

FEATURES

- Wide bandwidth: 0.1 GHz to 2.5 GHz min**
- High dynamic range: 70 dB to ± 3.0 dB**
- High accuracy: ± 1.0 dB over 65 dB range (@ 1.9 GHz)**
- Fast response: 40 ns full-scale typical**
- Controller mode with error output**
- Scaling stable over supply and temperature**
- Wide supply range: 2.7 V to 5.5 V**
- Low power: 40 mW at 3 V**
- Power-down feature: 60 mW at 3 V**
- Complete and easy to use**

APPLICATIONS

- RF transmitter power amplifier setpoint control and level monitoring**
- Logarithmic amplifier for RSSI measurement cellular base stations, radio link, radar**

GENERAL DESCRIPTION

The AD8313 is a complete multistage demodulating logarithmic amplifier that can accurately convert an RF signal at its differential input to an equivalent decibel-scaled value at its dc output. The AD8313 maintains a high degree of log conformance for signal frequencies from 0.1 GHz to 2.5 GHz and is useful over the range of 10 MHz to 3.5 GHz. The nominal input dynamic range is -65 dBm to 0 dBm (re: 50 Ω), and the sensitivity can be increased by 6 dB or more with a narrow-band input impedance matching network or a balun. Application is straightforward, requiring only a single supply of 2.7 V to 5.5 V and the addition of a suitable input and supply decoupling. Operating on a 3 V supply, its 13.7 mA consumption (for $T_A = 25^\circ\text{C}$) is only 41 mW. A power-down feature is provided; the input is taken high to initiate a low current (20 μA) sleep mode, with a threshold at half the supply voltage.

The AD8313 uses a cascade of eight amplifier/limiter cells, each having a nominal gain of 8 dB and a -3 dB bandwidth of 3.5 GHz. This produces a total midband gain of 64 dB. At each amplifier output, a detector (rectifier) cell is used to convert the RF signal to baseband form; a ninth detector cell is placed directly at the input of the AD8313. The current-mode outputs of these cells are summed to generate a piecewise linear approximation to the logarithmic function. They are converted to a low impedance voltage-mode output by a transresistance stage, which also acts as a low-pass filter.

Rev. D

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FUNCTIONAL BLOCK DIAGRAM

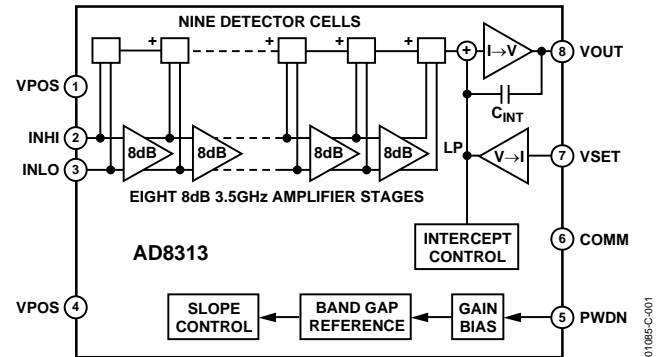


Figure 1.

When used as a log amplifier, scaling is determined by a separate feedback interface (a transconductance stage) that sets the slope to approximately 18 mV/dB; used as a controller, this stage accepts the setpoint input. The logarithmic intercept is positioned to nearly -100 dBm, and the output runs from about 0.45 V dc at -73 dBm input to 1.75 V dc at 0 dBm input. The scale and intercept are supply- and temperature-stable.

The AD8313 is fabricated on Analog Devices' advanced 25 GHz silicon bipolar IC process and is available in an 8-lead MSOP package. The operating temperature range is -40°C to $+85^\circ\text{C}$. An evaluation board is available.

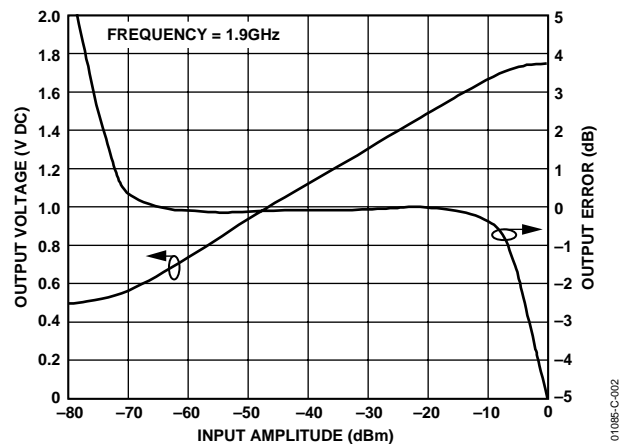


Figure 2. Typical Logarithmic Response and Error vs. Input Amplitude

SPECIFICATIONS

$T_A = 25^\circ\text{C}$, $V_S = 5\text{ V}$ ¹, $R_L = 10\text{ k}\Omega$, unless otherwise noted.

Table 1.

Parameter	Conditions	Min ²	Typ	Max ²	Unit
SIGNAL INPUT INTERFACE					
Specified Frequency Range		0.1		2.5	GHz
DC Common-Mode Voltage			$V_{POS} - 0.75$		V
Input Bias Currents			10		μA
Input Impedance	$f_{RF} < 100\text{ MHz}$ ³		900 1.1		ΩpF ⁴
LOG (RSSI) MODE					
	Sinusoidal, input termination configuration shown in Figure 29				
	Nominal conditions				
100 MHz ⁵					
±3 dB Dynamic Range ⁶		53.5	65		dB
Range Center			-31.5		dBm
±1 dB Dynamic Range			56		dB
Slope		17	19	21	mV/dB
Intercept		-96	-88	-80	dBm
	$2.7\text{ V} \leq V_S \leq 5.5\text{ V}$, $-40^\circ\text{C} \leq T \leq +85^\circ\text{C}$				
±3 dB Dynamic Range		51	64		dB
Range Center			-31		dBm
±1 dB Dynamic Range			55		dB
Slope		16	19	22	mV/dB
Intercept		-99	-89	-75	dBm
Temperature Sensitivity	$P_{IN} = -10\text{ dBm}$		-0.022		dB/°C
900 MHz ⁵	Nominal conditions				
±3 dB Dynamic Range		60	69		dB
Range Center			-32.5		dBm
±1 dB Dynamic Range			62		dB
Slope		15.5	18	20.5	mV/dB
Intercept		-105	-93	-81	dBm
	$2.7\text{ V} \leq V_S \leq 5.5\text{ V}$, $-40^\circ\text{C} \leq T \leq +85^\circ\text{C}$				
±3 dB Dynamic Range		55.5	68.5		dB
Range Center			-32.75		dBm
±1 dB Dynamic Range			61		dB
Slope		15	18	21	mV/dB
Intercept		-110	-95	-80	dBm
Temperature Sensitivity	$P_{IN} = -10\text{ dBm}$		-0.019		dB/°C
1.9 GHz ⁷	Nominal conditions				
±3 dB Dynamic Range		52	73		dB
Range Center			-36.5		dBm
±1 dB Dynamic Range			62		dB
Slope		15	17.5	20.5	mV/dB
Intercept		-115	-100	-85	dBm
	$2.7\text{ V} \leq V_S \leq 5.5\text{ V}$, $-40^\circ\text{C} \leq T \leq +85^\circ\text{C}$				
±3 dB Dynamic Range		50	73		dB
Range Center			-36.5		dBm
±1 dB Dynamic Range			60		dB
Slope		14	17.5	21.5	mV/dB
Intercept		-125	-101	-78	dBm
Temperature Sensitivity	$P_{IN} = -10\text{ dBm}$		-0.019		dB/°C

AD8313

Parameter	Conditions	Min ²	Typ	Max ²	Unit
2.5 GHz ⁷	Nominal conditions				
±3 dB Dynamic Range		48	66		dB
Range Center			-34		dBm
±1 dB Dynamic Range			46		dB
Slope		16	20	25	mV/dB
Intercept		-111	-92	-72	dBm
	2.7 V ≤ V _S ≤ 5.5 V, -40°C ≤ T ≤ +85°C				
±3 dB Dynamic Range		47	68		dB
Range Center			-34.5		dBm
±1 dB Dynamic Range			46		dB
Slope		14.5	20	25	mV/dB
Intercept		-128	-92	-56	dBm
Temperature Sensitivity	P _{IN} = -10 dBm		-0.040		dB/°C
3.5 GHz ⁵	Nominal conditions				
±3 dB Dynamic Range			43		dB
±1 dB Dynamic Range			35		dB
Slope			24		mV/dB
Intercept			-65		dBm
CONTROL MODE					
Controller Sensitivity	f = 900 MHz		23		V/dB
Low Frequency Gain	VSET to VOUT ⁸		84		dB
Open-Loop Corner Frequency	VSET to VOUT ⁸		700		Hz
Open-Loop Slew Rate	f = 900 MHz		2.5		V/μs
VSET Delay Time			150		ns
VOUT INTERFACE					
Current Drive Capability					
Source Current			400		μA
Sink Current			10		mA
Minimum Output Voltage	Open-loop		50		mV
Maximum Output Voltage	Open-loop		V _{POS} - 0.1		V
Output Noise Spectral Density	P _{IN} = -60 dBm, f _{SPOT} = 100 Hz		2.0		μV/√Hz
	P _{IN} = -60 dBm, f _{SPOT} = 10 MHz		1.3		μV/√Hz
Small Signal Response Time	P _{IN} = -60 dBm to -57 dBm, 10% to 90%		40	60	ns
Large Signal Response Time	P _{IN} = No signal to 0 dBm; settled to 0.5 dB		110	160	ns
VSET INTERFACE					
Input Voltage Range		0		V _{POS}	V
Input Impedance			18 1		kΩ pF
POWER-DOWN INTERFACE					
PWDN Threshold			V _{POS} /2		V
Power-Up Response Time	Time delay following high to low transition until device meets full specifications.		1.8		μs
PWDN Input Bias Current	PWDN = 0 V		5		μA
	PWDN = V _S		<1		μA
POWER SUPPLY					
Operating Range		2.7		5.5	V
Powered-Up Current			13.7	15.5	mA
	4.5 V ≤ V _S ≤ 5.5 V, -40°C ≤ T ≤ +85°C			18.5	mA
	2.7 V ≤ V _S ≤ 3.3 V, -40°C ≤ T ≤ +85°C			18.5	mA
Powered-Down Current			50	150	μA
	4.5 V ≤ V _S ≤ 5.5 V, -40°C ≤ T ≤ +85°C				
	2.7 V ≤ V _S ≤ 3.3 V, -40°C ≤ T ≤ +85°C		20	50	μA

¹ Except where otherwise noted; performance at $V_S = 3\text{ V}$ is equivalent to 5 V operation.

² Minimum and maximum specified limits on parameters that are guaranteed but not tested are 6 sigma values.

³ Input impedance shown over frequency range in Figure 26.

⁴ Double vertical bars (||) denote "in parallel with."

⁵ Linear regression calculation for error curve taken from -40 dBm to -10 dBm for all parameters.

⁶ Dynamic range refers to range over which the linearity error remains within the stated bound.

⁷ Linear regression calculation for error curve taken from -60 dBm to -5 dBm for 3 dB dynamic range. All other regressions taken from -40 dBm to -10 dBm .

⁸ AC response shown in Figure 12.

ABSOLUTE MAXIMUM RATINGS

Table 2.

Supply Voltage V_S	5.5 V
V_{OUT} , V_{SET} , $PWDN$	0 V, V_{POS}
Input Power Differential (re: 50 Ω , 5.5 V)	25 dBm
Input Power Single-Ended (re: 50 Ω , 5.5 V)	19 dBm
Internal Power Dissipation	200 mW
θ_{JA}	200°C/W
Maximum Junction Temperature	125°C
Operating Temperature Range	-40°C to +85°C
Storage Temperature Range	-65°C to +150°C

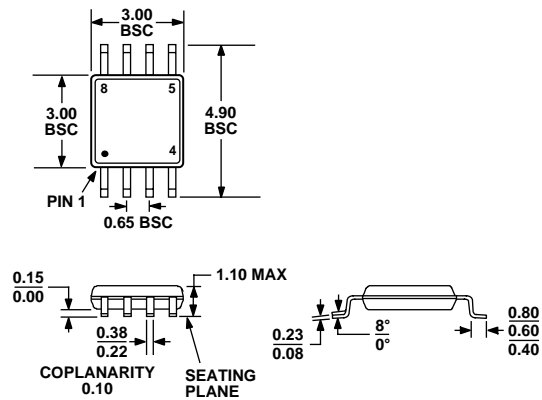
Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute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

ESD 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 this product 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



COMPLIANT TO JEDEC STANDARDS MO-187AA

Figure 46. 8-Lead MicroSOIC Package [MSOP] (RM-08)

Dimensions shown in millimeters and (inches)

ORDERING GUIDE

Model	Temperature Range	Package Descriptions	Package Option	Branding
AD8313ARM	-40°C to +85°C	8-Lead MSOP	RM-08	J1A
AD8313ARM-REEL	-40°C to +85°C	13" Tape and Reel	RM-08	J1A
AD8313ARM-REEL7	-40°C to +85°C	7" Tape and Reel	RM-08	J1A
AD8313ARMZ ¹	-40°C to +85°C	8-Lead MSOP		
AD8313ARMZ-REEL7 ¹	-40°C to +85°C	7" Tape and Reel		
AD8313-EVAL		Evaluation Board		

¹ Z = Pb-free part.