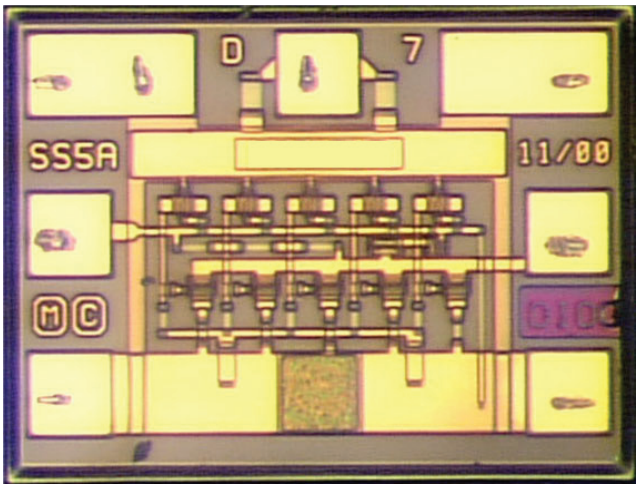
Keysight 1GC1-4030

DC - 10 GHz Medium Power Series– Shunt HBT Amplifier

Data Sheet



Features

- Frequency range: DC – 10 GHz
- Moderate gain: 11 dB
- P_{-1dB}: +19 dBm
- Low 1/f noise corner: < 20 kHz
- Return loss:
  Input: 20 dB
  Output: 15 dB
- Single supply operation
  V_{Supply} > 4.8 volts

KEYSIGHT TECHNOLOGIES

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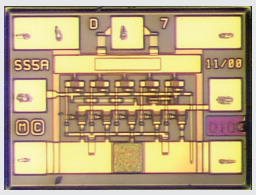
Description

The 1GC1-4030 is a DC – 10 GHz, 11 dB gain, feedback amplifier designed to be used as a cascadable gain block for a variety of applications. The device consists of a modified Darlington feedback pair which reduces the sensitivity to process variations and provides 50 ohm input/output port matches. Furthermore, this amplifier is fabricated using HFTC's Heterojunction Bipolar Transistor (HBT) process which provides excellent process uniformity, reliability and 1/f noise performance. The device requires a single positive supply voltage and generally operates Class-A for good distortion performance. DC power dissipation is less than 0.68 watts.



- Chip size: 610 x 460 µm (24 x 18 mils)
- Chip size tolerance: ±10 µm (± 0.4 mils)
- Chip thickness: 127 ±15 µm (5.0 ± 0.6 mils)
- Pad dimensions: 80 x 80 µm (3.2 x 3.2 mils), or larger

Absolute maximum ratings[1]

(@ T_A = 25 °C, unless otherwise indicated)

Symbol	Parameters/conditions	Min	Max	Units
V_{cc}	Collector pad voltage		7	Volts
I_{out}	Maximum collector current		90	mA
P_{in}	CW input power		18	dBm
T_J	Maximum junction temperature		170	°C
T_{op}	Operating temperature	-55	+85	°C
T_{bs}[2]	Die backside temperature		+85	°C
T_{stg}	Storage temperature	65	165	°C
T_{max}	Maximum assembly temperature		+300	°C

1. Operation in excess of any one of these conditions may result in permanent damage to this device.
2. MTTF > 5 x 10^5 hours @ T_{bs} = 85 °C. Operation in excess of maximum backside temperature (T_{bs}) will degrade MTTF.

DC specifications/physical properties

(Typicals are for T_A = 25 °C, V_{cc}= +5 V, I_{out}= +80 mA)

Symbol	Parameters/conditions	Min	Typ	Max	Units
V_{out}	Output pad voltage	4.3	4.8	5.3	Volts
V_{in}	Input pad voltage	3.1	3.4	3.7	Volts
I_{C1}	Stage–one supply current	50	60	70	mA
I_{C2}	Stage–two supply current		80		mA
I_{C1} + I_{C2}	Total supply current		140		mA
θch-s	Thermal resistance ($T_{substrate}$= 25 °C)		130		°C/W

RF specifications[1]

(Typicals are for T_A = 25 °C, V_{cc}= +5 V, I_{out}= 80 mA)

Symbol	Parameters/conditions	DC - 6 GHz			DC - 10 GHz			Units
		Min	Typ	Max	Min	Typ	Max	
BW	Operating bandwidth	8			10			GHz
S_{21}	Small signal gain	10	11		10	11		dB
ΔS_{21}	Small signal gain flatness		±0.2			±0.5		dB
TC	Temperature coefficient of gain		0.005			0.02		dB/°C
RL_{in}	Input return loss		–20			–20		dB
RL_{out}	Output return loss		–20			–15		dB
ISO	Isolation, reverse		16			17		dB
P_{1dB}	Output power at 1 db gain compression		19.5			18.5		dBm
P_{out}	Output power flatness vs. frequency		±0.5			±1		dBm
P_{sat}	Saturated output power		20			19		dBm
H_s	Second harmonics, P_{out} = +10 dbm		–30			–30		dBc
	Second harmonics, P_{out} = $P_{1\ db}$		–20			–20		dBc
H_3	Third harmonics, P_{out} = +10 dbm		–40			–40		dBc
	Third harmonics, P_{out} = $P_{1\ db}$		–20			–20		dBc
NF	Noise figure		7			7		dB

1. These RF specifications can be achieved when the device is properly biased and heat sunk. Specifications are per output and based on performance attained with a 1GC1-4030 mounted in an Keysight 83040 series Modular Microcircuit Package.

Biasing

The 1GC1-4030 can be operated from a single positive supply. This supply must be connected to two points on the chip, namely the V_{CC} pad and the output pad. The supply voltage may be directly connected to the V_{CC} pad as long as the voltage is between +4.75 to +5 volts; however, if the supply is higher than +7 volts, a series resistor (R_{CC}) should be used to reduce the voltage to the V_{CC} pad. See the bonding diagram for the equation used to select R_{CC}. In the case of the output pad, the supply voltage must be connected to the output transmission line through a resistor (R_{OUT}) and an inductor. See the bonding diagram for the equation used to select R_{OUT}. If R_{OUT} is greater than 300 ohms, the inductor may be omitted, however, the amplifier's gain may be reduced by ~0.5 dB. Figure 4 shows the recommended assembly and bonding method.

The chip contains a backside via to provide a low inductance ground path: therefore, the ground pad on the IC should not be bonded.

The voltage at the IN and OUT pads of the IC will be approximately 3.4 and 4.8 volts respectfully; therefore, DC blocking caps should be used at the input and output of the device.

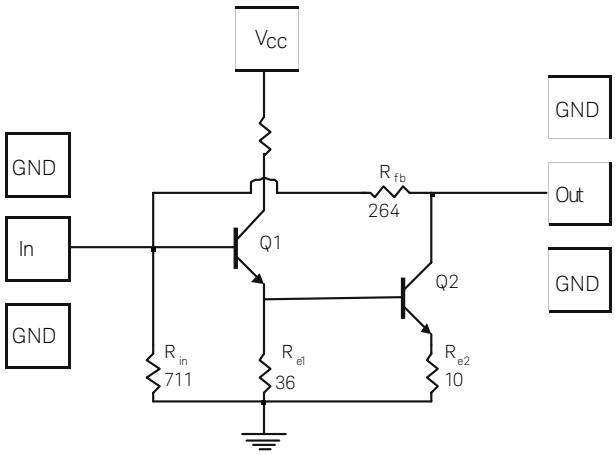
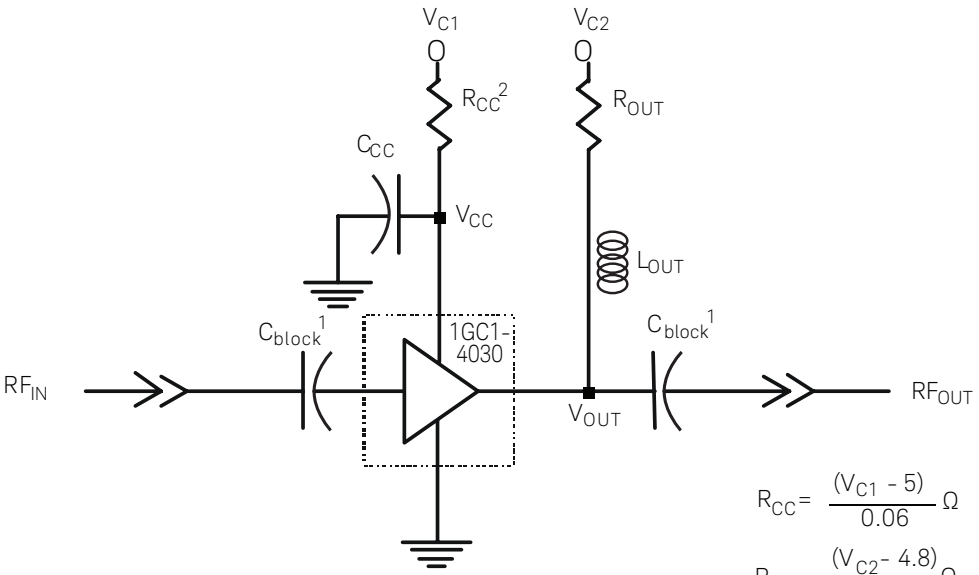


Figure 1. 1GC1-4030 simplified block diagram



$$R_{CC} = \frac{(V_{C1} - 5)}{0.06}\ \Omega$$

$$R_{OUT} = \frac{(V_{C2} - 4.8)}{0.08}\ \Omega$$

1. Blocking caps are required on input and output
2. RCC is only needed if $V_{C1} > 5$ V

Figure 2. 1GC1-4030 Biasing diagram

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 and duration of 64 ±1 dB and 76 ±8 msec, respectively. The top and bottom metallization is gold.

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

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

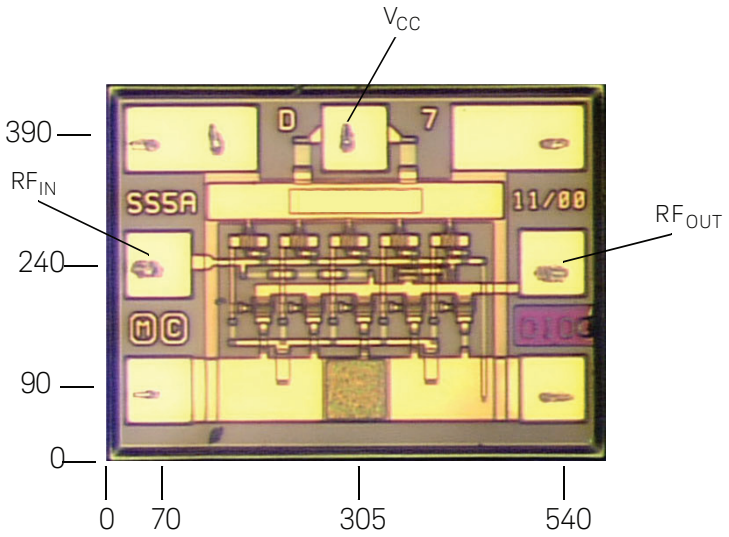


Figure 3. 1GC1-4030 chip bias/RF bond pad locations

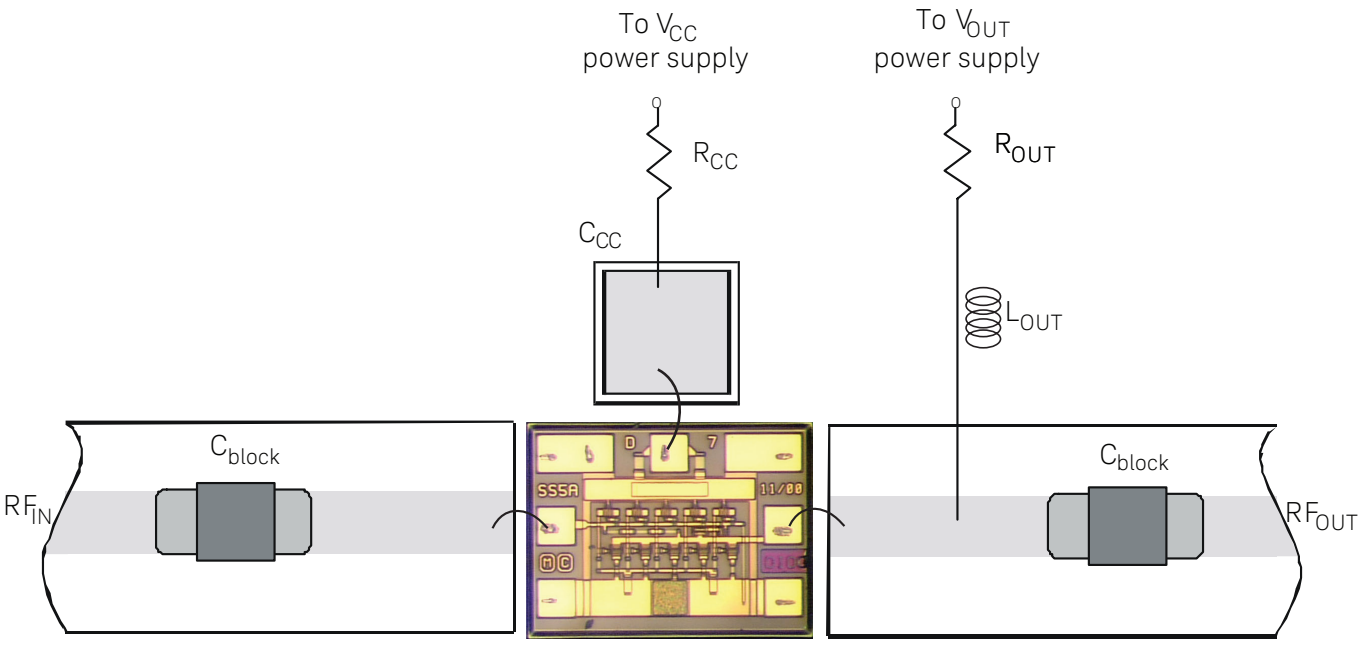


Figure 4. 1GC1-4030 chip assembly diagram

S–Parameters

(T_A = 25 °C, V_{cc} = 5V, V_{Out} = 4.8V, I_{C1}= 60 mA, I_{C2} = 80 mA, Z_o = 50 ohms)

Freq GHz	S11			S12			S21			S22		
	dB	Mag	Ang	dB	Mag	Ang	dB	Mag	Ang	dB	Mag	Ang
0.5	-30.0	0.032	91.4	-15.2	0.173	1.5	11.2	3.648	174.9	-23.0	0.071	6.0
1.0	-29.3	0.034	94.5	-15.4	0.171	-1.2	11.2	3.633	167.7	-23.4	0.067	-3.2
1.5	-28.2	0.039	92.9	-15.5	0.168	-4.3	11.2	3.615	160.5	-23.6	0.066	-11.6
2.0	-26.9	0.045	88.7	-15.6	0.166	-7.2	11.1	3.597	153.4	-23.7	0.065	-19.5
2.5	-25.7	0.052	83.0	-15.7	0.163	-9.9	11.1	3.581	146.6	-23.7	0.065	-27.3
3.0	-24.6	0.059	77.0	-15.8	0.162	-12.4	11.1	3.570	140.1	-23.7	0.065	-35.6
3.5	-23.7	0.065	71.0	-15.9	0.160	-14.5	11.0	3.566	133.8	-23.8	0.064	-44.7
4.0	-23.1	0.070	65.4	-16.0	0.159	-16.5	11.1	3.569	127.5	-24.0	0.063	-55.1
4.5	-22.6	0.074	60.3	-16.0	0.158	-18.5	11.1	3.581	121.4	-24.2	0.061	-67.0
5.0	-22.4	0.076	55.8	-16.0	0.158	-20.5	11.1	3.601	115.2	-24.4	0.060	-80.4
5.5	-22.4	0.076	51.6	-16.1	0.157	-22.5	11.2	3.630	108.9	-24.4	0.060	-95.0
6.0	-22.4	0.075	47.5	-16.1	0.156	-24.7	11.3	3.664	102.4	-24.1	0.062	-109.7
6.5	-22.6	0.074	42.9	-16.2	0.155	-27.0	11.4	3.703	95.8	-23.6	0.066	-123.5
7.0	-23.0	0.071	37.0	-16.3	0.154	-29.4	11.5	3.745	89.0	-22.8	0.073	-135.2
7.5	-23.4	0.068	28.7	-16.3	0.153	-31.9	11.6	3.792	82.0	-21.8	0.081	-144.6
8.0	-24.0	0.063	16.6	-16.4	0.151	-34.5	11.7	3.841	74.7	-20.8	0.091	-151.9
8.5	-24.6	0.059	-0.9	-16.5	0.149	-37.1	11.8	3.890	67.2	-19.7	0.103	-157.5
9.0	-24.7	0.058	-24.7	-16.6	0.147	-39.8	11.9	3.937	59.5	-18.6	0.117	-161.8
9.5	-23.7	0.065	-52.3	-16.8	0.145	-42.6	12.0	3.978	51.4	-17.5	0.133	-165.4
10.0	-21.7	0.083	-77.4	-16.9	0.143	-45.5	12.1	4.011	43.1	-16.4	0.151	-168.6
10.5	-19.2	0.110	-97.5	-17.1	0.140	-48.5	12.1	4.028	34.4	-15.3	0.171	-171.7
11.0	-16.8	0.145	-113.4	-17.3	0.137	-51.4	12.1	4.028	25.4	-14.2	0.194	-174.9
11.5	-14.6	0.186	-126.8	-17.5	0.133	-54.4	12.1	4.005	16.2	-13.2	0.219	-178.4
12.0	-12.7	0.233	-138.6	-17.8	0.129	-57.2	11.9	3.957	6.7	-12.1	0.247	177.8
12.5	-11.0	0.283	-149.3	-18.1	0.125	-60.0	11.8	3.880	-3.0	-11.2	0.277	173.7
13.0	-9.5	0.337	-159.4	-18.4	0.120	-62.6	11.5	3.775	-12.9	-10.2	0.309	169.3
13.5	-8.2	0.391	-168.9	-18.7	0.116	-65.0	11.2	3.641	-22.9	-9.3	0.341	164.6
14.0	-7.0	0.446	-178.1	-19.1	0.111	-67.2	10.8	3.479	-32.8	-8.5	0.374	159.6
14.5	-6.1	0.498	173.2	-19.4	0.107	-69.2	10.3	3.290	-42.8	-7.8	0.406	154.6
15.0	-5.2	0.547	164.9	-19.8	0.102	-71.1	9.8	3.080	-52.6	-7.2	0.437	149.6
15.5	-4.6	0.592	157.1	-20.2	0.098	-72.8	9.1	2.853	-62.3	-6.7	0.465	144.6
16.0	-4.0	0.632	149.6	-20.6	0.093	-74.3	8.4	2.619	-71.7	-6.2	0.491	139.7
16.5	-3.5	0.666	142.6	-21.0	0.089	-75.7	7.5	2.384	-80.6	-5.8	0.514	135.0
17.0	-3.2	0.695	135.9	-21.4	0.085	-76.8	6.7	2.157	-89.2	-5.4	0.536	130.3
17.5	-2.9	0.720	129.6	-21.8	0.081	-77.8	5.8	1.945	-97.2	-5.1	0.557	125.7
18.0	-2.6	0.743	123.6	-22.1	0.079	-78.5	4.9	1.755	-104.6	-4.8	0.578	121.1
18.5	-2.3	0.766	117.9	-22.3	0.077	-79.2	4.0	1.590	-111.5	-4.5	0.599	116.5
19.0	-2.0	0.790	112.4	-22.5	0.075	-79.7	3.2	1.452	-117.8	-4.1	0.621	111.9
19.5	-1.8	0.817	107.2	-22.5	0.075	-79.9	2.5	1.340	-123.8	-3.8	0.646	107.5
20.0	-1.4	0.851	102.9	-22.4	0.076	-79.3	2.0	1.253	-129.2	-3.4	0.675	103.8

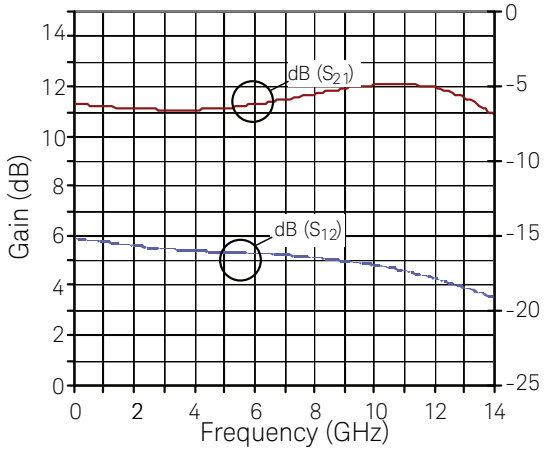


Figure 5. Gain and isolation vs. frequency[1]

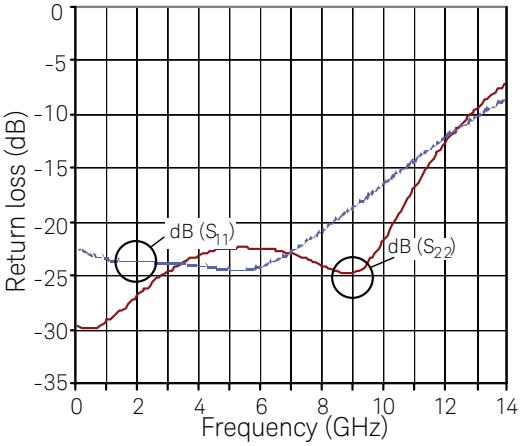


Figure 6. Return loss vs. frequency[1]

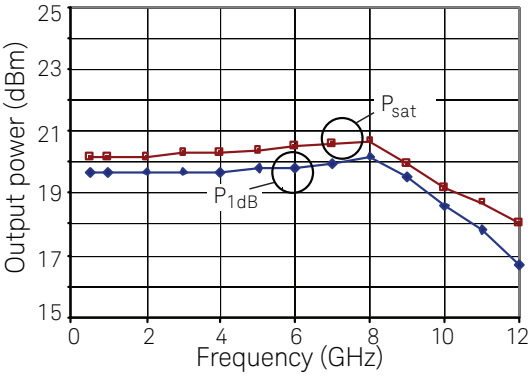


Figure 7. Output power vs. frequency[1]

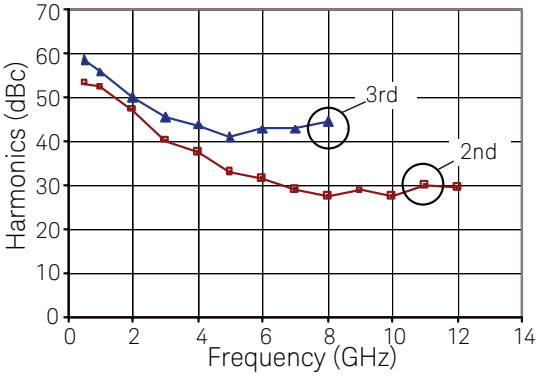


Figure 8. Harmonics vs. frequency @P_{OUT}= +10 dBm[1]

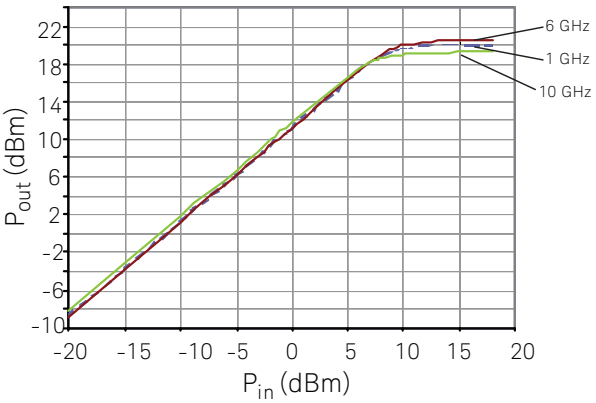


Figure 9. P_{in} vs. P_{out}[1]

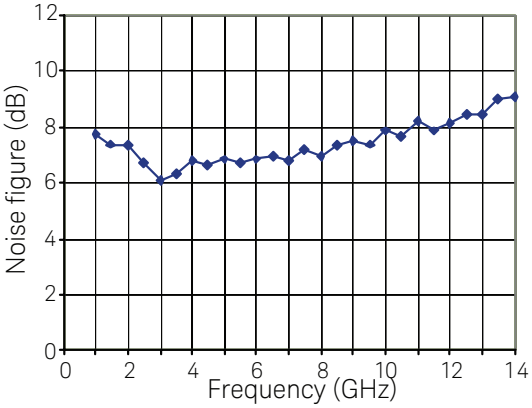


Figure 10. Noise figure vs. frequency[1]

1. All data was taken with T_A = 25 °C, V_C = 4.8 V, I_{CC} = 140 mA.
2. 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 HFTC GaAs ICs, for their design should obtain the current production specifications from HFTC Marketing. In this data sheet the term typical refers to the 50th percentile performance.

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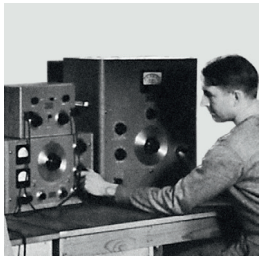

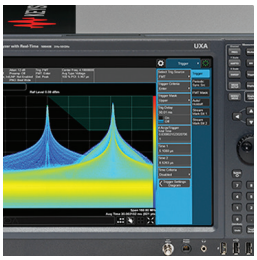

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