

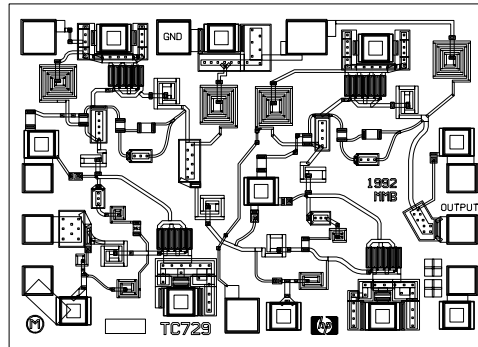
# 6–20 GHz High-Gain Amplifier

## Technical Data

### HMMC-5620

#### Features

- **Wide-Frequency Range:**  
6–20 GHz
- **High Gain:** 17 dB
- **Gain Flatness:**  $\pm 1.0$  dB
- **Return Loss:**  
Input -15 dB  
Output -15 dB
- **Single Bias Supply Operation**
- **Low DC Power Dissipation:**  
 $P_{DC} \sim 0.5$  Watts
- **Medium Power:**  
20 GHz:  $P_{-1dB}$ : 12 dBm  
 $P_{sat}$ : 13 dBm



Chip Size: 1410 x 1010  $\mu\text{m}$  (55.5 x 39.7 mils)  
 Chip Size Tolerance:  $\pm 10 \mu\text{m}$  ( $\pm 0.4$  mils)  
 Chip Thickness:  $127 \pm 15 \mu\text{m}$  ( $5.0 \pm 0.6$  mils)  
 Pad Dimensions: 80 x 80  $\mu\text{m}$  (2.95 x 2.95 mils), or larger

#### Description

The HMMC-5620 is a wideband GaAs MMIC Amplifier designed for medium output power and high gain over the 6 to 20 GHz frequency range. Four MESFET cascade stages provide high gain, while the single bias supply offers ease of use. E-Beam lithography is used to produce gate lengths of  $\approx 0.3 \mu\text{m}$ . The HMMC-5620 incorporates advanced MBE technology, Ti-Pt-Au gate metallization, silicon nitride passivation, and polyimide for scratch protection.

#### Absolute Maximum Ratings<sup>[1]</sup>

Symbol	Parameters/Conditions	Units	Min.	Max.
$V_{DD}$	Positive Drain Voltage	V		7.5
$I_{DD}$	Total Drain Current	mA		135
$P_{DC}$	DC Power Dissipation	watts		1.0
$P_{in}$	CW Input Power	dBm		20
$T_{ch}$	Operating Channel Temp.	$^{\circ}\text{C}$		+160
$T_{case}$	Operating Case Temp.	$^{\circ}\text{C}$	-55	
$T_{STG}$	Storage Temperature	$^{\circ}\text{C}$	-65	+165
$T_{max}$	Maximum Assembly Temp. (for 60 seconds maximum)	$^{\circ}\text{C}$		+300

#### Notes:

1. Operation in excess of any one of these conditions may result in permanent damage to this device.  $T_A = 25^{\circ}\text{C}$  except for  $T_{ch}$ ,  $T_{STG}$ , and  $T_{max}$ .

### HMMC-5620 DC Specifications/Physical Properties<sup>[1]</sup>

Symbol	Parameters and Test Conditions	Units	Min.	Typ.	Max.
$I_{DD}$	Drain Current ( $V_{DD} = +5.0\text{ V}$ )	mA	70	100	135
$I_{DD}$	Drain Current ( $V_{DD} = +7.0\text{ V}$ )	mA		105	
$\theta_{\text{ch-bs}}$	Thermal Resistance ( $T_{\text{backside}} = 25^\circ\text{C}$ )	$^\circ\text{C/W}$		70	

**Note:**

1. Measured in wafer form with  $T_{\text{chuck}} = 25^\circ\text{C}$ . (Except  $\theta_{\text{ch-bs}}$ ).

### HMMC-5620 RF Specifications/Physical Properties

$V_{DD} = 5.0\text{ V}$ ,  $I_{DD}(\text{Q}) = 100\text{ mA}$ ,  $Z_{\text{in}} = Z_o = 50\ \Omega$ <sup>[1]</sup>

Symbol	Parameters and Test Conditions	Units	Min.	Typ.	Max.
BW	Guaranteed Bandwidth	GHz	6		20
$S_{21}$	Small Signal Gain	dB	15	17	21
$\Delta S_{21}$	Small Signal Gain Flatness	dB		$\pm 1.0$	$\pm 1.25$
$RL_{\text{in}}$	Input Return Loss	dB		-15	-10
$RL_{\text{out}}$	Output Return Loss	dB		-15	-10
$S_{12}$	Reverse Isolation	dB		-55	
$P_{-1\text{dB}}$	Output Power @ 1 dB Gain Compression	dBm		12	
$P_{\text{sat}}$	Saturated Output Power	dBm		13	
$H_2$	Second Harmonic Power Level ( $6 < f_o < 20$ ) $P_o(f_o) = 10\text{ dBm}$	dBc		-30	
$H_3$	Third Harmonic Power Level ( $6 < f_o < 20$ ) $P_o(f_o) = 10\text{ dBm}$	dBc		-40	
NF	Noise Figure	dB		9.0	

**Note:**

1. Small-signal data measured in wafer form with  $T_{\text{chuck}} = 25^\circ\text{C}$ . Large-signal data measured on individual devices mounted in an HP83040 Series Modular Microcircuit Package at  $T_A = 25^\circ\text{C}$ .

## HMMC-5620 Applications

The HMMC-5620 amplifier is designed for use as a general purpose wideband, high gain stage in communication systems and microwave instrumentation. It is ideally suited for broadband applications requiring high gain and excellent port matches over a 6 to 20 GHz frequency range. Both RF input and output ports are AC-coupled on chip.

## Biasing and Operation

This amplifier is biased with a single positive drain supply ( $V_{DD}$ ). The recommended bias for the HMMC-5620 is  $V_{DD} = 5.0\text{ V}$ , which results in  $I_{DD} = 100\text{ mA}$  (Typ.). No

other bias supplies or connections to the device are required for 6 to 20 GHz operation. See Figure 3 for assembly information.

## Assembly Techniques

Solder die-attach using a fluxless AuSu solder preform is the recommended assembly method. Gold thermosonic wedge bonding with 0.7 or 1.0 mil diameter Au wire is recommended for D.C. bonds. For RF bonds, MWTC recommends low inductance mesh interconnections for best return loss performance. Tool force should be  $22 \pm 1\text{ gram}$ , stage temperature should be  $150 \pm 2^\circ\text{C}$ , and ultrasonic power and dura-

tion should be  $64 \pm 1\text{ dB}$  and  $76 \pm 8\text{ msec}$ , respectively. The bonding pad and chip backside metallization is gold.

For more detailed information see HP application note #999 "GaAs MMIC Assembly and Handling Guidelines."

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*GaAs MMICs are ESD sensitive. Proper precautions should be used when handling these devices.*

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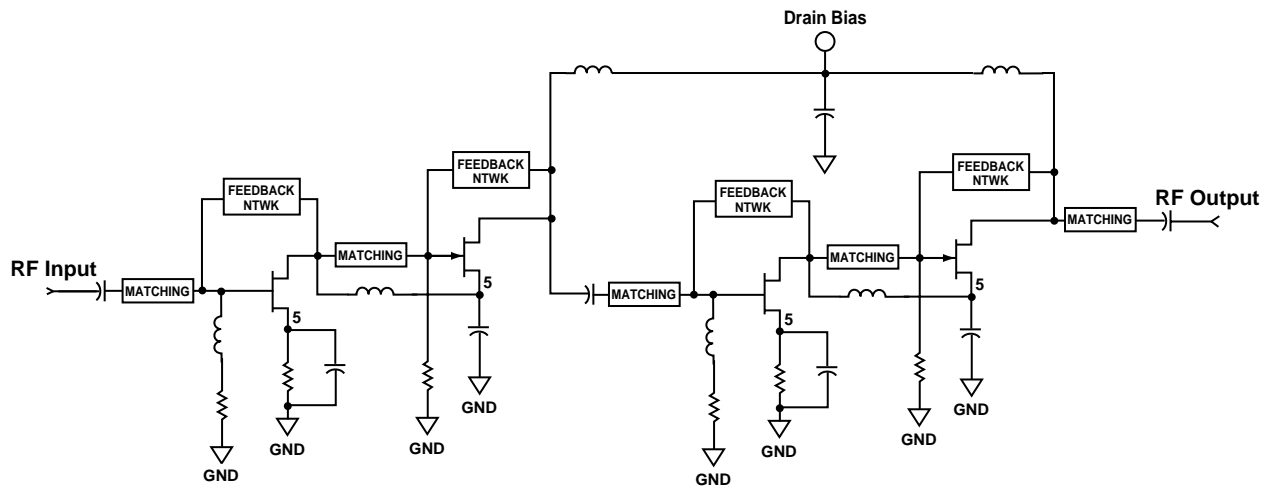


Figure 1. HMMC-5620 Schematic.

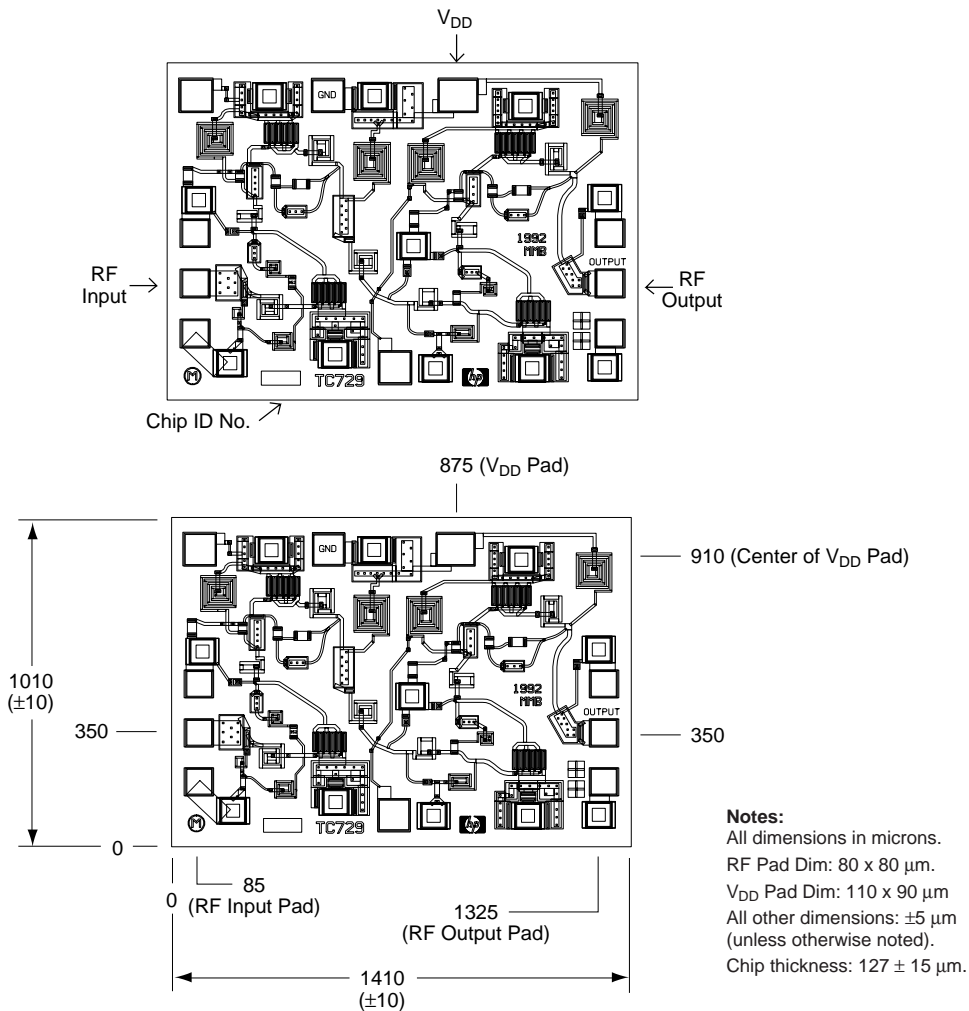


Figure 2. HMMC-5620 Bonding Pad Locations.

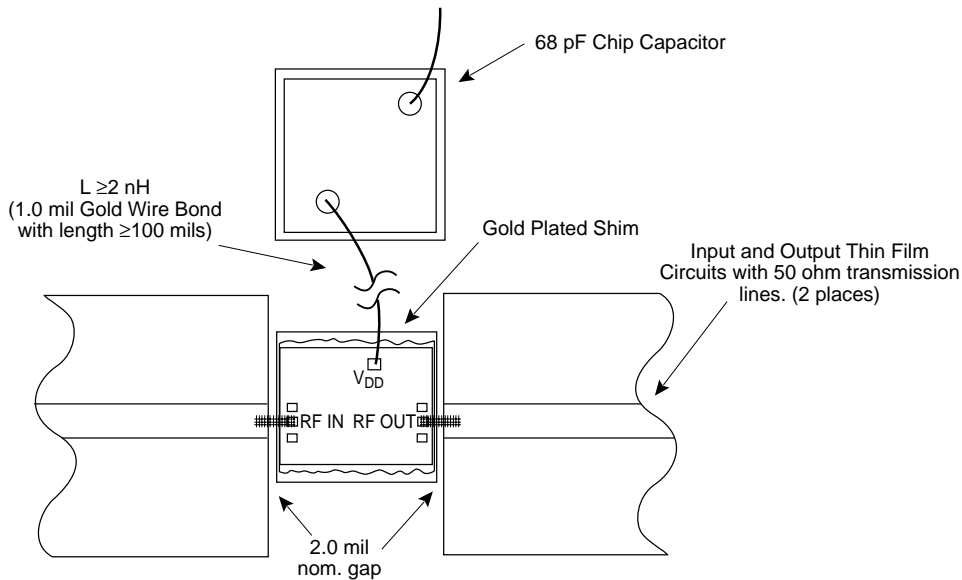


Figure 3. HMMC-5620 Assembly Diagram. (For 6.0 – 20.0 GHz Operation)

## HMMC-5620 Typical Performance

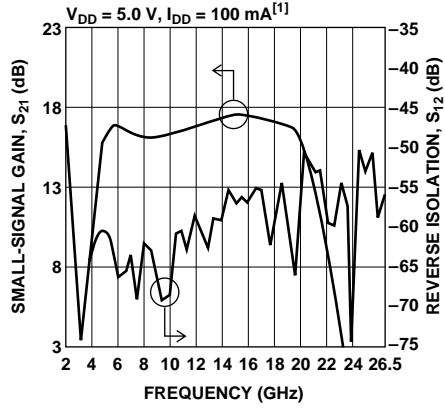


Figure 4. Typical Gain and Reverse Isolation vs. Frequency.

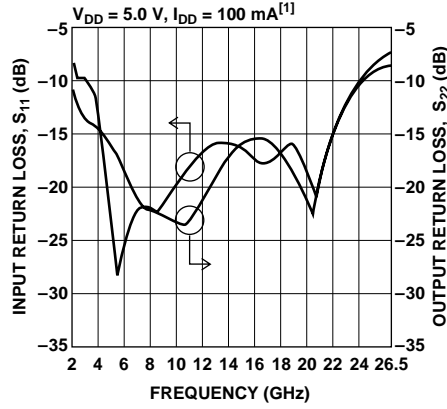


Figure 5. Typical Input and Output Return Loss vs. Frequency.

## Typical Scattering Parameters<sup>[1]</sup>, ( $T_{\text{chuck}} = 25^{\circ}\text{C}$ , $V_{\text{DD}} = 5.0\text{ V}$ , $I_{\text{DD}} = 100\text{ mA}$ , $Z_{\text{in}} = Z_0 = 50\ \Omega$ )

Freq. GHz	$S_{11}$			$S_{21}$			$S_{12}$			$S_{22}$		
	dB	Mag.	Ang.	dB	Mag.	Ang.	dB	Mag.	Ang.	dB	Mag.	Ang.
2.0	-10.7	0.292	-100.3	-46.1	0.0049	-174.7	-6.2	0.491	-52.2	-8.1	0.395	-152.2
3.0	-13.5	0.212	-117.5	-74.1	0.0002	114.0	3.5	1.489	-170.0	-10.1	0.311	-171.5
4.0	-14.6	0.186	-136.6	-63.1	0.0007	-122.1	13.0	4.486	82.2	-12.7	0.232	136.5
5.0	-15.8	0.162	-168.9	-60.4	0.0010	-161.8	16.0	6.310	-26.5	-21.7	0.082	61.5
6.0	-18.4	0.120	157.5	-66.5	0.0005	162.7	16.7	6.839	-116.8	-25.7	0.052	-86.6
7.0	-20.9	0.090	123.0	-62.7	0.0007	-175.3	16.3	6.531	173.2	-22.1	0.079	-131.4
8.0	-22.2	0.078	83.1	-61.3	0.0009	-178.0	16.0	6.310	114.2	-21.7	0.082	-150.6
9.0	-21.9	0.080	41.3	-66.5	0.0005	-62.4	16.0	6.310	60.2	-22.5	0.075	-156.7
10.0	-20.2	0.097	6.6	-68.1	0.0004	-159.3	16.1	6.383	9.0	-23.2	0.070	-152.9
11.0	-18.4	0.120	-21.0	-60.0	0.0010	-113.5	16.3	6.531	-40.7	-23.4	0.067	-143.0
12.0	-16.7	0.146	-46.4	-58.3	0.0012	-112.2	16.6	6.761	-89.9	-21.5	0.084	-136.8
13.0	-15.8	0.161	-70.0	-62.7	0.0007	-130.0	17.0	7.079	-139.4	-19.1	0.111	-133.7
14.0	-15.8	0.163	-90.0	-59.3	0.0011	-161.1	17.3	7.328	170.1	-17.2	0.137	-143.0
15.0	-16.4	0.151	-105.6	-57.5	0.0013	173.9	17.4	7.413	118.6	-16.0	0.159	-152.8
16.0	-17.5	0.134	-115.4	-57.1	0.0014	-165.9	17.5	7.499	66.0	-15.5	0.168	-167.9
17.0	-17.7	0.130	-114.1	-55.6	0.0017	175.5	17.3	7.328	12.3	-15.5	0.167	-179.7
18.0	-16.8	0.145	-118.4	-62.3	0.0008	98.2	17.0	7.079	-43.1	-16.5	0.149	162.9
19.0	-16.1	0.156	-131.6	-59.7	0.0010	112.8	16.7	6.839	-101.9	-17.7	0.130	145.2
20.0	-18.5	0.119	-143.8	-52.5	0.0024	72.9	16.0	6.310	-168.5	-20.8	0.091	93.0
21.0	-19.9	0.101	-108.1	-53.2	0.0022	-7.1	15.3	5.842	119.8	-20.4	0.096	-4.3
22.0	-14.2	0.195	-107.7	-59.3	0.0011	-8.0	10.7	3.414	54.2	-14.9	0.179	-63.6
23.0	-11.6	0.263	-125.6	-54.0	0.0020	-54.4	5.4	1.857	-0.4	-12.0	0.250	-93.3
24.0	-10.3	0.306	-142.2	-75.8	0.0002	-158.2	0.3	1.034	-47.5	-10.3	0.306	-110.4
25.0	-9.6	0.330	-157.2	-53.5	0.0021	-165.8	-4.5	0.595	-90.5	-9.0	0.353	-124.2
26.0	-9.2	0.347	-169.9	-59.0	0.0011	-137.5	-9.0	0.355	-131.1	-7.9	0.402	-134.3
26.5	-9.1	0.349	-357.4	-54.9	0.0018	78.2	-11.2	0.275	-511.3	-7.4	0.426	-140.2

**Note:**

1. Data obtained from on-wafer measurements.

## HMMC-5620 Typical Performance

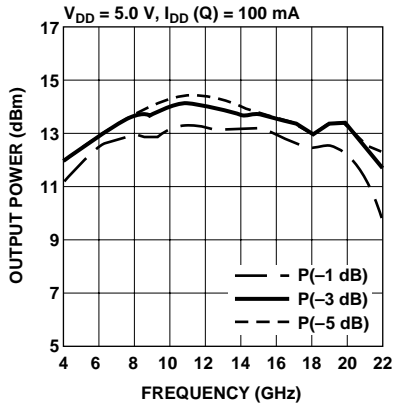


Figure 6. Typical Output Power vs. Frequency (with 5 V bias.)

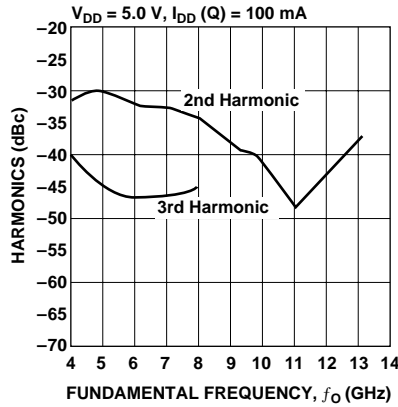


Figure 7. Typical Second and Third Harmonics vs. Fundamental Frequency at  $P_{OUT} = 10 \text{ dBm}$ .

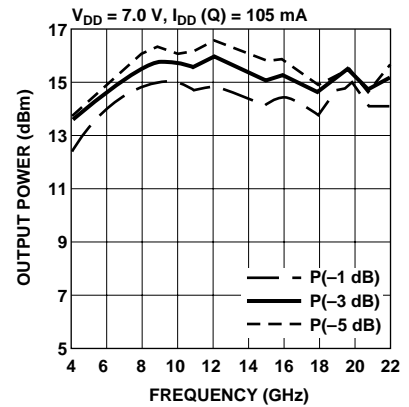


Figure 8. Typical Output Power vs. Frequency (with 7 V bias).

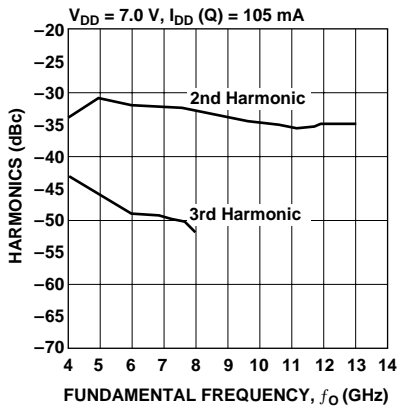


Figure 9. Typical Second and Third Harmonics vs. Fundamental Frequency at  $P_{OUT} = 10 \text{ dBm}$ .

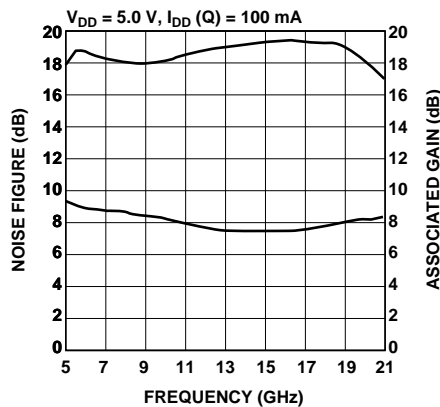


Figure 10. Typical Noise Figure Performance vs. Frequency.

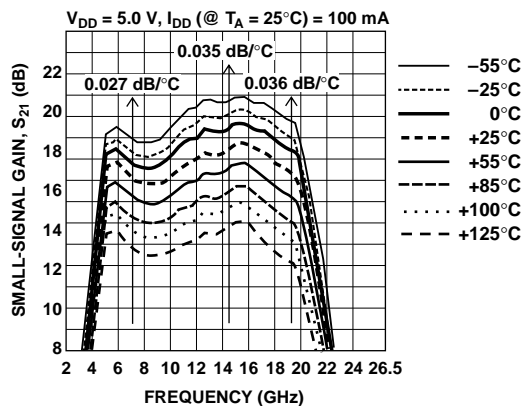


Figure 11. Typical Small-Signal Gain vs. Temperature.

This data sheet contains a variety of typical and guaranteed performance data. The information supplied should not be interpreted as a complete list of circuit specifications. In this data sheet the term *typical* refers to the 50th percentile performance. For additional information contact your local HP sales representative.