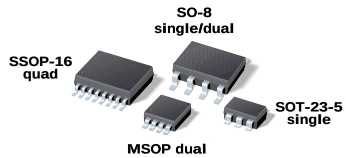
BURR - BROWN®



OPA237
OPA2237
OPA4237

SINGLE-SUPPLY OPERATIONAL AMPLIFIERS
*Micro**Amplifier***™ Series

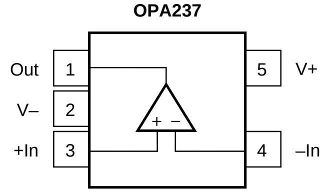
FEATURES

- **MICRO-SIZE, MINIATURE PACKAGES**
  Single: SOT-23-5, SO-8
  Dual: MSOP-8, SO-8
  Quad: SSOP-16
- **LOW OFFSET VOLTAGE: 750µV max**
- **WIDE SUPPLY RANGE**
  Single Supply: +2.7V to +36V
  Dual Supply: ±1.35V to ±18V
- **LOW QUIESCENT CURRENT: 350µA max**
- **WIDE BANDWIDTH: 1.5MHz**

APPLICATIONS

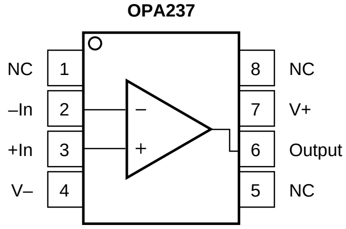
- **BATTERY POWERED INSTRUMENTS**
- **PORTABLE DEVICES**
- **PCMCIA CARDS**
- **MEDICAL INSTRUMENTS**
- **TEST EQUIPMENT**

OPA237



SOT-23-5

OPA237



SO-8

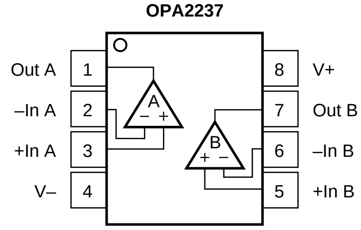
DESCRIPTION

The OPA237 op amp family is one of Burr-Brown's ***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.

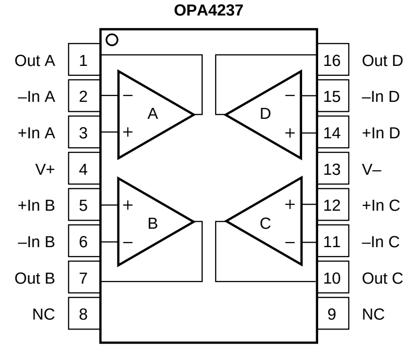
Single, dual, and quad are offered in space-saving surface-mount packages. The single version is available in the ultra-miniature 5-lead SOT-23-5 and SO-8 surface-mount. The dual version comes in a miniature MSOP-8 and SO-8 surface-mount. The quad is available in an SSOP-16. The SSOP-16 has the same body size as an SO-8 with 16 leads, while the MSOP-8 has the same lead count as a SO-8 but half the size. The SOT-23-5 is even smaller at one-fourth the size of an SO-8. All are specified for –40°C to +85°C operation. A macromodel is available for design analysis.

OPA2237



SO-8, MSOP-8

OPA4237



SSOP-16

International Airport Industrial Park • Mailing Address: PO Box 11400, Tucson, AZ 85734 • Street Address: 6730 S. Tucson Blvd., Tucson, AZ 85706 • Tel: (520) 746-1111 • Twx: 910-952-1111
Internet: http://www.burr-brown.com/ • FAXLine: (800) 548-6133 (US/Canada Only) • Cable: BBRCORP • Telex: 066-6491 • FAX: (520) 889-1510 • Immediate Product Info: (800) 548-6132

PDS-1327B

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SBOS057

SPECIFICATIONS: V_S = +5V

At T_A = +25°C, V_S = +5V, R_L = 10kΩ connected to V_S/2, unless otherwise noted.

PARAMETER	CONDITION	OPA237UA, NA OPA2237UA, EA OPA4237UA MIN	TYP	MAX	UNITS
OFFSET VOLTAGE					
Input Offset Voltage	V_{CM} = 2.5V		±250	±750	μV
vs Temperature[1]	Specified Temperature Range		±2	±5	μV/°C
vs Power Supply (PSRR)	V_S = +2.7V to +36V		10	30	μV/V
Channel Separation (dual and quad)			0.5		μV/V
INPUT BIAS CURRENT					
Input Bias Current[2]	V_{CM} = 2.5V		–10	–40	nA
Input Offset Current	V_{CM} = 2.5V		±0.5	±10	nA
NOISE					
Input Voltage Noise, f = 0.1 to 10Hz			1		μVp-p
Input Voltage Noise Density, f = 1kHz			28		$nV/\sqrt{Hz}$
Current Noise Density, f = 1kHz			60		$fA/\sqrt{Hz}$
INPUT VOLTAGE RANGE					
Common-Mode Voltage Range		–0.2		(V+) –1.5	V
Common-Mode Rejection	V_{CM} = –0.2V to 3.5V	78	86		dB
INPUT IMPEDANCE					
Differential			$5 \bullet 10^6 \parallel 4$		Ω ǁ pF
Common-Mode			$5 \bullet 10^9 \parallel 2$		Ω ǁ pF
OPEN-LOOP GAIN					
Open-Loop Voltage Gain	V_O = 0.5V to 4V	80	88		dB
FREQUENCY RESPONSE					
Gain-Bandwidth Product			1.4		MHz
Slew Rate	G = 1		0.5		V/μs
Settling Time: 0.1%	G = –1, 3V Step, C_L = 100pF		11		μs
0.01%	G = –1, 3V Step, C_L = 100pF		16		μs
OUTPUT					
Voltage Output, Positive	R_L = 100kΩ to Ground	(V+) –1	(V+) –0.75		V
Negative	R_L = 100kΩ to Ground	0.01	0.001		V
Positive	R_L = 100kΩ to 2.5V	(V+) –1	(V+) –0.75		V
Negative	R_L = 100kΩ to 2.5V	0.12	0.04		V
Positive	R_L = 10kΩ to 2.5V	(V+) –1	(V+) –0.75		V
Negative	R_L = 10kΩ to 2.5V	0.5	0.35		V
Short-Circuit Current			–10/+4		mA
Capacitive Load Drive (stable operation)			See Typical Curves		
POWER SUPPLY					
Specified Operating Voltage			+5		V
Operating Range		+2.7		+36	V
Quiescent Current (per amplifier)			170	350	μA
TEMPERATURE RANGE					
Specified Range		–40		+85	°C
Operating Range		–55		+125	°C
Storage		–55		+125	°C
Thermal Resistance, θ_{JA}					
5-Lead SOT-23-5			200		°C/W
MSOP-8 Surface-Mount			150		°C/W
SSOP-16 Surface-Mount			150		°C/W
SO-8 Surface-Mount			150		°C/W

NOTES: (1) Guaranteed by wafer-level test to 95% confidence. (2) Positive conventional current flows into the input terminals.

SPECIFICATIONS: V_S = +2.7V

At T_A = +25°C, V_S = +2.7V, R_L = 10kΩ connected to V_S/2, unless otherwise noted.

PARAMETER	CONDITION	OPA237UA, NA OPA2237UA, EA OPA4237UA MIN	TYP	MAX	UNITS
OFFSET VOLTAGE					
Input Offset Voltage	V_{CM} = 1V		±250	±750	µV
vs Temperature(1)	Specified Temperature Range		±2	±5	µV/°C
vs Power Supply (PSRR)	V_S = +2.7V to +36V		10	30	µV/V
Channel Separation (dual and quad)			0.5		µV/V
INPUT BIAS CURRENT					
Input Bias Current(2)	V_{CM} = 1V		–10	–40	nA
Input Offset Current	V_{CM} = 1V		±0.5	±10	nA
NOISE					
Input Voltage Noise, f = 0.1 to 10Hz			1		µVp-p
Input Voltage Noise Density, f = 1kHz			28		$nV/\sqrt{Hz}$
Current Noise Density, f = 1kHz			60		$fA/\sqrt{Hz}$
INPUT VOLTAGE RANGE					
Common-Mode Voltage Range		–0.2		(V+) –1.5	V
Common-Mode Rejection	V_{CM} = –0.2V to 1.2V	75	85		dB
INPUT IMPEDANCE					
Differential			$5 \cdot 10^6 \parallel 4$		Ω || pF
Common-Mode			$5 \cdot 10^9 \parallel 2$		Ω || pF
OPEN-LOOP GAIN					
Open-Loop Voltage Gain	V_O = 0.5V to 1.7V	80	88		dB
FREQUENCY RESPONSE					
Gain-Bandwidth Product			1.2		MHz
Slew Rate	G = 1		0.5		V/µs
Settling Time: 0.1%	G = –1, 1V Step, C_L = 100pF		5		µs
0.01%	G = –1, 1V Step, C_L = 100pF		8		µs
OUTPUT					
Voltage Output, Positive	R_L = 100kΩ to Ground	(V+) –1	(V+) –0.75		V
Negative	R_L = 100kΩ to Ground	0.01	0.001		V
Positive	R_L = 100kΩ to 1.35V	(V+) –1	(V+) –0.75		V
Negative	R_L = 100kΩ to 1.35V	0.06	0.02		V
Positive	R_L = 10kΩ to 1.35V	(V+) –1	(V+) –0.75		V
Negative	R_L = 10kΩ to 1.35V	0.3	0.2		V
Short-Circuit Current			–5/+3.5		mA
Capacitive Load Drive (stable operation)			See Typical Curves		
POWER SUPPLY					
Specified Operating Voltage			+2.7		V
Operating Range		+2.7		+36	V
Quiescent Current (per amplifier)			160	350	µA
TEMPERATURE RANGE					
Specified Range		–40		+85	°C
Operating Range		–55		+125	°C
Storage		–55		+125	°C
Thermal Resistance, θ_{JA}					
5-Lead SOT-23-5			200		°C/W
MSOP-8 Surface-Mount			150		°C/W
SSOP-16 Surface-Mount			150		°C/W
SO-8 Surface-Mount			150		°C/W

NOTES: (1) Guaranteed by wafer-level test to 95% confidence. (2) Positive conventional current flows into the input terminals.

SPECIFICATIONS: $V_S = \pm15V$

At $T_A = +25°C$, $V_S = \pm15V$, $R_L = 10k\Omega$ connected to $V_S/2$, unless otherwise noted.

PARAMETER	CONDITION	OPA237UA, NA / OPA2237UA, EA / OPA4237UA MIN	TYP	MAX	UNITS
OFFSET VOLTAGE					
Input Offset Voltage	$V_{CM} = 0V$		±350	±950	µV
vs Temperature(1)	Specified Temperature Range		±2.5	±7	µV/°C
vs Power Supply (PSRR)	$V_S = \pm1.35V$ to $\pm18V$		10	30	µV/V
Channel Separation (dual and quad)			0.5		µV/V
INPUT BIAS CURRENT					
Input Bias Current(2)	$V_{CM} = 0V$		–8.5	–40	nA
Input Offset Current	$V_{CM} = 0V$		±0.5	±10	nA
NOISE					
Input Voltage Noise, f = 0.1 to 10Hz			1		µVp-p
Input Voltage Noise Density, f = 1kHz			28		$nV/\sqrt{Hz}$
Current Noise Density, f = 1kHz			60		$fA/\sqrt{Hz}$
INPUT VOLTAGE RANGE					
Common-Mode Voltage Range		(V–) –0.2		(V+) –1.5	V
Common-Mode Rejection	$V_{CM} = -15V$ to $13.5V$	80	90		dB
INPUT IMPEDANCE					
Differential			$5 \cdot 10^6 \parallel 4$		Ω || pF
Common-Mode			$5 \cdot 10^9 \parallel 2$		Ω || pF
OPEN-LOOP GAIN					
Open-Loop Voltage Gain	$V_O = -14V$ to $13.8V$	80	88		dB
FREQUENCY RESPONSE					
Gain-Bandwidth Product			1.5		MHz
Slew Rate	G = 1		0.5		V/µs
Settling Time: 0.1%	G = –1, 10V Step, $C_L = 100pF$		18		µs
0.01%	G = –1, 10V Step, $C_L = 100pF$		21		µs
OUTPUT					
Voltage Output, Positive	$R_L = 100k\Omega$	(V+) –1.2	(V+) –0.9		V
Negative	$R_L = 100k\Omega$	(V–) +0.5	(V–) +0.3		V
Positive	$R_L = 10k\Omega$	(V+) –1.2	(V+) –0.9		V
Negative	$R_L = 10k\Omega$	(V–) +1	(V–) +0.85		V
Short-Circuit Current			–8/+4.5		mA
Capacitive Load Drive (stable operation)			See Typical Curves		
POWER SUPPLY					
Specified Operating Voltage			±15		V
Operating Range		±1.35		±18	V
Quiescent Current (per amplifier)			±200	±475	µA
TEMPERATURE RANGE					
Specified Range		–40		+85	°C
Operating Range		–55		+125	°C
Storage		–55		+125	°C
Thermal Resistance, θ_{JA}					
5-Lead SOT-23-5			200		°C/W
MSOP-8 Surface-Mount			150		°C/W
SSOP-16 Surface-Mount			150		°C/W
SO-8 Surface-Mount			150		°C/W

NOTES: (1) Guaranteed by wafer-level test to 95% confidence. (2) Positive conventional current flows into the input terminals.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V+ to V–	36V
Input Voltage	(V–) –0.7V to (V+) +0.7V
Output Short-Circuit[1]	Continuous
Operating Temperature	–40°C to +125°C
Storage Temperature	–55°C to +125°C
Junction Temperature	+150°C
Lead Temperature (soldering, 10s)	300°C

NOTE: (1) 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.

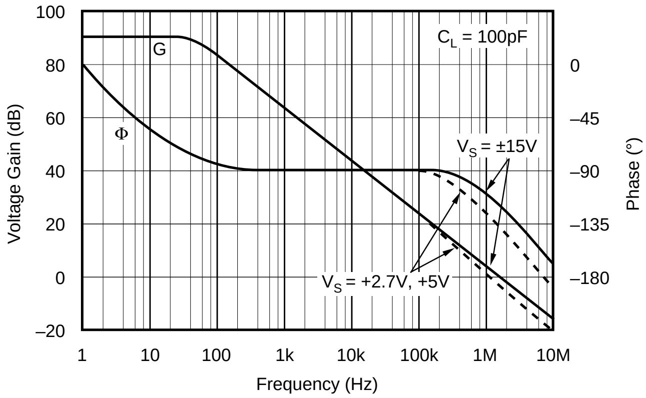
PACKAGE/ORDERING INFORMATION

PRODUCT	PACKAGE	PACKAGE DRAWING NUMBER[1]	TEMPERATURE RANGE	PACKAGE MARKING	ORDERING NUMBER[2]
Single					
OPA237NA	5-Lead SOT-23-5	331	–40°C to +85°C	A37A	OPA237NA-250
"	"	"	"	"	OPA237NA-3K
OPA237UA	SO-8 Surface-Mount	182	–40°C to +85°C	OPA237UA	OPA237UA
Dual					
OPA2237EA	MSOP-8 Surface-Mount	337	–40°C to +85°C	B37A	OPA2237EA-250
"	"	"	"	"	OPA2237EA-2500
OPA2237UA	SO-8 Surface-Mount	182	–40°C to +85°C	OPA2237UA	OPA2237UA
Quad					
OPA4237UA	SSOP-16 Surface-Mount	322	–40°C to +85°C	OPA4237UA	OPA4237UA-250
"	"	"	"	"	OPA4237UA-2500

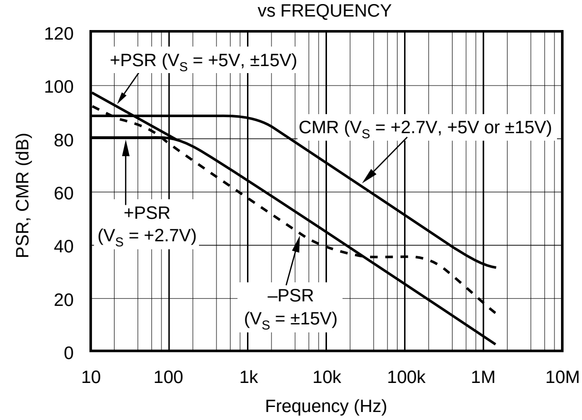
NOTE: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix C of Burr-Brown IC Data Book. (2) Models with -250, -2500, and -3K are available only in Tape and Reel in the quantity indicated (e.g., -250 indicates 250 devices per reel). Ordering 3000 pieces of "OPA237NA-3K" will get a single 3000 piece Tape and Reel. SO-8 models are available in tubes or Tape and Reel. For detailed Tape and Reel mechanical information, refer to Appendix B of Burr-Brown IC Data Book.

TYPICAL PERFORMANCE CURVES

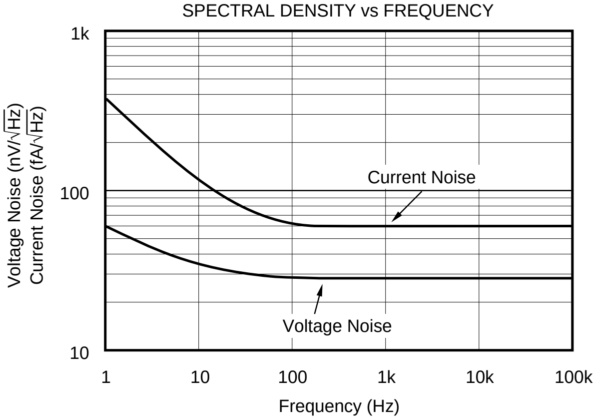
At $T_A = +25°C$ and $R_L = 10k\Omega$, unless otherwise noted.



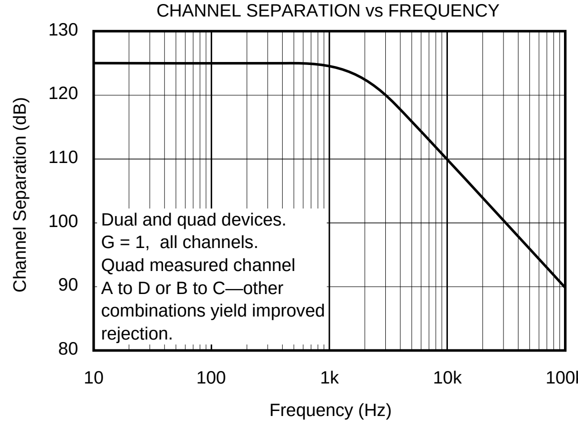
OPEN-LOOP GAIN/PHASE vs FREQUENCY



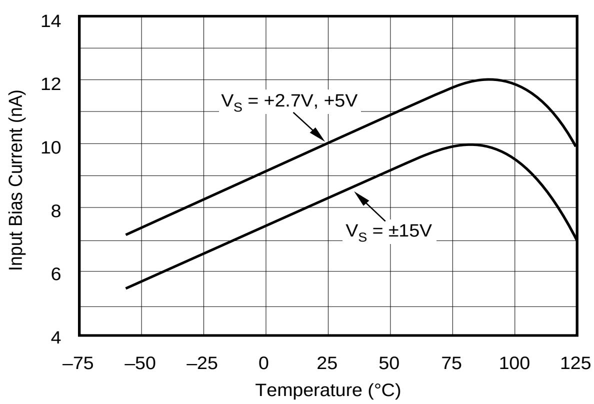
POWER SUPPLY and COMMON-MODE REJECTION vs FREQUENCY



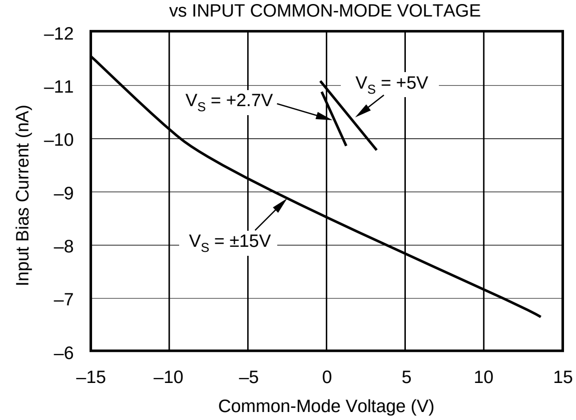
INPUT NOISE AND CURRENT NOISE SPECTRAL DENSITY vs FREQUENCY



CHANNEL SEPARATION vs FREQUENCY



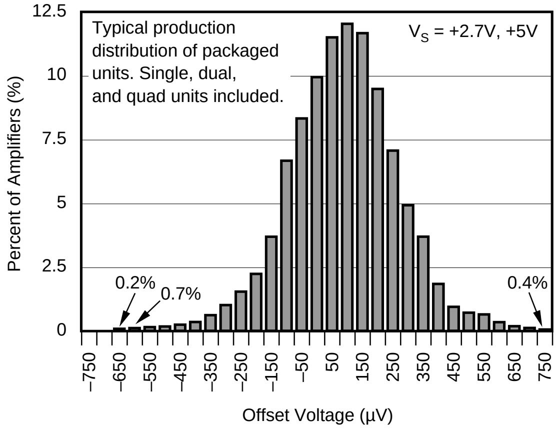
INPUT BIAS CURRENT vs TEMPERATURE



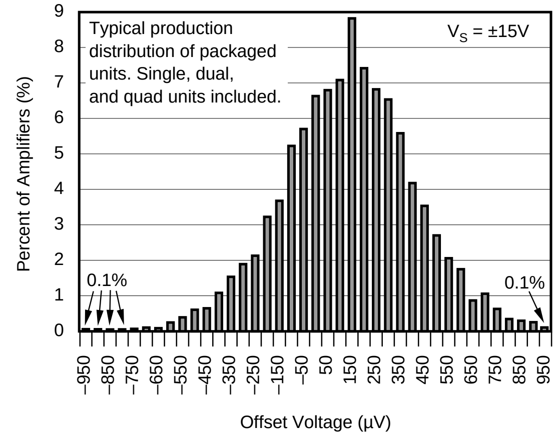
INPUT BIAS CURRENT vs INPUT COMMON-MODE VOLTAGE

At $T_A = +25°C$ and $R_L = 10k\Omega$, unless otherwise noted.

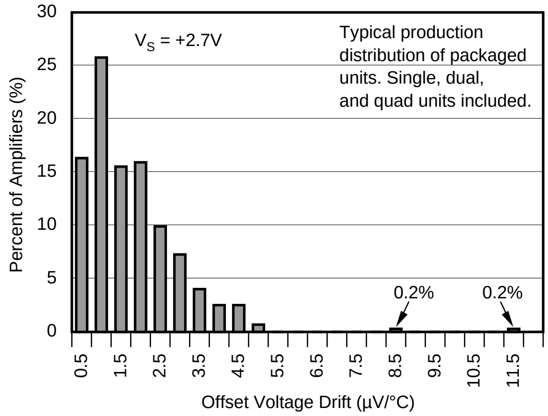
OFFSET VOLTAGE
PRODUCTION DISTRIBUTION



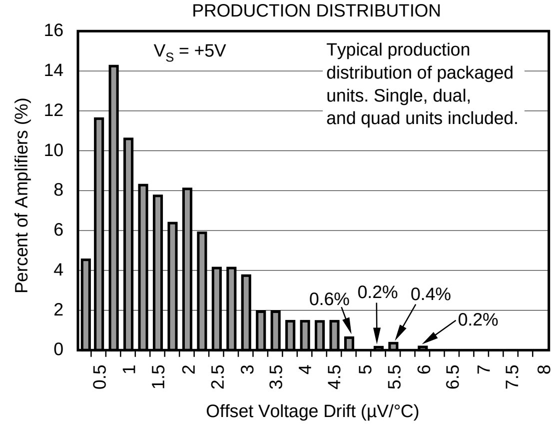
OFFSET VOLTAGE
PRODUCTION DISTRIBUTION



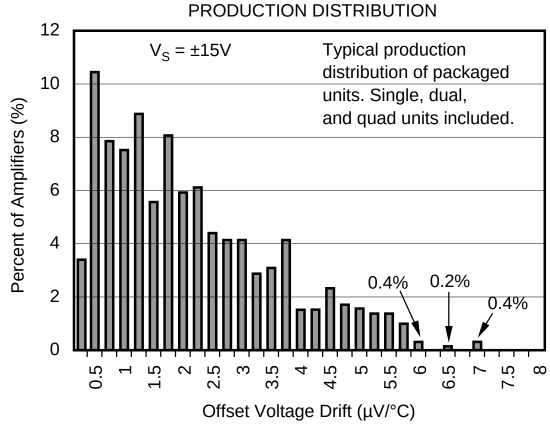
OFFSET VOLTAGE DRIFT
PRODUCTION DISTRIBUTION



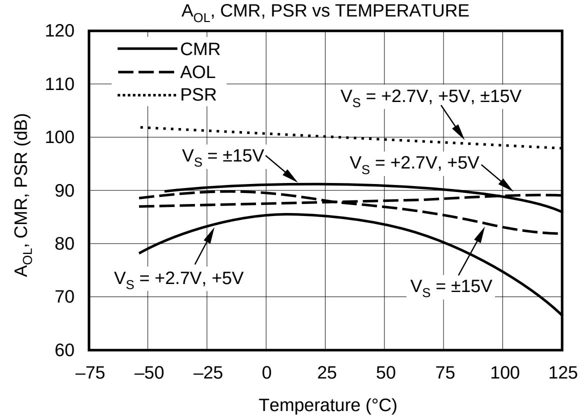
OFFSET VOLTAGE DRIFT
PRODUCTION DISTRIBUTION



OFFSET VOLTAGE DRIFT
PRODUCTION DISTRIBUTION



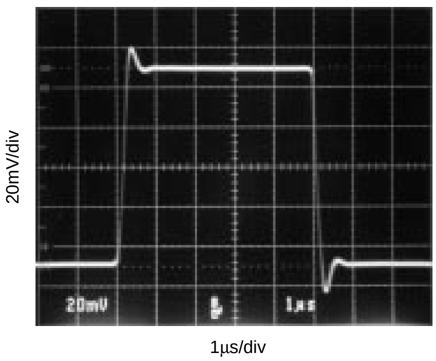
A_{OL}, CMR, PSR vs TEMPERATURE



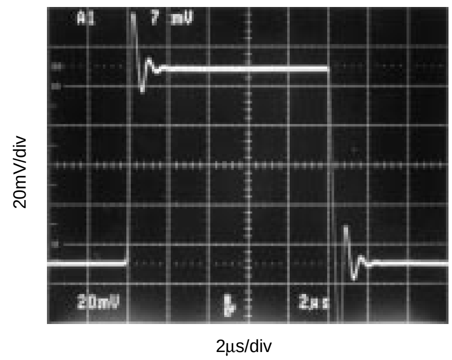
TYPICAL PERFORMANCE CURVES (CONT)

At T_A = +25°C and R_L = 10kΩ, unless otherwise noted.

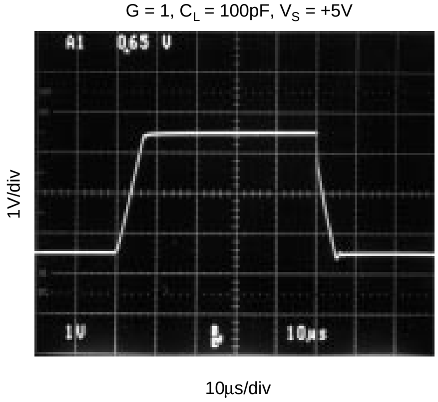
SMALL-SIGNAL STEP RESPONSE
G = 1, C_L = 100pF, V_S = +5V



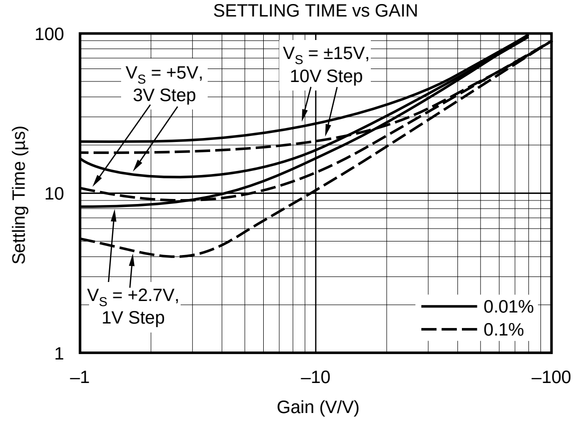
SMALL-SIGNAL STEP RESPONSE
G = 1, C_L = 220pF, V_S = +5V



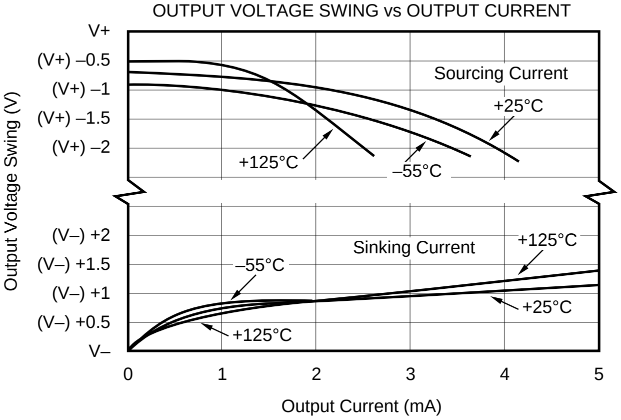
LARGE-SIGNAL STEP RESPONSE
G = 1, C_L = 100pF, V_S = +5V



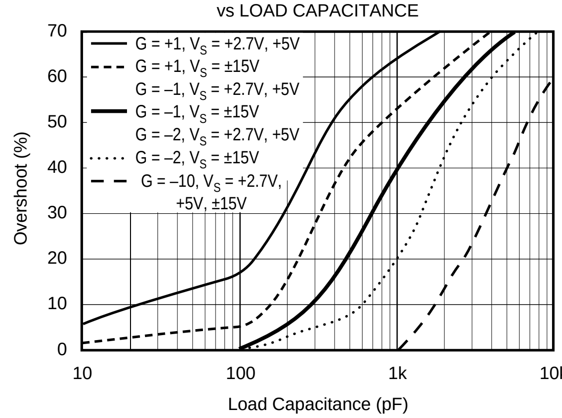
SETTLING TIME vs GAIN



OUTPUT VOLTAGE SWING vs OUTPUT CURRENT

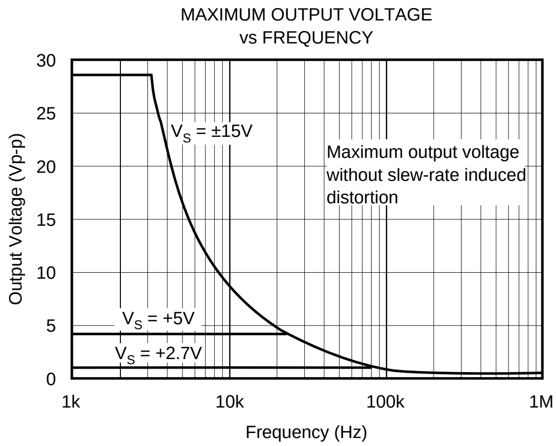


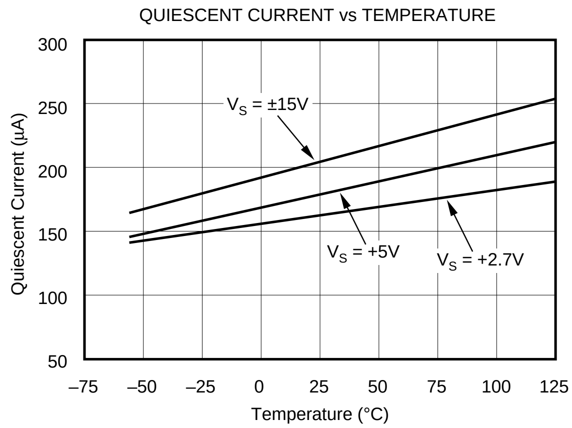
SMALL-SIGNAL OVERSHOOT
vs LOAD CAPACITANCE

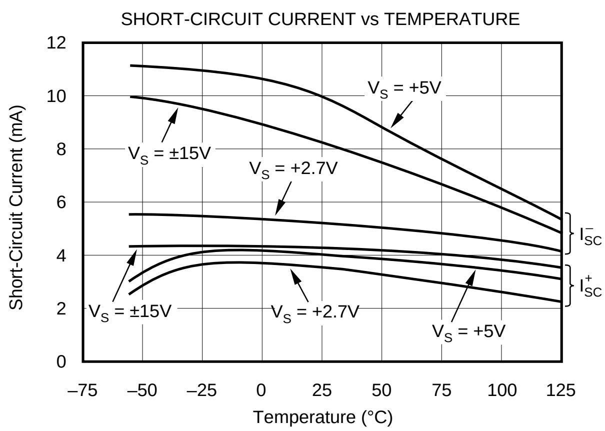


TYPICAL PERFORMANCE CURVES (CONT)

At T_A = +25°C and R_L = 10kΩ, unless otherwise noted.







APPLICATIONS 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 (±1.35V to ±18V) 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 ±15V 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 10kΩ 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 in Figure 1, can drive 10,000pF with output currents up to 1.5mA.

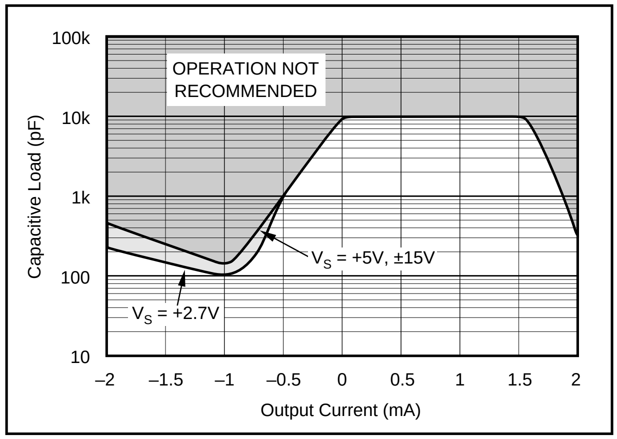


FIGURE 1. Stability-Capacitive Load vs Output Current.

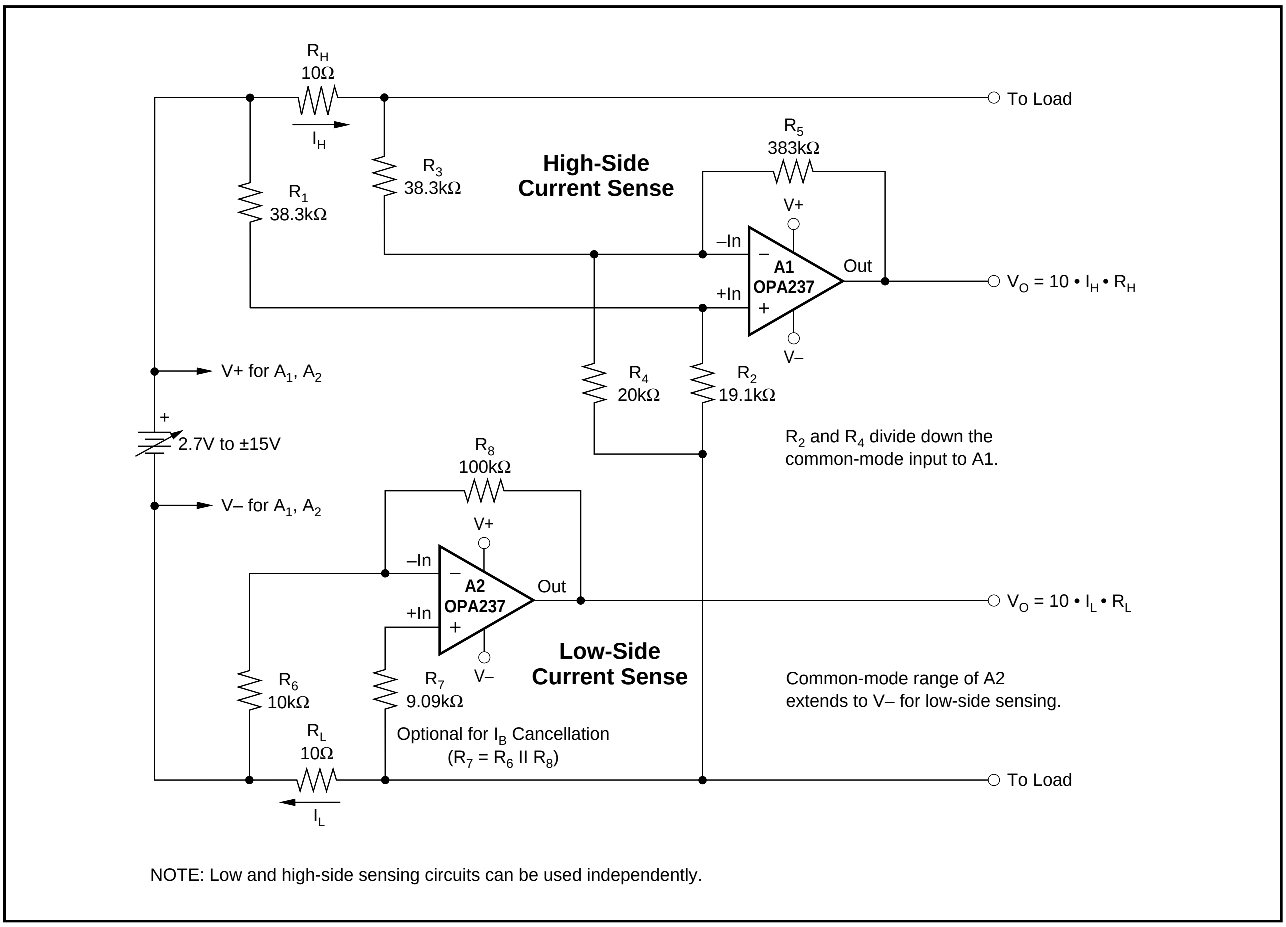


FIGURE 2. Low and High-Side Battery Current Sensing.

PACKAGING INFORMATION

ORDERABLE DEVICE	STATUS(1)	PACKAGE TYPE	PACKAGE DRAWING	PINS	PACKAGE QTY
OPA2237EA/250	ACTIVE	VSSOP	DGK	8	250
OPA2237EA/2K5	ACTIVE	VSSOP	DGK	8	2500
OPA2237UA	ACTIVE	SOIC	D	8	100
OPA2237UA/2K5	ACTIVE	SOIC	D	8	2500
OPA237NA/250	ACTIVE	SOP	DBV	5	250
OPA237NA/3K	ACTIVE	SOP	DBV	5	3000
OPA237UA	ACTIVE	SOIC	D	8	100
OPA237UA/2K5	ACTIVE	SOIC	D	8	2500
OPA4237UA/250	OBSOLETE	SSOP	DBQ	16	
OPA4237UA/2K5	OBSOLETE	SSOP	DBQ	16	

(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.

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