500 MHz, Linear-in-dB VGA with AGC Detector

AD8367

FEATURES

Broad-range analog variable gain: −2.5 dB to +42.5 dB
3 dB cutoff frequency of 500 MHz
Gain up and gain down modes
Linear-in-dB, scaled 20 mV/dB
Resistive ground referenced input
Nominal Z_{IN} = 200 Ω
On-chip, square-law detector
Single-supply operation: 2.7 V to 5.5 V

APPLICATIONS

Cellular base stations
Broadband access
Power amplifier control loops
Complete, linear IF AGC amplifiers
High speed data I/O

FUNCTIONAL BLOCK DIAGRAM

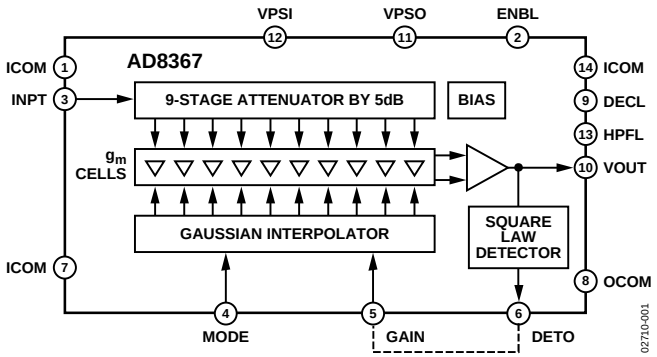

Figure 1.

GENERAL DESCRIPTION

The AD8367 is a high performance 45 dB variable gain amplifier with linear-in-dB gain control for use from low frequencies up to several hundred megahertz. The range, flatness, and accuracy of the gain response are achieved using Analog Devices' X-AMP® architecture, the most recent in a series of powerful proprietary concepts for variable gain applications, which far surpasses what can be achieved using competing techniques.

The input is applied to a 9-stage, 200 Ω resistive ladder network. Each stage has 5 dB of loss, giving a total attenuation of 45 dB. At maximum gain, the first tap is selected; at progressively lower gains, the tap moves smoothly and continuously toward higher attenuation values. The attenuator is followed by a 42.5 dB fixed gain feedback amplifier—essentially an operational amplifier with a gain bandwidth product of 100 GHz—and is very linear, even at high frequencies. The output third order intercept is +20 dBV at 100 MHz (+27 dBm, re 200 Ω), measured at an output level of 1 V p-p with V_S = 5 V.

The analog gain-control input is scaled at 20 mV/dB and runs from 50 mV to 950 mV. This corresponds to a gain of −2.5 dB to +42.5 dB, respectively, when the gain up mode is selected and +42.5 dB to −2.5 dB, respectively, when gain down mode is selected. The gain down, or inverse, mode must be selected when operating in AGC in which an integrated square-law detector with an internal setpoint is used to level the output to 354 mV rms, regardless of the crest factor of the output signal. A single external capacitor sets up the loop averaging time.

The AD8367 can be powered on or off by a voltage applied to the ENBL pin. When this voltage is at a logic LO, the total power dissipation drops to the milliwatt range. For a logic HI, the chip powers up rapidly to its normal quiescent current of 26 mA at 25°C. The AD8367 is available in a 14-lead TSSOP package for the industrial temperature range of −40°C to +85°C.

Rev. A

SPECIFICATIONS

V_S = 5 V, T_A = 25°C, system impedance Z_O = 200 Ω, V_{MODE} = 5 V, f = 10 MHz, unless otherwise noted.

Table 1.

Parameter	Conditions	Min	Typ	Max	Unit
OVERALL FUNCTION					
Frequency Range		LF		500	MHz
GAIN Range			45		dB
INPUT STAGE	Pins INPT and ICOM				
Maximum Input	To avoid input overload		700		mV p-p
Input Resistance	From INPT to ICOM	175	200	225	Ω
GAIN CONTROL INTERFACE	Pin GAIN				
Scaling Factor	V_{MODE} = 5 V, 50 mV ≤ V_{GAIN} ≤ 950 mV		+20		mV/dB
	V_{MODE} = 0 V, 50 mV ≤ V_{GAIN} ≤ 950 mV		−20		mV/dB
Gain Law Conformance	100 mV ≤ V_{GAIN} ≤ 900 mV		±0.2		dB
Maximum Gain	V_{GAIN} = 0.95 V		+42.5		dB
Minimum Gain	V_{GAIN} = 0.05 V		−2.5		dB
V_{GAIN} Step Response	From 0 dB to 30 dB		300		ns
	From 30 dB to 0 dB		300		ns
Small Signal Bandwidth	V_{GAIN} = 0.5 V		5		MHz
OUTPUT STAGE	Pin VOUT				
Maximum Output Voltage Swing	R_L = 1 kΩ		4.3		V p-p
	R_L = 200 Ω		3.5		V p-p
Output Source Resistance	Series resistance of output buffer		50		Ω
Output Centering Voltage[1]			V_S/2		V
SQUARE LAW DETECTOR	Pin DETO				
Output Set Point			354		mV rms
AGC Small Signal Response Time	C_{AGC} = 100 pF, 6 dB gain step		1		µs
POWER INTERFACE	Pins VPSI, VPSO, ICOM, and OCOM				
Supply Voltage		2.7		5.5	V
Total Supply Current	ENBL high, maximum gain, R_L = 200 Ω (includes load current)		26	30	mA
Disable Current vs. Temperature	ENBL low		1.3	1.6	mA
	−40°C ≤ TA ≤ +85°C			1.8	mA
MODE CONTROL INTERFACE	Pin MODE				
Mode LO Threshold	Device in negative slope mode of operation		1.2		V
Mode HI Threshold	Device in positive slope mode of operation		1.4		V
ENABLE INTERFACE	Pin ENBL				
Enable Threshold			2.5		V
Enable Response Time	Time delay following LO to HI transition until device meets full specifications.		1.5		µs
Enable Input Bias Current	ENBL at 5 V		27		µA
	ENBL at 0 V		32		nA
f = 70 MHz					
Gain	Maximum gain		+42.5		dB
	Minimum gain		−3.7		dB
Gain Scaling Factor			19.9		mV/dB
Gain Intercept			−5.6		dB
Noise Figure	Maximum gain		6.2		dB
Output IP3	f1 = 70 MHz, f2 = 71 MHz, V_{GAIN} = 0.5 V		36.5		dBm
			29.5		dBV rms
Output 1 dB Compression Point	V_{GAIN} = 0.5 V		8.5		dBm
			1.5		dBV rms

Parameter	Conditions	Min	Typ	Max	Unit
f = 140 MHz					
Gain	Maximum gain		+43.5		dB
	Minimum gain		−3.6		dB
Gain Scaling Factor			19.7		mV/dB
Gain Intercept			−5.3		dB
Noise Figure	Maximum gain		7.4		dB
Output IP3	f1 = 140 MHz, f2 = 141 MHz, V_{GAIN} = 0.5 V		32.7		dBm
			25.7		dBV rms
Output 1 dB Compression Point	V_{GAIN} = 0.5 V		8.4		dBm
			1.4		dBV rms
f = 190 MHz					
Gain	Maximum gain		+43.5		dB
	Minimum gain		−3.8		dB
Gain Scaling Factor			19.6		mV/dB
Gain Intercept			−5.3		dB
Noise Figure	Maximum gain		7.5		dB
Output IP3	f1 = 190 MHz, f2 = 191 MHz, V_{GAIN} = 0.5 V		30.9		dBm
			23.9		dBV rms
Output 1 dB Compression Point	V_{GAIN} = 0.5 V		8.4		dBm
			1.4		dBV rms
f = 240 MHz					
Gain	Maximum gain		+43		dB
	Minimum gain		−4.1		dB
Gain Scaling Factor			19.7		mV/dB
Gain Intercept			−5.2		dB
Noise Figure	Maximum gain		7.6		dB
Output IP3	f1 = 240 MHz, f2 = 241 MHz, V_{GAIN} = 0.5 V		29.2		dBm
			22.2		dBV rms
Output 1 dB Compression Point	V_{GAIN} = 0.5 V		8.1		dBm
			1.1		dBV rms

[1] The output dc centering voltage is normally set at $V_S/2$ and can be adjusted by applying a voltage to DECL.

ABSOLUTE MAXIMUM RATINGS

Table 2.

Parameter	Rating
Supply Voltage VPSO, VPSI	5.5 V
ENBL Voltage	V_S + 200 mV
MODE Select Voltage	V_S + 200 mV
V_{GAIN} Control Voltage	1.2 V
Input Voltage	±600 mV
Internal Power Dissipation	250 mW
θ_{JA}	150°C/W
Maximum Junction Temperature	125°C
Operating Temperature Range	−40°C to +85°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature Range (Soldering 60 sec)	300°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.

PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

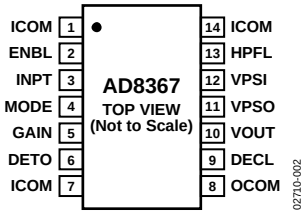

Figure 2. Pin Configuration

Table 3. Pin Function Descriptions

Pin No.	Mnemonic	Description
1, 7, 14	ICOM	Signal Common. Connect to low impedance ground.
2	ENBL	A HI Activates the Device.
3	INPT	Signal Input. 200 Ω to ground.
4	MODE	Gain Direction Control. HI for positive slope; LO for negative slope.
5	GAIN	Gain Control Voltage Input.
6	DETO	Detector Output. Provides output current for RSSI function and AGC control.
8	OCOM	Power Common. Connect to low impedance ground.
9	DECL	Output Centering Loop Decoupling Pin.
10	VOUT	Signal Output. To be externally ac-coupled to load.
11	VPSO	Positive Supply Voltage. 2.7 V to 5.5 V. VPSI and VPSO are tied together internally with back-to-back PN junctions. They should be tied together externally and properly bypassed.
12	VPSI	Positive Supply Voltage. 2.7 V to 5.5 V.
13	HPFL	High-Pass Filter Connection. A capacitor to ground sets the corner frequency of the output offset control loop.

OUTLINE DIMENSIONS

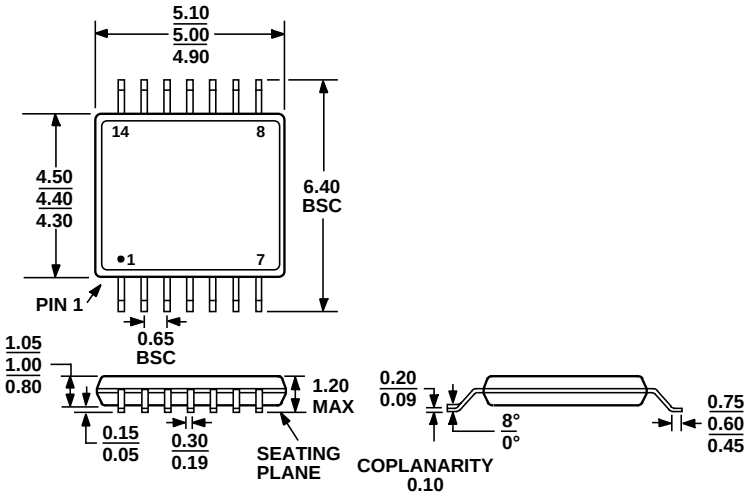

Figure 46. 14-Lead Thin Shrink Small Outline Package [TSSOP]
(RU-14)
Dimension shown millimeters

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
AD8367ARU	−40°C to +85°C	14-Lead TSSOP, Tube	RU-14
AD8367ARU-REEL-7	−40°C to +85°C	14-Lead TSSOP, 7" Tape and Reel	RU-14
AD8367ARUZ[1]	−40°C to +85°C	14-Lead TSSOP, Tube	RU-14
AD8367ARUZ-RL7[1]	−40°C to +85°C	14-Lead TSSOP, 7" Tape and Reel	RU-14
AD8367-EVAL		Evaluation Board	

[1] Z = Pb-free part.