

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 QUIESCENT CURRENT: 2.9mA max
- HIGH CMRR: 90dB
- FIXED GAIN = $\pm 6\text{dB}$
- PACKAGES—SINGLE: 8-PIN DIP, SO-8
DUAL: 14-PIN DIP, SO-14

DESCRIPTION

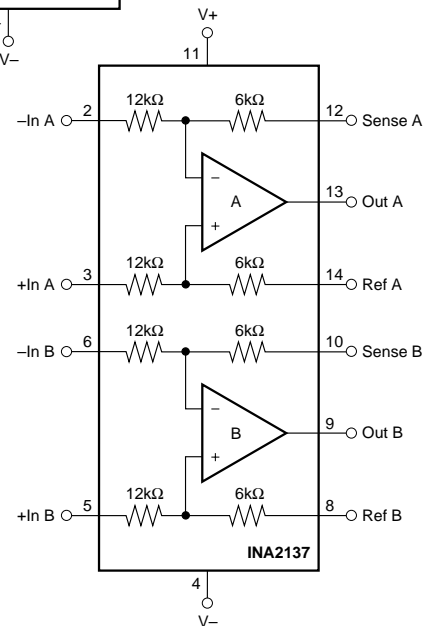
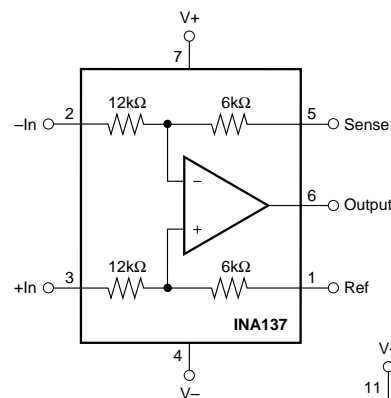
The INA137 and INA2137 are differential line receivers consisting of high performance op amps with on-chip precision resistors. They are fully specified for high performance audio applications and have excellent ac specifications, including low distortion (0.0005% at 1kHz) and high slew rate ($14\text{V}/\mu\text{s}$), 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 $\pm 18\text{V}$ (8V to 36V 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°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



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	
AUDIO PERFORMANCE Total Harmonic Distortion + Noise, $f = 1kHz$ Noise Floor, RTO ⁽¹⁾ Headroom, RTO ⁽¹⁾	$V_{IN} = 10V_{rms}$ 20kHz BW THD+N < 1%		0.0005 -106 +23		% dBu dBu
FREQUENCY RESPONSE Small-Signal Bandwidth Slew Rate Settling Time: 0.1% 0.01% Overload Recovery Time Channel Separation (dual), $f = 1kHz$	10V Step, $C_L = 100pF$ 10V Step, $C_L = 100pF$ 50% Overdrive		4.0 14 2 3 3 123		MHz V/ μs μs μs μs dB
OUTPUT NOISE VOLTAGE⁽²⁾ $f = 20Hz$ to 20kHz $f = 1kHz$			3.5 26		μV_{rms} nV/ \sqrt{Hz}
OFFSET VOLTAGE⁽³⁾ Input Offset Voltage vs Temperature vs Power Supply	RTO $V_{CM} = 0V$ Specified Temperature Range $V_S = \pm 4V$ to $\pm 18V$		± 100 ± 2 ± 5	± 1000 ± 60	μV $\mu V/^\circ C$ $\mu V/V$
INPUT Common-Mode Voltage Range: Positive Negative Differential Voltage Range Common-Mode Rejection Impedance ⁽⁴⁾ 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 Ω k Ω
GAIN Initial Error vs Temperature Nonlinearity	$V_O = -10V$ to $10V$ $V_O = -10V$ to $10V$		0.5 ± 0.01 ± 1 0.0001	± 0.1 ± 10	V/V % ppm/ $^\circ C$ %
OUTPUT Voltage Output, Positive Negative Current Limit, Continuous to Common Capacitive Load (Stable Operation)		(V+)-2 (V-)+2	(V+)-1.8 (V-)+1.6 ± 60 500		V V mA pF
POWER SUPPLY Rated Voltage Voltage Range Quiescent Current (per Amplifier)	$I_O = 0$	± 4	± 18 ± 2.4	± 18 ± 2.9	V V mA
TEMPERATURE RANGE Specification Range Operation Range Storage Range Thermal Resistance, θ_{JA} 8-Pin DIP SO-8 Surface-Mount 14-Pin DIP SO-14 Surface-Mount		-40 -55 -55	100 150 80 100	85 125 125	$^\circ C$ $^\circ C$ $^\circ C$ $^\circ C/W$ $^\circ C/W$ $^\circ C/W$ $^\circ C/W$

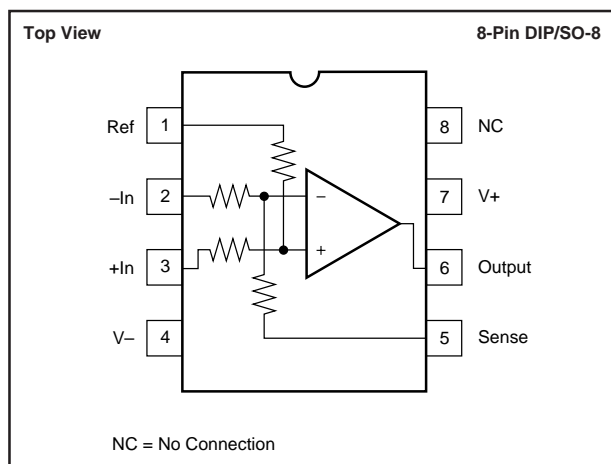
RTO = Referred to Output.

NOTES: (1) dBu = $20\log(V_{rms}/0.7746)$. (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⁽¹⁾

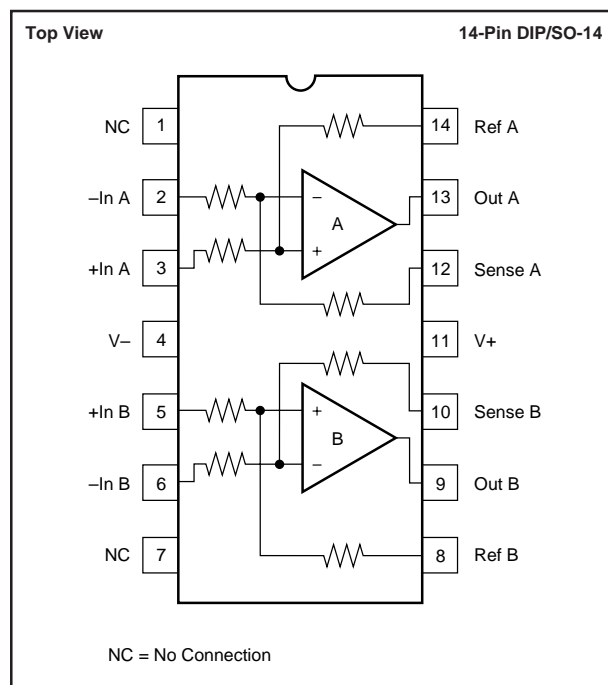
Supply Voltage, V+ to V-.....	40V
Input Voltage Range	±80V
Output Short-Circuit (to ground) ⁽²⁾	Continuous
Operating Temperature	-55°C to +125°C
Storage Temperature	-55°C to +125°C
Junction Temperature	+150°C
Lead Temperature (soldering, 10s)	+300°C

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

PACKAGE/ORDERING INFORMATION

PRODUCT	PACKAGE	PACKAGE DRAWING NUMBER ⁽¹⁾	SPECIFICATION TEMPERATURE RANGE
Single			
INA137PA	8-Pin DIP	006	-40°C to +85°C
INA137UA	SO-8 Surface-Mount	182	-40°C to +85°C
Dual			
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.



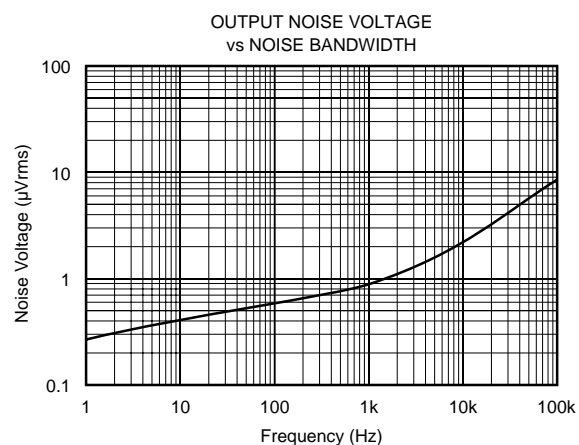
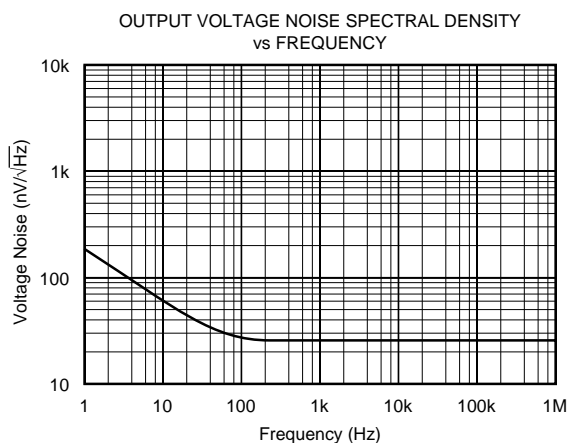
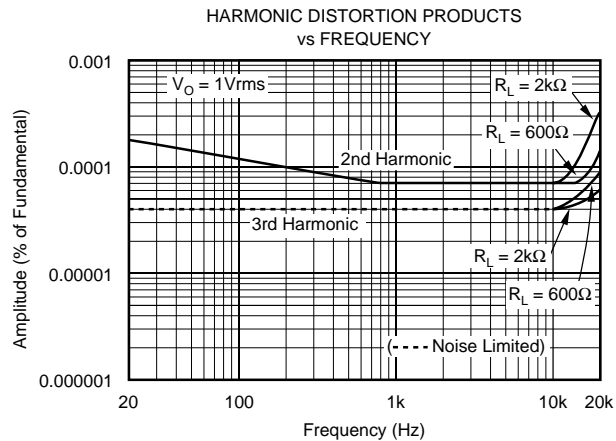
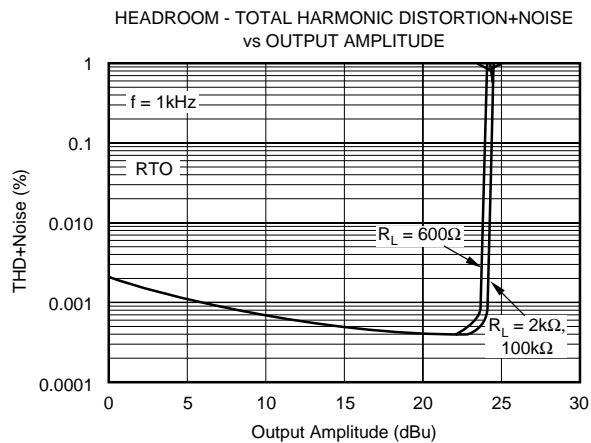
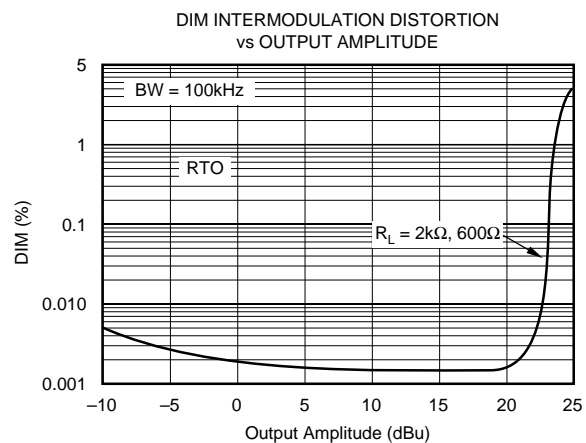
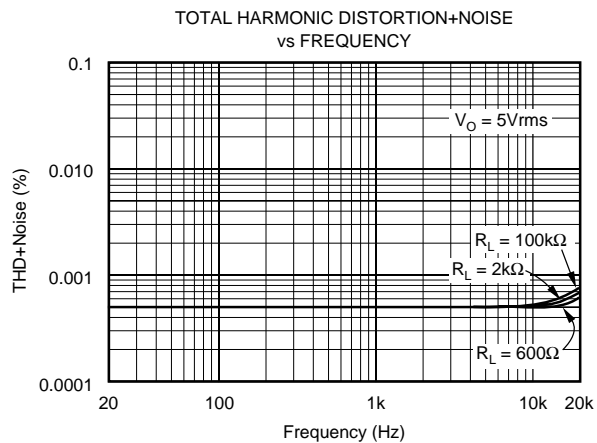
ELECTROSTATIC DISCHARGE SENSITIVITY

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.

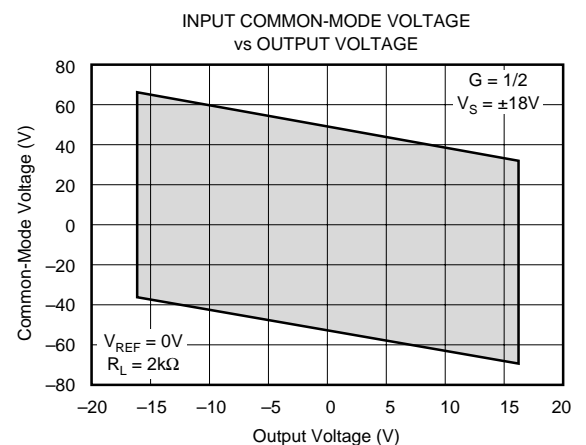
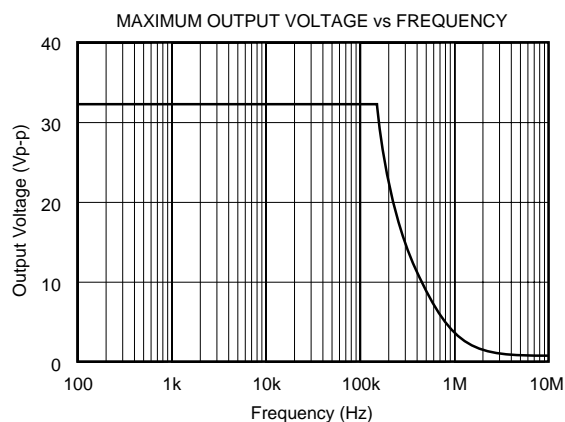
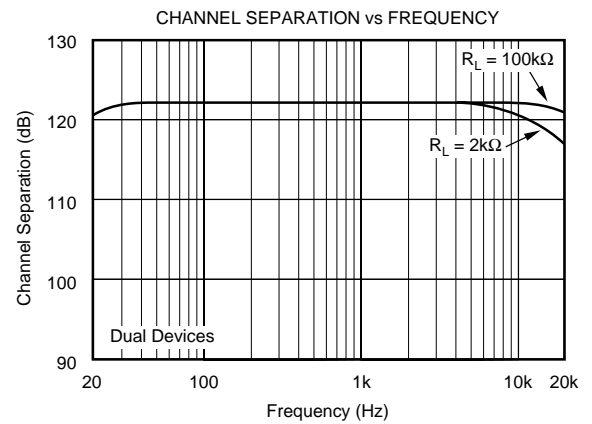
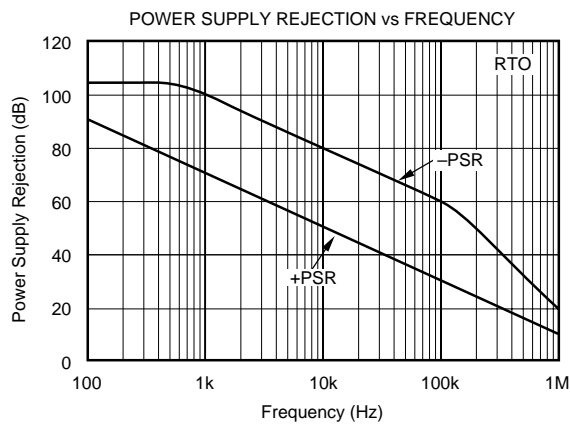
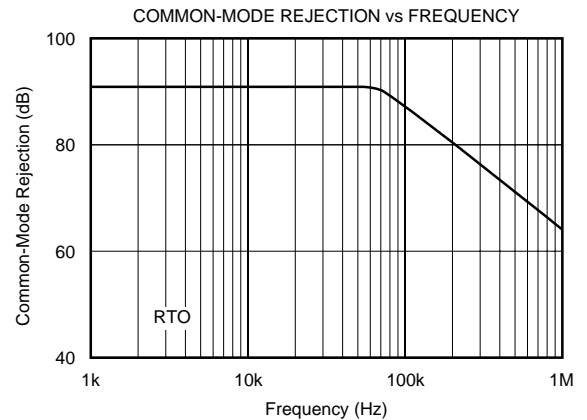
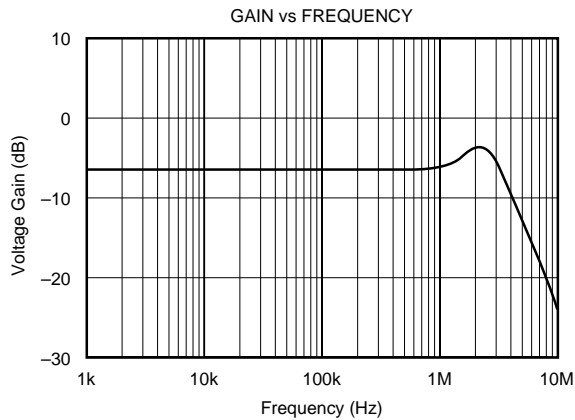
TYPICAL PERFORMANCE CURVES

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



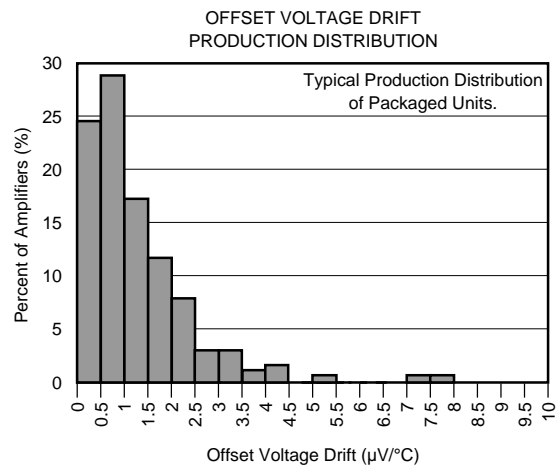
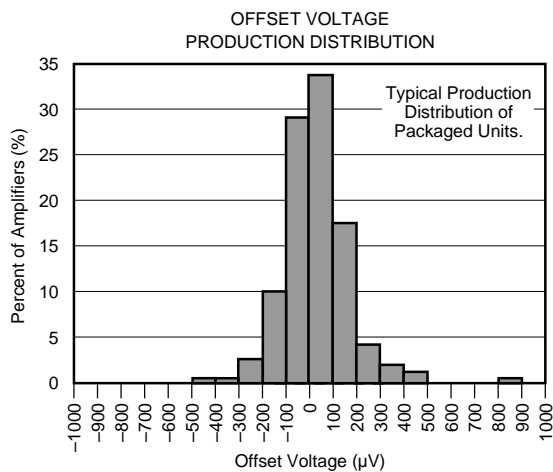
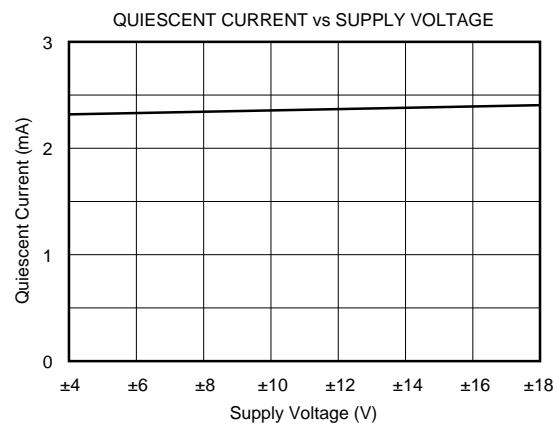
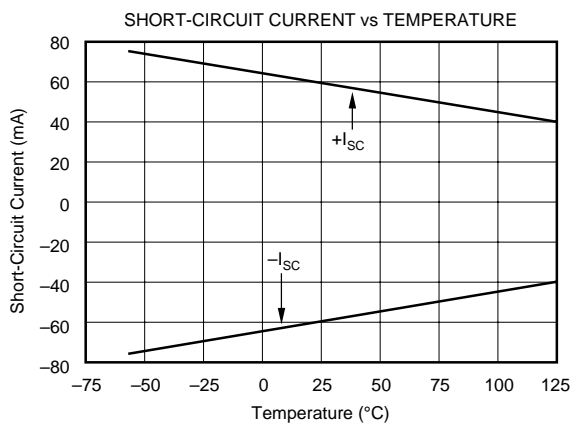
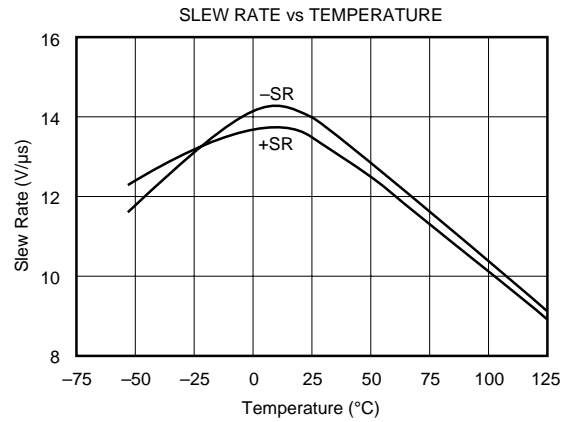
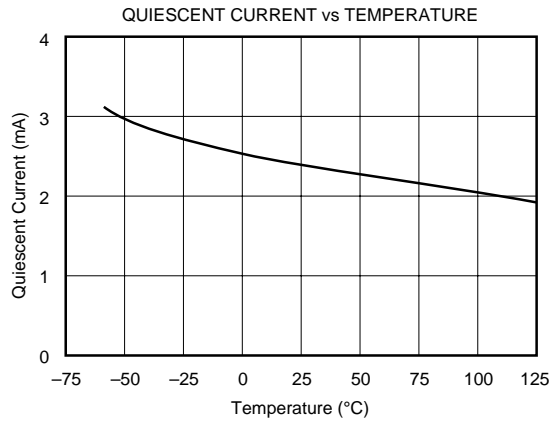
TYPICAL PERFORMANCE CURVES (CONT)

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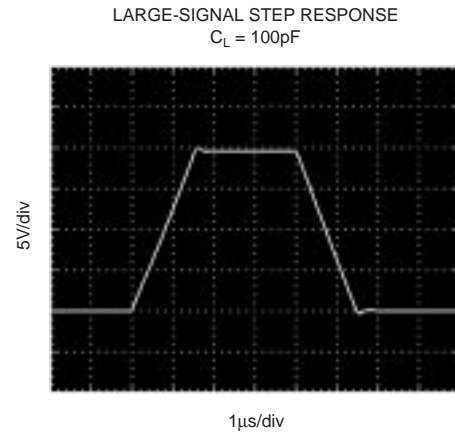
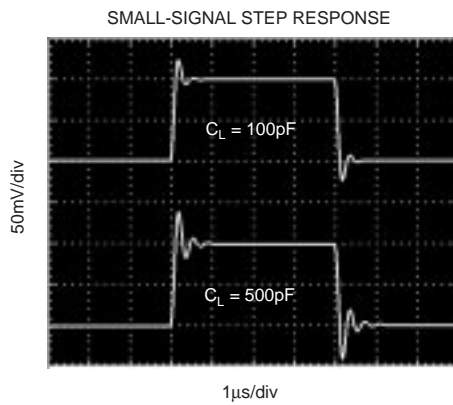
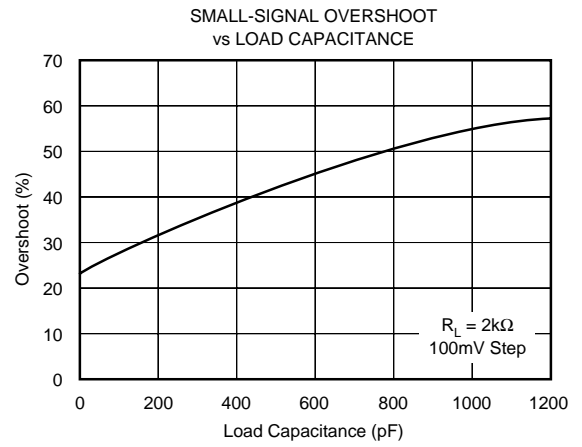
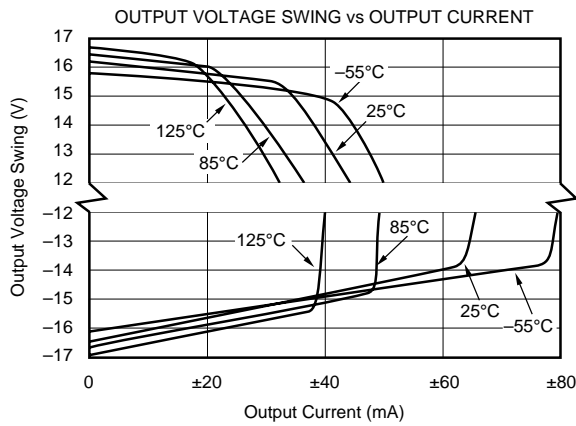
TYPICAL PERFORMANCE CURVES (CONT)

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 $G = 1/2$ (–6dB) differential receiver configuration. The input and feedback resistors can be reversed to achieve $G = 2$ (+6dB), as shown in Figure 2. For applications requiring $G = 1$ (0dB), 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 5Ω mismatch in source impedance will degrade the common-mode rejection of a typical device to approximately 77dB (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.

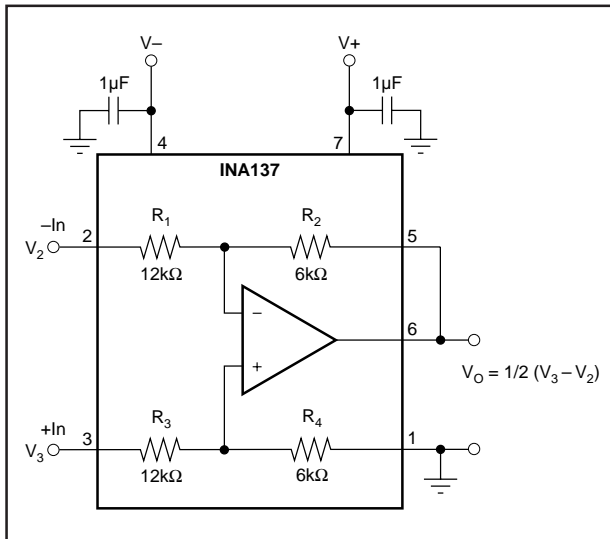


FIGURE 1. $G = 1/2$ Differential Receiver (Basic Power Supply and Signal Connections).

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 90dB), especially when compared to circuits implemented with an op amp and discrete precision resistors. In addition, high slew rate (14V/µs) and fast settling time (3µs to 0.01%) ensure excellent dynamic performance.

The INA137 and INA2137 have excellent distortion characteristics. THD+Noise is below 0.001% throughout the audio frequency range. Up to approximately 10kHz distortion is below the measurement limit of commonly used test equipment. Furthermore, distortion remains relatively flat over its wide output voltage swing range (approximately 1.7V 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 10Ω to maintain good common-mode rejection.

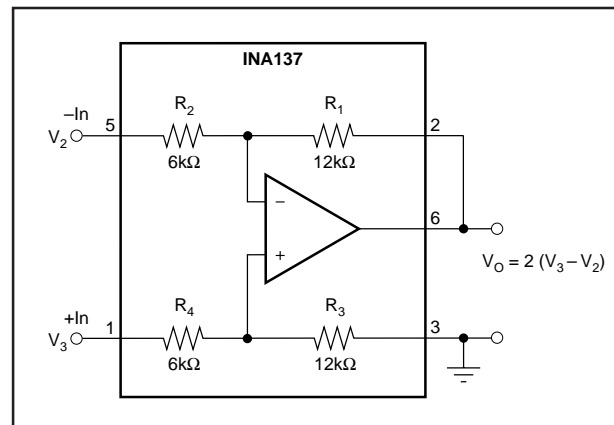


FIGURE 2. $G = 2$ Differential Receiver.

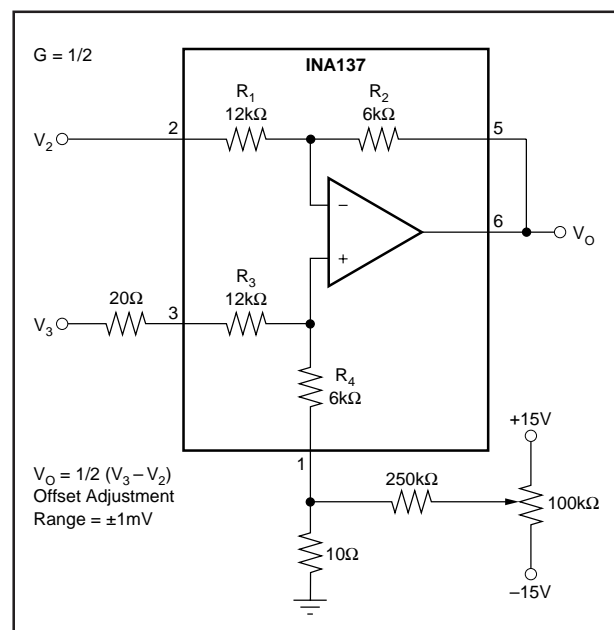


FIGURE 3. Offset Adjustment.

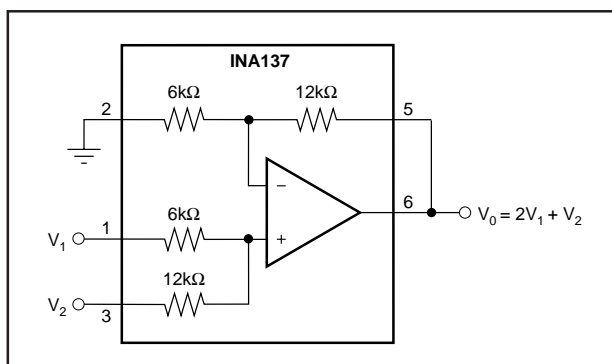


FIGURE 4. Precision Summing Amplifier.

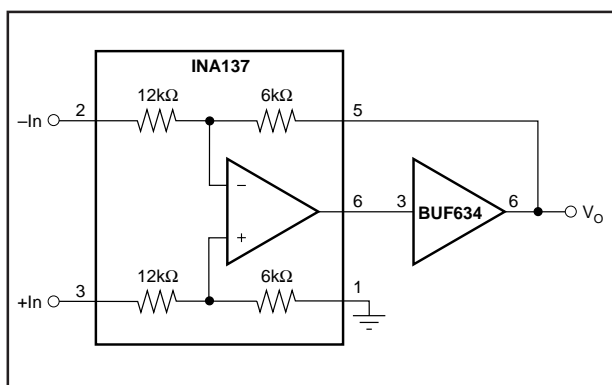


FIGURE 5. Boosting Output Current.

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

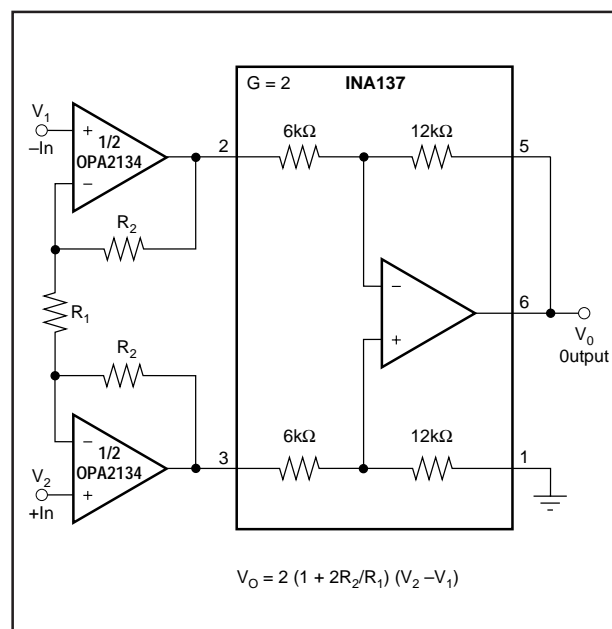
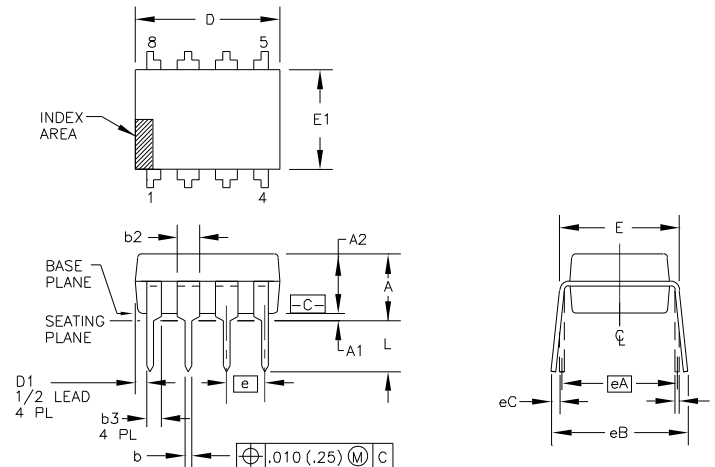


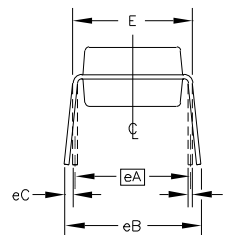
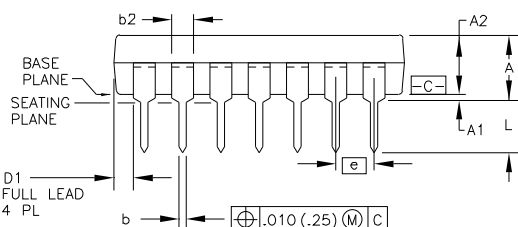
FIGURE 6. High Input Impedance Instrumentation Amplifier.

- Precision Voltage-to-Current Converter with Differential Inputs
- Differential Input Voltage-to-Current Converter for Low I_{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

Package Number 006 - 8-Pin Plastic, Single-Wide DIP

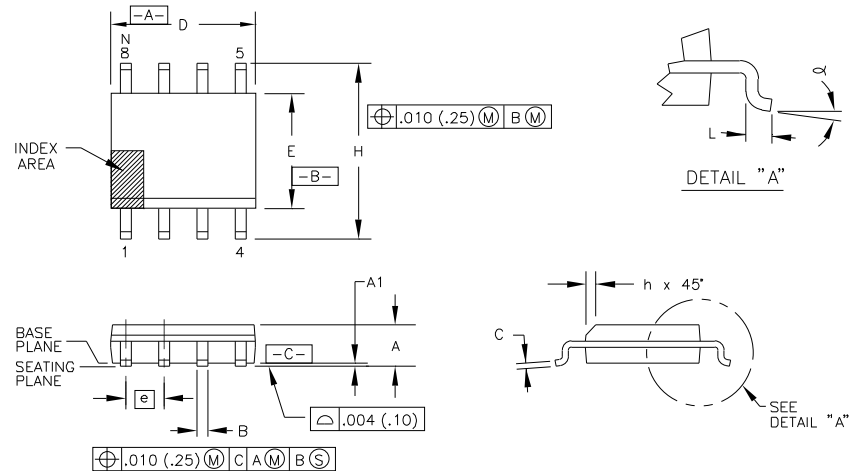


DIM	INCHES		MILLIMETERS		N O T E	DIM	INCHES		MILLIMETERS		N O T E	NOTES:	PACKAGE NUMBER: ZZ006	REV.: E
	MIN.	MAX.	MIN.	MAX.			MIN.	MAX.	MIN.	MAX.				
A	—	.210	—	5.33	3	eC	.000	.060	0.00	1.52	6	1. ALL DIMENSIONS ARE IN INCHES.		
A1	.015	—	0.38	—	3	L	.115	.150	2.92	3.81	3	2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1982.		
A2	.115	.195	2.92	4.95	3	N	8	—	8	—	7	3. DIMENSIONS A, A1, AND L ARE MEASURED WITH THE PACKAGE SEATED IN JEDEC SEATING PLANE GAUGE GS-3.		
b	.014	.022	0.36	0.56	—							4. D, D1, AND E1 DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .010 (0.25mm).		
b2	.045	.070	1.14	1.78	9							5. E AND eA MEASURED WITH THE LEADS CONSTRAINED TO BE PERPENDICULAR TO DATUM [C].		
b3	.030	.045	0.76	1.14	9							6. eB AND eC ARE MEASURED AT THE LEAD TIPS WITH THE LEADS UNCONSTRAINED.		
c	.008	.014	0.20	0.36	—							7. N IS THE MAXIMUM OF TERMINAL POSITIONS.		
D	.355	.400	9.02	10.16	4							8. POINTED OR ROUNDED LEAD TIPS ARE PREFERRED TO EASE INSERTION.		
D1	.005	—	0.13	—	4							9. b2 AND b3 MAXIMUM DIMENSIONS DO NOT INCLUDE DAMBAR PROTRUSIONS. DAMBAR PROTRUSIONS SHALL NOT EXCEED .010 (0.25mm).		
E	.300	.325	7.62	8.26	5							10. DISTANCE BETWEEN LEADS INCLUDING DAMBAR PROTRUSIONS TO BE .005 (0.13mm) MINIMUM.		
E1	.240	.280	6.10	7.11	4							11. A VISUAL INDEX FEATURE MUST BE LOCATED WITHIN THE CROSS-HATCHED AREA.		
e	.100	BASIC	2.54	BASIC	—							12. FOR AUTOMATIC INSERTION, ANY RAISED IRREGULARITY ON THE TOP SURFACE (STEP, MESA, ETC.) SHALL BE SYMMETRICAL ABOUT THE LATERAL AND LONGITUDINAL PACKAGE CENTERLINES.		
eA	.300	BASIC	7.63	BASIC	5									
eB	—	.430	—	10.92	6								JEDEC NUMBER: MS-001-BA	



DIM	INCHES		MILLIMETERS		N O T E	DIM	INCHES		MILLIMETERS		N O T E	NOTES:	8. POINTED OR ROUNDED LEAD TIPS ARE PREFERRED TO EASE INSERTION. 9. b2 MAXIMUM DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSIONS. DAMBAR PROTRUSIONS SHALL NOT EXCEED .010 (0.25mm). 10. DISTANCE BETWEEN LEADS INCLUDING DAMBAR PROTRUSIONS TO BE .005 (0.13mm) MINIMUM. 11. A VISUAL INDEX FEATURE MUST BE LOCATED WITHIN THE CROSS-HATCHED AREA. 12. FOR AUTOMATIC INSERTION, ANY RAISED IRREGULARITY ON THE TOP SURFACE (STEP, MESA, ETC.) SHALL BE SYMMETRICAL ABOUT THE LATERAL AND LONGITUDINAL PACKAGE CENTERLINES.
	MIN.	MAX.	MIN.	MAX.			MIN.	MAX.	MIN.	MAX.			
A	--	.210	--	5.33	3	L	.115	.150	2.92	3.81	3	1. ALL DIMENSIONS ARE IN INCHES. 2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1982.	
A1	.015	--	0.38	--	3	N	14	--	14	--	7	3. DIMENSIONS A, A1, AND L ARE MEASURED WITH THE PACKAGE SEATED IN JEDEC SEATING PLANE GAUGE GS-3.	
A2	.115	.195	2.92	4.95								4. D, D1, AND E1 DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .010 (0.25mm).	
b	.014	.022	0.36	0.56								5. E AND eA MEASURED WITH THE LEADS RAISED PERPENDICULAR TO DATUM [C-C].	
b2	.045	.070	1.14	1.78	9							6. eB AND eC ARE MEASURED AT THE LEAD TIPS WITH THE LEADS UNCONSTRAINED.	
c	.008	.014	0.20	0.36								7. N IS THE MAXIMUM OF TERMINAL POSITIONS.	
D	.735	.775	18.67	19.69	4								
D1	.005	--	0.13	--	4								
E	.300	.325	7.62	8.26	5								
E1	.240	.280	6.10	7.11	4								
e	.100	BASIC	2.54	BASIC									
eA	.300	BASIC	7.63	BASIC	5								
eB	--	.430	--	10.92	6								
eC	.000	.060	0.00	1.52	6								
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Package Number 182 - 8-Lead SOIC

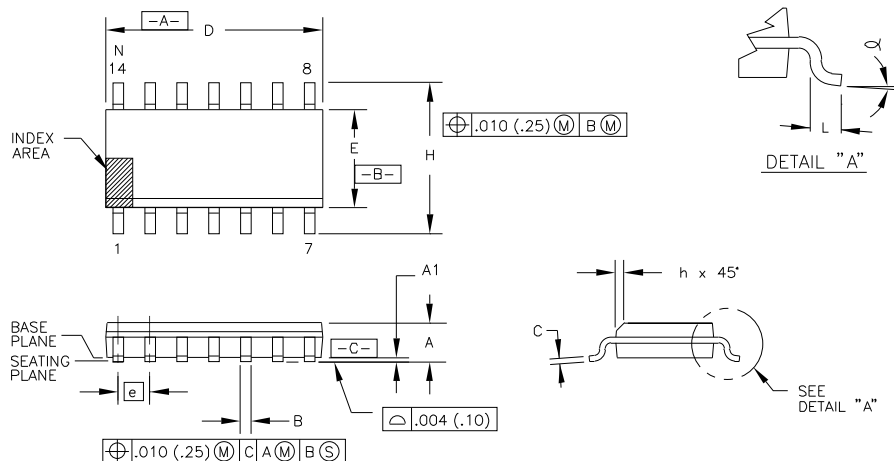


DIM	INCHES		MILLIMETERS		N
	MIN.	MAX.	MIN.	MAX.	
A	.0532	.0688	1.35	1.75	
A1	.004	.0098	0.10	0.23	
B	.013	.020	0.33	0.51	7
C	.0075	.0098	0.20	0.25	
D	.189	.1968	4.80	4.98	2
E	.1497	.1574	3.80	4.00	3
e	.050	BASIC	1.27	BASIC	
H	.2284	.244	5.80	6.20	
h	.0099	.0196	0.25	0.50	4
L	.016	.050	0.41	1.27	5
N	8		8		6
α	0°	8°	0°	8°	

- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1982.
 2. DIMENSION D DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS AND GATE BURRS SHALL NOT EXCEED .006 IN. (0.15 mm) PER SIDE.
 3. DIMENSION E DOES NOT INCLUDE INTER-LEAD FLASH OR PROTRUSIONS. INTER-LEAD FLASH AND PROTRUSIONS SHALL NOT EXCEED .010 IN. (0.25 mm) PER SIDE.
 4. THE CHAMFER ON THE BODY IS OPTIONAL. IF IT IS NOT PRESENT,

- A VISUAL INDEX FEATURE MUST BE LOCATED WITHIN THE CROSS-HATCHED AREA.
5. L IS THE LENGTH OF TERMINAL FOR SOLDERING TO A SUBSTRATE.
 6. N IS THE NUMBER OF TERMINAL POSITIONS.
 7. THE LEAD WIDTH B, AS MEASURED .014 IN. (0.36 mm) OR GREATER ABOVE THE SEATING PLANE, SHALL NOT EXCEED A MAXIMUM VALUE OF .024 IN. (0.61 mm).
 8. LEAD TO LEAD COPLANARITY SHALL BE LESS THAN .004 IN. (0.10 mm) FROM SEATING PLANE.
- | | | | |
|-----------------|-----------|-------|---|
| PACKAGE NUMBER: | ZZ182 | REV.: | H |
| JEDEC NUMBER: | MS-012-AA | | |

Package Number 235 - 14-Lead SOIC



DIM	INCHES	MILLIMETERS	N	DIM	INCHES	MILLIMETERS	N
	MIN.	MAX.			MIN.	MAX.	
A	.0532	.0688	1.35	1.75			
A1	.004	.0098	0.10	0.25			
B	.013	.020	0.33	0.51			
C	.0075	.0098	0.19	0.25			
D	.3367	.3444	8.55	8.75			
E	.1497	.1574	3.80	4.00			
e	.050	BASIC	1.27	BASIC			
H	.2284	.244	5.80	6.20			
h	.0099	.0196	0.25	0.50			
L	.016	.050	0.40	1.27			
N	14		14				
α	0°	8°	0°	8°			

- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1982.
 2. DIMENSION D DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS AND GATE BURRS SHALL NOT EXCEED .006 IN. (0.15 mm) PER SIDE.
 3. DIMENSION E DOES NOT INCLUDE INTER-LEAD FLASH OR PROTRUSIONS. INTER-LEAD FLASH AND PROTRUSIONS SHALL NOT EXCEED .010 IN. (0.25 mm) PER SIDE.
 4. THE CHAMFER ON THE BODY IS OPTIONAL. IF IT IS NOT PRESENT,

5. L IS THE LENGTH OF TERMINAL FOR SOLDERING TO A SUBSTRATE.
6. N IS THE NUMBER OF TERMINAL POSITIONS.
7. THE LEAD WIDTH B, AS MEASURED .014 IN. (0.36 mm) OR GREATER ABOVE THE SEATING PLANE, SHALL NOT EXCEED A MAXIMUM VALUE OF .024 IN. (0.61 mm).
8. LEAD TO LEAD COPLANARITY SHALL BE LESS THAN .004 IN. (0.10 mm) FROM SEATING PLANE.

PACKAGE NUMBER: ZZ235
JEDEC NUMBER: MS-012-AB
REV.: E