Commercial Space Product

GaAs, pHEMT, MMIC, Low Noise Amplifier, 14 GHz to 24 GHz

FEATURES

- Low noise, high gain LNA for Ku and K band
- Frequency range: 14 GHz to 24 GHz
- Low noise figure: 1.4 dB typical at 15 GHz to 22 GHz
- High gain: 29 dB typical at 14 GHz to 15 GHz
- Integrated AC coupling capacitors
- Integrated bias inductor
- Single positive supply: 2 V with I_{DQ} = 25 mA
- RBIAS drain current adjustment pin
- RoHS-compliant, 2 mm × 2 mm, 8-lead LFCSP

COMMERCIAL SPACE FEATURES

- Support aerospace applications
- Wafer diffusion lot traceability
- Radiation lot acceptance test (RLAT)
  - Total ionizing dose (TID): 30 krads
- Radiation benchmark
  - No single event latchup (SEL) occurs at ≤62.4 MeV-cm^2/mg linear energy transfer

APPLICATIONS

- Geosynchronous high throughput satellites (GEO HTS)
- Low Earth orbit (LEO) space payloads
- Satellite communication

GENERAL DESCRIPTION

The ADL8141-CSL is a low power consumption, low noise amplifier that operates from 14 GHz to 24 GHz. Typical gain, noise figure, and output third-order intercept (OIP3) are 29 dB at 14 GHz to 15 GHz, 1.4 dB at 15 GHz to 22 GHz, and 18 dBm at 15 GHz to 22 GHz, respectively. Typical supply current is 25 mA from a 2 V supply. OIP3 and output power for 1 dB compression (OP1dB) can be increased by adjusting a supply-referenced resistor connected to the RBIAS pin. The RF input and output of the ADL8141-CSL are internally matched and AC-coupled.

The ADL8141-CSL is fabricated on a gallium arsenide (GaAs), pseudomorphic high electron mobility transistor (pHEMT), monolithic microwave integrated circuit (MMIC) process. The ADL8141-CSL is housed in a RoHS-compliant, 2 mm × 2 mm, 8-lead LFCSP and is specified for operation from −40°C to +85°C.

Additional application and technical information can be found in the Commercial Space Products Program brochure and the ADL8141 data sheet.

FUNCTIONAL BLOCK DIAGRAM

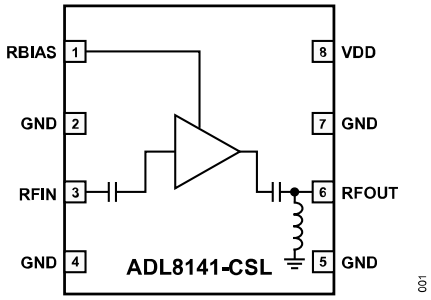

Figure 1. Functional Block Diagram

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REVISION HISTORY

12/2023—Revision 0: Initial Version

SPECIFICATIONS

14 GHz TO 15 GHz FREQUENCY RANGE

Supply voltage (V_{DD}) = 2 V, quiescent current (I_{DQ}) = 25 mA, bias reference (R_{BIAS}) = 768 Ω, and T_{CASE} = 25°C, unless otherwise noted.

Table 1. 14 GHz to 15 GHz Frequency Range Specifications

Parameter	Min	Typ	Max	Unit	Test Conditions/Comments
FREQUENCY RANGE	14		15	GHz	
GAIN	27	29		dB	
Gain Variation over Temperature		0.025		dB/°C	
NOISE FIGURE		1.7		dB	
RETURN LOSS					
Input (S11)		12.5		dB	
Output (S22)		7		dB	
OUTPUT					
OP1dB	3.5	6		dBm	
Saturated Output Power (P_{SAT})		9		dBm	
OIP3		11		dBm	Measurement taken at output power (P_{OUT}) per tone = −2 dBm
Second-Order Intercept (OIP2)		8.5		dBm	Measurement taken at P_{OUT} per tone = −2 dBm

15 GHz TO 22 GHz FREQUENCY RANGE

V_{DD} = 2 V, I_{DQ} = 25 mA, R_{BIAS} = 768 Ω, and T_C = 25°C, unless otherwise noted.

Table 2. 15 GHz to 22 GHz Frequency Range Specifications

Parameter	Min	Typ	Max	Unit	Test Conditions/Comments
FREQUENCY RANGE	15		22	GHz	
GAIN	26.5	28.5		dB	
Gain Variation over Temperature		0.024		dB/°C	
NOISE FIGURE		1.4		dB	
RETURN LOSS					
S11		15		dB	
S22		12		dB	
OUTPUT					
OP1dB	6	9		dBm	
P_{SAT}		11.5		dBm	
OIP3		18		dBm	Measurement taken at P_{OUT} per tone = −2 dBm
OIP2		23		dBm	Measurement taken at P_{OUT} per tone = −2 dBm

22 GHz TO 24 GHz FREQUENCY RANGE

V_{DD} = 2 V, I_{DQ} = 25 mA, R_{BIAS} = 768 Ω, and T_C = 25°C, unless otherwise noted.

Table 3. 22 GHz to 24 GHz Frequency Range Specifications

Parameter	Min	Typ	Max	Unit	Test Conditions/Comments
FREQUENCY RANGE	22		24	GHz	
GAIN		26		dB	
Gain Variation over Temperature		0.033		dB/°C	
NOISE FIGURE		1.5		dB	
RETURN LOSS					
S11		13.5		dB	
S22		5		dB	

SPECIFICATIONS

Table 3. 22 GHz to 24 GHz Frequency Range Specifications (Continued)

Parameter	Min	Typ	Max	Unit	Test Conditions/Comments
OUTPUT					
OP1dB		11		dBm	
P_{SAT}		12		dBm	
OIP3		17		dBm	Measurement taken at P_{OUT} per tone = −2 dBm
OIP2		31		dBm	Measurement taken at P_{OUT} per tone = −2 dBm

DC SPECIFICATIONS

Table 4. DC Specifications

Parameter	Min	Typ	Max	Unit
SUPPLY CURRENT				
I_{DQ}		25		mA
Amplifier Current (I_{DQ_AMP})		23		mA
RBIAS Current (I_{RBIAS})		2		mA
SUPPLY VOLTAGE				
V_{DD}	1.5	2	3.5	V

RADIATION TEST AND LIMIT SPECIFICATIONS

Electrical characteristics at V_{DD} = 2 V, I_{DQ} = 25 mA, R_{BIAS} = 768 Ω, and T_A = 25°C, unless otherwise noted. Total ionizing dose (TID) testing characterized to 30 krads.

Table 5. Radiation Test and Limit Specifications

Parameter	Min	Typ	Max	Unit
FREQUENCY RANGE	22		24	GHz
GAIN	22.5	26		dB
OUTPUT				
OP1dB	9	11		dBm
SUPPLY CURRENT				
I_{DQ}		25	32	mA
Amplifier Current (I_{DQ_AMP})		23		mA
RBIAS Current (I_{RBIAS})		2		mA
SUPPLY VOLTAGE				
V_{DD}	1.5	2	3.5	V

ABSOLUTE MAXIMUM RATINGS

Table 6. Absolute Maximum Ratings

Parameter	Rating
VDD	4 V
RFIN Power	20 dBm
Pulsed RFIN (Duty Cycle = 10%, Pulse Width = 100 µs)	22 dBm
Continuous Power Dissipation (P_{DISS}), T_{CASE} = 85°C (Derate 5.71 mW/°C Above 85°C)	0.51 W
Temperature	
Storage Range	−65°C to +150°C
Operating Range	−40°C to +85°C
Quiescent Channel (T_{CASE} = 85°C, V_{DD} = 2 V, I_{DQ} = 25 mA, Input Power (P_{IN}) = Off)	93.75°C
Maximum Channel	175°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. Careful attention to PCB thermal design is required.

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

Table 7. Thermal Resistance

Package Type	θ_{JC}	Unit
CP-8-30		
Quiescent, T_{CASE} = 25°C	141	°C/W
Worst Case[1], T_{CASE} = 85°C.	175	°C/W

[1] Worst case across all specified operating conditions

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	0.14	%
Collected Volatile Condensable Material	0.01	%
Water Vapor Recovered	0.03	%

RADIATION TESTING

Table 9. Radiation Testing

Specifications	Value	Unit
Maximum Total Dose Available (Dose Rate = 50 rads to 300 rads (Si)/sec)[1]	30	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.

[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.

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 ADL8141-CSL

Table 10. ADL8141-CSL, 8-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

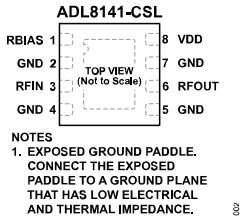

Figure 2. Pin Configuration

Table 11. Pin Function Descriptions

Pin No.	Mnemonic	Description
1	RBIAS	Bias Setting Resistor. Connect a resistor between RBIAS and VDD to set the I_{DQ}. See the typical application circuit and the recommended bias values for V_{DD} = 2 V table in the ADL8141 data sheet for more details.
2, 4, 5, 7	GND	Ground. Connect to a ground plane that has low electrical and thermal impedance.
3	RFIN	RF Input. The RFIN pin is AC-coupled and matched to 50 Ω.
6	RFOUT	RF Output. The RFOUT pin is AC-coupled and matched to 50 Ω.
8	VDD	Drain Bias. Connect the VDD pin to the supply voltage.
	EXPOSED PADDLE	Exposed Ground Paddle. Connect the exposed paddle to a ground plane that has low electrical and thermal impedance.

TYPICAL PERFORMANCE CHARACTERISTICS

See the ADL8141 data sheet for the typical performance characteristics plot.

OUTLINE DIMENSIONS

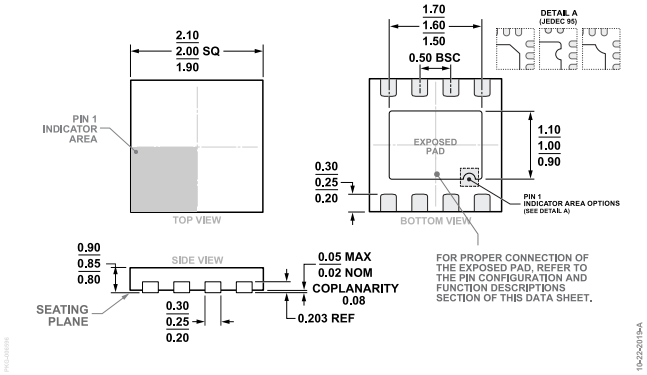

Figure 3. 8-Lead Lead Frame Chip Scale Package [LFCSP]
2 mm × 2 mm Body and 0.85 mm Package Height
(CP-8-30)
Dimensions shown in millimeters

ORDERING GUIDE

Model[1, 2]	Temperature Range	Package Description	Packing Quantity	Package Option
ADL8141ACPZN-CSL	−40°C to +85°C	8-Lead Lead Frame Chip Scale Package [LFCSP]	Reel, 500	CP-8-30
ADL8141ACPZN-R7-CSL	−40°C to +85°C	8-Lead Lead Frame Chip Scale Package [LFCSP]	Reel, 500	CP-8-30

[1] Z = RoHS Compliant Part.

[2] The lead finish of ADL8141ACPZN-CSL and ADL8141ACPZN-R7-CSL is nickel palladium gold.