

# DATA SHEET

## **NE/SA/SE5532/5532A**

Internally-compensated dual low noise  
operational amplifier

Product data  
Supersedes data of 1997 Sep 29

2001 Aug 03

# Internally-compensated dual low noise operational amplifier

NE/SA/SE5532/5532A

## DESCRIPTION

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 nV/ $\sqrt{\text{Hz}}$  (typical)
- DC voltage gain: 50000
- AC voltage gain: 2200 at 10 kHz
- Power bandwidth: 140 kHz
- Slew rate: 9 V/ $\mu\text{s}$
- Large supply voltage range:  $\pm 3$  to  $\pm 20$  V
- Compensated for unity gain

## PIN CONFIGURATIONS

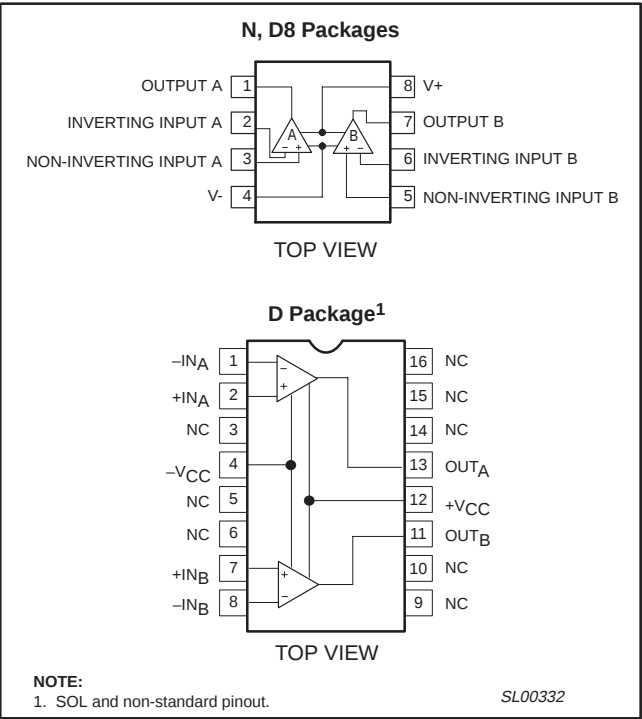


Figure 1. Pin Configurations

## ORDERING INFORMATION

| DESCRIPTION                                      | TEMPERATURE RANGE | ORDER CODE | DWG #    |
|--------------------------------------------------|-------------------|------------|----------|
| 8-Pin Small Outline Package (SO)                 | 0 °C to 70 °C     | NE5532AD8  | SOT96-1  |
| 8-Pin Plastic Dual In-Line Package (DIP)         | 0 °C to 70 °C     | NE5532AN   | SOT97-1  |
| 16-Pin Plastic Small Outline Large (SOL) Package | 0 °C to 70 °C     | NE5532D    | SOT162-1 |
| 8-Pin Small Outline Package (SO)                 | 0 °C to 70 °C     | NE5532D8   | SOT96-1  |
| 8-Pin Plastic Dual In-Line Package (DIP)         | 0 °C to 70 °C     | NE5532N    | SOT97-1  |
| 8-Pin Plastic Dual In-Line Package (DIP)         | -40 °C to +85 °C  | SA5532N    | SOT97-1  |
| 8-Pin Small Outline Package (SO)                 | -55 °C to +125 °C | SE5532AD8  | SOT96-1  |
| 16-Pin Plastic Dual In-Line Package (DIP)        | -55 °C to +125 °C | SE5532N    | SOT38-4  |

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## EQUIVALENT SCHEMATIC (EACH AMPLIFIER)

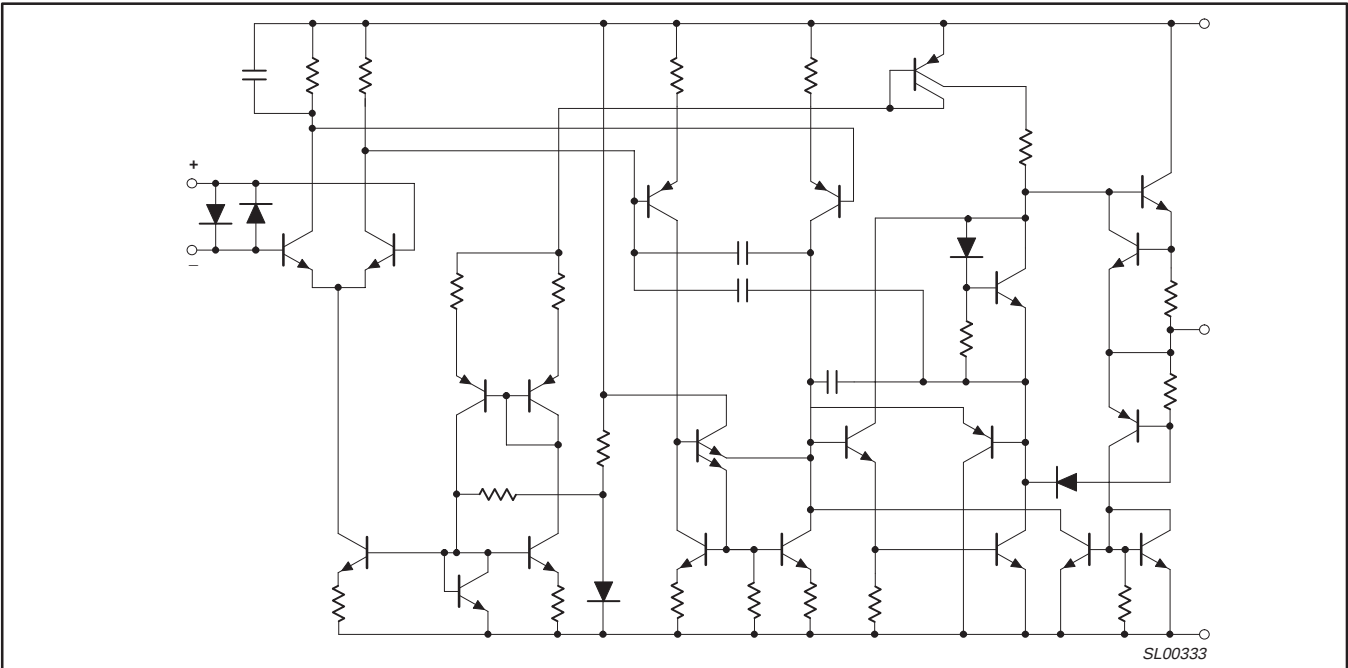


Figure 2. Equivalent Schematic (Each Amplifier)

## ABSOLUTE MAXIMUM RATINGS

| SYMBOL     | PARAMETER                                                                                                           | RATING                               | UNIT           |
|------------|---------------------------------------------------------------------------------------------------------------------|--------------------------------------|----------------|
| $V_S$      | Supply voltage                                                                                                      | $\pm 22$                             | V              |
| $V_{IN}$   | Input voltage                                                                                                       | $\pm V_{SUPPLY}$                     | V              |
| $V_{DIFF}$ | Differential input voltage <sup>1</sup>                                                                             | $\pm 0.5$                            | V              |
| $T_{amb}$  | Operating temperature range<br>NE5532/A<br>SA5532<br>SE5532/A                                                       | 0 to 70<br>-40 to +85<br>-55 to +125 | °C<br>°C<br>°C |
| $T_{stg}$  | Storage temperature                                                                                                 | -65 to +150                          | °C             |
| $T_j$      | Junction temperature                                                                                                | 150                                  | °C             |
| $P_D$      | Maximum power dissipation,<br>$T_{amb} = 25\text{ °C (still-air)}^2$<br>8 D8 package<br>8 N package<br>16 D package | 780<br>1200<br>1200                  | mW<br>mW<br>mW |
| $T_{sld}$  | Lead soldering temperature (10 sec max)                                                                             | 230                                  | °C             |

### NOTES:

1. Diodes protect the inputs against over-voltage. Therefore, unless current-limiting resistors are used, large currents will flow if the differential input voltage exceeds 0.6V. Maximum current should be limited to  $\pm 10\text{ mA}$ .
2. Thermal resistances of the above packages are as follows:  
N package at  $100\text{ °C/W}$   
D package at  $105\text{ °C/W}$   
D8 package at  $160\text{ °C/W}$

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## DC ELECTRICAL CHARACTERISTICS

 $T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $V_S = \pm 15\text{ V}$ , unless otherwise specified. 1, 2, 3

| SYMBOL                   | PARAMETER                    | TEST CONDITIONS                                        | SE5532/A |            |      | NE5532/A, SA5532 |            |      | UNIT                                 |
|--------------------------|------------------------------|--------------------------------------------------------|----------|------------|------|------------------|------------|------|--------------------------------------|
|                          |                              |                                                        | Min      | Typ        | Max  | Min              | Typ        | Max  |                                      |
| $V_{OS}$                 | Offset voltage               | Over temperature                                       |          | 0.5        | 2    |                  | 0.5        | 4    | mV                                   |
| $\Delta V_{OS}/\Delta T$ |                              |                                                        |          | 5          | 3    |                  | 5          | 5    | mV<br>$\mu\text{V}/^{\circ}\text{C}$ |
| $I_{OS}$                 | Offset current               | Over temperature                                       |          |            | 100  |                  | 10         | 150  | nA                                   |
| $\Delta I_{OS}/\Delta T$ |                              |                                                        |          | 200        | 200  |                  | 200        | 200  | nA<br>$\text{pA}/^{\circ}\text{C}$   |
| $I_B$                    | Input current                | Over temperature                                       |          | 200        | 400  |                  | 200        | 800  | nA                                   |
| $\Delta I_B/\Delta T$    |                              |                                                        |          | 5          | 700  |                  | 5          | 1000 | nA<br>$\text{nA}/^{\circ}\text{C}$   |
| $I_{CC}$                 | Supply current               | Over temperature                                       |          | 8          | 10.5 |                  | 8          | 16   | mA                                   |
|                          |                              |                                                        |          |            | 13   |                  |            |      | mA                                   |
| $V_{CM}$                 | Common-mode input range      |                                                        | $\pm 12$ | $\pm 13$   |      | $\pm 12$         | $\pm 13$   |      | V                                    |
| CMRR                     | Common-mode rejection ratio  |                                                        | 80       | 100        |      | 70               | 100        |      | dB                                   |
| PSRR                     | Power supply rejection ratio |                                                        |          | 10         | 50   |                  | 10         | 100  | $\mu\text{V}/\text{V}$               |
| $A_{VOL}$                | Large-signal voltage gain    | $R_L \geq 2\text{ k}\Omega$ ; $V_O = \pm 10\text{ V}$  | 50       | 100        |      | 25               | 100        |      | V/mV                                 |
|                          |                              | Over temperature                                       | 25       |            |      | 15               |            |      | V/mV                                 |
|                          |                              | $R_L \geq 600\text{ }\Omega$ ; $V_O = \pm 10\text{ V}$ | 40       | 50         |      | 15               | 50         |      | V/mV                                 |
|                          |                              | Over temperature                                       | 20       |            |      | 10               |            |      | V/mV                                 |
| $V_{OUT}$                | Output swing                 | $R_L \geq 600\text{ }\Omega$                           | $\pm 12$ | $\pm 13$   |      | $\pm 12$         | $\pm 13$   |      | V                                    |
|                          |                              | Over temperature                                       | $\pm 10$ | $\pm 12$   |      | $\pm 10$         | $\pm 12$   |      |                                      |
|                          |                              | $R_L \geq 600\text{ }\Omega$ ; $V_S = \pm 18\text{ V}$ | $\pm 15$ | $\pm 16$   |      | $\pm 15$         | $\pm 16$   |      |                                      |
|                          |                              | Over temperature                                       | $\pm 12$ | $\pm 14$   |      | $\pm 12$         | $\pm 14$   |      |                                      |
|                          |                              | $R_L \geq 2\text{ k}\Omega$                            | $\pm 13$ | $\pm 13.5$ |      | $\pm 13$         | $\pm 13.5$ |      |                                      |
|                          |                              | Over temperature                                       | $\pm 12$ | $\pm 12.5$ |      | $\pm 10$         | $\pm 12.5$ |      |                                      |
| $R_{IN}$                 | Input resistance             |                                                        | 30       | 300        |      | 30               | 300        |      | k $\Omega$                           |
| $I_{SC}$                 | Output short circuit current |                                                        | 10       | 38         | 60   | 10               | 38         | 60   | mA                                   |

### NOTES:

- 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  $\pm 10\text{ mA}$ .
- For operation at elevated temperature, derate packages based on the package thermal resistance.
- Output may be shorted to ground at  $V_S = \pm 15\text{ V}$ ,  $T_{amb} = 25\text{ }^{\circ}\text{C}$ . Temperature and/or supply voltages must be limited to ensure dissipation rating is not exceeded.

## AC ELECTRICAL CHARACTERISTICS

 $T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $V_S = \pm 15\text{ V}$ , unless otherwise specified.

| SYMBOL    | PARAMETER              | TEST CONDITIONS                                                                                                        | NE/SE5532/A, SA5532 |            |     | UNIT             |
|-----------|------------------------|------------------------------------------------------------------------------------------------------------------------|---------------------|------------|-----|------------------|
|           |                        |                                                                                                                        | Min                 | Typ        | Max |                  |
| $R_{OUT}$ | Output resistance      | $A_V = 30\text{ dB}$ Closed-loop<br>$f = 10\text{ kHz}$ , $R_L = 600\text{ }\Omega$                                    |                     | 0.3        |     | $\Omega$         |
|           | Overshoot              | Voltage-follower<br>$V_{IN} = 100\text{ mV}_{P-P}$<br>$C_L = 100\text{ pF}$ ; $R_L = 600\text{ }\Omega$                |                     | 10         |     | %                |
| $A_V$     | Gain                   | $f = 10\text{ kHz}$                                                                                                    |                     | 2.2        |     | V/mV             |
| GBW       | Gain bandwidth product | $C_L = 100\text{ pF}$ ; $R_L = 600\text{ }\Omega$                                                                      |                     | 10         |     | MHz              |
| SR        | Slew rate              |                                                                                                                        |                     | 9          |     | V/ $\mu\text{s}$ |
|           | Power bandwidth        | $V_{OUT} = \pm 10\text{ V}$<br>$V_{OUT} = \pm 14\text{ V}$ ; $R_L = 600\text{ }\Omega$ ,<br>$V_{CC} = \pm 18\text{ V}$ |                     | 140<br>100 |     | kHz<br>kHz       |

Internally-compensated dual low noise  
operational amplifier

NE/SA/SE5532/5532A

ELECTRICAL CHARACTERISTICS

T<sub>amb</sub> = 25 °C; V<sub>S</sub> = ±15 V, unless otherwise specified.

| SYMBOL             | PARAMETER           | TEST CONDITIONS                                  | NE/SE5532 |            |     | NE/SA/SE5532A |            |         | UNIT                                             |
|--------------------|---------------------|--------------------------------------------------|-----------|------------|-----|---------------|------------|---------|--------------------------------------------------|
|                    |                     |                                                  | Min       | Typ        | Max | Min           | Typ        | Max     |                                                  |
| V <sub>NOISE</sub> | Input noise voltage | f <sub>O</sub> = 30 Hz<br>f <sub>O</sub> = 1 kHz |           | 8<br>5     |     |               | 8<br>5     | 12<br>6 | nV/ $\sqrt{\text{Hz}}$<br>nV/ $\sqrt{\text{Hz}}$ |
| I <sub>NOISE</sub> | Input noise current | f <sub>O</sub> = 30 Hz<br>f <sub>O</sub> = 1 kHz |           | 2.7<br>0.7 |     |               | 2.7<br>0.7 |         | pA/ $\sqrt{\text{Hz}}$<br>pA/ $\sqrt{\text{Hz}}$ |
|                    | Channel separation  | f = 1 kHz; R <sub>S</sub> = 5 k $\Omega$         |           | 110        |     |               | 110        |         | dB                                               |

TYPICAL PERFORMANCE CHARACTERISTICS

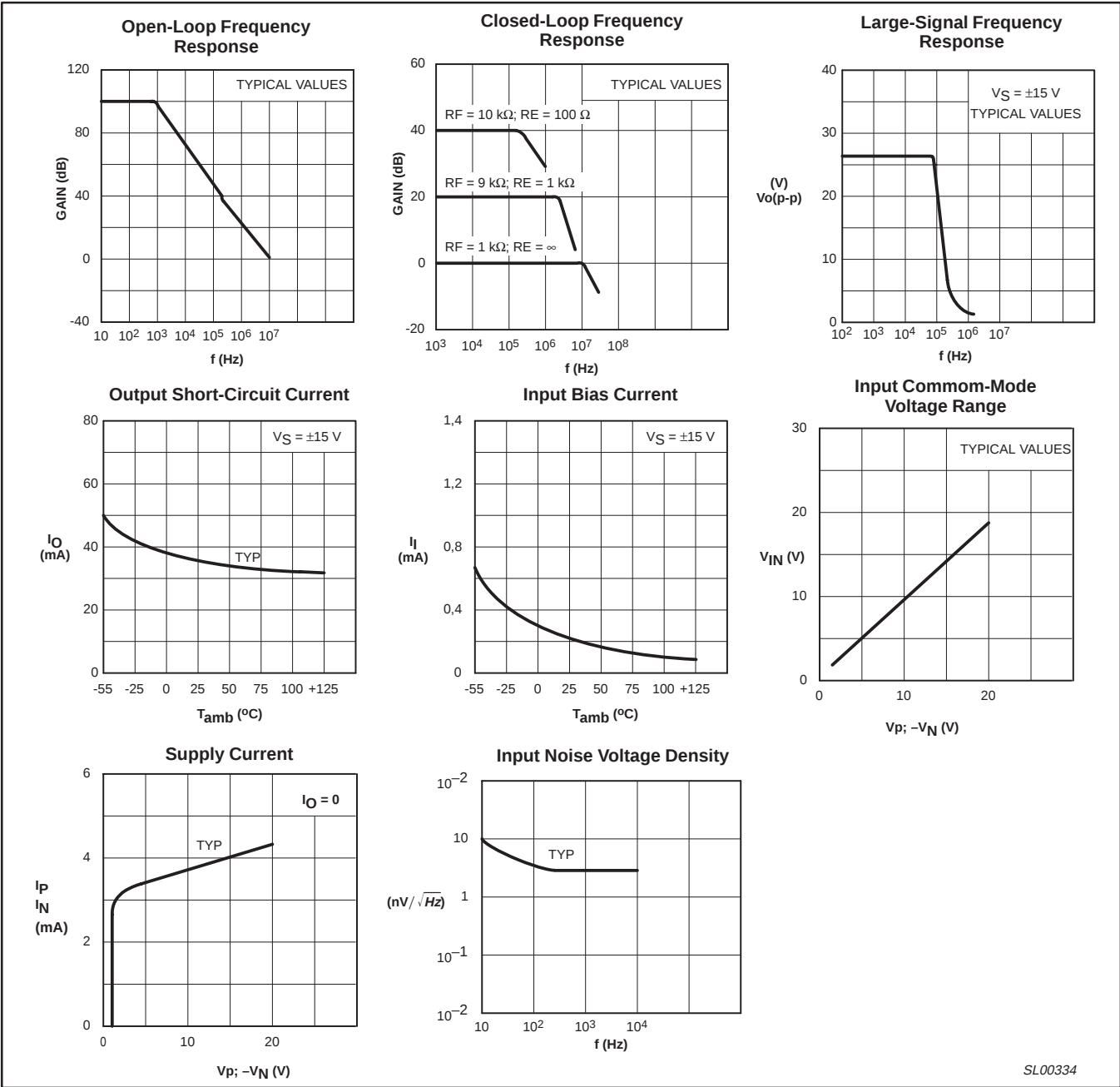


Figure 3. Typical Performance Characteristics

SL00334

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## TEST CIRCUITS

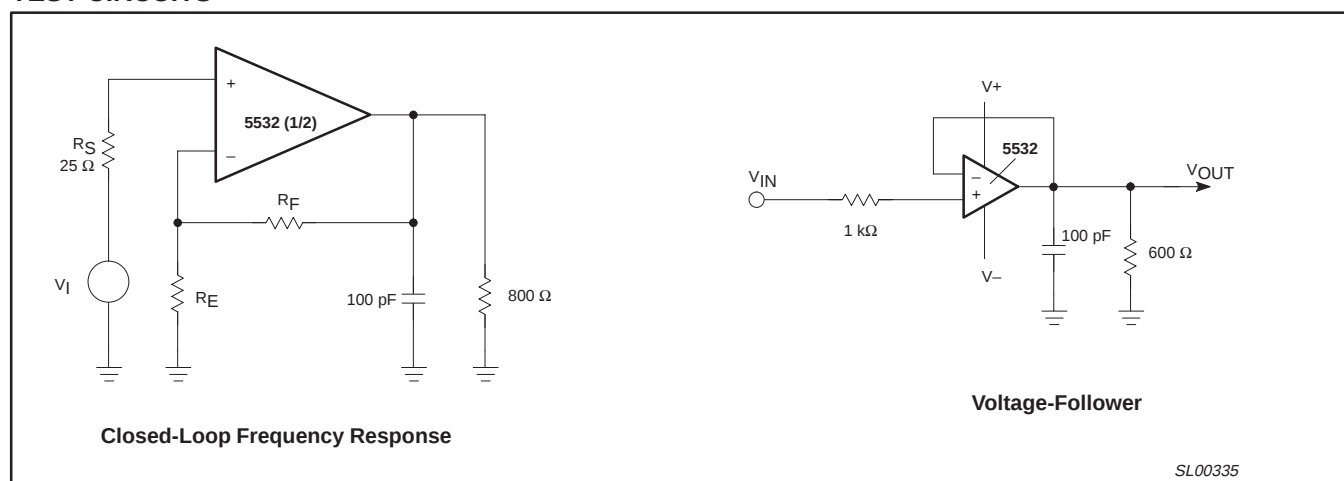


Figure 4. Test Circuits

Internally-compensated dual low noise  
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NE/SA/SE5532/5532A

DIP8: plastic dual in-line package; 8 leads (300 mil)

SOT97-1

0 5 10 mm  
scale

**DIMENSIONS (inch dimensions are derived from the original mm dimensions)**

| UNIT   | A<br>max. | A <sub>1</sub><br>min. | A <sub>2</sub><br>max. | b              | b <sub>1</sub> | b <sub>2</sub> | c              | D <sup>(1)</sup> | E <sup>(1)</sup> | e    | e <sub>1</sub> | L            | M <sub>E</sub> | M <sub>H</sub> | w     | Z <sup>(1)</sup><br>max. |
|--------|-----------|------------------------|------------------------|----------------|----------------|----------------|----------------|------------------|------------------|------|----------------|--------------|----------------|----------------|-------|--------------------------|
| mm     | 4.2       | 0.51                   | 3.2                    | 1.73<br>1.14   | 0.53<br>0.38   | 1.07<br>0.89   | 0.36<br>0.23   | 9.8<br>9.2       | 6.48<br>6.20     | 2.54 | 7.62           | 3.60<br>3.05 | 8.25<br>7.80   | 10.0<br>8.3    | 0.254 | 1.15                     |
| inches | 0.17      | 0.020                  | 0.13                   | 0.068<br>0.045 | 0.021<br>0.015 | 0.042<br>0.035 | 0.014<br>0.009 | 0.39<br>0.36     | 0.26<br>0.24     | 0.10 | 0.30           | 0.14<br>0.12 | 0.32<br>0.31   | 0.39<br>0.33   | 0.01  | 0.045                    |

**Note**

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

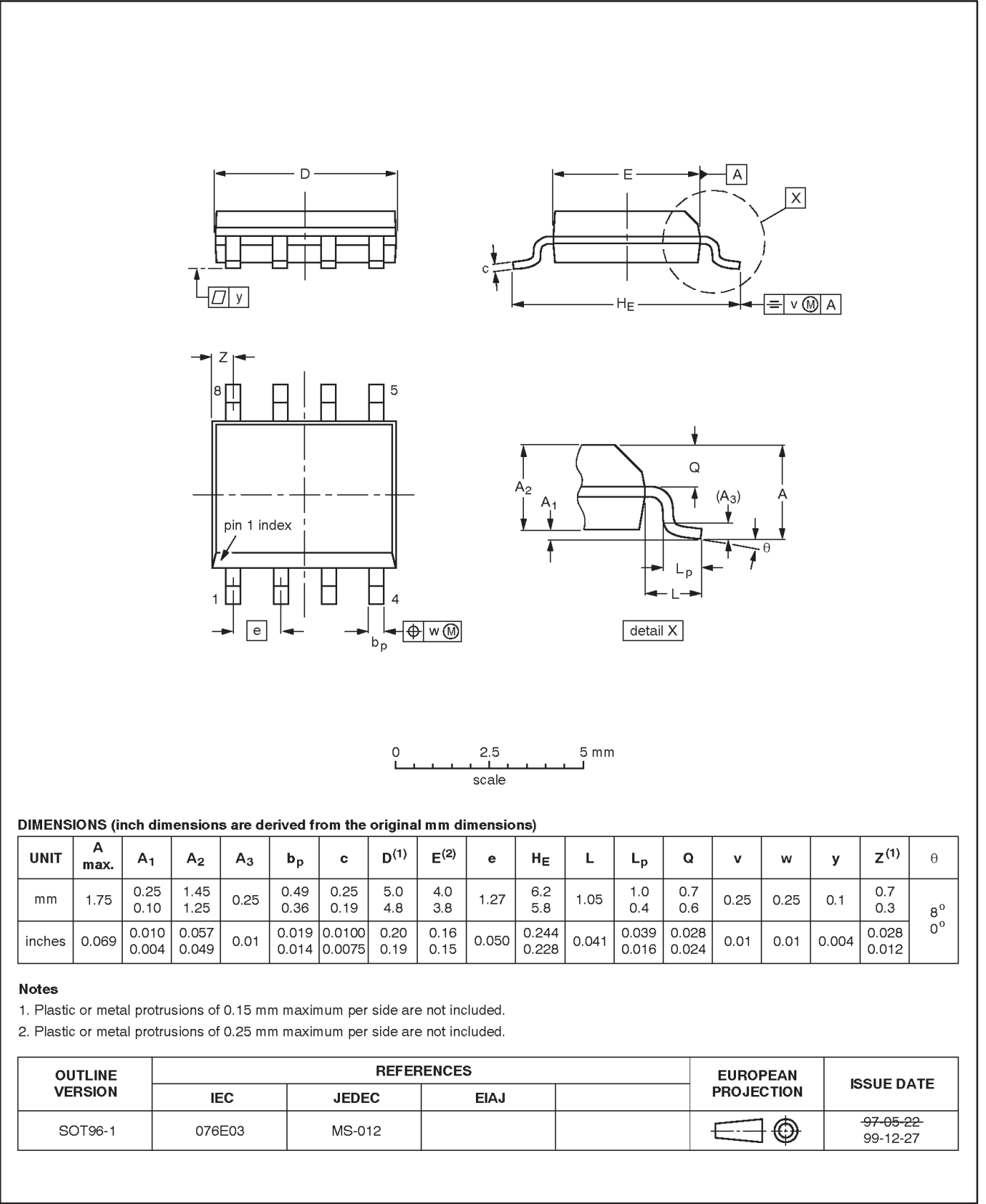
| OUTLINE<br>VERSION | REFERENCES |        |          |  | EUROPEAN<br>PROJECTION | ISSUE DATE           |
|--------------------|------------|--------|----------|--|------------------------|----------------------|
|                    | IEC        | JEDEC  | EIAJ     |  |                        |                      |
| SOT97-1            | 050G01     | MO-001 | SC-504-8 |  |                        | 95-02-04<br>99-12-27 |

Internally-compensated dual low noise operational amplifier

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SO8: plastic small outline package; 8 leads; body width 3.9 mm

SOT96-1

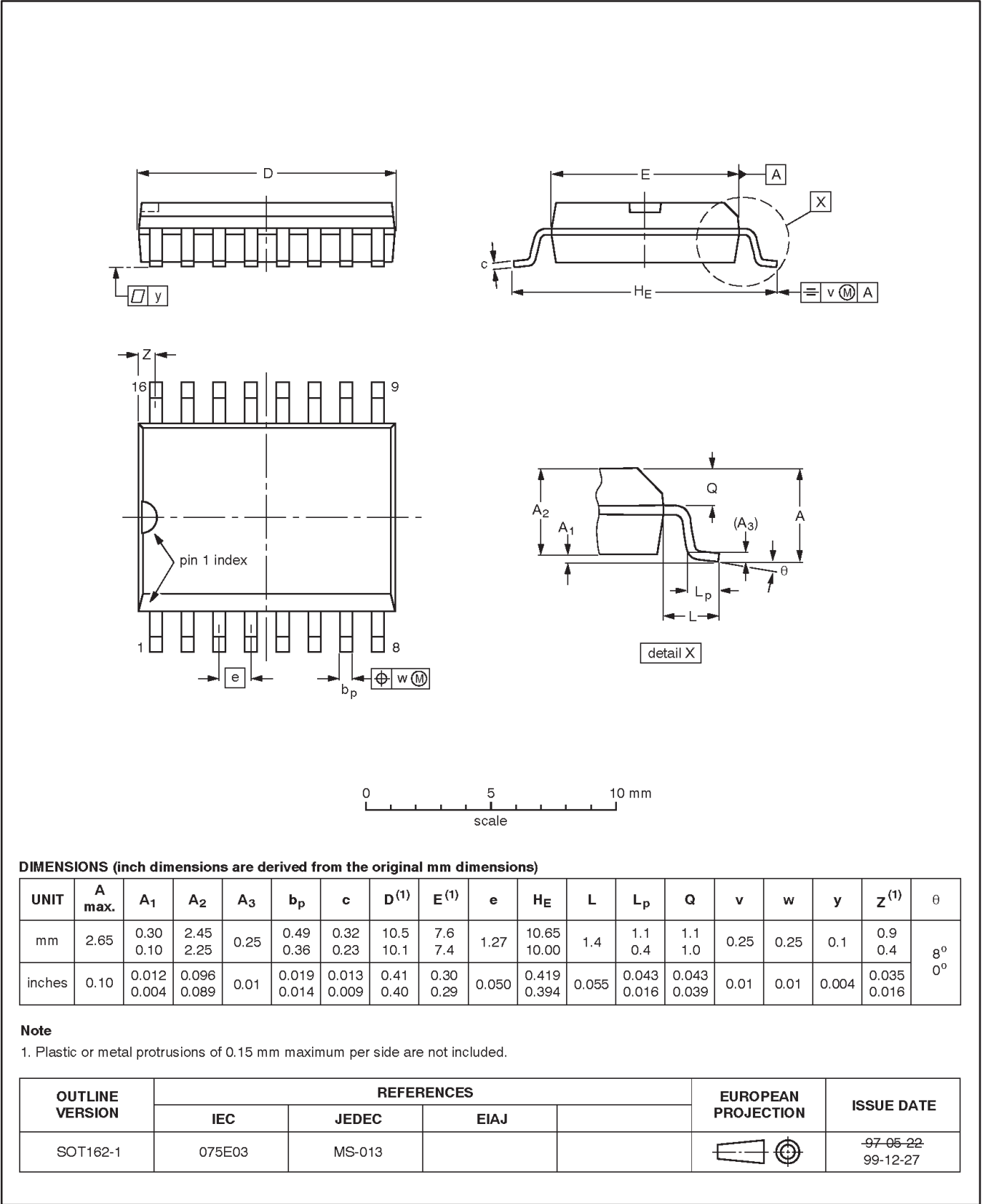


Internally-compensated dual low noise  
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NE/SA/SE5532/5532A

SO16: plastic small outline package; 16 leads; body width 7.5 mm

SOT162-1

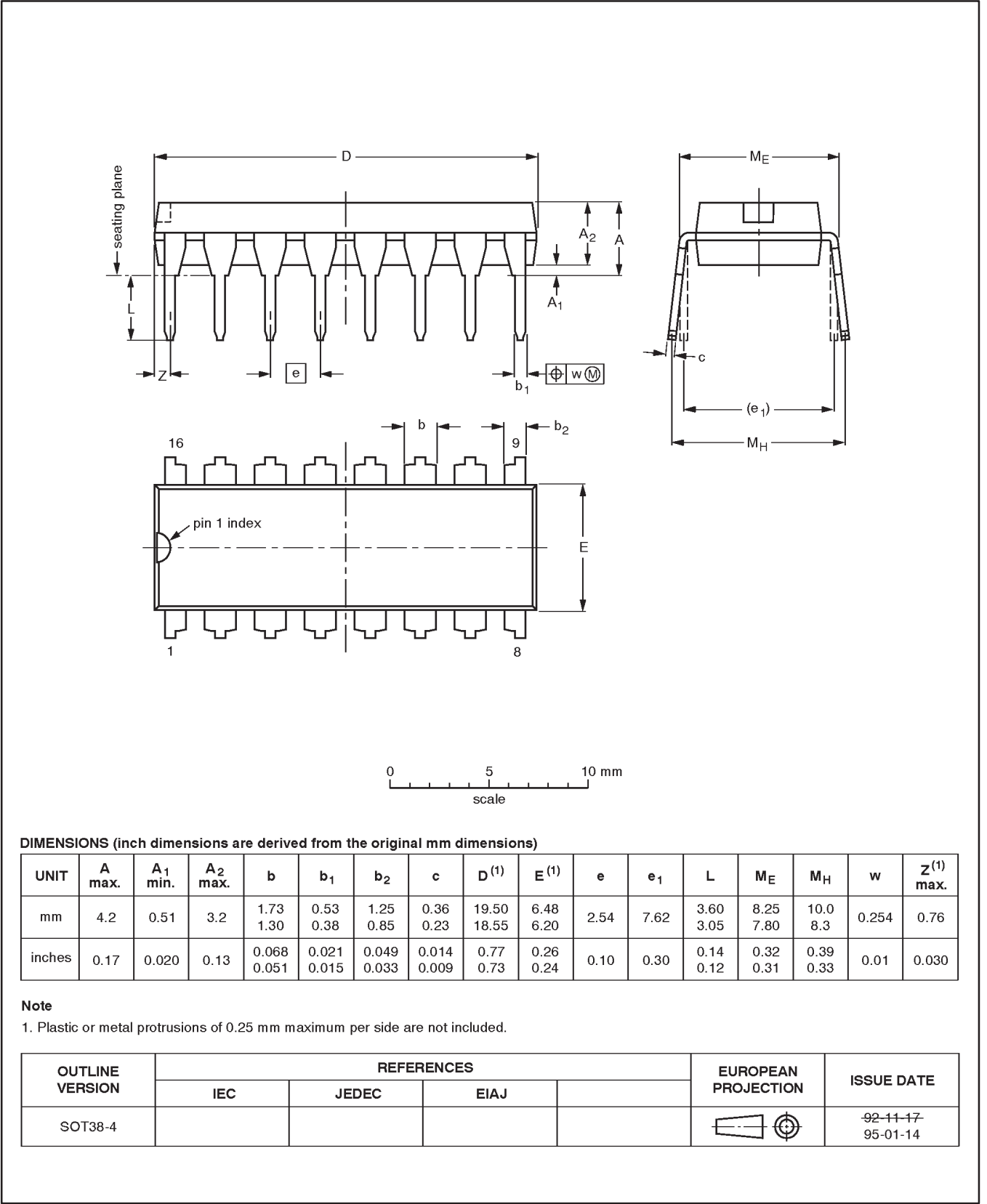


Internally-compensated dual low noise operational amplifier

NE/SA/SE5532/5532A

DIP16: plastic dual in-line package; 16 leads (300 mil)

SOT38-4



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**Internally-compensated dual low noise  
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**NE/SA/SE5532/5532A****NOTES**

# Internally-compensated dual low noise operational amplifier

NE/SA/SE5532/5532A

## Data sheet status

| Data sheet status <sup>[1]</sup> | Product status <sup>[2]</sup> | Definitions                                                                                                                                                                                                                                                                                                            |
|----------------------------------|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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