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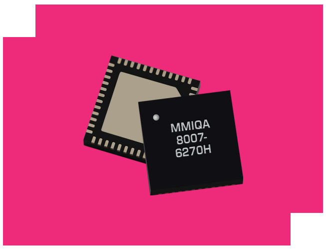
MMIQA-0626HPSM

Integrated Drive GaAs MMIC IQ Mixer

DEVICE OVERVIEW

General Description

The MMIQA-0626HPSM is a versatile, robust, and broadband IQ mixer with an integrated broadband LO driver amplifier. The MMIQA-0626HPSM is ideal for IQ, single sideband, and image reject mixing applications with wide bandwidths. The integrated LO driver amplifier allows for operation with LO powers as low as -2dBm while retaining exceptional conversion loss and linearity.



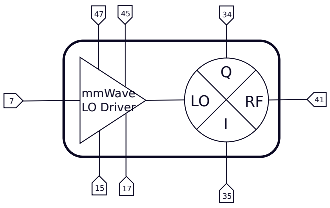
Features

RF/LO response: 6GHz - 26GHz
IF response: DC – 6GHz
I+Q Conversion Loss: 9 dB
Image Rejection: 30dBc
Minimum LO drive: -2dBm

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	Green Status	Product Lifecycle	Export Classification
MMIQA-0626HPSM	Integrated Drive GaAs MMIC IQ Mixer	QFN	REACH RoHS	Released	EAR99
EVB-MMIQA-0626H	Integrated Drive GaAs MMIC IQ Mixer	EVB	REACH RoHS	Released	EAR99

Table Of Contents

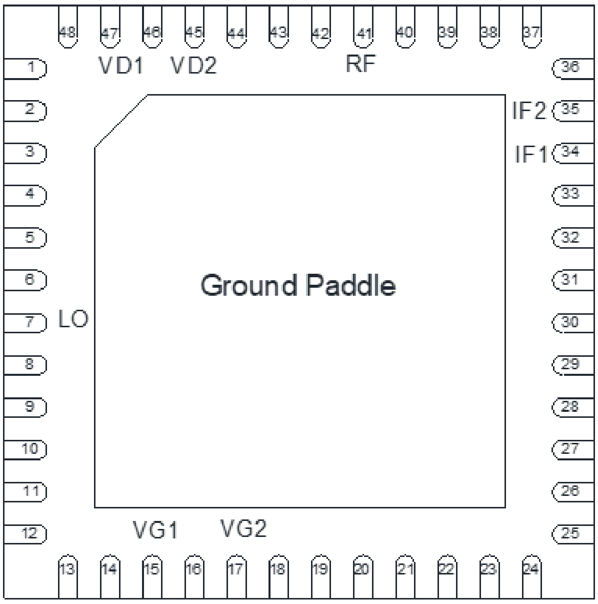
Revision History

Revision Code	Revision Date	Comment
-	2024-04-08	Datasheet Initial Release
A	2024-11-21	Updated 2D outline drawing per ECN#24129. Corrected number of decimal places in dimensions.
C	2025-04-03	Increased Power Handling Limits

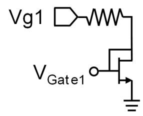
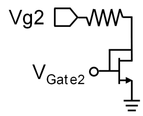
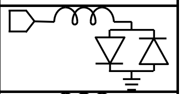
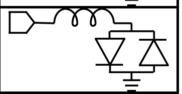
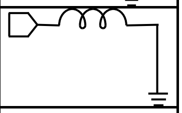
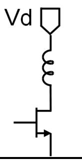
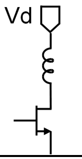
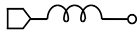
Port Configuration and Functions

Port Diagram

A top-down x-ray view of the MMIQA-0626HPSM's PSM package outline drawing is shown below. The MMIQA-0626HPSM has the input and output ports given in Port Functions.



Port Functions

Port	Function	Description	DC Equivalent Circuit
Pin 15	Vg1	Pin 15 provides bias for an internal current mirror that sets the current draw for amplifier input stage. Increasing current will increase gain at the expense of efficiency. The default series resistor (270 Ohms) is chosen to optimize gain, output power and efficiency when Vg1 and Vd1 are both tied to 5V.	
Pin 17	Vg2	Pin 17 provides bias for an internal current mirror that sets the current draw for amplifier output stage. Increasing current will increase gain at the expense of efficiency. The default series resistor (82.5 Ohms) is chosen to optimize gain, output power and efficiency when Vg2 and Vd2 are both tied to 5V.	
Pin 34	IF-1	Pin 34 is diode coupled and AC matched to 50Ω over the specified IF-1 port frequency range	
Pin 35	IF-2	Pin 35 is diode coupled and AC matched to 50Ω over the specified IF-2 port frequency range.	
Pin 41	RF	Pin 41 is DC short and AC matched to 50Ω over the specified RF frequency range.	
Pin 45	Vd2	Pin 45 is the DC supply pin for the amplifier's output stage.	
Pin 47	Vd1	Pin 47 is the DC supply pin for the amplifier's input stage	
Pin 7	LO Input	Pin 7 is DC open and AC matched to 50Ω over the specified LO frequency range.	

Specifications

Absolute Maximum Ratings

The Absolute Maximum Ratings indicate limits beyond which damage may occur to the device. If any one of these limits are exceeded, the device may become inoperable or have a reduced lifetime. Reliability limits are individual, instantaneous catastrophic limits only. Functional operation limits are indicated below. Operation of the device at multiple absolute maximum limits or for extended periods at a single limit can cause degradation and damage to the device.

Parameter	Maximum Rating	Unit
Bias Current (Ig)	95	mA
Bias Voltage (Vg)	6	V
Drain Current (Id)	400	mA
Drain Supply Voltage (Vd)	6	V
IF Input Power	25	dBm
LO Power Handling	15	dBm
Maximum Operating Temperature	85	°C
Maximum Storage Temperature	125	°C
Minimum Operating Temperature	-40	°C
Minimum Storage Temperature	-65	°C
Pin 29 DC Current (IF1)	30	mA
Pin 30 DC Current (IF2)	30	mA
RF Input Power	25	dBm

Package Information

Parameter	Details	Rating
Dimensions	-	7x7 mm
Moisture Sensitivity Level	-	MSL 1

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
LO Input Power	-2	0	8	dBm
Power Supply DC Current (Ig) (No RF Input)	11	19	23	mA
Power Supply DC Current (Id) (No RF Input)	121	218	259	mA
Positive DC Voltage	-	5	-	V

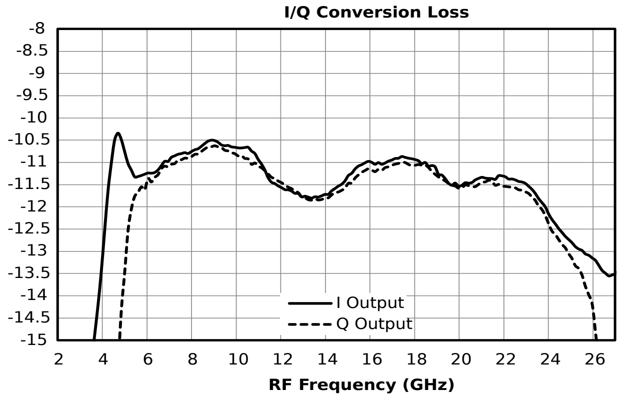
Electrical Specifications

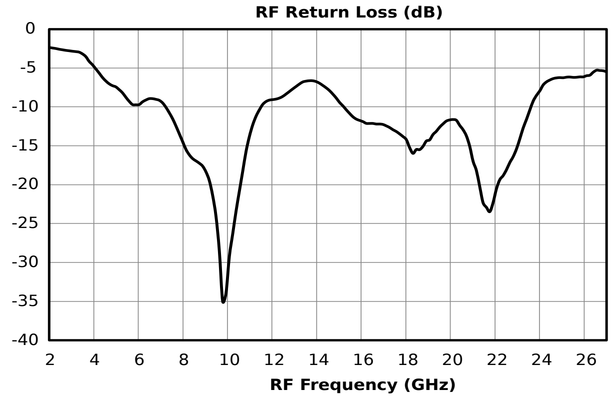
The electrical specifications apply at TA=+25°C in a 50Ω system. Typical data shown is for a down conversion application with a +0dBm LO input to the integrated LO driver amp biased at +5Vd1/+5Vd2/+5Vg1/+5Vg2 unless otherwise specified.

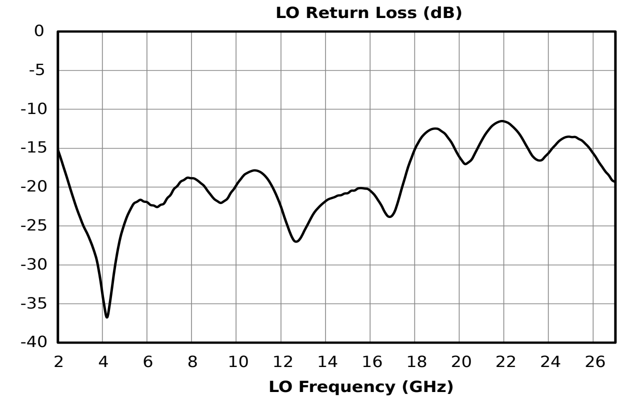
Parameter	Test Conditions	Minimum Frequency (GHz)	Maximum Frequency (GHz)	Min	Typ	Max	Unit
Amplitude Balance	RF/LO = 6 - 26 GHz I+Q = 0.091 GHz	-	-	-	0.5	-	dB
Conversion Loss	RF/LO = 6 - 26 GHz I = 0.01 - 6 GHz	-	-	-	12	-	dB
Conversion Loss	RF/LO = 6 - 26 GHz I+Q = 0.091 GHz	-	-	-	9	-	dB
Conversion Loss	RF/LO = 6 - 26 GHz Q= 0.01 - 6 GHz	-	-	-	12	-	dB
I Frequency Range	-	-	-	0	-	6	GHz
Image Rejection	RF/LO = 6 - 26 GHz I+Q = 0.091 GHz	-	-	-	30	-	dBc
Input IP3	RF/LO = 6 - 26 GHz I+Q = 0.091 GHz	-	-	-	26	-	dBm
Input P1dB, I	-	0	6	-	11	-	dBm
Input P1dB, Q	-	0	6	-	12	-	dBm
LO Frequency Range	-	-	-	6	-	26	GHz
LO Leakage, LO to IF	-	6	26	-	15	-	dBm
LO Leakage, LO to RF	-	6	26	-	28	-	dBm
Noise Figure	RF/LO = 6 - 26 GHz I = 0.091 GHz	-	-	-	12	-	dB
Noise Figure	RF/LO = 6 - 26 GHz Q = 0.091 GHz	-	-	-	12	-	dB
Phase Balance	RF/LO = 6 - 26 GHz I+Q = 0.091 GHz	-	-	-	5	-	°
Q Frequency Range	-	-	-	0	-	6	GHz
RF Frequency Range	-	-	-	6	-	26	GHz
RF-IF Isolation	-	6	26	-	35	-	dB

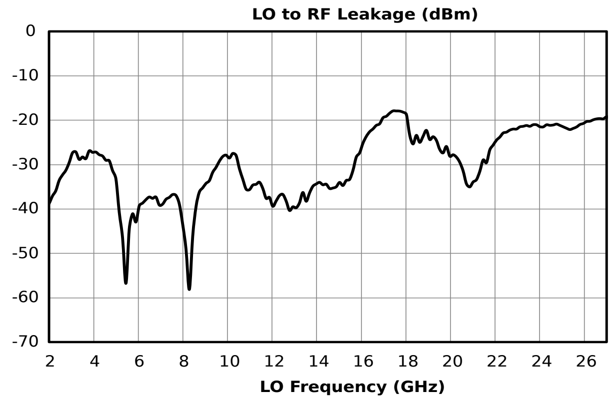
Eval board IF and RF traces were de-embedded and LO trace power correction was applied to show the true performance of the QFN. Measured as an I/Q down converter. (i.e., I and Q powers are not combined unless otherwise stated). Mixer Noise Figure typically measures within 0.5 dB of conversion loss for IF frequencies greater than 5 MHz. 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. Typical IIP3 is measured with I and Q ports combined with an external IF quadrature hybrid coupler.

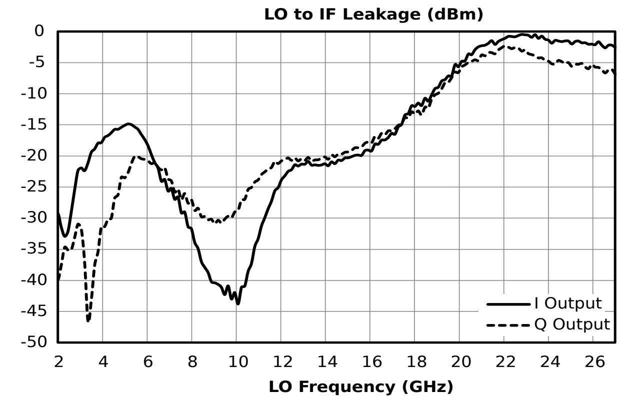
Typical Performance Plots

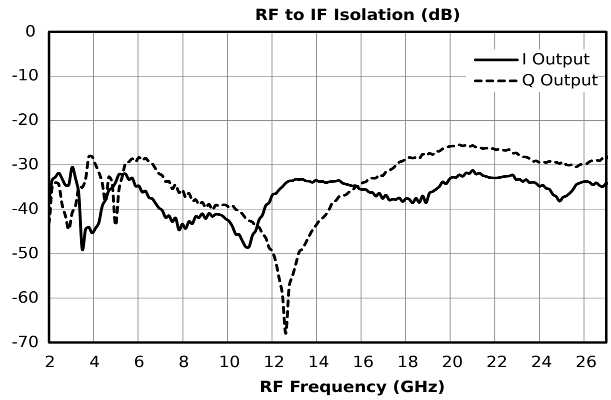


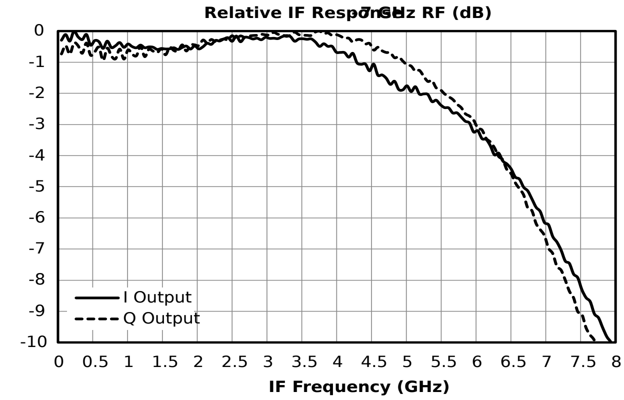


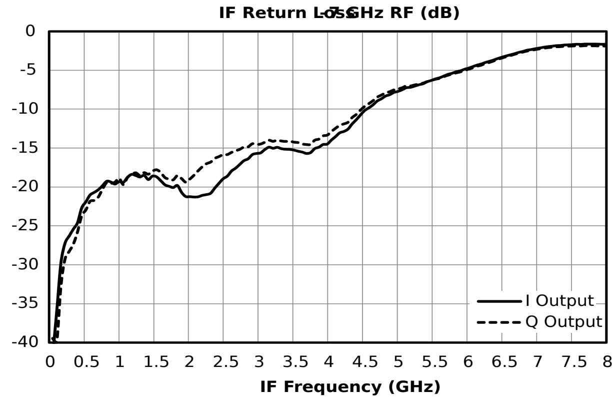


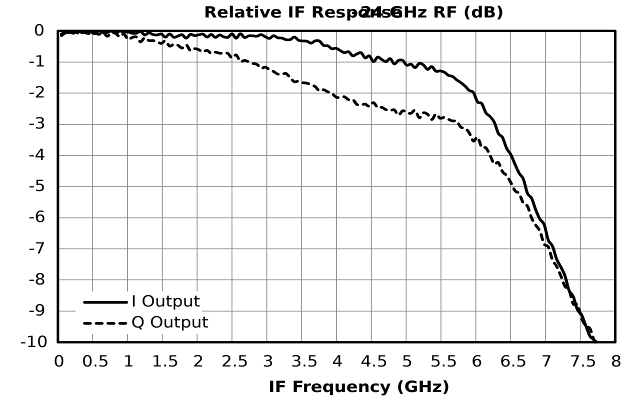


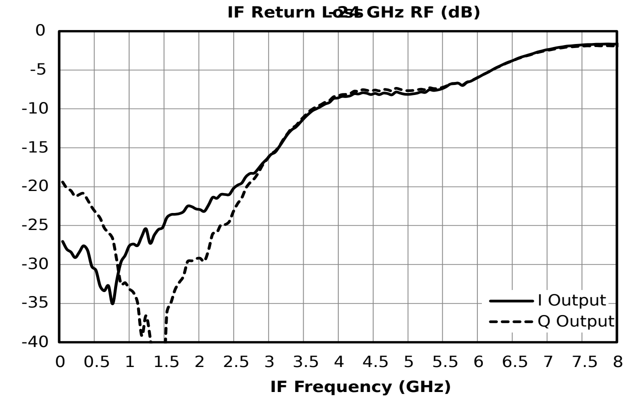


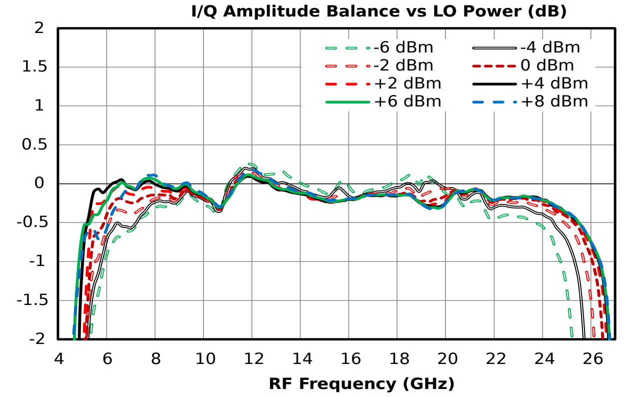


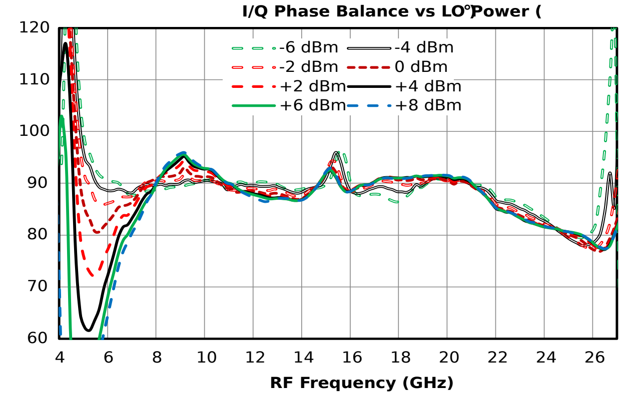


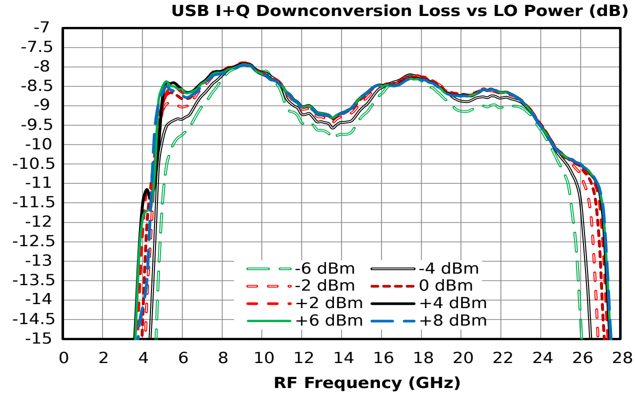


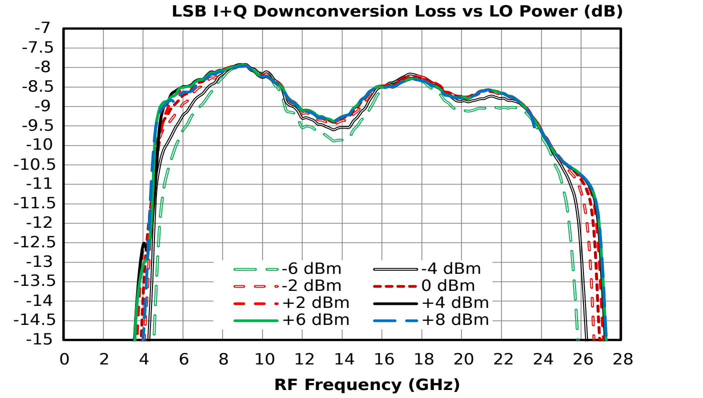

Relative IF Response 24 GHz RF (dB)
I Output
Q Output
IF Frequency (GHz)

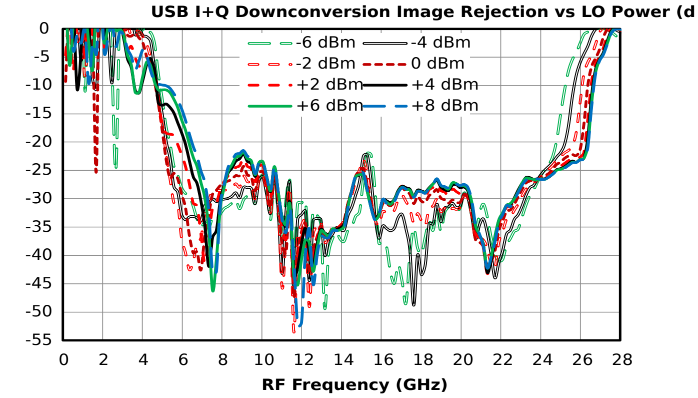

IF Return Loss 24 GHz RF (dB)
I Output
Q Output
IF Frequency (GHz)

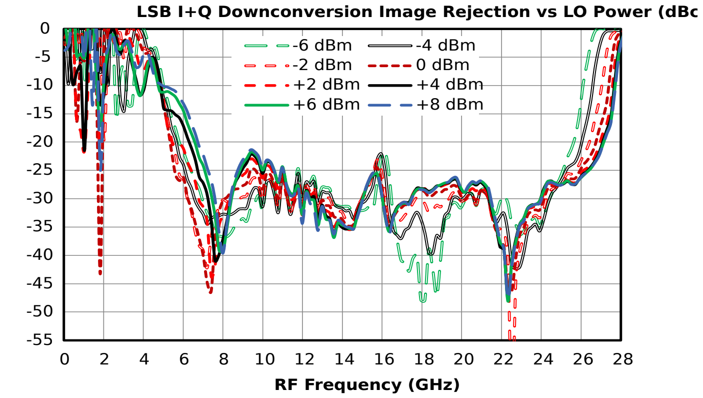

I/Q Amplitude Balance vs LO Power (dB)
-6 dBm
-4 dBm
-2 dBm
0 dBm
+2 dBm
+4 dBm
+6 dBm
+8 dBm
RF Frequency (GHz)

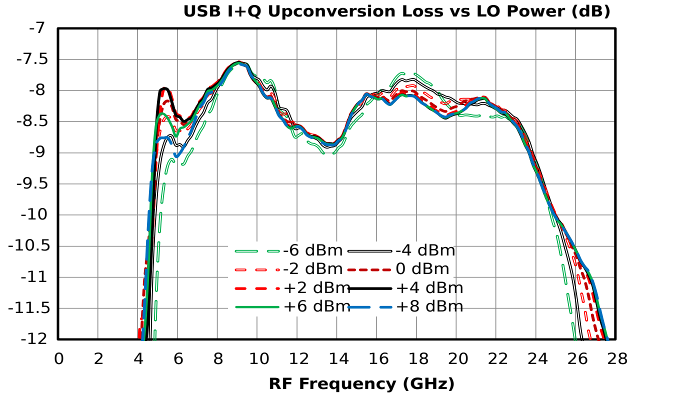

I/Q Phase Balance vs LO Power (°)
-6 dBm
-4 dBm
-2 dBm
0 dBm
+2 dBm
+4 dBm
+6 dBm
+8 dBm
RF Frequency (GHz)

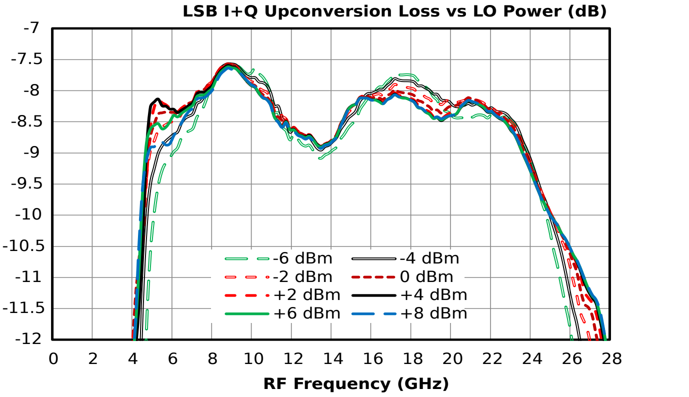

USB I+Q Downconversion Loss vs LO Power (dB)
-6 dBm
-4 dBm
-2 dBm
0 dBm
+2 dBm
+4 dBm
+6 dBm
+8 dBm
RF Frequency (GHz)

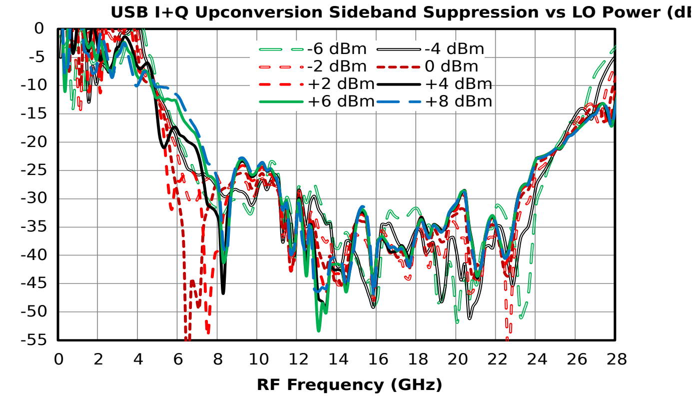

LSB I+Q Downconversion Loss vs LO Power (dB)
-6 dBm
-4 dBm
-2 dBm
0 dBm
+2 dBm
+4 dBm
+6 dBm
+8 dBm
RF Frequency (GHz)

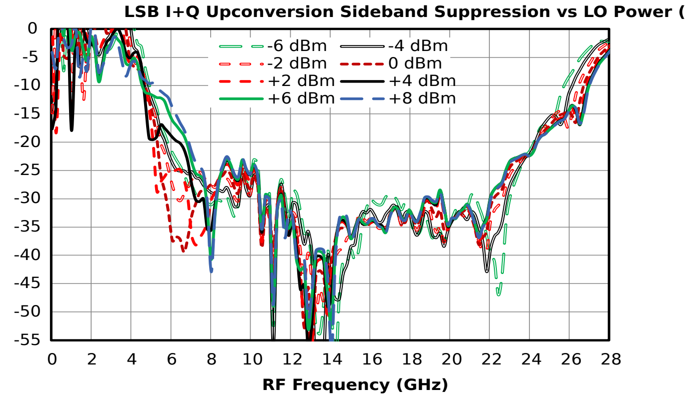

USB I+Q Downconversion Image Rejection vs LO Power (d
-6 dBm
-4 dBm
-2 dBm
0 dBm
+2 dBm
+4 dBm
+6 dBm
+8 dBm
RF Frequency (GHz)

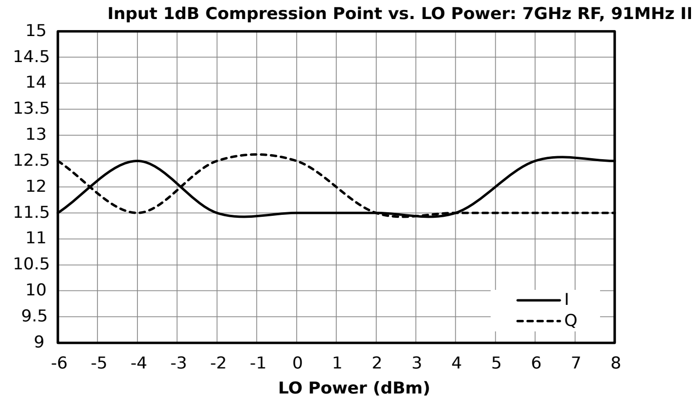

LSB I+Q Downconversion Image Rejection vs LO Power (dBc
-6 dBm
-4 dBm
-2 dBm
0 dBm
+2 dBm
+4 dBm
+6 dBm
+8 dBm
RF Frequency (GHz)

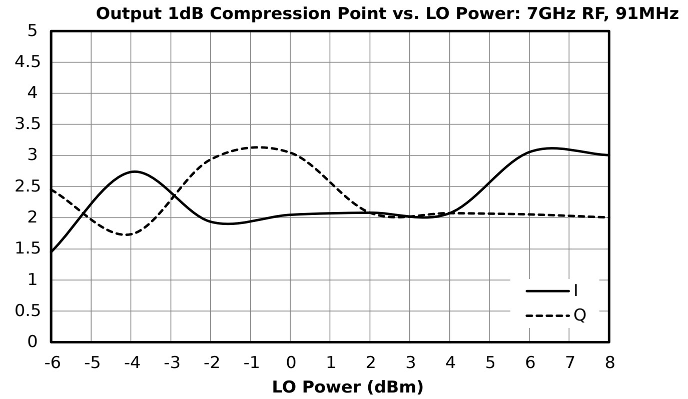

USB I+Q Upconversion Loss vs LO Power (dB)
-6 dBm
-4 dBm
-2 dBm
0 dBm
+2 dBm
+4 dBm
+6 dBm
+8 dBm
RF Frequency (GHz)


LSB I+Q Upconversion Loss vs LO Power (dB)
-6 dBm
-4 dBm
-2 dBm
0 dBm
+2 dBm
+4 dBm
+6 dBm
+8 dBm
RF Frequency (GHz)

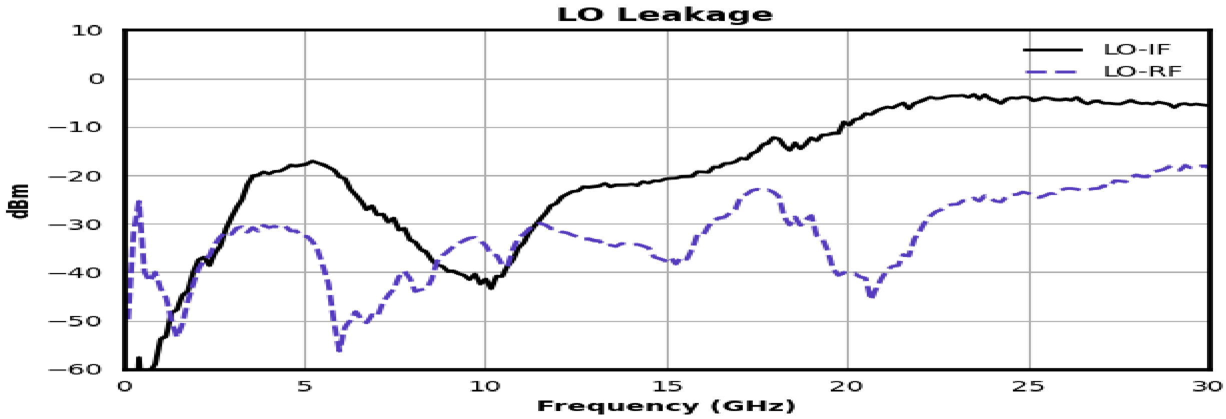

USB I+Q Upconversion Sideband Suppression vs LO Power (dI
-6 dBm
-4 dBm
-2 dBm
0 dBm
+2 dBm
+4 dBm
+6 dBm
+8 dBm
RF Frequency (GHz)


LSB I+Q Upconversion Sideband Suppression vs LO Power (
-6 dBm
-4 dBm
-2 dBm
0 dBm
+2 dBm
+4 dBm
+6 dBm
+8 dBm
RF Frequency (GHz)

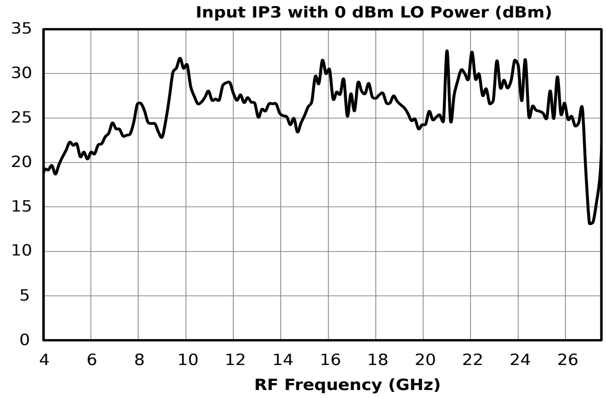

Input 1dB Compression Point vs. LO Power: 7GHz RF, 91MHz II
I
Q
LO Power (dBm)

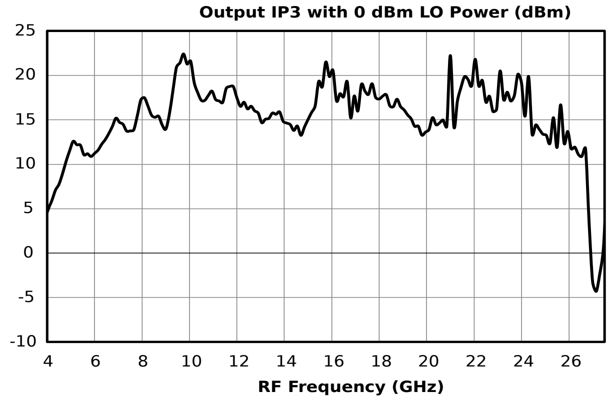

Output 1dB Compression Point vs. LO Power: 7GHz RF, 91MHz
I
Q
LO Power (dBm)

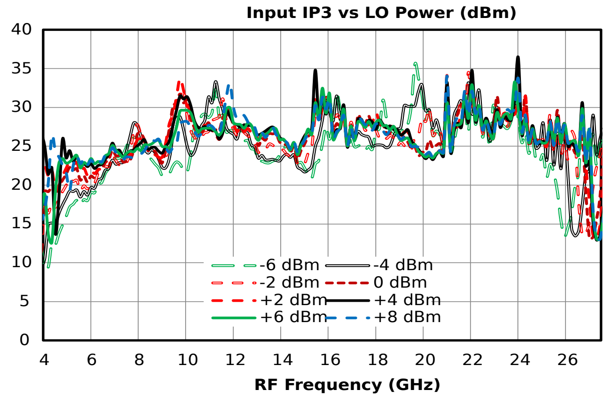
Generated Performance Plot

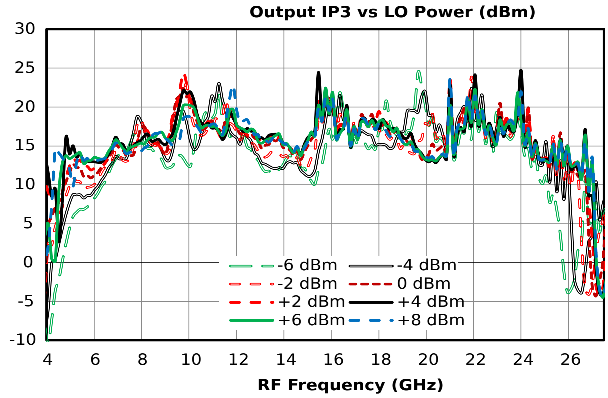


Typical Performance Plots: IP3

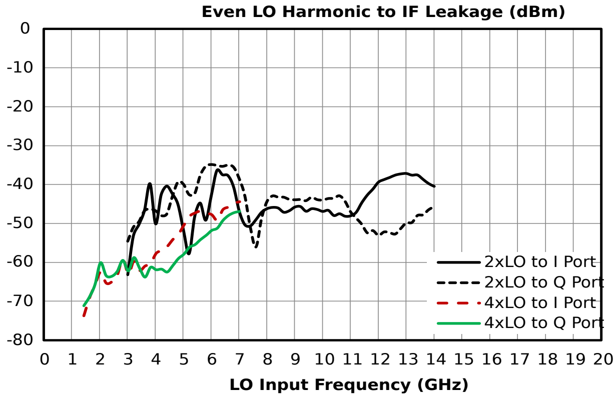


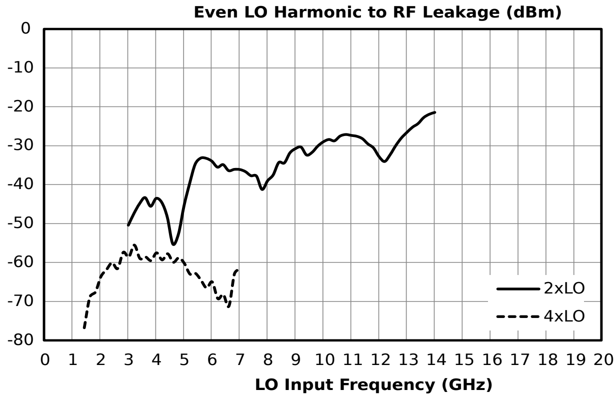


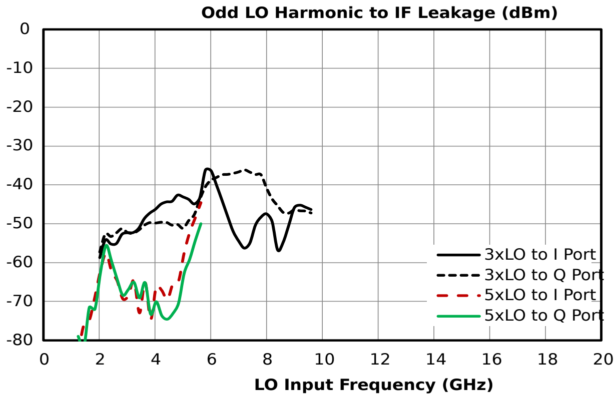


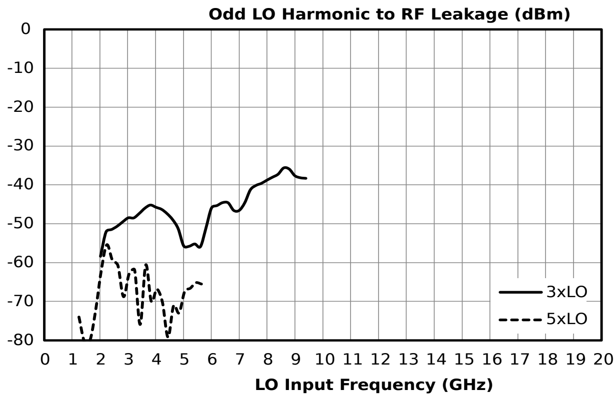


Typical Performance Plots: Harmonic Leakage









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 74 dBc for a -10 dBm input, so a -20 dBm RF input creates a spur that is (2-1) x (-10 dB) lower, or 84 dBc.

-10 dBm RF Input	0xLO I	0xLO Q	1xLO I	1xLO Q	2xLO I	2xLO Q	3xLO I	3xLO Q	4xLO I	4xLO Q	5xLO I	5xLO Q
1×RF	25	19	Reference	Reference	36	36	10	7	40	33	22	20
2xRF	79	75	66	62	74	70	74	69	75	71	72	72
3xRF	88	84	84	80	84	83	88	80	86	83	84	85
4xRF	99	94	95	97	97	94	97	97	96	93	96	93
5xRF	108	105	105	102	106	102	106	103	107	104	109	101

Typical Spurious Performance: Up-Conversion

Typical spurious data is provided by selecting IF and LO frequencies (±m*LO± n*IF) within the IF/LO bands, to create a spurious output within the RF 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 IF power levels by (n-1), where "n" is the IF spur order. For example, the 2IF x 1LO spur is 71 dBc for a -10 dBm input, so a -20 dBm RF input creates a spur that is (2-1) x (-10 dB) lower, or 81dBc.

-10 dBm IF Input	0xLO I	0xLO Q	1xLO I	1xLO Q	2xLO I	2xLO Q	3xLO I	3xLO Q	4xLO I	4xLO Q	5xLO I	5xLO Q
1×RF	29	27	Reference	Reference	34	37	9	9	41	34	19	24
2xRF	80	80	71	70	73	73	76	74	67	62	77	71
3xRF	88	87	86	83	90	89	83	77	91	85	77	61
4xRF	97	95	101	104	100	96	103	100	104	98	102	99
5xRF	108	108	113	112	110	112	113	110	110	110	110	101

Application Information

Application Information

MMIQA-0626HPSM belongs to Marki Microwave's MMIQ family of mixers with integrated LO drivers. 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 its on-chip LO quadrature hybrid. 30dBc of image rejection (i.e., single sideband suppression) can be obtained across the operating band by using the MMIQ-0626HPSM as an image rejection or single sideband mixer. The MMIQA-0626HPSM is the sister mixer of the MMIQ-0626HPSM. The MMIQA-0626HPSM requires a lower LO drive to operate the mixer thanks to the integrated LO driver amplifier.

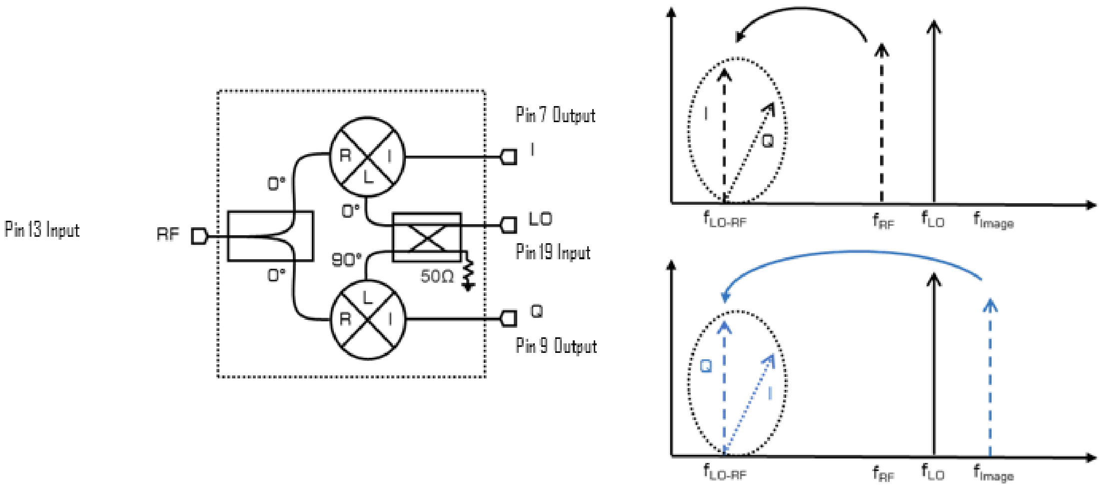
Band support for the low frequency 5G frequencies in K and Ku bands is offered by the ultra-broadband performance of the mixer's RF and LO ports. Direct baseband to Ka band frequency conversions are availableby using of this mixer as an up-converter. Traditional use of this mixer to do image reject or single sideband mixing is available with an external IF quadrature hybrid.

The RF port, and the LO port, supports a 6-26GHz signal. The I and Q ports, support a DC-6 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

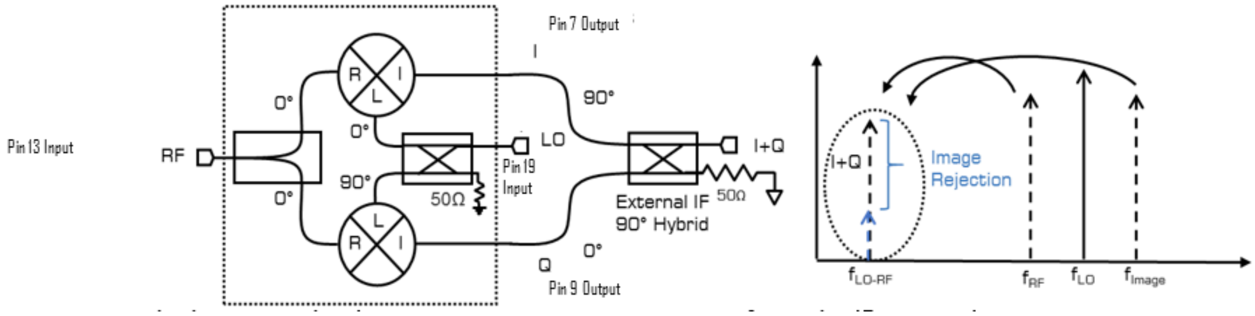


A down converter is a mixer application which takes a high frequency small signal RF input, and a high frequency large signal LO input and mixes the signals together to produce a low frequency IF output. The fundamental 1RFx1LO outputs present at the IF port are the f_{LO-RF} and f_{LO+RF} tones. The 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 input, a LO input, and pull the low frequency IF output. I and Q IF outputs will be at the same frequency but 90° out of phase (i.e., I and Q are in quadrature). If only a single IF output is desired, terminate either the I or Q ports with a wideband 50Ω load.

This is the input scheme was used to take I/Q down-conversion datafound in the Typical Performance Plots section.

Image Reject Down-Converter



An image reject mixer is a mixer which rejects the down converted image frequency from the IF output. Image reject mixers are constructed using an external quadrature hybrid attached to the I and Q (i.e., IF) output ports of an IQ mixer. Using the external IF quadrature hybrid, one can select whether the upper sideband or lower sideband signal is suppressed with respect to the LO signal.

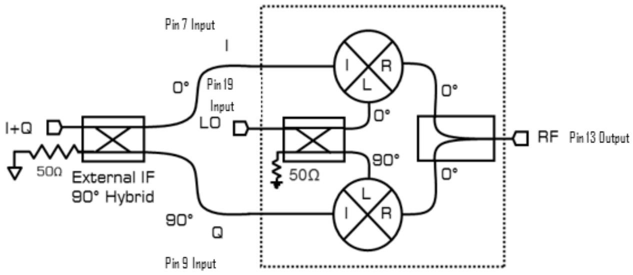
To use the IQ mixer as an image reject mixer, input the high frequency small signal RF and a LO input. Take the combined I+Q down converted signal through the IF quadrature hybrid. Select the upper sideband (i.e., suppress the lower sideband) by connecting the I port to the 0° port of the IF quadrature hybrid and attach the Q port to the 90° port of the IF quadrature hybrid. Select the lower sideband (i.e., suppress the upper sideband) by attaching the I port to the 90° port of the IF quadrature hybrid and attach the Q port to the 0° port of the IF quadrature hybrid.

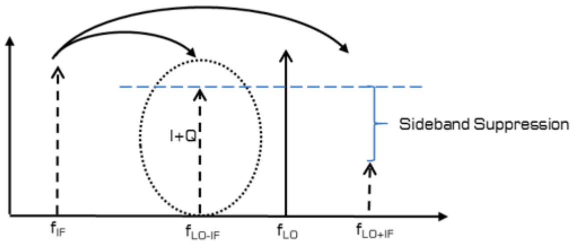
This is the input scheme was used to take I/Q down-conversion data found in the Typical Performance Plots section.

Up-Converter

This is the input scheme used to take I/Q up-conversion data found in the Typical Performance Plots section.

Single Sideband Up-Converter

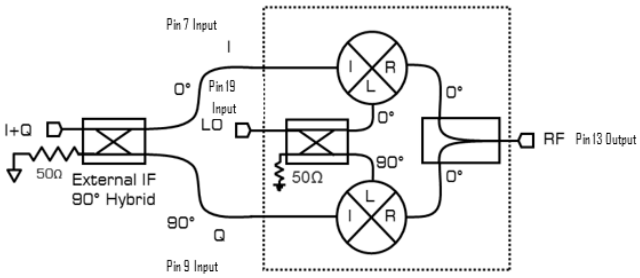


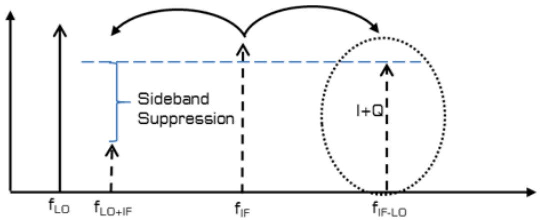


A single sideband mixer is a mixer which suppress the up converted image frequency from the RF output. Single sideband mixers are constructed using an external quadrature hybrid attached to the I and Q (i.e., IF) input ports. Using an external IF quadrature hybrid, one can select whether the upper sideband or the lower sideband signal is suppressed with respect to the LO signal.

To use the IQ mixer as a single sideband mixer, input the low frequency small signal I+Q IF signal into the IF quadrature hybrid. The IF quadrature hybrid is attached to the I and Q ports of the IQ mixer. Input the LO input and take the up converted high frequency RF signal. Select the upper sideband (i.e., suppress the lower sideband) by attaching the I port to the 90° port of the IF quadrature hybrid and attach the Q port to the 0° port of the IF quadrature hybrid. Select the lower sideband (i.e., suppress the upper sideband) by attaching the I port to the 0° port of the IF quadrature hybrid and attach the Q port to the 90° port of the IF quadrature hybrid.

Band Shifter





A band shifter is an unusual application for a mixer. Band shifters take an IF signal and shift it to a different band, generally to either avoid interference or for rebroadcast at a different frequency. For cases in which the desired band shift cannot be employed by using a standard up or down conversion scheme, an exotic input scheme is required.

A passive diode mixer is reciprocal on all ports. The RF port, supports a 6-26GHz signal. The LO port, supports a 6-26GHz signal. The IF ports, support a DC-6GHz signal. 2 signals input into any combination of the 3 ports, RF, LO, or IF, will result in an output signal at the 3rd port. In addition, an output signal will be present at both input ports. By using the IF port, as a large signal input port, low frequency LO applications can be supported.

The diagram above shows an IQ mixer being used as a band shifter. Using an IQ mixer as a band shifter allows for sideband suppression. This is identical to using the IQ mixer as a single sideband up converter. However, the large signal input port is now the IFs vs the LO. Selection of the output tone is done through the orientation of the LO quadrature hybrid.

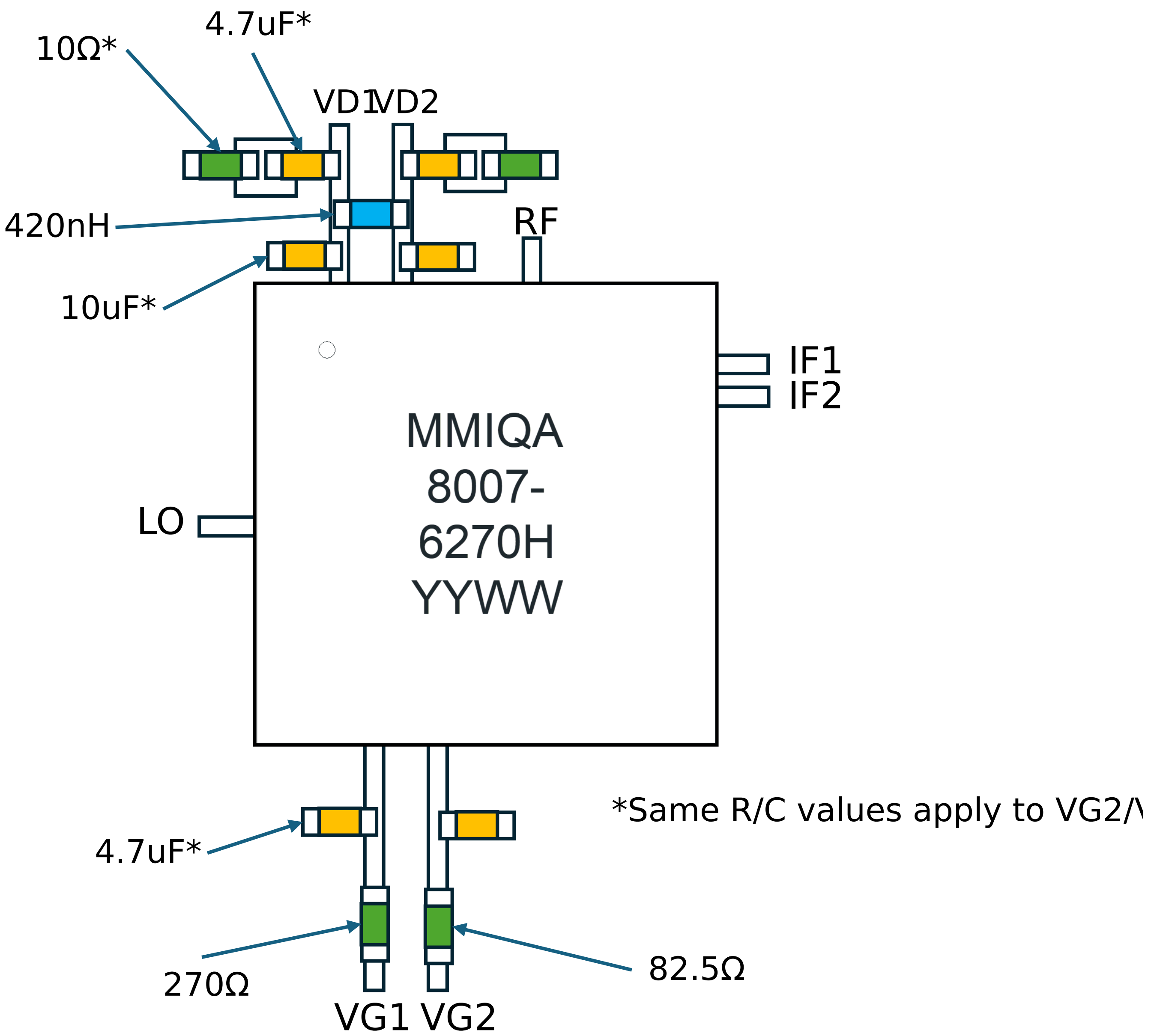
To use the mixer as a single sideband band shifter, input a low frequency LO into the external LO quadrature hybrid. Input the high frequency small signal IF signal and take the high frequency RF output. Select the upper sideband (i.e., suppress the lower sideband) by connecting the I port to the 90° port of the IF quadrature hybrid and connect the Q port to the 0° port of the LO quadrature hybrid. Select the lower sideband (i.e., suppress the upper sideband) by connecting the I port to the 0° port of the LO quadrature hybrid and connect the Q port to the 90° port of the LO quadrature hybrid.

This is the measurement scheme used to take vector modulator data found in the Typical Performance Plots: Vector Modulator section.

Using this input scheme requires careful accounting of which input signal is injecting which port. Injecting a signal into any port which does not support the correct band will lead to a degraded or no output response. Abide by the maximum DC current input into the I and Q ports of the mixer or otherwise irreversible damage to the mixer will occur.

The limitation in use of the mixer as an image reject band shifter is in the bandwidth of the external LO quadrature hybrid and bandwidth of the I and Q ports.

Application Circuit



Application Circuit Description

The application circuit for the MMIQA-0626HPSM requires 10uF bypass capacitors on the drain lines near the QFN. A 420nH inductor is needed between the VD lines to provide isolation as well as an RC network to ground comprised of a 4.7uF capacitor and 10Ω resistor. The VG lines require 4.7uF bypass capacitors and series resistors of 270Ω in line with the VG supply. The current evaluation circuit is configured for single supply operation, but can be operated as dual supply by removing the 420nH inductor.

Mechanical Data

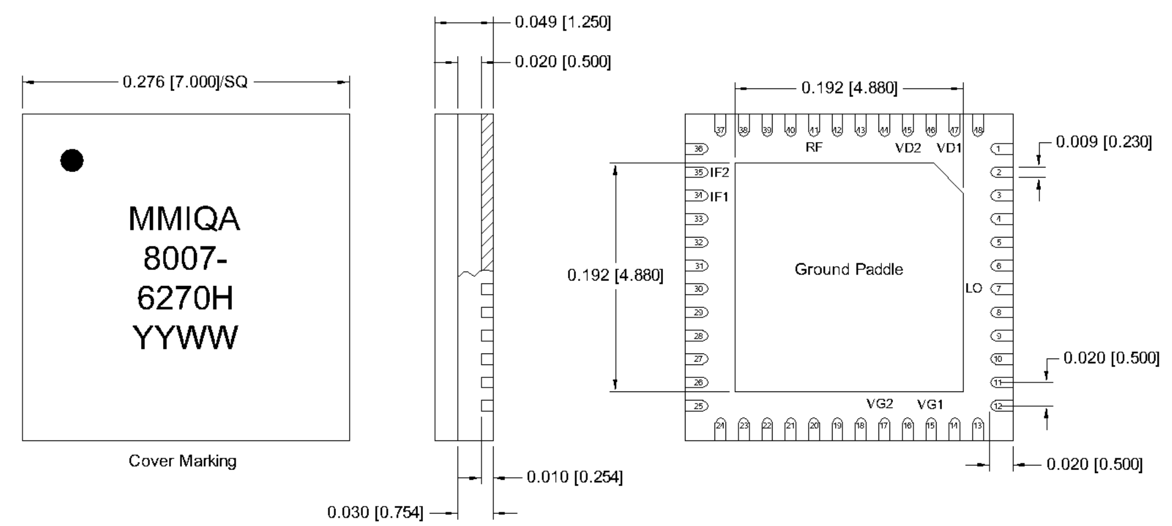
Outline Drawing

Download : Outline 2D Drawing

All dimensions are typical

PROJECTION: INCH [MM]

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVALS
B	ECN#24129	11/12/2024	OG



Pin #	Function
1	N/C
2	N/C
3	N/C
4	N/C
5	N/C
6	N/C
7	LO
8	N/C
9	N/C
10	N/C
11	N/C
12	N/C
13	N/C
14	N/C
15	VG1
16	N/C
17	VG2
18	N/C
19	N/C
20	N/C
21	N/C
22	N/C
23	N/C
24	N/C
25	N/C
26	N/C
27	N/C
28	N/C
29	N/C
30	N/C
31	N/C
32	N/C
33	N/C
34	IF1
35	IF2
36	N/C
37	N/C
38	N/C
39	N/C
40	N/C
41	RF
42	N/C
43	N/C
44	N/C
45	VD2
46	N/C
47	VD1
48	N/C

Notes (unless otherwise specified):

1. Substrate material is LCP.
2. I/O Leads and Die Paddle is (from base to finish):
   Ni: 0.5um - 2.0um
   Pd: 0.08um - 0.15um
   Au: 0.003um - 0.050um
3. All unconnected pins should be connected to PCB RF ground.

MATERIAL: Noted
FINISH:
DO NOT SCALE DRAWING
NOTES:
DRAWN BY: OG — DATE: 12/5/2023

Marki microwave — www.markimicrowave.com

Outline, Amp-Mixer Copackaged 7 mm Plastic QFN

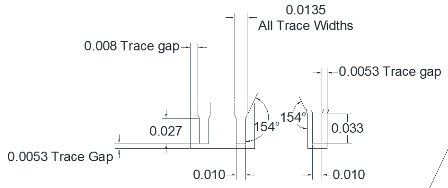
SIZE: A — CAGE CODE: 0UC32 — DWG. NO.: 351-8007-6270

SCALE 2/1 — SHEET 1 OF 2

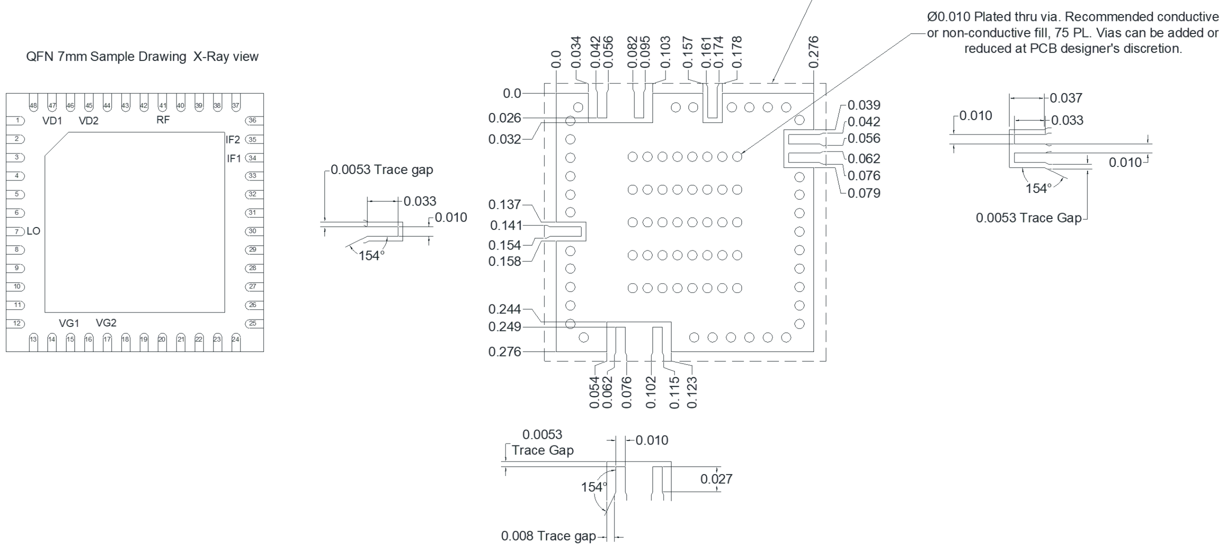
Footprint Image

Download : Footprint Drawing

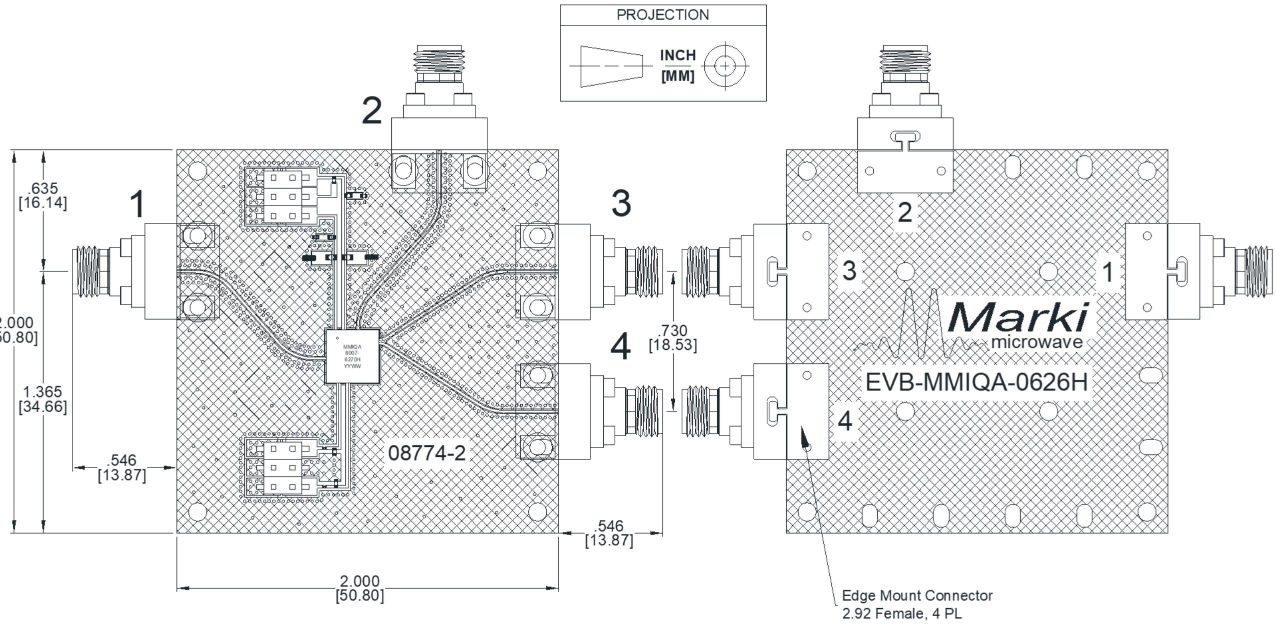
*Units are in Inches



The Landing Pattern is to be used on Rogers 4003, 0.008" thick ½ Oz Cu.



Evaluation Board - Outline Drawing



Port #	Function	VDC	Connector Type
1	LO	Open Line	2.92mm Female
2	RF	Short Circuit	2.92mm Female
3	I	0.664±20mV	2.92mm Female
4	Q	0.664±20mV	2.92mm Female

Note: Eval Connectors are not removeable.

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