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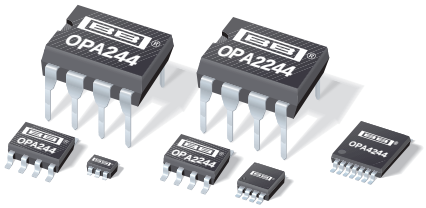


# OPA244
# OPA2244
# OPA4244

## *Micro*Power, Single-Supply OPERATIONAL AMPLIFIERS
## *Micro*Amplifier™ Series

## FEATURES

- *Micro*SIZE PACKAGES
  OPA244 (Single): SOT-23-5
  OPA2244 (Dual): MSOP-8
  OPA4244 (Quad): TSSOP-14
- *Micro*POWER: $I_Q$ = 50µA/channel
- SINGLE SUPPLY OPERATION
- WIDE BANDWIDTH: 430kHz
- WIDE SUPPLY RANGE:
  Single Supply: 2.2V to 36V
  Dual Supply: ±1.1V to ±18V

## APPLICATIONS

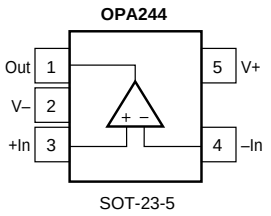
- BATTERY POWERED SYSTEMS
- PORTABLE EQUIPMENT
- PCMCIA CARDS
- BATTERY PACKS AND POWER SUPPLIES
- CONSUMER PRODUCTS

## DESCRIPTION

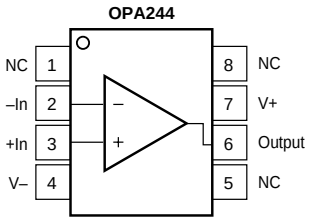
The OPA244 (single), OPA2244 (dual), and OPA4244 (quad) op amps are designed for very low quiescent current (50µA/channel), yet achieve excellent bandwidth. Ideal for battery powered and portable instrumentation, all versions are offered in micro packages for space-limited applications. The dual and quad versions feature completely independent circuitry for lowest crosstalk and freedom from interaction, even when overdriven or overloaded.

The OPA244 series is easy to use and free from phase inversion and overload problems found in some other op amps. These amplifiers are stable in unity gain and excellent performance is maintained as they swing to their specified limits. They can be operated from single (+2.2V to +36V) or dual supplies (±1.1V to ±18V). The input common-mode voltage range includes ground—ideal for many single supply applications. All versions have similar performance. However, there are some differences, such as common-mode rejection. All versions are interchangeable in most applications.

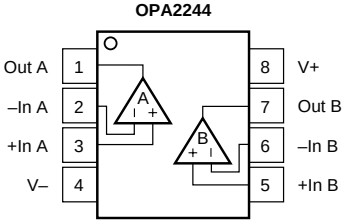
All versions are offered in miniature, surface-mount packages. OPA244 (single version) comes in the tiny 5-lead SOT-23-5 surface mount, SO-8 surface mount, and 8-pin DIP. OPA2244 (dual version) is available in the MSOP-8 surface mount, SO-8 surface-mount, and 8-pin DIP. The OPA4244 (quad) comes in the TSSOP-14 surface mount. They are fully specified from –40°C to +85°C and operate from –55°C to +125°C. A SPICE Macromodel is available for design analysis.



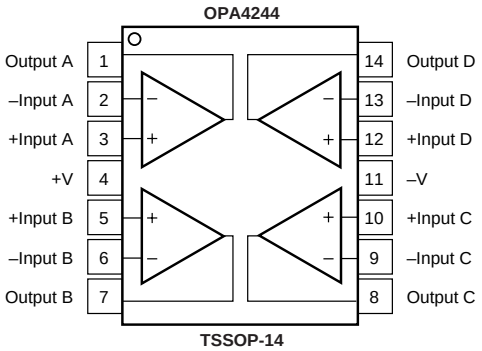
SOT-23-5



8-Pin DIP, SO-8



8-Pin DIP, SO-8, MSOP-8



TSSOP-14

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Twx: 910-952-1111 • Internet: http://www.burr-brown.com/ • Cable: BBRCORP • Telex: 066-6491 • FAX: (520) 889-1510 • Immediate Product Info: (800) 548-6132


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# SPECIFICATIONS: $V_S$ = +2.6V to +36V

**Boldface** limits apply over the specified temperature range, $T_A$ = –40°C to +85°C

At $T_A$ = +25°C, $R_L$ = 20kΩ connected to ground, unless otherwise noted.

| PARAMETER | | CONDITION | OPA244NA, PA, UA MIN | TYP[1] | MAX | UNITS |
|---|---|---|---|---|---|---|
| **OFFSET VOLTAGE** | | | | | | |
| Input Offset Voltage | $V_{OS}$ | $V_S$ = ±7.5V, $V_{CM}$ = 0 | | ±0.7 | ±1.5 | mV |
| **$T_A$ = –40°C to 85°C** | | | | | **±2** | mV |
| vs Temperature | $dV_{OS}/dT$ | **$T_A$ = –40°C to 85°C** | | **±4** | | µV/°C |
| vs Power Supply | PSRR | $V_S$ = +2.6V to +36V | | 5 | 50 | µV/V |
| **$T_A$ = –40°C to 85°C** | | $V_S$ = +2.6V to +36V | | | **50** | µV/V |
| **INPUT BIAS CURRENT** | | | | | | |
| Input Bias Current | $I_B$ | $V_{CM}$ = $V_S$/2 | | –10 | –25 | nA |
| Input Offset Current | $I_{OS}$ | $V_{CM}$ = $V_S$/2 | | ±1 | ±10 | nA |
| **NOISE** | | | | | | |
| Input Voltage Noise, f = 0.1kHz to 10kHz | | | | 0.4 | | µVp-p |
| Input Voltage Noise Density, f = 1kHz | $e_n$ | | | 22 | | nV/√Hz |
| Current Noise Density, f = 1kHz | $i_n$ | | | 40 | | fA/√Hz |
| **INPUT VOLTAGE RANGE** | | | | | | |
| Common-Mode Voltage Range | $V_{CM}$ | | 0 | | (V+) – 0.9 | V |
| Common-Mode Rejection | CMRR | $V_S$ = ±18V, $V_{CM}$ = –18V to +17.1V | 84 | 98 | | dB |
| **$T_A$ = –40°C to 85°C** | | $V_S$ = ±18V, $V_{CM}$ = –18V to +17.1V | **84** | | | dB |
| **INPUT IMPEDANCE** | | | | | | |
| Differential | | | | $10^6$ \|\| 2 | | Ω \|\| pF |
| Common-Mode | | | | $10^9$ \|\| 2 | | Ω \|\| pF |
| **OPEN-LOOP GAIN** | | | | | | |
| Open-Loop Voltage Gain | $A_{OL}$ | $V_O$ = 0.5V to (V+) – 0.9 | 86 | 106 | | dB |
| **$T_A$ = –40°C to 85°C** | | $V_O$ = 0.5V to (V+) – 0.9 | **86** | | | dB |
| **FREQUENCY RESPONSE** | | | | | | |
| Gain-Bandwidth Product | GBW | | | 430 | | kHz |
| Slew Rate | SR | G = 1 | | –0.1/+0.16 | | V/µs |
| Settling Time 0.01% | | 10V Step | | 150 | | µs |
| Overload Recovery Time | | $V_{IN}$ • Gain = $V_S$ | | 8 | | µs |
| **OUTPUT** | | | | | | |
| Voltage Output, Positive | $V_O$ | $A_{OL}$ ≥ 80dB, $R_L$ = 20kΩ to $V_S$/2 | (V+) – 0.9 | (V+) – 0.75 | | V |
| **$T_A$ = –40°C to 85°C** | | $A_{OL}$ ≥ 80dB, $R_L$ = 20kΩ to $V_S$/2 | **(V+) – 0.9** | (V+) – 0.75 | | V |
| Voltage Output, Negative | | $A_{OL}$ ≥ 80dB, $R_L$ = 20kΩ to $V_S$/2 | 0.5 | 0.2 | | V |
| **$T_A$ = –40°C to 85°C** | | $A_{OL}$ ≥ 80dB, $R_L$ = 20kΩ to $V_S$/2 | **0.5** | **0.2** | | V |
| Voltage Output, Positive | | $A_{OL}$ ≥ 80dB, $R_L$ = 20kΩ to Ground | | (V+) – 0.75 | | V |
| **$T_A$ = –40°C to 85°C** | | $A_{OL}$ ≥ 80dB, $R_L$ = 20kΩ to Ground | | (V+) – 0.75 | | V |
| Voltage Output, Negative | | $A_{OL}$ ≥ 80dB, $R_L$ = 20kΩ to Ground | | 0.1 | | V |
| **$T_A$ = –40°C to 85°C** | | $A_{OL}$ ≥ 80dB, $R_L$ = 20kΩ to Ground | | **0.1** | | V |
| Short-Circuit Current | $I_{SC}$ | | | –25/+12 | | mA |
| Capacitive Load Drive | $C_{LOAD}$ | | | See Typical Curve | | |
| **POWER SUPPLY** | | | | | | |
| Specified Voltage Range | $V_S$ | **$T_A$ = –40°C to 85°C** | **+2.6** | | **+36** | V |
| Minimum Operating Voltage | | | | +2.2 | | V |
| Quiescent Current | $I_Q$ | $I_O$ = 0 | | 50 | 60 | µA |
| **$T_A$ = –40°C to 85°C** | | $I_O$ = 0 | | | **70** | µA |
| **TEMPERATURE RANGE** | | | | | | |
| Specified Range | | | –40 | | 85 | °C |
| Operating Range | | | –55 | | 125 | °C |
| Storage Range | | | –65 | | 150 | °C |
| Thermal Resistance | $\theta_{JA}$ | | | | | |
| SOT-23-5 Surface-Mount | | | | 200 | | °C/W |
| SO-8 Surface-Mount | | | | 150 | | °C/W |
| 8-Pin DIP | | | | 100 | | °C/W |

NOTE: (1) $V_S$ = +15V.

# SPECIFICATIONS: $V_S$ = +2.6V to +36V

**Boldface** limits apply over the specified temperature range, $T_A$ = –40°C to +85°C

At $T_A$ = +25°C, $R_L$ = 20kΩ connected to ground, unless otherwise noted.

| PARAMETER | | CONDITION | OPA2244EA, PA, UA MIN | TYP(1) | MAX | UNITS |
|---|---|---|---|---|---|---|
| **OFFSET VOLTAGE** | | | | | | |
| Input Offset Voltage | $V_{OS}$ | $V_S$ = ±7.5V, $V_{CM}$ = 0 | | ±0.7 | ±1.5 | mV |
| **$T_A$ = –40°C to 85°C** | | | | | **±2** | mV |
| vs Temperature | $dV_{OS}/dT$ | **$T_A$ = –40°C to 85°C** | | **±4** | | µV/°C |
| vs Power Supply | PSRR | $V_S$ = +2.6V to +36V | | 5 | 50 | µV/V |
| **$T_A$ = –40°C to 85°C** | | $V_S$ = +2.6V to +36V | | | **50** | µV/V |
| Channel Separation | | | | 140 | | dB |
| **INPUT BIAS CURRENT** | | | | | | |
| Input Bias Current | $I_B$ | $V_{CM}$ = $V_S$/2 | | –10 | –25 | nA |
| Input Offset Current | $I_{OS}$ | $V_{CM}$ = $V_S$/2 | | ±1 | ±10 | nA |
| **NOISE** | | | | | | |
| Input Voltage Noise, f = 0.1kHz to 10kHz | | | | 0.4 | | µVp-p |
| Input Voltage Noise Density, f = 1kHz | $e_n$ | | | 22 | | nV/√Hz |
| Current Noise Density, f = 1kHz | $i_n$ | | | 40 | | fA/√Hz |
| **INPUT VOLTAGE RANGE** | | | | | | |
| Common-Mode Voltage Range | $V_{CM}$ | | 0 | | (V+) – 0.9 | V |
| Common-Mode Rejection | CMRR | $V_S$ = ±18V, $V_{CM}$ = –18V to +17.1V | 72 | 98 | | dB |
| **$T_A$ = –40°C to 85°C** | | $V_S$ = ±18V, $V_{CM}$ = –18V to +17.1V | **72** | | | dB |
| **INPUT IMPEDANCE** | | | | | | |
| Differential | | | | $10^6$ \|\| 2 | | Ω \|\| pF |
| Common-Mode | | | | $10^9$ \|\| 2 | | Ω \|\| pF |
| **OPEN-LOOP GAIN** | | | | | | |
| Open-Loop Voltage Gain | $A_{OL}$ | $V_O$ = 0.5V to (V+) – 0.9 | 86 | 106 | | dB |
| **$T_A$ = –40°C to 85°C** | | $V_O$ = 0.5V to (V+) – 0.9 | **86** | | | dB |
| **FREQUENCY RESPONSE** | | | | | | |
| Gain-Bandwidth Product | GBW | | | 430 | | kHz |
| Slew Rate | SR | G = 1 | | –0.1/+0.16 | | V/µs |
| Settling Time 0.01% | | 10V Step | | 150 | | µs |
| Overload Recovery Time | | $V_{IN}$ • Gain = $V_S$ | | 8 | | µs |
| **OUTPUT** | | | | | | |
| Voltage Output, Positive | $V_O$ | $A_{OL}$ ≥ 80dB, $R_L$ = 20kΩ to $V_S$/2 | (V+) – 0.9 | (V+) – 0.75 | | V |
| **$T_A$ = –40°C to 85°C** | | $A_{OL}$ ≥ 80dB, $R_L$ = 20kΩ to $V_S$/2 | **(V+) – 0.9** | (V+) – 0.75 | | V |
| Voltage Output, Negative | | $A_{OL}$ ≥ 80dB, $R_L$ = 20kΩ to $V_S$/2 | 0.5 | 0.2 | | V |
| **$T_A$ = –40°C to 85°C** | | $A_{OL}$ ≥ 80dB, $R_L$ = 20kΩ to $V_S$/2 | **0.5** | **0.2** | | V |
| Voltage Output, Positive | | $A_{OL}$ ≥ 80dB, $R_L$ = 20kΩ to Ground | | (V+) – 0.75 | | V |
| **$T_A$ = –40°C to 85°C** | | $A_{OL}$ ≥ 80dB, $R_L$ = 20kΩ to Ground | | (V+) – 0.75 | | V |
| Voltage Output, Negative | | $A_{OL}$ ≥ 80dB, $R_L$ = 20kΩ to Ground | | 0.1 | | V |
| **$T_A$ = –40°C to 85°C** | | $A_{OL}$ ≥ 80dB, $R_L$ = 20kΩ to Ground | | **0.1** | | V |
| Short-Circuit Current | $I_{SC}$ | | | –25/+12 | | mA |
| Capacitive Load Drive | $C_{LOAD}$ | | | See Typical Curve | | |
| **POWER SUPPLY** | | | | | | |
| Specified Voltage Range | $V_S$ | **$T_A$ = –40°C to 85°C** | **+2.6** | | **+36** | V |
| Minimum Operating Voltage | | | | +2.2 | | V |
| Quiescent Current (per amplifier) | $I_Q$ | $I_O$ = 0 | | 40 | 50 | µA |
| **$T_A$ = –40°C to 85°C** | | $I_O$ = 0 | | | **63** | µA |
| **TEMPERATURE RANGE** | | | | | | |
| Specified Range | | | –40 | | 85 | °C |
| Operating Range | | | –55 | | 125 | °C |
| Storage Range | | | –65 | | 150 | °C |
| Thermal Resistance | $\theta_{JA}$ | | | | | |
| MSOP-8 Surface-Mount | | | | 200 | | °C/W |
| SO-8 Surface-Mount | | | | 150 | | °C/W |
| 8-Pin DIP | | | | 100 | | °C/W |

NOTE: (1) $V_S$ = +15V.

# SPECIFICATIONS: $V_S$ = +2.6V to +36V

**Boldface** limits apply over the specified temperature range, $T_A$ = –40°C to +85°C

At $T_A$ = +25°C, $R_L$ = 20kΩ connected to ground, unless otherwise noted.

| PARAMETER | | CONDITION | OPA4244EA MIN | OPA4244EA TYP(1) | OPA4244EA MAX | UNITS |
|---|---|---|---|---|---|---|
| **OFFSET VOLTAGE** | | | | | | |
| Input Offset Voltage | $V_{OS}$ | $V_S$ = ±7.5V, $V_{CM}$ = 0 | | ±0.7 | ±1.5 | mV |
| **$T_A$ = –40°C to 85°C** | | | | | **±2** | mV |
| vs Temperature | $dV_{OS}/dT$ | **$T_A$ = –40°C to 85°C** | | **±4** | | µV/°C |
| vs Power Supply | PSRR | $V_S$ = +2.6V to +36V | | 5 | 50 | µV/V |
| **$T_A$ = –40°C to 85°C** | | $V_S$ = +2.6V to +36V | | | **50** | µV/V |
| Channel Separation | | | | 140 | | dB |
| **INPUT BIAS CURRENT** | | | | | | |
| Input Bias Current | $I_B$ | $V_{CM}$ = $V_S$/2 | | –10 | –25 | nA |
| Input Offset Current | $I_{OS}$ | $V_{CM}$ = $V_S$/2 | | ±1 | ±10 | nA |
| **NOISE** | | | | | | |
| Input Voltage Noise, f = 0.1kHz to 10kHz | | | | 0.4 | | µVp-p |
| Input Voltage Noise Density, f = 1kHz | $e_n$ | | | 22 | | nV/√Hz |
| Current Noise Density, f = 1kHz | $i_n$ | | | 40 | | fA/√Hz |
| **INPUT VOLTAGE RANGE** | | | | | | |
| Common-Mode Voltage Range | $V_{CM}$ | | 0 | | (V+) – 0.9 | V |
| Common-Mode Rejection | CMRR | $V_S$ = ±18V, $V_{CM}$ = –18V to +17.1V | 82 | 104 | | dB |
| **$T_A$ = –40°C to 85°C** | | $V_S$ = ±18V, $V_{CM}$ = –18V to +17.1V | **82** | | | dB |
| **INPUT IMPEDANCE** | | | | | | |
| Differential | | | | $10^6$ \|\| 2 | | Ω \|\| pF |
| Common-Mode | | | | $10^9$ \|\| 2 | | Ω \|\| pF |
| **OPEN-LOOP GAIN** | | | | | | |
| Open-Loop Voltage Gain | $A_{OL}$ | $V_O$ = 0.5V to (V+) – 0.9 | 86 | 106 | | dB |
| **$T_A$ = –40°C to 85°C** | | $V_O$ = 0.5V to (V+) – 0.9 | **86** | | | dB |
| **FREQUENCY RESPONSE** | | | | | | |
| Gain-Bandwidth Product | GBW | | | 430 | | kHz |
| Slew Rate | SR | G = 1 | | –0.1/+0.16 | | V/µs |
| Settling Time 0.01% | | 10V Step | | 150 | | µs |
| Overload Recovery Time | | $V_{IN}$ • Gain = $V_S$ | | 8 | | µs |
| **OUTPUT** | | | | | | |
| Voltage Output, Positive | $V_O$ | $A_{OL}$ ≥ 80dB, $R_L$ = 20kΩ to $V_S$/2 | (V+) – 0.9 | (V+) – 0.75 | | V |
| **$T_A$ = –40°C to 85°C** | | $A_{OL}$ ≥ 80dB, $R_L$ = 20kΩ to $V_S$/2 | **(V+) – 0.9** | (V+) – 0.75 | | V |
| Voltage Output, Negative | | $A_{OL}$ ≥ 80dB, $R_L$ = 20kΩ to $V_S$/2 | 0.5 | 0.2 | | V |
| **$T_A$ = –40°C to 85°C** | | $A_{OL}$ ≥ 80dB, $R_L$ = 20kΩ to $V_S$/2 | **0.5** | **0.2** | | V |
| Voltage Output, Positive | | $A_{OL}$ ≥ 80dB, $R_L$ = 20kΩ to Ground | | (V+) – 0.75 | | V |
| **$T_A$ = –40°C to 85°C** | | $A_{OL}$ ≥ 80dB, $R_L$ = 20kΩ to Ground | | (V+) – 0.75 | | V |
| Voltage Output, Negative | | $A_{OL}$ ≥ 80dB, $R_L$ = 20kΩ to Ground | | 0.1 | | V |
| **$T_A$ = –40°C to 85°C** | | $A_{OL}$ ≥ 80dB, $R_L$ = 20kΩ to Ground | | **0.1** | | V |
| Short-Circuit Current | $I_{SC}$ | | | –25/+12 | | mA |
| Capacitive Load Drive | $C_{LOAD}$ | | | See Typical Curve | | |
| **POWER SUPPLY** | | | | | | |
| Specified Voltage Range | $V_S$ | **$T_A$ = –40°C to 85°C** | **+2.6** | | **+36** | V |
| Minimum Operating Voltage | | | | +2.2 | | V |
| Quiescent Current (per amplifier) | $I_Q$ | $I_O$ = 0 | | 40 | 60 | µA |
| **$T_A$ = –40°C to 85°C** | | $I_O$ = 0 | | | **70** | µA |
| **TEMPERATURE RANGE** | | | | | | |
| Specified Range | | | –40 | | 85 | °C |
| Operating Range | | | –55 | | 125 | °C |
| Storage Range | | | –65 | | 150 | °C |
| Thermal Resistance | $\theta_{JA}$ | | | | | |
| TSSOP-14 Surface Mount | | | | 100 | | °C/W |

NOTE: (1) $V_S$ = +15V.

## ABSOLUTE MAXIMUM RATINGS(1)

| | |
|---|---|
| Supply Voltage, V+ to V– | 36V |
| Input Voltage Range(2) | (V–) – 0.3V to (V+) + 0.3V |
| Input Current(2) | 10mA |
| Output Short-Circuit(3) | Continuous |
| Operating Temperature | –55°C to +125°C |
| Storage Temperature | –65°C to +150°C |
| Junction Temperature | 150°C |
| Lead Temperature (soldering, 10s) | 300°C |
| ESD Capability | 2000V |

NOTES: (1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. (2) Inputs are diode-clamped to the supply rails and should be current-limited to 10mA or less if input voltages can exceed rails by more than 0.3V. (3) Short-circuit to ground, one amplifier per package.

## ELECTROSTATIC DISCHARGE SENSITIVITY

This integrated circuit can be damaged by ESD. Burr-Brown 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

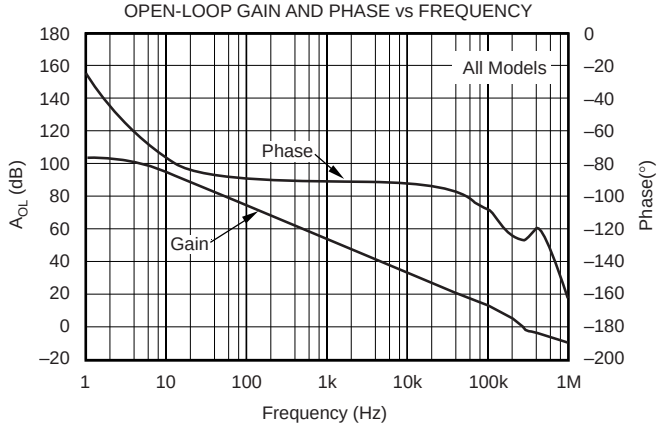
| PRODUCT | PACKAGE | PACKAGE DRAWING NUMBER | SPECIFIED TEMPERATURE RANGE | PACKAGE MARKING | ORDERING NUMBER(1) | TRANSPORT MEDIA |
|---|---|---|---|---|---|---|
| **Single** | | | | | | |
| OPA244NA | SOT-23-5 Surface-Mount | 331 | –40°C to +85°C | A44 | OPA244NA/250 | Tape and Reel |
| " | " | " | " | " | OPA244NA/3K | Tape and Reel |
| OPA244PA | 8-Pin DIP | 006 | –40°C to +85°C | OPA244PA | OPA244PA | Rails |
| OPA244UA | SO-8 Surface-Mount | 182 | –40°C to +85°C | OPA244UA | OPA244UA | Rails |
| " | " | " | " | " | OPA244UA/2K5 | Tape and Reel |
| **Dual** | | | | | | |
| OPA2244EA | MSOP-8 Surface-Mount | 337 | –40°C to +85°C | A44 | OPA2244EA/250 | Tape and Reel |
| " | " | " | " | " | OPA2244EA/2K5 | Tape and Reel |
| OPA2244PA | 8-Pin DIP | 006 | –40°C to +85°C | OPA2244PA | OPA2244PA | Rails |
| OPA2244UA | SO-8 Surface-Mount | 182 | –40°C to +85°C | OPA2244UA | OPA2244UA | Rails |
| " | " | " | " | " | OPA2244UA/2K5 | Tape and Reel |
| **Quad** | | | | | | |
| OPA4244EA | TSSOP-14 Surface-Mount | 357 | –40°C to +85°C | OPA4244EA | OPA4244EA/250 | Tape and Reel |
| " | " | " | " | " | OPA4244EA/2K5 | Tape and Reel |

NOTE: (1) Products followed by a slash (/) are only available in Tape and Reel in the quantities indicated (e.g., /250 indicates 250 devices per reel). Ordering 3000 pieces of “OPA244NA/3K” will get a single 3000 piece Tape and Reel.

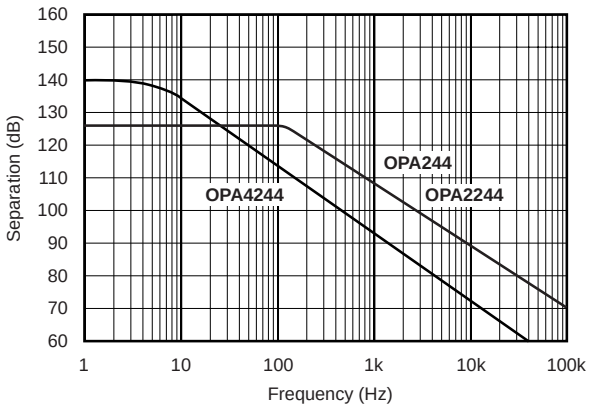
# TYPICAL PERFORMANCE CURVES

At $T_A$ = 25°C, $V_S$ = +15V, and $R_L$ = 20kΩ connected to Ground, unless otherwise noted.

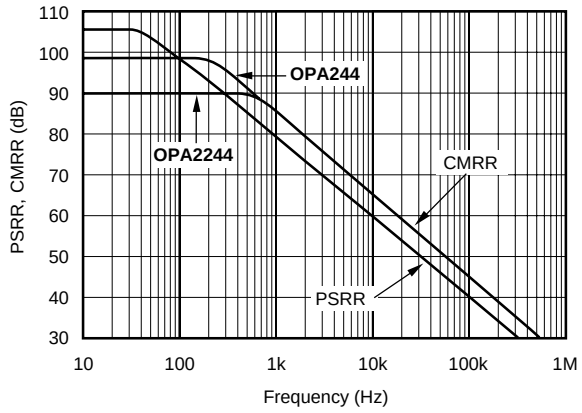
OPEN-LOOP GAIN AND PHASE vs FREQUENCY

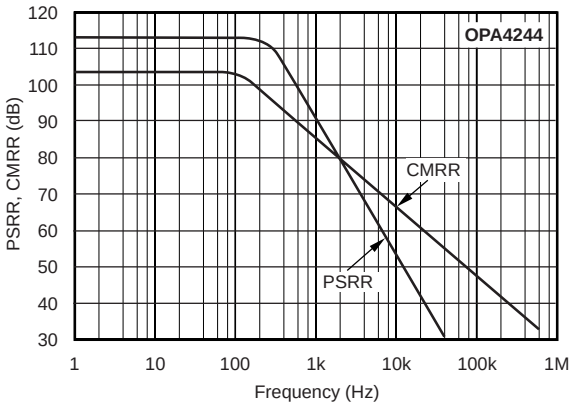



CHANNEL SEPARATION

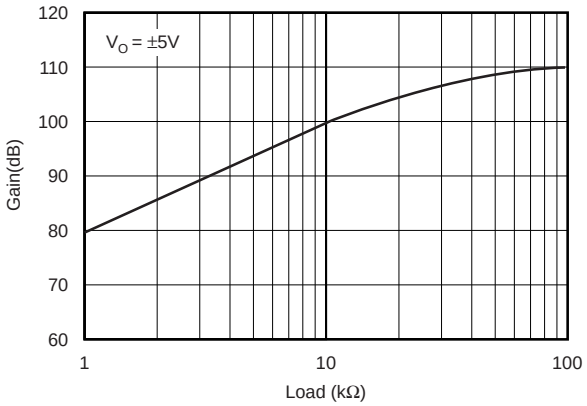



POWER SUPPLY AND COMMON-MODE REJECTION vs FREQUENCY

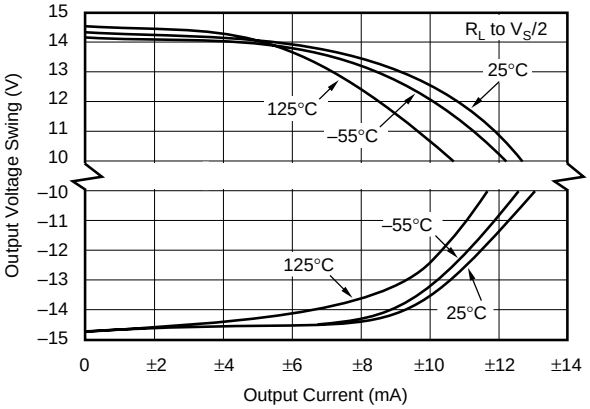



OPEN-LOOP GAIN vs LOAD RESISTANCE



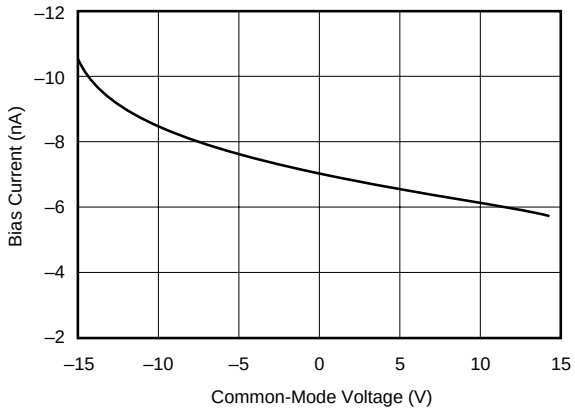

OUTPUT VOLTAGE SWING vs OUTPUT CURRENT



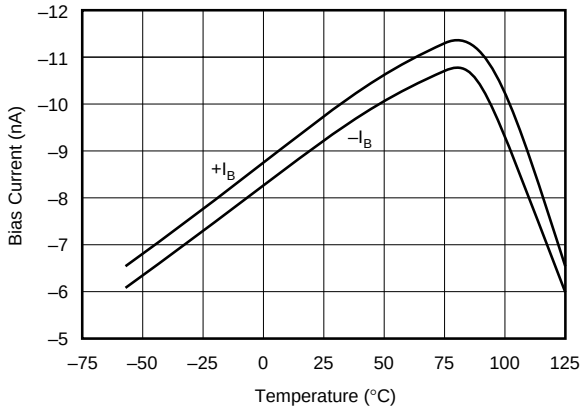
# TYPICAL PERFORMANCE CURVES (Cont.)

At $T_A$ = 25°C, $V_S$ = +15V, and $R_L$ = 20kΩ connected to Ground, unless otherwise noted.

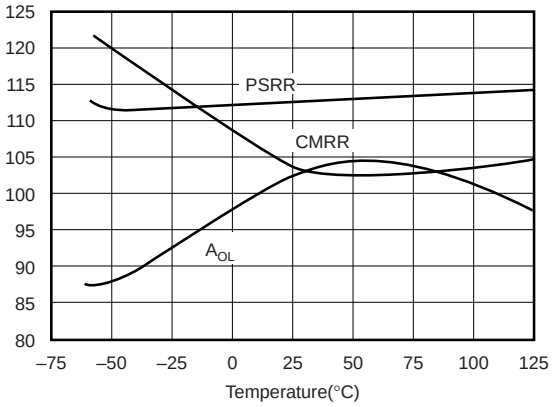
INPUT BIAS CURRENT
vs INPUT COMMON-MODE VOLTAGE



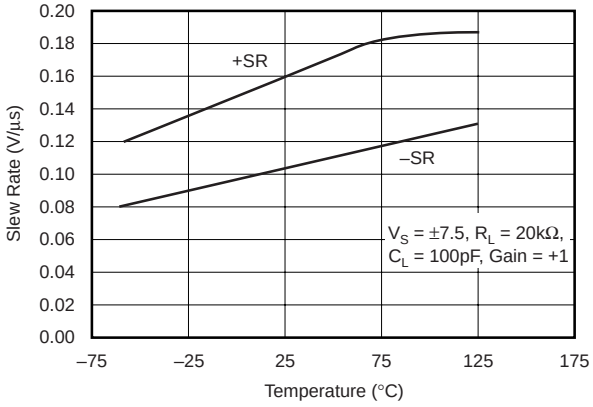

INPUT BIAS CURRENT vs TEMPERATURE



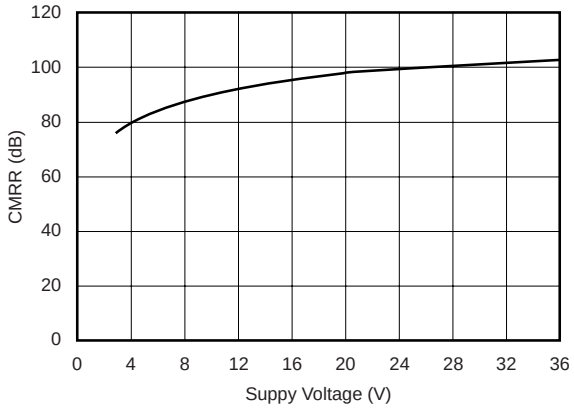

AOL, CMRR, PSRR vs TEMPERATURE



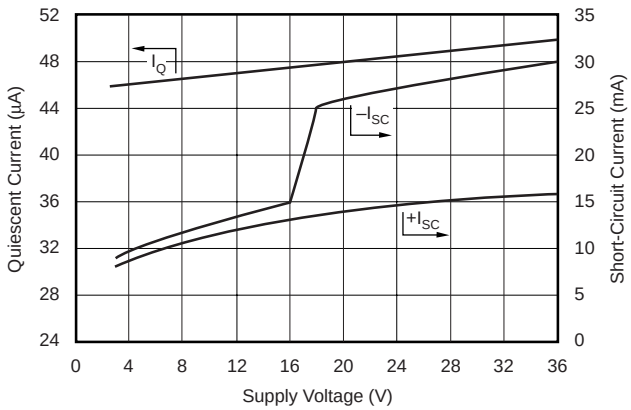

SLEW RATE vs TEMPERATURE




COMMON-MODE REJECTION
vs SUPPY VOLTAGE



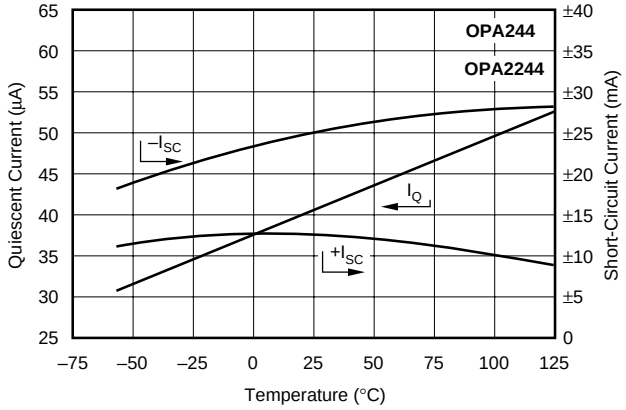

QUIESCENT CURRENT AND SHORT-CIRCUIT
vs SUPPLY VOLTAGE

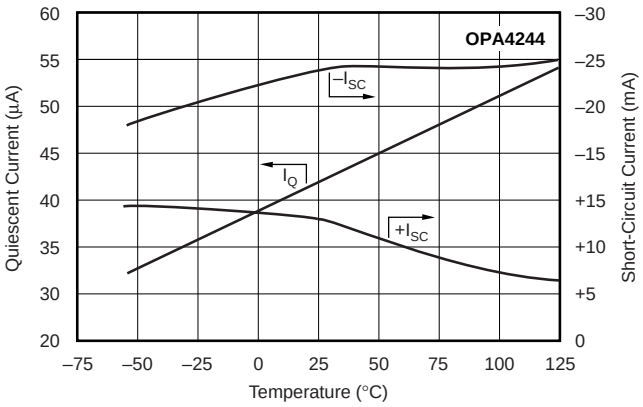


# TYPICAL PERFORMANCE CURVES (Cont.)

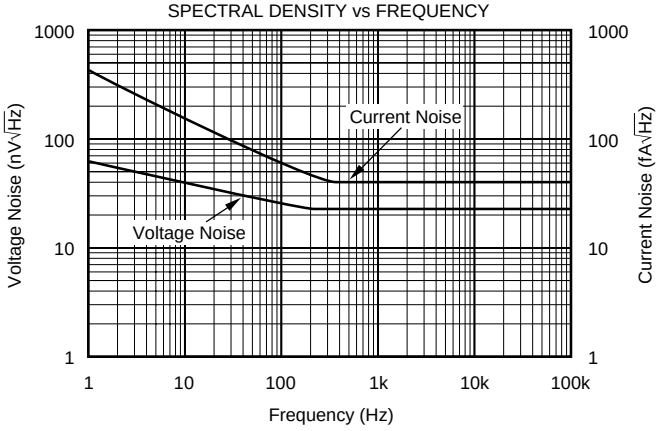
At $T_A$ = 25°C, $V_S$ = +15V, and $R_L$ = 20kΩ connected to Ground, unless otherwise noted.

QUIESCENT AND SHORT-CIRCUIT CURRENT vs TEMPERATURE

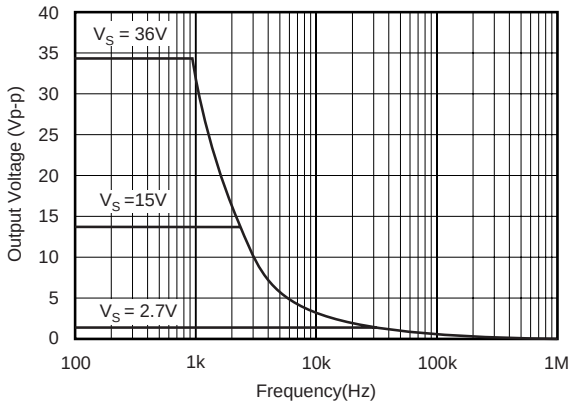


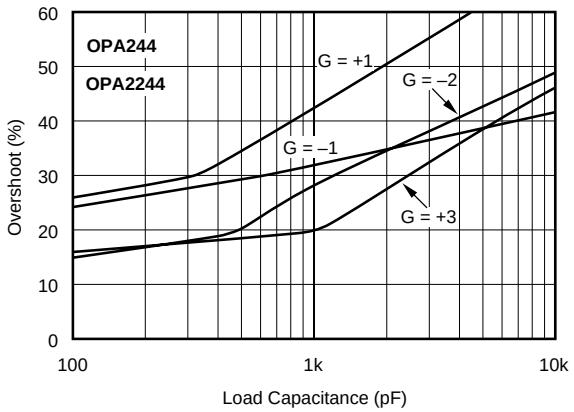

INPUT VOLTAGE AND CURRENT NOISE SPECTRAL DENSITY vs FREQUENCY

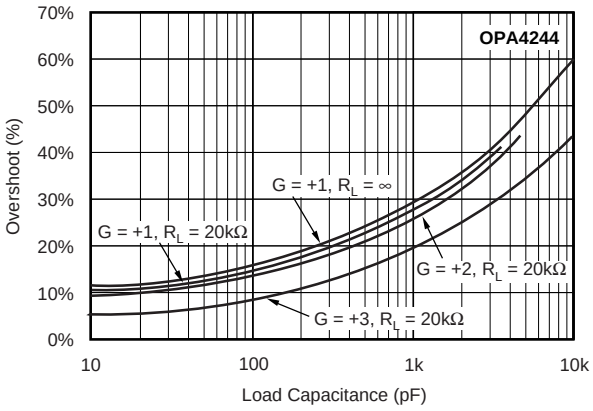



MAXIMUM OUTPUT VOLTAGE vs FREQUENCY




SMALL SIGNAL OVERSHOOT vs LOAD CAPACITANCE

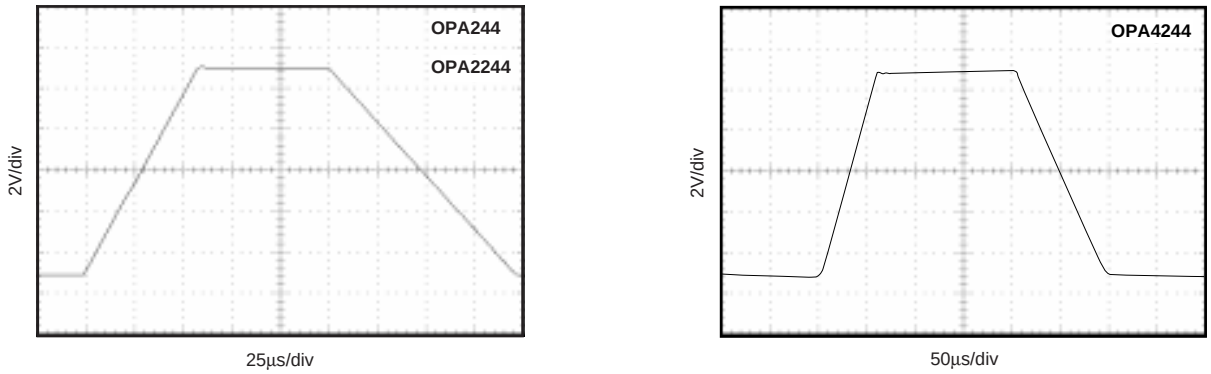


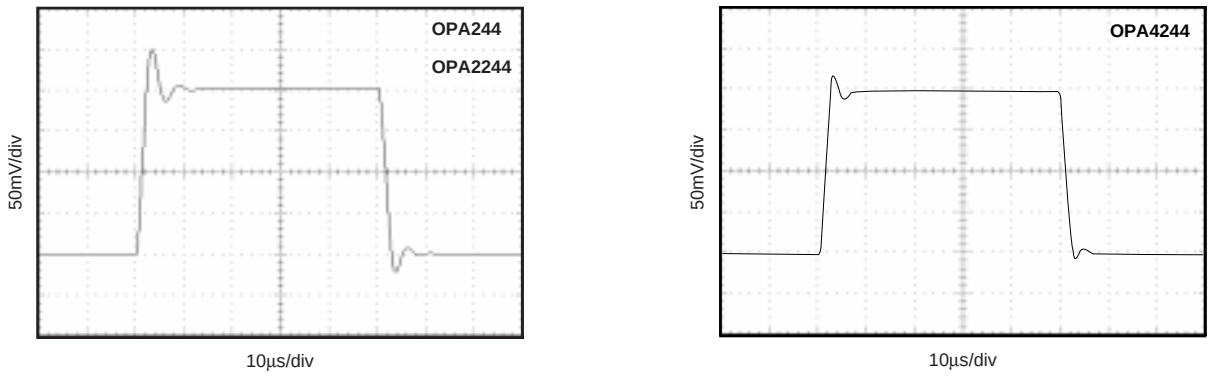
# TYPICAL PERFORMANCE CURVES (Cont.)

At $T_A$ = 25°C, $V_S$ = +15V, and $R_L$ = 20kΩ connected to Ground, unless otherwise noted.

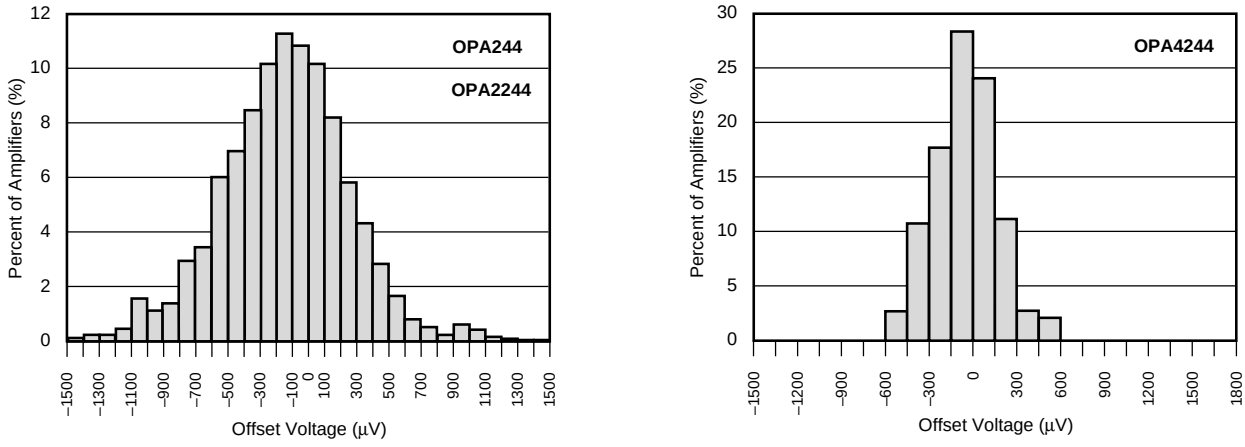
LARGE-SIGNAL STEP RESPONSE, G = 1, $C_L$ = 100pF




SMALL-SIGNAL STEP RESPONSE, G = 1, $C_L$ = 100pF



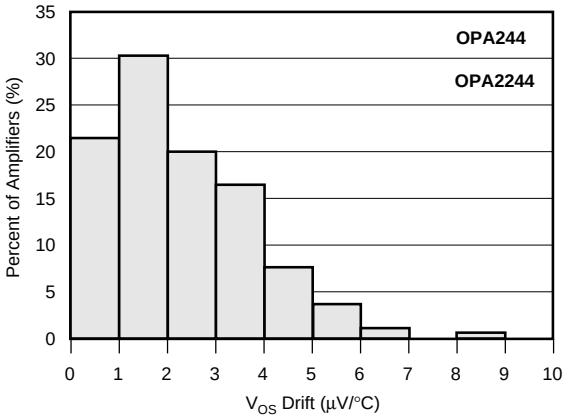

OFFSET VOLTAGE PRODUCTION DISTRIBUTION

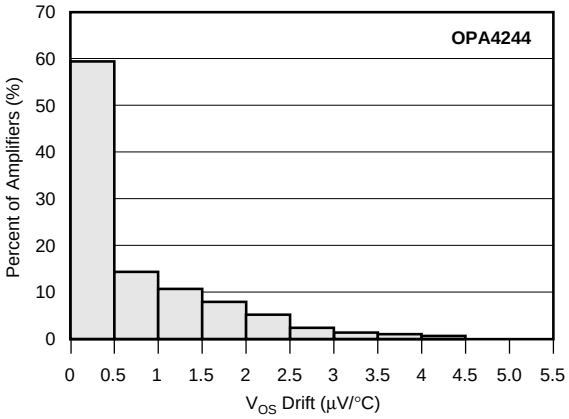


# TYPICAL PERFORMANCE CURVES (Cont.)

At $T_A$ = 25°C, $V_S$ = +15V, and $R_L$ = 20kΩ connected to Ground, unless otherwise noted.

OFFSET VOLTAGE PRODUCTION DISTRIBUTION



# APPLICATIONS INFORMATION

The OPA244 is unity-gain stable and suitable for a wide range of general purpose applications. Power supply pins should be bypassed with 0.01µF ceramic capacitors.

## OPERATING VOLTAGE

The OPA244 can operate from single supply (+2.2V to +36V) or dual supplies (±1.1 to ±18V) with excellent performance. Unlike most op amps which are specified at only one supply voltage, the OPA244 is specified for real world applications; a single set of specifications applies throughout the +2.6V to +36V (±1.3 to ±18V) supply range.

This allows a designer to have the same assured performance at any supply voltage within this range. In addition, many key parameters are guaranteed over the specified temperature range, –40°C to +85°C. Most behavior remains unchanged throughout the full operating voltage range. Parameters which vary significantly with operating voltage or temperature are shown in typical performance curves.

Useful information on solder pad design for printed circuit boards can be found in Burr-Brown's Application Bulletin AB-132B, “Solder Pad Recommendations for Surface-Mount Devices,” easily found at Burr-Brown's web site (http://www.burr-brown.com).

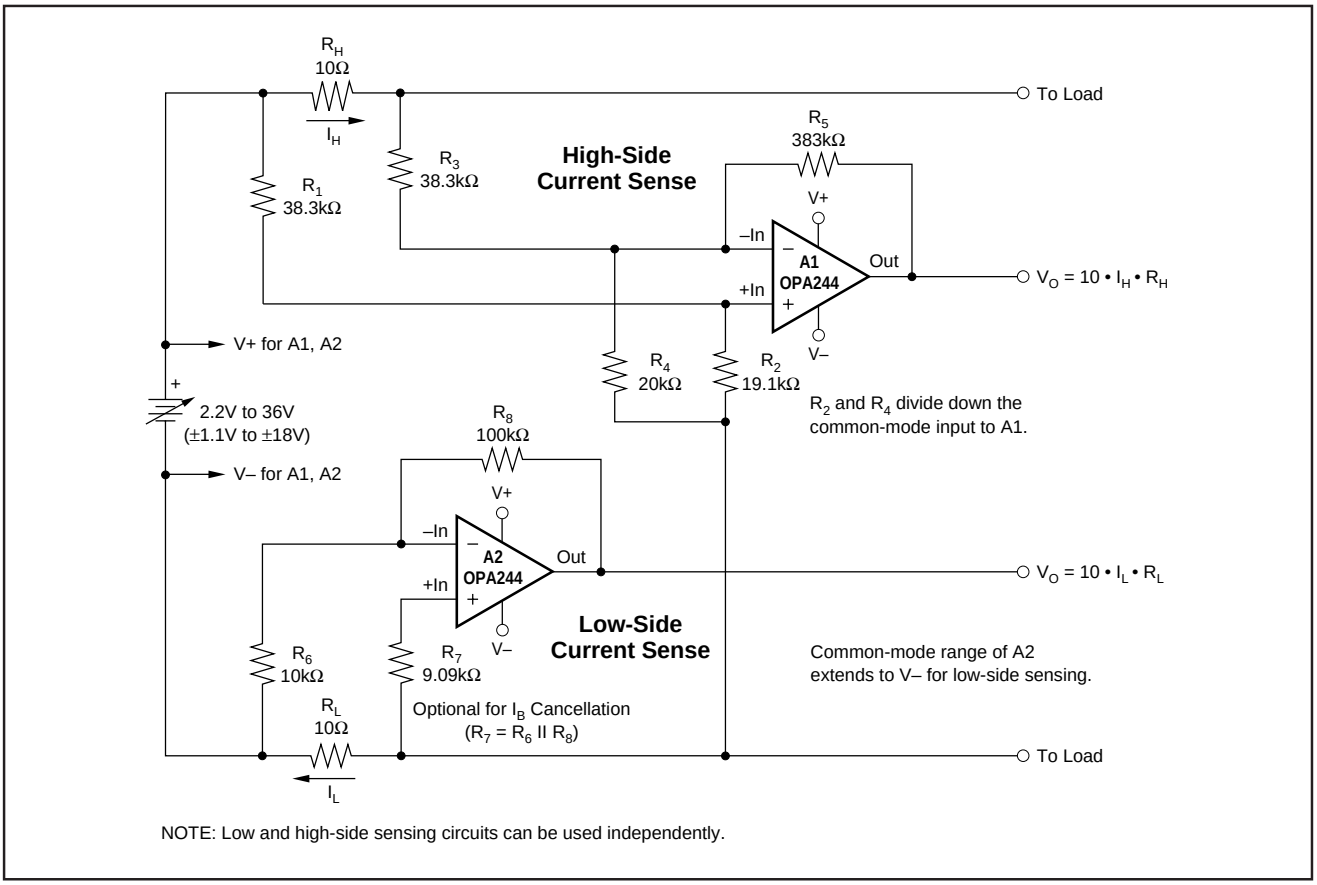



FIGURE 1. Low and High-Side Battery Current Sensing.

## 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| OPA2244EA/250 | ACTIVE | VSSOP | DGK | 8 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU \| CU NIPDAUAG | Level-2-260C-1 YEAR | -40 to 85 | A44 | Samples |
| OPA2244EA/250G4 | ACTIVE | VSSOP | DGK | 8 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | A44 | Samples |
| OPA2244EA/2K5 | ACTIVE | VSSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU \| CU NIPDAUAG | Level-2-260C-1 YEAR | -40 to 85 | A44 | Samples |
| OPA2244EA/2K5G4 | ACTIVE | VSSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | A44 | Samples |
| OPA2244PA | ACTIVE | PDIP | P | 8 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | N / A for Pkg Type | | OPA2244PA | Samples |
| OPA2244PAG4 | ACTIVE | PDIP | P | 8 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | N / A for Pkg Type | | OPA2244PA | Samples |
| OPA2244UA | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | | OPA 2244UA | Samples |
| OPA2244UA/2K5 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | | OPA 2244UA | Samples |
| OPA2244UA/2K5G4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | | OPA 2244UA | Samples |
| OPA2244UAG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | | OPA 2244UA | Samples |
| OPA244NA/250 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | | A44 | Samples |
| OPA244NA/250G4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | | A44 | Samples |
| OPA244NA/3K | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | | A44 | Samples |
| OPA244NA/3KG4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | | A44 | Samples |
| OPA244PA | LIFEBUY | PDIP | P | 8 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | N / A for Pkg Type | | OPA244PA | |
| OPA244PAG4 | LIFEBUY | PDIP | P | 8 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | N / A for Pkg Type | | OPA244PA | |
| OPA244UA | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | | OPA 244UA | Samples |

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| OPA244UA/2K5 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | | OPA 244UA | Samples |
| OPA244UAE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | | OPA 244UA | Samples |
| OPA4244EA/250 | ACTIVE | TSSOP | PW | 14 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | | OPA 4244EA | Samples |
| OPA4244EA/250E4 | ACTIVE | TSSOP | PW | 14 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | | OPA 4244EA | Samples |
| OPA4244EA/2K5 | ACTIVE | TSSOP | PW | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | | OPA 4244EA | 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.

**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

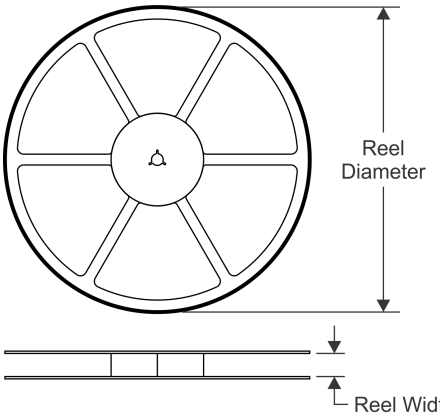
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

# PACKAGE MATERIALS INFORMATION

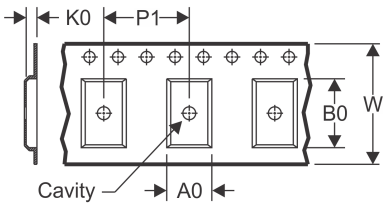


## TAPE AND REEL INFORMATION

REEL DIMENSIONS

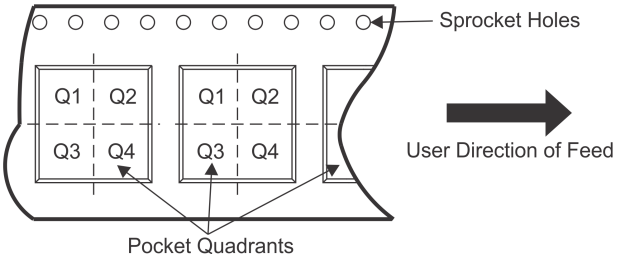



TAPE DIMENSIONS




| | |
|---|---|
| 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

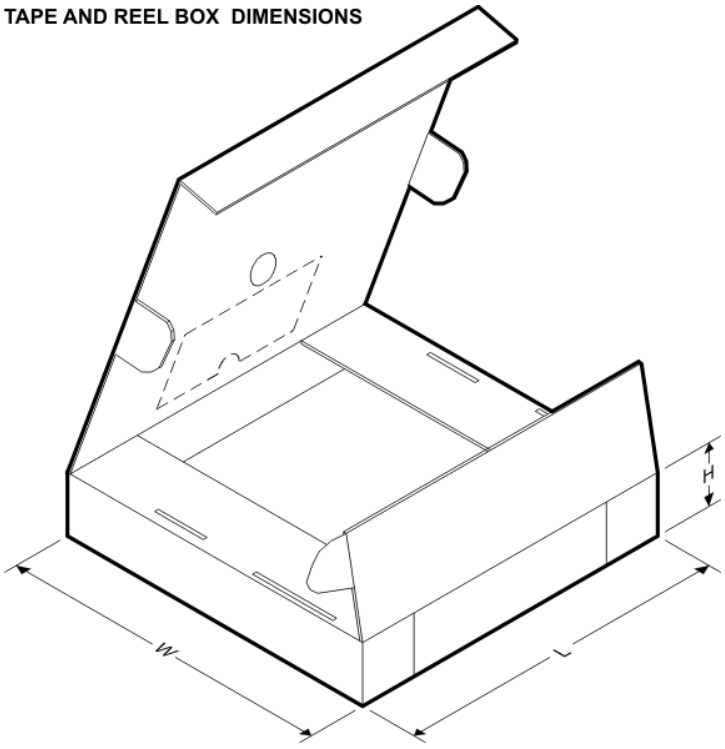
| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPA2244EA/250 | VSSOP | DGK | 8 | 250 | 180.0 | 12.4 | 5.3 | 3.4 | 1.4 | 8.0 | 12.0 | Q1 |
| OPA2244EA/2K5 | VSSOP | DGK | 8 | 2500 | 330.0 | 12.4 | 5.3 | 3.4 | 1.4 | 8.0 | 12.0 | Q1 |
| OPA2244UA/2K5 | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| OPA244NA/250 | SOT-23 | DBV | 5 | 250 | 178.0 | 8.4 | 3.3 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| OPA244NA/3K | SOT-23 | DBV | 5 | 3000 | 178.0 | 8.4 | 3.3 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| OPA244UA/2K5 | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| OPA4244EA/250 | TSSOP | PW | 14 | 250 | 180.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |
| OPA4244EA/2K5 | TSSOP | PW | 14 | 2500 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |

# PACKAGE MATERIALS INFORMATION

www.ti.com

15-Feb-2014

**TAPE AND REEL BOX DIMENSIONS**

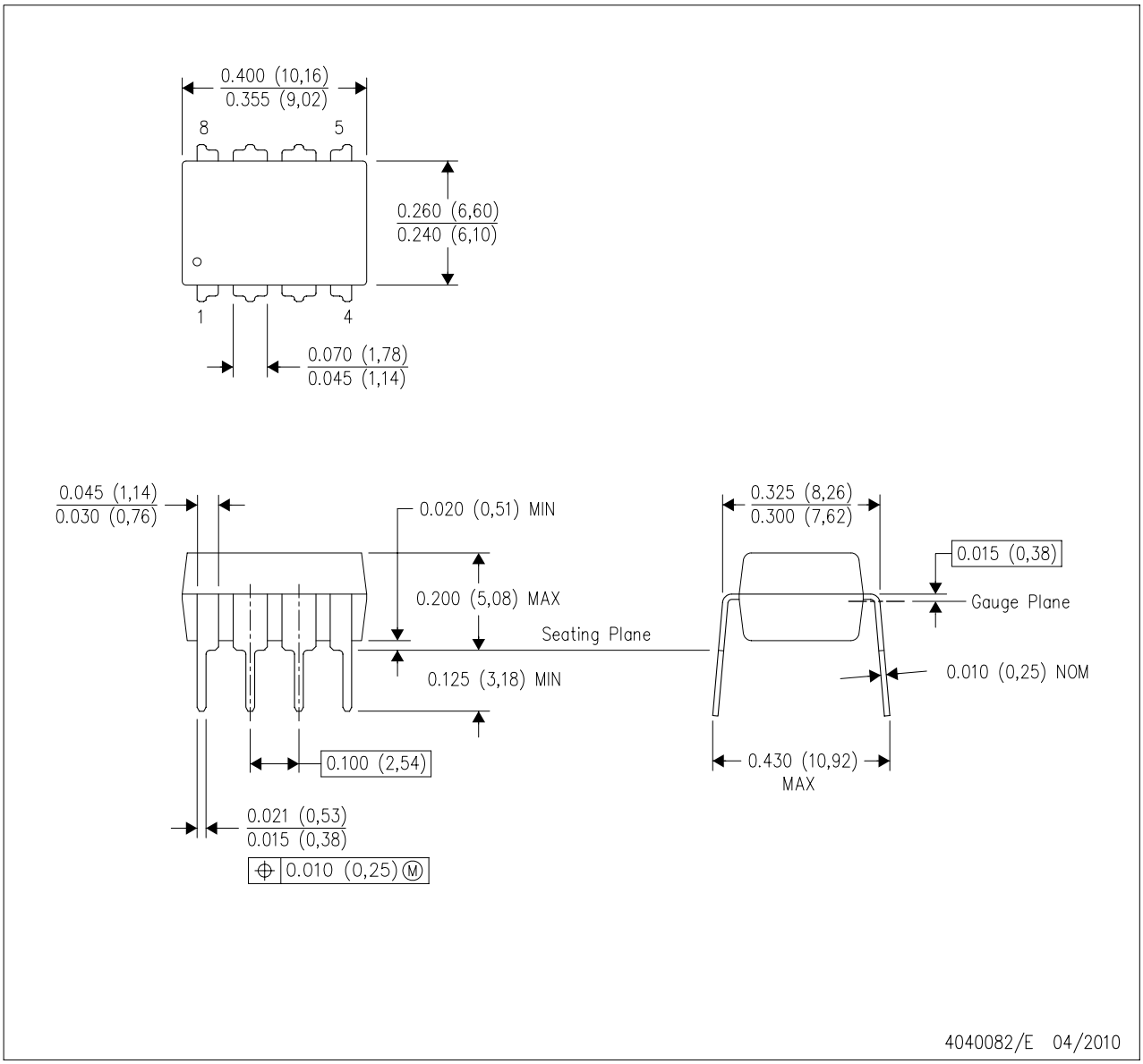



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| OPA2244EA/250 | VSSOP | DGK | 8 | 250 | 210.0 | 185.0 | 35.0 |
| OPA2244EA/2K5 | VSSOP | DGK | 8 | 2500 | 367.0 | 367.0 | 35.0 |
| OPA2244UA/2K5 | SOIC | D | 8 | 2500 | 367.0 | 367.0 | 35.0 |
| OPA244NA/250 | SOT-23 | DBV | 5 | 250 | 565.0 | 140.0 | 75.0 |
| OPA244NA/3K | SOT-23 | DBV | 5 | 3000 | 565.0 | 140.0 | 75.0 |
| OPA244UA/2K5 | SOIC | D | 8 | 2500 | 367.0 | 367.0 | 35.0 |
| OPA4244EA/250 | TSSOP | PW | 14 | 250 | 210.0 | 185.0 | 35.0 |
| OPA4244EA/2K5 | TSSOP | PW | 14 | 2500 | 367.0 | 367.0 | 35.0 |

## MECHANICAL DATA

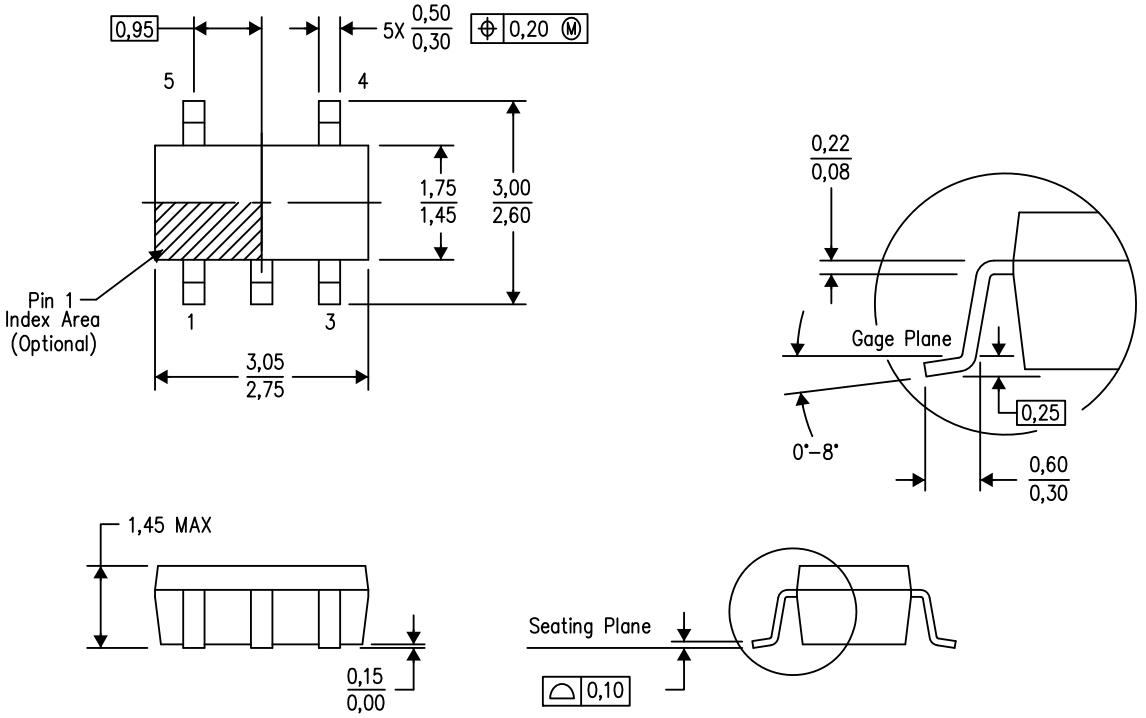
P (R–PDIP–T8) PLASTIC DUAL–IN–LINE PACKAGE




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.

## MECHANICAL DATA

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

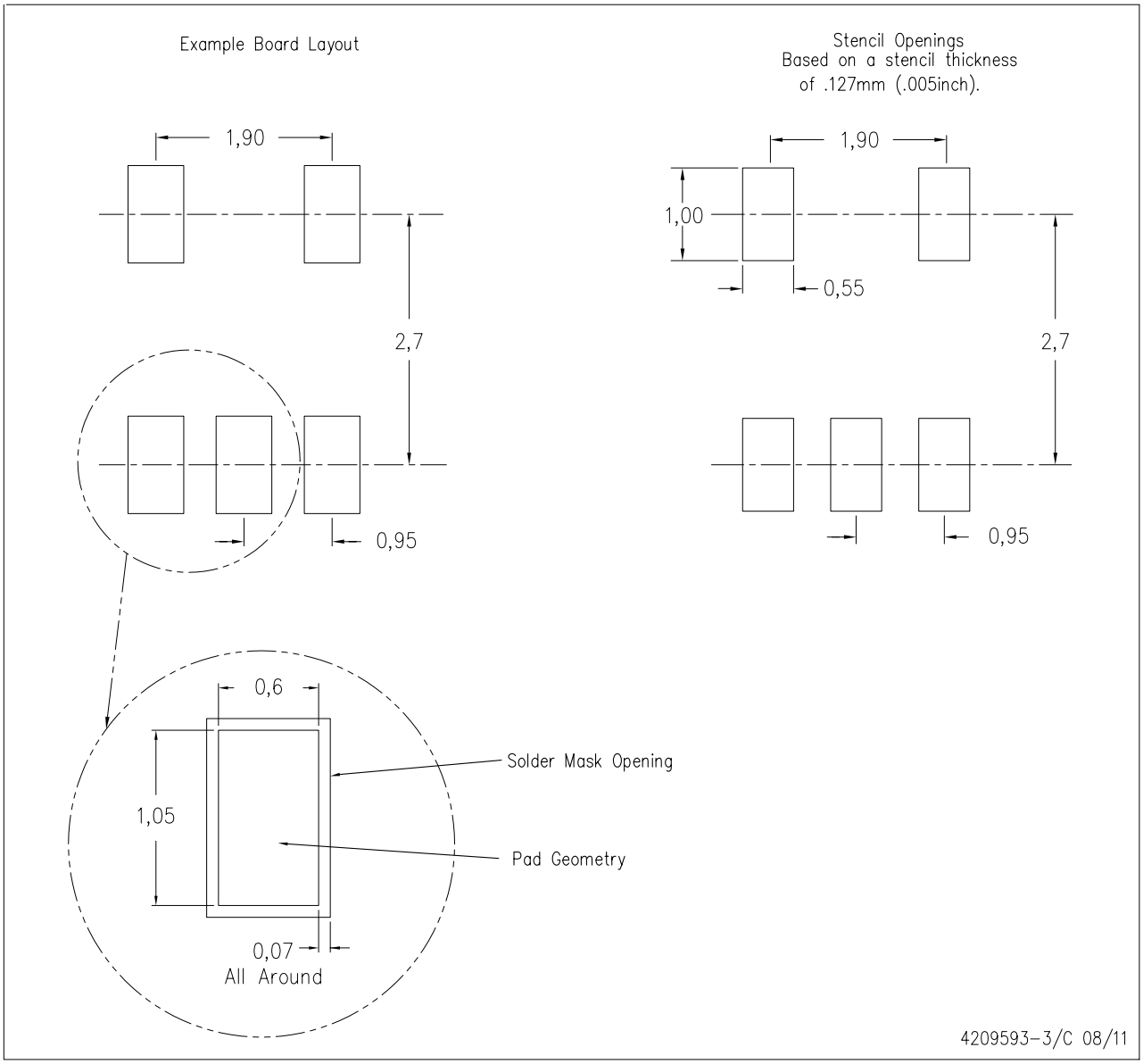



4073253–4/N 12/14

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.

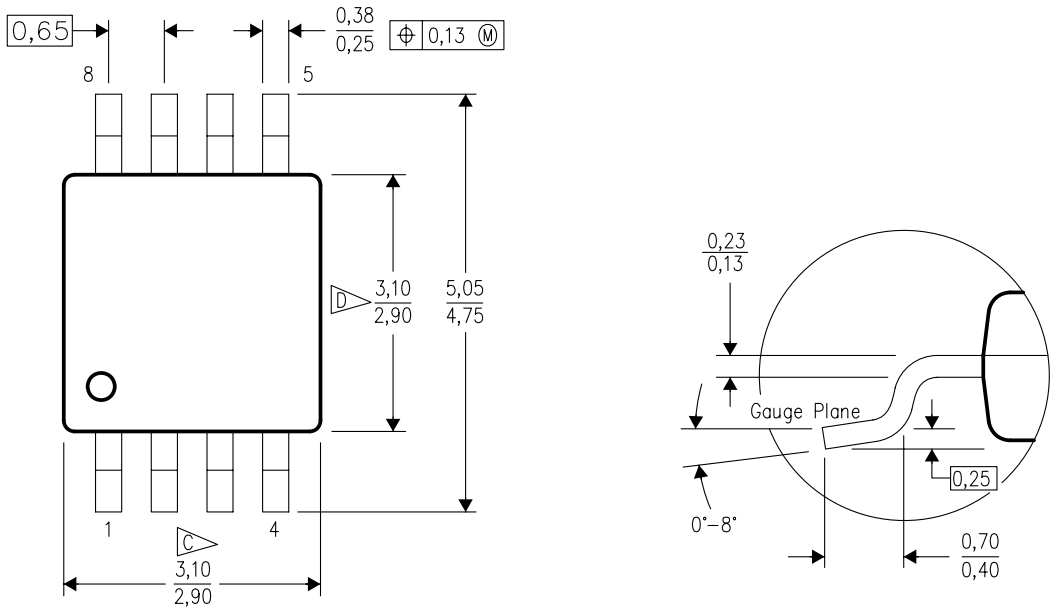
## LAND PATTERN DATA

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

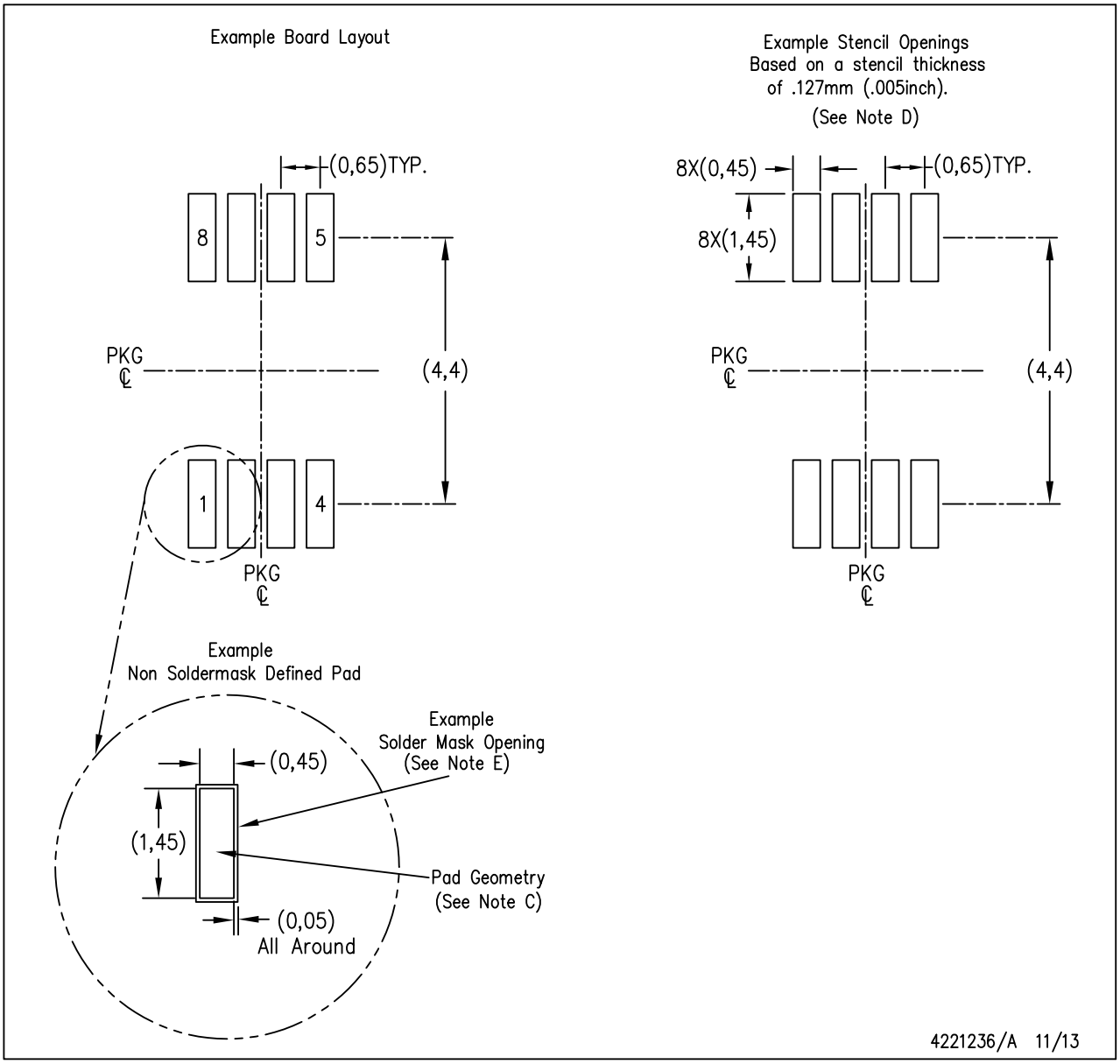



4073329/E 05/06

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.

## LAND PATTERN DATA

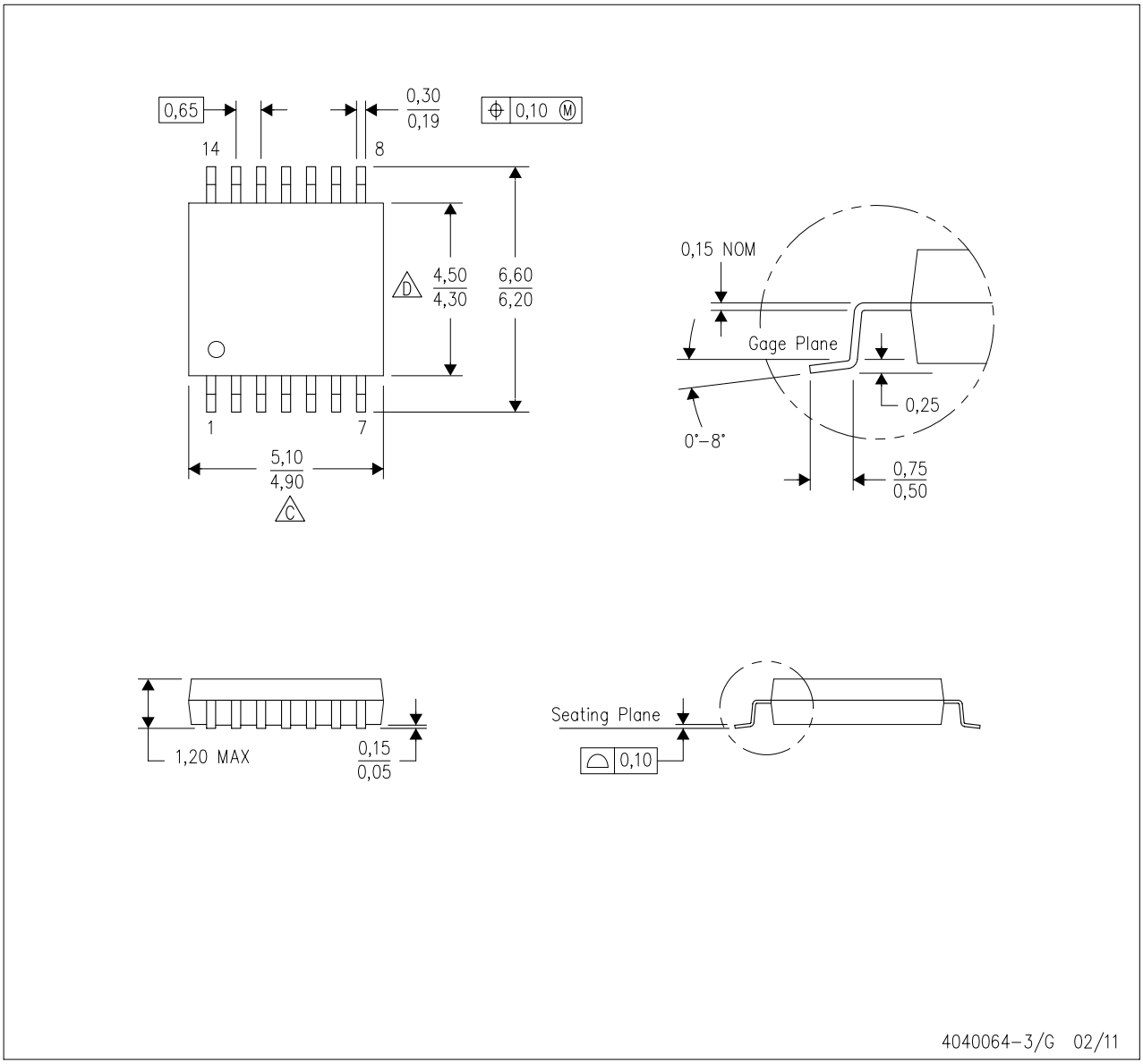
DGK (S–PDSO–G8) PLASTIC SMALL OUTLINE PACKAGE




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.

## MECHANICAL DATA

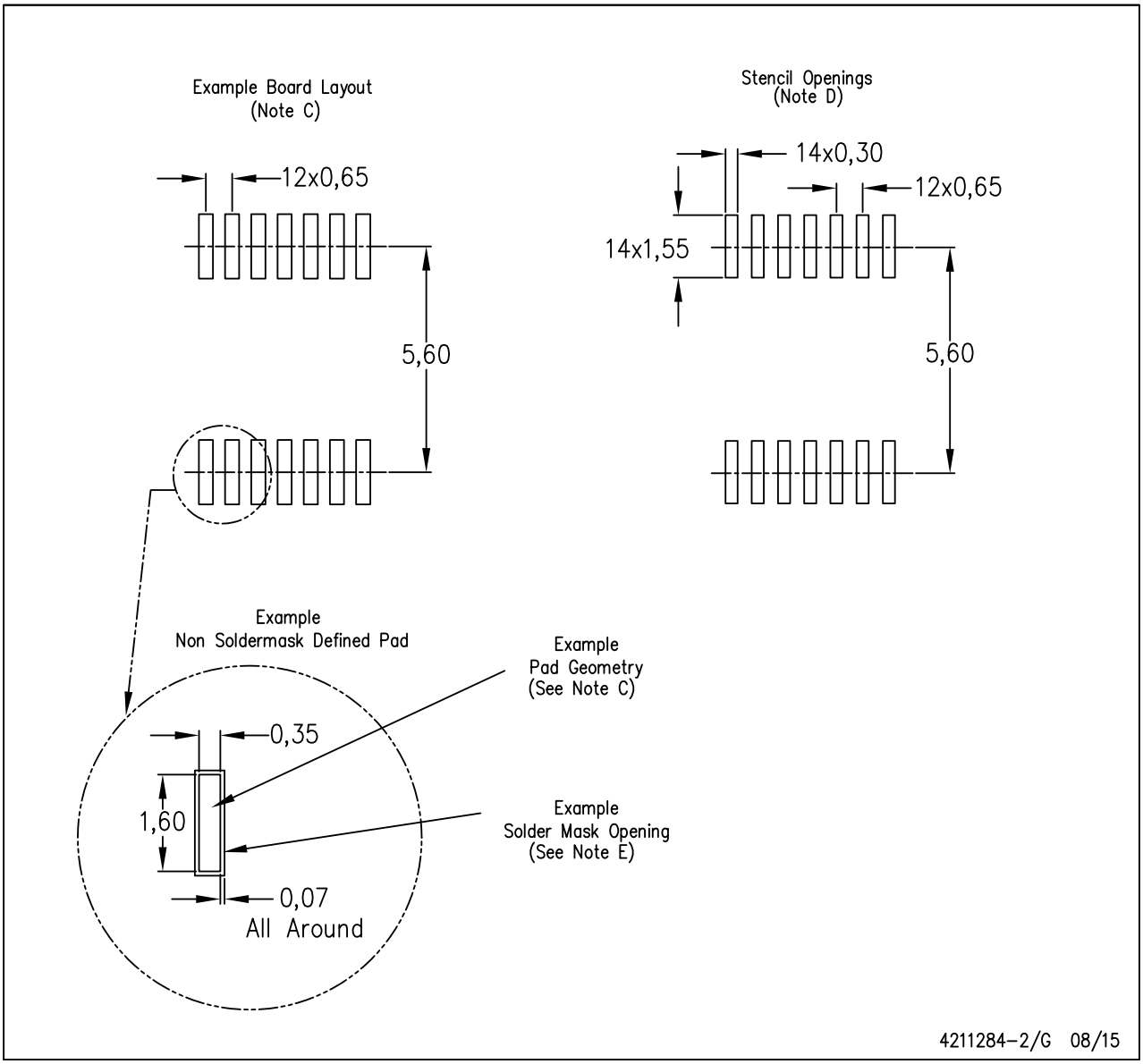
PW (R–PDSO–G14) PLASTIC SMALL OUTLINE




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

## LAND PATTERN DATA

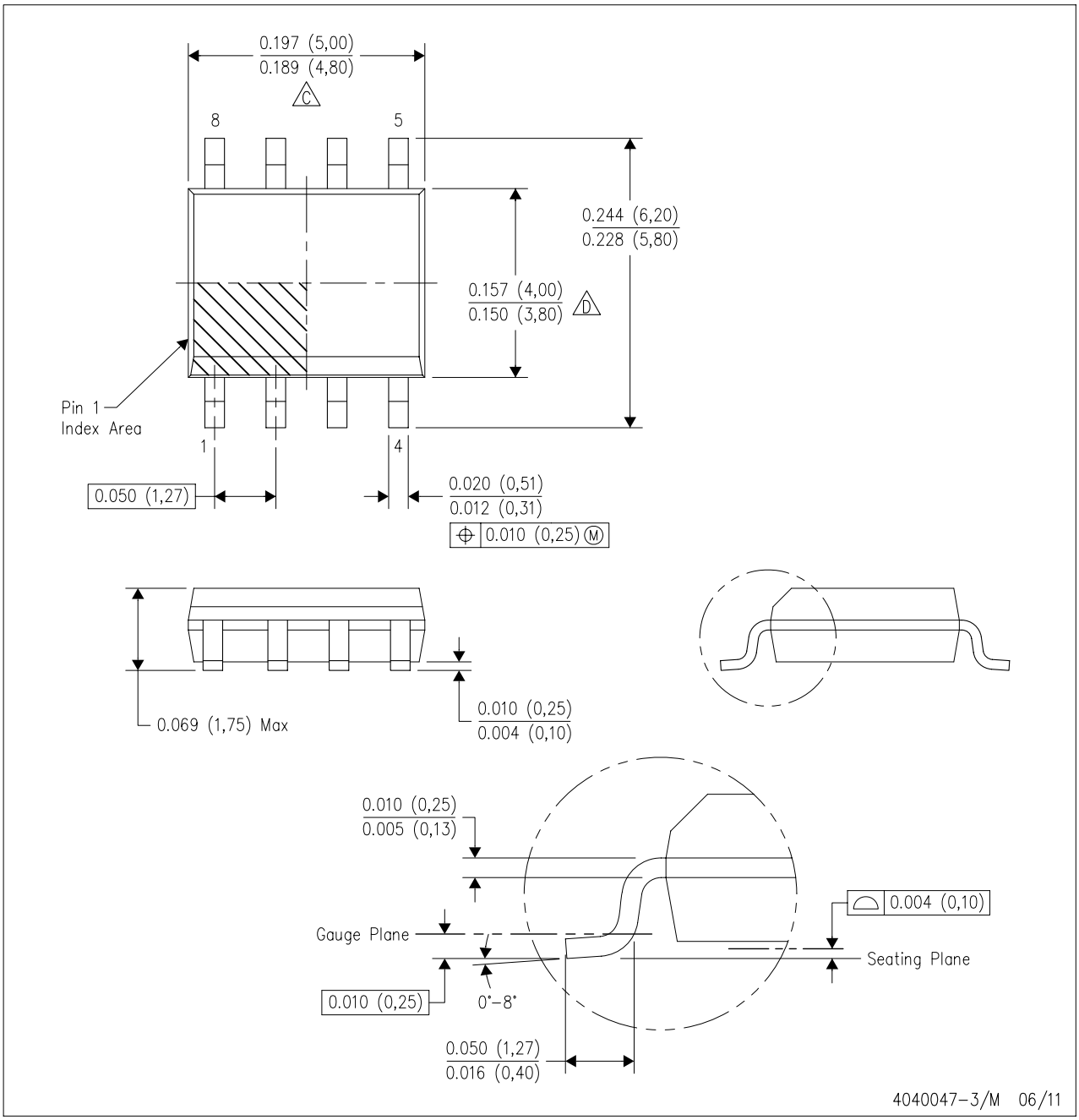
PW (R–PDSO–G14) PLASTIC SMALL OUTLINE




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.

## MECHANICAL DATA

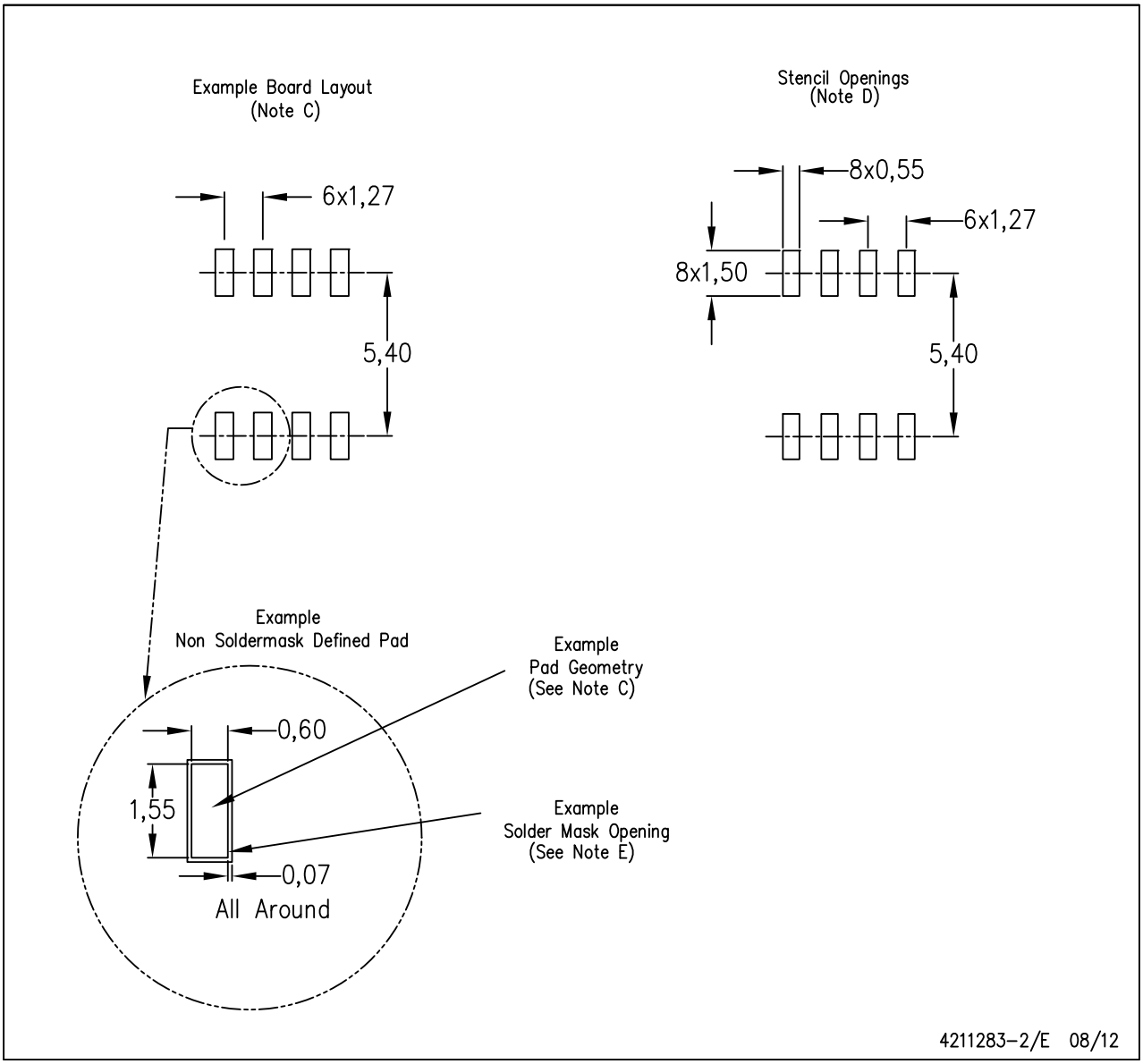
D (R–PDSO–G8) PLASTIC SMALL OUTLINE




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.

## LAND PATTERN DATA

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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