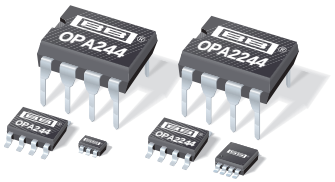
BURR-BROWN®



OPA244
OPA2244

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

FEATURES

- ***Micro*SIZE PACKAGES**
  OPA244 (Single): SOT-23-5
  OPA2244 (Dual): MSOP-8
- ***Micro*POWER: I_Q = 40μA/channel**
- **SINGLE SUPPLY OPERATION**
- **WIDE BANDWIDTH:**
  Single: 240kHz
  Dual: 300kHz
- **WIDE SUPPLY RANGE:**
  Single Supply: 2.2V to 36V
  Dual Supply: ±1.1V to ±18V
- **SINGLE AND DUAL VERSIONS**

APPLICATIONS

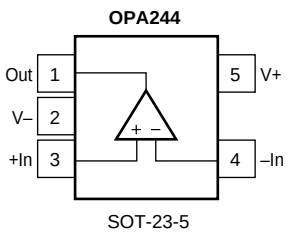
- **BATTERY POWERED SYSTEMS**
- **PORTABLE EQUIPMENT**
- **PCMCIA CARDS**
- **BATTERY PACKS AND POWER SUPPLIES**
- **CONSUMER PRODUCTS**

DESCRIPTION

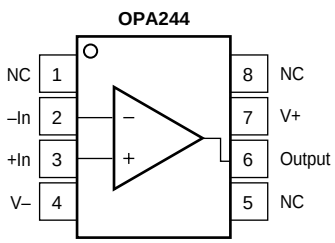
The OPA244 (single) and OPA2244 (dual) op amps are designed for very low quiescent current (40μA/channel) yet achieve excellent bandwidth. Ideal for battery powered and portable instrumentation, both single and dual versions are offered in micro packages for space-limited applications. The dual version features completely independent circuitry for lowest crosstalk and freedom from interaction, even when overdriven or overloaded.

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

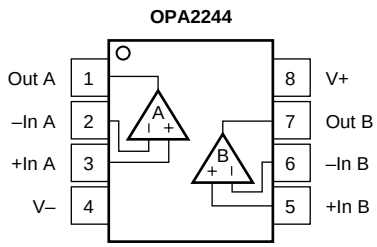
Both the single and dual versions are offered in miniature, surface-mount packages. OPA244 (single version) comes in the tiny 5-lead SOT-23-5 surface mount, SO-8 surface mount, and 8-pin DIP. OPA2244 (dual version) is available in the MSOP-8 surface mount, SO-8 surface-mount, and 8-pin DIP. They are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



SOT-23-5



8-Pin DIP, SO-8



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

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

Printed in U.S.A. October, 1998

SPECIFICATIONS: V_S = +2.6V to +36V

At T_A = +25°C, and R_L = 20kΩ connected to ground, unless otherwise noted.
Boldface limits apply over the specified temperature range, –40°C to +85°C.

PARAMETER		CONDITION	OPA244NA, PA, UA MIN	OPA244NA, PA, UA TYP[1]	OPA244NA, PA, UA MAX	UNITS
OFFSET VOLTAGE						
Input Offset Voltage	V_{OS}	$V_{CM} = V_S/2$		±0.7	±1.5	mV
T_A = –40°C to 85°C					**±2**	mV
vs Temperature	dV_{OS}/dT	**T_A = –40°C to 85°C**		**±4**		µV/°C
vs Power Supply	PSRR	V_S = +2.6V to +36V		5	50	µV/V
T_A = –40°C to 85°C		V_S = +2.6V to +36V			**50**	µV/V
INPUT BIAS CURRENT						
Input Bias Current	I_B	$V_{CM} = V_S/2$		–10	–25	nA
Input Offset Current	I_{OS}	$V_{CM} = V_S/2$		±1	±10	nA
NOISE						
Input Voltage Noise, f = 0.1 to 10kHz				0.4		µVp-p
Input Voltage Noise Density, f = 1kHz	e_n			22		nV/√Hz
Current Noise Density, f = 1kHz	i_n			40		fA/√Hz
INPUT VOLTAGE RANGE						
Common-Mode Voltage Range	V_{CM}		0		(V+) –1	V
Common-Mode Rejection	CMRR	V_{CM} = 0 to (V+) – 1	84[2]	98		dB
T_A = –40°C to 85°C		V_{CM} = 0 to (V+) – 1	**84**			dB
INPUT IMPEDANCE						
Differential				10^6 || 2		Ω || pF
Common-Mode				10^9 || 2		Ω || pF
OPEN-LOOP GAIN						
Open-Loop Voltage Gain	A_{OL}	V_O = 0.5V to (V+) – 1	86	106		dB
T_A = –40°C to 85°C		V_O = 0.5V to (V+) – 1	**86**			dB
FREQUENCY RESPONSE						
Gain-Bandwidth Product	GBW			240		kHz
Slew Rate	SR	G = 1		0.1		V/µs
Settling Time 0.1%				150		µs
Overload Recovery Time		$V_{IN} \bullet G = V_S$		8		µs
OUTPUT						
Voltage Output, Positive	V_O	$A_{OL} \geq$ 86dB	(V+) – 1	(V+) – 0.75		V
T_A = –40°C to 85°C		$A_{OL} \geq$ 86dB	**(V+) – 1**			V
Voltage Output, Negative		$A_{OL} \geq$ 86dB	0.5	0.3		V
T_A = –40°C to 85°C		$A_{OL} \geq$ 86dB	**0.5**			V
Short-Circuit Current	I_{SC}			–25/+12		mA
Capacitive Load Drive	C_{LOAD}			See Typical Curve		
POWER SUPPLY						
Specified Voltage Range	V_S	**T_A = –40°C to 85°C**	**+2.6**		**+36**	V
Minimum Operating Voltage				+2.2		V
Quiescent Current	I_Q	I_O = 0		40	60	µA
T_A = –40°C to 85°C		I_O = 0			**70**	µA
TEMPERATURE RANGE						
Specified Range			–40		85	°C
Operating Range			–55		125	°C
Storage Range			–55		125	°C
Thermal Resistance	θ_{JA}					
SOT-23-5 Surface-Mount				200		°C/W
SO-8 Surface-Mount				150		°C/W
8-Pin DIP				100		°C/W

NOTES: (1) V_S = +15V. (2) CMRR improves with increasing supply voltage, see “Common-Mode Rejection vs Supply Voltage” typical curve.

SPECIFICATIONS: V_S = +2.6V to +36V

At T_A = +25°C, and R_L = 20kΩ connected to ground, unless otherwise noted.
Boldface limits apply over the specified temperature range, –40°C to +85°C.

PARAMETER		CONDITION	OPA2244EA, PA, UA MIN	OPA2244EA, PA, UA TYP[1]	OPA2244EA, PA, UA MAX	UNITS
OFFSET VOLTAGE						
Input Offset Voltage	V_{OS}	$V_{CM} = V_S/2$		±0.3	±1.5	mV
T_A = –40°C to 85°C					**±2**	mV
vs Temperature	dV_{OS}/dT	**T_A = –40°C to 85°C**		**±2.3**		µV/°C
vs Power Supply	PSRR	V_S = +2.6V to +36V		5	50	µV/V
T_A = –40°C to 85°C		V_S = +2.6V to +36V			**50**	µV/V
Channel Separation, dc				0.5		µV/V
INPUT BIAS CURRENT						
Input Bias Current	I_B	$V_{CM} = V_S/2$		–10	–25	nA
Input Offset Current	I_{OS}	$V_{CM} = V_S/2$		±1	±10	nA
NOISE						
Input Voltage Noise, f = 0.1 to 10kHz				0.4		µVp-p
Input Voltage Noise Density, f = 1kHz	e_n			22		nV/√Hz
Current Noise Density, f = 1kHz	i_n			40		fA/√Hz
INPUT VOLTAGE RANGE						
Common-Mode Voltage Range	V_{CM}		0		(V+) –1	V
Common-Mode Rejection	CMRR	V_{CM} = 0 to (V+) – 1	72[2]	98		dB
T_A = –40°C to 85°C		V_{CM} = 0 to (V+) – 1	**72**			dB
INPUT IMPEDANCE						
Differential				10^6 || 2		Ω || pF
Common-Mode				10^9 || 2		Ω || pF
OPEN-LOOP GAIN						
Open-Loop Voltage Gain	A_{OL}	V_O = 0.5V to (V+) – 1	86	106		dB
T_A = –40°C to 85°C		V_O = 0.5V to (V+) – 1	**86**			dB
FREQUENCY RESPONSE						
Gain-Bandwidth Product	GBW			300		kHz
Slew Rate	SR	G = 1		0.1		V/µs
Settling Time 0.1%				150		µs
Overload Recovery Time		$V_{IN} \bullet G = V_S$		8		µs
OUTPUT						
Voltage Output, Positive	V_O	$A_{OL} \geq$ 86dB	(V+) – 1	(V+) – 0.75		V
T_A = –40°C to 85°C		$A_{OL} \geq$ 86dB	**(V+) – 1**			V
Voltage Output, Negative		$A_{OL} \geq$ 86dB	0.5	0.3		V
T_A = –40°C to 85°C		$A_{OL} \geq$ 86dB	**0.5**			V
Short-Circuit Current	I_{SC}			–25/+12		mA
Capacitive Load Drive	C_{LOAD}			See Typical Curve		
POWER SUPPLY						
Specified Voltage Range	V_S	**T_A = –40°C to 85°C**	**+2.6**		**+36**	V
Minimum Operating Voltage				+2.2		V
Quiescent Current (per amplifier)	I_Q	I_O = 0		40	50	µA
T_A = –40°C to 85°C		I_O = 0			**63**	µA
TEMPERATURE RANGE						
Specified Range			–40		85	°C
Operating Range			–55		125	°C
Storage Range			–55		125	°C
Thermal Resistance	θ_{JA}					
MSOP-8 Surface-Mount				150		°C/W
SO-8 Surface-Mount				150		°C/W
8-Pin DIP				100		°C/W

NOTES: (1) V_S = +15V. (2) CMRR improves with increasing supply voltage, see “Common-Mode Rejection vs Supply Voltage” typical curve.

ABSOLUTE MAXIMUM RATINGS[1]

Supply Voltage	36V
Signal Input Terminals, Voltage[2]	(V–) –0.5V to (V+) +0.5V
Current[2]	200µA
Output Short-Circuit[3]	Continuous
Operating Temperature	–55°C to +125°C
Storage Temperature	–55°C to +125°C
Junction Temperature	150°C
Lead Temperature (soldering, 10s)	300°C

NOTES: (1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may affect device reliability. (2) Input terminals are diode-clamped to the power supply rails. Input signals that can swing more than 0.5V beyond the supply rails should be current-limited to 200µA or less. (3) Short-circuit to ground, one amplifier per package.

ELECTROSTATIC DISCHARGE SENSITIVITY

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

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

PACKAGE/ORDERING INFORMATION

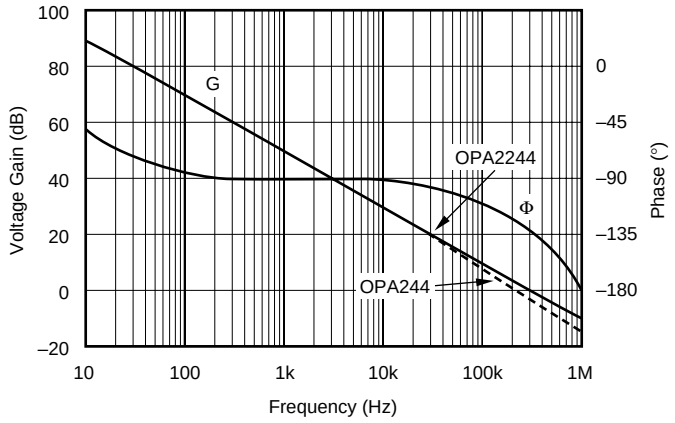
PRODUCT	PACKAGE	PACKAGE DRAWING NUMBER[1]	SPECIFIED TEMPERATURE RANGE	PACKAGE MARKING	ORDERING NUMBER[2]	TRANSPORT MEDIA
Single						
OPA244NA	SOT-23-5 Surface-Mount	331	–40°C to +85°C	A44	OPA244NA/250	Tape and Reel
"	"	"	"	"	OPA244NA/3K	Tape and Reel
OPA244PA	8-Pin DIP	006	–40°C to +85°C	OPA244PA	OPA244PA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

NOTES: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix C of Burr-Brown IC Data Book. (2) Products followed by a slash (/) are only available in Tape and Reel in the quantities indicated (e.g., /250 indicates 250 devices per reel). Ordering 3000 pieces of "OPA244NA/3K" will get a single 3000 piece Tape and Reel. For detailed Tape and Reel mechanical information, refer to Appendix B of Burr-Brown IC Data Book.

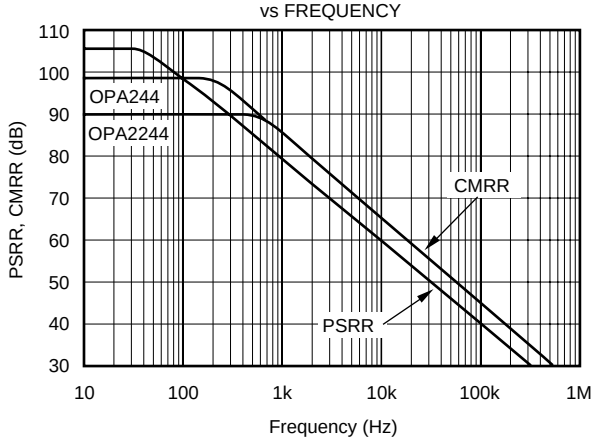
TYPICAL PERFORMANCE CURVES

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

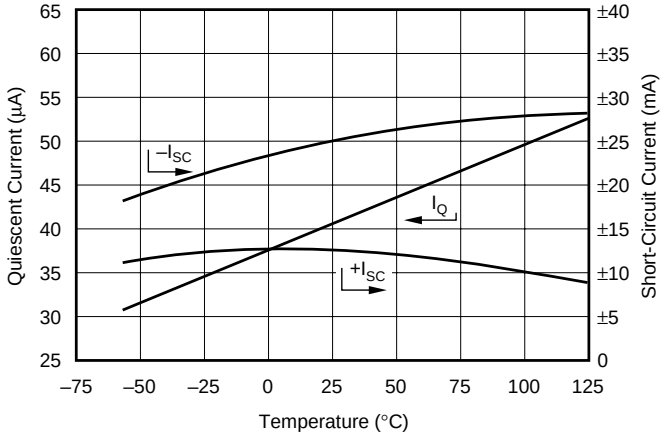
OPEN-LOOP GAIN/PHASE vs FREQUENCY



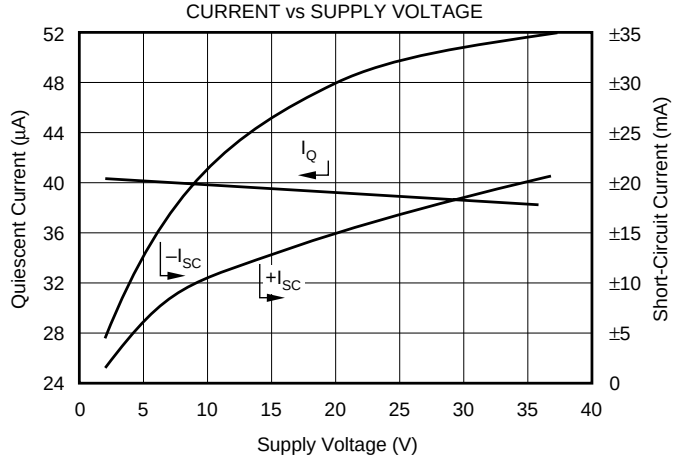
POWER SUPPLY AND COMMON-MODE REJECTION vs FREQUENCY



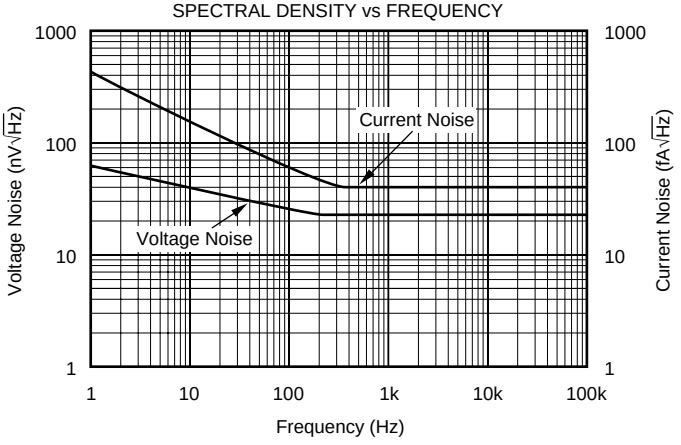
QUIESCENT AND SHORT-CIRCUIT CURRENT vs TEMPERATURE



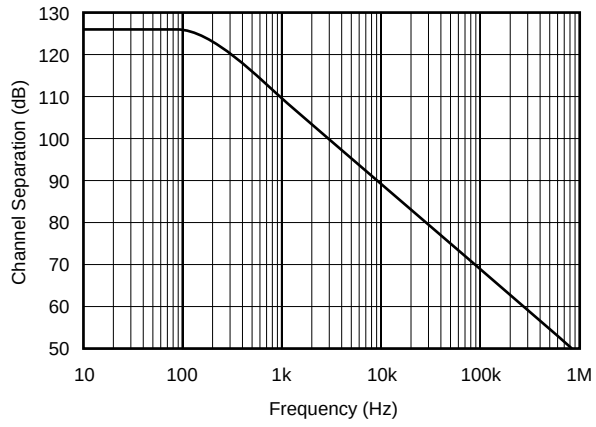
QUIESCENT AND SHORT-CIRCUIT CURRENT vs SUPPLY VOLTAGE



INPUT VOLTAGE AND CURRENT NOISE SPECTRAL DENSITY vs FREQUENCY



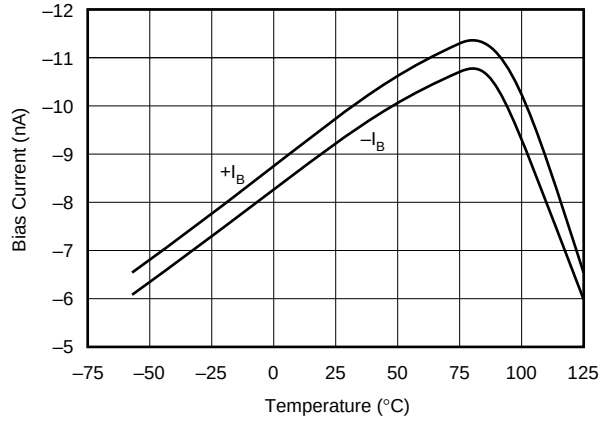
CHANNEL SEPARATION vs FREQUENCY



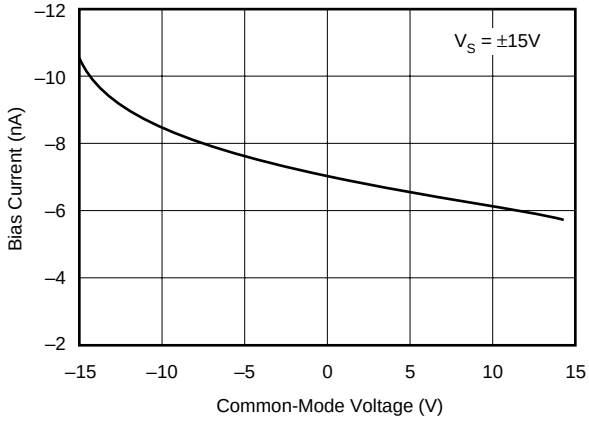
TYPICAL PERFORMANCE CURVES (CONT)

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

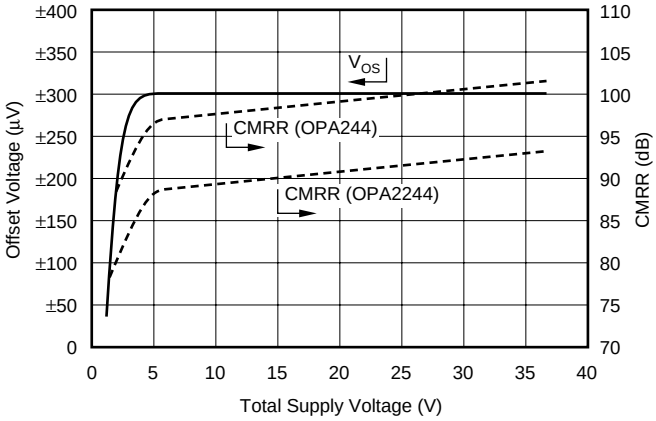
INPUT BIAS CURRENT vs TEMPERATURE



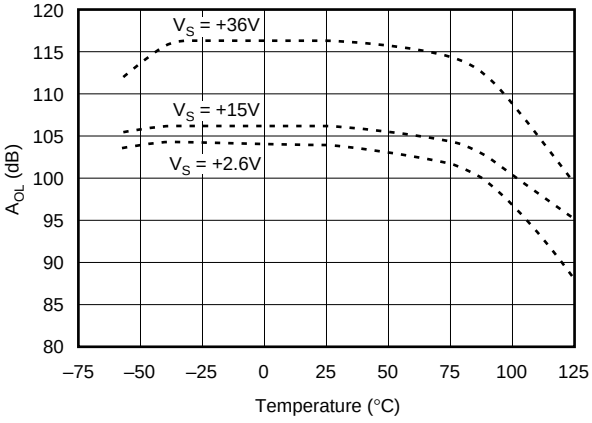
INPUT BIAS CURRENT
vs INPUT COMMON-MODE VOLTAGE



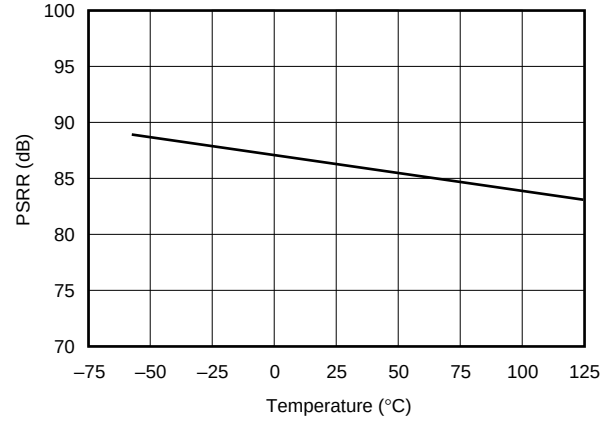
OFFSET VOLTAGE AND COMMON-MODE
REJECTION vs SUPPLY VOLTAGE



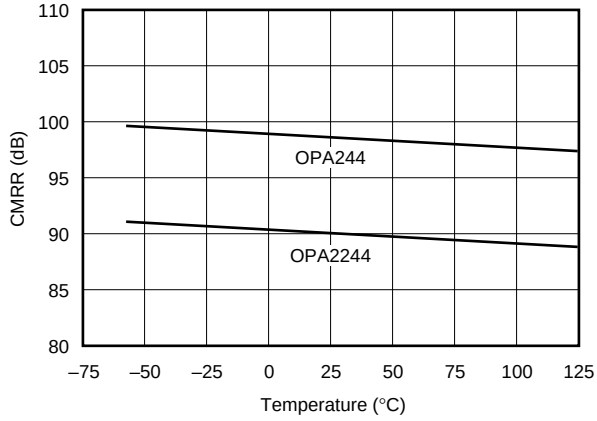
OPEN-LOOP GAIN vs TEMPERATURE



POWER SUPPLY REJECTION vs TEMPERATURE



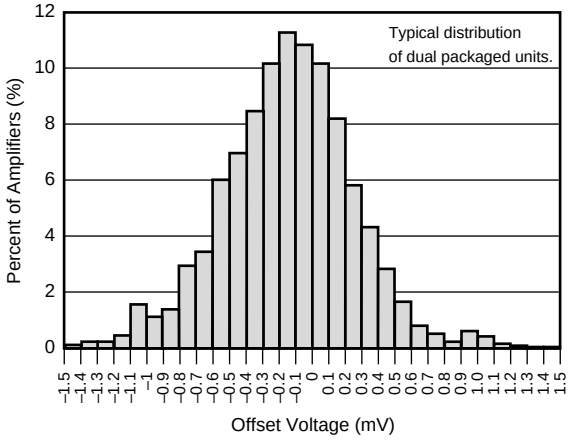
COMMON-MODE REJECTION vs TEMPERATURE



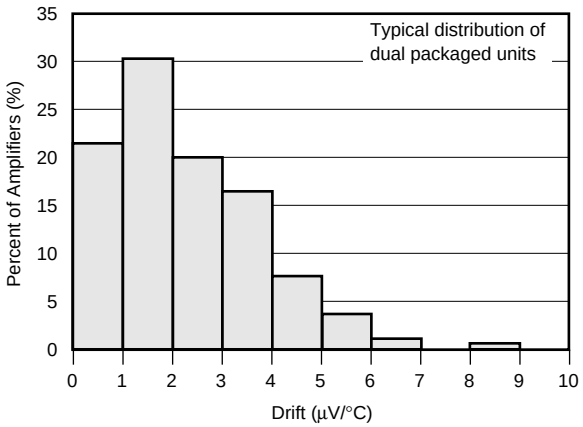
TYPICAL PERFORMANCE CURVES (CONT)

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

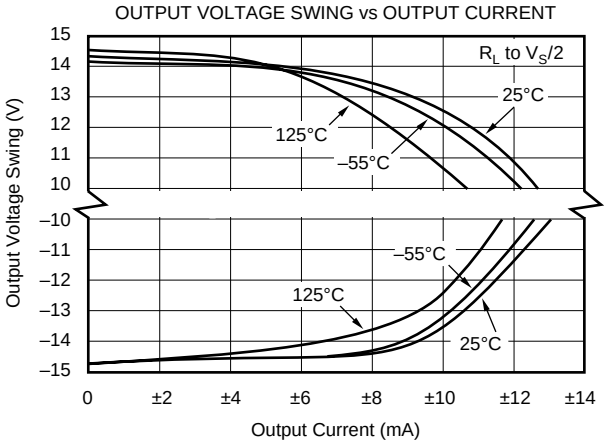
OFFSET VOLTAGE
PRODUCTION DISTRIBUTION



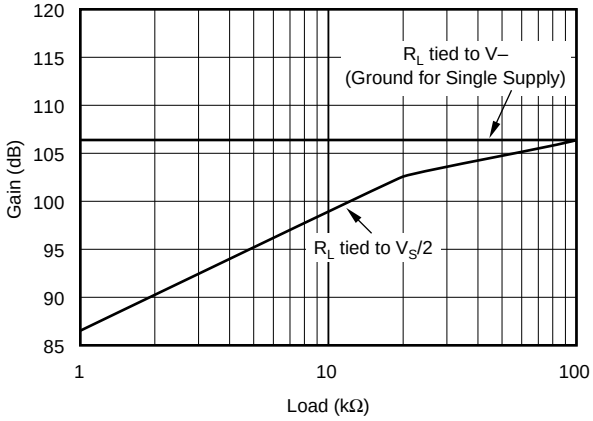
OFFSET VOLTAGE DRIFT
PRODUCTION DISTRIBUTION



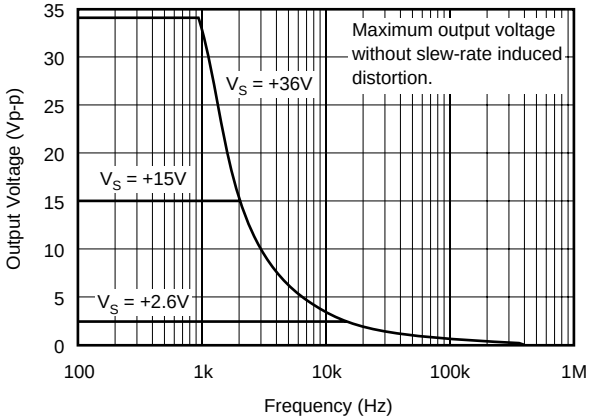
OUTPUT VOLTAGE SWING vs OUTPUT CURRENT



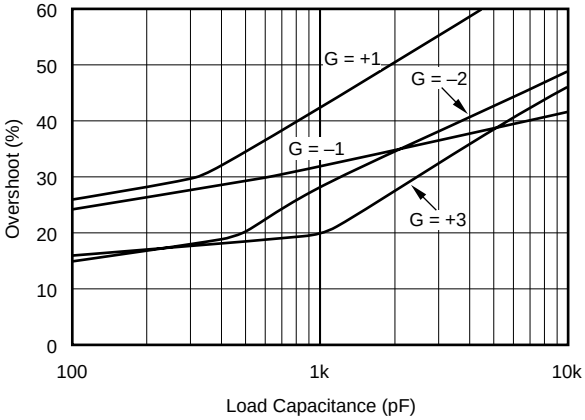
OPEN-LOOP GAIN
vs LOAD RESISTANCE



MAXIMUM OUTPUT VOLTAGE
vs FREQUENCY



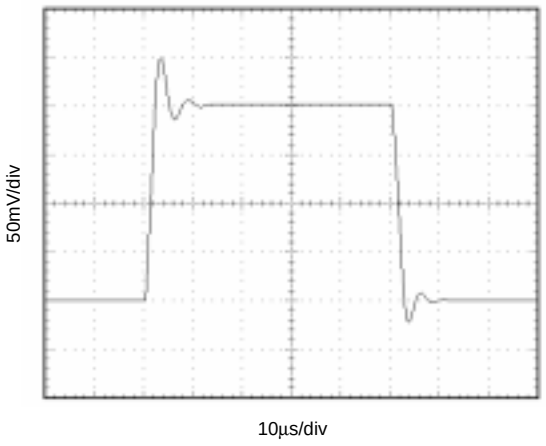
SMALL-SIGNAL OVERSHOOT
vs LOAD CAPACITANCE



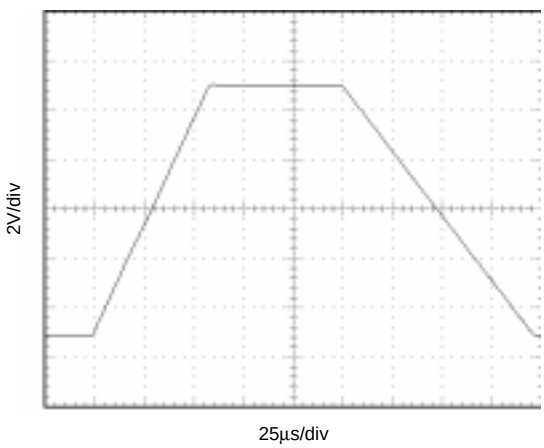
TYPICAL PERFORMANCE CURVES (CONT)

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

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



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



APPLICATIONS INFORMATION

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

OPERATING VOLTAGE

The OPA244 can operate from single supply (+2.2V to +36V) or dual supplies (±1.1 to ±18V) with excellent performance. Unlike most op amps which are specified at only one supply voltage, the OPA244 is specified for real world applications; a single set of specifications applies throughout the +2.6V to +36V (±1.3 to ±18V) supply range. This allows a designer to have the same assured performance at any supply voltage within this range. In addition, many key parameters are guaranteed over the specified temperature range, –40°C to +85°C. Most behavior remains unchanged throughout the full operating voltage range. Parameters which vary significantly with operating voltage or temperature are shown in typical performance curves.

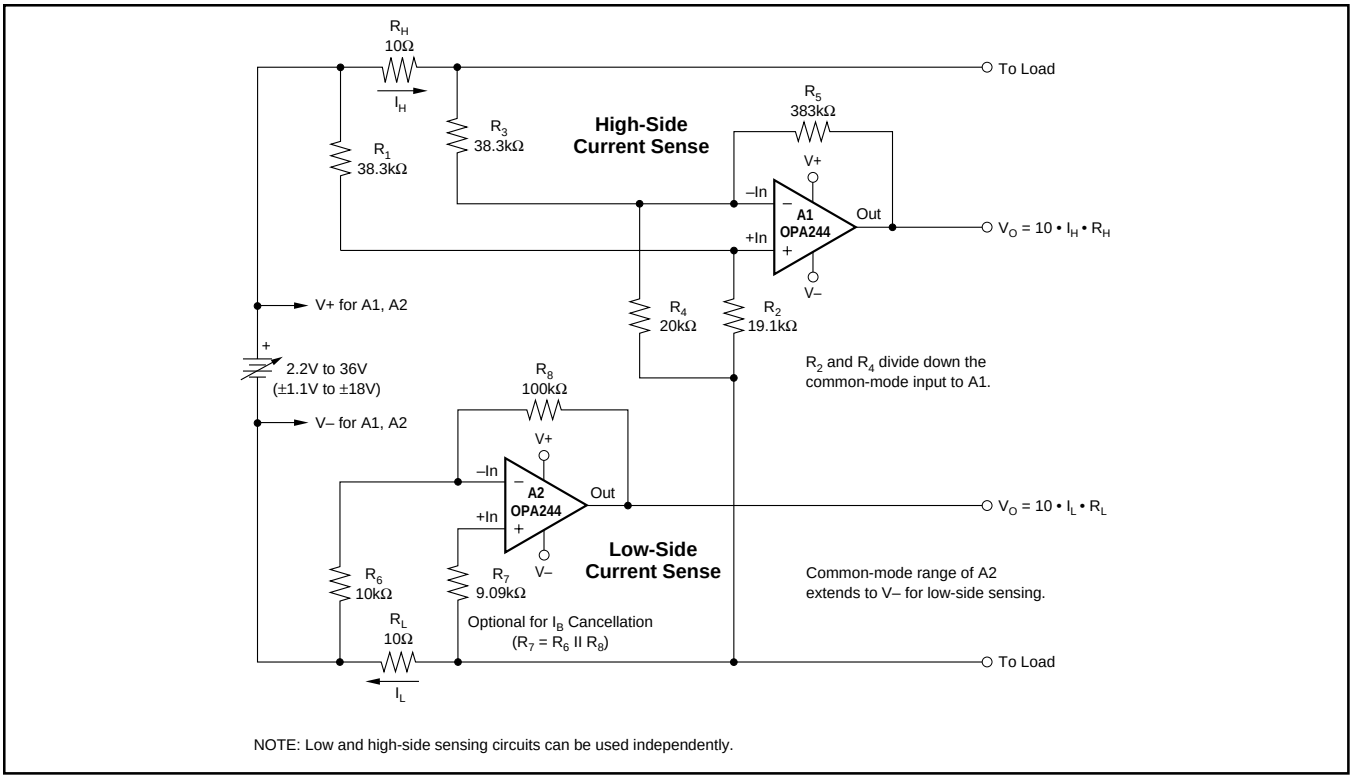
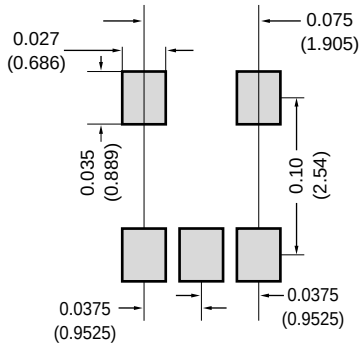
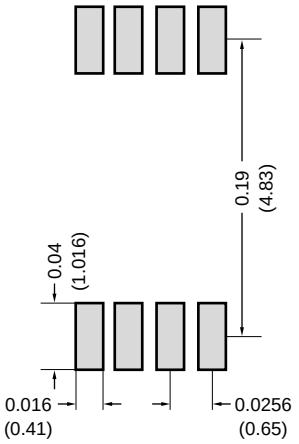


FIGURE 1. Low and High-Side Battery Current Sensing.

SOT-23-5
(Package Drawing #331)



MSOP-8
(Package Drawing #337)



Refer to end of data sheet or Appendix C of Burr-Brown Data Book for tolerances and detailed package drawing. For further information on solder pads for surface-mount devices consult Application Bulletin AB-132.

FIGURE 2. Recommended SOT-23-5 and MSOP-8 Solder Footprints.