Sales: 408-778-9952 | General: 408-778-4200 | Fax: 408-778-4300
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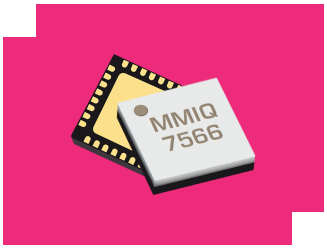
MMIQ-0106HCSM-2

Passive GaAs MMIC IQ Mixer

DEVICE OVERVIEW

General Description

MMIQ-0106HCSM is a high linearity, passive GaAs MMIC IQ mixer. This is an ultra-broadband mixer spanning 1.5 to 5.5 GHz on the RF and LO ports with an IF from DC to 3 GHz. Up to 33 dB of image rejection is available due to the excellent phase and amplitude balance of its on-chip LO quadrature hybrid. The MMIQ 0106HCSM is available in a 5x5 mm ceramic QFN package. Evaluation boards are available.



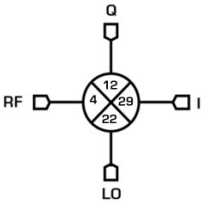
Features

Parameter	Typical	Unit
RF/LO Frequency Range	1.5 – 5.5	GHz
IF Frequency Range	DC – 3	GHz
I+Q Conversion Loss	8	dB
Image Rejection	33	dBc
LO-RF Isolation	62	dB

Applications

- Single Sideband and Image Rejection Mixing
- IQ Modulation / Demodulation
- Vector Amplitude Modulation
- Band Shifting

Functional Block Diagram



Part Ordering Options

Part Number	Description	Package	Packing Size	Green Status	Product Lifecycle	Export Classification
EVB-MMIQ-0106HC	Evaluation Board, Passive GaAs MMIC 1.5 - 5.5 GHz IQ Mixer.	-	-	RoHS	Released	EAR99
MMIQ-0106HCSM-2	Passive GaAs MMIC IQ Mixer	QFN	-	RoHS	Released	EAR99

Table Of Contents

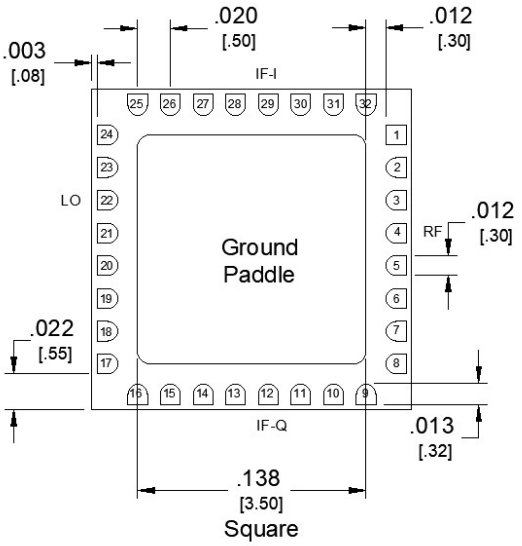
Revision History

Revision Code	Revision Date	Comment
-	2022-06-01	Datasheet Initial Release

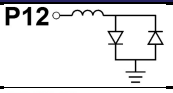
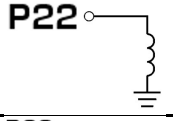
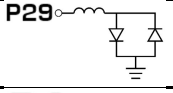
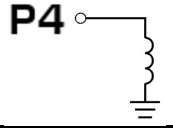
Port Configuration and Functions

Port Diagram

A bottom-up view of the MMIQ-0106HC's SM package outline drawing is shown below. The mixer may be operated as either a downconverter or an upconverter. Use of the RF or I/Q as the input or output port will depend on the application.



Port Functions

Port	Function	Description	Equivalent Circuit for Package
Pin 12	Q Input / Output	Pin 12 is diode coupled and AC matched to 50Ω over the specified Q port frequency range.	
Pin 22	LO Input	Pin 22 is DC short and AC matched to 50Ω over the specified RF frequency range.	
Pin 29	I Input / Output	Pin 29 is diode coupled and AC matched to 50Ω over the specified I port frequency range.	
Pin 4	RF Input / Output	Pin 4 is DC short and AC matched to 50Ω over the specified RF frequency range.	

Specifications

Absolute Maximum Ratings

The Absolute Maximum Ratings indicate limits beyond which damage may occur to the device. If these limits are exceeded, the device may be inoperable or have a reduced lifetime.

Parameter	Maximum Rating	Unit
Maximum Operating Temperature	100	°C
Maximum Storage Temperature	125	°C
Minimum Operating Temperature	-55	°C
Minimum Storage Temperature	-65	°C
Pin 22 DC Current	30	mA
Pin 4 DC Current	30	mA
Power Handling, at any Port	26	dBm

Package Information

Parameter	Details	Rating
ESD	250 to < 500 Volts	HBM Class 1A
Weight	Package name: QFN	22g
Dimensions	-	4.9x4.9 mm

Recommended Operating Conditions

The Recommended Operating Conditions indicate the limits, inside which the device should be operated, to guarantee the performance given in Electrical Specifications Operating outside these limits may not necessarily cause damage to the device, but the performance may degrade outside the limits of the electrical specifications. For limits, above which damage may occur, see Absolute Maximum Ratings.

Parameter	Min	Nominal	Max	Unit
RF/IF Input Power	-	-	11	dBm
LO Input Power	16	18	20	dBm
Ambient Temperature	-55	25	100	°C

Sequencing Requirements

There is no requirement to apply power to the ports in a specific order. However, it is recommended to provide a 50Ω termination to each port before applying power. This is a passive diode mixer that requires no DC bias.

Electrical Specifications

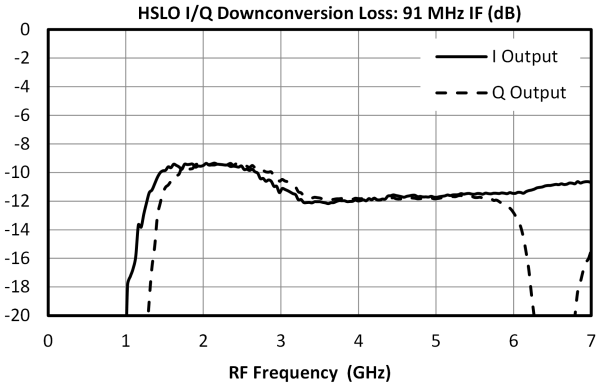
The electrical specifications apply at TA=+25°C in a 50Ω system. Typical data shown is for a down conversion application with a +18 dBm sine wave LO input. Min and Max limits apply only to our connectorized units and are guaranteed at TA=+25°C. All QFNs are 100% RF tested and visually inspected.

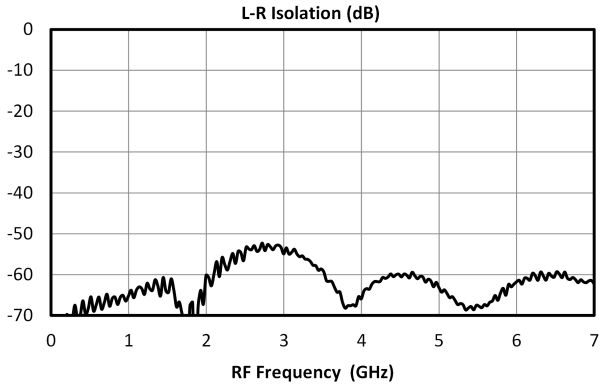
Parameter	Test Conditions	Minimum Frequency (GHz)	Maximum Frequency (GHz)	Min	Typ	Max	Unit
RF Frequency Range	-	-	-	1.5	-	5.5	GHz
LO Frequency Range	-	-	-	1.5	-	5.5	GHz
Conversion Loss [1]	RF/LO = 1.5 – 5.5 GHz I = 0.2 - 3 GHz	1.5	5.5	-	12.5	-	dB
Conversion Loss [2]	RF/LO = 1.5 – 5.5 GHz Q = 0.2 - 3 GHz	1.5	5.5	-	12.5	-	dB
Conversion Loss [3]	RF/LO = 1.5 – 5.5 GHz Q = DC - 0.2 GHz	1.5	5.5	-	11	14	dB
Conversion Loss [4]	RF/LO = 1.5 – 5.5 GHz I = DC - 0.2 GHz	1.5	5.5	-	11	-	dB
Noise Figure [5]	RF/LO = 1.5 – 5.5 GHz I = DC – 0.2 GHz	1.5	5.5	-	11	-	dB
Noise Figure [6]	RF/LO = 1.5 – 5.5 GHz Q = DC – 0.2 GHz	1.5	5.5	-	11	-	dB
Image Rejection [7]	RF/LO = 1.5 – 55. GHz I+Q = DC – 0.2 GHz	1.5	5.5	-	33	-	dBc
Input IP3 [8]	RF/LO = 1.5 – 5.5 GHz I = DC – 0.2 GHz	1.5	5.5	-	22	-	dBm
Amplitude Balance [9]	RF/LO = 1.5 – 5.5 GHz	1.5	5.5	-	0.3	-	dB
Phase Balance	RF/LO = 1.5 – 5.5 GHz	1.5	5.5	-	4	-	°
IF Frequency Range	-	-	-	0	-	3	GHz
Input 1 dB Gain Compression Point (P1dB), I	-	-	-	-	11	-	dBm
Input 1 dB Gain Compression Point (P1dB), Q	-	-	-	-	11	-	dBm
Q (Port 3) Frequency Range	-	-	-	0	-	3	GHz
Isolation, LO to IF	IF/LO = 1.5 – 5.5 GHz	1.5	5.5	-	32	-	dB
Isolation, LO to RF	RF/LO = 1.5 – 5.5 GHz	1.5	5.5	-	62	-	dB
Isolation, RF to IF	RF/IF = 1.5 – 5.5 GHz	1.5	5.5	-	43	-	dB

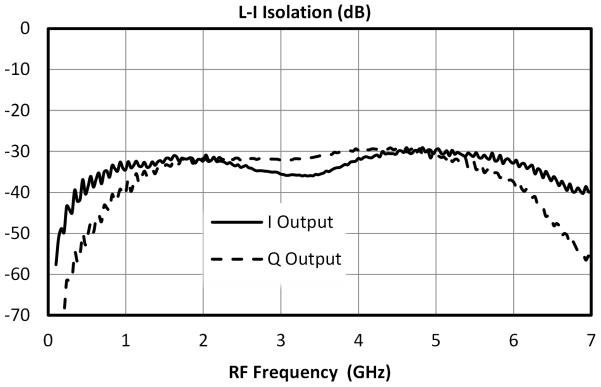
[1][2][3][4] Measured as an I/Q down converter (i.e., I and Q powers are not combined)
[5][6] Mixer Noise Figure typically measures within 0.5 dB of conversion loss for IF frequencies greater than 5 MHz.
[7] Image Rejection and Single sideband performance plots are defined by the upper sideband (USB) or lower sideband (LSB) with respect to the LO signal. Plots are defined by which sideband is selected by the external IF quadrature hybrid.
[8] Typical IIP3 is measured with I and Q ports combined with an external quadrature hybrid coupler in a down conversion.
[9] Amplitude and phase balance measured in a down conversion.

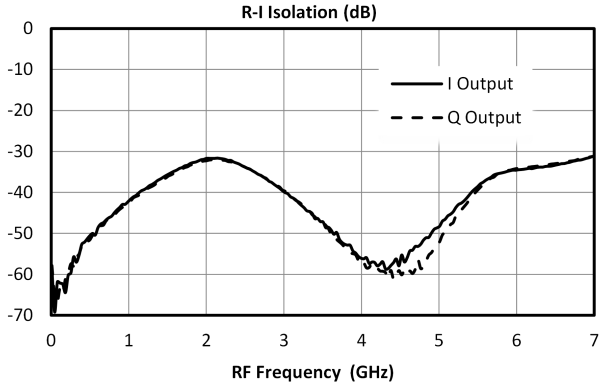
Typical Performance Plots

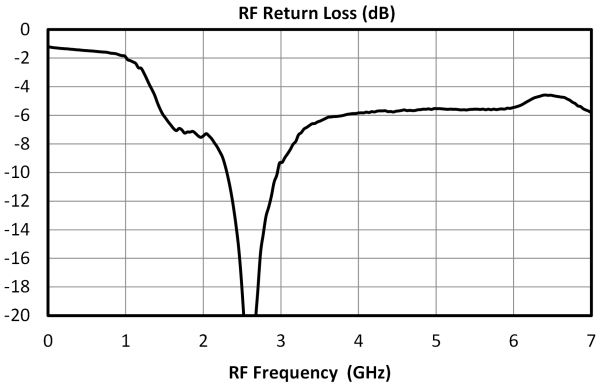
I output means that the IF output signal is measured at the I port of the mixer and the Q port is loaded. Q output means the IF output signal is measured at the Q port of the mixer while the I port is loaded.

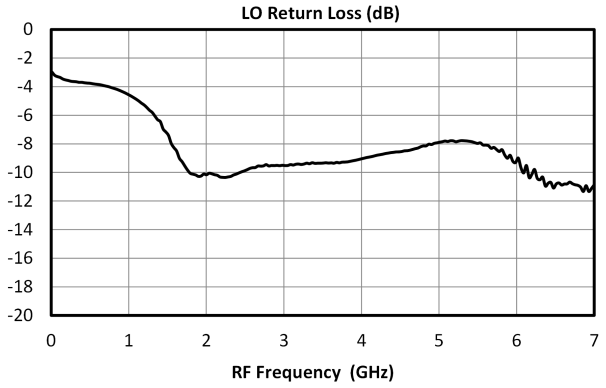


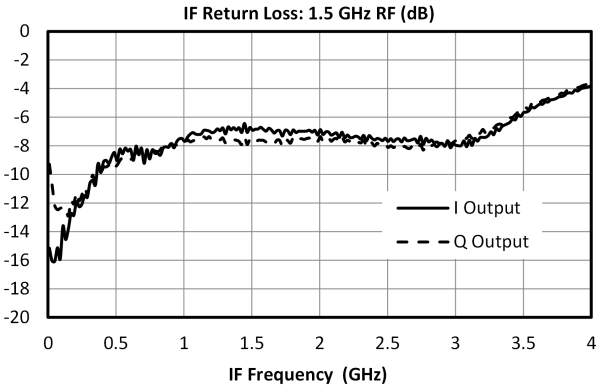


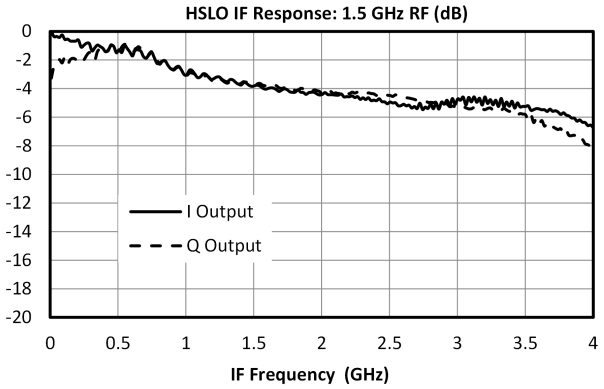


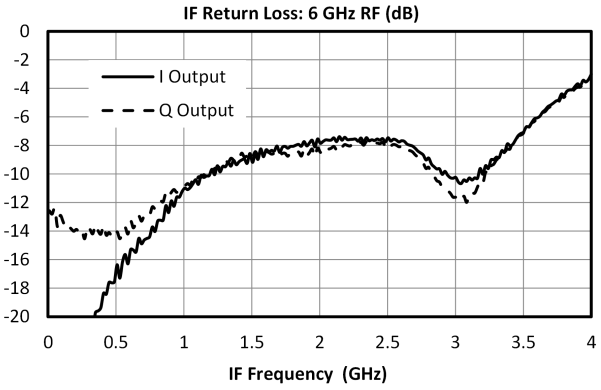


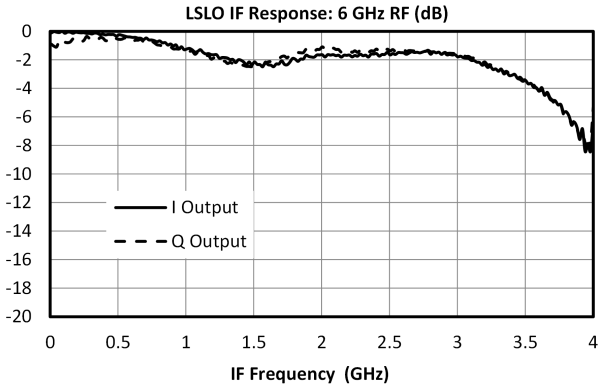


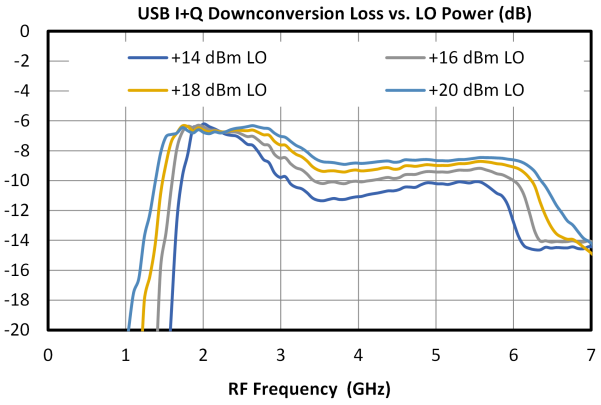


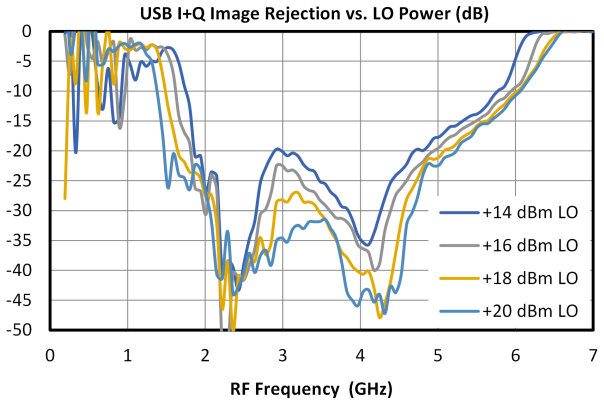


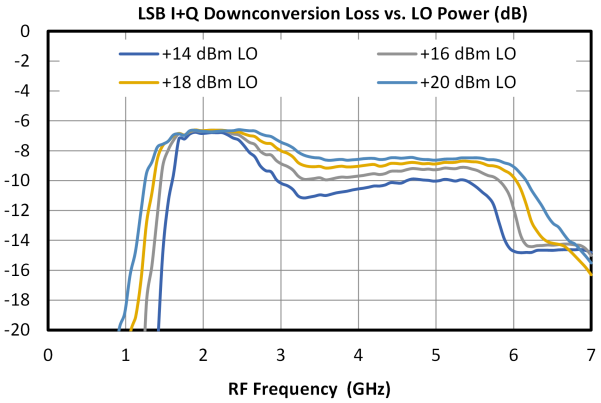


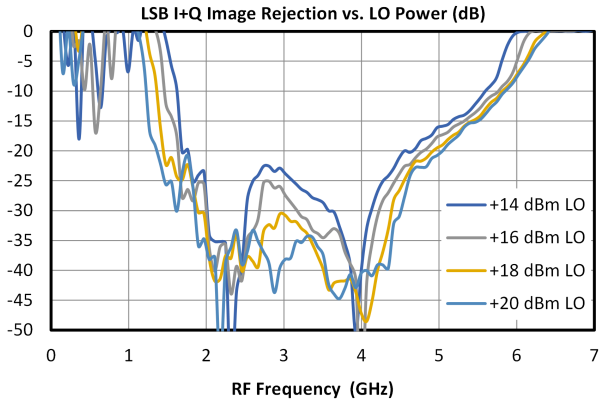


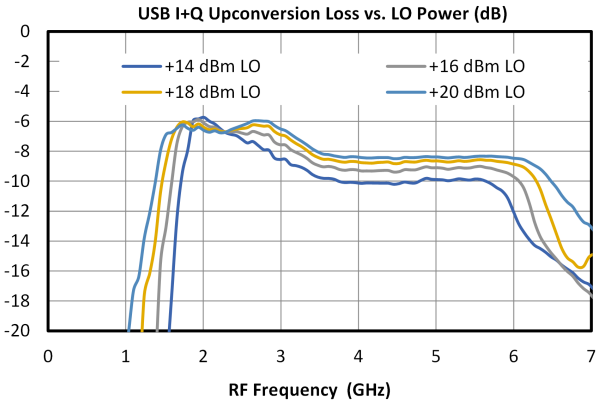


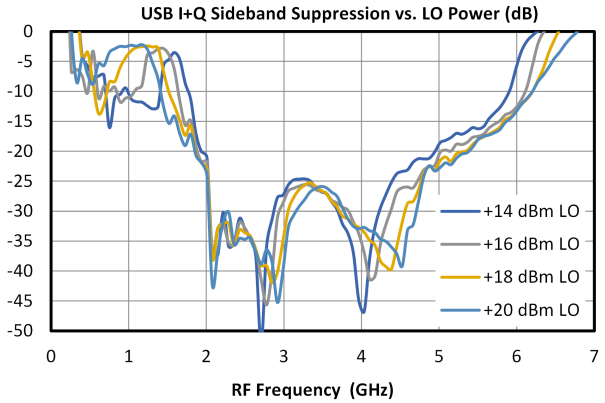


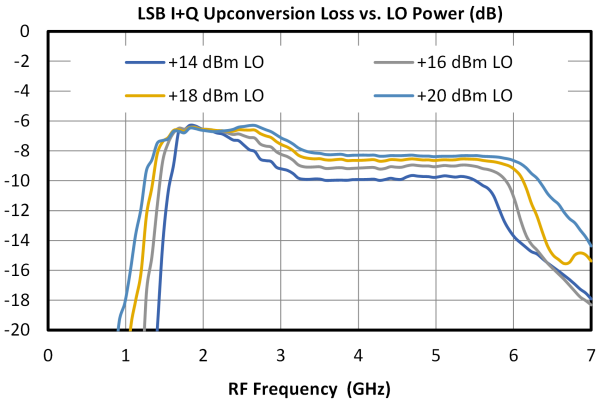


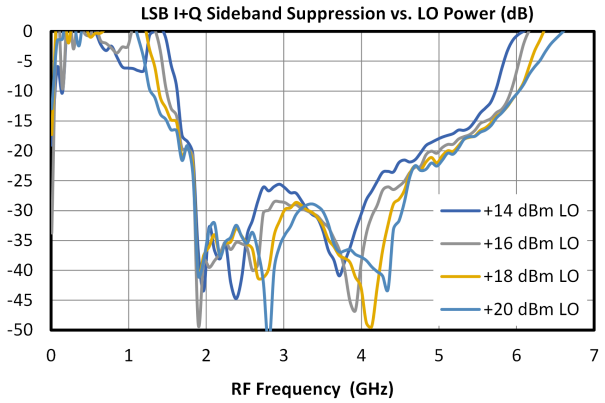




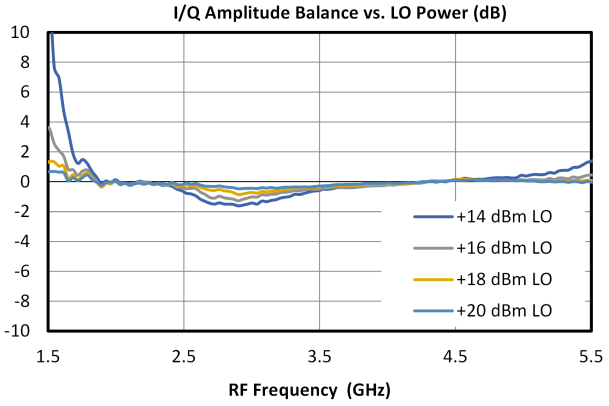




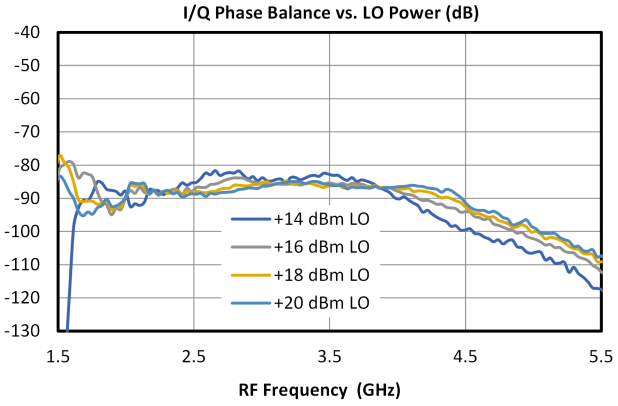




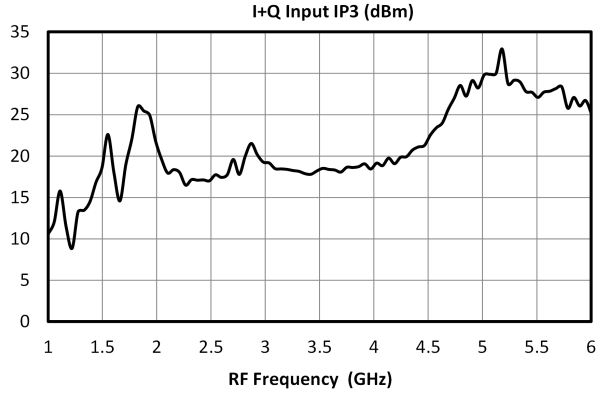
I/Q Amplitude Balance vs. LO Power (dB)



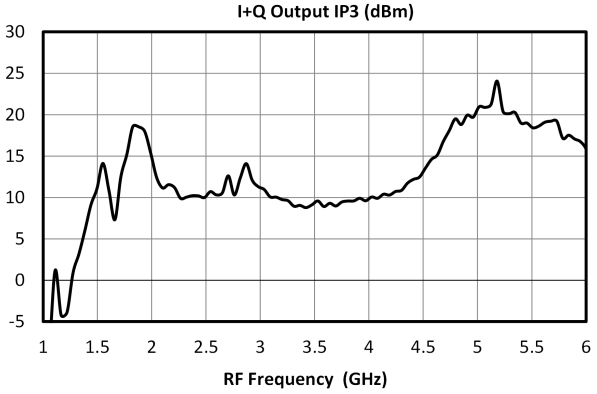
I/Q Phase Balance vs. LO Power (dB)



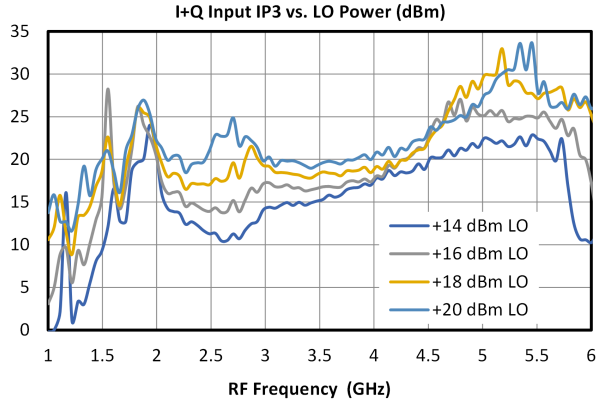
I+Q Input IP3 (dBm)



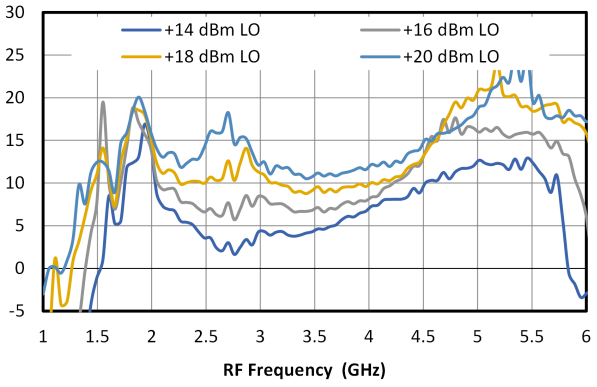
I+Q Output IP3 (dBm)

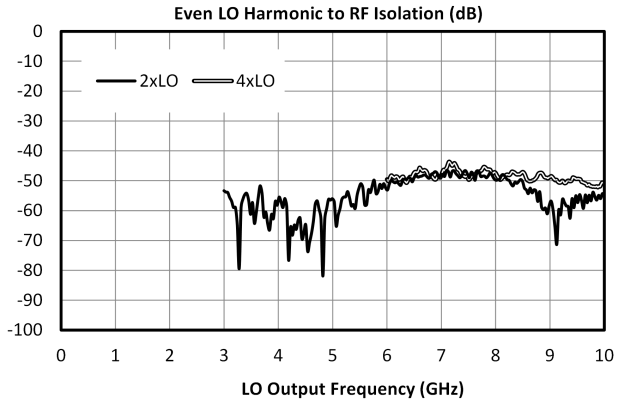


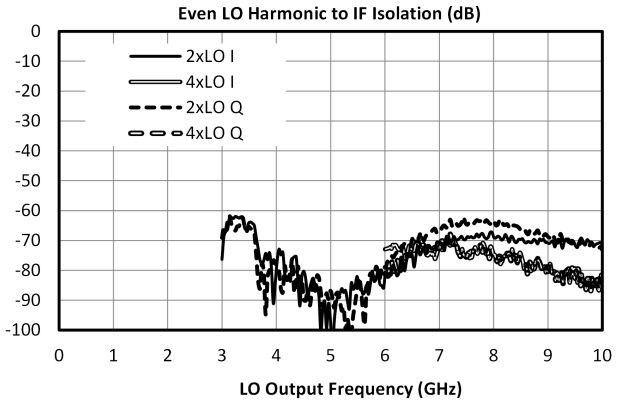
I+Q Input IP3 vs. LO Power (dBm)

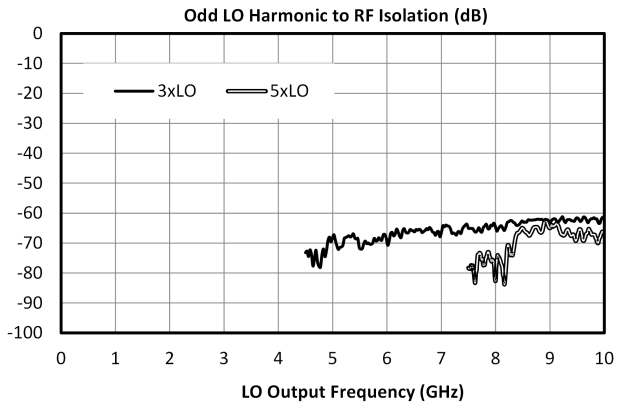


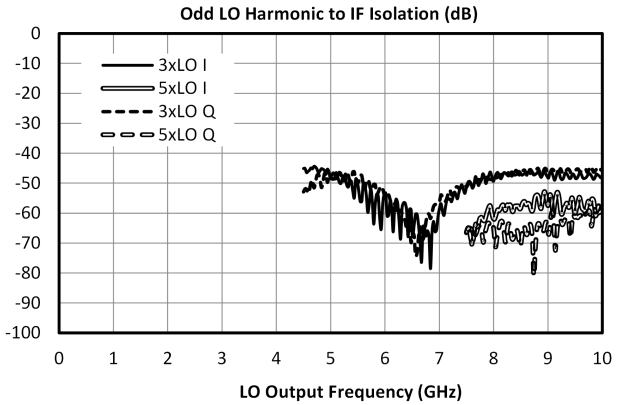
I+Q Output IP3 vs. LO Power (dBm)

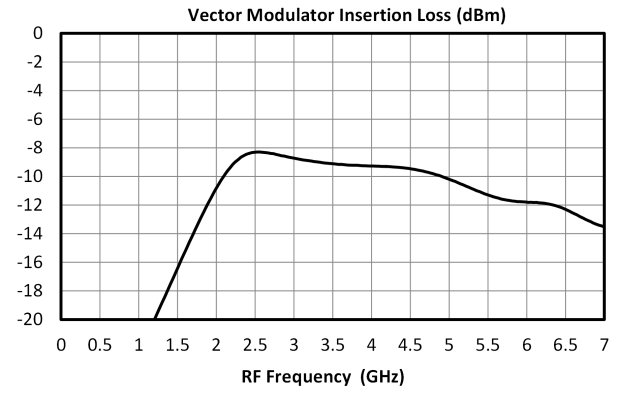












Spur Table

Typical Spurious Performance: Down-Conversion

Typical spurious data is provided by selecting RF and LO frequencies (± m*LO ± n*RF) within the RF/LO bands, to create a spurious output within the IF band. The mixer is swept across the full spurious band and the mean is calculated. The numbers shown in the table below are for a -10 dBm RF input. Spurious suppression is scaled for different RF power levels by (n-1), where “n” is the RF spur order. For example, the 2RF x 2LO spur is 75 dBc for a -10 dBm input, so a -20 dBm RF input creates a spur that is (2-1) x (-10 dB) lower, or 85 dBc.

Typical Down-conversion spurious suppression (dBc): I Port (Q Port)

-10 dBm RF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
1xRF	14 (14)	Reference	33 (28)	11 (12)	N/A	N/A
2xRF	67 (69)	61 (58)	75 (72)	60 (59)	80 (79)	65 (64)
3xRF	N/A	66 (65)	85 (81)	71 (74)	81 (85)	69 (71)
4xRF	N/A	116 (103)	116 (116)	107 (103)	115 (113)	108 (108)
5xRF	N/A	N/A	123 (127)	117 (116)	128 (128)	121 (120)

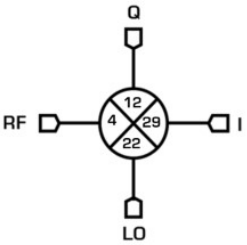
Typical Spurious Performance: Up-Conversion

Typical spurious data is taken by mixing an input within the IF band, with LO frequencies (± m*LO ± n*IF), to create a spurious output within the RF output band. The mixer is swept across the full spurious output band and the mean is calculated. The numbers shown in the table below are for a -10 dBm IF input. Spurious suppression is scaled for different IF input power levels by (n-1), where “n” is the IF spur order. For example, the 2IFx1LO spur is typically 69 dBc for a -10 dBm input with a sine-wave LO, so a -20 dBm IF input creates a spur that is (2-1) x (-10 dB) lower, or 79 dBc.

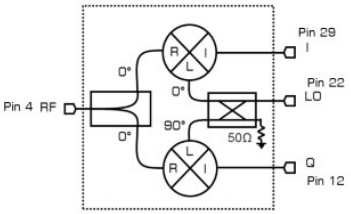
Typical Up-conversion spurious suppression (dBc): I Port (Q Port)

-10 dBm RF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
1xIF	20 (21)	Reference	30 (38)	20 (16)	N/A	N/A
2xIF	54 (53)	69 (66)	53 (52)	75 (76)	N/A	N/A
3xIF	54 (55)	49 (49)	72 (74)	54 (54)	N/A	N/A
4xIF	68 (67)	96 (93)	77 (76)	110 (108)	N/A	N/A
5xIF	72 (71)	94 (91)	97 (97)	80 (78)	N/A	N/A

Application Information



IQ Mixer



Internal Structure

Application Circuit Description

Detailed Description

MMIQ-0106HCSM belongs to Marki Microwave's MMIQ family of mixers. The MMIQ product line consists of passive GaAs MMIC mixers designed and fabricated with GaAs Schottky diodes. MMIQ mixers offer excellent amplitude and phase balance due to their on-chip LO quadrature hybrid. Up to 33 dB of typical image rejection (i.e., single sideband suppression) can be obtained by using the MMIQ-0106HCSM as an image rejection or single sideband mixer.

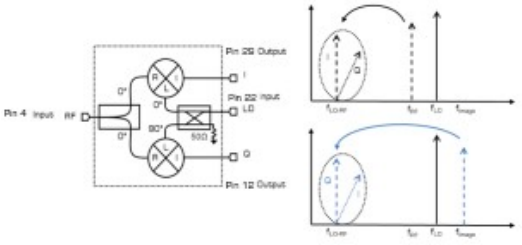
Support for the L, S, and C bands are offered by the ultra-broadband performance of the mixer's RF and LO ports. Traditional use of this mixer to do image reject or single sideband mixing is available with an external IF quadrature hybrid. The MMIQ-0106HCSM is also suitable for use as a Vector Modulator through DC bias of the I and Q ports.

The RF port and the LO port supports a 1.5-6 GHz signal. The I and Q ports support a DC-3 GHz signal. A signal may be input into any port of the mixer which supports that signal's frequency. This is the basis of using the mixer as a band shifter.

For a given LO power within the recommended operating range, the RF (in the case of a down conversion) or IF (in the case of an up conversion) input power should be below the input 1 dB compression point to avoid signal distortion. The input 1 dB compression point will vary across the mixer's operating bandwidth and with LO input power. Careful characterization is required for optimal performance for each application. There is no minimum small signal input power required for operation. Excessive RF/IF input power increases non-desired spurious output power and degrades the fundamental conversion loss. Excessive LO input power can also cause this effect. The table below describes how to use an IQ mixer and quad hybrid to select a single sideband.

Up Conversion		
Hybrid Port	Mixer Port	Sideband Selected
0	I	Lower Sideband
90	Q	
90	I	Upper Sideband
0	Q	
Down Conversion		
Hybrid Port	Mixer Port	Sideband Selected
0	I	Upper Sideband
90	Q	
90	I	Lower Sideband
0	Q	

Down Converter

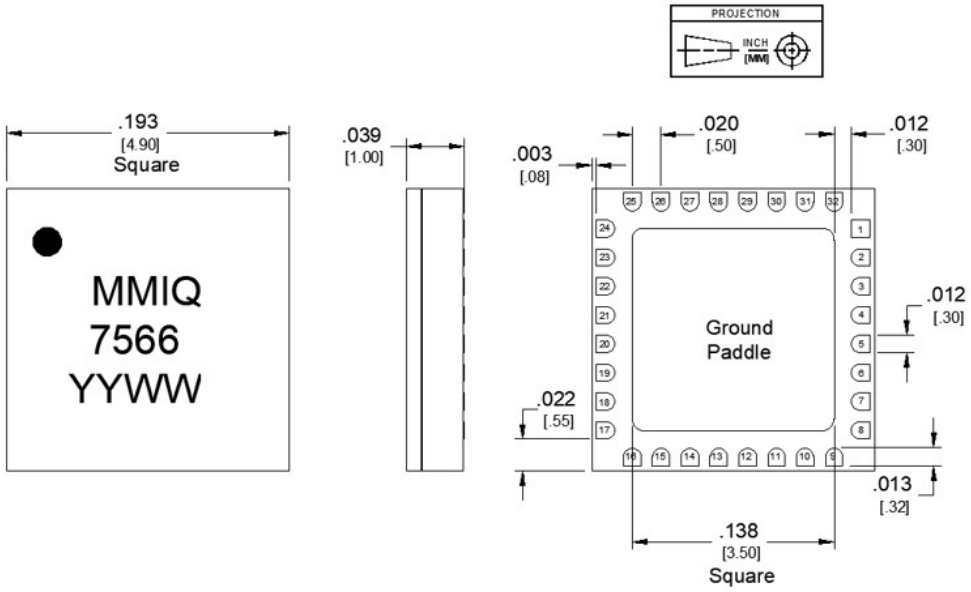


A down converter is a mixer application which takes a high frequency small signal RF input, and a high frequency large signal LO input and mixes the signals together to produce a low frequency IF output. The fundamental 1RFx1LO outputs present at the IF port are the f_{LO-RF} and f_{LO+RF} tones. The desired output in a down conversion is typically the f_{LO-RF} term. An image frequency at $f_{Image}=f_{2LO-RF}$ will also down convert to the f_{LO-RF} frequency. The above illustration shows the relative location of the image frequency for a highside LO, or the frequency plan for which $f_{LO} > f_{RF}$.

To use the IQ mixer as a down converter, input a high frequency small signal RF, a high frequency large signal LO input, and pull the low frequency IF output from the I and Q ports. I and Q IF outputs will be at the same frequency but 90° out of phase (i.e., I and

Mechanical Data

Outline Drawing



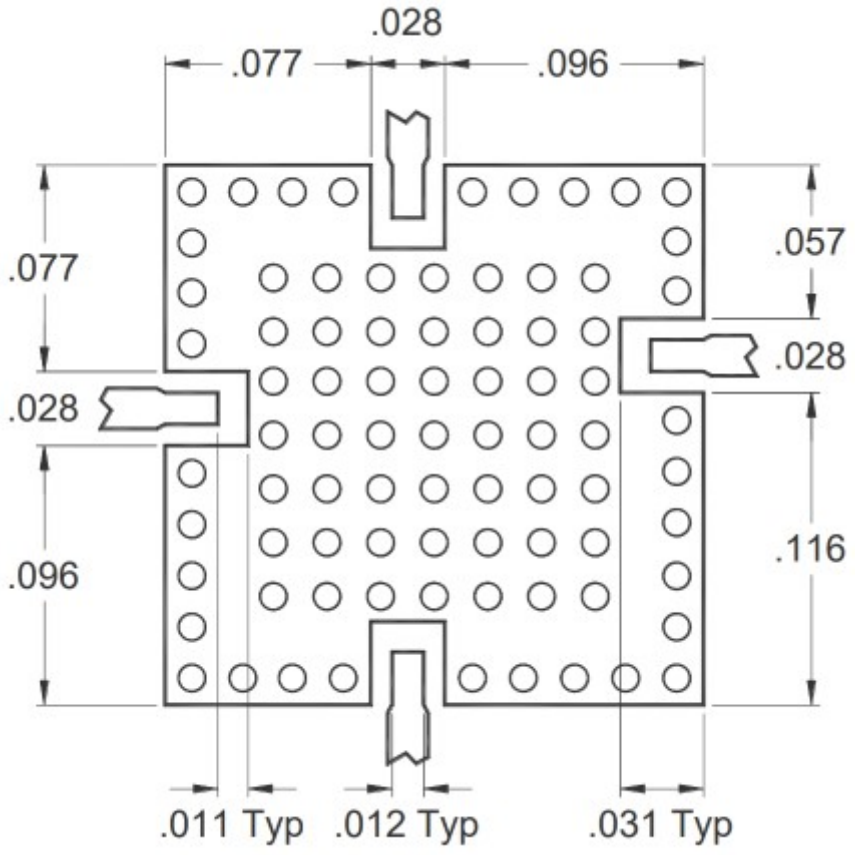
Pin #	Config A
1	N/C
2	N/C
3	N/C
4	RF
5	N/C
6	N/C
7	N/C
8	N/C
9	N/C
10	N/C
11	N/C
12	IF-Q
13	N/C
14	N/C
15	N/C
16	N/C
17	N/C
18	N/C
19	N/C
20	N/C
21	N/C
22	LO
23	N/C
24	N/C
25	N/C
26	N/C
27	N/C
28	N/C
29	IF-I
30	N/C
31	N/C
32	N/C

1. Substrate material is ceramic.
2. I/O Leads and Ground Paddle plating is (from base to finish):

Ni:	1.27um MIN
Pd:	0.07um MIN
Au:	0.254um MAX

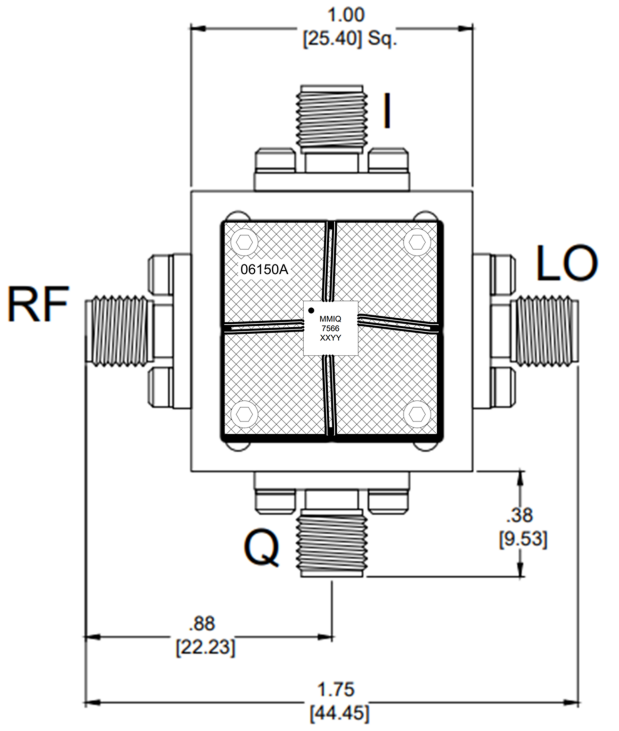
3. All unconnected pads should be connected to PCB RF ground.

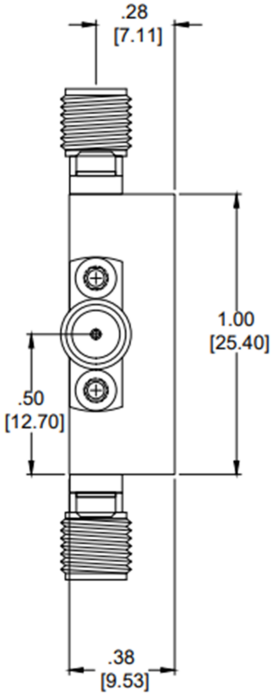
Footprint Image



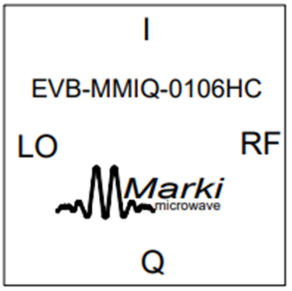
Port	Connector Type
LO	SMA Female
RF	SMA Female
I/Q	SMA Female
Note: Eval Connectors are not removeable.	

*Dimensions are typical





Backside Label



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