Agilent Technologies
Innovating the HP Way

3 GHz Wideband Power Amplifier

Technical Data

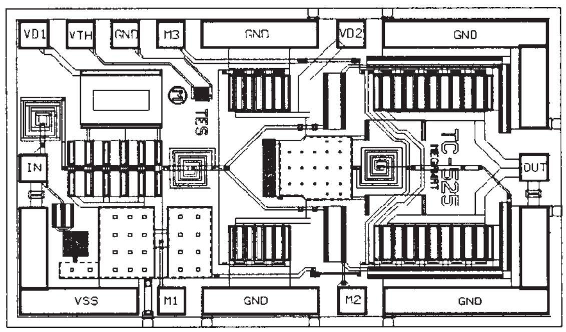
HMMC-5004

Features

- **Frequency Range:** 100 kHz – 3 GHz
- **High Gain:** 19 dB
- **Flat Response:** ±1 dB 10 MHz – 3 GHz
- **High Isolation:** -50 dB
- **Return Loss:** Input -20 dB Output -8 dB
- **High Power Output:** 26.5 dBm Saturated
- **Harmonics:** -35 dBc @ P_{out} = 21 dBm
- **Unconditionally Stable**

Description

The HMMC-5004 is a monolithic, wideband amplifier designed and fabricated using Agilent's GaAs RFIC process. It features low distortion and delivers (typically) 26.5 dBm saturated output power into 50 Ω over at least a 100 kHz to 3.0 GHz frequency range. The HMMC-5004 incorporates a 1.0 µm Ti-Pt-Au gate, silicon nitride passivation and polyimide for scratch protection.



Chip Size:	1530 x 910 µm (60.2 x 35.8 mils)
Chip Size Tolerance:	±10 µm (±0.4 mils)
Chip Thickness:	127 ± 15 µm (5.0 ± 0.6 mils)
Pad Dimensions:	75 x 75 µm (2.95 x 2.95 mils), or larger

Absolute Maximum Ratings[1]

Symbol	Parameters/Conditions	Units	Min.	Max.
V_{D1}	Stage 1 Drain Supply	volts		+10
V_{D2}	Driver Drain Supply	volts		+5.2
V_{D3}	Output Drain Supply	volts		+9
V_{SS}	Source Supply	volts	-8	-3.5
P_{in}	CW Input Power	dBm		23
T_{case}	Operating Case Temperature[2]	°C	-55	90
T_{stg}	Storage Temperature	°C	-65	+165
T_{max}	Max. Assembly Temperature (for 60 seconds maximum)	°C		+300

Notes:

1. 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}.
2. Max. continuous operating temperature to achieve 1×10^6 hours MTTF, while operating with V_{D1} = V_{D3} +8 V, V_{D2} = +5 V, V_{SS} = -5 V. Derate MTTF by a factor of 2 for every 8°C above this temperature.

HMMC-5004 DC Specifications/Physical Properties[1], T_{chuck} = 25°C

Symbol	Parameters/Conditions	Units	Min.	Typ.	Max.
I_{D1}	First Stage Drain Current ($V_{D1} = V_{D3}$ = +8 V, V_{D2} = +4.7 V, V_{SS} = -5 V)	mA	35	42	50
I_{D2}	Second Stage Drain Current ($V_{D1} = V_{D3}$ = +8 V, V_{D2} = +4.7 V, V_{SS} = -5 V)	mA	95	125	155
I_{D3}	Third Stage Drain Current ($V_{D1} = V_{D3}$ = +8 V, V_{D2} = +4.7 V, V_{SS} = -5 V)	mA	210	240	295
I_{SS}	Source Supply Current ($V_{D1} = V_{D3}$ = +8 V, V_{D2} = +4.7 V, V_{SS} = -5 V)	mA	60	75	95
P_{DC}	DC Power Dissipation ($V_{D1} = V_{D3}$ = +8 V, V_{D2} = +4.7 V, V_{SS} = -5 V)	Watts		3.2	

Note:

1. Data obtained from on-wafer measurements. All voltages specified at device pads.

RF Specifications[1], $V_{D1} = V_{D3}$ = +8 V, V_{D2} = +4.7 V, V_{SS} = -5 V, $Z_{in} = Z_{out}$ = 50 Ω

Symbol	Parameters/Conditions	Units	Min.	Typ.	Max.
BW	Guaranteed Operating Bandwidth[2]	GHz	.01		3
S_{21}	Small Signal Gain	dB	17	19	22
ΔS_{21}	Small Signal Gain Flatness	dB		±1	
RL_{in}	Input Return Loss	dB		-20	
RL_{out}	Output Return Loss	dB		-8	
S_{12}	Reverse Isolation	dB		-50	
P_{-1dB}	Output Power @ 1 dB Gain Compression	dBm		25	
P_{sat}	Saturated Output Power	dBm	25	26.5	
H_2, H_3	Harmonics (P_{out} @ fundamental = 21 dBm)	dBc		-35	-30
NF	Noise Figure (f_0 > 100 MHz)	dB		10	

Notes:

1. Data obtained from measurements on individual devices mounted in 83040 Series Modular Microcircuit Packages @ T_{case} = 25°C.
2. Performance may be extended to lower frequencies through the use of off-chip circuitry. Upper corner frequency ≈ 4.3 GHz.

Applications
The HMMC-5004 is designed for use as a broadband power amplifier in communication systems and microwave instrumentation. It is ideally suited for 100 kHz to 3 GHz applications where high output power, flat gain and low distortion are required.

Biasing
This device should be biased such that V_{SS} = -5 V, V_{D1} = V_{D3} = +8 V, and V_{D2} = +5 V. This may be accomplished in several ways. Three separate supplies may be used to directly provide the required voltages. Alternatively, two supplies (-5, +8 V) may be used. In the latter case, the +5 V bias for V_{D2} may be derived from the +8 supply with a variable resistor or regulator.

In addition to applying the proper voltages to the device, the off-chip impedances presented to V_{SS}, V_{D2}, and V_{D3} must be controlled. In particular, the V_{SS} pad must be bypassed to provide an RF ground while V_{D2} and V_{D3} must be biased through a high impedance across the desired operating frequency range. This high impedance bias may be accomplished using chokes, active loads, or a combination of these components. V_{D1} bypassing is not critical.

To prevent damage to the device, the V_{SS} supply should be turned on before the positive supplies during power up, and turned off after the positive supplies during power down. V_{SS} must never be open circuited during operation.

The input and output of the HMMC-5004 are DC coupled. The input pad will float at -5 V while the output pad is used to provide the V_{D3} bias and as a result will be at +8V. To prevent the disturbance of internal bias nodes, DC blocking capacitors must be used on the input and output. The pads labelled VTH, M1, M2, and M3 are internal voltage monitor points and may be ignored.

Assembly Techniques
Solder die attach using a AuSn solder preform is the recommended assembly method. Gold thermosonic wedge bonding with 0.7 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 ± 8 msec, respectively. The top and bottom metallization is gold.

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

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

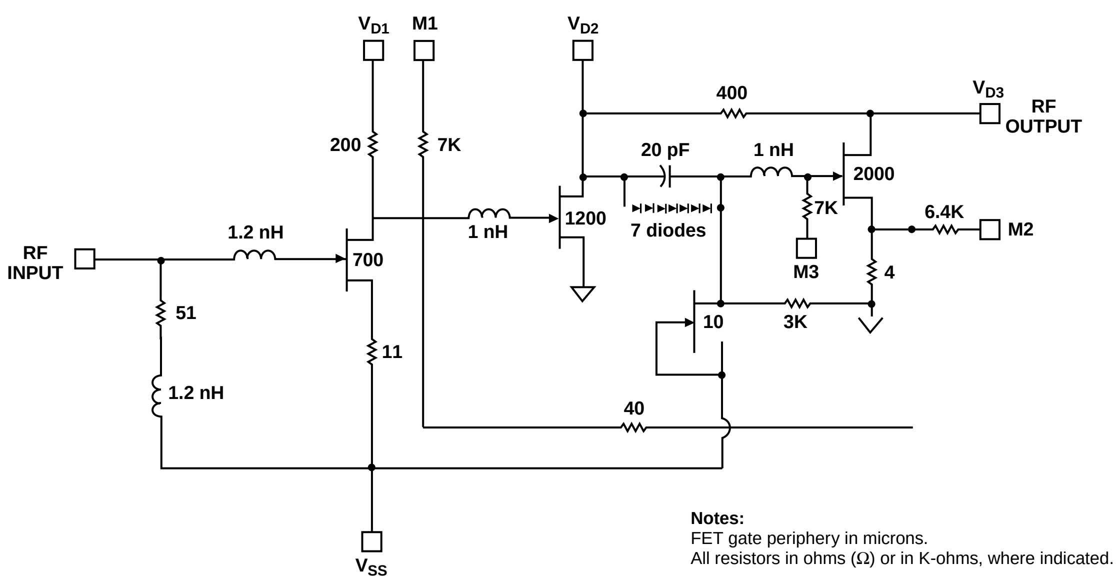
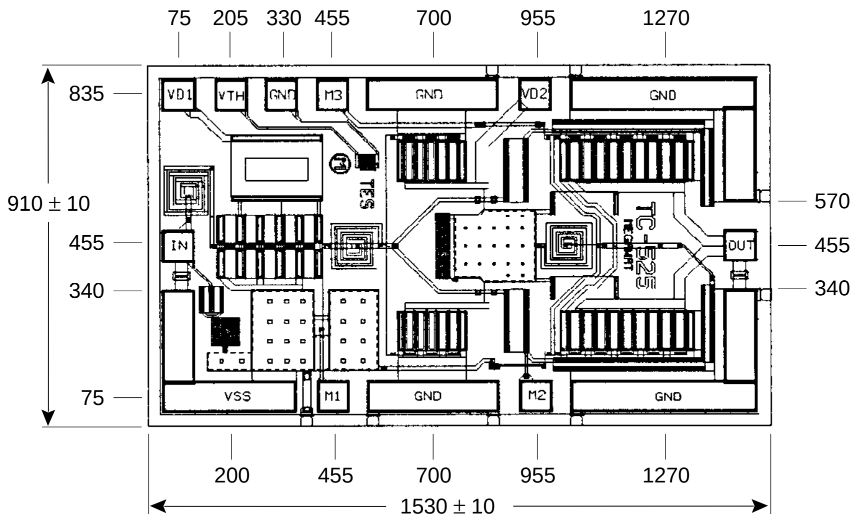


Figure 1. HMMC-5004 Schematic.



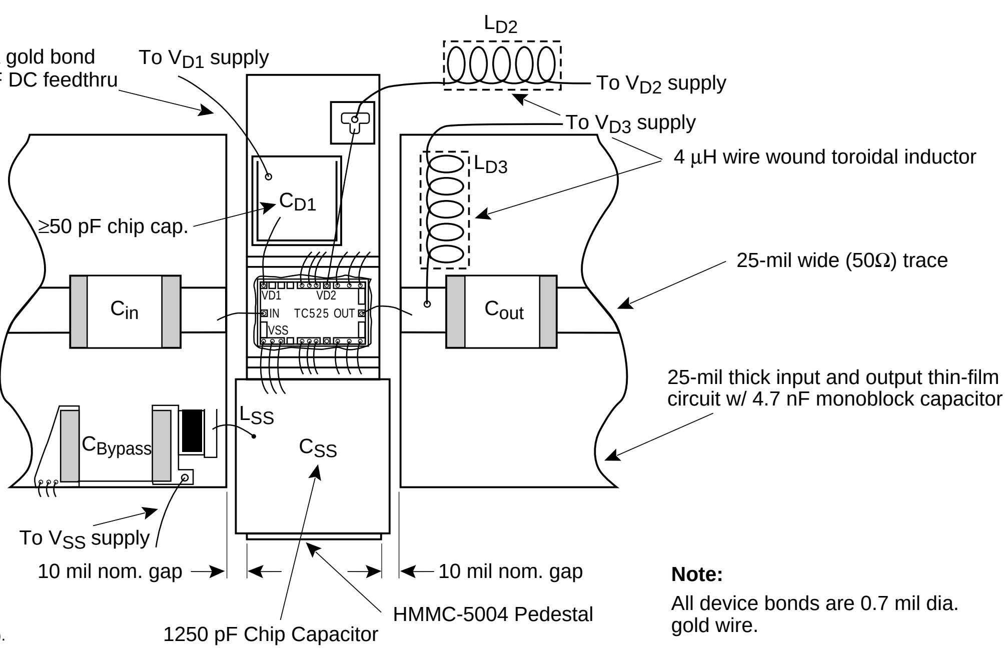
Notes:
All dimensions in microns.
Small Pad Dim: 75 x 75 µm.
V_{SS} Pad Dim: 325 x 75 µm.
GND1 & 2 Pad Dim: 320 x 75 µm.
GND3 & 4 Pad Dim: 450 x 75 µm.
All Tolerances: ±5 µm (unless otherwise noted).
Chip Thickness: 127 ± 15 µm.

Figure 2. HMMC-5004 Bond Pad Locations.

External Circuitry Guidelines[1]

Component	Value	Units
C_{in}, C_{out}	≥4.7	nF
C_{D1}	≥50	pF
C_{SS}	≥1250	pF
C_{Bypass}	≥.01	µF
R	~2.5	Ω
L_{D2}	≥4	µH
L_{D3}	≥4	µH
L_{SS}	≤5	nH

Note 1: Choose length of L_{SS} bond such that $L_{SS} \le R2C_{SS} - (L_R + C_{LBypass})$.



Note:
All device bonds are 0.7 mil dia. gold wire.

Figure 3. HMMC-5003 Assembly Diagram (for 10 MHz to 3 GHz Operation).

HMMC-5004 Typical Performance, $V_{D1} = V_{D3} = +8.0\,V$, $V_{D2} = +4.7\,V$, $V_{SS} = -5\,V$ [1]

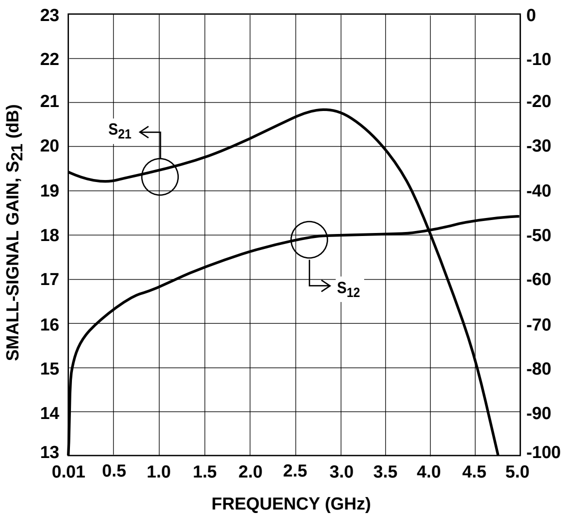


Figure 4. Typical Gain and Reverse Isolation vs. Frequency.

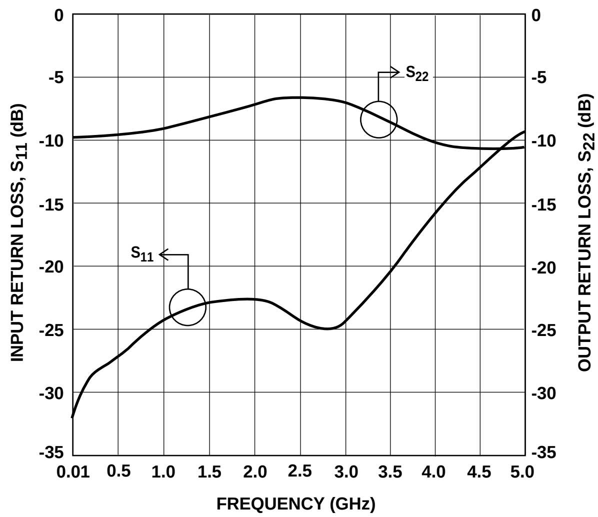


Figure 5. Typical Input and Output Return Loss vs. Frequency.

HMMC-5004 Typical S-Parameters[1] ($V_{D1} = V_{D3} = +8\,V$, $V_{D2} = +4.7\,V$, $V_{SS} = -5\,V$, $Z_{in} = Z_{out} = 50\,\Omega$)

Freq. MHz	S_{11}			S_{12}			S_{21}			S_{22}		
	dB	Mag	Ang	dB	Mag	Ang	dB	Mag	Ang	dB	Mag	Ang
0.1	-32.0	0.025	-84.2	-99.9	.00001	-114.6	19.4	9.372	-162.1	-9.4	0.338	3.2
1	-31.9	0.025	-79.4	-95.2	.00003	-113.9	19.4	9.370	-166.2	-9.4	0.336	1.1
10	-31.8	0.026	-76.6	-89.1	.00005	-107.1	19.4	9.353	-169.8	-9.5	0.335	-2.6
20	-31.4	0.027	-73.5	-83.4	.00007	-99.5	19.4	9.334	-171.6	-9.6	0.331	-3.8
50	-30.4	0.030	-64.2	-79.0	0.0001	-76.7	19.3	9.275	-176.7	-9.7	0.327	-4.2
100	-29.3	0.034	-47.5	-75.1	0.0001	-59.6	19.3	9.215	175.9	-9.8	0.323	-5.8
250	-28.0	0.040	-10.3	-70.9	0.0001	86.8	19.2	9.070	163.7	-9.6	0.331	-17.0
500	-27.0	0.045	17.2	-66.3	0.0003	95.0	19.2	9.142	145.4	-9.6	0.331	-32.3
750	-25.4	0.054	26.3	-63.3	0.0006	99.1	19.3	9.193	127.8	-9.4	0.338	-47.5
1000	-24.1	0.062	27.9	-61.7	0.0008	99.2	19.4	9.309	109.8	-9.1	0.351	-62.4
1250	-23.3	0.069	26.9	-59.0	0.0011	99.3	19.5	9.472	91.7	-8.7	0.367	-76.9
1500	-22.7	0.073	23.0	-57.5	0.0013	98.7	19.7	9.662	73.3	-8.3	0.386	-90.6
1750	-22.4	0.076	16.7	-55.2	0.0018	95.9	19.9	9.936	54.1	-7.8	0.408	-104.1
2000	-22.3	0.077	5.8	-53.7	0.0021	91.1	20.1	10.168	34.3	-7.3	0.430	-116.6
2250	-22.8	0.072	-10.9	-52.5	0.0024	87.4	20.4	10.454	13.9	-6.9	0.449	-128.8
2500	-24.0	0.063	-29.0	-51.4	0.0027	83.2	20.6	10.738	-7.8	-6.7	0.463	-140.3
2750	-24.8	0.058	-46.4	-51.1	0.0028	79.2	20.8	10.910	-31.2	-6.7	0.463	-151.2
3000	-24.2	0.061	-63.0	-50.8	0.0029	76.6	20.7	10.794	-55.3	-7.0	0.449	-160.3
3250	-22.6	0.074	-77.7	-50.4	0.0030	75.4	20.4	10.466	-80.1	-7.6	0.419	-168.3
3500	-20.3	0.096	-91.3	-50.4	0.0030	74.2	19.9	9.891	-105.6	-8.5	0.378	-173.3
3750	-18.0	0.126	-105.4	-49.9	0.0032	74.8	19.1	9.045	-131.4	-9.4	0.339	-175.8
4000	-15.8	0.163	-120.5	-49.0	0.0035	75.7	18.1	8.031	-157.2	-10.3	0.306	-175.0
4250	-13.8	0.204	-136.9	-48.3	0.0039	74.8	16.7	6.845	177.7	-10.7	0.291	-173.0
4500	-12.1	0.248	-153.9	-47.4	0.0043	73.4	15.1	5.708	153.2	-10.8	0.287	-171.3
4750	-10.6	0.295	-170.4	-46.6	0.0047	69.1	13.1	4.519	130.0	-10.6	0.296	-171.7
5000	-9.3	0.342	174.3	-46.0	0.0050	66.7	10.9	3.520	109.3	-10.3	0.305	-174.5

Note:

1. Data obtained from measurements on individual devices mounted in an 83040 Series Modular Package @ $T_{case} = 25°C$. (Tabular data at frequencies below 10 MHz are from small signal simulations, not measured data.

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HMMC-5004 Additional Performance Characteristics, $V_{D1} = V_{D3} = +8\,V$, $V_{D2} = +4.7\,V$, $V_{SS} = -5\,V$

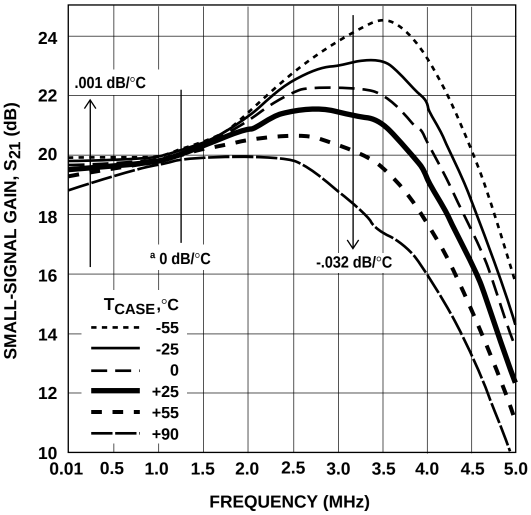

Figure 6. Typical Small-Signal Gain vs. Temperature.

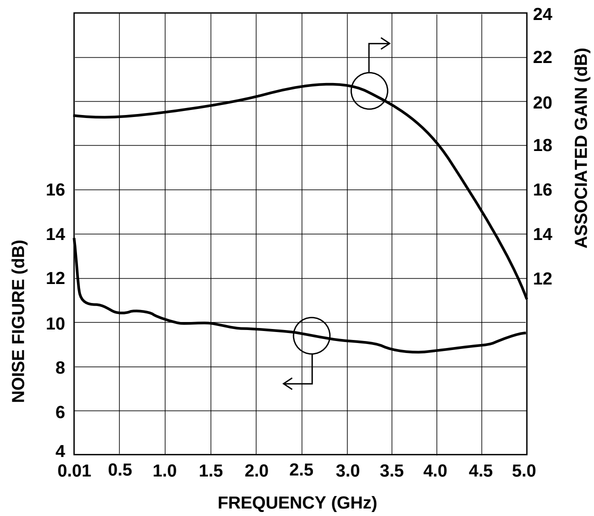

Figure 7. Typical Noise Figure Performance.

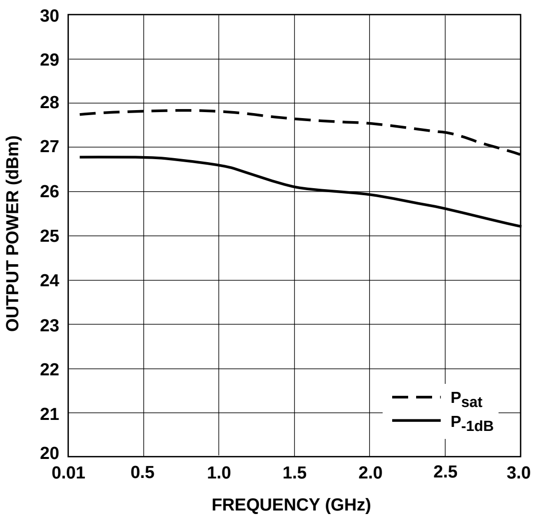

Figure 8. Typical 1dB Gain Compression and Saturated Output Power vs. Frequency.

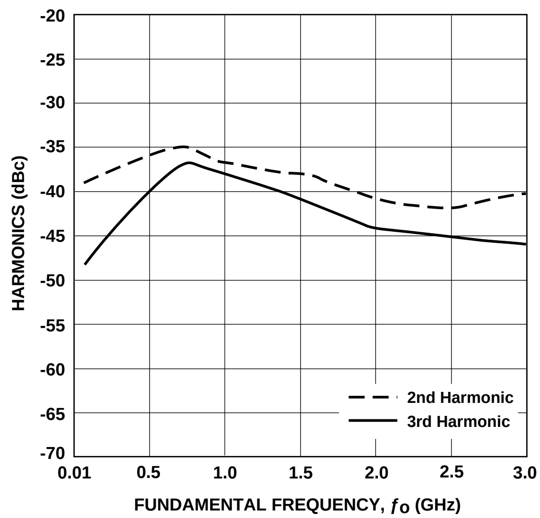

Figure 9. Typical Second and Third Harmonics vs. Fundamental Frequency at P_{out} = 21 dBm.

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 Agilent sales representative.

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Data subject to change.

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