

## FEATURES

**Output P1dB: 19 dBm (typical at 7 GHz to 11 GHz)**  
 **$P_{SAT}$ : 23 dBm (typical at 7 GHz to 14 GHz)**  
**Gain: 13 dB (typical at 7 GHz to 11 GHz)**  
**Output IP3: 31.5 dBm (typical at 7 GHz to 11 GHz)**  
**Phase noise:  $-172$  dBc/Hz at 10 kHz offset**  
 **$V_{CC}$ : 5 V at  $I_{CQ} = 76$  mA**  
**Die size: 1.490 mm  $\times$  0.930 mm  $\times$  0.102 mm**

## APPLICATIONS

**Military and space**  
**Test instrumentation**

## GENERAL DESCRIPTION

The ADL8150ACHIP is a self biased, gallium arsenide (GaAs), monolithic microwave integrated circuit (MMIC), heterojunction bipolar transistor (HBT), low phase noise amplifier that operates from 6 GHz to 14 GHz. The amplifier provides 13 dB of gain, 19 dBm output power for 1 dB gain compression (P1dB), and an output third-order intercept (IP3) of 31.5 dBm at 7 GHz to 11 GHz. The amplifier requires 76 mA of quiescent collector

## FUNCTIONAL BLOCK DIAGRAM

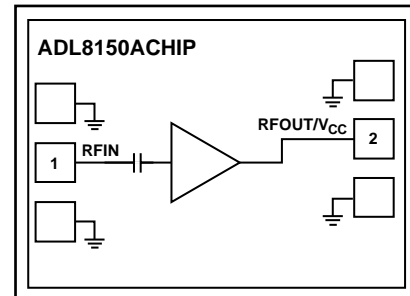


Figure 1.

supply current ( $I_{CQ}$ ) from a 5 V supply voltage ( $V_{CC}$ ). The ADL8150ACHIP also features inputs and outputs (I/Os) that are internally matched to 50  $\Omega$  and facilitates integration into multichip modules (MCMs). All data is taken with the chip connected via two wire bonds that are 0.025 mm (1 mil) wide and 0.31 mm (12 mil) long.

**TABLE OF CONTENTS**

Features.....	1	ESD Caution.....	5
Applications.....	1	Pin Configuration and Function Descriptions .....	6
Functional Block Diagram .....	1	Interface Schematics.....	6
General Description.....	1	Typical Performance Characteristics .....	7
Revision History .....	2	Theory of Operation .....	12
Specifications .....	3	Applications Information.....	13
Frequency Range: 6 GHz to 7 GHz.....	3	Biasing Procedures .....	13
Frequency Range: 7 GHz to 11 GHz.....	3	Assembly and Typical Application Circuit Diagrams.....	13
Frequency Range: 11 GHz to 14 GHz.....	4	Outline Dimensions .....	14
Absolute Maximum Ratings .....	5	Ordering Guide.....	14
Thermal Resistance.....	5		
Electrostatic Discharge (ESD) Ratings.....	5		

**REVISION HISTORY**

7/2020—Revision 0: Initial Version

**SPECIFICATIONS****FREQUENCY RANGE: 6 GHz TO 7 GHz**

$T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5\text{ V}$ , and  $I_{CQ} = 76\text{ mA}$  for nominal operation, unless otherwise noted.

Table 1.

Parameter	Min	Typ	Max	Unit	Test Conditions/Comments
FREQUENCY RANGE	6		7	GHz	
GAIN	9.5	12		dB	
Gain Flatness		$\pm 1.0$		dB	
Gain Variation over Temperature		0.011		dB/ $^\circ\text{C}$	
NOISE FIGURE		4		dB	
PHASE NOISE		-172		dBc/Hz	Measurement taken at 10 kHz offset from carrier
RETURN LOSS					
Input		2		dB	
Output		10		dB	
OUTPUT					
P1dB	16.5	18.5		dBm	
Saturated Output Power ( $P_{SAT}$ )		21		dBm	
IP3		30.5		dBm	Measurement taken at output power ( $P_{OUT}$ ) per tone = 6 dBm
SUPPLY					
$I_{CQ}$		76		mA	Self biased
$V_{CC}$	3	5	6	V	

**FREQUENCY RANGE: 7 GHz TO 11 GHz**

$T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5\text{ V}$ , and  $I_{CQ} = 76\text{ mA}$  for nominal operation, unless otherwise noted.

Table 2.

Parameter	Min	Typ	Max	Unit	Test Conditions/Comments
FREQUENCY RANGE	7		11	GHz	
GAIN	11	13		dB	
Gain Flatness		$\pm 0.8$		dB	
Gain Variation over Temperature		0.012		dB/ $^\circ\text{C}$	
NOISE FIGURE		3.5		dB	
PHASE NOISE		-172		dBc/Hz	Measurement taken at 10 kHz offset from carrier
RETURN LOSS					
Input		6		dB	
Output		7		dB	
OUTPUT					
P1dB	17	19		dBm	
$P_{SAT}$		23		dBm	
IP3		31.5		dBm	Measurement taken at $P_{OUT}$ per tone = 6 dBm
SUPPLY					
$I_{CQ}$		76		mA	Self biased
$V_{CC}$	3	5	6	V	

**FREQUENCY RANGE: 11 GHz TO 14 GHz**

$T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5\text{ V}$ , and  $I_{CQ} = 76\text{ mA}$  for nominal operation, unless otherwise noted.

**Table 3.**

Parameter	Min	Typ	Max	Unit	Test Conditions/Comments
FREQUENCY RANGE	11		14	GHz	
GAIN	9.5	11.5		dB	
Gain Flatness		$\pm 0.7$		dB	
Gain Variation over Temperature		0.014		dB/ $^\circ\text{C}$	
NOISE FIGURE		4		dB	
PHASE NOISE		-172		dBc/Hz	Measurement taken at 10 kHz offset from carrier
RETURN LOSS					
Input		5.5		dB	
Output		8		dB	
OUTPUT					
P1dB	17.5	19.5		dBm	
$P_{SAT}$		23		dBm	
IP3		31		dBm	Measurement taken at $P_{OUT}$ per tone = 6 dBm
SUPPLY					
$I_{CQ}$		76		mA	Self biased
$V_{CC}$	3	5	6	V	

## ABSOLUTE MAXIMUM RATINGS

Table 4.

Parameter	Rating
V <sub>CC</sub>	6.5 V
RFIN	20 dBm
Continuous Power Dissipation (P <sub>DISS</sub> ), T = 85°C (Derate 16.6 mW/°C Above 85°C)	0.879 W
Temperature	
Storage Range	–65°C to +150°C
Operating Range	–55°C to +85°C
Junction Temperature to Maintain 1,000,000 Hour Mean Time to Failure (MTTF)	138°C
Nominal Junction Temperature (T <sub>J</sub> = 85°C, V <sub>CC</sub> = 5 V, I <sub>CQ</sub> = 76 mA)	107.9°C

Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only; functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied.

Operation beyond the maximum operating conditions for extended periods may affect product reliability.

### THERMAL RESISTANCE

Thermal performance is directly linked to system design and operating environment. Careful attention to printed circuit board (PCB) thermal design is required.

$\theta_{JC}$  is the channel to case thermal resistance, channel to bottom of die.

Table 5. Thermal Resistance

Package Type	$\theta_{JC}$	Unit
C-2-4	60.3	°C/W

### ELECTROSTATIC DISCHARGE (ESD) RATINGS

The following ESD information is provided for handling of ESD-sensitive devices in an ESD protected area only.

Human body model (HBM) per ANSI/ESDA/JEDDEC JS-001.

#### ESD Ratings for ADL8150ACHIP

Table 6. ADL8150ACHIP, 2-Pad CHIP

ESD Model	Withstand Threshold (V)	Class
HBM	250	1A

### 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.

### PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

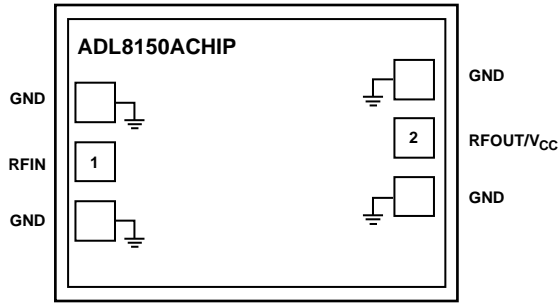


Figure 2. Pad Configuration

Table 7. Pad Function Descriptions

Pad No.	Mnemonic	Description
1	RFIN	RF Signal Input. The RFIN pad is ac-coupled and matched to 50 Ω.
2	RFOUT/V <sub>CC</sub>	RF Signal Output/Supply Voltage. The RFOUT/V <sub>CC</sub> pad is dc-coupled and matched to 50 Ω.
Die Bottom	GND	Die bottom must be connected to RF and dc ground.

### INTERFACE SCHEMATICS



Figure 3. GND Interface Schematic

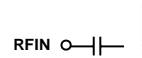


Figure 5. RFIN Interface Schematic

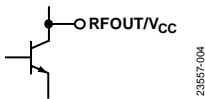


Figure 4. RFOUT/V<sub>CC</sub> Interface Schematic

# TYPICAL PERFORMANCE CHARACTERISTICS

Collector current without RF signal applied ( $I_{CQ}$ ) and collector current with RF signal applied ( $I_{CC}$ ).

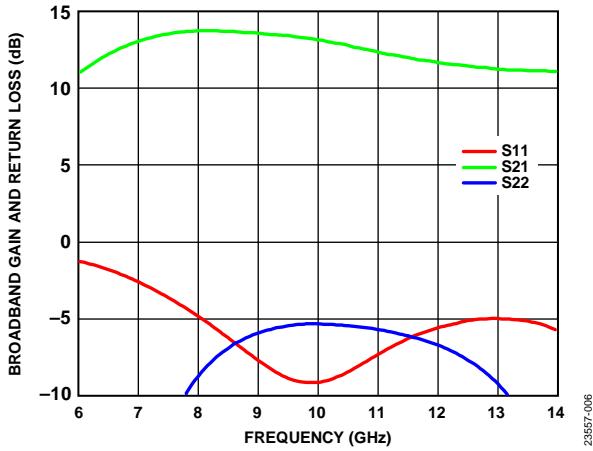


Figure 6. Broadband Gain and Return Loss vs. Frequency (S11 Is the Input Return Loss, S21 Is the Gain, and S22 Is the Output Return Loss)

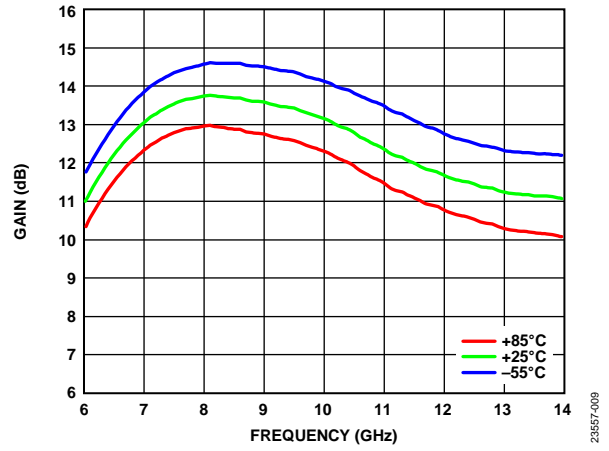


Figure 9. Gain vs. Frequency for Various Temperatures

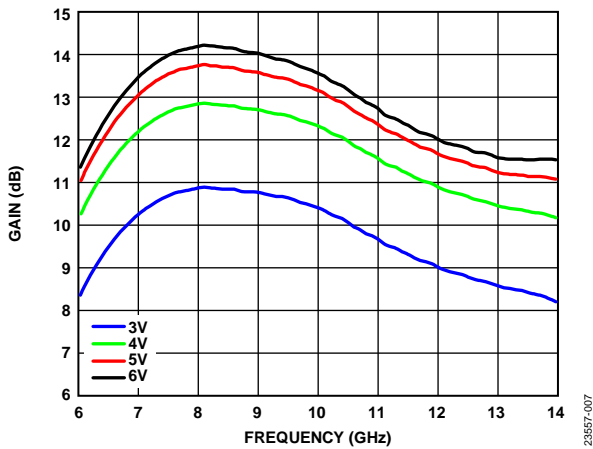


Figure 7. Gain vs. Frequency for Various Supply Voltages

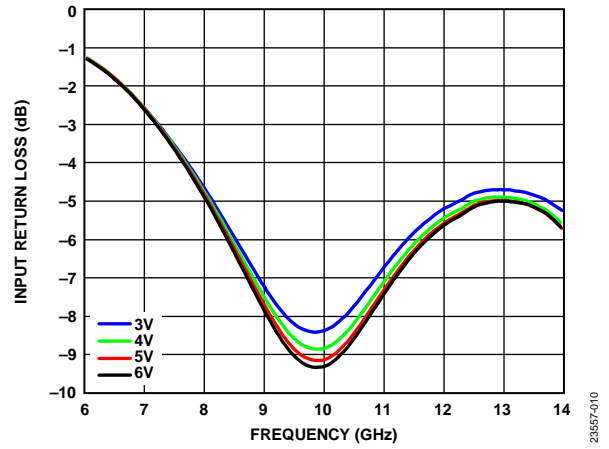


Figure 10. Input Return Loss vs. Frequency for Various Supply Voltages

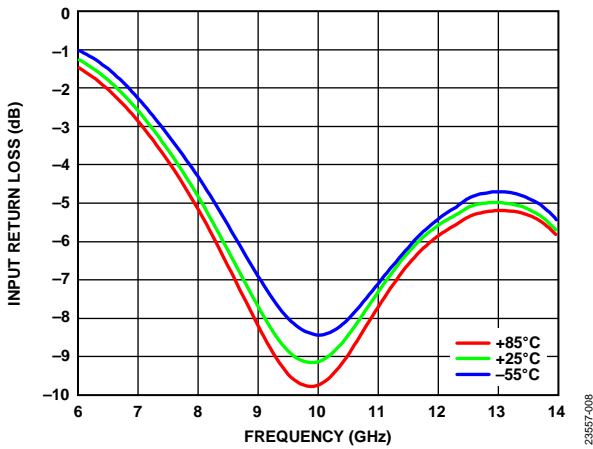


Figure 8. Input Return Loss vs. Frequency for Various Temperatures,  $V_{CC} = 5 V, I_{CQ} = 76 mA$

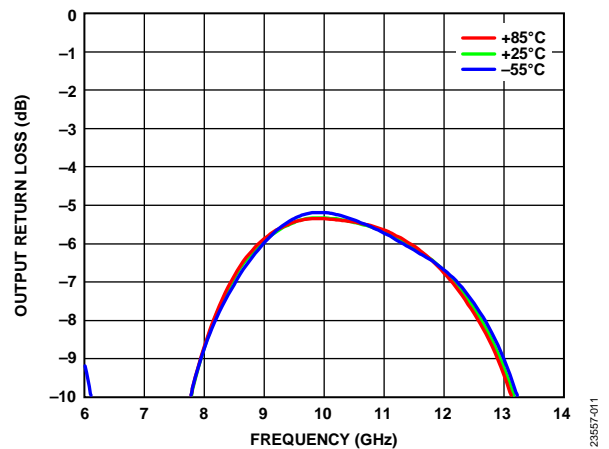


Figure 11. Output Return Loss vs. Frequency for Various Temperatures

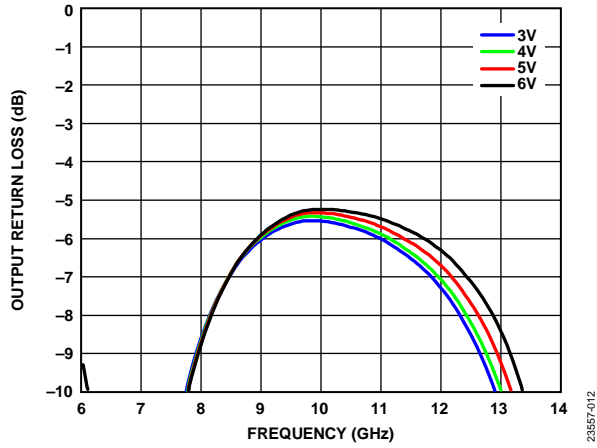


Figure 12. Output Return Loss vs. Frequency for Various Supply Voltages

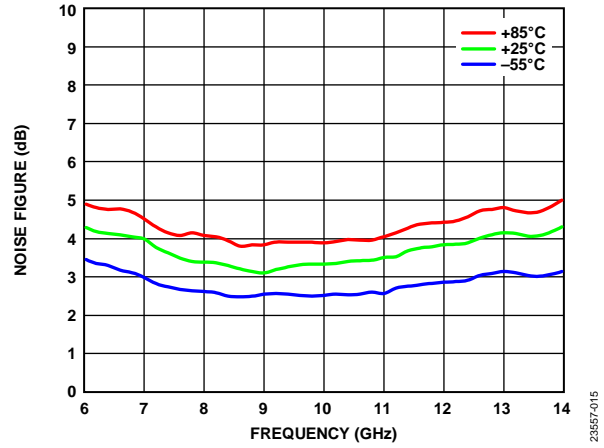


Figure 15. Noise Figure vs. Frequency for Various Temperatures

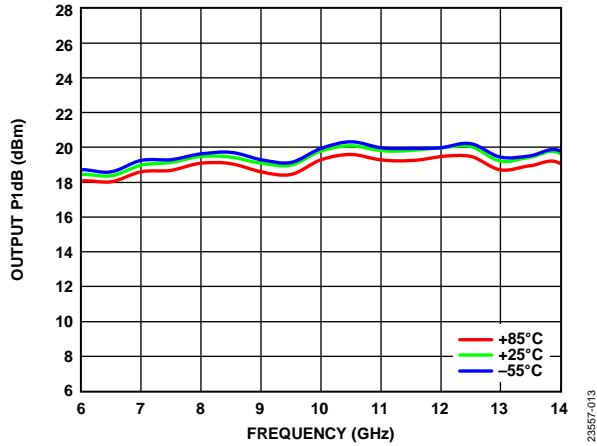


Figure 13. Output P1dB vs. Frequency for Various Temperatures

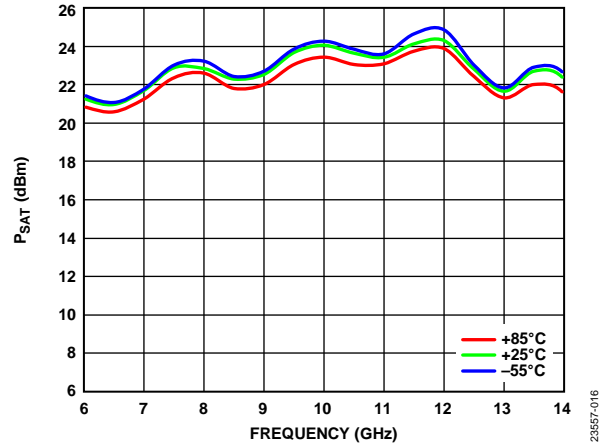


Figure 16. P<sub>SAT</sub> vs. Frequency for Various Temperatures

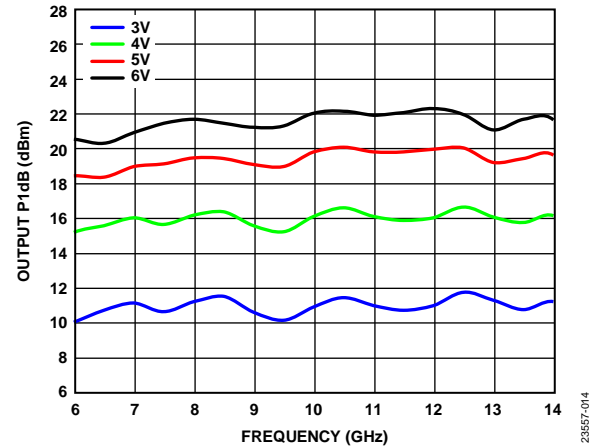


Figure 14. Output P1dB vs. Frequency for Various Supply Voltages

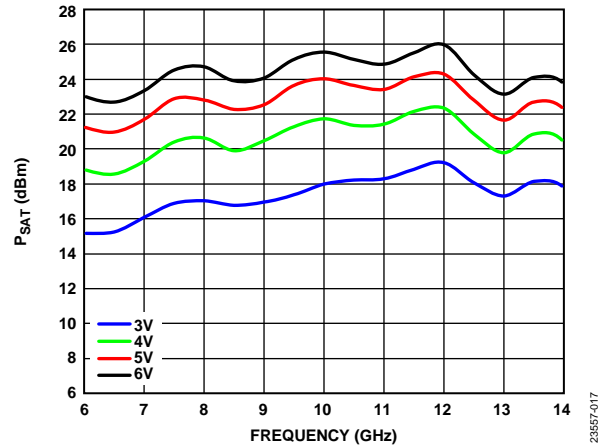


Figure 17. P<sub>SAT</sub> vs. Frequency for Various Supply Voltages



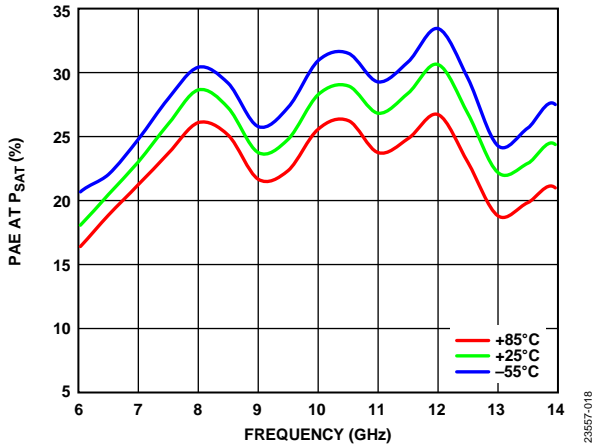


Figure 18. Power Added Efficiency (PAE) at  $P_{SAT}$  vs. Frequency for Various Temperatures

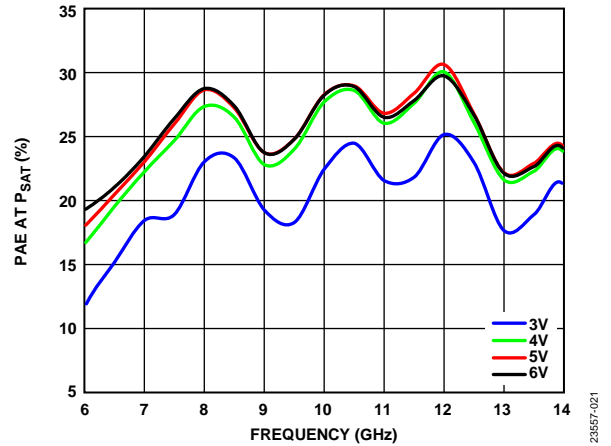


Figure 21. PAE at  $P_{SAT}$  vs. Frequency for Various Supply Voltages

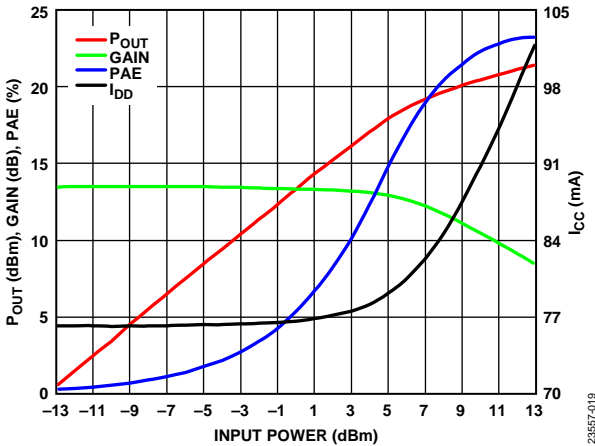


Figure 19.  $P_{OUT}$ , Gain, PAE, and  $I_{CC}$  vs. Input Power, Frequency = 7 GHz

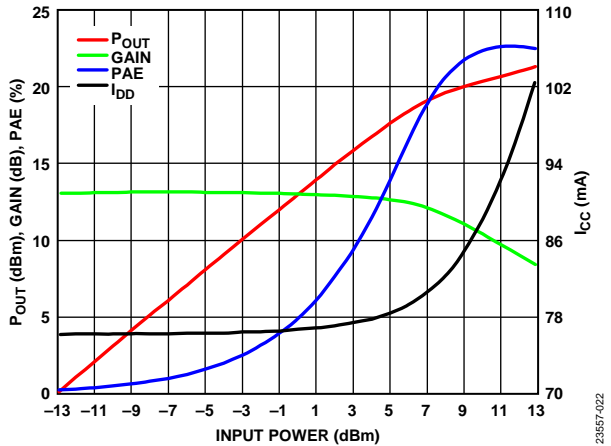


Figure 22.  $P_{OUT}$ , Gain, PAE, and  $I_{CC}$  vs. Input Power, Frequency = 13 GHz

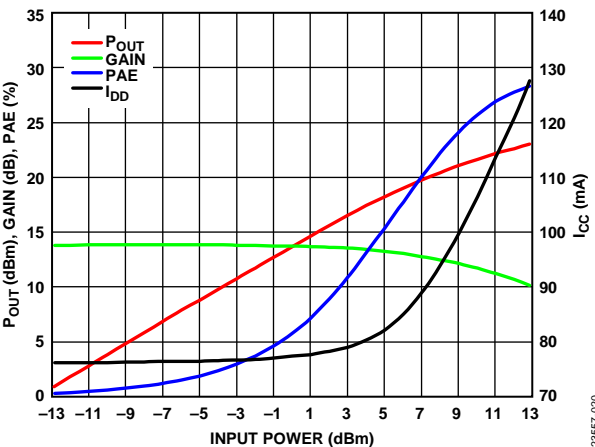


Figure 20.  $P_{OUT}$ , Gain, PAE, and  $I_{CC}$  vs. Input Power, Frequency = 10 GHz

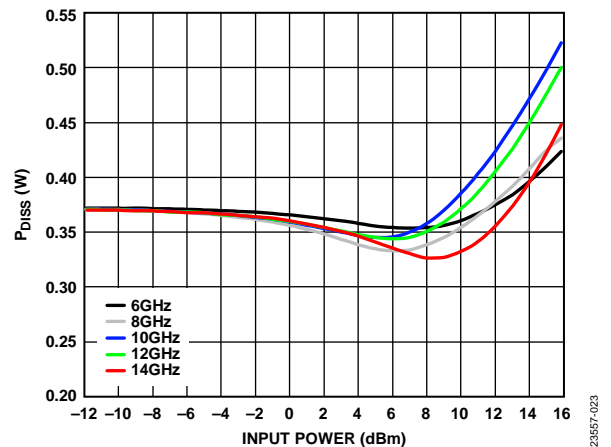


Figure 23.  $P_{DISS}$  vs. Input Power,  $T = 85^{\circ}C$

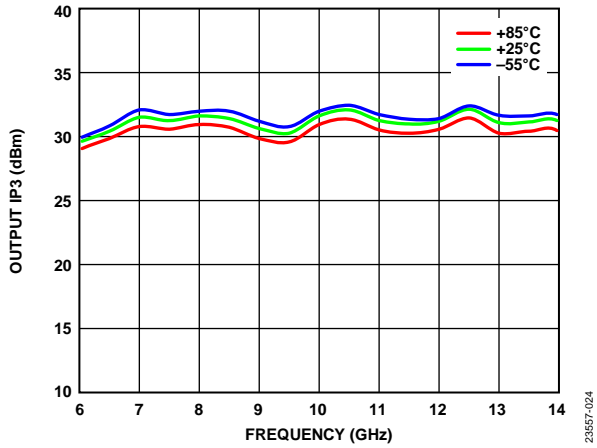


Figure 24. Output IP3 vs. Frequency for Various Temperatures,  $P_{OUT}$  per Tone = 6 dBm,  $V_{CC} = 5 V$

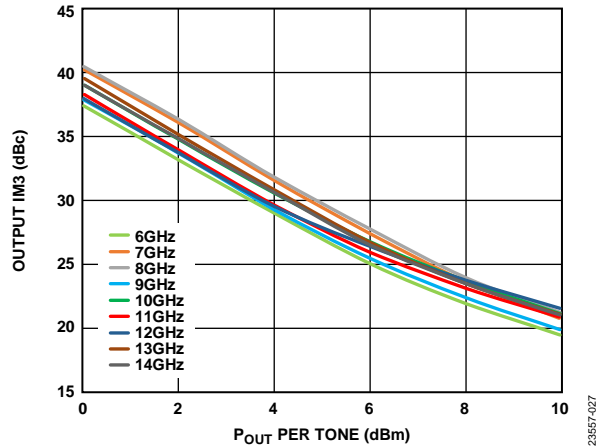


Figure 27. Output IM3 vs.  $P_{OUT}$  per Tone for Various Frequencies at  $V_{CC} = 3 V$

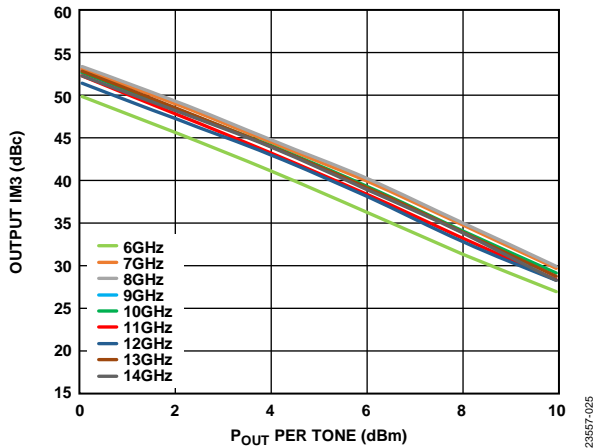


Figure 25. Output Third-Order Intermodulation (IM3) vs.  $P_{OUT}$  per Tone for Various Frequencies at  $V_{CC} = 4 V$

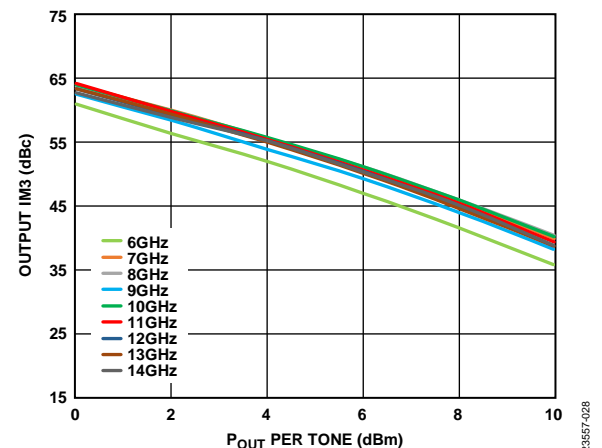


Figure 28. Output IM3 vs.  $P_{OUT}$  per Tone for Various Frequencies at  $V_{CC} = 5 V$

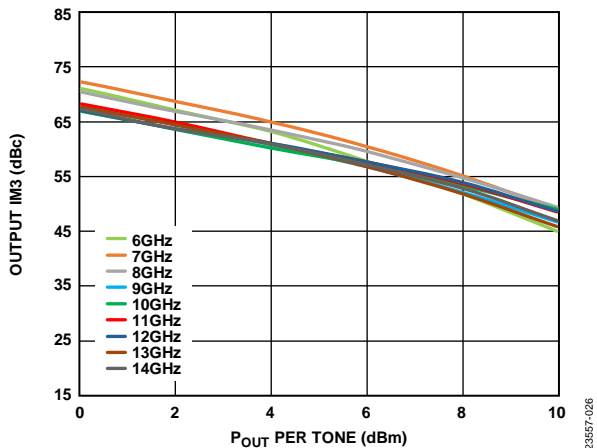


Figure 26. Output IM3 vs.  $P_{OUT}$  per Tone for Various Frequencies at  $V_{CC} = 6 V$

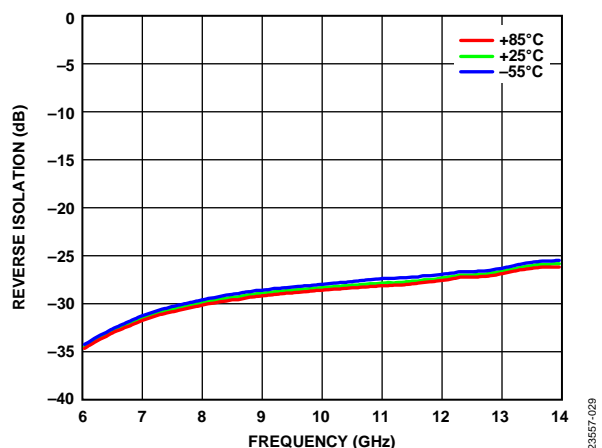


Figure 29. Reverse Isolation vs. Frequency for Various Temperatures

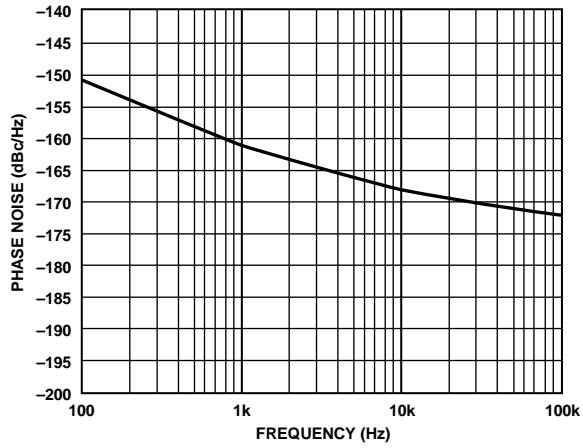


Figure 30. Phase Noise vs. Frequency at 10 GHz, P<sub>OUT</sub> = 10 dBm

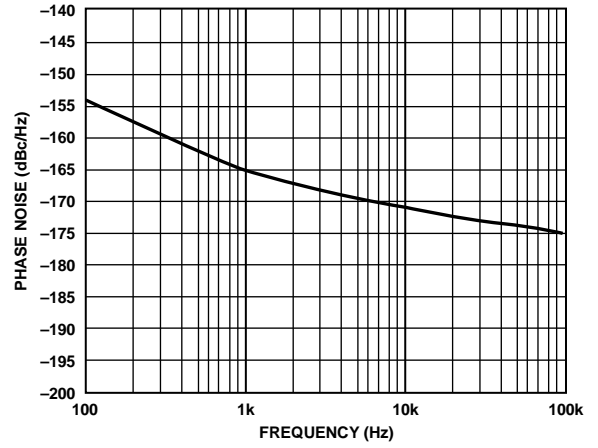


Figure 32. Phase Noise vs. Frequency at 10 GHz, P<sub>OUT</sub> = P1dB

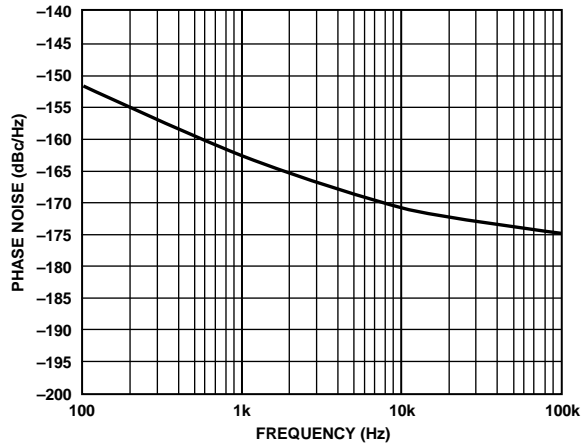


Figure 31. Phase Noise vs. Frequency at 10 GHz, P<sub>OUT</sub> = P<sub>SAT</sub>

## THEORY OF OPERATION

The ADL8150ACHIP is a self biased, single 5 V power supply amplifier. RFIN is dc-coupled, and RFOUT/V<sub>CC</sub> requires an external bias tee (see Figure 35). Figure 33 shows the simplified block diagram.

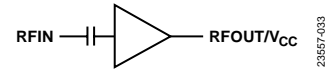


Figure 33. Simplified Block Diagram

## APPLICATIONS INFORMATION

### BIASING PROCEDURES

The ADL8150ACHIP is a self biased GaAs, MMIC, HBT, low phase noise amplifier. Figure 34 shows the typical application circuit. Adhere to the following bias sequence during power-up:

1. Connect the  $V_{CC}$  power supply.
2. Set the  $V_{CC}$  supply to 5 V on a bias tee on the RFOUT/ $V_{CC}$  pin (see Figure 34).
3. Apply the RF input signal.

Adhere to the following bias sequence during power-down:

1. Turn off the RF input signal.
2. Set the  $V_{CC}$  supply to 0 V.

### Handling Precautions

To avoid permanent damage to the die, follow these storage, cleanliness, static sensitivity, transient, and general handling precautions:

- Place all bare die in either waffle-based or gel-based ESD protective containers and then seal the die in an ESD protective bag for shipment. After the sealed ESD protective bag is opened, store all die in a dry nitrogen environment.
- Handle the chips in a clean environment. Do not attempt to clean the chip using liquid cleaning systems.
- Follow ESD precautions to protect against ESD strikes.
- When the bias is applied, suppress instrument and bias supply transients. Use a shielded signal and bias cables to minimize inductive pickup.
- Handle the chip along the edges with a vacuum collet or with a sharp pair of tweezers. The chip surface has fragile air bridges and must not be touched with a vacuum collet, tweezers, or fingers.

### Mounting

Before the epoxy die is attached to the ADL8150ACHIP, apply a minimum amount of epoxy (must order separately) to the mounting surface so that a thin epoxy fillet is observed around the perimeter of the chip after it is placed into position. Cure the epoxy per the schedule of the manufacturer.

### Wire Bonding

RF bonds made with 3 mil  $\times$  0.5 mil gold ribbon are recommended to be used with the RF ports. These bonds must be thermosonically bonded with a force between 40 g and 60 g. DC bonds of 0.025 mm (1 mil) in diameter, thermosonically bonded, are recommended for bond wire connections. Create ball bonds with a force between 40 g and 50 g, and wedge bonds with a force between 18 g and 22 g. Create all bonds with a nominal stage temperature of 150°C. Apply a minimum amount of ultrasonic energy to achieve reliable bonds. Keep all bonds as short as possible, less than 0.31 mm (12 mil).

### ASSEMBLY AND TYPICAL APPLICATION CIRCUIT DIAGRAMS

Figure 35 shows the assembly diagram, and Figure 34 shows the typical application circuit diagram.

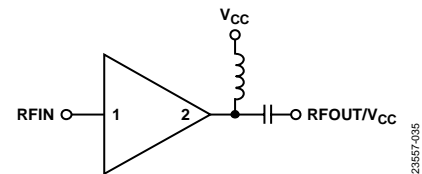


Figure 34. Typical Application Circuit

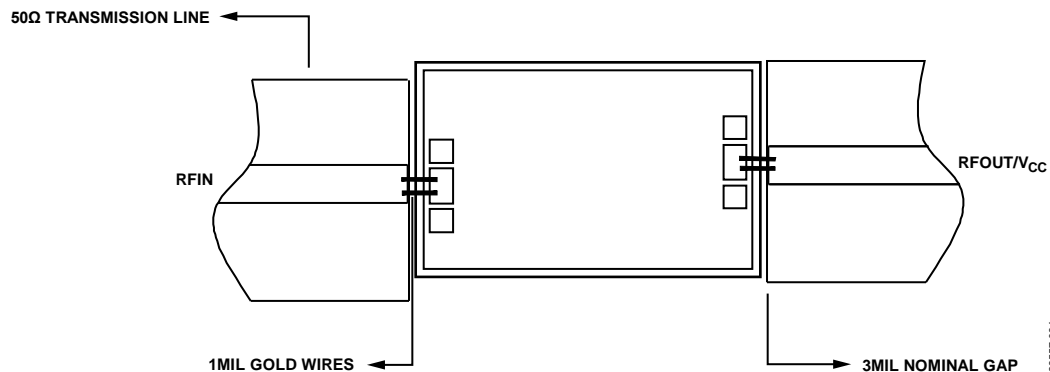


Figure 35. Assembly Diagram

OUTLINE DIMENSIONS

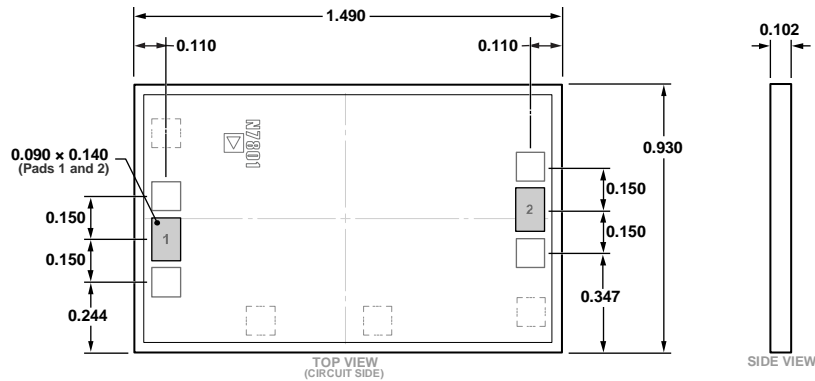


Figure 36. 2-Pad Bare Die [CHIP]  
(C-2-4)  
Dimensions shown in millimeters

ORDERING GUIDE

Model <sup>1,2</sup>	Temperature Range	Package Description	Package Option
ADL8150ACHIP	-55°C to +85°C	2-Pad Bare Die [CHIP]	C-2-4
ADL8150CHIP-SX	-55°C to +85°C	2-Pad Bare Die [CHIP]	C-2-4

<sup>1</sup> The ADL8150CHIP-SX is a sample order of two devices.

<sup>2</sup> The ADL8150ACHIP and ADL8150CHIP-SX are RoHS compliant parts.