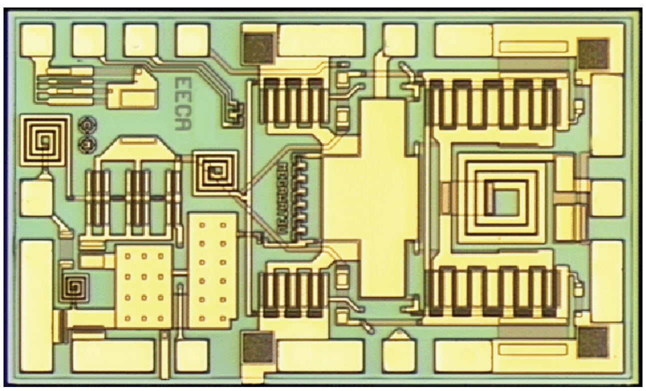
Keysight 1GG7-4147
100 kHz - 3 GHz Broadband Power Amplifier

Data Sheet



Features

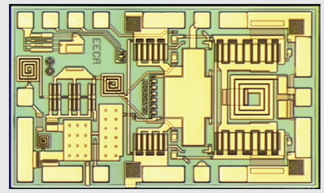
- Frequency range: 100 kHz –3 GHz
- High gain: 19 dB
- Flat response: ± 1 dB 10 MHz–3 GHz
- High isolation: –50 dB
- Return loss:
  input: –17 dB
  output: –8 dB
- High power output: 26.5 dBm saturated
- Harmonics: –37 dBc @ P_{out} = 21 dBm
- Unconditionally stable

KEYSIGHT TECHNOLOGIES

Unlocking Measurement Insights

Description

The 1GG7-4147 is a monolithic, wideband amplifier designed and fabricated using TSO's DF7M GaAs MESFET process. It features low distortion and delivers (typically) 26.5 dBm saturated output power into 50Ω over at least a 100 kHz to 3.0 GHz frequency range. The 1GG7-4147 is fabricated using the Keysight Technologies, Inc. GaAs FET process.



- Chip size: 1530 × 910 µm (60.2 × 35.8 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_{D1}	Stage 1 drain supply		+8.5	Volts
V_{D2}	Driver drain supply		+5.1	Volts
V_{D3}	Output drain supply		+8.5	Volts
V_{SS}	Source supply	–5.5	–3.5	Volts
P_{in}	CW input power		23	dBm
T_{case}	Operating case temperature[2]	–55	90	°C
T_{stg}	Storage temperature	–65	165	°C
T_{max}	Maximum assembly temperature (for 60 seconds maximum)		300	°C
ESD1	Electrostatic discharge damage level (1.5 KW, 100 pF), Unbiased, applied to any IC bond pad		±400	Volts
ESD2	Electrostatic discharge damage level (1.5 KW, 100 pF), biased, output pad thru DC blocking cap		±1000	Volts

1. Operation in excess of any one of these conditions may result in permanent damage to this device. Parameter specified at T_A = 25 °C, except for T_{case}, T_{stg}, and T_{max}.
2. Max continuous operating temp to achieve 1 × 10^6 MTTF, while operating with V_{D1} = V_{D3} +8 V, V_{D2} = +5, V_{SS} = –5 V. Derate MTTF by a factor of 2 for every 8 °C above this temperature.

DC specifications/physical properties[1]

(T_{chuck} = 25 °C)[2]

Symbol	Parameters/conditions	Min	Typ	Max	Units
I_{D1}	First stage drain ($V_{D1} = V_{D3} = +8$ V, $V_{D2} = +4.7$ V, $V_{SS} = -5$ V)	15	26	32	mA
I_{D2}	Second stage drain current ($V_{D1} = V_{D3} = +8$ V, $V_{D2} = +4.7$ V, $V_{SS} = -5$ V)	90	125	165	mA
I_{D3}	Third stage drain current ($V_{D1} = V_{D3} = +8$ V, $V_{D2} = +4.7$ V, $V_{SS} = -5$ V)	210	290	320	mA
I_{SS}	Source supply current ($V_{D1} = V_{D3} = +8$ V, $V_{D2} = +4.7$ V, $V_{SS} = -5$ V)	45	71	95	mA
P_{DC}	DC power dissipation ($V_{D1} = V_{D3} = +8$ V, $V_{D2} = +4.7$ V, $V_{SS} = -5$ V)		3.5		Watts

1. Data obtained from on–wafer measurements. All voltages specified at device pads.
2. I_{D2} and I_{D3} values are temperature-sensitive parameters. Values measured in a packaged or heat-sunk condition will be up to 20 % lower than measured on-wafer.

RF specifications[1]

($V_{D1} = V_{D3} = +8$ V, $V_{D2} = +4.7$ V, $V_{SS} = -5$ V, $Z_{in} = Z_o = 50\Omega$)

Symbol	Parameters/conditions	Min	Typ	Max	Units
BW	Guaranteed operating bandwidth[2]	.01		3	GHz
S_{21}	Small signal gain	17	19	22	dB
ΔS_{21}	Small signal gain flatness		±1		dB
RL_{in}	Input return loss		–17		dB
RL_{out}	Output return loss		–8		dB
S_{12}	Reverse isolation –50		–50		dB
P_{1dB}	Output power at 1 db gain compression		25		dBm
P_{sat}	Saturated output power	25	26.5		dBm
H_2,H_3	Harmonics (P_{out} @ fundamental = 21 dBm)		–35	–30	dBc
NF	Noise figure (f_0 >100 MHz) 10 dB		10		dB

1. Data obtained from measurements on individual devices mounted in an Keysight 83040 series modular microcircuit package @ 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 1GG7-4147 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} = +4.7 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 +4.7 V bias for V_{D2} may be derived from the +8 V 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 1GG7-4147 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.

Prolonged operation with maxi mum saturated output power into an open circuit should be avoided to prevent the possibility of long-term performance degration to the 1GG7-4147 device.

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.

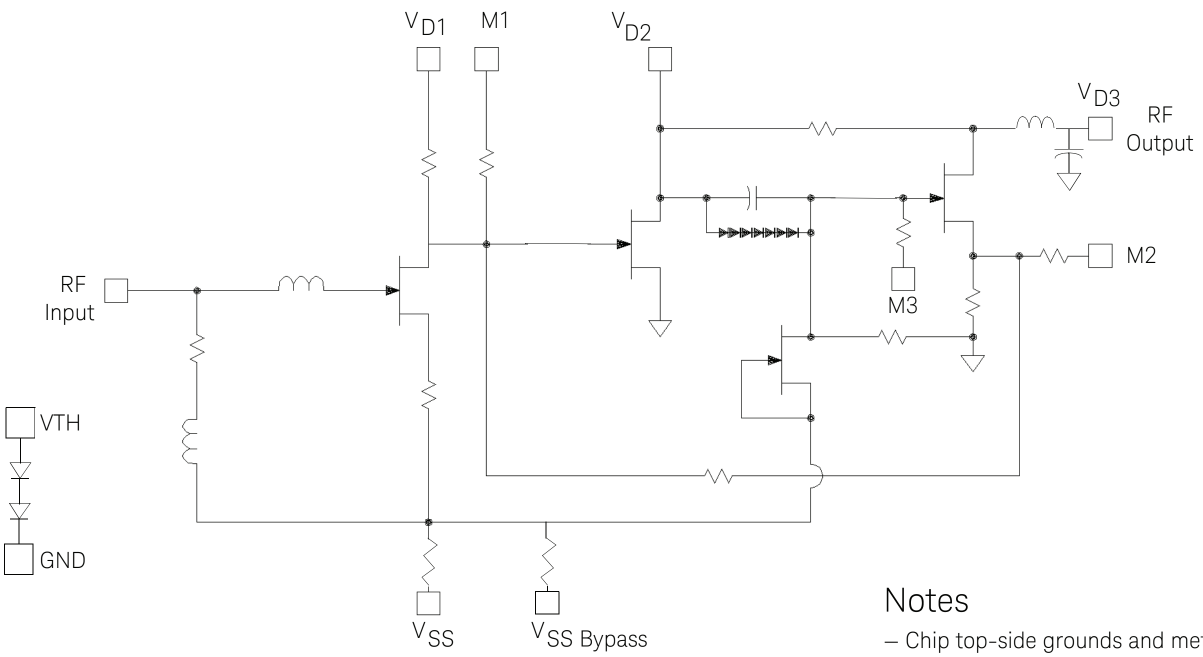
GaAs MMICs are ESD sensitive. ESD preventive measures must be employed in all aspects of storage, handling, and assembly.

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

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

RoHS Compliance

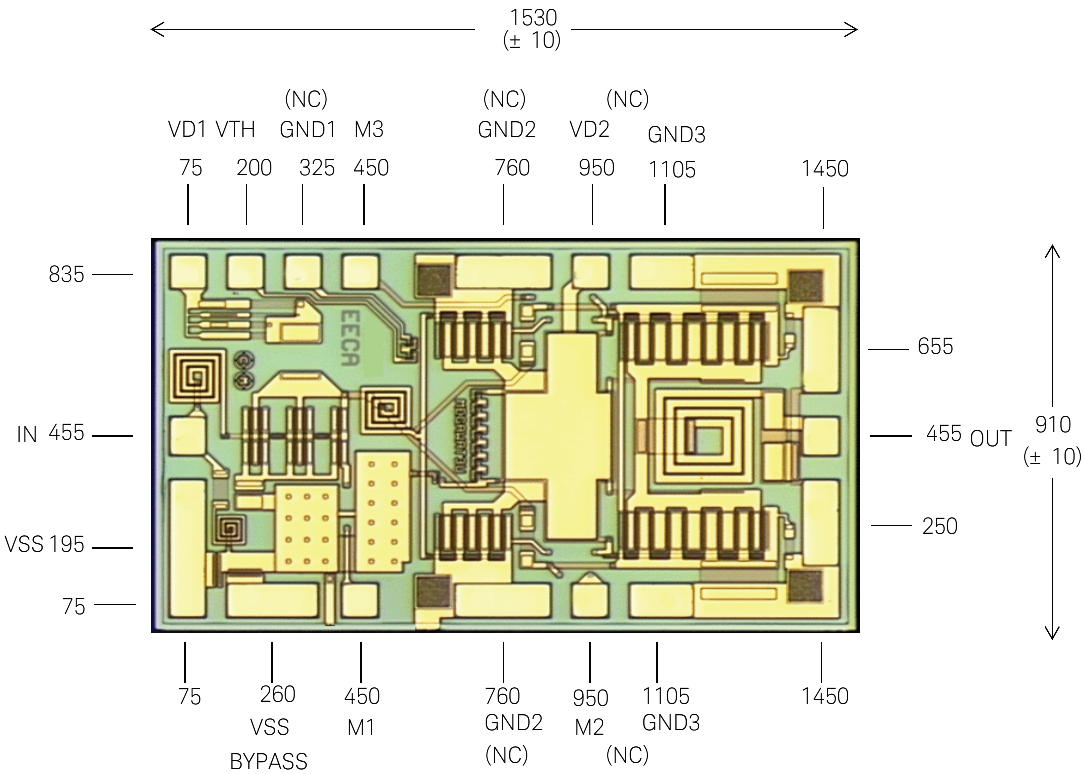
This device is RoHS Compliant. This means the component meets the requirements of the European Parliament and the Council of the European Union Restriction of Hazardous Substances Directive 2011/65/EU, commonly known as RoHS. The six regulated substances are lead, mercury, cadmium, chromium VI (hexavalent), polybrominated biphenyls (PBB) and polybrominated biphenyl ethers (PBDE). RoHS compliance implies that any residual concentration of these substances is below the RoHS Directive's maximum concentration values (MVC); being less than 1000 ppm by weight for all substances except for cadmium which is less than 100 ppm by weight.



Notes

– Chip top-side grounds and metalized chip backside connected through conductive Vias

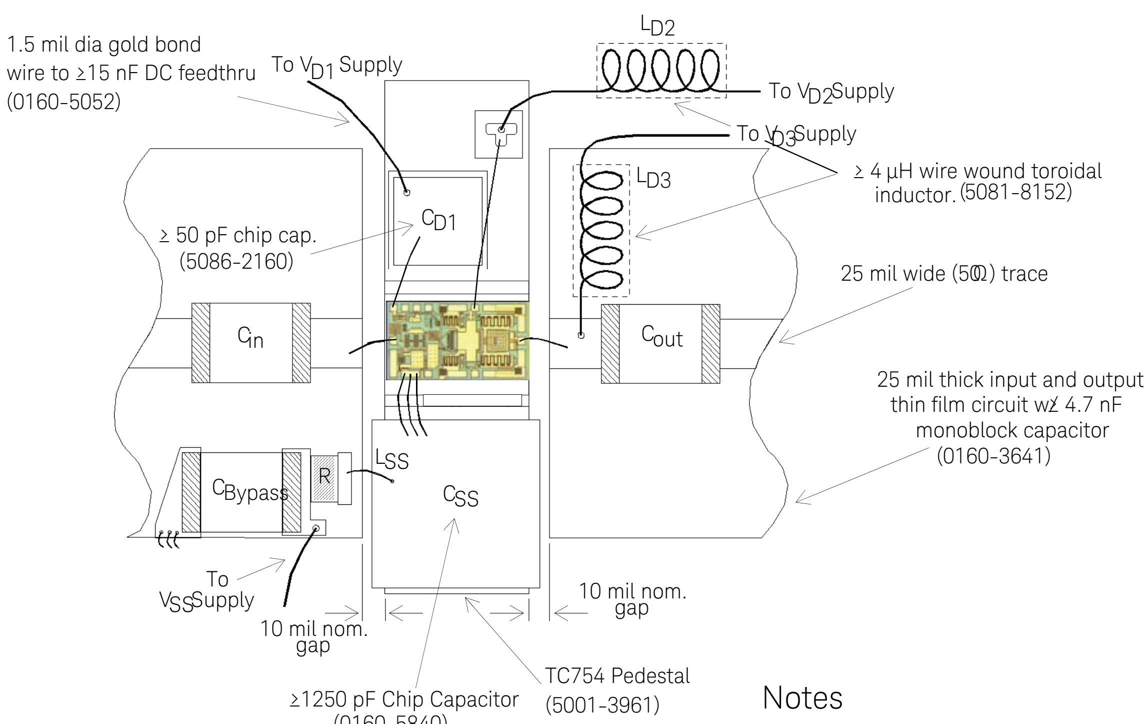
Figure 1. 1GG7-4147 schematic



Notes

- No bonding required on GND pads (Chip top-side grounds and metalized chip backside connected through conductive Vias)
- All dimensions in microns.
- Small pad dim: 75 x 75 µm.
- VSS pad dim: 325 × 75 µm.
- GND1 & 2 pad dim: 320 × 75 µm.
- GND3 & 4 pad dim: 450 × 75 µm.
- All tolerances: ± 5 µm (unless otherwise noted).
- Chip thickness: 127 ± 15 µm.

Figure 2.1GG7-4147 bond pad locations



Notes

- Part numbers for recommended Keysight components shown in parenthesis.
- All device bonds are 0.7 mil dia. gold wire

Figure 3. 1GG7-4147 assembly diagram (for 10 MHz to 3 GHz operation)

(V D1 = V D3 = +8.0 V, V D2 = +4.7 V, V SS = -5.0 V)†

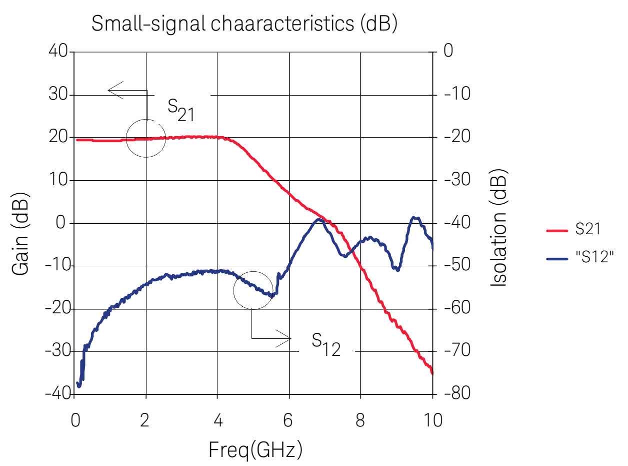


Figure 4. Typical gain and reverse isolation vs. frequency

(V D1 = V D3 = +8.0 V, V D2 = +4.7 V, V SS = -5.0 V)†

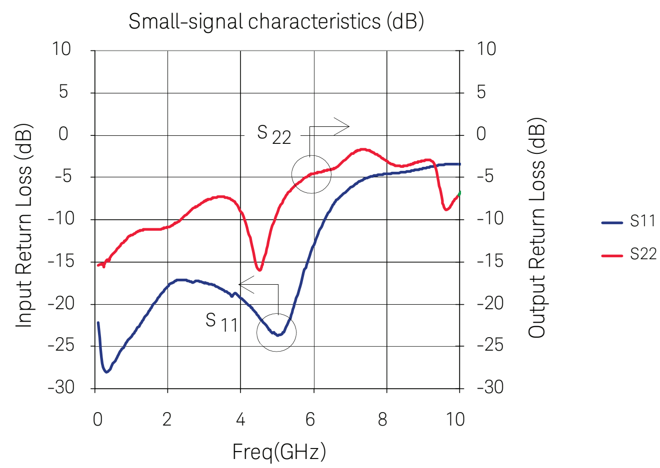


Figure 5. Typical input and output return loss vs. frequency

Typical S-parameters[1]

(VD1 = VD3 = +8 V, VD2 = +4.7 V, VSS = –5 V, Zin = Zo = 50 W)

Freq.	S11			S12			S21			S22		
(MHz)	dB	Mag	Ang	dB	Mag	Ang	dB	Ang	Ang	dB	Mag	Ang
1	–31.9	0.025	–79.4	–95.2	0.0000	–113.9	19.4	9.370	–166.2	–9.4	0.336	1.1
10	–31.8	0.026	–76.6	–89.1	0.0001	–107.1	19.4	9.353	–169.8	–9.5	0.335	–2.6
20	–31.4	0.027	–73.5	–83.4	0.0001	–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	-22.2	0.078	–47.5	-77.3	0.0001	–59.6	19.6	9.502	175.9	-15.4	0.170	–5.8
200	-27.0	0.044	–10.3	-73.2	0.0002	86.8	19.5	9.460	163.7	-15.2	0.173	–17.0
500	-27.0	0.044	17.2	-65.9	0.0005	95.0	19.4	9.305	145.4	-14.0	0.199	–32.3
750	-25.3	0.054	26.3	-63.1	0.0007	99.1	19.3	9.221	127.8	-12.8	0.229	–47.5
1000	-23.8	0.065	27.9	-59.9	0.0010	99.2	19.2	9.113	109.8	-11.8	0.256	–62.4
1250	-22.3	0.077	26.9	-59.0	0.0011	99.3	19.3	9.218	91.7	-11.3	0.273	–76.9
1500	-20.7	0.092	23.0	-57.5	0.0013	98.7	19.4	9.354	73.3	-11.1	0.278	–90.6
1750	-19.2	0.110	16.7	-56.1	0.0016	95.9	19.6	9.526	54.1	-11.1	0.278	–104.1
2000	-17.9	0.127	5.8	-54.4	0.0019	91.1	19.6	9.555	34.3	-10.9	0.285	–116.6
2250	-17.2	0.138	–10.9	-53.3	0.0022	87.4	19.8	9.814	13.9	-10.3	0.304	–128.8
2500	-17.2	0.138	–29.0	-52.5	0.0024	83.2	19.9	9.864	–7.8	-9.4	0.339	–140.3
2750	-17.3	0.137	–46.4	-52.5	0.0024	79.2	19.8	9.816	–31.2	-8.6	0.374	–151.2
3000	-17.5	0.134	–63.0	-51.9	0.0025	76.6	20.1	10.139	–55.3	-7.9	0.404	–160.3
3250	-17.7	0.130	–77.7	-52.0	0.0025	75.4	20.1	10.104	–80.1	-7.4	0.426	–168.3
3500	-18.3	0.121	–91.3	-51.6	0.0026	74.2	20.2	10.187	–105.6	-7.3	0.431	–173.3
3750	-19.0	0.112	–105.4	-51.3	0.0027	74.8	20.1	10.119	–131.4	-7.7	0.414	–175.8
4000	-19.3	0.108	–120.5	-51.6	0.0026	75.7	20.1	10.093	–157.2	-9.0	0.355	–175.0
4250	-20.3	0.097	–136.9	-51.6	0.0026	74.8	19.7	9.617	177.7	-12.1	0.247	–173.0
4500	-21.6	0.084	–153.9	-52.1	0.0025	73.4	18.8	8.717	153.2	-16.0	0.158	–171.3
4750	-22.9	0.072	–170.4	-53.6	0.0021	69.1	17.2	7.223	130.0	-12.6	0.234	–171.7
5000	-23.7	0.065	174.3	-54.4	0.0019	66.7	15.0	5.645	109.3	-9.2	0.347	–174.5

1. Data obtained from measurements on individual devices mounted in an Keysight 83040 series modular microcircuit package @T_{CASE} = 25 °C

Additional 1GG7-4147 performance characteristics[1]

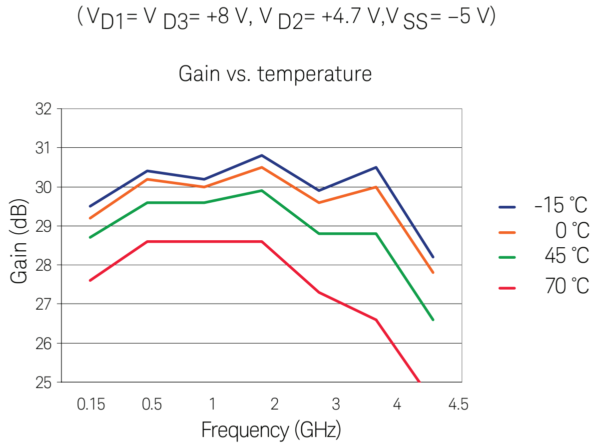


Figure 6. Typical small-signal gain vs. temperature

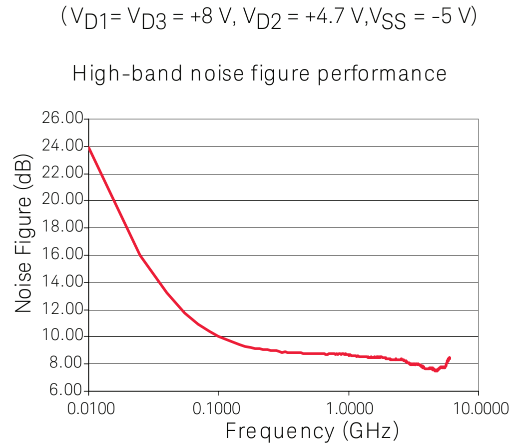


Figure 7. Typical noise figure vs. frequency

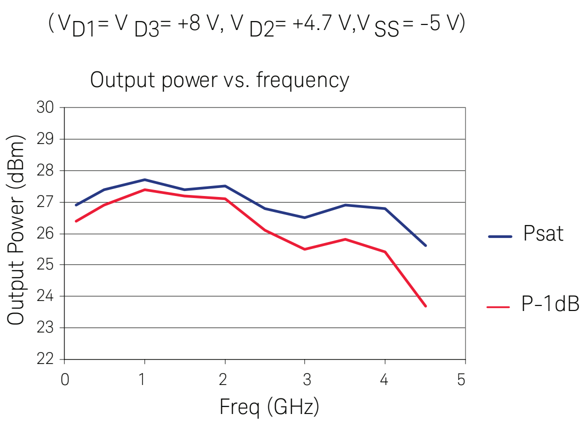


Figure 8. Typical 1 dB gain compression and saturated output power vs. frequency

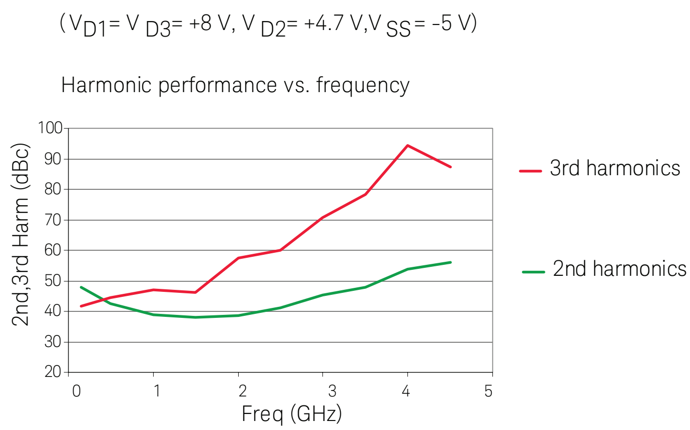
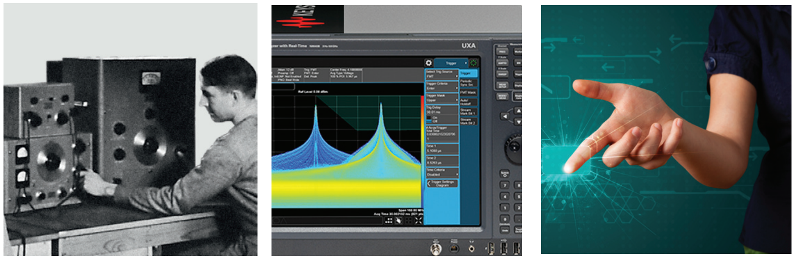


Figure 9. Typical second and third harmonics vs. fundamental frequency at P_{out} = 21 dBm

1. All data measured on individual devices mounted on a Keysight 83040 series modular microcircuit package @ T_{CASE} = 25 °C, except where noted.

Evolving

Our unique combination of hardware, software, support, and people can help you reach your next breakthrough. We are unlocking the future of technology.



From Hewlett-Packard to Agilent to Keysight

myKeysight

myKeysight
www.keysight.com/find/mykeysight
A personalized view into the information most relevant to you.

KEYSIGHT SERVICES
Accelerate Technology Adoption.
Lower costs.

Keysight Services
www.keysight.com/find/service
Keysight Services can help from acquisition to renewal across your instrument's lifecycle. Our comprehensive service offerings—one-stop calibration, repair, asset management, technology refresh, consulting, training and more—helps you improve product quality and lower costs.

Keysight Channel Partners
www.keysight.com/find/channelpartners
Get the best of both worlds: Keysight's measurement expertise and product breadth, combined with channel partner convenience.

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

The product described in this data sheet is RoHS Compliant. See RoHS Compliance section for more details.

www.keysight.com/find/mmic

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at:
www.keysight.com/find/contactus

Americas	
Canada	(877) 894 4414
Brazil	55 11 3351 7010
Mexico	001 800 254 2440
United States	(800) 829 4444

Asia Pacific	
Australia	1 800 629 485
China	800 810 0189
Hong Kong	800 938 693
India	1 800 11 2626
Japan	0120 (421) 345
Korea	080 769 0800
Malaysia	1 800 888 848
Singapore	1 800 375 8100
Taiwan	0800 047 866
Other AP Countries	(65) 6375 8100

Europe & Middle East	
Austria	0800 001122
Belgium	0800 58580
Finland	0800 523252
France	0805 980333
Germany	0800 6270999
Ireland	1800 832700
Israel	1 809 343051
Italy	800 599100
Luxembourg	+32 800 58580
Netherlands	0800 0233200
Russia	8800 5009286
Spain	800 000154
Sweden	0200 882255
Switzerland	0800 805353
	Opt. 1 (DE)
	Opt. 2 (FR)
	Opt. 3 (IT)
United Kingdom	0800 0260637

For other unlisted countries:
www.keysight.com/find/contactus
(BP-06-08-16)

DEKRA Certified
ISO9001 Quality Management System

www.keysight.com/go/quality
Keysight Technologies, Inc.
DEKRA Certified ISO 9001:2015
Quality Management System

KEYSIGHT TECHNOLOGIES
Unlocking Measurement Insights