GaAs-усилители миллиметрового и микроволнового диапазона

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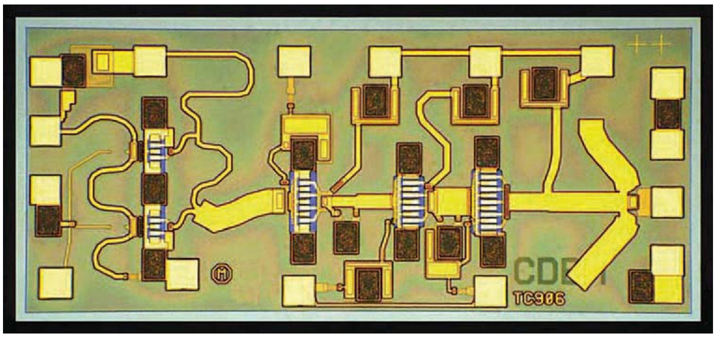
сайт: www.ksight.nt-rt.ru || эл. почта: kth@nt-rt.ru

Technologies

HMMC-5040
20–40 GHz Amplifier

1GG6-4066



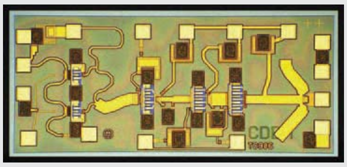
Features

- Large bandwidth:
  20 to 44 GHz typical
  21 to 40 GHz specified
- High gain: 22 dB typical
- Saturated output power:
  21 dB typical
- Supply bias:
  ≤ 4.5 volts @ ≤ 300 mA

KEYSIGHT
TECHNOLOGIES

Description

The Keysight Technologies, Inc. HMMC-5040 is a high-gain broad-band MMIC amplifier designed for both military applications and commercial communication systems. This four stage amplifier has input and output matching circuitry for use in 50 ohm environments. It is fabricated using a PHEMT integrated circuit structure that provides exceptional broadband performance. The backside of the chip is both RF and DC ground. This helps simplify the assembly process and reduces assembly related performance variations and costs. This MMIC is a cost effective alternative to hybrid (discrete-FET) amplifiers that require complex tuning and assembly processes.



Chip size:
1720 x 760 µm (67.7 x 29.9 mils)
Chip size tolerance:
±10 µm (±0.4 mils)
Chip thickness:
127 ± 15 µm (5 ±0.6 mils)
Pad dimensions:
80 x 80 µm (3.1 x 3.1 mils)

Absolute Maximum Ratings[1]

Symbol	Parameters/conditions	Min	Max	Units
$V_{1,2\text{-}3\text{-}4}$	Drain supply voltges		5	volts
$V_{G1,2,3\text{-}4}$	Gate supply voltages	–3.0	0.5	volts
I_{DD}	Total drain current		400	mA
P_{in}	RF input power		21	dBm
T_{ch}	Channel temperature[2]		160	°C
T_A	Backside Ambient Temperature	–55	+75	°C
T_{st}	Storage Temperature	–65	+165	°C
T_{max}	Maximum Assembly Temperature		300	°C

1. Absolute maximum ratings for continuous operation unless otherwise noted.
2. Refer to DC specifications/physical properties table for derating information.

DC Specifications/Physical Properties[1]

Symbol	Parameters/conditions	Min.	Typ.	Max	Units
$V_{D1,2\text{-}3\text{-}4}$	Drain supply operating voltages	20	5.0	5	Volts
I_{D1}	First stage drain supply current (V_{DD} = 4.5 V, V_{G1} ~= –0.6 V)		55		mA
$I_{D2\text{-}3\text{-}4}$	Total drain supply current for stage (V_{DD} = 4.5 V, V_{GG} ~= –0.6 V)		245		mA
$V_{G1,2,3\text{-}4}$	Gate supply operating voltages (I_{DD} ~= 300 mA)		–0.6		
V_P	Pinch-off voltage (V_{DD} = 4.5 V, I_{DD} ≤ 10 mA)	–2	–1.2	–0.8	Volts
Øch–bs	Thermal resistance[2] (channel-to-backside at T_{ch} = 160°C)		62		°C/Watt
Tch	Channel temperature[3] (T_A = 75°C, MTTF > 106 hrs, V_{DD} = 4.5 V, I_{DD} = 300 mA)		160		°C

1. Backside ambient operating temperature T_A = 25°C unless otherwise noted.
2. Thermal resistance (°C/Watt) at a channel temperature T (°C) can be estimated using the equation: $_q$(T) =~ 62 ¥ [T(°C)+273] / [160°C+273]
3. Derate MTTF by a factor of two for every 8°C above T_{ch}.

RF Specifications

(T_A = 25°C, Z_0 = 50 Ω, V_{DD} = 4.5 V, I_{DD} = 300 mA)

Symbol	Parameters/conditions	Broadband specifications			Narrow band performance			
		Min.	Typ.	Max.	Typical			Units
BW	Operating bandwidth	21	20-44	40	21-24	27-29	37-40	GHz
Gain	Small signal gain	20	22		25	23	22	dB
Δ Gain	Small signal gain flatness		±1.5		±1	±0.75	±0.3	dB
$(RL_{in})_{MIN}$	Minimum input return loss	8	10		9	10	14	dB
$(RL_{out})_{MIN}$	Minimum output return loss	8	10		10	11	12	dB
Isolation	Reverse isolation		54		54	54	54	dB
$P_{-1\ dB}$	Output power at 1 dB gain compression		18		18	18	18	dBm
P_{SAT}	Saturated output power at 3 dB compression	20	21		21	21	21	dBm

Applications

The HMMC-5040 broadband amplifier is designed for both military (35 GHz) applications and wireless communication systems that operate at 23, 28, and 38 GHz. It is also suitable for use as a frequency multiplier due to excellent below-band input return loss and high gain.

Biasing and Operation

The recommended DC bias condition is with all drains connected to single 4.5 volt supply and all gates connected to an adjustable negative voltage supply as shown in Figure 12. The gate voltage is adjusted for a total drain supply current of typically up to 300 mA. Figures 4, 5, 8, and 9 can be used to help estimate the minimum drain voltage and current necessary for a given RF gain and output power.

The second, third, and fourth stage DC drain bias lines are connected internally (Figure 1) and therefore require only a single bond wire. An additional bond wire is needed for the first stage DC drain bias, VD1.

Only the third and fourth stage DC gate bias lines are connected internally. A total of three DC gate bond wires are required: one for VG1, one for VG2, and one for the VG3-to-VG4 connection.

The RF input has matching circuitry that creates a 50 ohm DC and RF path to ground. A DC blocking capacitor should be used in the RF input transmission line. Any DC voltage applied to the RF input must be maintained below 1 volt. The RF output is AC-coupled.

No ground wires are needed since ground connections are made with plated through-holes to the backside of the device.

The HMMC-5040 can also be used to double, triple, or quadruple the frequency of input signals. Many bias schemes may be used to generate and amplify desired harmonics within the device. The information given here is intended to be used by the customer as a starting point for such applications. Optimum conversion efficiency is obtained with approximately 14 dBm input drive level.

As a doubler, the device can multiply an input signal in the 10 to 20 GHz frequency range up to 20 to 40 GHz with conversion gain for output frequencies exceeding 30 GHz. Similarly, 5 to 10 GHz signals can be quadrupled to 20 to 40 GHz with some conversion loss. Frequency doubling or quadrupling is accomplished by operating the first gain stage at pinch-off (VG1 = VP =~ 1.2 volts). Stages 2, 3, and 4 are biased for normal amplification. The assembly diagram shown in Figure 13 can be used.

To operate the device as a frequency tripler the drain voltage can be reduced to approximately 2.5 volts and the gate voltage can be set at about –0.4 volts or adjusted to minimize second harmonics if needed. Either of Figures 12 and 13 can be used.

Contact your local Keysight Technologies, INC. sales representative for additional information concerning multiplier performance and operating conditions.

Assembly Techniques

It is recommended that the RF input and output connections be made using either 500 lines/inch (or equivalent) gold wire mesh. The RF connections should be kept as short as possible to minimize inductance. The DC bias supply wires can be 0.7 mil diameter gold.

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

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

application note, *"GaAs MMIC ESD, Die Attach and Bonding Guidelines"* (literature #5991-3484EN) provides basic information on these subjects.

Additional references

application note, *"HMMC-5040 20-40 GHz Amplifier"* (5991-3564EN)

application note, *"HMMC-5040 As a 20-40 GHz Multiplier"* (5991-3565EN)

Keysight product note, *"HMMC-5040 and HMMC-5032 Demo, 20-32 GHz High Gain Medium Power Amp."* (5991-3571EN)

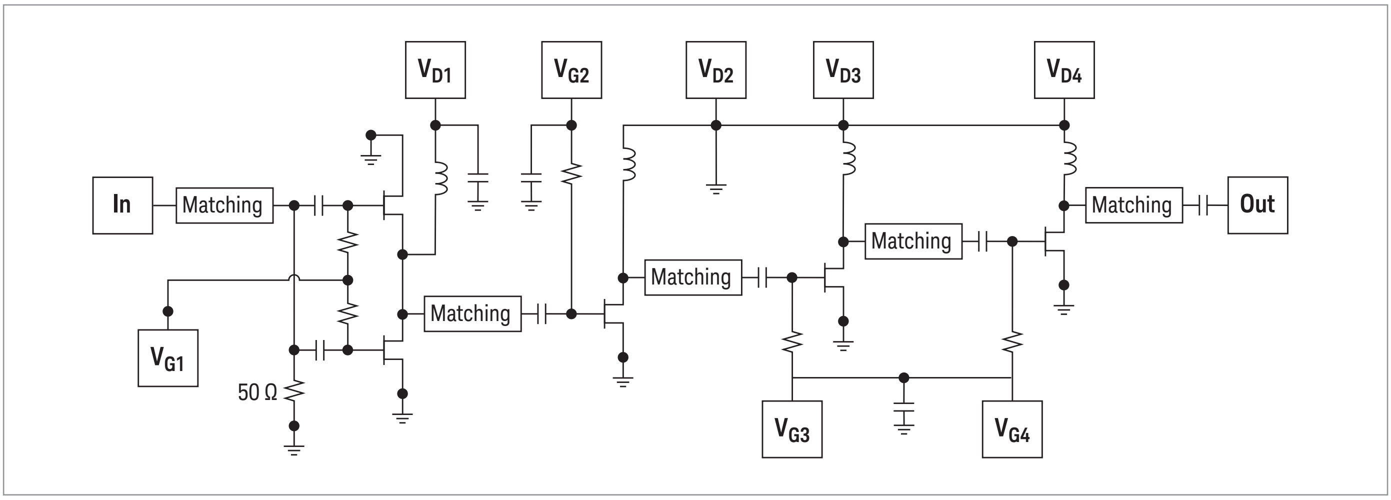


Figure 1. Simplified schematic diagram

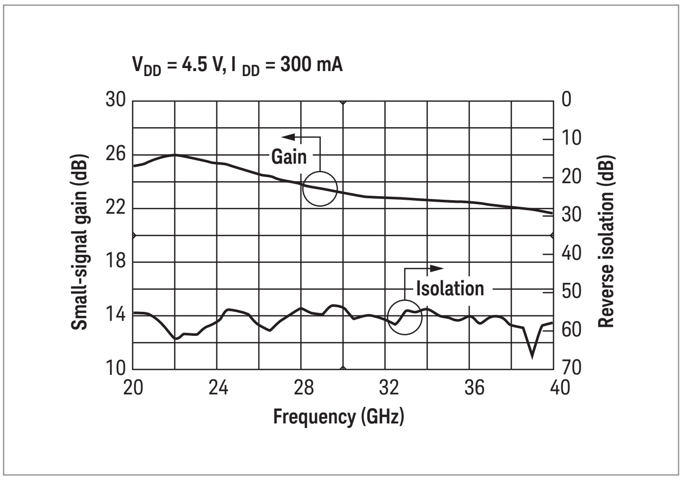


Figure 2. Typical gain and isolation vs. frequency[1]

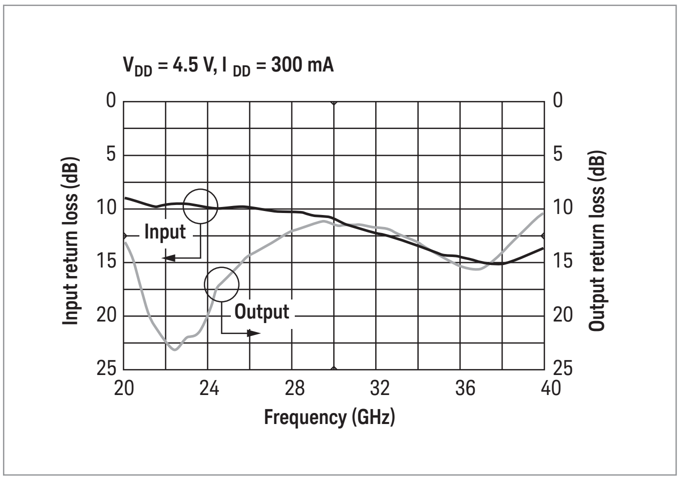


Figure 3. Typical input and output return loss vs. frequency[1]

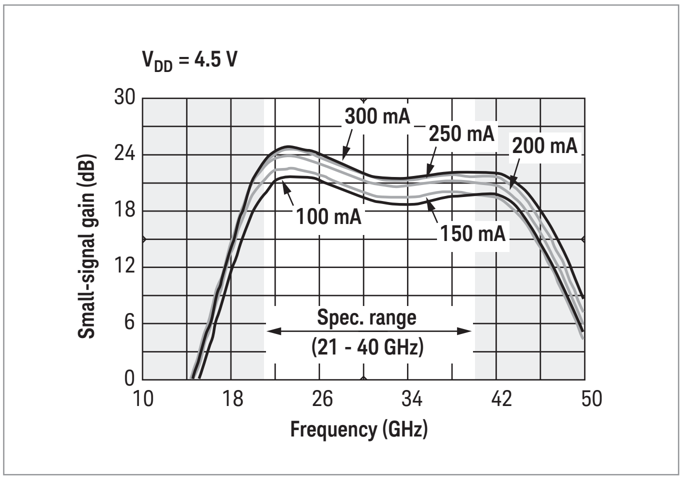


Figure 4. Broadband gain as a function of drain current vs. frequency with V_{DD} = 4.5 V1[1]

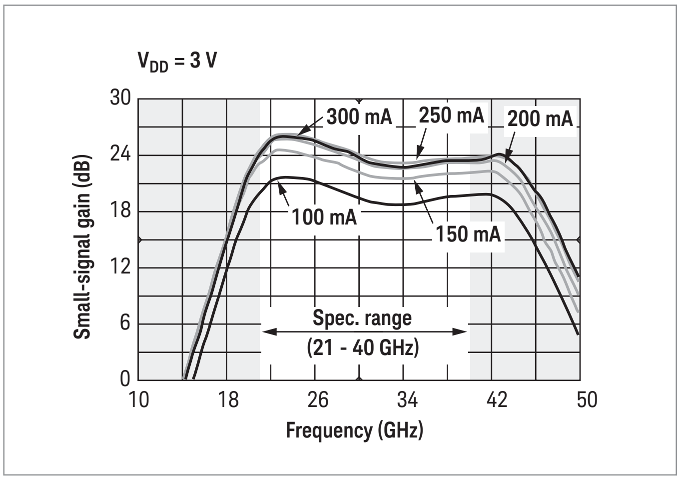


Figure 5. Broadband gain as a function of drain current vs. frequency with V_{DD} = 3 V[1]

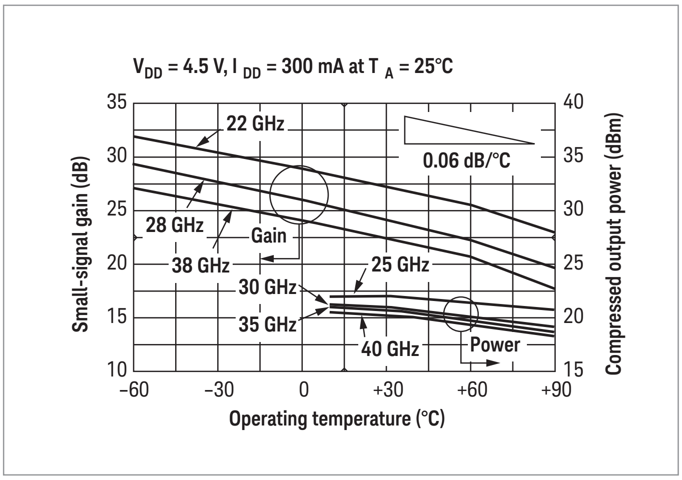


Figure 6. Small-signal gain[1] and compressed power[2] vs. temperature

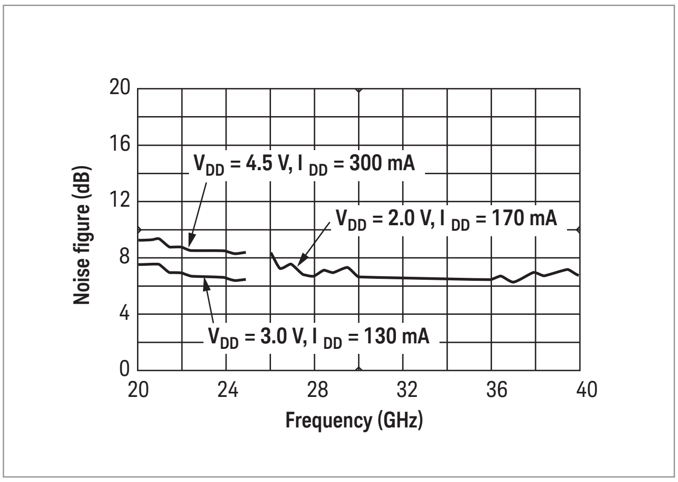


Figure 7. Noise figure vs. frequency

1.Measurements taken on a device mounted in a connectorized package calibrated at the connector terminals
2. Output power into 50 ohms with 2 dBm input power

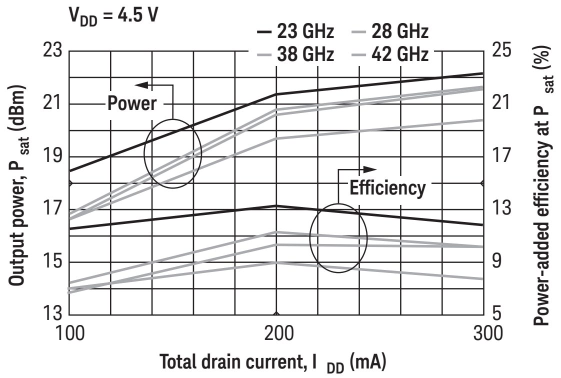


Figure 8. Output power[1] and efficiency vs. drain current with V_{DD} = 4.5 V

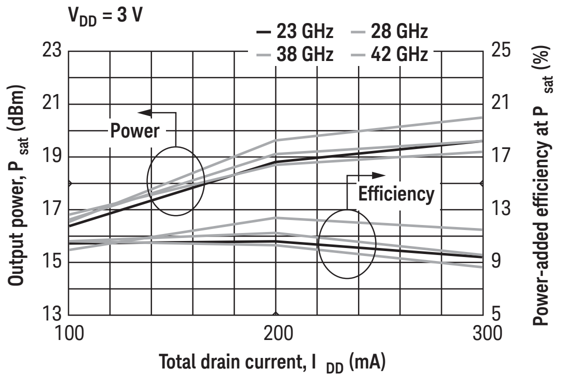


Figure 9. Output power[1] and efficiency vs. drain current with V_{DD} = 3 V

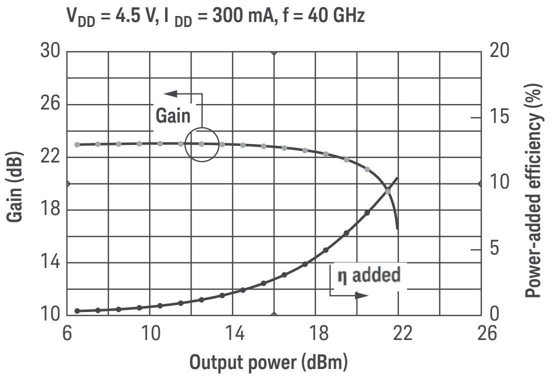


Figure 10. Gain compression and efficiency characteristics[2]

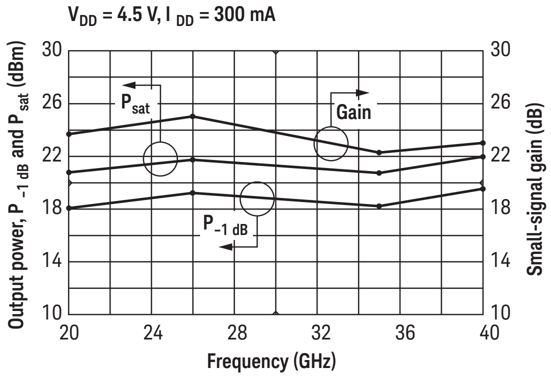


Figure 11. Output power and gain vs. frequency characteristics[2]

1. Output power into 50 ohms with 2 dBm input power
2. Wafer-probed measurements

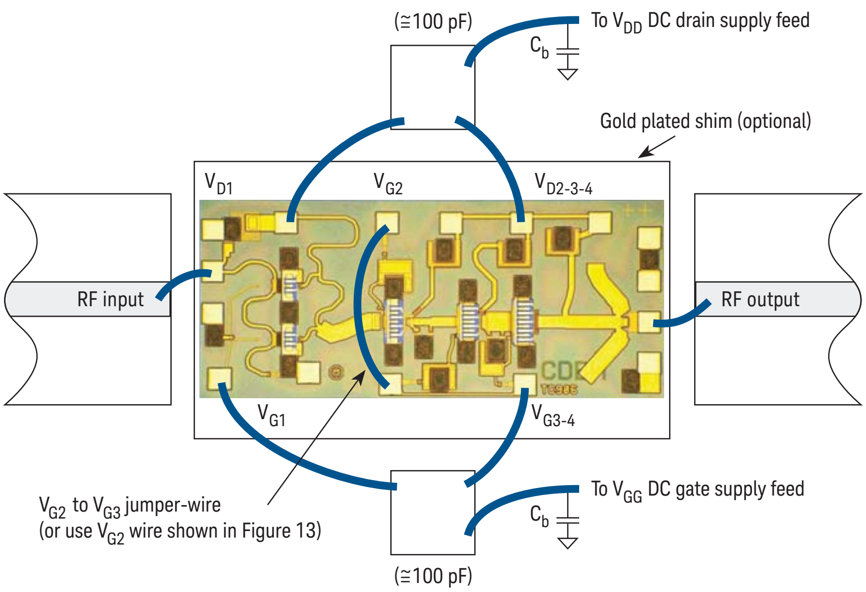
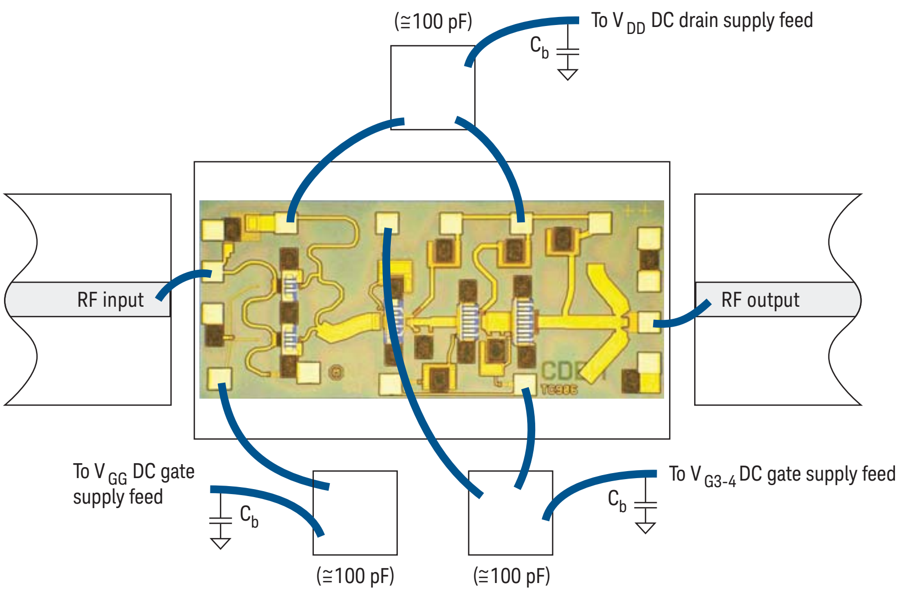
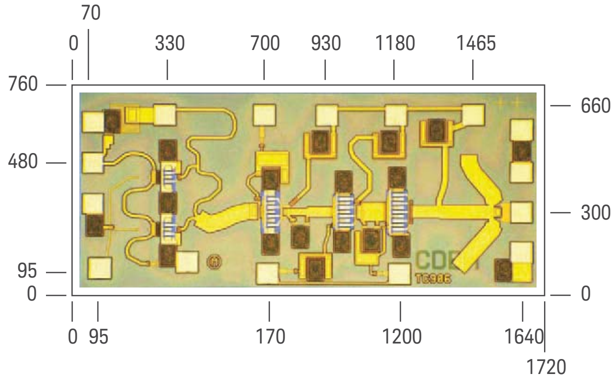


Figure 12. Single drain and single gate supply assembly for tripler and standard amplifier applications.



optional variation to the VG2 jumper-wire bonding scheme presented in Figure 12.



Note: All dimensions in micrometers.

Figure 14. Bonding pad locations.

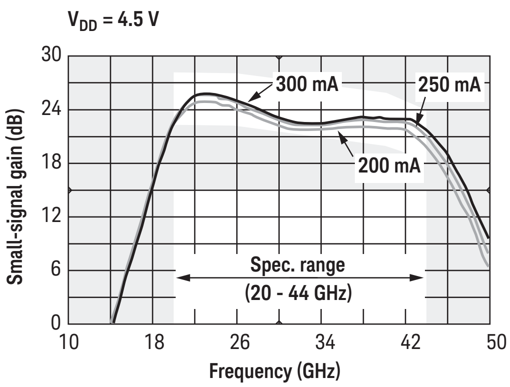
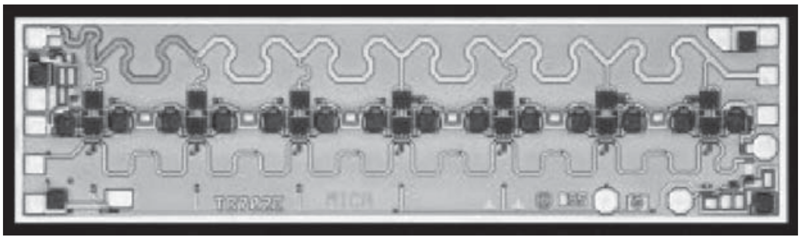


Figure 15. 1GG6-4066 broadband gain as a function of drain current vs. frequency with VDD = 4.5 V1

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. Customers considering the use of this, or other Keysight GaAs ICs, for their design should obtain the current production specifications from Keysight Technologies. In this data sheet the term typical refers to the 50th percentile performance. For additional information contact Technologies at MMIC_Helpline@keysight.com.

Technologies HMMC-5027
2 to 26.5 GHz
Medium Power Amplifier

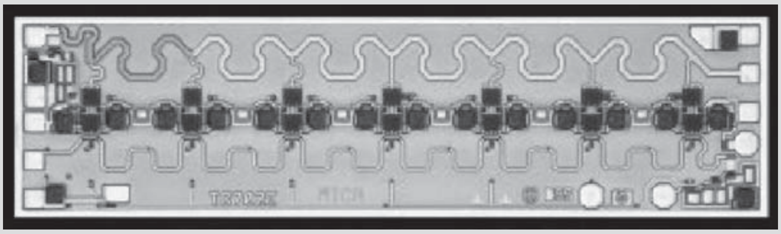


IGG7-8002
Data Sheet

KEYSIGHT
TECHNOLOGIES

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 incorporates 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 ± 0.6 mils)
Pad dimensions	75 × 75 µm (2.95 × 2.95 mils), or larger

Features

- Wide-frequency range:
  2 to 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
- Moderate power:
  20 GHz:
  $P_{-1\,dB}$: 22 dBm
  P_{sat} : 24 dBm
  26.5 GHz:
  $P_{-1\,dB}$: 19 dBm
  P_{sat} : 21 dBm

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}	Maximum 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}.

DC Specifications/Physical Properties[1]

Symbol	Parameters/conditions	Min	Typ	Max	Units
IDSS	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 × V_{DD})			volts
IDSOFF (V_{G1})	First gate pinch-off current (V_{DD} = 8.0 V, V_{G1} = –3.5 V, V_{G2} = open circuit)		7		mA
IDSOFF (V_{G2})	Second gate pinch-off current (V_{DD} = 5.0 V, V_{G1} = 0.0 V, V_{G2} = –3.5 V)		10		mA
θ_{ch-bs}	Thermal resistance ($T_{backside}$ = 25 °C)		28		°C/W

1. Measured in wafer form with T_{chuck} = 25 °C. (except θ_{ch-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 bandwidth2	2		26.5	GHz
S21	Small signal gain	6	7		dB
ΔS21	Small signal gain flatness		±0.8		dB
RLin	Input return loss		–13	–10	dB
RLout	Output return loss		–11	–10	dB
S12	Reverse isolation		–28	–25	dB
P–1 dB	Output power at 1 dB gain compression	16.5	19		dBm
Psat	Saturated output power	18.5	21		dBm
H2	Second harm. (2 < *f*o < 20), [Po(*f*o) = 21 dBm or P–1 dB, whichever is less]		–21	–18	dBc
H3	Third harm. (2 < *f*o < 20), [Po(*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 Tchuck = 25 °C. Large-signal data measured on individual devices mounted in an 83040 Series Modular Microcircuit Package @ TA = 25 °C.
2. Performance may be extended to lower frequencies through the use of appropriate off-chip circuitry. Upper corner frequency –30 GHz.

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.

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 performance 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 selfbias 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 maintaining 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, handling considerations, die attach and bonding methods are critical factors in successful GaAs MMIC performance and reliability.

GaAs MMIC ESD, Die Attach and Bonding Guidelines - Application Note, 5991-3484EN provides basic information on these subjects.

Additional References:

TC700/702 Traveling Wave Amplifier Environmental Data - Technical Overview, 5991-3553EN

GaAs MMIC TWA Users Guide - Application Note, 5991-3545EN

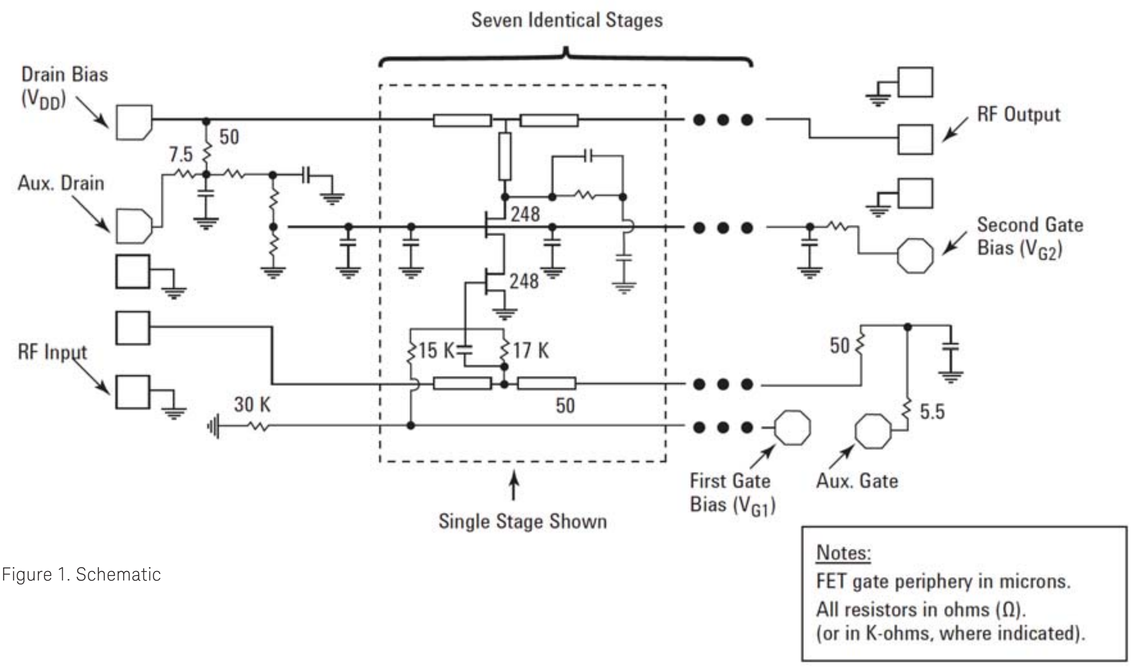


Figure 1. Schematic

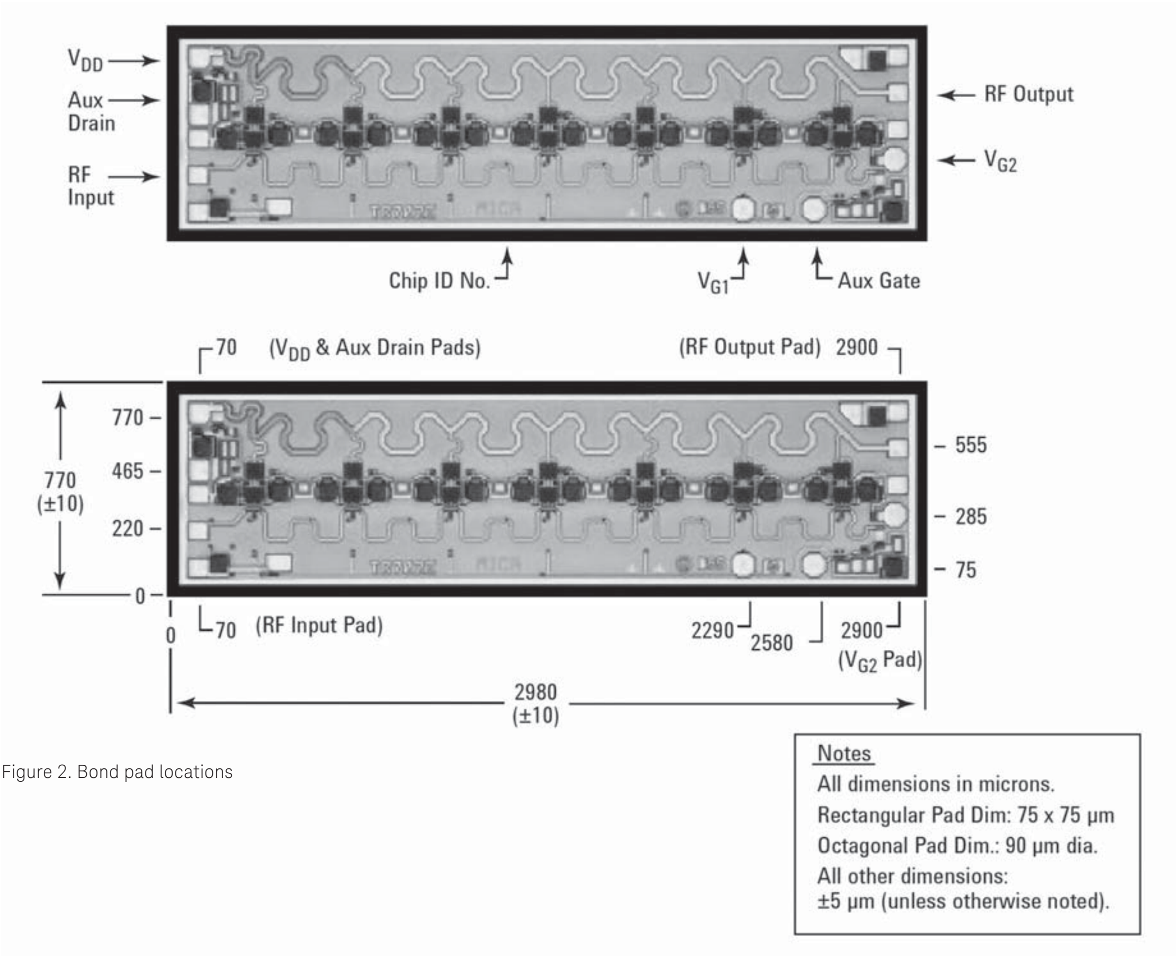


Figure 2. Bond pad locations

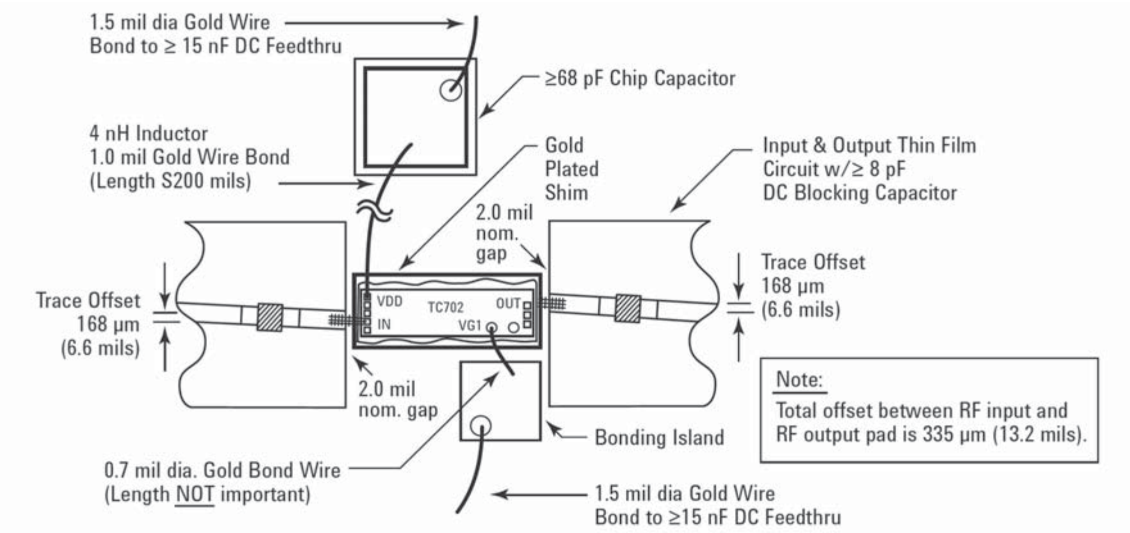


Figure 3. Assembly diagram (for 2.0 to 26.5 GHz operation)

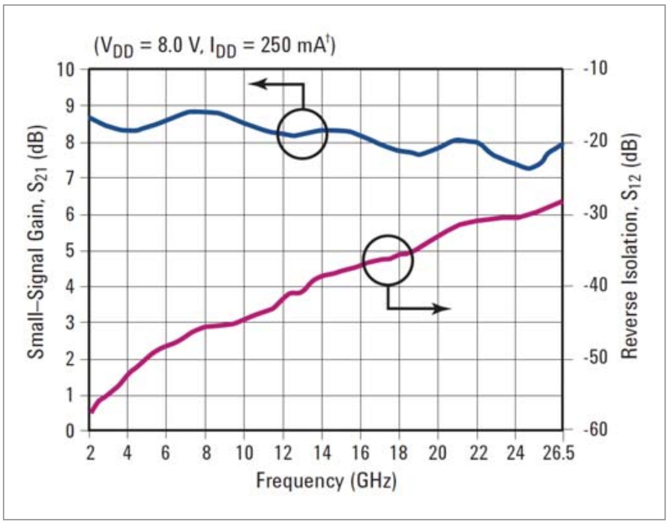


Figure 4. Typical gain and reverse isolation vs. frequency

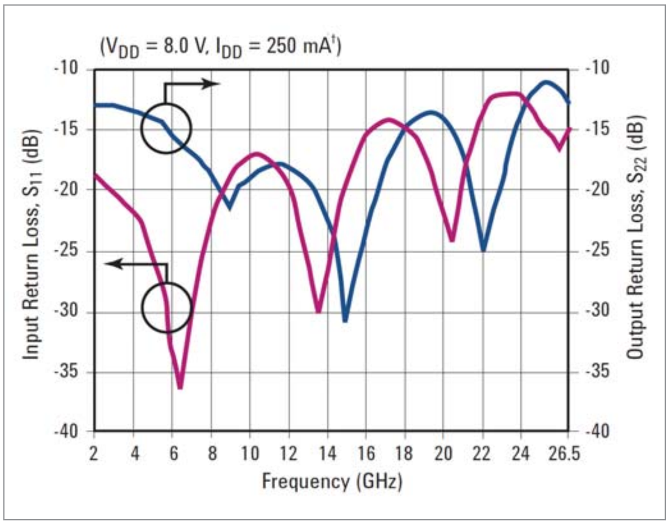


Figure 5. Typical input and output return loss vs. frequency

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_{out} = 50 Ω)

Freq.	S11			S12			S21			S22		
(GHz)	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.

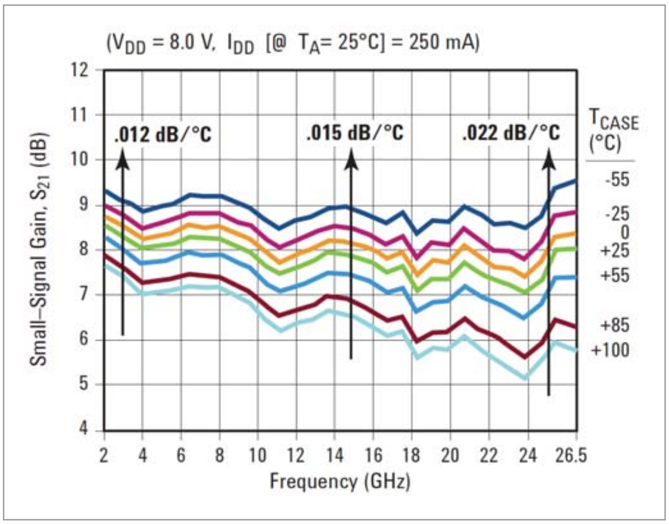


Figure 6. Typical small-signal gain vs. temperature

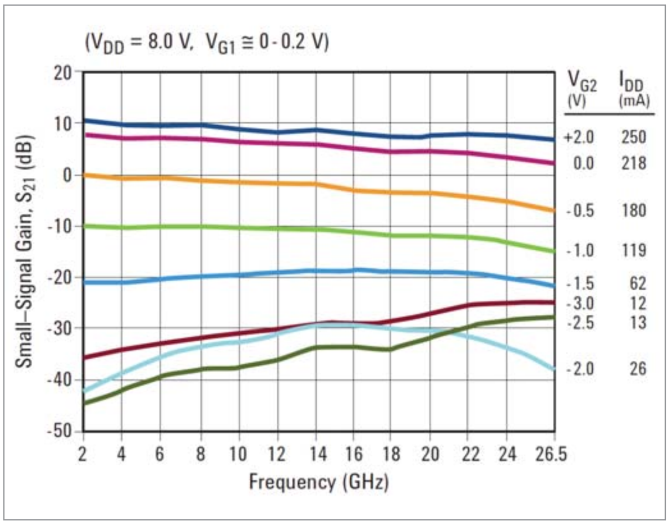


Figure 7. Typical gain vs. second gate control voltage

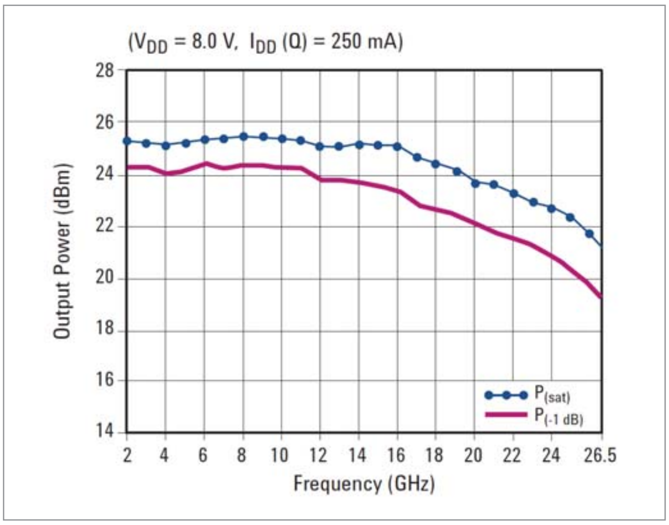


Figure 8. Typical 1 dB gain compression and saturated output power vs. frequency

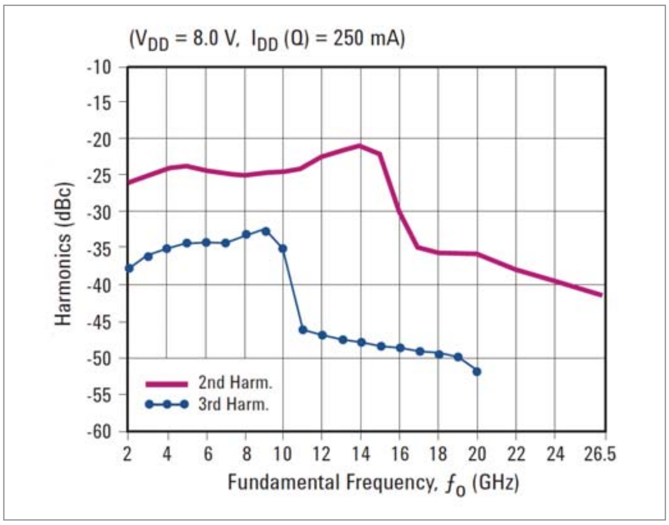


Figure 9. Typical second and third harmonics vs. fundamental frequency at Pout = +21 dBm

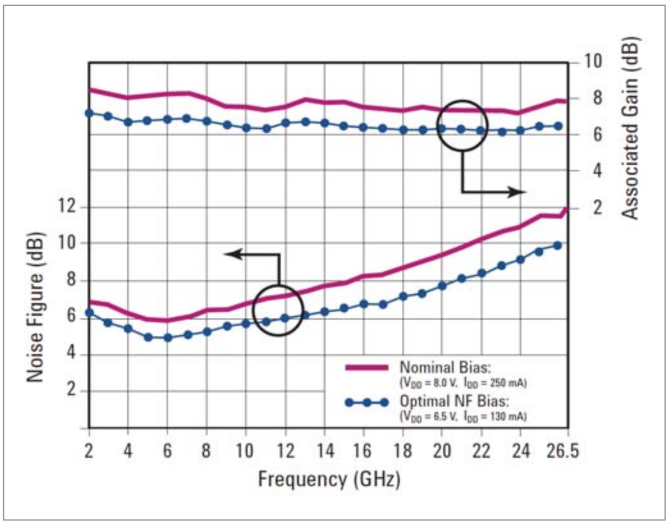


Figure 10. Typical noise figure performance

Notes

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

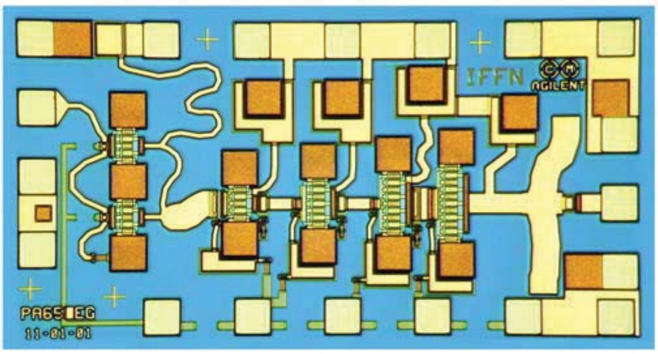
This data sheet contains a variety of typical and guaranteed performance data. The information supplied should not be interpreted as a complete list of circuit specifications. Customers considering the use of this, or other Keysight Technologies Inc. TCA GaAs ICs, for their design should obtain the current production specifications from Keysight TCA Marketing. In this data sheet the term typical refers to the 50th percentile performance. For additional information contact Keysight TCA Marketing at 707-577-4482.

1GG6-8070

40–68 GHz Medium Power Amplifier

TC956

Data Sheet



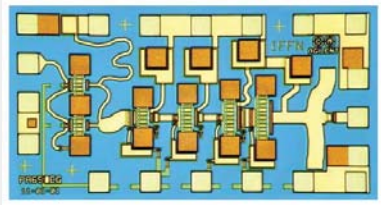
Features

- Frequency range:
  30–70 GHz usable range
- Small signal gain: 18.8 dB
- P–1 dB: 14 dBm
- P–3 dB: 17.6 dBm
- Return loss:
  - 10 dB input
  - 10 dB output

Description

The TC956 is a high–gain, medium–power mm–wave amplifier. It can be used as part of a banded solution to achieve respectable mm–wave power. Input and output ports are matched to 50 Ω.

The amplifier is biased with a single positive drain supply (V_{DD}) and a single negative gate supply (V_{G1}).



Chip size:
1440 x 780 µm (56.7 x 30.7 mils)
Chip size tolerance:
±10 µm (±0.4 mils)
Chip thickness:
62.5 ± 15 µm (2.5 ± 0.6 mils)
Pad dimensions:
80 x 80 µm (3.2 x 3.2 mils)

TC956

Absolute Maximum Ratings[1]

Symbol	Parameters/conditions	Minimum	Maximum	Units
$V_{D1,2-5}$	Drain supply voltage		3.25	Volts
I_{DD}	Total drain current		350	mA
$V_{G1,2-3,4,5}$	Gate voltage	–2.5	0.6	Volts
P_{DC}	DC power dissipation		1.2	Watts
P_{in}	CW input power		10	dBm
T_A	Backside ambient temperature	–55	75	°C
T_{ch}	Operating channel temperature[2]		160	°C
T_{case}	Operating case temperature	–55		°C
T_{stg}	Storage temperature	–65	165	°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}.
2. Refer to DC specifications/physical properties table for derating information.

DC Specifications/Physical Properties[1]

Symbol	Parameters/conditions	Minimum	Typical	Maximum	Units
V_{DD}	Drain supply operating voltage	2	3	3	Volts
I_{DD}	Drain supply operating current (V_{DD} = 3.0 V, V_{GG} = –0.1 V)		330		mA
V_{GG}	Gate supply operating voltage (V_{DD} = 3.0 V, I_{DD} = 330 mA)	–0.6	–0.1	0.5	Volts
V_P	Gate supply pinch–off voltage (V_{DD} = 3.0 V, I_{DD} ≤ 17 mA)		–1.2		Volts
θ_{ch-bs}	Thermal resistance (channel to backside at T_{ch} = 160 °C)			85	°C/Watt
T_{ch}	Channel temperature[2] (T_A = 75 °C, MTTF > 10^6 hours, V_{DD} = 3.0 V, I_{DD} = 330 mA)		160		°C

1. Measured in wafer form with T_{chuck} = 25 °C unless otherwise noted.
2. Derate MTTF by a factor of 2 for every 8 °C above T_{ch}.

RF Specifications[1]

		Minimum	Typical	Maximum	Units
BW	Guaranteed bandwidth	40		68	GHz
Gain	Small signal gain	17	18		dB
Flatness	Small signal gain flatness		±1.3		dB
RL_{in}	Input return loss	8	10		dB
RL_{out}	Output return loss	8	10		dB
Isolation	Reverse isolation		40		dB
$P_{-1 dB}$	Output power at 1 dB gain compression	13[2]	14		dBm
P_{sat}	Saturated output power	16[2]	17.6		dBm
NF	Noise figure		10		dB

1. Measured on wafer with T_{chuck} = 25 °C. Numbers given are minimum across the 40–67 band unless otherwise noted.
2. On–wafer gain and power measurements at 68 GHz have a measurement uncertainty of 1.5 dB. The number shown does not include guardband.

Applications

The TC956 amplifier offers high gain and power to mm frequencies. It can be used in mm–wave products with high power requirements, or in conjunction with a TC958 or TC906 in a banded design.

Biasing and Operation

The recommended bias conditions are to connect the drains to a shared 3 V supply and connect all gate pads to a shared, adjustable negative voltage. The gate voltage is adjusted for total drain supply current of 330 mA. Drain pains 2–4 are internally connected; either multiple bonds or a single bond is acceptable. Positive gate voltage can generate drain currents as high as 700 mA, so be sure that the bonds have sufficient capacity. Likewise, all gates can be controlled with a single bond wire attached to V_{G4}. The RF input matching circuity gives a 50 Ω DC and RF path to ground. A DC blocking capacitor should be used in the RF input transmission line. Any DC voltage applied to the RF input must be maintained below 1 V; DC voltage on the RF output can range from –7 V to +13 V.

No ground wires are needed since ground connections are made with plated through–holes to the backside of the device.

Reliability limits assume long–term operation into a 50 Ω match, with short–term excursions to an open circuit. Reliability will be degraded with long–term operation into an open circuit.

Assembly Techniques

For most applications, we recommend solder die attach. Reliability goals are modeled using solder attach to an infinite heat sink at 85 °C ambient. Epoxy attach requires 69 °C ambient. It is recommended that the RF input and output connectors be made using 500 lines per inch, or equivalent gold wire mesh. The RF connections should be kept as short as possible to minimize inductance. The DC bias supply wires can be 0.7 mil diameter gold.

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

Additional References

Technologies, Inc. application note, *GaAs MMIC ESD, Die Attach and Bonding Guidelines* - Application Note (5991-3498EN) provides additional information on these subjects.

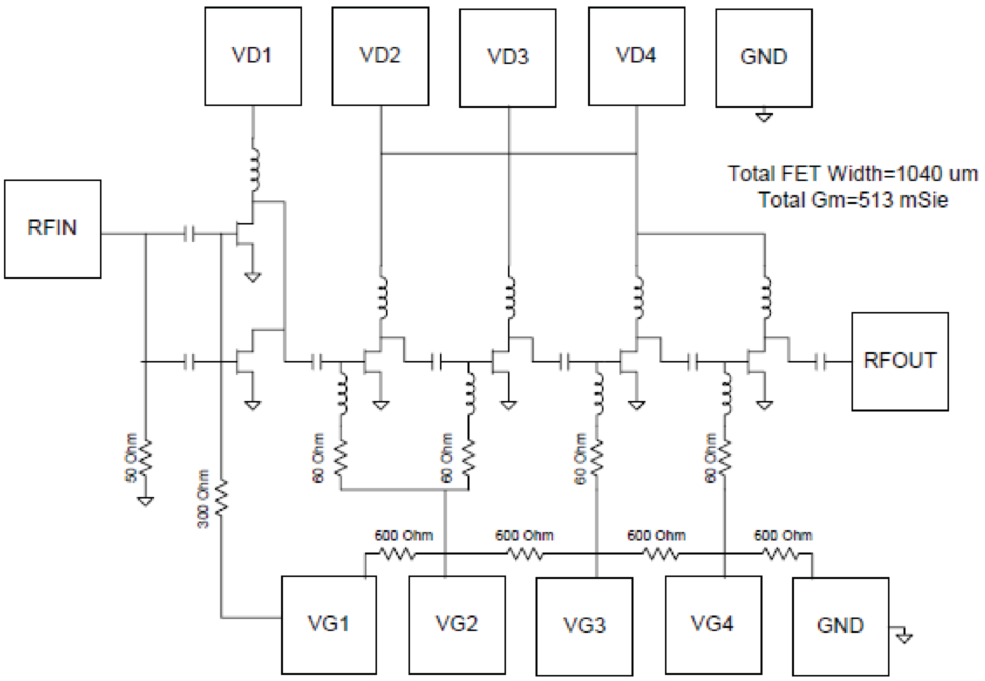


Figure 1. 1GG6-8070 schematic

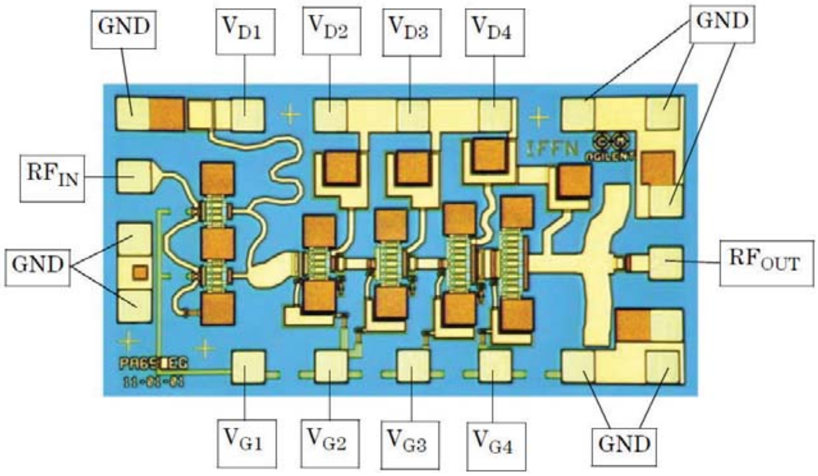


Figure 2. 1GG6-8070 pad locations

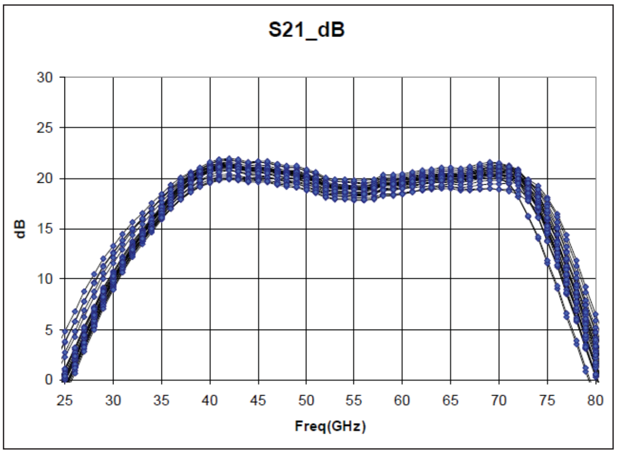


Figure 3. 1GG6-8070 gain

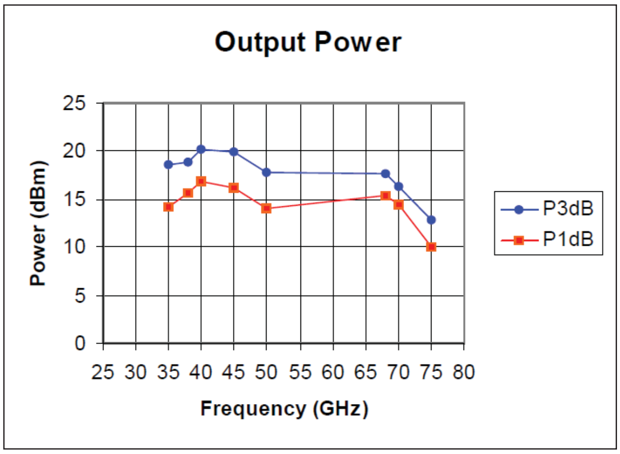


Figure 4. 1GG6-8070 output power

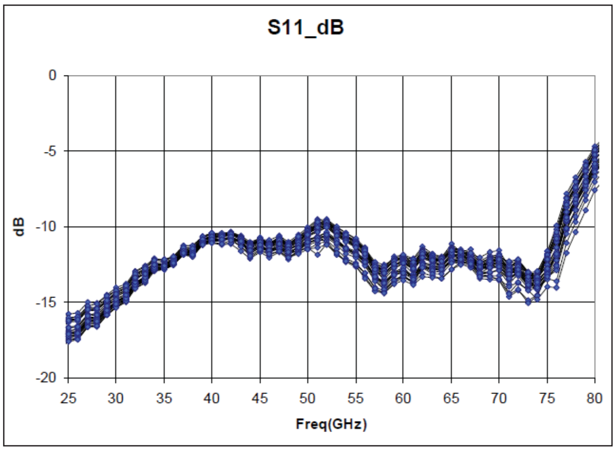


Figure 5. 1GG6-8070 input loss

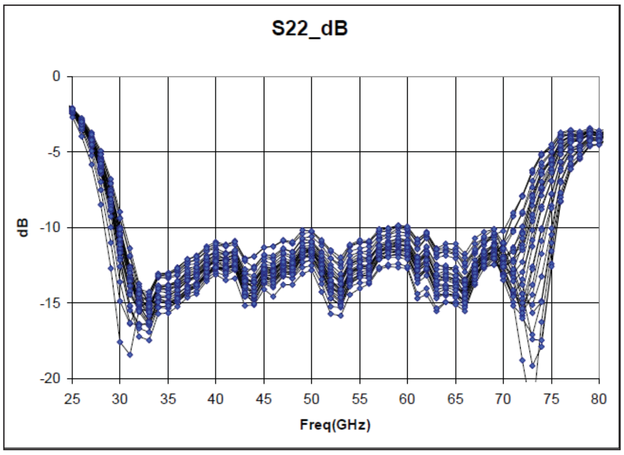
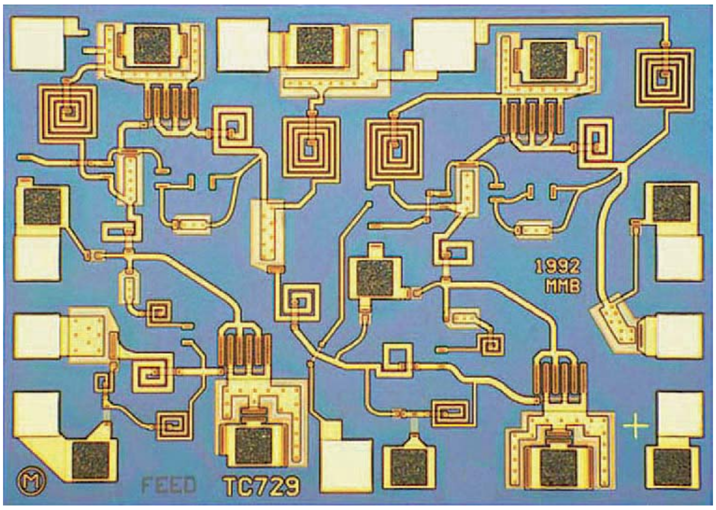


Figure 6. 1GG6-8070 output loss

Technologies HMMC-5620 6-20 GHz High-Gain Amplifie r

Data Sheet



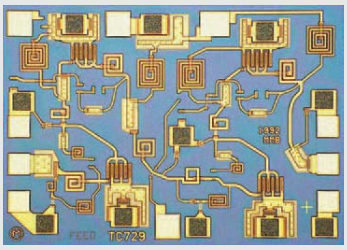
Features

- Wide-frequency range: 6-20 GHz
- High gain: 17 dB
- Gain flatness: ± 1.0 dB
- Return loss:
  Input –15 dB
  Output –15 dB
- Single bias supply operation
- Low DC power dissipation:
  P_{DC} ~0.5 watts
- Medium power:
  20 GHz:
  $P_{-1\ dB}$: 12 dBm
  P_{sat} : 13 dBm

KEYSIGHT TECHNOLOGIES

Description

The Keysight Technologies, Inc. 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 ~0.3 µm. The HMMC-5620 incorporates advanced MBE technology, Ti-Pt-Au gate metallization, silicon nitride passivation, and polyimide for scratch protection.



Chip size:
1410 × 1010 µm (55.5 × 39.7 mils)
Chip size tolerance:
±10 µm (±0.4 mils)
Chip thickness:
127 ± 15 µm (5 ±0.6 mils)
Pad dimensions:
80 × 80 µm (2.95 × 2.95 mils),
or larger

Absolute Maximum Ratings[1]

Symbol	Parameters/conditions	Min	Max	Units
V_{DD}	Positive drain voltage		7.55	volts
I_{DD}	Total drain current	–3.0	135	mA
P_{DC}	DC power dissipation		1.0	watts
P_{in}	CW input power		20	dBm
T_{ch}	Operating channel temperature		+160	°C
T_{case}	Operating case temperature	–55		°C
T_{st}	Storage Temperature	–65	+165	°C
T_{max}	Maximum Assembly Temperature (for 60 seconds max.)		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}.

DC Specifications/Physical Properties[1]

Symbol	Parameters/conditions	Min.	Typ.	Max	Units
I_{DD}	Drain current (V_{DD} = +5.0 V)	100	70	135	mA
I_{DD}	Drain current (V_{DD} = +7.0 V)	105			mA
θ_{ch-bs}	Thermal resistance ($T_{backside}$ = 25 °C)	70			°C/Watt

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

RF Specifications/Physical Proprties

(V_{DD} = 5.0 V, $I_{DD}(Q)$ = 100 mA, $Z_{in} = Z_o$ = 50 Ω)[1]

Symbol	Parameters/conditions	6.0-20.0 GHz			
		Typ.	Min.	Max.	Units
BW	Guaranteed bandwidth		6	20	GHz
S_{21}	Small signal gain	17	15	21	dB
ΔS_{21}	Small signal gain flatness	±1.0		±1.25	dB
$(RL_{in}$	Input return loss	–15		–10	dB
$(RL_{out}$	Output return loss	–15		–10	dB
S_{12}	Reverse isolation	–55			dB
$P_{-1\ dB}$	Output power at 1 dB gain compression	12			dBm
P_{SAT}	Saturated output power	13			dBm
H_2	Second harmonic, (6 < f_o < 20) ($P_o(f_o)$ = 10 dBm)	–30			dBc
H_3	Third harmonic, (6 < f_o < 20) ($P_o(f_o)$ = 10 dBm)	–40			dBc
NF	Noise figure	9.0			dB

1. Small-signal data measured in wafer form with T_{chuck} = 25 °C.
Large-signal data measured on individual devices mounted in an 83040 series modular microcircuit package @ T_A = 25 °C.

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 (VDD). The recommended bias for the HMMC-5620 is VDD = 5.0 V, which results in IDD = 100 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

For RF bonds, MWTC recommends low inductance mesh interconnections for best return loss performance. GaAs MMICs are ESD sensitive. ESD preventive measures must be employed in all aspects of storage, handling, and assembly.

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

GaAs MMIC ESD, Die Attach and Bonding Guidelines, Application Note (5991-3484EN) provides basic information on these subjects.

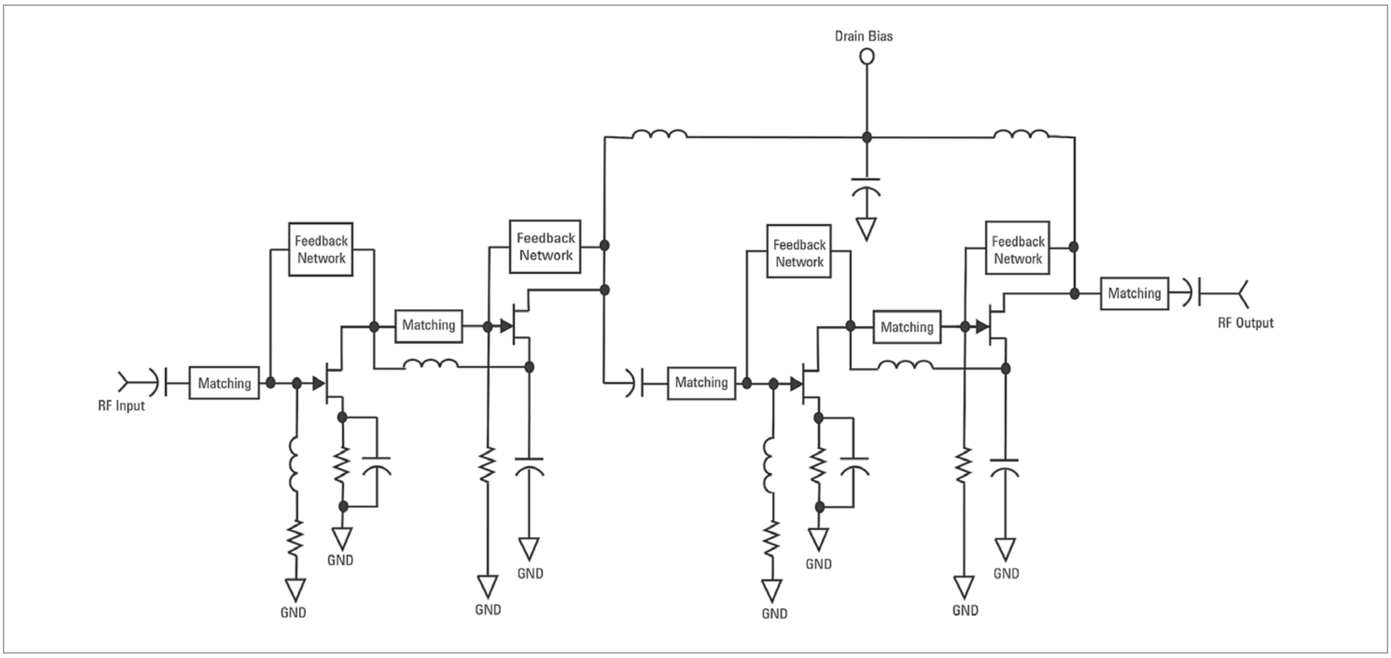


Figure 1. Simplified schematic diagram

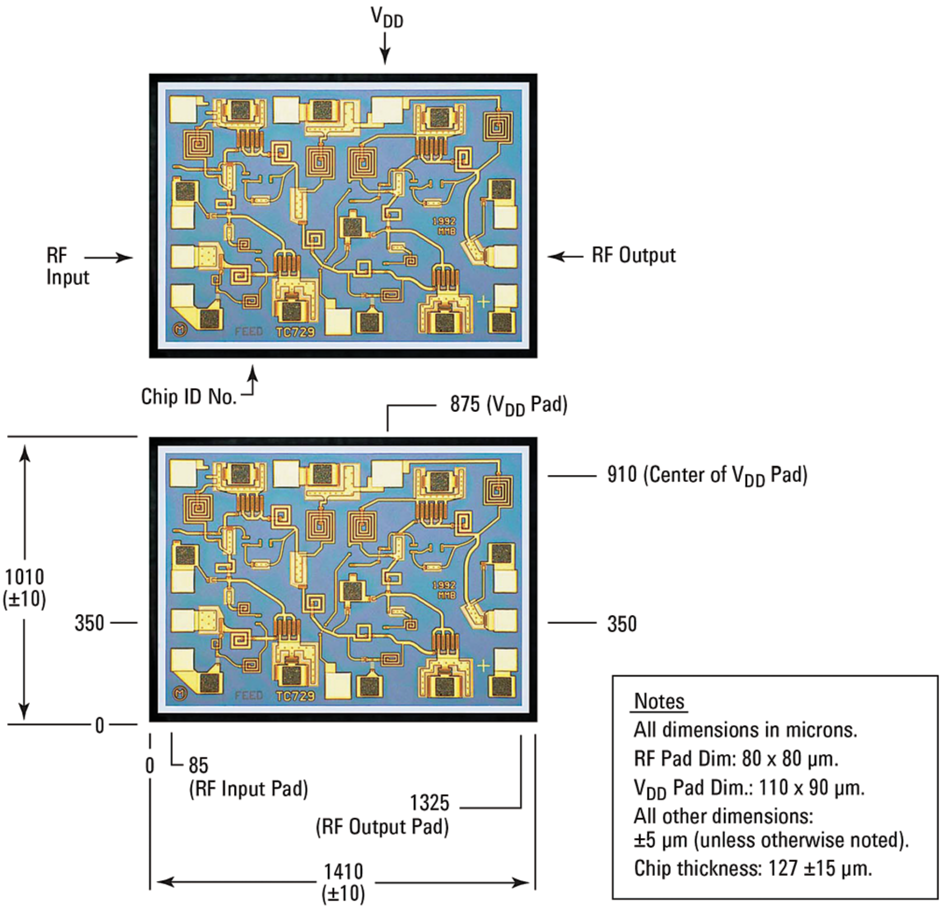


Figure 2. Bond pad locations

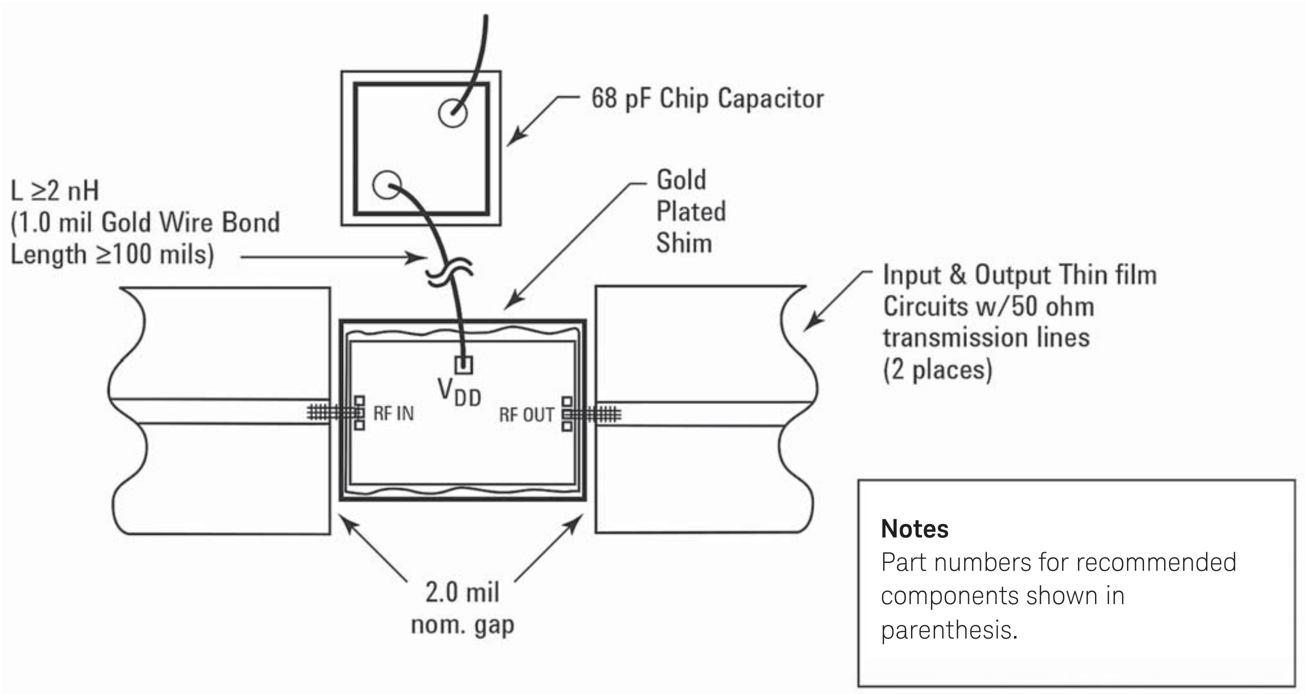


Figure 3. Assembly diagram (For 6.0-20.0 GHz operation)

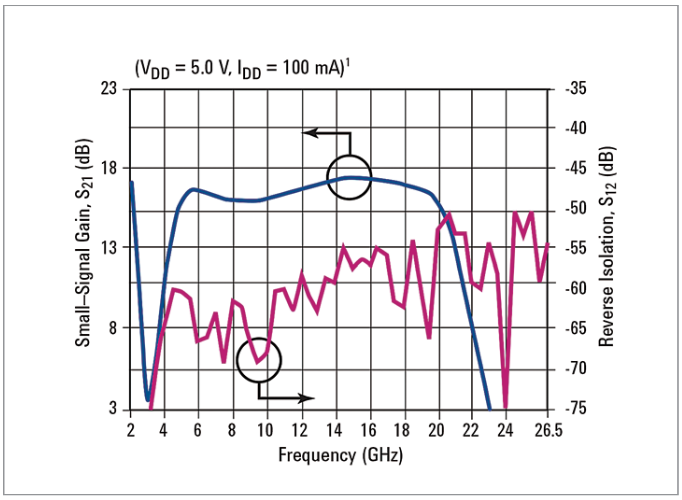


Figure 4. Typical gain and reverse isolation vs. frequency

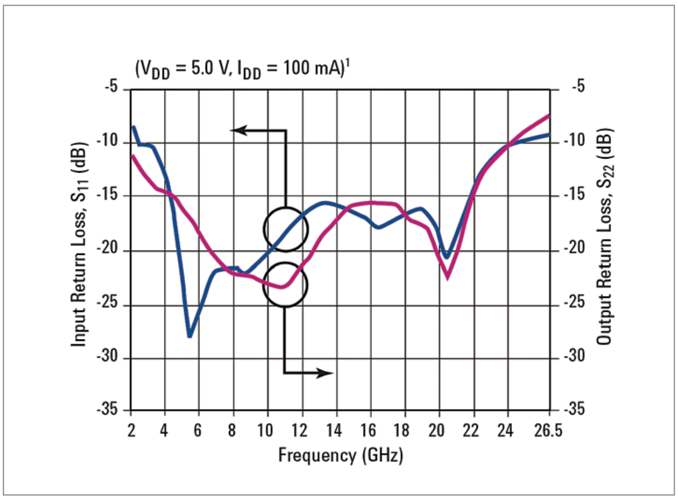


Figure 5. Typical input and output return loss vs. frequency

Typical S–Parameters[1]

(T_{chuck} = 25 °C, V_{DD} = 5.0 V, I_{DD} = 100 mA, Z_{in} = Z_o = 5 Ω)

	S_{11}			S_{12}			S_{21}			S_{22}		
Freq. (GHz)	**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

1. Data obtained from on-wafer measurements.

Additional Performance Characteristics

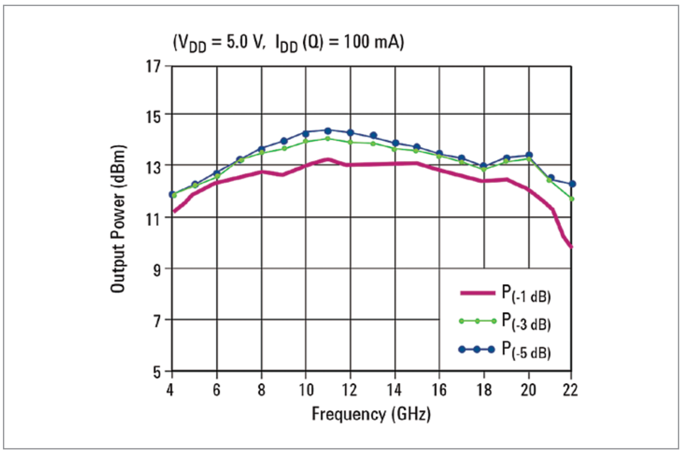


Figure 6. Typical output power vs. frequency (w/5 V bias)

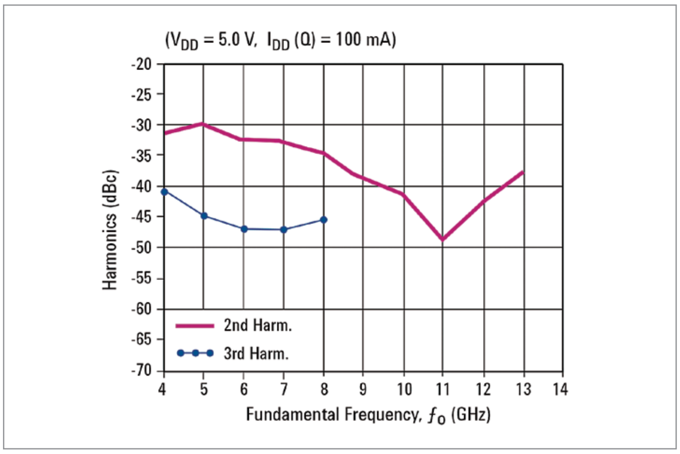


Figure 7. Typical second and third harmonics vs. fundamental frequency at Pout = 10 dBm

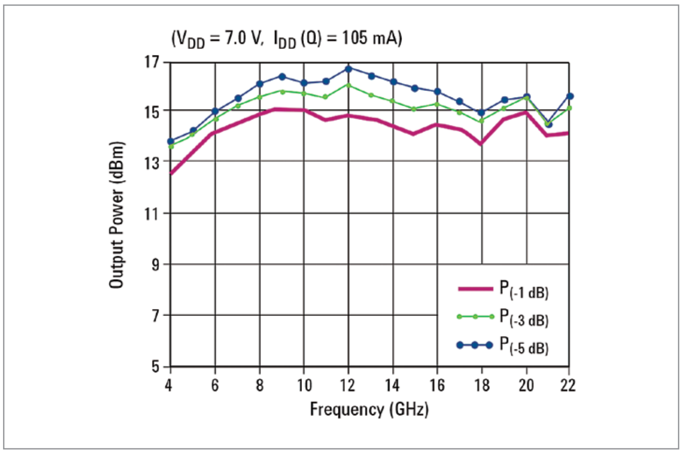


Figure 8. Typical output power vs. frequency (w/7 V bias)

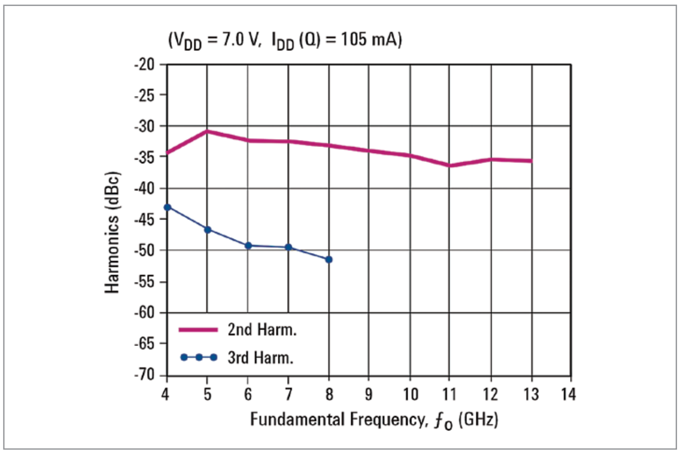


Figure 9. Typical second and third harmonics vs. fundamental frequency at Pout = 10 dBm

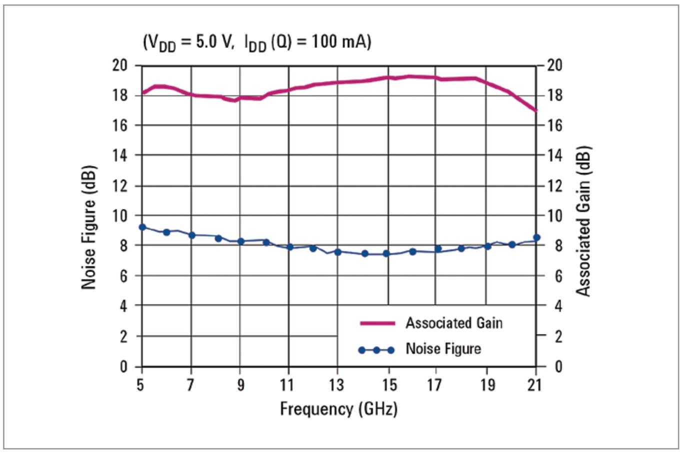


Figure 10. Typical noise figure performance vs. frequency

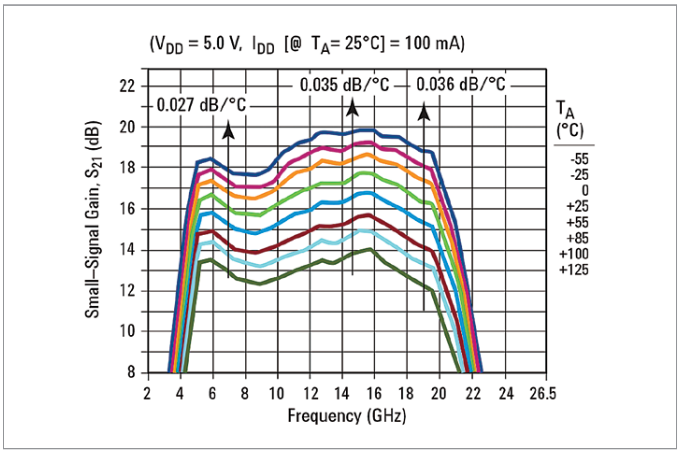


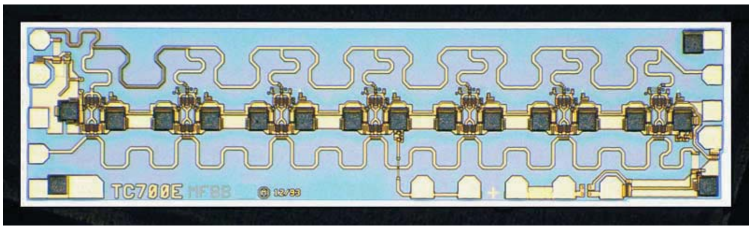
Figure 11. Typical small-signal gain vs. temperature

Note: All data measured on individual devices mounted in an 83040 series modular microcircuit package @ T_A = 25 °C, except where noted.

Technologies HMMC-5021, HMMC-5022, HMMC-5026, and QMMC-5002

GaAs MMIC Traveling Wave Amplifier

Data Sheet



Features

- Wide-frequency range:
  2 to 26.5 GHz
- High gain: 9.5 dB
- Gain flatness: ±0.75 dB
- Return loss:
  Input: –14 dB, Output: –13 dB
- Low-frequency operation capability:
  < 2 GHz
- Gain control: 35 dB dynamic range
- Moderate power:
  - 20 GHz:
    - $P_{-1\ dB}$: 18 dBm
    - P_{sat}: 20 dBm
  - 26.5 GHz:
    - $P_{-1\ dB}$: 15 dBm
    - P_{sat}: 17 dBm

KEYSIGHT TECHNOLOGIES

Description

The HMMC-5021/22/26/QMMC-5002 is a broadband GaAs MMIC traveling wave amplifier designed for high gain and moderate output power over the full 2 to 26.5 GHz frequency range. Seven MES-FET cascode stages provide a flat gain response, making the HMMC-5021/22/26/QMMC-5002 an ideal wideband gain block. Optical lithography is used to produce gate lengths of ≈ 0.4 µm. The HMMC-5021/22/26/QMMC-5002 incorporates 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 ±0.6 mils)
Pad dimensions:
75 × 75 µm (2.95 × 2.95 mils),
or larger

1GG7-8000, 1GG7-8006, 1GG7-8007

Absolute Maximum Ratings[1]

Symbol	Parameters/conditions	Minimum	Maximum	Units
V_{DD}	Positive drain voltage		8.0	Volts
I_{DD}	Total drain current		250	mA
V_{G1}	First gate voltage	–5	0	Volts
I_{G1}	First gate current	–9	+5	mA
V_{G2}[2]	Second gate voltage	–2.5	+3.5	Volts
I_{G2}	Second gate current	–7		mA
P_{DC}	DC power dissipation		2.0	Watts
P_{in}	CW input power		23	dB
T_{ch}	Operating channel temp.		+150	°C
T_{case}	Operating case temp.	–55		°C
T_{stg}	Storage temperature	–65	+165	°C
T_{max}	Maximum 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}.
2. Minimum voltage on V_{G2} must not violate the following: V_{G2} (min) > V_{DD} – 9 volts.

DC Specifications/Physical Properties[1] (Applies to All Part Numbers)

Symbol	Parameters/conditions	Min.	Typ.	Max	Units
I_{DSS}	Saturated drain current (V_{DD} = 7.0 V, V_{G1} = 0.0 V, V_{G2} = open circuit)	115	180	250	mA
V_p	First gate pinch-off voltage (V_{DD} = 7.0 V, I_{DD} = 16 mA, V_{G2} = open circuit)	–3.5	–1.5	–0.5	volts
V_{G2}	Second gate self-bias voltage (V_{DD} = 7.0 V, V_{G1} = 0.0 V)		2.1		volts
$I_{DSOFF}(V_{G1})$	First gate pinch-off current (V_{DD} = 7.0 V, V_{G1} = –3.5 V, V_{G2} = open circuit)		4		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)		8		mA
θ_{ch-bs}	Thermal resistance ($T_{backside}$ = 25 °C)		36		°C/W

1. Measured in wafer form with T_{chuck} = 25 °C. (except θ_{ch-bs}).

RF Specifications

(V_{DD} = 7.0 V, I_{DD}(Q) = 150 mA, Z_{in} = Z_o = 50 Ω)[1]

		5021 2.0 to 22.0 GHz			5022 2.0 to 22.0 GHz		5026 2.0 to 26.5 GHz				QMMC-5002 2.0 to 22.0 GHz		
Symbol	Parameters/conditions	Typ	Min	Max	Min	Max	Typ.	Min		Max	Min	Max	Units
BW	Guaranteed bandwidth[2]		2	22	2	22		2	24	26.5	2	22	GHz
S_{21}	Small signal gain	10			8	12	9.5	7		12	10[3]	14[3]	dB
ΔS_{21}	Small signal gain flatness	±0.5				±1	±0.75			±1.5		±0.5[3]	dB
$RL_{in(min)}$	Minimum input return loss	16			15		14	12			15		dB
$RL_{out(min)}$	Minimum output return loss	13			13		13	10			13		dB
Isolation	Minimum reverse isolation	32			23		30	23			23		dB
$P_{-1\,dB}$	Output power at 1 dB gain compression	18			15		15	12			15		dBm
P_{sat}	Saturated output power	20			17		17	14	18		17		dBm
$H_{2(max)}$	Max. second harm. (2 < f_o < 20), [$P_o(f_o)$ = 17 dBm or P_{-1dB}, whichever is less]	–25				–20	–25			–20		–20	dBc
$H_{3(max)}$	Max. third harm. (2 < f_o < 20), [$P_o(f_o)$ = 17 dBm or P_{-1dB}, whichever is less]	–34				–20	–34			–20		–20	dBc
NF	Noise figure	8					10						dB

1. Small-signal data measured in wafer form with T_{chuck} = 25 °C. Large-signal data measured on individual devices mounted in an 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 –3 dB corner frequency ~ 29.5 GHz.
3. These specifications are applicable to 2.0 to 18 GHz only.

Applications

The HMMC-5021/22/26/QMMC-5002 Series of traveling wave amplifiers are designed for use as general purpose wideband gain blocks 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.

It is characteristic of traveling wave amplifiers that S_{22} tends to 0 dB and greater out of band. This is the design trade-off for the broadband performance of TWAs. As a consequence, TWAs are not necessarily unconditionally stable out of band. This means that if a TWA is followed by a reflective low-pass filter, oscillations can occur. This phenomenon is exacerbated by low temperature where the gain is higher. More data will follow on individual devices.

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-5021/22/26/QMMC-5002 are V_{DD} = 7.0 V, I_{DD} = 150 mA for best overall performance. To achieve this drain current level, V_{G1} is typically biased between –0.2 V and –0.5 V. No other bias supplies or connections to the device are required for 2 to 26.5 GHz operation. See Figure 3 for assembly information.

The auxiliary gate and drain contacts are used only for low-frequency performance extension below ≈ 1.0 GHz. When used, these contacts must be AC coupled only. (Do not attempt to apply bias to these pads.)

The second gate (V_{G2}) can be used to obtain 35 dB (typical) dynamic gain control.

For normal operation, no external bias is required on this contact and its self-bias voltage is ≈ +2.1 V. Applying an external bias between its open-circuit voltage and –2.5 volts will adjust the gain while maintaining a good input/output port match.

Assembly Techniques

Solder die-attach using a flux-less AuSu solder preform is the recommended assembly method. Gold thermosonic wedge bonding with 0.7 mil diameter Au wire is recommended for all bonds. Tool force should be 22 ±1 gram, stage temperature should be 150 ±2 °C, and ultrasonic power and duration should be 64 ±1 dB and 76 ±8 msec, respectively. The bonding pad and chip backside metallization is gold.

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

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

application note, *GaAs MMIC ESD, Die Attach and Bonding Guidelines* (5991-3484EN) provides basic information on these subjects.

Additional References

2–26.5 GHz Variable Gain Amplifier Using TC700 and TC701 GaAs MMIC Components, Technical Overview (5991-3543EN)

TC700/702 Traveling Wave Amplifier Environmental Data, Technical Overview (5991-3553EN)

TC700 S–Parameters Performance as a Function of Bonding Configuration, Technical Overview (5991-3552EN)

GaAs MMIC TWA, Users Guide (5991-3545EN)

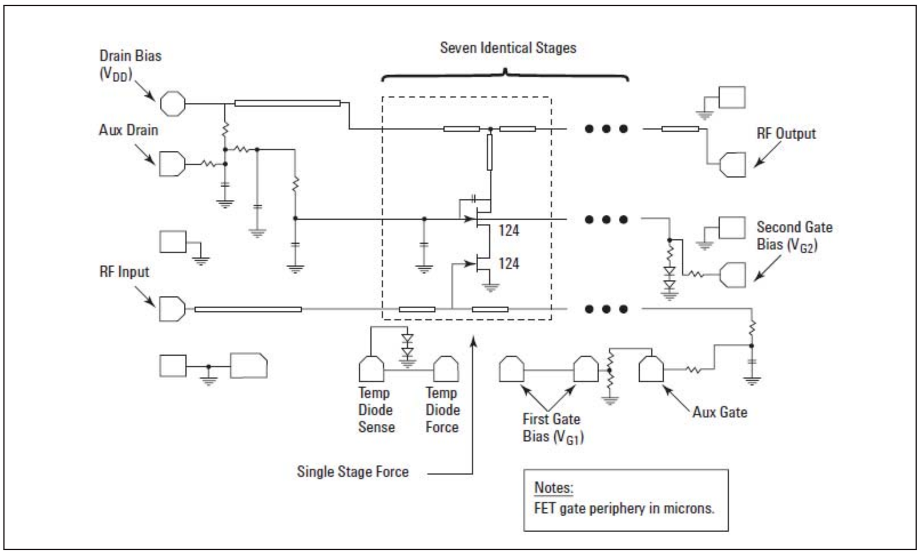


Figure 1. Schematic

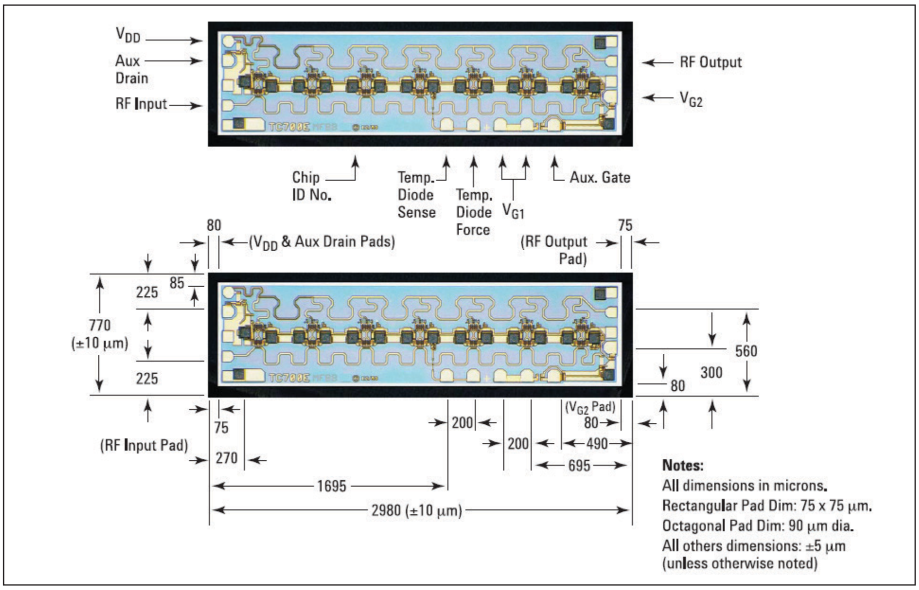


Figure 2. Bonding pad locations

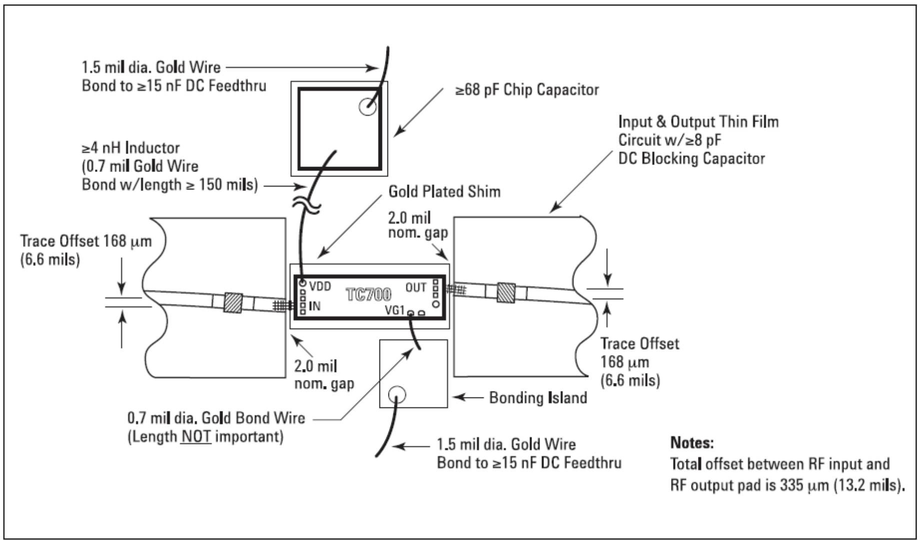


Figure 3. Assembly diagram
(For 2.0 - 26.5 GHz operation)

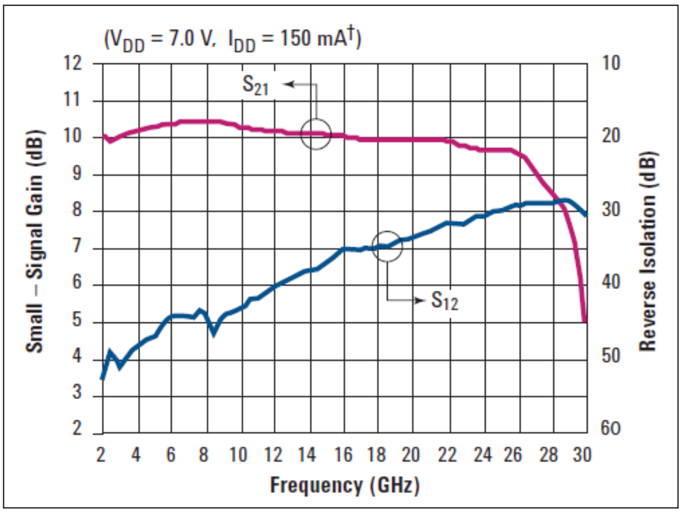


Figure 4. Typical gain and reverse isolation vs. frequency

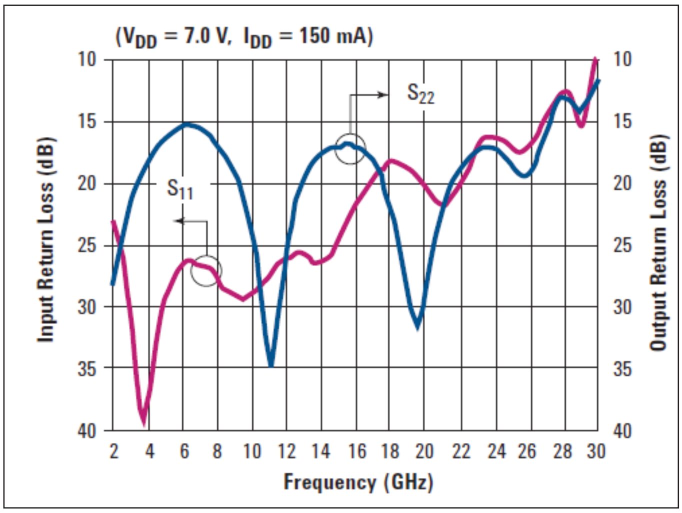


Figure 5. Typical input and out return loss vs. frequency

Typical S–Parameters[1]

(T_{chuck} = 25° C, V_{DD} = 7.0 V, I_{DD} = 150 mA, Z_{in} = Z_{out} = 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	–22.6	0.074	–174.1	–53.1	0.0022	167.3	–10.1	3.183	123.6	–28.9	0.036	77.3
3.0	–30.6	0.030	130.4	–51.0	0.0028	120.1	–10.0	3.173	102.1	–21.6	0.083	64.1
4.0	–37.8	0.013	–19.8	–48.0	0.0040	95.0	–10.2	3.225	78.2	–18.2	0.124	45.4
5.0	–29.4	0.034	–79.9	–46.8	0.0046	67.1	–10.3	3.275	53.5	–16.3	0.153	23.4
6.0	–26.6	0.047	–113.8	–44.4	0.0060	36.0	–10.4	3.303	28.1	–15.4	0.170	2.5
7.0	–26.6	0.047	–137.0	–44.1	0.0062	1.0	–10.3	3.330	2.3	–15.7	0.165	–19.5
8.0	–27.7	0.041	–152.6	–43.4	0.0067	–27.5	–10.5	3.331	–23.8	–17.0	0.141	–40.7
9.0	–29.0	0.035	–149.8	–44.3	0.0061	–31.8	–10.4	3.312	–50.2	–19.2	0.110	–59.7
10.0	–29.0	0.036	–140.8	–43.0	0.0071	–53.6	–10.3	3.282	–76.4	–24.3	0.061	–76.8
11.0	–27.3	0.043	–138.1	–41.6	0.0083	–74.8	–10.2	3.253	–102.5	–35.1	0.018	–32.6
12.0	–26.2	0.049	–141.9	–40.0	0.0100	–96.9	–10.2	3.227	–128.8	–24.6	0.059	21.0
13.0	–25.8	0.052	–148.5	–38.9	0.0113	–120.9	–10.2	3.218	–155.4	–19.7	0.103	2.8
14.0	–26.4	0.048	–143.0	–38.1	0.0125	–145.6	–10.1	3.204	177.8	–17.6	0.132	–21.2
15.0	–24.6	0.059	–131.7	–36.6	0.0148	–169.9	–10.1	3.197	150.4	–17.0	0.141	–44.8
16.0	–21.6	0.083	–133.7	–35.3	0.0172	160.9	–10.0	3.177	122.5	–17.1	0.140	–67.4
17.0	–19.4	0.107	–143.5	–35.0	0.0177	130.6	–10.0	3.149	94.4	–18.5	0.119	–91.8
18.0	–18.3	0.121	–158.7	–34.7	0.0184	105.0	–9.9	3.138	65.9	–21.8	0.081	–116.0
19.0	–18.7	0.116	–172.6	–33.9	0.0201	80.2	–9.9	3.140	36.8	–28.9	0.036	–121.7
20.0	–20.3	0.097	–179.5	–33.3	0.0217	50.7	–10.0	3.151	6.6	–28.5	0.038	–57.0
21.0	–21.8	0.082	–168.3	–32.7	0.0233	22.5	–10.0	3.150	–24.9	–21.7	0.082	–59.1
22.0	–19.9	0.101	–155.3	–31.7	0.0259	–8.4	–9.9	3.126	–57.5	–18.6	0.117	–81.5
23.0	–17.3	0.137	–158.8	–31.4	0.0268	–39.5	–9.8	3.076	–91.0	–17.3	0.137	–103.3
24.0	–16.3	0.153	–169.9	–30.7	0.0291	–71.5	–9.7	3.045	–125.5	–17.3	0.137	–123.8
25.0	–17.1	0.139	–175.4	–30.0	0.0317	–106.2	–9.7	3.045	–162.2	–18.5	0.118	–135.3
26.0	–17.0	0.141	–165.0	–29.2	0.0345	–145.5	–9.6	3.027	157.2	–19.4	0.107	–122.5
26.5	–15.7	0.163	–161.1	–29.0	0.0356	–166.7	–9.5	2.970	135.4	–17.6	0.132	–114.2
27.0	–14.3	0.192	–162.7	–28.9	0.0357	171.7	–9.2	2.876	112.9	–15.3	0.173	–116.0
28.0	–13.2	0.220	–175.7	–28.8	0.0362	126.3	–8.5	2.648	65.8	–12.6	0.233	–138.1
29.0	–14.1	0.197	–176.9	–28.6	0.0371	73.0	–7.7	2.433	10.3	–15.4	0.170	–144.7
30.0	–14.1	0.266	–171.6	–30.8	0.0287	4.8	–4.6	1.689	–61.1	–8.7	0.369	–123.6

1. Data obtained from on-wafer measurements.

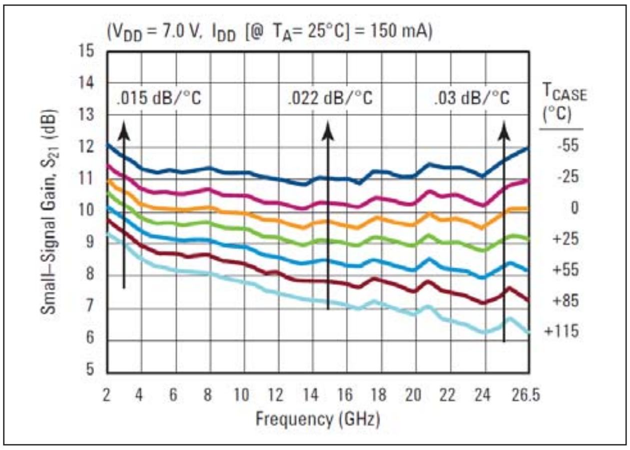


Figure 6. Typical small-signal gain vs. temperature

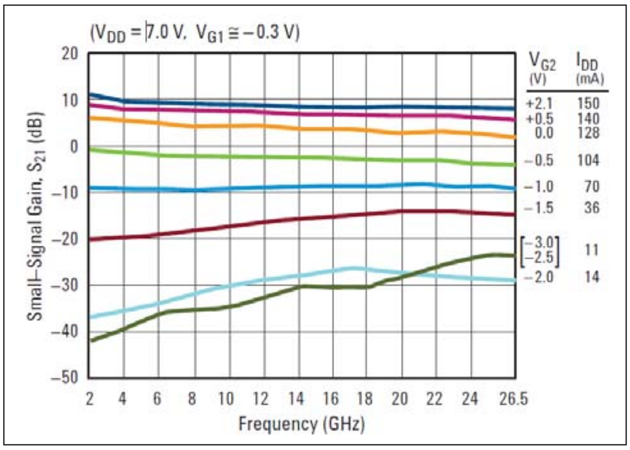


Figure 7. Typical gain vs. second gate control voltage

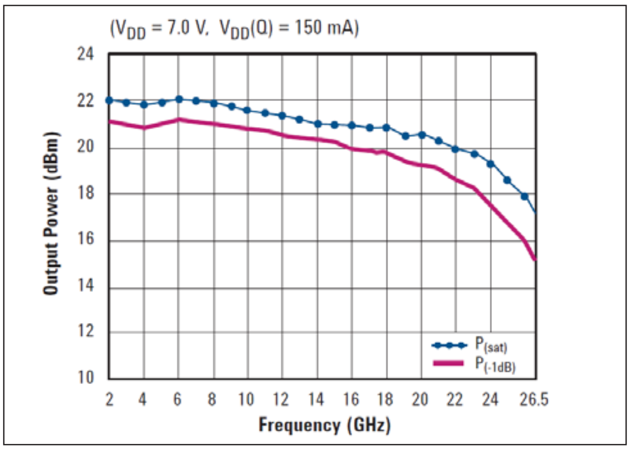


Figure 8. Typical 1 dB gain compression and saturated output power

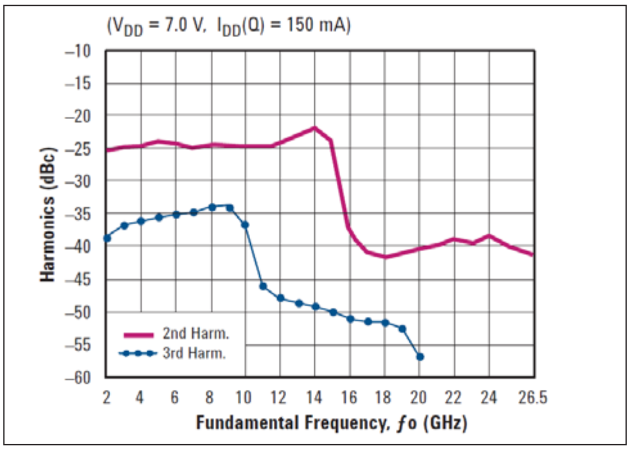


Figure 9. Typical second and third harmonics vs. fundamental frequency at P_{out} = +17 dBm

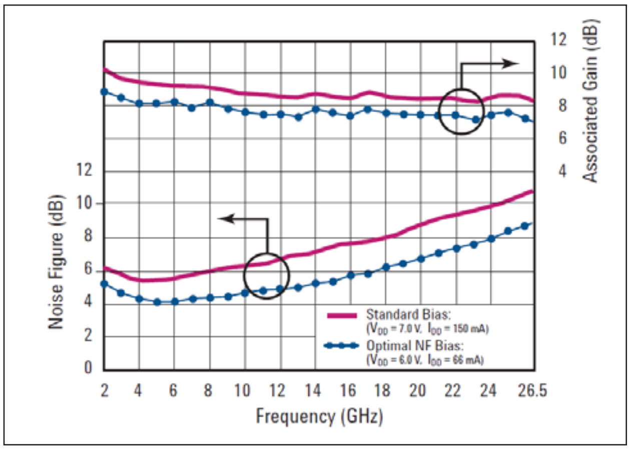


Figure 10. Typical noise figure performance

Notes

All data measured on individual devices mounted in an Keysight 83040 Series Modular Microcircuit Package @ T_A = 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. Customers considering the use of this, or other TCA GaAs ICs, for their design should obtain the current production specifications from . In this data sheet the term typical refers to the 50th percentile performance. For additional information and support email: mmic_helpline@keysight.com.

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