Agilent HMMC-5027
2-26.5 GHz
Medium Power Amplifier

1GG7-8002

Data Sheet

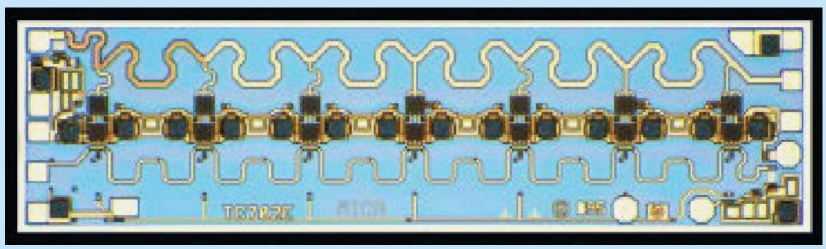
Features

- Wide-frequency range: 2-26.5 GHz
- Moderate gain: 7 dB
- Gain flatness: ±1 dB
- Return loss:
  Input: -13 dB, Output: -11 dB
- Low-frequency operation capability:
  < 2 GHz
- Gain control: 30 dB dynamic range
- Medium power:
  20 GHz:
  $P_{-1\ dB}$: 22 dBm
  P_{sat} : 24 dBm

  26.5 GHz:
  $P_{-1\ dB}$: 19 dBm
  P_{sat} : 21 dBm

Description

The HMMC-5027 is a broadband GaAs MMIC traveling wave amplifier designed for medium output power and moderate gain over the full 2 to 26.5 GHz frequency range. Seven MES-FET cascode stages provide a flat gain response, making the HMMC-5027 an ideal wideband power block. Optical lithography is used to produce gate lengths of ≈0.5 µm. The HMMC-5027 incorprates advanced MBE technology, Ti-Pt-Au gate metallization, silicon nitride passivation, and polyimide for scratch protection.



Chip Size:	2980 × 770 µm (117.3 × 30.3 mils)
Chip Size Tolerance:	±10 µm (±0.4 mils)
Chip Thickness:	127 ±15 µm (5.0 ±0.6 mils)
Pad Dimensions:	75 × 75 µm (2.95 × 2.95 mils), or larger

Absolute Maximum Ratings[1]

Symbol	Parameters/Conditions	Min.	Max.	Units
V_{DD}	Positive Drain Voltage		8.0	volts
I_{DD}	Total Drain Current		300	mA
V_{G1}	First Gate Voltage	-5	0	volts
I_{G1}	First Gate Current	-1	+1	mA
V_{G2}	Second Gate Voltage	-2.5	+5	volts
I_{G2}	Second Gate Current	-25		mA
P_{DC}	DC Power Dissipation		2.4	watts
P_{in}	CW Input Power		23	dBm
T_{ch}	Operating Channel Temp.		+150	°C
T_{case}	Operating Case Temp.	-55		°C
T_{stg}	Storage Temperature	-65	+165	°C
T_{max}	Max. Assembly Temp. (for 60 seconds maximum)		300	°C

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

Agilent Technologies

Applications

The HMMC-5027 series of traveling wave amplifiers are designed for use as general purpose wideband power stages in communication systems and microwave instrumentation. They are ideally suited for broadband applications requiring a flat gain response and excellent port matches over a 2 to 26.5 GHz frequency range. Dynamic gain control and low-frequency extension capabilities are designed into these devices.

DC Specifications/Physical Properties[1]

Symbol	Parameters/Conditions	Min.	Typ.	Max.	Units
I_{DSS}	Saturated Drain Current (V_{DD} = 8.0 V, V_{G1} = 0.0 V, V_{G2} = open circuit)	200	300	500	mA
V_p	First Gate Pinch-Off Voltage (V_{DD} = 8.0 V, I_{DD} = 30 mA, V_{G2} = open circuit)	-2.2	-1.3	-0.5	volts
V_{G2}	Second Gate Self-Bias Voltage (V_{DD} = 8.0 V, V_{G1} = 0.0 V)		1.8 (0.27 x V_{DD})		volts
I_{DSOFF} (V_{G1})	First Gate Pinch-Off Current (V_{DD} = 8.0 V, V_{G1} = -3.5 V, V_{G2}= open circuit)		7		mA
I_{DSOFF} (V_{G2})	Second Gate Pinch-Off Current (V_{DD} = 5.0 V, V_{G1} = 0.0 V, V_{G2} = -3.5 V)		10		mA
$\theta_{ch\text{-}bs}$	Thermal Resistance ($T_{backside}$ = 25°C)		28		°C/W

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

RF Specifications[1]

(V_{DD} = 8.0 V, $I_{DD}(Q)$ = 250 mA or I_{DSS}, $Z_{in} = Z_o$ = 50 Ω)

Symbol	Parameters/Conditions	Min.	Typ.	Max.	Units
BW	Guaranteed Bandwidth[2]	2		26.5	GHz
S_{21}	Small Signal Gain	6	7		dB
ΔS_{21}	Small Signal Gain Flatness		±0.8		dB
RL_{in}	Input Return Loss		-13	-10	dB
RL_{out}	Output Return Loss		-11	-10	dB
S_{12}	Reverse Isolation		-28	-25	dB
$P_{-1\ dB}$	Output Power at 1 dB Gain Compression	16.5	19		dBm
P_{sat}	Saturated Output Power	18.5	21		dBm
H_2	Second Harm. (2 <f_o<20), [$P_o(f_o)$ = 21 dBm or $P_{-1\ dB}$, whichever is less]		-21	-18	dBc
H_3	Third Harm. (2 <f_o<20), [$P_o(f_o)$ = 21 dBm or $P_{-1\ dB}$, whichever is less]		-32	-18	dBc
NF	Noise Figure		11		dB

1 Small-signal data measured in wafer form with T_{chuck} = 25°C. Large-signal data measured on individual devices mounted in an Agilent 83040 Series Modular Microcircuit Package @ T_A = 25°C.

2 Performance may be extended to lower frequencies through the use of appropriate off-chip circuitry. Upper corner frequency -30 GHz.

Biasing and Operation

These amplifiers are biased with a single positive drain supply (V_{DD}) and a single negative gate supply (V_{G1}). The recommended bias conditions for the HMMC-5027 are V_{DD} = 8.0 V, I_{DD} = 250 mA or I_{DSS}, whichever is less. To achieve this drain current level, V_{G1} is typically biased between 0 V and -0.6 V. No other bias supplies or connections to the device are required for 2 to 26.5 GHz operation. The gate voltage (V_{G1}) *MUST* be applied prior to the drain voltage (V_{DD}) during power up and removed after the drain voltage during power down. See Figure 3 for assembly information.

The HMMC-5027 is a DC coupled amplifier. External coupling capacitors are needed on RF_{IN} and RF_{OUT} ports. The drain bias pad is connected to RF and must be decoupled to the lowest operating frequency.

The auxiliary gate and drain contacts are provided when per-formance below 1 GHz is required. Connect external capacitors to ground to maintain input and output VSWR at low frequencies (see Additional References). Do not apply bias to these pads.

The second gate (V_{G2}) can be used to obtain 30 dB (typical) dynamic gain control. For normal operation, no external bias is required on this contact and its self-bias potential is between +1.5 and +2.5 volts. Applying an external bias between its open circuit potential and -2.5 volts will adjust the gain while main-taining a good input/output port match.

Assembly Techniques

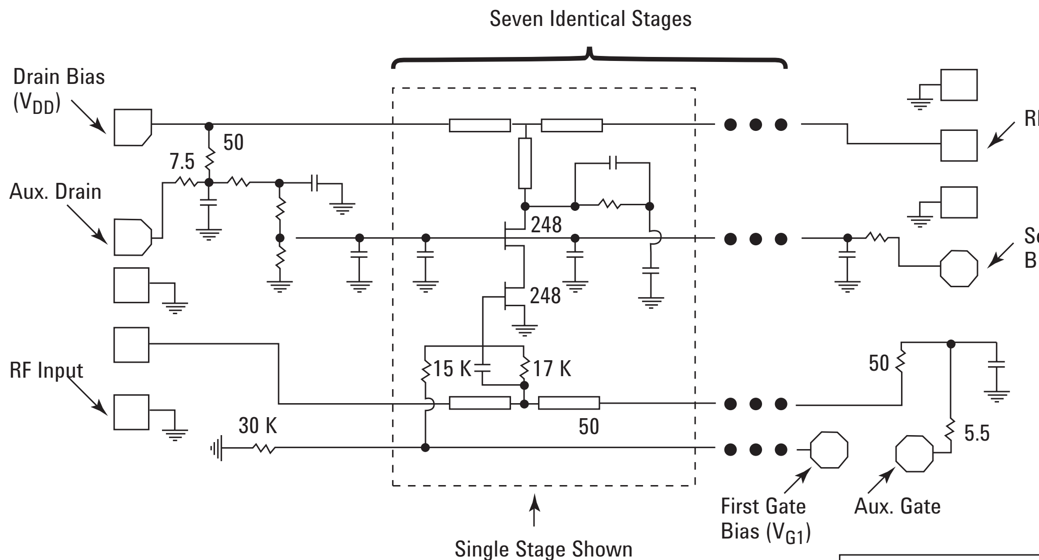
GaAs MMICs are ESD sensitive. ESD preventive measures must be employed in all aspects of storage, handling, and assembly.

MMIC ESD precautions, hand-ling considerations, die attach and bonding methods are critical factors in successful GaAs MMIC performance and reliability.

Agilent application note #54, "GaAs MMIC ESD, Die Attach and Bonding Guidelines" provides basic information on these subjects.

Additional References:

AN #34, "HMMC-5021/22/26/27 TWA Environmental Data,"
AN #56, "GaAs MMIC TWA Users Guide."



Notes:
FET gate periphery in microns.
All resistors in ohms (Ω).
(or in K-ohms, where indicated).

Figure 1. Schematic

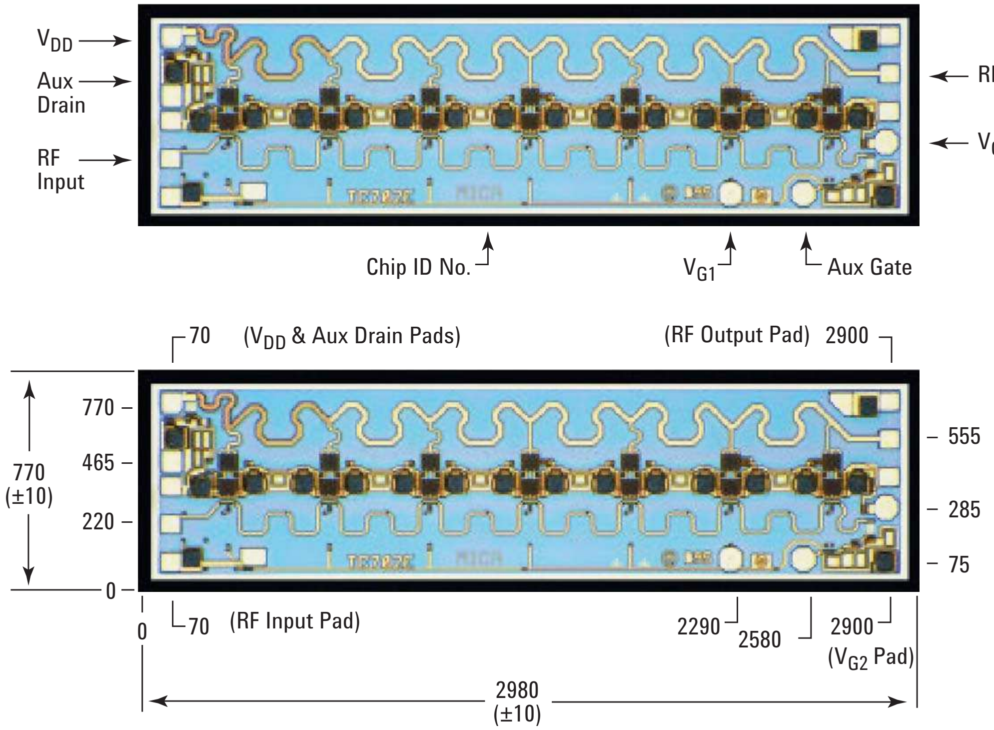


Figure 2. Bond Pad Locations

Notes
All dimensions in microns.
Rectangular Pad Dim: 75 x 75 µm
Octagonal Pad Dim.: 90 µm dia.
All other dimensions:
±5 µm (unless otherwise noted).

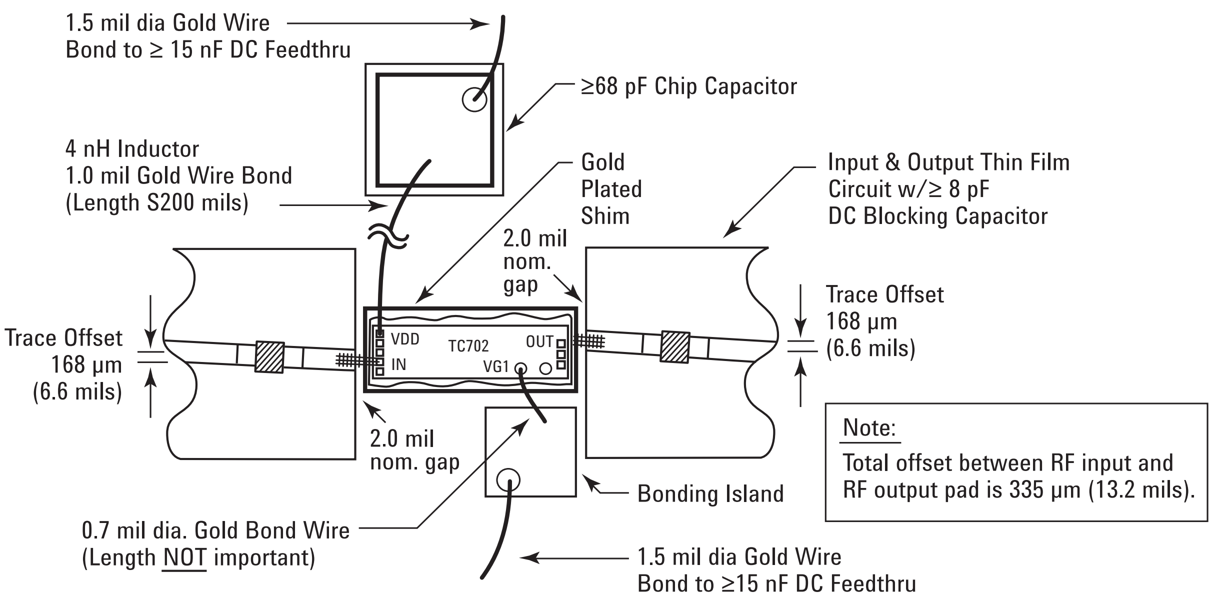


Figure 3. Assembly Diagram (For 2.0-26.5 GHz Operation)

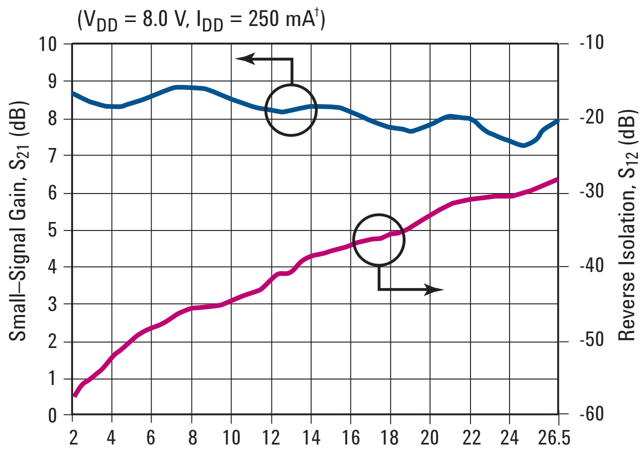


Figure 4. Typical Gain and Reverse Isolation vs. Frequency

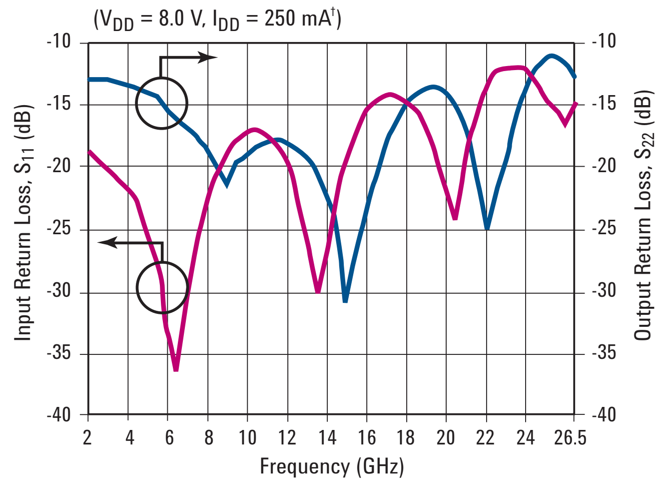


Figure 5. Typical Input and Output Return Loss vs. Frequency

Typical S–Parameters[1]

(T_{chuck} = 25°C, V_{DD} = 8.0 V, I_{DD} = 250 mA or I_{DSS}, whichever is less, $Z_{in} = Z_o$ = 50 Ω)

Freq. (GHz)	S_{11}			S_{12}			S_{21}			S_{22}		
	dB	Mag	Ang	dB	Mag	Ang	dB	Mag	Ang	dB	Mag	Ang
2.0	-18.7	0.116	-139.5	-57.7	0.0013	-165.2	8.7	2.717	116.6	-13.0	0.223	173.5
3.0	-20.1	0.099	-159.0	-54.9	0.0018	144.2	8.4	2.635	94.8	-13.0	0.224	150.0
4.0	-21.5	0.084	-175.7	-52.0	0.0025	154.0	8.3	2.612	72.0	-13.5	0.212	127.1
5.0	-24.6	0.059	167.8	-49.9	0.0032	111.3	8.4	2.634	48.2	-14.0	0.200	101.6
6.0	-32.0	0.025	167.4	-48.2	0.0039	91.3	8.6	2.699	23.3	-15.3	0.171	71.7
7.0	-30.8	0.029	-94.8	-46.9	0.0045	74.9	8.8	2.763	-3.5	-16.9	0.143	39.5
8.0	-22.7	0.073	-103.2	-45.5	0.0053	21.0	8.8	2.768	-30.9	-18.4	0.120	- 2.2
9.0	-18.9	0.114	-121.5	-45.2	0.0055	10.3	8.8	2.744	-58.9	-21.3	0.086	-46.9
10.0	-17.2	0.137	-142.6	-44.7	0.0058	-15.5	8.5	2.673	-85.9	-18.9	0.114	-90.7
11.0	-17.4	0.135	-163.9	-43.5	0.0067	-33.4	8.3	2.608	-112.5	-17.9	0.127	-129.6
12.0	-19.3	0.108	175.6	-41.5	0.0084	-45.4	8.2	2.564	-138.5	-18.2	0.123	-162.6
13.0	-25.6	0.052	170.3	-40.6	0.0093	-75.8	8.2	2.578	-164.9	-19.3	0.108	163.4
14.0	-27.0	0.045	-113.0	-38.6	0.0118	-95.9	8.3	2.610	167.1	-22.1	0.078	126.5
15.0	-19.2	0.109	-111.0	-37.8	0.0129	-124.7	8.3	2.605	138.4	-31.2	0.028	56.7
16.0	-15.6	0.167	-127.9	-37.1	0.0139	-149.1	8.2	2.574	108.8	-23.5	0.067	-33.3
17.0	-14.3	0.193	-148.4	-36.3	0.0153	-174.5	8.0	2.510	79.7	-18.1	0.124	-80.7
18.0	-14.8	0.182	-166.6	-35.8	0.0163	164.1	7.8	2.444	50.9	-15.2	0.174	-115.2
19.0	-17.1	0.140	-179.3	-34.7	0.0185	141.5	7.7	2.418	22.1	-13.7	0.207	-147.6
20.0	-21.4	0.086	-166.2	-32.9	0.0227	112.6	7.8	2.466	-7.5	-13.9	0.202	177.9
21.0	-18.4	0.121	-129.5	-31.6	0.0262	80.7	8.1	2.527	-39.9	-16.8	0.145	136.7
22.0	-13.8	0.205	-137.2	-30.9	0.0285	42.7	8.0	2.512	-74.0	-25.3	0.054	66.9
23.0	-12.1	0.247	-152.7	-30.6	0.0296	13.3	7.6	2.395	-108.4	-19.8	0.102	-56.2
24.0	-12.3	0.244	-169.8	-30.3	0.0304	-15.5	7.4	2.344	-142.5	-13.7	0.207	-103.5
25.0	-14.7	0.184	-175.8	-29.7	0.0329	-44.9	7.3	2.315	-175.6	-11.3	0.272	-136.7
26.0	-16.7	0.146	-149.3	-28.5	0.0375	-78.1	7.9	2.469	148.1	-11.7	0.259	-171.3
26.5	-14.1	0.197	-141.6	-28.0	0.0399	-98.5	8.0	2.503	126.9	-13.0	0.223	172.3

[1] Data obtained from on-wafer measurements.

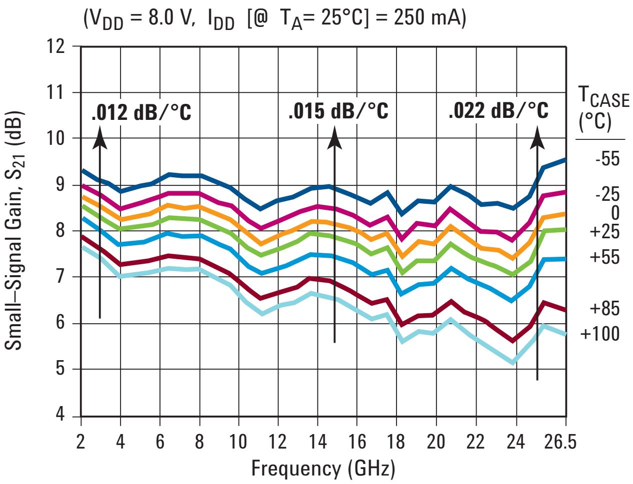


Figure 6. Typical Small-Signal Gain vs. Temperature

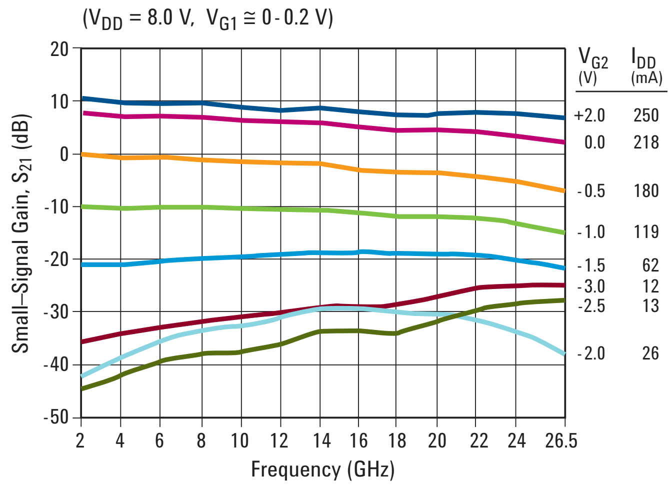


Figure 7. Typical Gain vs. Second Gate Control Voltage

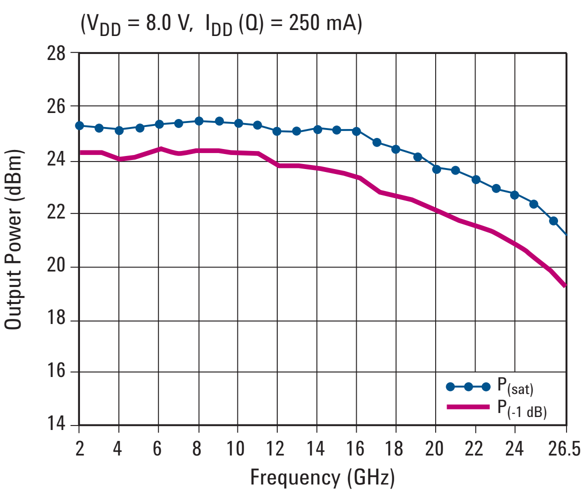


Figure 8. Typical 1 dB Gain Compression and Saturated Output Power vs. Frequency

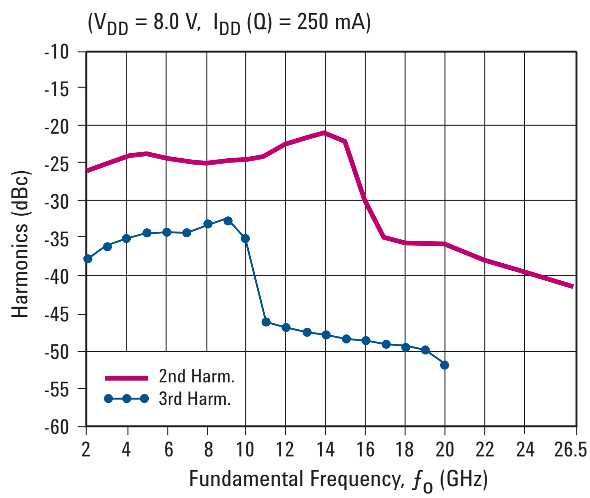


Figure 9. Typical Second and Third Harmonics vs. Fundamental Frequency at P_{out} = +21 dBm

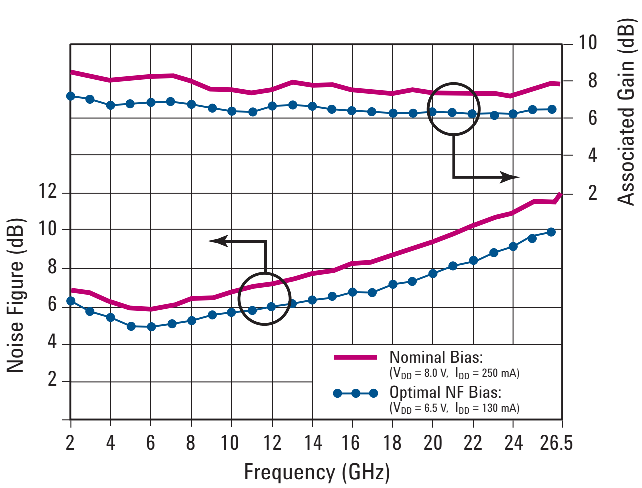


Figure 10. Typical Noise Figure Performance

Notes:

All data measured on individual devices mounted in an Agilent 83040 Series Modular Microcircuit Package @ T_A = 25°C (except where noted).

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