

# 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

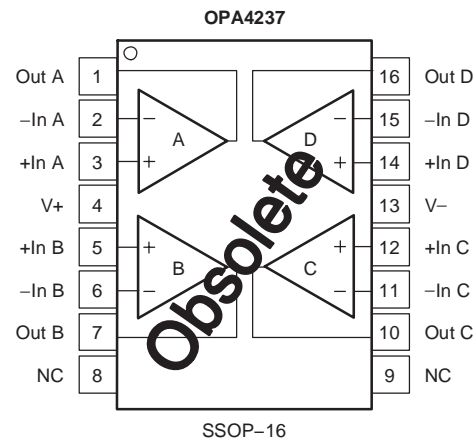
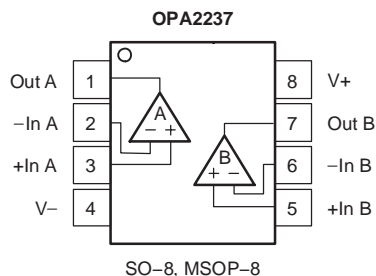
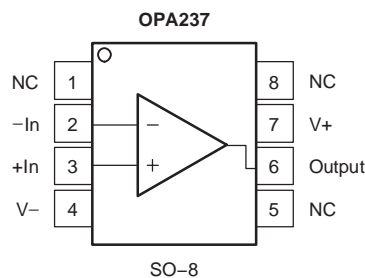
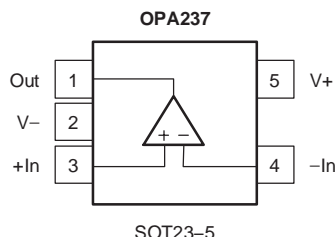
- BATTERY-POWERED INSTRUMENTS
- PORTABLE DEVICES
- PCMCIA CARDS
- MEDICAL INSTRUMENTS
- TEST EQUIPMENT

### 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 The quad version is obsolete.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.



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

MicroAmplifier is a trademark of Texas Instruments. All other trademarks are the property of their respective owners.

## 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	$V_{CM} = 2.5V$		$\pm 250$	$\pm 750$	$\mu V$
<b>vs Temperature<sup>(1)</sup></b>	<b>Specified Temperature Range</b>		$\pm 2$	$\pm 5$	$\mu V/^\circ\text{C}$
<b>vs Power Supply (PSRR)</b>	$V_S = +2.7V$ 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>	$V_{CM} = 2.5V$		-10	-40	nA
Input Offset Current	$V_{CM} = 2.5V$		$\pm 0.5$	$\pm 10$	nA
<b>NOISE</b>					
Input Voltage Noise, $f = 0.1$ to $10\text{Hz}$			1		$\mu V_{pp}$
Input Voltage Noise Density, $f = 1\text{kHz}$			28		$nV/\sqrt{\text{Hz}}$
Current Noise Density, $f = 1\text{kHz}$			60		$fA/\sqrt{\text{Hz}}$
<b>INPUT VOLTAGE RANGE</b>					
Common-Mode Voltage Range		-0.2		(V+) -1.5	V
Common-Mode Rejection Ratio	$V_{CM} = -0.2V$ to $3.5V$	78	86		dB
<b>INPUT IMPEDANCE</b>					
Differential			$5 \cdot 10^6 \parallel 4$		$\Omega \parallel pF$
Common-Mode			$5 \cdot 10^9 \parallel 2$		$\Omega \parallel pF$
<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			1.4		MHz
Slew Rate	$G = 1$		0.5		V/ $\mu s$
Settling Time, 0.1%	$G = -1$ , 3V Step, $C_L = 100pF$		11		$\mu s$
0.01%	$G = -1$ , 3V Step, $C_L = 100pF$		16		$\mu s$
<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 $2.5V$	(V+) -1	(V+) -0.75		V
Negative	$R_L = 100k\Omega$ to $2.5V$	0.12	0.04		V
Positive	$R_L = 10k\Omega$ to $2.5V$	(V+) -1	(V+) -0.75		V
Negative	$R_L = 10k\Omega$ to $2.5V$	0.5	0.35		V
Short-Circuit Current			-10/+4		mA
Capacitive Load Drive (stable operation)		See Typical Characteristic Curves			
<b>POWER SUPPLY</b>					
Specified Operating Voltage			+5		V
Operating Range		+2.7		+36	V
Quiescent Current (per amplifier)			170	350	$\mu A$
<b>TEMPERATURE RANGE</b>					
Specified Range		-40		+85	$^\circ\text{C}$
Operating Range		-55		+125	$^\circ\text{C}$
Storage Range		-55		+125	$^\circ\text{C}$
Thermal Resistance, $\theta_{JA}$					
SOT23-5			200		$^\circ\text{C/W}$
MSOP-8			150		$^\circ\text{C/W}$
SSOP-16 (Obsolete)			150		$^\circ\text{C/W}$
SO-8			150		$^\circ\text{C/W}$

(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.

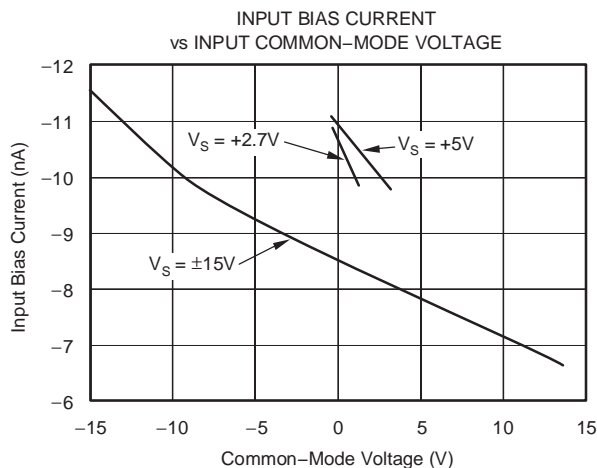
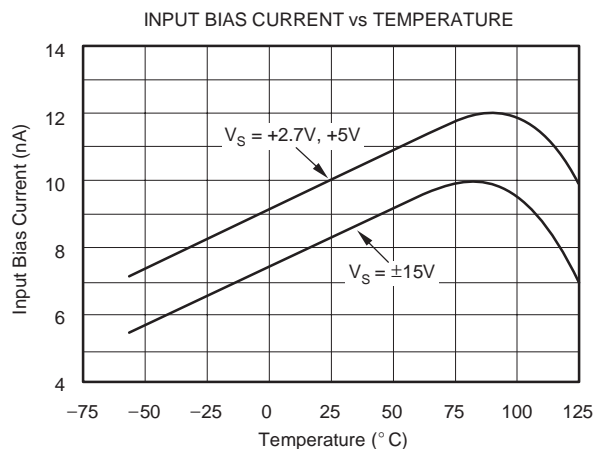
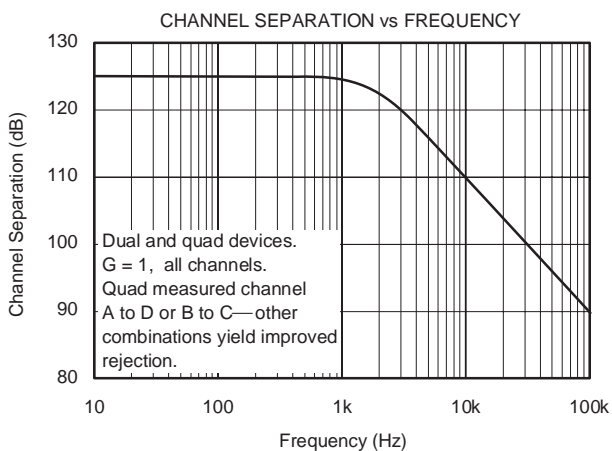
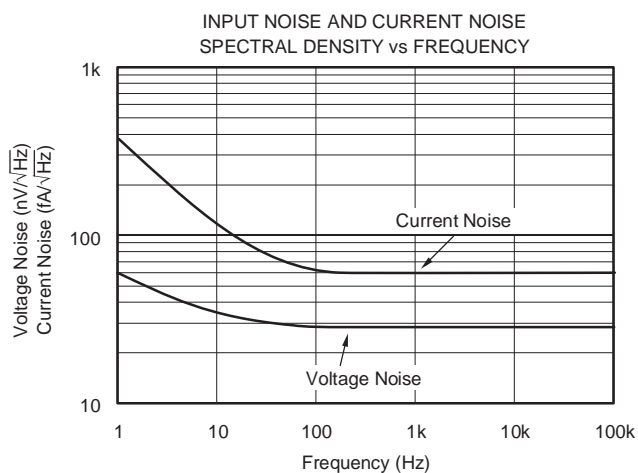
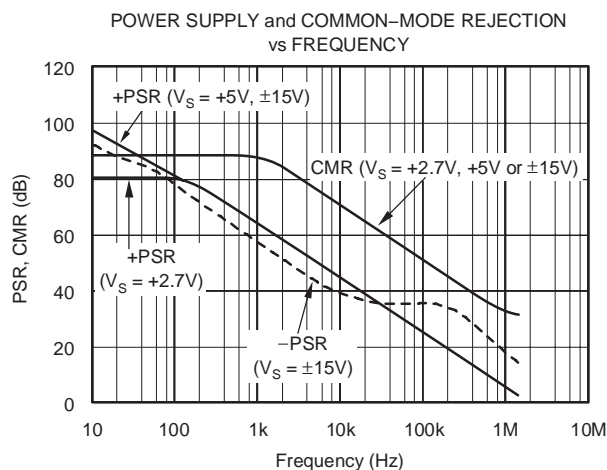
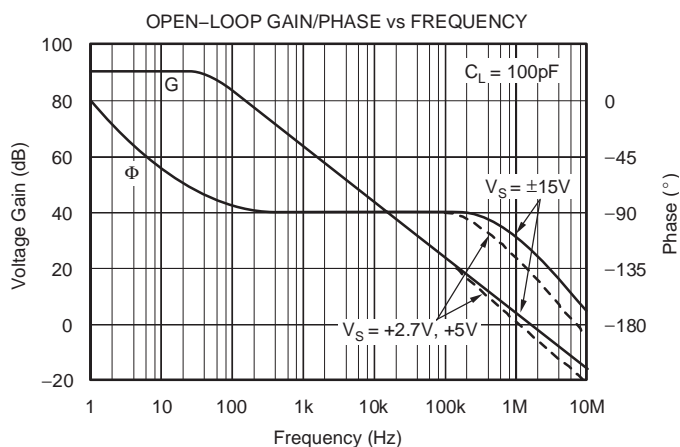
PARAMETER	CONDITIONS	OPA237UA, NA OPA2237UA, EA OPA4237UA			UNITS
		MIN	TYP	MAX	
<b>OFFSET VOLTAGE</b> Input Offset Voltage <b>vs Temperature<sup>(1)</sup></b> vs Power Supply (PSRR) Channel Separation (dual and quad)	$V_{CM} = 0V$ <b>Specified Temperature Range</b> $V_S = \pm 1.35V$ to $\pm 18V$		$\pm 350$ <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.

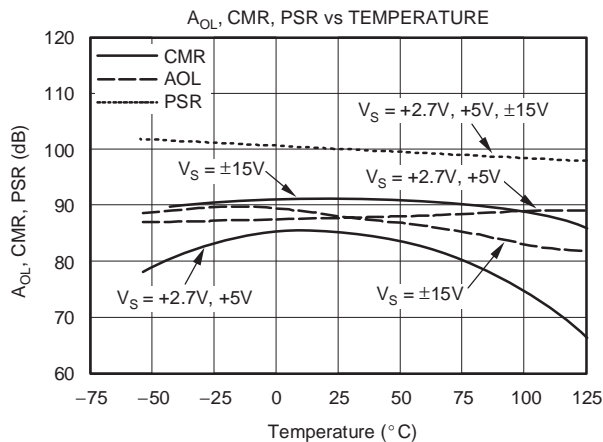
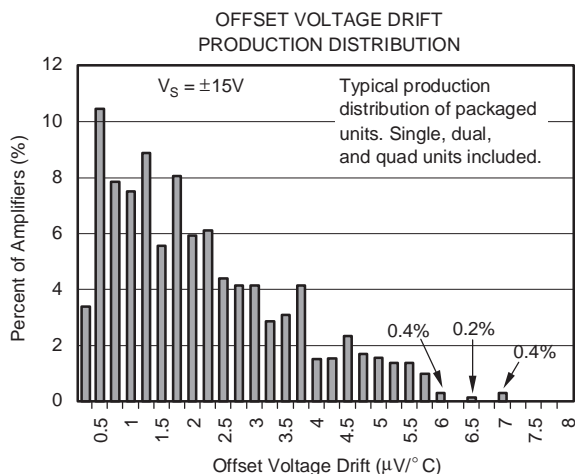
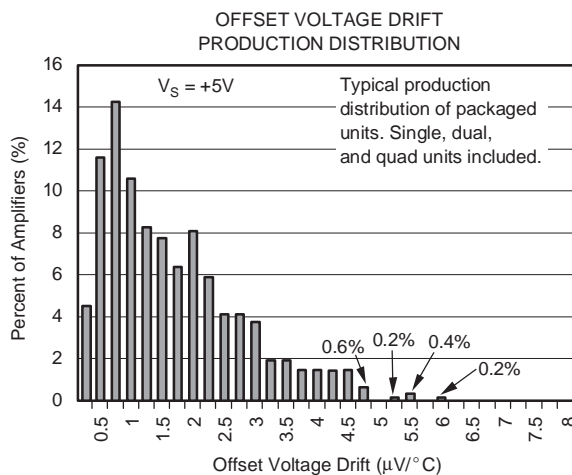
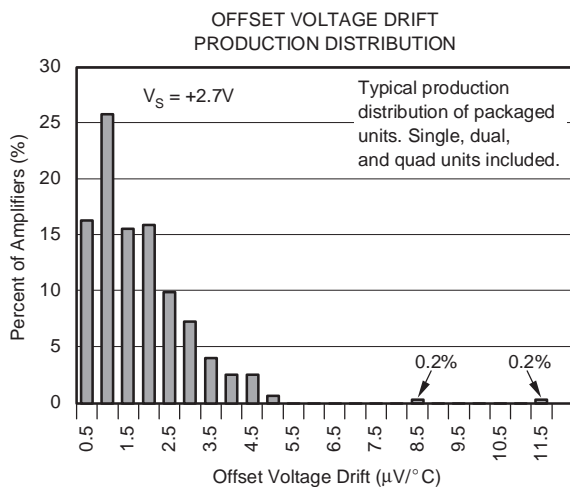
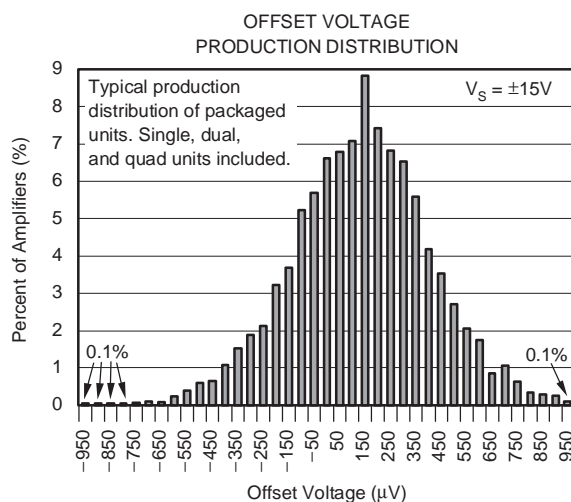
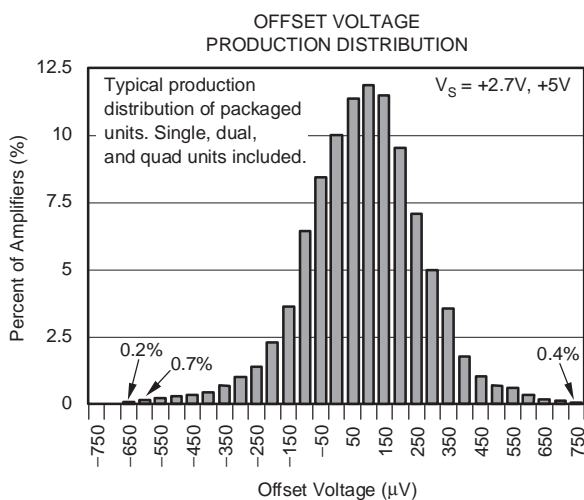
## TYPICAL CHARACTERISTICS

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



## TYPICAL CHARACTERISTICS (Continued)

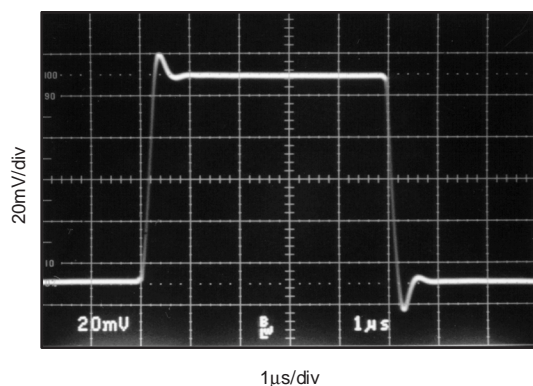
At  $T_A = +25^\circ\text{C}$  and  $R_L = 10\text{k}\Omega$ , unless otherwise noted.



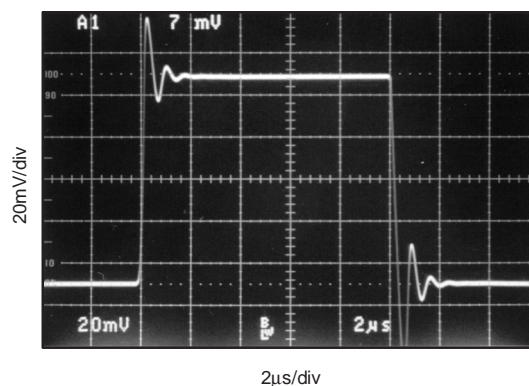
## TYPICAL CHARACTERISTICS (Continued)

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

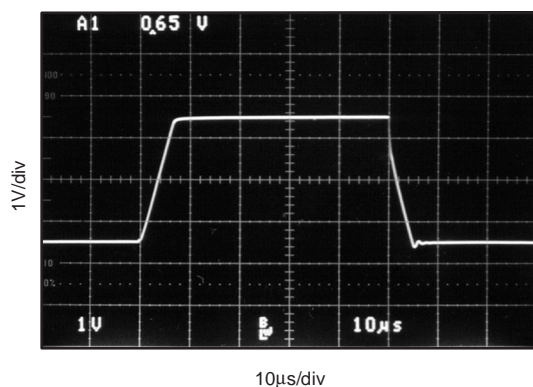
SMALL-SIGNAL STEP RESPONSE  
( $G = 1$ ,  $C_L = 100\text{pF}$ ,  $V_S = +5\text{V}$ )



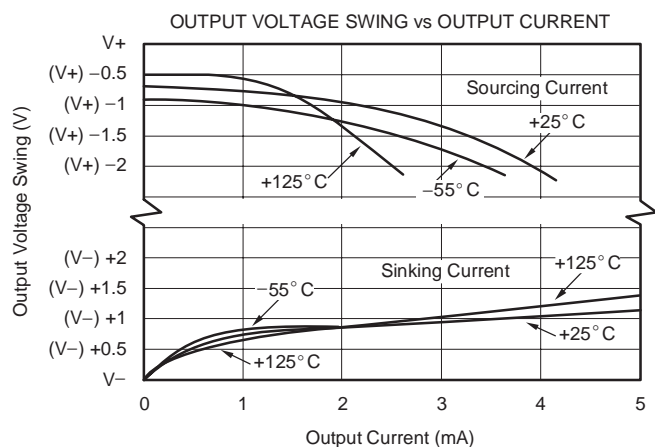
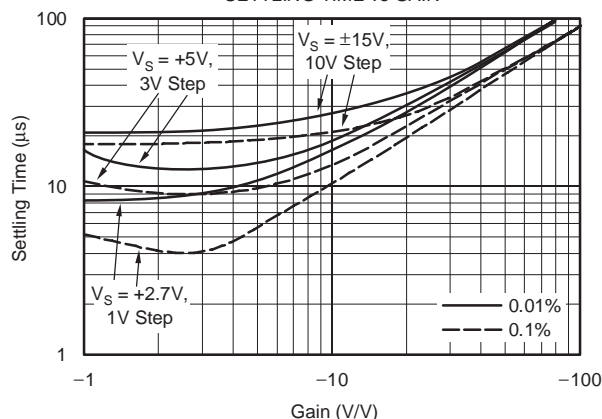
SMALL-SIGNAL STEP RESPONSE  
( $G = 1$ ,  $C_L = 220\text{pF}$ ,  $V_S = +5\text{V}$ )



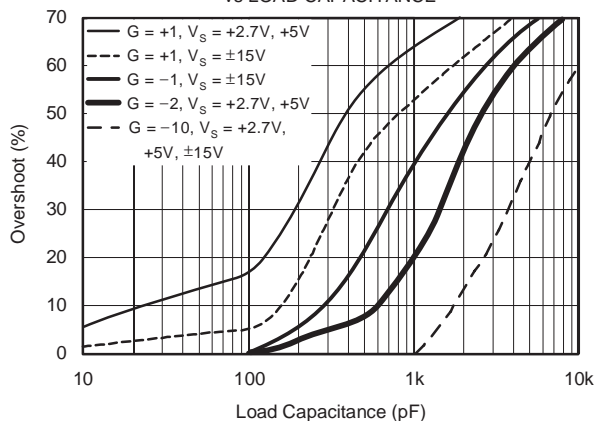
LARGE-SIGNAL STEP RESPONSE  
( $G = 1$ ,  $C_L = 100\text{pF}$ ,  $V_S = +5\text{V}$ )



SETTLING TIME vs GAIN



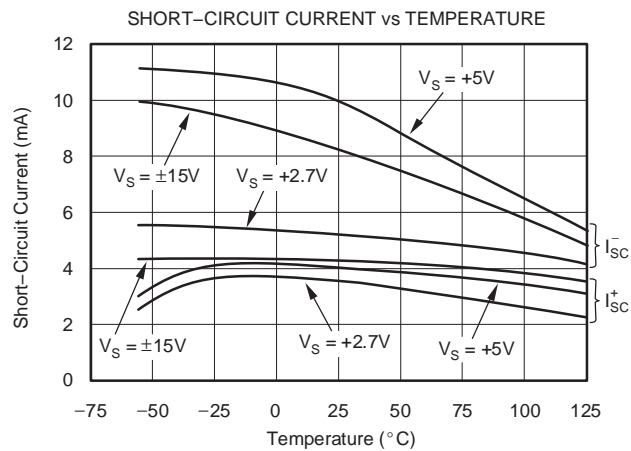
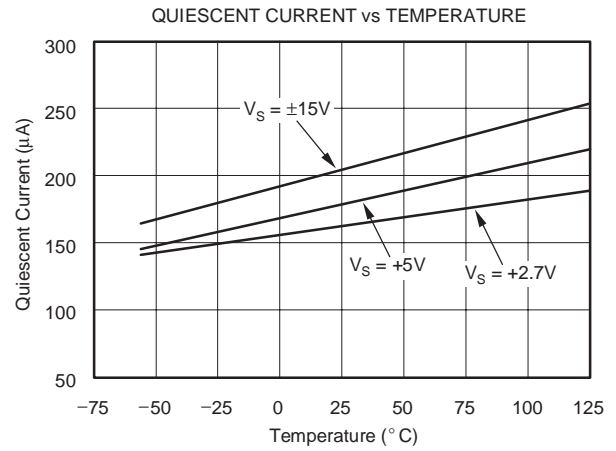
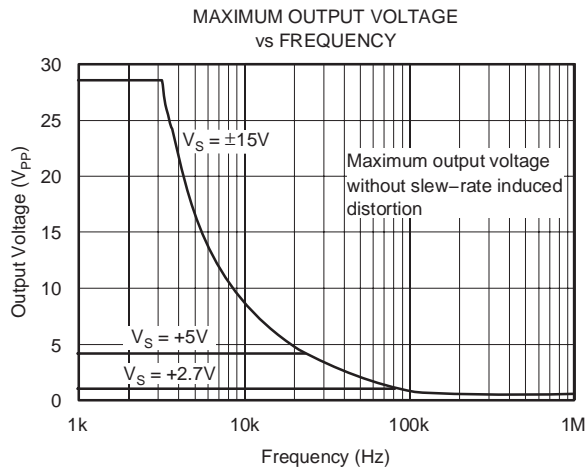
SMALL-SIGNAL OVERSHOOT  
vs LOAD CAPACITANCE





## 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.

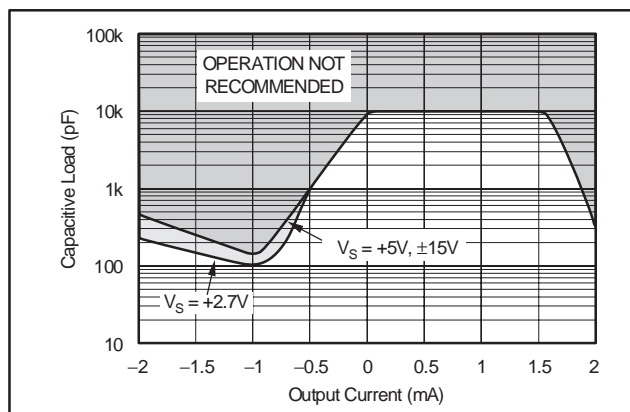


Figure 1. Stability-Capacitive Load vs Output Current

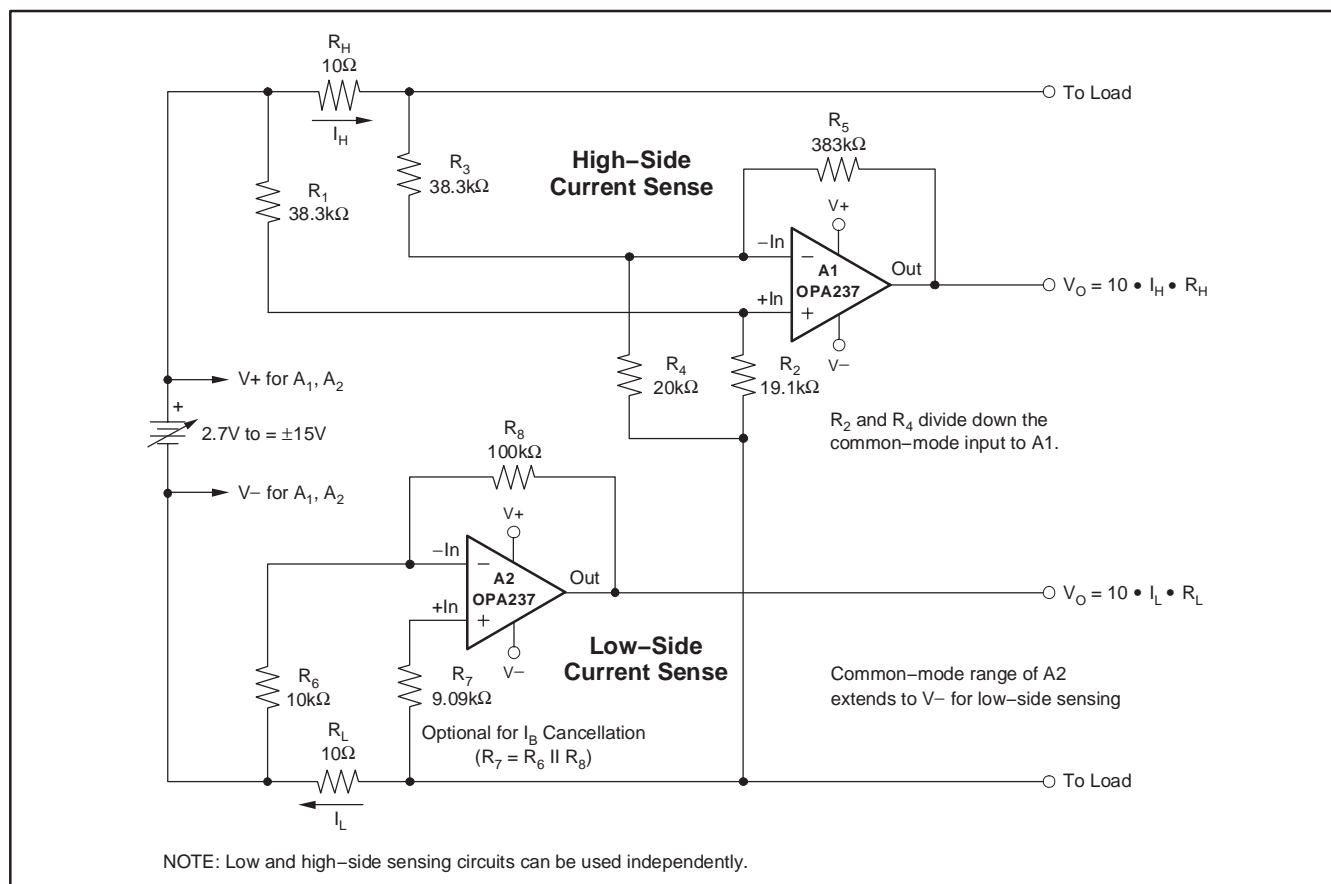


Figure 2. Low and High-Side Battery Current Sensing

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
OPA2237EA/250	ACTIVE	MSOP	DGK	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
OPA2237EA/250G4	ACTIVE	MSOP	DGK	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
OPA2237EA/2K5	ACTIVE	MSOP	DGK	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
OPA2237EA/2K5G4	ACTIVE	MSOP	DGK	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
OPA2237UA	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
OPA2237UA/2K5	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
OPA2237UA/2K5E4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
OPA2237UAE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
OPA237NA/250	ACTIVE	SOT-23	DBV	5	250	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR
OPA237NA/250E4	ACTIVE	SOT-23	DBV	5	250	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR
OPA237NA/3K	ACTIVE	SOT-23	DBV	5	3000	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR
OPA237NA/3KE4	ACTIVE	SOT-23	DBV	5	3000	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR
OPA237UA	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
OPA237UA/2K5	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
OPA237UA/2K5G4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
OPA237UAG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
OPA4237UA/250	OBSOLETE	SSOP/ QSOP	DBQ	16		TBD	Call TI	Call TI
OPA4237UA/2K5	OBSOLETE	SSOP/ QSOP	DBQ	16		TBD	Call TI	Call TI

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

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

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

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and

---

package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

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

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

**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.

**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	MSOP	DGK	8	250	180.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
OPA2237EA/2K5	MSOP	DGK	8	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
OPA2237UA/2K5	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
OPA237NA/250	SOT-23	DBV	5	250	180.0	8.4	3.2	3.1	1.39	4.0	8.0	Q3
OPA237NA/3K	SOT-23	DBV	5	3000	180.0	8.4	3.2	3.1	1.39	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	MSOP	DGK	8	250	190.5	212.7	31.8
OPA2237EA/2K5	MSOP	DGK	8	2500	346.0	346.0	29.0
OPA2237UA/2K5	SOIC	D	8	2500	346.0	346.0	29.0
OPA237NA/250	SOT-23	DBV	5	250	190.5	212.7	31.8
OPA237NA/3K	SOT-23	DBV	5	3000	190.5	212.7	31.8
OPA237UA/2K5	SOIC	D	8	2500	346.0	346.0	29.0

## DBV (R-PDSO-G5)

## PLASTIC SMALL-OUTLINE PACKAGE



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

DGK (S-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



4073329/E 05/06

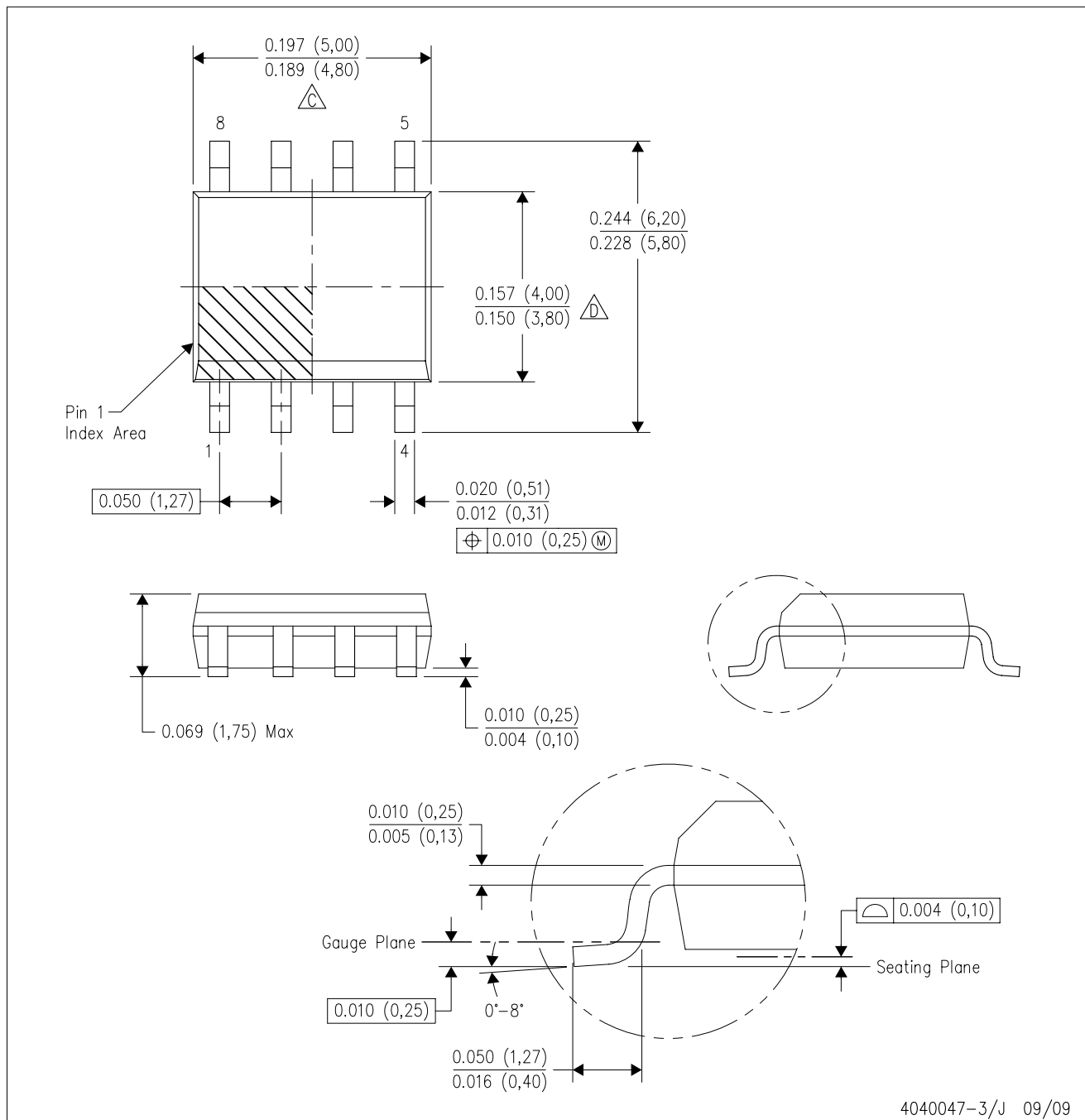
## NOTES:

- 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.



D (R-PDSO-G8)

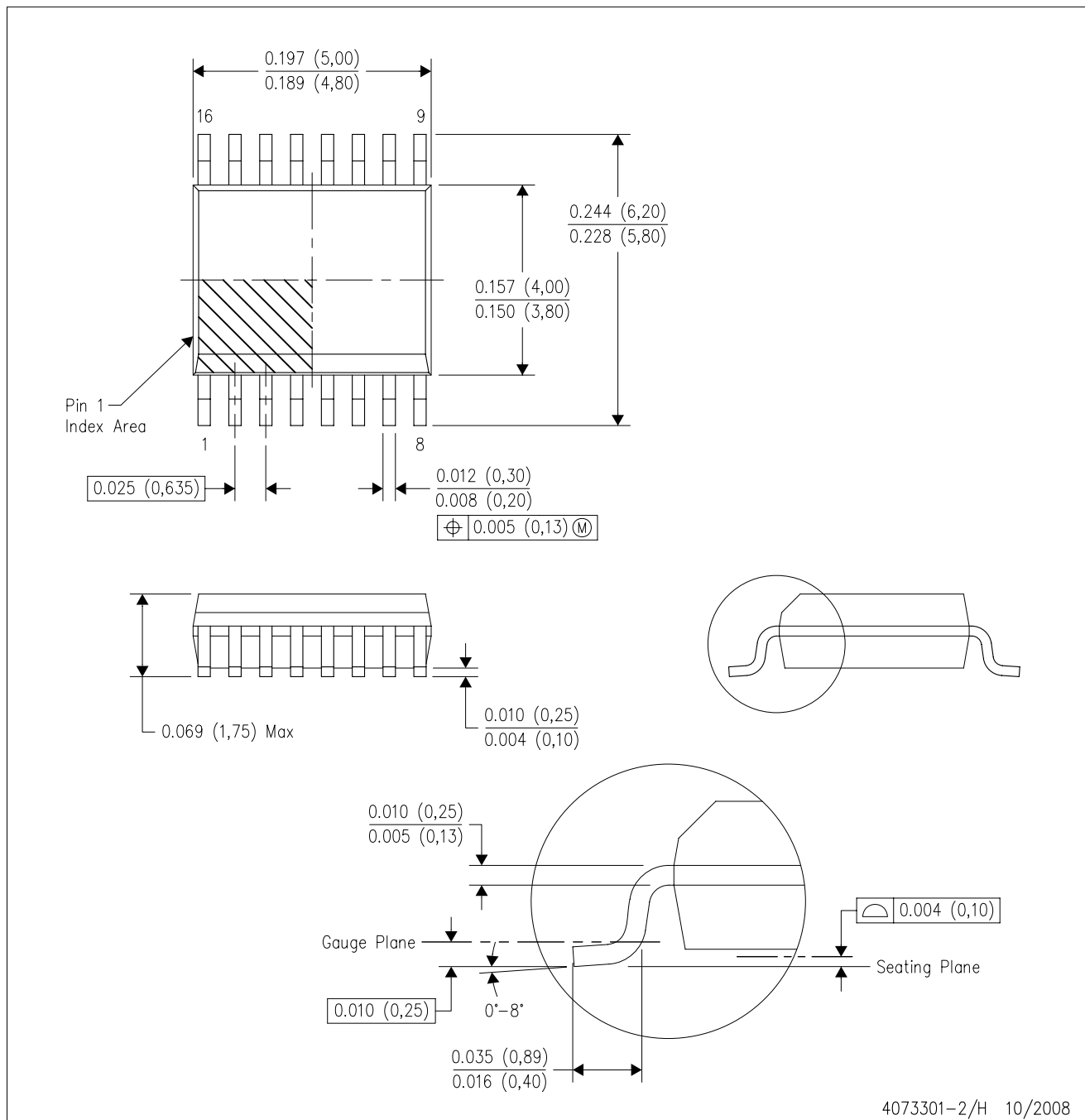
PLASTIC SMALL-OUTLINE PACKAGE



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

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.

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

### Products

Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
RF/IF and ZigBee® Solutions	<a href="http://www.ti.com/lprf">www.ti.com/lprf</a>

### Applications

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Broadband	<a href="http://www.ti.com/broadband">www.ti.com/broadband</a>
Digital Control	<a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Military	<a href="http://www.ti.com/military">www.ti.com/military</a>
Optical Networking	<a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Telephony	<a href="http://www.ti.com/telephony">www.ti.com/telephony</a>
Video & Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
Wireless	<a href="http://www.ti.com/wireless">www.ti.com/wireless</a>

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2009, Texas Instruments Incorporated