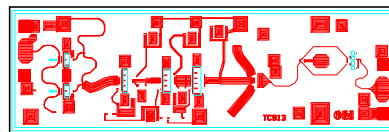


# 20-43 GHz Double-Balanced Mixer and LO-Amplifier

## 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

HMMC-3040



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

## 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 up-converter or as a down-converter 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.

## Absolute Maximum Ratings\*

Symbol	Parameters/Conditions	Min.	Max.	Units
V <sub>D1,2</sub>	Drain Supply Voltages		5	Volts
V <sub>G1,2</sub>	Gate Supply Voltages	-3.0	0.5	Volts
I <sub>DD</sub>	Total Drain Current		400	mA
P <sub>in</sub>	RF Input Power		21	dBm
T <sub>ch</sub>	Channel Temperature**		160	°C
T <sub>A</sub>	Backside Ambient Temperature	-55	+75	°C
T <sub>st</sub>	Storage Temperature	-65	+165	°C
T <sub>max</sub>	Max. Assembly Temperature		300	°C

\* Absolute maximum ratings for continuous operation unless otherwise noted.

\*\* Refer to *DC Specifications / Physical Properties* table for derating information.

## DC Specifications/Physical Properties \*

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

\*Backside ambient operating temperature  $T_A = 25^\circ\text{C}$ , unless otherwise noted.

<sup>†</sup>Thermal resistance ( $^\circ\text{C}/\text{Watt}$ ) at a channel temperature  $T$  ( $^\circ\text{C}$ ) can be *estimated* using the equation:  
 $\theta(T) \cong 62 \times [T(^\circ\text{C})+273] / [160^\circ\text{C}+273]$ .

<sup>\*\*</sup>Derate MTTF by a factor of two for every  $8^\circ\text{C}$  above  $T_{ch}$ .

## RF Specifications

( $T_A = 25^\circ\text{C}$ ,  $Z_0 = 50 \Omega$ ,  $V_{DD} = 4.5$  V,  $I_{DD} = 150$  mA)

Symbol	Parameters/Conditions		Specifications			Units
			Min.	Typ.	Max.	
BW	Operating Bandwidth	RF and LO	20	20-43	43	GHz
		IF	DC	DC-5	5	GHz
C.L.	Conversion Loss			9.5	12	dB
$P_{LO}$	LO Drive Level			2		dBm
LO/RF Isolation	LO-to-RF Isolation	LO ampl. input		18		dB
		LO mixer input		38		dB
$P_{-1dB}$	Input Power (@ 1dB increase in C.L.)	Down-Convert		15		dBm
		Up-Convert		8		dBm

## 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 operated 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 gates connected to an adjustable negative voltage supply. The gate voltage is adjusted for a total drain supply current of typically 150-230mA. 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.

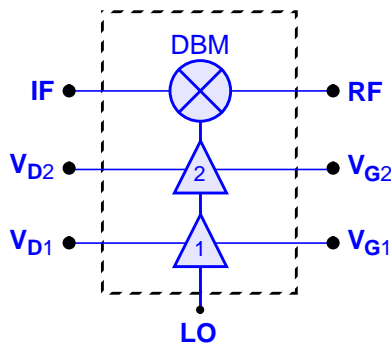
It is recommended that the electrical connections to the bonding pads be made using 0.7-1.0 mil diameter gold wire. The microwave/millimeter-wave connections should be kept as short as possible to minimize inductance. For assemblies requiring long bond wires, multiple wires can be attached to the RF 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  $150 \pm 2^\circ\text{C}$ .

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

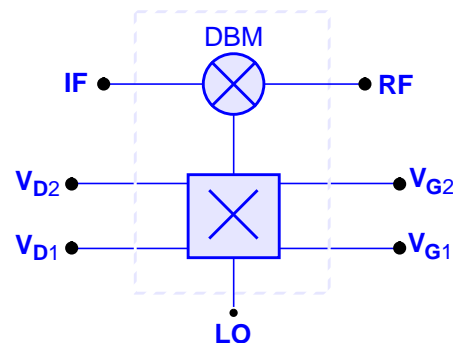
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*GaAs MMICs are ESD sensitive. Proper precautions should be used when handling these devices.*

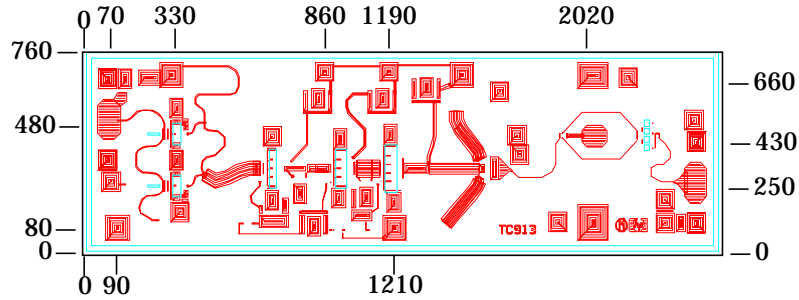
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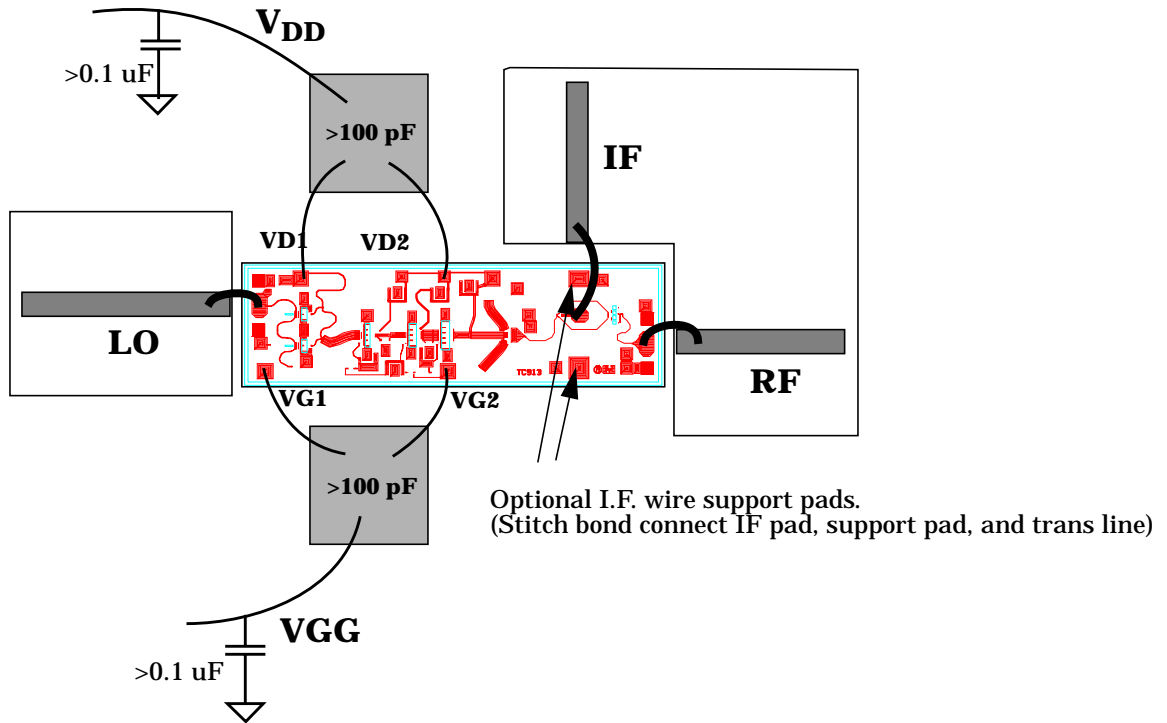
**Figure 1.**  
**Simplified Block Diagram**



**Figure 2.**  
**Harmonic Mixing Block Diagram**

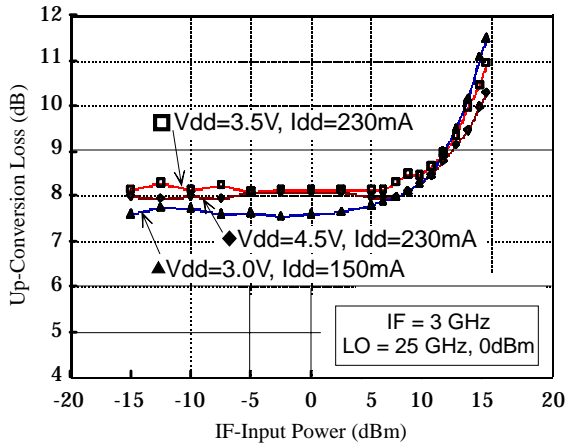


**Figure 3.**  
**HMMC-3040 Bonding Pad Positions**  
 (Dimensions are micrometers)

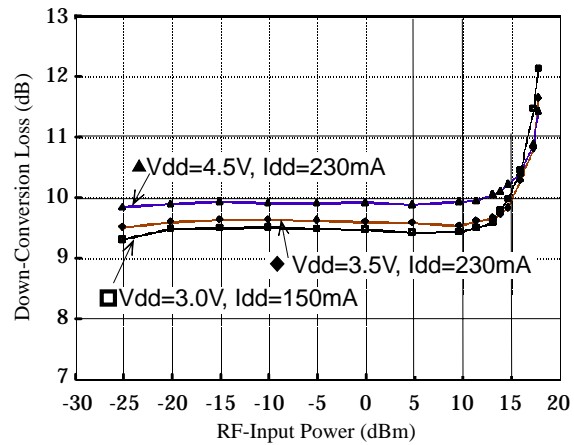


**Figure 4.**  
**HMMC-3040 Common Assembly Diagram**

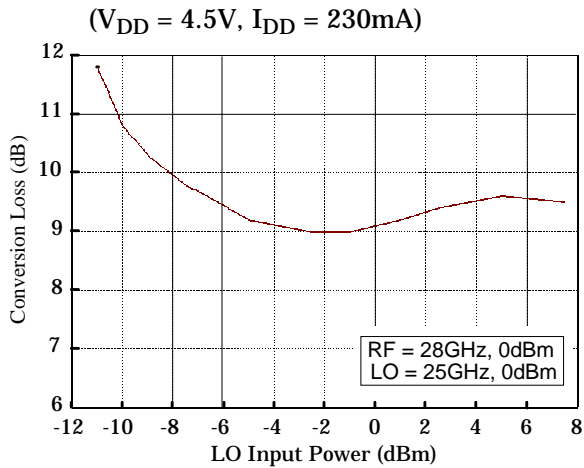
## Additional HMMC-3040 Performance Characteristics (Data refer to Figure 1)



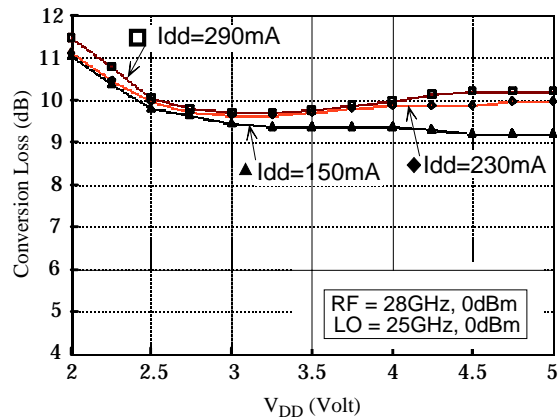
**Figure 5.**  
**Up-Conversion Loss versus IF Input Power**



**Figure 6.**  
**Down-Conversion Loss versus RF Input Power**



**Figure 7.**  
**Conversion Loss versus LO Input Power**



**Figure 8.**  
**Conversion Loss versus  $V_{DD}$  for Various LO Amplifier Drain Currents**

**Notes:**

All data measured on individual devices mounted in a 50 GHz test package  $T_A = 25^\circ\text{C}$  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 HP sales representative.

**Notes:**