8 to 21 GHz Output x2 Active Frequency Multiplier

ADH561S

1.0 SCOPE

This specification documents the detail requirements for space qualified die per MIL-PRF-38534 class K except as modified herein.

The manufacturing flow described in the SPACE DIE BROCHURE is to be considered a part of this specification.

This datasheet specifically details the space grade version of this product. A more detailed operational description and a complete datasheet for commercial product grades can be found at https://www.analog.com/hmc561-die.

2.0 Part Number:

The complete part number(s) of this specification follows:

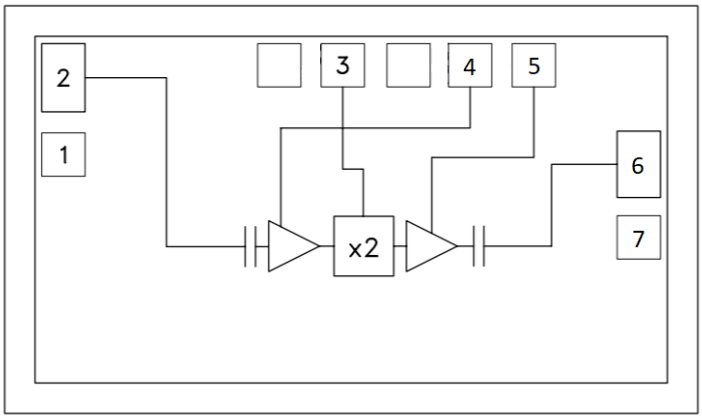
Specific Part Number	Description
ADH561-000C	8 to 21 GHz Output GaAs PHEMT MMIC x2 Active Frequency Multiplier

3.0 Die Information

3.1. Die Dimensions

Die Size	Die Thickness	Bond Pad and Backside Metallization
34.2 mils x 60.2 mils	4 mils	Au

3.2. Die Picture

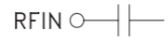
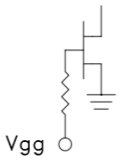
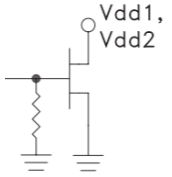
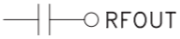


1. GND
2. RFIN
3. Vgg
4. Vdd1
5. Vdd2
6. RFOUT
7. GND

Die bottom is GND

One Analog Way, Wilmington, MA 01887, U.S.A.
Tel: 781.935.5565 www.analog.com
Fax: 800.262.5643

3.3. Pad Descriptions

Pad Number	Function	Description	Interface Schematic
2	RFIN	Pad is AC coupled and matched to 50 Ohms.	
3	Vgg	Gain Control to the Amplifier. Adjust to Idd1 + Idd2 = 98 mA (Typ.)	
4, 5	Vdd1, Vdd2	Supply Voltage (+5 V ± 0.5 V) External bypass capacitors of 100 pF and 0.1 µF are recommended on each pad.	
6	RFOUT	Pad is AC coupled and matched to 50 Ohms.	
1, 7, Die Bottom	GND	These pads and Die bottom must be connected to RF/DC ground.	

4.0 Specifications

4.1. Absolute Maximum Ratings 1/

RF Input Power (Vdd1 = Vdd2 = +5 V)	+10 dBm
Supply Voltage (Vdd1, Vdd2)	+5.5 Vdc
Channel Temperature	175 °C
Continuous Pdiss (T = +85 °C) (Derate 8.62 mW/°C above +85 °C)	776 mW
Thermal Resistance (Channel to die bottom)	116 °C/W
Storage Temperature Range	-65 °C to +150 °C
Operating Temperature Range (T_A) (Performance)	-40 °C to +85 °C
Operating Temperature Range (T_A)	-55 °C to +85 °C
ESD Sensitivity (HBM)	Class 0

4.2 Recommended Operating Conditions

Supply Voltage (Vdd1 = Vdd2)	+4.5 Vdc to +5.5 Vdc
Drive Level Range	0 dBm to +6 dBm

4.3 Nominal Operating Performance Characteristics 2/

Fo Isolation (with respect to output level) ..... 18 dBc
3Fo Isolation (with respect to output level) ..... 19 dBc
4Fo Isolation (with respect to output level) ..... 15 dBc
Input Return Loss ..... 15 dB
Output Return Loss ..... 12 dB
SSB Phase Noise (100 kHz Offset) ..... -139 dBc/Hz 3/

4.4 Nominal Isolation Performance Characteristics 4/

Fo Isolation (with respect to output level) ..... 16 dBc
3Fo Isolation (with respect to output level) ..... 13 dBc
4Fo Isolation (with respect to output level) ..... 19 dBc

1/ Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions outside of those indicated in the operation sections of this specification is not implied. Exposure to absolute maximum ratings for extended periods may affect device reliability.
2/ All specifications apply with T_A = 25 °C, Vdd1 = Vdd2 = +5 Vdc, +5 dBm Drive Level, Idd (Idd1 +Idd2) = 98 mA, and RFOUT Frequency Range = 8 GHz to 21 GHz only, unless otherwise noted.
3/ Output Frequency = 16 GHz.
4/ All specifications apply with T_A = 25 °C, Vdd1 = Vdd2 = +3.5 Vdc, +5 dBm Drive Level, Idd (Idd1 + Idd2) = 98 mA, and RFOUT Frequency Range = 8 GHz to 21 GHz only.

5.0 Die Qualification

In accordance with class-K version of MIL-PRF-38534, Appendix C, Table C-II, except as modified herein.
(a) Pre-screen test post assembly required prior to die qualification, to remove all assembly related rejects.
(b) Mechanical Shock or Constant Acceleration not performed.
(c) Interim and post burn-in electrical tests will include tests screened at +25 °C only.

6.0 Dice Electrical Characteristics

TABLE I – DIE ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Conditions 1/2/3/ Unless otherwise specified	Limits		Unit
			Min	Max	
Output Power	POUT		14		dBm
Supply Current (Idd1 + Idd2)	Idd	No Drive level applied at RFIN		126	mA

TABLE I Notes:

1/ Limits apply at T_A = +25 °C only with Vdd1 = Vdd2 = +5 Vdc and +5 dBm Drive level.
2/ Parameters measured at FOUT = 8 GHz, 14.5 GHz and 21 GHz only.
3/ Adjust Vgg between -2 Vdc and -1.2 Vdc to achieve Idd (Idd1 + Idd2) = 98 mA.

TABLE II – ELECTRICAL CHARACTERISTICS FOR QUALIFICATION SAMPLES						
Parameter	**Symbol**	**Conditions 1/2/3/4/ Unless otherwise specified**	**Sub-Group 5/**	**Limits**		**Unit**
				Min	**Max**	
Output Power	POUT	FOUT = 8 GHz, 14.5 GHz, 21 GHz	4, 6	14		dBm
		FOUT = 8 GHz, 21 GHz	5	11.5		dBm
		FOUT = 14.5 GHz	5	12.5		dBm
Supply Current (Idd1 + Idd2)	Idd	No Drive level applied at RFIN	1, 2, 3		126	mA

TABLE II Notes:

1/ T_A Nom = +25 ºC, T_A Max = +85 ºC, T_A Min = -40 ºC.

2/ Vdd1 = Vdd2 = +5 Vdc and +5 dBm Drive level.

3/ Parameters measured at FOUT = 8 GHz, 14.5 GHz and 21 GHz only.

4/ Vgg adjusted between -2 Vdc and -1.2 Vdc to achieve Idd (Idd1 + Idd2) = 98 mA typical at T_A nom, T_A max, and T_A min.

5/ See ML-PRF-38534 Table C-Xa for Sub-Group parameter definitions.

TABLE III – BURN-IN/LIFE TEST DELTA LIMITS 1/2/3/4/5/			
Parameter	**Symbol**	**Delta**	**Unit**
Output Power	POUT	± 1	dB
Supply Current (Idd1 + Idd2)	Idd	± 10	%

TABLE III Notes:

1/ 240 hour burn-in and 1000 hour life test end point electrical parameters.

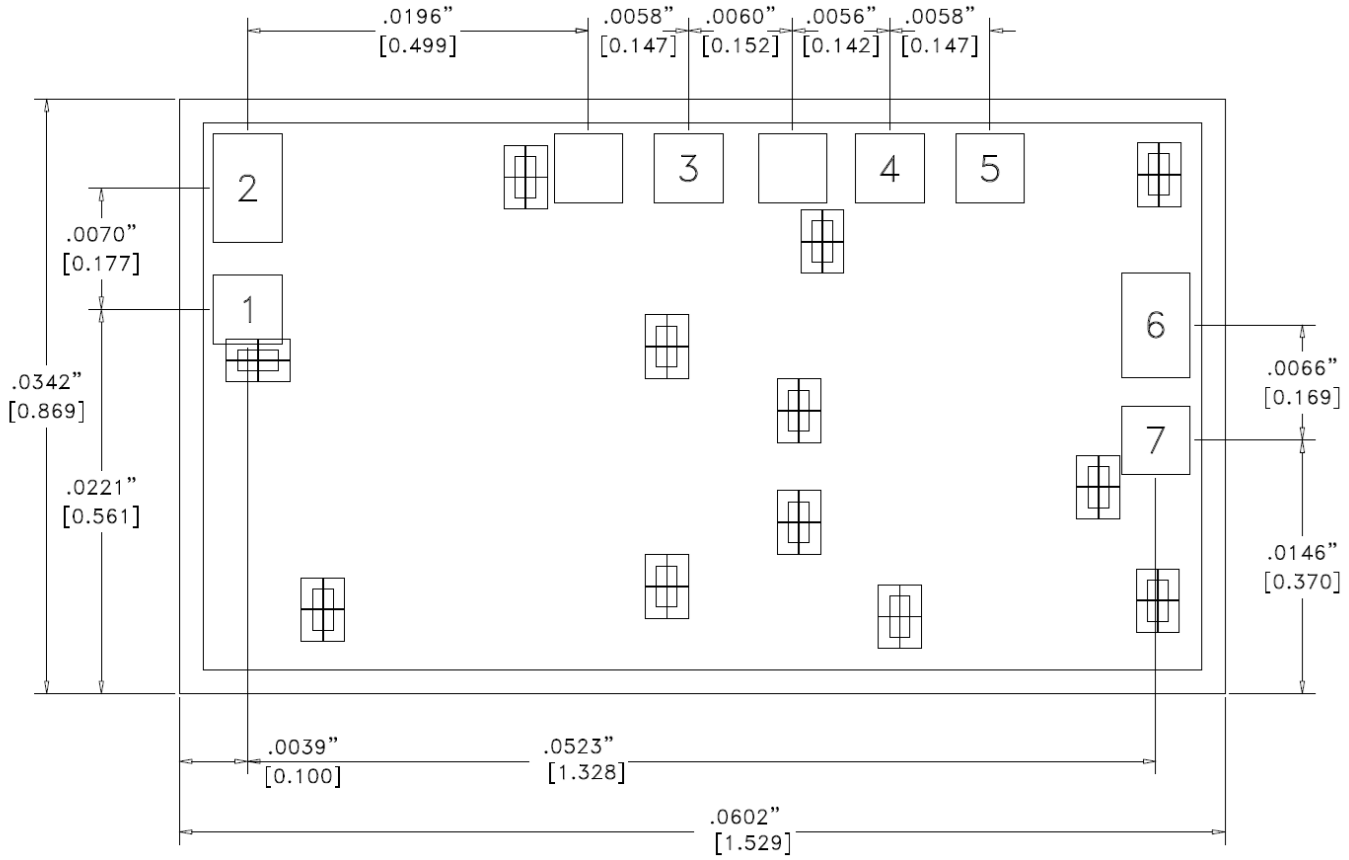
2/ Deltas are performed at T_A = +25 °C only.

3/ Product is tested in accordance with conditions in Table II.

4/ Table II limits shall not be exceeded.

5/ Vgg voltage set at pre burn-in value for each device.

7.0 Die Outline



PAD	DESCRIPTION	PAD SIZE
1	GND	.0039[.100] X .0039[.100]
2	RFIN	.0039[.100] X .0062[.158]
3	Vgg	.0039[.100] X .0039[.100]
4	Vdd1	.0039[.100] X .0039[.100]
5	Vdd2	.0039[.100] X .0039[.100]
6	RFOUT	.0039[.100] X .0060[.153]
7	GND	.0039[.100] X .0039[.100]

NOTES:

1. ALL DIMENSIONS ARE IN INCHES [MM]
2. DIE THICKNESS IS .004"
3. TYPICAL BOND PAD IS .004" SQUARE
4. BOND PAD METALIZATION: GOLD
5. BACKSIDE METALIZATION: GOLD
6. BACKSIDE METAL IS GROUND
7. NO CONNECTION REQUIRED FOR UNLABELED BOND PADS
8. OVERALL DIE SIZE ±.002"

8.0 Application Notes

Figure 1 shows the assembly diagram. The die should be attached directly to the ground plane using an eutectic mixture or with conductive epoxy. The 50 Ω microstrip transmission lines on 0.127 mm (5 mils) thick alumina thin film substrates are recommended for bringing RF to and from the chip (Figure 2). If 0.254 mm (10 mils) thick alumina thin film substrates must be used, the die should be raised 0.15 mm (6 mils) so that the surface of the die is coplanar with the surface of the substrate. This can be accomplished by attaching the 0.102 mm (4 mils) thick die to a 0.150 mm (6 mils) thick molybdenum heat spreader (moly-tab) which is then attached to the ground plane (Figure 3). Microstrip substrates should be brought as close to the die as possible in order to minimize wire bond length. Typical die-to-substrate spacing is 0.076 mm to 0.152 mm (3 to 6 mils).

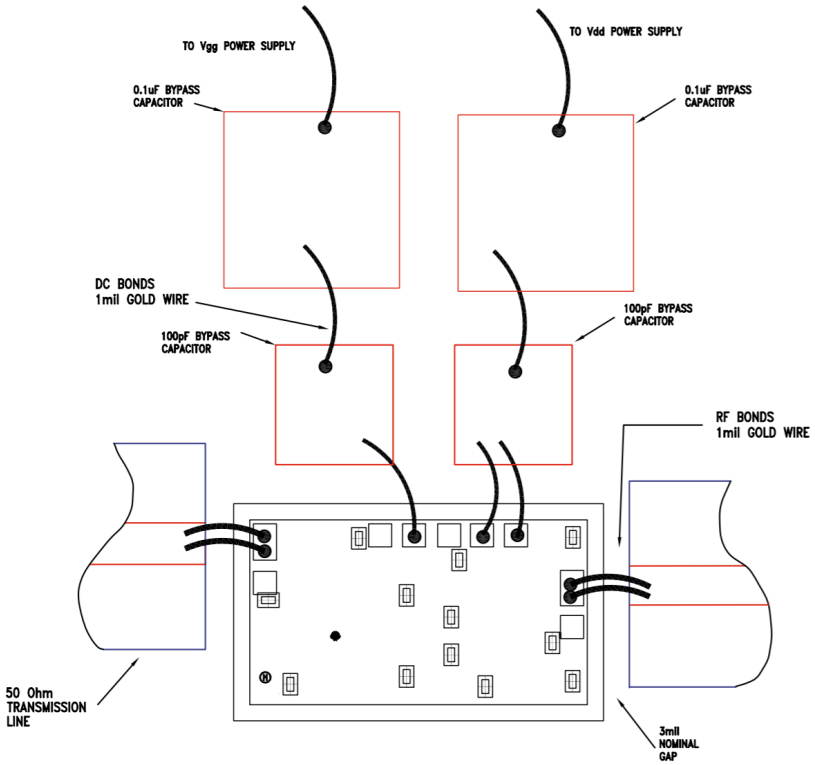


Figure 1. Assembly Diagram

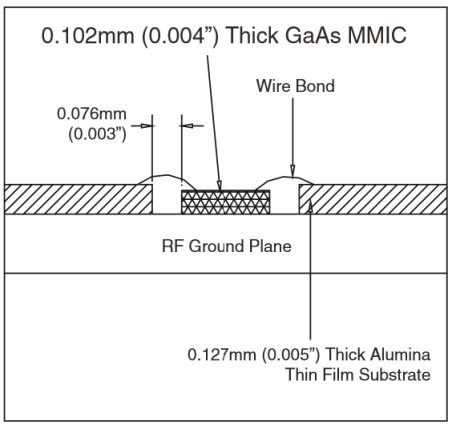


Figure 2. Die without Moly Tab

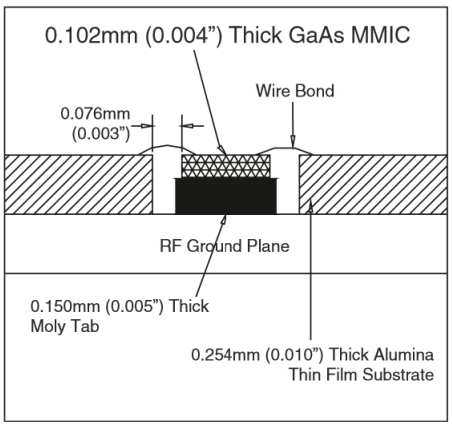


Figure 3. Die with Moly Tab

TYPICAL PERFORMANCE CHARACTERISTICS

All typical performance characteristics apply with Vdd1 = Vdd2 = +5 Vdc, Idd1 + Idd2 = 98 mA, +5 dBm Drive Level and T_A = +25 °C unless otherwise noted.

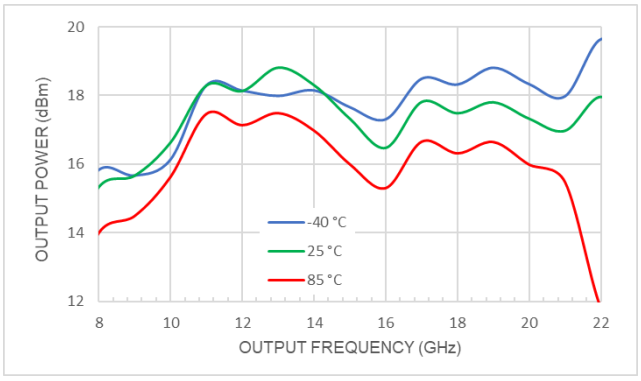


Figure 4. Output Power vs. Temperature

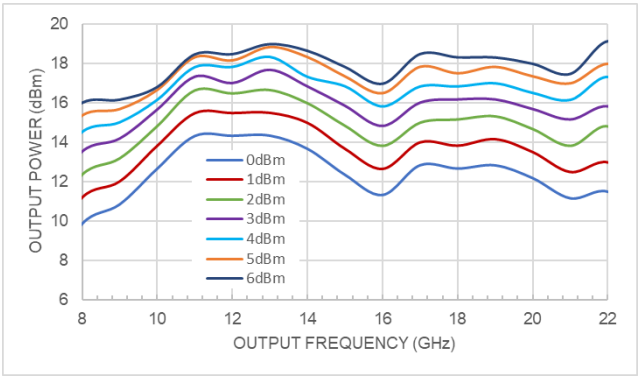


Figure 7. Output Power vs. Drive Level

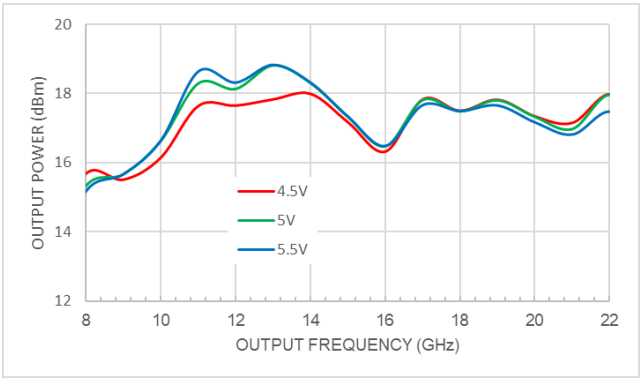


Figure 5. Output Power vs. Supply Voltage

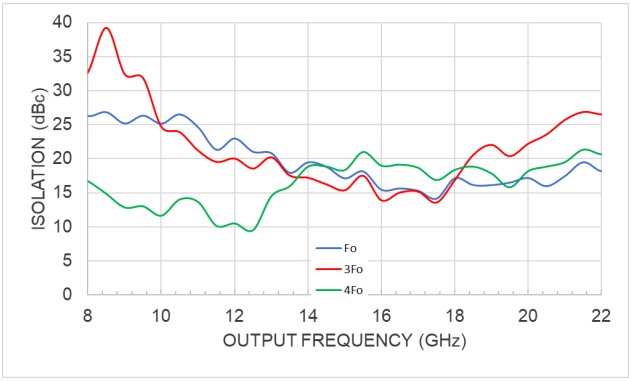


Figure 8. Isolation (with respect to output level) vs. Output Frequency

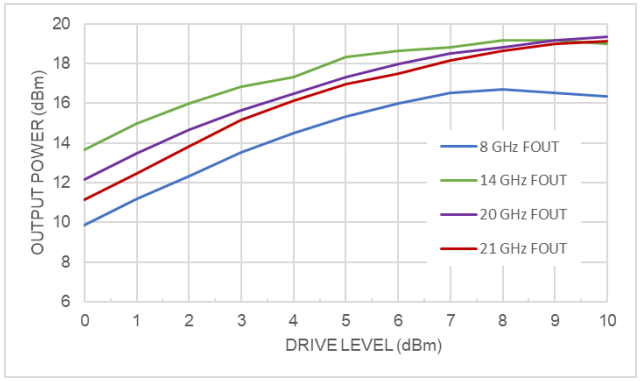


Figure 6. Output Power vs. Drive Level

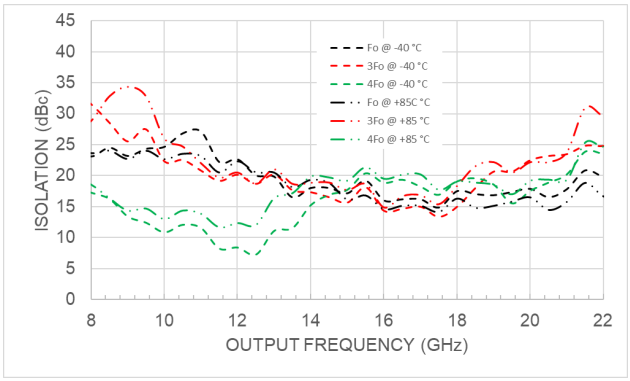


Figure 9. Isolation (with respect to output level) vs. Temperature

Die Packaging Information

Standard	Alternate
GP-2 (Gel Pack)	1/

Note:

1/ For alternate packaging information, contact Analog Devices Inc.

Revision History		
Rev	**Description of Change**	**Date**
A	Initial Production Release	29-Mar-2023

ANALOG DEVICES

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