# 36V, Single-Supply, SOT553, General-Purpose OPERATIONAL AMPLIFIERS Value Line Series

**Check for Samples: OPA171, OPA2171, OPA4171**

## FEATURES

- **Supply Range: +2.7V to +36V, ±1.35V to ±18V**
- **Low Noise: 14nV/√Hz**
- **Low Offset Drift: ±0.3µV/°C (typ)**
- **RFI Filtered Inputs**
- **Input Range Includes the Negative Supply**
- **Input Range Operates to Positive Supply**
- **Rail-to-Rail Output**
- **Gain Bandwidth: 3MHz**
- **Low Quiescent Current: 475µA per Amplifier**
- **High Common-Mode Rejection: 120dB (typ)**
- **Low Input Bias Current: 8pA**
- **Industry-Standard Packages:**
  - **8-Pin SOIC**
  - **8-Pin MSOP**
  - **14-Pin TSSOP**
- ***micro*Packages:**
  - **Single in SOT553**
  - **Dual in VSSOP-8**

## APPLICATIONS

- **Tracking Amplifier in Power Modules**
- **Merchant Power Supplies**
- **Transducer Amplifiers**
- **Bridge Amplifiers**
- **Temperature Measurements**
- **Strain Gauge Amplifiers**
- **Precision Integrators**
- **Battery-Powered Instruments**
- **Test Equipment**

**Product Family**

| DEVICE | PACKAGE |
|---|---|
| OPA171 | SOT553, SOT23-5, SO-8 |
| OPA2171 (dual) | VSSOP-8, SO-8, MSOP-8 |
| OPA4171 (quad) | TSSOP-14, SO-14 |

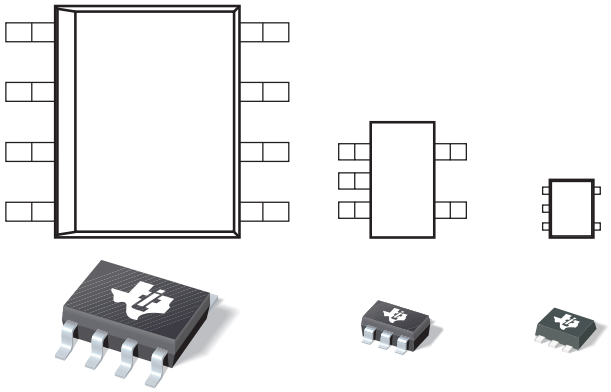
## DESCRIPTION

The OPA171, OPA2171 and OPA4171 (OPAx171) are a family of 36V, single-supply, low-noise operational amplifiers with the ability to operate on supplies ranging from +2.7V (±1.35V) to +36V (±18V). These devices are available in micro-packages and offer low offset, drift, and bandwidth with low quiescent current. The single, dual, and quad versions all have identical specifications for maximum design flexibility.

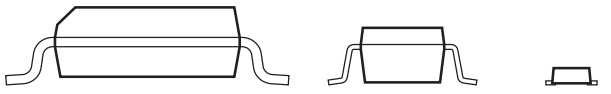
Unlike most op amps, which are specified at only one supply voltage, the OPAx171 family is specified from +2.7V to +36V. Input signals beyond the supply rails do not cause phase reversal. The OPAx171 family is stable with capacitive loads up to 300pF. The input can operate 100mV below the negative rail and within 2V of the top rail during normal operation. Note that these devices can operate with full rail-to-rail input 100mV beyond the top rail, but with reduced performance within 2V of the top rail.

The OPAx171 series of op amps are specified from –40°C to +125°C.

**Package Footprint Comparison (to Scale)**



**Package Height Comparison (to Scale)**



D (SO-8) DBV (SOT23-5) DRL (SOT553)

**Smallest Packaging for 36V Op Amps**

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This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

## PACKAGE/ORDERING INFORMATION (1)

| PRODUCT | PACKAGE-LEAD | PACKAGE DESIGNATOR | PACKAGE MARKING | ORDERING NUMBER | TRANSPORT MEDIA, QUANTITY |
|---|---|---|---|---|---|
| OPA171 | SOT553 | DRL | DAP | OPA171AIDRLT | Tape and Reel, 250 |
| | | | | OPA171AIDRLR | Tape and Reel, 4000 |
| | SOT23-5 | DBV | OSUI | OPA171AIDBVT | Tape and Reel, 250 |
| | | | | OPA171AIDBVR | Tape and Reel, 3000 |
| | SO-8 | D | O171A | OPA171AID | Rail, 75 |
| | | | | OPA171AIDR | Tape and Reel, 2500 |
| OPA2171 | MSOP-8 | DGK | OPMI | OPA2171AIDGK | Rail, 80 |
| | | | | OPA2171AIDGKR | Tape and Reel, 2500 |
| | VSSOP-8 | DCU | OPOC | OPA2171AIDCUT | Tape and Reel, 250 |
| | | | | OPA2171AIDCUR | Tape and Reel, 3000 |
| | SO-8 | D | 2171A | OPA2171AID | Rail, 75 |
| | | | | OPA2171AIDR | Tape and Reel, 2500 |
| OPA4171 | SO-14 | D | OPA4171 | OPA4171AID | Rail, 50 |
| | | | | OPA4171AIDR | Tape and Reel, 2500 |
| | TSSOP-14 | PW | OPA4171 | OPA4171AIPW | Rail, 90 |
| | | | | OPA4171AIPWR | Tape and Reel, 2000 |

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or visit the device product folder at www.ti.com.

## ABSOLUTE MAXIMUM RATINGS(1)

Over operating free-air temperature range, unless otherwise noted.

| | | OPAx171 | UNIT |
|---|---|---|---|
| Supply voltage | | ±20 | V |
| Signal input terminals | Voltage | (V–) – 0.5 to (V+) + 0.5 | V |
| | Current | ±10 | mA |
| Output short circuit(2) | | Continuous | |
| Operating temperature | | –55 to +150 | °C |
| Storage temperature | | –65 to +150 | °C |
| Junction temperature | | +150 | °C |
| ESD ratings: | Human body model (HBM) | 4 | kV |
| | Charged device model (CDM) | 750 | V |

(1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.
(2) Short-circuit to ground, one amplifier per package.


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## ELECTRICAL CHARACTERISTICS

**Boldface** limits apply over the specified temperature range, **$T_A$ = –40°C to +125°C.**
At $T_A$ = +25°C, $V_S$ = +2.7V to +36V, $V_{CM}$ = $V_{OUT}$ = $V_S$/2, and $R_{LOAD}$ = 10kΩ connected to $V_S$/2, unless otherwise noted.

| PARAMETER | | TEST CONDITIONS | OPA171, OPA2171, OPA4171 MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **OFFSET VOLTAGE** | | | | | | |
| Input offset voltage | $V_{OS}$ | | | 0.25 | ±1.8 | mV |
| **Over temperature** | | | | **0.3** | **±2** | **mV** |
| **Drift** | **$dV_{OS}/dT$** | | | **0.3** | **±2** | **µV/°C** |
| **vs power supply** | **PSRR** | **$V_S$ = +4V to +36V** | | **1** | **±3** | **µV/V** |
| Channel separation, dc | | dc | | 5 | | µV/V |
| **INPUT BIAS CURRENT** | | | | | | |
| Input bias current | $I_B$ | | | ±8 | ±15 | pA |
| **Over temperature** | | | | | **±3.5** | **nA** |
| Input offset current | $I_{OS}$ | | | ±4 | | pA |
| **Over temperature** | | | | | **±3.5** | **nA** |
| **NOISE** | | | | | | |
| Input voltage noise | | f = 0.1Hz to 10Hz | | 3 | | $\mu V_{PP}$ |
| Input voltage noise density | $e_n$ | f = 100Hz | | 25 | | nV/√Hz |
| | | f = 1kHz | | 14 | | nV/√Hz |
| **INPUT VOLTAGE** | | | | | | |
| Common-mode voltage range(1) | $V_{CM}$ | | (V–) – 0.1V | | (V+) – 2V | V |
| **Common-mode rejection ratio** | **CMRR** | **$V_S$ = ±2V, (V–) – 0.1V < $V_{CM}$ < (V+) – 2V** | **90** | **104** | | **dB** |
| | | **$V_S$ = ±18V, (V–) – 0.1V < $V_{CM}$ < (V+) – 2V** | **104** | **120** | | **dB** |
| **INPUT IMPEDANCE** | | | | | | |
| Differential | | | | 100 \|\| 3 | | MΩ \|\| pF |
| Common-mode | | | | 6 \|\| 3 | | $10^{12}$Ω \|\| pF |
| **OPEN-LOOP GAIN** | | | | | | |
| **Open-loop voltage gain** | **$A_{OL}$** | **$V_S$ = +4V to +36V, (V–) + 0.35V < $V_O$ < (V+) – 0.35V** | **110** | **130** | | **dB** |
| **FREQUENCY RESPONSE** | | | | | | |
| Gain bandwidth product | GBP | | | 3.0 | | MHz |
| Slew rate | SR | G = +1 | | 1.5 | | V/µs |
| Settling time | $t_S$ | To 0.1%, $V_S$ = ±18V, G = +1, 10V step | | 6 | | µs |
| | | To 0.01% (12 bit), $V_S$ = ±18V, G = +1, 10V step | | 10 | | µs |
| Overload recovery time | | $V_{IN}$ × Gain > $V_S$ | | 2 | | µs |
| Total harmonic distortion + noise | THD+N | G = +1, f = 1kHz, $V_O$ = $3V_{RMS}$ | | 0.0002 | | % |
| **OUTPUT** | | | | | | |
| Voltage output swing from rail | $V_O$ | $V_S$ = 5V, $R_L$ = 10kΩ | | 30 | | mV |
| **Over temperature** | | **$R_L$ = 10kΩ, $A_{OL}$ ≥ 110dB** | **(V–) + 0.35** | | **(V+) – 0.35** | **V** |
| Short-circuit current | $I_{SC}$ | | | +25/–35 | | mA |
| Capacitive load drive | $C_{LOAD}$ | | See Typical Characteristics | | | pF |
| Open-loop output resistance | $R_O$ | f = 1MHz, $I_O$ = 0A | | 150 | | Ω |
| **POWER SUPPLY** | | | | | | |
| Specified voltage range | $V_S$ | | +2.7 | | +36 | V |
| Quiescent current per amplifier | $I_Q$ | $I_O$ = 0A | | 475 | 595 | µA |
| **Over temperature** | | **$I_O$ = 0A** | | | **650** | **µA** |
| **TEMPERATURE** | | | | | | |
| Specified range | | | –40 | | +125 | °C |
| Operating range | | | –55 | | +150 | °C |

(1) The input range can be extended beyond (V+) – 2V up to V+. See the *Typical Characteristics* and *Application Information* sections for additional information.

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## THERMAL INFORMATION: OPA171

| THERMAL METRIC(1) | | OPA171 | | | UNITS |
|---|---|---|---|---|---|
| | | D (SO) | DBV (SOT23) | DRL (SOT553) | |
| | | 8 PINS | 5 PINS | 5 PINS | |
| $\theta_{JA}$ | Junction-to-ambient thermal resistance | 149.5 | 245.8 | 208.1 | °C/W |
| $\theta_{JC(top)}$ | Junction-to-case(top) thermal resistance | 97.9 | 133.9 | 0.1 | |
| $\theta_{JB}$ | Junction-to-board thermal resistance | 87.7 | 83.6 | 42.4 | |
| $\psi_{JT}$ | Junction-to-top characterization parameter | 35.5 | 18.2 | 0.5 | |
| $\psi_{JB}$ | Junction-to-board characterization parameter | 89.5 | 83.1 | 42.2 | |
| $\theta_{JC(bottom)}$ | Junction-to-case(bottom) thermal resistance | N/A | N/A | N/A | |

(1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, SPRA953.

## THERMAL INFORMATION: OPA2171

| THERMAL METRIC(1) | | OPA2171 | | | UNITS |
|---|---|---|---|---|---|
| | | D (SO) | DCU (VSSOP) | DGK (MSOP) | |
| | | 8 PINS | 8 PINS | 8 PINS | |
| $\theta_{JA}$ | Junction-to-ambient thermal resistance | 134.3 | 175.2 | 195.3 | °C/W |
| $\theta_{JC(top)}$ | Junction-to-case(top) thermal resistance | 72.1 | 74.9 | 59.4 | |
| $\theta_{JB}$ | Junction-to-board thermal resistance | 60.6 | 22.2 | 115.1 | |
| $\psi_{JT}$ | Junction-to-top characterization parameter | 18.2 | 1.6 | 4.7 | |
| $\psi_{JB}$ | Junction-to-board characterization parameter | 53.8 | 22.8 | 114.4 | |
| $\theta_{JC(bottom)}$ | Junction-to-case(bottom) thermal resistance | N/A | N/A | N/A | |

(1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, SPRA953.

## THERMAL INFORMATION: OPA4171

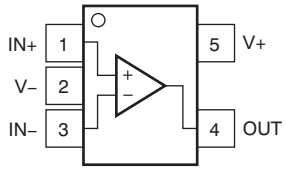
| THERMAL METRIC(1) | | OPA4171 | | UNITS |
|---|---|---|---|---|
| | | D (SO) | PW (TSSOP) | |
| | | 14 PINS | 14 PINS | |
| $\theta_{JA}$ | Junction-to-ambient thermal resistance | 93.2 | 106.9 | °C/W |
| $\theta_{JC(top)}$ | Junction-to-case(top) thermal resistance | 51.8 | 24.4 | |
| $\theta_{JB}$ | Junction-to-board thermal resistance | 49.4 | 59.3 | |
| $\psi_{JT}$ | Junction-to-top characterization parameter | 13.5 | 0.6 | |
| $\psi_{JB}$ | Junction-to-board characterization parameter | 42.2 | 54.3 | |
| $\theta_{JC(bottom)}$ | Junction-to-case(bottom) thermal resistance | N/A | N/A | |

(1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, SPRA953.

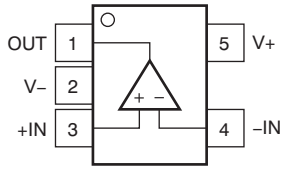

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## PIN CONFIGURATIONS

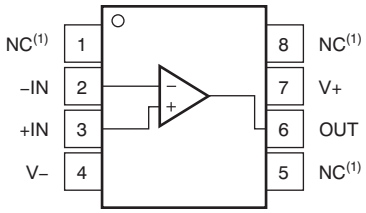
**DRL PACKAGE: OPA171**
**SOT-553**
**(TOP VIEW)**




**DBV PACKAGE: OPA171**
**SOT23-5**
**(TOP VIEW)**

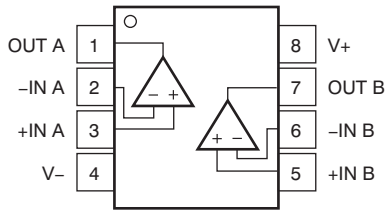



**D PACKAGE: OPA171**
**SO-8**
**(TOP VIEW)**

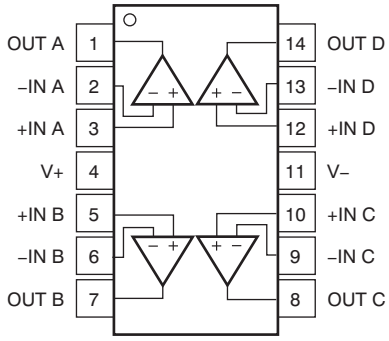



(1) No internal connection.

**D, DCU, AND DGK PACKAGES: OPA2171**
**SO-8, VSSOP-8, AND MSOP-8**
**(TOP VIEW)**




**D AND PW PACKAGES: OPA4171**
**SO-14 AND TSSOP-14**
**(TOP VIEW)**



## TYPICAL CHARACTERISTICS

### Table 1. Characteristic Performance Measurements

| DESCRIPTION | FIGURE |
|---|---|
| Offset Voltage Production Distribution | Figure 1 |
| Offset Voltage Drift Distribution | Figure 2 |
| Offset Voltage vs Temperature | Figure 3 |
| Offset Voltage vs Common-Mode Voltage | Figure 4 |
| Offset Voltage vs Common-Mode Voltage (Upper Stage) | Figure 5 |
| Offset Voltage vs Power Supply | Figure 6 |
| $I_B$ and $I_{OS}$ vs Common-Mode Voltage | Figure 7 |
| Input Bias Current vs Temperature | Figure 8 |
| Output Voltage Swing vs Output Current (Maximum Supply) | Figure 9 |
| CMRR and PSRR vs Frequency (Referred-to Input) | Figure 10 |
| CMRR vs Temperature | Figure 11 |
| PSRR vs Temperature | Figure 12 |
| 0.1Hz to 10Hz Noise | Figure 13 |
| Input Voltage Noise Spectral Density vs Frequency | Figure 14 |
| THD+N Ratio vs Frequency | Figure 15 |
| THD+N vs Output Amplitude | Figure 16 |
| Quiescent Current vs Temperature | Figure 17 |
| Quiescent Current vs Supply Voltage | Figure 18 |
| Open-Loop Gain and Phase vs Frequency | Figure 19 |
| Closed-Loop Gain vs Frequency | Figure 20 |
| Open-Loop Gain vs Temperature | Figure 21 |
| Open-Loop Output Impedance vs Frequency | Figure 22 |
| Small-Signal Overshoot vs Capacitive Load (100mV Output Step) | Figure 23, Figure 24 |
| No Phase Reversal | Figure 25 |
| Positive Overload Recovery | Figure 26 |
| Negative Overload Recovery | Figure 27 |
| Small-Signal Step Response (100mV) | Figure 28, Figure 29 |
| Large-Signal Step Response | Figure 30, Figure 31 |
| Large-Signal Settling Time (10V Positive Step) | Figure 32 |
| Large-Signal Settling Time (10V Negative Step) | Figure 33 |
| Short-Circuit Current vs Temperature | Figure 34 |
| Maximum Output Voltage vs Frequency | Figure 35 |
| Channel Separation vs Frequency | Figure 36 |


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## TYPICAL CHARACTERISTICS

$V_S$ = ±18V, $V_{CM}$ = $V_S$/2, $R_{LOAD}$ = 10kΩ connected to $V_S$/2, and $C_L$ = 100pF, unless otherwise noted.

**OFFSET VOLTAGE PRODUCTION DISTRIBUTION**

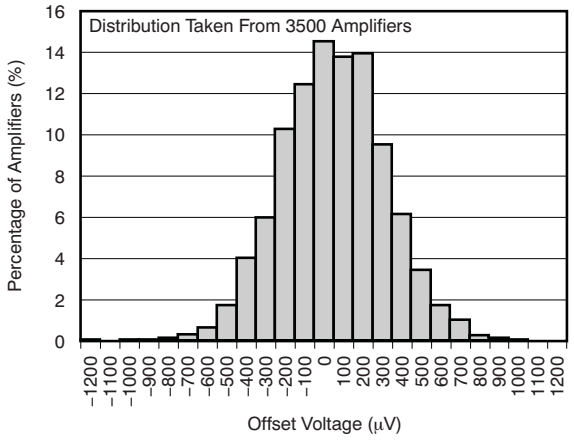



**Figure 1.**

**OFFSET VOLTAGE DRIFT DISTRIBUTION**

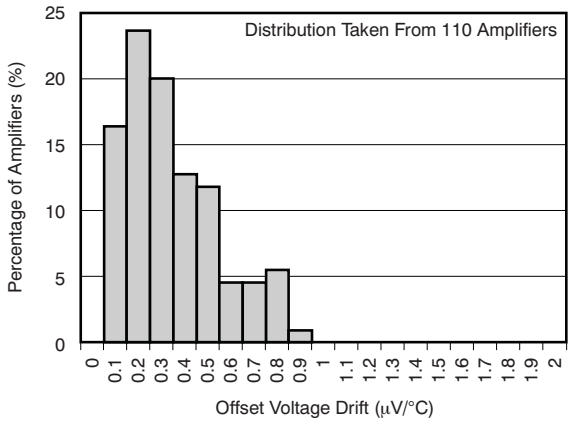



**Figure 2.**

**OFFSET VOLTAGE vs TEMPERATURE**

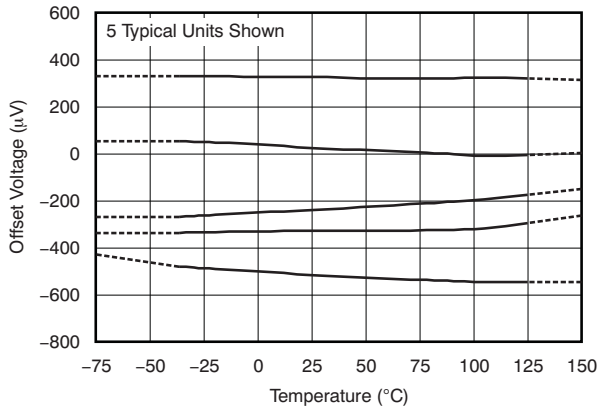



**Figure 3.**

**OFFSET VOLTAGE vs COMMON-MODE VOLTAGE**

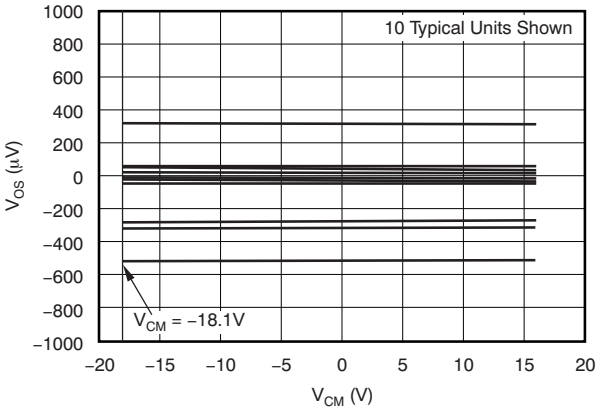



**Figure 4.**

**OFFSET VOLTAGE vs COMMON-MODE VOLTAGE (Upper Stage)**

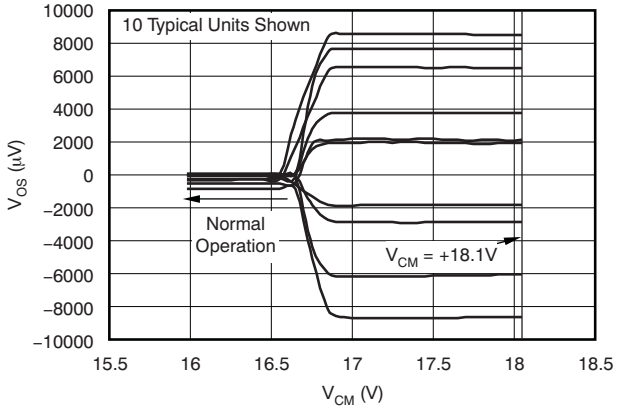



**Figure 5.**

**OFFSET VOLTAGE vs POWER SUPPLY**

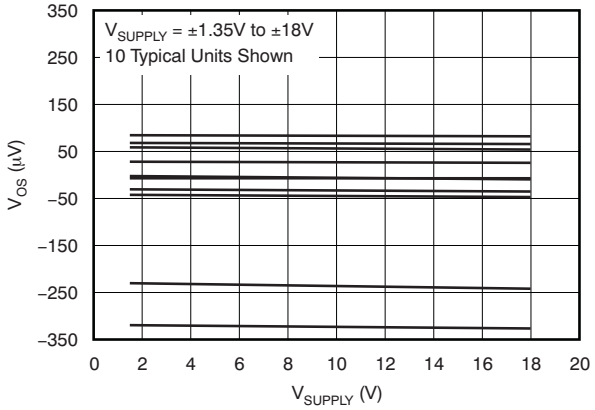



**Figure 6.**

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## TYPICAL CHARACTERISTICS (continued)

$V_S$ = ±18V, $V_{CM}$ = $V_S$/2, $R_{LOAD}$ = 10kΩ connected to $V_S$/2, and $C_L$ = 100pF, unless otherwise noted.

**$I_B$ AND $I_{OS}$ vs COMMON-MODE VOLTAGE**

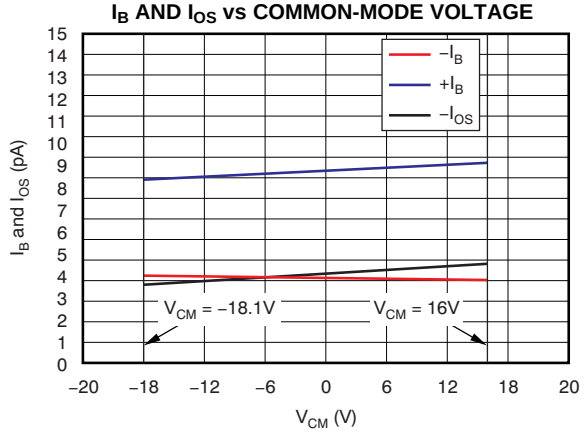



**Figure 7.**

**INPUT BIAS CURRENT vs TEMPERATURE**

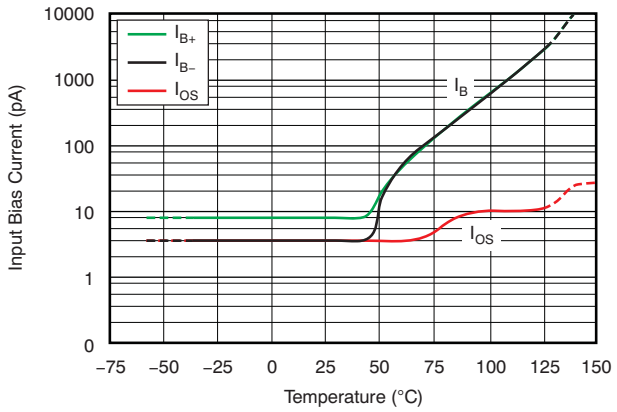



**Figure 8.**

**OUTPUT VOLTAGE SWING vs OUTPUT CURRENT (Maximum Supply)**

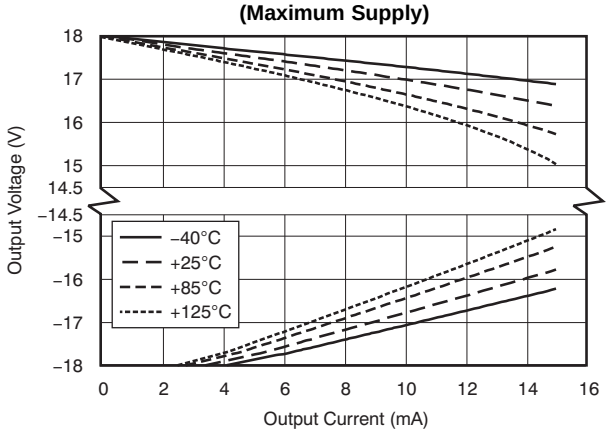



**Figure 9.**

**CMRR AND PSRR vs FREQUENCY (Referred-to Input)**

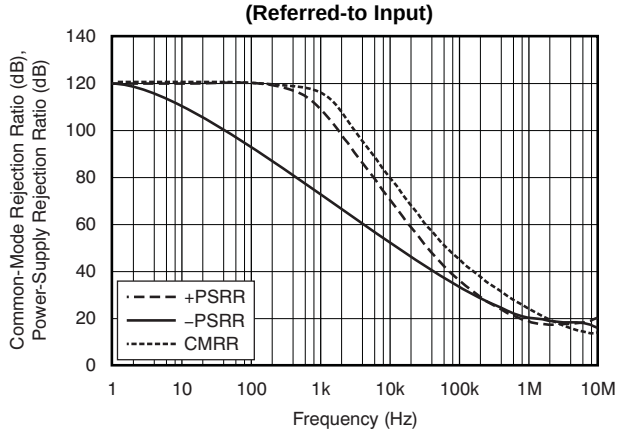



**Figure 10.**

**CMRR vs TEMPERATURE**

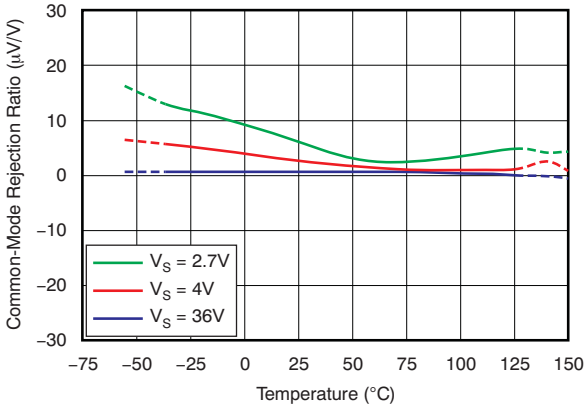



**Figure 11.**

**PSRR vs TEMPERATURE**

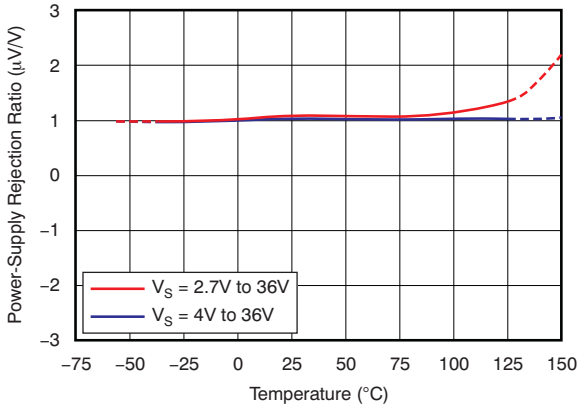



**Figure 12.**


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## TYPICAL CHARACTERISTICS (continued)

$V_S$ = ±18V, $V_{CM}$ = $V_S$/2, $R_{LOAD}$ = 10kΩ connected to $V_S$/2, and $C_L$ = 100pF, unless otherwise noted.

**0.1Hz TO 10Hz NOISE**

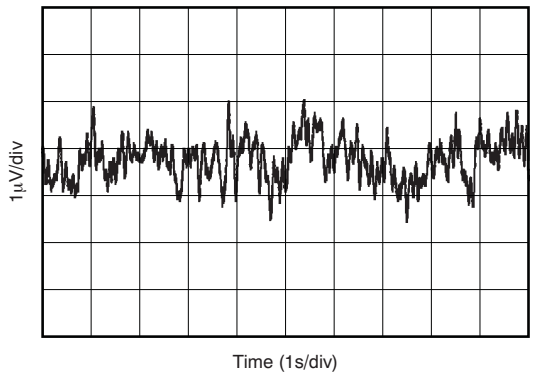



**Figure 13.**

**INPUT VOLTAGE NOISE SPECTRAL DENSITY vs FREQUENCY**

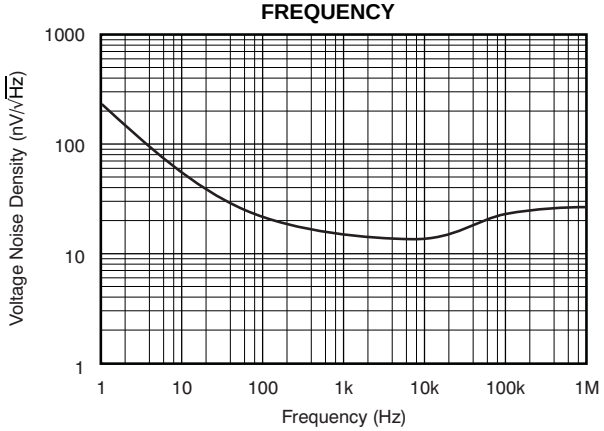



**Figure 14.**

**THD+N RATIO vs FREQUENCY**

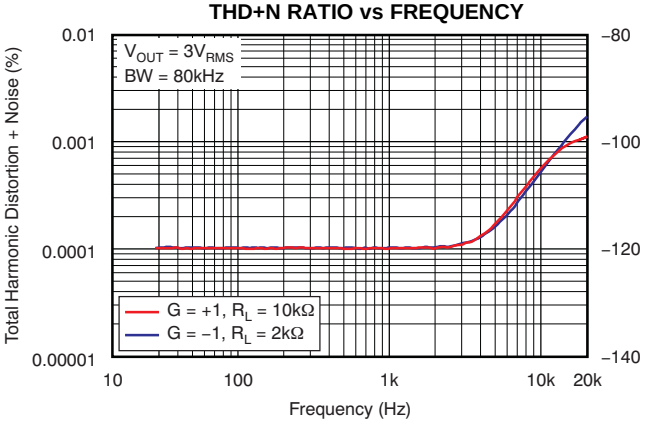



**Figure 15.**

**THD+N vs OUTPUT AMPLITUDE**

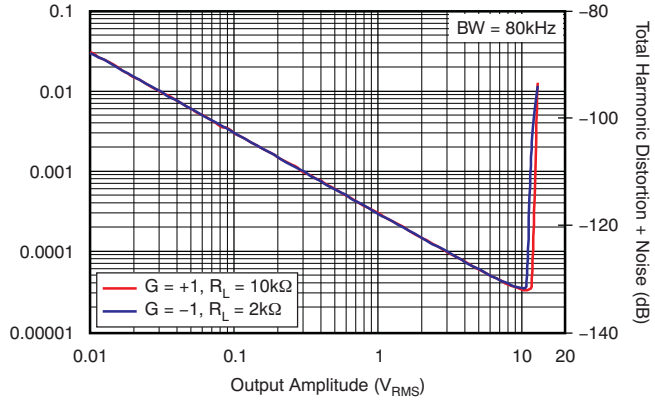



**Figure 16.**

**QUIESCENT CURRENT vs TEMPERATURE**

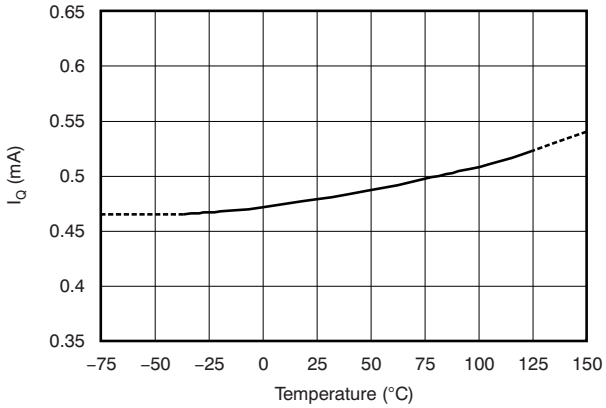



**Figure 17.**

**QUIESCENT CURRENT vs SUPPLY VOLTAGE**

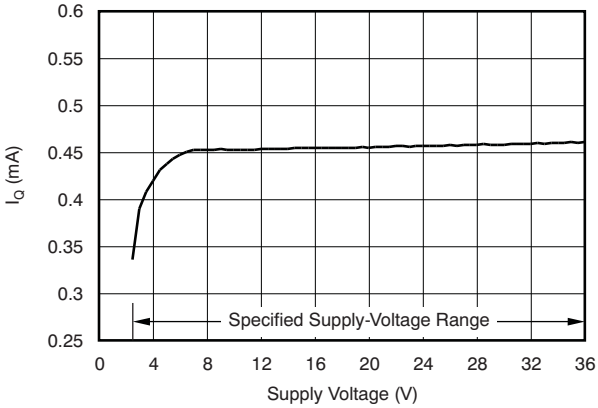



**Figure 18.**

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## TYPICAL CHARACTERISTICS (continued)

$V_S$ = ±18V, $V_{CM}$ = $V_S$/2, $R_{LOAD}$ = 10kΩ connected to $V_S$/2, and $C_L$ = 100pF, unless otherwise noted.

**OPEN-LOOP GAIN AND PHASE vs FREQUENCY**

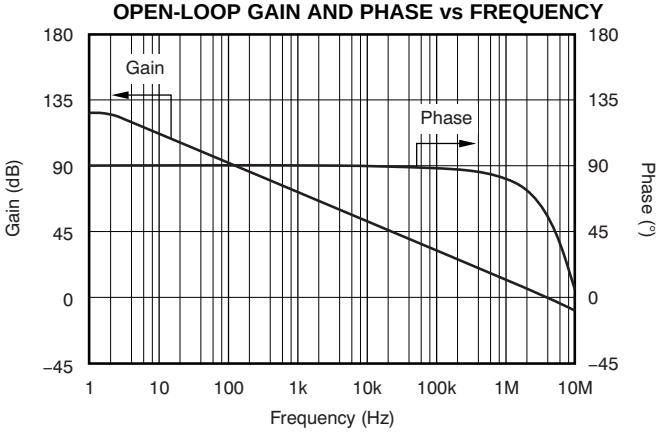



**Figure 19.**

**CLOSED-LOOP GAIN vs FREQUENCY**

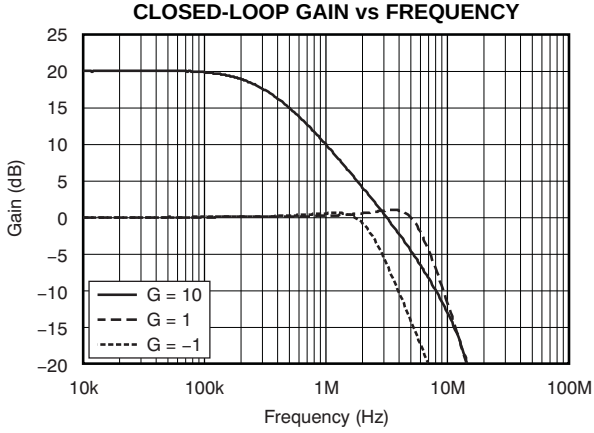



**Figure 20.**

**OPEN-LOOP GAIN vs TEMPERATURE**

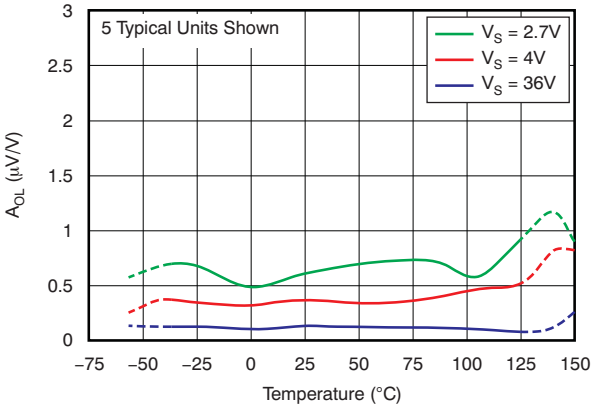



**Figure 21.**

**OPEN-LOOP OUTPUT IMPEDANCE vs FREQUENCY**

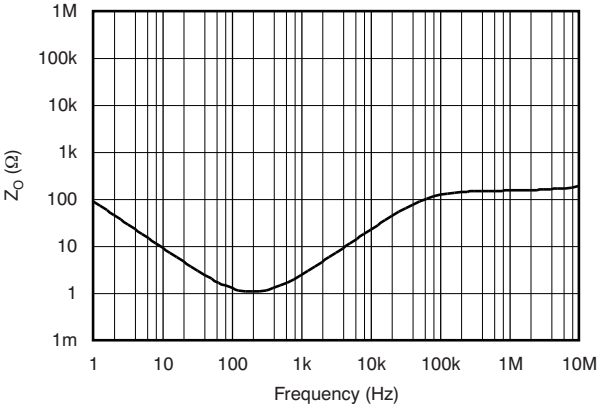



**Figure 22.**

**SMALL-SIGNAL OVERSHOOT vs CAPACITIVE LOAD (100mV Output Step)**

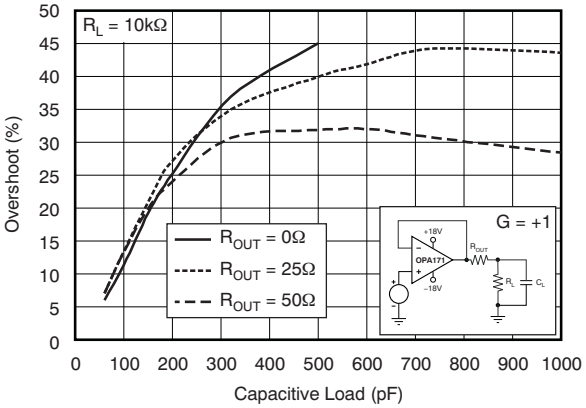



**Figure 23.**

**SMALL-SIGNAL OVERSHOOT vs CAPACITIVE LOAD (100mV Output Step)**

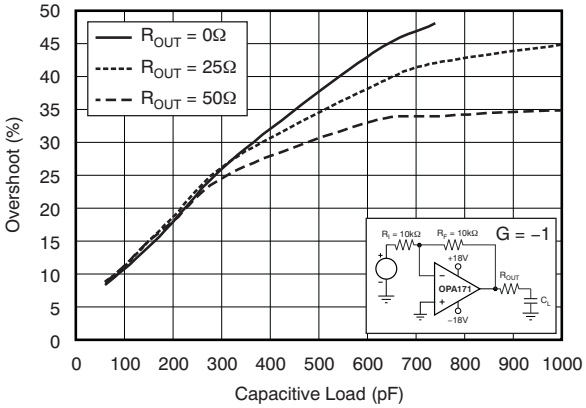



**Figure 24.**


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## TYPICAL CHARACTERISTICS (continued)

$V_S$ = ±18V, $V_{CM}$ = $V_S$/2, $R_{LOAD}$ = 10kΩ connected to $V_S$/2, and $C_L$ = 100pF, unless otherwise noted.

**NO PHASE REVERSAL**

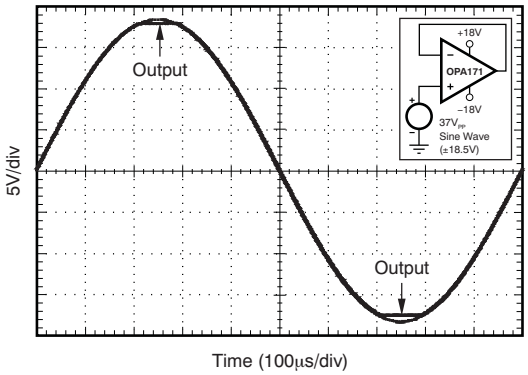



**Figure 25.**

**POSITIVE OVERLOAD RECOVERY**

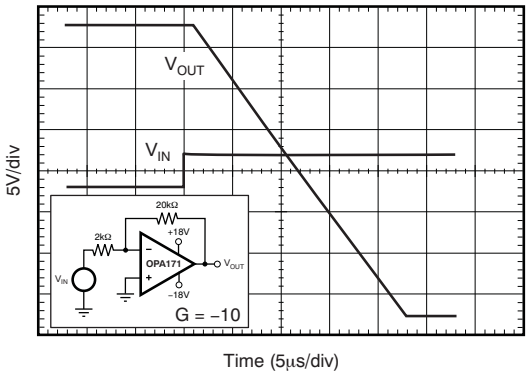



**Figure 26.**

**NEGATIVE OVERLOAD RECOVERY**

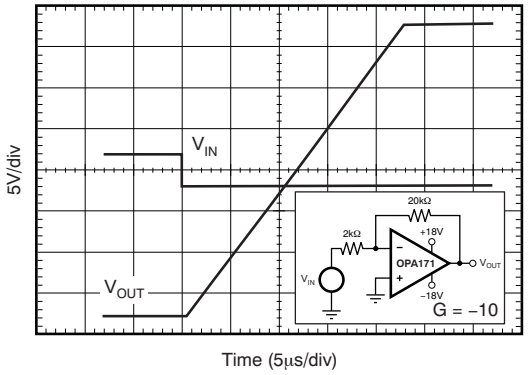



**Figure 27.**

**SMALL-SIGNAL STEP RESPONSE (100mV)**

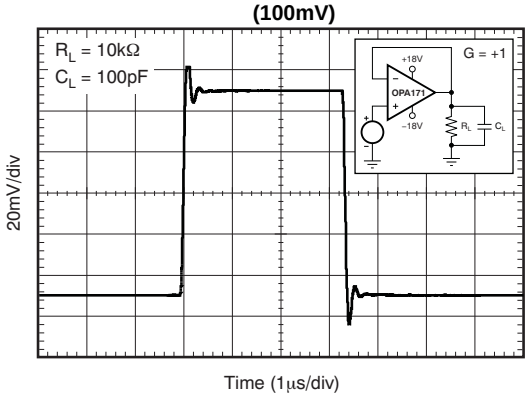



**Figure 28.**

**SMALL-SIGNAL STEP RESPONSE (100mV)**

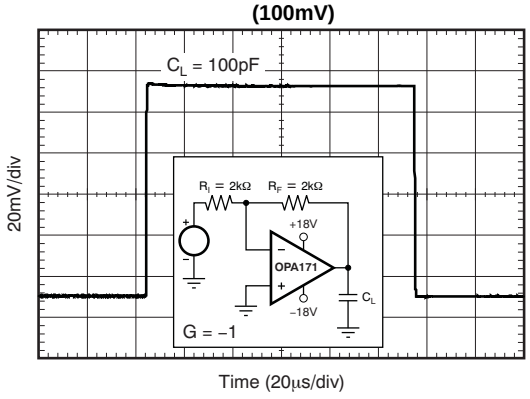



**Figure 29.**

**LARGE-SIGNAL STEP RESPONSE**

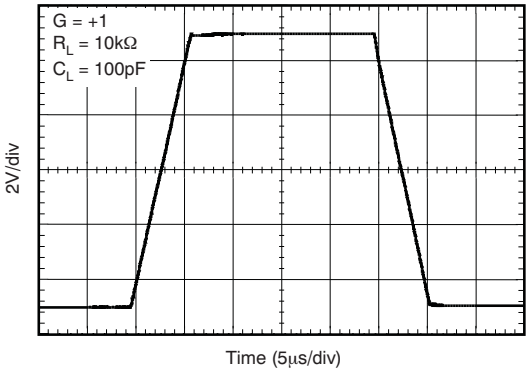



**Figure 30.**

## TYPICAL CHARACTERISTICS (continued)

$V_S$ = ±18V, $V_{CM}$ = $V_S$/2, $R_{LOAD}$ = 10kΩ connected to $V_S$/2, and $C_L$ = 100pF, unless otherwise noted.

**LARGE-SIGNAL STEP RESPONSE**

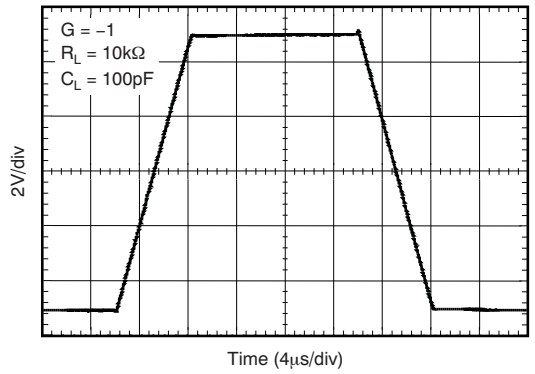



**Figure 31.**

**LARGE-SIGNAL SETTLING TIME (10V Positive Step)**

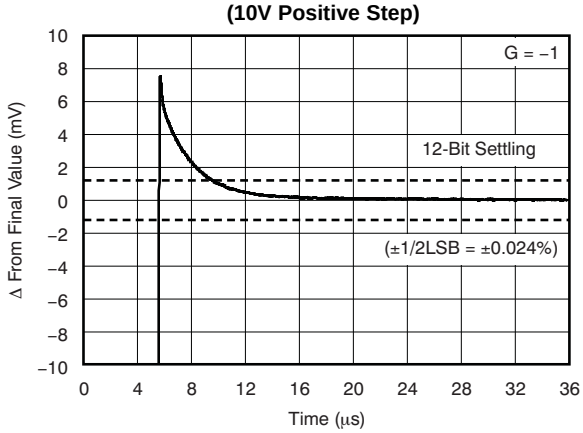



**Figure 32.**

**LARGE-SIGNAL SETTLING TIME (10V Negative Step)**

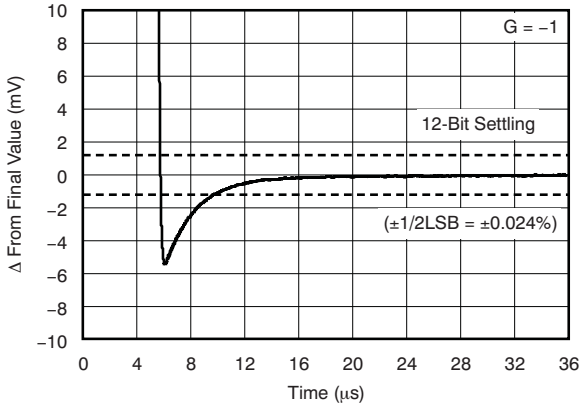



**Figure 33.**

**SHORT-CIRCUIT CURRENT vs TEMPERATURE**

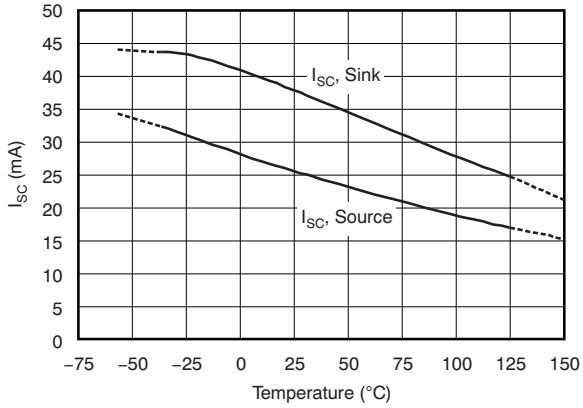



**Figure 34.**

**MAXIMUM OUTPUT VOLTAGE vs FREQUENCY**

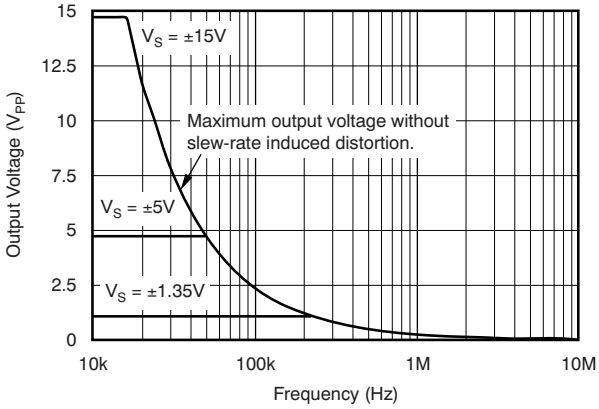



**Figure 35.**

**CHANNEL SEPARATION vs FREQUENCY**

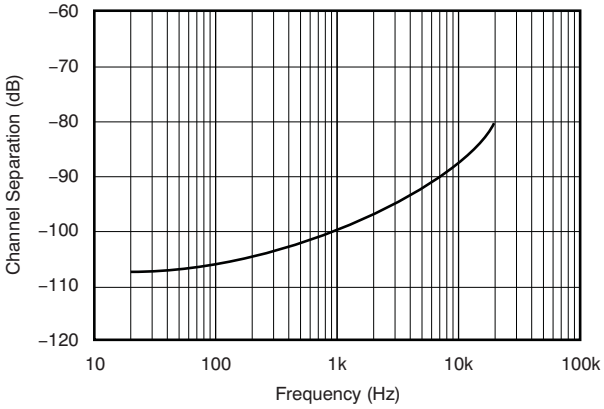



**Figure 36.**


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## APPLICATION INFORMATION

The OPAx171 family of operational amplifiers provide high overall performance, making them ideal for many general-purpose applications. The excellent offset drift of only 2µV/°C provides excellent stability over the entire temperature range. In addition, the device offers very good overall performance with high CMRR, PSRR, and $A_{OL}$. As with all amplifiers, applications with noisy or high-impedance power supplies require decoupling capacitors close to the device pins. In most cases, 0.1µF capacitors are adequate.

### OPERATING CHARACTERISTICS

The OPAx171 family of amplifiers is specified for operation from 2.7V to 36V (±1.35V to ±18V). Many of the specifications apply from –40°C to +125°C. Parameters that can exhibit significant variance with regard to operating voltage or temperature are presented in the Typical Characteristics.

### GENERAL LAYOUT GUIDELINES

For best operational performance of the device, good printed circuit board (PCB) layout practices are recommended. Low-loss, 0.1µF bypass capacitors should be connected between each supply pin and ground, placed as close to the device as possible. A single bypass capacitor from V+ to ground is applicable to single-supply applications.

### COMMON-MODE VOLTAGE RANGE

The input common-mode voltage range of the OPAx171 series extends 100mV below the negative rail and within 2V of the top rail for normal operation. This device can operate with full rail-to-rail input 100mV beyond the top rail, but with reduced performance within 2V of the top rail. The typical performance in this range is summarized in Table 2.

### PHASE-REVERSAL PROTECTION

The OPAx171 family has an internal phase-reversal protection. Many op amps exhibit a phase reversal when the input is driven beyond its linear common-mode range. This condition is most often encountered in noninverting circuits when the input is driven beyond the specified common-mode voltage range, causing the output to reverse into the opposite rail. The input of the OPAx171 prevents phase reversal with excessive common-mode voltage. Instead, the output limits into the appropriate rail. This performance is shown in Figure 37.

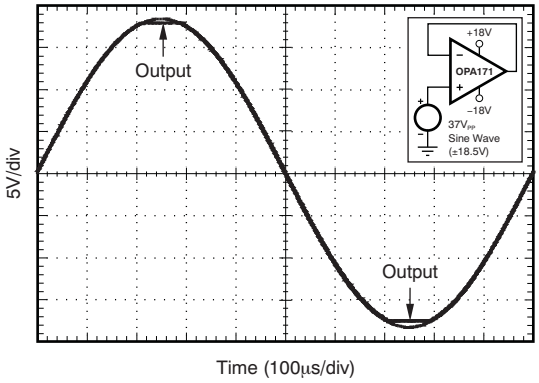



**Figure 37. No Phase Reversal**

**Table 2. Typical Performance Range**

| PARAMETER | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|
| **Input Common-Mode Voltage** | **(V+) – 2** | | **(V+) + 0.1** | **V** |
| Offset voltage | | 7 | | mV |
| **vs Temperature** | | **12** | | **µV/°C** |
| Common-mode rejection | | 65 | | dB |
| Open-loop gain | | 60 | | dB |
| GBW | | 0.7 | | MHz |
| Slew rate | | 0.7 | | V/µs |
| Noise at f = 1kHz | | 30 | | nV/√Hz |

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## CAPACITIVE LOAD AND STABILITY

The dynamic characteristics of the OPAx171 have been optimized for commonly encountered operating conditions. The combination of low closed-loop gain and high capacitive loads decreases the phase margin of the amplifier and can lead to gain peaking or oscillations. As a result, heavier capacitive loads must be isolated from the output. The simplest way to achieve this isolation is to add a small resistor (for example, $R_{OUT}$ equal to 50Ω) in series with the output. Figure 38 and Figure 39 illustrate graphs of small-signal overshoot versus capacitive load for several values of $R_{OUT}$. Also, refer to Applications Bulletin AB-028 (*SBOA015*), available for download from the TI website for details of analysis techniques and application circuits.

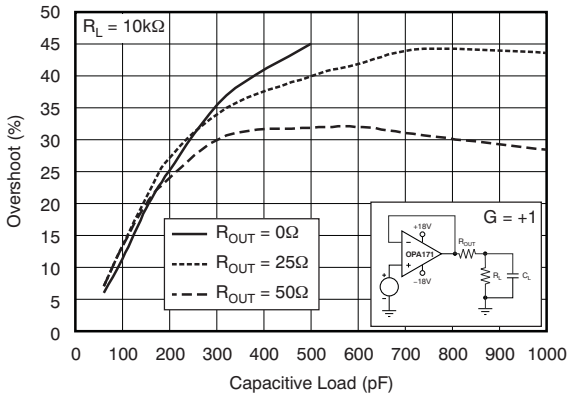



**Figure 38. Small-Signal Overshoot versus Capacitive Load (100mV Output Step)**

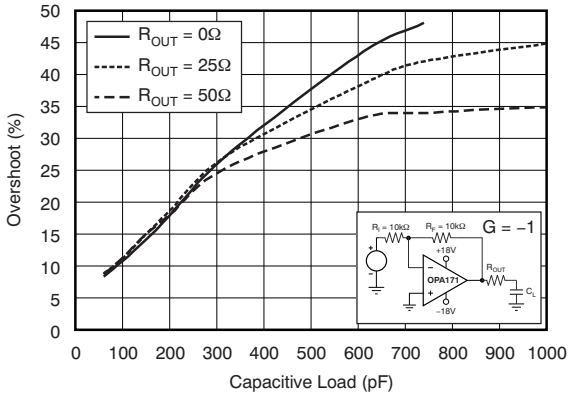



**Figure 39. Small-Signal Overshoot versus Capacitive Load (100mV Output Step)**

## ELECTRICAL OVERSTRESS

Designers often ask questions about the capability of an operational amplifier to withstand electrical overstress. These questions tend to focus on the device inputs, but may involve the supply voltage pins or even the output pin. Each of these different pin functions have electrical stress limits determined by the voltage breakdown characteristics of the particular semiconductor fabrication process and specific circuits connected to the pin. Additionally, internal electrostatic discharge (ESD) protection is built into these circuits to protect them from accidental ESD events both before and during product assembly.

These ESD protection diodes also provide in-circuit, input overdrive protection, as long as the current is limited to 10mA as stated in the Absolute Maximum Ratings. Figure 40 shows how a series input resistor may be added to the driven input to limit the input current. The added resistor contributes thermal noise at the amplifier input and its value should be kept to a minimum in noise-sensitive applications.

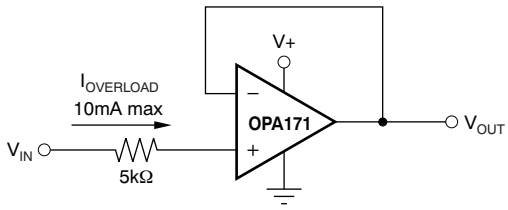



**Figure 40. Input Current Protection**

An ESD event produces a short duration, high-voltage pulse that is transformed into a short duration, high-current pulse as it discharges through a semiconductor device. The ESD protection circuits are designed to provide a current path around the operational amplifier core to prevent it from being damaged. The energy absorbed by the protection circuitry is then dissipated as heat.

When the operational amplifier connects into a circuit, the ESD protection components are intended to remain inactive and not become involved in the application circuit operation. However, circumstances may arise where an applied voltage exceeds the operating voltage range of a given pin. Should this condition occur, there is a risk that some of the internal ESD protection circuits may be biased on, and conduct current. Any such current flow occurs through ESD cells and rarely involves the absorption device.

If there is an uncertainty about the ability of the supply to absorb this current, external zener diodes may be added to the supply pins. The zener voltage must be selected such that the diode does not turn on during normal operation.

However, its zener voltage should be low enough so that the zener diode conducts if the supply pin begins to rise above the safe operating supply voltage level.


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## REVISION HISTORY

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

**Changes from Revision C (June 2011) to Revision D** **Page**

- Added "Value Line Series" to title ..... 1

**Changes from Revision B (November 2010) to Revision C** **Page**

- Added MSOP-8 package to device graphic ..... 1
- Added MSOP-8 package to Features bullets ..... 1
- Added MSOP-8 package to Product Family table ..... 1
- Added MSOP-8 package to Package/Ordering Information table ..... 2
- Deleted "A" suffix from OPA4171 package markings in Package/Ordering Information table. ..... 2
- Added new row for Voltage Output Swing from Rail parameter to *Output* subsection of Electrical Characteristics ..... 3
- Changed Voltage Output Swing from Rail parameter to over temperature in *Output* subsection of Electrical Characteristics ..... 3
- Updated format of thermal information tables ..... 4
- Added MSOP-8 package to OPA2171 Thermal Information table ..... 4
- Updated pinout configurations for OPA2171 and OPA4171 ..... 5
- Changed Figure 9 ..... 8

**Changes from Revision A (November, 2010) to Revision B** **Page**

- Changed input offset voltage specification ..... 3
- Changed input offset voltage, over temperature specification ..... 3
- Changed quiescent current per amplifier, over temperature specification ..... 3

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## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| OPA171AID | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | O171A | Samples |
| OPA171AIDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | OSUI | Samples |
| OPA171AIDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | OSUI | Samples |
| OPA171AIDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | O171A | Samples |
| OPA171AIDRLR | ACTIVE | SOT | DRL | 5 | 4000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | DAP | Samples |
| OPA171AIDRLT | ACTIVE | SOT | DRL | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | DAP | Samples |
| OPA2171AID | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | 2171A | Samples |
| OPA2171AIDCUR | ACTIVE | US8 | DCU | 8 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | OPOC | Samples |
| OPA2171AIDCUT | ACTIVE | US8 | DCU | 8 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | OPOC | Samples |
| OPA2171AIDGK | ACTIVE | VSSOP | DGK | 8 | 80 | Green (RoHS & no Sb/Br) | CU NIPDAU \| CU NIPDAUAG | Level-2-260C-1 YEAR | -40 to 125 | OPMI | Samples |
| OPA2171AIDGKR | ACTIVE | VSSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU \| CU NIPDAUAG | Level-2-260C-1 YEAR | -40 to 125 | OPMI | Samples |
| OPA2171AIDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | 2171A | Samples |
| OPA4171AID | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 125 | OPA4171 | Samples |
| OPA4171AIDR | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 125 | OPA4171 | Samples |
| OPA4171AIPW | ACTIVE | TSSOP | PW | 14 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | OPA4171 | Samples |
| OPA4171AIPWR | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | OPA4171 | Samples |

(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.

(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/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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**OTHER QUALIFIED VERSIONS OF OPA171 :**

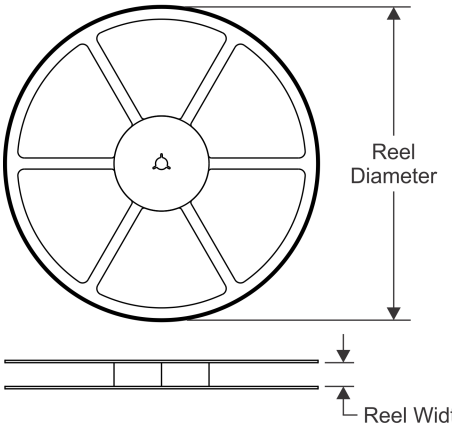
- Automotive: OPA171-Q1

NOTE: Qualified Version Definitions:

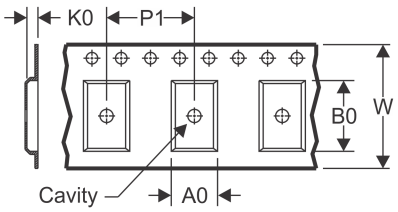
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

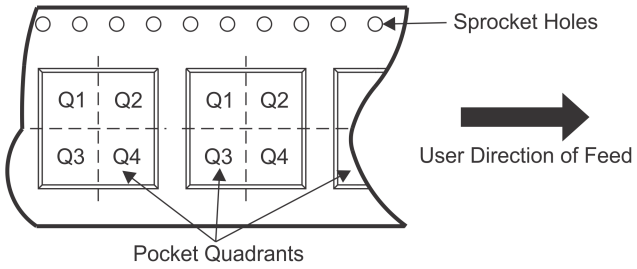



**TAPE DIMENSIONS**




| | |
|---|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

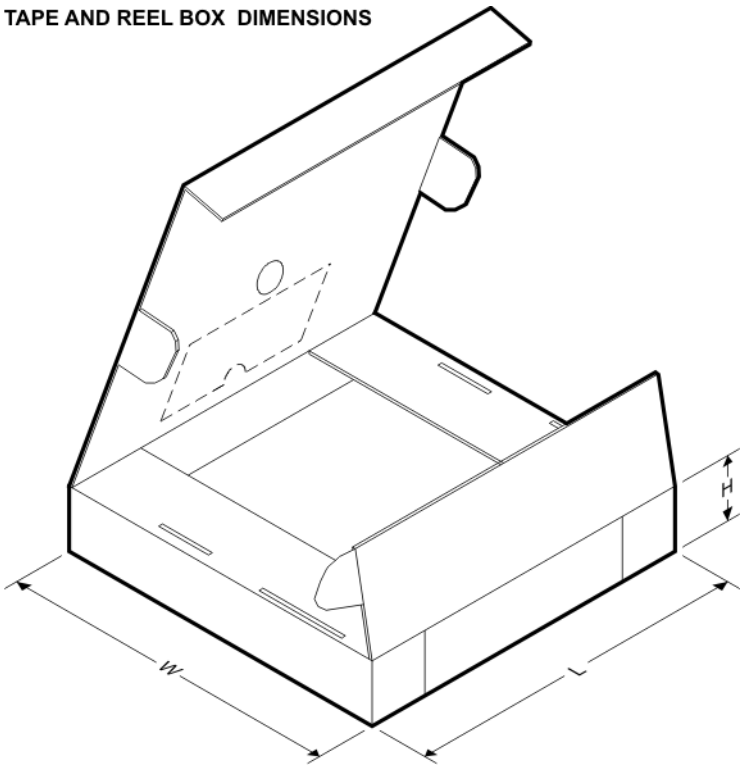
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPA171AIDBVR | SOT-23 | DBV | 5 | 3000 | 179.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| OPA171AIDBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 8.4 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| OPA171AIDBVT | SOT-23 | DBV | 5 | 250 | 180.0 | 8.4 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| OPA171AIDBVT | SOT-23 | DBV | 5 | 250 | 179.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| OPA171AIDRLR | SOT | DRL | 5 | 4000 | 180.0 | 8.4 | 1.98 | 1.78 | 0.69 | 4.0 | 8.0 | Q3 |
| OPA171AIDRLT | SOT | DRL | 5 | 250 | 180.0 | 8.4 | 1.98 | 1.78 | 0.69 | 4.0 | 8.0 | Q3 |
| OPA2171AIDCUR | US8 | DCU | 8 | 3000 | 180.0 | 8.4 | 2.25 | 3.35 | 1.05 | 4.0 | 8.0 | Q3 |
| OPA2171AIDCUT | US8 | DCU | 8 | 250 | 180.0 | 8.4 | 2.25 | 3.35 | 1.05 | 4.0 | 8.0 | Q3 |
| OPA2171AIDGKR | VSSOP | DGK | 8 | 2500 | 330.0 | 12.4 | 5.3 | 3.4 | 1.4 | 8.0 | 12.0 | Q1 |
| OPA2171AIDGKR | VSSOP | DGK | 8 | 2500 | 330.0 | 12.4 | 5.3 | 3.4 | 1.4 | 8.0 | 12.0 | Q1 |
| OPA2171AIDR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| OPA4171AIPWR | TSSOP | PW | 14 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |

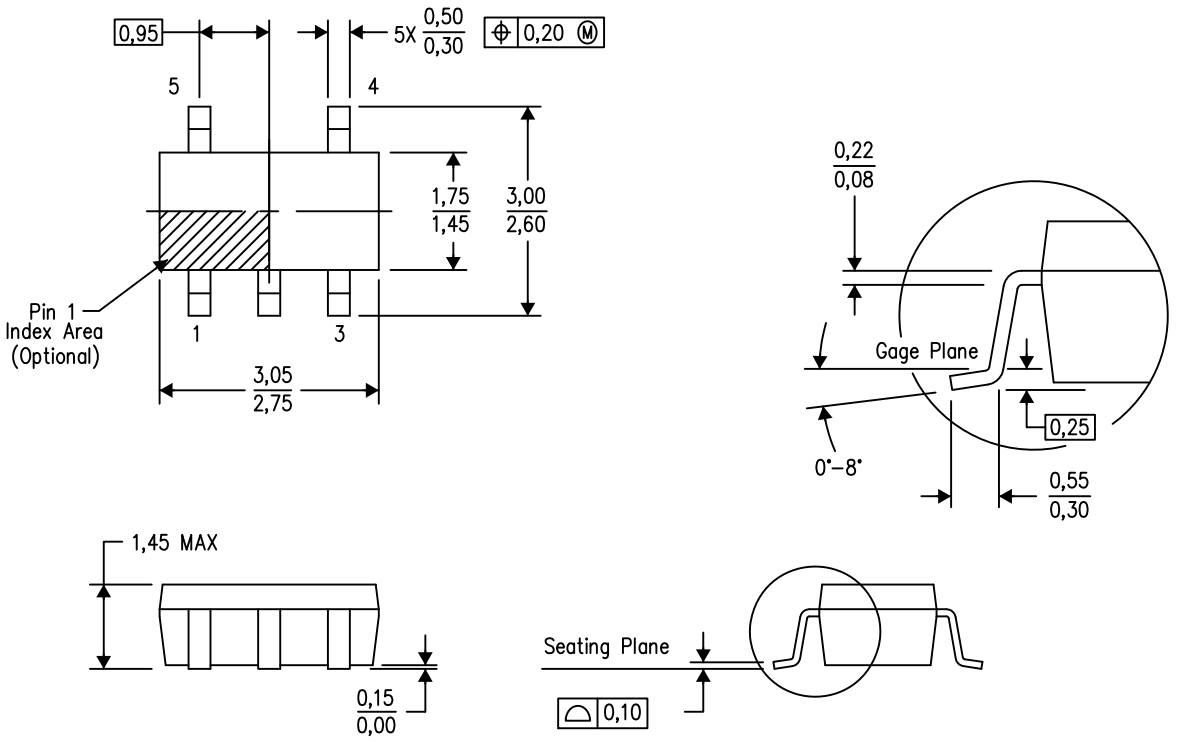
**TAPE AND REEL BOX DIMENSIONS**




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| OPA171AIDBVR | SOT-23 | DBV | 5 | 3000 | 195.0 | 200.0 | 45.0 |
| OPA171AIDBVR | SOT-23 | DBV | 5 | 3000 | 202.0 | 201.0 | 28.0 |
| OPA171AIDBVT | SOT-23 | DBV | 5 | 250 | 202.0 | 201.0 | 28.0 |
| OPA171AIDBVT | SOT-23 | DBV | 5 | 250 | 195.0 | 200.0 | 45.0 |
| OPA171AIDRLR | SOT | DRL | 5 | 4000 | 202.0 | 201.0 | 28.0 |
| OPA171AIDRLT | SOT | DRL | 5 | 250 | 202.0 | 201.0 | 28.0 |
| OPA2171AIDCUR | US8 | DCU | 8 | 3000 | 202.0 | 201.0 | 28.0 |
| OPA2171AIDCUT | US8 | DCU | 8 | 250 | 202.0 | 201.0 | 28.0 |
| OPA2171AIDGKR | VSSOP | DGK | 8 | 2500 | 366.0 | 364.0 | 50.0 |
| OPA2171AIDGKR | VSSOP | DGK | 8 | 2500 | 358.0 | 335.0 | 35.0 |
| OPA2171AIDR | SOIC | D | 8 | 2500 | 367.0 | 367.0 | 35.0 |
| OPA4171AIPWR | TSSOP | PW | 14 | 2000 | 367.0 | 367.0 | 35.0 |

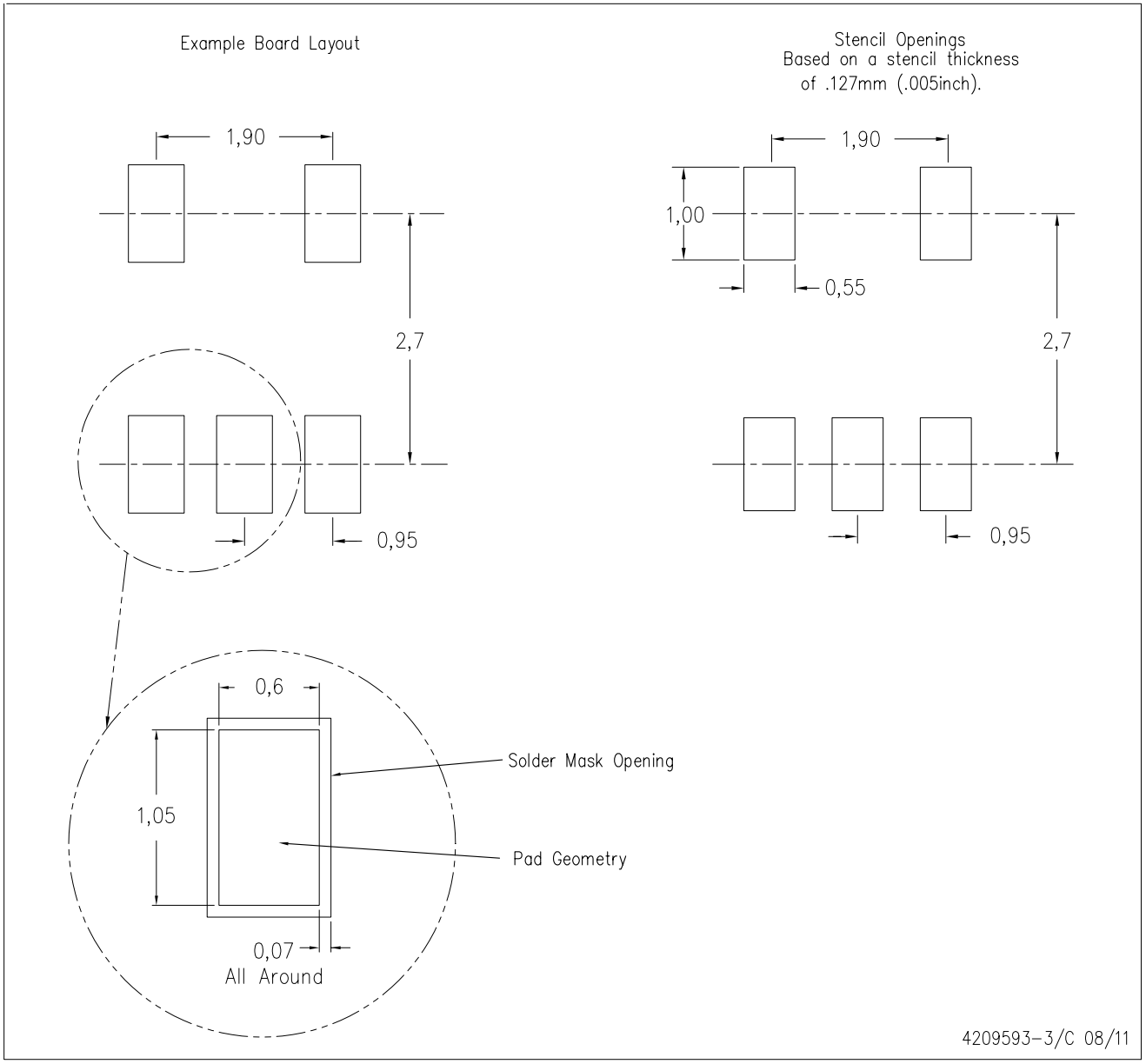
DBV (R–PDSO–G5) PLASTIC SMALL–OUTLINE PACKAGE




4073253–4/L 08/2013

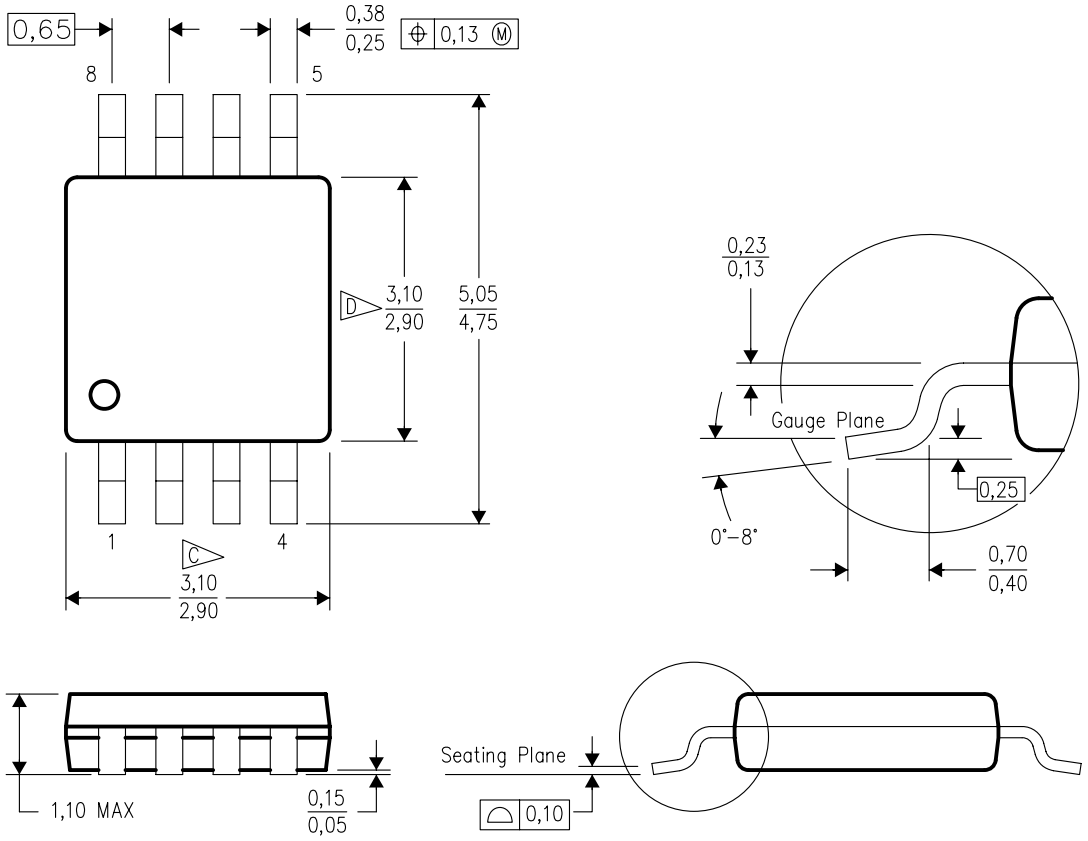
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
D. Falls within JEDEC MO–178 Variation AA.

DBV (R–PDSO–G5) PLASTIC SMALL OUTLINE




NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
D. Publication IPC–7351 is recommended for alternate designs.
E. 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. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC–7525 for other stencil recommendations.

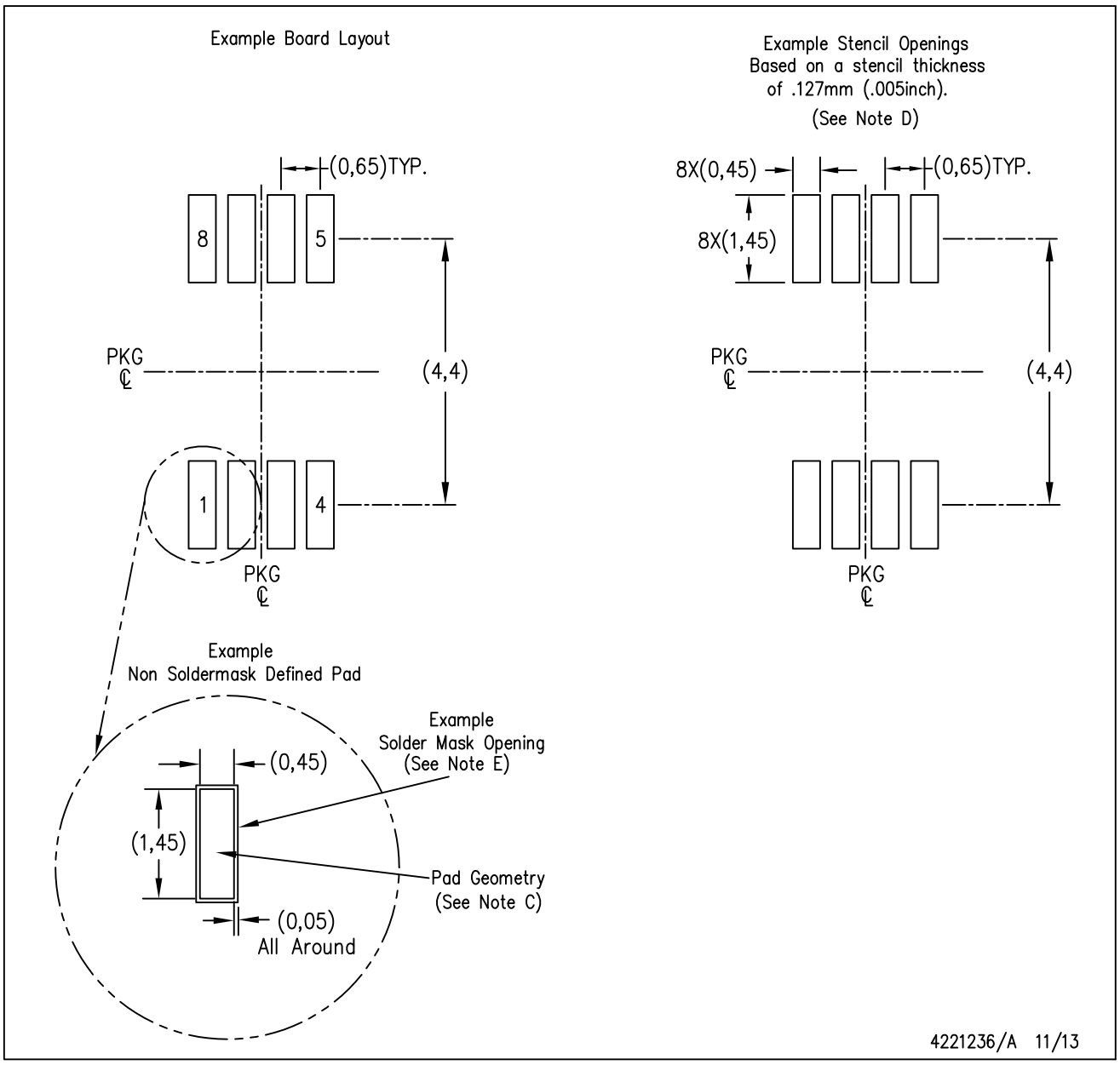
## DGK (S–PDSO–G8) PLASTIC SMALL–OUTLINE PACKAGE




4073329/E 05/06

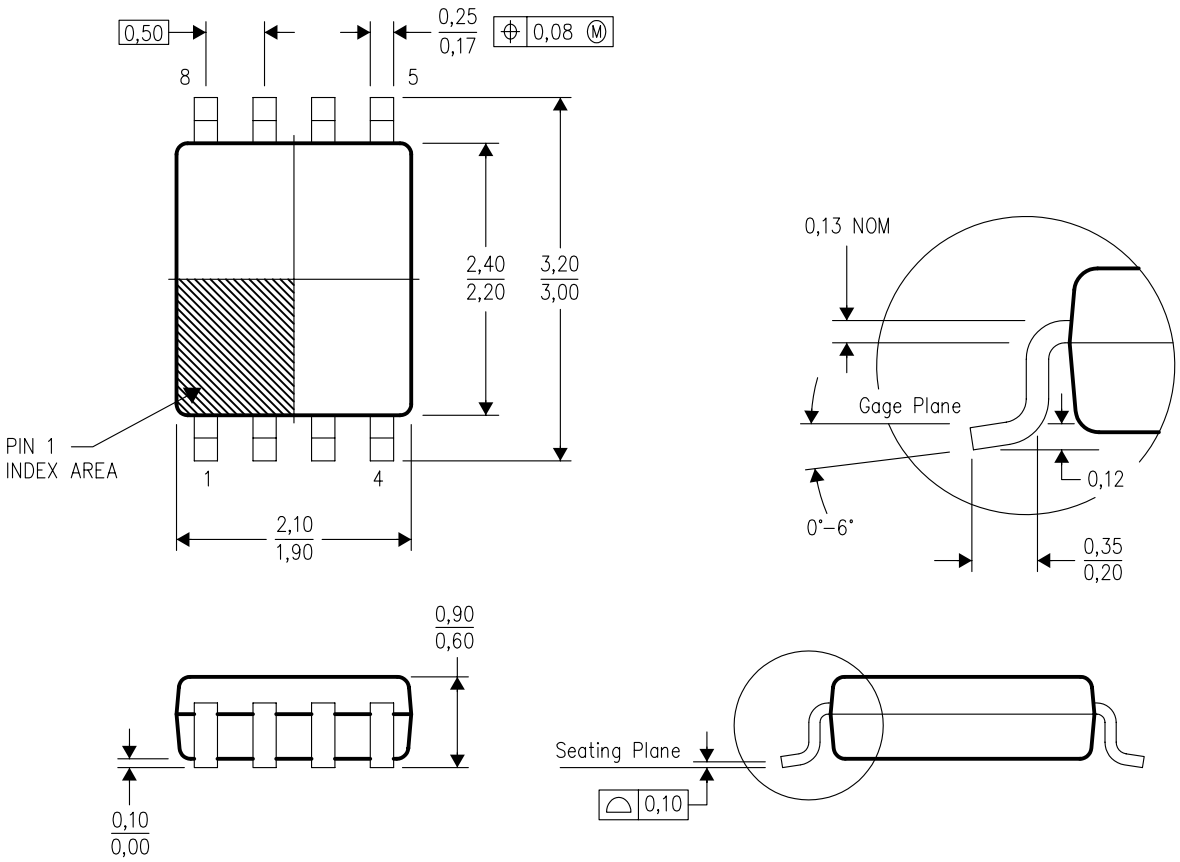
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 per end.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0.50 per side.
E. Falls within JEDEC MO–187 variation AA, except interlead flash.

# DGK (S–PDSO–G8) PLASTIC SMALL OUTLINE PACKAGE




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.

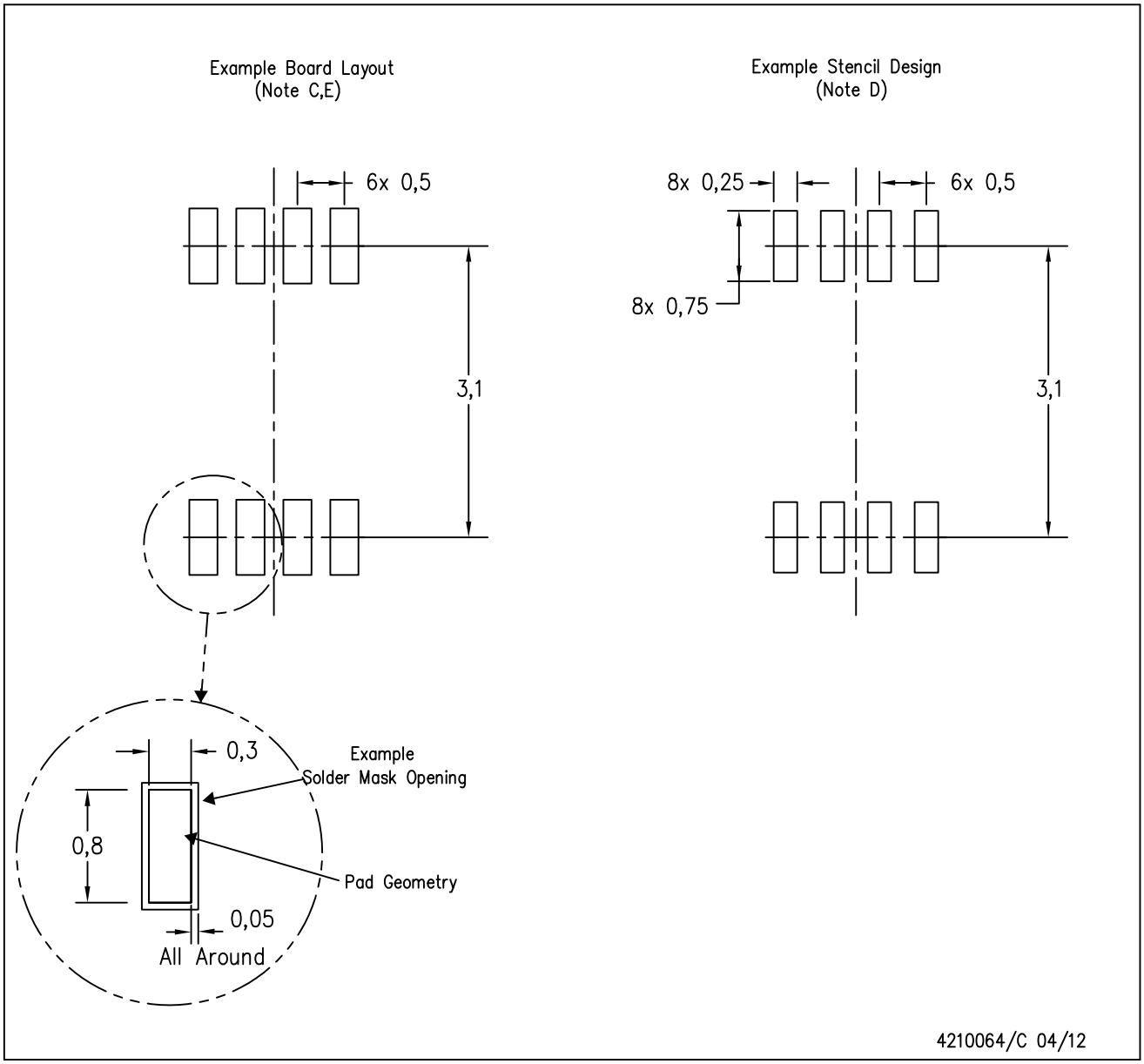
## DCU (R–PDSO–G8) PLASTIC SMALL–OUTLINE PACKAGE (DIE DOWN)



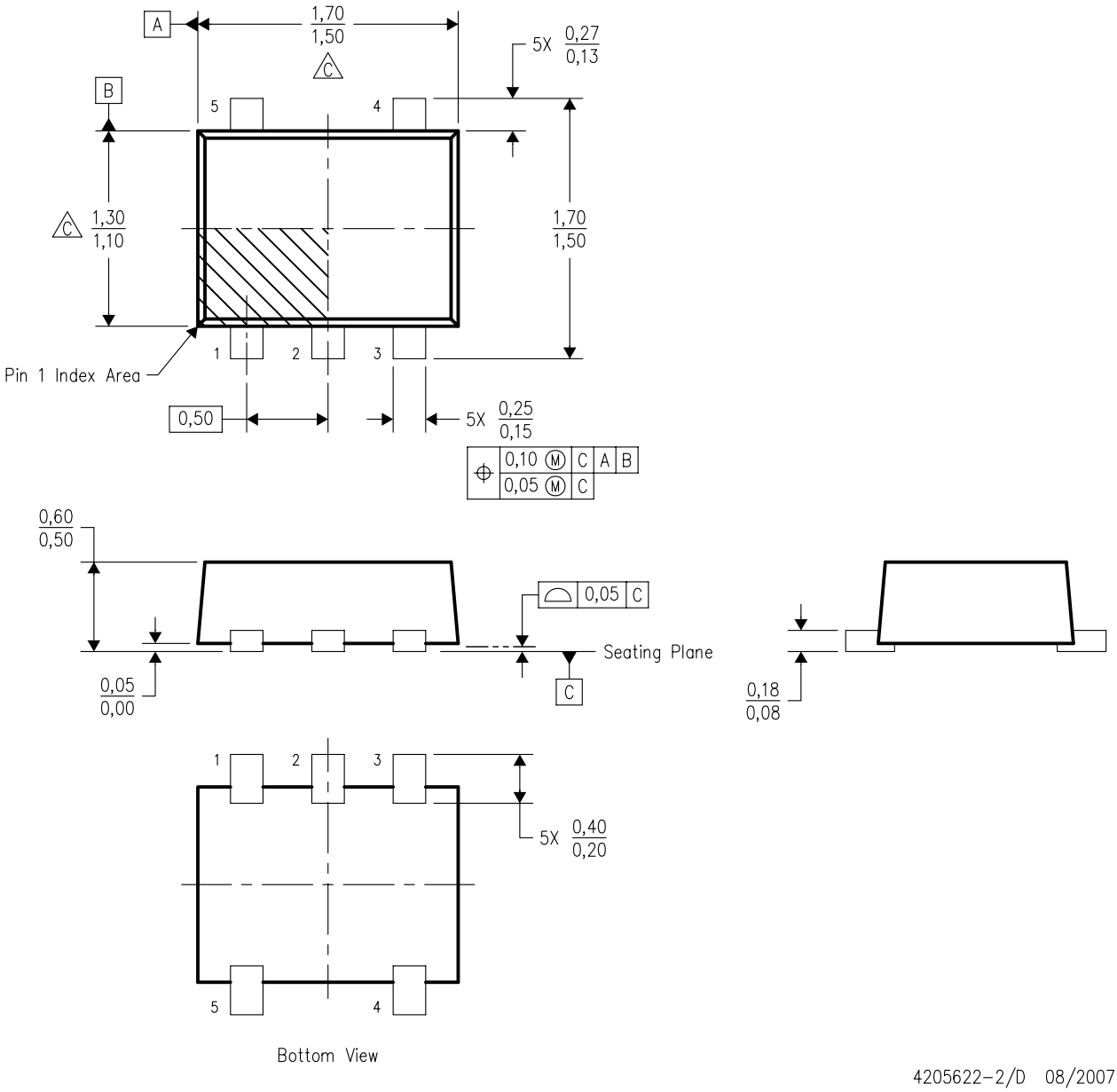

4200503/F 07/05

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. Mold flash and protrusion shall not exceed 0.15 per side.
D. Falls within JEDEC MO–187 variation CA.

DCU (S–PDSO–G8) PLASTIC SMALL OUTLINE PACKAGE (DIE DOWN)



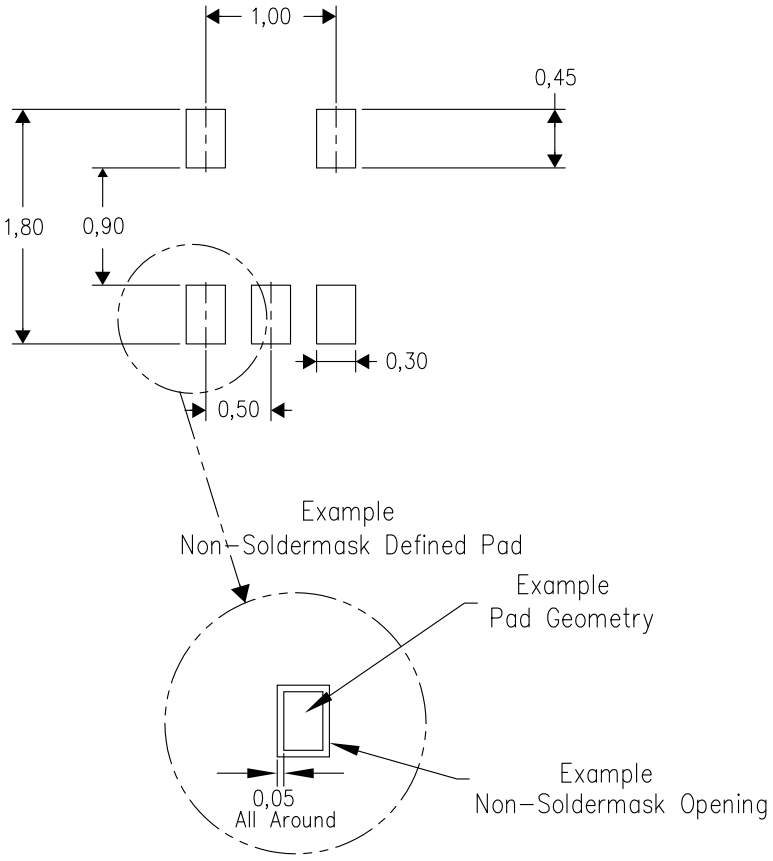

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact 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.



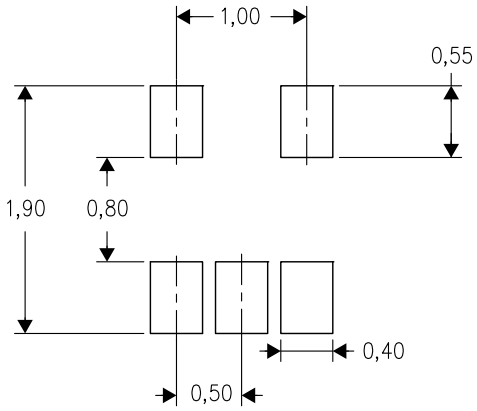

NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash, interlead flash, protrusions, or gate burrs. Mold flash, interlead flash, protrusions, or gate burrs shall not exceed 0,15 per end or side.
D. JEDEC package registration is pending.

DRL (R–PDSO–N5) PLASTIC SMALL OUTLINE

Example Board Layout



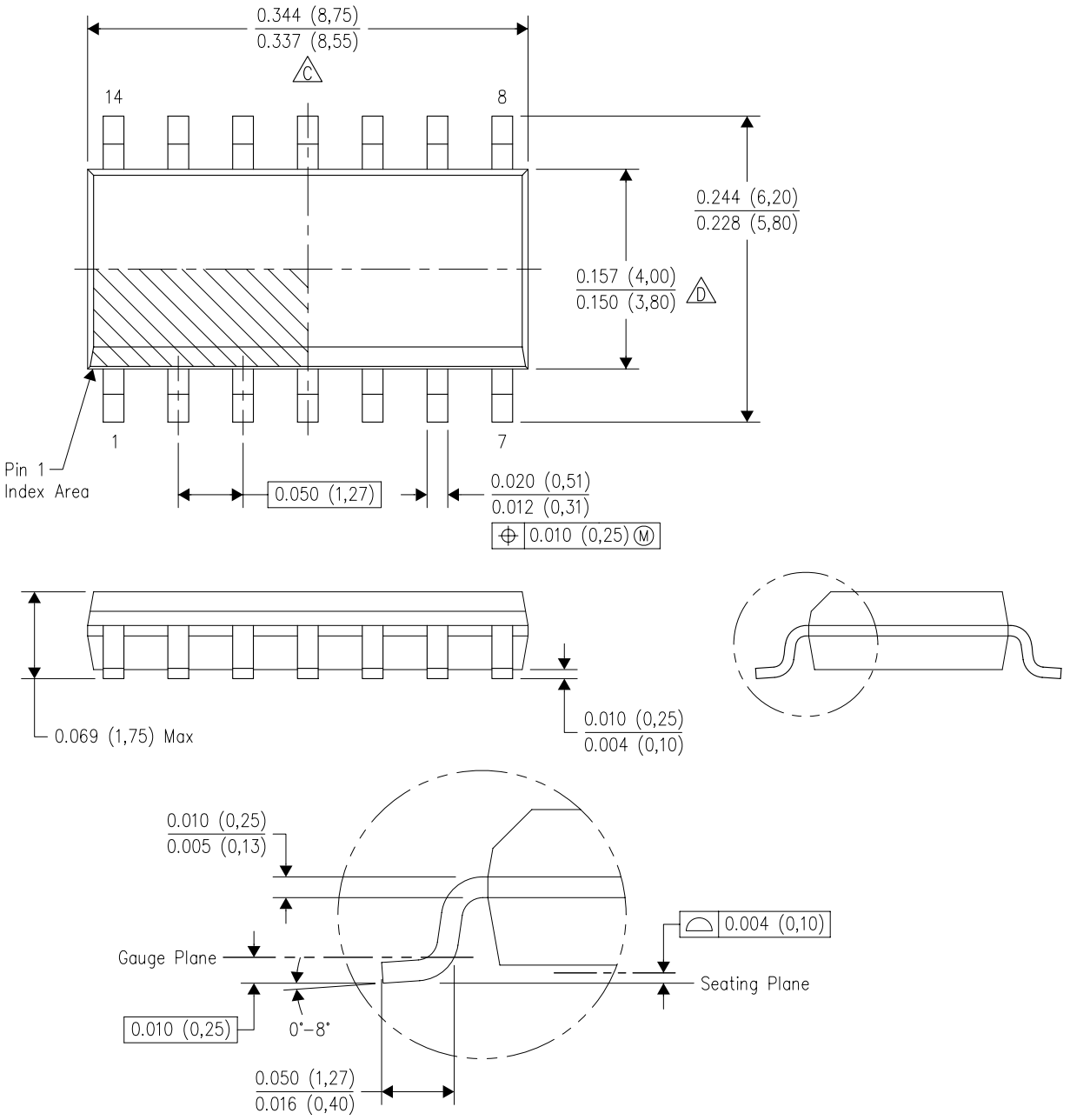

Example Stencil Design
(Note E)




4208207–2/E 06/12

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. Customers should contact their board fabrication site for minimum solder mask web tolerances between signal pads.
E. Maximum stencil thickness 0,127 mm (5 mils). All linear dimensions are in millimeters.
F. 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 stencil design considerations.
G. Side aperture dimensions over–print land for acceptable area ratio > 0.66. Customer may reduce side aperture dimensions if stencil manufacturing process allows for sufficient release at smaller opening.

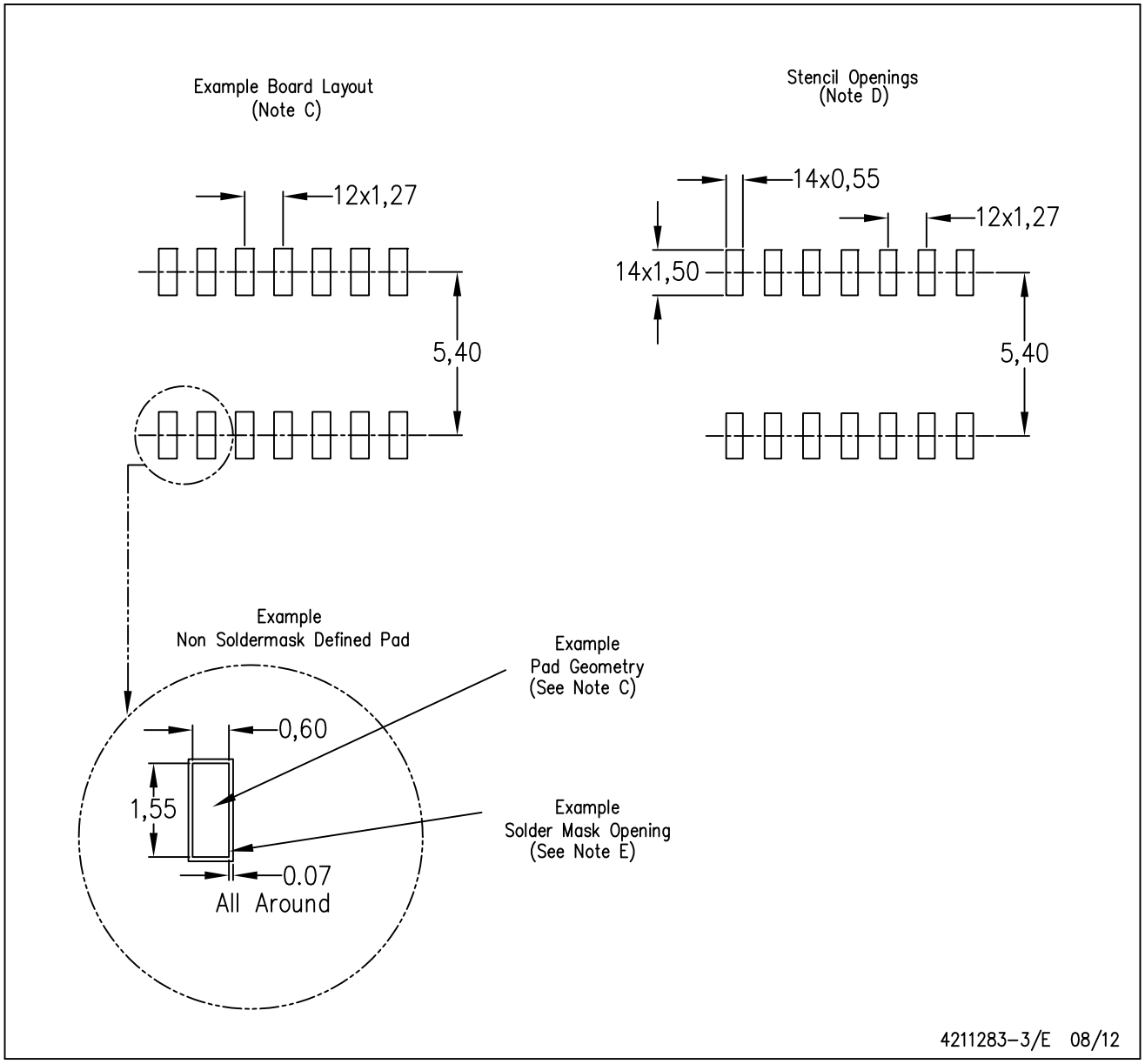
D (R–PDSO–G14) PLASTIC SMALL OUTLINE




4040047–5/M 06/11

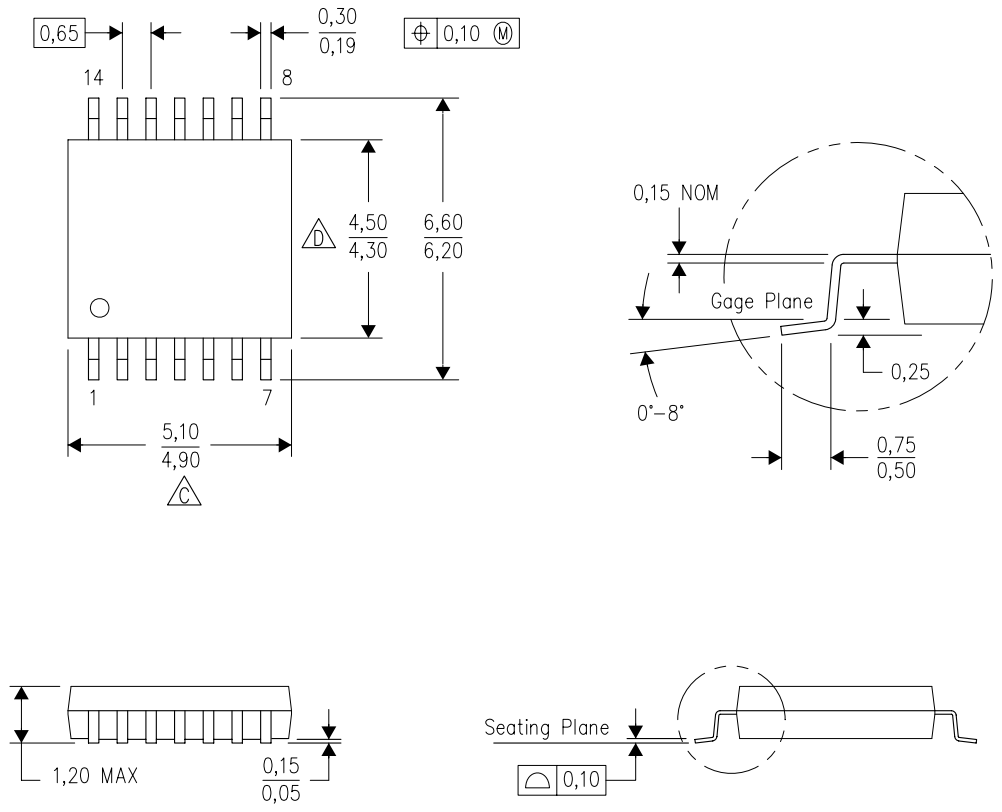
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
E. Reference JEDEC MS–012 variation AB.

D (R–PDSO–G14) 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.

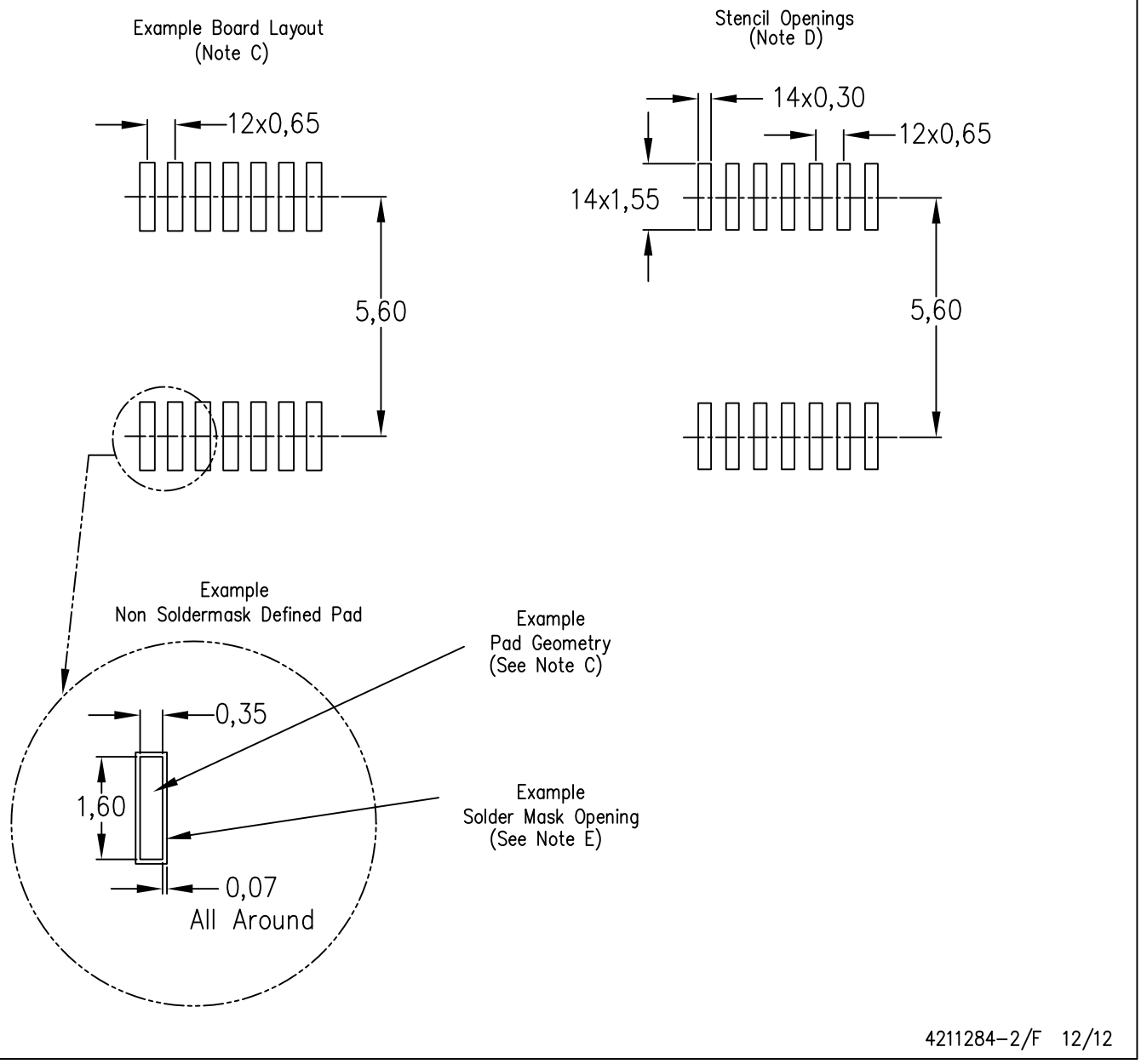
PW (R–PDSO–G14) PLASTIC SMALL OUTLINE




4040064–3/G 02/11

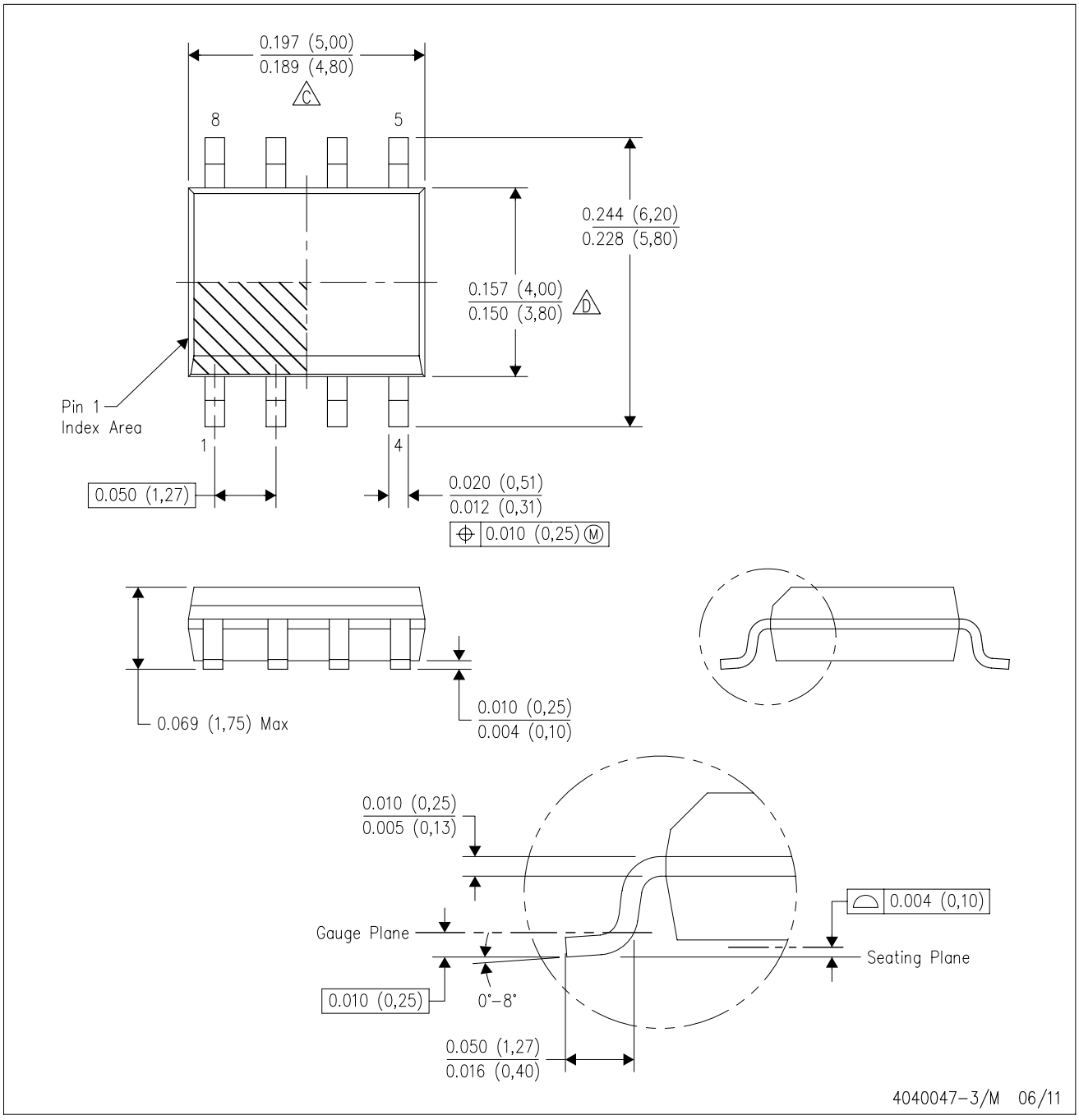
NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
E. Falls within JEDEC MO–153

PW (R–PDSO–G14) PLASTIC SMALL OUTLINE



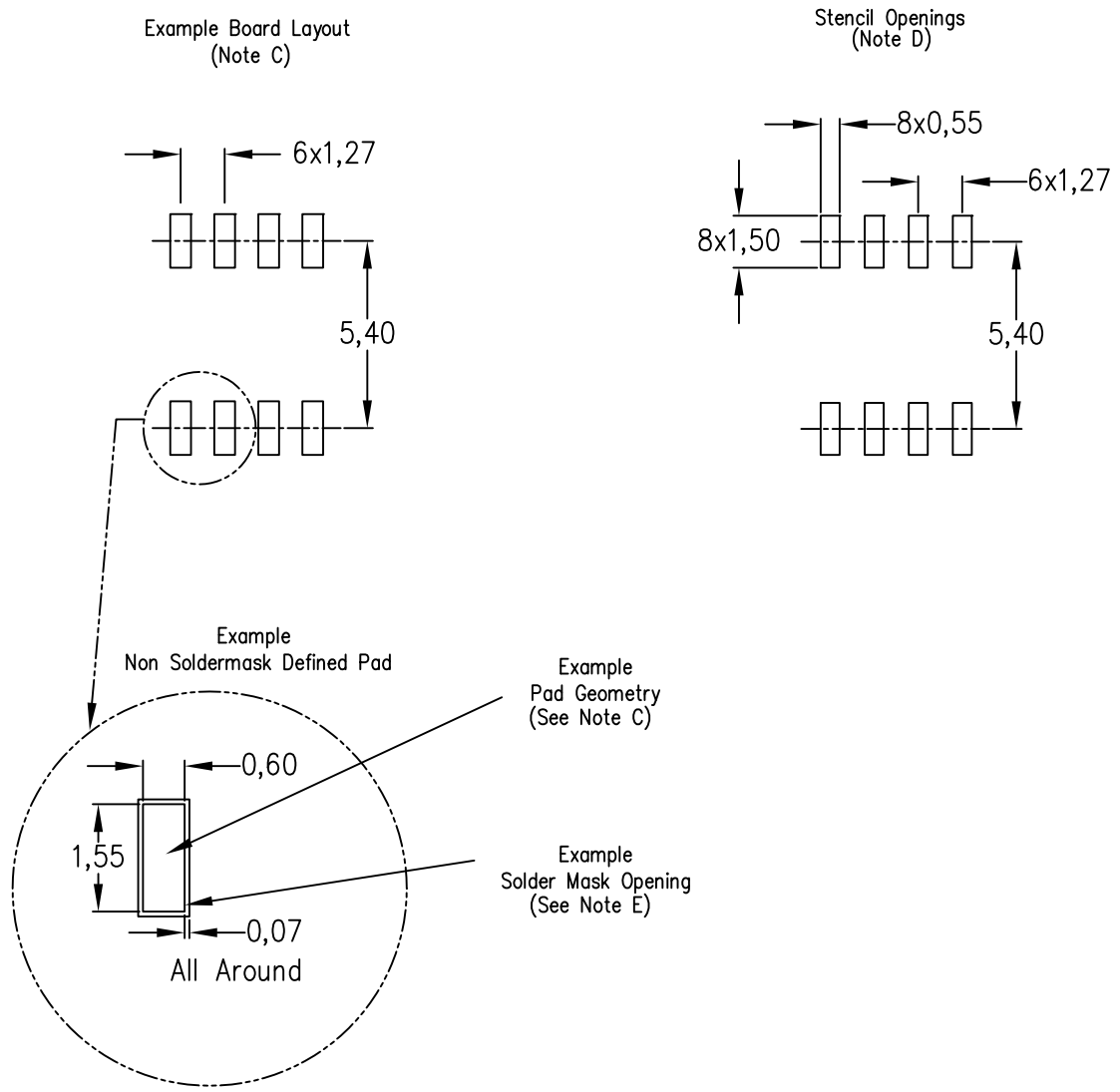

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact 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.

D (R–PDSO–G8) PLASTIC SMALL OUTLINE




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 0.006 (0,15) each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
E. Reference JEDEC MS–012 variation AA.

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.

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