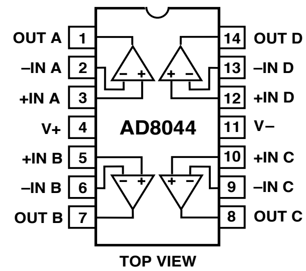
Quad 150 MHz Rail-to-Rail Amplifier

AD8044

FEATURES
- Single AD8041 and Dual AD8042 Also Available
- Fully Specified at +3 V, +5 V, and ±5 V Supplies
- Output Swings to Within 25 mV of Either Rail
- Input Voltage Range Extends 200 mV Below Ground
- No Phase Reversal with Inputs 1 V Beyond Supplies
- Low Power of 2.75 mA/Amplifier
- High Speed and Fast Settling on +5 V
  - 150 MHz –3 dB Bandwidth (G = +1)
  - 170 V/µs Slew Rate
  - 40 ns Settling Time to 0.1%
- Good Video Specifications (R_L = 150 Ω, G = +2)
  - Gain Flatness of 0.1 dB to 12 MHz
  - 0.06% Differential Gain Error
  - 0.15° Differential Phase Error
- Low Distortion
  - –68 dBc Total Harmonic @ 5 MHz
- Outstanding Load Drive Capability
  - Drives 30 mA 0.5 V from Supply Rails

APPLICATIONS
- Active Filters
- Video Switchers
- Distribution Amplifiers
- A/D Driver
- Professional Cameras
- CCD Imaging Systems
- Ultrasound Equipment (Multichannel)

CONNECTION DIAGRAM
14-Lead Plastic DIP and SOIC



PRODUCT DESCRIPTION

The AD8044 is a quad, low power, voltage feedback, high speed amplifier designed to operate on +3 V, +5 V, or ±5 V supplies. It has true single-supply capability with an input voltage range extending 200 mV below the negative rail and within 1 V of the positive rail.

The output voltage swing extends to within 25 mV of each rail, providing the maximum output dynamic range. Additionally, it features gain flatness of 0.1 dB to 12 MHz, while offering differential gain and phase error of 0.04% and 0.22° on a single +5 V supply. This makes the AD8044 useful for video electronics, such as cameras, video switchers, or any high speed portable equipment. The AD8044's low distortion and fast settling make it ideal for active filter applications.

The AD8044 offers low power supply current of 13.1 mA max and can run on a single +3.3 V power supply. These features are ideally suited for portable and battery-powered applications where size and power are critical.

The wide bandwidth of 150 MHz, along with 170 V/µs of slew rate on a single +5 V supply, make the AD8044 useful in many general-purpose, high speed applications where dual power supplies of up to ±6 V and single supplies from +3 V to +12 V are needed. The AD8044 is available in 14-lead PDIP and SOIC.

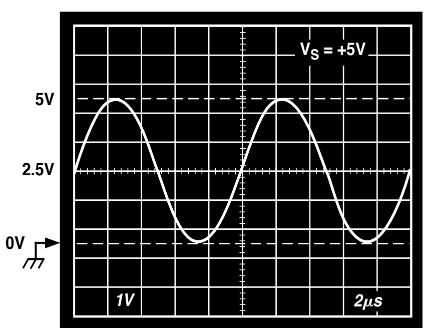


Figure 1. Output Swing: Gain = –1, R_L = 2 kΩ

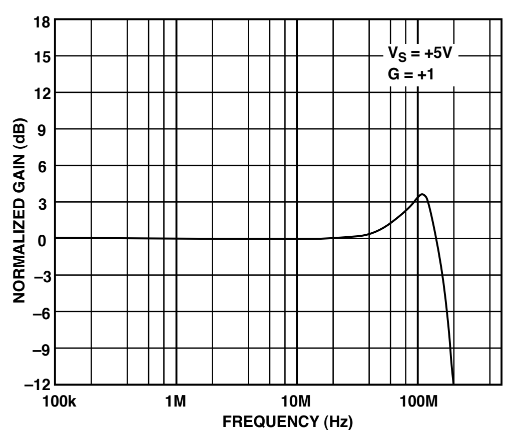


Figure 2. Frequency Response: Gain = +1, V_S = +5 V

AD8044–SPECIFICATIONS (@ T_A = +25°C, V_S = +5 V, R_L = 2 kΩ to 2.5 V, unless otherwise noted.)

Parameter	Conditions	AD8044A Min	Typ	Max	Units
DYNAMIC PERFORMANCE					
–3 dB Small Signal Bandwidth, V_O < 0.5 V p-p	G = +1	80	150		MHz
Bandwidth for 0.1 dB Flatness	G = +2, R_L = 150 Ω		12		MHz
Slew Rate	G = –1, V_O = 4 V Step	140	170		V/µs
Full Power Response	V_O = 2 V p-p		26		MHz
Settling Time to 1%	G = –1, V_O = 2 V Step		30		ns
Settling Time to 0.1%			40		ns
NOISE/DISTORTION PERFORMANCE					
Total Harmonic Distortion	f_C = 5 MHz, V_O = 2 V p-p, G = +2, R_L = 1 kΩ		–68		dB
Input Voltage Noise	f = 10 kHz		16		$nV/\sqrt{Hz}$
Input Current Noise	f = 10 kHz		850		$fA/\sqrt{Hz}$
Differential Gain Error (NTSC)	G = +2, R_L = 150 Ω to 2.5 V		0.04		%
Differential Phase Error (NTSC)	G = +2, R_L = 150 Ω to 2.5 V		0.22		Degrees
Crosstalk	f = 5 MHz, R_L = 1 kΩ, G = +2		–60		dB
DC PERFORMANCE					
Input Offset Voltage			1.0	6	mV
	T_{MIN}–T_{MAX}			8	mV
Offset Drift			8		µV/°C
Input Bias Current			2	4.5	µA
	T_{MIN}–T_{MAX}			4.5	µA
Input Offset Current			0.2	1.2	µA
Open-Loop Gain	R_L = 1 kΩ	82	94		dB
	T_{MIN}–T_{MAX}		88		dB
INPUT CHARACTERISTICS					
Input Resistance			225		kΩ
Input Capacitance			1.6		pF
Input Common-Mode Voltage Range			–0.2 to 4		V
Common-Mode Rejection Ratio	V_{CM} = 0 V to 3.5 V	80	90		dB
OUTPUT CHARACTERISTICS					
Output Voltage Swing	R_L = 10 kΩ to 2.5 V		0.03 to 4.975		V
	R_L = 1 kΩ to 2.5 V	0.25 to 4.75	0.075 to 4.91		V
	R_L = 150 Ω to 2.5 V	0.55 to 4.4	0.25 to 4.65		V
Output Current	T_{MIN}–T_{MAX}, V_{OUT} = 0.5 V to 4.5 V		30		mA
Short Circuit Current	Sourcing		45		mA
	Sinking		85		mA
Capacitive Load Drive	G = +2		40		pF
POWER SUPPLY					
Operating Range		3		12	V
Quiescent Current			11	13.1	mA
Power Supply Rejection Ratio	V_S = 0, +5 V, ±1 V	70	80		dB
OPERATING TEMPERATURE RANGE		–40		+85	°C

Specifications subject to change without notice.

SPECIFICATIONS (@ T_A = +25°C, V_S = +3 V, R_L = 2 kΩ to 1.5 V, unless otherwise noted.)

Parameter	Conditions	AD8044A Min	Typ	Max	Units
DYNAMIC PERFORMANCE					
–3 dB Small Signal Bandwidth, V_O < 0.5 V p-p	G = +1	80	135		MHz
Bandwidth for 0.1 dB Flatness	G = +2, R_L = 150 Ω		10		MHz
Slew Rate	G = –1, V_O = 2 V Step	110	150		V/μs
Full Power Response	V_O = 2 V p-p		22		MHz
Settling Time to 1%	G = –1, V_O = 2 V Step		35		ns
Settling Time to 0.1%			55		ns
NOISE/DISTORTION PERFORMANCE					
Total Harmonic Distortion	f_C = 5 MHz, V_O = 2 V p-p, G = –1, R_L = 100 Ω		–48		dB
Input Voltage Noise	f = 10 kHz		16		nV/√Hz
Input Current Noise	f = 10 kHz		600		fA/√Hz
Differential Gain Error (NTSC)	G = +2, R_L = 150 Ω to 1.5 V, Input V_{CM} = 0.5 V		0.13		%
Differential Phase Error (NTSC)	G = +2, R_L = 150 Ω to 1.5 V, Input V_{CM} = 0.5 V		0.3		Degrees
Crosstalk	f = 5 MHz, R_L = 1 kΩ, G = +2		–60		dB
DC PERFORMANCE					
Input Offset Voltage			1.5	5.5	mV
	T_{MIN}–T_{MAX}			7.5	mV
Offset Drift			8		μV/°C
Input Bias Current			2	4.5	μA
	T_{MIN}–T_{MAX}			4.5	μA
Input Offset Current			0.2	1.2	μA
Open-Loop Gain	R_L = 1 kΩ	80	92		dB
	T_{MIN}–T_{MAX}		88		dB
INPUT CHARACTERISTICS					
Input Resistance			225		kΩ
Input Capacitance			1.6		pF
Input Common-Mode Voltage Range			–0.2 to 2		V
Common-Mode Rejection Ratio	V_{CM} = 0 V to 1.5 V	76	90		dB
OUTPUT CHARACTERISTICS					
Output Voltage Swing	R_L = 10 kΩ to 1.5 V		0.025 to 2.98		V
	R_L = 1 kΩ to 1.5 V	0.17 to 2.82	0.06 to 2.93		V
	R_L = 150 Ω to 1.5 V	0.35 to 2.55	0.15 to 2.75		V
Output Current	T_{MIN}–T_{MAX}, V_{OUT} = 0.5 V to 2.5 V		25		mA
Short Circuit Current	Sourcing		30		mA
	Sinking		50		mA
Capacitive Load Drive	G = +2		35		pF
POWER SUPPLY					
Operating Range		3		12	V
Quiescent Current			10.5	12.5	mA
Power Supply Rejection Ratio	V_S = 0, +3 V, +0.5 V	70	80		dB
OPERATING TEMPERATURE RANGE		0		+70	°C

Specifications subject to change without notice.

AD8044–SPECIFICATIONS (@ T_A = +25°C, V_S = ±5 V, R_L = 2 kΩ to 0 V, unless otherwise noted.)

Parameter	Conditions	AD8044A Min	Typ	Max	Units
DYNAMIC PERFORMANCE					
–3 dB Small Signal Bandwidth, V_O < 0.5 V p-p	G = +1	85	160		MHz
Bandwidth for 0.1 dB Flatness	G = +2, R_L = 150 Ω		15		MHz
Slew Rate	G = –1, V_O = 8 V Step	150	190		V/µs
Full Power Response	V_O = 2 V p-p		29		MHz
Settling Time to 0.1%	G = –1, V_O = 2 V Step		30		ns
Settling Time to 0.01%			40		ns
NOISE/DISTORTION PERFORMANCE					
Total Harmonic Distortion	f_C = 5 MHz, V_O = 2 V p-p, G = +2		–72		dB
Input Voltage Noise	f = 10 kHz		16		nV/√Hz
Input Current Noise	f = 10 kHz		900		fA/√Hz
Differential Gain Error (NTSC)	G = +2, R_L = 150 Ω		0.06		%
Differential Phase Error (NTSC)	G = +2, R_L = 150 Ω		0.15		Degrees
Crosstalk	f = 5 MHz, R_L = 1 kΩ, G = +2		–60		dB
DC PERFORMANCE					
Input Offset Voltage			1.4	6.5	mV
	T_{MIN}–T_{MAX}			9	mV
Offset Drift			10		µV/°C
Input Bias Current			2	4.5	µA
	T_{MIN}–T_{MAX}			4.5	µA
Input Offset Current			0.2	1.2	µA
Open-Loop Gain	R_L = 1 kΩ	82	96		dB
	T_{MIN}–T_{MAX}		92		dB
INPUT CHARACTERISTICS					
Input Resistance			225		kΩ
Input Capacitance			1.6		pF
Input Common-Mode Voltage Range			–5.2 to 4		V
Common-Mode Rejection Ratio	V_{CM} = –5 V to 3.5 V	76	90		dB
OUTPUT CHARACTERISTICS					
Output Voltage Swing	R_L = 10 kΩ		–4.97 to +4.97		V
	R_L = 1 kΩ	–4.6 to +4.6	–4.85 to +4.85		V
	R_L = 150 Ω	–4.0 to +3.8	–4.5 to +4.5		V
Output Current	T_{MIN}–T_{MAX}, V_{OUT} = –4.5 V to +4.5 V		30		mA
Short Circuit Current	Sourcing		60		mA
	Sinking		100		mA
Capacitive Load Drive	G = +2		40		pF
POWER SUPPLY					
Operating Range		3		12	V
Quiescent Current			11.5	13.6	mA
Power Supply Rejection Ratio	V_S = –5, +5 V, ±1 V	70	80		dB
OPERATING TEMPERATURE RANGE		–40		+85	°C

Specifications subject to change without notice.

ABSOLUTE MAXIMUM RATINGS[1]

Supply Voltage . . . . +12.6 V
Internal Power Dissipation[2]
  Plastic DIP Package (N) . . . . 1.6 Watts
  Small Outline Package (R) . . . . 1.0 Watts
Input Voltage (Common-Mode) . . . . $\pm V_S \pm 0.5$ V
Differential Input Voltage . . . . ±3.4 V
Output Short Circuit Duration
. . . . Observe Power Derating Curves
Storage Temperature Range (N, R) . . . . –65°C to +125°C
Lead Temperature Range (Soldering 10 sec) . . . . +300°C

NOTES
[1]Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.
[2]Specification is for the device in free air:
14-Lead Plastic Package: θ_{JA} = 75°C/W
14-Lead SOIC Package: θ_{JA} = 120°C/W

MAXIMUM POWER DISSIPATION

The maximum power that can be safely dissipated by the AD8044 is limited by the associated rise in junction temperature. The maximum safe junction temperature for plastic encapsulated devices is determined by the glass transition temperature of the plastic, approximately +150°C. Exceeding this limit temporarily may cause a shift in parametric performance due to a change in the stresses exerted on the die by the package. Exceeding a junction temperature of +175°C for an extended period can result in device failure.

While the AD8044 is internally short-circuit protected, this may not be sufficient to guarantee that the maximum junction temperature (+150°C) is not exceeded under all conditions. To ensure proper operation, it is necessary to observe the maximum power derating curves.

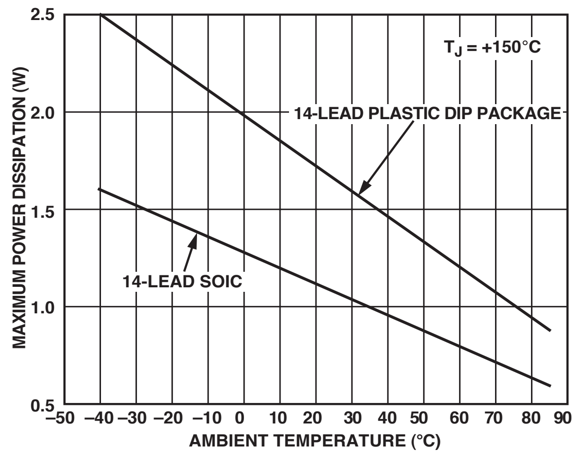


Figure 3. Maximum Power Dissipation vs. Temperature

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
AD8044AN	–40°C to +85°C	14-Lead PDIP	N-14
AD8044AR-14	–40°C to +85°C	14-Lead SOIC	R-14
AD8044AR-14-REEL	–40°C to +85°C	14-Lead SOIC 13" REEL	R-14
AD8044AR-14-REEL7	–40°C to +85°C	14-Lead SOIC 7" REEL	R-14
AD8044ARZ-14*	–40°C to +85°C	14-Lead Plastic SOIC	R-14
AD8044ARZ-14-REEL*	–40°C to +85°C	14-Lead SOIC 13" REEL	R-14
AD8044ARZ-14-REEL7*	–40°C to +85°C	14-Lead SOIC 7" REEL	R-14

*Z = Pb free part

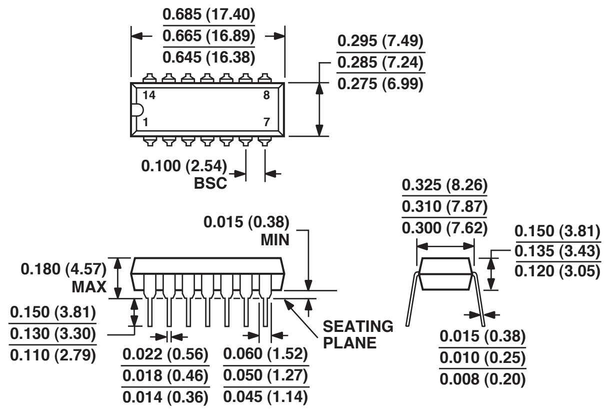
CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although the AD8016 features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

OUTLINE DIMENSIONS

14-Lead Plastic Dual In-Line Package [PDIP] (N-14)

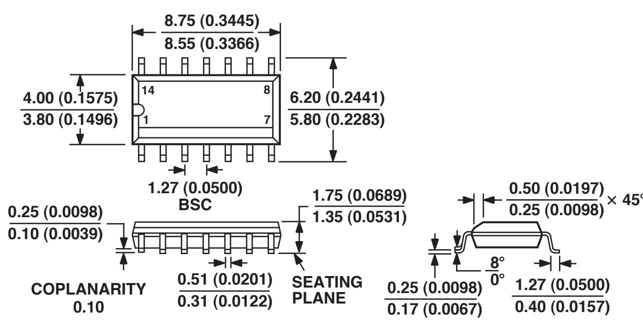
Dimensions shown in inches and (millimeters)



COMPLIANT TO JEDEC STANDARDS MO-095-AB
CONTROLLING DIMENSIONS ARE IN INCHES; MILLIMETER DIMENSIONS (IN PARENTHESES) ARE ROUNDED-OFF INCH EQUIVALENTS FOR REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN

14-Lead Standard Small Outline Package [SOIC] Narrow Body (R-14)

Dimensions shown in millimeters and (inches)



COMPLIANT TO JEDEC STANDARDS MS-012AB
CONTROLLING DIMENSIONS ARE IN MILLIMETERS; INCH DIMENSIONS (IN PARENTHESES) ARE ROUNDED-OFF MILLIMETER EQUIVALENTS FOR REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN