Data Sheet

ADH8412S-CSL

Commercial Space Product

Low Noise Amplifier, 0.4 GHz to 11 GHz

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

COMMERCIAL SPACE FEATURES

- Supports aerospace applications
- Wafer diffusion lot traceability
- Radiation monitor
  - Total ionizing dose (TID)
- Outgassing characterization

APPLICATIONS

- Low and medium Earth orbit (LEO/MEO) satellites
- Avionics
- Test instrumentation
- Telecommunications
- Military radar and communication
- Electronic warfare
- Aerospace

GENERAL DESCRIPTION

The ADH8412S-CSL 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 ADH8412S-CSL provides a typical gain of 15.5 dB, a 1.4 dB typical noise figure, and a typical output third-order intercept (OIP3) of ≤33 dBm, requiring only 60 mA from a 5 V drain supply voltage. The saturated output power (P_{SAT}) of ≤20.5 dBm typical enables the low noise amplifier (LNA) to function as a local oscillator (LO) driver for many Analog Devices, Inc., balanced, in-phase and quadrature (I/Q), or image rejection mixers.

The ADH8412S-CSL also features inputs and outputs that are internally matched to 50 Ω, making the device ideal for surface-mount technology (SMT)-based, space applications.

The ADH8412S-CSL is housed in a 2 mm × 2 mm, 6-lead lead frame chip scale package (LFCSP).

Additional application and technical information can be found in the Commercial Space Products Program brochure and HMC8412 data sheet.

FUNCTIONAL BLOCK DIAGRAM

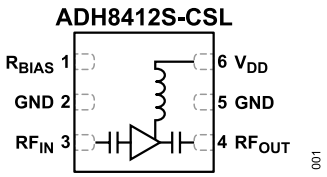

Figure 1. Functional Block Diagram

Rev. 0

DOCUMENT FEEDBACK

TECHNICAL SUPPORT

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REVISION HISTORY

2/2024—Revision 0: Initial Version

SPECIFICATIONS

0.4 GHZ TO 3 GHZ FREQUENCY RANGE

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

Table 1. 0.4 GHz to 3 GHz Frequency Range

Parameter	Min	Typ	Max	Unit	Test Conditions/Comments
FREQUENCY RANGE	0.4		3	GHz	
GAIN	13	15.5		dB	
Gain Variation over Temperature		0.010		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	
Amplifier Current (I_{DQ_AMP})		58.04		mA	
R_{BIAS} Current (I_{RBIAS})		1.96		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. 3 GHz to 9 GHz Frequency Range

Parameter	Min	Typ	Max	Unit	Test Conditions/Comments
FREQUENCY RANGE	3		9	GHz	
GAIN	13	15		dB	
Gain Variation over Temperature		0.012		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	
I_{DQ_AMP}		58.04		mA	
I_{RBIAS}		1.96		mA	
V_{DD}	2	5	6	V	

SPECIFICATIONS

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. 9 GHz to 11 GHz Frequency Range

Parameter	Min	Typ	Max	Unit	Test Conditions/Comments
FREQUENCY RANGE	9		11	GHz	
GAIN	12	14		dB	
Gain Variation over Temperature		0.022		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	
I_{DQ_AMP}		58.04		mA	
I_{RBIAS}		1.96		mA	
V_{DD}	2	5	6	V	

RADIATION TEST AND LIMIT SPECIFICATIONS

V_{DD} = 5 V, I_{DQ} = 60 mA, R_{BIAS} = 1.47 kΩ, and T_A = 25°C, unless otherwise noted. TID testing is characterized to 30 krads.

Table 4. Radiation Test and Limit Specifications

Parameter	Min	Typ	Max	Unit
GAIN				
Frequency (f) = 1 GHz to 3 GHz	13	15.5		dB
f = 6 GHz	13	15		dB
f = 10 GHz	12	14		dB
OUTPUT				
OP1dB				
f = 1 GHz to 3 GHz	15	18		dBm
f = 6 GHz	15.5	18		dBm
f = 10 GHz	11	14		dBm
SUPPLY				
I_{DQ}		60	65	mA

ABSOLUTE MAXIMUM RATINGS

Table 5. Absolute Maximum Ratings

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))	260°C
T_J to Maintain 1,000,000 Hours Mean Time to Failure (MTTF)	175°C
Nominal Channel Temperature (T_A = 125°C, V_{DD} = 5 V, I_{DQ} = 60 mA)	157.8°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 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 6. Thermal Resistance

Package Type	θ_{JC}	Unit
CP-6-12	109.3	°C/W

OUTGAS TESTING

The criteria used for the acceptance and rejection of materials must be determined by the user and be 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 7. Outgas Testing

Specification (Tested per ASTM E595-15)	Value	Unit
Total Mass Lost	0.05	%
Collected Volatile Condensable Material	<0.01	%
Water Vapor Recovered	0.02	%

RADIATION FEATURES

Table 8. Radiation Features

Specification (Tested per ASTM E595-15)	Value	Unit

Table 8. Radiation Features (Continued)

Specification (Tested per ASTM E595-15)	Value	Unit
Maximum Total Dose Available (Dose Rate = 50 rad(Si)/s to 300 rad(Si)/s)[1]	30	krad(Si)

[1] Guaranteed by device and process characterization. Contact Analog Devices, Inc., for data available up to 30 krads.

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 ADH8412S-CSL

Table 9. ADH8412S-CSL, 6-Lead LFCSP

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

POWER DERATING CURVES

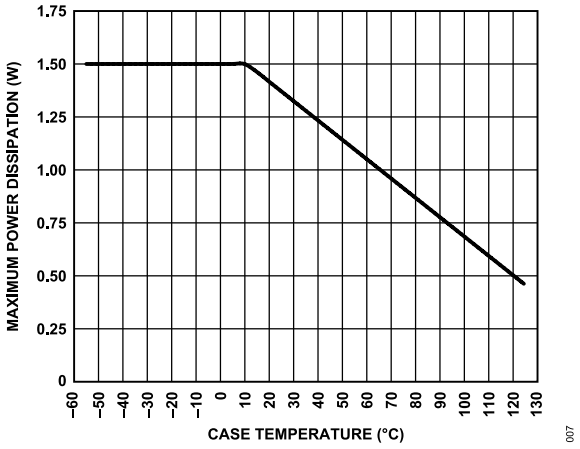

Figure 2. Maximum Power Dissipation vs. Case Temperature

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

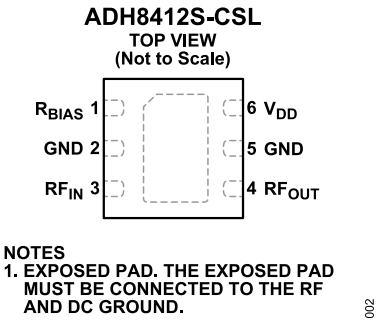

Figure 3. Pin Configuration

Table 10. 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

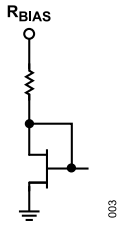

Figure 4. R_{BIAS} Interface Schematic

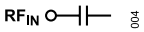

Figure 5. RF_{IN} Interface Schematic

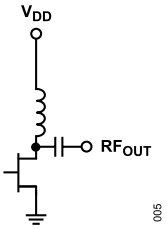

Figure 6. V_{DD} and RF_{OUT} Interface Schematic

Figure 7. GND Interface Schematic

TYPICAL PERFORMANCE CHARACTERISTICS

See the HMC8412TCPZ-EP data sheet for a full set of Typical Performance Characteristics plots.

OUTLINE DIMENSIONS

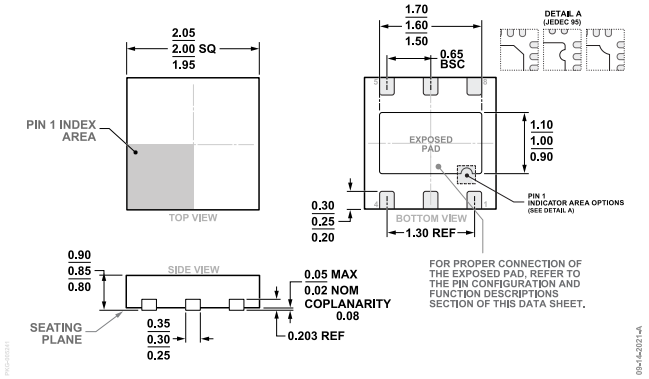

Figure 8. 6-Lead Lead Frame Chip Scale Package [LFCSP]
2 mm × 2 mm Body and 0.85 mm Package Height
(CP-6-12)
Dimensions shown in millimeters

ORDERING GUIDE

Model[1, 2]	Temperature Range	Package Description	Packing Quantity	Package Option
ADH8412TCPZ-R7-CSL	−55°C to 125°C	6-Lead LFCSP (2 mm × 2 mm w/ EP)	Reel, 500	CP-6-12
ADH8412TCPZ-PT-CSL	−55°C to 125°C	6-Lead LFCSP (2 mm × 2 mm w/ EP)	Reel, 500	CP-6-12

[1] Z = RoHS Compliant Part.

[2] The lead finish of the ADH8412TCPZ-PT-CSL and ADH8412TCPZ-R7-CSL is nickel palladium gold (NiPdAu).