

## DUAL AUDIO OPERATIONAL AMPLIFIER

### FEATURES

- Operating Voltage . . .  $\pm 2$  V to  $\pm 18$  V
- Low Noise Voltage . . .  $1.2 \mu\text{Vrms}$  (Typ)
- Wide GBW . . . 15 MHz (Typ)
- Low THD . . . 0.05% (Typ)
- Slew Rate . . .  $5.5 \text{ V}/\mu\text{sec}$  (Typ)
- Suitable for Applications Such as Audio Preamplifier, Active Filter, Headphone Amplifier, Industrial Measurement Equipment

### DESCRIPTION/ORDERING INFORMATION

The RC4560 is a high-gain, wide-bandwidth, dual operational amplifier capable of driving 20 V peak-to-peak into 400- $\Omega$  loads. The RC4560 combines many of the features of the RC4558, but with wider bandwidth and higher slew rate, making this device ideal for active filters, data and telecommunications, and many instrumentation applications.

#### ORDERING INFORMATION<sup>(1)</sup>

| $T_A$         | PACKAGE <sup>(2)</sup> |              | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---------------|------------------------|--------------|-----------------------|------------------|
| -40°C to 85°C | PDIP – P               | Tube of 50   | RC4560IP              | RC4560IP         |
|               | SOIC – D               | Tube of 75   | RC4560ID              | R4560I           |
|               |                        | Reel of 2500 | RC4560IDR             |                  |
|               | TSSOP – PW             | Tube of 150  | RC4560IPW             | R4560I           |
|               |                        | Reel of 2000 | RC4560IPWR            |                  |

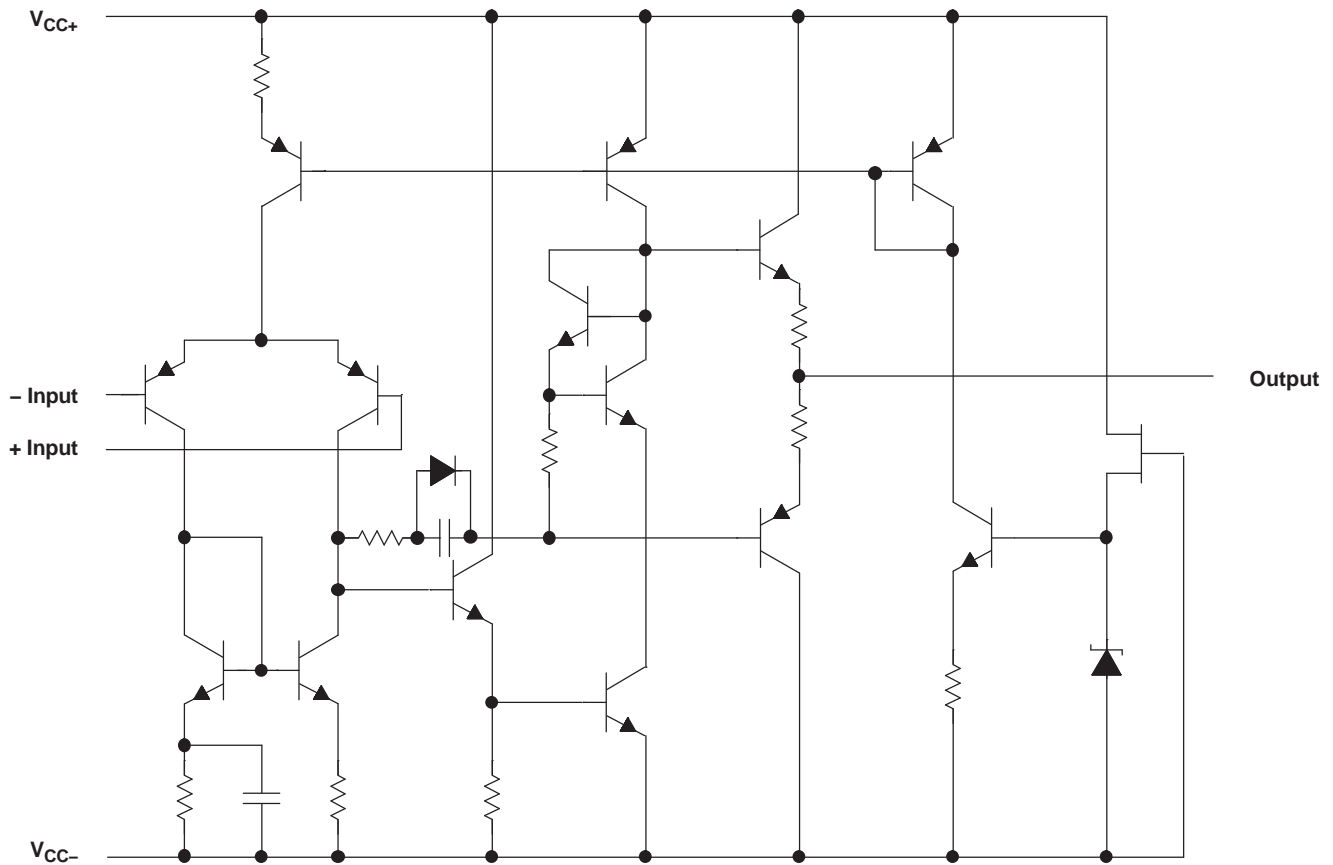
(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at [www.ti.com](http://www.ti.com).

(2) Package drawings, thermal data, and symbolization are available at [www.ti.com/packaging](http://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.

## EQUIVALENT CIRCUIT

ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

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

|               |   |            |                |
|---------------|---|------------|----------------|
| $V_{CC\pm}$   | Supply voltage                              |            | $\pm 18$ V     |
|               | Input voltage (any input)                   |            | $\pm 15$ V     |
|               | Output current                              |            | $\pm 50$ mA    |
| $\theta_{JA}$ | Package thermal impedance <sup>(2)(3)</sup> | D package  | 97°C/W         |
|               |   | P package  | 85°C/W         |
|               |   | PW package | 149°C/W        |
| $T_J$         | Operating virtual junction temperature      |            | 150°C          |
| $T_{stg}$     | Storage temperature range                   |            | -60°C to 125°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) Maximum power dissipation is a function of  $T_J(\max)$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\max) - T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of 150°C can impact reliability.
- (3) The package thermal impedance is calculated in accordance with JESD 51-7.

## RECOMMENDED OPERATING CONDITIONS

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

|           |                                      | MIN | MAX | UNIT |
|-----------|--------------------------------------|-----|-----|------|
| $V_{CC+}$ | Supply voltage                       | 2   | 16  | V    |
| $V_{CC-}$ |                                      | -2  | -16 |      |
| $V_{ID}$  | Differential input voltage           |     | ±30 | V    |
| $V_{ICR}$ | Input common mode range              | -14 | 14  | V    |
| $T_A$     | Operating free-air temperature range | -40 | 85  | °C   |

## ELECTRICAL CHARACTERISTICS

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

| PARAMETER |   | TEST CONDITIONS                                       | MIN  | TYP   | MAX | UNIT       |
|-----------|---|---|------|-------|-----|------------|
| $V_{IO}$  | Input offset voltage                            | $R_S \leq 10\text{ k}\Omega$                          |      | 0.5   | 6   | mV         |
| $I_{IO}$  | Input offset current                            |   |      | 5     | 200 | nA         |
| $I_{IB}$  | Input bias current                              |   |      | 40    | 500 | nA         |
| $A_{VD}$  | Large-signal differential voltage amplification | $R_L \geq 2\text{ k}\Omega$ , $V_O = \pm 10\text{ V}$ | 86   | 100   |     | dB         |
| $r_i$     | Input resistance                                |   | 0.3  | 5     |     | M $\Omega$ |
| $V_O$     | Output voltage swing                            | $R_L \geq 2\text{ k}\Omega$                           | ±12  | ±14   |     | V          |
|           |   | $I_O = 25\text{ mA}$                                  | ±10  | ±12.5 |     |            |
| $V_{ICR}$ | Common-mode input voltage range                 |   | ±12  | ±14   |     | V          |
| CMRR      | Common-mode rejection ratio                     | $R_S \leq 10\text{ k}\Omega$                          | 70   | 90    |     | dB         |
| $k_{SVR}$ | Supply-voltage rejection ratio <sup>(1)</sup>   | $R_S \leq 10\text{ k}\Omega$                          | 76.5 | 90    |     | dB         |
| $I_{CC}$  | Supply current (all amplifiers)                 |   |      | 4.3   | 5.7 | mA         |

 (1) Measured with  $V_{CC\pm}$  differentially varied simultaneously from  $\pm 4\text{ V}$  to  $\pm 15\text{ V}$ 

## OPERATING CHARACTERISTICS

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

| PARAMETER |                                | TEST CONDITIONS  | TYP  | UNIT             |
|-----------|--------------------------------|--|------|------------------|
| SR        | Slew rate at unity gain        |  | 5.5  | V/ $\mu\text{s}$ |
| GBW       | Gain bandwidth product         |  | 15   | MHz              |
| THD       | Total harmonic distortion      | $V_O = 5\text{ V}$ , $R_L = 2\text{ k}\Omega$ , $f = 1\text{ kHz}$ , $A_{VD} = 20\text{ dB}$ | 0.05 | %                |
| $V_n$     | Equivalent input noise voltage | RIAA, $R_S \leq 2\text{ k}\Omega$ , 30-kHz LPF   | 1.2  | $\mu\text{Vrms}$ |

**PACKAGING INFORMATION**

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| RC4560ID         | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| RC4560IDE4       | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| RC4560IDG4       | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| RC4560IDR        | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| RC4560IDRE4      | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| RC4560IDRG4      | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| RC4560IP         | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| RC4560IPE4       | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| RC4560IPW        | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| RC4560IPWE4      | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| RC4560IPWG4      | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| RC4560IPWR       | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| RC4560IPWRE4     | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| RC4560IPWRG4     | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |

<sup>(1)</sup> 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.

<sup>(2)</sup> 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)

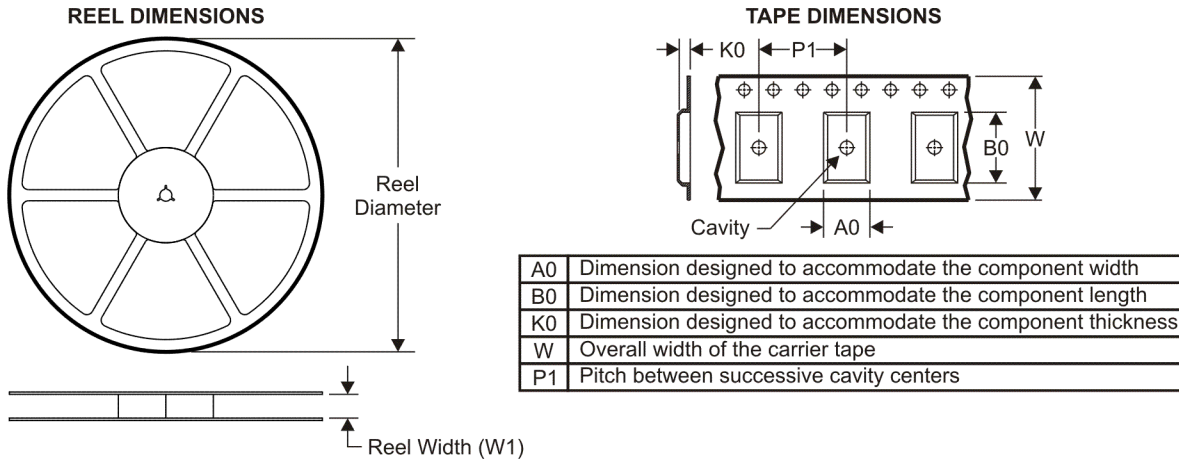
<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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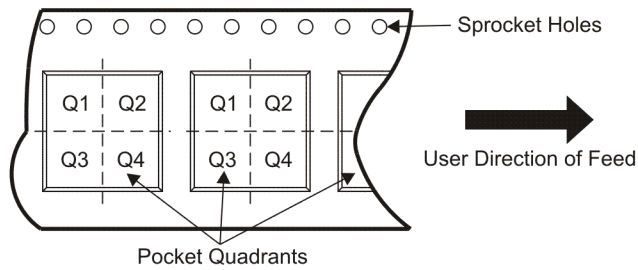
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**TAPE AND REEL INFORMATION**



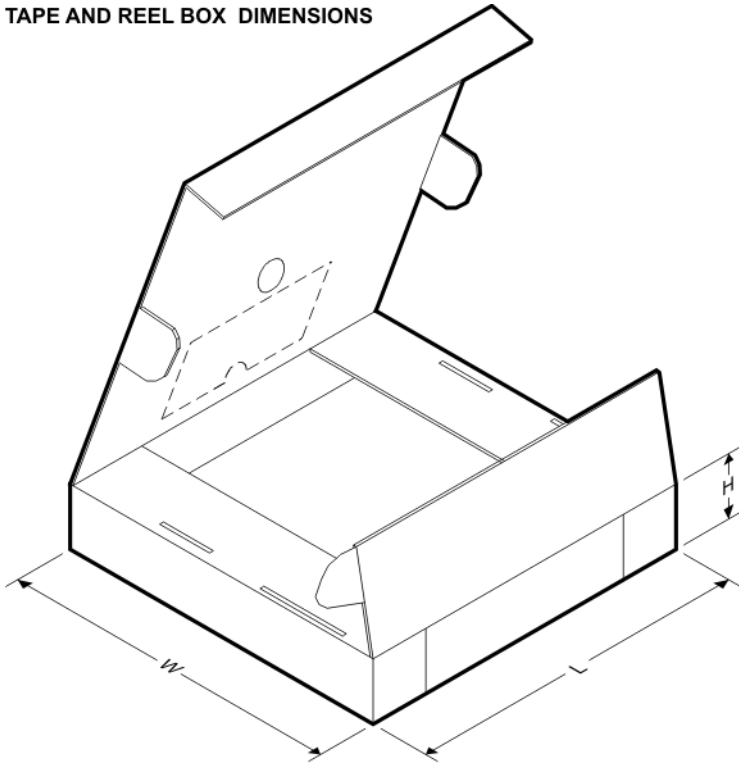
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**



\*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 |
|------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| RC4560IDR  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| RC4560IPWR | TSSOP        | PW              | 8    | 2000 | 330.0              | 12.4               | 7.0     | 3.6     | 1.6     | 8.0     | 12.0   | Q1            |

**TAPE AND REEL BOX DIMENSIONS**

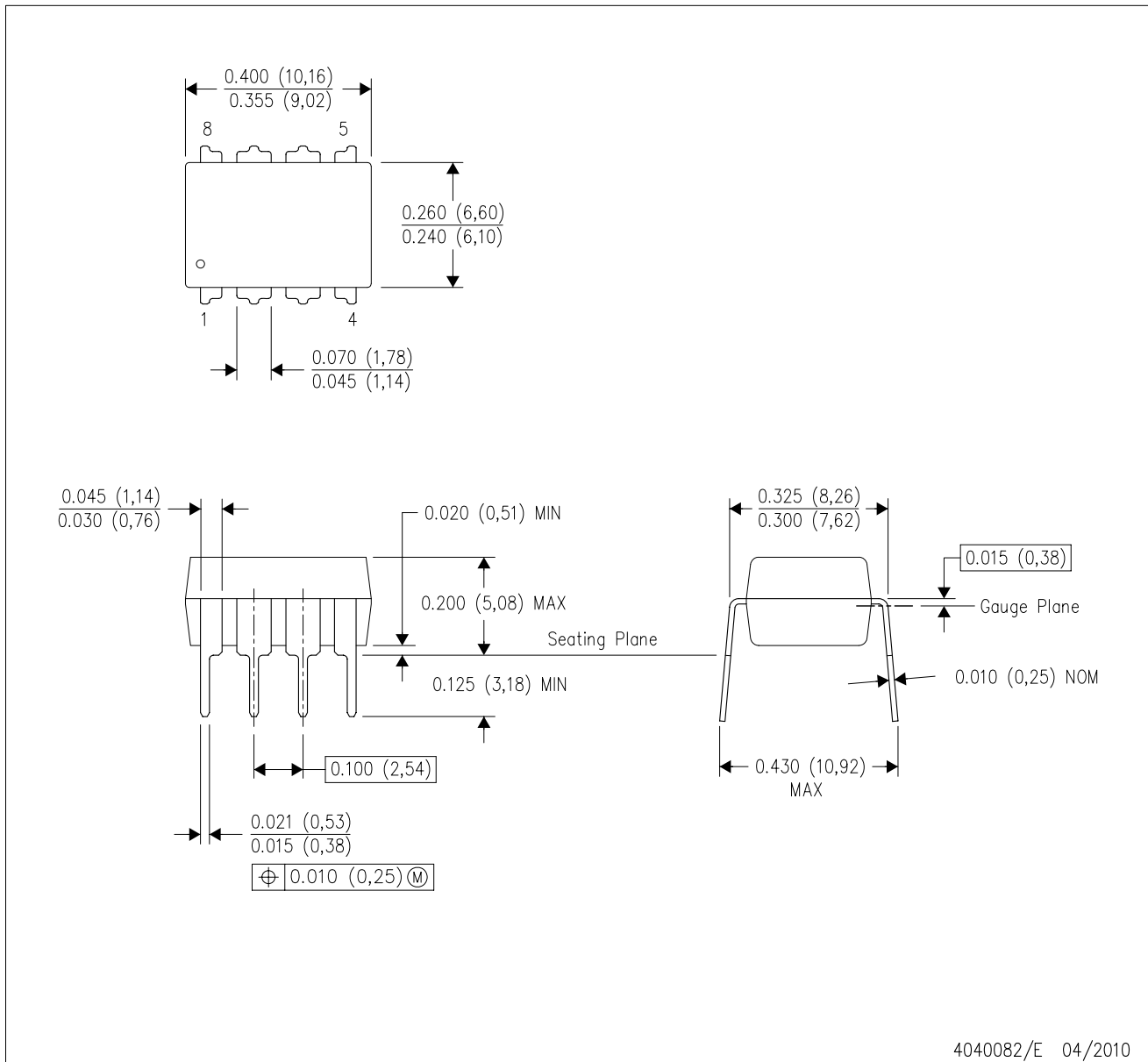


\*All dimensions are nominal

| Device     | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|------------|--------------|-----------------|------|------|-------------|------------|-------------|
| RC4560IDR  | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| RC4560IPWR | TSSOP        | PW              | 8    | 2000 | 346.0       | 346.0      | 29.0        |

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE PACKAGE

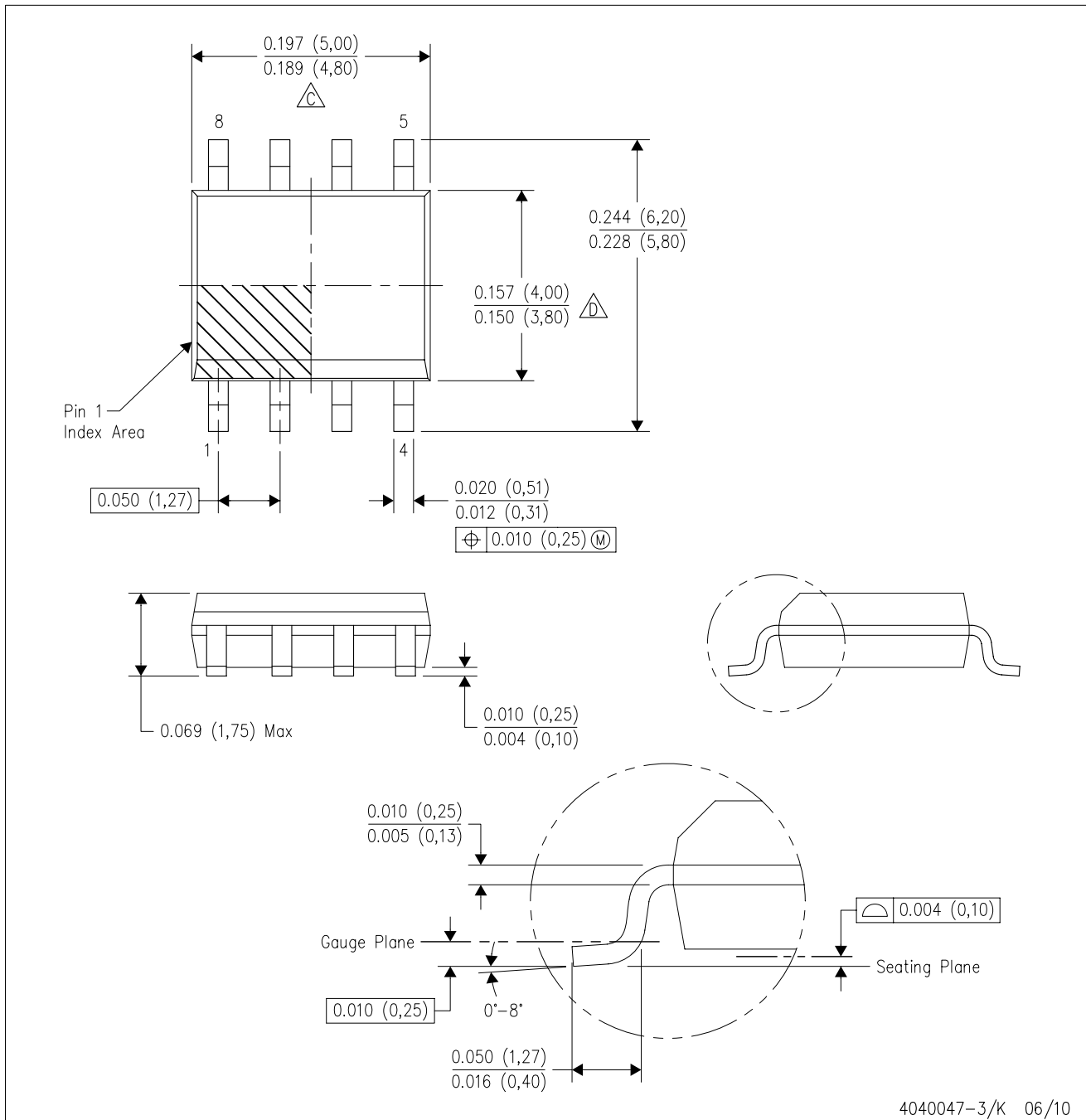


- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Falls within JEDEC MS-001 variation BA.



D (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
  - E. Reference JEDEC MS-012 variation AA.

PW (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



4040064/F 01/97

- 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.  
 D. Falls within JEDEC MO-153

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