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Application Notes

- AN-1363: Meeting Biasing Requirements of Externally Biased RF/Microwave Amplifiers with Active Bias Controllers
- Broadband Biasing of Amplifiers General Application Note
- MMIC Amplifier Biasing Procedure Application Note
- Thermal Management for Surface Mount Components General Application Note

Data Sheet

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Quality Documentation

- Package/Assembly Qualification Test Report: 20L 7x7mm Ceramic LCC Package (QTR: 11005P REV: 03)
- Semiconductor Qualification Test Report: PHEMT-K (QTR: 2013-00500)

[Design Resources](#)

- HMC6981 Material Declaration
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GaAs pHEMT MMIC 2 WATT POWER AMPLIFIER, 15 - 20 GHz

Typical Applications

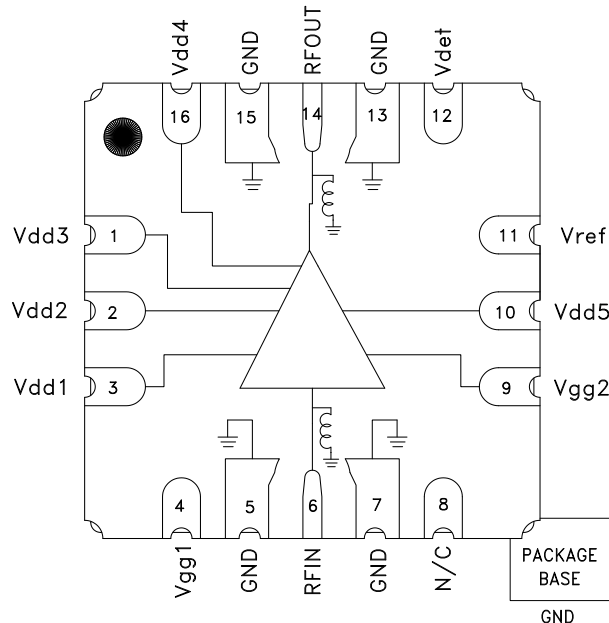
The HMC6981LS6 is ideal for:

- Point-to-Point Radios
- Point-to-Multi-Point Radios
- SATCOM

Features

- P1dB Output Power: +33.5 dBm
- 25% PAE @ +34.5 dBm Pout
- Gain: 26 dB
- Output IP3: +43.5 dBm
- 50 Ohm Matched Input/Output
- Ceramic 6 x 6 mm High Frequency Air Cavity Package

Functional Diagram



General Description

The HMC6981LS6 is a four-stage GaAs pHEMT MMIC Power Amplifier with an integrated temperature compensated on-chip Power Detector, which operates between 15 and 20 GHz. The amplifier provides 26 dB of gain, +34.5 dBm of saturated output power, and 25% PAE from a +6V supply. With an excellent output IP3 of +43.5 dBm, the HMC6981LS6 is ideal for linear applications such as high capacity point-to-point or point-to-multi-point radios or SATCOM applications demanding +34.5 dBm of efficient saturated output power. The HMC6981LS6 is housed in a ceramic 6 x 6 mm high frequency air cavity package which exhibits low thermal resistance and is compatible with high volume surface mount manufacturing techniques. The RF I/Os are internally matched to 50 Ohms.

Electrical Specifications, $T_A = +25^\circ C$

$V_{dd} = V_{dd1}, V_{dd2}, V_{dd3}, V_{dd4}, V_{dd5} = +6V, I_{dd} = 1100 mA$ [1]

| Parameter | Min. | Typ. | Max. | Min. | Typ. | Max. | Units |
|---|---------|------|---------|------|------|------|--------|
| Frequency Range | 15 - 17 | | 17 - 20 | | | | GHz |
| Gain | 24 | 27 | | 23 | 26 | | dB |
| Gain Variation Over Temperature | 0.042 | | 0.038 | | | | dB/ °C |
| Input Return Loss | 9 | | 13 | | | | dB |
| Output Return Loss | 13 | | 15 | | | | dB |
| Output Power for 1 dB Compression (P1dB) | 31 | 33 | | 31.5 | 33.5 | | dBm |
| Saturated Output Power (P _{sat}) | 34.5 | | 34.5 | | | | dBm |
| Output Third Order Intercept (IP3) ^[2] | 42 | | 43.5 | | | | dBm |
| Total Supply Current (I _{dd}) | 1100 | | 1100 | | | | mA |

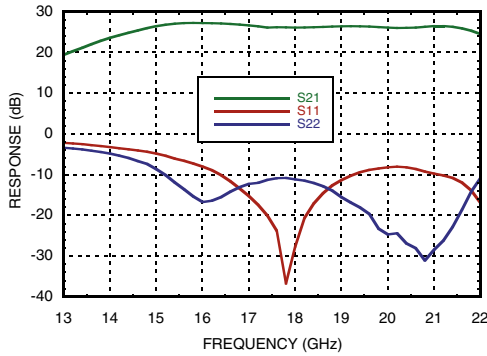
[1] Adjust V_{gg} between -2 to 0V to achieve I_{dd} = 1100 mA typical.

[2] Measurement taken at +6V @ 1100 mA, P_{out} / Tone = +20 dBm

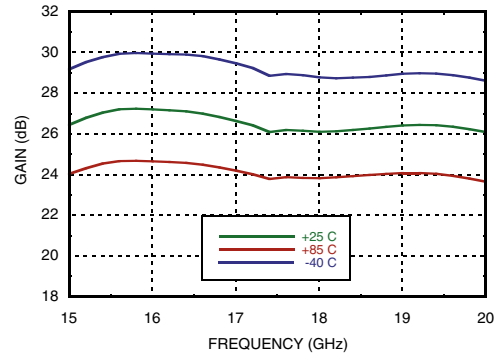


GaAs pHEMT MMIC 2 WATT POWER AMPLIFIER, 15 - 20 GHz

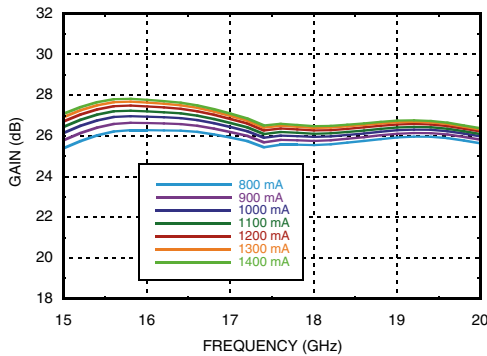
Gain & Return Loss



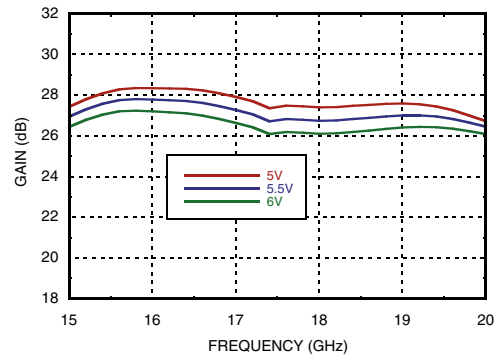
Gain vs. Temperature



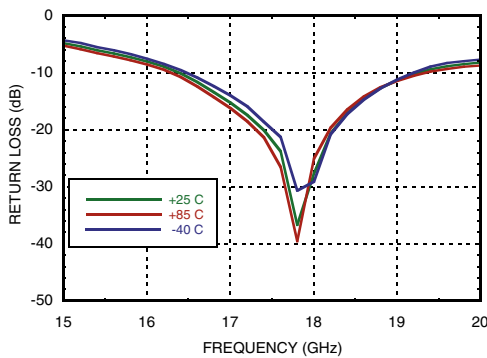
Gain vs. Supply Current



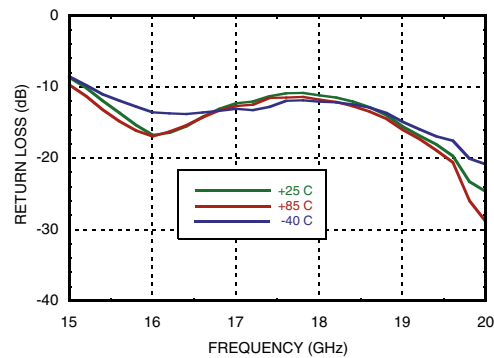
Gain vs. Supply Voltage



Input Return Loss vs. Temperature



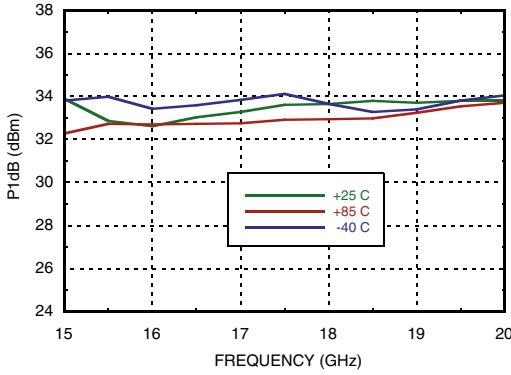
Output Return Loss vs. Temperature



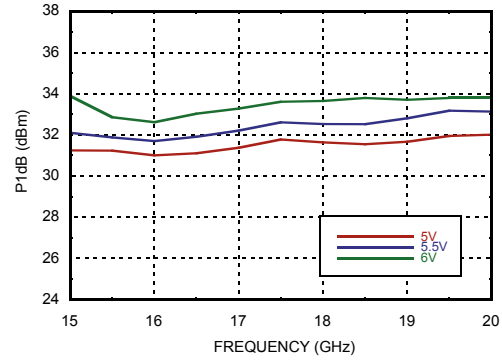


GaAs pHEMT MMIC 2 WATT POWER AMPLIFIER, 15 - 20 GHz

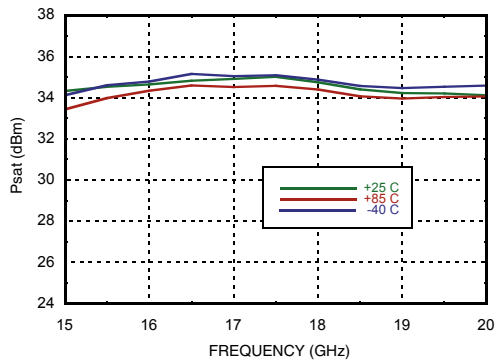
P1dB vs. Temperature



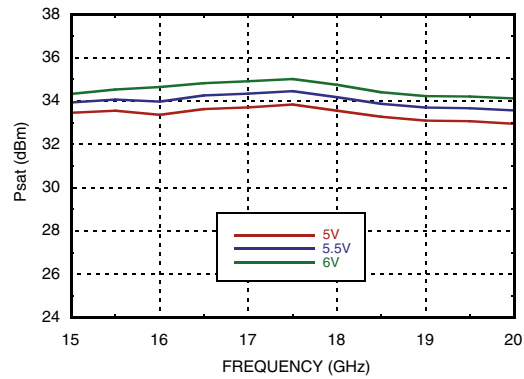
P1dB vs. Supply Voltage



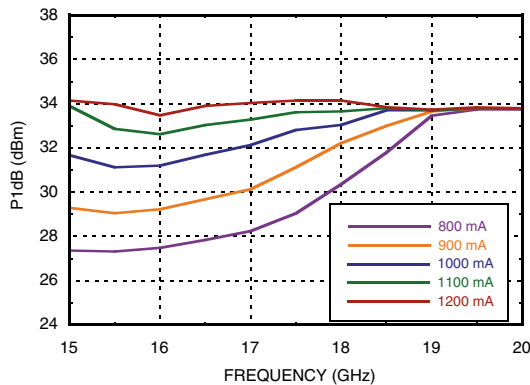
Psat vs. Temperature



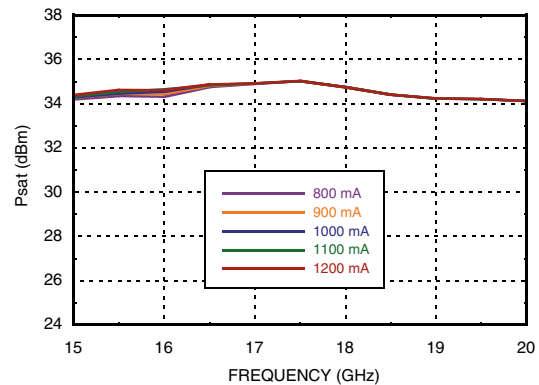
Psat vs. Supply Voltage



P1dB vs. Supply Current



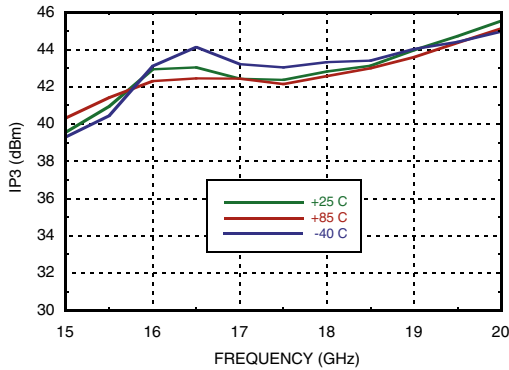
Psat vs. Supply Current



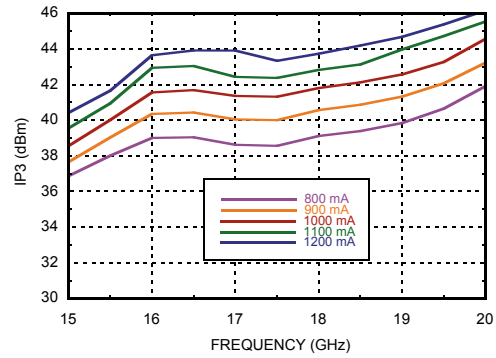


GaAs pHEMT MMIC 2 WATT POWER AMPLIFIER, 15 - 20 GHz

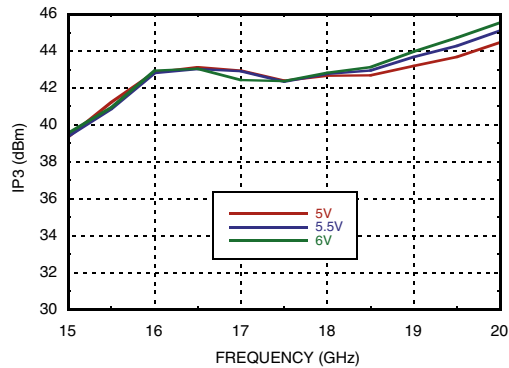
**Output IP3 vs. Temperature,
Pout/tone = +20 dBm**



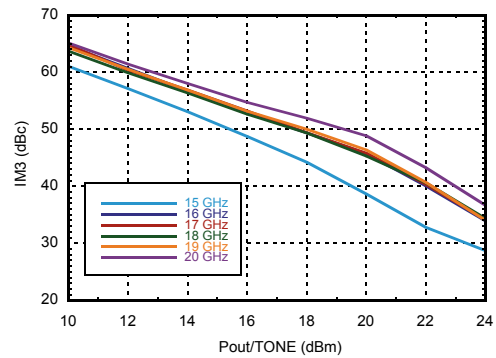
**Output IP3 vs. Supply Current,
Pout/tone = +20 dBm**



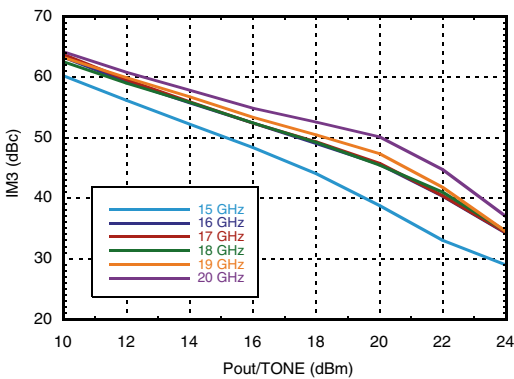
**Output IP3 vs. Supply Voltage,
Pout/tone = +20 dBm**



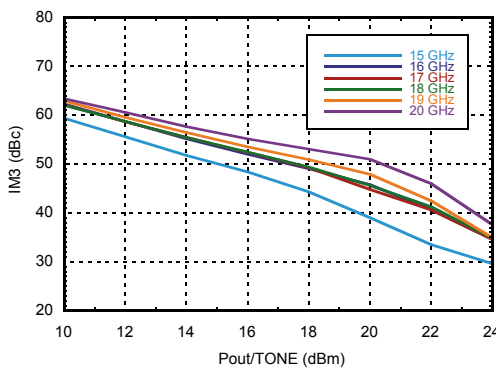
Output IM3 @ Vdd = +5V



Output IM3 @ Vdd = +5.5V



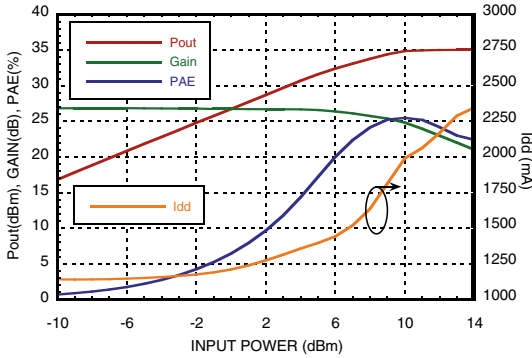
Output IM3 @ Vdd = +6V



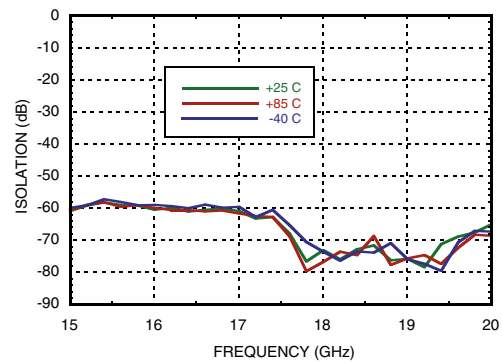


GaAs pHEMT MMIC 2 WATT POWER AMPLIFIER, 15 - 20 GHz

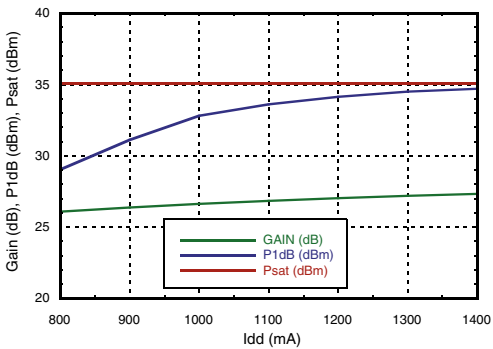
Power Compression @ 17.5 GHz



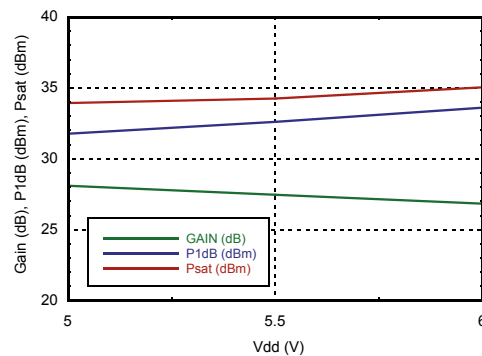
Reverse Isolation vs. Temperature



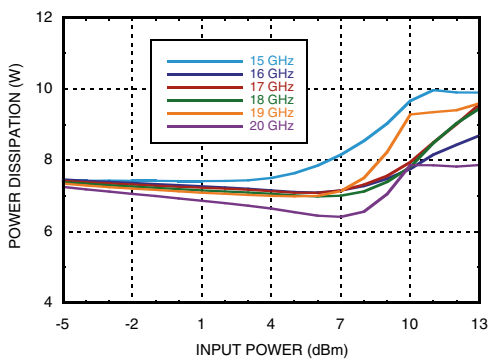
**Gain & Power vs.
Supply Current @ 17.5 GHz**



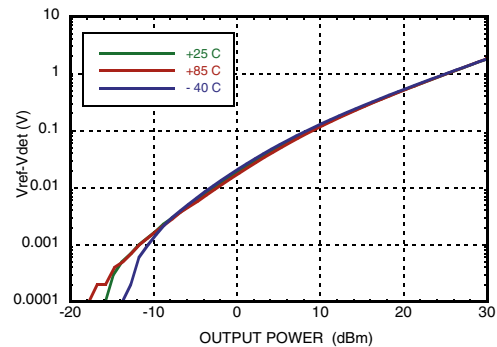
**Gain & Power vs.
Supply Voltage @ 17.5 GHz**



Power Dissipation



**Detector Voltage vs.
Temperature @ 17.5 GHz**

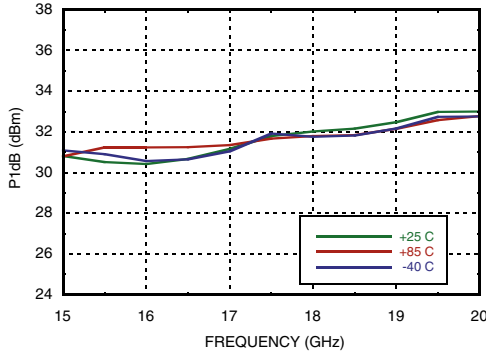




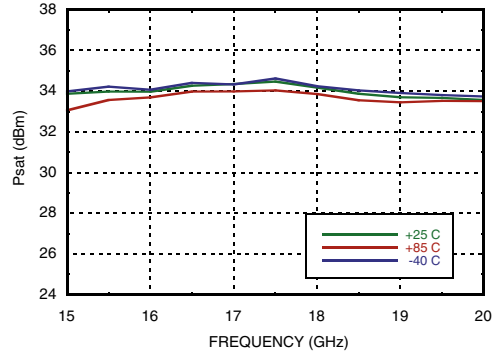
**GaAs pHEMT MMIC 2 WATT
POWER AMPLIFIER, 15 - 20 GHz**

Low DC Power Mode, Vdd = 5.5V, Idd = 1000 mA

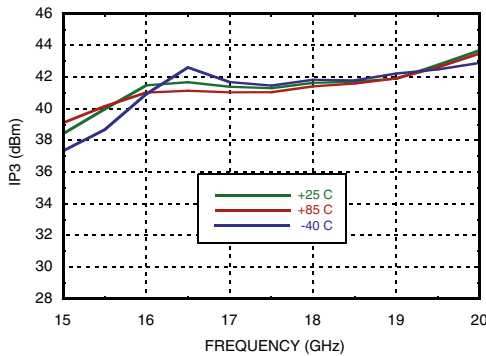
P1dB vs. Temperature



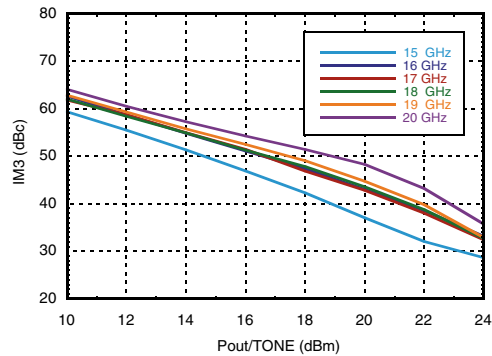
Psat vs. Temperature



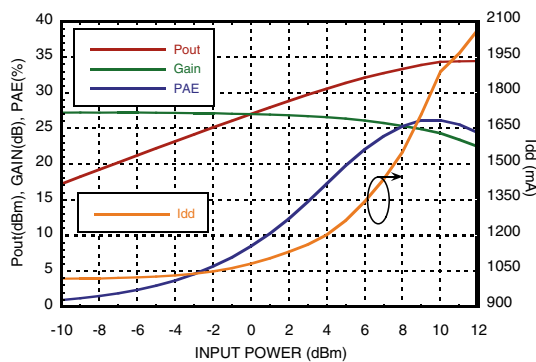
**Output IP3 vs. Temperature,
Pout/tone = +20 dBm**



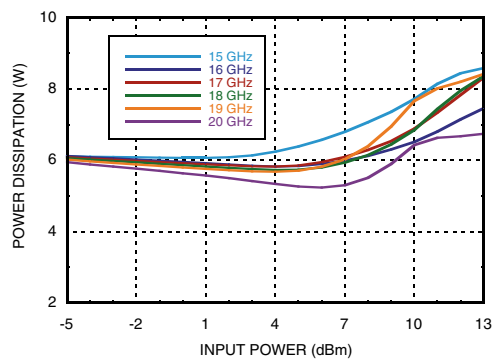
Output IM3 @ Vdd = +5.5V, 1000 mA



Power Compression @ 17.5 GHz



Power Dissipation





GaAs pHEMT MMIC 2 WATT POWER AMPLIFIER, 15 - 20 GHz

Absolute Maximum Ratings

| | |
|--|----------------------|
| Drain Bias Voltage (Vdd) | +6.5 Vdc |
| Gate Bias Voltage (Vgg) | -3 to 0 Vdc |
| RF Input Power (RFIN) | +18 dBm |
| Channel Temperature | 175 °C |
| Continuous Pdiss (T = 85 °C) (derate 129 mW/°C above 85 °C) | 11.7 W |
| Thermal Resistance (channel to ground paddle) | 7.7 °C/W |
| Storage Temperature | -65 to 150 °C |
| Operating Temperature | -40 to 85 °C |
| ESD Sensitivity (HBM) | Class 0, Passed 150V |

Typical Supply Current vs. Vdd

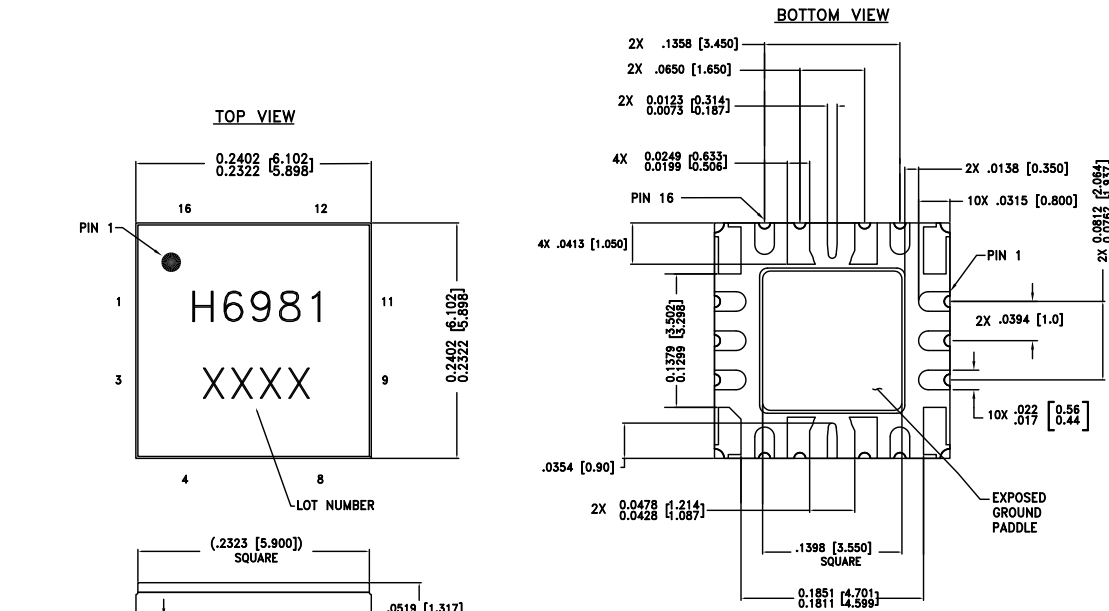
| Vdd (V) | Idd (mA) |
|---------|----------|
| +5 | 1100 |
| +5.5 | 1100 |
| +6 | 1100 |

Adjust Vgg to achieve Idd = 1100 mA



**ELECTROSTATIC SENSITIVE DEVICE
OBSERVE HANDLING PRECAUTIONS**

Outline Drawing



NOTES:

1. PACKAGE BODY MATERIAL: ALUMINA, WHITE
2. LEAD AND GROUND PADDLE PLATING: GOLD OVER NICKEL.
3. CHARACTERS TO BE BLACK INK MARKED WITH .018"MIN to .030"MAX HEIGHT REQUIREMENTS. UTILIZE MAXIMUM CHARACTER HEIGHT BASED ON LID DIMENSIONS AND BEST FIT. LOCATE APPROX. AS SHOWN.
4. ALL GROUND LEADS AND GROUND PADDLE MUST BE SOLDERED TO PCB RF GROUND.
5. REFER TO HITTITE APPLICATION NOTE FOR SUGGESTED PCB LAND PATTERN.

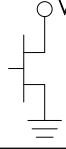
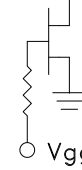

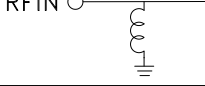
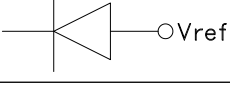
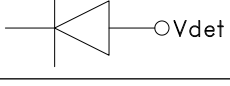
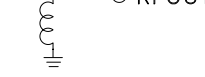
Package Information

| Part Number | Package Body Material | Lead Finish | MSL Rating [2] | Package Marking [1] |
|-------------|-----------------------|------------------|----------------|---------------------|
| HMC6981LS6 | ALUMINA WHITE | Gold over Nickel | N/A | H6981 XXXX |

[1] 4-Digit lot number XXXX

[2] Max peak reflow temperature of 260 °C

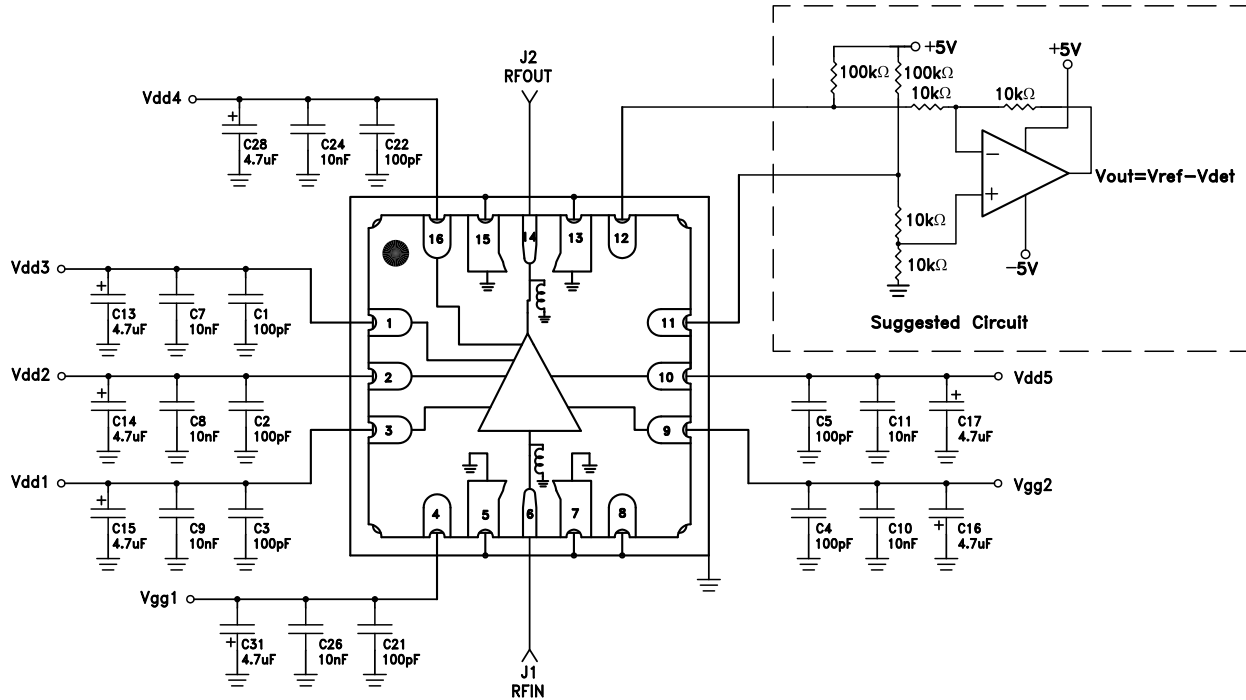

**GaAs pHEMT MMIC 2 WATT
POWER AMPLIFIER, 15 - 20 GHz**
Pin Descriptions

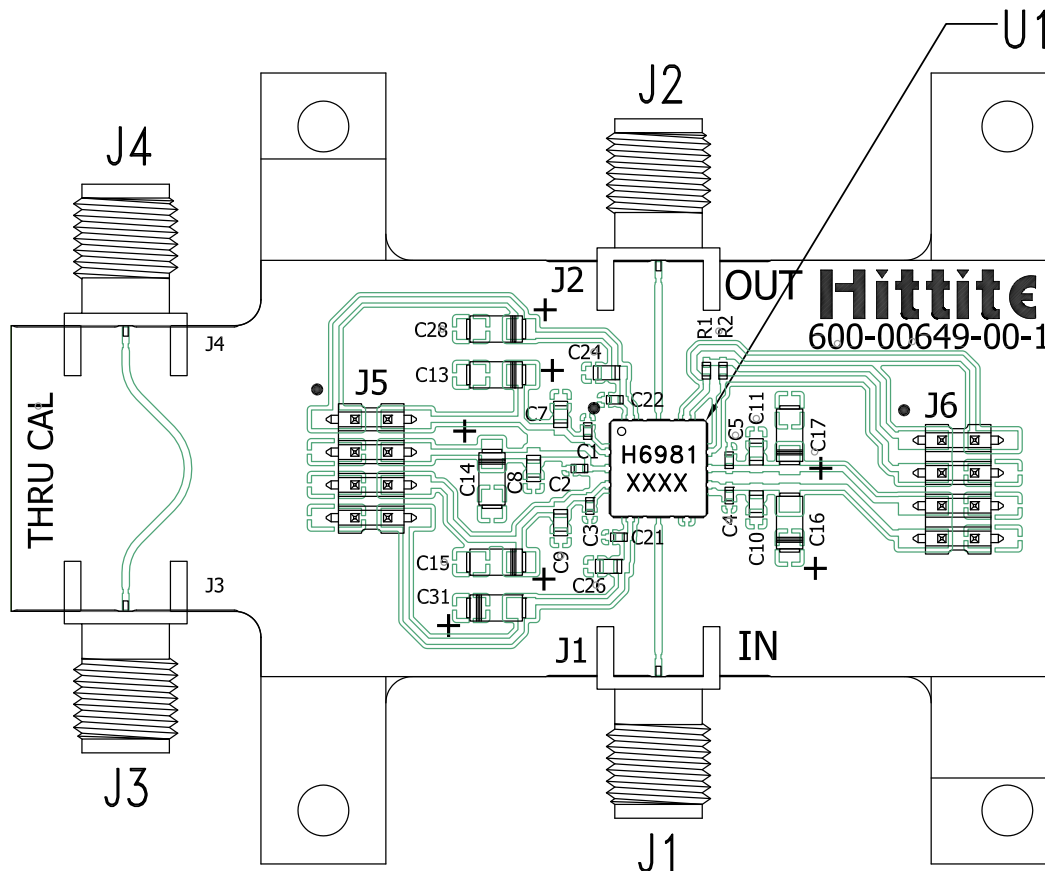
| Pad Number | Function | Description | Interface Schematic |
|-----------------|------------------------------|--|---|
| 1, 2, 3, 10, 16 | Vdd3, Vdd2, Vdd1, Vdd5, Vdd4 | Drain bias voltage. External bypass capacitors of 100 pF, 10 nF, and 4.7 uF are required for each pin. |  |
| 4, 9 | Vgg1, Vgg2 | Gate control for PA. Adjust Vgg to achieve recommended bias current. External bypass capacitors 100 pF, 10 nF, and 4.7 uF are required. Apply Vgg bias to either pin 4 or pin 9. |  |
| 5, 7, 13, 15 | GND | These pins and exposed ground paddle must be connected to RF/DC ground. |  |
| 6 | RFIN | This pin is DC coupled and matched to 50 Ohms. |  |
| 11 | Vref | DC voltage of diode biased through external resistor used for temperature compensation of Vdet. See Application Circuit. |  |
| 12 | Vdet | DC voltage representing RF output power rectified by diode which is biased through an external resistor. See Application Circuit. |  |
| 14 | RFOUT | This pin is DC coupled and matched to 50 Ohms. |  |



GaAs pHEMT MMIC 2 WATT POWER AMPLIFIER, 15 - 20 GHz

Application Circuit



Evaluation PCB

List of Materials for Evaluation PCB EVAL01-HMC6981LS6 [1]

| Item | Description |
|---------------------|-------------------------------|
| J1 - J4 | "K" Connector, SRI |
| J5, J6 | DC Pin |
| C1 - C5, C21, C22 | 100 pF Capacitor, 0402 Pkg. |
| C7 - C11, C24, C26 | 10000 pF Capacitor, 0603 Pkg. |
| C13 - C17, C28, C31 | 4.7 uF Capacitor, Case A Pkg. |
| R1, R2 | 42.6K Ohm Resistor, 0402 Pkg. |
| U1 | HMC6981LS6 Amplifier |
| PCB [2] | 600-00649-00 Eval Board |

[1] Reference this number when ordering complete evaluation PCB

[2] Circuit Board Material: Rogers 4350

The circuit board used in the application should use RF circuit design techniques. Signal lines should have 50 Ohm impedance while the package ground leads and exposed paddle should be connected directly to the ground plane similar to that shown. A sufficient number of via holes should be used to connect the top and bottom ground planes. The evaluation circuit board shown is available from Hittite upon request.