VA-1 VA-2
PRECISION INSTRUMENTATION AMPLIFIER

TECHNICAL REFERENCE

Click to see photo: www.eeci.com/va-1p.htm

PHONE.................. (937) 349-6000
ORDERS................ (800) 842-7714
TECH SUPPORT... (937) 349-6000
E-mail.................... sales@eeci.com

www.eeci.com
Click for Website

SPECIFICATIONS

Size (VA-1)........................1.75" by 3.75" (VA-2).............1.75" by 5.25"

Weight (VA-1)...................1 ounce (VA-2)............. 2 ounces

Voltage output range.........0 to 5 volts DC

Voltage input range...........adjustable: 0 to 1 millivolt through 0 to 5 volts DC (0 to 100 millivolt typical)

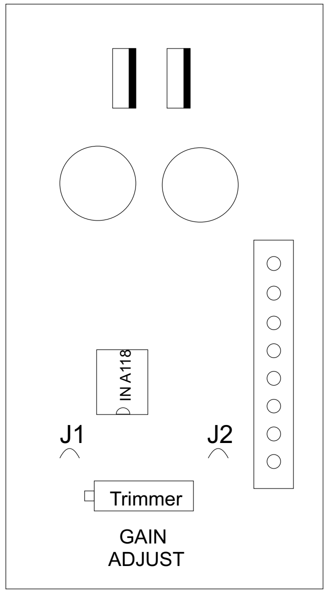
Differential input range......adjustable: +1 to -1 millivolt through +5 to -5 volts DC (+1 to -1 volt typical)

Power requirements..........18 to 24 volts DC (50 milliamp)

TECHNICAL SUPPORT

Technical support for our products is available by calling (937) 349-6000. If a technical adviser is not available, please leave your name, phone number and a time that you can be reached. Your call will be returned within 24 hours.

CONNECTION DIAGRAM



(USE CAUTION, REVERSED POLARITY MAY CAUSE DAMAGE)

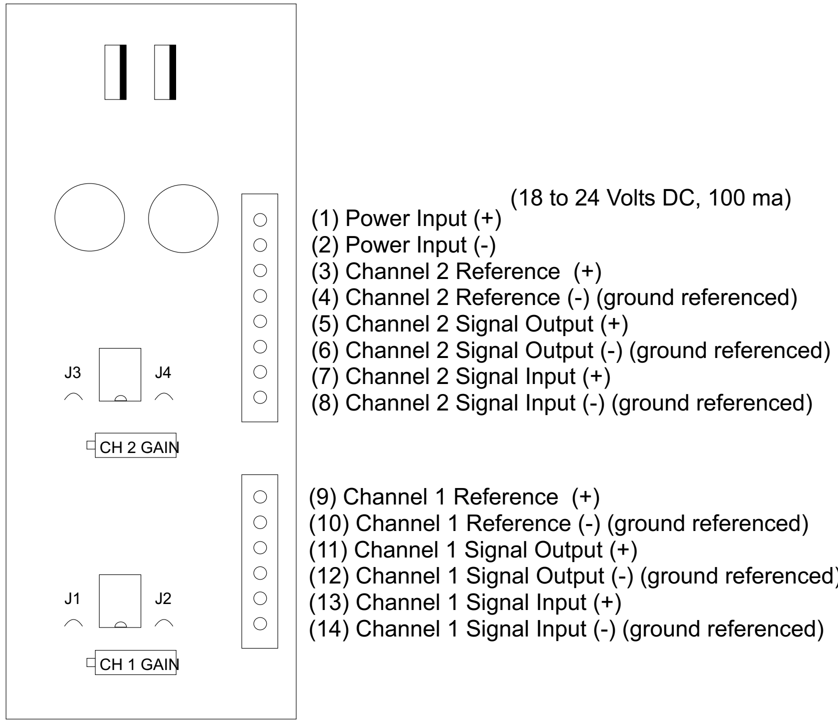
(1) Power Input (+) (18 to 24 Volts DC, 50 ma)*
(2) Power Input (-)
(3) ADC-16 Reference (+) (for differential inputs only)
(4) ADC-16 Reference (-) (connected to terminal (6))
(5) Amplifier Output (+)
(6) ADC-16 Reference (-)
(7) Signal In (+)
(8) Signal In (-) (ground referenced)

*Use PS-12VDC-500 power supply (unregulated)
The power souce must be completely isolated.
Do not use the VA-1 power source to power the ADC-16 or any other device.

NOTE: If a zero voltage output is desired with the inputs floating (left disconnected), install a 50K ohm resistor across the VA-1 input. This will however, greatly reduce the input impedance and may slightly load your signal source.

Terminals (3) and (4) are not used unless the input signal is differential.

VA-2 CONNECTION DIAGRAM



POWER SUPPLY REQUIREMENTS

The power supply used to power the VA-1 or VA-2 must be isolated from the ADC-16. We recommend a seperate isolated power source for use with the VA-1 to prevent voltage offsets and to reduce possible noise sources to the op amps. A wall type transformer supply is available for the VA-1 and VA-2 (specify PS-12VDC-500 when ordering). Note: The PS-12VDC-500 is an unregulated supply and provides a voltage output of approximately 18 volts DC under a 50 milliamp load. Voltage regulators on the VA-1 or VA-2 convert this voltage to a regulated + and - 8 volts DC.

ADJUSTMENTS

NOTE: Two .01 mf filter capacitors are installed at the amplifier inputs to filter out input noise. These filter capacitors may be removed to provide a faster response time for the input.

GAIN: (voltage amplification level)...Using a digital multimeter (set to the 10 volt DC range), measure the voltage across the reference (-) and (+) at the RCT-8 (connected to the ADC-16). Make a note of this voltage to within 10 millivolts (it should be about 5 volts). Now connect the digital multimeter to the voltage output on the VA-1 or VA-2. Apply the full scale input voltage to the the VA-1 or VA-2 input. A test voltage may be generated using the circuit shown in figure A. Adjust the gain trimpot so that the digital multimeter equals the voltage that you previously measured across reference (-) and (+). The VA-1 is now adjusted for this input voltage range. EXAMPLE: If a 0 to 100 millivolt input range is desired, apply 100 millivolts to the input and adjust the output to equal the ADC-16 reference voltage. The 8 bit ADC-16 will display the analog information equal to 100 millivolts divided into 256 increments (0 millivolts = 0, 50 millivolts = 128, 100 millivolts = 255, etc.).

There are several options available when selecting the desired input range and gain sensitivity. Both J1 and J2 may be removed and replaced with resistances of various values to decrease gain sensitivity and/or to place upper and lower limits on the gain adjustment. The trimpot may be completely removed and replaced with a fixed value resistance to prevent any changes to the gain or to prevent minor changes in gain as a result of vibration or temperature changes. A low temperature coefficient resister may be desired if maximum accuracy is required when the VA-1 is operated in changing temperature environments.

In the event that the input voltage range is greater than 0 to 400 millivolts, it will be necessary to remove one of the two jumpers and replacing with a series resistance of the needed value (3K or greater, up to 50K). One of the jumpers may be completely removed (disconnecting the 5K trimpot) if a gain of 1 is desired. For input voltage ranges below 0 to 200 millivolts, you may wish to replace the 5K trimpot with a 1K or 500 ohm trimpot and adding a series resistance to decrease gain sensitivity. This will allow you to fine tune the gain with greater precision (see gain resistance charts on the following pages).

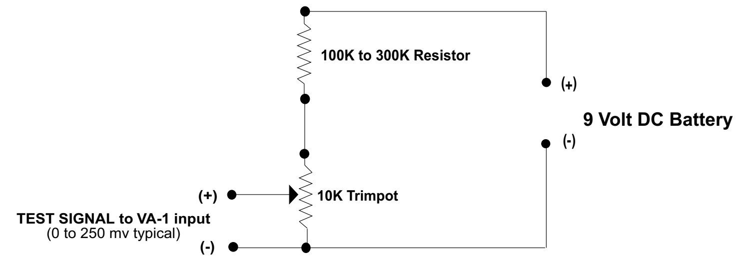


FIGURE A

INPUT NOISE

Input noise will become more of a problem the lower the input range (at the 0 to 5 millivolt input range, noise will be quite apparent). When the input to the VA-1 or VA-2 is left disconnected, the output voltage will fluctuate as a result of this noise and usually will generate a negative output signal as a result of insufficient input bias current. If a zero voltage output is desired with the inputs floating (left disconnected), install a 50K ohm resistor across the VA-1 input. This will however, greatly reduce the input impedance and may slightly load your signal source. Input noise is generated by a variety of sources such as radio signals, light fixtures, electric motors, lightning, etc. Most input noise is easily eliminated by installing the VA-1 or VA-2 in a metal enclosure and using shielded cable on the input connections (the shield should not be connected at the source and should be connected to an earth ground at the VA-1). The shield should be also connected to the metal enclosure and the ADC-16 REF (-)). A 1 mf or 10 mf filter capacitor may be installed across the VA-1 input to help reduce fluctuations caused by noise. The filter capacitor may be removed if faster response times are required for the analog input.

IMPORTANT: When calibrating the VA-1 or VA-2, it is important that you remain clear of any device which may produce noise (such as fluorescent lamps, motors, transformers, power supplies, soldering apparatus, etc.).

INPUT IMPEDANCE

The input impedance of the VA-1 and VA-2 amplifiers is approximately 1 trillion ohms with the filter capacitors and the 10 megohm input resistor shunt removed. The amplifiers require only a 5 nA input current and have high common-mode rejection (115db at G=1,000).

A variety of input configurations are possible. The (V-) input to the amplifier is normally connected to REF (-) which is also connected to the ADC-16 or ADC-4 power ground and to the RS-232 signal ground. On a desk-top PC, the RS-232 signal ground is also connected to an electrical system ground (and earth ground) through the third prong on the computer's electrical cord. The (V-) input to the amplifier may be removed from ground if desired (although a 100K (or lower) resistor connected to ground at both (+) and (-) inputs may be necessary to reduce input noise to the amplifier and to provide the needed input bias current). The data sheets on the following pages show a number of possible input configurations.

USE OF THERMOCOUPLES

Most types of themocouples may be connected directly to the VA-1 input. Type K thermocouples will reverse polarity at approximately room temperature so it will be necessary to configure the VA-1 for differential input to read temperatures which produce a negative voltage. Adjust the amplifier gain to allow for the desired temperature range.
NOTE: The VA-1 is a linear amplifier. Since the output from a thermocouple is not linear, it will be necessary to provide the proper calculations in your software to compensate for the difference.

DIFFERENTIAL SIGNAL INPUTS

The VA-1 will accept most types of differential input signals from various instruments, load cells, transducers, etc.

To configure the VA-1 for differential signals, all that is necessary is to connect the REF (+) (terminal (3) on the VA-1) to the REF(+) output on the ADC-16 or ADC-4. The connection of terminal (3) will create a 2.5 volt offset at the output to allow the negative side of the differential signal to be passed on to the 0 to 5 volt input to the ADC-16 or ADC-4. It will not be necessary to connect terminal (4) to the ADC-16 if the REF (-) terminal (6) is already connected to the REF (-) ground on the ADC-16 or ADC-4. Adjust the gain on the VA-1 for the desired input voltage range. EXAMPLE: With the VA-1 adjusted for a -1 volt to +1 volt input range the VA-1 ouput will be 0 volts with the input at -1 volt, 2.5 volts with the input at 0 volts and 5 volts with the input at +1 volt.

BURR-BROWN®

INA118

ADVANCED INFORMATION
SUBJECT TO CHANGE

Precision, Low Power
INSTRUMENTATION AMPLIFIER

FEATURES

- LOW OFFSET VOLTAGE: 50μV max
- LOW DRIFT: 0.5μV/°C max
- LOW INPUT BIAS CURRENT: 5nA max
- HIGH CMR: 115dB min
- INPUT PROTECTED TO ±40V
- WIDE SUPPLY RANGE: ±1.35 to ±18V
- LOW QUIESCENT CURRENT: 280μA
- 8-PIN PLASTIC DIP, SO-8

APPLICATIONS

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

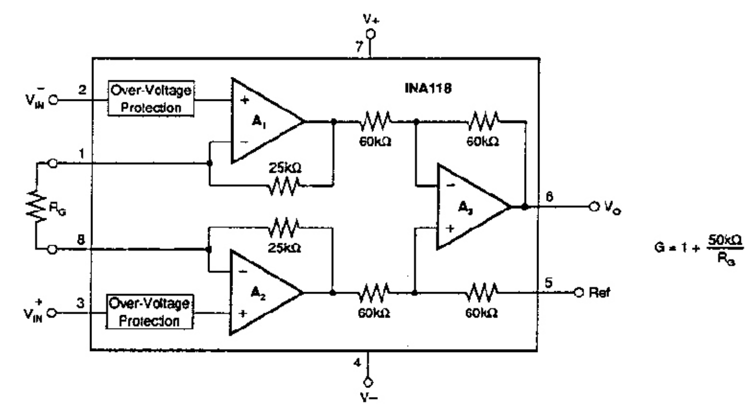
DESCRIPTION

The INA118 is a low power, 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. Current-feedback input circuitry provides wide bandwidth even at high gain (100kHz at G=100).

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

The INA118 is laser trimmed for very low offset voltage (50μV), drift (0.5μV/°C) and high common-mode rejection (115dB at G = 1000). It operates with power supplies as low as ±1.35V, and quiescent current is only 280μA—ideal for battery operated systems.

The INA118 is available in 8-pin plastic DIP, and SO-8 surface-mount packages, specified for the –40°C to +85°C temperature range.



SPECIFICATIONS

ELECTRICAL

At T_A = +25°C, V_S = ±15V, R_L = 10kΩ unless otherwise noted.

PARAMETER	CONDITIONS	INA118PB, UB MIN	INA118PB, UB TYP	INA118PB, UB MAX	INA118P, U MIN	INA118P, U TYP	INA118P, U MAX	UNITS
INPUT								
Offset Voltage, RTI								
Initial	T_A = +25°C		±10 ± 50/G	±50 ± 250/G		±25 ±100/G	±125 ± 750/G	µV
vs Temperature	T_A = T_{MIN} to T_{MAX}		±0.2 ± 0.3/G	±0.5 ± 5/G		±0.2 ± 1/G	±1 ± 10/G	µV/°C
vs Power Supply	V_S = ±1.35V to ±18V		±1 ±10/G	3 ± 100/G		*	*	µV/V
Long-Term Stability			±0.5 ±1/G			*		µV/mo
Impedance, Differential			10^{10} ∥ 5			*		Ω ∥ pF
Common-Mode			10^{10} ∥ 5			*		Ω ∥ pF
Input Common-Mode Range	V_O = 0V		$\pm V_S$ ±0.9			*		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			±1	±5		*	±10	nA
vs Temperature			±20			*		pA/°C
OFFSET CURRENT			±1	±5		*	±10	nA
vs Temperature			±20			*		pA/°C
NOISE VOLTAGE, RTI	G = 1000, R_S = 0Ω							
f = 10Hz			12			*		nV/√Hz
f = 100Hz			10			*		nV/√Hz
f = 1kHz			9			*		nV/√Hz
f_B = 0.1Hz to 10Hz			0.4			*		µVp-p
Noise Current								
f=10Hz			0.6			*		pA/√Hz
f=1kHz			0.3			*		pA/√Hz
f_B = 0.1Hz to 10Hz			25			*		pAp-p
GAIN								
Gain Equation			1 + (50kΩ/R_G)			*		V/V
Range of Gain		1		10000	*		*	V/V
Gain Error	G = 1		±0.01	±0.02		*	±0.1	%
	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		±0.003	±0.01		*	±0.02	% of FSR
OUTPUT								
Voltage	I_O = 2mA, T_{MIN} to T_{MAX}	+14/–14.6	+14.2/–14.6		*	*		V
	V_S = ±1.35V, R_L = 2kΩ	+0.35/–1.15	+0.5/–1.25		*	*		V
Load Capacitance Stability			1000			*		pF
Short Circuit Current			±12			*		mA
FREQUENCY RESPONSE								
Bandwidth, –3dB	G = 1		500			*		kHz
	G = 10		400			*		kHz
	G = 100		100			*		kHz
	G = 1000		10			*		kHz
Slew Rate	V_O = ±10V, G = 10		1			*		V/µs
Settling Time, 0.01%	G = 1		15			*		µs
	G = 10		15			*		µs
	G = 100		15			*		µs
	G = 1000		150			*		µs
Overload Recovery	50% Overdrive		20			*		µs
POWER SUPPLY								
Voltage Range		±1.35	±15	±18	*	*	*	V
Current	V_{IN} = 0V		±280			*		µA
TEMPERATURE RANGE								
Specification		–40		85	*		*	°C
Operating		–40		125	*		*	°C
θ_{JA}			80			*		°C/W

* Specification same as INA118PB, UB.

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

BURR-BROWN®

INA111

High Speed FET-Input INSTRUMENTATION AMPLIFIER

FEATURES

- FET INPUT: I_B = 20pA max
- HIGH SPEED: T_S = 4µs (G = 100, 0.01%)
- LOW OFFSET VOLTAGE: 500µV max
- LOW OFFSET VOLTAGE DRIFT: 5µV/°C max
- HIGH COMMON-MODE REJECTION: 106dB min
- 8-PIN PLASTIC DIP, SOL-16 SOIC

APPLICATIONS

- MEDICAL INSTRUMENTATION
- DATA ACQUISITION

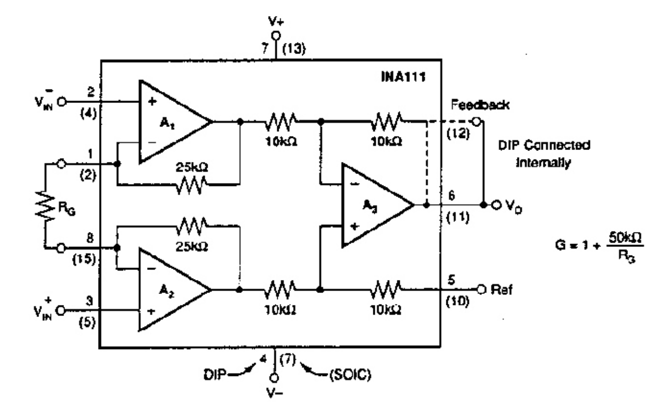
DESCRIPTION

The INA111 is a high speed, FET-input instrumentation amplifier offering excellent performance.

The INA111 uses a current-feedback topology providing extended bandwidth (2MHz at G = 10) and fast settling time (4µs to 0.01% at G = 100). A single external resistor sets any gain from 1 to over 1000.

Offset voltage and drift are laser trimmed for excellent DC accuracy. The INA111's FET inputs reduce input bias current to under 20pA, simplifying input filtering and limiting circuitry.

The INA111 is available in 8-pin plastic DIP, and SOL-16 surface-mount packages, specified for the –40°C to +85°C temperature range.



SPECIFICATIONS

ELECTRICAL

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

PARAMETER	CONDITIONS	INA111BP, BU MIN	INA111BP, BU TYP	INA111BP, BU MAX	INA111AP, AU MIN	INA111AP, AU TYP	INA111AP, AU MAX	UNITS
INPUT								
Offset Voltage, RTI								
Initial	T_A = +25°C		±100 ± 500/G	±500 ± 2000/G		±200 ± 500/G	±1000 ±5000/G	μV
vs Temperature	$T_A = T_{MIN}$ to T_{MAX}		±2 ± 10/G	±5 ± 100/G		±2 ± 20/G	±10 ± 100/G	μV/°C
vs Power Supply	V_S = ±6V to ±18V		2 +10/G	30 + 100/G		*	*	μV/V
Impedance, Differential			10^{12} ∥ 6			*		Ω ∥ pF
Common-Mode			10^{12} ∥ 3			*		Ω ∥ pF
Input Common-Mode Range	V_{DIFF} = 0V	±10	±12		*	*		V
Common-Mode Rejection	V_{CM} = ±10V, ΔR_S = 1kΩ							
	G = 1	80	90		75	*		dB
	G = 10	96	110		90	*		dB
	G = 100	106	115		100	*		dB
	G = 1000	106	115		100	*		dB
BIAS CURRENT			±2	±20		*	*	pA
OFFSET CURRENT			±0.1	±10		*	*	pA
NOISE VOLTAGE, RTI	G = 1000, R_S = 0Ω							
f = 100Hz			13			*		nV/√Hz
f = 1kHz			10			*		nV/√Hz
f = 10kHz			10			*		nV/√Hz
f_B = 0.1Hz to 10Hz			1			*		μVp-p
Noise Current								
f = 10kHz			0.8			*		fA/√Hz
GAIN								
Gain Equation			1 + (50kΩ/R_G)			*		V/V
Range of Gain		1		10000	*		*	V/V
Gain Error	G = 1, R_L = 10kΩ		±0.01	±0.02		*	0.05	%
	G = 10, R_L = 10kΩ		±0.1	±0.5		*	*	%
	G = 100, R_L = 10kΩ		±0.15	±0.5		*	±0.7	%
	G = 1000, R_L = 10kΩ		±0.25	±1		*	±2	%
Gain vs Temperature	G = 1		±1	±10		*	*	ppm/°C
50kΩ Resistance(1)			±25	±100		*	*	ppm/°C
Nonlinearity	G = 1		±0.0005	±0.005		*	*	% of FSR
	G = 10		±0.001	±0.005		*	±0.01	% of FSR
	G = 100		±0.001	±0.005		*	±0.01	% of FSR
	G = 1000		±0.005	±0.02		*	±0.04	% of FSR
OUTPUT								
Voltage	I_O = 5mA, T_{MIN} to T_{MAX}	±11	±12.7		*	*		V
Load Capacitance Stability			1000			*		pF
Short Circuit Current			+30/–25			*		mA
FREQUENCY RESPONSE								
Bandwidth, –3dB	G = 1		2			*		MHz
	G = 10		2			*		MHz
	G = 100		450			*		kHz
	G = 1000		50			*		kHz
Slew Rate	V_O = ±10V, G = 2 to 100		17			*		V/μs
Settling Time, 0.01%	G = 1		2			*		μs
	G = 10		2			*		μs
	G = 100		4			*		μs
	G = 1000		30			*		μs
Overload Recovery	50% Overdrive		1			*		μs
POWER SUPPLY								
Voltage Range		±6	±15	±18	*	*	*	V
Current	V_{IN} = 0V		±3.3	±4.5		*	*	mA
TEMPERATURE RANGE								
Specification		–40		85	*		*	°C
Operating	Plastic P, U	–40		125	*		*	°C
θ_{JA}	Plastic P, U		100			*		°C/W

* Specification same as INA111BP.

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

APPLICATION INFORMATION

Figure 1 shows the basic connections required for operation of the INA111. 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 2Ω in series with the Ref pin will cause a typical device with 90dB CMR to degrade to approximately 80dB CMR (G=1).

SETTING THE GAIN

Gain of the INA111 is set by connecting a single external resistor, R_G:

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

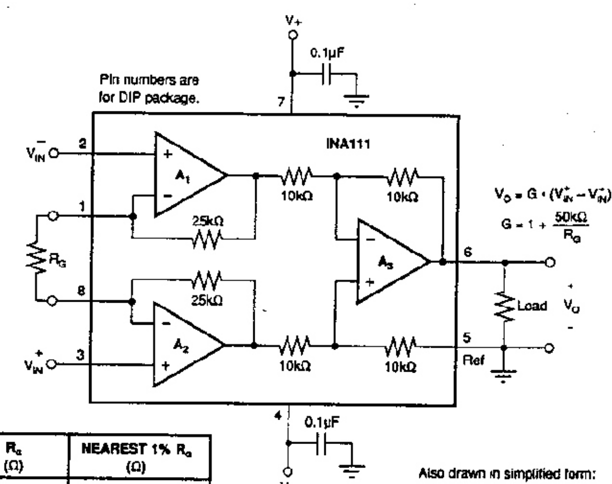
Commonly used gains and resistor values are shown in Figure 1.

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 INA111.

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.

DYNAMIC PERFORMANCE

The typical performance curve "Gain vs Frequency" shows that the INA111 achieves wide bandwidth over a wide range of gain. This is due to the current-feedback topology of the INA111. Settling time also remains excellent over wide gains.



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

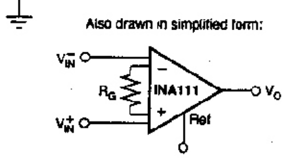


FIGURE 1. Basic Connections

The INA111 exhibits approximately 6dB rise in gain at 2MHz in unity gain. This is a result of its current-feedback topology and is not an indication of instability. Unlike an op amp with poor phase margin, the rise in response is a predictable +6dB/octave due to a response zero. A simple pole at 700kHz or lower will produce a flat passband response (see Input Filtering).

The INA111 provides excellent rejection of high frequency common-mode signals. The typical performance curve, "Common-Mode Rejection vs Frequency" shows this behavior. If the inputs are not properly balanced, however, common-mode signals can be converted to differential signals. Run the V_{IN}^+ and V_{IN}^- connections directly adjacent each other, from the source signal all the way to the input pins. If possible use a ground plane under both input traces. Avoid running other potentially noisy lines near the inputs.

NOISE AND ACCURACY PERFORMANCE

The INA111's FET input circuitry provides low input bias current and high speed. It achieves lower noise and higher accuracy with high impedance sources. With source impedances of 2kΩ to 50kΩ the INA114 may provide lower offset voltage and drift. For very low source impedance (≤1kΩ), the INA103 may provide improved accuracy and lower noise.

OFFSET TRIMMING

The INA111 is laser trimmed for 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. The op amp shown maintains low output impedance at high frequency. Trim circuits with higher source impedance should be buffered with an op amp follower circuit to assure low impedance on the Ref pin.

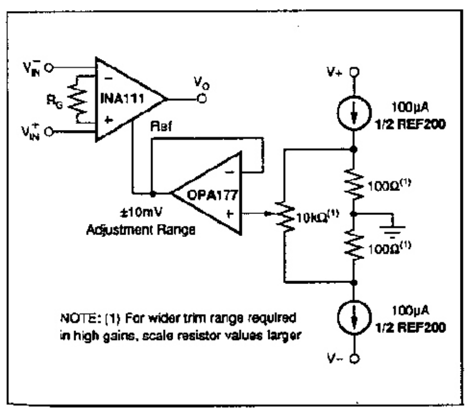


FIGURE 2. Optional Trimming of Output Offset Voltage.

INPUT BIAS CURRENT RETURN PATH

The input impedance of the INA111 is extremely high—approximately $10^{12}Ω$. However, a path must be provided for the input bias current of both inputs. This input bias current is typically less than 10pA. 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 INA111 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 INA111 and the input amplifiers will saturate.

If the differential source resistance is low, the bias current return path can be connected to one input (see the 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 high-frequency common-mode rejection.

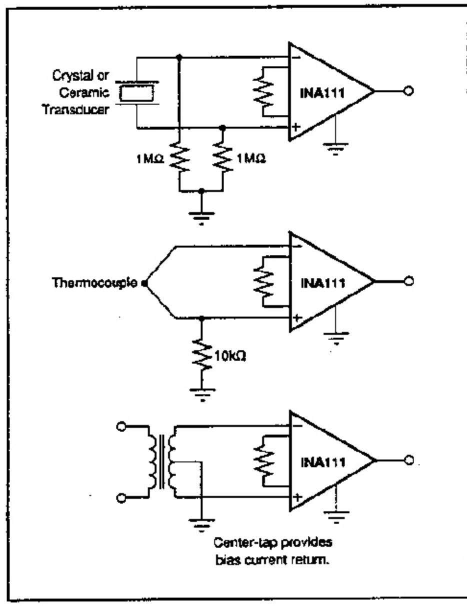


FIGURE 3. Providing an Input Common-Mode Current Path.

INPUT COMMON-MODE RANGE

The linear common-mode range of the input op amps of the INA111 is approximately ±12V (or 3V 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".

A combination of common-mode and differential input voltage 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. For applications where input common-mode range must be maximized, limit the output voltage swing by connecting the INA111 in a lower gain (see performance curve "Input Common-Mode Voltage Range vs Output Voltage"). If necessary, add gain after the INA111 to increase the voltage swing.

Input-overload often produces an output voltage that appears normal. For example, consider an input voltage of +14V on one input and +15V on the other input will obviously exceed the linear common-mode range of both input amplifiers. Since both input amplifiers are saturated to the nearly the same output voltage limit, the difference voltage measured by the output amplifier will be near zero. The output of the INA111 will be near 0V even though both inputs are overloaded.

INPUT PROTECTION

Inputs of the INA111 are protected for input voltages from 0.7V below the negative supply to 15V above the positive power supply voltages. If the input current is limited to less than 1mA, clamp diodes are not required; internal junctions will clamp the input voltage to safe levels. If the input source can supply more than 1mA, use external clamp diodes as shown in Figure 5. The source current can be limited with series resistors R_1 and R_2 as shown. Resistor values greater than 10kΩ will contribute noise to the circuit.

A diode formed with a 2N4117A transistor as shown in Figure 5 assures low leakage. Common signal diodes such as the 1N4148 may have leakage currents far greater than the input bias current of the INA111 and are usually sensitive to light.

INPUT FILTERING

The INA111's FET input allows use of an R/C input filter without creating large offsets due to input bias current. Figure 6 shows proper implementation of this input filter to preserve the INA111's excellent high frequency common-mode rejection. Mismatch of the common-mode input capacitance (C_1 and C_2), either from stray capacitance or

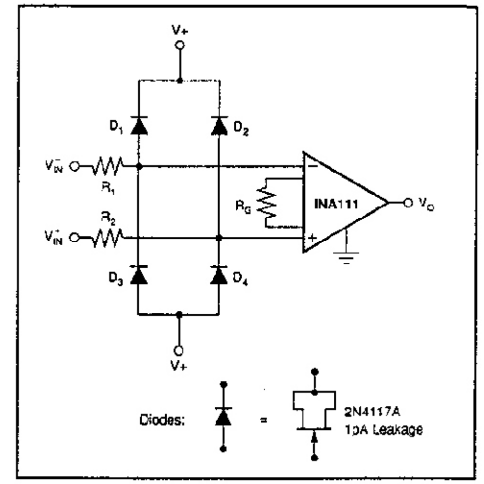


FIGURE 5. Input Protection Voltage Clamp.

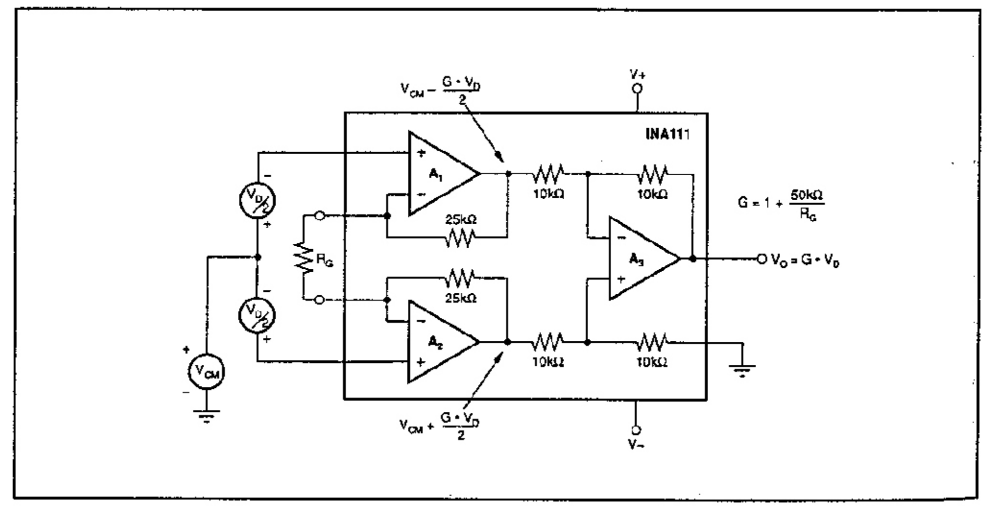


FIGURE 4. Voltage Swing of A_1 and A_2.

mismatched values, causes a high frequency common-mode signal to be converted to a differential signal. This degrades common-mode rejection. The differential input capacitor, C_3, reduces the bandwidth and mitigates the effects of mismatch in C_1 and C_2. Make C_3 much larger than C_1 and C_2. If properly matched, C_1 and C_2 also improve CMR.

OUTPUT VOLTAGE SENSE (SOL-16 Package Only)

The surface-mount version of the INA111 has a separate output sense feedback connection (pin 12). Pin 12 must be connected, usually to the output terminal, pin 11, for proper operation. (This connection is made internally on the DIP version of the INA111.)

The output feedback connection can be used to sense the output voltage directly at the load for best accuracy. Figure 8 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.

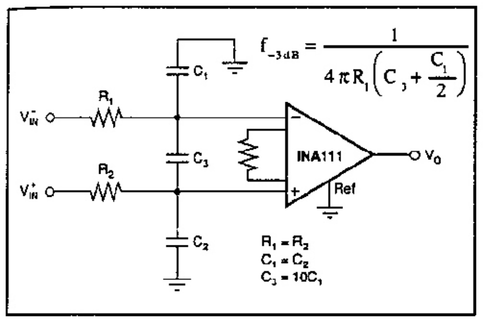


FIGURE 6. Input Low-Pass Filter.

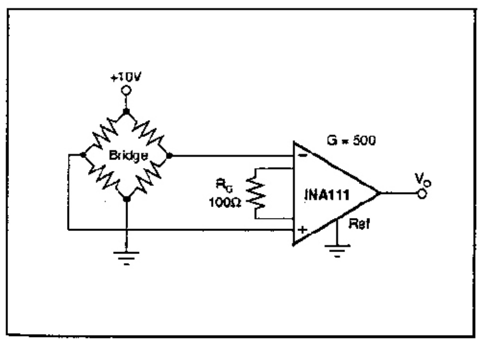


FIGURE 7. Bridge Transducer Amplifier.

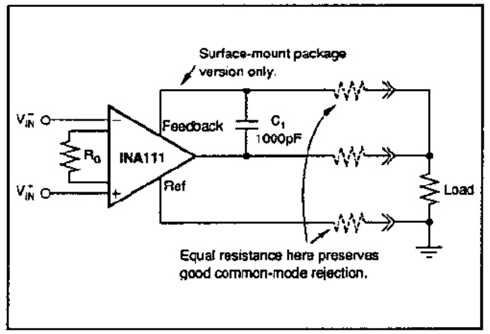


FIGURE 8. Remote Load and Ground Sensing.

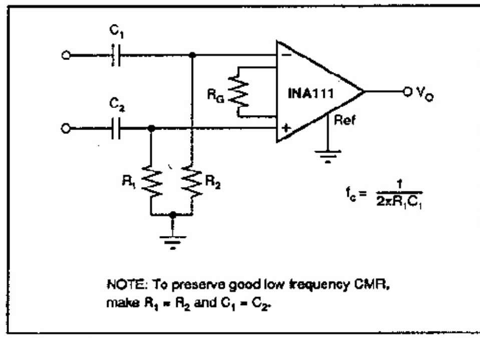


FIGURE 9. High-Pass Input Filter.

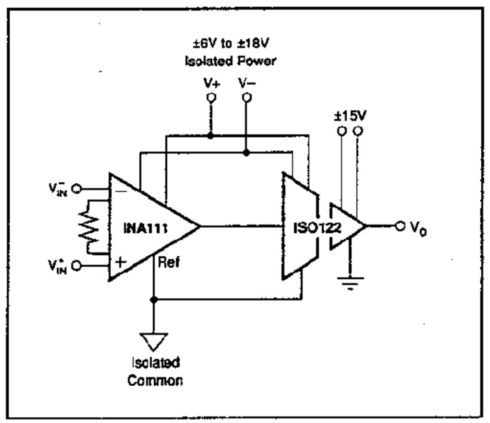


FIGURE 10. Galvanically Isolated Instrumentation Amplifier.

CONTROL SYSTEM TECHNOLOGY

ELECTRONIC ENERGY CONTROL, INC.
14960 Maple Ridge Rd
Milford Center OH 43045-9016
USA
PHONE*................. (937) 349-6000
ORDERS................ (800) 842-7714
TECH SUPPORT... (937) 349-6000
E-mail*.................... cst@eeci.com
Web*........................http://www.eeci.com
*International & Domestic

Copyright © 1989 - 2021 Electronic Energy Control, Inc. All Rights Reserved