Data Sheet

ADH8411S

Commercial Space Product

0.01 GHz to 10 GHz Low Noise Amplifier

FEATURES

- Low noise figure: 1.7 dB typical
- Single positive supply (self biased)
- High gain: 15.5 dB typical
- High OIP3: 34 dBm typical
- 6-lead, 2 mm × 2 mm LFCSP

COMMERCIAL SPACE FEATURES

- Supports aerospace applications
- Certificate of Conformance
- Wafer diffusion lot traceability
- Burn-in, life test, and deltas analysis
- Radiation lot acceptance test (RLAT)
  - Total ionizing dose (TID)
- Radiation benchmark
  - No SEL occurs at effective linear energy transfer (LET): ≤ 62.4 MeV-cm^2/mg

APPLICATIONS

- Low earth orbit (LEO) satellites
- Military communications

FUNCTIONAL BLOCK DIAGRAM

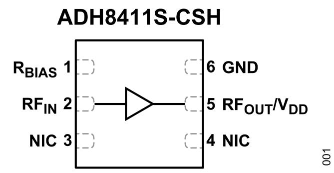

Figure 1.

GENERAL DESCRIPTION

The ADH8411S-CSH is a gallium arsenide (GaAs), monolithic microwave integrated circuit (MMIC), pseudomorphic high electron mobility transistor (pHEMT), low noise wideband amplifier that operates from 0.01 GHz to 10 GHz.

The ADH8411S-CSH provides a typical gain of 15.5 dB, a 1.7 dB typical noise figure, and a typical output third-order intercept (OIP3) of 34 dBm, requiring only 55 mA from a 5 V supply voltage. The saturated output power (P_{SAT}) of 19.5 dBm typical enables the low noise amplifier (LNA) to function as a local oscillator (LO) driver for many of Analog Devices, Inc., balanced, in-phase/quadrature (I/Q), or image rejection mixers.

The ADH8411S-CSH also features inputs and outputs that are internally matched to 50 Ω, making the device ideal for surface-mounted technology (SMT)-based, high capacity microwave radio applications.

The ADH8411S-CSH is housed in a RoHS compliant, 2 mm × 2 mm, 6-lead LFCSP.

Throughout this data sheet, multifunction pins, such as RF_{OUT}/V_{DD}, are referred to either by the entire pin name or by a single function of the pin, for example, RF_{OUT}, when only that function is relevant.

Additional application and technical information can be found in the Commercial Space Products Program brochure and the HMC8411 data sheet.

Rev. 0

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REVISION HISTORY

12/2022—Revision 0: Initial Version

SPECIFICATIONS

0.01 GHZ TO 1 GHZ FREQUENCY RANGE

V_{DD} = 5 V, supply current (I_{DQ}) = 55 mA, and T_A = 25°C, unless otherwise noted.

Table 1.

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
FREQUENCY RANGE		0.01		1	GHz	
GAIN		12.5	15.5		dB	
Gain Variation over Temperature			0.005		dB/°C	
NOISE FIGURE			1.8		dB	
RETURN LOSS						
Input			22		dB	
Output			17		dB	
OUTPUT						
Output Power for 1 dB Compression	P1dB	17	20		dBm	
Saturated Output Power	P_{SAT}		20.5		dBm	
Output Third-Order Intercept	OIP3		33.5		dBm	Measurement taken at output power (P_{OUT}) per tone = 6 dBm
Output Second-Order Intercept	OIP2		43		dBm	Measurement taken at P_{OUT} per tone = 6 dBm
POWER ADDED EFFICIENCY	PAE		30		%	Measured at P_{SAT}
SUPPLY CURRENT	I_{DQ}		55		mA	Measurement taken at resistor bias (R_{BIAS}) = 1.1 kΩ
Amplifier Drain Current	I_{DD}		52.47		mA	
Resistor Bias Current	I_{RBIAS}		2.53		mA	
SUPPLY VOLTAGE	V_{DD}	2	5	6	V	

1 GHZ TO 6 GHZ FREQUENCY RANGE

V_{DD} = 5 V, I_{DQ} = 55 mA, and T_A = 25°C, unless otherwise noted.

Table 2.

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
FREQUENCY RANGE		1		6	GHz	
GAIN		12	15		dB	
Gain Variation over Temperature			0.010		dB/°C	
NOISE FIGURE			1.7		dB	
RETURN LOSS						
Input			25		dB	
Output			18		dB	
OUTPUT						
Output Power for 1 dB Compression	P1dB	17	20		dBm	
Saturated Output Power	P_{SAT}		21		dBm	
Output Third-Order Intercept	OIP3		34		dBm	Measurement taken at P_{OUT} per tone = 6 dBm
Output Second-Order Intercept	OIP2		39		dBm	Measurement taken at P_{OUT} per tone = 6 dBm
POWER ADDED EFFICIENCY	PAE		34		%	Measured at P_{SAT}
SUPPLY CURRENT	I_{DQ}		55		mA	Measurement taken at R_{BIAS} = 1.1 kΩ
Amplifier Drain Current	I_{DD}		52.47		mA	
Resistor Bias Current	I_{RBIAS}		2.53		mA	
SUPPLY VOLTAGE	V_{DD}	2	5	6	V	

SPECIFICATIONS

6 GHZ TO 10 GHZ FREQUENCY RANGE

V_{DD} = 5 V, I_{DQ} = 55 mA, and T_A = 25°C, unless otherwise noted.

Table 3.

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
FREQUENCY RANGE		6		10	GHz	
GAIN		11	14		dB	
Gain Variation over Temperature			0.013		dB/°C	
NOISE FIGURE			2		dB	
RETURN LOSS						
Input			15		dB	
Output			17		dB	
OUTPUT						
Output Power for 1 dB Compression	P1dB	13	16		dBm	
Saturated Output Power	P_{SAT}		19.5		dBm	
Output Third-Order Intercept	OIP3		33		dBm	Measurement taken at P_{OUT} per tone = 6 dBm
Output Second-Order Intercept	OIP2		40		dBm	Measurement taken at P_{OUT} per tone = 6 dBm
POWER ADDED EFFICIENCY	PAE		23		%	Measured at P_{SAT}
SUPPLY CURRENT	I_{DQ}		55		mA	Measurement taken at R_{BIAS} = 1.1 kΩ
Amplifier Drain Current	I_{DD}		52.47		mA	
Resistor Bias Current	I_{RBIAS}		2.53		mA	
SUPPLY VOLTAGE	V_{DD}	2	5	6	V	

BURN-IN DELTA LIMIT SPECIFICATIONS

V_{DD} = 5 V and I_{DQ} = 55 mA. Delta limits apply at room temperature (T_A = 25°C) for post 240 hour burn-in test. Delta calculation is based on absolute maximum changes (see Figure 28).

Table 4.

Parameter[1,2]	Min	Typ	Max	Unit
GAIN				
Input frequency (f_{IN}) = 1 GHz, 5 GHz, 10 GHz	−1.5		+1.5	dB
SUPPLY CURRENT				
I_{DD}	−0.7		+0.7	mA

1 Delta = Max(Abs(Maximum Post 240 Hour Burn-in Data − Minimum Pre 240 Hour Burn-in Data), Abs(Minimum Post 240 Hour Burn-in Data − Maximum Pre 240 Hour Burn-in Data))

2 Devices are not serialized during testing

RADIATION TEST AND LIMIT SPECIFICATIONS

V_{DD} = 5 V, I_{DQ} = 55 mA, and T_A = 25°C, unless otherwise noted. Total ionizing dose (TID) testing is characterized to 150 krads (100 krads + 50% overstress) with biased annealing at 100°C for 168 hours. After TID testing is characterized, TID testing is performed to 100 krads only.

Table 5.

Parameter	Symbol	Min	Typ	Max	Unit
GAIN					
f_{IN} = 1 GHz		12.5	15.5		dB
f_{IN} = 5 GHz		12	15		dB
f_{IN} = 10 GHz		11	14		dB
RETURN LOSS					
f_{IN} = 1 GHz					
Input			22		dB

SPECIFICATIONS

Table 5. (Continued)

Parameter	Symbol	Min	Typ	Max	Unit
Output			17		dB
f_{IN} = 5 GHz					
Input			25		dB
Output			18		dB
f_{IN} = 10 GHz					
Input			15		dB
Output			17		dB
OUTPUT					
Output Power for 1 dB Compression	P1dB				
f_{IN} = 1 GHz		17	20		dBm
f_{IN} = 5 GHz		17	20		dBm
f_{IN} = 10 GHz		13	16		dBm
Output Third-Order Intercept	OIP3				
f_{IN} = 1 GHz			33.5		dBm
f_{IN} = 5 GHz			34		dBm
f_{IN} = 10 GHz			33		dBm
SUPPLY CURRENT	I_{DQ}		55		mA
Amplifier Drain Current	I_{DD}		52.47		mA

ABSOLUTE MAXIMUM RATINGS

Table 6.

Parameter[1]	Rating
Supply Voltage (V_{DD})	7 V
Radio Frequency Input (RF_{IN}) Power	20 dBm
Channel Temperature	175°C
Continuous Power Dissipation (P_{DIS})[2]	
T_{CASE} = 85°C	0.78 W
T_{CASE} = 125°C	0.43 W
Storage Temperature Range	−65°C to +150°C
Operating Temperature Range	−55°C to +125°
Peak Reflow Temperature Moisture Sensitivity Level 1 (MSL1)	260°C

[1] When referring to a single function of a multifunction pin in the parameters, only the portion of the pin name that is relevant to the specification is listed. For full pin names of multifunction pins, refer to the Pin Configuration and Function Descriptions section.

[2] For maximum power dissipation vs. case temperature, see Figure 2.

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 7. Thermal Resistance

Package Type	θ_{JC}	Unit
CP-6-12	115.35	°C/W

POWER DERATING CURVES

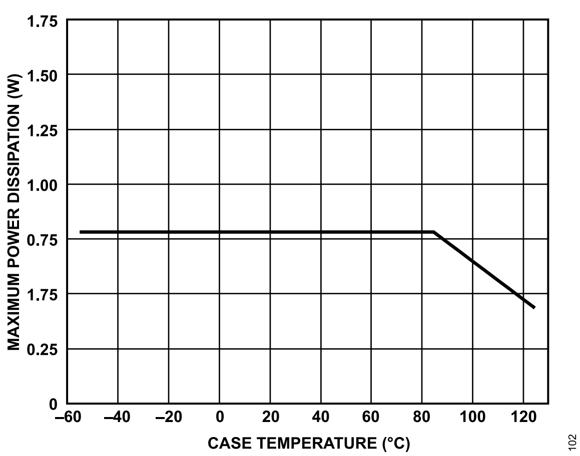


Figure 2. Maximum Power Dissipation vs. Case Temperature

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

OUTGAS TESTING

The criteria used for the acceptance and rejection of materials must be determined by the user and based upon specific component and system requirements. Historically, a total mass loss (TML) of 1.00% and collected volatile condensable material (CVCM) of 0.10% have been used as screening levels for rejection of spacecraft materials.

Table 8. Outgas Testing

Specification (Tested per ASTM E595 -15)	Value	Unit
Total Mass Lost	0.06	%
Collected Volatile Condensable Material	0.01	%
Water Vapor Recovered	0.04	%

RADIATION FEATURES

Table 9. Radiation Features

Specifications	Value	Unit
Maximum Total Dose Available (dose rate = 50 to 300 rads (Si)/sec)[1]	100	krads (Si)
No Single Event Latch-Up (SEL) Occurs at Effective Linear Energy Transfer (LET)[2]	≤62.4	MeV-cm^2/mg

[1] Guaranteed by device and process characterization. Contact Analog Devices for data available up to 100 krads.

[2] Limits are characterized at initial qualification and after any design or process changes that may affect the SEL characteristics, but are not production lot tested unless specified by the customer through the purchase order or contract. For more information on single event effect (SEE) test results, contact Analog Devices for further data beyond published report on the Analog Devices website.

ELECTROSTATIC DISCHARGE (ESD) RATINGS

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

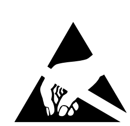
Human body model (HBM) per ANSI/ESDA/JEDEC JS-001.

ESD Ratings for ADH8411S-CSH

Table 10. ADH8411S-CSH, 6-Lead LFCSP

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

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

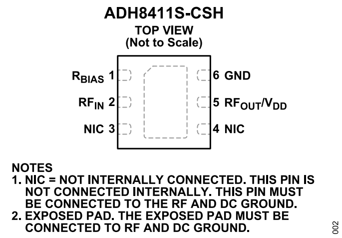


Figure 3. Pin Configuration

Table 11. Pin Function Descriptions

Pin No.	Mnemonic	Description
1	R_{BIAS}	Current Mirror Bias Resistor Pin. Use this pin to set the current to the internal resistor by the external resistor. See Figure 4 for the interface schematic.
2	RF_{IN}	RF Input. This pin is AC-coupled and matched to 50 Ω. See Figure 5 for the interface schematic.
3, 4	NIC	Not Internally Connected. This pin is not connected internally. This pin must be connected to the RF and DC ground.
5	RF_{OUT}/V_{DD}	Radio Frequency Output (RF_{OUT}). This pin is AC-coupled and matched to 50 Ω. See Figure 6 for the interface schematic.
		Drain Bias for the Amplifier (V_{DD}). This pin is AC-coupled and matched to 50 Ω. See Figure 6 for the interface schematic.
6	GND	Ground. This pin must be connected to the RF and DC ground. See Figure 7 for the interface schematic.
	EPAD	Exposed Pad. The exposed pad must be connected to RF and DC ground.

INTERFACE SCHEMATICS

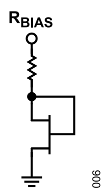


Figure 4. R_{BIAS} Interface Schematic

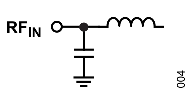


Figure 5. RF_{IN} Interface Schematic

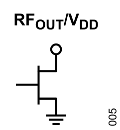


Figure 6. RF_{OUT}/V_{DD} Interface Schematic

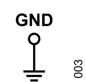


Figure 7. GND Interface Schematic

TYPICAL PERFORMANCE CHARACTERISTICS

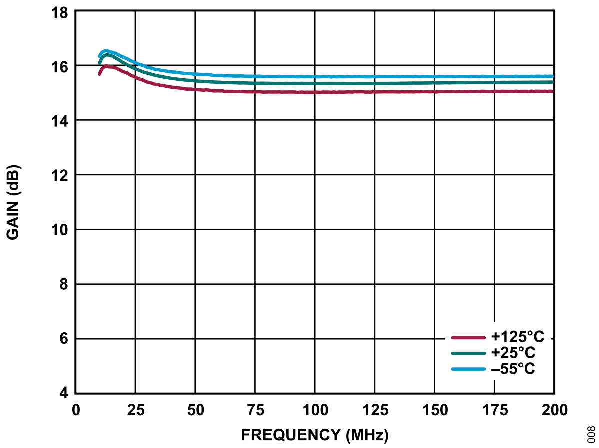


Figure 8. Gain vs. Frequency, 10 MHz to 200 MHz, for Various Temperatures, V_{DD} = 5 V, I_{DQ} = 55 mA

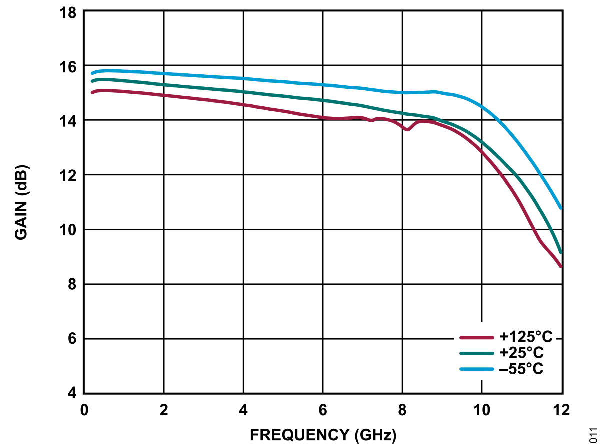


Figure 11. Gain vs. Frequency, 200 MHz to 12 GHz, for Various Temperatures, V_{DD} = 5 V, I_{DQ} = 55 mA

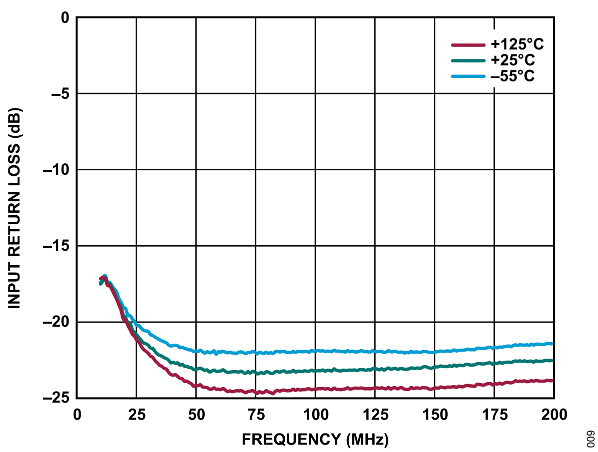


Figure 9. Input Return Loss vs. Frequency, 10 MHz to 200 MHz, for Various Temperatures, V_{DD} = 5 V, I_{DQ} = 55 mA

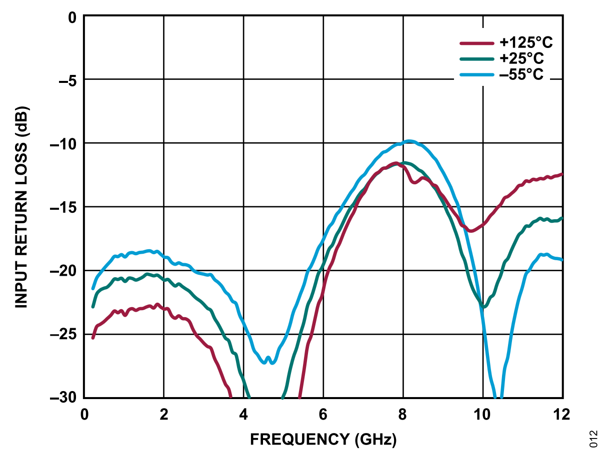


Figure 12. Input Return Loss vs. Frequency, 200 MHz to 12 GHz, for Various Temperatures, V_{DD} = 5 V, I_{DQ} = 55 mA

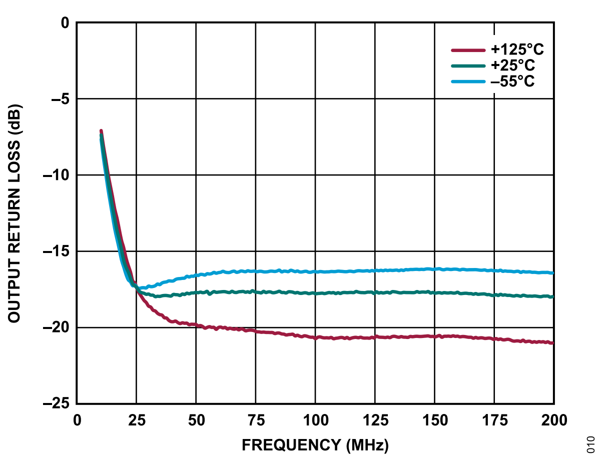


Figure 10. Output Return Loss vs. Frequency, 10 MHz to 200 MHz, for Various Temperatures, V_{DD} = 5 V, I_{DQ} = 55 mA

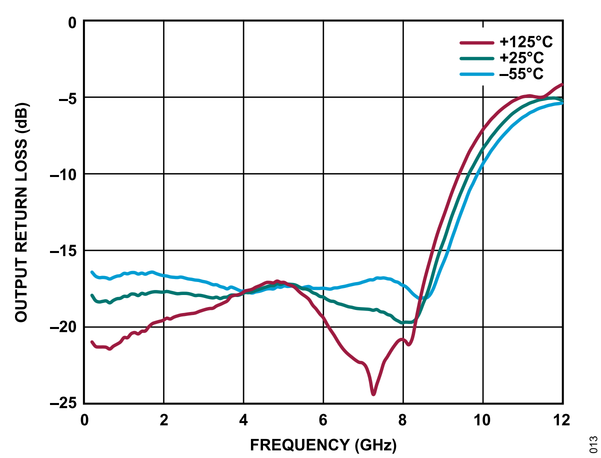


Figure 13. Output Return Loss vs. Frequency, 200 MHz to 12 GHz, for Various Temperatures, V_{DD} = 5 V, I_{DQ} = 55 mA

TYPICAL PERFORMANCE CHARACTERISTICS

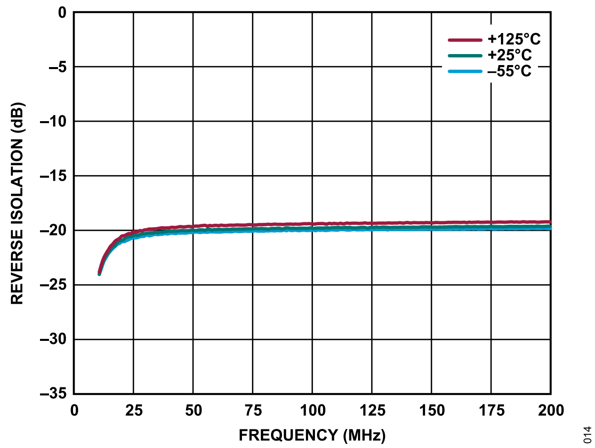


Figure 14. Reverse Isolation vs. Frequency, 10 MHz to 200 MHz, for Various Temperatures, V_{DD} = 5 V, I_{DQ} = 55 mA

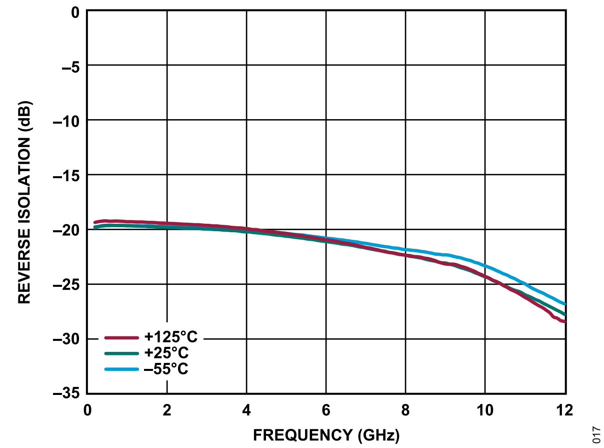


Figure 17. Reverse Isolation vs. Frequency, 200 MHz to 12 GHz, for Various Temperatures, V_{DD} = 5 V, I_{DQ} = 55 mA

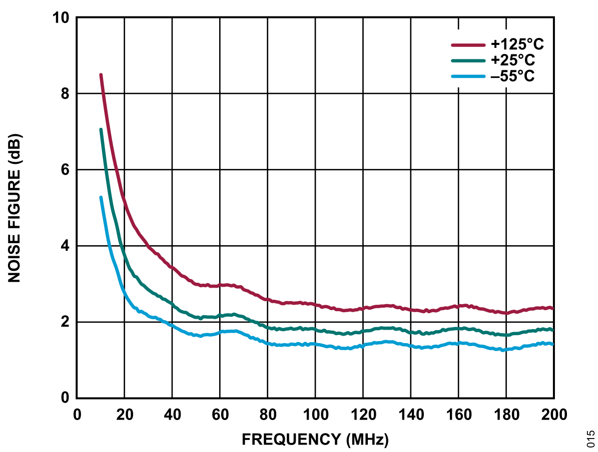


Figure 15. Noise Figure vs. Frequency, 10 MHz to 200 MHz, for Various Temperatures, V_{DD} = 5 V, I_{DQ} = 55 mA

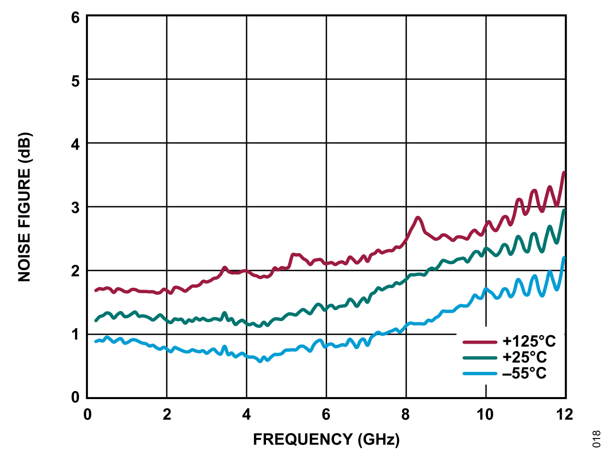


Figure 18. Noise Figure vs. Frequency, 200 MHz to 12 GHz, for Various Temperatures, V_{DD} = 5 V, I_{DQ} = 55 mA

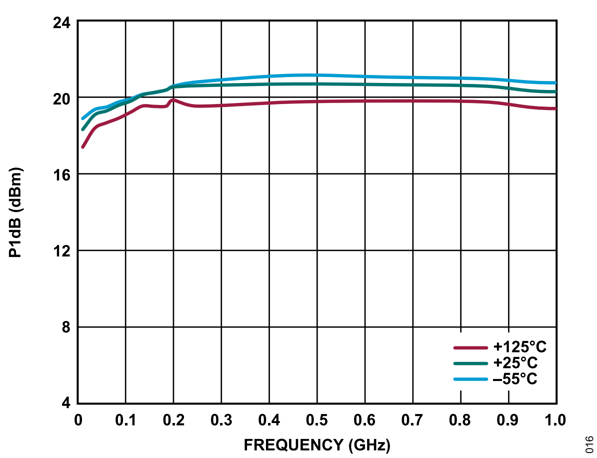


Figure 16. P1dB vs. Frequency, 0.01 GHz to 1.0 GHz, for Various Temperatures, V_{DD} = 5 V, I_{DQ} = 55 mA

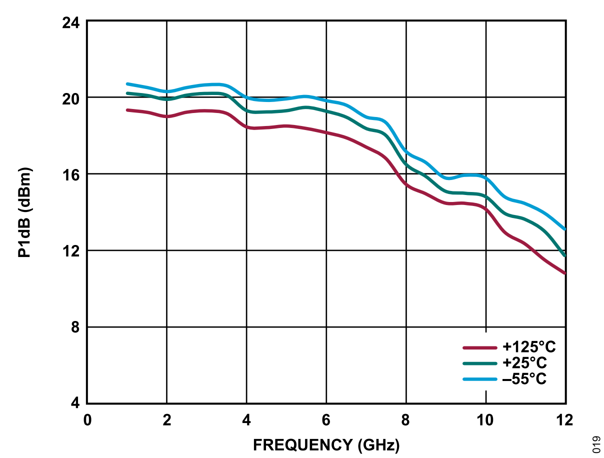


Figure 19. P1dB vs. Frequency, 1 GHz to 12 GHz, for Various Temperatures, V_{DD} = 5 V, I_{DQ} = 55 mA

TYPICAL PERFORMANCE CHARACTERISTICS

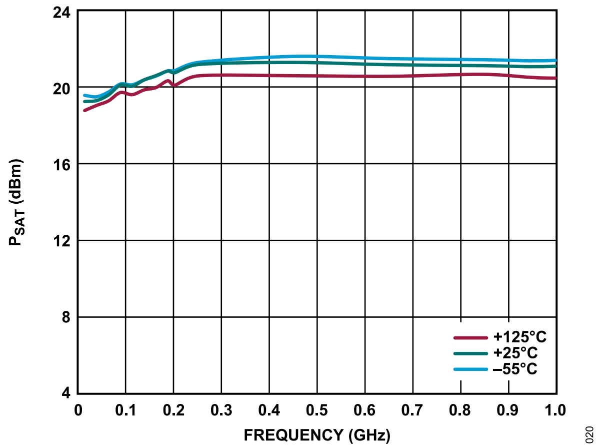


Figure 20. P_{SAT} vs. Frequency, 0.01 GHz to 1.0 GHz, for Various Temperatures, V_{DD} = 5 V, I_{DQ} = 55 mA

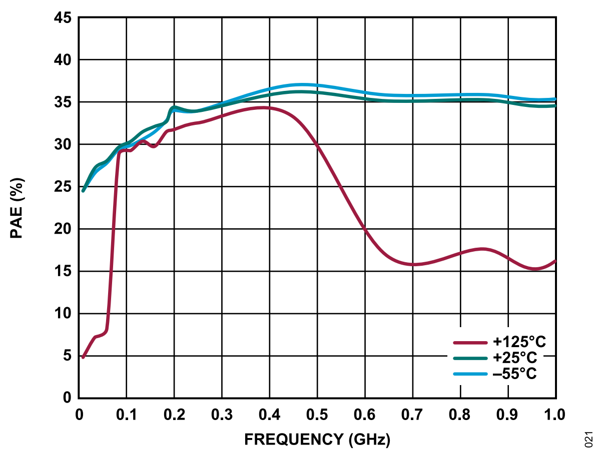


Figure 21. PAE vs. Frequency, 0.01 GHz to 1.0 GHz, for Various Temperatures, V_{DD} = 5 V, I_{DQ} = 55 mA

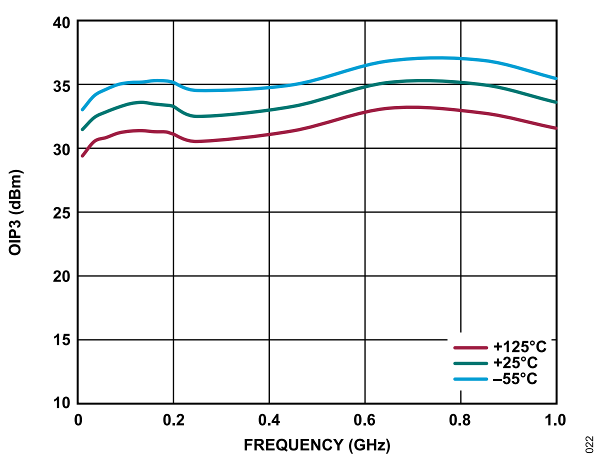


Figure 22. OIP3 vs. Frequency, 0.01 GHz to 1.0 GHz, for Various Temperatures, V_{DD} = 5 V, I_{DQ} = 55 mA

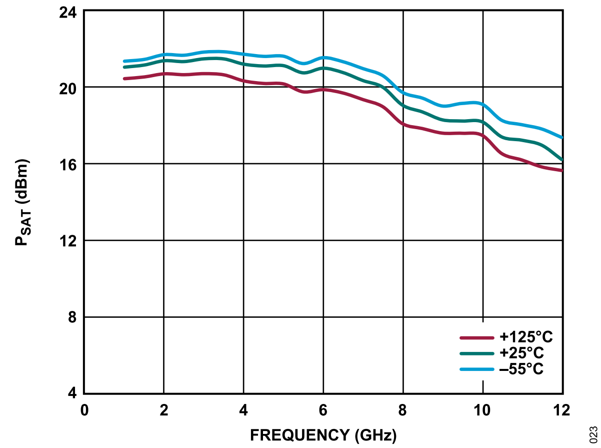


Figure 23. P_{SAT} vs. Frequency, 1 GHz to 12 GHz, for Various Temperatures, V_{DD} = 5 V, I_{DQ} = 55 mA

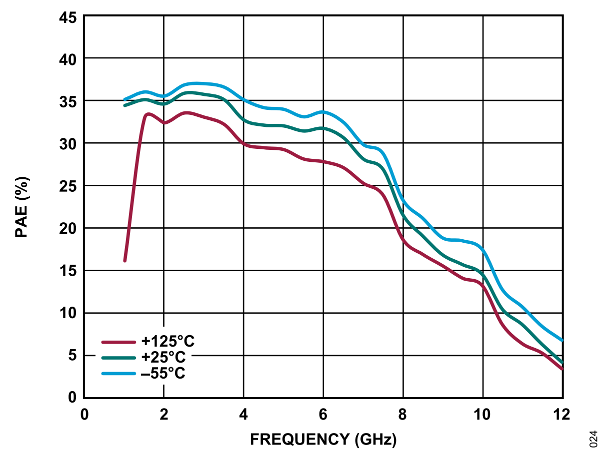


Figure 24. PAE vs. Frequency, 1 GHz to 12 GHz, for Various Temperatures, V_{DD} = 5 V, I_{DQ} = 55 mA

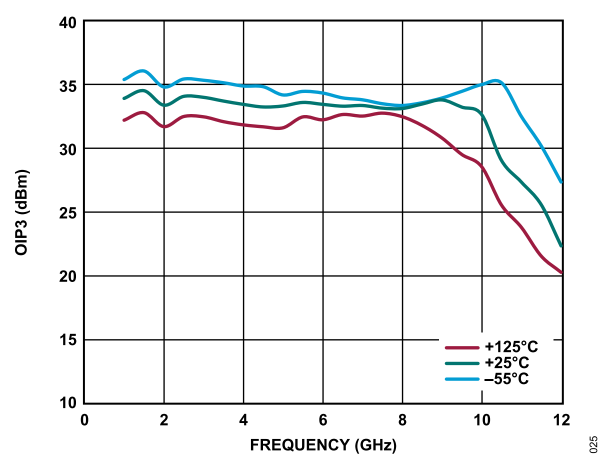


Figure 25. OIP3 vs. Frequency, 1 GHz to 12 GHz, for Various Temperatures, V_{DD} = 5 V, I_{DQ} = 55 mA

TYPICAL PERFORMANCE CHARACTERISTICS

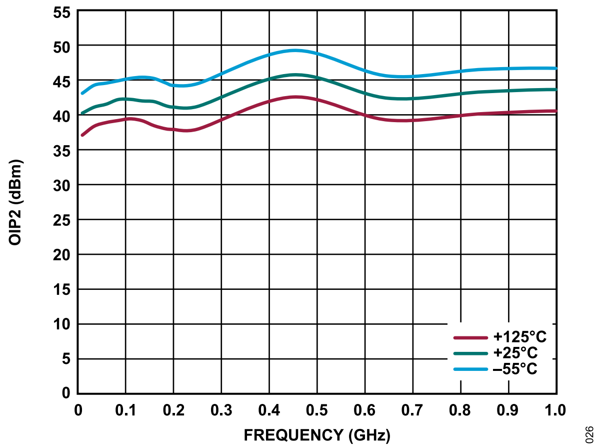


Figure 26. OIP2 vs. Frequency, 0.01 GHz to 1.0 GHz, for Various Temperatures, V_{DD} = 5 V, I_{DQ} = 55 mA

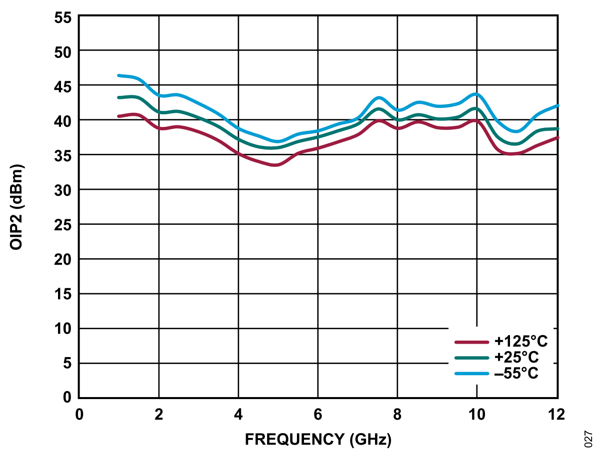


Figure 27. OIP2 vs. Frequency, 1 GHz to 12 GHz, for Various Temperatures, V_{DD} = 5 V, I_{DQ} = 55 mA

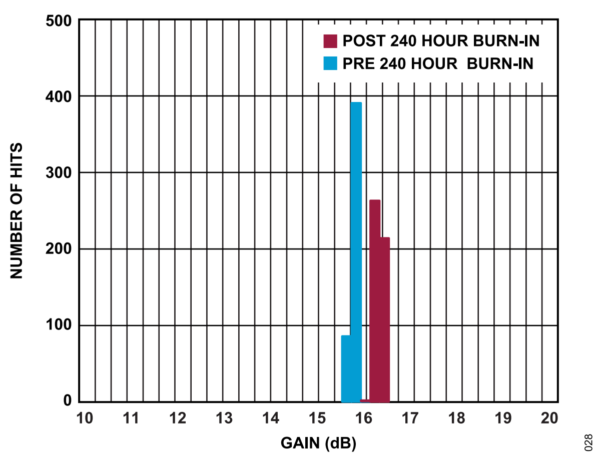


Figure 28. Gain Distribution Before and After 240 Hour Burn-in, Frequency = 1 GHz

OUTLINE DIMENSIONS

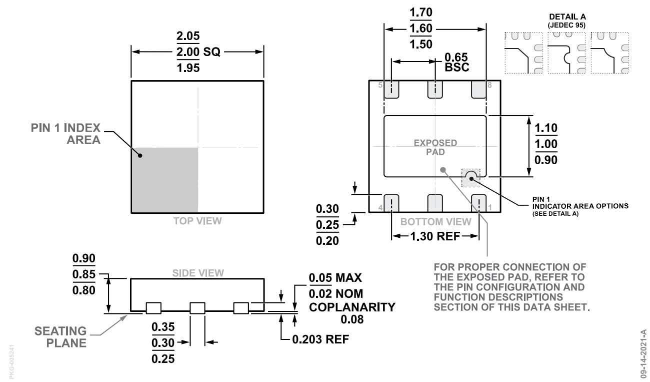


Figure 29. 6-Lead Lead Frame Chip Scale Package [LFCSP]
2 mm × 2 mm Body and 0.85 mm Package Height
(CP-6-12)
Dimensions shown in millimeters

Updated: December 14, 2022

ORDERING GUIDE

Model[1]	Temperature Range	Package Description	Packing Quantity	Package Option
ADH8411TCPZ-CSH-PT	-55°C to +125°C	6-Lead LFCSP (2mm x 2mm)	Reel, 500	CP-6-12

1 Z = RoHS Compliant Part.