Low Noise Amplifier, 0.4 GHz to 11 GHz

Enhanced Product

HMC8412TCPZ-EP

FEATURES

Low noise figure: 1.4 dB typical at 0.4 GHz to 3 GHz
Single positive supply (self biased)
High gain: ≤15.5 dB typical
High OIP3: ≤33 dBm typical
RoHS compliant, 2 mm × 2 mm, 6-lead LFCSP

ENHANCED PRODUCT FEATURES

Supports defense and aerospace applications (AQEC standard)
Military temperature range (−55°C to +125°C)
Controlled manufacturing baseline
1 assembly/test site
1 fabrication site
Product change notification
Qualification data available on request

APPLICATIONS

Test instrumentation
Telecommunications
Military radar and communication
Electronic warfare
Aerospace

FUNCTIONAL BLOCK DIAGRAM

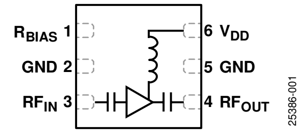

Figure 1.

GENERAL DESCRIPTION

The HMC8412TCPZ-EP is a gallium arsenide (GaAs), monolithic microwave integrated circuit (MMIC), pseudomorphic high electron mobility transistor (pHEMT), low noise, wideband amplifier that operates from 0.4 GHz to 11 GHz.

The HMC8412TCPZ-EP provides a typical gain of ≤15.5 dB, a typical 1.4 dB noise figure at 0.4 GHz to 3 GHz, and a typical output third-order intercept (OIP3) of ≤33 dBm, requiring only 60 mA from a 5 V drain supply voltage. The typical saturated output power (P_{SAT}) of ≤20.5 dBm enables the low noise amplifier (LNA) to function as a local oscillator (LO) driver for many Analog Devices, Inc., balanced, inphase and quadrature (I/Q) or image rejection mixers.

The HMC8412TCPZ-EP also features inputs and outputs that are internally matched to 50 Ω, making the device ideal for surface-mount technology (SMT)-based, high capacity microwave radio applications.

The HMC8412TCPZ-EP is housed in an RoHS compliant, 2 mm × 2 mm, 6-lead LFCSP.

Additional application and technical information can be found in the HMC8412 data sheet.

Rev. 0 Document Feedback

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Technical Support www.analog.com

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REVISION HISTORY

10/2020—Revision 0: Initial Version

SPECIFICATIONS

0.4 GHz TO 3 GHz FREQUENCY RANGE

V_{DD} = 5 V, supply current (I_{DQ}) = 60 mA, R_{BIAS} = 1.47 kΩ, and T_A = 25°C, unless otherwise noted.

Table 1.

Parameter	Min	Typ	Max	Unit	Test Conditions/Comments
FREQUENCY RANGE	0.4		3	GHz	
GAIN	13	15.5		dB	
Gain Variation over Temperature		0.005		dB/°C	
NOISE FIGURE		1.4		dB	
RETURN LOSS					
Input		14		dB	
Output		13		dB	
OUTPUT					
Power for 1 dB Compression (OP1dB)	15	18		dBm	
P_{SAT}		20.5		dBm	
OIP3		32		dBm	Measurement taken at output power (P_{OUT}) per tone = 0 dBm
Second-Order Intercept (OIP2)		40		dBm	Measurement taken at P_{OUT} per tone = 0 dBm
POWER ADDED EFFICIENCY (PAE)		28		%	Measured at P_{SAT}
SUPPLY					
I_{DQ}		60		mA	
V_{DD}	2	5	6	V	

3 GHz TO 9 GHz FREQUENCY RANGE

V_{DD} = 5 V, I_{DQ} = 60 mA, R_{BIAS} = 1.47 kΩ, and T_A = 25°C, unless otherwise noted.

Table 2.

Parameter	Min	Typ	Max	Unit	Test Conditions/Comments
FREQUENCY RANGE	3		9	GHz	
GAIN	13	15		dB	
Gain Variation over Temperature		0.007		dB/°C	
NOISE FIGURE		1.5		dB	
RETURN LOSS					
Input		15		dB	
Output		16		dB	
OUTPUT					
OP1dB	15.5	18		dBm	
P_{SAT}		20.5		dBm	
OIP3		33		dBm	Measurement taken at P_{OUT} per tone = 0 dBm
OIP2		41.5		dBm	Measurement taken at P_{OUT} per tone = 0 dBm
PAE		29		%	Measured at P_{SAT}
SUPPLY					
I_{DQ}		60		mA	
V_{DD}	2	5	6	V	

9 GHz TO 11 GHz FREQUENCY RANGE

V_{DD} = 5 V, I_{DQ} = 60 mA, R_{BIAS} = 1.47 kΩ, and T_A = 25°C, unless otherwise noted.

Table 3.

Parameter	Min	Typ	Max	Unit	Test Conditions/Comments
FREQUENCY RANGE	9		11	GHz	
GAIN	12	14		dB	
Gain Variation over Temperature		0.012		dB/°C	
NOISE FIGURE		1.8		dB	
RETURN LOSS					
Input		14		dB	
Output		10		dB	
OUTPUT					
OP1dB	11	14		dBm	
P_{SAT}		18		dBm	
OIP3		31		dBm	Measurement taken at P_{OUT} per tone = 0 dBm
OIP2		49.5		dBm	Measurement taken at P_{OUT} per tone = 0 dBm
PAE		15.5		%	Measured at P_{SAT}
SUPPLY					
I_{DQ}		60		mA	
V_{DD}	2	5	6	V	

ABSOLUTE MAXIMUM RATINGS

Table 4.

Parameter	Rating
V_{DD}	7 V
RF Input Power	25 dBm
Continuous Power Dissipation (P_{DISS})	
T_{CASE} = 85°C	0.82 W
T_{CASE} = 125°C	0.46 W
Temperature	
Storage Range	−65°C to +150°C
Operating Range	−55°C to +125°C
Peak Reflow (Moisture Sensitivity Level 1 (MSL1))[1]	260°C
Junction Temperature to Maintain 1,000,000 Hours Mean Time to Failure (MTTF)	175°C
Nominal Junction Temperature (T_A = 125°C, V_{DD} = 5 V, I_{DQ} = 60 mA	157.8°C

[1] See the Ordering Guide for more information.

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 printed circuit board (PCB) design and operating environment. Close attention to PCB thermal design is required.

θ_{JC} is the junction to case thermal resistance.

Table 5. Thermal Resistance

Package Type	θ_{JC}	Unit
CP-6-12	109.3	°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/JEDEC JS-001.

ESD Ratings for HMC8412TCPZ-EP

Table 6. HMC8412TCPZ-EP, 6-Lead LFCSP

ESD Model	Withstand Threshold (V)	Class
HBM	±500	1B

POWER DERATING CURVES

Figure 2 shows the maximum power dissipation vs. case temperature.

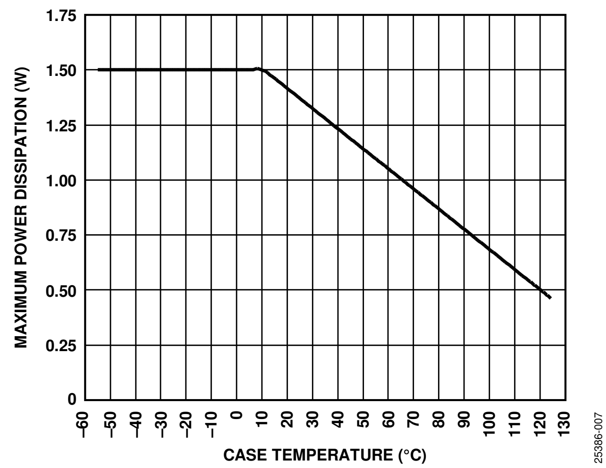

Figure 2. Maximum Power Dissipation vs. Case Temperature

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

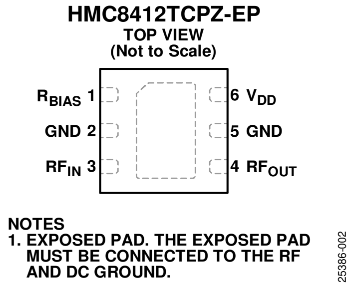

Figure 3. Pin Configuration

Table 7. Pin Function Descriptions

Pin No.	Mnemonic	Description
1	R_{BIAS}	Current Mirror Bias Resistor. Use the R_{BIAS} pin to set the quiescent current by connecting the external bias resistor. Refer to the HMC8412 data sheet for the bias resistor connection and for recommended bias resistor values. See Figure 4 for the interface schematic.
2, 5	GND	Ground. The GND pin must be connected to RF and dc ground. See Figure 7 for the interface schematic.
3	RF_{IN}	RF Input. The RF_{IN} pin is ac-coupled and matched to 50 Ω. See Figure 5 for the interface schematic.
4	RF_{OUT}	RF Output. The RF_{OUT} pin is ac-coupled and matched to 50 Ω. See Figure 6 for the interface schematic.
6	V_{DD}	Drain Supply Voltage for the Amplifier. See Figure 6 for the interface schematic.
	EPAD	Exposed Pad. The exposed pad must be connected to the RF and dc ground.

INTERFACE SCHEMATICS

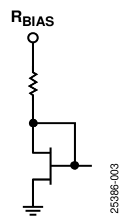

Figure 4. R_{BIAS} Interface Schematic

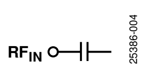

Figure 5. RF_{IN} Interface Schematic

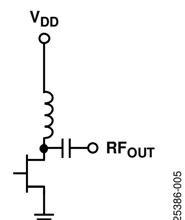

Figure 6. V_{DD} and RF_{OUT} Interface Schematic

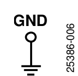

Figure 7. GND Interface Schematic

TYPICAL PERFORMANCE CHARACTERISTICS

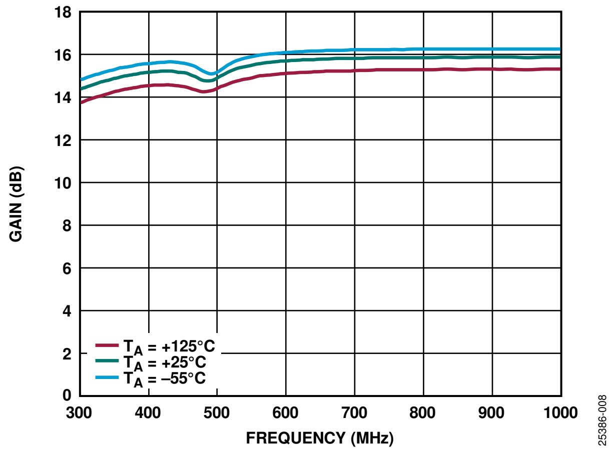

Figure 8. Gain vs. Frequency for Various Temperatures, 300 MHz to 1 GHz, V_{DD} = 5 V, I_{DQ} = 60 mA, R_{BIAS} = 1.47 kΩ

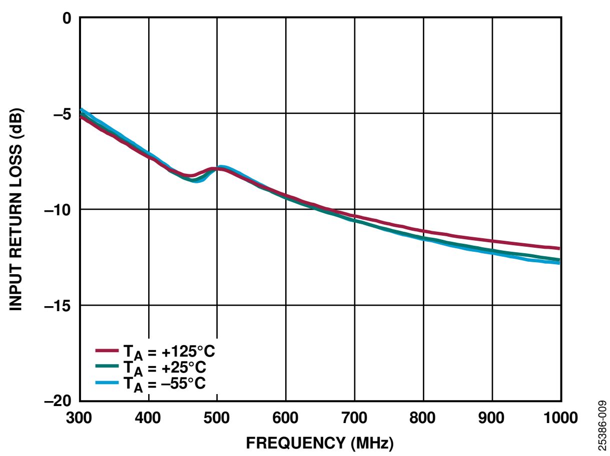

Figure 9. Input Return Loss vs. Frequency for Various Temperatures, 300 MHz to 1 GHz, V_{DD} = 5 V, I_{DQ} = 60 mA, R_{BIAS} = 1.47 kΩ

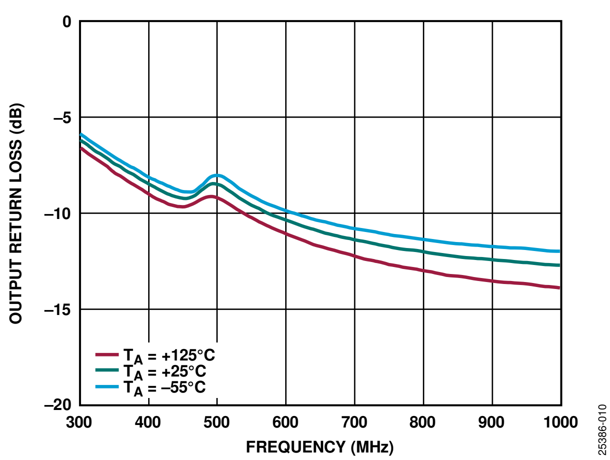

Figure 10. Output Return Loss vs. Frequency for Various Temperatures, 300 MHz to 1 GHz, R_{BIAS} = 1.47 kΩ

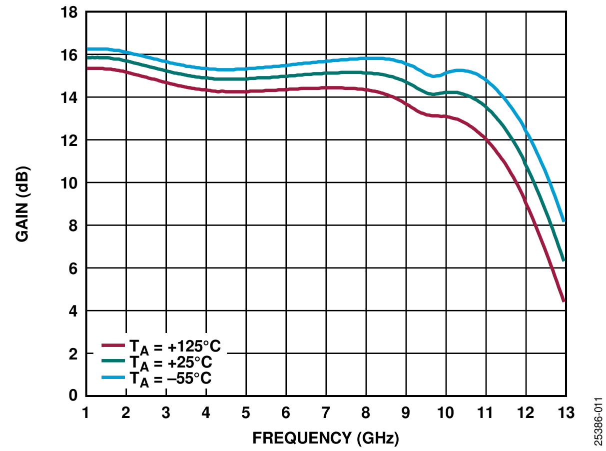

Figure 11. Gain vs. Frequency for Various Temperatures, 1 GHz to 13 GHz, V_{DD} = 5 V, I_{DQ} = 60 mA, R_{BIAS} = 1.47 kΩ

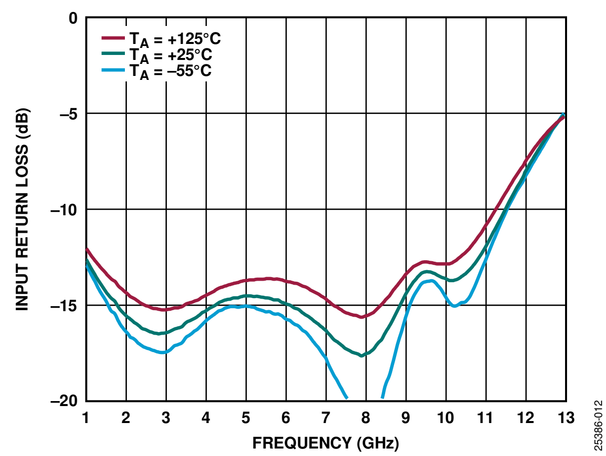

Figure 12. Input Return Loss vs. Frequency for Various Temperatures, 1 GHz to 13 GHz, V_{DD} = 5 V, I_{DQ} = 60 mA, R_{BIAS} = 1.47 kΩ

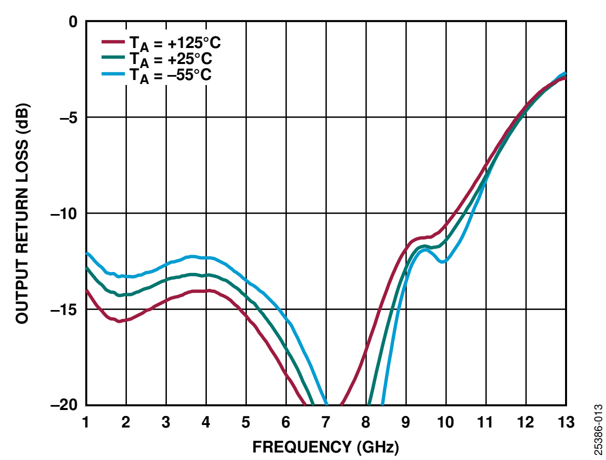

Figure 13. Output Return Loss vs. Frequency for Various Temperatures, 1 GHz to 13 GHz, V_{DD} = 5 V, I_{DQ} = 60 mA, R_{BIAS} = 1.47 kΩ

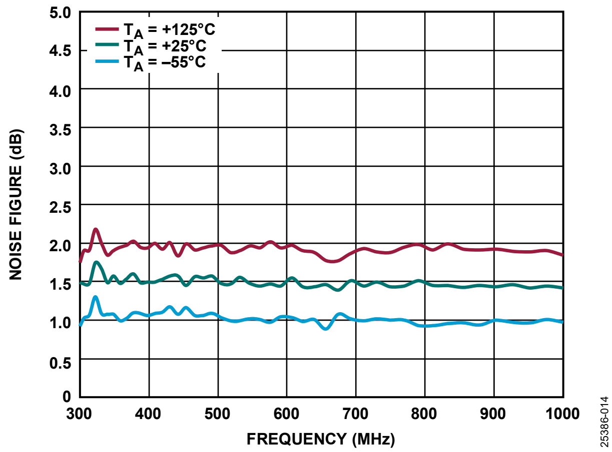

Figure 14. Noise Figure vs. Frequency for Various Temperatures, 300 MHz to 1 GHz, V_{DD} = 5 V, I_{DQ} = 60 mA, R_{BIAS} = 1.47 kΩ

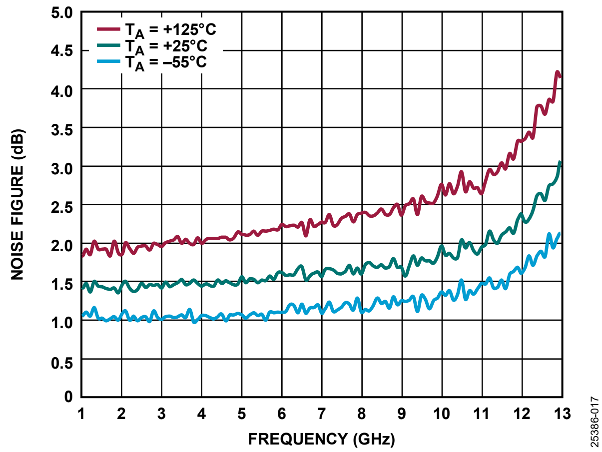

Figure 17. Noise Figure vs. Frequency for Various Temperatures, 1 GHz to 13 GHz, V_{DD} = 5 V, I_{DQ} = 60 mA, R_{BIAS} = 1.47 kΩ

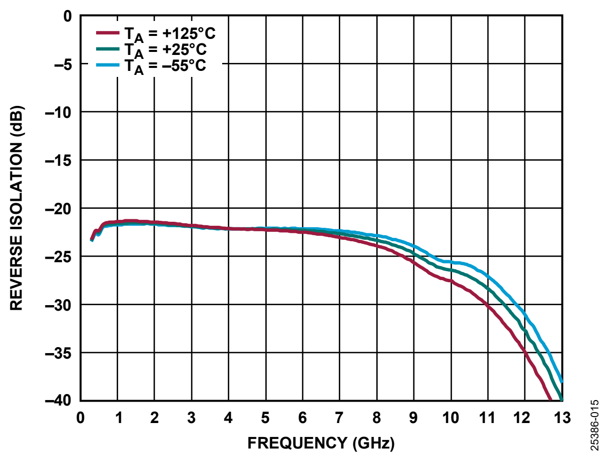

Figure 15. Reverse Isolation vs. Frequency for Various Temperatures, 300 MHz to 13 GHz, V_{DD} = 5 V, I_{DQ} = 60 mA, R_{BIAS} = 1.47 kΩ

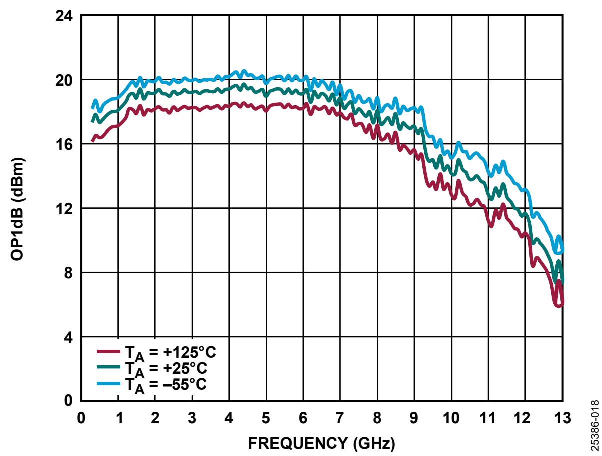

Figure 18. OP1dB vs. Frequency for Various Temperatures, 300 MHz to 13 GHz, V_{DD} = 5 V, I_{DQ} = 60 mA, R_{BIAS} = 1.47 kΩ

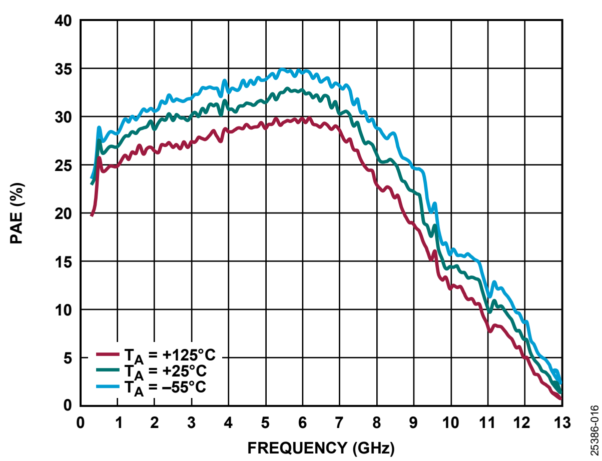

Figure 16. PAE vs. Frequency for Various Temperatures, 300 MHz to 13 GHz, V_{DD} = 5 V, I_{DQ} = 60 mA, R_{BIAS} = 1.47 kΩ

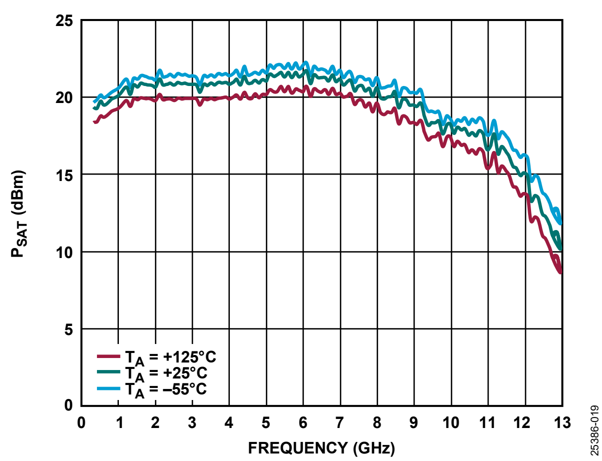

Figure 19. P_{SAT} vs. Frequency for Various Temperatures, 300 MHz to 13 GHz, V_{DD} = 5 V, I_{DQ} = 60 mA, R_{BIAS} = 1.47 kΩ

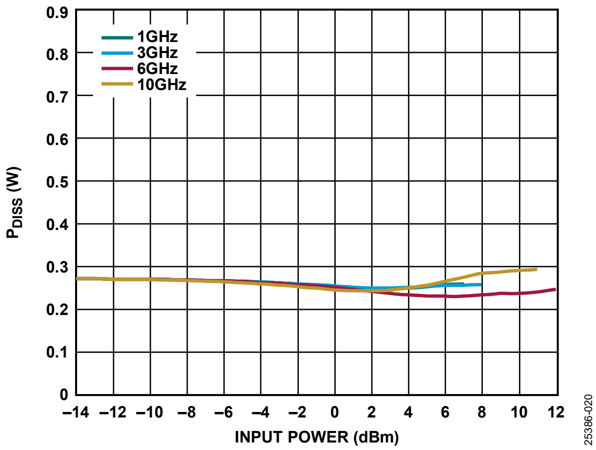

Figure 20. P_{DISS} vs. Input Power at T_A = 125°C, V_{DD} = 5 V, I_{DQ} = 60 mA, R_{BIAS} = 1.47 kΩ

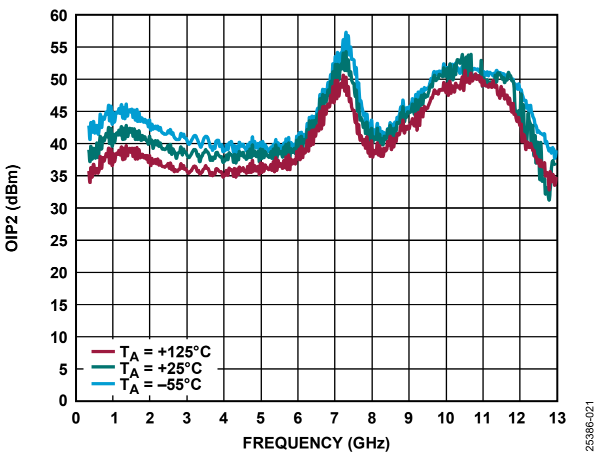

Figure 21. OIP2 vs. Frequency for Various Temperatures, 300 MHz to 13 GHz, V_{DD} = 5 V, I_{DQ} = 60 mA, R_{BIAS} = 1.47 kΩ, P_{OUT} per Tone = 0 dBm

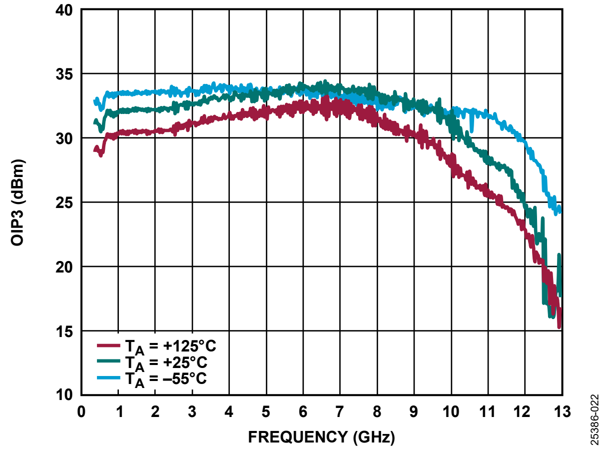

Figure 22. OIP3 vs. Frequency for Various Temperatures, 300 MHz to 13 GHz, V_{DD} = 5 V, I_{DQ} = 60 mA, R_{BIAS} = 1.47 kΩ, P_{OUT} per Tone = 0 dBm

OUTLINE DIMENSIONS

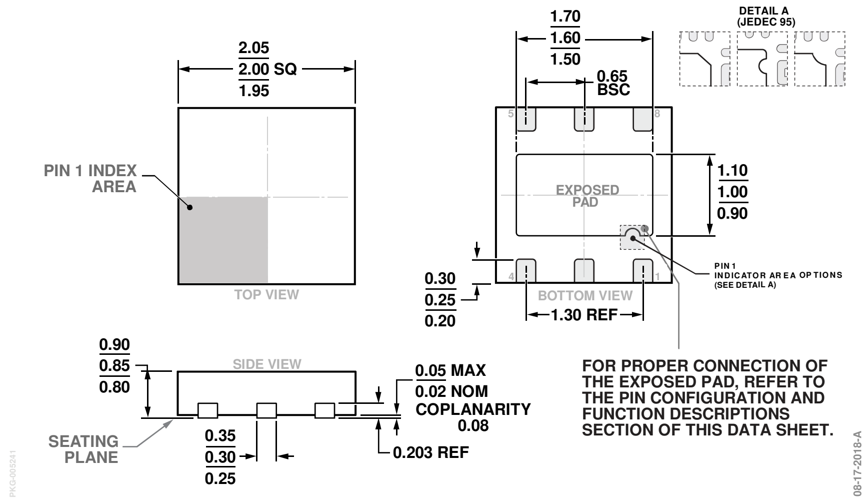

Figure 23. 6-Lead Lead Frame Chip Scale Package [LFCSP]
2 mm × 2 mm Body and 0.85 mm Package Height
(CP-6-12)
Dimensions shown in millimeters

ORDERING GUIDE

Model[1]	Temperature Range	MSL Rating[2]	Package Description[3]	Package Option
HMC8412TCPZ-EP-PT	−55°C to +125°C	MSL1	6-Lead Lead Frame Chip Scale Package [LFCSP]	CP-6-12
HMC8412TCPZ-EP-R7	−55°C to +125°C	MSL1	6-Lead Lead Frame Chip Scale Package [LFCSP]	CP-6-12

[1] The HMC8412TCPZ-EP-PT and HMC8412TCPZ-EP-R7 are RoHS compliant parts.
[2] See the Absolute Maximum Ratings section for additional information.
[3] The lead finish of the HMC8412TCPZ-EP-PT and HMC8412TCPZ-EP-R7 is nickel palladium gold (NiPdAu).