0.1 GHz to 2.5 GHz 70 dB Logarithmic Detector/Controller

AD8313

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

FUNCTIONAL BLOCK DIAGRAM

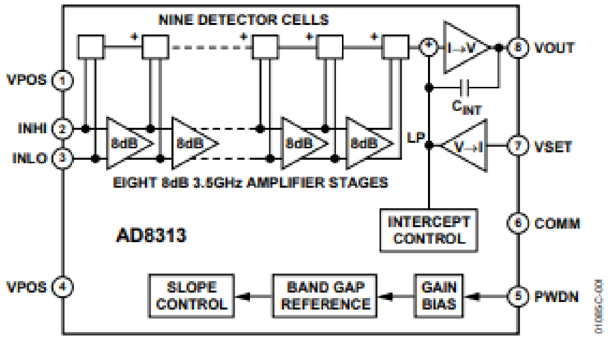

Figure 1.

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°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.

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°C. An evaluation board is available.

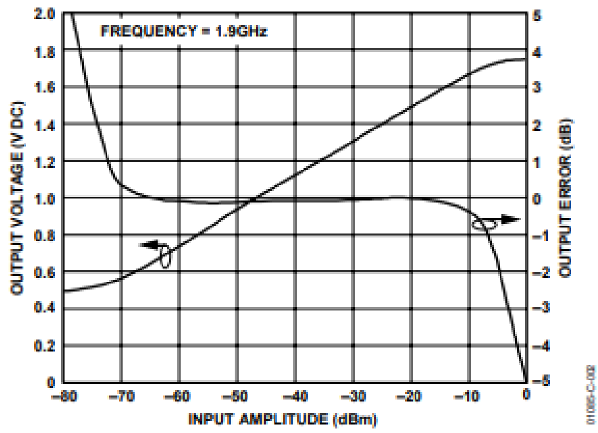

Figure 2. Typical Logarithmic Response and Error vs. Input Amplitude

SPECIFICATIONS

T_A = 25°C, V_S = 5 V[1], R_L 10 kΩ, 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 MHz[3]		900‖1.1		Ω‖pF[4]
LOG (RSSI) MODE	Sinusoidal, input termination configuration shown in Figure 29				
100 MHz[5]	Nominal conditions				
±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 V ≤ V_S ≤ 5.5 V, −40°C ≤ T ≤ +85°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 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 V ≤ V_S ≤ 5.5 V, −40°C ≤ T ≤ +85°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 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 V ≤ V_S ≤ 5.5 V, −40°C ≤ T ≤ +85°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 dBm		−0.019		dB/°C

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
	$2.7\ V \le V_S \le 5.5\ V$, $-40°C \le T \le +85°C$				
±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
	$4.5\ V \le V_S \le 5.5\ V$, $-40°C \le T \le +85°C$			18.5	mA
	$2.7\ V \le V_S \le 3.3\ V$, $-40°C \le T \le +85°C$			18.5	mA
Powered-Down Current	$4.5\ V \le V_S \le 5.5\ V$, $-40°C \le T \le +85°C$		50	150	µA
	$2.7\ V \le V_S \le 3.3\ V$, $-40°C \le T \le +85°C$		20	50	µA

ABSOLUTE MAXIMUM RATINGS

Table 2.

Supply Voltage V_S	5.5 V
VOUT, VSET, PWDN	0 V, VPOS
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.

OUTLINE DIMENSIONS

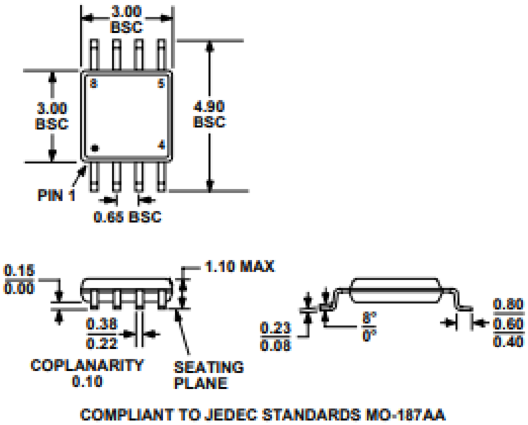

Figure 46 . 8-Lead MicroSOIC Package [MSOP]
(RM-08)
Dimensions shown in millimeters and (inches)