# AUDIO DIFFERENTIAL LINE RECEIVER 0dB (G = 1)

**Check for Samples: INA2134-EP**

## FEATURES

- **Single and Dual Versions**
- **Low Distortion: 0.0005% at f = 1 kHz**
- **High Slew Rate: 14 V/ms**
- **Fast Settling Time: 3 ms to 0.01%**
- **Wide Supply Range: ±4 V to ±18 V**
- **Low Quiescent Current: 3.1 mA max**
- **High CMRR: 90 dB**
- **Fixed Gain = 0 dB (1V/V)**
- **Dual 14-Pin SOIC Package**

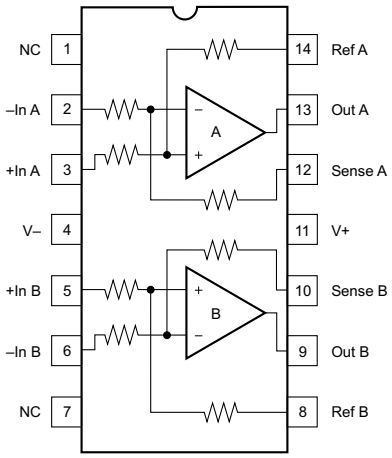
## APPLICATIONS

- **Audio Differential Line Receiver**
- **Summing Amplifier**
- **Unity-Gain Inverting Amplifier**
- **Psuedoground Generator**
- **Instrumentation Building Block**
- **Current Shunt Monitor**
- **Voltage-Controlled Current Source**
- **Ground Loop Eliminator**

## SUPPORTS DEFENSE, AEROSPACE, AND MEDICAL APPLICATIONS

- **Controlled Baseline**
- **One Assembly/Test Site**
- **One Fabrication Site**
- **Available in Military (–55°C/125°C) Temperature Range**(1)
- **Extended Product Life Cycle**
- **Extended Product-Change Notification**
- **Product Traceability**

D PACKAGE
(TOP VIEW)




NC = No Connection

(1) Additional temperature ranges available - contact factory

## DESCRIPTION

The INA2134 is a differential line receiver consisting of high performance op amps with onchip precision resistors. The device is fully specified for high performance audio applications and has excellent ac specifications, including low distortion (0.0005% at 1 kHz) and high slew rate (14 V/ms), 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 INA2134 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 ±4 V to ±18 V (8-V to 36-V total supply).

The INA2134 comes in a 14-pin SOIC surface-mount package and is specified for operation over the military temperature range, –55°C to 125°C.

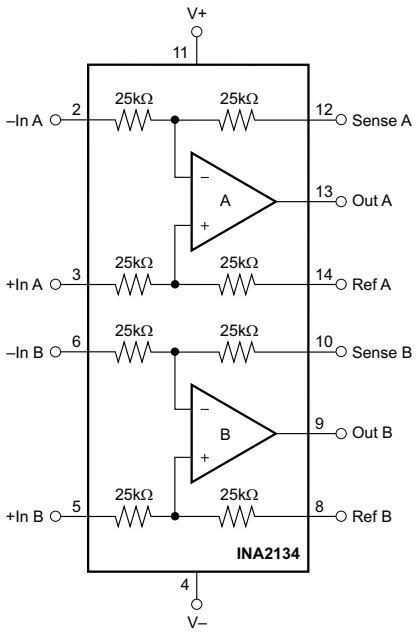
This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

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.

## ORDERING INFORMATION(1)

| $T_A$ | PACKAGE | TOP-SIDE MARKING | ORDERABLE PART NUMBER | VID NUMBER | TRANSPORT MEDIA |
|---|---|---|---|---|---|
| –55°C to 125°C | SOIC-14 – D | INA2134M | INA2134MDREP | V62/12613-01XE | Tape and Reel, large |
| | | | INA2134MDEP | V62/12613-02XE | Tube |

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at www.ti.com.




## ABSOLUTE MAXIMUM RATINGS(1)

over operating free-air temperature range (unless otherwise noted)

| | | VALUE | UNIT |
|---|---|---|---|
| Supply voltage, V+ to V- | | 40 | V |
| Input voltage range | | ±80 | V |
| Output short-circuit (to ground)(2) | | Continuous | |
| Operating temperature | | -55 to 125 | °C |
| Storage temperature | | -65 to 150 | °C |
| Junction temperature | | 150 | °C |
| Lead temperature (soldering, 10 s) | | 300 | °C |
| ESD Rating | Human Body Model (HBM) | 500 | V |
| | Machine Model (MM) | 100 | V |

(1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) One channel per package.

## THERMAL INFORMATION

| THERMAL METRIC[1] | | INA2134 D 14 PINS | UNITS |
|---|---|---|---|
| $\theta_{JA}$ | Junction-to-ambient thermal resistance[2] | 73.1 | °C/W |
| $\theta_{JC}$ | Junction-to-case thermal resistance | 31.1 | |
| $\theta_{JB}$ | Junction-to-board thermal resistance[3] | 27.6 | |
| $\psi_{JT}$ | Junction-to-top characterization parameter[4] | 3.2 | |
| $\psi_{JB}$ | Junction-to-board characterization parameter[5] | 27.3 | |

(1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, SPRA953.
(2) The junction-to-ambient thermal resistance under natural convection is obtained in a simulation on a JEDEC-standard, high-K board, as specified in JESD51-7, in an environment described in JESD51-2a.
(3) The junction-to-board thermal resistance is obtained by simulating in an environment with a ring cold plate fixture to control the PCB temperature, as described in JESD51-8.
(4) The junction-to-top characterization parameter, $\psi_{JT}$, estimates the junction temperature of a device in a real system and is extracted from the simulation data for obtaining $\theta_{JA}$, using a procedure described in JESD51-2a (sections 6 and 7).
(5) The junction-to-board characterization parameter, $\psi_{JB}$, estimates the junction temperature of a device in a real system and is extracted from the simulation data for obtaining $\theta_{JA}$ , using a procedure described in JESD51-2a (sections 6 and 7).

## ELECTRICAL CHARACTERISTICS

At $T_A$ = 25°C, $V_S$ = ±18 V, $R_L$ = 2 kΩ, and Ref pin connected to Ground (unless otherwise noted).

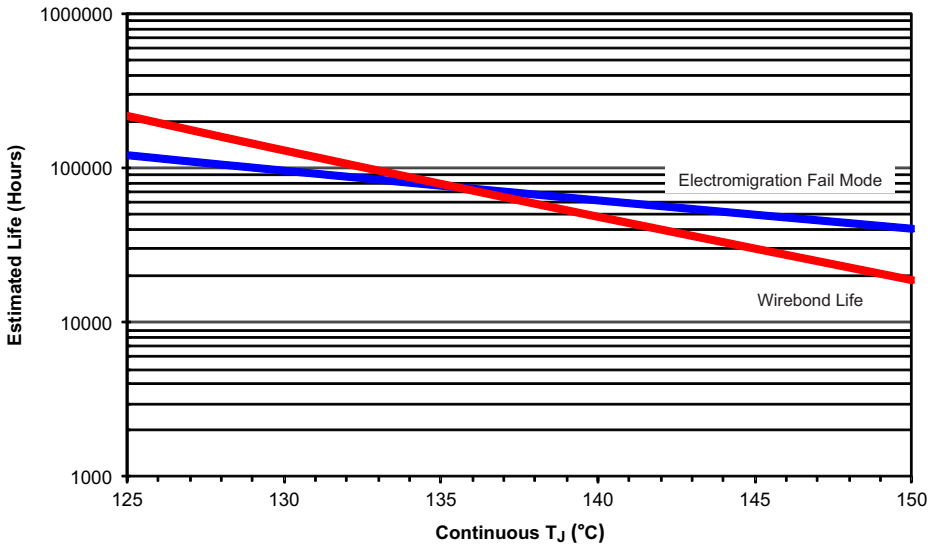
| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **AUDIO PERFORMANCE** | | | | | | |
| Total harmonic distortion + noise, f = 1 kHz | | $V_{IN}$ = 10 Vrms | | 0.0005 | | % |
| Noise floor[1] | | 20 kHz BW | | -100 | | dBu |
| Headroom[1] | | THD+N < 1% | | 23 | | dBu |
| **FREQUENCY RESPONSE** | | | | | | |
| Small-signal bandwidth | | | | 3.1 | | MHz |
| Slew rate | | | | 14 | | V/µs |
| Settling time: | 0.1% | 10-V step, $C_L$ = 100 pF | | 2 | | µs |
| | 0.01% | 10-V step, $C_L$ = 100 pF | | 3 | | µs |
| Overload recovery time | | 50% overdrive | | 3 | | µs |
| Channel separation (dual), f = 1 kHz | | | | 117 | | dB |
| **OUTPUT NOISE VOLTAGE[2]** | | | | | | |
| f = 20 Hz to 20 kHz | | | | 7 | | µVrms |
| f = 1 kHz | | | | 52 | | nV/√Hz |
| **OFFSET VOLTAGE[3]** | | | | | | |
| Input offset voltage | | $V_{CM}$ = 0 V | | ±100 | ±1000 | µV |
| | vs Temperature | -55°C to 125°C | | ±2 | | µV/°C |
| | vs Power supply | $V_S$ = ±4 V to ±18 V, -55°C to 125°C | | ±5 | ±60 | µV/V |
| **INPUT** | | | | | | |
| Common-mode voltage range: | Positive | $V_O$ = 0 V | 2(V+) – 5 | 2(V+) – 4 | | V |
| | Negative | $V_O$ = 0 V | 2(V-) + 5 | 2(V-) + 2 | | V |
| Differential voltage range | | | See Typical Curve | | | |
| Common-mode rejection | | $V_{CM}$ = ±31 V, $R_S$ = 0 Ω | 74 | 90 | | dB |
| | | $V_{CM}$ = ±31 V, $R_S$ = 0 Ω, -55°C to 125°C | 72 | 85 | | dB |
| Impedance:[4] | Differential | | | 50 | | kΩ |
| | Common-mode | | | 50 | | kΩ |

(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) 25-kΩ resistors are ratio matched, but have ±25% absolute value.

## ELECTRICAL CHARACTERISTICS (continued)

At $T_A$ = 25°C, $V_S$ = ±18 V, $R_L$ = 2 kΩ, and Ref pin connected to Ground (unless otherwise noted).

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **GAIN** | | | | | | |
| Initial | | | | 1 | | V/V |
| Error | | $V_O$ = –16 V to 16 V | | ±0.02 | ±0.1 | % |
| | vs Temperature | $V_O$ = –16 V to 16 V, -55°C to 125°C | | ±2 | ±3.5 | % |
| | Nonlinearity | $V_O$ = –16 V to 16 V | | 0.0001 | | % |
| **OUTPUT** | | | | | | |
| Voltage output: | Positive | | (V+) – 2 | (V+) – 1.8 | | V |
| | Negative | | (V-) + 2 | (V-) + 1.6 | | V |
| | Positive | Specified temperature range | (V+) – 2.45 | (V+) – 2.1 | | V |
| | Negative | Specified temperature range | (V-) + 2.45 | (V-) + 1.8 | | V |
| Current limit, continuous to common | | | | ±60 | | mA |
| Capacitive load (stable operation) | | | | 500 | | pF |
| **POWER SUPPLY** | | | | | | |
| Rated voltage | | | | ±18 | | V |
| Voltage range | | | ±4 | | ±18 | V |
| Quiescent current (per amplifier) | | $I_O$ = 0 A | | ±2.4 | ±2.9 | mA |
| | | $I_O$ = 0 A, -55°C to 125°C | | ±2.7 | ±3.1 | mA |
| **TEMPERATURE RANGE** | | | | | | |
| Specified temperature range | | | –55 | | 125 | °C |
| Operating temperature range | | | –55 | | 125 | °C |
| Storage temperature range | | | –65 | | 150 | °C |




A. See datasheet for absolute maximum and minimum recommended operating conditions.

B. Silicon operating life design goal is 10 years at 105°C junction temperature (does not include package interconnect life).

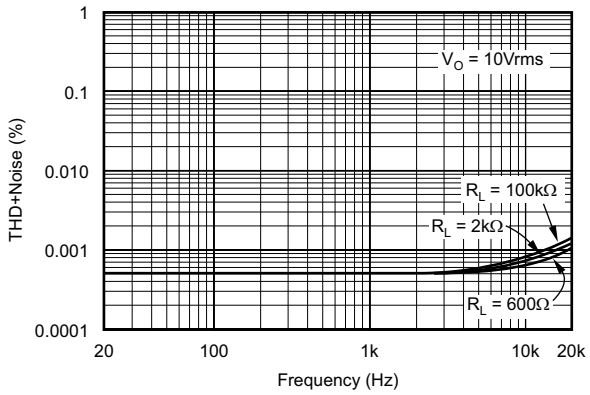
C. The predicted operating lifetime vs. junction temperature is based on reliability modeling using electromigration as the dominant failure mechanism affecting device wearout for the specific device process and design characterisitics.

**Figure 1. INA2134 Electromigration Fail Mode/Wirebond Life Derating Chart**

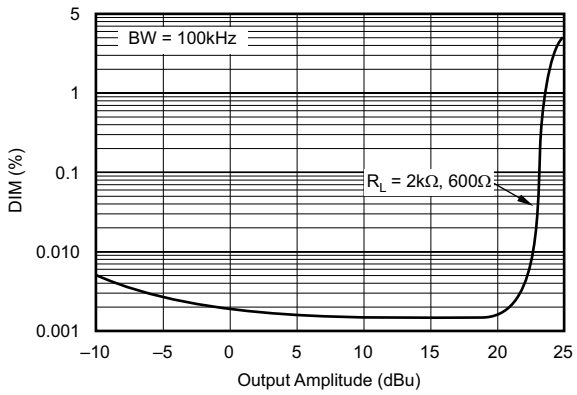
## TYPICAL CHARACTERISTICS

At $T_A$ = 25°C, $V_S$ = ±18 V (unless otherwise noted).

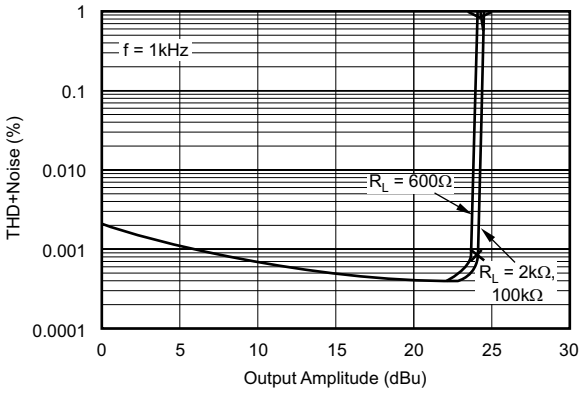
TOTAL HARMONIC DISTORTION+NOISE vs FREQUENCY



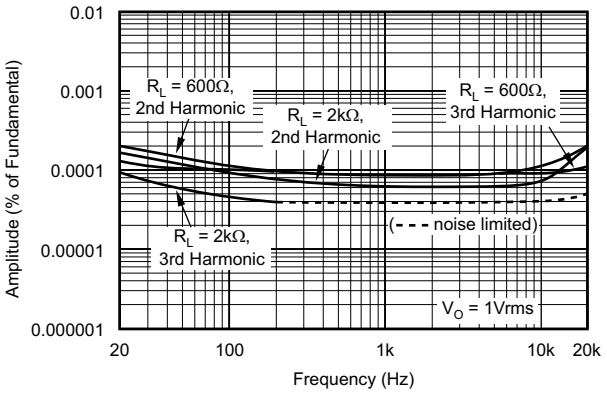

DIM INTERMODULATION DISTORTION vs OUTPUT AMPLITUDE



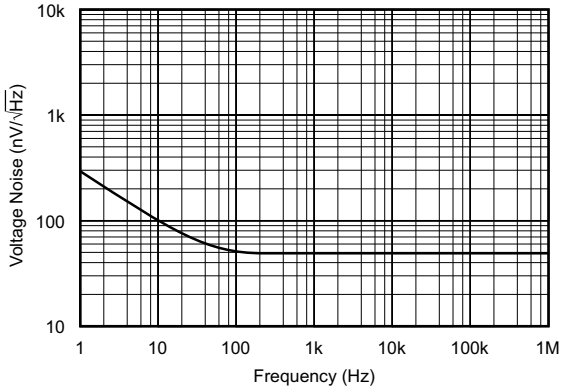

HEADROOM - TOTAL HARMONIC DISTORTION+NOISE vs OUTPUT AMPLITUDE



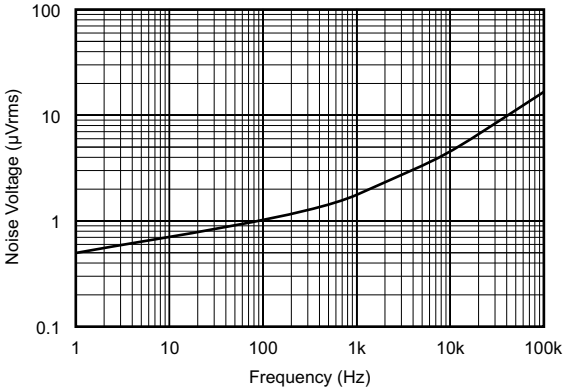

HARMONIC DISTORTION PRODUCTS vs FREQUENCY




OUTPUT VOLTAGE NOISE SPECTRAL DENSITY vs FREQUENCY



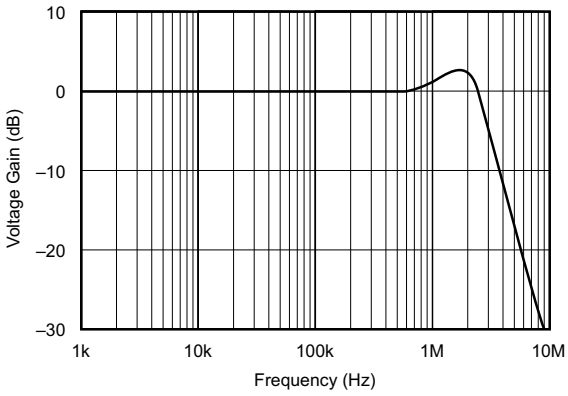

OUTPUT NOISE VOLTAGE vs NOISE BANDWIDTH



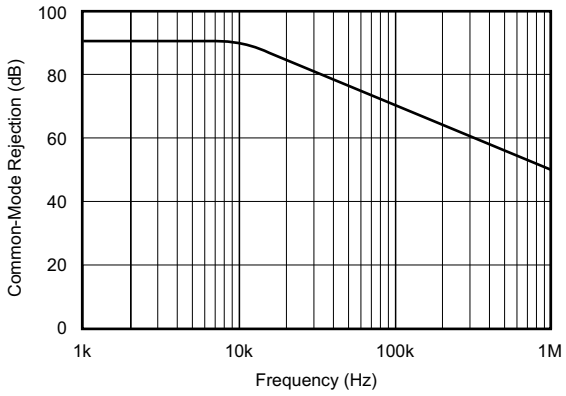
## TYPICAL CHARACTERISTICS (continued)

At $T_A$ = 25°C, $V_S$ = ±18 V (unless otherwise noted).

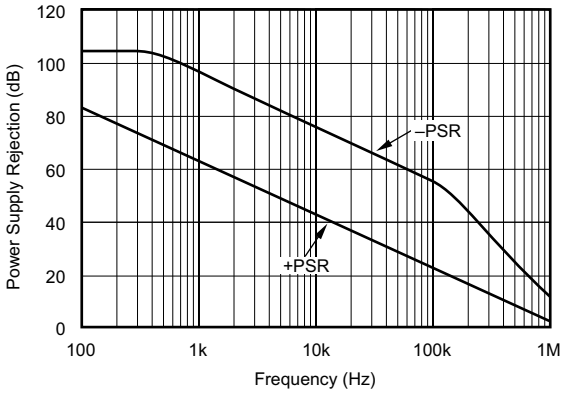
GAIN vs FREQUENCY



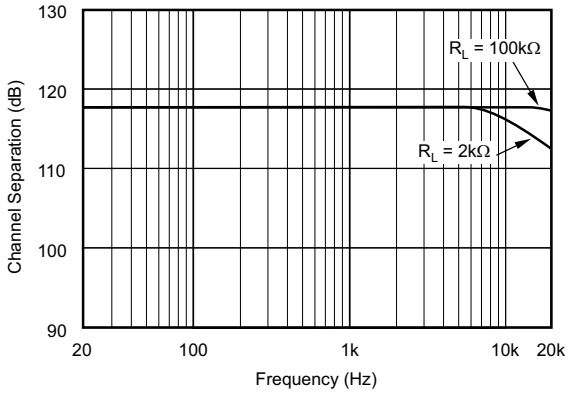

COMMON-MODE REJECTION vs FREQUENCY



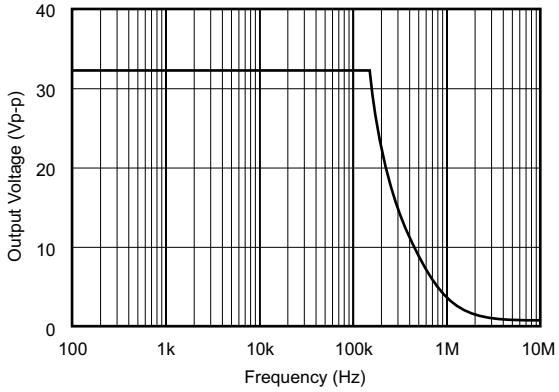

POWER SUPPLY REJECTION vs FREQUENCY



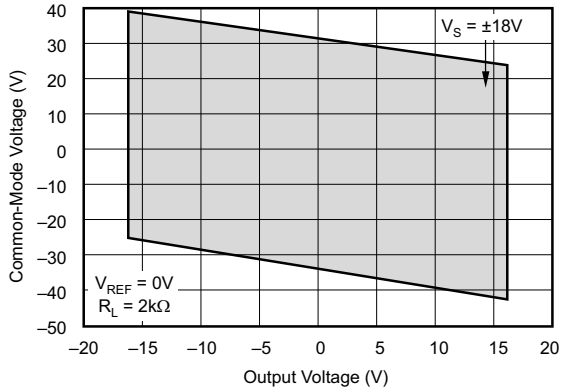

CHANNEL SEPARATION vs FREQUENCY




MAXIMUM OUTPUT VOLTAGE vs FREQUENCY



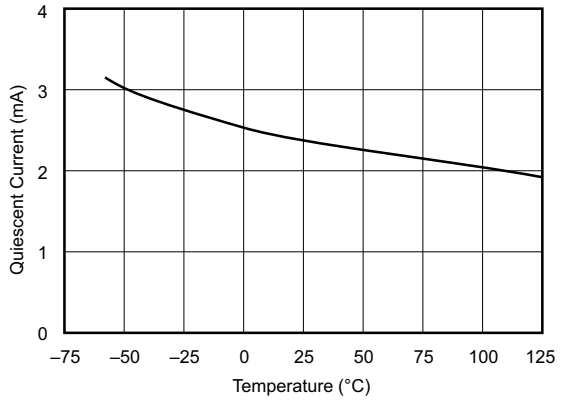

INPUT COMMON-MODE VOLTAGE RANGE vs OUTPUT VOLTAGE



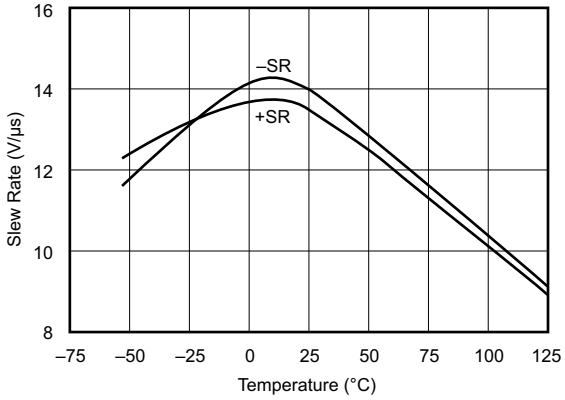
## TYPICAL CHARACTERISTICS (continued)

At $T_A$ = 25°C, $V_S$ = ±18 V (unless otherwise noted).

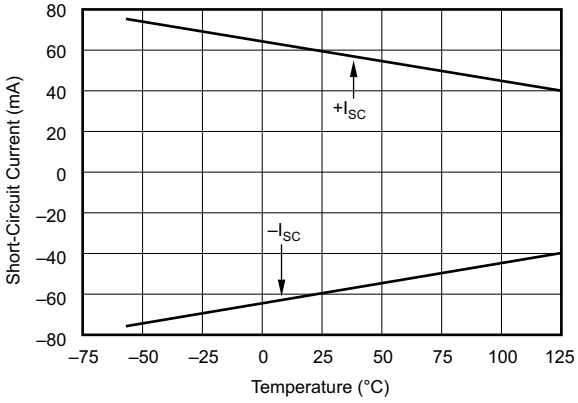
QUIESCENT CURRENT vs TEMPERATURE



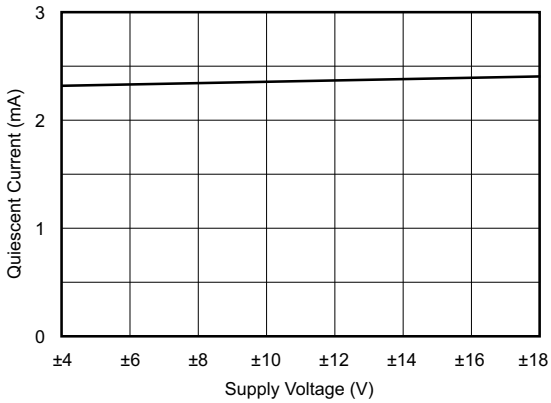

SLEW RATE vs TEMPERATURE



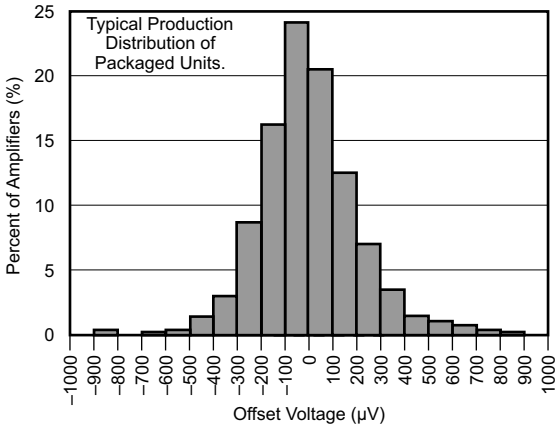

SHORT-CIRCUIT CURRENT vs TEMPERATURE




QUIESCENT CURRENT vs SUPPLY VOLTAGE



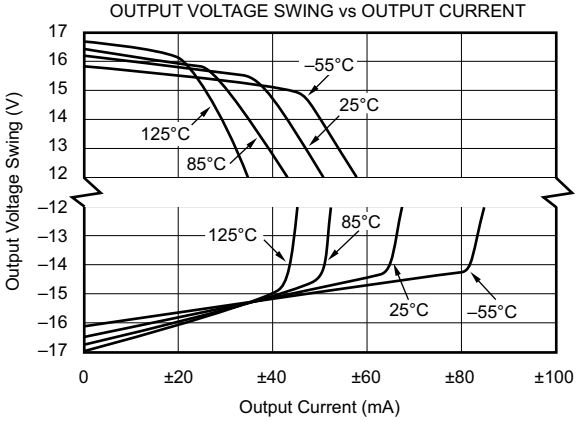

OFFSET VOLTAGE
PRODUCTION DISTRIBUTION



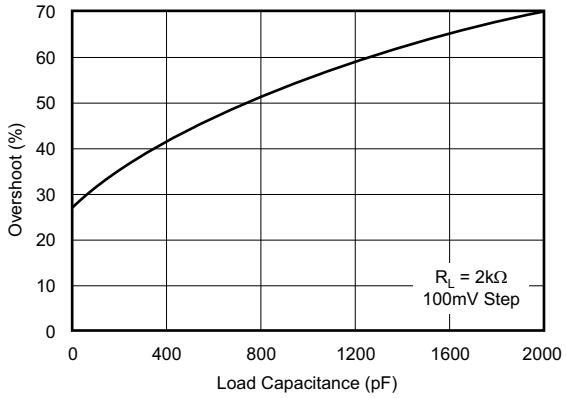
## TYPICAL CHARACTERISTICS (continued)

At $T_A$ = 25°C, $V_S$ = ±18 V (unless otherwise noted).

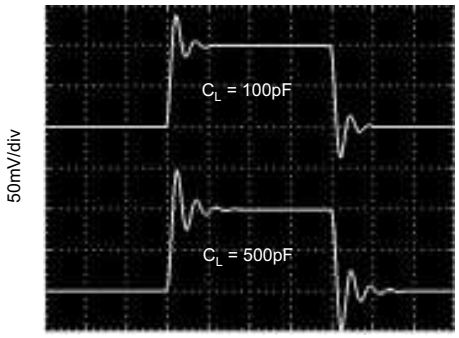
OUTPUT VOLTAGE SWING vs OUTPUT CURRENT



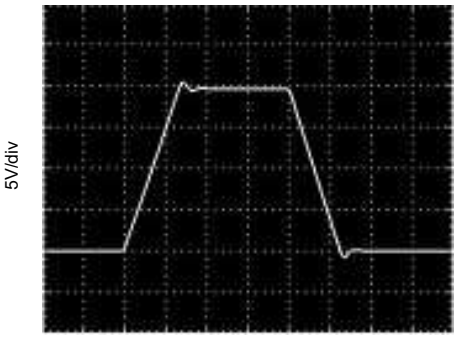

SMALL-SIGNAL OVERSHOOT vs LOAD CAPACITANCE




SMALL-SIGNAL STEP RESPONSE




LARGE-SIGNAL STEP RESPONSE
$C_L$ = 500pF



## APPLICATION INFORMATION

### Basic Connection

Figure 2 shows the basic connections required for operation of the INA2134. Decoupling capacitors are strongly recommended in applications with noisy or high impedance power supplies. The capacitors should be placed close to the device pins as shown in Figure 2. 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 2, 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 10-Ω mismatch in source impedance will degrade the common-mode rejection of a typical device to approximately 74 dB. 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.

Do not interchange pins 1 and 3 or pins 2 and 5, even though nominal resistor values are equal. These resistors are laser trimmed for precise resistor ratios to achieve accurate gain and highest CMR. Interchanging these pins would not provide specified performance.

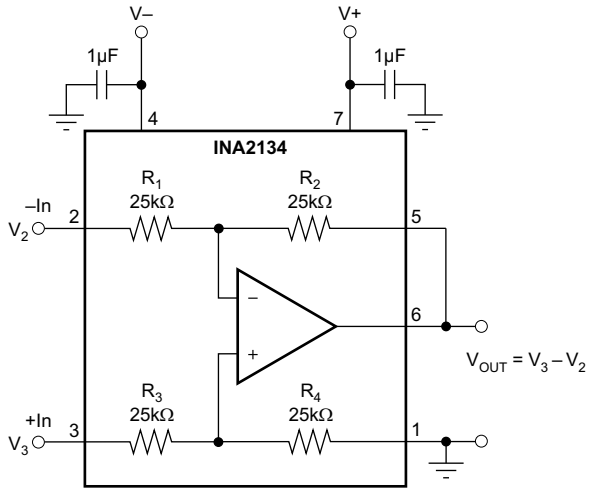



**Figure 2. Precision Difference Amplifier (Basic Power Supply and Signal Connections)**

### Audio Performance

The INA2134 was 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 dB), especially when compared to circuits implemented with an operational amplifier and discrete precision resistors. In addition, high slew rate (14 V/µs) and fast settling time (3 ms to 0.01%) ensure good dynamic performance.

The INA2134 has excellent distortion characteristics. THD+Noise is below 0.002% throughout the audio frequency range. Up to approximately 10-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 V from either supply).

### Offset Voltage Trim

The INA2134 is 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 Ω to maintain good common-mode rejection.

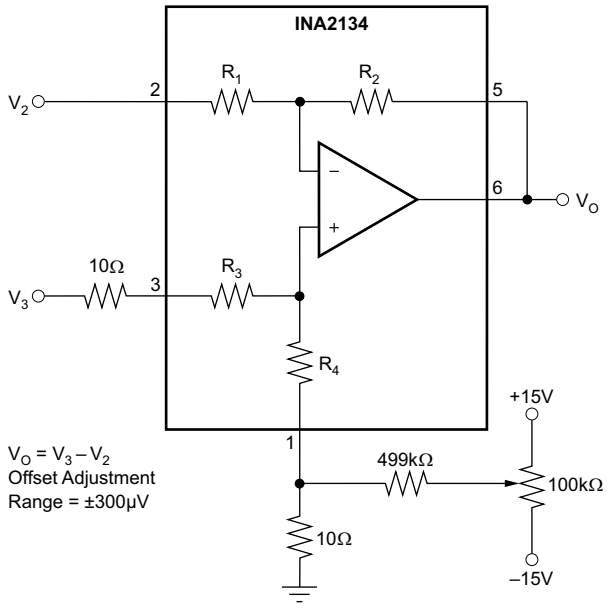



**Figure 3. Offset Adjustment**

### Other Applications

The difference amplifier is a highly versatile building block that is useful in a wide variety of applications. See the INA105 data sheet (SBOS145) for additional applications ideas, including:

- Current Receiver with Compliance to Rails
- Precision Unity-Gain Inverting Amplifier
- ±10-V Precision Voltage Reference
- ±5- Precision Voltage Reference
- Precision Unity-Gain Buffer
- Precision Average Value Amplifier
- Precision G = 2 Amplifier
- Precision Summing Amplifier
- Precision G = 1/2 Amplifier
- Precision Bipolar Offsetting
- Precision Summing Amplifier with Gain
- Instrumentation Amplifier Guard Drive Generator
- Precision Summing Instrumentation Amplifier
- Precision Absolute Value Buffer
- 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
- Digitally Controlled Gain of ±1 Amplifier

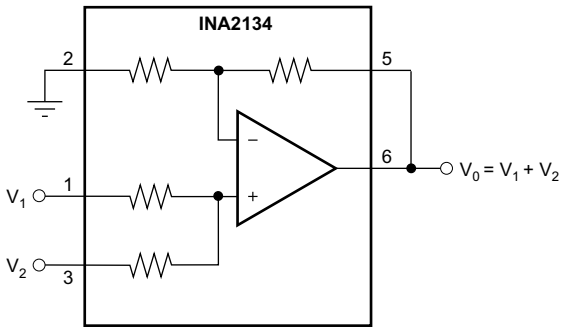



**Figure 4. Precision Summing Amplifier**

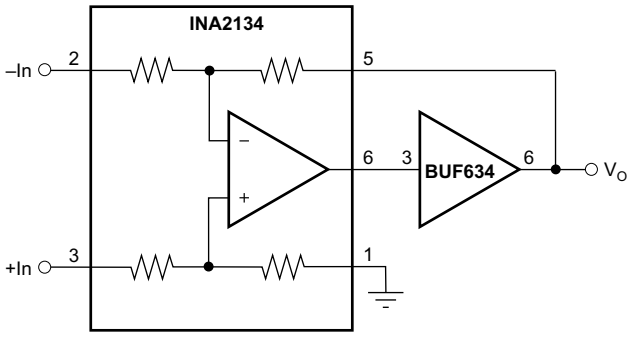
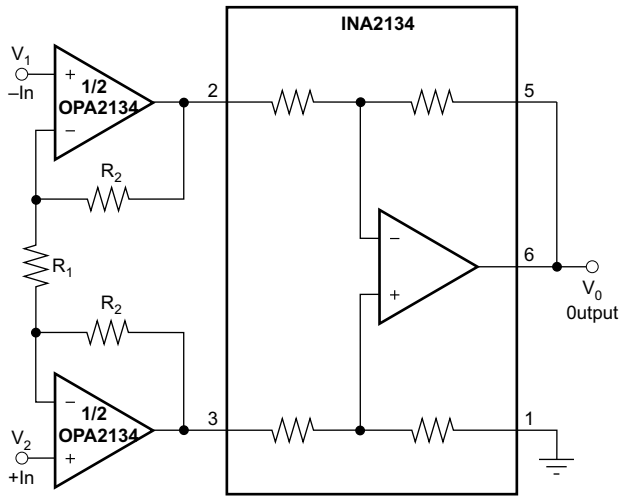



**Figure 5. Boosting Output Current**




$V_O = (1 + 2R_2/R_1)(V_2 - V_1)$

**Figure 6. High Input Impedance Instrumentation Amplifier**

## PACKAGING INFORMATION

| Orderable part number | Status (1) | Material type (2) | Package \| Pins | Package qty \| Carrier | RoHS (3) | Lead finish/ Ball material (4) | MSL rating/ Peak reflow (5) | Op temp (°C) | Part marking (6) |
|---|---|---|---|---|---|---|---|---|---|
| INA2134MDREP | Active | Production | SOIC (D) \| 14 | 2500 \| LARGE T&R | Yes | NIPDAU | Level-3-260C-168 HR | -55 to 125 | INA2134M |
| INA2134MDREP.A | Active | Production | SOIC (D) \| 14 | 2500 \| LARGE T&R | Yes | NIPDAU | Level-3-260C-168 HR | -55 to 125 | INA2134M |

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts 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.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.



**OTHER QUALIFIED VERSIONS OF INA2134-EP :**

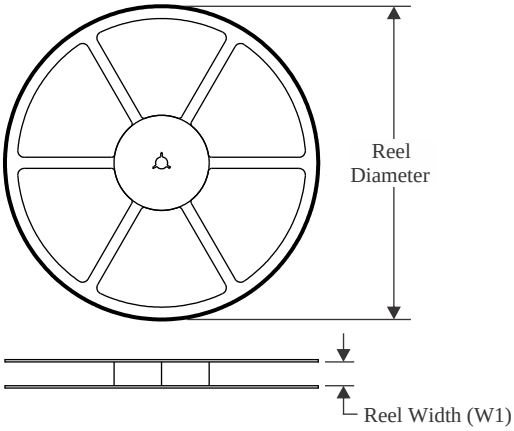
- Catalog : INA2134

NOTE: Qualified Version Definitions:

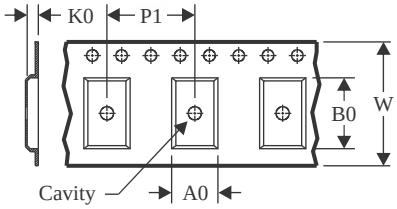
- Catalog - TI's standard catalog product

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

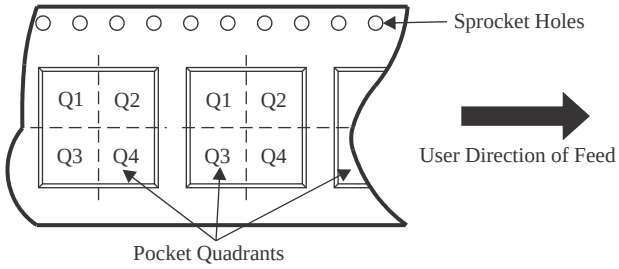



**TAPE DIMENSIONS**




| | |
|---|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

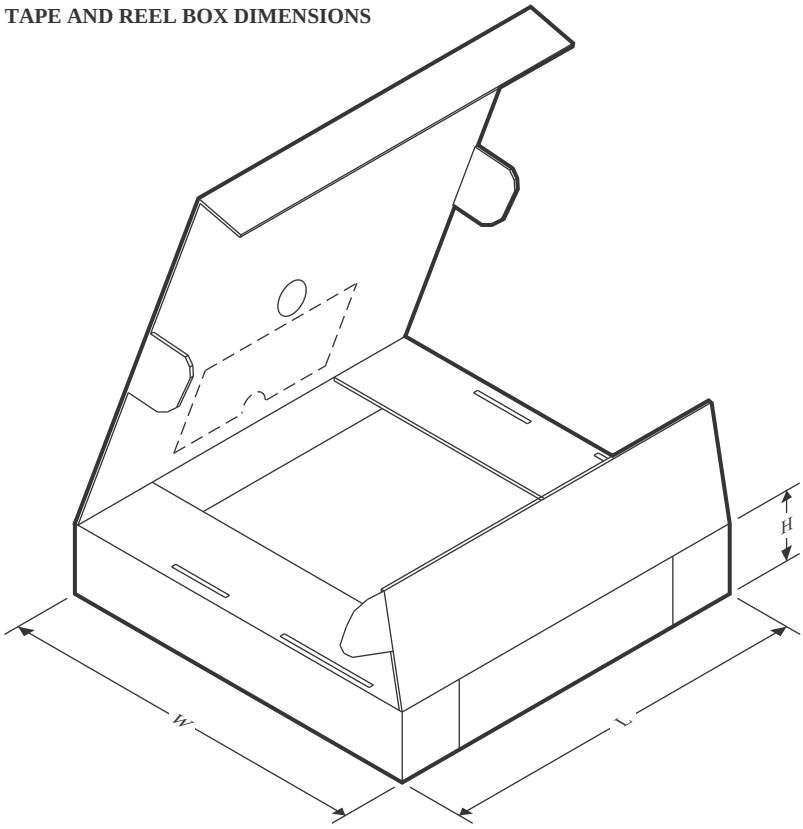
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*All dimensions are nominal

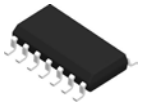
| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INA2134MDREP | SOIC | D | 14 | 2500 | 330.0 | 16.4 | 6.5 | 9.0 | 2.1 | 8.0 | 16.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| INA2134MDREP | SOIC | D | 14 | 2500 | 353.0 | 353.0 | 32.0 |

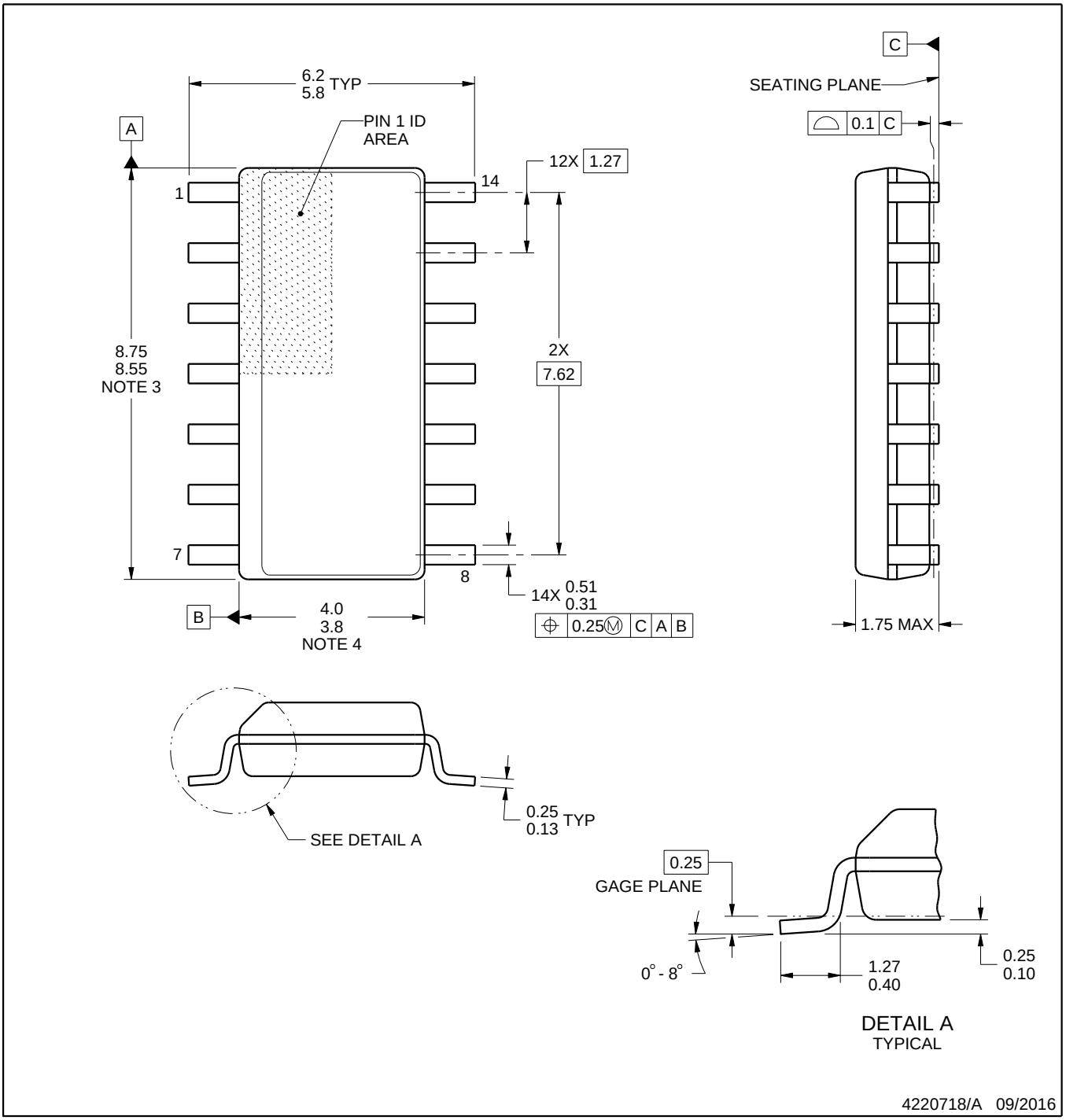


# PACKAGE OUTLINE

## D0014A

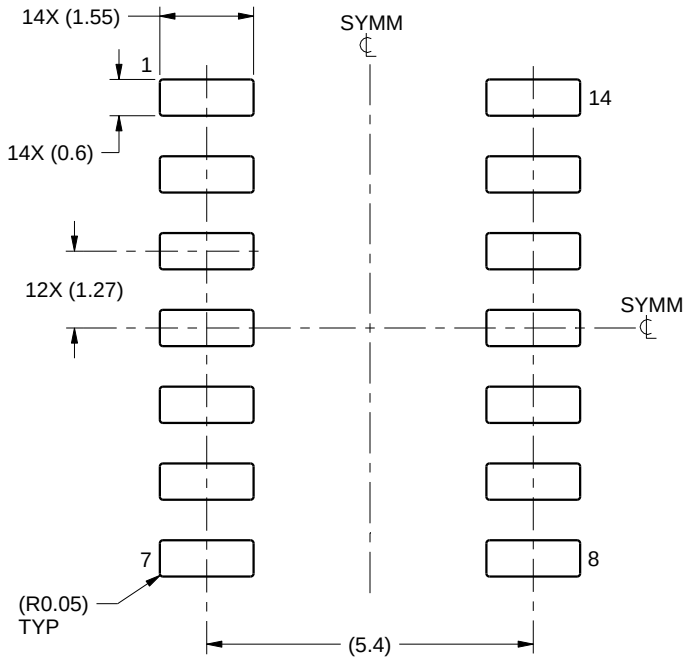
## SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT

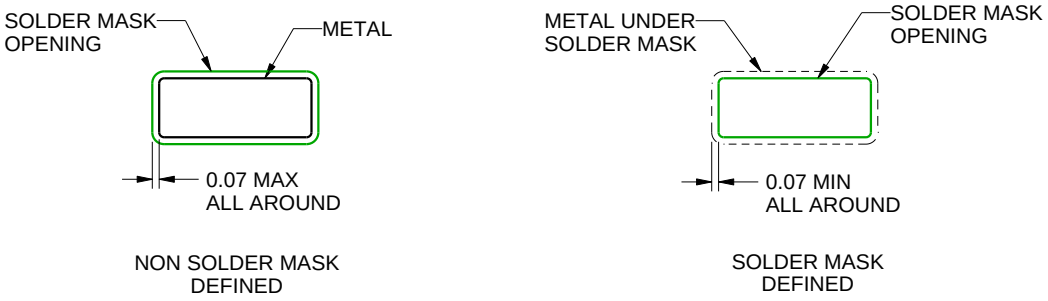



NOTES:

1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm, per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.43 mm, per side.
5. Reference JEDEC registration MS-012, variation AB.




LAND PATTERN EXAMPLE
SCALE:8X




SOLDER MASK DETAILS

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NOTES: (continued)

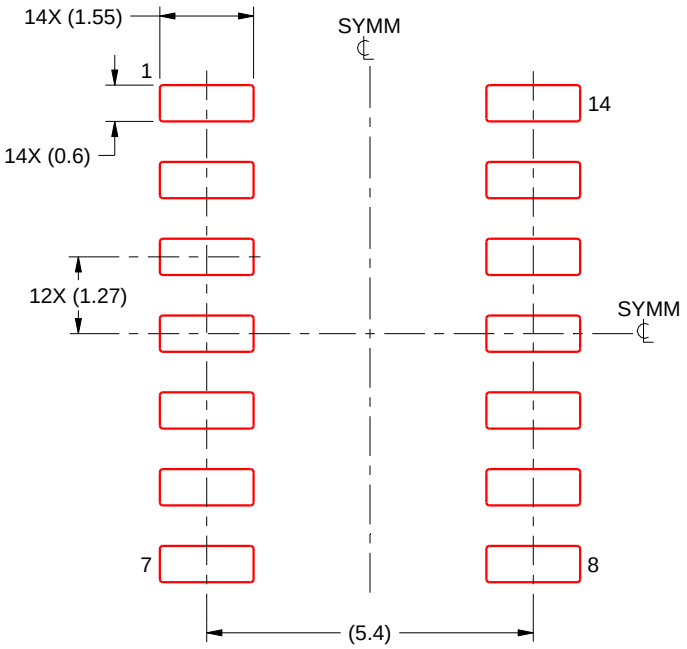
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

## D0014A

## SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT




SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:8X

4220718/A 09/2016

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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