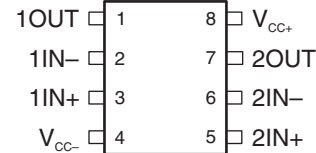


DUAL LOW-NOISE OPERATIONAL AMPLIFIERS

FEATURES

- **Equivalent Input Noise Voltage:**
5 nV/ $\sqrt{\text{Hz}}$ Typ at 1 kHz
- **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 26 V Typ**
With $V_{CC\pm} = \pm 15\text{ V}$ and $R_L = 600\ \Omega$
- **High Slew Rate:** 9 V/ μs Typ

NE5532, NE5532A . . . D, P, OR PS PACKAGE
SA5532, SA5532A . . . D OR P PACKAGE
(TOP VIEW)



DESCRIPTION/ORDERING INFORMATION

The NE5532, NE5532A, SA5532, and SA5532A are high-performance operational amplifiers combining excellent dc and ac characteristics. They feature very low noise, high output-drive capability, high unity-gain and maximum-output-swing bandwidths, low distortion, high slew rate, input-protection diodes, and output short-circuit protection. These operational amplifiers are compensated internally for unity-gain operation. These devices have specified maximum limits for equivalent input noise voltage.

ORDERING INFORMATION⁽¹⁾

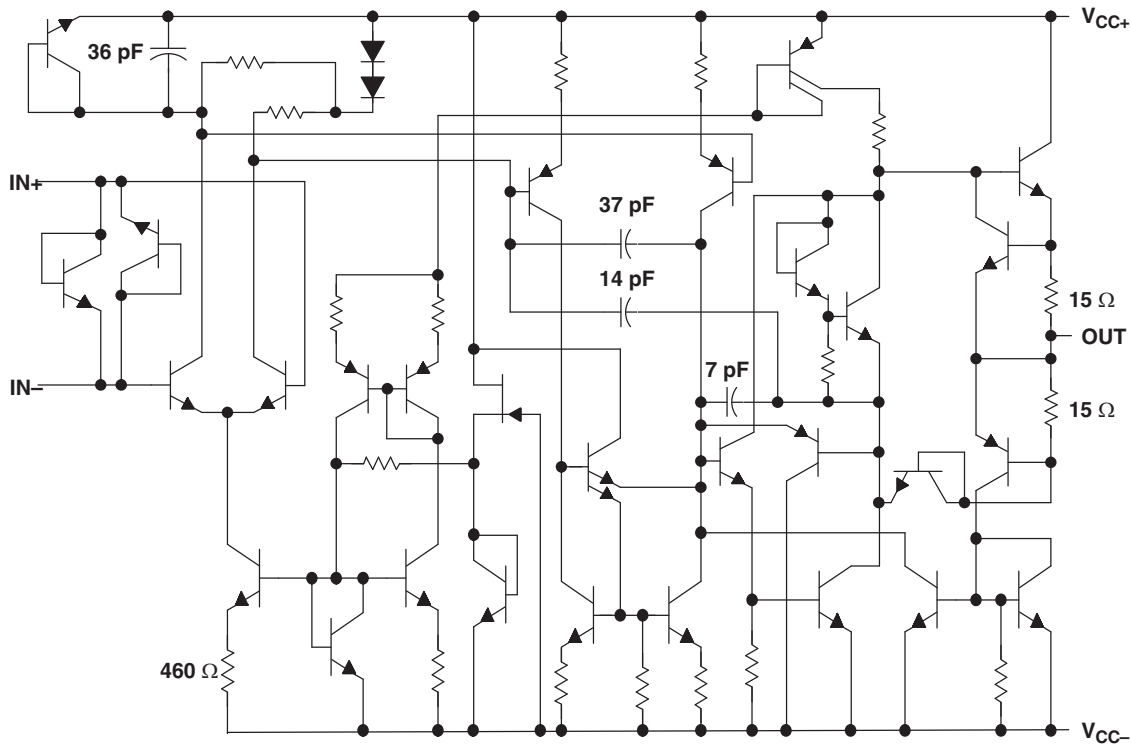
| T _A | PACKAGE ⁽²⁾ | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|----------------|------------------------|--------------|-----------------------|------------------|
| 0°C to 70°C | PDIP – P | Tube of 50 | NE5532P | NE5532P |
| | | | NE5532AP | NE5532AP |
| | SOIC – D | Tube of 75 | NE5532D | N5532 |
| | | | Reel of 2500 | |
| | | Reel of 2500 | NE5532AD | N5532A |
| | | | NE5532ADR | |
| | SOP – PS | Reel of 2000 | NE5532PSR | N5532 |
| | | | NE5532APSR | N5532A |
| –40°C to 85°C | PDIP – P | Tube of 50 | SA5532P | SA5532P |
| | | | SA5532AP | SA5532AP |
| | SOIC – D | Tube of 75 | SA5532D | SA5532 |
| | | | Reel of 2500 | |
| | | Reel of 2500 | SA5532AD | SA5532A |
| | | | SA5532ADR | |

- (1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.
- (2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

SCHEMATIC (EACH AMPLIFIER)



Component values shown are nominal.

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

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

| | | | |
|---|---|------------------|--------|
| V _{CC} | Supply voltage ⁽²⁾ | V _{CC+} | 22 V |
| | | V _{CC-} | -22 V |
| Input voltage, either input ⁽²⁾⁽³⁾ | | V _{CC±} | |
| Input current ⁽⁴⁾ | | ±10 mA | |
| Duration of output short circuit ⁽⁵⁾ | | Unlimited | |
| θ _{JA} | Package thermal impedance ⁽⁶⁾⁽⁷⁾ | D package | 97°C/W |
| | | P package | 85°C/W |
| | | PS package | 95°C/W |
| T _J | Operating virtual-junction temperature | 150°C | |
| T _{stg} | Storage temperature range | -65°C to 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_{CC+} and V_{CC-}.
- (3) The magnitude of the input voltage must never exceed the magnitude of the supply voltage.
- (4) Excessive input 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.
- (6) The package thermal impedance is calculated in accordance with JESD 51-7.
- (7) Maximum power dissipation is a function of T_{J(max)}, θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is P_D = (T_{J(max)} - T_A)/θ_{JA}. Operating at the absolute maximum T_J of 150°C can affect reliability.

RECOMMENDED OPERATING CONDITIONS

| | | MIN | MAX | UNIT |
|-----------|--------------------------------|-----------------|-----|------|
| V_{CC+} | Supply voltage | 5 | 15 | V |
| V_{CC-} | Supply voltage | -5 | -15 | V |
| T_A | Operating free-air temperature | NE5532, NE5532A | | °C |
| | | SA5532, SA5532A | | |

ELECTRICAL CHARACTERISTICS

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

| PARAMETER | | TEST CONDITIONS ⁽¹⁾ | | MIN | TYP | MAX | UNIT |
|-----------|---|---|---------------------------------|----------|----------|------|------------|
| V_{IO} | Input offset voltage | $V_O = 0$ | $T_A = 25^\circ\text{C}$ | | 0.5 | 4 | mV |
| | | | $T_A = \text{Full range}^{(2)}$ | | | 5 | |
| I_{IO} | Input offset current | $T_A = 25^\circ\text{C}$ | | | 10 | 150 | nA |
| | | $T_A = \text{Full range}^{(2)}$ | | | | 200 | |
| I_{IB} | Input bias current | $T_A = 25^\circ\text{C}$ | | | 200 | 800 | nA |
| | | $T_A = \text{Full range}^{(2)}$ | | | | 1000 | |
| V_{ICR} | Common-mode input-voltage range | | | ± 12 | ± 13 | | V |
| V_{OPP} | Maximum peak-to-peak output-voltage swing | $R_L \geq 600\ \Omega$, $V_{CC\pm} = \pm 15\text{ V}$ | | 24 | 26 | | V |
| A_{VD} | Large-signal differential-voltage amplification | $R_L \geq 600\ \Omega$, $V_O = \pm 10\text{ V}$ | $T_A = 25^\circ\text{C}$ | 15 | 50 | V/mV | |
| | | | $T_A = \text{Full range}^{(2)}$ | 10 | | | |
| | | $R_L \geq 2\text{ k}\Omega$, $V_O = \pm 10\text{ V}$ | $T_A = 25^\circ\text{C}$ | 25 | 100 | | |
| | | | $T_A = \text{Full range}^{(2)}$ | 15 | | | |
| A_{vd} | Small-signal differential-voltage amplification | $f = 10\text{ kHz}$ | | | 2.2 | | V/mV |
| B_{OM} | Maximum output-swing bandwidth | $R_L = 600\ \Omega$, $V_O = \pm 10\text{ V}$ | | | 140 | | kHz |
| B_1 | Unity-gain bandwidth | $R_L = 600\ \Omega$, $C_L = 100\text{ pF}$ | | | 10 | | MHz |
| r_i | Input resistance | | | 30 | 300 | | k Ω |
| z_o | Output impedance | $A_{VD} = 30\text{ dB}$, $R_L = 600\ \Omega$, $f = 10\text{ kHz}$ | | | 0.3 | | Ω |
| CMRR | Common-mode rejection ratio | $V_{IC} = V_{ICR\text{ min}}$ | | 70 | 100 | | dB |
| k_{SVR} | Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$) | $V_{CC\pm} = \pm 9\text{ V}$ to $\pm 15\text{ V}$, $V_O = 0$ | | 80 | 100 | | dB |
| I_{OS} | Output short-circuit current | | | 10 | 38 | 60 | mA |
| I_{CC} | Total supply current | $V_O = 0$, No load | | | 8 | 16 | mA |
| | Crosstalk attenuation (V_{O1}/V_{O2}) | $V_{O1} = 10\text{ V peak}$, $f = 1\text{ kHz}$ | | | 110 | | dB |

(1) All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified.

(2) Full temperature ranges are: -40°C to 85°C for the SA5532 and SA5532A, and 0°C to 70°C for the NE5532 and NE5532A.

OPERATING CHARACTERISTICS

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

| PARAMETER | | TEST CONDITIONS | NE5532, SA5532 | | | NE5532A, SA5532A | | | UNIT |
|-----------|--------------------------------|---|----------------|-----|-----|------------------|-----|------------------------|------------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR | Slew rate at unity gain | | 9 | | | 9 | | | V/ μ s |
| | Overshoot factor | $V_i = 100\text{ mV}$, $R_L = 600\ \Omega$, $A_{VD} = 1$, $C_L = 100\text{ pF}$ | 10 | | | 10 | | | % |
| V_n | Equivalent input noise voltage | $f = 30\text{ Hz}$ | 8 | | | 8 | 10 | nV/ $\sqrt{\text{Hz}}$ | |
| | | $f = 1\text{ kHz}$ | 5 | | | 5 | 6 | | |
| I_n | Equivalent input noise current | $f = 30\text{ Hz}$ | 2.7 | | | 2.7 | | | pA/ $\sqrt{\text{Hz}}$ |
| | | $f = 1\text{ kHz}$ | 0.7 | | | 0.7 | | | |

PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/ Ball Finish | MSL Peak Temp ⁽³⁾ | Samples (Requires Login) |
|------------------|-----------------------|--------------|-----------------|------|-------------|----------------------------|----------------------|------------------------------|-----------------------------|
| NE5532AD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| NE5532ADE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| NE5532ADG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| NE5532ADR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| NE5532ADRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| NE5532ADRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| NE5532AIP | OBSOLETE | PDIP | P | 8 | | TBD | Call TI | Call TI | |
| NE5532AP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type | |
| NE5532APE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type | |
| NE5532APSR | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| NE5532APSRE4 | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| NE5532APSRG4 | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| NE5532D | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| NE5532DE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| NE5532DG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| NE5532DR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| NE5532DRE4 | ACTIVE | SOIC | D | 8 | 2500 | TBD | Call TI | Call TI | |
| NE5532DRG4 | ACTIVE | SOIC | D | 8 | 2500 | TBD | Call TI | Call TI | |
| NE5532IP | OBSOLETE | PDIP | P | 8 | | TBD | Call TI | Call TI | |
| NE5532P | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type | |

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/ Ball Finish | MSL Peak Temp ⁽³⁾ | Samples (Requires Login) |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|----------------------|------------------------------|-----------------------------|
| NE5532PE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type | |
| NE5532PSR | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| NE5532PSRE4 | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| NE5532PSRG4 | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| SA5532AD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| SA5532ADE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| SA5532ADG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| SA5532ADR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| SA5532ADRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| SA5532ADRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| SA5532AP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type | |
| SA5532APE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type | |
| SA5532D | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| SA5532DE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| SA5532DG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| SA5532DR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| SA5532DRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| SA5532DRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| SA5532P | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type | |
| SA5532PE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type | |

(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) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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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 |
|------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| NE5532ADR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| NE5532APSR | SO | PS | 8 | 2000 | 330.0 | 16.4 | 8.2 | 6.6 | 2.5 | 12.0 | 16.0 | Q1 |
| NE5532DR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| NE5532PSR | SO | PS | 8 | 2000 | 330.0 | 16.4 | 8.2 | 6.6 | 2.5 | 12.0 | 16.0 | Q1 |
| SA5532ADR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| SA5532DR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|------------|--------------|-----------------|------|------|-------------|------------|-------------|
| NE5532ADR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| NE5532APSR | SO | PS | 8 | 2000 | 346.0 | 346.0 | 33.0 |
| NE5532DR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| NE5532PSR | SO | PS | 8 | 2000 | 346.0 | 346.0 | 33.0 |
| SA5532ADR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| SA5532DR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |

P (R-PDIP-T8)

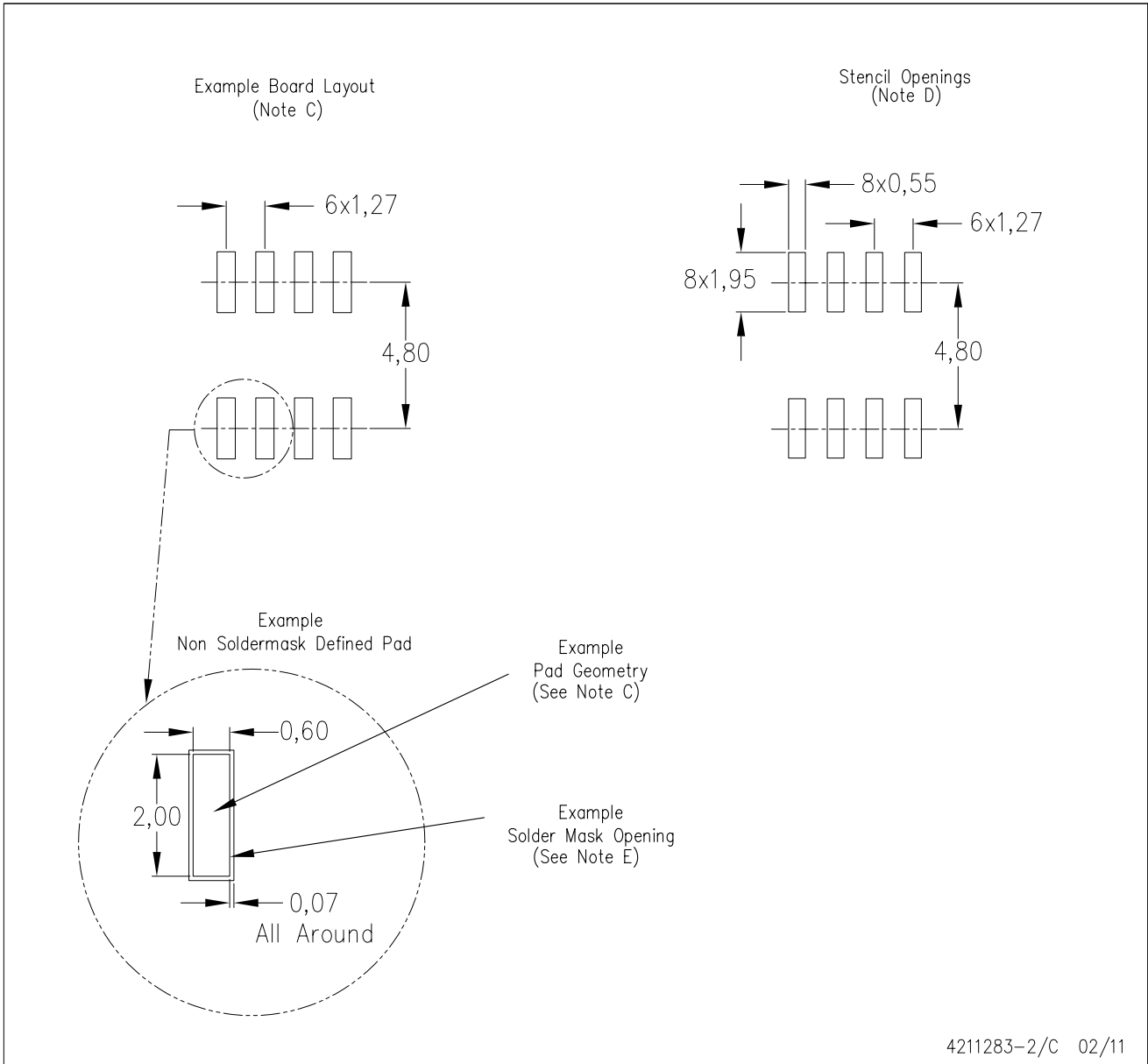
PLASTIC DUAL-IN-LINE PACKAGE



- 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.

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Publication IPC-7351 is recommended for alternate designs.
 - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
 - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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.

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| RFID | www.ti-rfid.com |
| RF/IF and ZigBee® Solutions | www.ti.com/lprf |

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