

# ON Semiconductor

## Is Now



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# NE5532, SA5532, SE5532, NE5532A, SE5532A

## Internally Compensated Dual Low Noise Operational Amplifier

The 5532 is a dual high-performance low noise operational amplifier. Compared to most of the standard operational amplifiers, such as the 1458, it shows better noise performance, improved output drive capability and considerably higher small-signal and power bandwidths.

This makes the device especially suitable for application in high-quality and professional audio equipment, instrumentation and control circuits, and telephone channel amplifiers. The op amp is internally compensated for gains equal to one. If very low noise is of prime importance, it is recommended that the 5532A version be used because it has guaranteed noise voltage specifications.

### Features

- Small-Signal Bandwidth: 10 MHz
- Output Drive Capability: 600  $\Omega$ , 10 V<sub>RMS</sub>
- Input Noise Voltage: 5.0 nV/ $\sqrt{\text{Hz}}$  (Typical)
- DC Voltage Gain: 50000
- AC Voltage Gain: 2200 at 10 kHz
- Power Bandwidth: 140 kHz
- Slew Rate: 9.0 V/ $\mu\text{s}$
- Large Supply Voltage Range:  $\pm 3.0$  to  $\pm 20$  V
- Compensated for Unity Gain
- Pb-Free Packages are Available

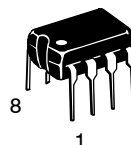


**ON Semiconductor®**

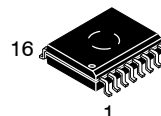
<http://onsemi.com>



**SOIC-8  
D SUFFIX  
CASE 751**



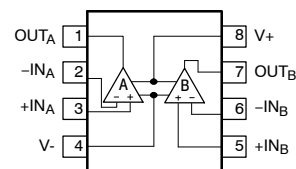
**PDIP-8  
N SUFFIX  
CASE 626**



**SOIC-16 WB  
D SUFFIX  
CASE 751G**

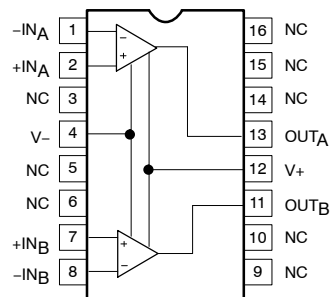
### PIN CONNECTIONS

#### N, D8 Packages



Top View

#### D Package\*



Top View

\*SOL and non-standard pinout.

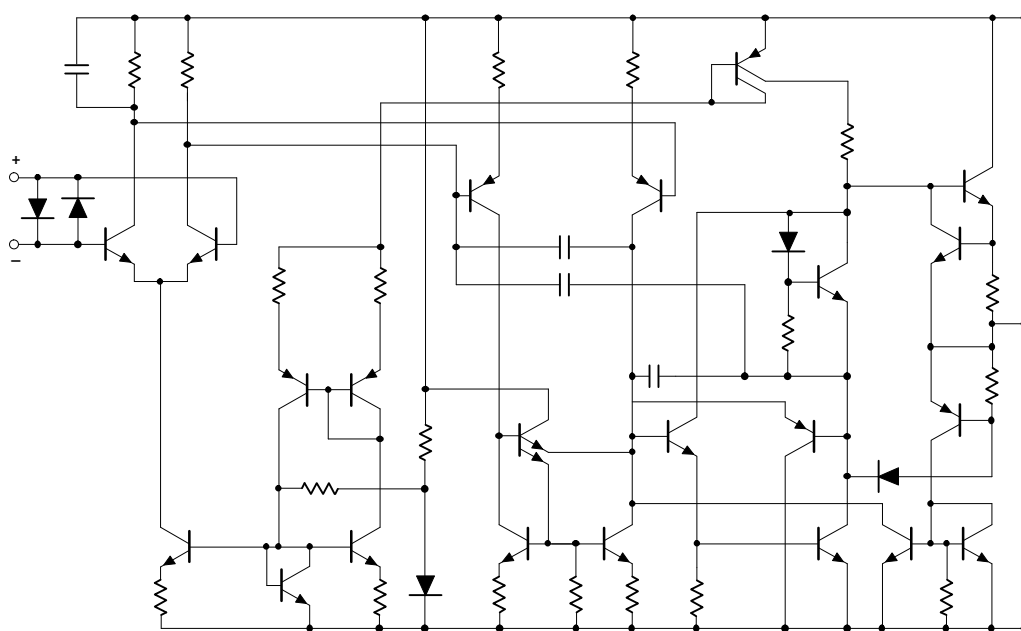
### DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 6 of this data sheet.

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 7 of this data sheet.

# NE5532, SA5532, SE5532, NE5532A, SE5532A



**Figure 1. Equivalent Schematic (Each Amplifier)**

## MAXIMUM RATINGS

| Rating                                                                                                             | Symbol          | Value                                | Unit |
|--------------------------------------------------------------------------------------------------------------------|-----------------|--------------------------------------|------|
| Supply Voltage                                                                                                     | $V_S$           | $\pm 22$                             | V    |
| Input Voltage                                                                                                      | $V_{IN}$        | $\pm V_{SUPPLY}$                     | V    |
| Differential Input Voltage (Note 1)                                                                                | $V_{DIFF}$      | $\pm 0.5$                            | V    |
| Operating Temperature Range<br>NE5532/A<br>SA5532<br>SE5532/A                                                      | $T_{amb}$       | 0 to 70<br>-40 to +85<br>-55 to +125 | °C   |
| Storage Temperature                                                                                                | $T_{stg}$       | -65 to +150                          | °C   |
| Junction Temperature                                                                                               | $T_j$           | 150                                  | °C   |
| Maximum Power Dissipation, $T_{amb} = 25^\circ\text{C}$ (Still-Air)<br>8 D8 Package<br>8 N Package<br>16 D Package | $P_D$           | 780<br>1200<br>1200                  | mW   |
| Thermal Resistance, Junction-to-Ambient<br>8 D8 Package<br>8 N Package<br>16 D Package                             | $R_{\theta JA}$ | 182<br>130<br>140                    | °C/W |
| Lead Soldering Temperature (10 sec max)                                                                            | $T_{sld}$       | 230                                  | °C   |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

- Diodes protect the inputs against overvoltage. Therefore, unless current-limiting resistors are used, large currents will flow if the differential input voltage exceeds 0.6 V. Maximum current should be limited to  $\pm 10$  mA.

# NE5532, SA5532, SE5532, NE5532A, SE5532A

## DC ELECTRICAL CHARACTERISTICS ( $T_{amb} = 25^{\circ}\text{C}$ ; $V_S = \pm 15\text{ V}$ , unless otherwise noted.) (Notes 2, 3 and 4)

| Characteristic               | Symbol                   | Test Conditions                                         | SE5532/A |            |      | NE5532/A, SA5532 |            |      | Unit                           |
|------------------------------|--------------------------|---------------------------------------------------------|----------|------------|------|------------------|------------|------|--------------------------------|
|                              |                          |                                                         | Min      | Typ        | Max  | Min              | Typ        | Max  |                                |
| Offset Voltage               | $V_{OS}$                 | –                                                       | –        | 0.5        | 2.0  | –                | 0.5        | 4.0  | mV                             |
|                              | –                        | Overtemperature                                         | –        | –          | 3.0  | –                | –          | 5.0  | mV                             |
|                              | $\Delta V_{OS}/\Delta T$ | –                                                       | –        | 5.0        | –    | –                | 5.0        | –    | $\mu\text{V}/^{\circ}\text{C}$ |
| Offset Current               | $I_{OS}$                 | –                                                       | –        | –          | 100  | –                | 10         | 150  | nA                             |
|                              | –                        | Overtemperature                                         | –        | –          | 200  | –                | –          | 200  | nA                             |
|                              | $\Delta I_{OS}/\Delta T$ | –                                                       | –        | 200        | –    | –                | 200        | –    | $\text{pA}/^{\circ}\text{C}$   |
| Input Current                | $I_B$                    | –                                                       | –        | 300        | 500  | –                | 300        | 800  | nA                             |
|                              | –                        | Overtemperature                                         | –        | –          | 700  | –                | –          | 1000 | nA                             |
|                              | $\Delta I_B/\Delta T$    | –                                                       | –        | 5.0        | –    | –                | 5.0        | –    | $\text{nA}/^{\circ}\text{C}$   |
| Supply Current               | $I_{CC}$                 | –                                                       | –        | 8.0        | 10.5 | –                | 8.0        | 16   | mA                             |
|                              | –                        | Overtemperature                                         | –        | –          | 13   | –                | –          | –    |                                |
| Common-Mode Input Range      | $V_{CM}$                 | –                                                       | $\pm 12$ | $\pm 13$   | –    | $\pm 12$         | $\pm 13$   | –    | V                              |
| Common-Mode Rejection Ratio  | CMRR                     | –                                                       | 80       | 100        | –    | 70               | 100        | –    | dB                             |
| Power Supply Rejection Ratio | PSRR                     | –                                                       | –        | 10         | 50   | –                | 10         | 100  | $\mu\text{V}/\text{V}$         |
| Large-Signal Voltage Gain    | $A_{VOL}$                | $R_L \geq 2.0\text{ k}\Omega$ ; $V_O = \pm 10\text{ V}$ | 50       | 100        | –    | 25               | 100        | –    | V/mV                           |
|                              |                          | Overtemperature                                         | 25       | –          | –    | 15               | –          | –    |                                |
|                              |                          | $R_L \geq 600\text{ }\Omega$ ; $V_O = \pm 10\text{ V}$  | 40       | 50         | –    | 15               | 50         | –    |                                |
|                              |                          | Overtemperature                                         | 20       | –          | –    | 10               | –          | –    |                                |
| Output Swing                 | $V_{OUT}$                | $R_L \geq 600\text{ }\Omega$                            | $\pm 12$ | $\pm 13$   | –    | $\pm 12$         | $\pm 13$   | –    | V                              |
|                              |                          | Overtemperature                                         | $\pm 10$ | $\pm 12$   | –    | $\pm 10$         | $\pm 12$   | –    |                                |
|                              |                          | $R_L \geq 600\text{ }\Omega$ ; $V_S = \pm 18\text{ V}$  | $\pm 15$ | $\pm 16$   | –    | $\pm 15$         | $\pm 16$   | –    |                                |
|                              |                          | Overtemperature                                         | $\pm 12$ | $\pm 14$   | –    | $\pm 12$         | $\pm 14$   | –    |                                |
|                              |                          | $R_L \geq 2.0\text{ k}\Omega$                           | $\pm 13$ | $\pm 13.5$ | –    | $\pm 13$         | $\pm 13.5$ | –    |                                |
|                              |                          | Overtemperature                                         | $\pm 12$ | $\pm 12.5$ | –    | $\pm 10$         | $\pm 12.5$ | –    |                                |
| Input Resistance             | $R_{IN}$                 | –                                                       | 30       | 300        | –    | 30               | 300        | –    | k $\Omega$                     |
| Output Short Circuit Current | $I_{SC}$                 | –                                                       | 10       | 38         | 60   | 10               | 38         | 60   | mA                             |

2. Diodes protect the inputs against overvoltage. Therefore, unless current-limiting resistors are used, large currents will flow if the differential input voltage exceeds 0.6 V. Maximum current should be limited to  $\pm 10\text{ mA}$ .
3. For operation at elevated temperature, derate packages based on the package thermal resistance.
4. Output may be shorted to ground at  $V_S = \pm 15\text{ V}$ ,  $T_{amb} = 25^{\circ}\text{C}$ . Temperature and/or supply voltages must be limited to ensure dissipation rating is not exceeded.

# NE5532, SA5532, SE5532, NE5532A, SE5532A

## AC ELECTRICAL CHARACTERISTICS ( $T_{amb} = 25^{\circ}\text{C}$ ; $V_S = \pm 15\text{ V}$ , unless otherwise noted.)

| Characteristic         | Symbol    | Test Conditions                                                                                   | NE/SE5532/A, SA5532 |     |     | Unit             |
|------------------------|-----------|---------------------------------------------------------------------------------------------------|---------------------|-----|-----|------------------|
|                        |           |                                                                                                   | Min                 | Typ | Max |                  |
| Output Resistance      | $R_{OUT}$ | $A_V = 30\text{ dB}$ Closed-loop<br>$f = 10\text{ kHz}$ , $R_L = 600\ \Omega$                     | –                   | 0.3 | –   | $\Omega$         |
| Overshoot              | –         | Voltage-Follower<br>$V_{IN} = 100\text{ mV}_{P-P}$<br>$C_L = 100\text{ pF}$ ; $R_L = 600\ \Omega$ | –                   | 10  | –   | %                |
| Gain                   | $A_V$     | $f = 10\text{ kHz}$                                                                               | –                   | 2.2 | –   | V/mV             |
| Gain Bandwidth Product | GBW       | $C_L = 100\text{ pF}$ ; $R_L = 600\ \Omega$                                                       | –                   | 10  | –   | MHz              |
| Slew Rate              | SR        | –                                                                                                 | –                   | 9.0 | –   | V/ $\mu\text{s}$ |
| Power Bandwidth        | –         | $V_{OUT} = \pm 10\text{ V}$                                                                       | –                   | 140 | –   | kHz              |
|                        |           | $V_{OUT} = \pm 14\text{ V}$ ;<br>$R_L = 600\ \Omega$                                              | –                   | 100 | –   |                  |
|                        |           | $V_{CC} = \pm 18\text{ V}$                                                                        |                     |     |     |                  |

## ELECTRICAL CHARACTERISTICS ( $T_{amb} = 25^{\circ}\text{C}$ ; $V_S = \pm 15\text{ V}$ , unless otherwise noted.)

| Characteristic      | Symbol      | Test Conditions                                   | NE/SE5532 |     |     | NE/SA/SE5532A |     |     | Unit                   |
|---------------------|-------------|---------------------------------------------------|-----------|-----|-----|---------------|-----|-----|------------------------|
|                     |             |                                                   | Min       | Typ | Max | Min           | Typ | Max |                        |
| Input Noise Voltage | $V_{NOISE}$ | $f_O = 30\text{ Hz}$                              | –         | 8.0 | –   | –             | 8.0 | 12  | nV/ $\sqrt{\text{Hz}}$ |
|                     |             | $f_O = 1.0\text{ kHz}$                            | –         | 5.0 | –   | –             | 5.0 | 6.0 |                        |
| Input Noise Current | $I_{NOISE}$ | $f_O = 30\text{ Hz}$                              | –         | 2.7 | –   | –             | 2.7 | –   | pA/ $\sqrt{\text{Hz}}$ |
|                     |             | $f_O = 1.0\text{ kHz}$                            | –         | 0.7 | –   | –             | 0.7 | –   |                        |
| Channel Separation  | –           | $f = 1.0\text{ kHz}$ ; $R_S = 5.0\text{ k}\Omega$ | –         | 110 | –   | –             | 110 | –   | dB                     |

TYPICAL PERFORMANCE CHARACTERISTICS

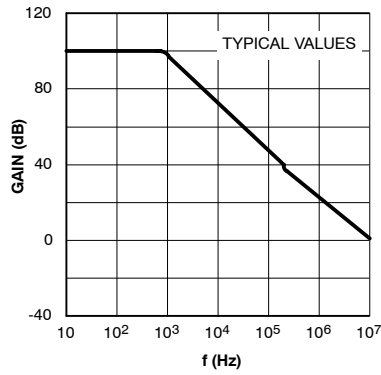


Figure 2. Open-Loop Frequency Response

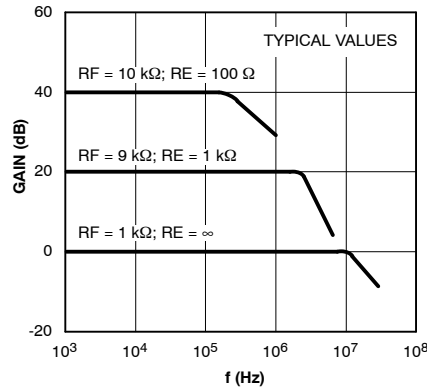


Figure 3. Closed-Loop Frequency Response

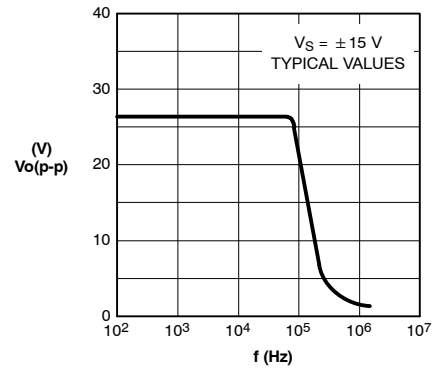


Figure 4. Large-Signal Frequency Response

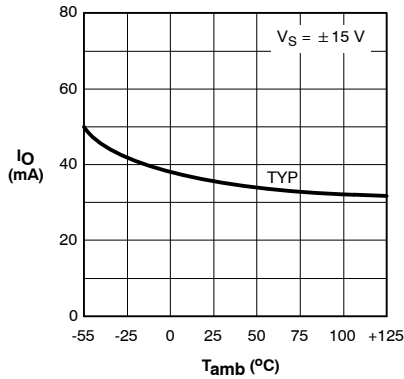


Figure 5. Output Short-Circuit Current

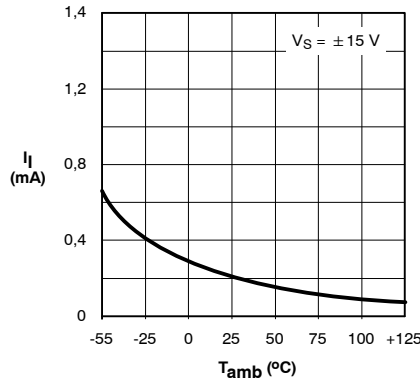


Figure 6. Input Bias Current

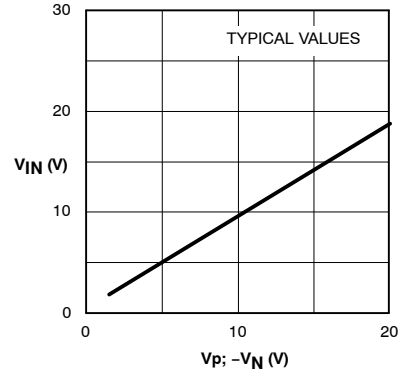


Figure 7. Input Common-Mode Voltage Range

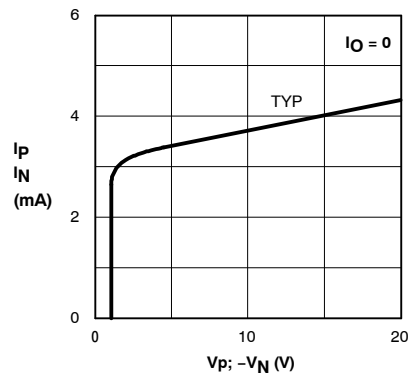


Figure 8. Supply Current

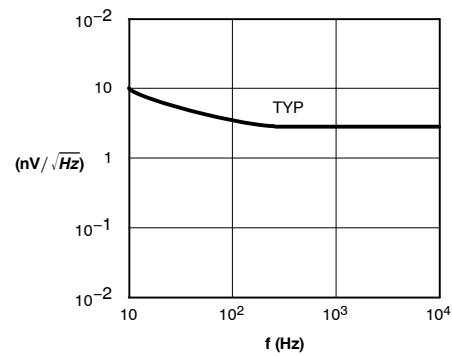
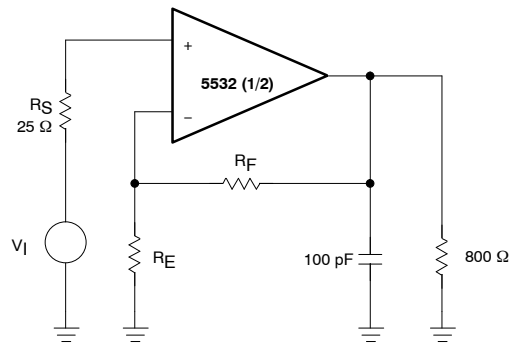
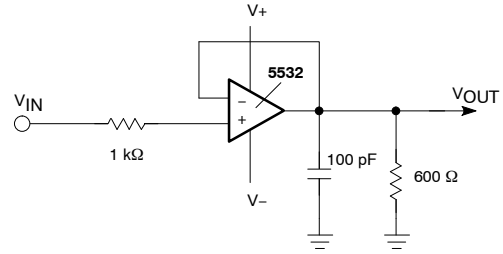


Figure 9. Input Noise Voltage Density

# NE5532, SA5532, SE5532, NE5532A, SE5532A



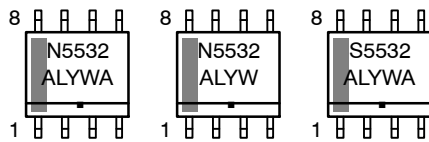
**Closed-Loop Frequency Response**



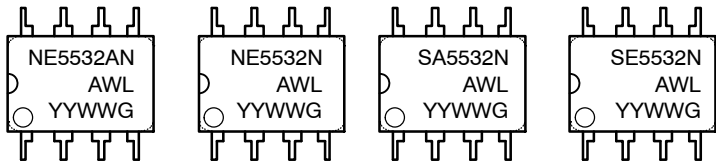
**Voltage-Follower**

**Figure 10. Test Circuits**

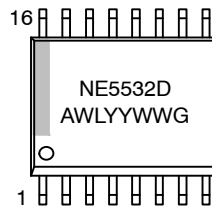
## MARKING DIAGRAMS



**SOIC-8  
D SUFFIX  
CASE 751**



**PDIP-8  
N SUFFIX  
CASE 626**



**SOIC-16 WB  
D SUFFIX  
CASE 751G**

A = Assembly Location  
WL, L = Wafer Lot  
YY, Y = Year  
WW, W = Work Week  
G or ■ = Pb-Free Package

# NE5532, SA5532, SE5532, NE5532A, SE5532A

## ORDERING INFORMATION

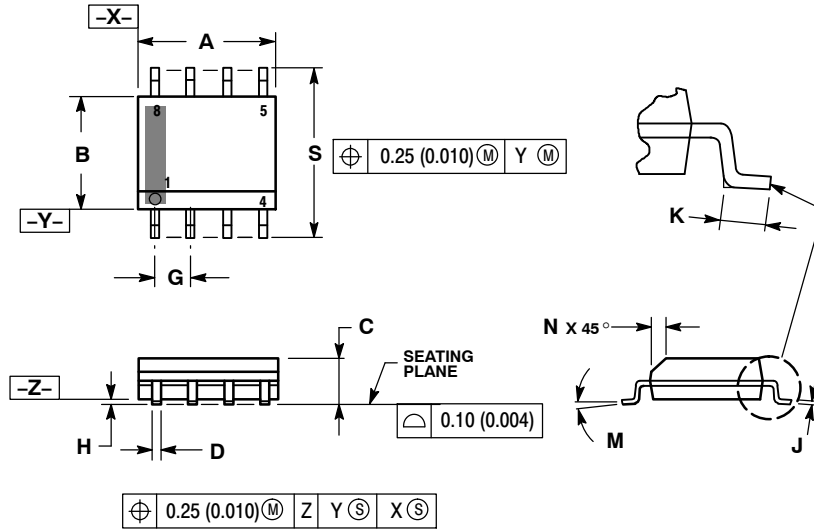
| Device       | Description                                               | Temperature Range | Shipping†          |
|--------------|-----------------------------------------------------------|-------------------|--------------------|
| NE5532AD8    | 8-Pin Plastic Small Outline (SO-8) Package                | 0 to 70°C         | 98 Units / Rail    |
| NE5532AD8G   | 8-Pin Plastic Small Outline (SO-8) Package (Pb-Free)      |                   | 98 Units / Rail    |
| NE5532AD8R2  | 8-Pin Plastic Small Outline (SO-8) Package                |                   | 2500 / Tape & Reel |
| NE5532AD8R2G | 8-Pin Plastic Small Outline (SO-8) Package (Pb-Free)      |                   | 2500 / Tape & Reel |
| NE5532AN     | 8-Pin Plastic Dual In-Line Package (PDIP-8)               |                   | 50 Units / Rail    |
| NE5532ANG    | 8-Pin Plastic Dual In-Line Package (PDIP-8) (Pb-Free)     |                   | 50 Units / Rail    |
| NE5532D      | 16-Pin Plastic Small Outline (SO-16 WB) Package           |                   | 47 Units / Rail    |
| NE5532DG     | 16-Pin Plastic Small Outline (SO-16 WB) Package (Pb-Free) |                   | 47 Units / Rail    |
| NE5532DR2    | 16-Pin Plastic Small Outline (SO-16 WB) Package           |                   | 1000 Tape & Reel   |
| NE5532DR2G   | 16-Pin Plastic Small Outline (SO-16 WB) Package (Pb-Free) |                   | 1000 Tape & Reel   |
| NE5532D8     | 8-Pin Plastic Small Outline (SO-8) Package                |                   | 98 Units / Rail    |
| NE5532D8G    | 8-Pin Plastic Small Outline (SO-8) Package (Pb-Free)      |                   | 98 Units / Rail    |
| NE5532D8R2   | 8-Pin Plastic Small Outline (SO-8) Package                |                   | 2500 / Tape & Reel |
| NE5532D8R2G  | 8-Pin Plastic Small Outline (SO-8) Package (Pb-Free)      |                   | 2500 / Tape & Reel |
| NE5532N      | 8-Pin Plastic Dual In-Line Package (PDIP-8)               |                   | 50 Units / Rail    |
| NE5532NG     | 8-Pin Plastic Dual In-Line Package (PDIP-8) (Pb-Free)     |                   | 50 Units / Rail    |
| SA5532N      | 8-Pin Plastic Dual In-Line Package (PDIP-8)               | -40 to +85°C      | 50 Units / Rail    |
| SA5532NG     | 8-Pin Plastic Dual In-Line Package (PDIP-8) (Pb-Free)     |                   | 50 Units / Rail    |
| SE5532AD8    | 8-Pin Plastic Small Outline (SO-8) Package                | -55 to +125°C     | 98 Units / Rail    |
| SE5532AD8G   | 8-Pin Plastic Small Outline (SO-8) Package (Pb-Free)      |                   | 98 Units / Rail    |
| SE5532AD8R2  | 8-Pin Plastic Small Outline (SO-8) Package                |                   | 2500 / Tape & Reel |
| SE5532AD8R2G | 8-Pin Plastic Small Outline (SO-8) Package (Pb-Free)      |                   | 2500 / Tape & Reel |
| SE5532N      | 8-Pin Plastic Dual In-Line Package (PDIP-8)               |                   | 50 Units / Rail    |
| SE5532NG     | 8-Pin Plastic Dual In-Line Package (PDIP-8) (Pb-Free)     |                   | 50 Units / Rail    |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.



PACKAGE DIMENSIONS

SOIC-8 NB  
CASE 751-07  
ISSUE AK

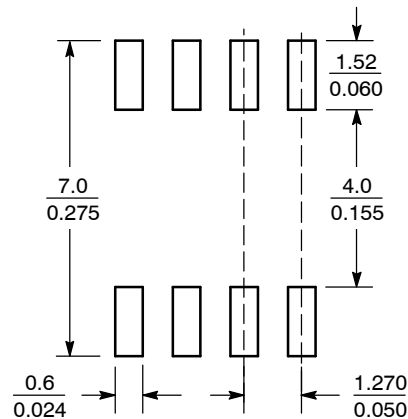


NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. 751-01 THRU 751-06 ARE OBSOLETE. NEW STANDARD IS 751-07.

| DIM | MILLIMETERS |      | INCHES    |       |
|-----|-------------|------|-----------|-------|
|     | MIN         | MAX  | MIN       | MAX   |
| A   | 4.80        | 5.00 | 0.189     | 0.197 |
| B   | 3.80        | 4.00 | 0.150     | 0.157 |
| C   | 1.35        | 1.75 | 0.053     | 0.069 |
| D   | 0.33        | 0.51 | 0.013     | 0.020 |
| G   | 1.27 BSC    |      | 0.050 BSC |       |
| H   | 0.10        | 0.25 | 0.004     | 0.010 |
| J   | 0.19        | 0.25 | 0.007     | 0.010 |
| K   | 0.40        | 1.27 | 0.016     | 0.050 |
| M   | 0°          | 8°   | 0°        | 8°    |
| N   | 0.25        | 0.50 | 0.010     | 0.020 |
| S   | 5.80        | 6.20 | 0.228     | 0.244 |

SOLDERING FOOTPRINT\*



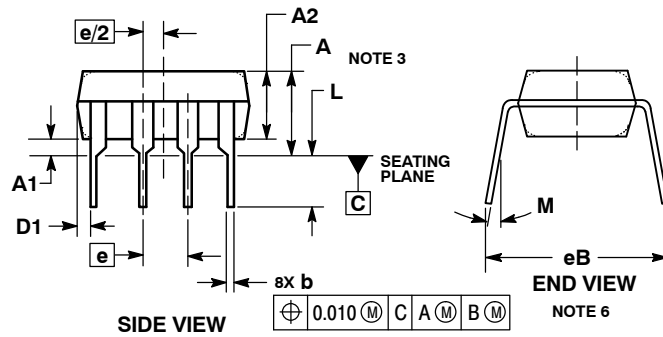
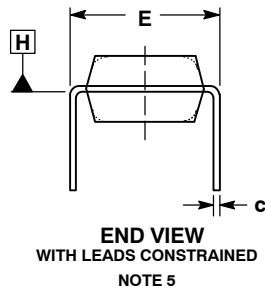
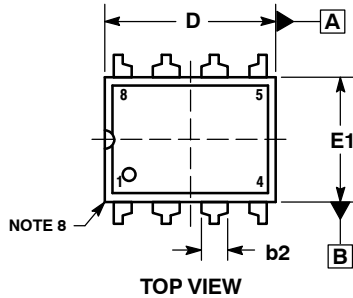
SCALE 6:1 (mm/inches)

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERM/D.

## PACKAGE DIMENSIONS

## 8-Pin Plastic Dual In-Line Package (PDIP-8)

N SUFFIX  
CASE 626-05  
ISSUE N



## NOTES:

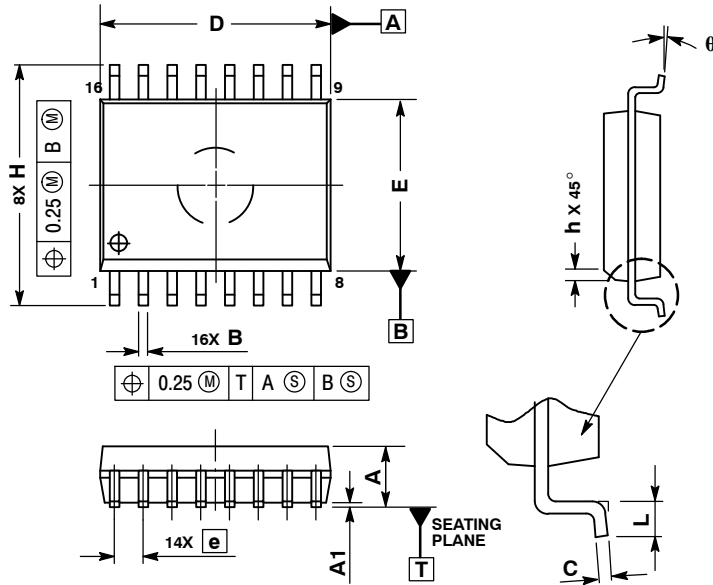
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. DIMENSIONS A, A1 AND L ARE MEASURED WITH THE PACKAGE SEATED IN JEDEC SEATING PLANE GAUGE GS-3.
4. DIMENSIONS D, D1 AND E1 DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS ARE NOT TO EXCEED 0.10 INCH.
5. DIMENSION E IS MEASURED AT A POINT 0.015 BELOW DATUM PLANE H WITH THE LEADS CONSTRAINED PERPENDICULAR TO DATUM C.
6. DIMENSION E3 IS MEASURED AT THE LEAD TIPS WITH THE LEADS UNCONSTRAINED.
7. DATUM PLANE H IS COINCIDENT WITH THE BOTTOM OF THE LEADS, WHERE THE LEADS EXIT THE BODY.
8. PACKAGE CONTOUR IS OPTIONAL (ROUNDED OR SQUARE CORNERS).

| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | ---       | 0.210 | ---         | 5.33  |
| A1  | 0.015     | ---   | 0.38        | ---   |
| A2  | 0.115     | 0.195 | 2.92        | 4.95  |
| b   | 0.014     | 0.022 | 0.35        | 0.56  |
| b2  | 0.060 TYP |       | 1.52 TYP    |       |
| C   | 0.008     | 0.014 | 0.20        | 0.36  |
| D   | 0.355     | 0.400 | 9.02        | 10.16 |
| D1  | 0.005     | ---   | 0.13        | ---   |
| E   | 0.300     | 0.325 | 7.62        | 8.26  |
| E1  | 0.240     | 0.280 | 6.10        | 7.11  |
| e   | 0.100 BSC |       | 2.54 BSC    |       |
| eB  | ---       | 0.430 | ---         | 10.92 |
| L   | 0.115     | 0.150 | 2.92        | 3.81  |
| M   | ---       | 10°   | ---         | 10°   |

# NE5532, SA5532, SE5532, NE5532A, SE5532A

## PACKAGE DIMENSIONS

SOIC-16 WB  
D SUFFIX  
CASE 751G-03  
ISSUE D

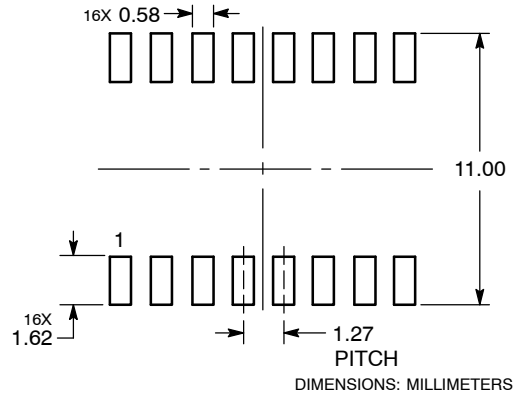


### NOTES:

1. DIMENSIONS ARE IN MILLIMETERS.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
3. DIMENSIONS D AND E DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.
5. DIMENSION B DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.13 TOTAL IN EXCESS OF THE B DIMENSION AT MAXIMUM MATERIAL CONDITION.

| DIM | MILLIMETERS |       |
|-----|-------------|-------|
|     | MIN         | MAX   |
| A   | 2.35        | 2.65  |
| A1  | 0.10        | 0.25  |
| B   | 0.35        | 0.49  |
| C   | 0.23        | 0.32  |
| D   | 10.15       | 10.45 |
| E   | 7.40        | 7.60  |
| e   | 1.27        | BSC   |
| H   | 10.05       | 10.55 |
| h   | 0.25        | 0.75  |
| L   | 0.50        | 0.90  |
| q   | 0°          | 7°    |

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