

# SINGLE-SUPPLY OPERATIONAL AMPLIFIERS

## *MicroAmplifier™* Series

### FEATURES

- **MICRO-SIZE, MINIATURE PACKAGES:**
  - Single: SOT23-5, SO-8
  - Dual: MSOP-8, SO-8
  - Quad: SSOP-16 (Obsolete)
- **LOW OFFSET VOLTAGE:** 750 $\mu$ V max
- **WIDE SUPPLY RANGE:**
  - Single Supply: +2.7V to +36V
  - Dual Supply:  $\pm$ 1.35V to  $\pm$ 18V
- **LOW QUIESCENT CURRENT:** 350 $\mu$ V max
- **WIDE BANDWIDTH:** 1.5MHz

### APPLICATIONS

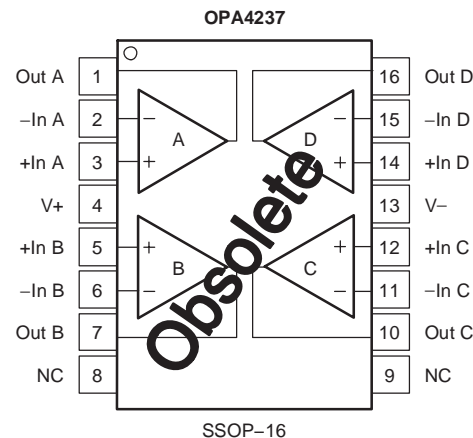
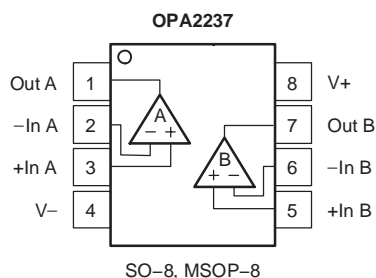
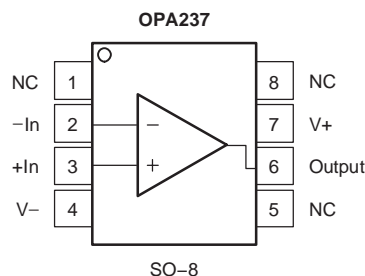
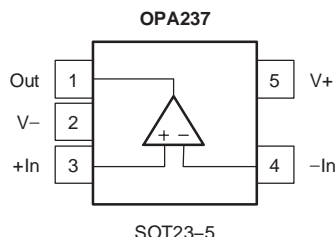
- BATTERY-POWERED INSTRUMENTS
- PORTABLE DEVICES
- PCMCIA CARDS
- MEDICAL INSTRUMENTS
- TEST EQUIPMENT

### DESCRIPTION

The OPA237 op amp family is one of Texas Instruments' MicroAmplifier™ series of miniature products. In addition to small size, these devices feature low offset voltage, low quiescent current, low bias current, and a wide supply range. Single, dual, and quad versions have identical specifications for maximum design flexibility. They are ideal for single-supply, battery-operated, and space-limited applications, such as PCMCIA cards and other portable instruments.

OPA237 series op amps can operate from either single or dual supplies. When operated from a single supply, the input common-mode range extends below ground and the output can swing to within 10mV of ground. Dual and quad designs feature completely independent circuitry for lowest crosstalk and freedom from interaction.

Single, dual, and quad are offered in space-saving surface-mount packages. The single version is available in the ultra-miniature 5-lead SOT23-5 and SO-8 surface-mount. The dual version comes in a miniature MSOP-8 and SO-8 surface-mount. The quad version is obsolete. MSOP-8 has the same lead count as a SO-8 but half the size. The SOT23-5 is even smaller at one-fourth the size of an SO-8. All are specified for  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  operation. A macromodel is available for design analysis.



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

Supply Voltage, V+ to V–	36V
Input Voltage	(V–) –0.7V to (V+) +0.7V
Output Short-Circuit <sup>(2)</sup>	Continuous
Operating Temperature Range	–55°C to +125°C
Storage Temperature Range	–55°C to +125°C
Junction Temperature Range	+150°C

(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.



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<sup>(1)</sup>

PRODUCT	PACKAGE-LEAD	PACKAGE DRAWING	PACKAGE MARKING
<b>Single</b>			
OPA237NA	SOT23-5	DBV	A37A
OPA237UA	SO-8	D	OPA237UA
<b>Dual</b>			
OPA2237EA	MSOP-8	DGK	B37A
OPA2237UA	SO-8	D	OPA2237UA
<b>Quad<sup>(2)</sup></b>			
OPA4237UA	SSOP-16	DBQ	OPA4237UA

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

(2) Quad version is obsolete.

## ELECTRICAL CHARACTERISTICS: $V_S = +5V$

**Boldface** limits apply over the specified temperature range,  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ .

At  $T_A = +25^\circ\text{C}$ ,  $V_S = +5V$ ,  $R_L = 10\text{k}\Omega$ , connected to  $V_S/2$ , unless otherwise noted.

PARAMETER	CONDITIONS	OPA237UA, NA OPA2237UA, EA OPA4237UA			UNITS
		MIN	TYP	MAX	
<b>OFFSET VOLTAGE</b> Input Offset Voltage <b>vs Temperature<sup>(1)</sup></b> vs Power Supply (PSRR) Channel Separation (dual and quad)	$V_{CM} = 2.5V$ <b>Specified Temperature Range</b> $V_S = +2.7V$ to $+36V$		$\pm 250$ <b><math>\pm 2</math></b> 10 0.5	$\pm 750$ <b><math>\pm 5</math></b> 30	$\mu V$ <b><math>\mu V/^\circ\text{C}</math></b> $\mu V/V$ $\mu V/V$
<b>INPUT BIAS CURRENT</b> Input Bias Current <sup>(2)</sup> Input Offset Current	$V_{CM} = 2.5V$ $V_{CM} = 2.5V$		-10 $\pm 0.5$	-40 $\pm 10$	nA nA
<b>NOISE</b> Input Voltage Noise, $f = 0.1$ to $10\text{Hz}$ Input Voltage Noise Density, $f = 1\text{kHz}$ Current Noise Density, $f = 1\text{kHz}$			1 28 60		$\mu V_{pp}$ $nV/\sqrt{\text{Hz}}$ $fA/\sqrt{\text{Hz}}$
<b>INPUT VOLTAGE RANGE</b> Common-Mode Voltage Range Common-Mode Rejection Ratio	$V_{CM} = -0.2V$ to $3.5V$	-0.2 78	86	(V+) -1.5	V dB
<b>INPUT IMPEDANCE</b> Differential Common-Mode			$5 \cdot 10^6 \parallel 4$ $5 \cdot 10^9 \parallel 2$		$\Omega \parallel pF$ $\Omega \parallel pF$
<b>OPEN-LOOP GAIN</b> Open-Loop Voltage Gain	$V_O = 0.5V$ to $4V$	80	88		dB
<b>FREQUENCY RESPONSE</b> Gain-Bandwidth Product Slew Rate Settling Time, 0.1% 0.01%	$G = 1$ $G = -1$ , 3V Step, $C_L = 100pF$ $G = -1$ , 3V Step, $C_L = 100pF$		1.4 0.5 11 16		MHz V/ $\mu s$ $\mu s$ $\mu s$
<b>OUTPUT</b> Voltage Output, Positive Negative Positive Negative Positive Negative Short-Circuit Current Capacitive Load Drive (stable operation)	$R_L = 100k\Omega$ to Ground $R_L = 100k\Omega$ to Ground $R_L = 100k\Omega$ to $2.5V$ $R_L = 100k\Omega$ to $2.5V$ $R_L = 10k\Omega$ to $2.5V$ $R_L = 10k\Omega$ to $2.5V$	(V+) -1 0.01 (V+) -1 0.12 (V+) -1 0.5	(V+) -0.75 0.001 (V+) -0.75 0.04 (V+) -0.75 0.35 -10/+4		V V V V V V mA
		See Typical Characteristic Curves			
<b>POWER SUPPLY</b> Specified Operating Voltage Operating Range Quiescent Current (per amplifier)		+2.7	+5 170	+36 350	V V $\mu A$
<b>TEMPERATURE RANGE</b> Specified Range Operating Range Storage Range Thermal Resistance, $\theta_{JA}$ SOT23-5 MSOP-8 SSOP-16 (Obsolete) SO-8		-40 -55 -55		+85 +125 +125	$^\circ\text{C}$ $^\circ\text{C}$ $^\circ\text{C}$ $^\circ\text{C/W}$ $^\circ\text{C/W}$ $^\circ\text{C/W}$ $^\circ\text{C/W}$

(1) Specified by wafer-level test to 95% confidence.

(2) Positive conventional current flows into the input terminals.

## ELECTRICAL CHARACTERISTICS: $V_S = +2.7V$

**Boldface** limits apply over the specified temperature range,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ .

At  $T_A = +25^{\circ}C$ ,  $V_S = +2.7V$ ,  $R_L = 10k\Omega$ , connected to  $V_S/2$ , unless otherwise noted.

PARAMETER	CONDITIONS	OPA237UA, NA OPA2237UA, EA OPA4237UA			UNITS
		MIN	TYP	MAX	
<b>OFFSET VOLTAGE</b>					
Input Offset Voltage	$V_{CM} = 1V$		$\pm 250$	$\pm 750$	$\mu V$
<b>vs Temperature<sup>(1)</sup></b>	<b>Specified Temperature Range</b>		$\pm 2$	$\pm 5$	$\mu V/^{\circ}C$
vs Power Supply (PSRR)	$V_S = +2.7V$ to $+36V$		10	30	$\mu V/V$
Channel Separation (dual and quad)			0.5		$\mu V/V$
<b>INPUT BIAS CURRENT</b>					
Input Bias Current <sup>(2)</sup>	$V_{CM} = 1V$		-10	-40	nA
Input Offset Current	$V_{CM} = 1V$		$\pm 0.5$	$\pm 10$	nA
<b>NOISE</b>					
Input Voltage Noise, $f = 0.1$ to $10Hz$			1		$\mu V_{PP}$
Input Voltage Noise Density, $f = 1kHz$			28		$nV/\sqrt{Hz}$
Current Noise Density, $f = 1kHz$			60		$fA/\sqrt{Hz}$
<b>INPUT VOLTAGE RANGE</b>					
Common-Mode Voltage Range		-0.2		(V+) -1.5	V
Common-Mode Rejection Ratio	$V_{CM} = -0.2V$ to $1.2V$	75	85		dB
<b>INPUT IMPEDANCE</b>					
Differential			$5 \bullet 10^6 \parallel 4$		$\Omega \parallel pF$
Common-Mode			$5 \bullet 10^9 \parallel 2$		$\Omega \parallel pF$
<b>OPEN-LOOP GAIN</b>					
Open-Loop Voltage Gain	$V_O = 0.5V$ to $1.7V$	80	88		dB
<b>FREQUENCY RESPONSE</b>					
Gain-Bandwidth Product			1.2		MHz
Slew Rate	$G = 1$		0.5		V/ $\mu s$
Settling Time, 0.1%	$G = -1$ , 1V Step, $C_L = 100pF$		5		$\mu s$
0.01%	$G = -1$ , 1V Step, $C_L = 100pF$		8		$\mu s$
<b>OUTPUT</b>					
Voltage Output, Positive	$R_L = 100k\Omega$ to Ground	(V+) -1	(V+) -0.75		V
Negative	$R_L = 100k\Omega$ to Ground	0.01	0.001		V
Positive	$R_L = 100k\Omega$ to $1.35V$	(V+) -1	(V+) -0.75		V
Negative	$R_L = 100k\Omega$ to $1.35V$	0.06	0.02		V
Positive	$R_L = 10k\Omega$ to $1.35V$	(V+) -1	(V+) -0.75		V
Negative	$R_L = 10k\Omega$ to $1.35V$	0.3	0.2		V
Short-Circuit Current			-5/+3.5		mA
Capacitive Load Drive (stable operation)		See Typical Characteristic Curves			
<b>POWER SUPPLY</b>					
Specified Operating Voltage			+2.7		V
Operating Range		+2.7		+36	V
Quiescent Current (per amplifier)			160	350	$\mu A$
<b>TEMPERATURE RANGE</b>					
Specified Range		-40		+85	$^{\circ}C$
Operating Range		-55		+125	$^{\circ}C$
Storage Range		-55		+125	$^{\circ}C$
Thermal Resistance, $\theta_{JA}$					
SOT23-5			200		$^{\circ}C/W$
MSOP-8			150		$^{\circ}C/W$
SSOP-16 (Obsolete)			150		$^{\circ}C/W$
SO-8			150		$^{\circ}C/W$

(1) Specified by wafer-level test to 95% confidence.

(2) Positive conventional current flows into the input terminals.

**ELECTRICAL CHARACTERISTICS:  $V_S = \pm 15V$** 
**Boldface** limits apply over the specified temperature range,  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ .

At  $T_A = +25^\circ\text{C}$ ,  $V_S = \pm 15V$ ,  $R_L = 10k\Omega$ , connected to  $V_S/2$ , unless otherwise noted.

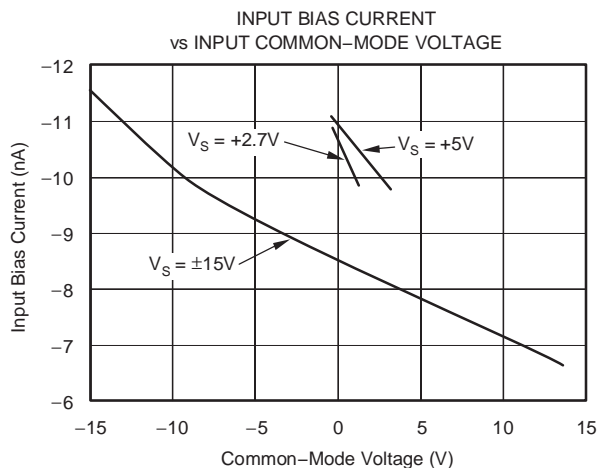
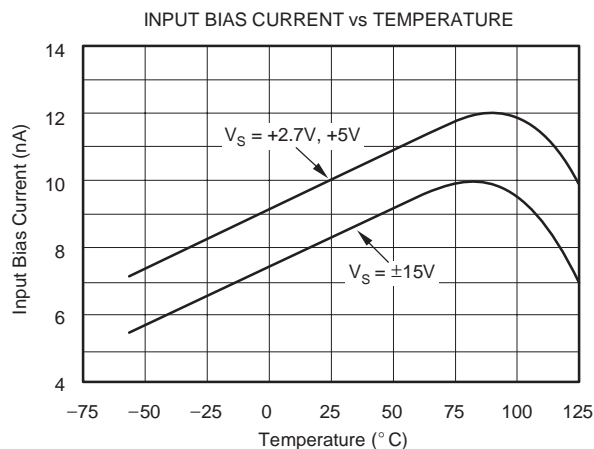
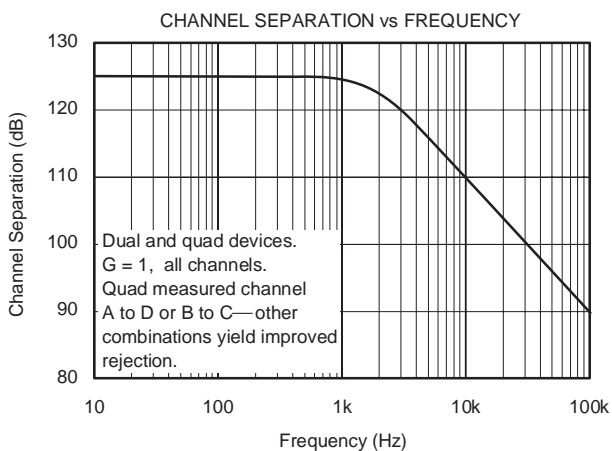
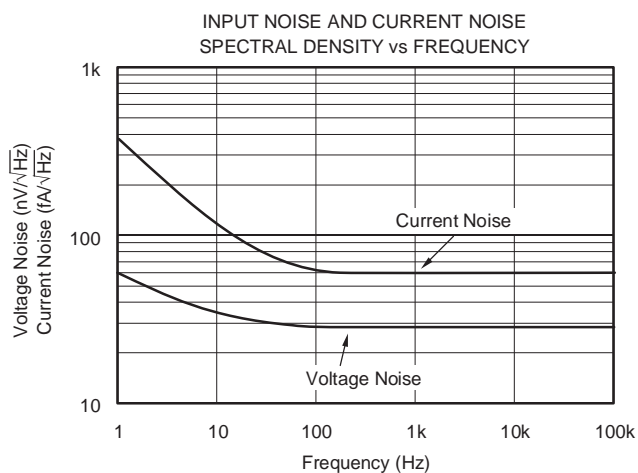
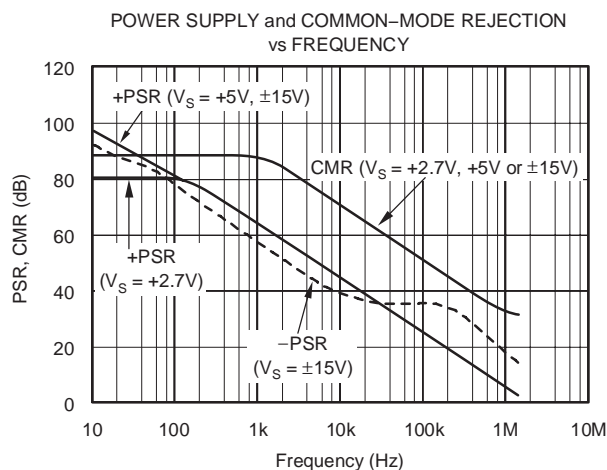
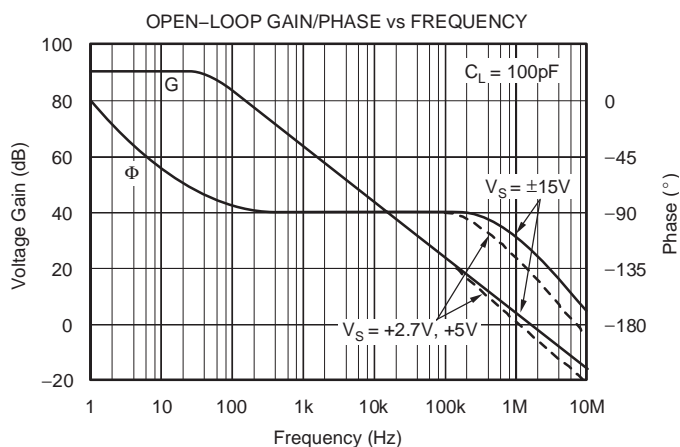
PARAMETER	CONDITIONS	OPA237UA, NA OPA2237UA, EA OPA4237UA			UNITS
		MIN	TYP	MAX	
<b>OFFSET VOLTAGE</b> Input Offset Voltage <b>vs Temperature<sup>(1)</sup></b> vs Power Supply (PSRR) Channel Separation (dual and quad)	$V_{CM} = 0V$ <b>Specified Temperature Range</b> $V_S = \pm 1.35V$ to $\pm 18V$		$\pm 350$ <b><math>\pm 2.5</math></b> 10 0.5	$\pm 950$ <b><math>\pm 7</math></b> 30	$\mu V$ <b><math>\mu V/^\circ\text{C}</math></b> $\mu V/V$ $\mu V/V$
<b>INPUT BIAS CURRENT</b> Input Bias Current <sup>(2)</sup> Input Offset Current	$V_{CM} = 0V$ $V_{CM} = 0V$		-8.5 $\pm 0.5$	-40 $\pm 10$	nA nA
<b>NOISE</b> Input Voltage Noise, $f = 0.1$ to $10\text{Hz}$ Input Voltage Noise Density, $f = 1\text{kHz}$ Current Noise Density, $f = 1\text{kHz}$			1 28 60		$\mu V_{pp}$ $nV/\sqrt{\text{Hz}}$ $fA/\sqrt{\text{Hz}}$
<b>INPUT VOLTAGE RANGE</b> Common-Mode Voltage Range Common-Mode Rejection Ratio	$V_{CM} = -15V$ to $13.5V$	(V-) -0.2 80	90	(V+) -1.5	V dB
<b>INPUT IMPEDANCE</b> Differential Common-Mode			$5 \cdot 10^6 \parallel 4$ $5 \cdot 10^9 \parallel 2$		$\Omega \parallel pF$ $\Omega \parallel pF$
<b>OPEN-LOOP GAIN</b> Open-Loop Voltage Gain	$V_O = -14V$ to $13.8V$	80	88		dB
<b>FREQUENCY RESPONSE</b> Gain-Bandwidth Product Slew Rate Settling Time, 0.1% 0.01%	$G = 1$ $G = -1$ , 10V Step, $C_L = 100pF$ $G = -1$ , 10V Step, $C_L = 100pF$		1.5 0.5 18 21		MHz V/ $\mu s$ $\mu s$ $\mu s$
<b>OUTPUT</b> Voltage Output, Positive Negative Positive Negative Short-Circuit Current Capacitive Load Drive (stable operation)	$R_L = 100k\Omega$ $R_L = 100k\Omega$ $R_L = 10k\Omega$ $R_L = 10k\Omega$	(V+) -1.2 (V-) +0.5 (V+) -1.2 (V-) +1	(V+) -0.9 (V-) +0.3 (V+) -0.9 (V-) +0.85 -8/+4.5		V V V V mA
		See Typical Characteristic Curves			
<b>POWER SUPPLY</b> Specified Operating Range Operating Range Quiescent Current (per amplifier)		$\pm 1.35$	$\pm 15$  $\pm 200$	$\pm 18$  $\pm 475$	V V $\mu A$
<b>TEMPERATURE RANGE</b> Specified Range Operating Range Storage Range Thermal Resistance, $\theta_{JA}$ SOT23-5 MSOP-8 SSOP-16 (Obsolete) SO-8		-40 -55 -55		+85 +125 +125	$^\circ\text{C}$ $^\circ\text{C}$ $^\circ\text{C}$
			200 150 150 150		$^\circ\text{C/W}$ $^\circ\text{C/W}$ $^\circ\text{C/W}$ $^\circ\text{C/W}$

(1) Specified by wafer-level test to 95% confidence.

(2) Positive conventional current flows into the input terminals.

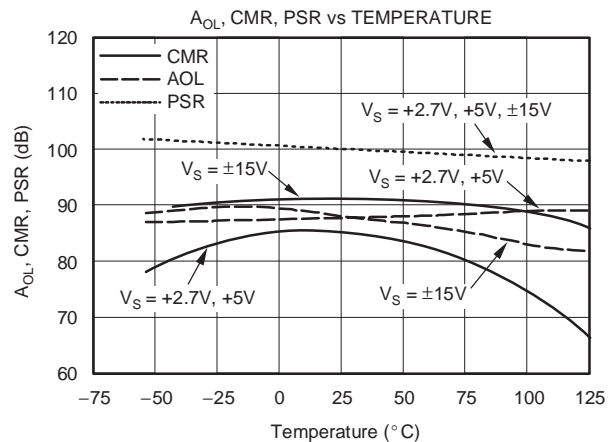
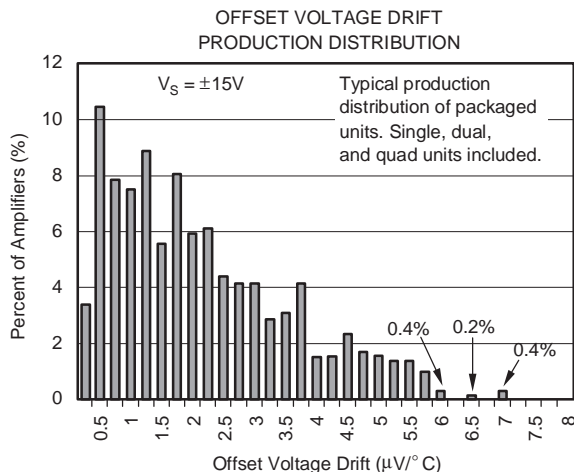
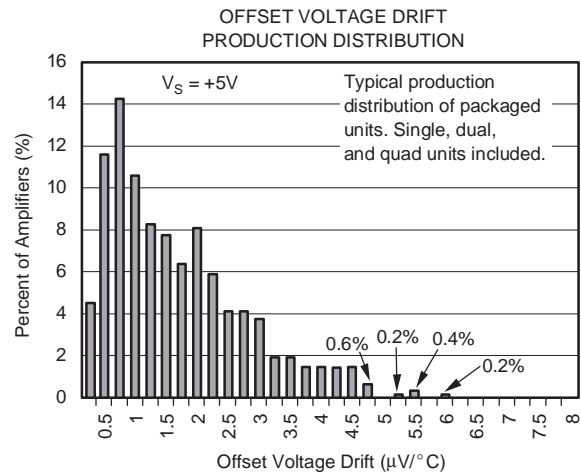
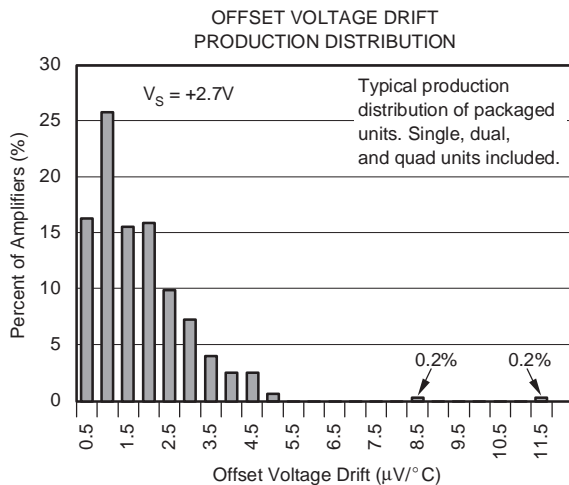
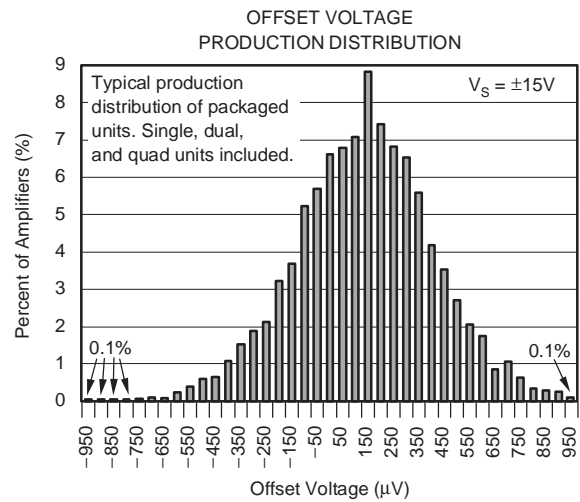
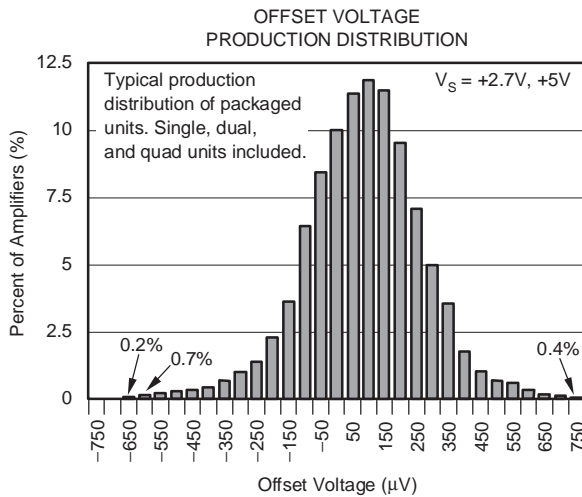
## TYPICAL CHARACTERISTICS

At  $T_A = +25^\circ\text{C}$  and  $R_L = 10\text{k}\Omega$ , unless otherwise noted.



## TYPICAL CHARACTERISTICS (Continued)

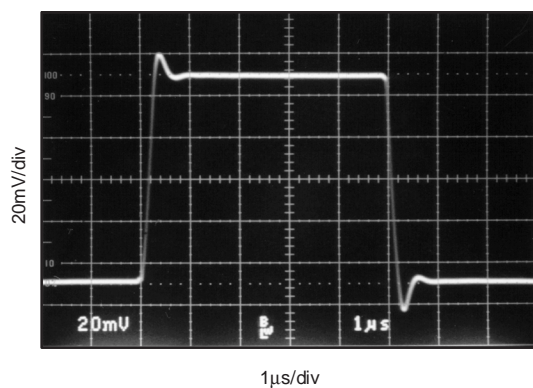
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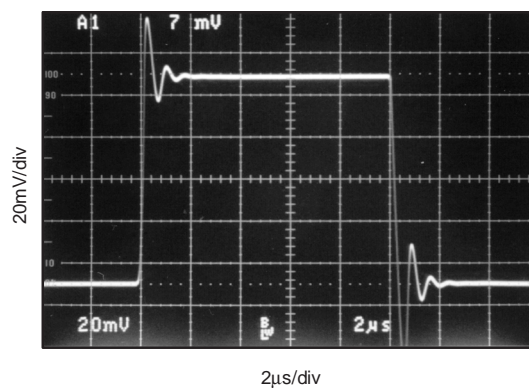
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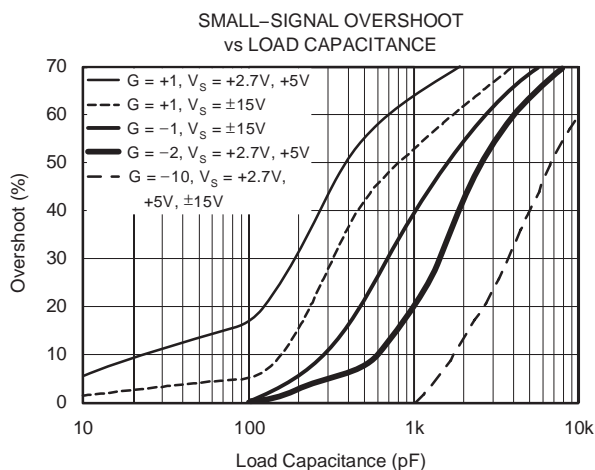
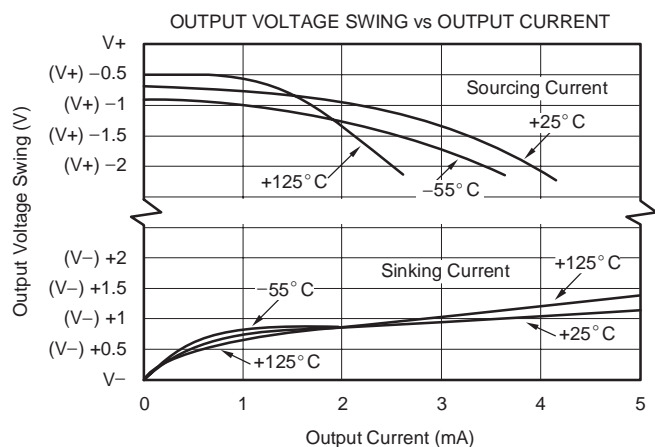
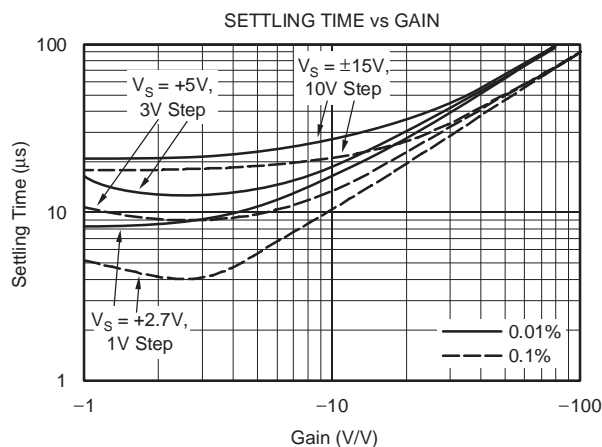
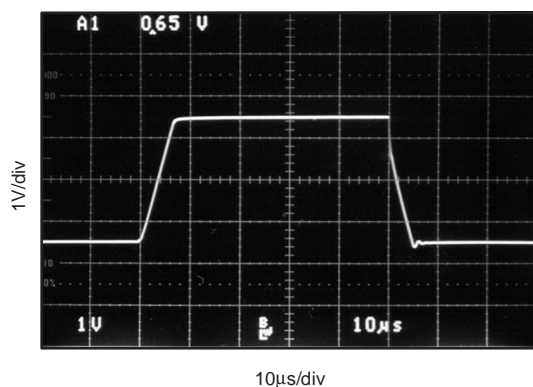
SMALL-SIGNAL STEP RESPONSE  
( $G = 1$ ,  $C_L = 100\text{pF}$ ,  $V_S = +5\text{V}$ )



SMALL-SIGNAL STEP RESPONSE  
( $G = 1$ ,  $C_L = 220\text{pF}$ ,  $V_S = +5\text{V}$ )



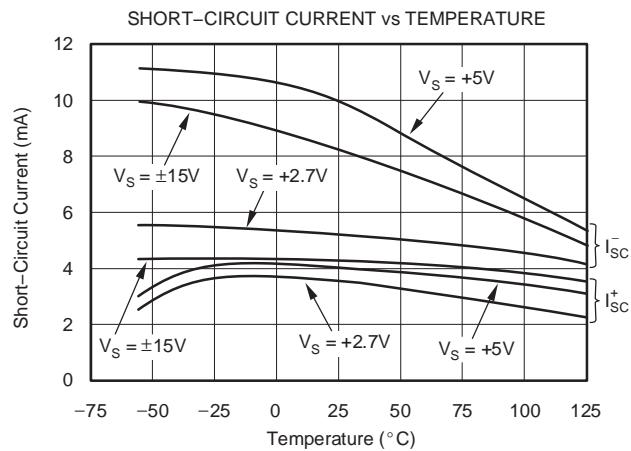
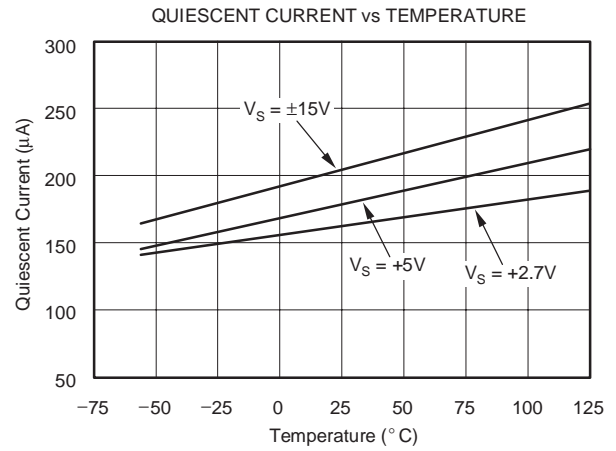
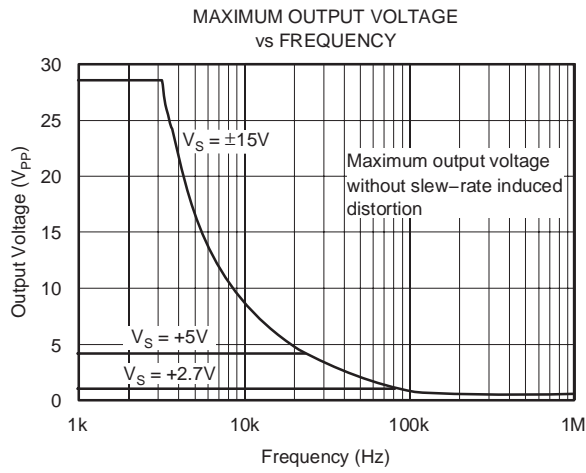
LARGE-SIGNAL STEP RESPONSE  
( $G = 1$ ,  $C_L = 100\text{pF}$ ,  $V_S = +5\text{V}$ )





## TYPICAL CHARACTERISTICS (Continued)

At  $T_A = +25^\circ\text{C}$  and  $R_L = 10\text{k}\Omega$ , unless otherwise noted.



## APPLICATION INFORMATION

OPA237 series op amps are unity-gain stable and suitable for a wide range of general-purpose applications. Power supply pins should be bypassed with 10nF ceramic capacitors.

### OPERATING VOLTAGE

OPA237 series op amps operate from single (+2.7V to +36V) or dual ( $\pm 1.35$ V to  $\pm 18$ V) supplies with excellent performance. Most behavior remains unchanged throughout the full operating voltage range. Parameters which vary significantly with operating voltage are shown in typical performance curves. Specifications are production tested with +2.7V, +5V, and  $\pm 15$ V supplies.

### OUTPUT CURRENT AND STABILITY

OPA237 series op amps can drive large capacitive loads. However, under certain limited output conditions any op amp may become unstable. Figure 1 shows the region where the OPA237 has a potential for instability. These load conditions are rarely encountered, especially for single supply applications. For example, take the case when a +5V supply with a 10k $\Omega$  load to  $V_S/2$  is used.

OPA237 series op amps remain stable with capacitive loads up to 4,000pF, if sinking current and up to 10,000pF, if sourcing current. Furthermore, in single-supply applications where the load is connected to ground, the op amp is only sourcing current, and as shown Figure 1, can drive 10,000pF with output currents up to 1.5mA.

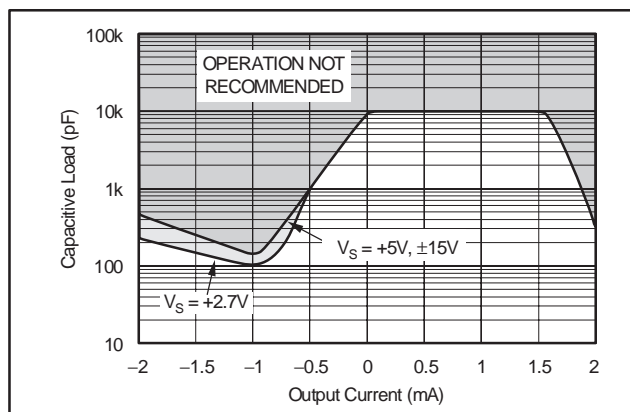


Figure 1. Stability-Capacitive Load vs Output Current

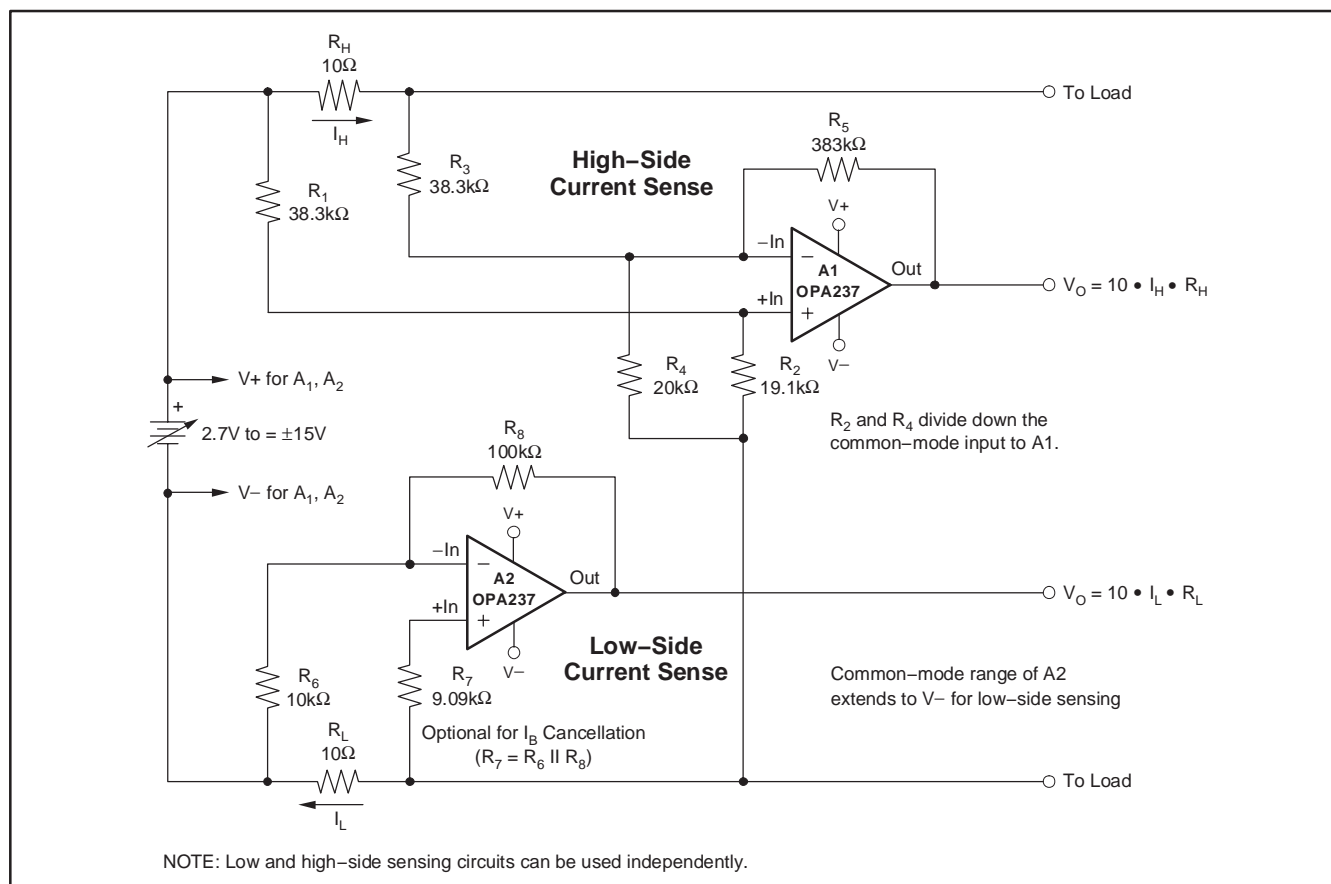


Figure 2. Low and High-Side Battery Current Sensing

**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
OPA2237EA/250	ACTIVE	VSSOP	DGK	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU   CU NIPDAUAG	Level-3-260C-168 HR		B37A	<a href="#">Samples</a>
OPA2237EA/250G4	ACTIVE	VSSOP	DGK	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR		B37A	<a href="#">Samples</a>
OPA2237EA/2K5	ACTIVE	VSSOP	DGK	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU   CU NIPDAUAG	Level-3-260C-168 HR	-40 to 85	B37A	<a href="#">Samples</a>
OPA2237EA/2K5G4	ACTIVE	VSSOP	DGK	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	-40 to 85	B37A	<a href="#">Samples</a>
OPA2237UA	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR		OPA 2237UA	<a href="#">Samples</a>
OPA2237UA/2K5	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR		OPA 2237UA	<a href="#">Samples</a>
OPA2237UA/2K5E4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR		OPA 2237UA	<a href="#">Samples</a>
OPA2237UAE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR		OPA 2237UA	<a href="#">Samples</a>
OPA237NA/250	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR		A37A	<a href="#">Samples</a>
OPA237NA/250E4	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR		A37A	<a href="#">Samples</a>
OPA237NA/3K	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR		A37A	<a href="#">Samples</a>
OPA237NA/3KE4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR		A37A	<a href="#">Samples</a>
OPA237UA	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR		OPA 237UA	<a href="#">Samples</a>
OPA237UA/2K5	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR		OPA 237UA	<a href="#">Samples</a>
OPA237UA/2K5G4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR		OPA 237UA	<a href="#">Samples</a>
OPA237UAG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR		OPA 237UA	<a href="#">Samples</a>
OPA4237UA/250	OBSOLETE	SSOP	DBQ	16		TBD	Call TI	Call TI			
OPA4237UA/2K5	OBSOLETE	SSOP	DBQ	16		TBD	Call TI	Call TI	0 to 70		

(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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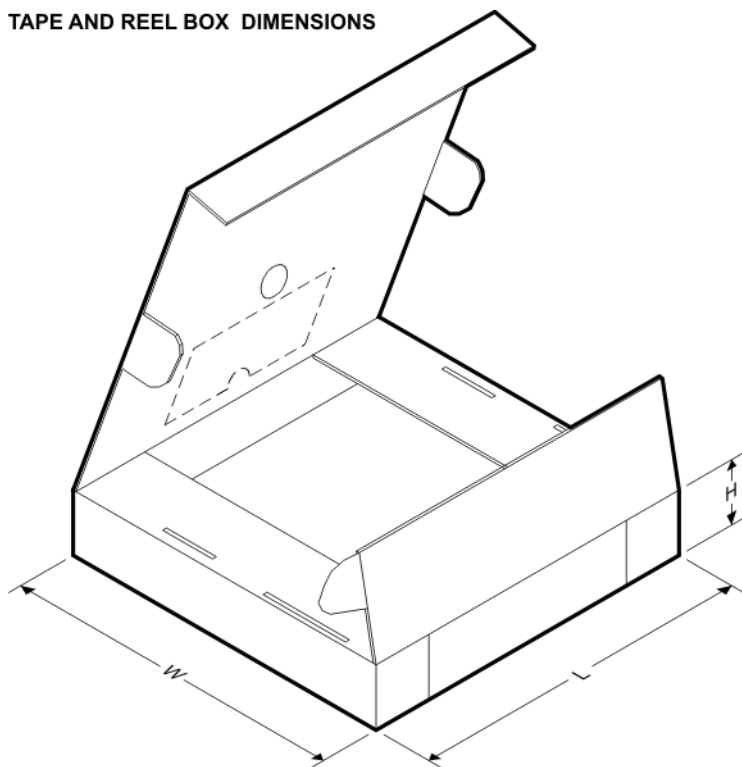
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**TAPE AND REEL INFORMATION**


\*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
OPA2237EA/250	VSSOP	DGK	8	250	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
OPA2237EA/2K5	VSSOP	DGK	8	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
OPA237NA/250	SOT-23	DBV	5	250	178.0	9.0	3.3	3.2	1.4	4.0	8.0	Q3
OPA237NA/3K	SOT-23	DBV	5	3000	178.0	9.0	3.3	3.2	1.4	4.0	8.0	Q3
OPA237UA/2K5	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1

## TAPE AND REEL BOX DIMENSIONS

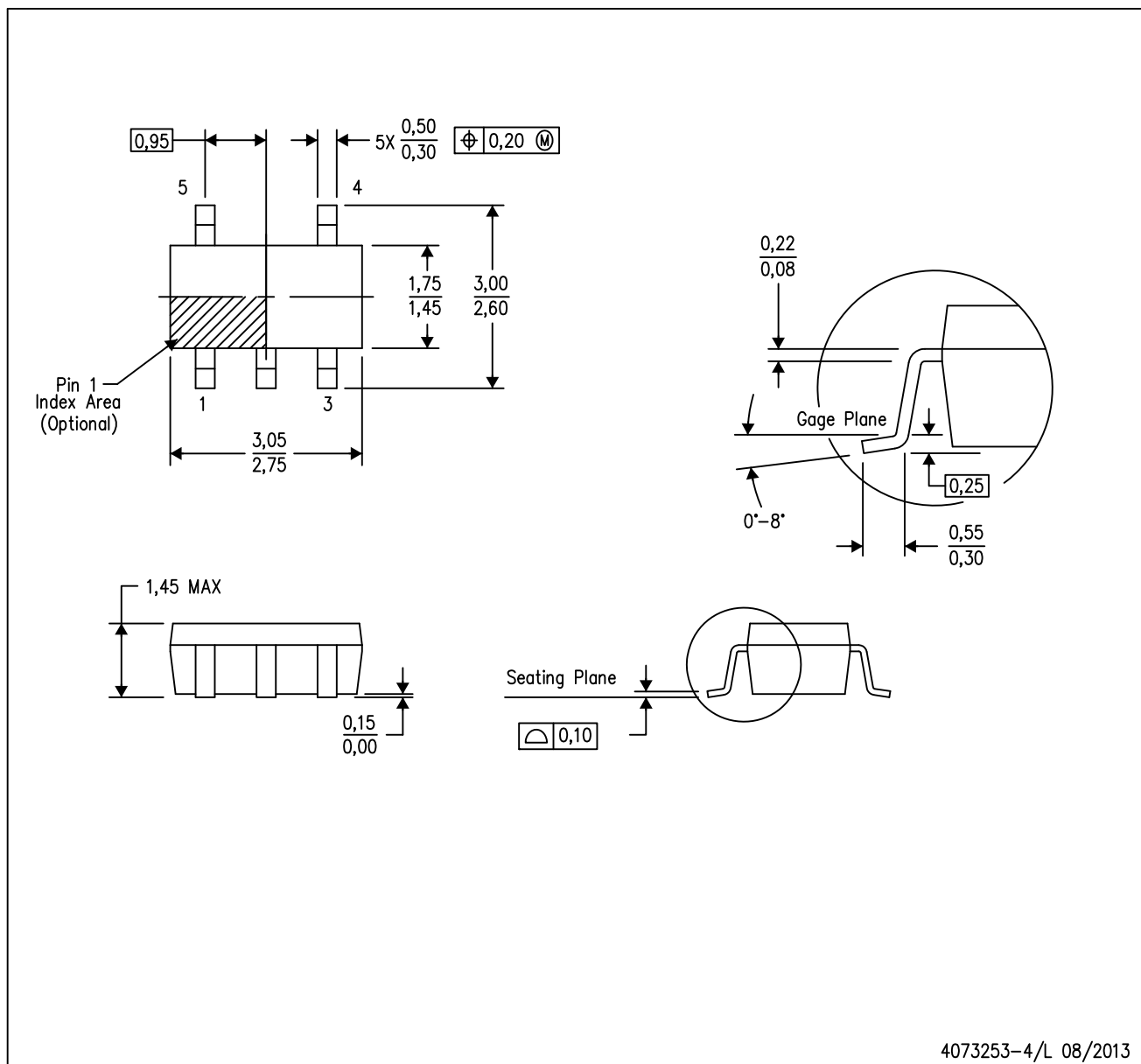


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
OPA2237EA/250	VSSOP	DGK	8	250	366.0	364.0	50.0
OPA2237EA/2K5	VSSOP	DGK	8	2500	366.0	364.0	50.0
OPA237NA/250	SOT-23	DBV	5	250	180.0	180.0	18.0
OPA237NA/3K	SOT-23	DBV	5	3000	180.0	180.0	18.0
OPA237UA/2K5	SOIC	D	8	2500	367.0	367.0	35.0

DBV (R-PDSO-G5)

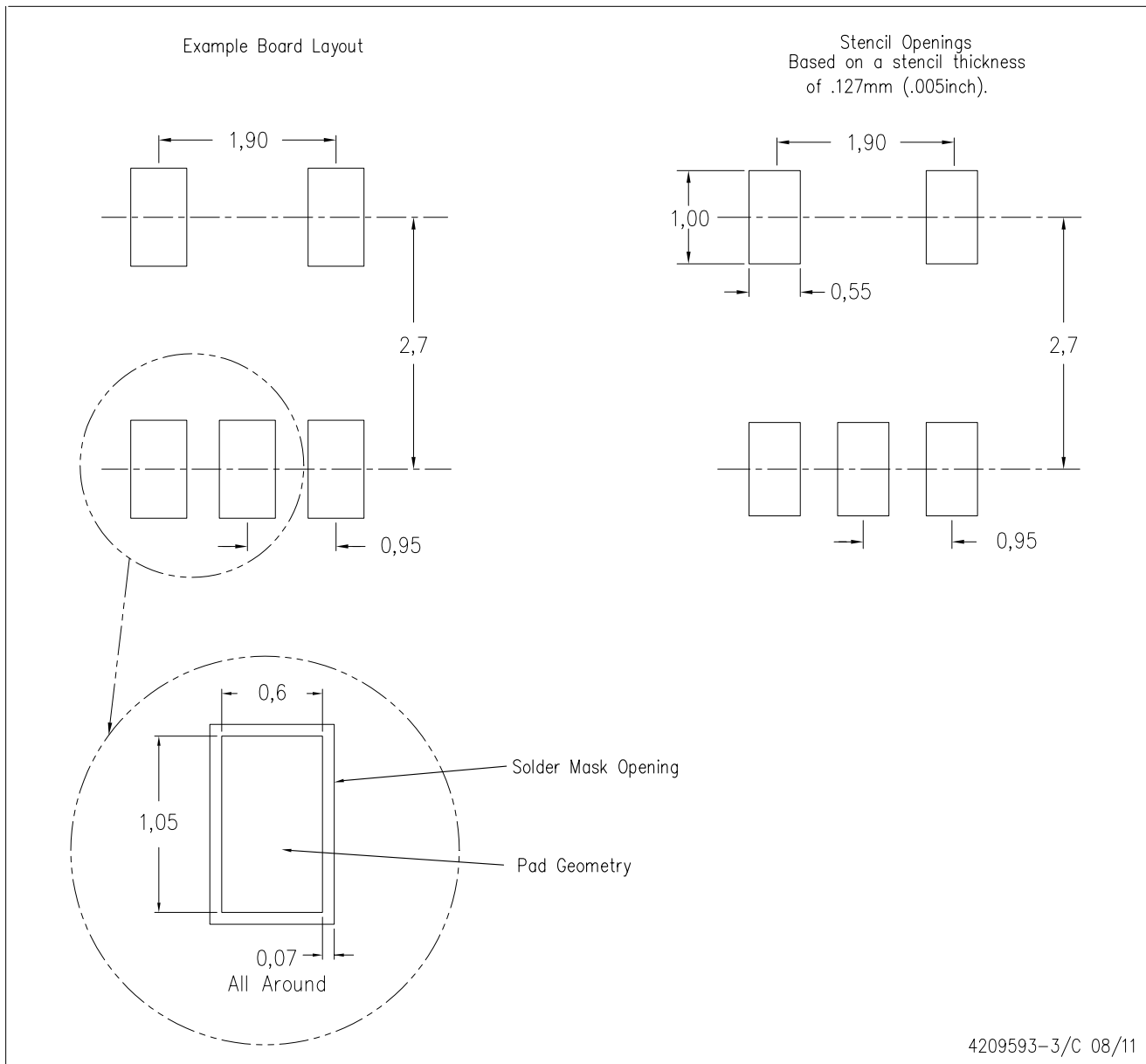
PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion. 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

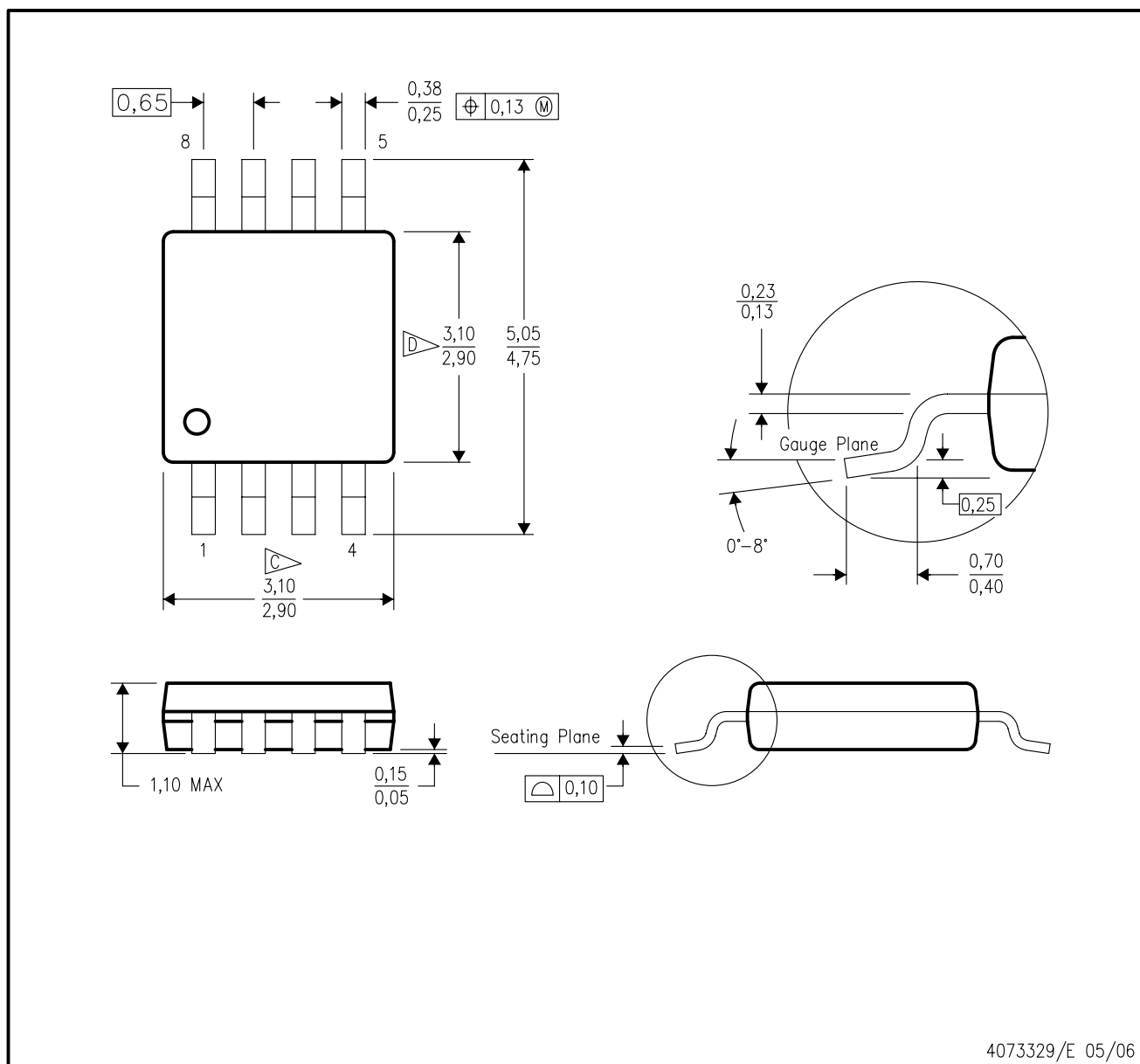


- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
  - D. Publication IPC-7351 is recommended for alternate designs.
  - 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



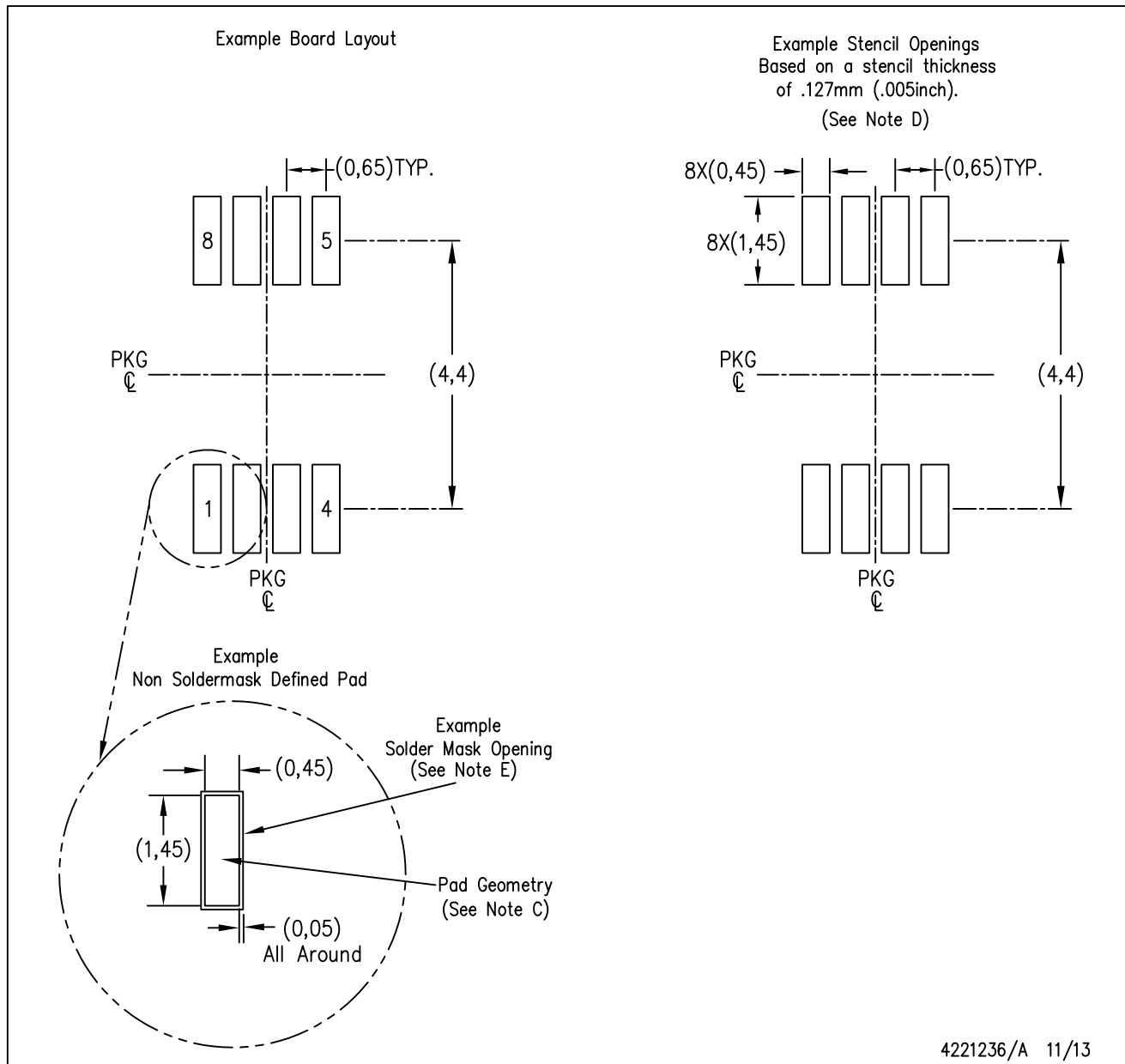
4073329/E 05/06

## 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)

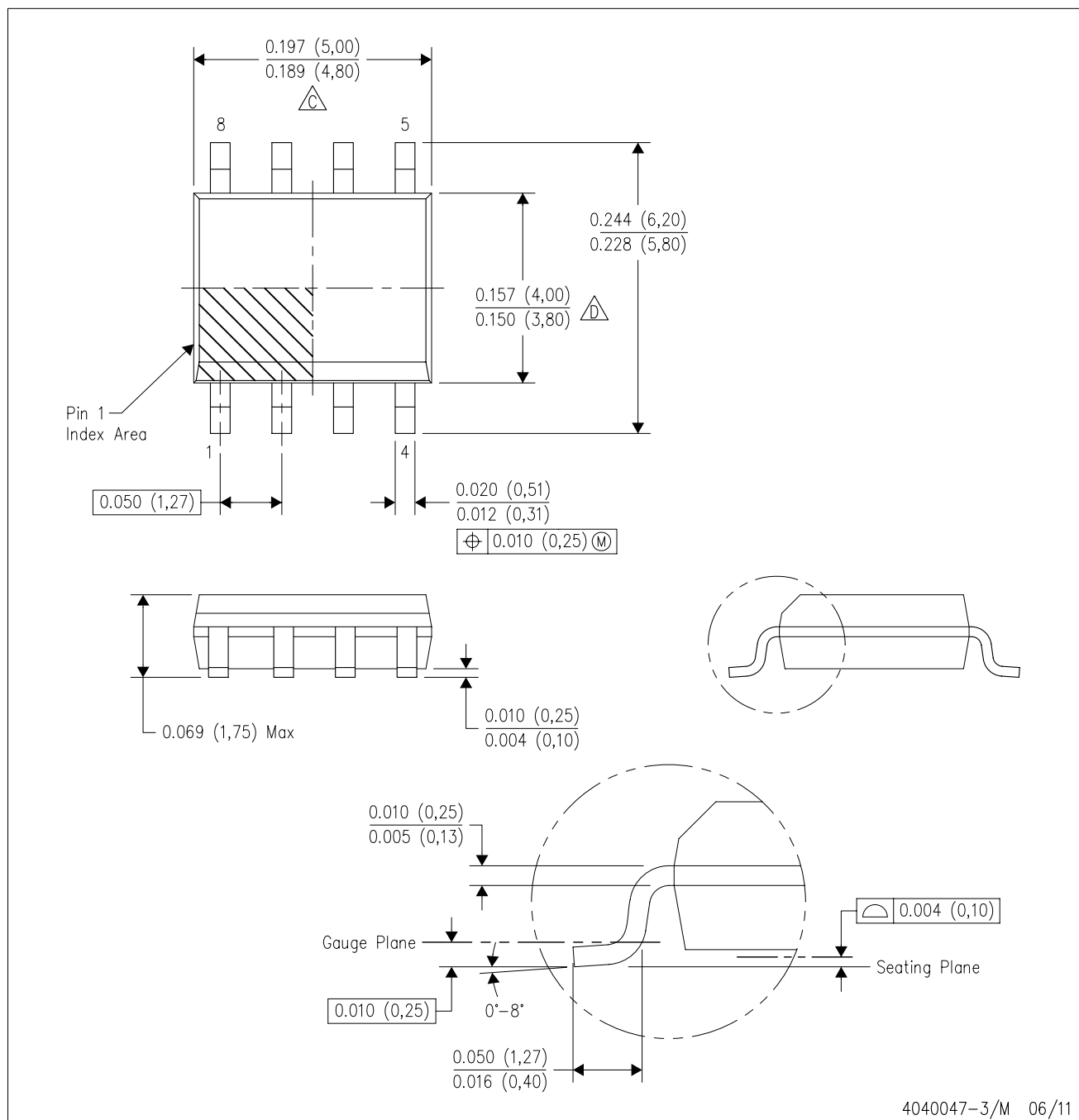
PLASTIC SMALL OUTLINE PACKAGE



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-7351 is recommended for alternate designs.
  - 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.
  - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

D (R-PDSO-G8)

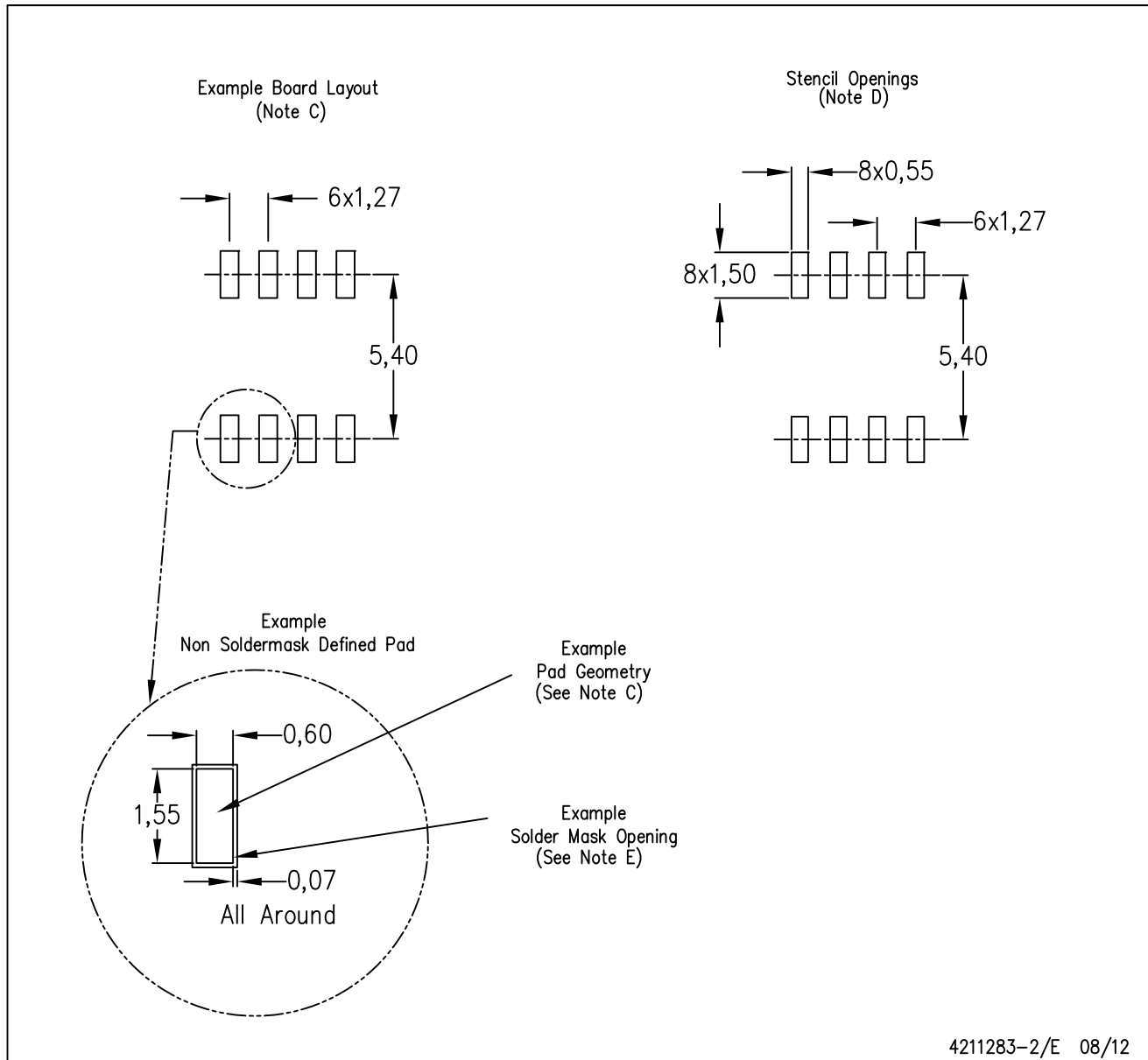
PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - $\triangle C$  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.
  - $\triangle D$  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)

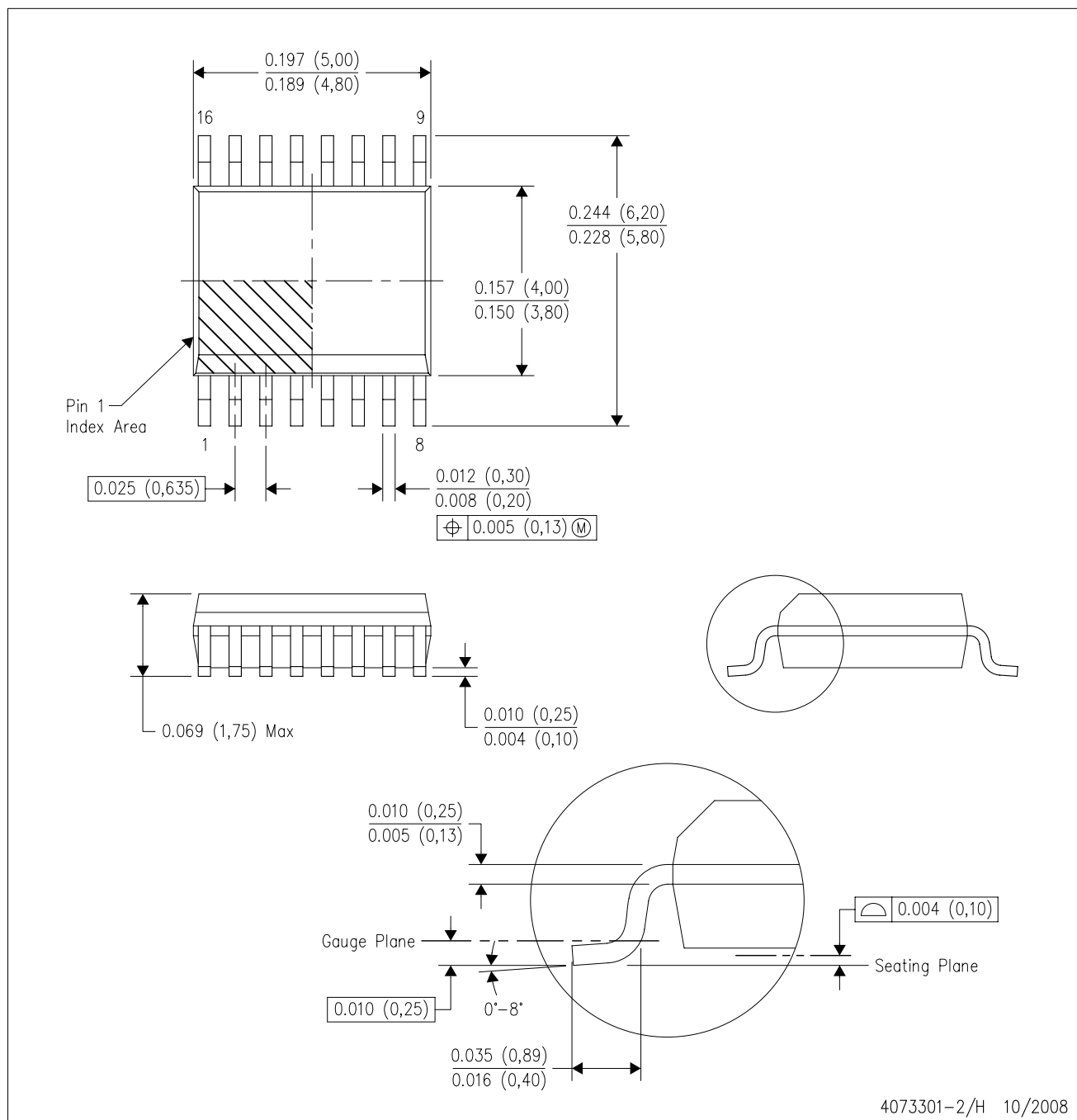
PLASTIC SMALL OUTLINE



- 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.

DBQ (R-PDSO-G16)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15) per side.
  - D. Falls within JEDEC MO-137 variation AB.

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