# 5.0 GHz to 18.0 GHz Medium Power Amplifier

# ADH451S

## 1.0 SCOPE

This specification documents the detail requirements for an internally defined equivalent flow per MIL-PRF-38535 Level V expect as modified herein.

The manufacturing flow described in the RF & MICROWAVE STANDARD SPACE LEVEL PRODUCTS PROGRAM is to be considered a part of this specification.

This data specifically details the space grade version of this product. A more detailed operational description and a complete data sheet for commercial product grades can be found at http://www.analog.com/HMC451

## 2.0 Part Number:

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

| Specific Part Number | Description |
|---|---|
| ADH451-701LH5 | 5.0 GHz to 18.0 GHz Medium Power Amplifier |

## 3.0 Case Outline

The case outline(s) are as designated in MIL-STD-1835 and as follows:

| Outline Letter | Descriptive Designator | Terminals | Lead Finish | Package style |
|---|---|---|---|---|
| X | E-12-5 | 12 Lead | Gold | Ceramic Hermetic SMT (LH5) |

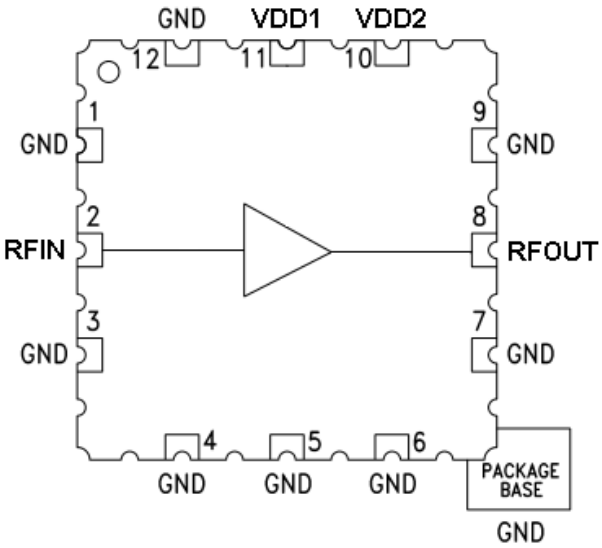



Figure 1 – Functional Block Diagram




One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106, U.S.A.
Tel: 781.329.4700 www.analog.com
Fax: 781.326.8703 

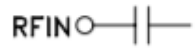
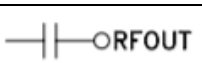
| Package: X | | | | |
|---|---|---|---|---|
| **Pin Number** | **Terminal Symbol** | **Pin Type** | **Pin Description** | **Interface Schematic** |
| 1 | GND | Power | RF/DC ground. |   |
| 2 | RFIN | Input | RF Input 1/ |   |
| 3 | GND | Power | RF/DC ground. |   |
| 4 | GND | Power | RF/DC ground. | |
| 5 | GND | Power | RF/DC ground. | |
| 6 | GND | Power | RF/DC ground. | |
| 7 | GND | Power | RF/DC ground. | |
| 8 | RFOUT | Output | RF Output 1/ |   |
| 9 | GND | Power | RF/DC ground. |   |
| 10 | VDD2 | Power | Power Supply Voltage for the amplifier. 2/ |   |
| 11 | VDD1 | Power | Power Supply Voltage for the amplifier. 2/ |   |
| 12 | GND | Power | RF/DC ground. |   |
| Package Base | GND | Power | RF/DC ground 3/ 4/ |   |
| Package Lid | GND | Power | | |

Figure 2 – Terminal connections

1/ This pin is AC coupled and matched to 50 Ohms.
2/ External bypass capacitors of 100 pF, 1000 pF and 2.2µF are required.
3/ Package base must be connected to RF/DC ground.
4/ Package lid is internally connected to RF/DC ground.

## 4.0 Specifications

### 4.1. Absolute Maximum Ratings 1/

Drain Bias Voltage (Vdd1 = Vdd2) ..... 5.5 V 2/
RF Input Power (RFIN) (Vdd1 = Vdd2 = +5V) ..... +10 dBm
Channel Temperature ..... +175 °C
Continuous Pdiss (T = +85 °C) (Derate 9.29mW/°C above +85 °C) . 0.836 W
Thermal resistance (Channel to package bottom) ..... 107.64 °C/W
Storage temperature range ..... -65 °C to +150 °C
ESD Sensitivity (HBM) ..... Class 1A, passed 250V

### 4.2. Recommended Operating Conditions

Supply voltage (Vdd1 = Vdd2) ..... +4.5 V to +5.5 V
Ambient operating temperature range ($T_A$) ..... -40 °C to +85 °C

### 4.3. Nominal Operating Performance Characteristics 3/

Input Return Loss (IRL) (5 GHz – 13 GHz) ..... 11 dB
Input Return Loss (IRL) (13 GHz – 18 GHz) ..... 5 dB
Output Return Loss (ORL) (5 GHz – 13 GHz) ..... 11 dB
Output Return Loss (ORL) (13 GHz – 18 GHz) ..... 5 dB
Noise Figure (NF) (5 GHz – 13 GHz) ..... 8 dB
Noise Figure (NF) (13 GHz – 18 GHz) ..... 6.5 dB
Saturated Output Power (Psat) (5 GHz – 13 GHz) ..... 22 dBm 4/
Saturated Output Power (Psat) (13 GHz – 18 GHz) ..... 20 dBm 4/
Output Third Order Intercept (OIP3) (5 GHz – 13 GHz) ..... 30 dBm 5/
Output Third Order Intercept (OIP3) (13 GHz – 18 GHz) ..... 28 dBm 5/

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 voltages are relative to their respective grounds.
3/ All typical specifications are at $T_A$ = 25 °C and Vdd1 = Vdd2 = +5 V, unless otherwise noted.
4/ Psat specified as OP5dB
5/ RFOUT = 0 dBm per tone, 1MHz spacing.

## TABLE I – ELECTRICAL PERFORMANCE CHARACTERISTICS

| Parameter<br>See notes at end of table | Symbol | Conditions 1/<br>Unless otherwise specified | Group A<br>Subgroups | Limits | | Units |
|---|---|---|---|---|---|---|
| | | | | Min | Max | |
| **Frequency = 5.0GHz Continuous Wave (CW) input** | | | | | | |
| Gain | S21 | RF In =-10dBm | 4 | 16 | | dB |
| | | | 5, 6 | 14 | | dB |
| Gain Variation Over Temperature | S21/ºC | RF In =-10dBm | 4, 5, 6 | | 0.035 | dB/ºC |
| Output Power for 1dB Compression | OP1dB | | 7 | 16.5 | | dBm |
| | | | 8A, 8B | 16 | | |
| **Frequency = 11.5GHz Continuous Wave (CW) input** | | | | | | |
| Gain | S21 | RF In =-10dBm | 4 | 15 | | dB |
| | | | 5, 6 | 13 | | dB |
| Gain Variation Over Temperature | S21/ºC | RF In =-10dBm | 4, 5, 6 | | 0.035 | dB/ºC |
| Output Power for 1dB Compression | OP1dB | | 7 | 16 | | dBm |
| | | | 8A, 8B | 15 | | dBm |
| **Frequency = 18.0GHz Continuous Wave (CW) input** | | | | | | |
| Gain | S21 | RF In =-10dBm | 4 | 14 | | dB |
| | | | 5, 6 | 12 | | dB |
| Gain Variation Over Temperature | S21/ºC | RF In =-10dBm | 4, 5, 6 | | 0.035 | dB/ºC |
| Output Power for 1dB Compression | OP1dB | | 7 | 16.5 | | dBm |
| | | | 8A, 8B | 16 | | dBm |
| **Power Supplies** | | | | | | |
| Quiescent supply current | Idd | No signal at RFIN | 1, 2, 3 | | 150 | mA |

Table I Note:
1/ $T_A$ nom = +25 ºC, $T_A$ max = +85 ºC, $T_A$ min = -40 ºC and Vdd1 = Vdd2 =+ 5V nom.

## TABLE IIA – ELECTRICAL TEST REQUIREMENTS

| Test Requirements | Subgroups (in accordance with MIL-PRF-38535, Table III) |
|---|---|
| Interim Electrical Parameters | 1, 4 |
| Final Electrical Parameters | 1, 4, 7 1/ 2/ |
| Group A Test Requirements | 1, 2, 3, 4, 5, 6, 7, 8A, 8B |
| Group C end-point electrical parameters | 1, 4, 7 2/ |
| Group D end-point electrical parameters | 1, 4, 7 |

Table IIA Notes:
1/ PDA applies to Table I subgroup 1 only and Table IIB delta parameters.
2/ See Table IIB for delta parameters

**TABLE IIB – BURN-IN/LIFE TEST DELTA LIMITS 1/ 2/**

| Parameter | Test Conditions | Symbol | Delta | Units |
|---|---|---|---|---|
| Gain | Per Table I | S21 | ± 1.0 | dB |
| Quiescent supply current | | Idd | ± 10 | % |

Table IIB Notes:
1/ 240 hour burn in and 1000 hour life test (Group C) end-point electrical parameters.
2/ Deltas are performed at room temperature $T_A$ = +25°C only.

## 5.0 Burn-In Life Test, and Radiation

5.1. Burn-In Test Circuit, Life Test Circuit

5.1.1. The test conditions and circuit shall be maintained by the manufacturer under document revision level control and shall be made available to the preparing or acquiring activity upon request. The test circuit shall specify the inputs, outputs, biases, and power dissipation, as applicable, in accordance with the intent specified in method 1015 test condition B of MIL-STD-883.

5.1.2. HTRB is not applicable for this drawing.

## 6.0 MIL-PRF-38535 QMLV Exceptions

6.1. Wafer Fabrication

Foundry information is available on request.

6.2. Group D

Group D-5 Salt Atmosphere is not performed.

## 7.0 Application Notes

| Component | Value |
|---|---|
| C1, C2 | 100pF |
| C3, C4 | 1000pF |
| C5, C6 | 2.2µF (Tantalum) |

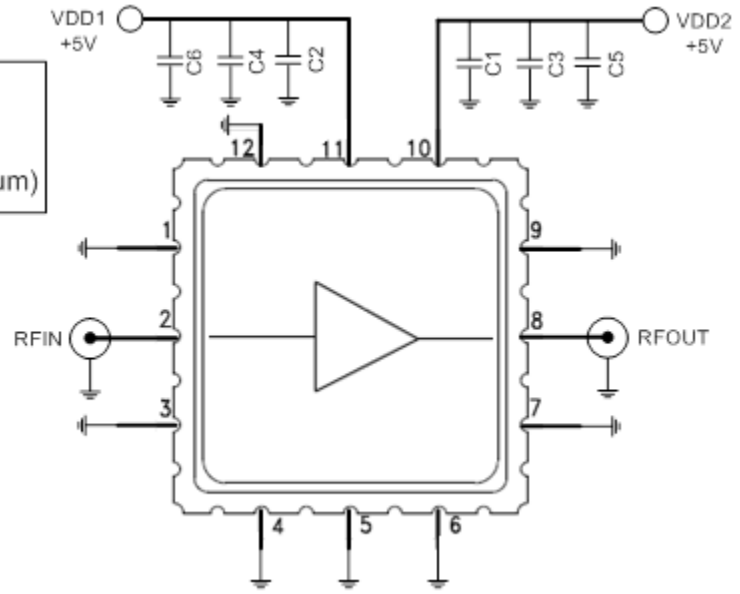



Figure 3 – Recommended configuration for the ADH451-701LH5

The circuit board used in the final application should use RF circuit design techniques. Signal lines should have 50 Ohm impedance while the package ground leads and package bottom should be connected directly to the ground plane. A sufficient number of via holes should be used to connect the top and bottom ground planes. The circuit board should be mounted to an appropriate heat sink.

## 8.0 Package Outline Dimensions

The LH5 package and outline dimensions can be found at http://www.analog.com or upon request.

## ORDERING GUIDE

| Model | Temperature Range | Package Description | Package Option |
|---|---|---|---|
| ADH451-701LH5 | –40 °C to +85 °C | 12 Lead Ceramic Hermetic SMT | LH5 (E-12-5) |

| Revision History | | |
|---|---|---|
| Rev | Description of Change | Date |
| A | Initiate. | 12/21/18 |
| B | Update Section 3.0, 4.3, 6.0, 7.0, & 8.0 | 05/06/19 |
| C | Correct Figure labels, Update Figure 2 and Section 5.1.1 | 10/01/2020 |
| | | |
| | | |