



THE DATASHEET OF INA166UA





Low-Noise, Low-Distortion, G = 2000 INSTRUMENTATION AMPLIFIER

FEATURES

- LOW NOISE: $1.3nV/\sqrt{Hz}$ at 1kHz
- LOW THD+N: 0.09% at 1kHz
- WIDE BANDWIDTH: 450kHz
- WIDE SUPPLY RANGE: $\pm 4.5V$ to $\pm 18V$
- HIGH CMR: $> 100dB$
- GAIN SET WITH EXTERNAL RESISTOR
- SO-14 SURFACE-MOUNT PACKAGE

APPLICATIONS

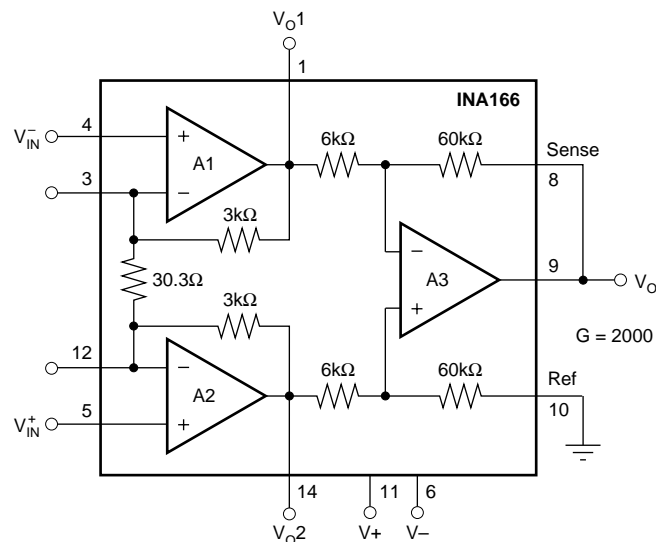
- MOVING-COIL TRANSDUCER AMPLIFIERS
- DIFFERENTIAL RECEIVERS
- BRIDGE TRANSDUCER AMPLIFIERS
- MICROPHONE AND HYDROPHONE PREAMPS

DESCRIPTION

The INA166 is a very low-noise, low-distortion, monolithic instrumentation amplifier. Its current-feedback circuitry achieves very wide bandwidth and excellent dynamic response over a wide range of gain. It is ideal for low-level signals such as microphones or hydrophones. Many industrial, instrumentation, and medical applications also benefit from its low noise and wide bandwidth.

Unique distortion cancellation circuitry reduces distortion to extremely low levels, even in high gain. The INA166 provides near-theoretical noise performance for 200Ω source impedance. Its differential input, low noise, and low distortion provide superior performance as a low-level signal amplifier.

The INA166 is available in a space-saving SO-14 surface-mount package, specified for operation over the $-40^{\circ}C$ to $+85^{\circ}C$ temperature range.

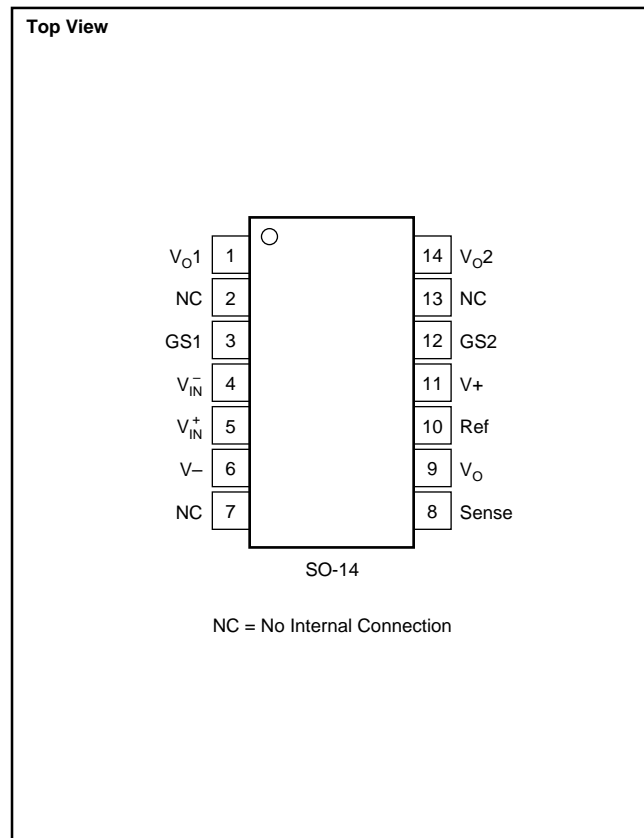


SPECIFICATIONS: $V_S = \pm 5V$

$T_A = +25^\circ\text{C}$ and at rated supplies, $V_S = \pm 5V$, $R_L = 2k\Omega$ connected to ground, $G = 2000$, unless otherwise noted.

PARAMETER	CONDITIONS	INA166UA			UNITS
		MIN	TYP	MAX	
GAIN Gain Error Gain Temp Drift Coefficient Nonlinearity			± 0.3 ± 10 ± 0.005	± 1	% ppm/ $^\circ\text{C}$ % of FS
INPUT REFERRED NOISE Voltage Noise $f_O = 1\text{kHz}$ $f_O = 100\text{Hz}$ $f_O = 10\text{Hz}$ Current Noise $f_O = 1\text{kHz}$	$R_{\text{SOURCE}} = 0\Omega$		1.3 1.6 2 0.8		nV/ $\sqrt{\text{Hz}}$ nV/ $\sqrt{\text{Hz}}$ nV/ $\sqrt{\text{Hz}}$ pA/ $\sqrt{\text{Hz}}$
INPUT OFFSET VOLTAGE Input Offset Voltage vs Temperature vs Power Supply	$V_{\text{CM}} = V_{\text{OUT}} = 0V$ $T_A = T_{\text{MIN}}$ to T_{MAX} $V_S = \pm 4.5V$ to $\pm 18V$		± 50 ± 2.5 ± 1	± 250 ± 3	μV $\mu\text{V}/^\circ\text{C}$ $\mu\text{V}/V$
INPUT VOLTAGE RANGE Common-Mode Voltage Range Common-Mode Rejection	$V_{\text{IN}^+} - V_{\text{IN}^-} = 0V$ $V_{\text{IN}^+} - V_{\text{IN}^-} = 0V$ $V_{\text{CM}} = \pm 1V$, $R_{\text{SRC}} = 0\Omega$	$(V^+) - 4$ $(V^-) + 4$ 100	$(V^+) - 3$ $(V^-) + 3$ 120		V V dB
INPUT BIAS CURRENT Initial Bias Current vs Temperature Initial Offset Current vs Temperature			2.5 15 0.1 0.5	12 1	μA nA/ $^\circ\text{C}$ μA nA/ $^\circ\text{C}$
INPUT IMPEDANCE	Differential Common-Mode		$60 \parallel 2$ $60 \parallel 2$		M $\Omega \parallel$ pF M $\Omega \parallel$ pF
DYNAMIC RESPONSE Bandwidth, Small Signal, -3dB Slew Rate THD+Noise, $f = 1\text{kHz}$ Settling Time, 0.1% 0.01% Overload Recovery	5V Step 5V Step 50% Overdrive		450 15 0.09 2.5 3.5 1		kHz V/ μs % μs μs μs
OUTPUT Voltage Load Capacitance Stability Short-Circuit Current	$R_L = 2k\Omega$ to Ground Continuous-to-Common	$(V^+) - 2$ $(V^-) + 2$	$(V^+) - 1.8$ $(V^-) + 1.8$ 1000 ± 60		V V pF mA
POWER SUPPLY Rated Voltage Voltage Range Current, Quiescent	$I_O = 0\text{mA}$	± 4.5	± 5 ± 10	± 18 ± 12	V V mA
TEMPERATURE RANGE Specification Operating Thermal Resistance, θ_{JA}		-40 -40	 100	$+85$ $+125$	$^\circ\text{C}$ $^\circ\text{C}$ $^\circ\text{C}/\text{W}$

PIN CONFIGURATION



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.

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

Power Supply Voltage	±18V
Signal Input Terminals, Voltage ⁽²⁾	(V-) - 0.5V to (V+) + 0.5V
Current ⁽²⁾	10mA
Output Short-Circuit to Ground	Continuous
Operating Temperature	-55°C to +125°C
Storage Temperature	-55°C to +125°C
Junction Temperature	+150°C
Lead Temperature (soldering, 10s)	+300°C

NOTES: (1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied. (2) Input terminals are diode-clamped to the power-supply rails. Input signals that can swing more than 0.5V beyond the supply rails should be current limited to 10mA or less.

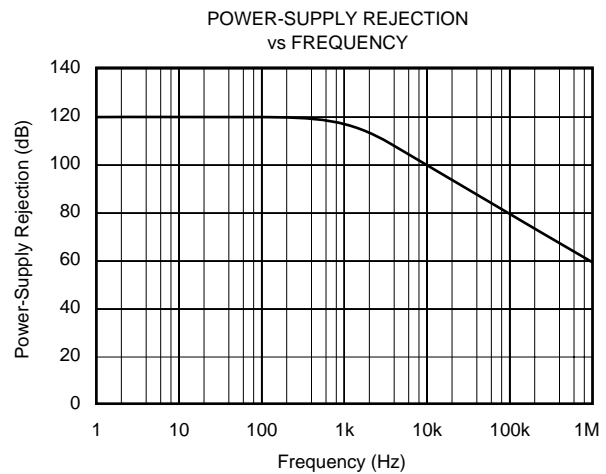
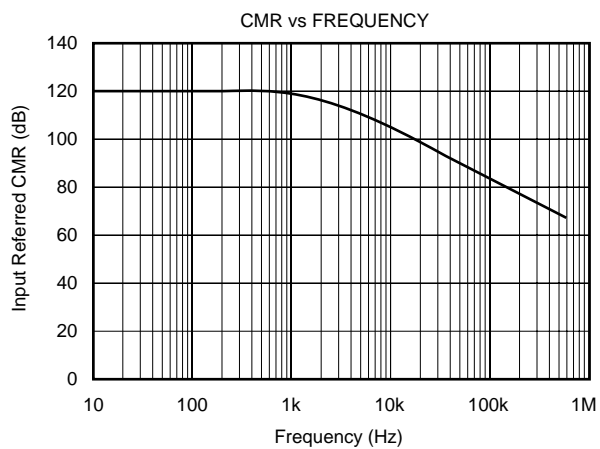
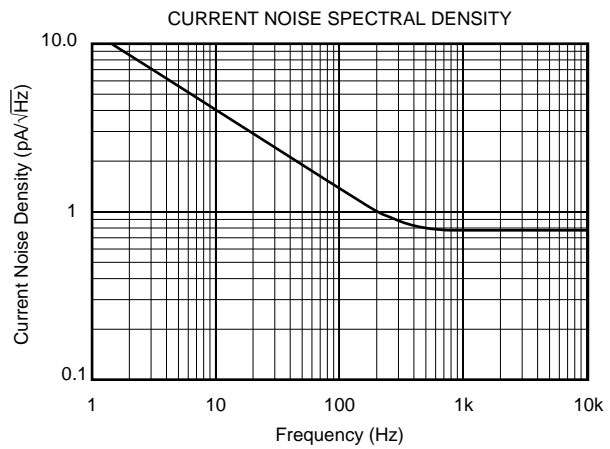
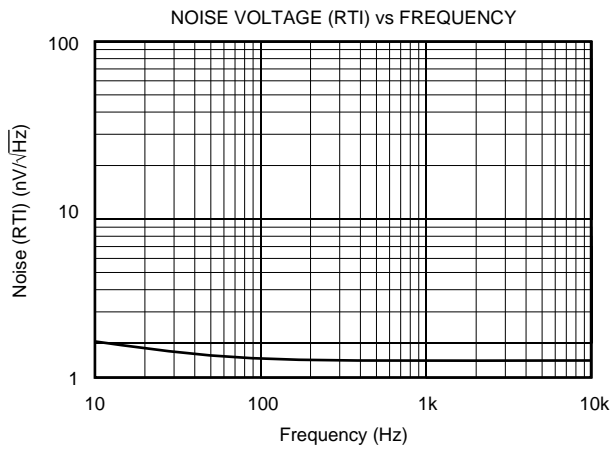
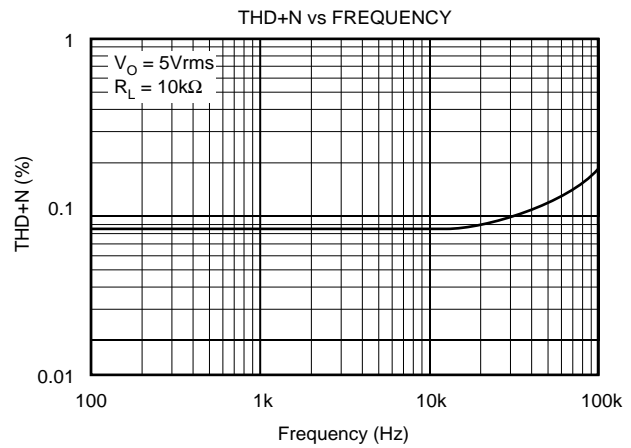
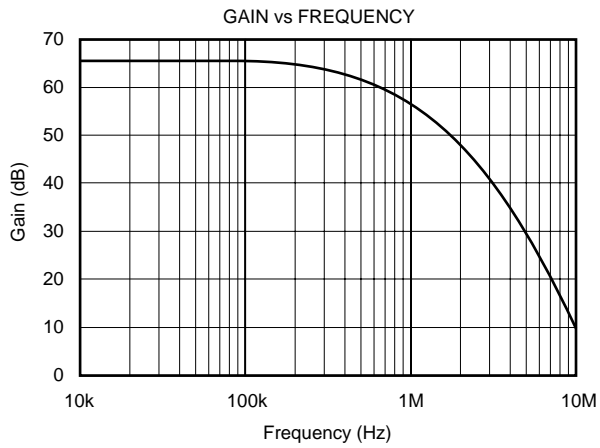
PACKAGE/ORDERING INFORMATION

PRODUCT	PACKAGE	PACKAGE DRAWING NUMBER	PACKAGE MARKING	ORDERING NUMBER ⁽¹⁾	TRANSPORT MEDIA
INA166UA "	SO-14 Surface Mount "	235 "	INA166UA "	INA166UA INA166UA/2K5	Rails Tape and Reel

NOTE: (1) Models with a slash (/) are available only in Tape and Reel in the quantities indicated (e.g., /2K5 indicates 2500 devices per reel). Ordering 2500 pieces of "INA166UA/2K5" will get a single 2500-piece Tape and Reel.

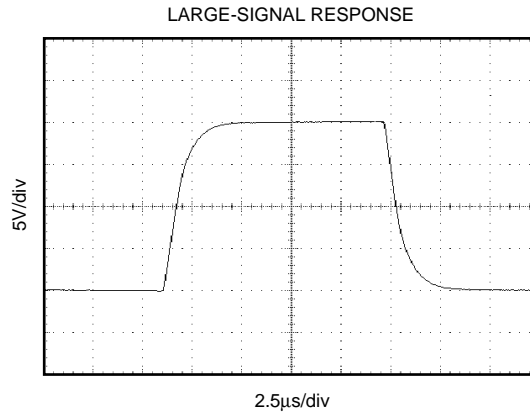
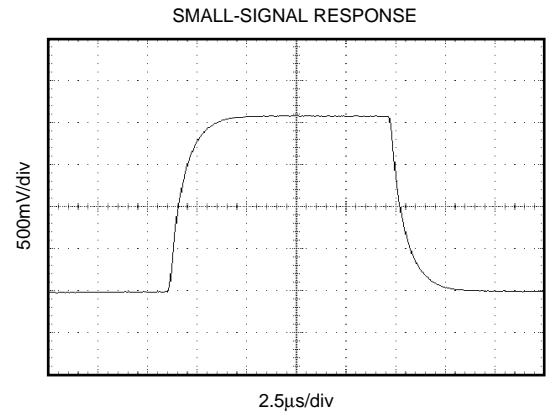
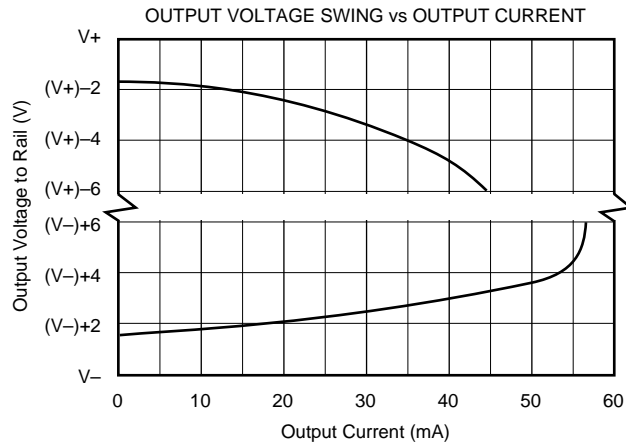
TYPICAL PERFORMANCE CURVES

At $T_A = +25^\circ\text{C}$, $V_S = \pm 5\text{V}$, $R_L = 2\text{k}\Omega$, $C_L = 50\text{pF}$, $G = 2000$, unless otherwise noted.



TYPICAL PERFORMANCE CURVES (Cont.)

At $T_A = +25^\circ\text{C}$, $V_S = \pm 5\text{V}$, $R_L = 2\text{k}\Omega$, $C_L = 50\text{pF}$, $G = 2000$, unless otherwise noted.



APPLICATIONS INFORMATION

Figure 1 shows the basic connections required for operation. Power supplies should be bypassed with 0.1µF tantalum capacitors near the device pins. The output Sense (pin 8) and output Reference (pin 10) should be low-impedance connections. Resistance of greater than 5Ω in series with these connections will degrade the common-mode rejection of the INA166.

GAIN

Gain of the INA166 is internally set for $G = 2000$. Input stage (A1, A2) gain is 200 and the output stage gain (A3) is 10. Internal resistor values are laser trimmed for accurate ratios to achieve excellent gain accuracy and common-mode rejection, but absolute resistor values are approximately $\pm 20\%$. Nominal resistor values are shown.

Although the INA166 is primarily intended for fixed-gain applications, the gain can be increased by connecting a gain-set resistor, R_G , between pin 3 and pin 12. The nominal gain will be:

$$G = 2000 + \frac{60000}{R_G}$$

Accuracy of the 60000 term in this equation is approximately $\pm 20\%$. The stability and temperature drift of R_G contributes to the overall gain accuracy and these effects can be inferred from this gain equation.

NOISE PERFORMANCE

The INA166 provides very low-noise with low-source impedance. Its $1.3nV/\sqrt{Hz}$ voltage noise delivers near-theoretical noise performance with a source impedance of 200Ω.

The input stage design used to achieve this low noise, results in relatively high input bias current and input bias current noise. As a result, the INA166 may not provide the best noise performance with a source impedance greater than 10kΩ. For source impedance greater than 10kΩ, other instrumentation amplifiers may provide improved noise performance.

INPUT CONSIDERATIONS

Very low source impedance (less than 10Ω) can cause the INA166 to oscillate. This depends on circuit layout, signal source, and input cable characteristics. An input network consisting of a small inductor and resistor, as shown in Figure 2, can greatly reduce any tendency to oscillate. This is especially useful if a variety of input sources are to be connected to the INA166. Although not shown in other figures, this network can be used as needed with all applications shown.

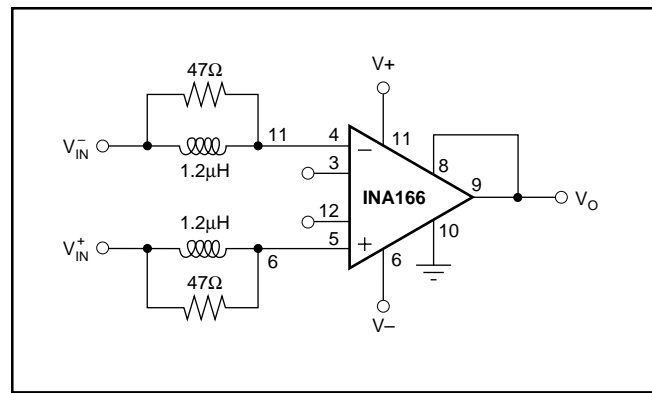


FIGURE 2. Input Stabilization Network.

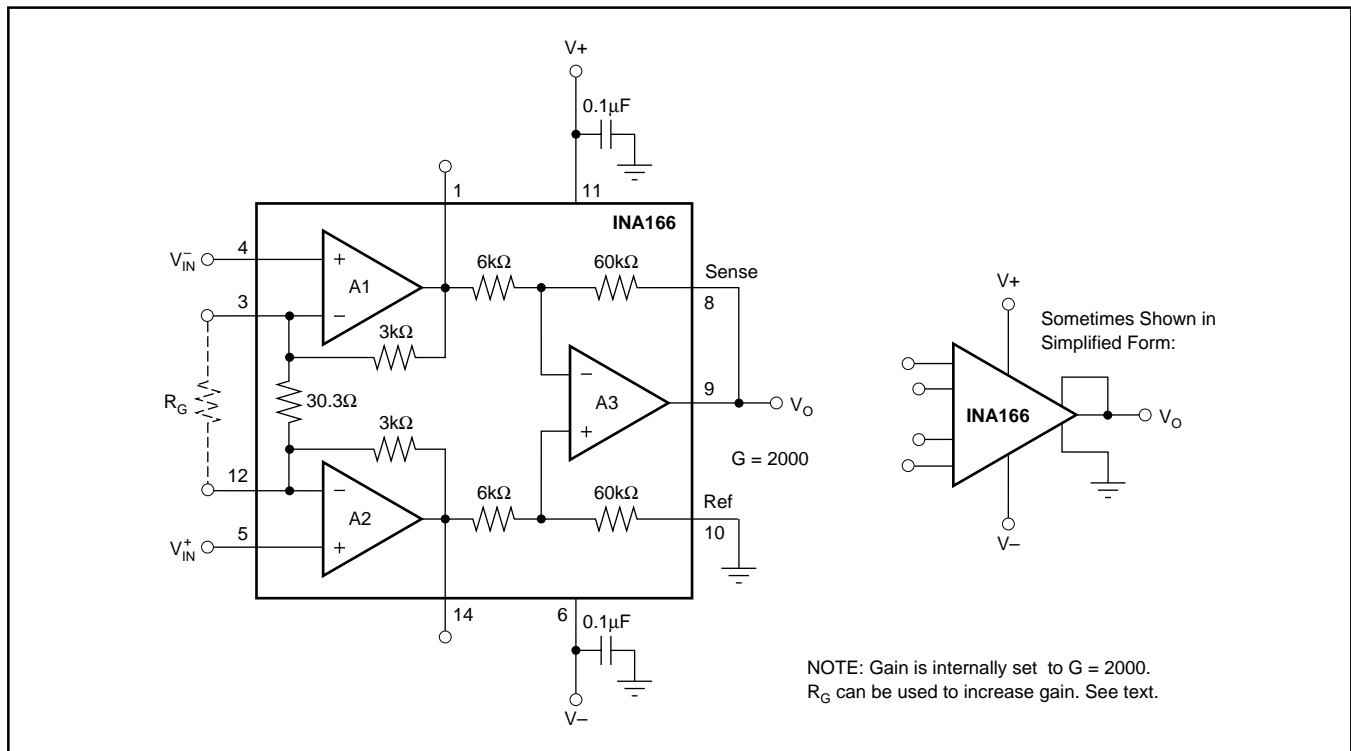


FIGURE 1. Basic Circuit Connections.

OFFSET VOLTAGE TRIM

A variable voltage applied to pin 10, as shown in Figure 3, can be used to adjust the output offset voltage. A voltage applied to pin 10 is summed with the output signal. An op amp connected as a buffer is used to provide a low impedance at pin 10 to assure good common-mode rejection.

OUTPUT SENSE

An output sense terminal allows greater gain accuracy in driving the load. By connecting the sense connection at the load, $I \cdot R$ voltage loss to the load is included inside the feedback loop. Current drive can be increased by connecting a buffer amp inside the feedback loop, as shown in Figure 4.

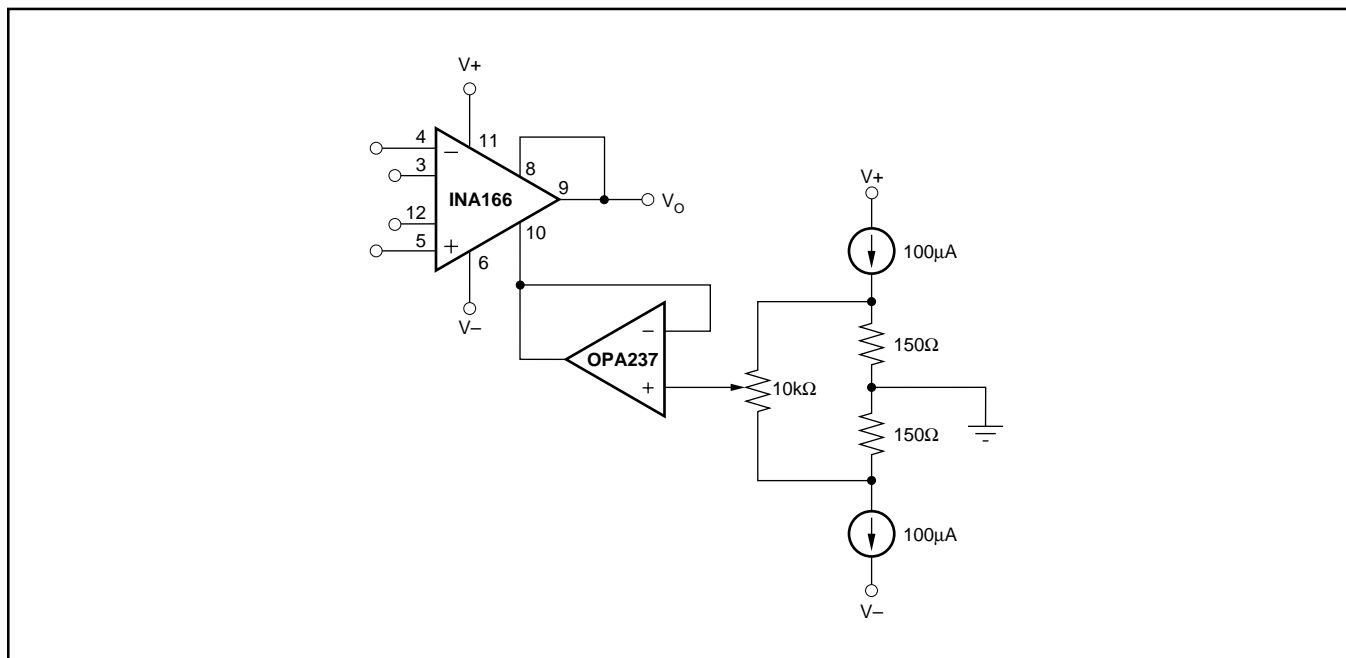


FIGURE 3. Offset Voltage Adjustment Circuit.

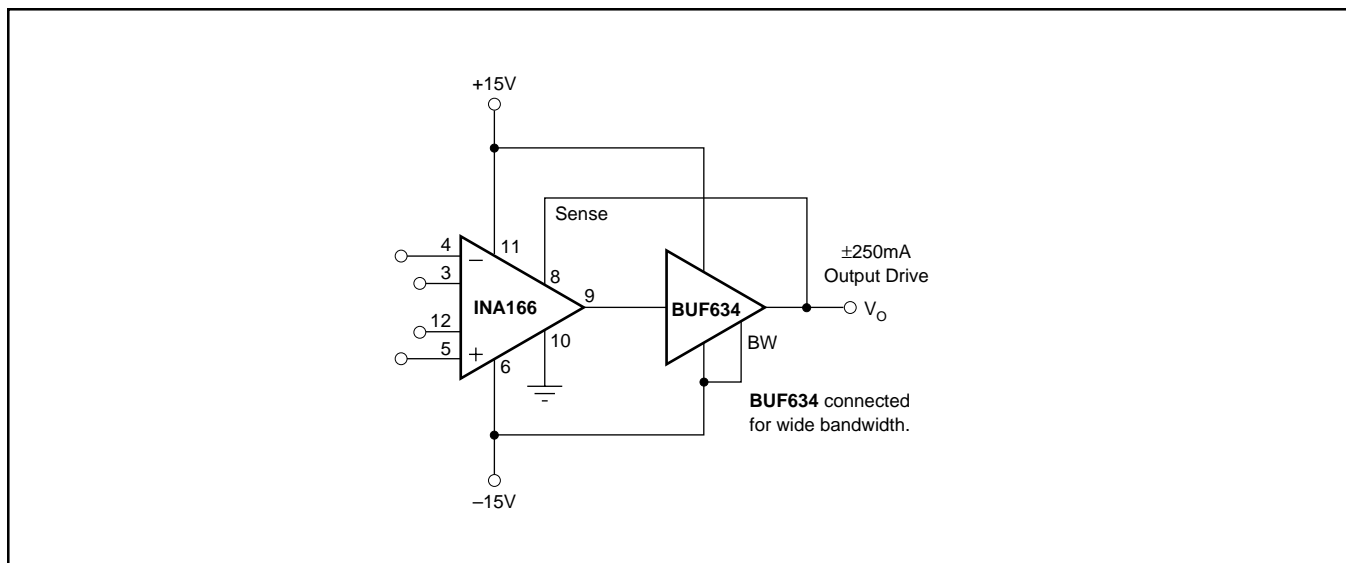


FIGURE 4. Buffer for Increase Output Current.

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
INA166UA	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
INA166UA/2K5	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
INA166UA/2K5G4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
INA166UAG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR

⁽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.

OBSOLETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

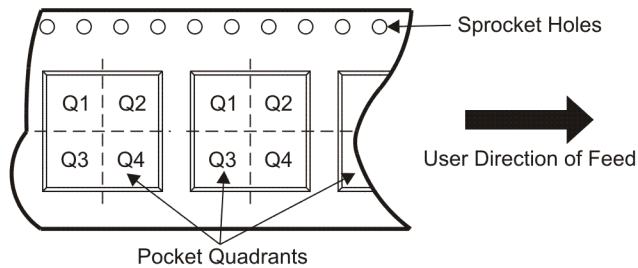
Important Information and Disclaimer:The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION



QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
INA166UA/2K5	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
INA166UA/2K5	SOIC	D	14	2500	346.0	346.0	33.0

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products

Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
RF/IF and ZigBee® Solutions	www.ti.com/lprf

Applications

Audio	www.ti.com/audio
Automotive	www.ti.com/automotive
Broadband	www.ti.com/broadband
Digital Control	www.ti.com/digitalcontrol
Medical	www.ti.com/medical
Military	www.ti.com/military
Optical Networking	www.ti.com/opticalnetwork
Security	www.ti.com/security
Telephony	www.ti.com/telephony
Video & Imaging	www.ti.com/video
Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2008, Texas Instruments Incorporated

Looking for pricing, stock, or lifecycle information?

Click below to explore more details on WIN SOURCE:

 [View INA166UA](#) on WIN SOURCE

 [Texas Instruments](#) Information

Optimize Your Supply Chain with WIN SOURCE Solutions

-  Global Sourcing Solution
-  Obsolete Management
-  Cost Control Management
-  Shortage Management
-  Alternative Solution
-  Excess Inventory Management