Low Cost, DC to 500 MHz, 92 dB Logarithmic Amplifier

AD8307

FEATURES

Complete multistage logarithmic amplifier
92 dB dynamic range: –75 dBm to +17 dBm
to –90 dBm using matching network
Single supply of 2.7 V minimum at 7.5 mA typical
DC to 500 MHz operation, ±1 dB linearity
Slope of 25 mV/dB, intercept of –84 dBm
Highly stable scaling over temperature
Fully differential dc-coupled signal path
100 ns power-up time, 150 µA sleep current

APPLICATIONS

Conversion of signal level to decibel form
Transmitter antenna power measurement
Receiver signal strength indication (RSSI)
Low cost radar and sonar signal processing
Network and spectrum analyzers (to 120 dB)
Signal level determination down to 20 Hz
True decibel ac mode for multimeters

FUNCTIONAL BLOCK DIAGRAM

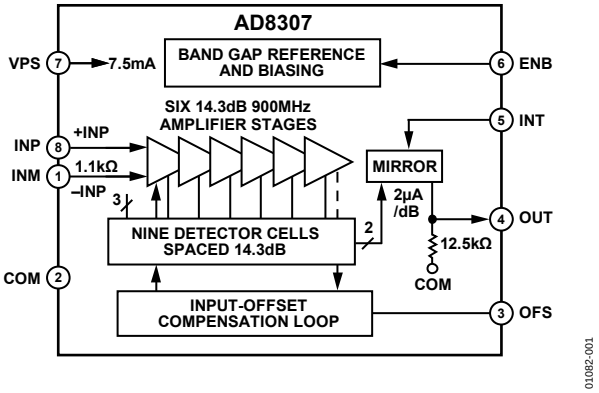


Figure 1.

GENERAL DESCRIPTION

The AD8307 is the first logarithmic amplifier made available in an 8-lead (SOIC_N) package. It is a complete 500 MHz monolithic demodulating logarithmic amplifier based on the progressive compression (successive detection) technique, providing a dynamic range of 92 dB to ±3 dB law-conformance and 88 dB to a tight ±1 dB error bound at all frequencies up to 100 MHz. It is extremely stable and easy to use, requiring no significant external components. A single-supply voltage of 2.7 V to 5.5 V at 7.5 mA is needed, corresponding to an unprecedented power consumption of only 22.5 mW at 3 V. A fast acting CMOS-compatible control pin can disable the AD8307 to a standby current of less than 150 µA.

Each of the cascaded amplifier/limiter cells has a small signal gain of 14.3 dB, with a −3 dB bandwidth of 900 MHz. The input is fully differential and at a moderately high impedance (1.1 kΩ in parallel with about 1.4 pF). The AD8307 provides a basic dynamic range extending from approximately −75 dBm (where dBm refers to a 50 Ω source, that is, a sine amplitude of about ±56 µV) up to +17 dBm (a sine amplitude of ±2.2 V). A simple input matching network can lower this range to −88 dBm to +3 dBm. The logarithmic linearity is typically within ±0.3 dB up to 100 MHz over the central portion of this range, and degrades only slightly at 500 MHz. There is no minimum frequency limit. The AD8307 can be used at audio frequencies of 20 Hz or lower.

The output is a voltage scaled 25 mV/dB, generated by a current of nominally 2 µA/dB through an internal 12.5 kΩ resistor. This voltage varies from 0.25 V at an input of −74 dBm (that is, the ac intercept is at −84 dBm, a 20 µV rms sine input), up to 2.5 V for an input of +16 dBm. This slope and intercept can be trimmed using external adjustments. Using a 2.7 V supply, the output scaling can be lowered, for example to 15 mV/dB, to permit utilization of the full dynamic range.

The AD8307 exhibits excellent supply insensitivity and temperature stability of the scaling parameters. The unique combination of low cost, small size, low power consumption, high accuracy and stability, very high dynamic range, and a frequency range encompassing audio through IF to UHF makes this product useful in numerous applications requiring the reduction of a signal to its decibel equivalent.

The AD8307 operates over the industrial temperature range of −40°C to +85°C, and is available in 8-lead SOIC and 8-lead PDIP packages.

Rev. D
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SPECIFICATIONS

V_S = 5 V, T_A = 25°C, $R_L \geq 1$ MΩ, unless otherwise noted.

Table 1.

Parameter	Conditions	Min	Typ	Max	Unit
GENERAL CHARACTERISTICS					
Input Range (±3 dB Error)	From noise floor to maximum input		92		dB
Input Range (±1 dB Error)	From noise floor to maximum input		88		dB
Logarithmic Conformance	f ≤ 100 MHz, central 80 dB		±0.3	±1	dB
	f = 500 MHz, central 75 dB		±0.5		dB
Logarithmic Slope	Unadjusted[1]	23	25	27	mV/dB
vs. Temperature		23		27	mV/dB
Logarithmic Intercept	Sine amplitude, unadjusted[2]		20		μV
	Equivalent sine power in 50 Ω	−87	−84	−77	dBm
vs. Temperature		−88		−76	dBm
Input Noise Spectral Density	Inputs shorted		1.5		nV/√Hz
Operating Noise Floor	R_{SOURCE} = 50 Ω/2		−78		dBm
Output Resistance	Pin 4 to ground	10	12.5	15	kΩ
Internal Load Capacitance			3.5		pF
Response Time	Small signal, 10% to 90%, 0 mV to 100 mV, C_L = 2 pF		400		ns
	Large signal, 10% to 90%, 0 V to 2.4 V, C_L = 2 pF		500		ns
Upper Usable Frequency			500		MHz
Lower Usable Frequency	AC-coupled input		10		Hz
AMPLIFIER CELL CHARACTERISTICS					
Cell Bandwidth	−3 dB		900		MHz
Cell Gain			14.3		dB
INPUT CHARACTERISTICS					
DC Common-Mode Voltage	AC-coupled input		3.2		V
Common-Mode Range	Either input (small signal)	−0.3	+1.6	V_S − 1	V
DC Input Offset Voltage[3]	R_{SOURCE} ≤ 50 Ω		50	500	μV
	Drift		0.8		μV/°C
Incremental Input Resistance	Differential		1.1		kΩ
Input Capacitance	Either pin to ground		1.4		pF
Bias Current	Either input		10	25	μA
POWER INTERFACES					
Supply Voltage		2.7		5.5	V
Supply Current	$V_{ENB} \geq 2$ V		8	10	mA
Disabled	$V_{ENB} \leq 1$ V		150	750	μA

[1] This can be adjusted downward by adding a shunt resistor from the output to ground. A 50 kΩ resistor reduces the nominal slope to 20 mV/dB.
[2] This can be adjusted in either direction by a voltage applied to Pin 5, with a scale factor of 8 dB/V.
[3] Normally nulled automatically by internal offset correction loop and can be manually nulled by a voltage applied between Pin 3 and ground; see the Applications Information section.

ABSOLUTE MAXIMUM RATINGS

Table 2.

Parameter	Ratings
Supply	7.5 V
Input Voltage (Pin 1 and Pin 8)	V_{SUPPLY}
Storage Temperature Range (N, R)	−65°C to +125°C
Ambient Temperature Range, Rated Performance Industrial, AD8307AN, AD8307AR	−40°C to +85°C
Lead Temperature Range (Soldering, 10 sec)	300°C

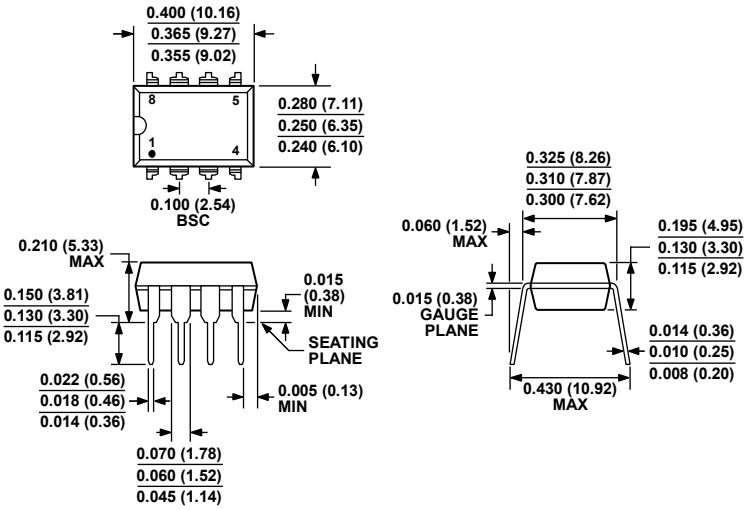
Stresses above those listed under Absolute Maximum Ratings can cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods can affect device reliability.

ESD CAUTION



ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

OUTLINE DIMENSIONS

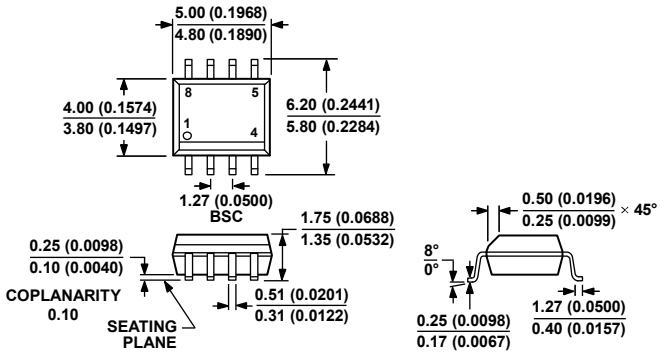


COMPLIANT TO JEDEC STANDARDS MS-001

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. CORNER LEADS MAY BE CONFIGURED AS WHOLE OR HALF LEADS.

070606-A

Figure 45. 8-Lead Plastic Dual In-Line Package [PDIP]
(N-8)
Dimensions shown in inches and (millimeters)



COMPLIANT TO JEDEC STANDARDS MS-012-AA

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.

012407-A

Figure 46. 8-Lead Standard Small Outline Package [SOIC_N]
Narrow Body
(R-8)
Dimensions shown in millimeters and (inches)

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
AD8307AN	−40°C to +85°C	8-Lead PDIP	N-8
AD8307ANZ[1]	−40°C to +85°C	8-Lead PDIP	N-8
AD8307AR	−40°C to +85°C	8-Lead SOIC_N	R-8
AD8307AR-REEL	−40°C to +85°C	8-Lead SOIC_N 13" Tape and Reel	R-8
AD8307AR-REEL7	−40°C to +85°C	8-Lead SOIC_N 7" Tape and Reel	R-8
AD8307ARZ[1]	−40°C to +85°C	8-Lead SOIC_N	R-8
AD8307ARZ-REEL[1]	−40°C to +85°C	8-Lead SOIC_N 13" Tape and Reel	R-8
AD8307ARZ-RL7[1]	−40°C to +85°C	8-Lead SOIC_N 7" Tape and Reel	R-8

[1] Z = RoHS Compliant Part.