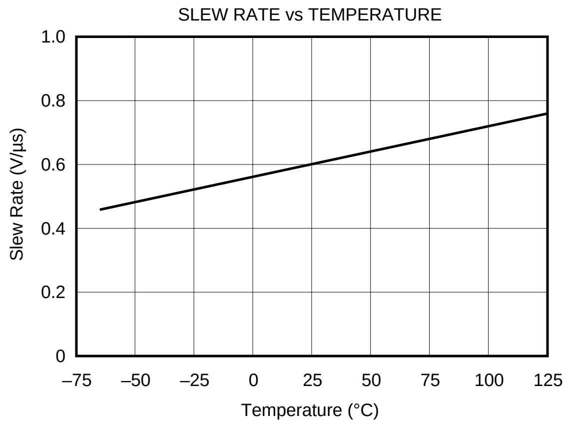


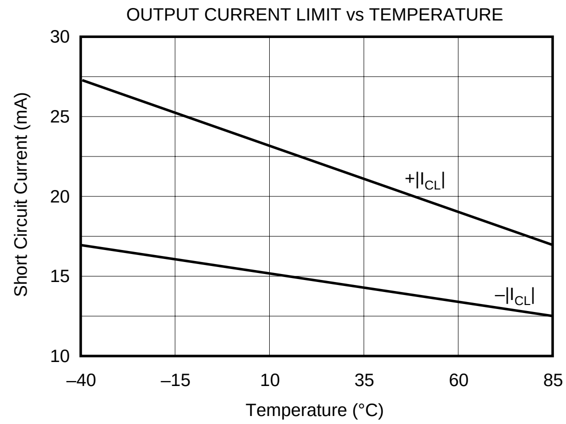
MAXIMUM OUTPUT SWING vs FREQUENCY

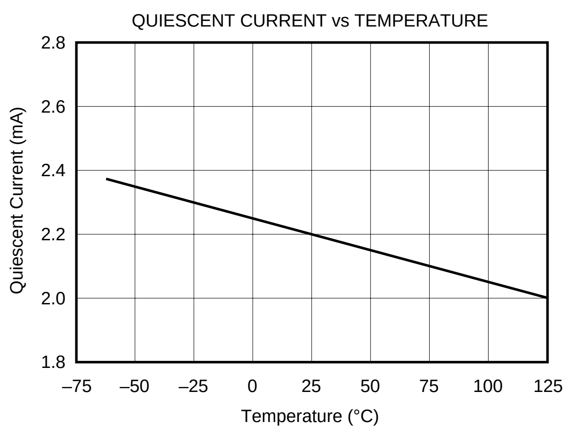


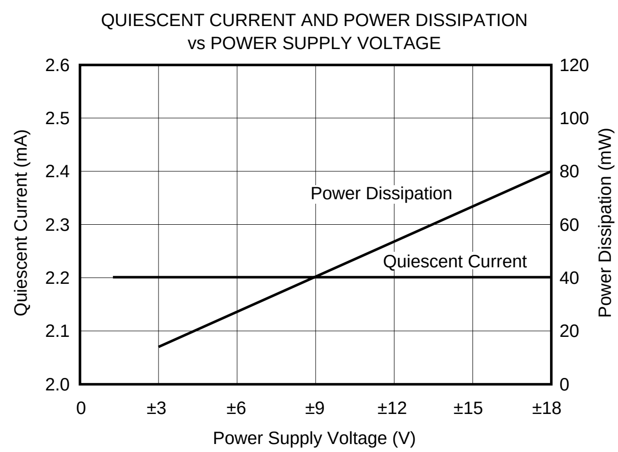
TYPICAL PERFORMANCE CURVES (CONT)

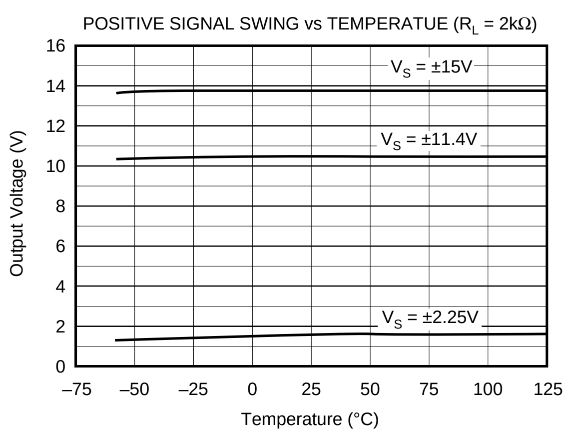
At T_A = +25°C, V_S = ±15V, unless otherwise noted.

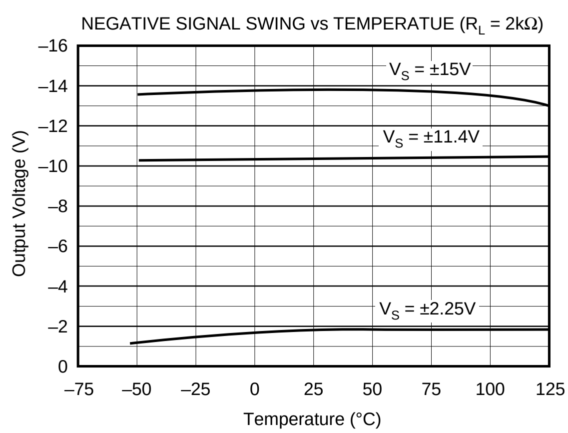








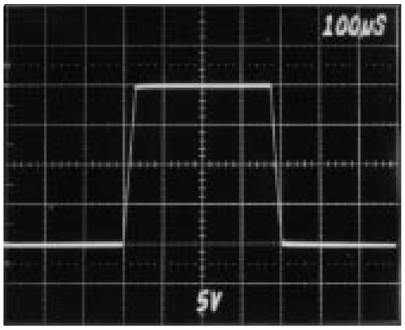




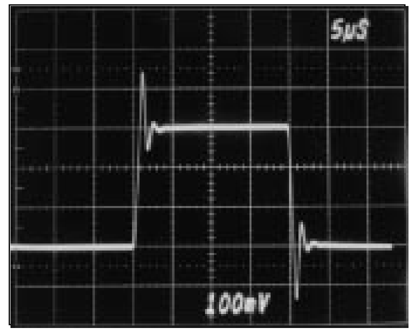
TYPICAL PERFORMANCE CURVES (CONT)

At $T_A = +25°C$, $V_S = ±15V$, unless otherwise noted.

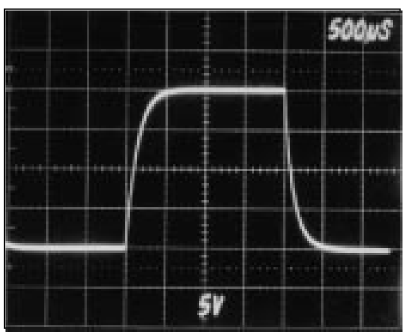
LARGE SIGNAL RESPONSE, G = 1



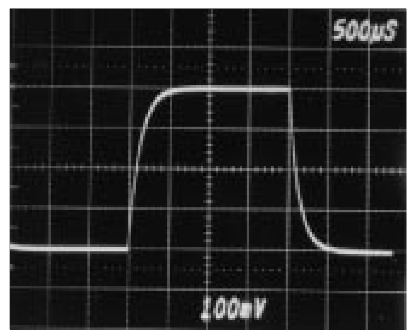
SMALL SIGNAL RESPONSE, G = 1



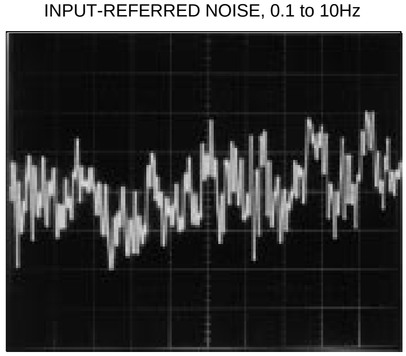
LARGE SIGNAL RESPONSE, G = 1000



SMALL SIGNAL RESPONSE, G = 1000



INPUT-REFERRED NOISE, 0.1 to 10Hz



APPLICATION INFORMATION

Figure 1 shows the basic connections required for operation of the INA114. Applications with noisy or high impedance power supplies may require decoupling capacitors close to the device pins as shown.

The output is referred to the output reference (Ref) terminal which is normally grounded. This must be a low-impedance connection to assure good common-mode rejection. A resistance of 5Ω in series with the Ref pin will cause a typical device to degrade to approximately 80dB CMR (G = 1).

SETTING THE GAIN

Gain of the INA114 is set by connecting a single external resistor, R_G:

$$G = 1 + \frac{50\ k\Omega}{R_G} \quad (1)$$

Commonly used gains and resistor values are shown in Figure 1.

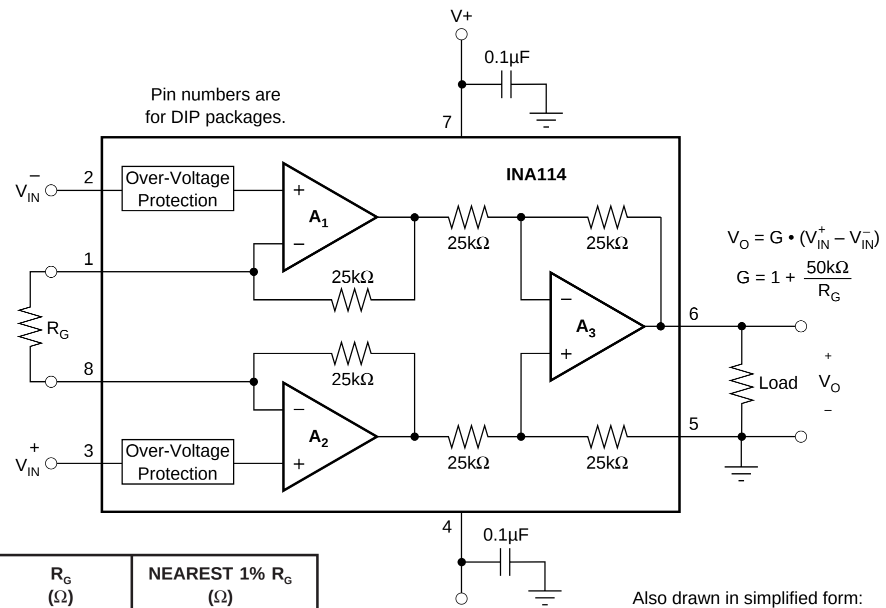
The 50kΩ term in equation (1) comes from the sum of the two internal feedback resistors. These are on-chip metal film resistors which are laser trimmed to accurate absolute values. The accuracy and temperature coefficient of these resistors are included in the gain accuracy and drift specifications of the INA114.

The stability and temperature drift of the external gain setting resistor, R_G, also affects gain. R_G's contribution to gain accuracy and drift can be directly inferred from the gain equation (1). Low resistor values required for high gain can make wiring resistance important. Sockets add to the wiring resistance which will contribute additional gain error (possibly an unstable gain error) in gains of approximately 100 or greater.

NOISE PERFORMANCE

The INA114 provides very low noise in most applications. For differential source impedances less than 1kΩ, the INA103 may provide lower noise. For source impedances greater than 50kΩ, the INA111 FET-input instrumentation amplifier may provide lower noise.

Low frequency noise of the INA114 is approximately 0.4µVp-p measured from 0.1 to 10Hz. This is approximately one-tenth the noise of "low noise" chopper-stabilized amplifiers.



DESIRED GAIN	R_G (Ω)	NEAREST 1% R_G (Ω)
1	No Connection	No Connection
2	50.00k	49.9k
5	12.50k	12.4k
10	5.556k	5.62k
20	2.632k	2.61k
50	1.02k	1.02k
100	505.1	511
200	251.3	249
500	100.2	100
1000	50.05	49.9
2000	25.01	24.9
5000	10.00	10
10000	5.001	4.99

Also drawn in simplified form:

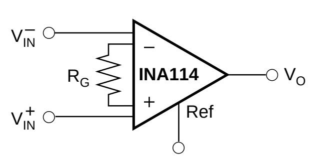


FIGURE 1. Basic Connections.

OFFSET TRIMMING

The INA114 is laser trimmed for very low offset voltage and drift. Most applications require no external offset adjustment. Figure 2 shows an optional circuit for trimming the output offset voltage. The voltage applied to Ref terminal is summed at the output. Low impedance must be maintained at this node to assure good common-mode rejection. This is achieved by buffering trim voltage with an op amp as shown.

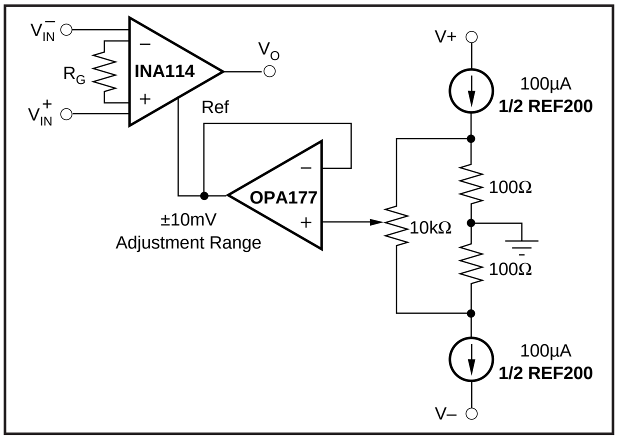


FIGURE 2. Optional Trimming of Output Offset Voltage.

INPUT BIAS CURRENT RETURN PATH

The input impedance of the INA114 is extremely high—approximately $10^{10}\Omega$. However, a path must be provided for the input bias current of both inputs. This input bias current is typically less than ±1nA (it can be either polarity due to cancellation circuitry). High input impedance means that this input bias current changes very little with varying input voltage.

Input circuitry must provide a path for this input bias current if the INA114 is to operate properly. Figure 3 shows various provisions for an input bias current path. Without a bias current return path, the inputs will float to a potential which exceeds the common-mode range of the INA114 and the input amplifiers will saturate. If the differential source resistance is low, bias current return path can be connected to one input (see thermocouple example in Figure 3). With higher source impedance, using two resistors provides a balanced input with possible advantages of lower input offset voltage due to bias current and better common-mode rejection.

INPUT COMMON-MODE RANGE

The linear common-mode range of the input op amps of the INA114 is approximately ±13.75V (or 1.25V from the power supplies). As the output voltage increases, however, the linear input range will be limited by the output voltage swing of the input amplifiers, A_1 and A_2. The common-mode range is related to the output voltage of the complete amplifier—see performance curve "Input Common-Mode Range vs Output Voltage."

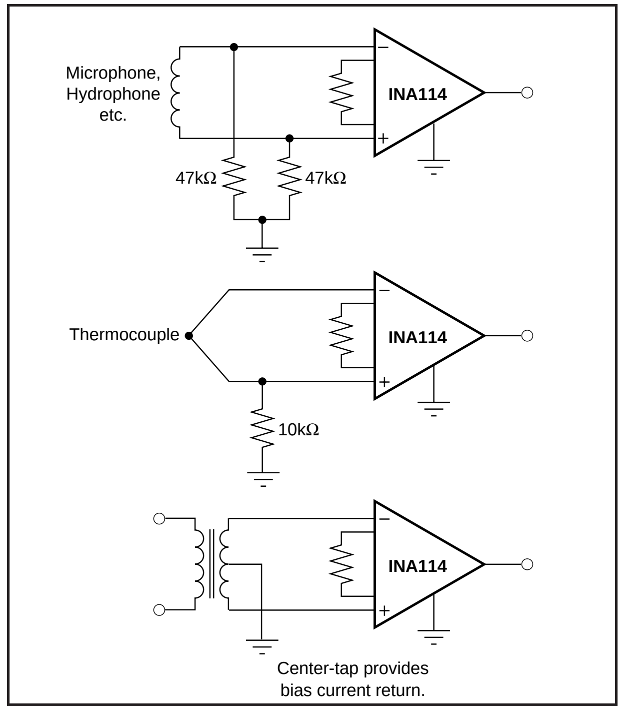


FIGURE 3. Providing an Input Common-Mode Current Path.

A combination of common-mode and differential input signals can cause the output of A_1 or A_2 to saturate. Figure 4 shows the output voltage swing of A_1 and A_2 expressed in terms of a common-mode and differential input voltages. Output swing capability of these internal amplifiers is the same as the output amplifier, A_3. For applications where input common-mode range must be maximized, limit the output voltage swing by connecting the INA114 in a lower gain (see performance curve "Input Common-Mode Voltage Range vs Output Voltage"). If necessary, add gain after the INA114 to increase the voltage swing.

Input-overload often produces an output voltage that appears normal. For example, an input voltage of +20V on one input and +40V on the other input will obviously exceed the linear common-mode range of both input amplifiers. Since both input amplifiers are saturated to nearly the same output voltage limit, the difference voltage measured by the output amplifier will be near zero. The output of the INA114 will be near 0V even though both inputs are overloaded.

INPUT PROTECTION

The inputs of the INA114 are individually protected for voltages up to ±40V. For example, a condition of –40V on one input and +40V on the other input will not cause damage. Internal circuitry on each input provides low series impedance under normal signal conditions. To provide equivalent protection, series input resistors would contribute excessive noise. If the input is overloaded, the protection circuitry limits the input current to a safe value (approximately 1.5mA). The typical performance curve "Input Bias Current vs Common-Mode Input Voltage" shows this input current limit behavior. The inputs are protected even if no power supply voltage is present.

OUTPUT VOLTAGE SENSE (SOL-16 package only)

The surface-mount version of the INA114 has a separate output sense feedback connection (pin 12). Pin 12 must be connected to the output terminal (pin 11) for proper operation. (This connection is made internally on the DIP version of the INA114.)

The output sense connection can be used to sense the output voltage directly at the load for best accuracy. Figure 5 shows how to drive a load through series interconnection resistance. Remotely located feedback paths may cause instability. This can be generally be eliminated with a high frequency feedback path through C_1. Heavy loads or long lines can be driven by connecting a buffer inside the feedback path (Figure 6).

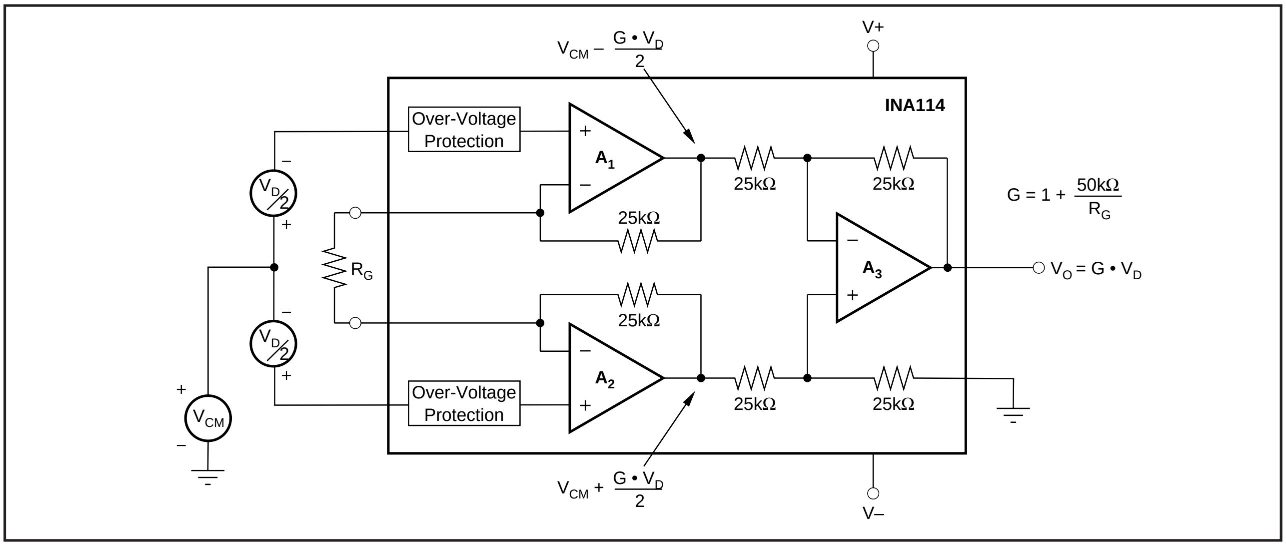


FIGURE 4. Voltage Swing of A_1 and A_2.

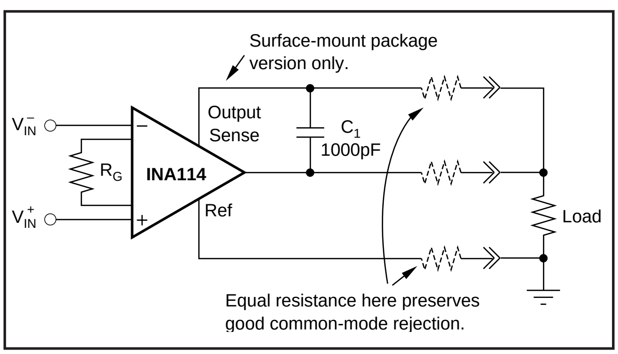


FIGURE 5. Remote Load and Ground Sensing.

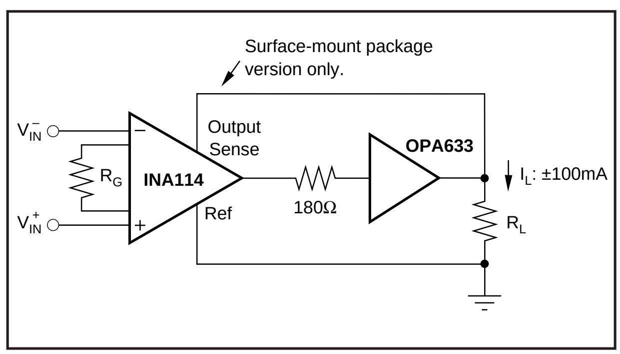


FIGURE 6. Buffered Output for Heavy Loads.

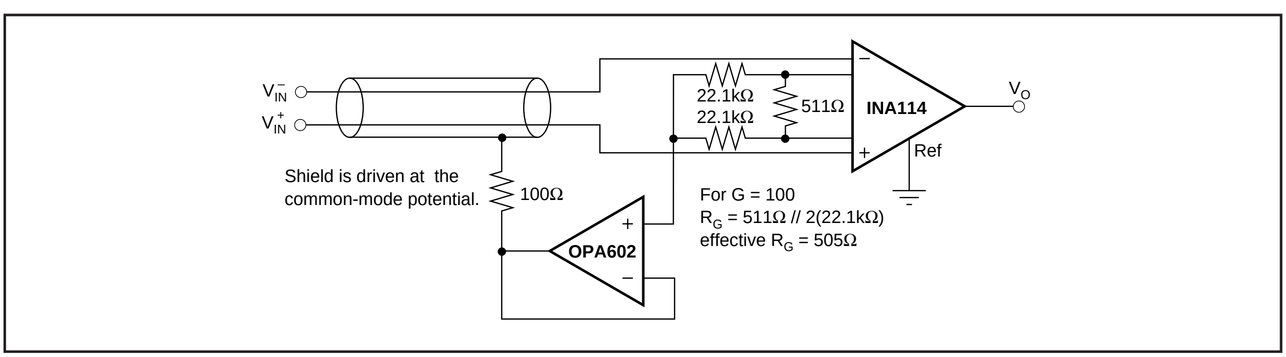


FIGURE 7. Shield Driver Circuit.

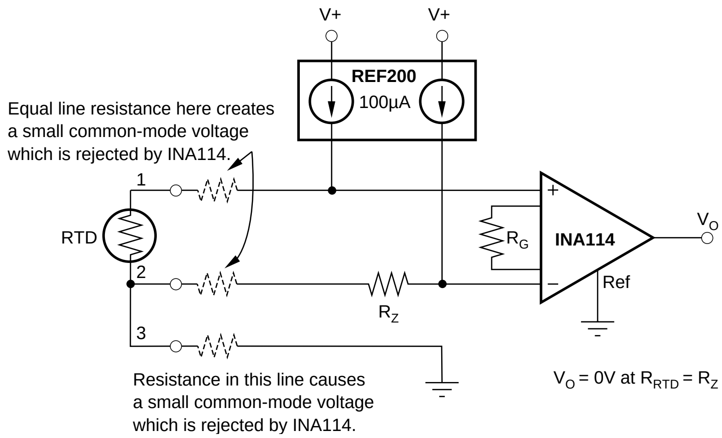
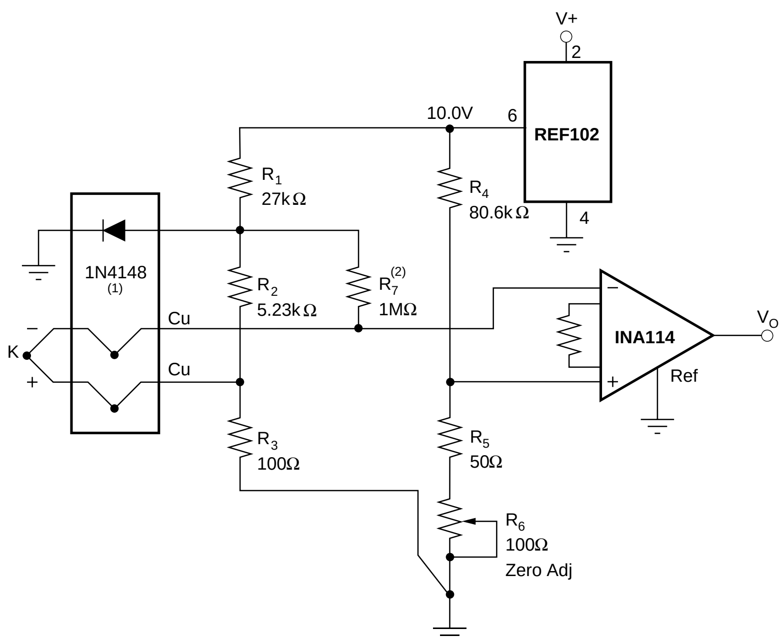


FIGURE 8. RTD Temperature Measurement Circuit.



ISA TYPE	MATERIAL	SEEBECK COEFFICIENT (µV/°C)	R_2 (R_3 = 100Ω)	R_4 (R_5 + R_6 = 100Ω)
E	Chromel Constantan	58.5	3.48kΩ	56.2kΩ
J	Iron Constantan	50.2	4.12kΩ	64.9kΩ
K	Chromel Alumel	39.4	5.23kΩ	80.6kΩ
T	Copper Constantan	38.0	5.49kΩ	84.5kΩ

NOTES: (1) –2.1mV/°C at 200µA. (2) R_7 provides down-scale burn-out indication.

FIGURE 9. Thermocouple Amplifier With Cold Junction Compensation.

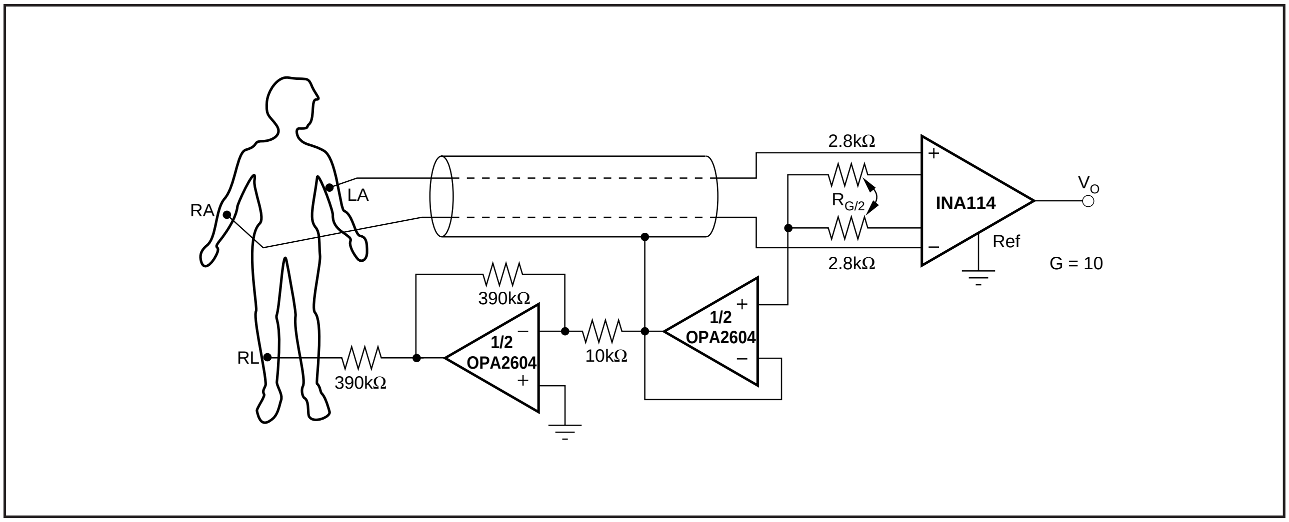


FIGURE 10. ECG Amplifier With Right-Leg Drive.

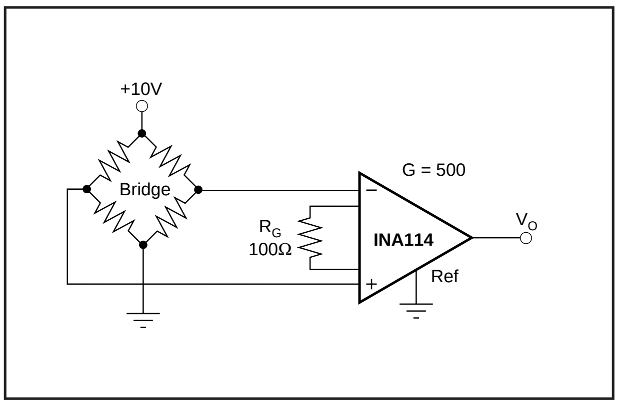


FIGURE 11. Bridge Transducer Amplifier.

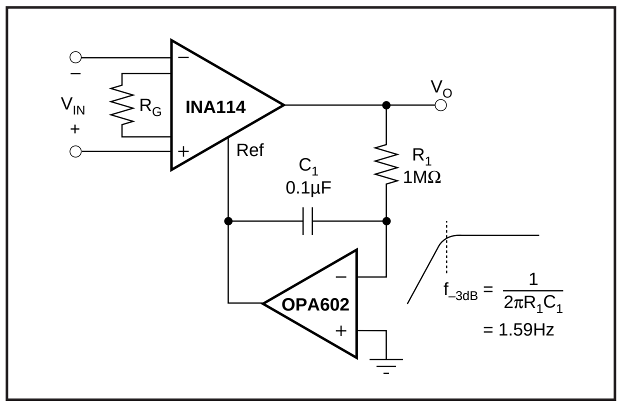
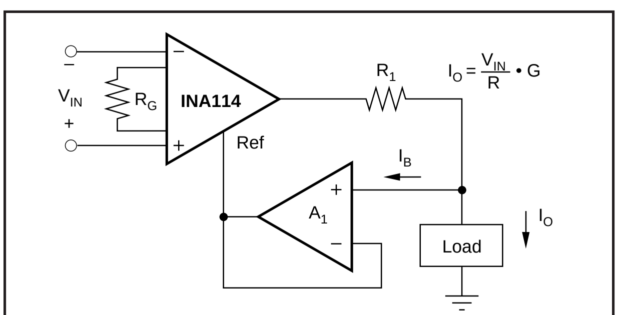


FIGURE 12. AC-Coupled Instrumentation Amplifier.



A_1	I_B Error
OPA177	±1.5nA
OPA602	1pA
OPA128	75fA

FIGURE 13. Differential Voltage-to-Current Converter.

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INA114　計測アンプ　　Burr Brown

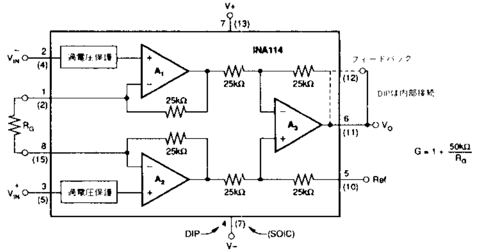
3個の演算増幅器で構成された汎用計測アンプで，1本の外付け抵抗により1～10,000までのゲインが設定できる．入力端子は過電圧保護回路により±40Vの電圧まで保護されている．

- ○動作電源電圧範囲………±2.25V～±18V（±15V typ）
- ○オフセット電圧…………50μV max
- ○ドリフト…………………25μV/℃ max
- ○入力バイアス電流………2nA max
- ○同相モード除去…………115dB min
- ○無信号時電流……………3mA max
- ○パッケージ　8ピン　セラミック　DILパッケージ（コードG）
  - 8ピン　プラスチック　DILパッケージ（コードP）
  - 16ピン　プラスチック　SOパッケージ（コードU）

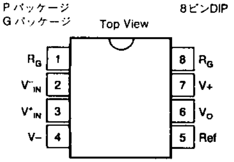
■最大定格

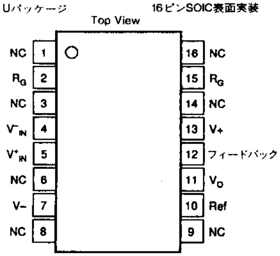
$\pm V_{CC}$	：±18V	T_{stg}	：−40～+125℃
V_{INR}	：±40V	T_j	：150℃
t_{short}	：連続（対GND）	T_{pin}	：300℃・10秒
T_{opt}	：−40～+85℃	θ_{j-A}	：80℃/W

ブロック図



端子接続

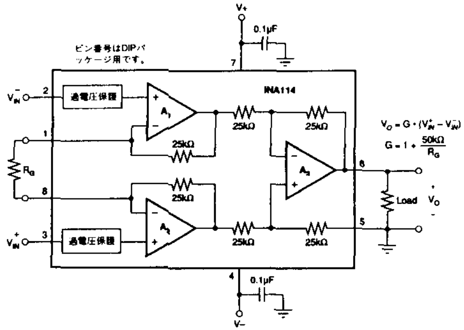




■電気的特性（$\pm V_{CC}=\pm15V$，$R_L=2k\Omega$，$T_A=25℃$）

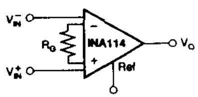
記号	測定条件		INA114BG/BP/BU			INA114AG/AP/AU			単位
			最小	標準	最大	最小	標準	最大	
入力									
オフセット電圧，RTI	初期値　$T_A=25℃$			±10+20/G	±50+100/G		±25+30/G	±125+500/G	μV
	対温度　$T_A=-40$ to 85℃			±0.1+0.5/G	±0.25+5/G		±0.25+5/G	±1+10/G	μV/℃
	対電源　$\pm V_{CC}=\pm2.25V$ to ±18V			0.5+2/G	3+10/G		0.5+2/G	3+10/G	μV/V
	長期安定度			±0.2+0.5/G			±0.2+0.5/G		μV/Month
インピーダンス	差動			10^{10}//6			10^{10}//6		Ω//pF
	同相モード			10^{10}//6			10^{10}//6		
同相モード入力範囲			±11	±13.5		±11	±13.5		V
許容入力電圧					±40			±40	V
同相モード除去	$V_{IC}=\pm10V$，$\Delta R_S=1k\Omega$	$G=1$	80	96		75	90		dB
		$G=10$	96	115		90	106		
		$G=100$	110	120		106	110		
		$G=1000$	115	120		106	110		
バイアス電流				±0.5	±2		±0.5	±5	nA
	対温度			±8			±8		pA/℃
オフセット電流				±0.5	±2		±0.5	±5	nA
	対温度			±8			±8		pA/℃

基本接続



要求ゲイン	R_G (Ω)	E96での近似値 (Ω)
1	No Connection	No Connection
2	50.00k	49.9k
5	12.50k	12.4k
10	5.556k	5.62k
20	2.632k	2.61k
50	1.02k	1.02k
100	505.1	511
200	251.3	249
500	100.2	100
1000	50.05	49.9
2000	25.01	24.9
5000	10.00	10
10000	5.001	4.99

簡略化回路



■電気的特性（つづき）（$\pm V_{CC}=\pm15V$, $R_L=2k\Omega$, $T_A=25℃$）

記号	測定条件		INA114BG/BP/BU 最小	INA114BG/BP/BU 標準	INA114BG/BP/BU 最大	INA114AG/AP/AU 最小	INA114AG/AP/AU 標準	INA114AG/AP/AU 最大	単位
ノイズ電圧，RTI	$G=1000$, $R_S=0\Omega$	$f=10Hz$		15			15		$nV/\sqrt{Hz}$
		$f=100Hz$		11			11		$nV/\sqrt{Hz}$
		$f=1kHz$		11			11		$nV/\sqrt{Hz}$
		$f_B=0.1$ to 10Hz		0.4			0.4		μV_{P-P}
ノイズ電流	$G=1000$, $R_S=0\Omega$	$f=10Hz$		0.4			0.4		$pA/\sqrt{Hz}$
		$f=1kHz$		0.2			0.2		$pA/\sqrt{Hz}$
		$f_B=0.1$ to 10Hz		18			18		pA_{P-P}
ゲイン　ゲイン計算式：1＋（50kΩ/R_G）V/V									
ゲイン範囲			1		10000	1		10000	V/V
ゲイン誤差		$G=1$		±0.01	±0.05		±0.01	±0.05	%
		$G=10$		±0.02	±0.4		±0.02	±0.5	%
		$G=100$		±0.05	±0.5		±0.05	±0.7	%
		$G=1000$		±0.5	±1		±0.5	±2	%
対温度		$G=1$		±2	±10		±2	±10	ppm/℃
非直線性		$G=1$		±0.0001	±0.001		±0.0001	±0.002	% of FSR
		$G=10$		±0.0005	±0.002		±0.0005	±0.004	% of FSR
		$G=100$		±0.0005	±0.002		±0.0005	±0.004	% of FSR
		$G=1000$		±0.002	±0.01		±0.002	±0.02	% of FSR
出力									
電圧	$I_{OUT}=5mA$, $T_A=-40$ to +85℃		±13.5	±13.7		±13.5	±13.7		V
	$\pm V_{CC}=\pm11.4V$, $R_L=2k\Omega$		±10	±10.5		±10	±10.5		V
	$\pm V_{CC}=\pm2.25V$, $R_L=2k\Omega$		±1	±1.5		±1	±1.5		V
容量性負荷	安定動作			1000			1000		pF
短絡電流				+20/−15			+20/−15		mA
ダイナミック・レスポンス									
帯域幅	−3dB	$G=1$		1			1		MHz
		$G=10$		100			100		kHz
		$G=100$		10			10		kHz
		$G=1000$		1			1		kHz
スルーレート	$V_{OUT}=\pm10V$, $G=10$		0.3	0.6		0.3	0.6		V/μs
セットリング・タイム	To 0.01%	$G=1$		18			18		μs
		$G=10$		20			20		μs
		$G=100$		120			120		μs
		$G=1000$		1100			1100		μs
過負荷復帰	50%オーバ・ドライブ			20			20		μs
電源									
電圧範囲			±2.25	±15	±18	±2.25	±15	±18	V
電流	$V_{IN}=0V$			±2.2	±3		±2.2	±3	mA