10 Watt, GaN Power Amplifier, 2.7 GHz to 3.8 GHz

Preliminary Technical Data

HMC1114

FEATURES

- **High saturated output power (P_{SAT}): 41.5 dBm**
- **High small signal gain: 35 dB**
- **High large signal gain: 25.5 dB**
- **Bandwidth: 2.7 GHz to 3.8 GHz**
- **High power added efficiency (PAE): 54%**
- **High output IP3: 44 dBm**
- **Supply voltage: V_{DD} = 28 V at 150 mA**
- **32-lead, 5 mm × 5 mm LFSCP package: 25 mm²**

APPLICATIONS

- **Extended battery operation for public mobile radio**
- **Power amplifier stage for wireless infrastructure**
- **Test and measurement equipment**
- **Commercial and military radar**
- **General-purpose transmitter amplification**

FUNCTIONAL BLOCK DIAGRAM

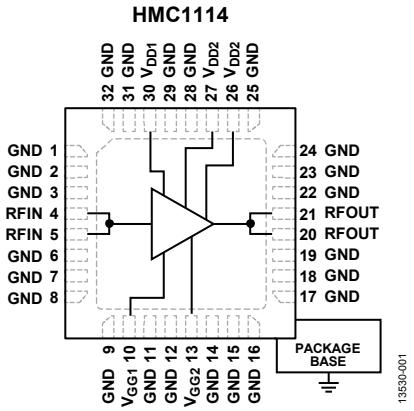

Figure 1.

GENERAL DESCRIPTION

The HMC1114 is a gallium nitride (GaN) broadband power amplifier delivering 10 watts with more than 50% PAE across a bandwidth of 2.7 GHz to 3.8 GHz. The HMC1114 provides ±0.5 dB gain flatness

The HMC1114 is ideal for pulsed or continuous wave (CW) applications such as wireless infrastructure, radar, public mobile radio, and general-purpose amplification.

The HMC1114 is housed in a compact LFCSP package.

Rev. PrA **Document Feedback**

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Tel: 781.329.4700 **Technical Support** **www.analog.com**

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SPECIFICATIONS

ELECTRICAL SPECIFICATIONS

T_A = 25°C, V_{DD} = 28 V, I_{DQ} = 150 mA, frequency range = 2.7 GHz to 3.2 GHz.

Table 1.

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
FREQUENCY RANGE		2.7		3.2	GHz	
GAIN						
Small Signal Gain		32	35		dB	
Gain Flatness			±0.5		dB	
Power Gain for 4 dB Compression			29		dB	
Power Gain for Saturated Output Power			25.5		dB	Measurement taken at P_{IN} = 16 dBm
RETURN LOSS						
Input			14		dB	
Output			11		dB	
POWER						
Output Power for 4 dB Compression	P4dB		39		dBm	
Saturated Output Power	P_{SAT}		41.5		dBm	Measurement taken at P_{IN} = 16 dBm
Power Added Efficiency	PAE		54		%	
OUTPUT THIRD-ORDER INTERCEPT	IP3		44			Measurement taken at P_{OUT} ÷ tone = 30 dBm
TARGET QUIESCENT CURRENT	I_{DQ}		150		mA	Adjust the gate control voltage (V_{GGx}) between −8 V and 0 V to achieve an I_{DQ} = 150 mA, typical

T_A = 25°C, V_{DD} = 28 V, I_{DQ} = 150 mA, frequency range = 3.2 GHz to 3.8 GHz.

Table 2.

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
FREQUENCY RANGE		3.2		3.8	GHz	
GAIN						
Small Signal Gain		33	33		dB	
Gain Flatness			±1		dB	
Power Gain for 4 dB Compression			28		dB	
Power Gain for Saturated Output Power			25		dB	Measurement taken at P_{IN} = 16 dBm
RETURN LOSS						
Input			25		dB	
Output			9		dB	
POWER						
Output Power for 4 dB Compression	P4dB		40		dBm	
Saturated Output Power	P_{SAT}		40.5		dBm	Measurement taken at P_{IN} = 16 dBm
Power Added Efficiency	PAE		53		%	
OUTPUT THIRD-ORDER INTERCEPT	IP3		44			Measurement taken at P_{OUT} ÷ tone = 30 dBm
TARGET QUIESCENT CURRENT	I_{DQ}		150		mA	Adjust the gate control voltage (V_{GGx}) between −8 V and 0 V to achieve an I_{DQ} = 150 mA, typical

TOTAL SUPPLY CURRENT BY V_{DD}

Table 3.

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
SUPPLY CURRENT	I_{DQ}					Adjust V_{GGx} to achieve an I_{DQ} = 150 mA, typical
V_{DD} = 25 V			150		mA	
V_{DD} = 28 V			150		mA	
V_{DD} = 32 V			150		mA	

ABSOLUTE MAXIMUM RATINGS

Table 4.

Parameter	Rating
Drain Bias Voltage (V_{DDx})	32 V dc
Gate Bias Voltage (V_{GGx})	
RF Input Power (RFIN)[1]	30 dBm
Channel Temperature	225°C
Continuous P_{DISS} (T = 85°C) (Derate 227 mW/°C Above 120°C)	24 W
Thermal Resistance, Junction to Back of Paddle	4.4°C/W
Maximum Forward Gate Current	4 mA
Maximum Voltage Standing Wave Ratio (VSWR)[1]	6:1
Maximum Peak Reflow Temperature	260°C
Storage Temperature Range	−55°C to +150°C
Operating Temperature Range	−40°C to +85°C

[1] Restricted by maximum power dissipation.

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.

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

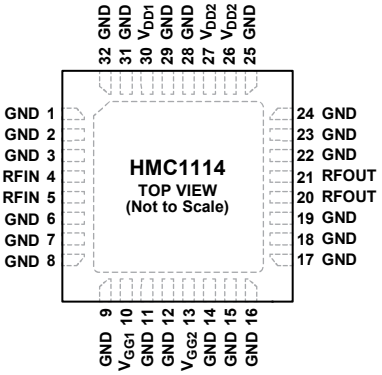

Figure 2. Pin Configuration

Table 5. Pin Function Descriptions

Pin No.	Mnemonic	Description
1 to 3, 6 to 9, 11, 12, 14 to 19, 22 to 25, 28, 29, 31, 32	GND	Ground. These pins and the package bottom (EPAD) must be connected to RF/dc ground. See Figure 3 for the GND interface schematic.
4, 5	RFIN	RF Input. These pins are dc-coupled and matched to 50 Ω. See Figure 4 for the RFIN interface schematic.
10, 13	V_{GG1}, V_{GG2}	Gate Control Voltage. External bypass capacitors of 1 µF and 10 µF are required. See Figure 5 for the V_{GGx} interface schematic.
20, 21	RFOUT	RF Output. These pins are ac-coupled and matched to 50 Ω. See Figure 6 for the RFOUT interface schematic.
26, 27, 30	V_{DD2}, V_{DD1}	Drain Bias for the Amplifiers. External bypass capacitors of 100 pF, 1 µF, and 10 µF are required. See Figure 7 for the V_{DDx} interface schematic.
	EPAD	Exposed Pad. The exposed pad must be connected to RF/dc ground.

INTERFACE SCHEMATICS

Figure 3. GND Interface

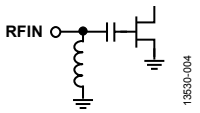

Figure 4. RFIN Interface

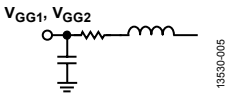

Figure 5. V_{GGx} Interface

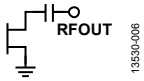

Figure 6. RFOUT Interface

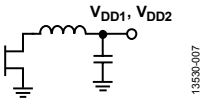

Figure 7. V_{DDx} Interface

TYPICAL PERFORMANCE CHARACTERISTICS

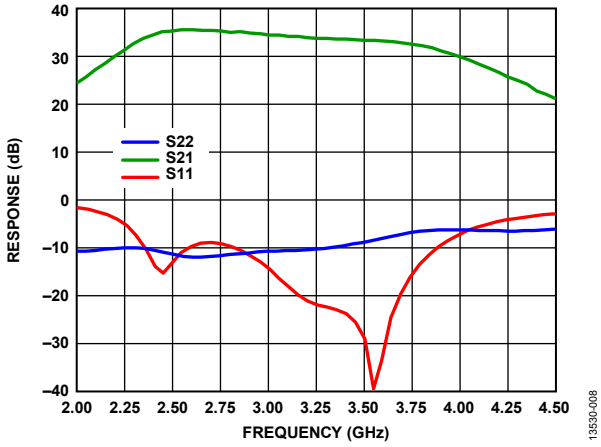

Figure 8. Gain and Return Loss

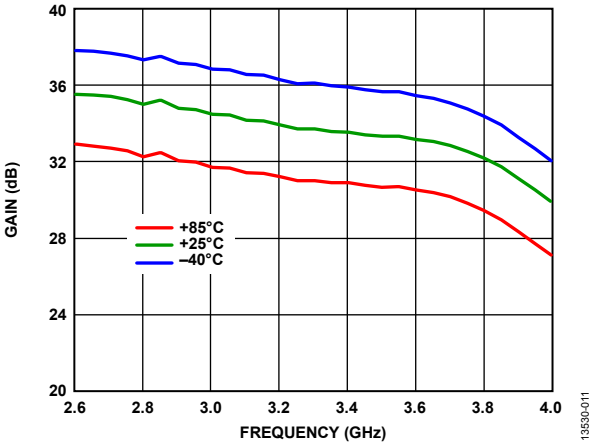

Figure 11. Gain vs. Frequency at Various Temperatures

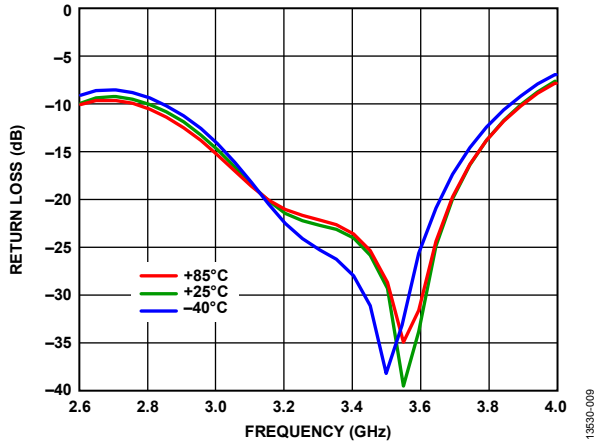

Figure 9. Input Return Loss vs. Frequency at Various Temperatures

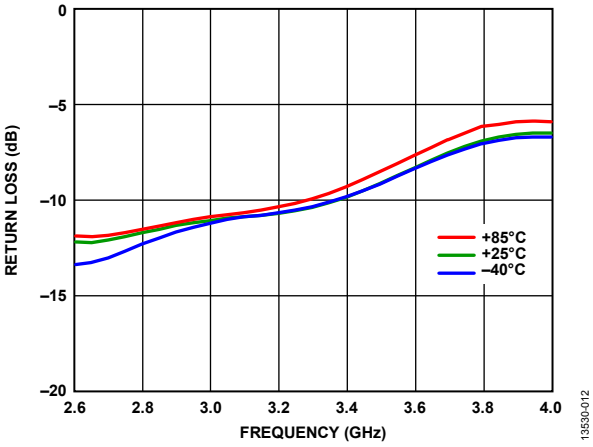

Figure 12. Output Return Loss vs. Frequency at Various Temperatures

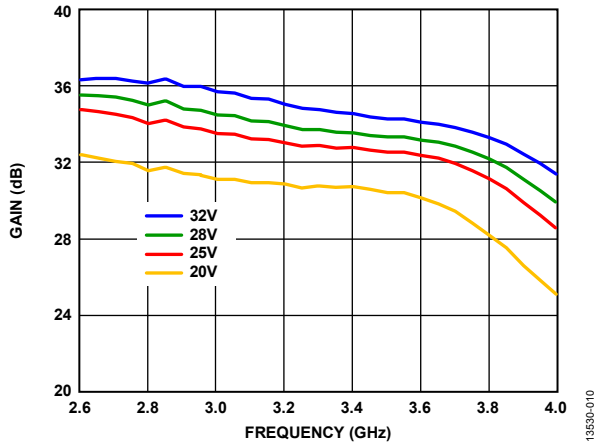

Figure 10. Gain vs. Frequency at Various Supply Voltages

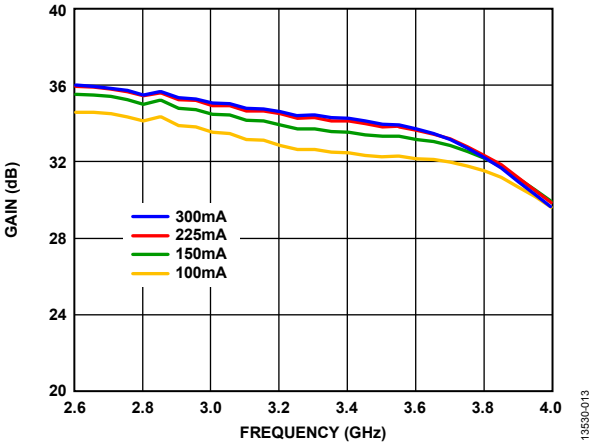

Figure 13. P1dB vs. Frequency at Various Supply Currents

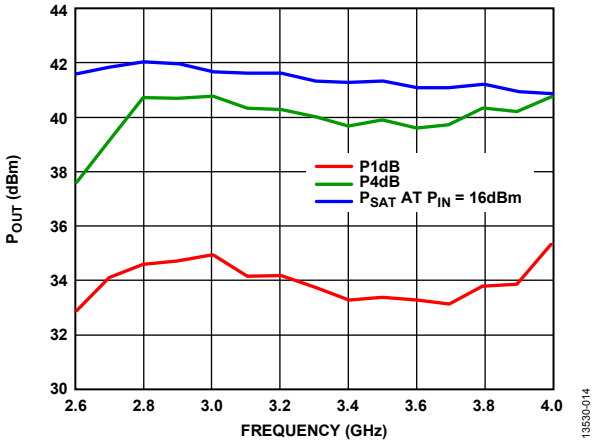

Figure 14. P_{OUT} vs. Frequency, Measurement Taken at P_{IN} = 16 dBm

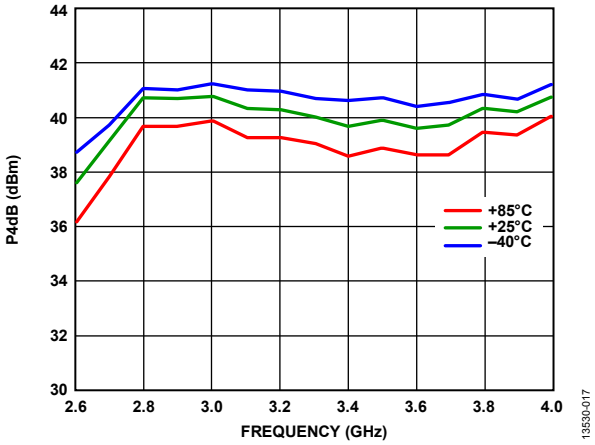

Figure 17. P4dB vs. Frequency at Various Temperatures

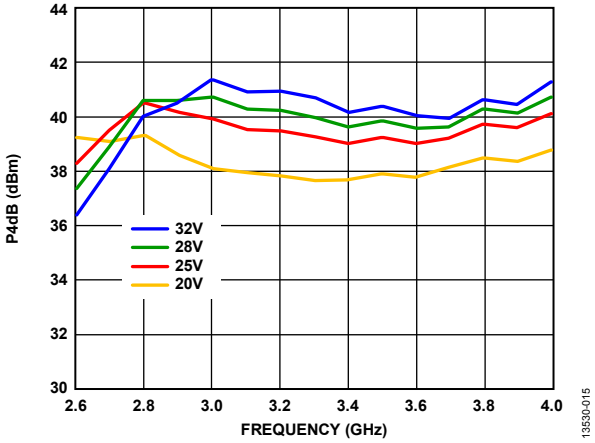

Figure 15. P4dB vs. Frequency at Various Supply Voltages

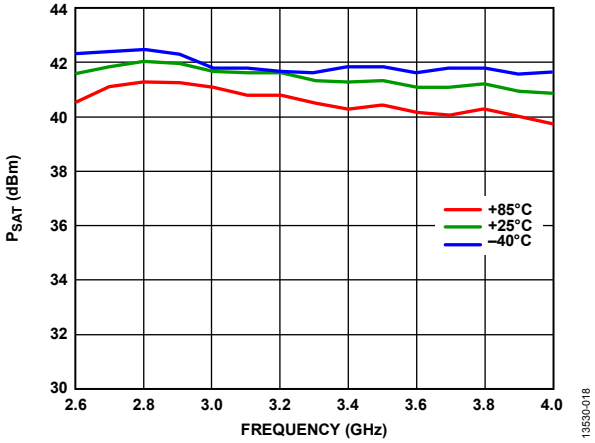

Figure 18. P_{SAT} vs. Frequency at Various Supply Temperatures, Measurement Taken at P_{IN} = 16 dBm

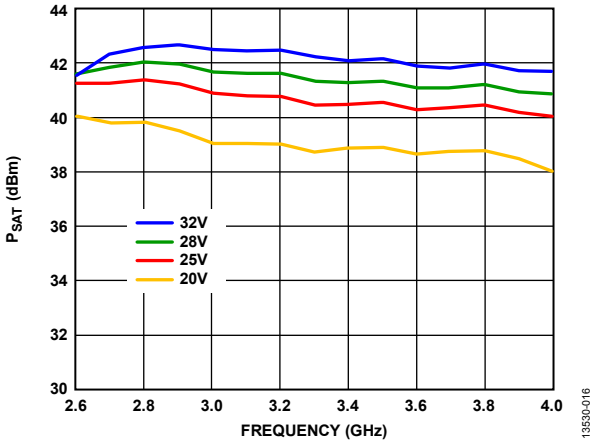

Figure 16. P_{SAT} vs. Frequency at Various Supply Voltages, Measurement Taken at P_{IN} = 16 dBm

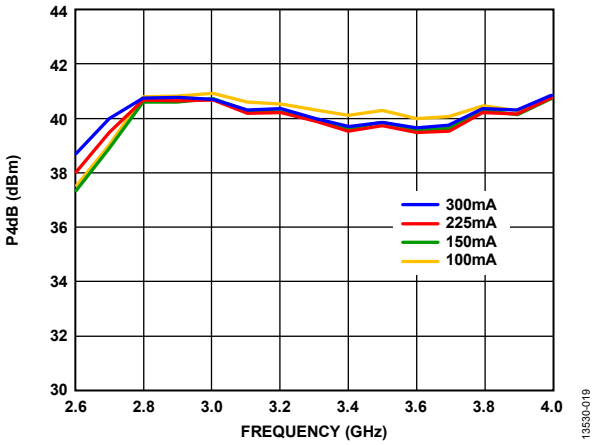

Figure 19. P4dB vs. Frequency at Various Supply Currents

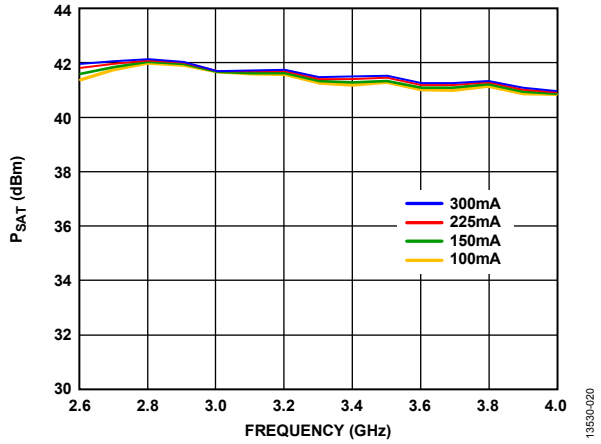

Figure 20. P_{SAT} vs. Frequency at Various Supply Currents, Measurement Taken at P_{IN} = 16 dBm

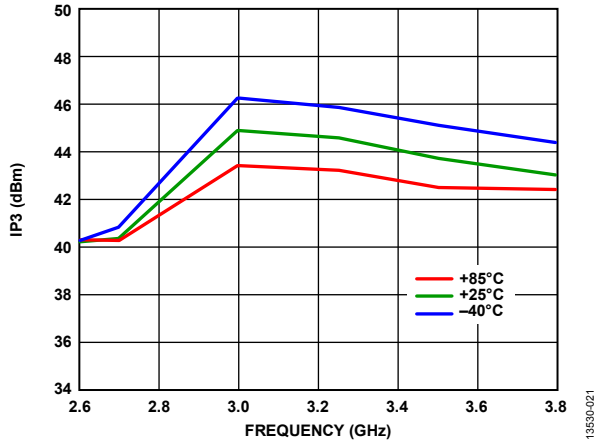

Figure 21. Output IP3 vs. Frequency at Various Temperatures, P_{OUT}/Tone = 30 dBm

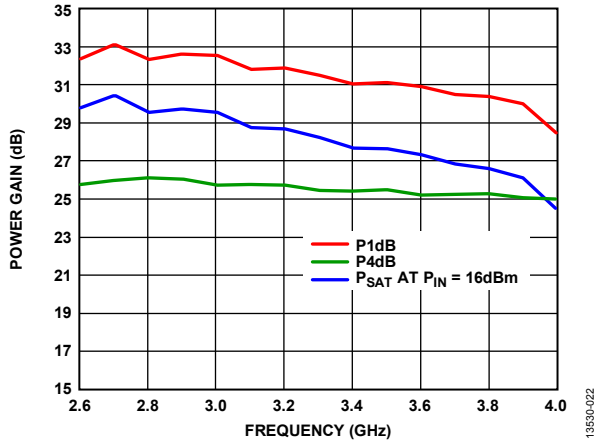

Figure 22. Power Gain vs. Frequency

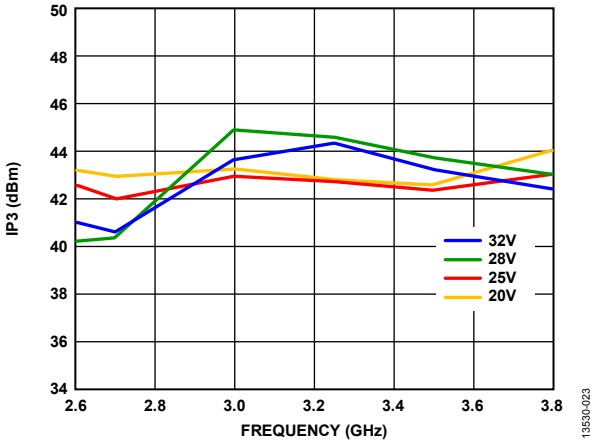

Figure 23. Output IP3 vs. Frequency at Various Supply Voltages, P_{OUT}/Tone = 30 dBm

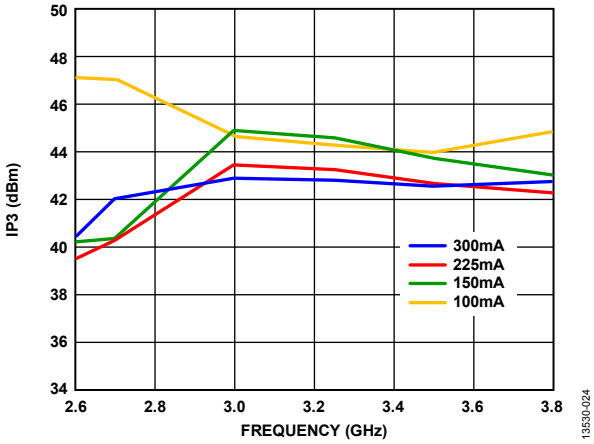

Figure 24. Output IP3 vs. Frequency at Various Supply Currents, P_{OUT}/Tone = 30 dBm

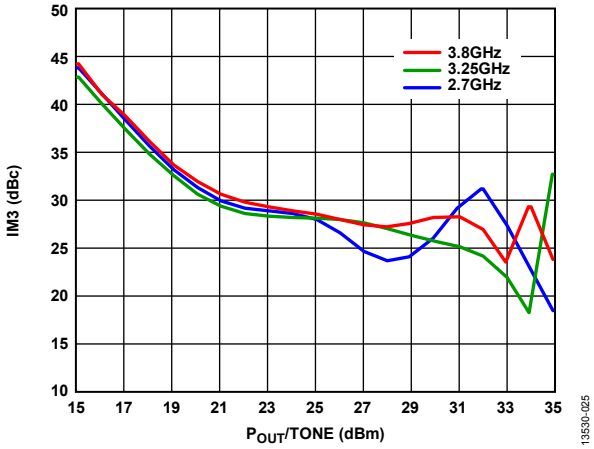

Figure 25. Output Third-Order Intermodulation (IM3) at V_{DD} = 20 V

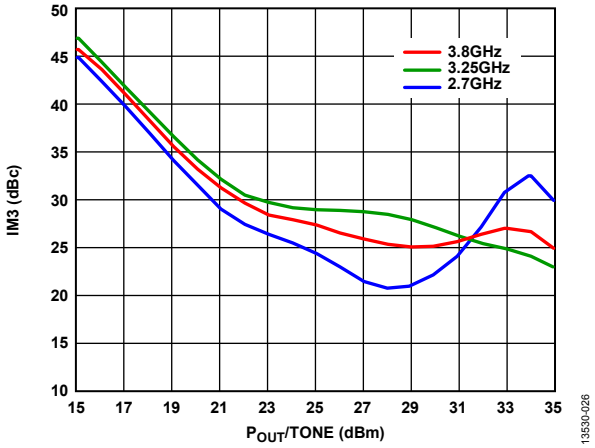

Figure 26. Output IM3 at V_{DD} = 28 V

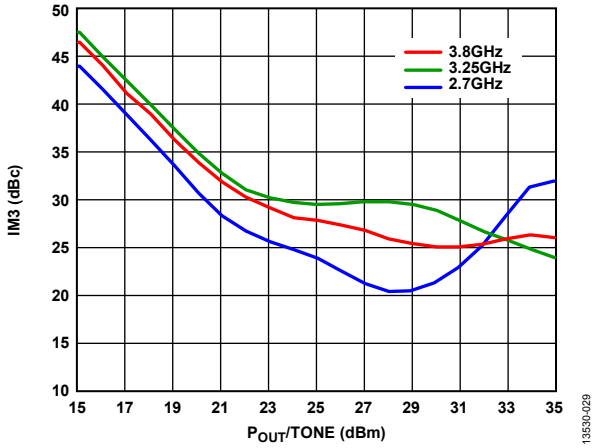

Figure 29. Output IM3 at V_{DD} = 32 V

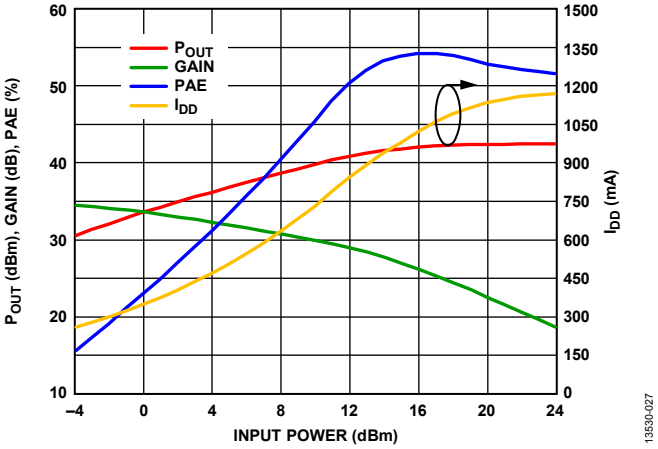

Figure 27. Power Compression at 2.7 GHz

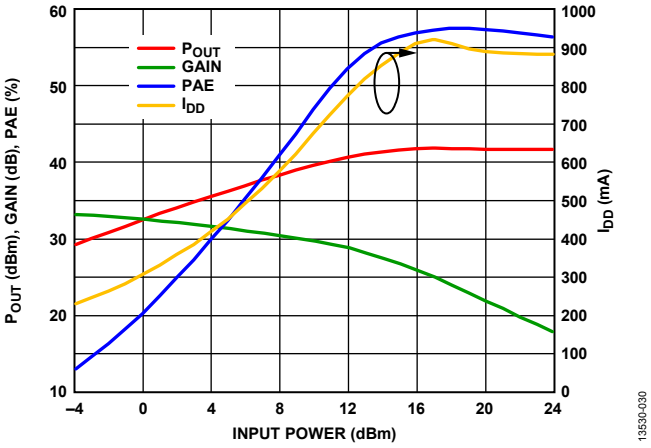

Figure 30. Power Compression at 3.2 GHz

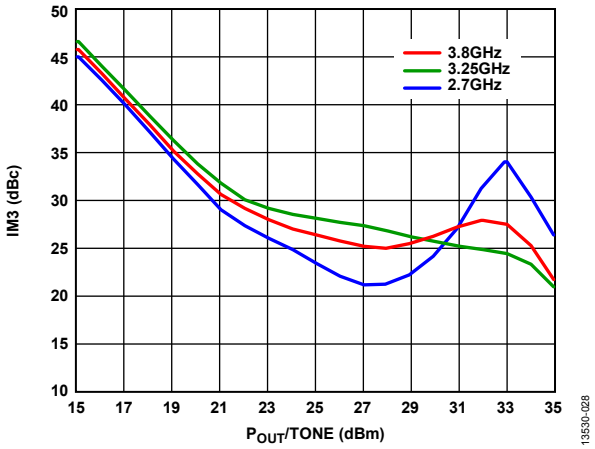

Figure 28. Output IM3 at V_{DD} = 25 V

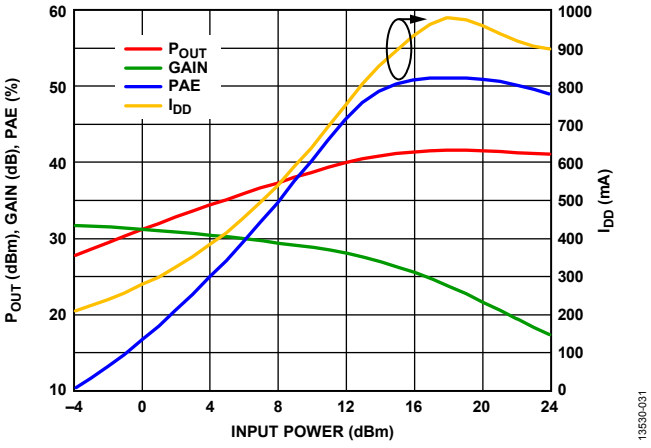

Figure 31. Power Compression at 3.8 GHz

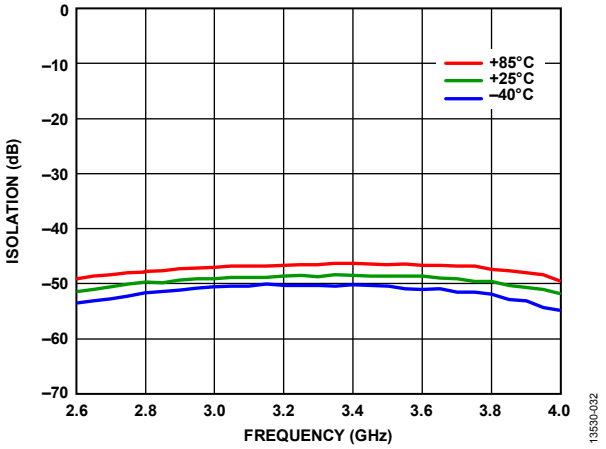

Figure 32. Reverse Isolation vs. Frequency at Various Temperatures

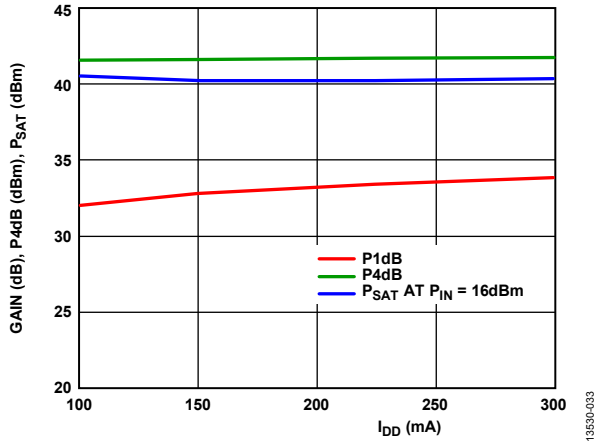

Figure 33. Gain and Power vs. Supply Current (I_{DD}), at 3.2 GHz

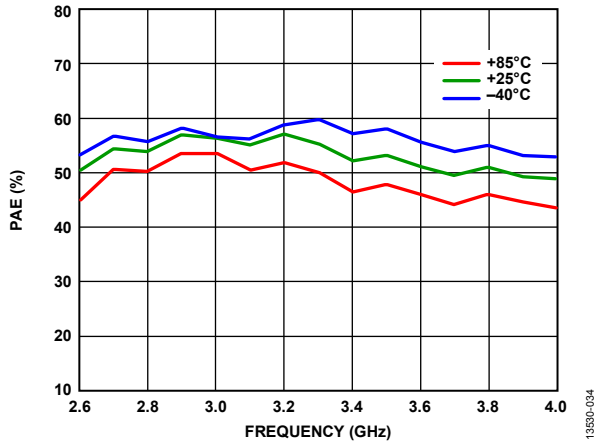

Figure 34. PAE vs. Frequency at Various Temperatures, P_{IN} = 16 dBm

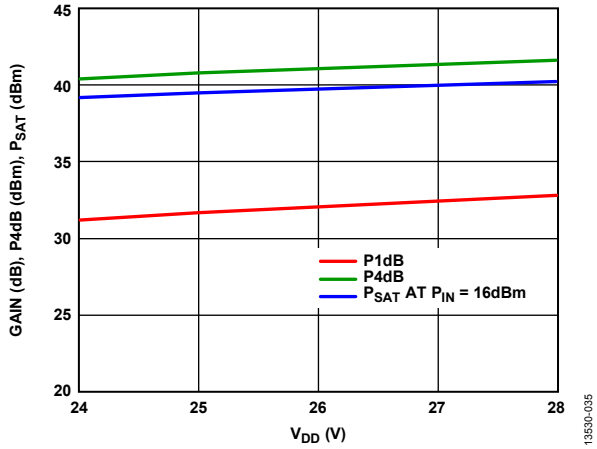

Figure 35. Gain and Power vs. Supply Voltage (V_{DD}) at 3.2 GHz

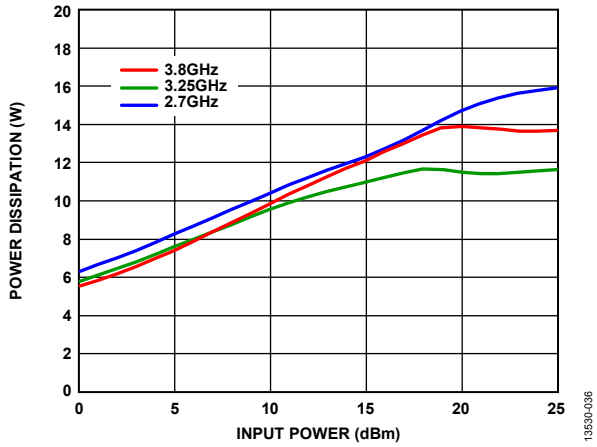

Figure 36. Power Dissipation at 85°C

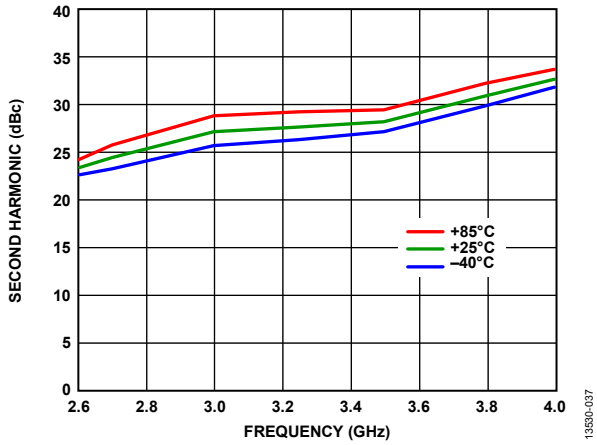

Figure 37. Second-Order Harmonics at Various Temperatures, P_{OUT} = 30 dBm

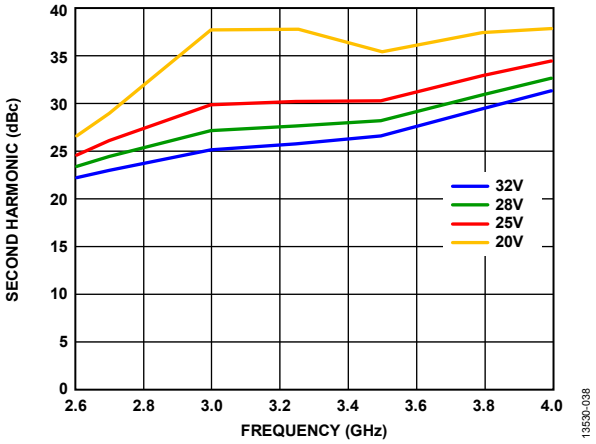

Figure 38. Second-Order Harmonics at Various Supply Voltages, P_{OUT} = 30 dBm

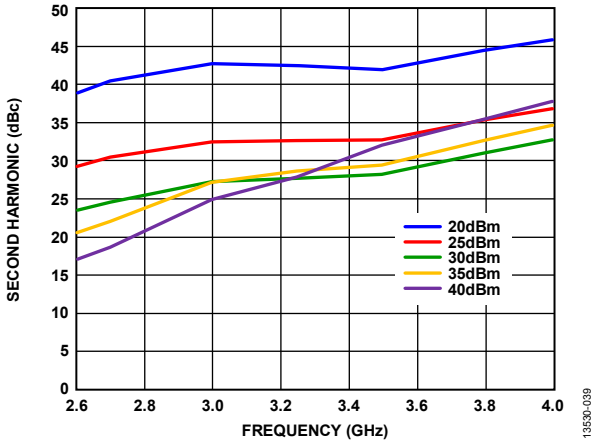

Figure 39. Second-Order Harmonics at Various Output Powers

APPLICATIONS INFORMATION

APPLICATION CIRCUIT

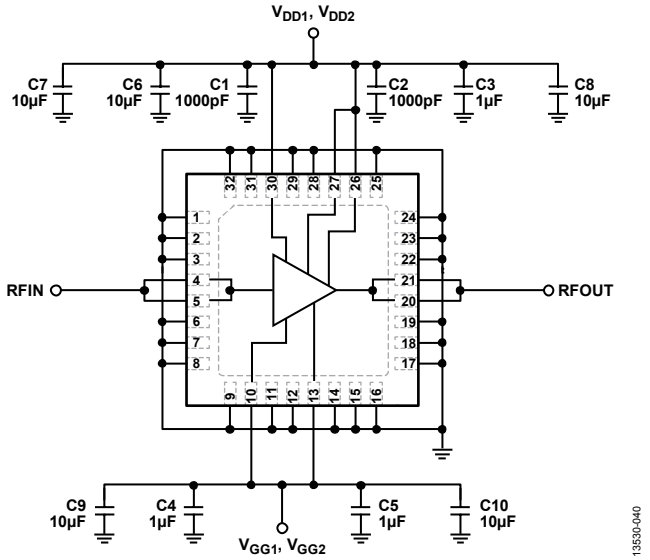

Figure 40. Typical Application Circuit

EVALUATION PRINTED CIRCUIT BOARD (PCB)

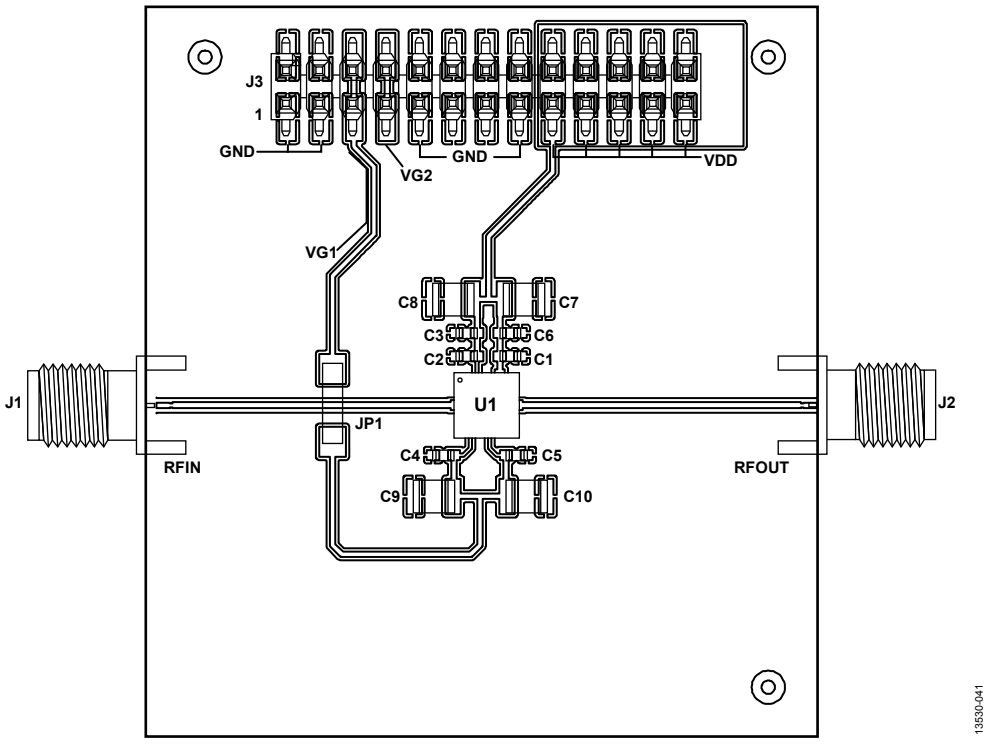

Figure 41. Evaluation Printed Circuit Board (PCB)

BILL OF MATERIALS

Use RF circuit design techniques for the circuit board used in the application. Provide 50 Ω impedance for the signal lines and directly connect the package ground leads and exposed paddle to the ground plane, similar to that shown in Figure 41. Use a sufficient number of via holes to connect the top and bottom ground planes. The evaluation circuit board shown in Figure 41 is available from Analog Devices, Inc., upon request.

Table 6. Bill of Materials for Evaluation PCB EVL1-HMC1114LP5D

Item	Description
J1, J2	SMA connectors.
J3	DC pins.
JP1	Preform jumper.
C1, C2	1000 pF capacitors, 0603 package.
C3 to C6	1 µF capacitors, 0603 package.
C7 to C10	10 µF capacitor, 1210 package.
U1	HMC1114LP5DE.
PCB	600-01209-00 evaluation PCB. Circuit board material: Rogers 4350 or Arlon 25FR.

OUTLINE DIMENSIONS

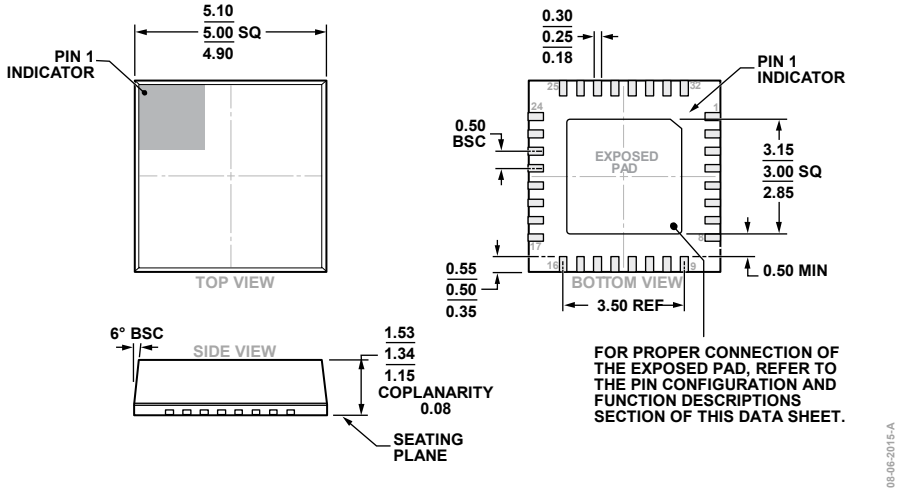

Figure 42. 32-Lead Lead Frame Chip Scale Package [LFCSP]
5 mm × 5 mm Body and 1.34 mm Package Height
(HCP-32-2)
Dimensions shown in millimeters

ORDERING GUIDE

Model[1, 2, 3]	Temperature	MSL Rating[4]	Description[5]	Package Option	Package Marking[6]
HMC1114LP5DE	−40°C to +85°C	MSL3	32-Lead Lead Frame Chip Scale Package [LFCSP]	HCP-32-2	H1114 XXXX
EVL1-HMC1114LP5D			HMC1114LP5DE Evaluation Board		

[1] HMC1114LP5DE is an LFCSP premolded copper alloy leadframe.
[2] When ordering the evaluation board only, reference the model number, EVL1-HMC1114LP5D.
[3] The HMC1114LP5DE and EVL1-HMC1114LP5D are not in production; for preproduction samples, contact an Analog Devices, Inc., sales representative.
[4] Maximum peak reflow temperature of 260°C.
[5] HMC1114LP5DE lead finish is NiPdAu.
[6] HMC1114LP5DE 4-digit lot number is represented by XXXX.