Keysight 1GC1-4262
DC - 4 GHz, High-Gain, Dual-Mode: Low-Noise/Medium-Power HBT Amplifier

Data Sheet

Features

- Dual operating modes[1]:
  - Low-noise mode:
    NF = 3 dB
    P_{-1dB} = 14 dBm
    TOI = 24 dBm
    SHI = 48 dBm
    I_{Total} = 64 mA
    P_{DC} = 207 mW
  - High-power mode:
    NF = 3.5 dB
    P_{-1dB} = 19.5 dBm
    TOI = 33 dBm
    SHI = 53 dBm
    I_{Total} = 90 mA
    P_{DC} = 373 mW
- Broad bandwidth, F_{-1dB}:
  7 GHz (S.S. gain)
  3 GHz (P_{OUT})
- High gain: (3 GHz)
  20.5 dB ±0.8 dB
- Low l/f noise corner: < 20 kHz
- Single supply operation:
  V_{Supply} > 4.8 volts

1. Typical performance @ F=3 GHz, P_{DC}=DC power dissipation on-chip.

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Description

The 1GC1-4262 is a DC to 4 GHz, 20 dB gain, amplifier designed for use as a cascadable gain block as either a low-noise preamplifier for receivers or as an output amplifier for moderate output power applications. The device consists of a modified Darlington feed-back pair which reduces the sensitivity to process variations and provides 50 ohm input/output port matches. This amplifier is fabricated using HFTC's GaAs Heterojunction Bipolar Transistor (HBT) process which provides excellent process uniformity, reliability and 1/f noise performance. Internal saturation diode clamps prevent RF overdrive damage to the device.

- Package type: Quad flat - no leads (SMT QFN)
- Package dimensions: 2.0 x 2.0 mm (0.079 x 0.079 in)
- Package thickness: 0.90 ±0.10 mm (0.035 ±0.0039 in)
- Lead pitch: 0.40 mm (0.016 in)
- Lead width: 0.20 mm(0.008 in)

Absolute maximum ratings[1]

Symbol	Parameters/conditions	Min	Max	Units
V_{CC}	V_{CC} voltage (Pin 1)		6.0	Volts
V_{OUT}	RF output port voltage (Pin 6)		4.3	Volts
I_{CC}	Stage one current		22	mA
I_{OUT}	Stage two current		75	mA
P_{in}	RF input power		0	dBm
T_{ch}	Channel temperature		+150	°C
T_{pkg}[2]	Pkg. backside temperature	–55	+85	°C
T_{st}	Storage temperature	–65	+165	°C
T_{max}[3]	Max. assembly temperature		+260	°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_{PKG} = 85 °C. Operation in excess of maximum backside temperature (T_{PKG}) will degrade MTTF.
3. Refer to JEDEC J-STD-020D for detailed reflow profile.

DC specifications/physical properties[1]

(T_A = 25 °C, $Z_{IN} = Z_{OUT}$ = 50 Ω, $R_{OUT} = [(V_{Supply} - V_{OUT})/I_{OUT}]$)

Symbol	Parameters/conditions	Min	Typ	Max	Units
V_{CC}	Stage one collector voltage	4.8	5.0	6.0	Volts
$\theta_{J\text{-}bs}$	Thermal resistance (junction–to–backside at T_J = 150 °C)		175		°C/Watt
			Low–noise mode V_{SEL} = OPEN, I_{SEL} = OPEN		
I_{CC}	Stage one collector current	7	9	11	mA
I_{OUT}	Stage two collector current		55	75	mA
$I_{CC} + I_{OUT}$	Total supply current		64		mA
V_{RFin}	RF input voltage (I_{CC} = 9 mA, I_{OUT} = 55 mA)	2.6	2.85	3.1	Volts
V_{OUT}	RF output voltage (I_{CC} = 9 mA, I_{OUT} = 55 mA)	2.7	2.95	3.2	Volts
P_{DC}	Total DC power dissipation (within amplifier package) (V_{CC} = +5 V, V_{OUT} = 3 V, I_{OUT} = 55 mA)		207		mW
			High P_{OUT} mode V_{SEL} = GND, I_{SEL} = GND		
I_{CC}	Stage one collector current	15.0	18.5	21.5	mA
I_{OUT}	Stage two collector current		72	75	mA
$I_{CC} + I_{OUT}$	Total supply current		90.5		mA
V_{RFin}	RF input voltage (I_{CC} = 18.5 mA, I_{OUT} = 72 mA)	2.7	2.90	3.1	Volts
V_{OUT}	RF output voltage (I_{CC}= 18.5 mA, I_{OUT} = 72 mA)	3.6	3.85	4.1	Volts
P_{DC}	Total DC power dissipation (within amplifier package) (V_{CC} = +5 V, V_{OUT} = 3.9 V, I_{OUT} = 72 mA)		373		mW

1. Backside ambient operating temperature $T_A = T_{PKG}$ = 25 °C unless otherwise noted.

RF specifications[1]

(T_A = 25 °C, $Z_{IN} = Z_{OUT}$ = 50 Ω, $R_{OUT} = [(V_{Supply} - V_{OUT})/I_{OUT}]$)

			1GC1-4262		
Symbol	**Parameters/conditions**	**Min**	**Typ**	**Max**	**Units**
BW	Operating bandwidth (f_{-1db}, high P_{OUT} mode)	4	5		GHz
S_{21}	Small–signal gain (DC - 3 GHz, low-noise mode)	18.5	19.5	21.0	dB
	Small–signal gain (DC - 3 GHz, high P_{OUT} mode)	18.5	20	21.5	dB
ΔS_{21}	Gain flatness (DC - 3 GHz)		±1.0		dB
T_C	Gain temperature coefficient (DC - 3 GHz, low-noise mode)		0.005		dB/°C
	Gain temperature coefficient (DC - 3 GHz, high P_{OUT} mode)		0.003		dB/°C
$RL_{IN(Min)}$	Minimum input return loss (DC - 3 GHz)		15		dB
$RL_{OUT(Min)}$	Minimum output return loss (DC - 3 GHz)		15		dB
S_{12}	Reverse isolation (DC - 3 GHz)		21		dB

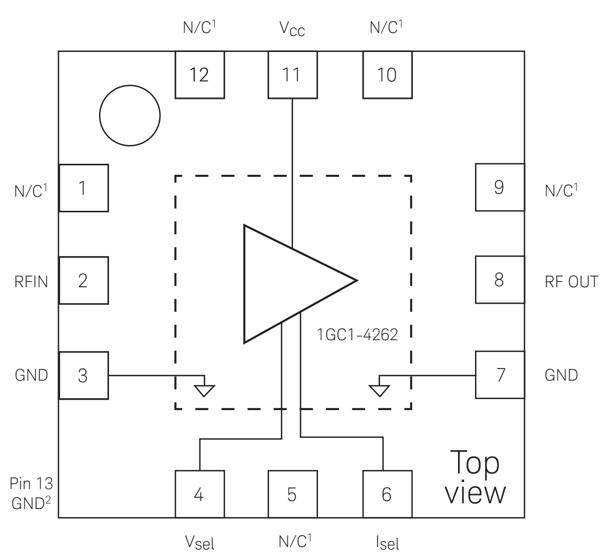
RF specifications[1] *(continued)*

(T_A = 25 °C, Z_{IN} = Z_{OUT} = 50 Ω, R_{OUT} = [(V_{Supply} – V_{OUT})/I_{OUT}])

			Low-noise mode V_{SEL} = OPEN, I_{SEL} = OPEN		
Symbol	**Parameters/conditions**	**Min**	**Typ**	**Max**	**Units**
P_{-1dB}	Output power at 1 dB gain compression (F = 3 GHz)	11.5	14		dBm
P_{SAT}	Output power at 4 dB gain compression (F = 3 GHz)		15		dBm
H_2	2nd harmonics (F = 3 GHz, P_{OUT} = +5 dBm)		–30		dBc
H_3	3rd harmonics (F = 3 GHz, P_{OUT} = +5 dBm)		–50		dBc
SHI	2nd harmonic intercept point (fund. = 1.5 GHz, 2*fund. = 3.0 GHz, P_{OUT} (fund.) = 0 dBm)		48		dBm
TOI	Two-tone, third order intercept point (tone spacing = 200 kHz, fund. = 3 GHz)		24		dBm
NF	Noise figure (F = 3 GHz)		3.2	4.0	dB

			High P_{OUT} mode V_{SEL} = GND, I_{SEL} = GND		
Symbol	**Parameters/conditions**	**Min**	**Typ**	**Max**	**Units**
P_{-1dB}	Output power at 1 dB gain compression (F = 3 GHz)	18.0	19.5		dBm
P_{SAT}	Output power at 4 dB gain compression (F = 3 GHz)		20.5		dBm
H_2	2nd harmonics (F = 3 GHz, P_{OUT} = +5 dBm)		–33		dBc
H_3	3rd harmonics (F = 3 GHz, P_{OUT} = +5 dBm)		–54		dBc
SHI	2nd harmonic intercept point (fund. = 1.5 GHz, 2*fund. = 3.0 GHz, P_{OUT} (fund.) = 0 dBm)		53		dBm
TOI	Two-tone, third order intercept point (tone spacing = 200 kHz, fund. = 3 GHz)		33		dBm
NF	Noise figure (F = 3 GHz)		3.8	5.0	dB

1. All large-signal specifications referred to output power



1. N/C pins can be left open, but it is recommended to connect these to RF/DC ground.
2. Pin 13 is the center heat slug this must be connected to RF/DC ground. Use "filled" vias to prevent solder voids.

Figure 1. 1GC1-4262 schematic diagram

Applications

The 1GC1-4262 is designed for use in RF and microwave communications systems and instrumentation applications where broadband low–noise operation or moderate output power amplification is required. The device is designed to operate into 50 Ω.

Biasing and Operation

The 1GC1-4262 can be operated from a single positive supply or two independent supplies greater than 4.8 volts. The first stage collector voltage (V_{CC}) must be biased between 4.8 and 6 volts. An external R_{CC} resistor is required if the supply voltage is greater than 6 volts.

The second stage collector voltage (V_{OUT}) is supplied through the RF output port and should be biased through an off-pkg. drop resistor (R_{OUT}) or current source. An external RF choke circuit consisting of a series inductor and shunt capacitor is typically used to pass the DC bias to the RF output. The high impedance bias feed eliminates loading on the amplifier output. The output current is adjustable via the off-pkg. R_{OUT} bias resistor value. For more information on the correct values of R_{CC} and R_{OUT}, refer to the information and formulas available in Figure 2.

The 1GC1-4262 features dual-mode operation in either a low-noise, low-P_{DC} mode or high P_{OUT} mode and are selectable by two independent control contacts as summarized in the following table:

Operating mode states

Operating mode	V_{SEL} state (Pin 4)	V_{OUT} (V)	I_{SEL} state (Pin 5)	I_{cc} (mA)
Low noise	OPEN	+ 2.9	OPEN	~9
High power	GND	+ 3.9	GND	~18.5

R_{CC} bias formulas

For: $4.8 \text{ V} \leq V_{Supply} \leq 6 \Rightarrow R_{CC} = 0\ \Omega$
For: $V_{Supply} > 6 \text{ V} \Rightarrow R_{CC} = [(V_{Supply} - 5) \div (I_{CC})]\ \text{K}\ \Omega$
where I_{CC} = 9 mA @ I_{SEL} = Open circuit
or I_{CC} = 18.5 mA @ ISEL = GND

R_{OUT} bias formulas

$R_{OUT} = [(V_{Supply} - V_{OUT}) \div (I_{OUT})]\ \text{K}\ \Omega$
where V_{OUT} = 3.0 v @ V_{SEL} = Open circuit
or V_{OUT} = 3.9 v @ V_{SEL} = GND
and I_{OUT} £ 72 mA

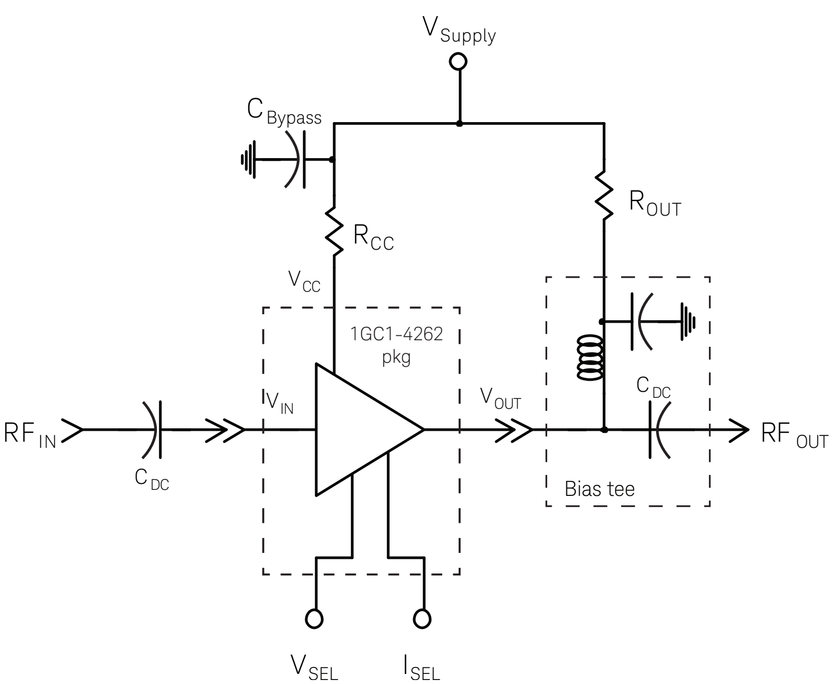


Figure 2. 1GC1-4262 biasing diagram

Low-noise mode operation

In this mode the device is biased to operate with the lowest possible noise figure and minimum DC power dissipation. The RF output voltage is set to V_{OUT} = 2.9 volts by applying an open circuit to the V_{SEL} lead (Pin 4) and the stage one current is reduced to ~9 mA by applying an open circuit to the I_{SEL} lead (Pin 5).

High P_{OUT} mode operation:

In this mode the device is biased to operate with the highest possible output power and power bandwidth while still delivering reasonably low DC power dissipation. The RF output voltage is set to V_{OUT} = 3.9 volts by grounding the V_{SEL} lead (Pin 4) and the stage one current is increased to ~ 18 mA to optimize power compression characteristics by applying an short circuit to the I_{SEL} lead (Pin 5). In either mode the output current (I_{OUT}) can be adjusted to any value up to 72 mA by varying the off–chip biasing resistor (R_{OUT}) or adjusting the RF output current source, whichever is employed. Output currents (I_{OUT}) lower than 55 mA will adversely affect output power performance above 2 GHz. Higher output currents (maximum of 72 mA) will maximize P_{OUT} and output power bandwidth at the expense of slightly higher DC power dissipation and higher noise figure. If R_{OUT} is greater than 300 ohms, the output RF choke may be omitted; however, the amplifier's gain may be reduced by ~1.0 dB.

DC blocking caps are recommended at the package RF input and output leads (Pins 3 & 6), since the voltage at these pins will be between 3 and 4 volts above ground potential. A 0.1 µF AC bypass cap is recommended between V_{CC} (Pin 1) and ground to prevent low–frequency bias oscillations. Bypass caps may be required on the V_{SEL} (Pin 4) or I_{SEL} (Pin 5) leads to improve RF I/O match and in-band gain flatness. For package pin-outs and the package schematic refer to Figures 1 and 3.

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.

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

Moisture sensitivity classification: Class 1, per JESD22-A112-A.

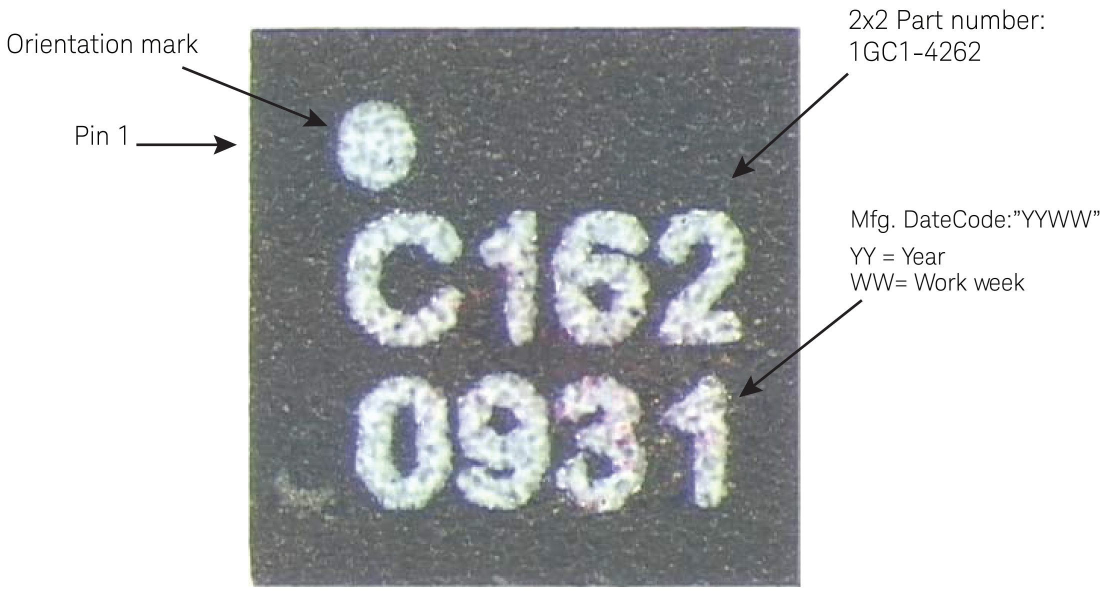
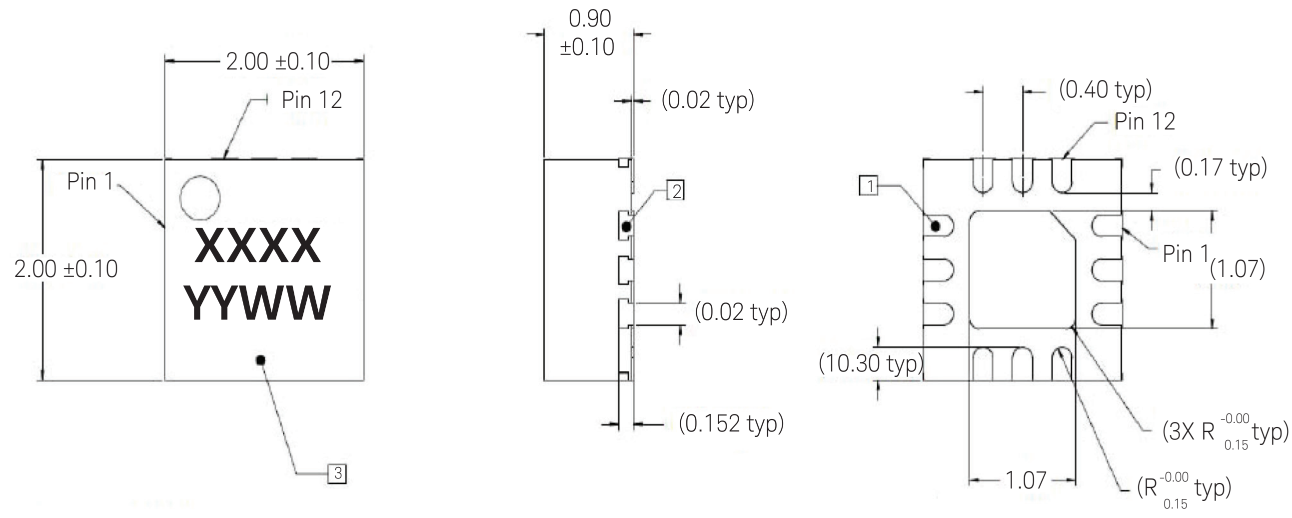


Figure 3. 1GC1-4262 package photo



Topside label:
nnXX-nnXX = Keysight 4x4 part number
YYWW = Year - Work Week

3 Permanently mark 4x4 part number without leading '1G' and '42,' and date code (Example: 'C145' for 1GC1-4245 year, work week)
2 Side of lead is not plated (bare copper alloy) max burr 0.05 mm
1 Lead plating per assembly drawing
Notes: (Unless otherwise specified)

Notes:
- All dimensions ±0.08 mm (unless otherwise specified)
- Top-side orientation mark located · next to PIN 1.
- Backside and lead plating metallization is Sn-plated copper.
- Package top surface labeled with · last two digits of leading and trailing Keysight 4 x 4 part number (XXC1-XX51) and mfg date in Year (YY) and work week (WW) format

Figure 4. 1GC1-4262 package dimensions

The 1GC1-4262 die is fabricated using a GaAs-based diode semiconductor material structure which is compatible with newer RoHS assembly temperatures and allows the device to be attached to a hybrid microcircuit housing or to thermally conductive embedded heatsinks which exist in QFN SMT Packages.

Moisture Compatibility

Injection mold components like the 1GC1-4262 in QFN are moisture-sensitive. The product is tested to the Moisture and Reflow Sensitivity Level 5A as per IPC/Jedec J-STD-020 and must be mounted within 24 hours of opening the shipping container. Store and handle parts for reflow and for rework per IPC/Jedec J- STD-033B. An example of the moisture sensitivity label is shown in Figure 5.

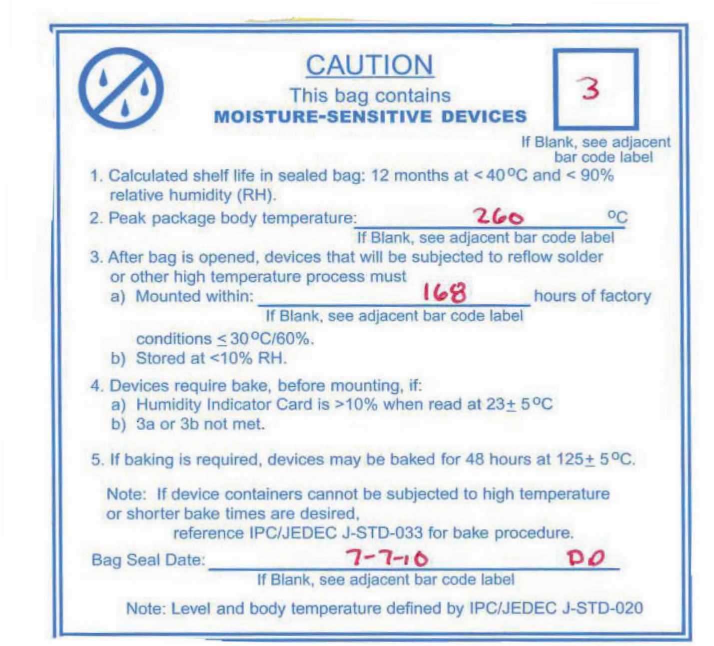


Figure 5. 1GC1-4262 Moisture Sensitivity Label

Tape and Reel

The 1GC1-4262 is available in tape and reel format to facilitate automatic pick and place manufacturing. See Figure 6.

Figure 6. Tape and reel label

RoHS Compliance

The 1GC1-4262 prescaler 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.

Typical S-parameter Response[1]

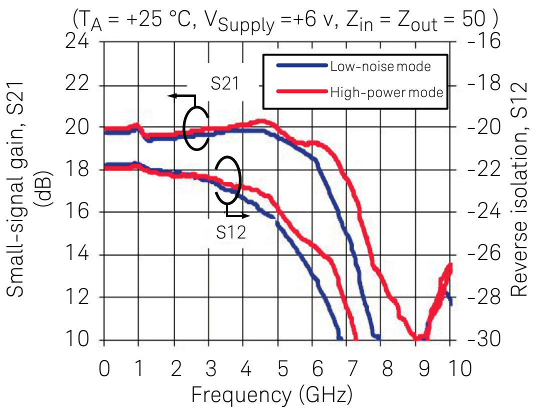


Figure 7. Small-signal gain and reverse isolation

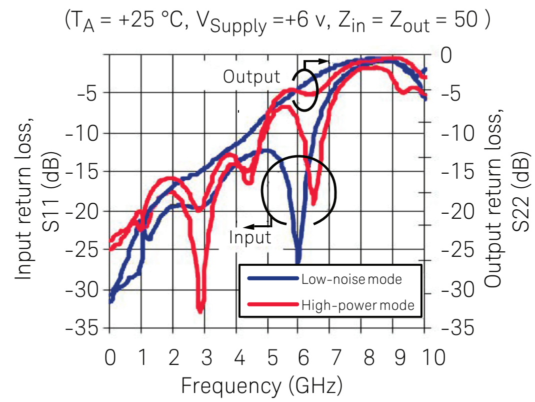


Figure 8. Small-signal input/output return loss

Low-noise/low-power mode

(T_A = 25 °C, V_{Supply} = +6 v, I_{OUT} = 55 mA, V_{SEL}= I_{SEL} = Open Circuit, Z_{in} = Z_{OUT} = 50)

Freq. (MHz)	S_{12} dB	S_{12} Mag	S_{12} Ang	S_{12} dB	S_{12} Mag	S_{12} Ang	S_{21} dB	S_{21} Mag	S_{21} Ang	S_{22} dB	S_{22} Mag	S_{22} Ang
100	–30.4	0.030	161.5	–21.8	0.082	–1.4	19.7	9.671	177.0	–35.5	0.017	178.5
500	–26.8	0.046	94.1	–21.8	0.082	–8.9	19.7	9.703	164.6	–33.7	0.021	–169.4
1000	–21.1	0.088	28.8	–21.7	0.082	–18.8	19.9	9.859	147.8	–30.9	0.028	–141.3
1500	–21.9	0.081	7.1	–22.1	0.079	–27.7	19.4	9.348	134.2	–21.7	0.083	176.5
2000	–19.5	0.106	–20.5	–22.2	0.078	–36.8	19.5	9.411	119.6	–19.4	0.107	147.7
2500	–19.4	0.107	–55.1	–22.3	0.077	–46.9	19.6	9.516	104.4	–18.0	0.126	124.0
3000	–19.5	0.106	–108.2	–22.5	0.075	–57.4	19.6	9.602	88.4	–16.8	0.145	108.4
3500	–16.7	0.146	–160.2	–22.9	0.071	–68.5	19.8	9.761	72.0	–14.8	0.182	88.8
4000	–14.0	0.200	170.9	–23.3	0.068	–79.5	19.8	9.803	53.8	–13.2	0.219	51.8
5000	–12.3	0.242	150.9	–24.6	0.059	–103.2	19.5	9.474	14.5	–8.7	0.368	–53.7
6000	–27.3	0.043	29.0	–26.9	0.045	–127.5	18.6	8.485	–28.9	–5.1	0.559	–106.4
7000	–5.0	0.560	–117.0	–30.7	0.029	–148.4	15.0	5.641	–73.7	–2.1	0.781	–145.8
8000	–1.4	0.848	–159.8	–34.8	0.018	–145.8	9.9	3.135	–95.4	–0.7	0.918	–179.1
9000	–0.9	0.900	–179.5	–34.5	0.019	–131.4	8.8	2.754	–99.0	–1.1	0.885	153.7
10000	–5.5	0.533	118.8	–30.8	0.029	–174.1	11.9	3.944	–162.0	–2.3	0.764	15.4

High-power mode

(T_A = 25 °C, V_{Supply} = +6 v, I_{OUT} = 72 mA, V_{SEL}= I_{SEL} = GND, Z_{in} = Z_{OUT} = 50)

Freq. (MHz)	S_{12} dB	S_{12} Mag	S_{12} Ang	S_{12} dB	S_{12} Mag	S_{12} Ang	S_{21} dB	S_{21} Mag	S_{21} Ang	S_{22} dB	S_{22} Mag	S_{22} Ang
100	–24.7	0.058	169.1	–21.9	0.080	–1.2	19.9	9.865	177.4	–27.0	0.045	177.5
500	–23.1	0.070	120.6	–21.9	0.080	–8.3	19.9	9.900	165.6	–25.6	0.052	167.3
1000	–20.1	0.099	60.4	–21.8	0.081	–17.4	20.1	10.059	149.6	–25.7	0.052	157.9
1500	–19.0	0.113	50.1	–22.2	0.078	–25.6	19.6	9.562	137.2	–19.1	0.110	142.8
2000	–17.6	0.131	25.1	–22.3	0.077	–33.5	19.7	9.607	123.8	–18.0	0.125	116.0
2500	–20.8	0.091	–1.3	–22.3	0.077	–42.9	19.8	9.734	109.8	–20.1	0.099	101.0
3000	–30.0	0.031	–143.5	–22.4	0.076	–52.7	19.9	9.866	94.9	–21.8	0.081	137.6
3500	–16.5	0.150	161.4	–22.7	0.074	–63.1	19.9	9.898	79.9	–15.8	0.162	143.9
4000	–14.0	0.198	149.5	–22.8	0.072	–72.9	20.1	10.088	64.1	–15.1	0.175	111.8
5000	-9.3	0.342	-165.5	-23.8	0.065	-98.4	20.0	9.950	26.3	-9.4	0.339	-75.3
6000	-8.7	0.368	167.9	-25.5	0.053	-118.4	19.3	9.186	-7.5	-5.4	0.539	-124.4
7000	-7.1	0.440	-105.8	-28.4	0.038	-149.5	17.6	7.569	-54.0	-3.8	0.649	-122.7
8000	-1.8	0.813	-150.5	-36.3	0.015	-152.5	13.0	4.483	-84.6	-1.0	0.887	-158.4
9000	-3.1	0.697	171.1	-38.7	0.012	-89.4	10.1	3.210	-98.2	-0.5	0.949	170.9
10000	-5.1	0.558	142.8	-26.5	0.048	-143.8	13.2	4.567	-124.5	-3.2	0.688	81.4

1. Data measured on 1GC1-4262 plastic package mounted on PCB test fixture. Magnitudes and phase have been corrected for fixture loss and phase delay.

Supplemental Data[1]

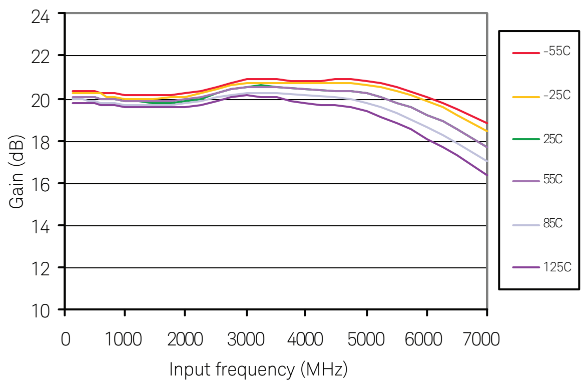


Figure 9. Typical small signal gain vs. frequency and temperature in low-noise mode

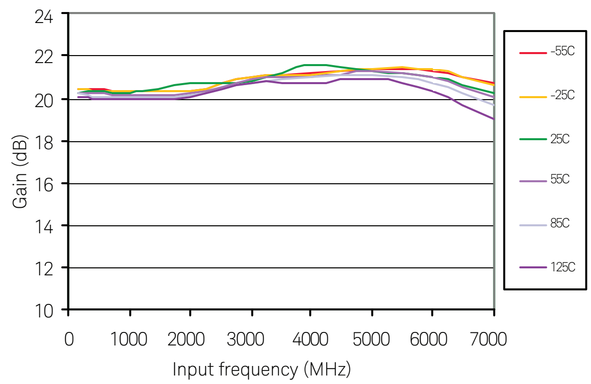


Figure 10. Typical small signal gain vs. frequency and temperature in high-power mode

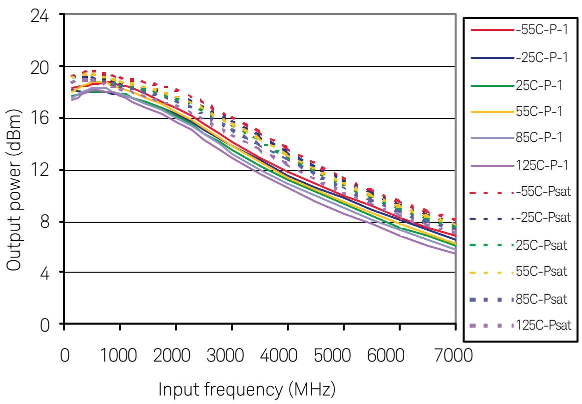


Figure 11. Typical output power P_{-1dB} and P_{sat} vs. frequency and temperature in low-noise mode

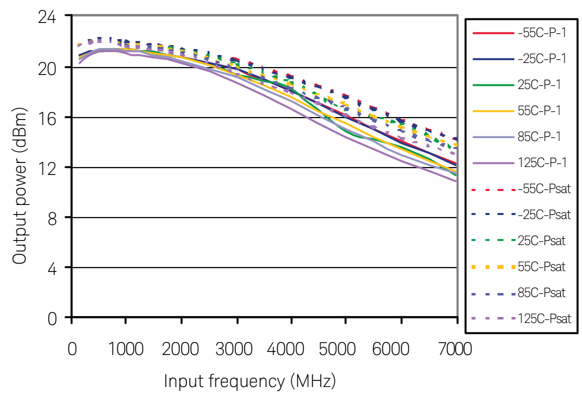


Figure 12. Typical output power P_{-1dB} and P_{sat} vs. frequency and temperature in high-power mode

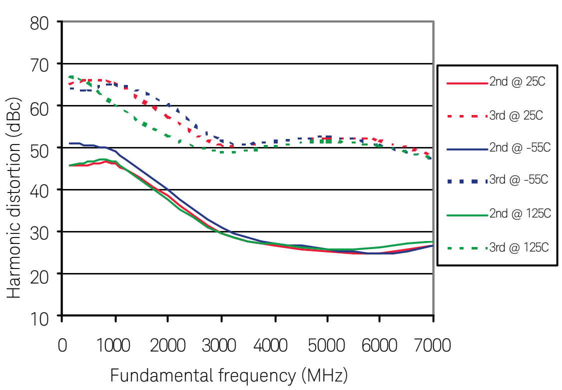


Figure 13. Typical 2nd and 3rd harmonics vs. frequency and temperature in low-noise mode[2]

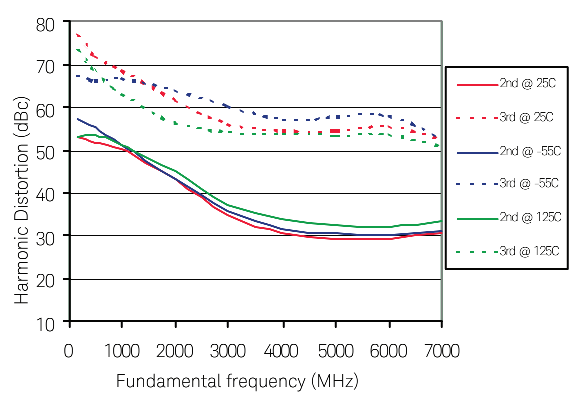


Figure 14. Typical 2nd and 3rd harmonics vs. frequency and temperature in high-power mode[2]

1. Data measured on 1GC1-4262 plastic package surface-mounted onto PCB test substrate. Data has been corrected for test substrate insertion loss.
2. Measured at P_{OUT} = +5 dBm

Supplemental Data[1] (continued)

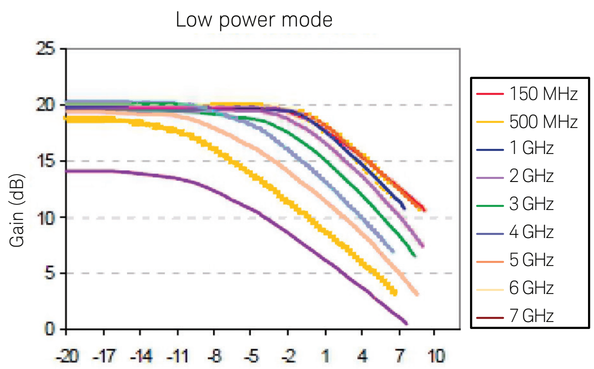


Figure 15. Typical gain vs. input power at T_A= 25 °C

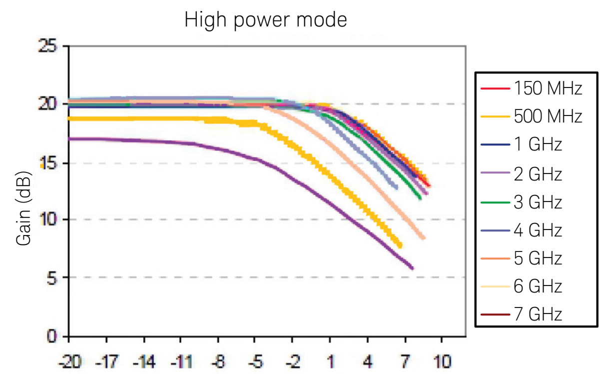


Figure 16. Typical gain vs. input power at T_A= 25 °C in high-power mode

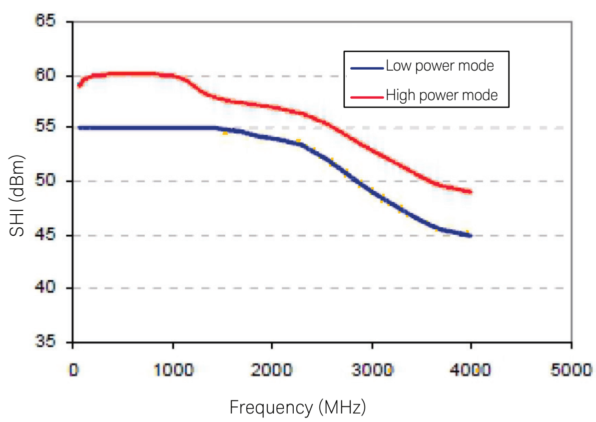


Figure 17. Typical SHI vs. 2nd harmonic frequency at T_A= 25 °C and P_{OUT} = 0 dBm

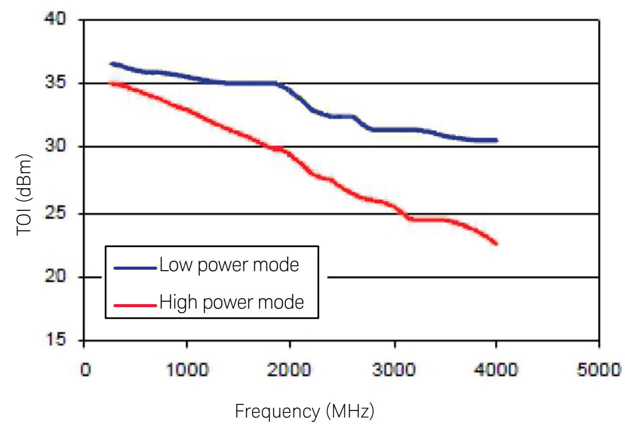


Figure 18. Typical TOI vs. frequency at T_A= 25 °C, P_{OUT} = 0 dBm and 200 KHz spacing

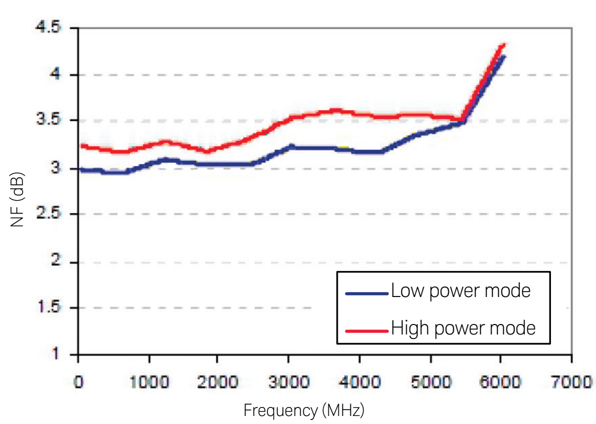


Figure 19. Typical noise figure vs. frequency at T_A= 25 °C and P_{OUT} 0 dBm.

1. Data measured on 1GC1-4262 plastic package surface–mounted onto PCB test substrate. Data has been corrected for test substrate insertion loss.

Device Orientation

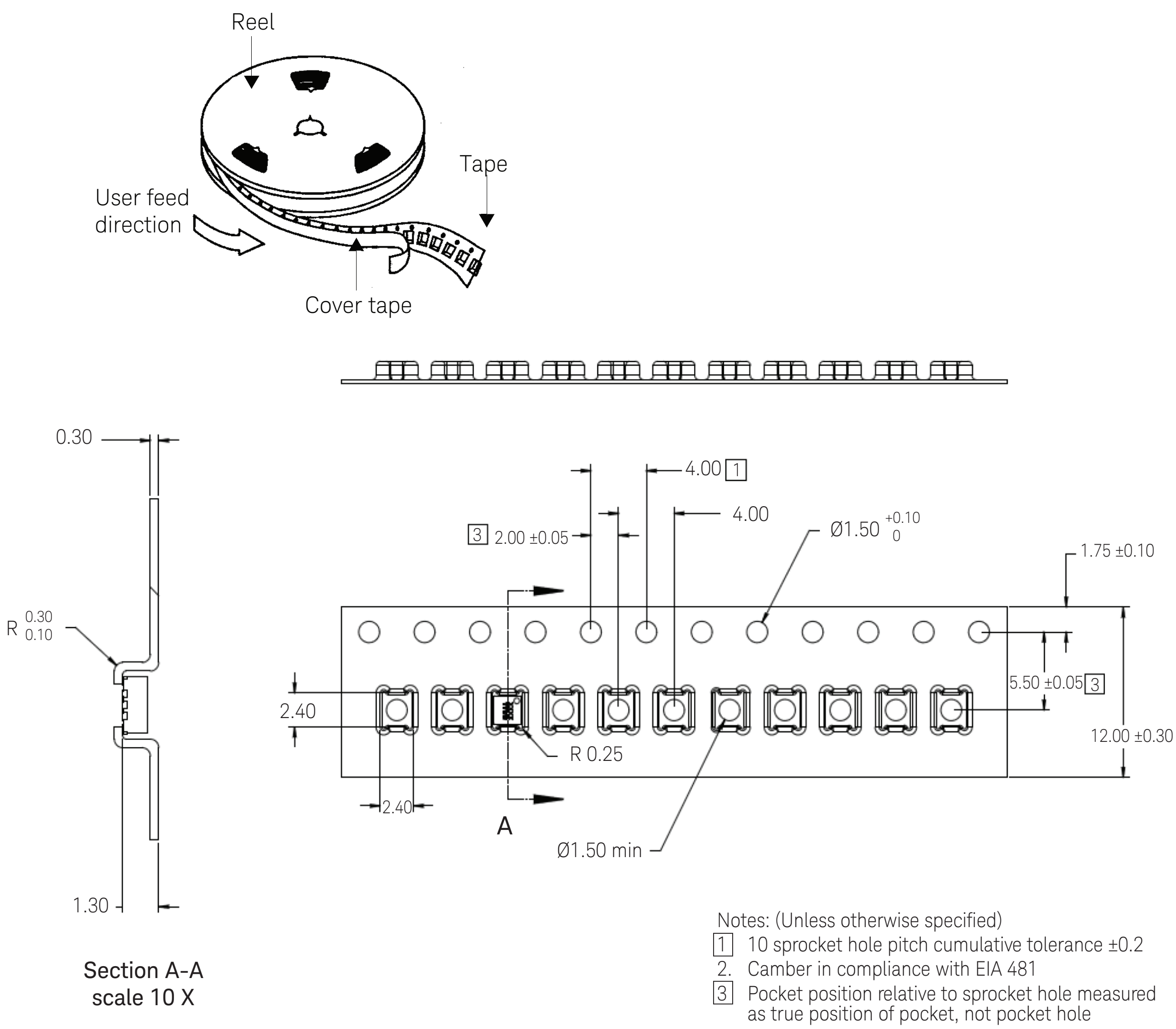


Figure 20. Tape and reel configuration

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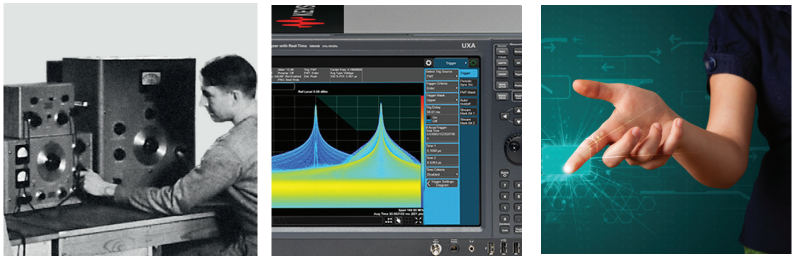

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The product described in this data sheet is **RoHS Compliant** and **RoHS Process Compatible** with a maximum temperature of 260 °C and a maximum of 3 temperature cycles

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