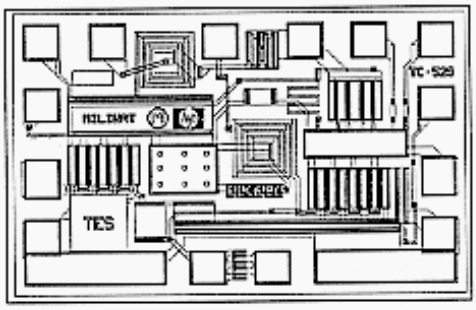
HEWLETT® PACKARD

4 GHz Wideband Preamplifier/Amplifier

HMMC-5003



Chip Size:	1120 × 700 µm (44.1 × 27.6 mils)
Chip Size Tolerance:	± 10 µm (± 0.4 mils)
Chip Thickness:	127 ± 15 µm (5.0 ± 0.6 mils)
Pad Dimensions:	85 × 90 µm (3.35 × 3.54 mils)

Features

- Frequency Range: DC - 4 GHz
- Flat Response: ± 0.75 dB 5 MHz - 4 GHz
- High Gain: 11 dB
- High Isolation: -37 dB
- Return Loss: Input -15 dB Output -15 dB
- High Power Output: 19.5 dBm Saturated
- Harmonics: -35 dBc @ P_{out} = 10 dBm
- Noise Figure: 7.5 dB
- Unconditionally Stable

Description

The HMMC-5003 is a monolithic, wideband preamplifier designed and fabricated using HP's GaAs RFIC process. It features low distortion and delivers (typically) 19.5 dBm saturated output power into 50 Ω to at least 4.0 GHz. The incorporates a 1.0 µm Ti-Pt-Au gate, silicon nitride passivation and polyimide for scratch protection.

Absolute Maximum Ratings†

Symbol	Parameters/Conditions	Min.	Max.	Units
V_{DD}	Drain Supply		+9.5	volts
V_{SS}	Source Supply	-6.5	-3.0	volts
P_{IN}	CW Input Power		25	dBm
T_{case}	Operating Case Temp.††	-55	125	°C
T_{stg}	Storage Temperature	-65	165	°C
T_{max}	Maximum Assembly Temp. (for 60 seconds maximum)		300	°C

† Operation in excess of any one of these conditions may result in permanent damage to this device. Parameters specified at T_A = 25°C, except for T_{case}, T_{stg}, and T_{max}.

†† Max. continuous operating temperature to achieve $1x10^6$ hours MTTF, while operating with V_{DD} = +8.5 V and V_{SS} = -5V. Derate MTTF by a factor of 2 for every 8°C above this temperature.

DC Specifications

Symbol	Parameters/Conditions	Min.	Typ.	Max.	Units
I_{DD}	Positive Supply Current† V_{DD} = +8.5 volts, V_{SS} = -5 volts	125	155	185	mA
I_{SS}	Negative Supply Current† V_{DD} = +8.5 volts, V_{SS} = -5 volts	8	12	16	mA
P_{DC}	DC Power Dissipation V_{DD} = +8.5 volts, V_{SS} = -5 volts		1.3		Watts

† Data obtained from on-wafer measurements @ T_{chuck} = 25°C. All voltages specified at device pads.

RF Specifications

(V_{DD} = +8.5V, V_{SS} = -5V, Z_{in} = Z_{out} = 50Ω)†

Symbol	Parameters/Conditions	Min.	Typ.	Max.	Units
BW	Guaranteed Operating Bandwidth††	5		4000	MHz
S_{21}	Small-Signal Gain	9	11	13	dB
ΔS_{21}	Small-Signal Gain Flatness		± 0.75		dB
RL_{IN}	Input Return Loss		-15		dB
RL_{OUT}	Output Return Loss		-15		dB
S_{12}	Reverse Isolation		-37		dB
P_{-1dB}	Output Power @ -1dB Gain Compression		17.5		dBm
P_{SAT}	Saturated Output Power (@-3dB Gain Compression)	18	19.5		dBm
H_2, H_3	Harmonics (P_{out} with fundamental @ 10 dBm)		-35	-30	dBc
NF	Noise Figure ($f_0 \geq$ 300 MHz)		7.5		dB

†Data obtained from measurements on individual devices mounted in HP83040 Series Modular Microcircuit Packages @ T_{case} = 25°C.

††Performance may be extended to lower frequencies with an additional off-chip capacitor. Upper f_{3dB} = 6.0 GHz; lower f_{3dB} = 800 KHz without optional L.F.E. capacitor.

Applications

The HMMC-5003 is designed for use as a broadband power preamplifier or stand-alone amplifier in communication systems and RF instrumentation. It is ideally suited for DC to 4 GHz applications where medium output power, flat gain, low distortion, and clean pulse response are required.

Biasing

This device should be biased such that V_{SS} = -5V and V_{DD} = +8.5V. These voltages are applied directly to the pads labeled V_{DD} and V_{SS}. The V_{DD} Bypass and V_{SS} Bypass pads should be connected to bypass capacitors near the chip as shown in Figure 3. Note: the device should NEVER be biased through the V_{DD} Bypass pad.

The input and output of the HMMC-5003 are DC coupled. The input pad will float at ~-1V and the output pad will float at ~ +4.5V. To prevent the disturbance of internal bias nodes, DC blocking capacitors or level shift stages must be used on the input and output.

When assembled as shown in Figure 3, the HMMC-5003 will function from 5 MHz to 4 GHz; however, the low frequency performance of this device may be extended to DC. The low frequency corner of the device can be modified by adding capacitance in series between the two Low-Frequency Extension pads. For example, a 10nF monoblock capacitor added between these pads results in the low frequency corner below 1 kHz. For performance down to DC, the Low- Frequency Extension pads may be shorted together with a bond wire; with this configuration however, the voltage on the V_{SS} pad must be adjusted during initial turn on such that the DC voltage on the output pad is approximately 4.5 Volts. Some RF performance parameters will be affected. With the capacitive extension technique, no adjustments are required. In addition, these frequency extension techniques are not sensitive to bond wire inductances due to on-chip isolation resistors.

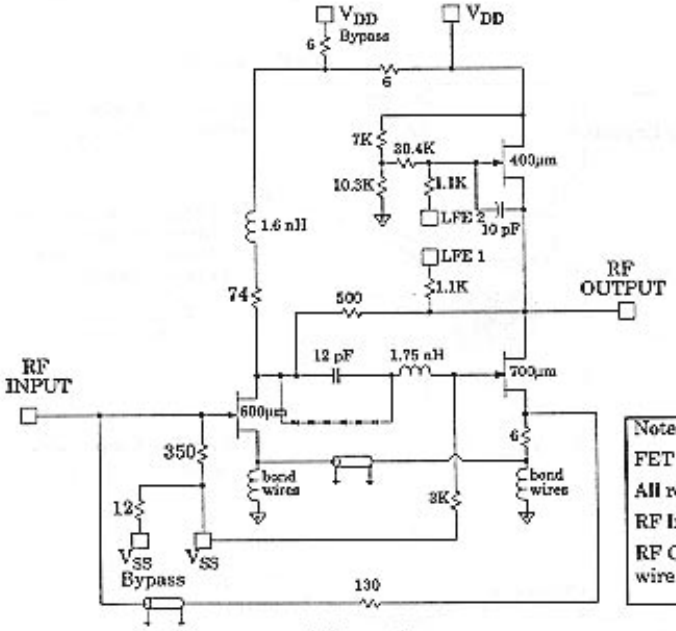
There are no power supply sequencing requirements for the HMMC-5003.

Assembly Techniques

Solder die attach using a AuSn solder preform is the recommended assembly method. Gold thermosonic wedge bonding with 0.7 or 1.0 mil wire is recommended for all bonds. Tool force should be 22 grams ±1 gram, stage temperature is 150 ± 2°C, and ultrasonic power of 64 ± 1 dB and 76 ± 8msec, respectively. The top and bottom metallization is gold.

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

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



Notes:
FET gate periphery in microns.
All resistors in ohms.
RF Input designed to have 1 nH bond wire.
RF Output designed to have 0.5 nH. bond wire.

Figure 1.
HMMC-5003 Schematic

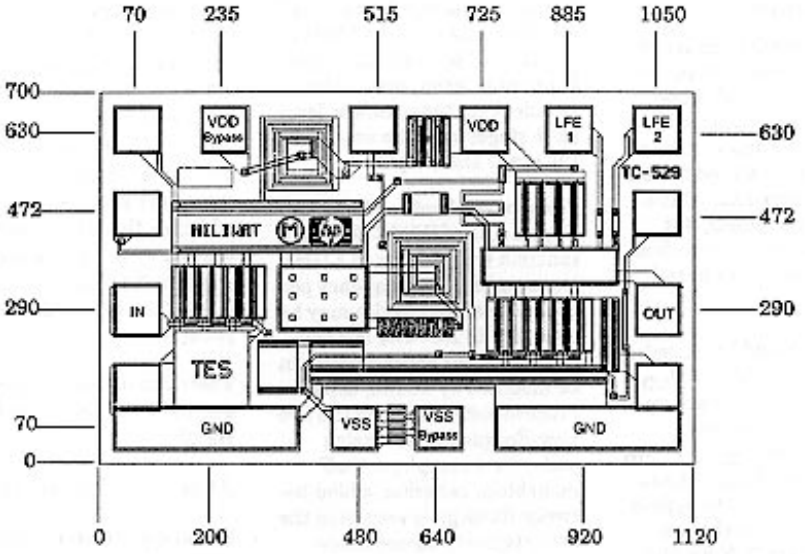
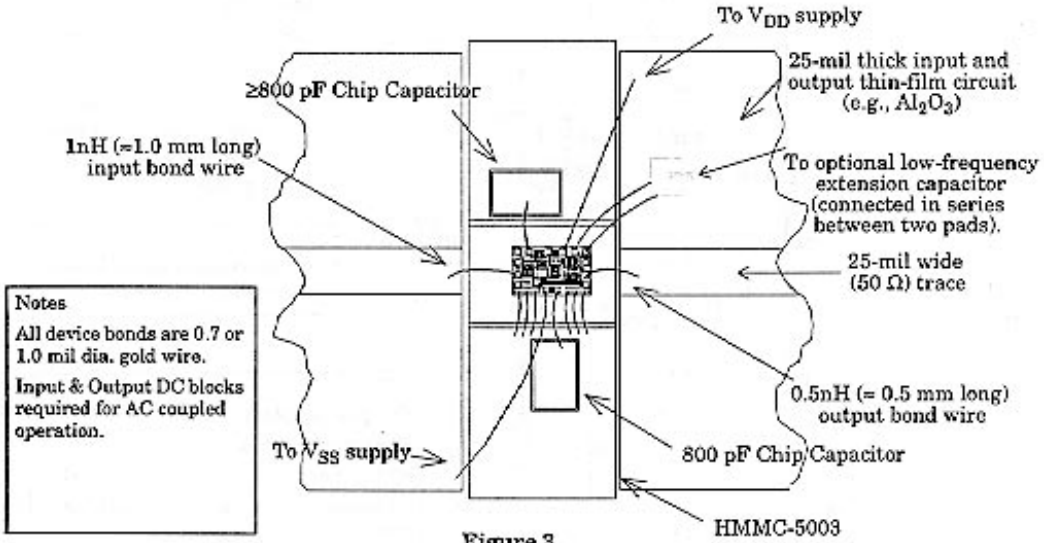


Figure 2.
HMMC-5003 Bond Pad Locations

Notes
All dimensions in microns.
Large GND Pad: 350 × 85 µm.
All other pads: ≥ 85 × 90 µm.



Notes
All device bonds are 0.7 or 1.0 mil dia. gold wire.
Input & Output DC blocks required for AC coupled operation.

Figure 3.
HMMC-5003 Assembly Diagram.
(for 5 MHz to 4 GHz Operation)

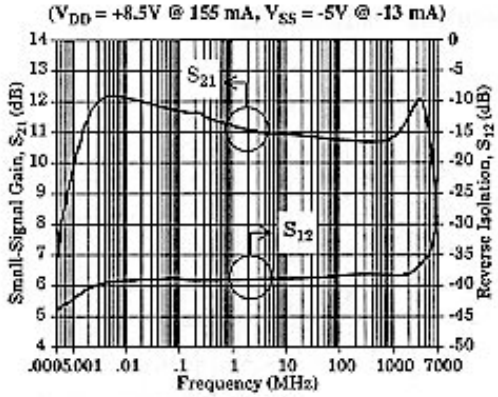


Figure 4.
Typical† Gain and Reverse Isolation vs. Frequency

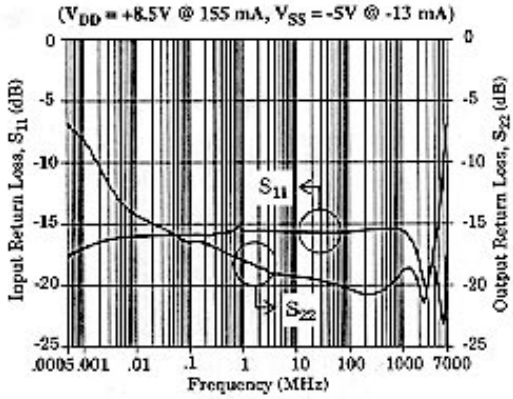


Figure 5.
Typical† Input and Output Return Loss vs. Frequency

Typical S-Parameters†

(V_{DD} = +8.5V @ 155mA, V_{SS} = -5V @ -13mA, Z_{in} = Z_{out} = 50Ω)

Freq.††	S_{11}			S_{12}			S_{21}			S_{22}		
(MHz)	dB	Mag	Ang	dB	Mag	Ang	dB	Mag	Ang	dB	Mag	Ang
0.01	-16.0	0.156	4.92	-39.2	0.011	21.65	12.2	4.070	23.24	-14.2	0.195	125.97
0.02	-15.9	0.160	4.46	-38.9	0.011	15.71	12.1	4.035	17.30	-14.9	0.180	93.14
0.05	-15.8	0.162	3.03	-38.9	0.011	7.26	11.9	3.942	8.86	-15.8	0.162	50.44
0.1	-15.8	0.162	2.35	-38.9	0.011	3.73	11.8	3.896	5.32	-16.5	0.149	28.10
0.2	-15.9	0.160	1.98	-39.2	0.012	1.91	11.7	3.852	3.47	-16.6	0.148	15.27
0.5	-15.7	0.163	1.76	-39.2	0.012	0.85	11.5	3.764	2.37	-17.4	0.135	7.43
1	-15.5	0.167	1.70	-39.1	0.012	0.57	11.3	3.678	1.60	-18.0	0.126	5.09
2	-15.5	0.167	1.68	-38.9	0.011	0.57	11.2	3.633	1.28	-18.6	0.117	4.39
5	-15.5	0.167	1.68	-38.5	0.012	0.87	11.1	3.595	0.68	-19.1	0.111	2.93
10	-15.7	0.163	1.43	-38.8	0.012	1.43	11.0	3.559	-.068	-19.3	0.108	1.10
20	-15.9	0.160	1.21	-38.9	0.012	2.12	10.9	3.503	-1.98	-19.6	0.105	-0.51
50	-15.7	0.163	-0.11	-38.6	0.012	2.74	10.8	3.458	-2.72	-19.9	0.102	-7.13
100	-15.6	0.165	-2.18	-38.4	0.012	3.00	10.8	3.448	-4.31	-20.3	0.096	-10.68
250	-15.5	0.169	-8.35	-38.1	0.012	2.57	10.7	3.429	-9.62	-20.8	0.092	-18.91
500	-15.4	0.170	-17.66	-38.1	0.012	3.64	10.7	3.418	-18.41	-20.2	0.098	-31.64
750	-15.4	0.170	-25.85	-38.2	0.012	5.33	10.7	3.432	-27.26	-19.5	0.105	-41.23
1000	-15.5	0.167	-33.01	-38.3	0.012	7.38	10.8	3.476	-36.09	-18.9	0.113	-47.49
1500	-16.4	0.151	-44.75	-38.3	0.012	13.26	11.1	3.567	-54.72	-18.8	0.115	-57.55
2000	-17.9	0.127	-57.22	-38.1	0.012	18.83	11.5	3.747	-74.27	-20.1	0.099	-74.30
2500	-19.9	0.102	-78.00	-37.6	0.013	24.34	11.8	3.912	-96.08	-21.3	0.086	-108.76
3000	-20.2	0.098	-109.02	-36.9	0.014	27.21	11.9	3.995	-119.12	-19.5	0.106	-146.05
3500	-18.2	0.123	-122.10	-36.2	0.015	30.45	11.9	3.992	-142.02	-18.4	0.121	-159.93
4000	-16.7	0.146	-135.85	-35.7	0.016	33.14	11.8	3.874	-165.48	-18.6	0.117	-177.74
4500	-15.4	0.170	-148.64	-35.2	0.017	37.56	11.3	3.687	171.49	-19.9	0.102	163.75
5000	-13.9	0.203	-161.49	-34.5	0.019	42.55	10.8	3.476	148.98	-21.3	0.086	145.69
5500	-11.9	0.254	-173.10	-33.4	0.021	47.70	10.3	3.261	126.59	-22.6	0.075	136.64
6000	-9.8	0.323	177.28	-31.8	0.026	51.56	9.6	3.030	103.81	-23.1	0.070	149.34
6500	-8.0	0.399	168.26	-30.0	0.032	52.35	8.8	2.754	80.58	-20.4	0.096	173.50
7000	-6.6	0.468	158.10	-28.3	0.038	50.50	7.7	2.420	57.42	-16.5	0.149	-177.22
7500	-5.6	0.525	146.07	-26.6	0.047	46.16	6.2	2.042	35.24	-13.8	0.204	-179.48
8000	-4.9	0.570	132.74	-25.3	0.055	39.45	4.4	1.663	15.01	-12.2	0.246	172.16

† Data obtained from measurements on an individual device mounted in an HP83040 Series Modular Package @ T_{case} = 25°C.
†† All data listed measured with a 10 nF monoblock capacitor connected in series between two on-chip low-frequency extension pads.

Additional HMMC-5003 Performance Characteristics

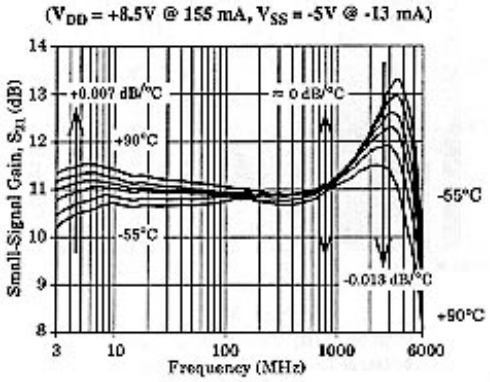


Figure 6.
Typical Small-Signal Gain vs. Temperature

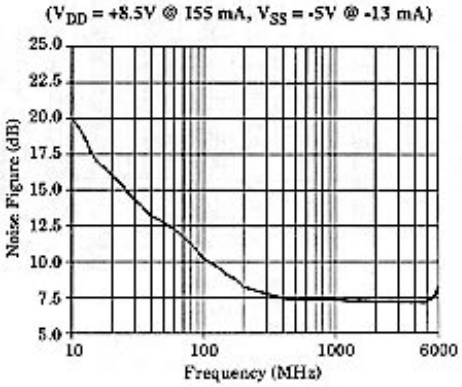


Figure 7.
Typical Noise Figure Performance

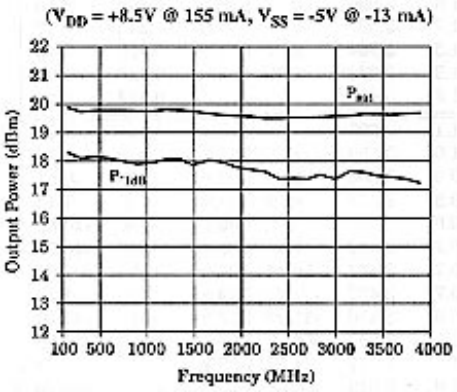


Figure 8.
Typical Output Power @ 1dB Gain Compression (P_{-1dB}) and 3dB Gain Compression (P_{sat}) vs. Frequency

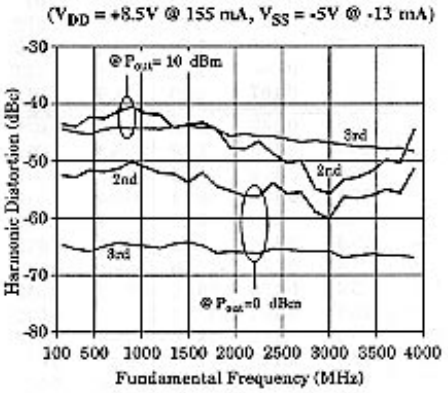


Figure 9.
Typical Second and Third Harmonics vs. Fundamental Frequency at P_{out} = 10 & 0 dBm

Note:

All data measured on individual devices mounted in an HP83040 Series Modular Microcircuit Package @ T_{case} = 25°C, except where noted.

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.

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