



# 1 MHz - 3 GHz VGA with 60dB Gain Control Range

## Preliminary Technical Data

## ADL5330

### FEATURES

- Voltage-Controlled Amplifier/Attenuator
- Operating Frequency 1 MHz to 3 GHz
- Optimized for Controlling Output Power
  - High Linearity: OIP3 31 dBm @ 900 MHz
  - Output Noise Floor -150 dBm/Hz @ 900 MHz
- Fully-Balanced Differential Signal Path
  - Differential Input at 50  $\Omega$
- Wide Gain-Control Range: -34 dB to +22 dB @ 900 MHz
  - Linear-in-dB Gain Control Function, 20 mV/dB
- Single Supply 4.75 – 6 V

### APPLICATIONS

- Output Power Control for Wireless Infrastructure

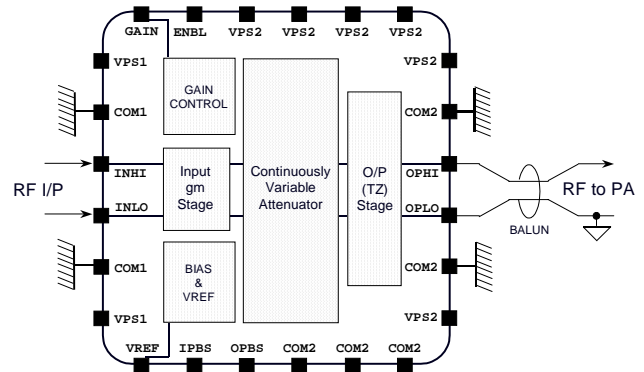


Figure 1. Functional Block Diagram

### PRODUCT DESCRIPTION

The ADL5330 is a high-performance voltage-controlled variable-gain amplifier/attenuator, for use up to 3 GHz. The signal path is fully differential; the balanced structure minimizes distortion, and reduces the risk of spurious feed-forward at low gains and high frequencies due to substrate coupling. While operation between a balanced source and load is recommended, a single-sided input is internally converted to differential. The input impedance is 50- $\Omega$  from **INHI** to **INLO**. The outputs will usually be coupled into a 50- $\Omega$  grounded load via a 1:1 balun. However, the output pins, **OPHI** and **OPLO**, may also be used separately, with some noise degradation. A single supply of 4.75 to 6 V is required.

With a 2140 MHz W-CDMA 3GPP forward path signal, the ADL5330 is capable of producing greater than -3 dBm output power while maintaining ACPR greater than 55 dB, and an output noise floor less than -144 dBm/Hz.

Three cascaded sections are used. The 50- $\Omega$  input system converts the applied voltage to a pair of differential currents with high linearity and good common rejection if driven by a single-sided source. The signal currents are then applied to a proprietary voltage-controlled attenuator, which provides precise definition of the overall gain, under the control of the Linear-in-dB interface. Pin **GAIN** accepts a voltage from 0 V at minimum gain to 1.4 V at full gain. The scaling factor is 20 mV/dB. Optional external control of the input-stage and/or output-stage biasing is provided using pins **IPBS** and **OPBS** respectively.

The output of the high-accuracy wideband attenuator is applied to a differential trans-impedance output stage. Higher output power is attainable at the lower operating frequencies by raising the supply voltage to 6 V. When powered-down by a logic LO input on the **ENBL** pin, the current consumption is < TBD  $\mu$ A.

The ADL5330 is available in a 24-lead (4 x 4mm) CSP package and is specified for operation from ambient temperatures of -40°C to +85°C.

Multiple Patents Pending

### Rev. PrK

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## ADL5330 SPECIFICATIONS

Table 1.  $V_S = 5\text{ V}$ ;  $T_A = 25^\circ\text{C}$ ;  $800\text{ MHz} < f < 2.2\text{GHz}$ . 1:1 balun at input and output for single-ended  $50\ \Omega$  match

Parameter	Conditions	Min	Typ	Max	Unit
<b>General</b>					
Usable Frequency Range		0.001		3	GHz
Nominal Input Impedance	via 1:1 Single-Sided to Differential Balun		50		$\Omega$
Nominal Output Impedance	via 1:1 Differential to Single-Sided Balun		50		$\Omega$
<b>100 MHz</b>					
Gain Control Span	+/-3 dB Gain Law Conformance		58		dB
Max Gain	$V_{GAIN} = 1.4\text{ V}$		+23		dB
Min Gain	$V_{GAIN} = 0.1\text{ V}$		-35		dB
Gain Control Slope			21		mV/dB
Input Compression Point	$V_{GAIN} = 1.3\text{ V}$		+2		dBm
Output Compression Point - P1dB	$V_{GAIN} = 1.3\text{ V}$		+22		dBm
Third-Order Intercept - OIP3	$V_{GAIN} = 1.3\text{ V}$		+36		dBm
<b>900 MHz</b>					
Gain Control Span	+/-3 dB Gain Law Conformance		52		dB
Max Gain	$V_{GAIN} = 1.4\text{ V}$		22		dB
Min Gain	$V_{GAIN} = 0.1\text{ V}$		-34		dB
Gain Control Slope			20		mV/dB
Input Compression Point	$V_{GAIN} = 1.3\text{ V}$		+3		dBm
Output Compression Point - P1dB	$V_{GAIN} = 1.3\text{ V}$		+22		dBm
Third-Order Intercept - OIP3	$V_{GAIN} = 1.3\text{ V}$		+31		dBm
Output Noise Floor	20 MHz Carrier Offset, $V_{GAIN} = 1.3\text{ V}$ , $P_{out} = -2\text{ dBm}$		-144		dBm/Hz
<b>1900 MHz</b>					
Gain Control Span	+/-3 dB Gain Law Conformance		47		dB
Max Gain	$V_{GAIN} = 1.4\text{ V}$		19		dB
Min Gain	$V_{GAIN} = 0.5\text{ V}$		-27		dB
Gain Control Slope			18		mV/dB
Input Compression Point	$V_{GAIN} = 1.3\text{ V}$		+1		dBm
Output Compression Point - P1dB	$V_{GAIN} = 1.3\text{ V}$		+17		dBm
Third-Order Intercept - OIP3	$V_{GAIN} = 1.3\text{ V}$		+24		dBm
Output Noise Floor	20 MHz Carrier Offset, $V_{GAIN} = 1.3\text{ V}$ , $P_{out} = -7\text{ dBm}$		-148		dBm/Hz
<b>2200 MHz</b>					
Gain Control Span	+/-3 dB Gain Law Conformance		48		dB
Max Gain	$V_{GAIN} = 1.4\text{ V}$		17		dB
Min Gain	$V_{GAIN} = 0.5\text{ V}$		-31		dB
Gain Control Slope			17		mV/dB
Input Compression Point	$V_{GAIN} = 1.3\text{ V}$		+1		dBm
Output Compression Point - P1dB	$V_{GAIN} = 1.3\text{ V}$		+14		dBm
Third-Order Intercept - OIP3	$V_{GAIN} = 1.3\text{ V}$		+20		dBm
<b>GAIN CONTROL INPUT</b>					
Gain Control Voltage Range	Pin <b>GAIN</b>	0		1.4	V
Incremental Input Resistance	Pin <b>GAIN</b> to <b>COM1</b>	TBD			$M\Omega$
Full-Scale Response Time	$V_{GN}$ 0-1.6V, to within 0.25 dB of final gain		500		ns
<b>POWER SUPPLIES</b>					
Voltage	Pins <b>VPS1</b> , <b>VPS2</b> , <b>COM1</b> , <b>COM2</b> , <b>ENBL</b>	4.75	5	6	V
Current, Nominal Active	$V_{GN} = 0\text{ V}$		TBD		mA
	$V_{GN} = 1.4\text{ V}$		240		mA
Current, Disabled	<b>ENBL</b> = LO		TBD	TBD	$\mu\text{A}$

Table 2. Pin Function Description

Pin	Name	Description
1,6	VPS1	Positive Supply for input stage. Nominally equal to 5 V
2,5	COM1	Common for input stage
3, 4	INHI , INLO	Differential inputs
7	VREF	Voltage reference output of 1.5 volts
8	IPBS	Input bias, normally no connection. This function is subject to change. PCB designs should include the possibility to connect a capacitor between Pin 8 and Pin 9.
9	OPBS	Output bias, normally no connection. This function is subject to change. PCB designs should include the possibility to connect a capacitor between Pin 8 and Pin 9.
10,11,12,14, 17	COM2	Common for output stage
13,18,19,20, 21,22	VPS2	Positive Supply for output stage. Nominally equal to 5 V
15	OPLO	Low side of differential output, bias to $V_P$ with RF chokes
16	OPHI	High side of differential output, bias to $V_P$ with RF chokes
23	ENBL	Device enable, apply logic high for normal operation. Enable Threshold = 1.6 V
24	GAIN	Gain-control voltage input. Nominal Range 0 to 1.4 V.

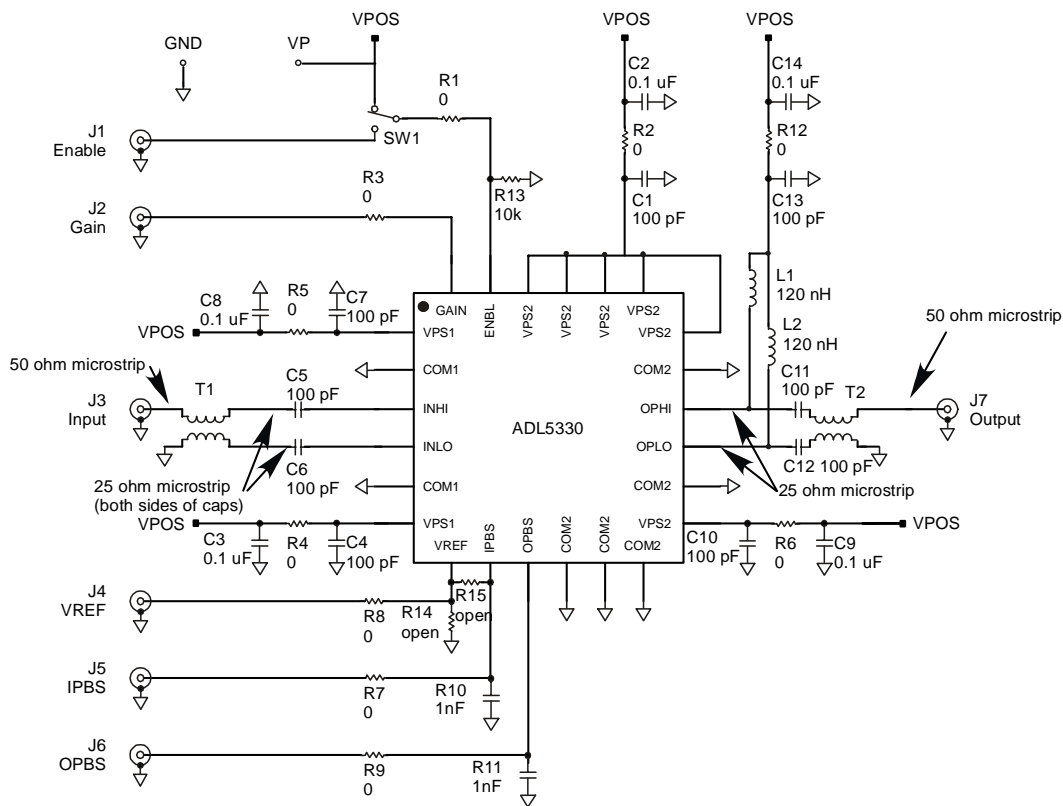


Figure 2. ADL5330 Evaluation Board Schematic

### Typical Performance Characteristics

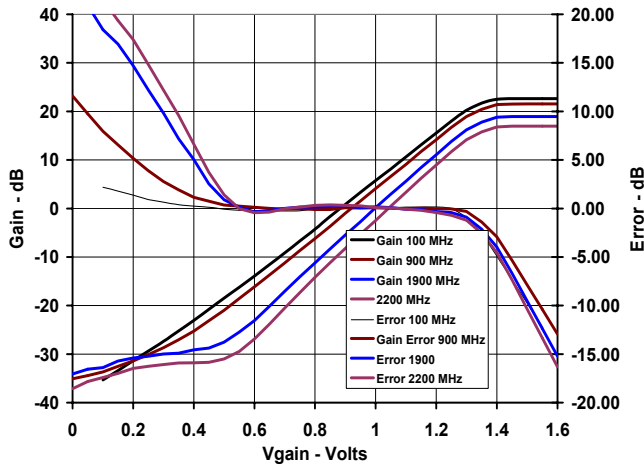


Figure 3. Gain and Gain Law Conformance vs. Vgain

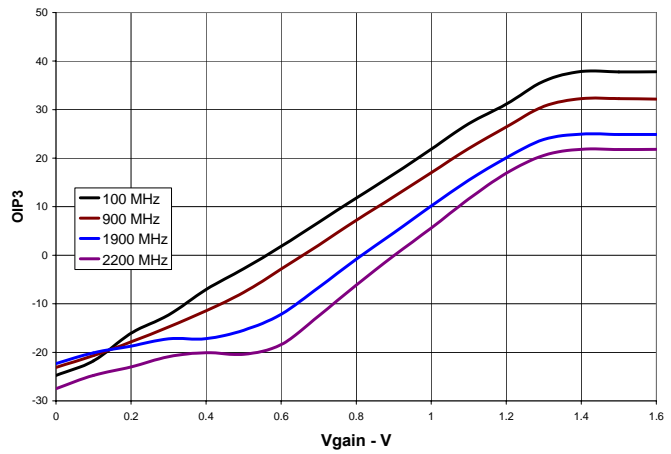


Figure 5. OIP3 vs. Gain

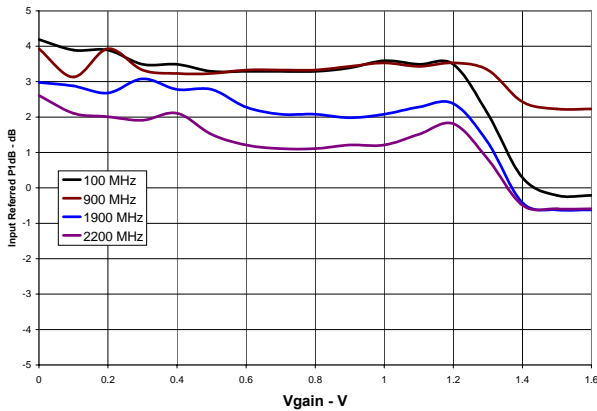


Figure 4. Input Referred Compression Point vs. Gain

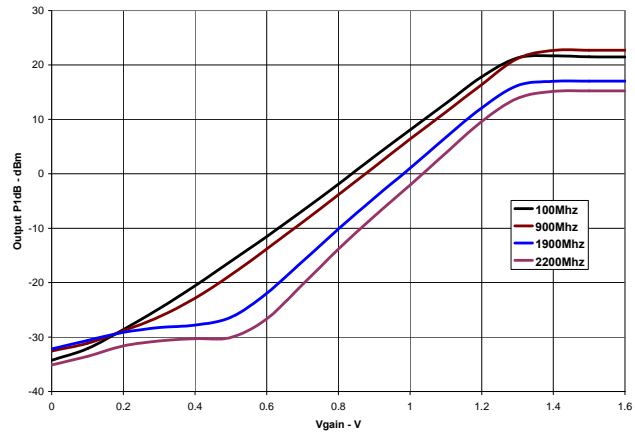


Figure 7. Output Referred Compression Point vs. Gain

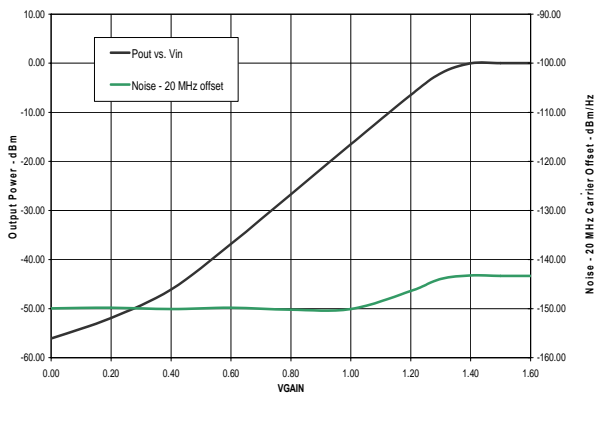


Figure 8. Pout and Noise Floor vs. Gain, 900 MHz. Pin = -21 dBm

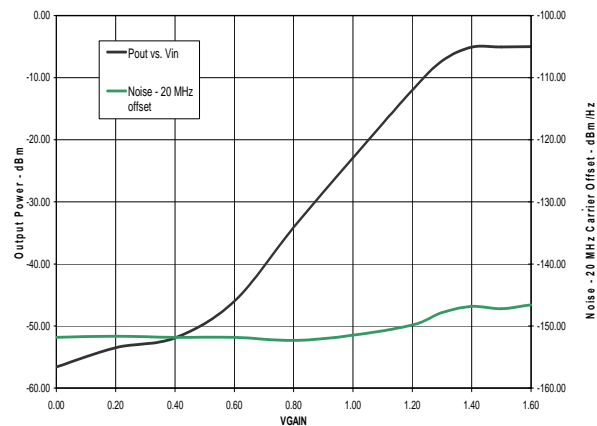


Figure 8. Pout and Noise Floor vs. Gain 1.9 GHz. Pin = -22 dBm



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