Agilent Technologies
Innovating the HP Way

20–43 GHz Double-Balanced Mixer and LO-Amplifier

Technical Data

HMMC-3040

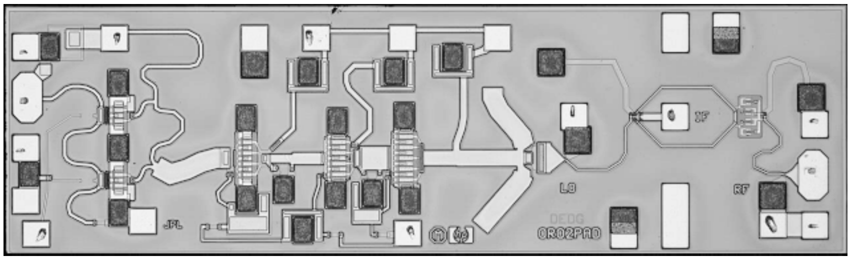
Features

- **Both Up and Down-converting Functions**
- **Harmonic LO Mixing Capability**
- **Large Bandwidth:**
  RF Port: 20–43 GHz
  LO Port Match: DC–43 GHz
  LO Amplifier: 20–43 GHz
  IF Port: DC–5 GHz
- **Repeatable Conversion Loss:**
  9.5 dB Typical at 30 GHz
- **Low LO Drive Required**
- **50 Ω Port Matching Networks**

Description

The HMMC-3040 is a broadband MMIC Double-Balanced Mixer (DBM) with an integrated high-gain LO amplifier. It can be used as either an upconverter or as a downconverter in microwave/millimeter-wave transceivers. If desired, the LO amplifier can be biased to function as a frequency multiplier to enable harmonic mixing of a LO source.

This three-port device has input and output matching circuitry for use in 50 ohm environments. The MMIC provides repeatable conversion loss (requiring no tuning), thereby making it suitable for automated assembly processes.



Chip Size:	2520 x 730 µm (99.2 x 28.7 mils)
Chip Size Tolerance:	±10 µm (±0.4 mils)
Chip Thickness:	127 ± 15 µm (5.0 ± 0.6 mils)

Absolute Maximum Ratings[1]

Symbol	Parameters/Conditions	Units	Min.	Max.
$V_{D1,2}$	Drain Supply Voltages	V		5
$V_{G1,2}$	Gate Supply Voltages	V	-3.0	0.5
I_{DD}	Total Drain Current	mA		400
P_{in}	RF Input Power	dBm		21
T_{ch}	Channel Temperature[2]	°C		+160
T_A	Backside Ambient Temp.	°C	-55	+75
T_{STG}	Storage Temperature	°C	-65	+165
T_{max}	Maximum Assembly Temp.	°C		+300

Notes:
1. Absolute maximum ratings for continuous operation unless otherwise noted.
2. Refer to *DC Specifications/Physical Properties* table for derating information.

HMMC-3040 DC Specifications/Physical Properties[1]

Symbol	Parameters and Test Conditions	Units	Min.	Typ.	Max.
$V_{D1,2}$	Drain Supply Operating Voltages	V	2	4.5	5
I_{D1}	First Stage Drain Supply Current (V_{DD} = 4.5 V, $V_{G1} \cong$ -0.8 V)	mA		27	
I_{D2}	Total Drain Supply Current for Stage 2 (V_{DD} = 4.5 V, $V_{GG} \cong$ -0.8 V)	mA		123	
$V_{G1,2}$	Gate Supply Operating Voltages ($I_{DD} \cong$ 150 mA)	V		-0.8	
V_P	Pinch-off Voltage (V_{DD} = 4.5 V, $I_{DD} \leq$ 10 mA)	V	-2	-1.2	-0.8
$\theta_{ch\text{-}bs}$	Thermal Resistance[2] (Channel-to-Backside at T_{ch} = 160°C)	°C/Watt		62	
T_{ch}	Channel Temperature[3] (T_A = 75°C, MTTF > 10^6 hrs, (V_{DD} = 4.5 V, I_{DD} = 300 mA)	°C		160	

Notes:

1. Backside ambient operating temperature T_A = 25°C unless otherwise noted.
2. Thermal resistance (°C/Watt) at a channel temperature T (°C) can be estimated using the equation: $\theta(T) \cong 62 \text{ x } [T(°C) + 273] / [160°C + 273]$.
3. Derate MTTF by a factor of two for every 8°C above T_{ch}.

HMMC-3040 RF Specifications,

T_A = 25°C, Z_O = 50 Ω, V_{DD} = 4.5 V, I_{DD} = 150 mA

Symbol	Parameters and Test Conditions		Units	Min.	Typ.	Max.
BW	Operating Bandwidth	RF and LO	GHz	20	20-43	43
		IF	GHz	DC	DC-5	5
C.L.	Conversion Loss		dB		9.5	12
P_{LO}	LO Drive Level		dBm		2	
LO/RF Isolation	LO-to-RF Isolation		dB		18	
P_{-1dB}	Input Power (@ 1 dB increase in C.L.)	Down-Convert	dBm		15	
		Up-Convert	dBm		8	

HMMC-3040 Applications

The HMMC-3040 MMIC is a broadband double-balanced mixer (DBM) with an integrated LO amplifier. It can be used as either a frequency up-converter or down-converter. This mixer was designed specifically for microwave/millimeter-wave point-to-point and-point-to-multipoint (including LMDS/LMCS/MVDS) communication systems that operate in the 20 – 43 GHz frequency range.

The LO amplifier can also be biased to provide frequency multiplication of the LO source (Figure 2). The integrated LO amplifier will provide a good impedance match to low frequency input signals. Frequencies below approximately 18 GHz will not be passed by the LO network, enhancing LO rejection.

Biasing and Operation

The recommended DC bias condition is with all drains connected to a single 3.5 – 4.5 volt supply and all drains connected to an adjustable negative voltage supply. The gate voltage is adjusted for a total drain supply current of typically 150 – 230 mA. An assembly diagram is shown in Figure 4.

The LO amplifier has effectively two gain stages as indicated in Figure 1. One wire connection is needed to each DC drain bias supply pad, V_{D1} and V_{D2}, and one to each DC gate bias pad, V_{G1} and V_{G2}.

Many biasing configurations are available when biasing the LO amplifier to function as a multiplier. For example, when tripling a 10 GHz LO source, an effective LO amplifier bias is $V_{D1} = V_{D2} = 2.5$ V and $I_{D1} + I_{D2} = 275$ mA. Even-order harmonics of the LO source are generated when the first stage is pinched off and $V_{D1} = V_{D2} = 4.5$ V with $I_{D2} = 150 – 230$ mA. When operated as a multiplier, 10 – 14 dBm is generally required to drive to LO input. No impedance matching network is needed because the LO port provides a good match to signals having frequency from DC to approximately 43 GHz.

The microwave/millimeter-wave ports are not AC-coupled. A DC blocking capacitor is required on any RF port that may be exposed to DC voltages.

No ground wires are needed because ground connections are made with plated through-holes to the backside of the device.

Assembly Techniques

Electrical and thermal conductive epoxy die attach is the preferred assembly method. Solder die attach using a fluxless gold-tin solder preform can also be used. The device should be attached to an electrically conductive surface to complete the DC and RF ground paths. The backside metallization on the device is gold.

It is recommended that the electrical connections to the bonding pads be made using 0.7 – 1.0 mil diameter gold wire. The microwave/millimeter-wave connections should be kept as short as possible to minimize inductance. For assemblies requiring long bond wires, multiple wires can be attached to the RF bonding pads.

Thermosonic wedge is the preferred method for wire bonding to the gold bond pads. 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.

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

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

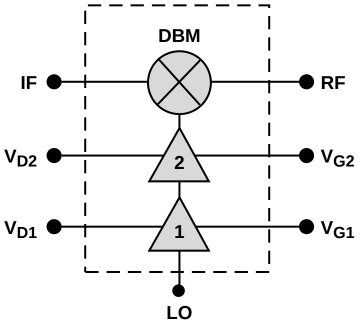


Figure 1. Simplified Block Diagram.

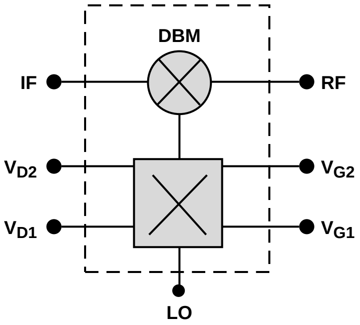


Figure 2. Harmonic Mixing Block Diagram.

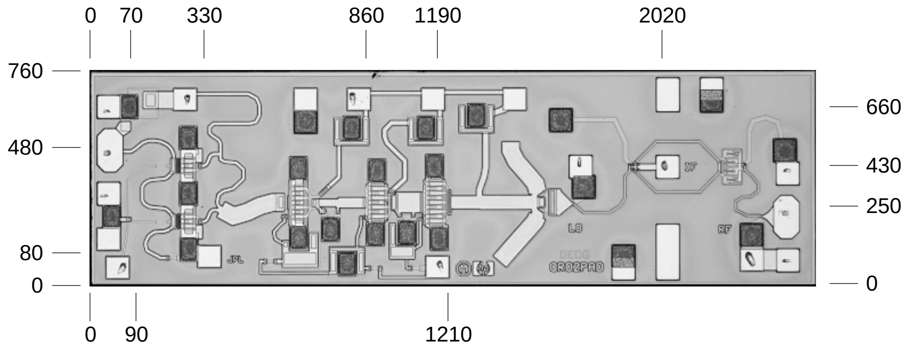
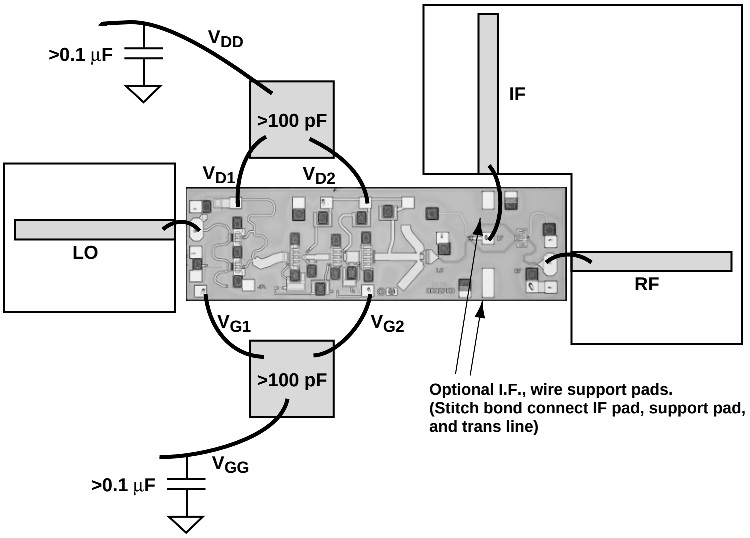


Figure 3. HMMC-3040 Bonding Pad Positions. (Dimensions are in micrometers)



Optional I.F., wire support pads.
(Stitch bond connect IF pad, support pad, and trans line)

Figure 4. HMMC-3040 Common Assembly Diagram.

Additional HMMC-3040 Performance Characteristics (Data refer to Figure 1)

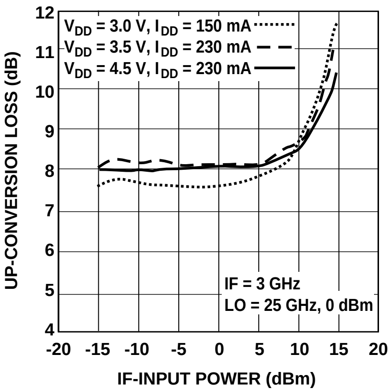


Figure 5. Up-Conversion Loss vs. IF Input Power.

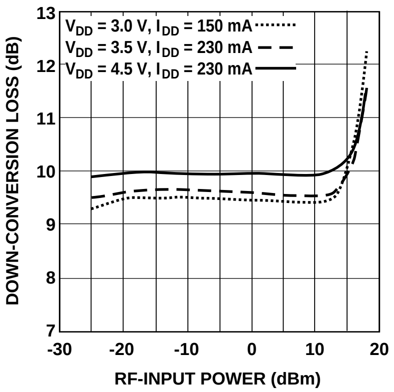


Figure 6. Down-Conversion Loss vs. RF Input Power.

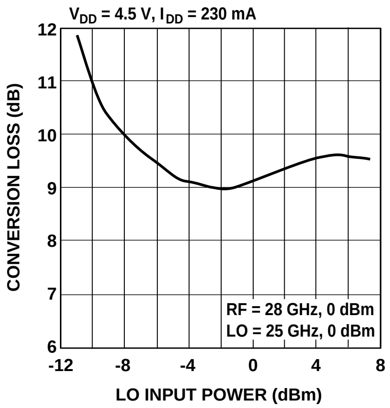


Figure 7. Conversion Loss vs. LO Input Power.

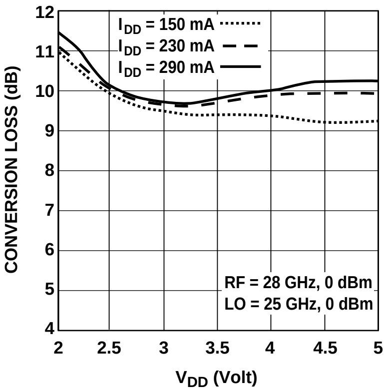


Figure 8. Conversion Loss vs. V_{DD} for Various LO Amplifier Drain Currents.

Note:

All data measured on individual devices mounted in a 50 GHz test package T_A = 25°C and under Figure 1 condition (except where noted).

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. In this data sheet the term *typical* refers to the 50th percentile performance. For additional information contact your local Agilent sales representative.

Agilent Technologies
Innovating the HP Way

www.semiconductor.agilent.com

Data subject to change.

5966-4571E (11/99)