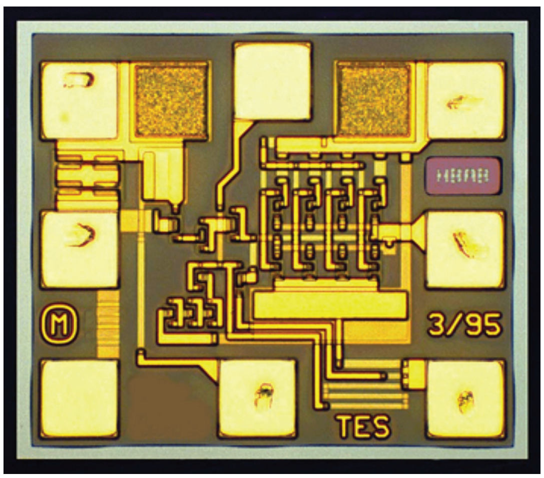
Keysight 1GC1-4001
DC to 12 GHz HBT High-Isolation Amplifier

Data Sheet



Features

- High reverse isolation: 55 dB typical (into 50 Ω)
- Moderate gain (into 50 Ω):
- 10.6 dB typical @ 1.5 GHz
- P_{-1dB} @ 1.5 GHz: 13.3 dBm typical
- Low l/f noise corner: <20 kHz typical
- Low power dissipation: 256 mW typical on chip
  92 mW @ +3.3 V
  119 mW @ +7 V
  45 mW @ –5 V

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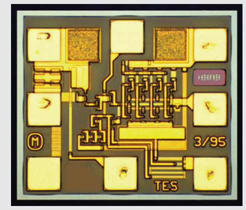
Description

The 1GC1-4001 is a DC to 12 GHz, 10.6 dB gain into 50 Ω, feedback amplifier designed to be used as a cascadable gain block for applications requiring high reverse isolation. The device consists of a common–base first stage followed by a modified Darlington feedback pair. This amplifier is fabricated using the Keysight Technologies, Inc. InGaP/GaAs heterojunction bipolar transistor (HBT) process which provides excellent process uniformity and exceptional 1/f noise performance. The device requires a positive and a negative supply voltage and generally operates Class-A for good distortion performance.



- Chip size: 530 × 460 µm (20.9 × 18.1 mils)
- Chip size tolerance: ± 10 µm (± 0.4 mils)
- Chip thickness: 127 ± 15 µm (5.0 ± 0.6 mils)
- Pad dimensions: 70 × 70 µm (2.8 × 2.8 mils), or larger

Absolute maximum ratings[1]

Symbol	Parameters/conditions	Min	Max	Units
V_{CC}	V_{CC} pad voltage		8.0	Volts
V_{EE}	V_{EE} pad voltage	–6.0		Volts
I_{OUT}	Output pad supply current		40	mA
P_{in}	RF input power		13	dBm
T_{op}	Operating temperature	–55	+85	°C
T_{st}	Storage temperature	–65	+165	°C
T_{max}	Max. assembly temperature		+300	°C

1. Operation in excess of any one of these ratings may result in permanent damage to this device. For normal operation, all combined bias and thermal conditions should be chosen such that the maximum operating temperature (T_{op}) is not exceeded. T_A = 25 °C except for T_{op}, T_{st}, and T_{max}.

DC specifications/physical properties[1]

(Typicals are for V_{CC} = +7 V, V_{supply} = +6V , R_{out} = 100 Ω,V_{EE} = –5 V, 50 Ω system)

Symbol	Parameters/conditions	Min	Typ	Max	Units
V_{CC}	Supply voltage at V_{CC} pad	6.75	7.0	7.25	Volts
V_{EE}	Supply voltage at V_{EE} pad	–5.25	–5.0	–4.75	Volts
I_{CC}	V_{CC} supply current	17	21.7	27	mA
I_{OUT}	Output pad supply current	25	30	35	mA
I_{EE}	Supply current at V_{EE} pad	6.5	8.7	11.5	mA

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

RF specifications

(T_A = 25 °C, V_{CC} = +7 V, V_{supply} = +6 V, R_{out} = 100 Ω, V_{EE} = –5 V, 50 Ω system)

Symbol	Parameters/conditions	Min	Typ	Max	Units
BW	Operating bandwidth ($f_{–3db}$)	12			GHz
S_{21}	Small signal gain (@ 1.5 GHz into 50 Ω input)		10.6		dB
S_{21}	Small signal gain (@ 1.5 GHz into 16 Ω input)	12.5	14.0	15.5	dB
ΔS_{21}	Small signal gain flatness (DC to 12 GHz into 50 Ω input)		± 1		dB
(RL_{in})MIN	Minimum input return loss (1.5 GHz into 50 Ω input)		25		dB
	Minimum input return loss (1.5 GHz into 16 Ω input)	3.0	5.4		
(RL_{out})MIN	Minimum output return loss (DC to 12 GHz)		25		dB
Isolation	Reverse isolation (from output to 50 Ω input – DC to 12 GHz)		55		dB
	Reverse isolation (from output to 16 Ω input – DC to 12 GHz)	40	50		dB
$P_{–1dB}$	Output power at 1 dB gain compression (@ 1.5 GHz)		13.3		dBm
	Output power at 1 dB gain compression (@ 9 GHz)		11.2		dBm
NF	Noise Figure using 50 Ω input (@ 4 GHz)		12.5		dB
	Noise figure using 16 Ω input (@ 4 GHz)		9.5	12.0	dB

Applications

The 1GC1-4001 can be used for a variety of applications requiring reverse isolation, moderate amounts of gain and low power dissipation in any system with 16 to 50 ohm input impedance.

Biasing and Operation

The 1GC1-4001 requires a positive supply and a negative supply. The positive supply must be connected to two points on the chip, namely the V_{CC} pad and the output pad. The negative supply must be connected to the V_{EE} pad. The positive supply voltage may be directly connected to the V_{CC} pad as long as the voltage is between +6.75 to +7.25 volts; however, if the supply is higher than +7.25 volts, a series resistor (RCC) should be used to reduce the voltage to the V_{CC} pad. The negative supply voltage may be directly connected to the V_{EE} pad as long as the voltage is between –4.75 to –5.25 volts; however, if the supply is more negative than –5.25 volts, a series resistor (R_{EE}) should be used to reduce the voltage to the V_{EE} pad. See the bonding diagram for the equation used to select R_{CC} and R_{EE}. In the case of the output pad, the supply voltage must be connected to the output transmission line through a resistor and an RF choke. The required value of the resistor is given by the equation:

$$R_{out} = 35.7\ V_{supply} - 114.3 \text{ ohms},$$

where V_{supply} is in volts. If R_{out} is greater than 300 ohms, the choke may be omitted, however, the amplifier's gain may be reduced by ~0.5 dB. Figure 4 shows a recommended bonding strategy. The chip contains a backside via to provide a low inductance ground path; therefore, the ground pads on the IC should not be bonded. The voltage at the IN and OUT pads of the IC will be approximately –1.5 volts and 3.0 volts, respectively; therefore, DC blocking caps should be used at these ports.

Assembly Techniques

Solder die attach using a fluxless gold–tin (AuSn) solder preform is the recommended assembly method. A conductive epoxy such as ABLEBOND 71- 1LM1 or ABLEBOND 36-2 may also be used for die attaching provided the absolute maximum thermal ratings are not exceeded. The device should be attached to an electrically conductive surface to complete the DC and RF ground paths. Ground path inductance should be minimized. The backside metallization on the device is gold.

It is recommended that the RF input and RF output connections be made using 0.7 mil diameter gold wire. The chip is designed to operate with 0.1 to 0.3 nH of inductance at the RF input and output. This can be accomplished by using 10 mil bond wire lengths on the RF input and output. The bias supply wire can be a 0.7 mil diameter gold wire attached to the VCC bonding pad.

Thermosonic wedge is the preferred method for wire bonding to the gold bond pads. Mesh wires can be attached using a 2 mil round tacking tool and a tool force of approximately 22 grams with an ultrasonic power of roughly 55 dB for a duration of 76 ± 8 msec. A guided–wedge at an ultrasonic power level of 64 dB can be used for the 0.7 mil wire. The recommended wire bond stage temperature is 150 ± 2 °C.

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 reliabil reliability. The Keysight Technologies Inc., *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.

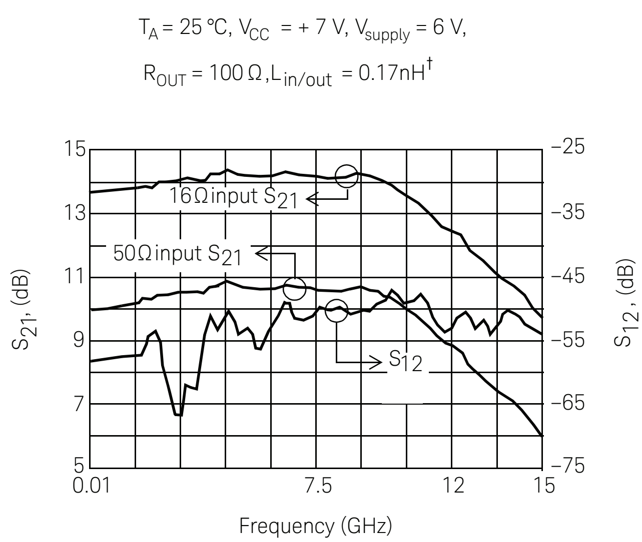


Figure 1. Typical S_{21} and S_{12} response

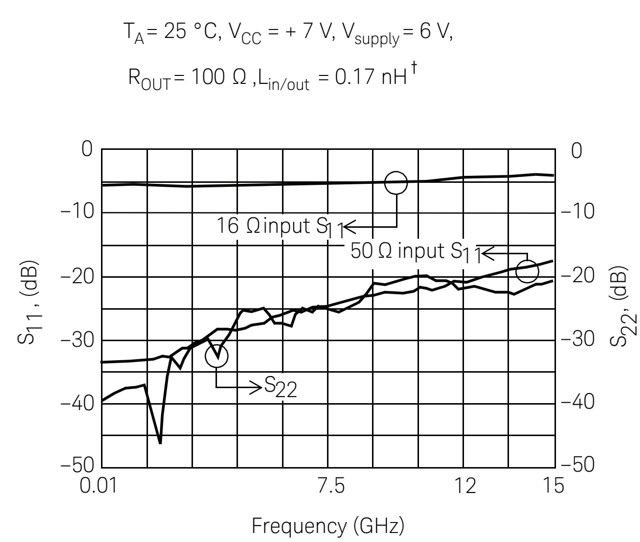


Figure 2. Typical S_{11} and S_{22} response

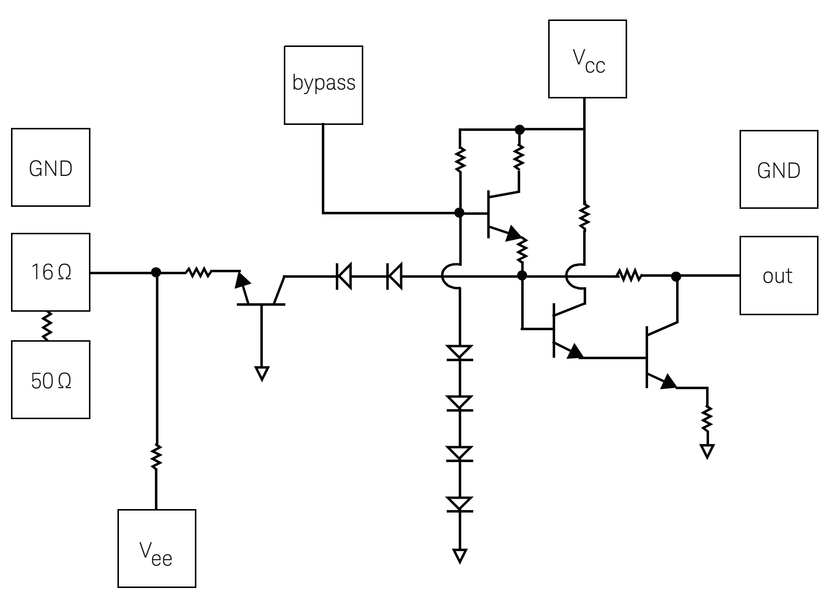
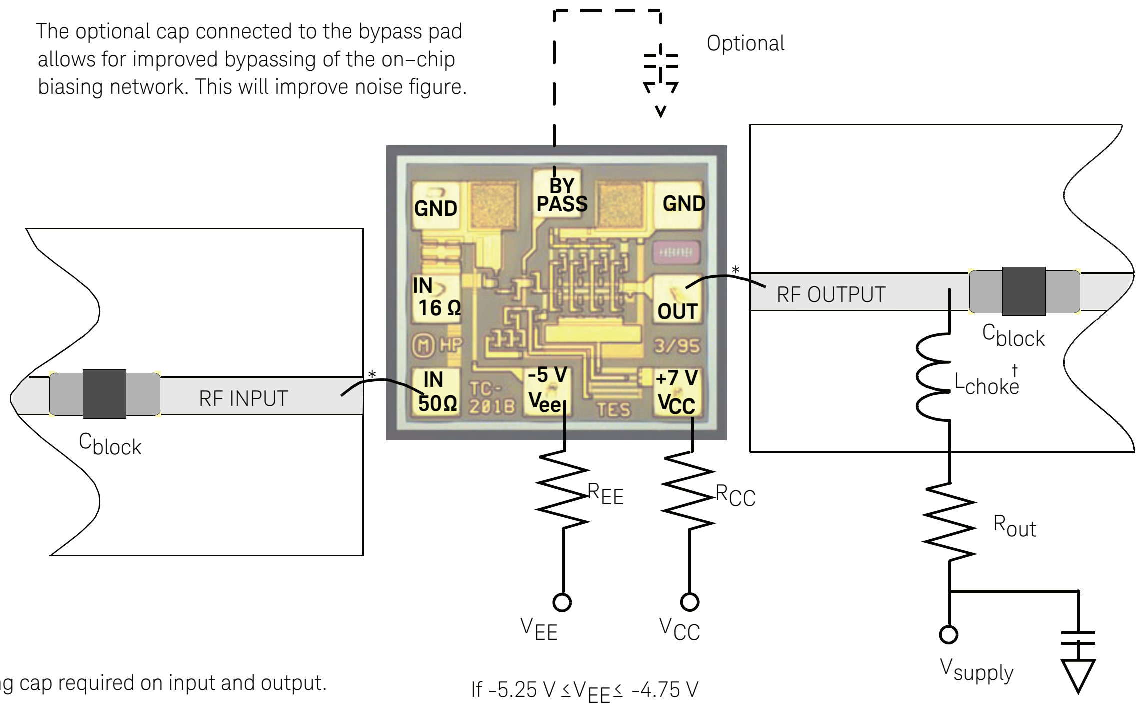


Figure 3. 1GC1-4001 simplified schematic diagram



Notes
Blocking cap required on input and output.

*For optimum performance, the input and output bond wire inductances should each be 0.1 to 0.3 nH (bond wire has about 20 pH/mil of inductance).

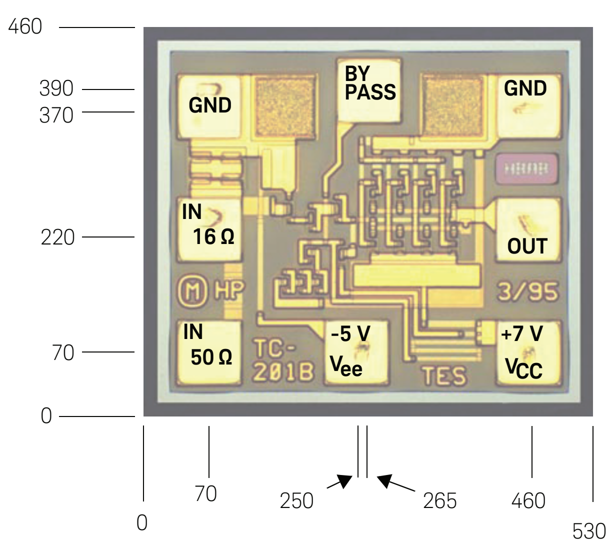
†L_{choke} is optional if R_{out} is greater than 300 Ω, however, gain will be reduced by about 0.5 dB.

If $-5.25\text{ V} \le V_{EE} \le -4.75\text{ V}$
$R_{EE} = 0$
If $V_{EE} < -5.25\text{V}$
$R_{EE} = [(V_{EE} + 5.0)*(1/0.009)]\ \Omega$

If $6.75\text{V} \le V_{CC} \le 7.25\text{ V}$
$R_{CC} = 0$
If $V_{CC} > 7.25\text{ V}$
$R_{CC} = [(V_{CC} - 7.0)*(1/0.017)]\ \Omega$

$V_{supply} > 4.75\text{ V}$
$R_{out} = [(V_{supply} - 3.2)*(1/0.028)]\ \Omega$

Figure 4. 1GC1-4001 assembly diagram



Note: All dimensions in microns.

Figure 5. Bonding pad positions

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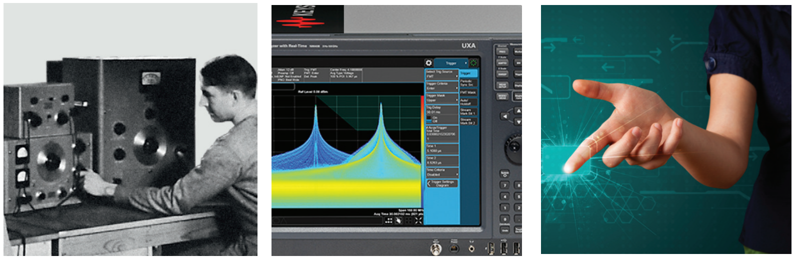

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This data sheet contains a variety of typical and guaranteed performance data. The information supplied should not be interpreted as a complete list of circuit specifications. Customers considering the use of this, or other Keysight Technologies GaAs 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.

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