DC – 15 GHz HBT Series-Shunt Amplifier

Technical Data

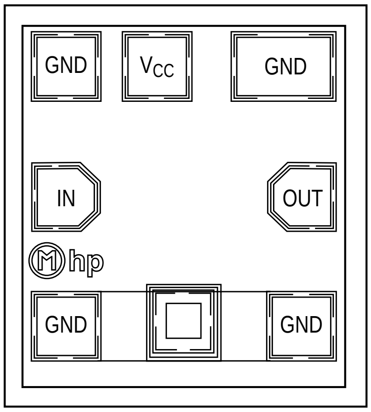
HMMC-5220

Features

- **High Bandwidth, F_{-1dB}:** 16 GHz Typical
- **Moderate Gain:** 9.5 dB ±1 dB @ 1.5 GHz
- **P_{-1dB} @ 1.5 GHz:** 12 dBm Typical
- **Low l/f Noise Corner:** 100 kHz Typical
- **Single Supply Operation:** >4.75 volts @ 44 mA Typ.
- **Low Power Dissipation:** 190 mW Typ. for chip

Description

The HMMC-5220 is a DC to 15 GHz, 9.5 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 MWTD'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.



Chip Size:	410 x 460 µm (16.1 x 18.1 mils)
Chip Size Tolerance:	±10 µm (±0.4 mils)
Chip Thickness:	127 ± 15 µm (5.0 ± 0.6 mils)
Pad Dimensions:	70 x 70 µm (2.8 x 2.8 mils), or larger

Absolute Maximum Ratings[1]

Symbol	Parameters/Conditions	Units	Min.	Max.
V_{CC}	V_{CC} Pad Voltage	V		8.0
V_{PAD}	Output Pad Voltage	V		3.5
P_{in}	RF Input Power	dBm		13
T_J	Junction Temperature	°C		+150
T_{op}	Operating Temperature	°C	-55	+85
T_{STG}	Storage Temperature	°C	-65	+165
T_{max}	Maximum Assembly Temp.	°C		+300

Note:

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 Junction Temperature (T_J) is not exceeded. T_A = 25°C except for T_{op}, T_{STG}, and T_{max}.

DC Specifications/Physical Properties[1]**,** (Typicals are for V_{CC} = +6 V, R_{out} = 100 Ω)

Symbol	**Parameters and Test Conditions**	**Units**	**Min.**	**Typ.**	**Max.**
V_{CC}	Supply Voltage	V	4.75	6.0	
I_{C1}	Stage-One Supply Current	mA	14.5	17	20
I_{C2}	Stage-Two Supply Current	mA		28	32
$I_{C1} + I_{C2}$	Total Supply Current	mA		45	
$\theta_{J\text{-}bs}$	Thermal Resistance[1] (Junction-to-Backside at T_J = 150°C)[2]	°C/Watt			

Notes:

1. Backside ambient operating temperature $T_A = T_{op}$ = 25°C unless otherwise noted.
2. Thermal resistance (in °C/Watt) at a junction temperature T(°C) can be *estimated* using the equation:
   $\theta(T) \cong \theta(T_J)\,[T(°C)+273] / [T_J\,(°C)+273]$ where $\theta(T_J = 150°C) = \theta_{J\text{-}bs}$.

RF Specifications, T_A = 25°C, V_{CC} = +6 V, R_{out} = 100 Ω, 50 Ω system

Symbol	**Parameters and Test Conditions**	**Units**	**Min.**	**Typ.**	**Max.**
BW	Operating Bandwidth ($f_{-3\,dB}$)	GHz	15		
BW	Operating Bandwidth ($f_{-1\,dB}$)	GHz		16	
S_{21}	Small Signal Gain (@1.5 GHz)	dB	8.5		10.5
Δ Gain	Small Signal Gain Flatness (DC – 5 GHz)	dB		0.2	
	Small Signal Gain Flatness (DC – 15 GHz)	dB		1	
TC	Temperature Coefficient of Gain (DC – 10 GHz)	dB/°C		0.004	
	Temperature Coefficient of Gain (10 – 15 GHz)	dB/°C		0.02	
$(RL_{in})_{MIN}$	Minimum Input Return Loss (DC – 10 GHz)	dB		-15	
	Minimum Input Return Loss (10 – 15 GHz)	dB		-12	
$(RL_{out})_{MIN}$	Minimum Output Return Loss	dB		-15	
Isolation	Reverse Isolation	dB		-15	
$P_{-1\,dB}$	Output Power at 1 dB Gain Compression (@ 1.5 GHz)	dBm		12	
P_{SAT}	Saturated Output Power (@ 1.5 GHz)	dBm		13	
NF	Noise Figure	dB		6.5	

Applications

The HMMC-5220 can be used for a variety of applications requiring moderate amounts of gain and low power dissipation in a 50 Ω system.

Biasing and Operation

The HMMC-5220 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 +7 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 and an inductor. The required value of the resistor is given by the equation:

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

where V_{supply} is in volts. If R_{out} is greater than 300 Ω, the inductor 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 3.2 Volts; 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 – 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 V_{CC} 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 recom-mended wire bond stage temperature is 150 ± 2°C.

For more detailed information see HP application note #999 "GaAs MMIC Assembly and Handling Guidelines."

GaAs MMICs are ESD sensitive. Proper precautions should be used when handling these devices.

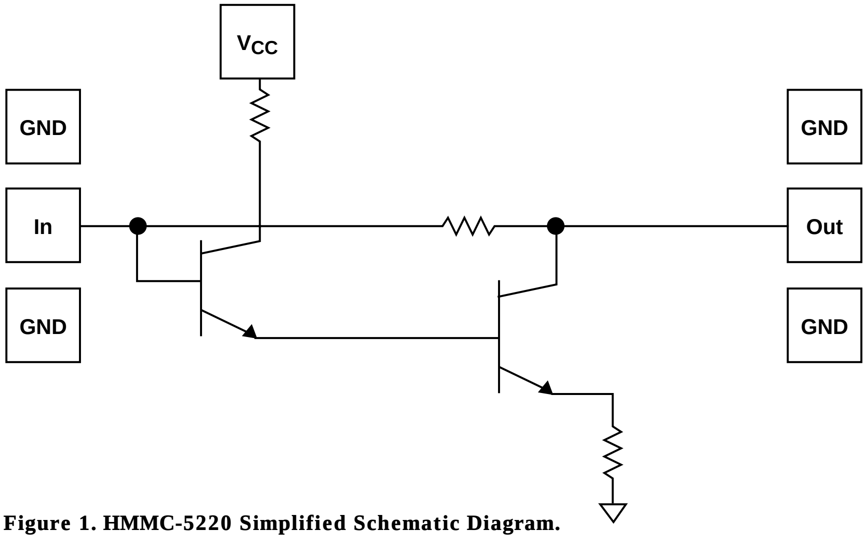


Figure 1. HMMC-5220 Simplified Schematic Diagram.

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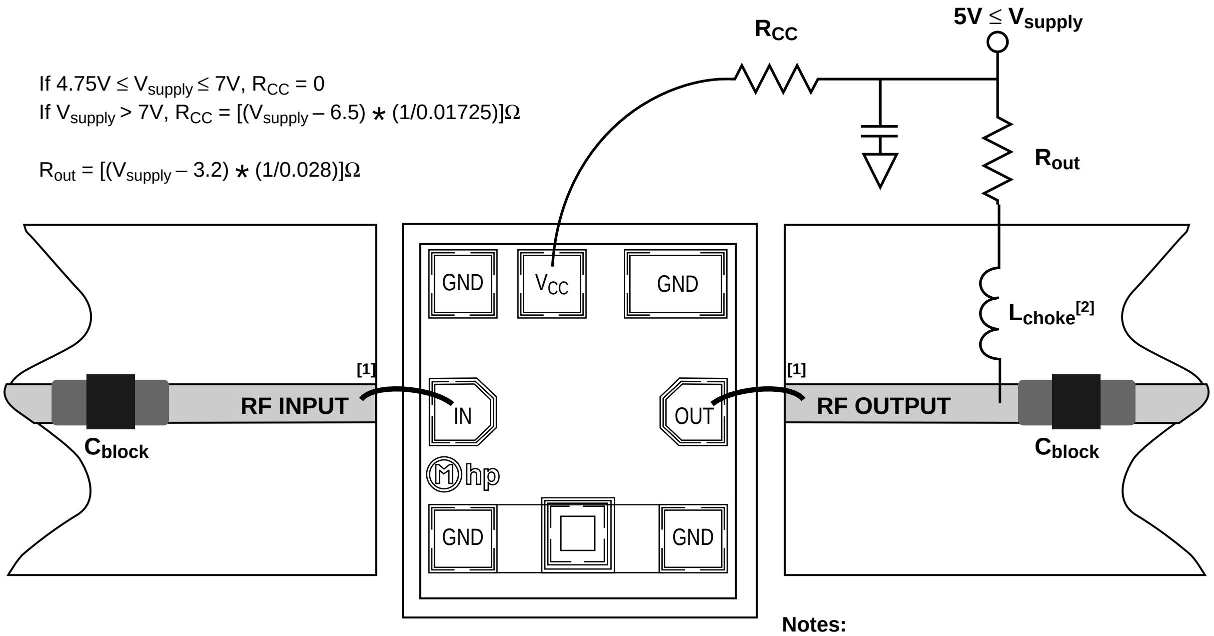

Notes:

Blocking Cap required on input and output.

1. For optimum performance, the input and output bond wire inductances should each be 0.1–0.3 nH. (bond wire has about 20 pH/mil of inductance).
2. L_{choke} is optional if R_{out} is greater than 300Ω, however, gain will be reduced by about 0.5 dB.

Figure 4. HMMC-5220 Assembly Diagram.

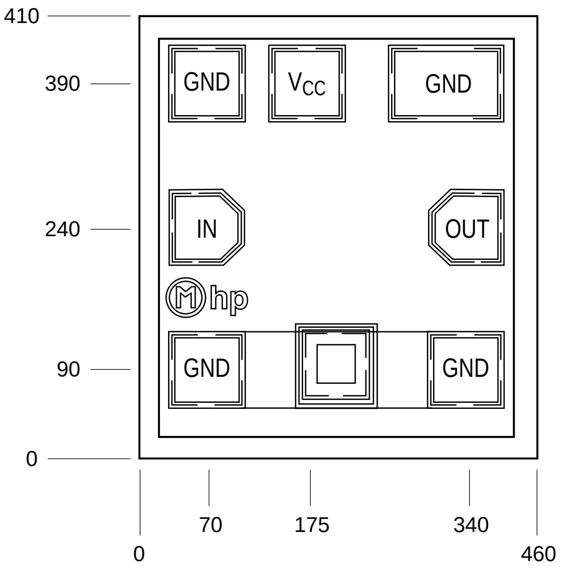

Figure 5. HMMC-5220 Bonding Pad Positions. (all dimensions in microns)

This data sheet contains a variety of typical performance data. The information supplied should not be interpreted as a complete list of circuit specifications. In this data sheet the term *typical* refers to the 50th percentile performance. For additional information contact your local HP sales representative.

www.hp.com/go/rf

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