

**INA137**  
**INA2137**

## AUDIO DIFFERENTIAL LINE RECEIVERS

### $\pm 6\text{dB}$ ( $G = 1/2$ or $2$ )

### FEATURES

- SINGLE AND DUAL VERSIONS
- LOW DISTORTION: 0.0005% at  $f = 1\text{kHz}$
- HIGH SLEW RATE:  $14\text{V}/\mu\text{s}$
- FAST SETTLING TIME:  $3\mu\text{s}$  to  $0.01\%$
- WIDE SUPPLY RANGE:  $\pm 4\text{V}$  to  $\pm 18\text{V}$
- LOW QUIESCIENT CURRENT:  $2.9\text{mA}$  max
- HIGH CMRR:  $90\text{dB}$
- FIXED GAIN =  $\pm 6\text{dB}$
- PACKAGES—SINGLE: 8-PIN DIP, SO-8  
DUAL: 14-PIN DIP, SO-14

### DESCRIPTION

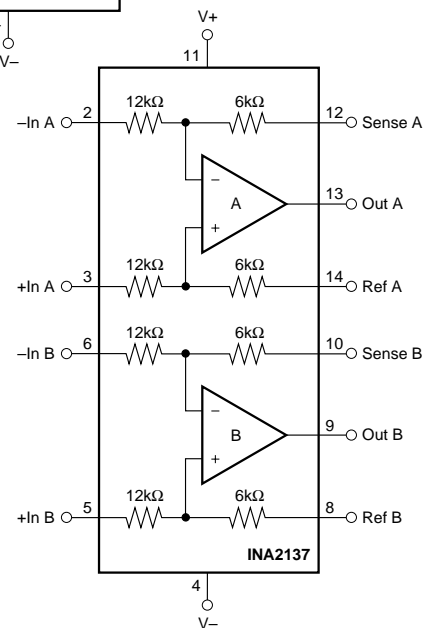
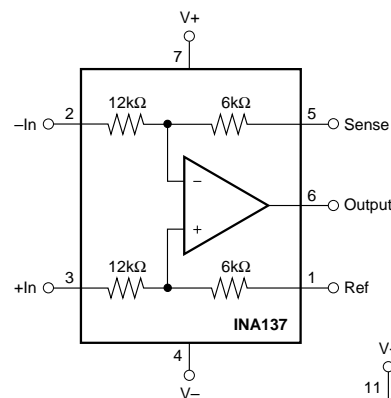
The INA137 and INA2137 are differential line receivers consisting of high performance op amps with on-chip precision resistors. They are fully specified for high performance audio applications and have excellent ac specifications, including low distortion (0.0005% at 1kHz) and high slew rate ( $14\text{V}/\mu\text{s}$ ), assuring good dynamic response. In addition, wide output voltage swing and high output drive capability allow use in a wide variety of demanding applications. The dual version features completely independent circuitry for lowest crosstalk and freedom from interaction, even when overdriven or overloaded.

The INA137 and INA2137 on-chip resistors are laser trimmed for accurate gain and optimum common-mode rejection. Furthermore, excellent TCR tracking of the resistors maintains gain accuracy and common-mode rejection over temperature. Operation is guaranteed from  $\pm 4\text{V}$  to  $\pm 18\text{V}$  ( $8\text{V}$  to  $36\text{V}$  total supply).

The INA137 is available in 8-pin DIP and SO-8 surface-mount packages. The INA2137 comes in 14-pin DIP and SO-14 surface-mount packages. Both are specified for operation over the extended industrial temperature range,  $-40^\circ\text{C}$  to  $+85^\circ\text{C}$ .

### APPLICATIONS

- AUDIO DIFFERENTIAL LINE RECEIVER
- $G = 1/2$  OR  $G = 2$  AMPLIFIER
- INSTRUMENTATION BUILDING BLOCK
- CURRENT SHUNT MONITOR
- VOLTAGE-CONTROLLED CURRENT SOURCE
- GROUND LOOP ELIMINATOR



International Airport Industrial Park • Mailing Address: PO Box 11400, Tucson, AZ 85734 • Street Address: 6730 S. Tucson Blvd., Tucson, AZ 85706 • Tel: (520) 746-1111 • Twx: 910-952-1111  
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

# SPECIFICATIONS: $V_S = \pm 18V$

At  $T_A = +25^\circ C$ ,  $V_S = \pm 18V$ ,  $R_L = 2k\Omega$ ,  $G = 1/2$ , and Ref Pin connected to Ground, unless otherwise noted.

PARAMETER	CONDITIONS	INA137PA, UA INA2137PA, UA			UNITS
		MIN	TYP	MAX	
<b>AUDIO PERFORMANCE</b> Total Harmonic Distortion + Noise, $f = 1\text{kHz}$ Noise Floor, RTO <sup>(1)</sup> Headroom, RTO <sup>(1)</sup>	$V_{IN} = 10V_{rms}$ 20kHz BW THD+N < 1%		0.0005 -106 +23		% dBu dBu
<b>FREQUENCY RESPONSE</b> Small-Signal Bandwidth Slew Rate Settling Time: 0.1% 0.01% Overload Recovery Time Channel Separation (dual), $f = 1\text{kHz}$	10V Step, $C_L = 100pF$ 10V Step, $C_L = 100pF$ 50% Overdrive		4.0 14 2 3 3 123		MHz V/ $\mu s$ $\mu s$ $\mu s$ $\mu s$ dB
<b>OUTPUT NOISE VOLTAGE</b> <sup>(2)</sup> $f = 20\text{Hz}$ to 20kHz $f = 1\text{kHz}$			3.5 26		$\mu V_{rms}$ nV/ $\sqrt{Hz}$
<b>OFFSET VOLTAGE</b> <sup>(3)</sup> Input Offset Voltage vs Temperature vs Power Supply	RTO $V_{CM} = 0V$ Specified Temperature Range $V_S = \pm 4V$ to $\pm 18V$		$\pm 100$ $\pm 2$ $\pm 5$	$\pm 1000$  $\pm 60$	$\mu V$ $\mu V/^\circ C$ $\mu V/V$
<b>INPUT</b> Common-Mode Voltage Range: Positive Negative Differential Voltage Range Common-Mode Rejection Impedance <sup>(4)</sup> Differential Common-Mode	$V_O = 0V$ $V_O = 0V$  $V_{CM} = \pm 46.5V$ , $R_S = 0\Omega$	3(V+)-7.5 3(V-)+7.5  74	3(V+)-6 3(V-)+3 See Typical Curve  90 24 18		V V dB k $\Omega$ k $\Omega$
<b>GAIN</b> Initial Error vs Temperature Nonlinearity	$V_O = -10V$ to $10V$  $V_O = -10V$ to $10V$		0.5 $\pm 0.01$ $\pm 1$ 0.0001	$\pm 0.1$  $\pm 10$	V/V % ppm/ $^\circ C$ %
<b>OUTPUT</b> Voltage Output, Positive Negative Current Limit, Continuous to Common Capacitive Load (Stable Operation)		(V+)-2 (V-)+2	(V+)-1.8 (V-)+1.6 $\pm 60$ 500		V V mA pF
<b>POWER SUPPLY</b> Rated Voltage Voltage Range Quiescent Current (per Amplifier)	  $I_O = 0$	$\pm 4$	$\pm 18$ $\pm 2.4$	$\pm 18$ $\pm 2.9$	V V mA
<b>TEMPERATURE RANGE</b> Specification Range Operation Range Storage Range Thermal Resistance, $\theta_{JA}$ 8-Pin DIP SO-8 Surface-Mount 14-Pin DIP SO-14 Surface-Mount		-40 -55 -55		85 125 125	$^\circ C$ $^\circ C$ $^\circ C$ $^\circ C/W$ $^\circ C/W$ $^\circ C/W$ $^\circ C/W$

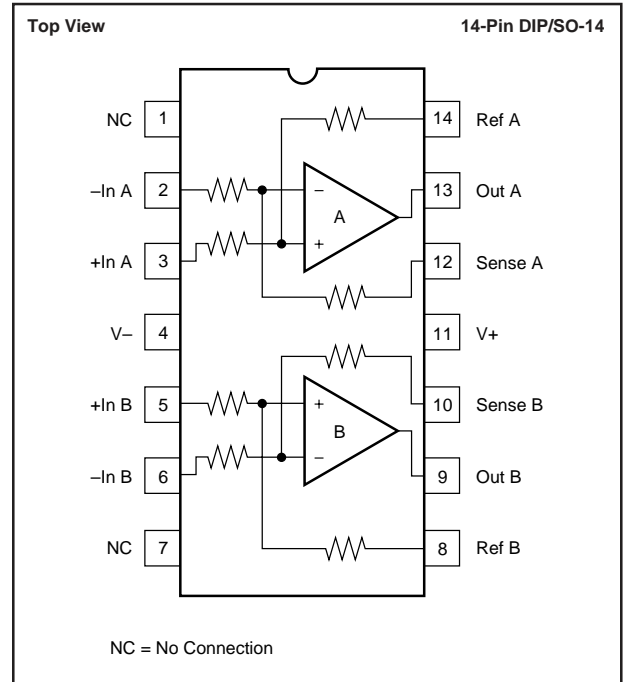
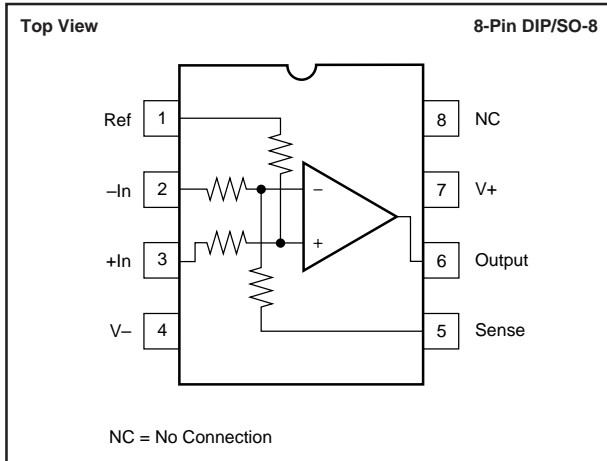
RTO = Referred to Output.

NOTES: (1) dBu = 20log (Vrms/0.7746). (2) Includes effects of amplifier's input current noise and thermal noise contribution of resistor network. (3) Includes effects of amplifier's input bias and offset currents. (4) Internal resistors are ratio matched but have  $\pm 25\%$  absolute value.

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## PIN CONFIGURATIONS



## ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

Supply Voltage, V+ to V-	40V
Input Voltage Range	±80V
Output Short-Circuit (to ground) <sup>(2)</sup>	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

NOTE: (1) Stresses above these ratings may cause permanent damage.  
 (2) One channel per package.

## PACKAGE/ORDERING INFORMATION

PRODUCT	PACKAGE	PACKAGE DRAWING NUMBER <sup>(1)</sup>	SPECIFICATION TEMPERATURE RANGE
<b>Single</b>			
INA137PA	8-Pin DIP	006	-40°C to +85°C
INA137UA	SO-8 Surface-Mount	182	-40°C to +85°C
<b>Dual</b>			
INA2137PA	14-Pin DIP	010	-40°C to +85°C
INA2137UA	SO-14 Surface-Mount	235	-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.

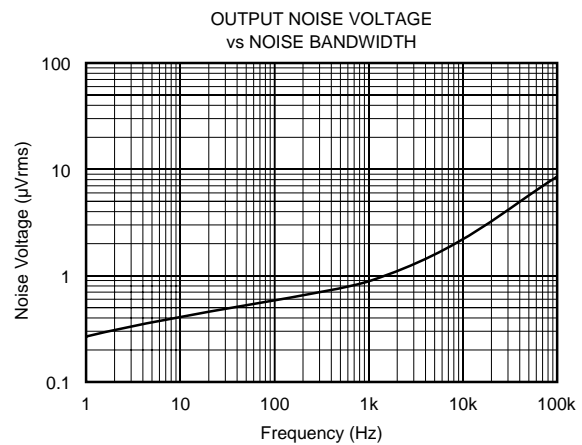
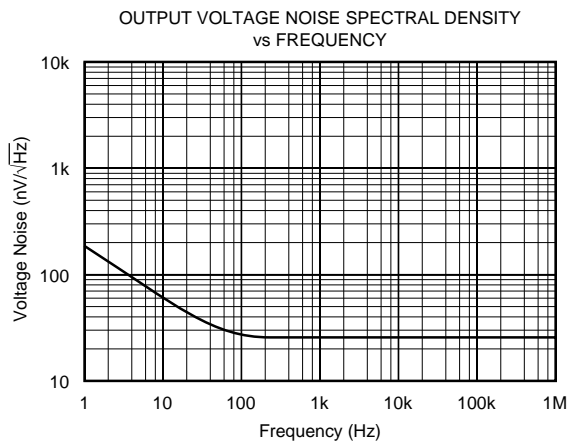
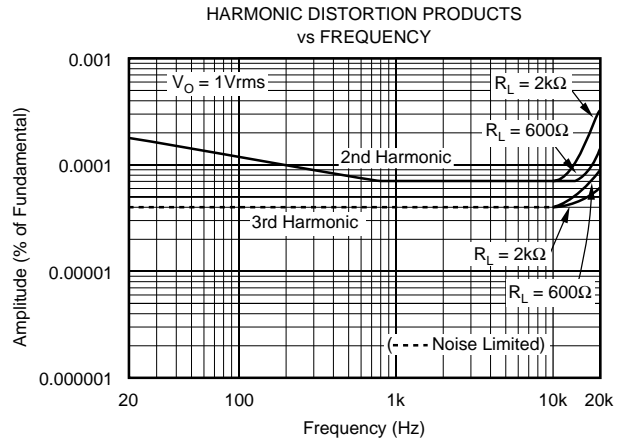
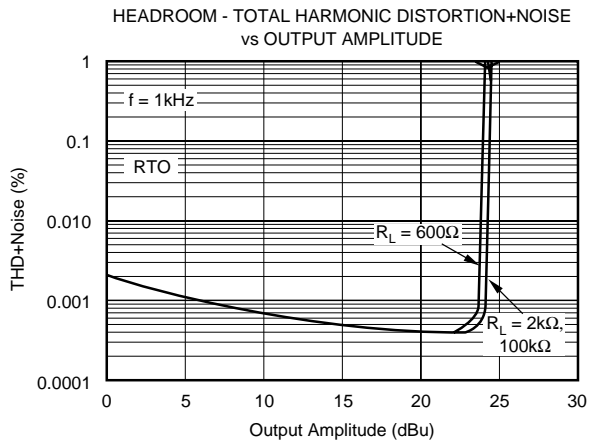
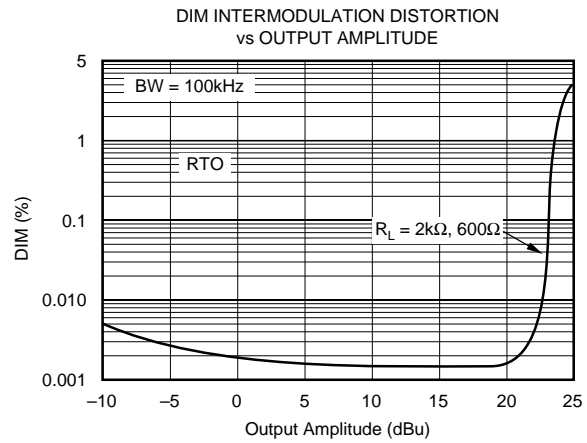
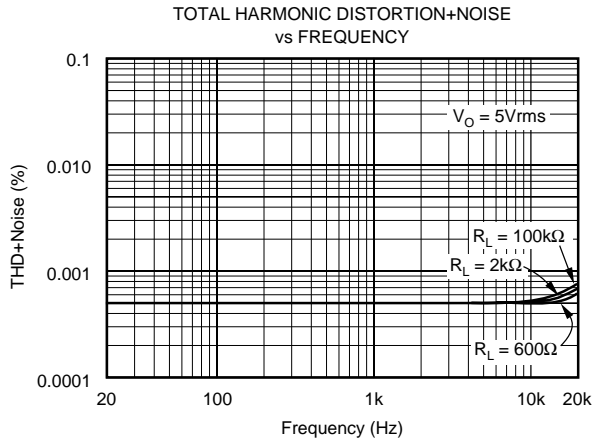
## ELECTROSTATIC DISCHARGE SENSITIVITY

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.

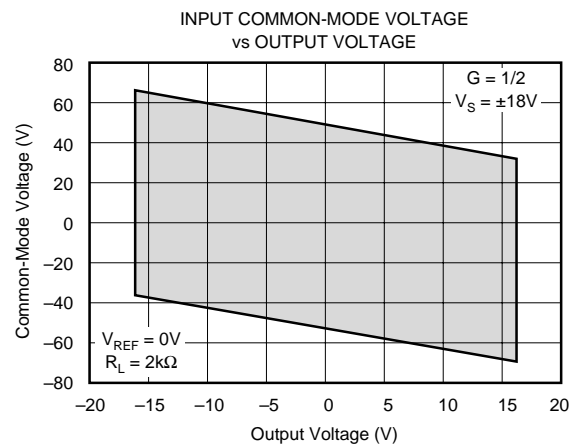
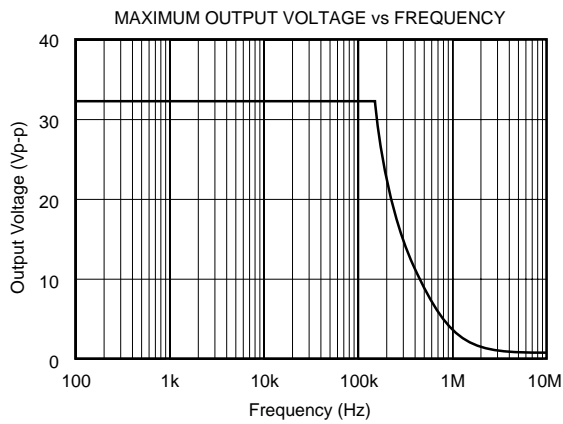
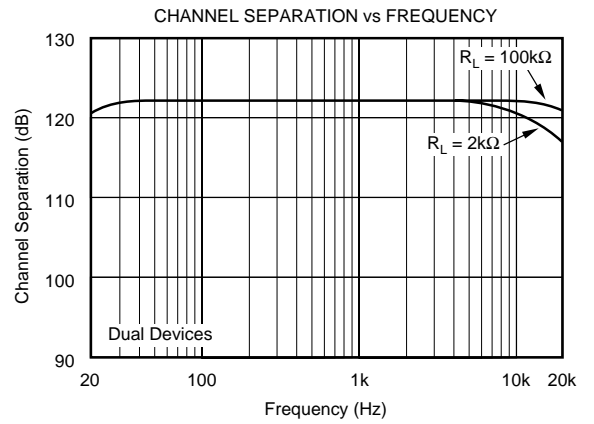
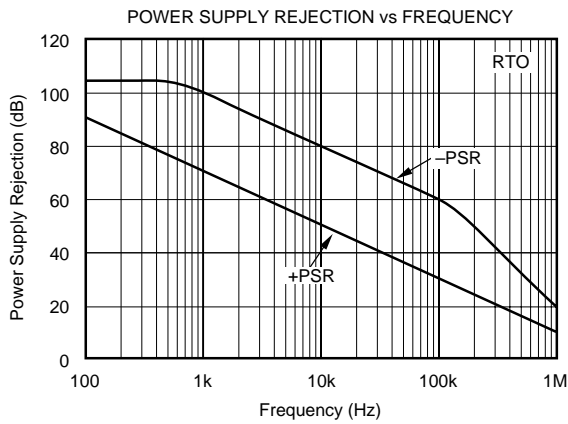
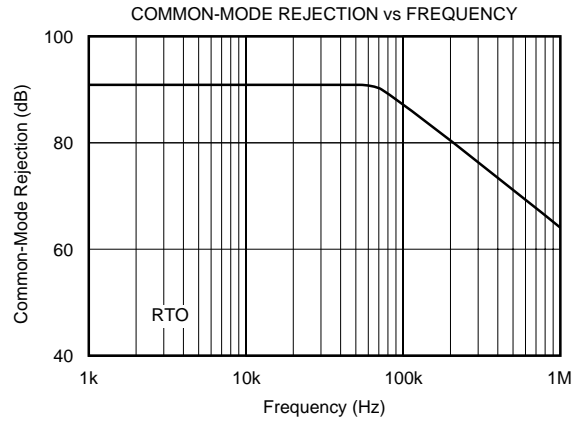
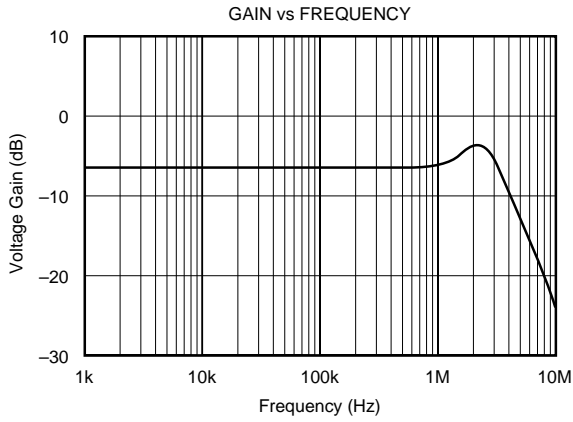
# TYPICAL PERFORMANCE CURVES

At  $T_A = +25^\circ\text{C}$ ,  $V_S = \pm 18\text{V}$ , and  $G = 1/2$ , unless otherwise noted.



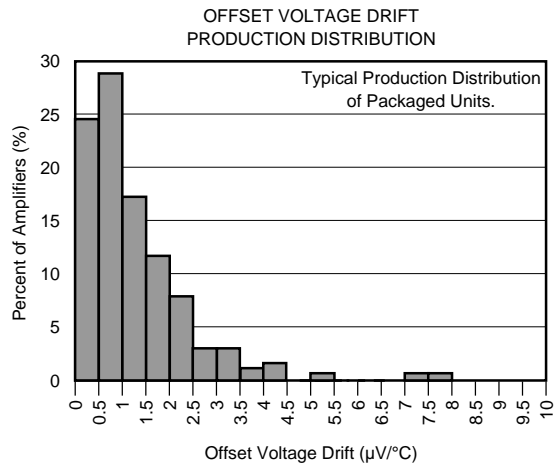
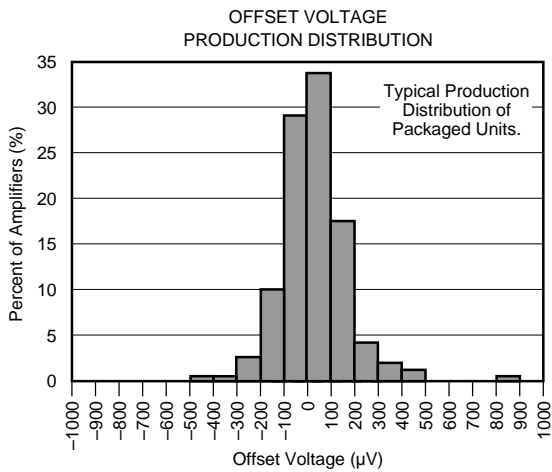
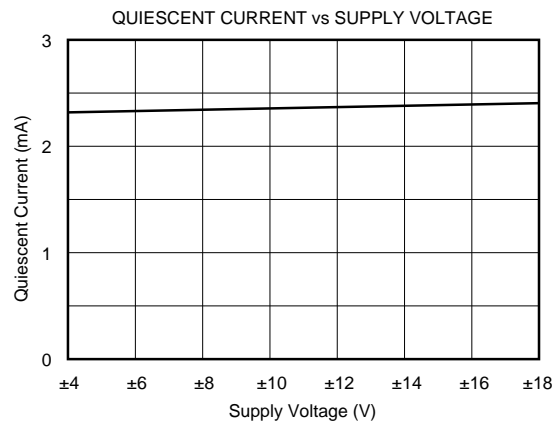
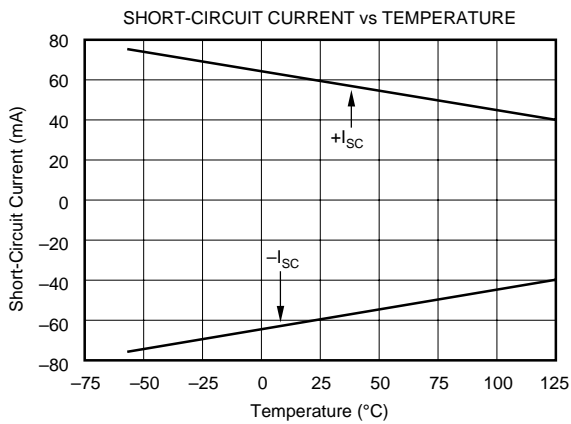
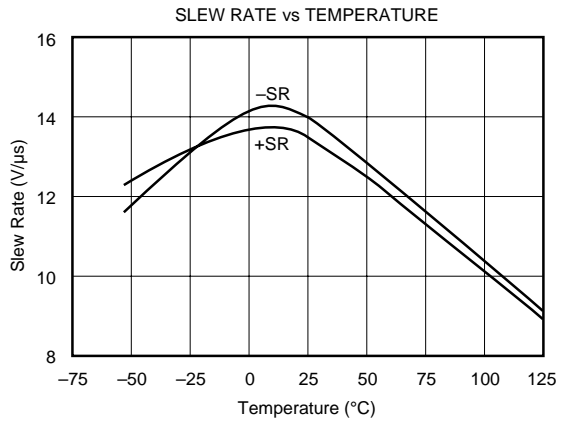
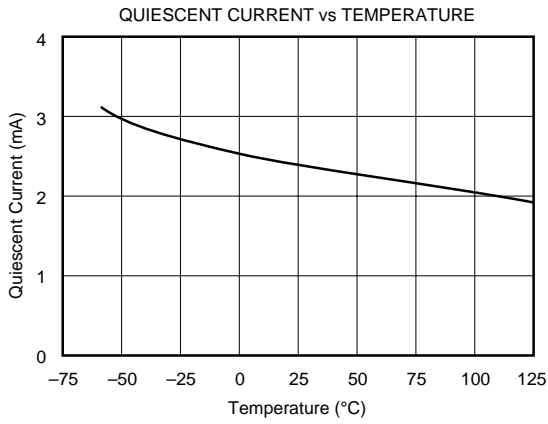
# TYPICAL PERFORMANCE CURVES (CONT)

At  $T_A = +25^\circ\text{C}$ ,  $V_S = \pm 18\text{V}$ , and  $G = 1/2$ , unless otherwise noted.



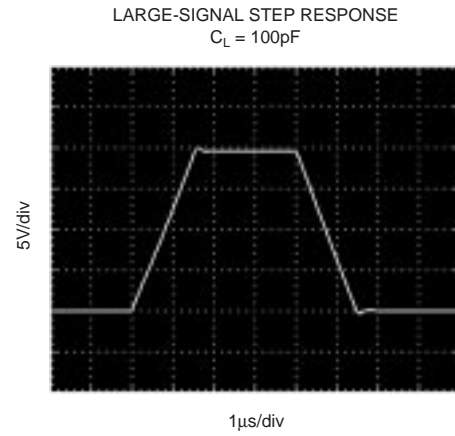
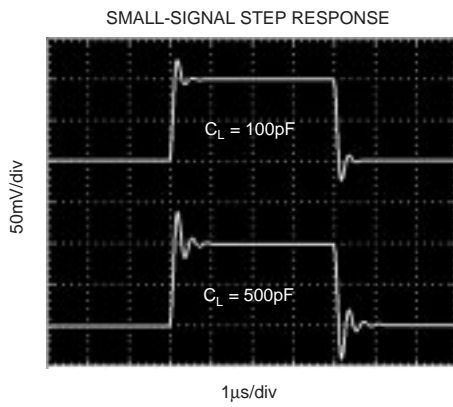
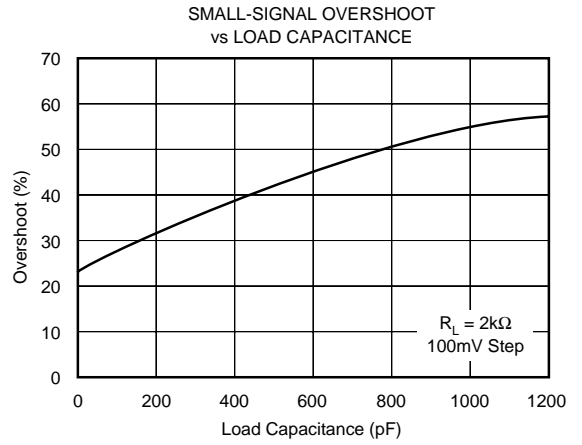
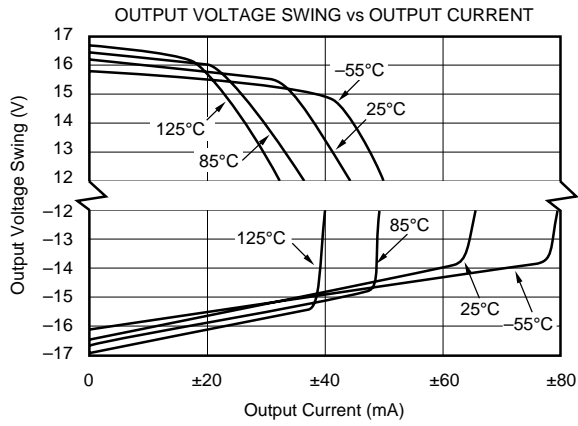
# TYPICAL PERFORMANCE CURVES (CONT)

At  $T_A = +25^\circ\text{C}$ ,  $V_S = \pm 18\text{V}$ , and  $G = 1/2$ , unless otherwise noted.



# TYPICAL PERFORMANCE CURVES (CONT)

At  $T_A = +25^\circ\text{C}$ ,  $V_S = \pm 18\text{V}$ , and  $G = 1/2$ , unless otherwise noted.



# APPLICATIONS INFORMATION

The INA137 and INA2137 are differential line receivers suitable for a wide range of audio and general-purpose applications. Figure 1 shows the basic  $G = 1/2$  ( $-6\text{dB}$ ) differential receiver configuration. The input and feedback resistors can be reversed to achieve  $G = 2$  ( $+6\text{dB}$ ), as shown in Figure 2. For applications requiring  $G = 1$  ( $0\text{dB}$ ), the INA134 and INA2134 are recommended.

Decoupling capacitors are strongly recommended for applications with noisy or high impedance power supplies. The capacitors should be placed close to the device pins as shown in Figure 1. All circuitry is completely independent in the dual version assuring lowest crosstalk and normal behavior when one amplifier is overdriven or short-circuited.

As shown in Figure 1, the differential input signal is connected to pins 2 and 3. The source impedances connected to the inputs must be nearly equal to assure good common-mode rejection. A  $5\Omega$  mismatch in source impedance will degrade the common-mode rejection of a typical device to approximately  $77\text{dB}$  (RTO). If the source has a known impedance mismatch, an additional resistor in series with the opposite input can be used to preserve good common-mode rejection.

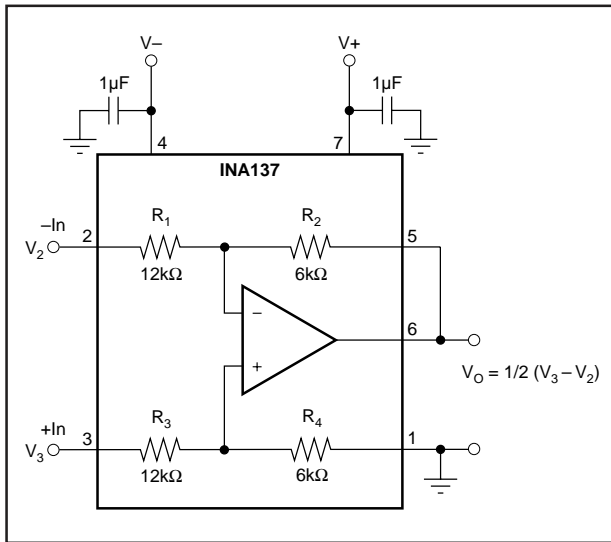


FIGURE 1.  $G = 1/2$  Differential Receiver (Basic Power Supply and Signal Connections).

## AUDIO PERFORMANCE

The INA137 and INA2137 were designed for enhanced ac performance. Very low distortion, low noise, and wide bandwidth provide superior performance in high quality audio applications. Laser-trimmed matched resistors provide optimum common-mode rejection (typically  $90\text{dB}$ ), especially when compared to circuits implemented with an op amp and discrete precision resistors. In addition, high slew rate ( $14\text{V}/\mu\text{s}$ ) and fast settling time ( $3\mu\text{s}$  to  $0.01\%$ ) ensure excellent dynamic performance.

The INA137 and INA2137 have excellent distortion characteristics.  $\text{THD} + \text{Noise}$  is below  $0.001\%$  throughout the audio frequency range. Up to approximately  $10\text{kHz}$  distortion is below the measurement limit of commonly used test equipment. Furthermore, distortion remains relatively flat over its wide output voltage swing range (approximately  $1.7\text{V}$  from either supply).

## OFFSET VOLTAGE TRIM

The INA137 and INA2137 are laser trimmed for low offset voltage and drift. Most applications require no external offset adjustment. Figure 3 shows an optional circuit for trimming the output offset voltage. 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. This can be used to null offset voltage as shown in Figure 3. The source impedance of a signal applied to the Ref terminal should be less than  $10\Omega$  to maintain good common-mode rejection.

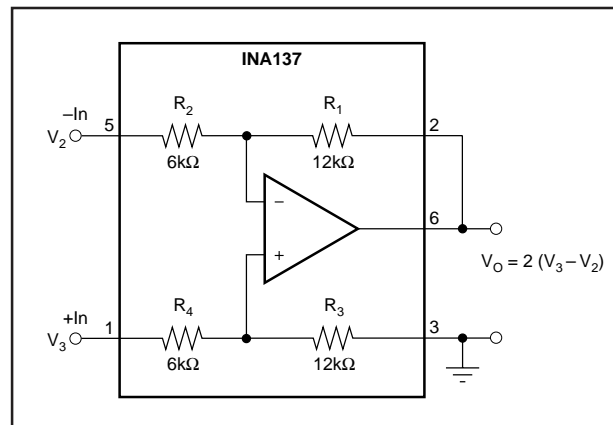


FIGURE 2.  $G = 2$  Differential Receiver.

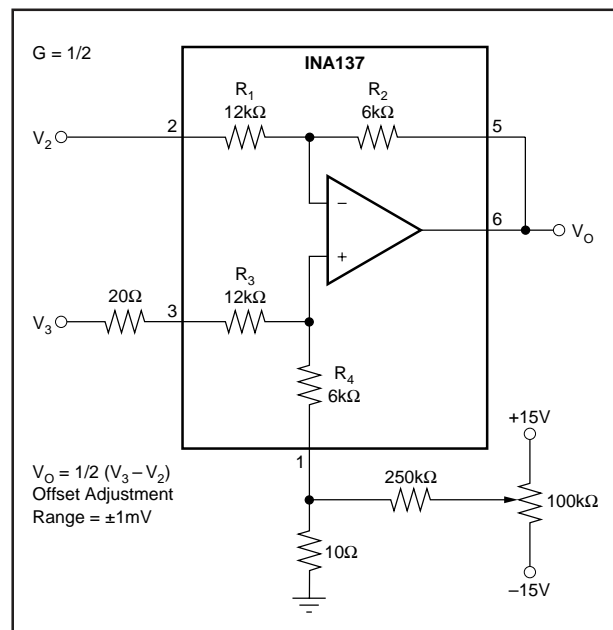


FIGURE 3. Offset Adjustment.



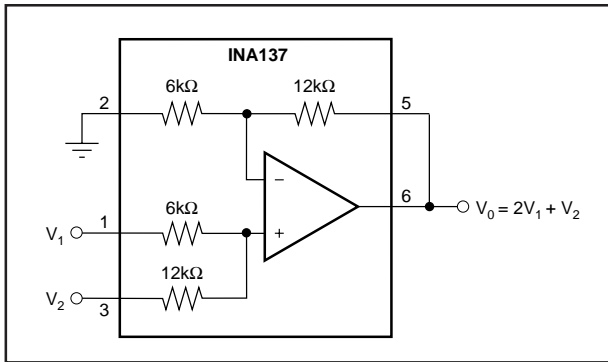


FIGURE 4. Precision Summing Amplifier.

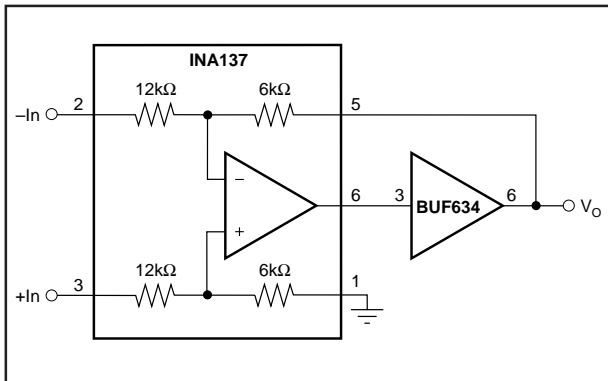


FIGURE 5. Boosting Output Current.

The difference amplifier is a highly versatile building block that is useful in a wide variety of applications. See the INA105 data sheet for additional applications ideas, including:

- Current Receiver with Compliance to Rails
- $\pm 10\text{V}$  Precision Voltage Reference
- $\pm 5\text{V}$  Precision Voltage Reference
- Precision Average Value Amplifier
- Precision Bipolar Offsetting
- Precision Summing Amplifier with Gain
- Instrumentation Amplifier Guard Drive Generator
- Precision Summing Instrumentation Amplifier
- Precision Absolute Value Buffer

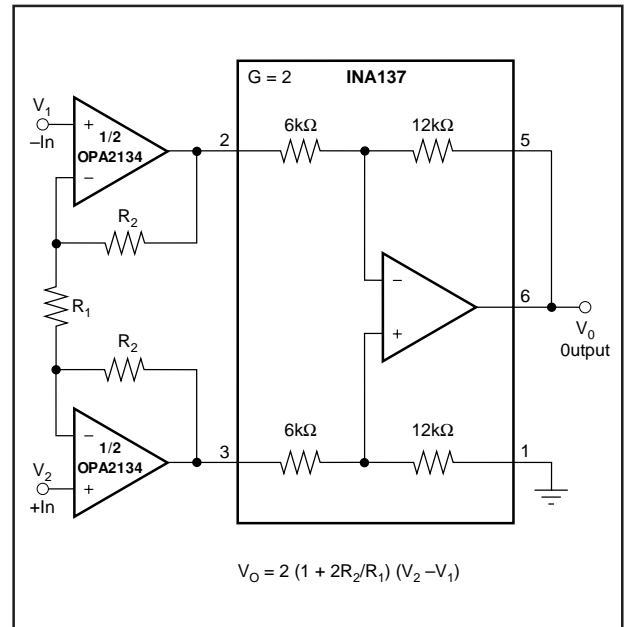


FIGURE 6. High Input Impedance Instrumentation Amplifier.

- Precision Voltage-to-Current Converter with Differential Inputs
- Differential Input Voltage-to-Current Converter for Low  $I_{\text{OUT}}$
- Isolating Current Source
- Differential Output Difference Amplifier
- Isolating Current Source with Buffering Amplifier for Greater Accuracy
- Window Comparator with Window Span and Window Center Inputs
- Precision Voltage-Controlled Current Source with Buffered Differential Inputs and Gain

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
INA137UA	ACTIVE	SOIC	D	8	75	RoHS & Green	NIPDAU	Level-3-260C-168 HR	-40 to 85	INA 137UA	<a href="#">Samples</a>
INA137UA/2K5	ACTIVE	SOIC	D	8	2500	RoHS & Green	NIPDAU	Level-3-260C-168 HR	-40 to 85	INA 137UA	<a href="#">Samples</a>
INA137UA/2K5G4	LIFEBUY	SOIC	D	8	2500	RoHS & Green	NIPDAU	Level-3-260C-168 HR	-40 to 85	INA 137UA	
INA137UAG4	LIFEBUY	SOIC	D	8	75	RoHS & Green	NIPDAU	Level-3-260C-168 HR	-40 to 85	INA 137UA	
INA2137PA	LIFEBUY	PDIP	N	14	25	RoHS & Green	NIPDAU	N / A for Pkg Type	-40 to 85	INA2137PA	
INA2137UA	ACTIVE	SOIC	D	14	50	RoHS & Green	NIPDAU	Level-3-260C-168 HR		INA2137UA	<a href="#">Samples</a>
INA2137UA/2K5	ACTIVE	SOIC	D	14	2500	RoHS & Green	NIPDAU	Level-3-260C-168 HR		INA2137UA	<a href="#">Samples</a>
INA2137UAE4	LIFEBUY	SOIC	D	14	50	RoHS & Green	NIPDAU	Level-3-260C-168 HR		INA2137UA	

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

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

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

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

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

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

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

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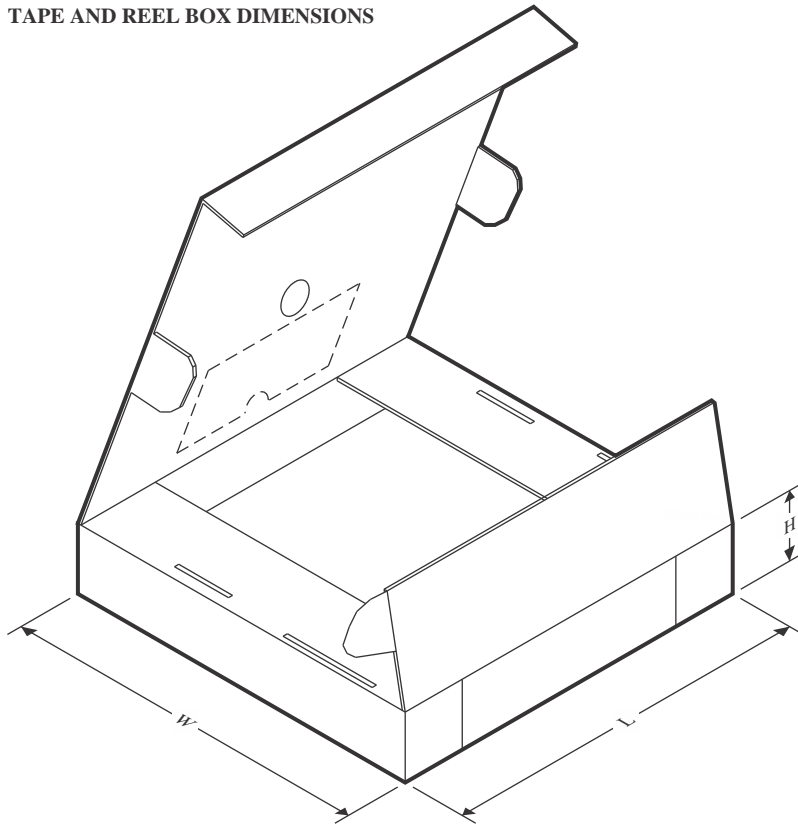
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**TAPE AND REEL INFORMATION**

**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
INA137UA/2K5	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
INA2137UA/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)
INA137UA/2K5	SOIC	D	8	2500	356.0	356.0	35.0
INA2137UA/2K5	SOIC	D	14	2500	356.0	356.0	35.0

**TUBE**


\*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
INA137UA	D	SOIC	8	75	506.6	8	3940	4.32
INA137UAG4	D	SOIC	8	75	506.6	8	3940	4.32
INA2137PA	N	PDIP	14	25	506	13.97	11230	4.32
INA2137UA	D	SOIC	14	50	506.6	8	3940	4.32
INA2137UAE4	D	SOIC	14	50	506.6	8	3940	4.32

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