

## NE5534x, SA5534x Low-Noise Operational Amplifiers

### 1 Features

- Equivalent Input Noise Voltage 3.5 nV/ $\sqrt{\text{Hz}}$  Typ
- Unity-Gain Bandwidth 10 MHz Typ
- Common-Mode Rejection Ratio 100 dB Typ
- High DC Voltage Gain 100 V/mV Typ
- Peak-to-Peak Output Voltage Swing 32 V Typ With  $V_{CC\pm} = \pm 18$  V and  $R_L = 600 \Omega$
- High Slew Rate 13 V/ $\mu\text{s}$  Typ
- Wide Supply-Voltage Range  $\pm 3$  V to  $\pm 20$  V
- Low Harmonic Distortion
- Offset Nulling Capability
- External Compensation Capability

### 2 Applications

- Audio Preamplifiers
- Servo Error Amplifiers
- Medical Equipment
- Telephone Channel Amplifiers

### 3 Description

The NE5534, NE5534A, SA5534, and SA5534A devices are high-performance operational amplifiers combining excellent dc and ac characteristics. Some of the features include very low noise, high output-drive capability, high unity-gain and maximum-output-swing bandwidths, low distortion, and high slew rate.

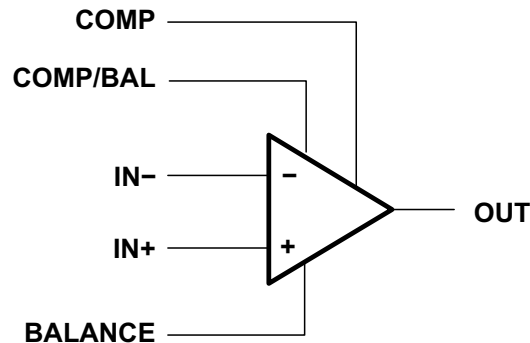
These operational amplifiers are compensated internally for a gain equal to or greater than three. Optimization of the frequency response for various applications can be obtained by use of an external compensation capacitor between COMP and COMP/BAL. The devices feature input-protection diodes, output short-circuit protection, and offset-voltage nulling capability with use of the BALANCE and COMP/BAL pins (see [Figure 10](#)).

For the NE5534A and SA5534A devices, a maximum limit is specified for the equivalent input noise voltage.

#### Device Information

| PART NUMBER | PACKAGE (PIN) | BODY SIZE (NOM)   |
|-------------|---------------|-------------------|
| NE5534x     | SOIC (8)      | 4.90 mm × 3.91 mm |
| SA5534x     | SOIC (8)      | 4.90 mm × 3.91 mm |
|             | SO (8)        | 6.20 mm × 5.30 mm |

### 4 Simplified Schematic



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## 5 Revision History

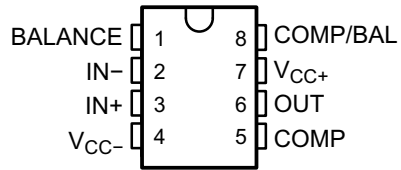
### Changes from Revision C (September 2004) to Revision D

**Page**

- Added *Applications*, *Device Information* table, *Handling Ratings* table, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section. .... **1**
- Deleted *Ordering Information* table. .... **1**

## 6 Pin Configuration and Functions

NE5534, SA5534 . . . D (SOIC), P (PDIP),  
OR PS (SOP) PACKAGE  
NE5534A, SA5534A . . . D (SOIC) OR P (PDIP) PACKAGE  
(TOP VIEW)



### Pin Functions

| PIN              |     | TYPE | DESCRIPTION  |
|------------------|-----|------|--|
| NAME             | NO. |      |  |
| BALANCE          | 1   | I    | External frequency compensation                                    |
| COMP/BAL         | 8   | I    | External offset voltage adjustment/External frequency compensation |
| COMP             | 5   | O    | External offset voltage adjustment                                 |
| IN+              | 3   | I    | Noninverting input   |
| IN-              | 2   | I    | Inverting Input  |
| OUT              | 6   | O    | Output   |
| V <sub>CC+</sub> | 7   | —    | Positive Supply  |
| V <sub>CC-</sub> | 4   | —    | Negative Supply  |

## 7 Specifications

### 7.1 Absolute Maximum Ratings

 over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

|   |  | MIN              | TYP | MAX              | UNIT |
|---|--|------------------|-----|------------------|------|
| V <sub>CC</sub>                                 | Supply voltage <sup>(2)</sup>          | V <sub>CC+</sub> |     | 22               | V    |
|   |  | V <sub>CC-</sub> | -22 | 0                | V    |
| Input voltage, either input <sup>(2)(3)</sup>   |  | V <sub>CC-</sub> |     | V <sub>CC+</sub> | V    |
| Input current <sup>(4)</sup>                    |  | -10              |     | 10               | mA   |
| Duration of output short circuit <sup>(5)</sup> |  | Unlimited        |     |                  |      |
| T <sub>J</sub>                                  | Operating virtual-junction temperature |                  |     | 150              | °C   |

- (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) All voltage values, except differential voltages, are with respect to the midpoint between V<sub>CC+</sub> and V<sub>CC-</sub>.
- (3) The magnitude of the input voltage must never exceed the magnitude of the supply voltage.
- (4) Excessive current will flow if a differential input voltage in excess of approximately 0.6 V is applied between the inputs, unless some limiting resistance is used.
- (5) The output may be shorted to ground or either power supply. Temperature and/or supply voltages must be limited to ensure the maximum dissipation rating is not exceeded.

### 7.2 Handling Ratings

|                    |                           | MIN   | MAX | UNIT |   |
|--------------------|---------------------------|---|-----|------|---|
| T <sub>stg</sub>   | Storage temperature range | -65   | 150 | °C   |   |
| V <sub>(ESD)</sub> | Electrostatic discharge   | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins              | 0   | 2000 | V |
|                    |                           | Charged device model (CDM), per JEDEC specification JESD22-C101, all pins | 0   | 200  |   |

### 7.3 Recommended Operating Conditions

|                 |                                | MIN              | MAX | UNIT |    |
|-----------------|--------------------------------|------------------|-----|------|----|
| V <sub>CC</sub> | Supply voltage                 | V <sub>CC+</sub> | 5   | 15   | V  |
|                 |                                | V <sub>CC-</sub> | -5  | -15  | V  |
| T <sub>A</sub>  | Operating free-air temperature | NE5534, NE5534A  | 0   | 70   | °C |
|                 |                                | SA5534, SA5534A  | -40 | 85   |    |

### 7.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup> | NE5534, NE5534A<br>SA5534, and SA5534A      |    |    | UNIT |      |
|-------------------------------|---|----|----|------|------|
|                               | D   | P  | PS |      |      |
|                               | 8 PINS                                      |    |    |      |      |
| R <sub>θJA</sub>              | Package thermal impedance <sup>(2)(3)</sup> | 97 | 85 | 95   | °C/W |

- (1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report ([SPRA953](#)).
- (2) The package thermal impedance is calculated in accordance with JESD 51-7.
- (3) Maximum power dissipation is a function of T<sub>J(max)</sub>, θ<sub>JA</sub>, and T<sub>A</sub>. The maximum allowable power dissipation at any allowable ambient temperature is P<sub>D</sub> = (T<sub>J(max)</sub> - T<sub>A</sub>) / θ<sub>JA</sub>. Operating at the absolute maximum T<sub>J</sub> of 150°C can affect reliability.

## 7.5 Electrical Characteristics

 $V_{CC\pm} = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$  (unless otherwise noted)

| PARAMETER   |   | TEST CONDITIONS <sup>(1)</sup>                                   |   | MIN      | TYP      | MAX  | UNIT       |
|-------------|---|--|---|----------|----------|------|------------|
| $V_{IO}$    | Input offset voltage  | $V_O = 0$<br>$R_S = 50\ \Omega$                                  | $T_A = 25^\circ\text{C}$                        | 0.5      | 4        |      | mV         |
|             |   |  | $T_A = \text{Full range}$                       |          |          | 5    |            |
| $I_{IO}$    | Input offset current  | $V_O = 0$  | $T_A = 25^\circ\text{C}$                        | 20       | 300      |      | nA         |
|             |   |  | $T_A = \text{Full range}$                       |          |          | 400  |            |
| $I_{IB}$    | Input bias current  | $V_O = 0$  | $T_A = 25^\circ\text{C}$                        | 500      | 1500     |      | nA         |
|             |   |  | $T_A = \text{Full range}$                       |          |          | 2000 |            |
| $V_{ICR}$   | Common-mode input-voltage range                                       |  |   | $\pm 12$ | $\pm 13$ |      | V          |
| $V_{O(PP)}$ | Maximum peak-to-peak output-voltage swing                             | $R_L \geq 600\ \Omega$   | $V_{CC\pm} = \pm 15\text{ V}$                   | 24       | 26       |      | V          |
|             |   |  | $V_{CC\pm} = \pm 18\text{ V}$                   | 30       | 32       |      |            |
| $A_{VD}$    | Large-signal differential-voltage amplification                       | $V_O = \pm 10\text{ V}$<br>$R_L \geq 600\ \Omega$ ,              | $T_A = 25^\circ\text{C}$                        | 25       | 100      |      | V/mV       |
|             |   |  | $T_A = \text{Full range}$                       | 15       |          |      |            |
|             |   | $R_L \geq 2\text{ k}\Omega$ , $V_O \pm 10\text{ V}$              | $T_A = 25^\circ\text{C}$                        | 25       | 100      |      |            |
|             |   |  | $T_A = \text{Full range}$                       | 15       |          |      |            |
| $A_{vd}$    | Small-signal differential-voltage amplification                       | $f = 10\text{ kHz}$  | $C_C = 0$                                       |          | 6        |      | V/mV       |
|             |   |  | $C_C = 22\text{ pF}$                            |          | 2.2      |      |            |
| $B_{OM}$    | Maximum output-swing bandwidth  | $V_O = \pm 10\text{ V}$  | $C_C = 0$                                       |          | 200      |      | kHz        |
|             |   |  | $C_C = 22\text{ pF}$                            |          | 95       |      |            |
|             |   | $V_{CC\pm} = 18\text{ V}$ ,<br>$R_L = 600\ \Omega$               | $V_O = \pm 14\text{ V}$<br>$C_C = 22\text{ pF}$ |          | 70       |      |            |
| $B_1$       | Unity-gain bandwidth  | $C_C = 22\text{ pF}$   | $C_L = 100\text{ pF}$                           |          | 10       |      | MHz        |
| $r_i$       | Input resistance  |  |   | 30       | 100      |      | k $\Omega$ |
| $z_o$       | Output impedance  | $A_{VD} = 30\text{ dB}$ ,<br>$C_C = 22\text{ pF}$                | $R_L = 600\ \Omega$ ,<br>$f = 10\text{ kHz}$    |          | 0.3      |      | $\Omega$   |
| CMRR        | Common-mode rejection ratio   | $V_O = 0$ ,<br>$R_S = 50\ \Omega$                                | $V_{IC} = V_{ICRmin}$                           | 70       | 100      |      | dB         |
| $k_{SVR}$   | Supply-voltage rejection ratio ( $\Delta V_{CC}$ or $\Delta V_{IO}$ ) | $V_{CC\pm} = \pm 9\text{ V}$ to $\pm 15\text{ V}$ ,<br>$V_O = 0$ | $R_S = 50\ \Omega$                              | 80       | 100      |      | dB         |
| $I_{OS}$    | Output short-circuit current  |  |   |          | 38       |      | mA         |
| $I_{CC}$    | Total supply current  | $V_O = 0$ , No load  | $T_A = 25^\circ\text{C}$                        |          | 4        | 8    | mA         |

(1) All characteristics are measured under open-loop conditions with zero common-mode input voltage, unless otherwise specified. For NE5534 and NE5534A, full range is  $0^\circ\text{C}$  to  $70^\circ\text{C}$ . For SA5534 and SA5534A, full range is  $-40^\circ\text{C}$  to  $85^\circ\text{C}$ .

## 7.6 Operating Characteristics

 $V_{CC\pm} = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$  (unless otherwise noted)

| PARAMETER |                                | TEST CONDITIONS  |  | NE5534,<br>SA5534 | NE5534A, SA5534A |     | UNIT                   |
|-----------|--------------------------------|--|--|-------------------|------------------|-----|------------------------|
|           |                                |  |  | TYP               | MIN              | TYP |                        |
| SR        | Slew rate                      | $C_C = 0$  |  | 13                | 13               |     | V/ $\mu\text{s}$       |
|           |                                | $C_C = 22\text{ pF}$   |  | 6                 | 6                |     |                        |
| $t_r$     | Rise time                      | $V_i = 50\text{ mV}$ ,<br>$R_L = 600\ \Omega$ ,<br>$C_L = 100\text{ pF}$ | $A_{VD} = 1$ ,<br>$C_C = 22\text{ pF}$ | 20                | 20               |     | ns                     |
|           | Overshoot factor               |  |  | 20                | 20               |     | %                      |
|           | Rise time                      | $V_i = 50\text{ mV}$ ,<br>$R_L = 600\ \Omega$ ,<br>$C_L = 500\text{ pF}$ | $A_{VD} = 1$ ,<br>$C_C = 47\text{ pF}$ | 50                | 50               |     | ns                     |
|           | Overshoot factor               |  |  | 35%               | 35%              |     | —                      |
| $V_n$     | Equivalent input noise voltage | $f = 30\text{ Hz}$   |  | 7                 | 5.5              | 7   | nV/ $\sqrt{\text{Hz}}$ |
|           |                                | $f = 1\text{ kHz}$   |  | 4                 | 3.5              | 4.5 |                        |
| $I_n$     | Equivalent input noise current | $f = 30\text{ Hz}$   |  | 2.5               | 1.5              |     | pA/ $\sqrt{\text{Hz}}$ |
|           |                                | $f = 1\text{ kHz}$   |  | 0.6               | 0.4              |     |                        |
| $\bar{F}$ | Average noise figure           | $R_S = 5\text{ k}\Omega$   | $f = 10\text{ Hz to } 20\text{ kHz}$   |                   | 0.9              |     | dB                     |

## 7.7 Typical Characteristics

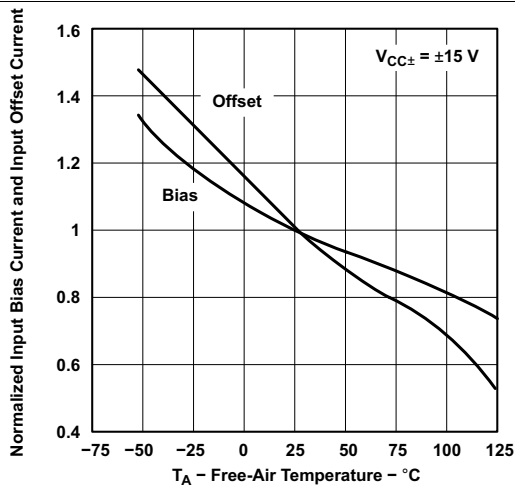


Figure 1. Normalized Input Bias Current and Input Offset Current vs Free-Air Temperature

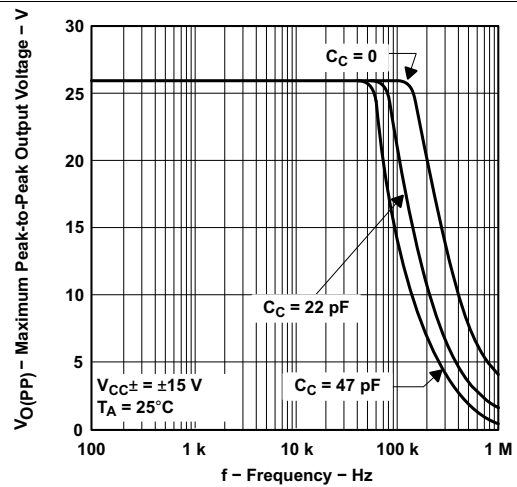


Figure 2. Maximum Peak-to-Peak Output Voltage vs Frequency

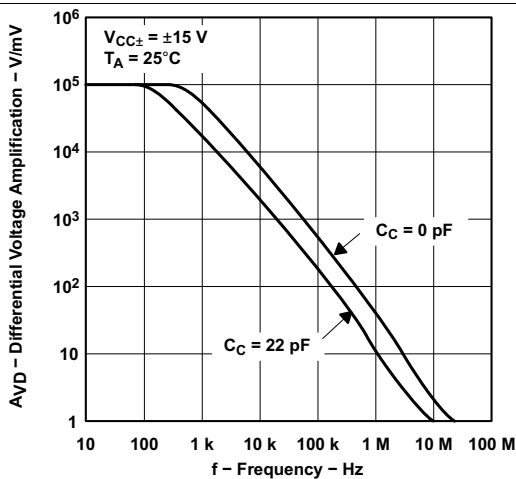


Figure 3. Large-Signal Differential Voltage Amplification vs Frequency

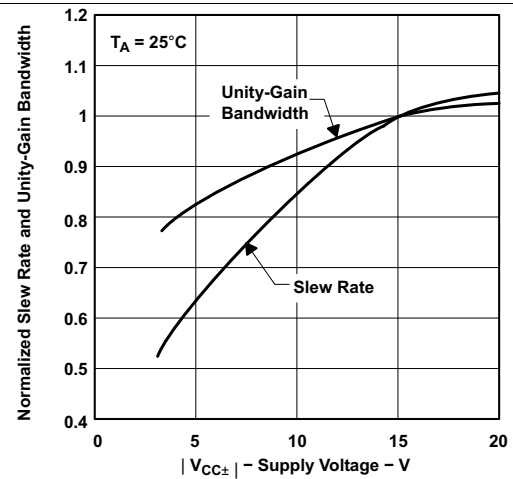


Figure 4. Normalized Slew Rate and Unity-Gain Bandwidth vs Supply Voltage

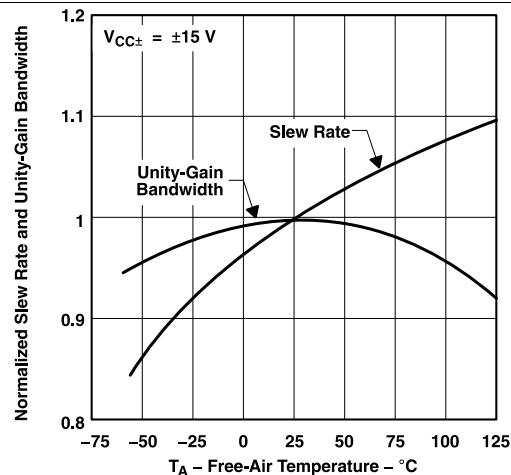


Figure 5. Normalized Slew Rate and Unity-Gain Bandwidth vs Free-Air Temperature

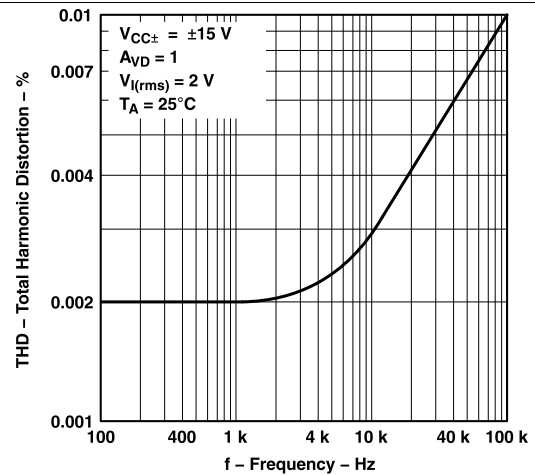


Figure 6. Total Harmonic Distortion vs Frequency

Typical Characteristics (continued)

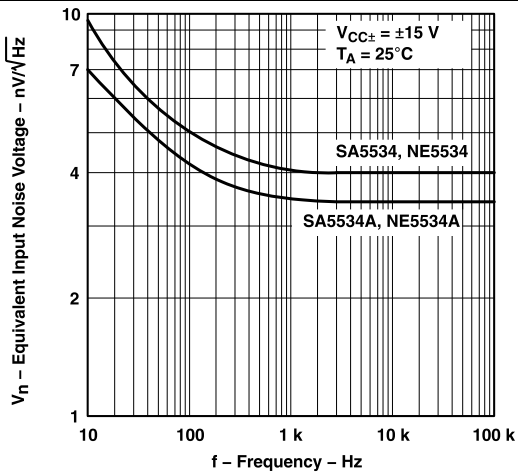


Figure 7. Equivalent Input Noise Voltage vs Frequency

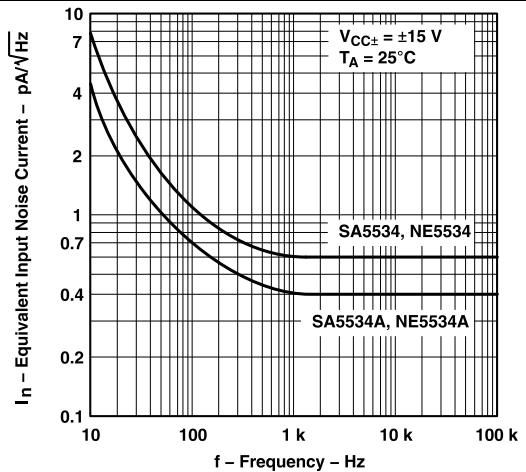


Figure 8. Equivalent Input Noise Current vs Frequency

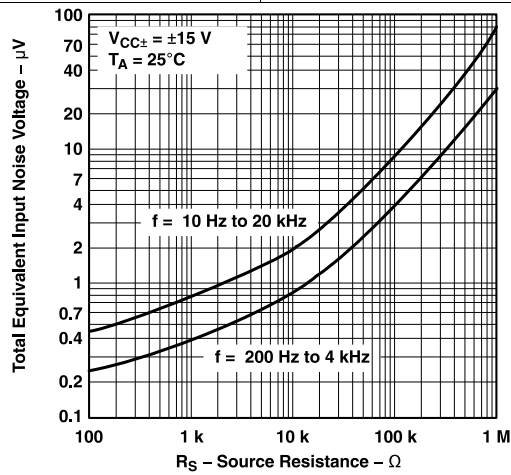


Figure 9. Total Equivalent Input Noise Voltage vs Source Resistance



## 8 Detailed Description

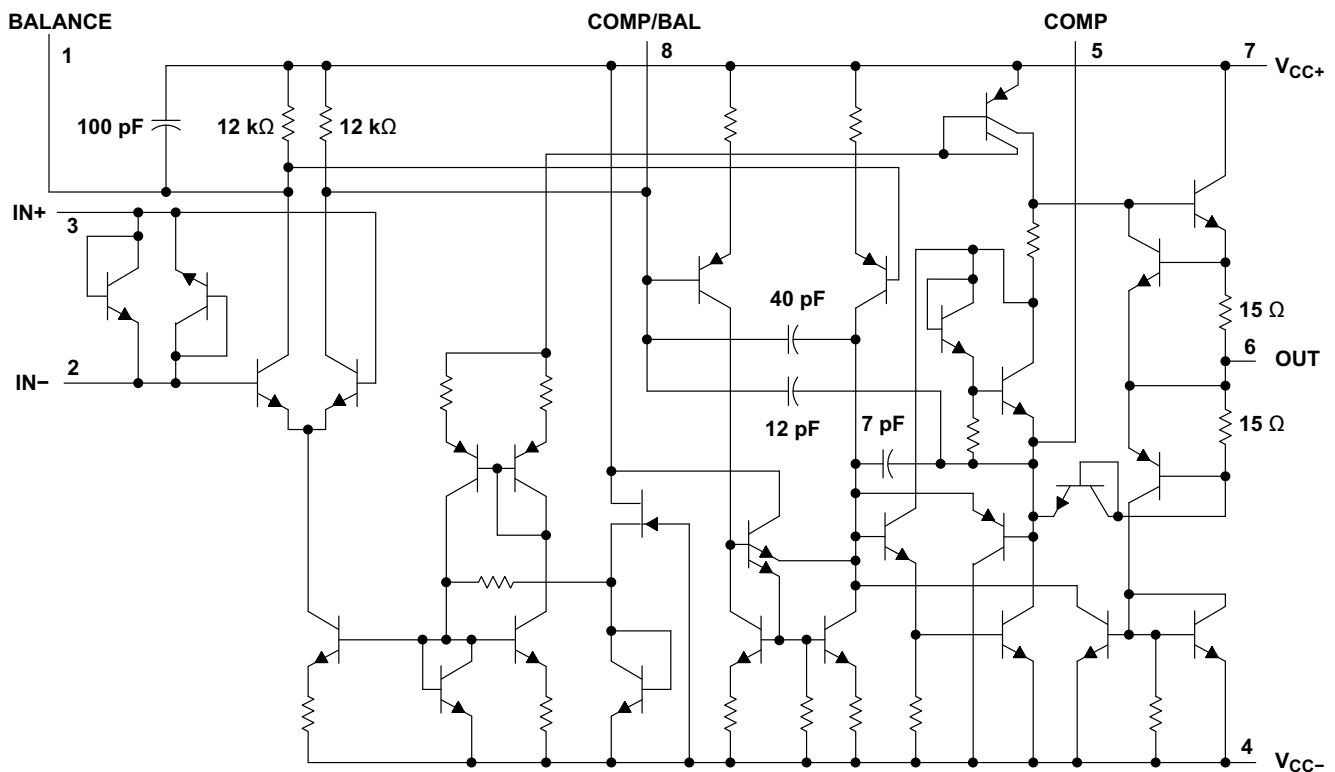
### 8.1 Overview

The NE5534, NE5534A, SA5534, and SA5534A devices are high-performance operational amplifiers combining excellent dc and ac characteristics. Some of the features include very low noise, high output-drive capability, high unity-gain and maximum-output-swing bandwidths, low distortion, and high slew rate.

These operational amplifiers are compensated internally for a gain equal to or greater than three. Optimization of the frequency response for various applications can be obtained by use of an external compensation capacitor between COMP and COMP/BAL. The devices feature input-protection diodes, output short-circuit protection, and offset-voltage nulling capability with use of the BALANCE and COMP/BAL pins (see the [Application Circuit Diagram](#)).

For the NE5534A and SA5534A devices, a maximum limit is specified for the equivalent input noise voltage.

### 8.2 Functional Block Diagram



## 8.3 Feature Description

### 8.3.1 Offset-Voltage Null Capability

The input offset voltage of operational amplifiers (op amps) arises from unavoidable mismatches in the differential input stage of the op-amp circuit caused by mismatched transistor pairs, collector currents, current-gain betas ( $\beta$ ), collector or emitter resistors, and so on. The input offset pins allow the designer to adjust for these mismatches by external circuitry. See the [Application and Implementation](#) section for more details on design techniques.

### 8.3.2 Slew Rate

The slew rate is the rate at which an operational amplifier can change its output when there is a change on the input. The NE5534 and SA5534 devices have a 13-V/ $\mu$ s slew rate.

### 8.3.3 Common-Mode Rejection Ratio

The common-mode rejection ratio (CMRR) of an amplifier is a measure of how well the device rejects unwanted input signals common to both input leads. It is found by taking the ratio of the change in input offset voltage to the change in the input voltage and converting to decibels. Ideally the CMRR is infinite, but in practice, amplifiers are designed to have it as high as possible. The CMRR of the NE5534 and SA5534 devices is 100 dB.

### 8.3.4 Unity-Gain Bandwidth

The unity-gain bandwidth is the frequency up to which an amplifier with a unity gain may be operated without greatly distorting the signal. The NE5534 and SA5534 devices have a 10-MHz unity-gain bandwidth.

### 8.3.5 External Compensation Capability

Frequency compensation with a capacitor may be used to increase the gain-bandwidth product (GBW) of the amplifier. See the [Application and Implementation](#) section for more details on design techniques.

## 8.4 Device Functional Modes

The NE5534 and SA5534 devices are powered on when the supply is connected. Each of these devices can be operated as a single supply operational amplifier or dual supply amplifier depending on the application.

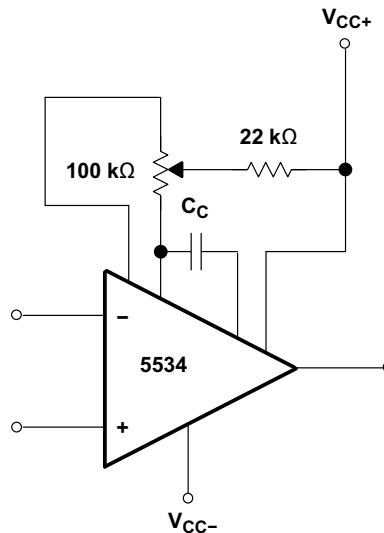
## 9 Application and Implementation

### NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

### 9.1 General Application

The input offset voltage of operational amplifiers (op amps) arises from unavoidable mismatches in the differential input stage of the op-amp circuit caused by mismatched transistor pairs, collector currents, current-gain betas ( $\beta$ ), collector or emitter resistors, and so on. The input offset pins allow the designer to adjust for these mismatches by external circuitry. These input mismatches can be adjusted by putting resistors or a potentiometer between the inputs as shown in [Figure 10](#). A potentiometer can be used to fine tune the circuit during testing or for applications which require precision offset control. More information about designing using the input-offset pins, see *Offset Voltage of Operational Amplifiers* ([SLOA045](#)).

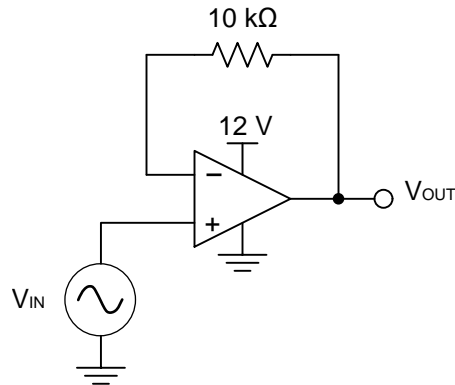


Frequency Compensation and Offset-Voltage Nulling Circuit

**Figure 10. Application Circuit**

## 9.2 Typical Application

The voltage follower configuration of the operational amplifier is used for applications where a weak signal is used to drive a relatively high current load. This circuit is also called a buffer amplifier or unity gain amplifier. The inputs of an operational amplifier have a very high resistance which puts a negligible current load on the voltage source. The output resistance of the operational amplifier is almost negligible, so it can provide as much current as necessary to the output load.



**Figure 11. Voltage Follower Schematic**

### 9.2.1 Design Requirements

- Output range of 2 V to 11 V
- Input range of 2 V to 11 V

### 9.2.2 Detailed Design Procedure

#### 9.2.2.1 Output Voltage Swing

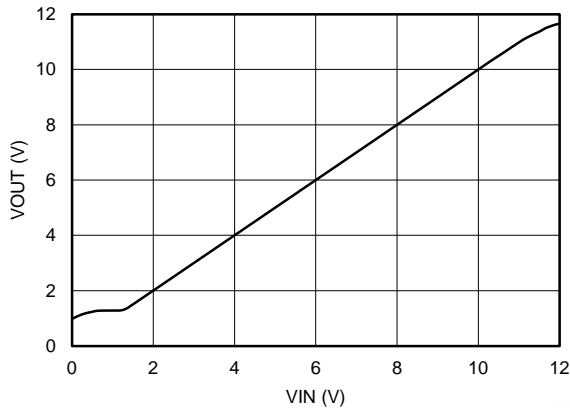
The output voltage of an operational amplifier is limited by its internal circuitry to some level below the supply rails. For this amplifier, the output voltage swing is within  $\pm 12$  V, which accommodates the input and output voltage requirements.

#### 9.2.2.2 Supply and Input Voltage

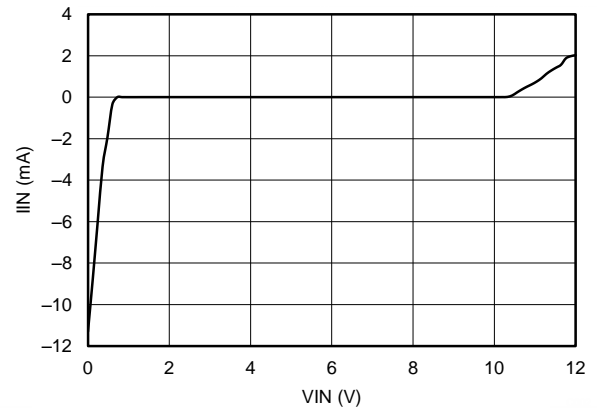
For correct operation of the amplifier, neither input must be higher than the recommended positive supply rail voltage or lower than the recommended negative supply rail voltage. The chosen amplifier must be able to operate at the supply voltage that accommodates the inputs. Because the input for this application goes up to 11 V, the supply voltage must be 12 V. Using a negative voltage on the lower rail rather than ground, allows the amplifier to maintain linearity for inputs below 2 V.

**Typical Application (continued)**

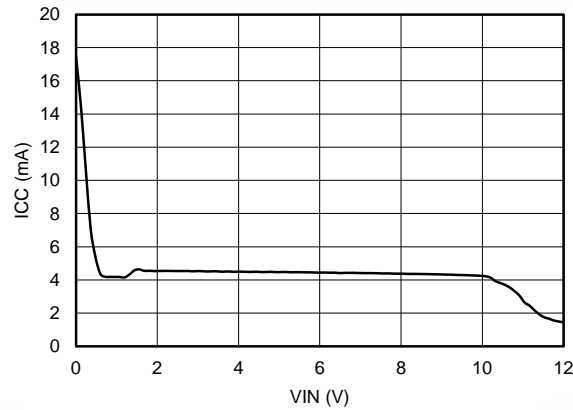
**9.2.3 Application Curves for Output Characteristics**



**Figure 12. Output Voltage vs Input Voltage**



**Figure 13. Current Drawn by the Input of the Voltage Follower ( $I_{IN}$ ) vs the Input Voltage**



**Figure 14. Current Drawn from Supply ( $I_{CC}$ ) vs the Input Voltage**

## 10 Power Supply Recommendations

The NE5534 and SA5534 devices are specified for operation from  $\pm 5$  to  $\pm 15$  V; many specifications apply from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$  for the NE5534 device and  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$  for the SA5534 device.

### CAUTION

Supply voltages larger than  $\pm 22$  V can permanently damage the device (see the [Absolute Maximum Ratings](#)).

Place 0.1- $\mu\text{F}$  bypass capacitors close to the power-supply pins to reduce errors coupling in from noisy or high impedance power supplies. For more detailed information on bypass capacitor placement, refer to the [Layout Guidelines](#).

## 11 Layout

### 11.1 Layout Guidelines

For best operational performance of the device, use good PCB layout practices, including:

- Noise can propagate into analog circuitry through the power pins of the circuit as a whole, as well as the operational amplifier. Bypass capacitors are used to reduce the coupled noise by providing low-impedance power sources local to the analog circuitry.
  - Connect low-ESR, 0.1- $\mu$ F ceramic bypass capacitors between each supply pin and ground, placed as close to the device as possible. A single bypass capacitor from V+ to ground is applicable for single supply applications.
- Separate grounding for analog and digital portions of circuitry is one of the simplest and most-effective methods of noise suppression. On multilayer PCBs, one or more layers are usually devoted to ground planes. A ground plane helps distribute heat and reduces EMI noise pickup. Make sure to physically separate digital and analog grounds, paying attention to the flow of the ground current. For more detailed information, refer to *Circuit Board Layout Techniques* (SLOA089).
- To reduce parasitic coupling, run the input traces as far away from the supply or output traces as possible. If it is not possible to keep them separate, it is much better to cross the sensitive trace perpendicularly, as opposed to in parallel, with the noisy trace.
- Place the external components as close to the device as possible. Keeping RF and RG close to the inverting input minimizes parasitic capacitance, as shown in .
- Keep the length of input traces as short as possible. Always remember that the input traces are the most sensitive part of the circuit.
- Consider a driven, low-impedance guard ring around the critical traces. A guard ring can significantly reduce leakage currents from nearby traces that are at different potentials.

### 11.2 Layout Example

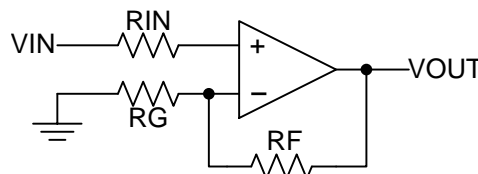


Figure 15. Operational Amplifier Schematic for Noninverting Configuration

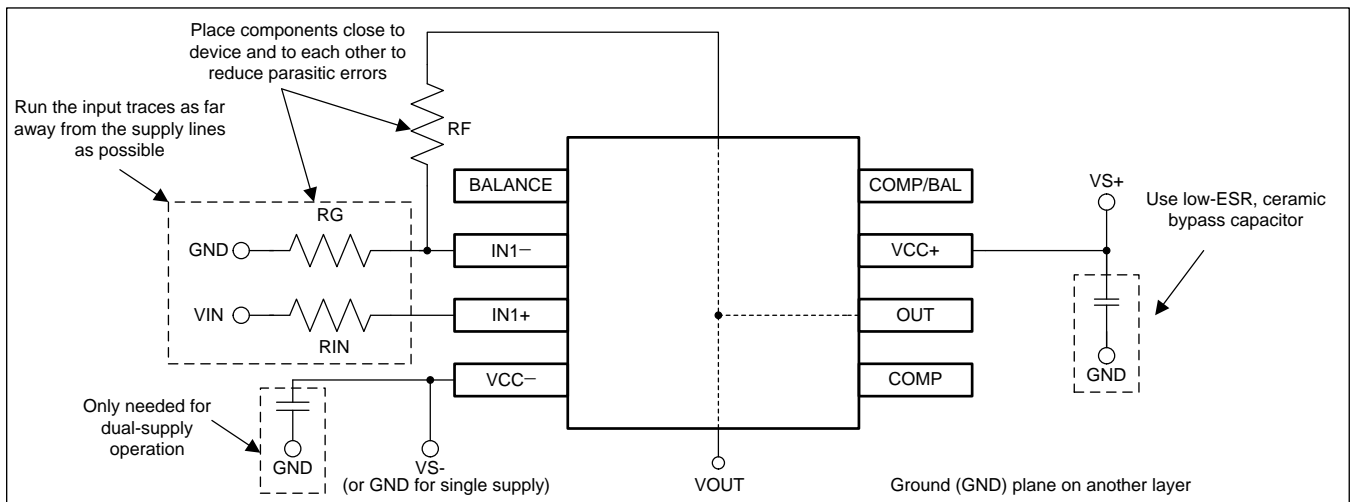


Figure 16. Operational Amplifier Board Layout for Noninverting Configuration

## 12 Device and Documentation Support

### 12.1 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

**Table 1. Related Links**

| PARTS   | PRODUCT FOLDER             | SAMPLE & BUY               | TECHNICAL DOCUMENTS        | TOOLS & SOFTWARE           | SUPPORT & COMMUNITY        |
|---------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| NE5534  | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> |
| NE5534A | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> |
| SA5534  | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> |
| SA5534A | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> |

### 12.2 Trademarks

All trademarks are the property of their respective owners.

### 12.3 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

### 12.4 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

## 13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.



**PACKAGING INFORMATION**

| Orderable Device | Status<br>(1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan<br>(2) | Lead finish/<br>Ball material<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| NE5534AD         | ACTIVE        | SOIC         | D               | 8    | 75          | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | 0 to 70      | 5534A                   | <a href="#">Samples</a> |
| NE5534ADR        | ACTIVE        | SOIC         | D               | 8    | 2500        | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | 0 to 70      | 5534A                   | <a href="#">Samples</a> |
| NE5534ADRE4      | ACTIVE        | SOIC         | D               | 8    | 2500        | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | 0 to 70      | 5534A                   | <a href="#">Samples</a> |
| NE5534ADRG4      | ACTIVE        | SOIC         | D               | 8    | 2500        | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | 0 to 70      | 5534A                   | <a href="#">Samples</a> |
| NE5534AP         | ACTIVE        | PDIP         | P               | 8    | 50          | RoHS & Green    | NIPDAU                               | N / A for Pkg Type   | 0 to 70      | NE5534AP                | <a href="#">Samples</a> |
| NE5534APE4       | ACTIVE        | PDIP         | P               | 8    | 50          | RoHS & Green    | NIPDAU                               | N / A for Pkg Type   | 0 to 70      | NE5534AP                | <a href="#">Samples</a> |
| NE5534D          | ACTIVE        | SOIC         | D               | 8    | 75          | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | 0 to 70      | NE5534                  | <a href="#">Samples</a> |
| NE5534DR         | ACTIVE        | SOIC         | D               | 8    | 2500        | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | 0 to 70      | NE5534                  | <a href="#">Samples</a> |
| NE5534DRE4       | ACTIVE        | SOIC         | D               | 8    | 2500        | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | 0 to 70      | NE5534                  | <a href="#">Samples</a> |
| NE5534DRG4       | ACTIVE        | SOIC         | D               | 8    | 2500        | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | 0 to 70      | NE5534                  | <a href="#">Samples</a> |
| NE5534P          | ACTIVE        | PDIP         | P               | 8    | 50          | RoHS & Green    | NIPDAU                               | N / A for Pkg Type   | 0 to 70      | NE5534P                 | <a href="#">Samples</a> |
| NE5534PE4        | ACTIVE        | PDIP         | P               | 8    | 50          | RoHS & Green    | NIPDAU                               | N / A for Pkg Type   | 0 to 70      | NE5534P                 | <a href="#">Samples</a> |
| SA5534AD         | ACTIVE        | SOIC         | D               | 8    | 75          | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | -40 to 85    | SA5534A                 | <a href="#">Samples</a> |
| SA5534ADR        | ACTIVE        | SOIC         | D               | 8    | 2500        | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | -40 to 85    | SA5534A                 | <a href="#">Samples</a> |
| SA5534AP         | ACTIVE        | PDIP         | P               | 8    | 50          | RoHS & Green    | NIPDAU                               | N / A for Pkg Type   | -40 to 85    | SA5534AP                | <a href="#">Samples</a> |
| SA5534APE4       | ACTIVE        | PDIP         | P               | 8    | 50          | RoHS & Green    | NIPDAU                               | N / A for Pkg Type   | -40 to 85    | SA5534AP                | <a href="#">Samples</a> |
| SA5534D          | ACTIVE        | SOIC         | D               | 8    | 75          | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | -40 to 85    | SA5534                  | <a href="#">Samples</a> |
| SA5534DR         | ACTIVE        | SOIC         | D               | 8    | 2500        | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | -40 to 85    | SA5534                  | <a href="#">Samples</a> |
| SA5534P          | ACTIVE        | PDIP         | P               | 8    | 50          | RoHS & Green    | NIPDAU                               | N / A for Pkg Type   | -40 to 85    | SA5534P                 | <a href="#">Samples</a> |
| SA5534PSR        | ACTIVE        | SO           | PS              | 8    | 2000        | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 85    | SA5534                  | <a href="#">Samples</a> |

(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  $\leq 1000$ ppm threshold. Antimony trioxide based flame retardants must also meet the  $\leq 1000$ ppm 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.

(6) 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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## 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 |
|-----------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| NE5534ADR | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| NE5534DR  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| SA5534ADR | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| SA5534DR  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| SA5534PSR | SO           | PS              | 8    | 2000 | 330.0              | 16.4               | 8.35    | 6.6     | 2.4     | 12.0    | 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) |
|-----------|--------------|-----------------|------|------|-------------|------------|-------------|
| NE5534ADR | SOIC         | D               | 8    | 2500 | 340.5       | 336.1      | 25.0        |
| NE5534DR  | SOIC         | D               | 8    | 2500 | 340.5       | 336.1      | 25.0        |
| SA5534ADR | SOIC         | D               | 8    | 2500 | 340.5       | 336.1      | 25.0        |
| SA5534DR  | SOIC         | D               | 8    | 2500 | 340.5       | 336.1      | 25.0        |
| SA5534PSR | SO           | PS              | 8    | 2000 | 853.0       | 449.0      | 35.0        |

**TUBE**


\*All dimensions are nominal

| Device     | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|------------|--------------|--------------|------|-----|--------|--------|--------|--------|
| NE5534AD   | D            | SOIC         | 8    | 75  | 507    | 8      | 3940   | 4.32   |
| NE5534AP   | P            | PDIP         | 8    | 50  | 506    | 13.97  | 11230  | 4.32   |
| NE5534APE4 | P            | PDIP         | 8    | 50  | 506    | 13.97  | 11230  | 4.32   |
| NE5534D    | D            | SOIC         | 8    | 75  | 507    | 8      | 3940   | 4.32   |
| NE5534P    | P            | PDIP         | 8    | 50  | 506    | 13.97  | 11230  | 4.32   |
| NE5534PE4  | P            | PDIP         | 8    | 50  | 506    | 13.97  | 11230  | 4.32   |
| SA5534AD   | D            | SOIC         | 8    | 75  | 507    | 8      | 3940   | 4.32   |
| SA5534AP   | P            | PDIP         | 8    | 50  | 506    | 13.97  | 11230  | 4.32   |
| SA5534APE4 | P            | PDIP         | 8    | 50  | 506    | 13.97  | 11230  | 4.32   |
| SA5534D    | D            | SOIC         | 8    | 75  | 507    | 8      | 3940   | 4.32   |
| SA5534P    | P            | PDIP         | 8    | 50  | 506    | 13.97  | 11230  | 4.32   |

## MECHANICAL DATA

PS (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Falls within JEDEC MS-001 variation BA.



D0008A

# PACKAGE OUTLINE

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



NOTES:

1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. 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  $.006$  [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.



# EXAMPLE BOARD LAYOUT

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



LAND PATTERN EXAMPLE  
 EXPOSED METAL SHOWN  
 SCALE:8X



SOLDER MASK DETAILS

4214825/C 02/2019

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

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



SOLDER PASTE EXAMPLE  
BASED ON .005 INCH [0.125 MM] THICK STENCIL  
SCALE:8X

4214825/C 02/2019

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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