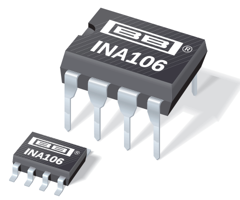


INA106

Precision Gain = 10 DIFFERENTIAL AMPLIFIER

FEATURES

- ACCURATE GAIN: ±0.025% max
- HIGH COMMON-MODE REJECTION: 86dB min
- NONLINEARITY: 0.001% max
- EASY TO USE
- PLASTIC 8-PIN DIP, SO-8 SOIC PACKAGES

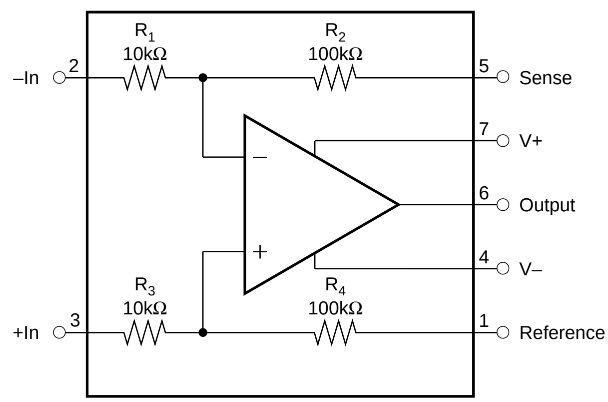
APPLICATIONS

- G = 10 DIFFERENTIAL AMPLIFIER
- G = +10 AMPLIFIER
- G = –10 AMPLIFIER
- G = +11 AMPLIFIER
- INSTRUMENTATION AMPLIFIER

DESCRIPTION

The INA106 is a monolithic Gain = 10 differential amplifier consisting of a precision op amp and on-chip metal film resistors. The resistors are laser trimmed for accurate gain and high common-mode rejection. Excellent TCR tracking of the resistors maintains gain accuracy and common-mode rejection over temperature.

The differential amplifier is the foundation of many commonly used circuits. The INA106 provides this precision circuit function without using an expensive resistor network. The INA106 is available in 8-pin plastic DIP and SO-8 surface-mount packages.



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Internet: http://www.burr-brown.com/ • FAXLine: (800) 548-6133 (US/Canada Only) • Cable: BBRCORP • Telex: 066-6491 • FAX: (520) 889-1510 • Immediate Product Info: (800) 548-6132

 PDS-729F Printed in U.S.A. August, 1998

SPECIFICATIONS

ELECTRICAL

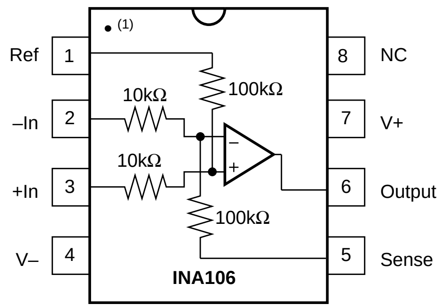
At +25°C, V_S = ±15V, unless otherwise specified.

PARAMETER	CONDITIONS	INA106KP, U MIN	TYP	MAX	UNITS
GAIN					
Initial(1)			10		V/V
Error			0.01	0.025	%
vs Temperature			–4		ppm/°C
Nonlinearity(2)			0.0002	0.001	%
OUTPUT					
Related Voltage	I_O = +20mA, –5mA	10	12		V
Rated Current	V_O = 10V	+20, –5			mA
Impedance			0.01		Ω
Current Limit	To Common		+40/–10		mA
Capacitive Load	Stable Operation		1000		pF
INPUT					
Impedance	Differential		10		kΩ
	Common-Mode		110		kΩ
Voltage Range	Differential	±1			V
	Common-Mode	±11			V
Common-Mode Rejection(3)	$T_A = T_{MIN}$ to T_{MAX}	86	100		dB
OFFSET VOLTAGE	RTI(4)				
Initial			50	200	µV
vs Temperature			0.2		µV/°C
vs Supply	$\pm V_S$ = 6V to 18V		1	10	µV/V
vs Time			10		µV/mo
NOISE VOLTAGE	RTI(5)				
f_B = 0.01Hz to 10Hz			1		µVp-p
f_O = 10kHz			30		$nV/\sqrt{Hz}$
DYNAMIC RESPONSE					
Small Signal	–3dB		5		MHz
Full Power BW	V_O = 20Vp-p	30	50		kHz
Slew Rate		2	3		V/µs
Settling Time: 0.1%	V_O = 10V Step		5		µs
0.01%	V_O = 10V Step		10		µs
0.01%	V_{CM} = 10V Step, V_{DIFF} = 0V		5		µs
POWER SUPPLY					
Rated			±15		V
Voltage Range	Derated Performance	±5		±18	V
Quiescent Current	V_O = 0V		±1.5	±2	mA
TEMPERATURE RANGE					
Specification		0		+70	°C
Operation		–40		+85	°C
Storage		–65		+150	°C

NOTES: (1) Connected as difference amplifier (see Figure 1). (2) Nonlinearity is the maximum peak deviation from the best-fit straight line as a percent of full-scale peak-to-peak output. (3) With zero source impedance (see "Maintaining CMR" section). (4) Includes effects of amplifiers's input bias and offset currents. (5) Includes effect of amplifier's input current noise and thermal noise contribution of resistor network.

PIN CONFIGURATION

Top View | DIP/SOIC



NOTE: (1) Pin 1 indentifier for SO-8 package. Model number identification may be abbreviated on SO-8 package due to limited available space.

ABSOLUTE MAXIMUM RATINGS

Power Supply Voltage	±18V
Input Voltage Range	$\pm V_S$
Operating Temperature Range: P, U	–40°C to +85°C
Storage Temperature Range	–40°C to +85°C
Lead Temperature (soldering, 10s): P	+300°C
Wave Soldering (3s, max) U	+260°C
Output Short Circuit to Common	Continuous

ELECTROSTATIC DISCHARGE SENSITIVITY

This integral 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 published specifications.

PACKAGE/ORDERING INFORMATION

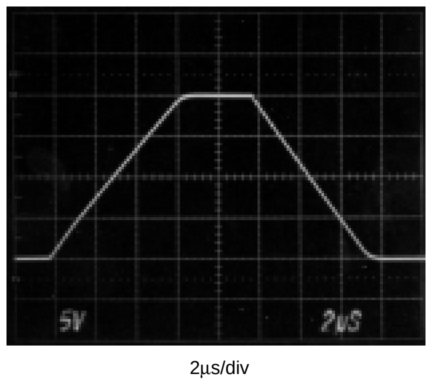
PRODUCT	PACKAGE	PACKAGE DRAWING NUMBER(1)	TEMPERATURE RANGE
INA106KP	8-Pin Plastic DIP	006	0°C to +70°C
INA106U	SO-8 Surface Mount	182	0°C to +70°C

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

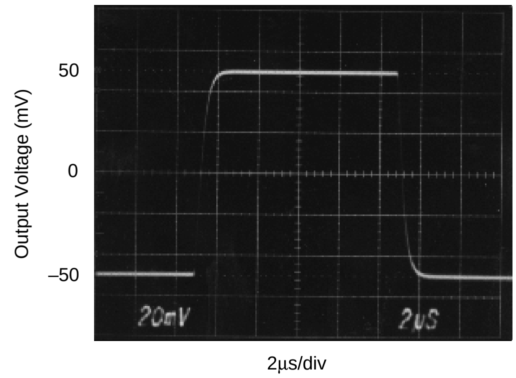
TYPICAL PERFORMANCE CURVES

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

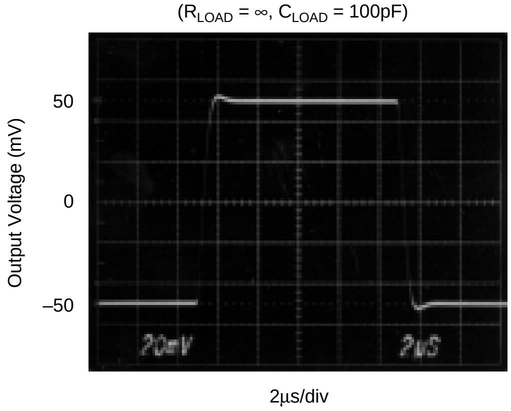
STEP RESPONSE



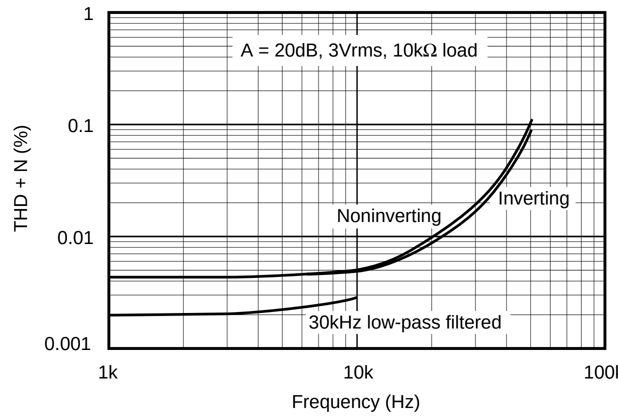
SMALL SIGNAL RESPONSE
(No Load)



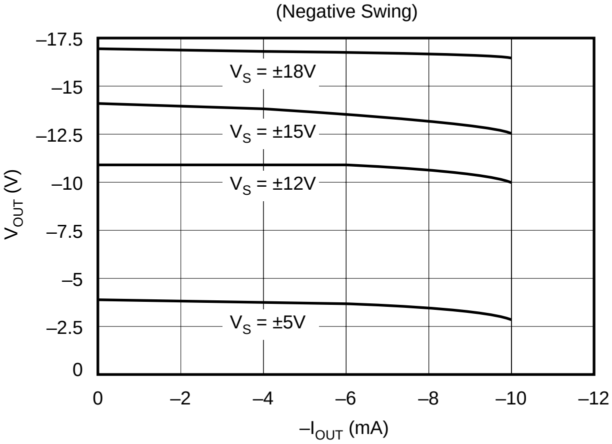
SMALL SIGNAL RESPONSE
(R_{LOAD} = ∞, C_{LOAD} = 100pF)



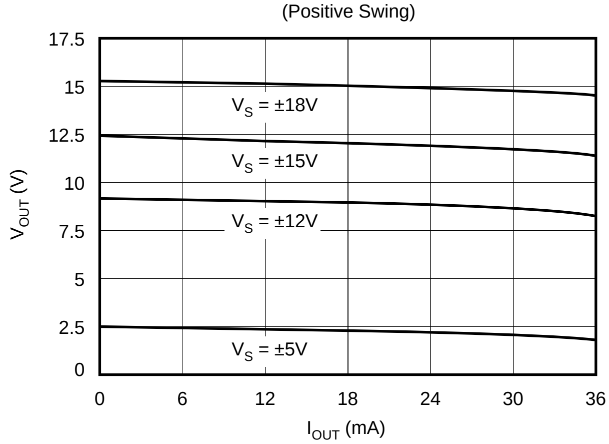
TOTAL HARMONIC DISTORTION AND NOISE
vs FREQUENCY



MAXIMUM V_{OUT} vs I_{OUT}
(Negative Swing)

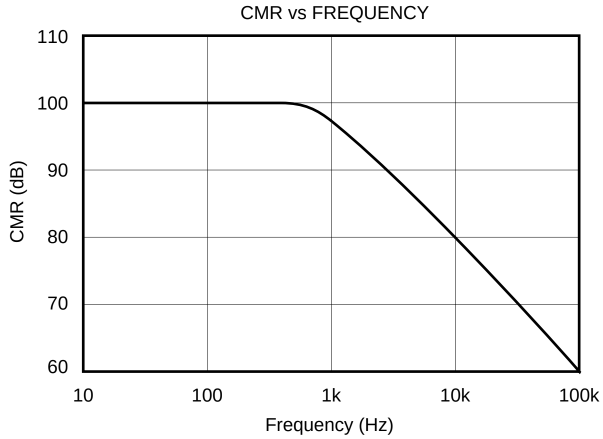


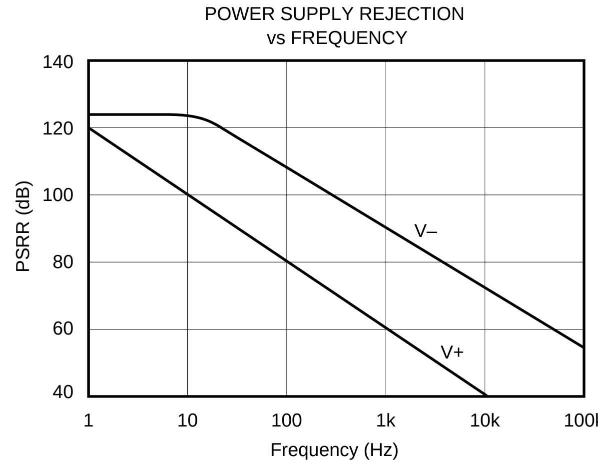
MAXIMUM V_{OUT} vs I_{OUT}
(Positive Swing)



TYPICAL PERFORMANCE CURVES (CONT)

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





APPLICATIONS INFORMATION

Figure 1 shows the basic connections required for operation of the INA106. Power supply bypass capacitors should be connected close to the device pins as shown.

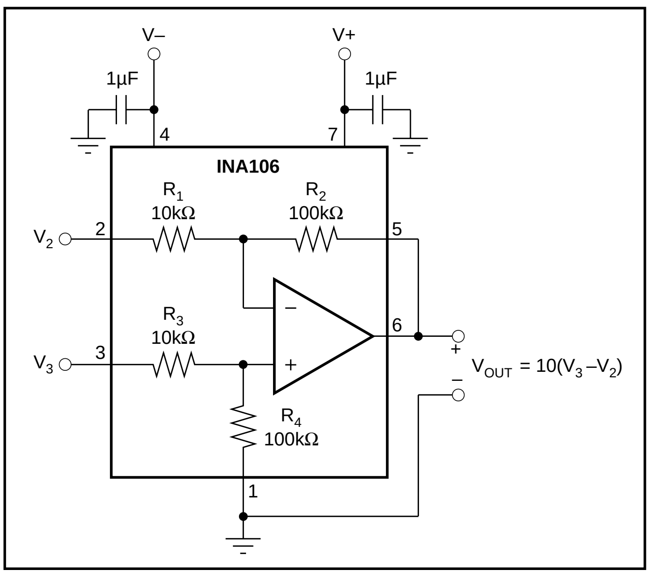


FIGURE 1. Basic Power Supply and Signal Connections.

The differential input signal is connected to pins 2 and 3 as shown. The source impedance connected to the inputs must be equal to assure good common-mode rejection. A 5Ω mismatch in source impedance will degrade the common-mode rejection of a typical device to approximately 86dB. If the source has a known source impedance mismatch, an additional resistor in series with one input can be used to preserve good common-mode rejection.

The output is referred to the output reference terminal (pin 1) which is normally grounded. A voltage applied to the Ref terminal will be summed with the output signal. The source impedance of a signal applied to the Ref terminal should be less than 10Ω to maintain good common-mode rejection.

Figure 2 shows a voltage applied to pin 1 to trim the offset voltage of the INA106. The known 100Ω source impedance of the trim circuit is compensated by the 10Ω resistor in series with pin 3 to maintain good CMR.

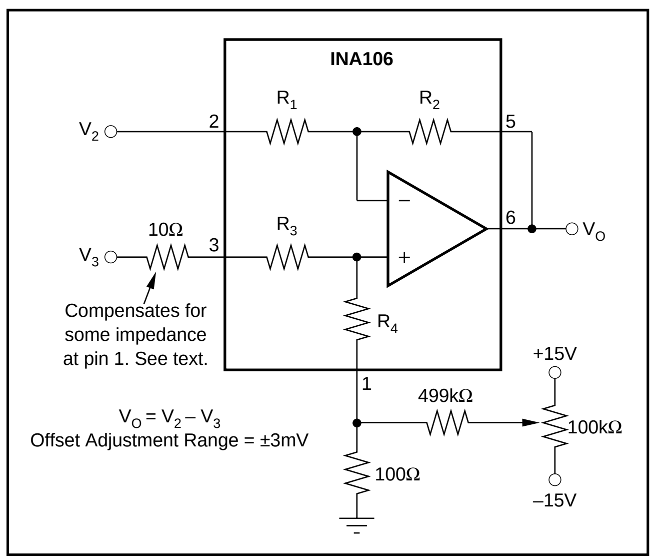
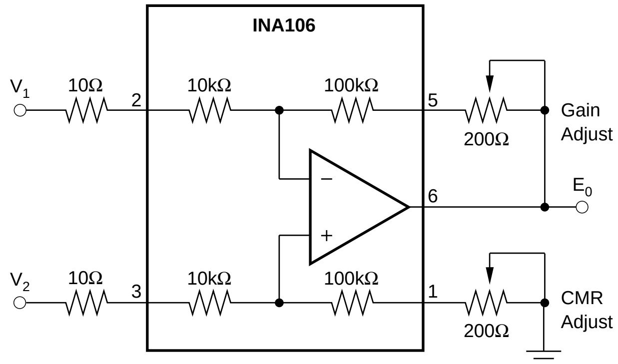


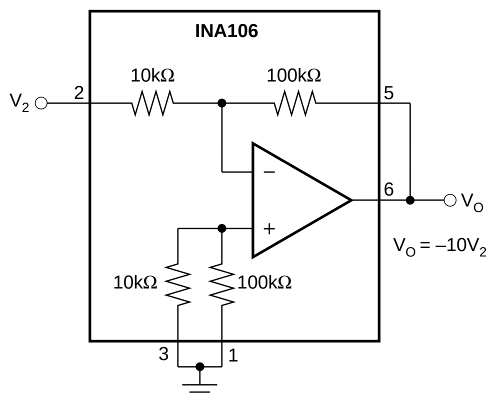
FIGURE 2. Offset Adjustment.

Referring to Figure 1, the CMR depends upon the match of the internal R_4/R_3 ratio to the R_1/R_2 ratio. A CMR of 106dB requires resistor matching of 0.005%. To maintain high CMR over temperature, the resistor TCR tracking must be better than 2ppm/°C. These accuracies are difficult and expensive to reliably achieve with discrete components.



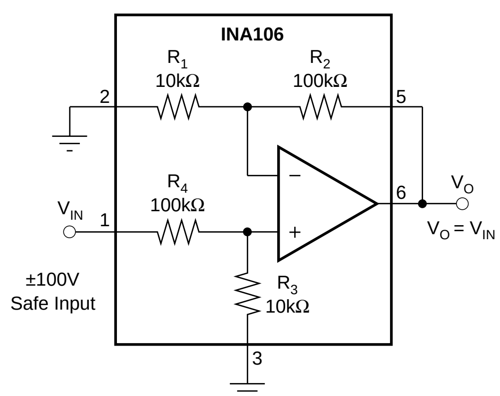
To eliminate adjustment interactions, first adjust gain with V_2 grounded.

FIGURE 3. Difference Amplifier with Gain and CMR Adjust.



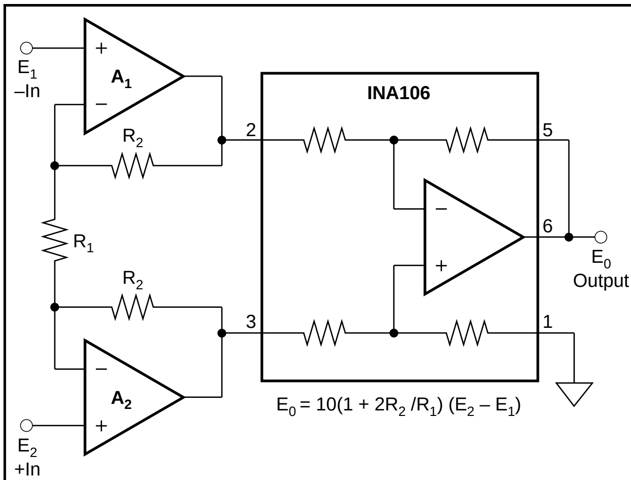
Gain Error = 0.01% maximum
Nonlinearity = 0.001% maximum
Gain Drift = 2.ppm/°C

FIGURE 4. Precision G = –10 Inverting Amplifier.



This circuit follows an 11/1 divider with a gain of 11 for an overall gain of unity. With an 11/1 divider, the input signal can exceed 100V without damage.

FIGURE 5. Voltage Follower with Input Protection.



To make a high performance high gain instrumentation amplifier, the INA106 can be combined with state-of-the-art op amps. For low source impedance applications, OPA37s will give the best noise, offset, and temperature drift. At source impedances above about 10kΩ, the bias current noise of the OPA37 reacting with input impedance degrades noise. For these applications, use an OPA111 or a dual OPA2111 FET input op amp for lower noise. For an electrometer grade IA, use the OPA128—see table below.

Using the INA106 for the difference amplifier also extends the input common-mode range of the instrumentation amplifier to ±10V. A conventional IA with a unity-gain difference amplifier has an input common-mode range limited to ±5V for an output swing of ±10V. This is because a unity-gain difference amp needs ±5V at the input for 10V at the output, allowing only 5V additional for common-mode.

A_1, A_2	R_1 (Ω)	R_2 (kΩ)	GAIN (V/V)	CMRR (dB)	I_b (pA)	NOISE AT 1kHz (nV/$\sqrt{Hz}$)
OPA37A	50.5	2.5	1000	128	40000	4
OPA111B	202	10	1000	110	1	10
OPA128LM	202	10	1000	118	0.075	38

FIGURE 6. Precision Instrumentation Amplifier.

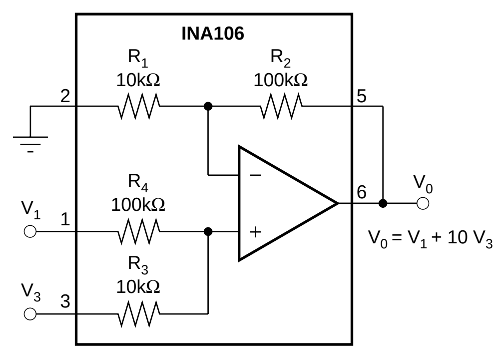


FIGURE 7. Precision Summing Amplifier.

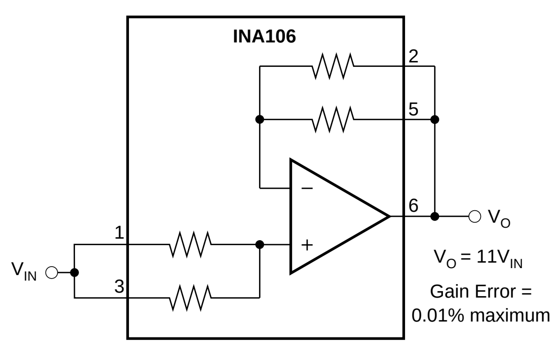


FIGURE 8. Precision G = 11 Buffer.