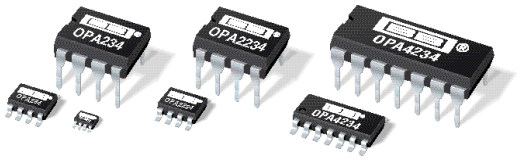
BURR-BROWN®




# OPA234
# OPA2234
# OPA4234

# Low Power, Precision SINGLE-SUPPLY OPERATIONAL AMPLIFIERS

## FEATURES

- **WIDE SUPPLY RANGE:**
  **Single Supply: $V_S$ = +2.7V to +36V**
  **Dual Supply: $V_S$ = ±1.35V to ±18V**
- **GUARANTEED PERFORMANCE: +2.7V, +5V, and ±15V**
- **LOW QUIESCENT CURRENT: 250µA/amp**
- **LOW INPUT BIAS CURRENT: 25nA max**
- **LOW OFFSET VOLTAGE: 100µV max**
- **HIGH CMRR, PSRR, and $A_{OL}$**
- **SINGLE, DUAL, and QUAD VERSIONS**

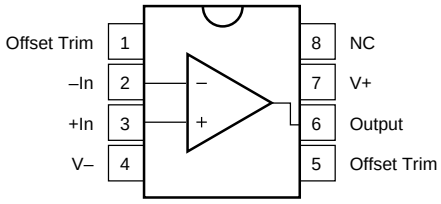
## DESCRIPTION

The OPA234 series low cost op amps are ideal for single supply, low voltage, low power applications. The series provides lower quiescent current than older "1013"-type products and comes in current industry-standard packages and pinouts. The combination of low offset voltage, high common-mode rejection, high power supply rejection, and a wide supply range provides excellent accuracy and versatility. Single, dual, and quad versions have identical specifications for maximum design flexibility. These general purpose op amps are ideal for portable and battery powered applications.

OPA234 series op amps operate from either single or dual supplies. In single supply operation, the input common-mode range extends below ground and the output can swing to within 50mV of ground. Excellent phase margin makes the OPA234 series ideal for demanding applications, including high load capacitance. Dual and quad designs feature completely independent circuitry for lowest crosstalk and freedom from interaction.

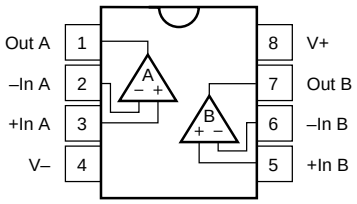
Single version packages are 8-Pin DIP, SO-8 surface-mount, and a space-saving MSOP-8(1) surface-mount. Dual packages are 8-Pin DIP and SO-8 surface-mount. Quad packages are 14-Pin DIP and SO-14 surface-mount. All are specified for –40°C to +85°C operation.

OPA234



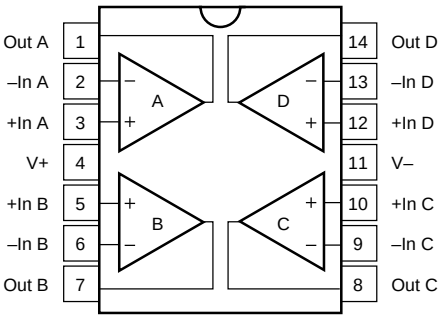

8-Pin DIP, SO-8, MSOP-8(1)

OPA2234




8-Pin DIP, SO-8

OPA4234




14-Pin DIP
SO-14

NOTE: (1) MSOP package available 4Q 96.

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 • Cable: BBRCORP • Telex: 066-6491 • FAX: (520) 889-1510 • Immediate Product Info: (800) 548-6132


PDS-1318 Printed in U.S.A. May, 1996

# SPECIFICATIONS: $V_S$ = +5V

At $T_A$ = 25°C, $V_S$ = +5V, $R_L$ = 10kΩ connected to $V_S/2$ and $V_{OUT} = V_S/2$, unless otherwise noted.

| PARAMETER | CONDITION | OPA234P, U OPA2234P, U MIN | OPA234P, U OPA2234P, U TYP | OPA234P, U OPA2234P, U MAX | OPA234PA, UA OPA2234PA, UA OPA4234PA, UA MIN | OPA234PA, UA OPA2234PA, UA OPA4234PA, UA TYP | OPA234PA, UA OPA2234PA, UA OPA4234PA, UA MAX | UNITS |
|---|---|---|---|---|---|---|---|---|
| **OFFSET VOLTAGE** | | | | | | | | |
| Input Offset Voltage | $V_{CM}$ = 2.5V | | ±40 | ±100 | | * | ±250 | µV |
| vs Temperature[1] | Operating Temperature Range | | ±0.5 | ±3 | | * | * | µV/°C |
| vs Power Supply | $V_S$ = +2.7V to +30V, $V_{CM}$ = 1.7V | | 3 | 10 | | * | 20 | µV/V |
| vs Time | | | 0.2 | | | * | | µV/mo |
| Channel Separation (Dual, Quad) | | | 0.3 | | | * | | µV/V |
| **INPUT BIAS CURRENT** | | | | | | | | |
| Input Bias Current[2] | $V_{CM}$ = 2.5V | | –15 | –25 | | * | –50 | nA |
| Input Offset Current | $V_{CM}$ = 2.5V | | ±1 | ±5 | | * | * | nA |
| **NOISE** | f = 1kHz | | | | | | | |
| Input Voltage Noise Density | | | 25 | | | * | | nV/√Hz |
| Current Noise Density | | | 80 | | | * | | fA/√Hz |
| **INPUT VOLTAGE RANGE** | | | | | | | | |
| Common-Mode Voltage Range | | –0.1 | | (V+) –1 | * | | * | V |
| Common-Mode Rejection | $V_{CM}$ = –0.1V to 4V | 96 | 106 | | 86 | * | | dB |
| **INPUT IMPEDANCE** | | | | | | | | |
| Differential | | | $10^7$ \|\| 5 | | | * | | Ω \|\| pF |
| Common-Mode | $V_{CM}$ = 2.5V | | $10^{10}$ \|\| 6 | | | * | | Ω \|\| pF |
| **OPEN-LOOP GAIN** | $V_O$ = 0.25V to 4V | | | | | | | |
| Open-Loop Voltage Gain | $R_L$ = 10kΩ | 110 | 120 | | 100 | * | | dB |
| | $R_L$ = 2kΩ | 90 | 96 | | 86 | * | | dB |
| **FREQUENCY RESPONSE** | | | | | | | | |
| Gain-Bandwidth Product | $C_L$ = 100pF | | 0.35 | | | * | | MHz |
| Slew Rate | | | 0.2 | | | * | | V/µs |
| Settling Time: 0.1% | G = 1, 3V Step, $C_L$ = 100pF | | 15 | | | * | | µs |
| 0.01% | G = 1, 3V Step, $C_L$ = 100pF | | 25 | | | * | | µs |
| Overload Recovery Time | ($V_{IN}$) (Gain) = $V_S$ | | 16 | | | * | | µs |
| **OUTPUT** | | | | | | | | |
| Voltage Output: Positive | $R_L$ = 10kΩ to $V_S/2$ | (V+) –1 | (V+) –0.65 | | * | * | | V |
| Negative | $R_L$ = 10kΩ to $V_S/2$ | 0.25 | 0.05 | | * | * | | V |
| Positive | $R_L$ = 10kΩ to Ground | (V+) –1 | (V+) –0.65 | | * | * | | V |
| Negative | $R_L$ = 10kΩ to Ground | 0.1 | 0.05 | | * | * | | V |
| Short-Circuit Current | | | ±11 | | | * | | mA |
| Capacitive Load Drive (Stable Operation)[3] | G = +1 | | 1000 | | | * | | pF |
| **POWER SUPPLY** | | | | | | | | |
| Specified Operating Voltage | | | +5 | | | * | | V |
| Operating Voltage Range | | +2.7 | | +36 | * | | * | V |
| Quiescent Current (per amplifier) | $I_O$ = 0 | | 250 | 300 | | * | * | µA |
| **TEMPERATURE RANGE** | | | | | | | | |
| Specified Range | | –40 | | +85 | * | | * | °C |
| Operating Range | | –40 | | +125 | * | | * | °C |
| Storage | | –55 | | +125 | * | | * | °C |
| Thermal Resistance, $\theta_{JA}$ | | | | | | | | |
| 8-Pin DIP | | | 100 | | | * | | °C/W |
| SO-8 Surface-Mount | | | 150 | | | * | | °C/W |
| 14-Pin DIP | | | 80 | | | * | | °C/W |
| SO-14 Surface-Mount | | | 110 | | | * | | °C/W |

* Specifications same as OPA234P.

NOTES: (1) Guaranteed by wafer-level test to 95% confidence level. (2) Positive conventional current flows into the input terminals. (3) See “Small-Signal Overshoot vs Load Capacitance” typical curve.

# SPECIFICATIONS: $V_S$ = +2.7V

At $T_A$ = 25°C, $V_S$ = +2.7V, $R_L$ = 10kΩ connected to $V_S/2$ and $V_{OUT} = V_S/2$, unless otherwise noted.

| PARAMETER | CONDITION | OPA234P, U OPA2234P, U MIN | OPA234P, U OPA2234P, U TYP | OPA234P, U OPA2234P, U MAX | OPA234PA, UA OPA2234PA, UA OPA4234PA, UA MIN | OPA234PA, UA OPA2234PA, UA OPA4234PA, UA TYP | OPA234PA, UA OPA2234PA, UA OPA4234PA, UA MAX | UNITS |
|---|---|---|---|---|---|---|---|---|
| **OFFSET VOLTAGE** | | | | | | | | |
| Input Offset Voltage | $V_{CM}$ = 1.35V | | ±40 | ±100 | | * | ±250 | µV |
| vs Temperature[1] | Operating Temperature Range | | ±0.5 | ±3 | | * | * | µV/°C |
| vs Power Supply | $V_S$ = +2.7V to +30V, $V_{CM}$ = 1.7V | | 3 | 10 | | * | 20 | µV/V |
| vs Time | | | 0.2 | | | * | | µV/mo |
| Channel Separation (Dual, Quad) | | | 0.3 | | | * | | µV/V |
| **INPUT BIAS CURRENT** | | | | | | | | |
| Input Bias Current[2] | $V_{CM}$ = 1.35V | | –15 | –25 | | * | –50 | nA |
| Input Offset Current | $V_{CM}$ = 1.35V | | ±1 | ±5 | | * | * | nA |
| **NOISE** | f = 1kHz | | | | | | | |
| Input Voltage Noise Density | | | 25 | | | * | | nV/√Hz |
| Current Noise Density | | | 80 | | | * | | fA/√Hz |
| **INPUT VOLTAGE RANGE** | | | | | | | | |
| Common-Mode Voltage Range | | –0.1 | | (V+) –1 | * | | * | V |
| Common-Mode Rejection | $V_{CM}$ = –0.1V to 1.7V | 96 | 106 | | 86 | * | | dB |
| **INPUT IMPEDANCE** | | | | | | | | |
| Differential | | | $10^7$ \|\| 5 | | | * | | Ω \|\| pF |
| Common-Mode | $V_{CM}$ = 1.35V | | $10^{10}$ \|\| 6 | | | * | | Ω \|\| pF |
| **OPEN-LOOP GAIN** | $V_O$ = 0.25V to 1.7V | | | | | | | |
| Open-Loop Voltage Gain | $R_L$ = 10kΩ | 110 | 125 | | 100 | * | | dB |
| | $R_L$ = 2kΩ | 90 | 96 | | 86 | * | | dB |
| **FREQUENCY RESPONSE** | | | | | | | | |
| Gain-Bandwidth Product | $C_L$ = 100pF | | 0.35 | | | * | | MHz |
| Slew Rate | | | 0.2 | | | * | | V/µs |
| Settling Time: 0.1% | G = 1, 1V Step, $C_L$ = 100pF | | 6 | | | * | | µs |
| 0.01% | G = 1, 1V Step, $C_L$ = 100pF | | 16 | | | * | | µs |
| Overload Recovery Time | ($V_{IN}$) (Gain) = $V_S$ | | 8 | | | * | | µs |
| **OUTPUT** | | | | | | | | |
| Voltage Output: Positive | $R_L$ = 10kΩ to $V_S/2$ | (V+) –1 | (V+) –0.6 | | * | * | | V |
| Negative | $R_L$ = 10kΩ to $V_S/2$ | 0.25 | 0.05 | | * | * | | V |
| Positive | $R_L$ = 10kΩ to Ground | (V+) –1 | (V+) –0.65 | | * | * | | V |
| Negative | $R_L$ = 10kΩ to Ground | 0.1 | 0.05 | | * | * | | V |
| Short-Circuit Current | | | ±8 | | | * | | mA |
| Capacitive Load Drive (Stable Operation)[3] | G = +1 | | 1000 | | | * | | pF |
| **POWER SUPPLY** | | | | | | | | |
| Specified Operating Voltage | | | +2.7 | | | * | | V |
| Operating Voltage Range | | +2.7 | | +36 | * | | * | V |
| Quiescent Current (per amplifier) | $I_O$ = 0 | | 250 | 300 | | * | * | µA |
| **TEMPERATURE RANGE** | | | | | | | | |
| Specified Range | | –40 | | +85 | * | | * | °C |
| Operating Range | | –40 | | +125 | * | | * | °C |
| Storage | | –55 | | +125 | * | | * | °C |
| Thermal Resistance, $\theta_{JA}$ | | | | | | | | |
| 8-Pin DIP | | | 100 | | | * | | °C/W |
| SO-8 Surface-Mount | | | 150 | | | * | | °C/W |
| 14-Pin DIP | | | 80 | | | * | | °C/W |
| SO-14 Surface-Mount | | | 110 | | | * | | °C/W |

* Specifications same as OPA234P.

NOTES: (1) Guaranteed by wafer-level test to 95% confidence level. (2) Positive conventional current flows into the input terminals. (3) See “Small-Signal vs Load Capacitance” typical curve.

# SPECIFICATIONS: $V_S = \pm 15V$

At $T_A$ = 25°C, $V_S$ = ±15V, $R_L$ = 10kΩ connected to ground, unless otherwise noted.

| PARAMETER | CONDITION | OPA234P, U OPA2234P, U | | | OPA234PA, UA OPA2234PA, UA OPA4234PA, UA | | | UNITS |
|---|---|---|---|---|---|---|---|---|
| | | MIN | TYP | MAX | MIN | TYP | MAX | |
| **OFFSET VOLTAGE** | | | | | | | | |
| Input Offset Voltage | $V_{CM}$ = 0V | | ±70 | ±250 | | * | ±500 | µV |
| vs Temperature[1] | Operating Temperature Range | | ±0.5 | ±5 | | * | * | µV/°C |
| vs Power Supply | $V_S$ = ±1.35V to ±18V, $V_{CM}$ = 0V | | 3 | 10 | | * | 20 | µV/V |
| vs Time | | | 0.2 | | | * | | µV/mo |
| Channel Separation (Dual, Quad) | | | 0.3 | | | * | | µV/V |
| **INPUT BIAS CURRENT** | | | | | | | | |
| Input Bias Current[2] | $V_{CM}$ = 0V | | –12 | –25 | | * | –50 | nA |
| Input Offset Current | $V_{CM}$ = 0V | | ±1 | ±5 | | * | * | nA |
| **NOISE** | f = 1kHz | | | | | | | |
| Input Voltage Noise Density | | | 25 | | | * | | nV/√Hz |
| Current Noise Density | | | 80 | | | * | | fA/√Hz |
| **INPUT VOLTAGE RANGE** | | | | | | | | |
| Common-Mode Voltage Range | | (V–) | | (V+) –1 | * | | * | V |
| Common-Mode Rejection | $V_{CM}$ = –15V to 14V | 96 | 106 | | 86 | * | | dB |
| **INPUT IMPEDANCE** | | | | | | | | |
| Differential | | | $10^7$ \|\| 5 | | | * | | Ω \|\| pF |
| Common-Mode | $V_{CM}$ = 0V | | $10^{10}$ \|\| 6 | | | * | | Ω \|\| pF |
| **OPEN-LOOP GAIN** | | | | | | | | |
| Open-Loop Voltage Gain | $V_O$ = –14.5V to 14V | 110 | 120 | | 100 | * | | dB |
| **FREQUENCY RESPONSE** | | | | | | | | |
| Gain-Bandwidth Product | $C_L$ = 100pF | | 0.35 | | | * | | MHz |
| Slew Rate | | | 0.2 | | | * | | V/µs |
| Settling Time: 0.1% | G = 1, 10V Step, $C_L$ = 100pF | | 41 | | | * | | µs |
| 0.01% | G = 1, 10V Step, $C_L$ = 100pF | | 47 | | | * | | µs |
| Overload Recovery Time | ($V_{IN}$) (Gain) = $V_S$ | | 22 | | | * | | µs |
| **OUTPUT** | | | | | | | | |
| Voltage Output: Positive | | (V+) –1 | (V+) –0.7 | | * | * | | V |
| Negative | | (V–) +0.5 | (V–) +0.15 | | * | * | | V |
| Short-Circuit Current | | | ±22 | | | * | | mA |
| Capacitive Load Drive (Stable Operation)[3] | G = +1 | | 1000 | | | * | | pF |
| **POWER SUPPLY** | | | | | | | | |
| Specified Operating Voltage | | | ±15 | | | * | | V |
| Operating Voltage Range | | ±1.35 | | ±18 | * | | * | V |
| Quiescent Current (per amplifier) | $I_O$ = 0 | | ±275 | ±350 | | * | * | µA |
| **TEMPERATURE RANGE** | | | | | | | | |
| Specified Range | | –40 | | +85 | * | | * | °C |
| Operating Range | | –40 | | +125 | * | | * | °C |
| Storage | | –55 | | +125 | * | | * | °C |
| Thermal Resistance, $\theta_{JA}$ | | | | | | | | |
| 8-Pin DIP | | | 100 | | | * | | °C/W |
| SO-8 Surface-Mount | | | 150 | | | * | | °C/W |
| 14-Pin DIP | | | 80 | | | * | | °C/W |
| SO-14 Surface-Mount | | | 110 | | | * | | °C/W |

* Specifications same as OPA234P.

NOTES: (1) Guaranteed by wafer-level test to 95% confidence level. (2) Positive conventional current flows into the input terminals. (3) See “Small-Signal Overshoot vs Load Capacitance” typical curve.

## 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.

## PACKAGE INFORMATION

| MODEL | PACKAGE | PACKAGE DRAWING NUMBER[1] |
|---|---|---|
| **Single** | | |
| OPA234PA | 8-Pin Plastic DIP | 006 |
| OPA234P | 8-Pin Plastic DIP | 006 |
| OPA234UA | SO-8 Surface-Mount | 182 |
| OPA234U | SO-8 Surface-Mount | 182 |
| OPA234N[2] | MSOP-8 Surface-Mount | 337 |
| **Dual** | | |
| OPA2234PA | 8-Pin Plastic DIP | 006 |
| OPA2234P | 8-Pin Plastic DIP | 006 |
| OPA2234UA | SO-8 Surface-Mount | 182 |
| OPA2234U | SO-8 Surface-Mount | 182 |
| **Quad** | | |
| OPA4234PA | 14-Pin Plastic DIP | 010 |
| OPA4234UA | SO-14 Surface-Mount | 235 |

NOTE: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix D of Burr-Brown IC Data Book. (2) MSOP version available 4Q 96.

## ORDERING INFORMATION

| MODEL | PACKAGE | TEMPERATURE RANGE |
|---|---|---|
| **Single** | | |
| OPA234PA | 8-Pin Plastic DIP | –40°C to +85°C |
| OPA234P | 8-Pin Plastic DIP | –40°C to +85°C |
| OPA234UA | SO-8 Surface-Mount | –40°C to +85°C |
| OPA234U | SO-8 Surface-Mount | –40°C to +85°C |
| **Dual** | | |
| OPA2234PA | 8-Pin Plastic DIP | –40°C to +85°C |
| OPA2234P | 8-Pin Plastic DIP | –40°C to +85°C |
| OPA2234UA | SO-8 Surface-Mount | –40°C to +85°C |
| OPA2234U | SO-8 Surface-Mount | –40°C to +85°C |
| **Quad** | | |
| OPA4234PA | 14-Pin Plastic DIP | –40°C to +85°C |
| OPA4234UA | SO-14 Surface-Mount | –40°C to +85°C |

## ELECTROSTATIC DISCHARGE SENSITIVITY

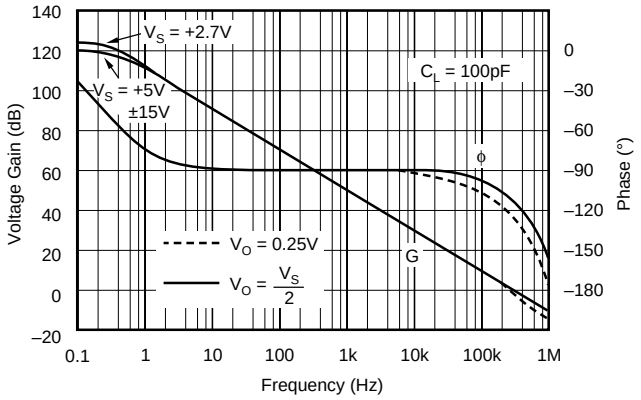
This integrated circuit can be damaged by ESD. Burr-Brown recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

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.

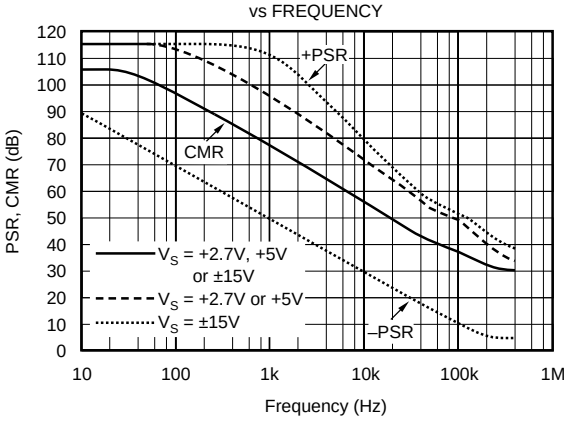
# TYPICAL PERFORMANCE CURVES

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

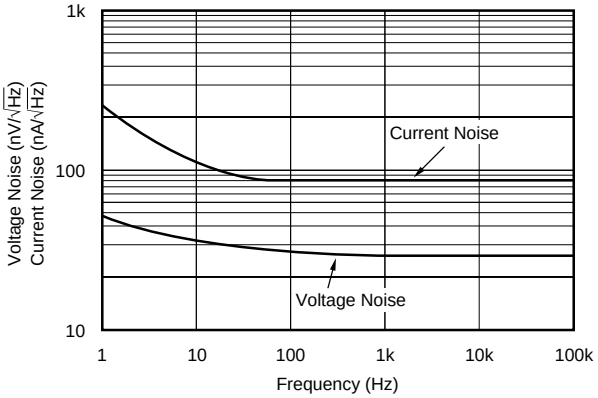
OPEN-LOOP GAIN/PHASE vs FREQUENCY



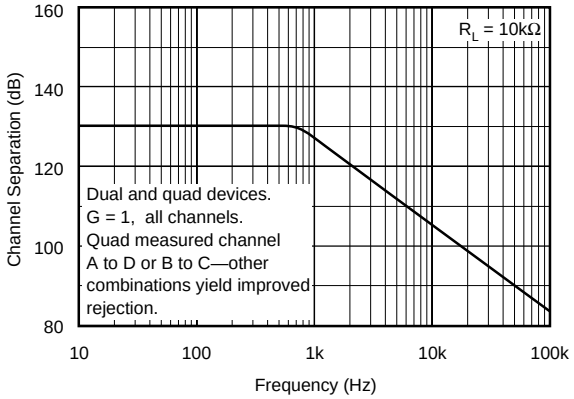

POWER SUPPLY AND COMMON-MODE REJECTION vs FREQUENCY



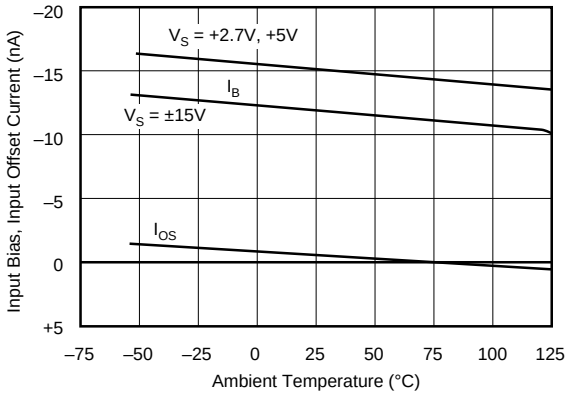

INPUT NOISE AND CURRENT NOISE SPECTRAL DENSITY vs FREQUENCY



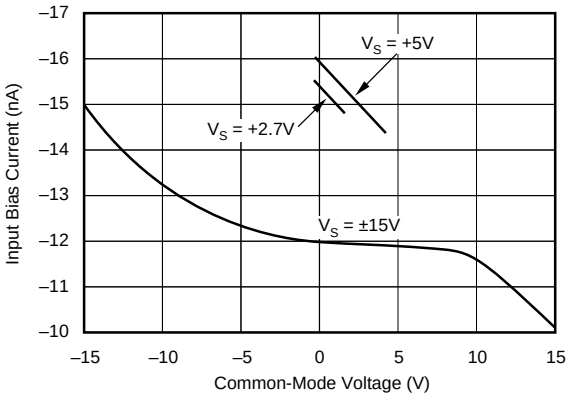

CHANNEL SEPARATION vs FREQUENCY




INPUT BIAS AND INPUT OFFSET CURRENT vs TEMPERATURE



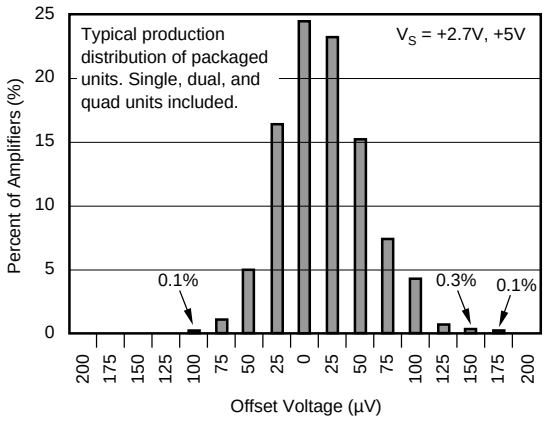

INPUT BIAS CURRENT vs INPUT COMMON-MODE VOLTAGE



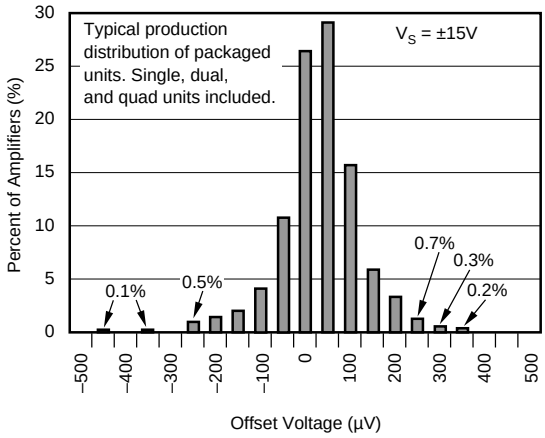
# TYPICAL PERFORMANCE CURVES (CONT)

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

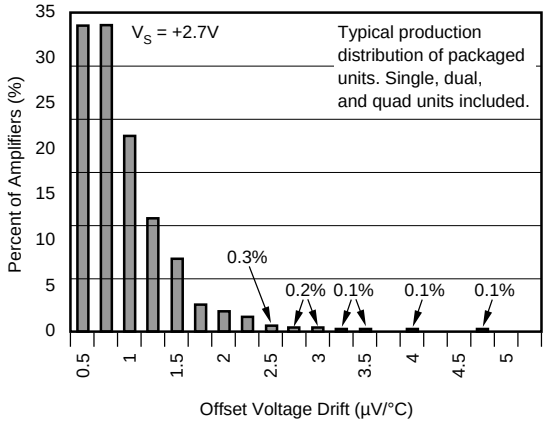
OFFSET VOLTAGE
PRODUCTION DISTRIBUTION



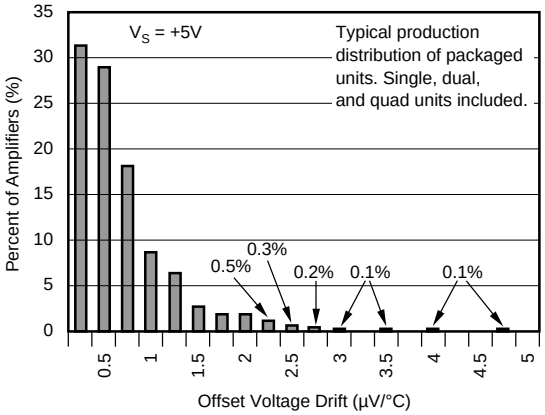

OFFSET VOLTAGE
PRODUCTION DISTRIBUTION



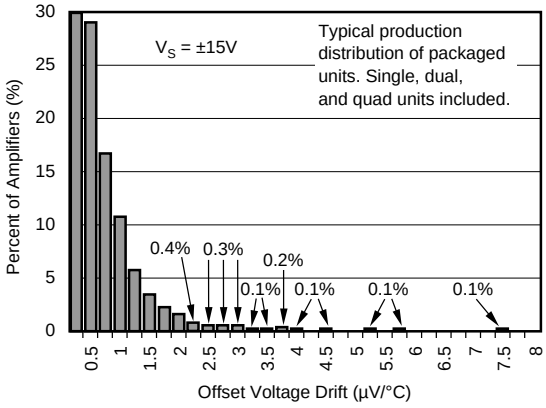

OFFSET VOLTAGE DRIFT
PRODUCTION DISTRIBUTION



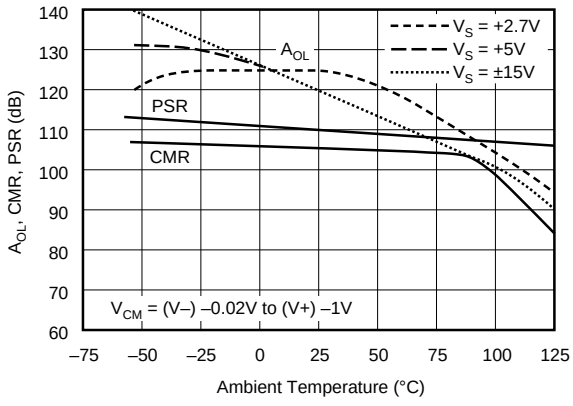

OFFSET VOLTAGE DRIFT
PRODUCTION DISTRIBUTION




OFFSET VOLTAGE DRIFT
PRODUCTION DISTRIBUTION



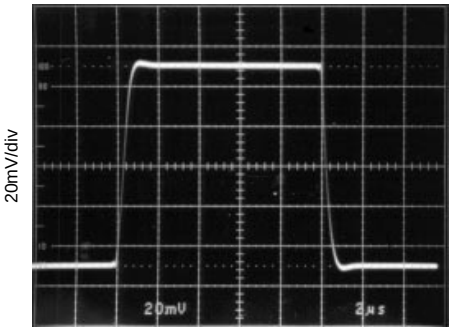

$A_{OL}$, CMR, PSR vs TEMPERATURE



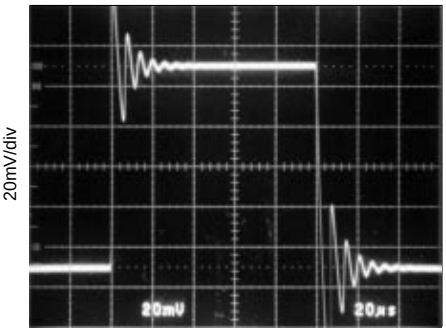
# TYPICAL PERFORMANCE CURVES (CONT)

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

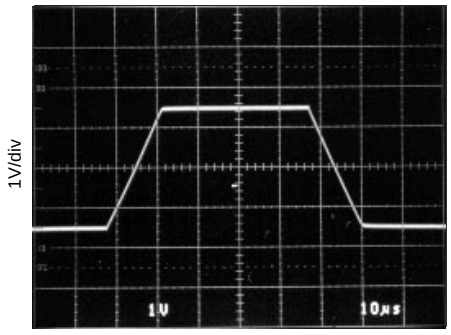
SMALL-SIGNAL STEP RESPONSE
G = 1, $C_L$ = 100pF, $V_S$ = +5V



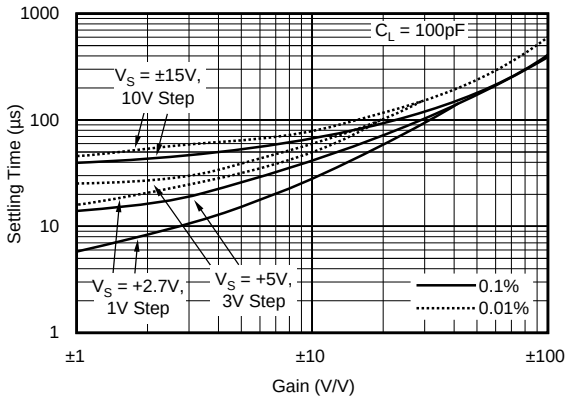

SMALL-SIGNAL STEP RESPONSE
G = 1, $C_L$ = 10,000pF, $V_S$ = +5V



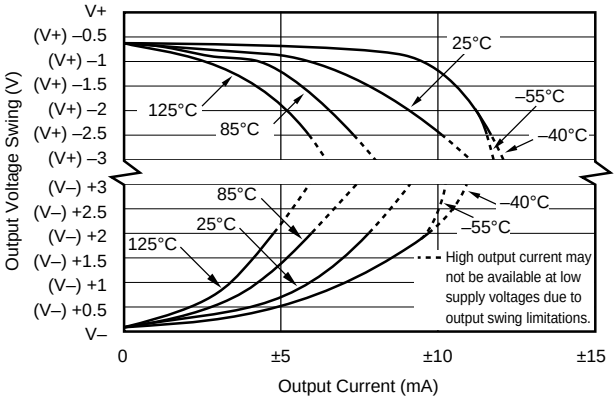

LARGE-SIGNAL STEP RESPONSE
G = 1, $C_L$ = 100pF, $V_S$ = +5V



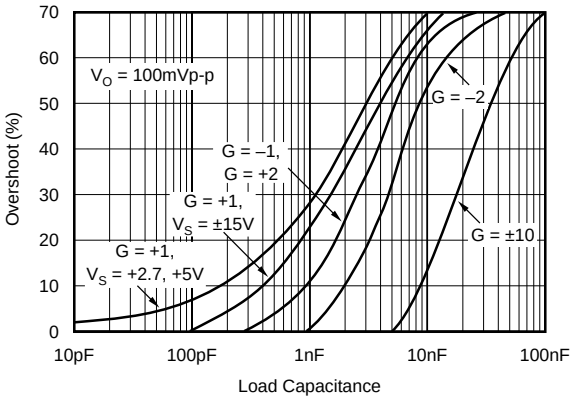

SETTLING TIME vs CLOSED-LOOP GAIN




OUTPUT VOLTAGE SWING vs OUTPUT CURRENT

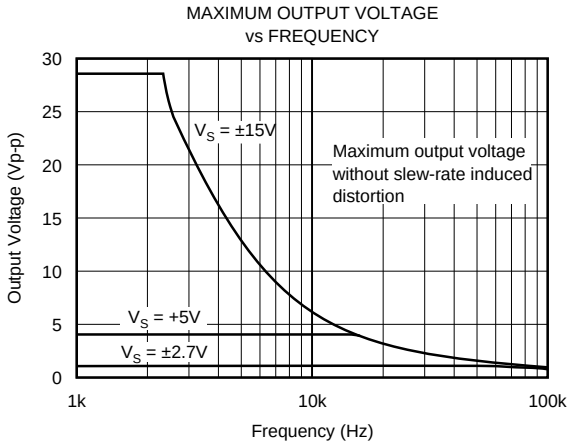


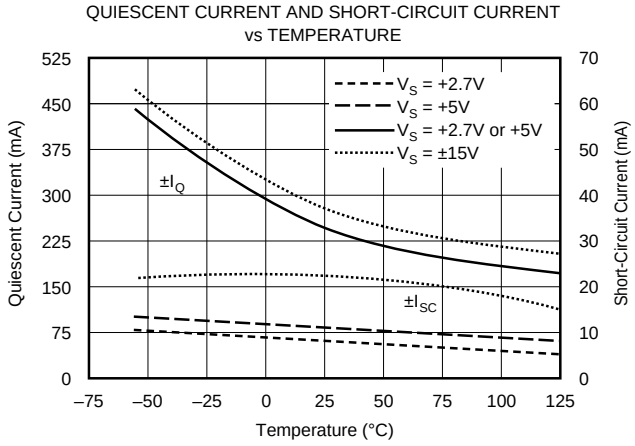

SMALL-SIGNAL OVERSHOOT
vs LOAD CAPACITANCE



# TYPICAL PERFORMANCE CURVES (CONT)

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




# APPLICATIONS INFORMATION

OPA234 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

OPA234 series op amps operate from single (+2.7V to +36V) or dual (±1.35V to ±18V) supplies with excellent performance. Specifications are production tested with +2.7V, +5V, and ±15V supplies. Most behavior remains unchanged throughout the full operating voltage range. Parameters which vary significantly with operating voltage are shown in typical performance curves.

### OFFSET VOLTAGE TRIM

Offset voltage of OPA234 series amplifiers is laser trimmed and usually requires no user adjustment. The OPA234 (single op amp version) provides offset voltage trim connections on pins 1 and 5. Offset voltage can be adjusted by connecting a potentiometer as shown in Figure 1. This adjustment should be used only to null the offset of the op amp, not to adjust system offset or offset produced by the signal source. Nulling offset could degrade the offset drift behavior of the op amp. While it is not possible to predict the exact change in drift, the effect is usually small.

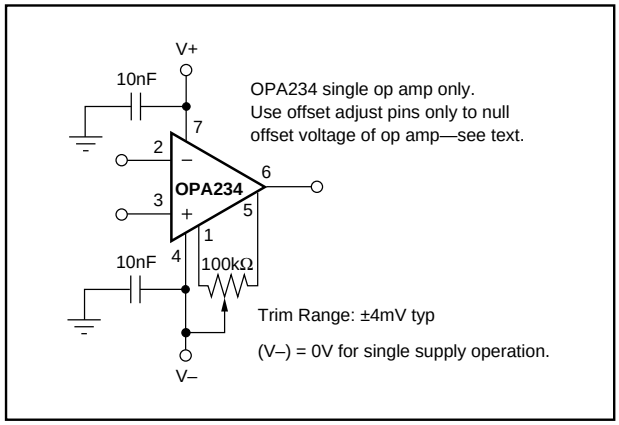



FIGURE 1. OPA234 Offset Voltage Trim Circuit.