Sales: 408-778-9952 | General: 408-778-4200 | Fax: 408-778-4300
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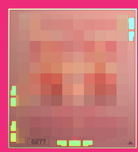
MMIQ-0626HCH-2

Passive GaAs MMIC IQ Mixer

DEVICE OVERVIEW

General Description

MMIQ-0626H is a high linearity, passive GaAs MMIC IQ mixer. This is an ultra-broadband mixer spanning 6 to 26 GHz on the RF and LO ports with an IF from DC to 6 GHz. Up to 40 dB of image rejection is available due to the excellent phase and amplitude balance of its on-chip LO quadrature hybrid. Both wire bondable die and connectorized modules are available.



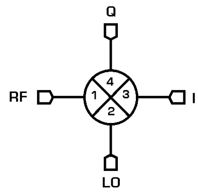
Features

N/A

Applications

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

Functional Block Diagram



Part Ordering Options

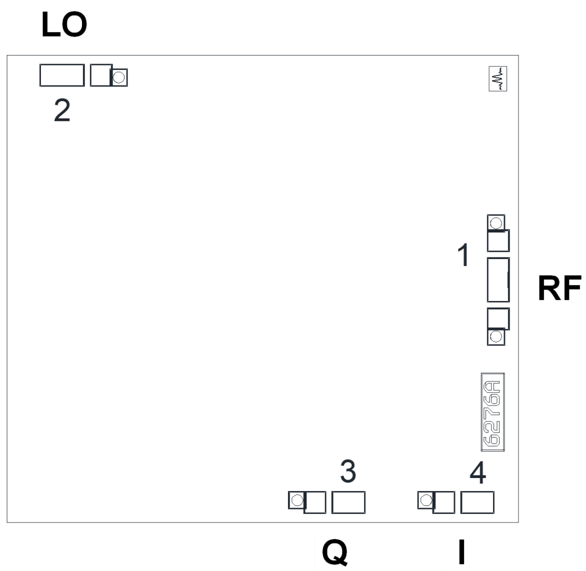
Part Number	Description	Package	Connectors	Green Status	Product Lifecycle	Export Classification
MMIQ-0626HS	Passive GaAs MMIC IQ Mixer	S	Standard	REACH RoHS	Released	EAR99
MMIQ-0626HCH-2	Passive GaAs MMIC IQ Mixer	CH	-	REACH RoHS	Released	EAR99

Table Of Contents

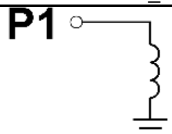
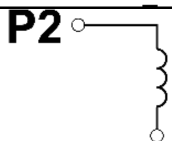
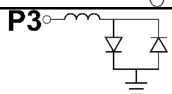
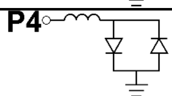
Port Configuration and Functions

Port Diagram

A top-down view of the MMIQ-0626H's CH-2 package outline drawing is shown below. The mixer may be operated as either a downconverter or an upconverter. Use of the RF or IF as the input or output port will depend on the application. See Application Information for input and output port configuration for common applications.



Port Functions

Port	Function	Description	Equivalent Circuit for Package
GND	Ground	CH package ground path is taken through the substrate.	
Port 1	RF Input / Output	Port 1 is DC short and AC matched to 50Ω over the specified RF frequency range.	
Port 2	LO Input	Port 2 is DC open and AC matched to 50Ω over the specified LO frequency range.	
Port 3	Q Input / Output	Port 3 is diode coupled and AC matched to 50Ω over the specified I port frequency range.	
Port 4	I Input / Output	Port 4 is diode coupled and AC matched to 50Ω over the specified Q port 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	mA
Minimum Operating Temperature	-55	°C
Minimum Storage Temperature	-65	mA
Port 3 DC Current	30	mA
Port 4 DC Current	30	mA
Power Handling, at any Port	27	dBm

Package Information

Parameter	Details	Rating
ESD	250 to < 500 Volts	HBM Class 1A
Dimensions	-	2.28x2.09mm

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
Ambient Temperature	-55	25	100	°C
RF/IF Input Power	-	-	11	dBm
LO Input Power	13	19	23	dBm

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 +19dBm sine wave LO input. Min and Max limits apply only to our connectorized units and are guaranteed at TA=+25°C. All bare die are 100% DC tested and visually inspected.

Parameter	Test Conditions	Minimum Frequency (GHz)	Maximum Frequency (GHz)	Min	Typ	Max	Unit
RF Frequency Range	-	-	-	6	-	26	GHz
LO Frequency Range	-	-	-	6	-	26	GHz
Conversion Loss [1]	RF/LO = 6 - 24 GHz I = DC – 0.2 GHz	6	24	-	12	15	dB
Conversion Loss [2]	RF/LO = 6 - 24 GHz Q = DC -0.2 GHz	6	24	-	12	15	dB
Conversion Loss [3]	RF/LO = 6 - 26 GHz I = 0.2 - 6 GHz	6	26	-	14	-	dB
Conversion Loss [4]	RF/LO = 6 - 26 GHz Q = 0.2 - 6 GHz	6	26	-	14	-	dB
Conversion Loss [5]	RF/LO = 24 - 26 GHz I = DC – 0.2 GHz	24	26	-	14	17	dB
Conversion Loss [6]	RF/LO = 24 - 26 GHz Q = DC - 0.2 GHz	24	26	-	13	16	dB
Noise Figure [7]	RF/LO = 6 - 24 GHz I = DC – 0.2 GHz	6	24	-	12	-	dB
Noise Figure [8]	RF/LO = 6 - 24 GHz Q = DC – 0.2 GHz	6	24	-	12	-	dB
Image Rejection [9]	RF/LO = 6 - 26 GHz I+Q = DC – 0.2 GHz	-	-	-	35	-	dBc
Input IP3 [10]	RF/LO = 6 - 26 GHz I = DC – 0.2 GHz	6	26	-	24	-	dBm
Amplitude Balance	-	-	-	-	0.5	-	dB
Phase Balance	-	-	-	-	2	-	dB
IF Frequency Range	-	-	-	0	-	6	GHz
Input 1 dB Gain Compression Point, I	-	-	-	-	11	-	dBm
Input 1 dB Gain Compression Point, Q	-	-	-	-	11	-	dBm
Q (Port 3) Frequency Range	-	-	-	0	-	6	GHz
Isolation, LO to IF	IF/LO = 6 - 26 GHz	6	26	-	50	-	dB
Isolation, LO to RF	RF/LO = 6 - 26 GHz	6	26	-	41	-	dB
Isolation, RF to IF	RF/IF = 6 - 26 GHz	6	26	-	36	-	dB

[1][2][3][4][5][6] Measured as an I/Q down converter. (i.e., I and Q powers are not combined)
[7][8] Mixer Noise Figure typically measures within 0.5 dB of conversion loss for IF frequencies greater than 5 MHz.
[9] 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.
[10] Typical IIP3 measured with I and Q ports combined with an external quadrature hybrid coupler.

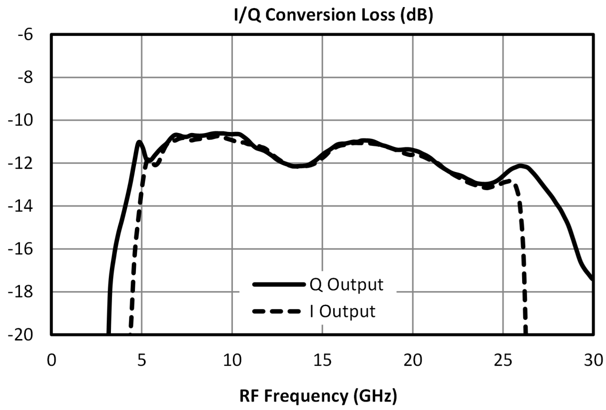
Typical Performance Plots

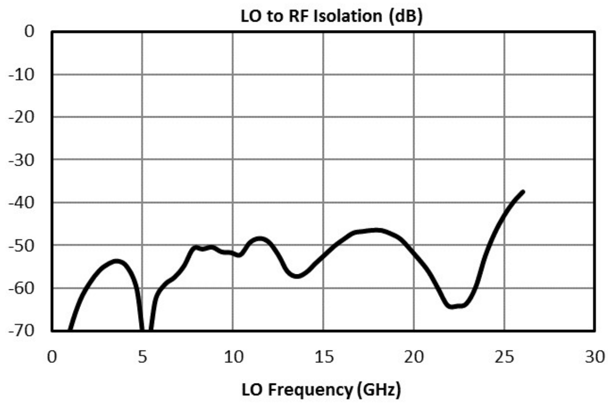
The test conditions and frequency plan below applies to all following sections, unless otherwise specified.

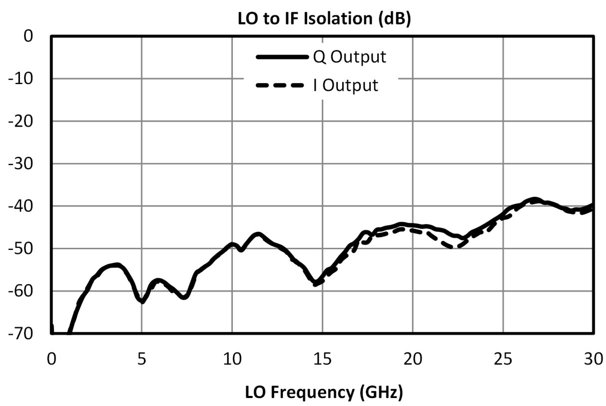
Parameter		Port	Start	Nominal	Stop	Units
RF Input Frequency		1	0		30	GHz
RF Input Power				-10		dBm
LO Input Frequency		2	0.091		30.091	GHz
LO Input Power				+19		dBm
IF Output Frequency	Q	3		91		MHz
	I	4		91		
	I+Q[7]	3+4		91		
T_A, Ambient Temperature				+25		°C
Z_0, System Impedance				50		Ω

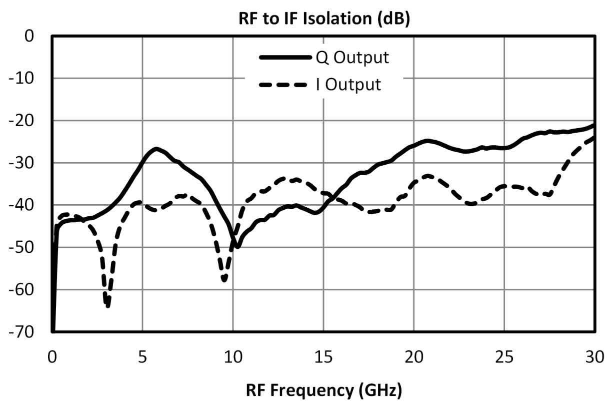
I output means that the IF output signal is measured at the I port of the mixer and the Q port is loaded. Q output means the IF output signal is measured at the Q port of the mixer while the I port is loaded.

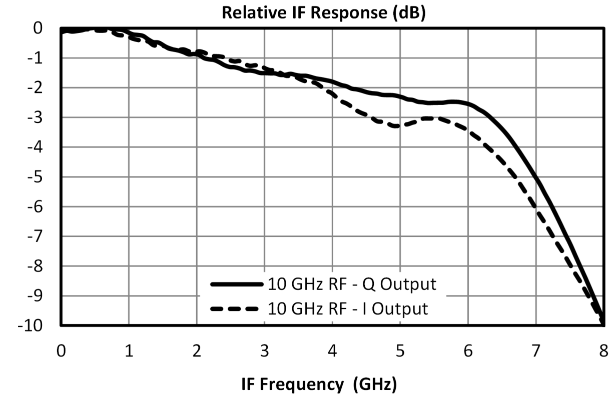
[7] I+Q measurements taken with an external quadrature hybrid attached to the I and Q ports of the mixer. Orientation depends on up conversion or down conversion measurement.

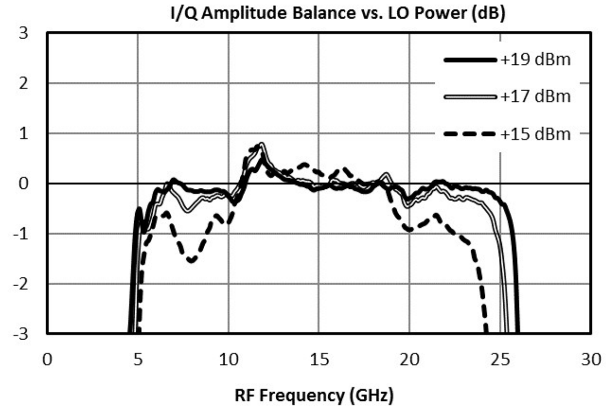


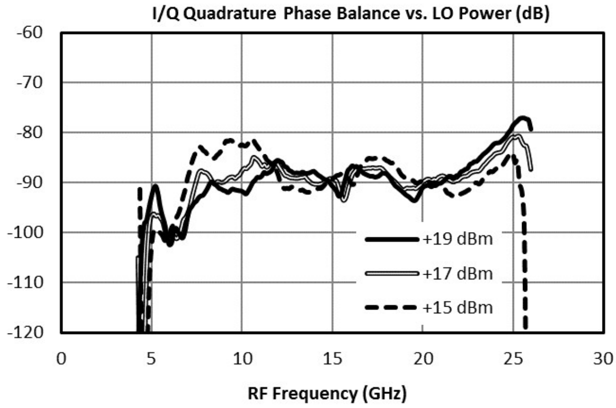


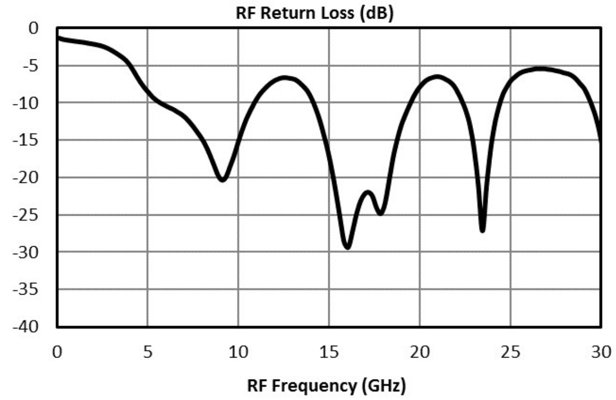


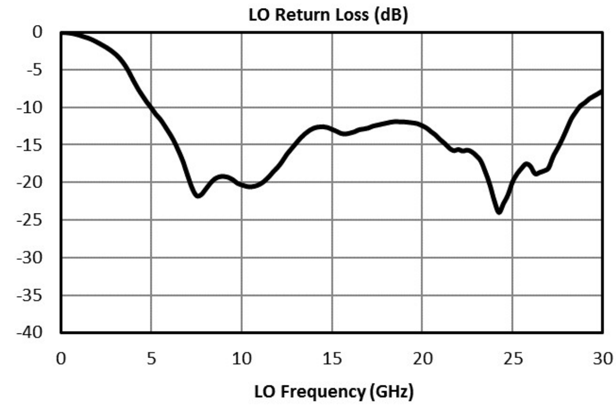


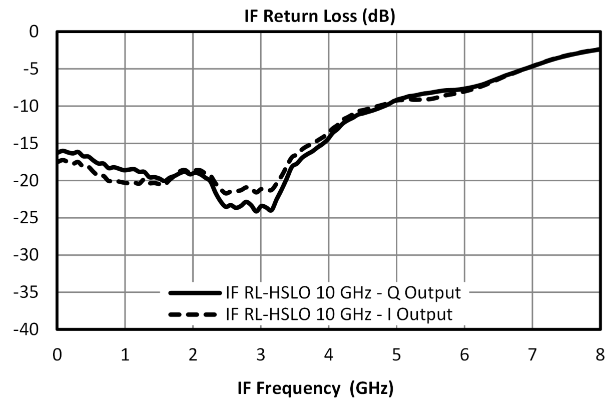

Relative IF Response (dB)
10 GHz RF - Q Output
10 GHz RF - I Output
IF Frequency (GHz)

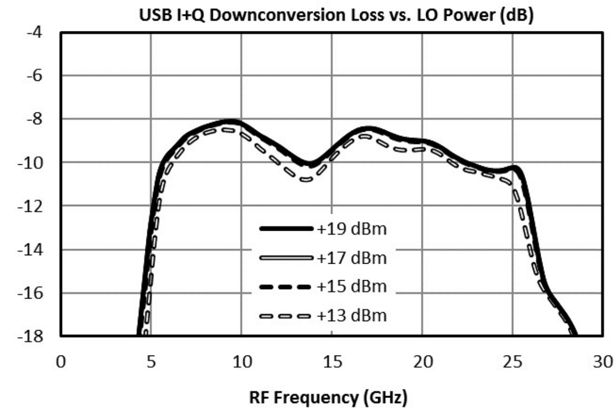

I/Q Amplitude Balance vs. LO Power (dB)
+19 dBm
+17 dBm
+15 dBm
RF Frequency (GHz)

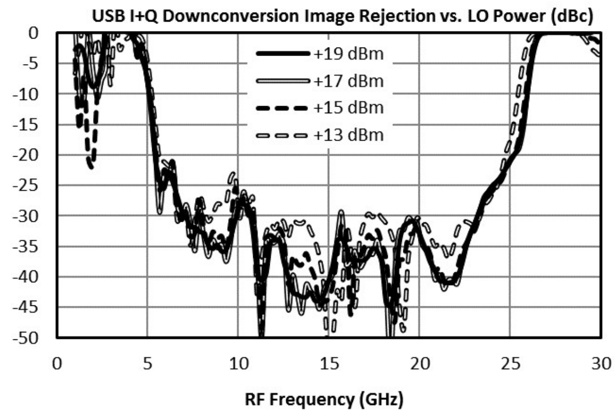

I/Q Quadrature Phase Balance vs. LO Power (dB)
+19 dBm
+17 dBm
+15 dBm
RF Frequency (GHz)

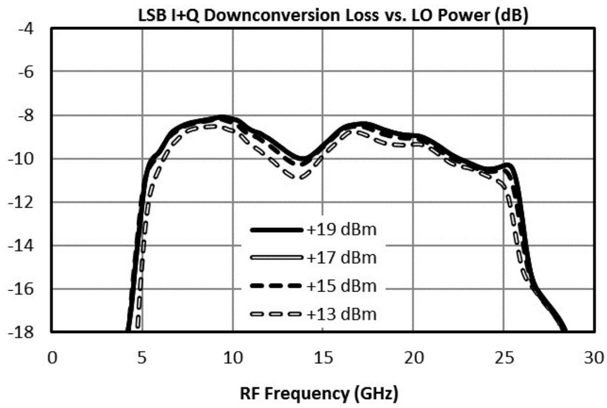

RF Return Loss (dB)
RF Frequency (GHz)

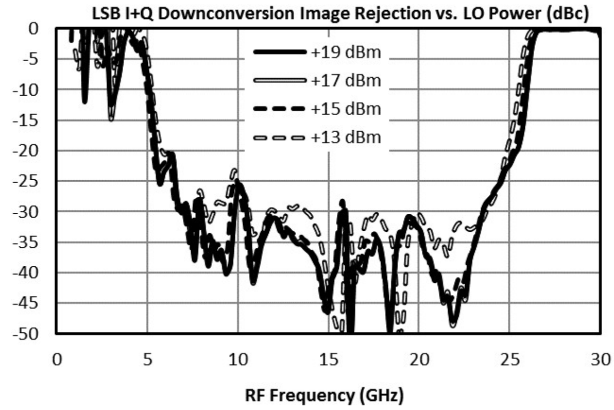

LO Return Loss (dB)
LO Frequency (GHz)

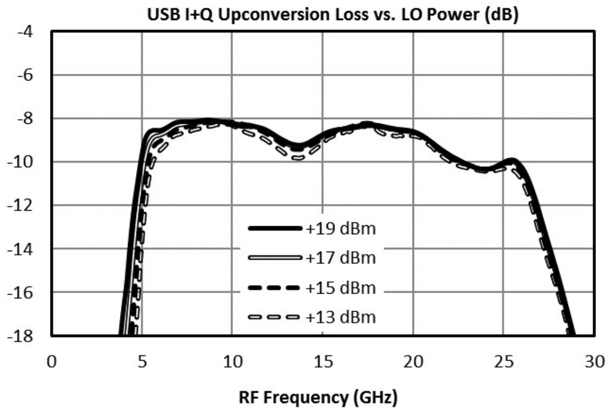

IF Return Loss (dB)
IF RL-HSLO 10 GHz - Q Output
IF RL-HSLO 10 GHz - I Output
IF Frequency (GHz)

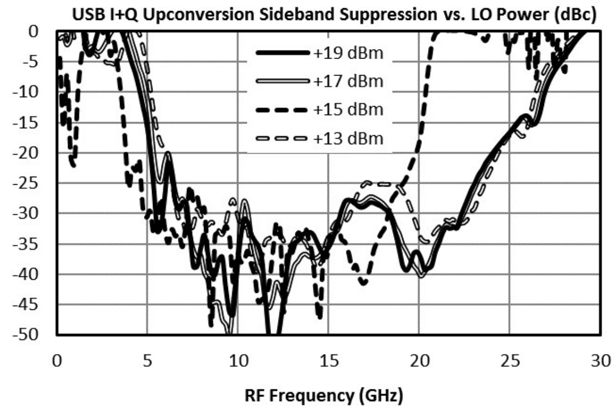

USB I+Q Downconversion Loss vs. LO Power (dB)
+19 dBm
+17 dBm
+15 dBm
+13 dBm
RF Frequency (GHz)

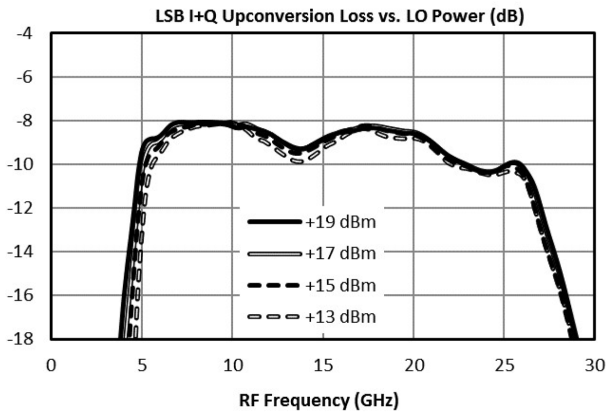

USB I+Q Downconversion Image Rejection vs. LO Power (dBc)
+19 dBm
+17 dBm
+15 dBm
+13 dBm
RF Frequency (GHz)

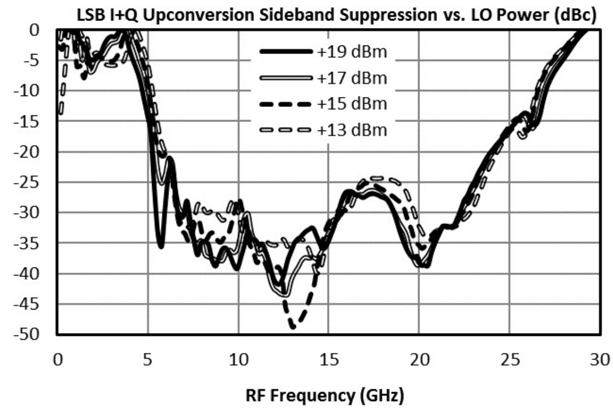




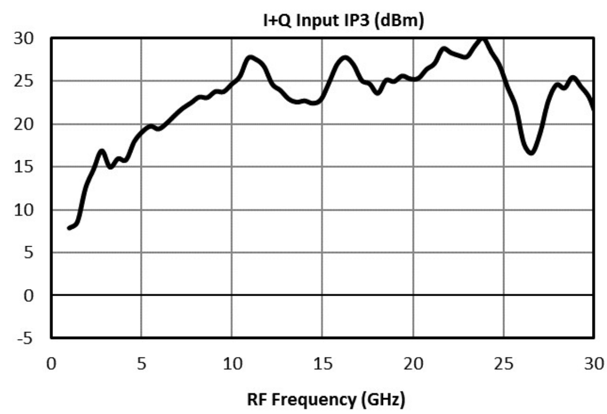


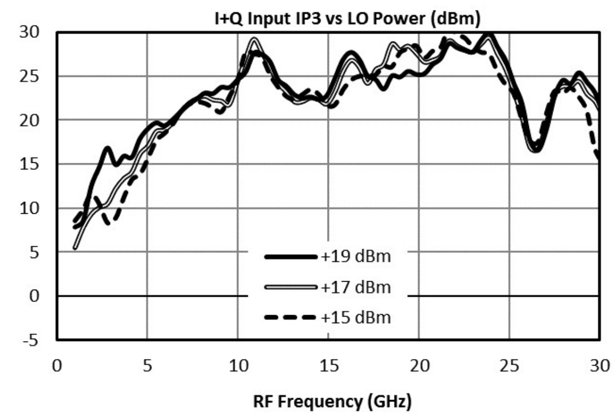


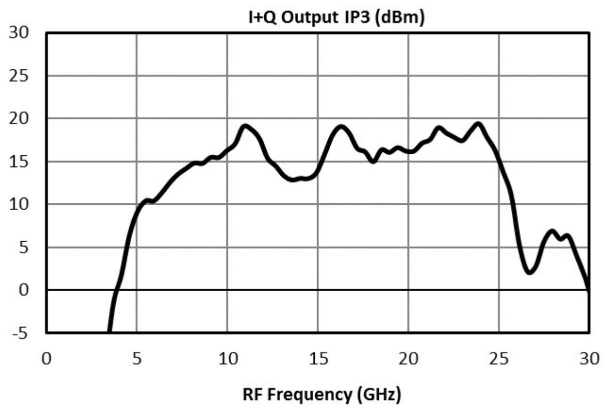


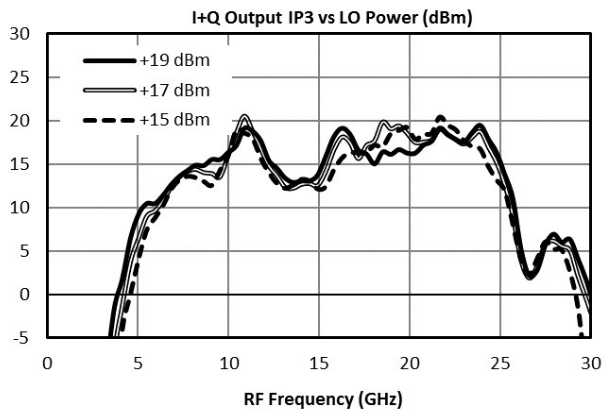


Typical Performance Plots: IP3





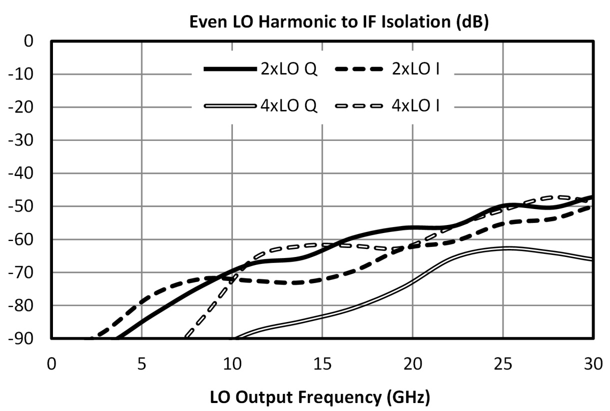


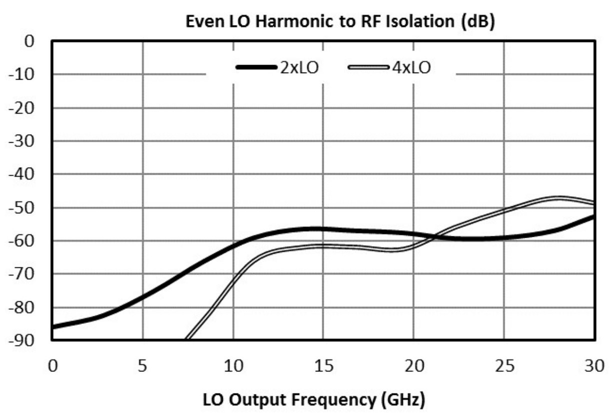


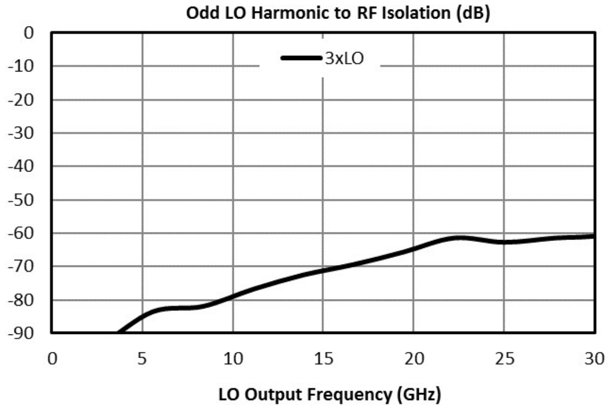
Typical Performance Plots: LO Harmonic Isolation

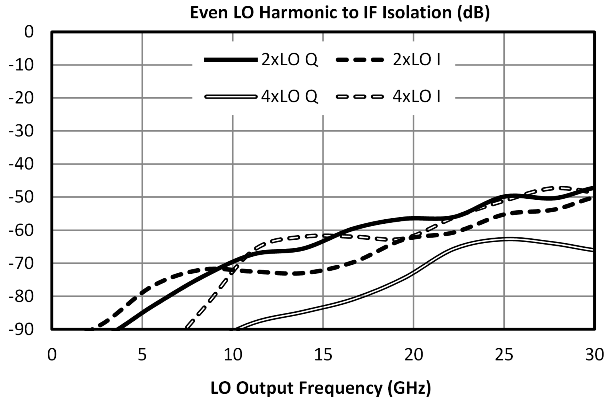
LO Harmonic Isolation plots are taken with the following test conditions and based on the following fundamental input signal frequency plan:

Parameter		Port	Start	Nominal	Stop	Units
RF Input Frequency		1	0		30	GHz
RF Input Power				-10		dBm
LO Input Frequency		2	0.091		30.091	GHz
LO Input Power				+19		dBm
IF Output Frequency	I	3		91		MHz
	Q	4		91		
T_A, Ambient Temperature				+25		°C
Z_0, System Impedance				50		Ω









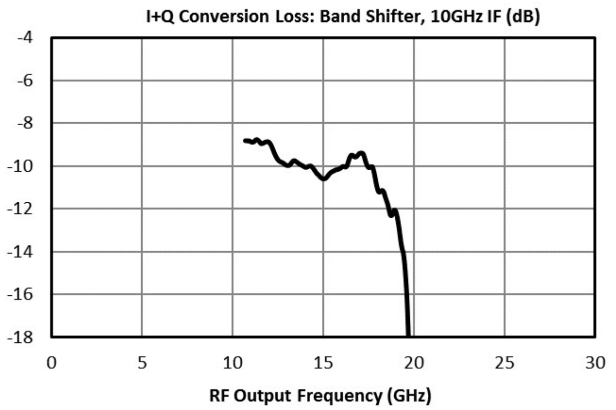
Typical Performance Plots: Band Shifter

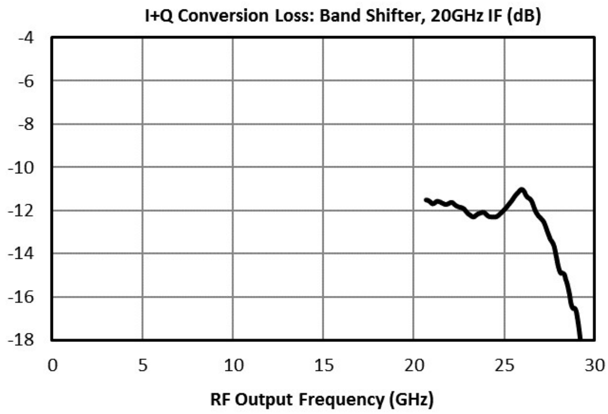
Band Shifter performance plots are taken with the following test conditions and frequency plan:

Parameter	Port	Start	Nominal	Stop	Units
IF Input Frequency	2		See Plot		GHz
IF Input Power	2		-10		dBm
LO Input Frequency[9]	3+4	0.7		15	GHz
LO Input Power	3+4		+19		dBm
RF Output Frequency	1	IF+0.7		IF+15	GHz
T_A, Ambient Temperature			+25		°C
Z_0, System Impedance			50		Ω

Band shifter utilizes the mixer in a unique configuration with a low frequency LO signal. Refer to the Application Information section for more details.

[9] Low frequency LO quadrature hybrid used to take data is the QH-0R714.





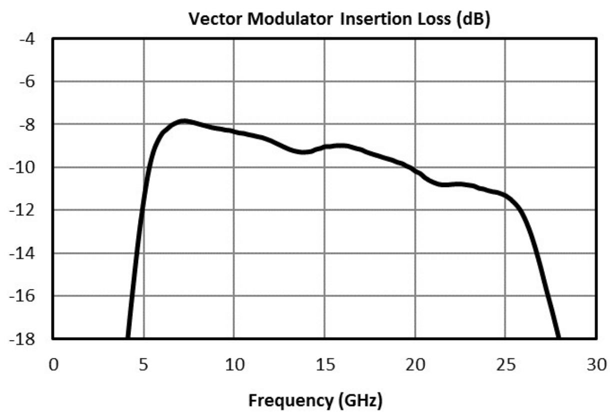
Typical Performance Plots: Vector Modulator

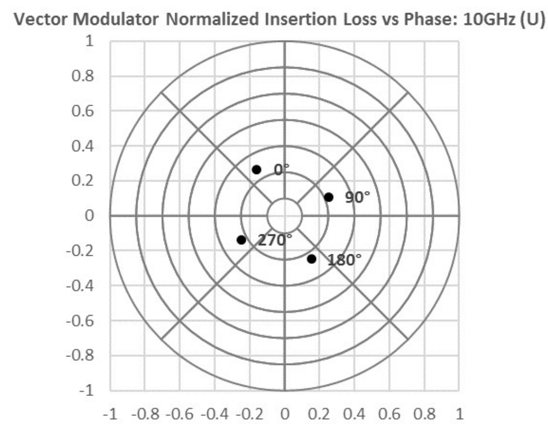
Vector Modulator performance plots are taken with the following test conditions and frequency plan:

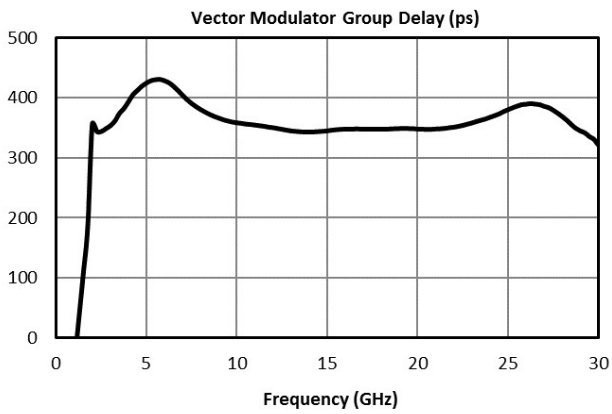
Parameter		Port	Start	Nominal	Stop	Units
Input Frequency		2	0		30	GHz
Input Power				-10		dBm
I/Q Input Current	I	3		+19		mA
	Q	4		+19		
Output Frequency		1	0		30	GHz
T_A, Ambient Temperature				+25		°C
Z_0, System Impedance				50		Ω

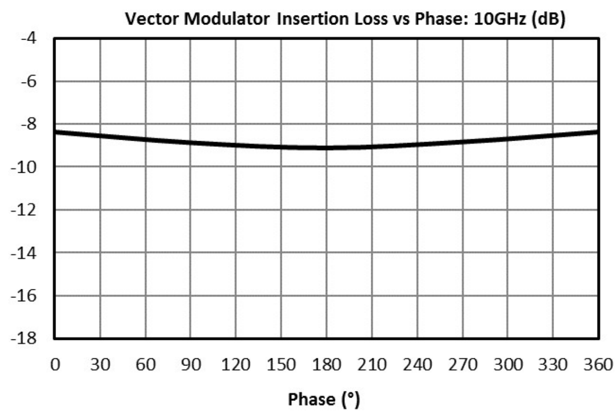
Nominal I/Q bias current given in the table to the right to tune a 10 GHz input signal's phase to 0°, 90°, 180°, or 270° at the port 1 RF output.

Phase Shift (°)	I Port 4 Input Current (mA)	Q Port 3 Input Current (mA)
0	+19	+19
90	-19	+3
180	-19	-19
270	+19	-3









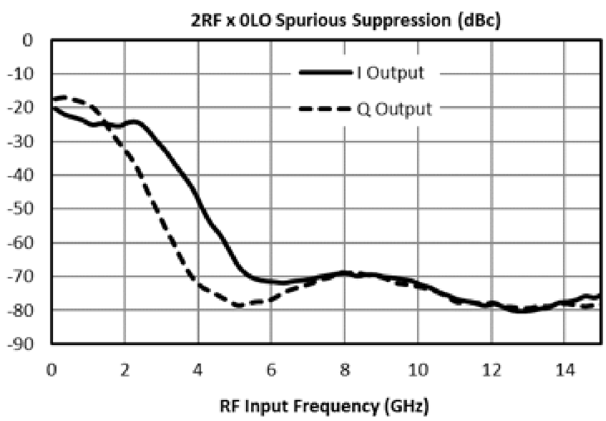
Spur Table

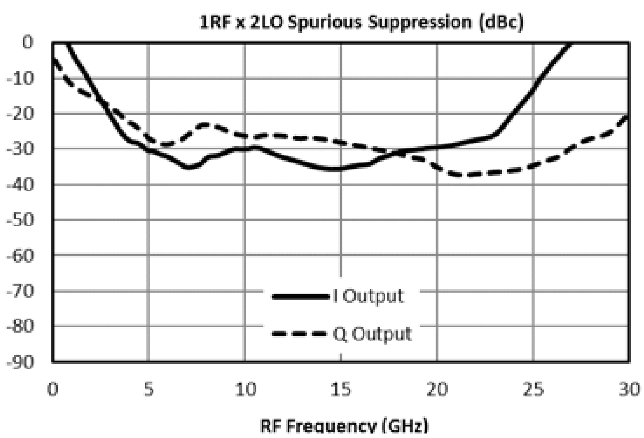
Typical Spurious Performance: Down-Conversion

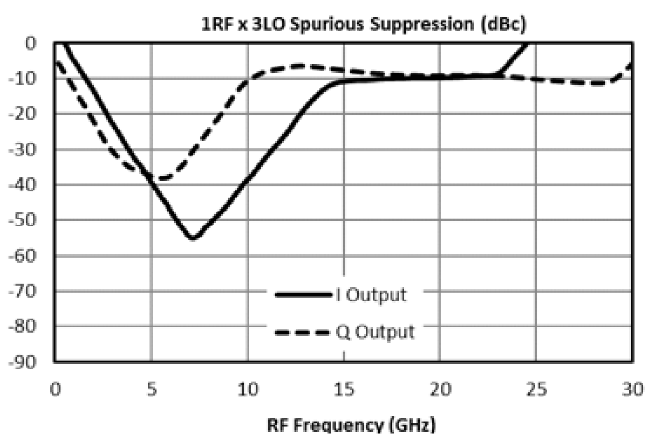
Typical spurious data is provided by selecting RF and LO frequencies (± m*LO ± n*RF) within the RF/LO bands, to create a spurious output within the IF band. The mixer is swept across the full spurious band and the mean is calculated. The numbers shown in the table below are for a -10 dBm RF input. Spurious 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 72 dBc for a -10 dBm input, so a -20 dBm RF input creates a spur that is (2-1) x (-10 dB) lower, or 82 dBc. Data is shown for the frequency plan inTypical Performance. mLOx0RF plots can be found inTypical Performance Plots: LO Harmonic Isolation. 0LOx1RF plot is identical to the plot of LO-RF isolation.

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

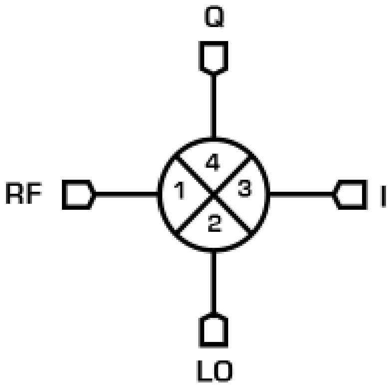
-10 dBm RF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
0xRF	-	49 (50)	60 (60)	57 (56)	74 (75)	N/A
1xRF	33 (39)	Reference	32 (26)	51 (28)	47 (52)	N/A
2xRF	71 (72)	54 (57)	72 (75)	64 (66)	73 (75)	68 (68)
3xRF	93 (98)	67 (72)	72 (83)	83 (86)	91 (93)	77 (76)
4xRF	110 (121)	82 (108)	106 (111)	93 (103)	108 (110)	107 (111)
5xRF	N/A	N/A	127 (127)	126 (126)	112 (122)	123 (125)



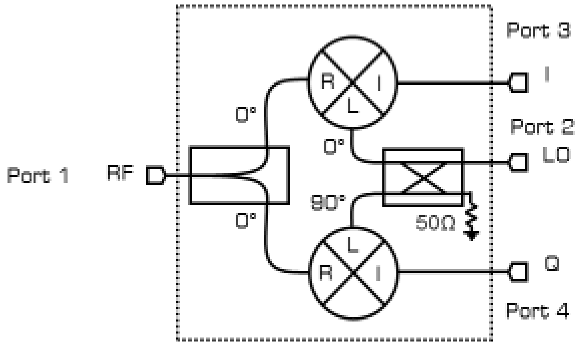




Application Circuit



IQ Mixer



Internal Structure

Application Circuit Description

Detailed Description

MMIQ-0626 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 from the due to its on-chip LO quadrature hybrid. Up to 40dB of image rejection (i.e., single sideband suppression) can be obtained by using the MMIQ-0626 as an image rejection or single sideband mixer. The MMIQ-0626H is the sister mixer of the MMIQ-0626L. The MMIQ-0626H requires a higher LO drive to operate the mixer. In exchange, the MMIQ-0626H displays higher linearity (i.e., higher IIP3, P1dB, Spurious Suppression) than the MMIQ-0626L. Marki H and L diodes correspond to different diode forward turn on voltages.

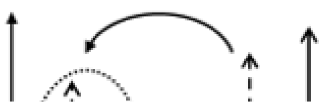
Support for the X, Ku, and K bands are offered by the ultra-broadband performance of the mixer's RF and LO ports (ports 1 and 2). Direct baseband to K band frequency conversions are available by using this mixer as an up-converter. Traditional use of this mixer to do image reject or single sideband mixing is available with an external IF quadrature hybrid. The MMIQ-0626 is also suitable for use as a Vector Modulator through DC bias of the I and Q ports (ports 3 and 4).

Port 1, the RF port, and port 2, the LO port, supports a 6-26GHz signal. Ports 3 and 4, the I and Q ports, support a DC-6GHz 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 1dB compression point to avoid signal distortion. The input 1dB 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



Die Mounting Recommendations

Mounting and Bonding Recommendations

Marki MMICs should be attached directly to a ground plane with conductive epoxy. The ground plane electrical impedance should be as low as practically possible. This will prevent resonances and permit the best possible electrical performance. Datasheet performance is only guaranteed in an environment with a low electrical impedance ground.

Mounting

To epoxy the chip, apply a minimum amount of conductive epoxy to the mounting surface so that a thin epoxy fillet is observed around the perimeter of the chip. Cure epoxy according to manufacturer instructions.

Wire Bonding

Ball or wedge bond with 0.025 mm (1 mil) diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150 °C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Use the minimum level of ultrasonic energy to achieve reliable wirebonds. Wirebonds should be started on the chip and terminated on the package or substrate. All bonds should be as short as possible <0.31 mm (12 mils).

Circuit Considerations

50 Ω transmission lines should be used for all high frequency connections in and out of the chip. Wirebonds should be kept as short as possible, with multiple wirebonds recommended for higher frequency connections to reduce parasitic inductance. In circumstances where the chip more than .001” thinner than the substrate, a heat spreading spacer tab is optional to further reduce bondwire length and parasitic inductance.

Handling Precautions

General Handling

Chips should be handled with care using tweezers or a vacuum collet. Users should take precautions to protect chips from direct human contact that can deposit contaminants, like perspiration and skin oils on any of the chip's surfaces.

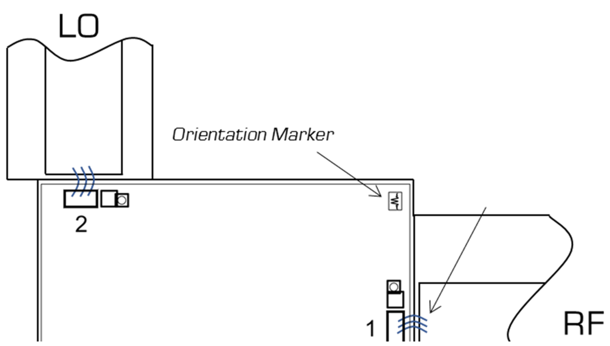
Static Sensitivity

GaAs MMIC devices are sensitive to ESD and should be handled, assembled, tested, and transported only in static protected environments.

Cleaning and Storage

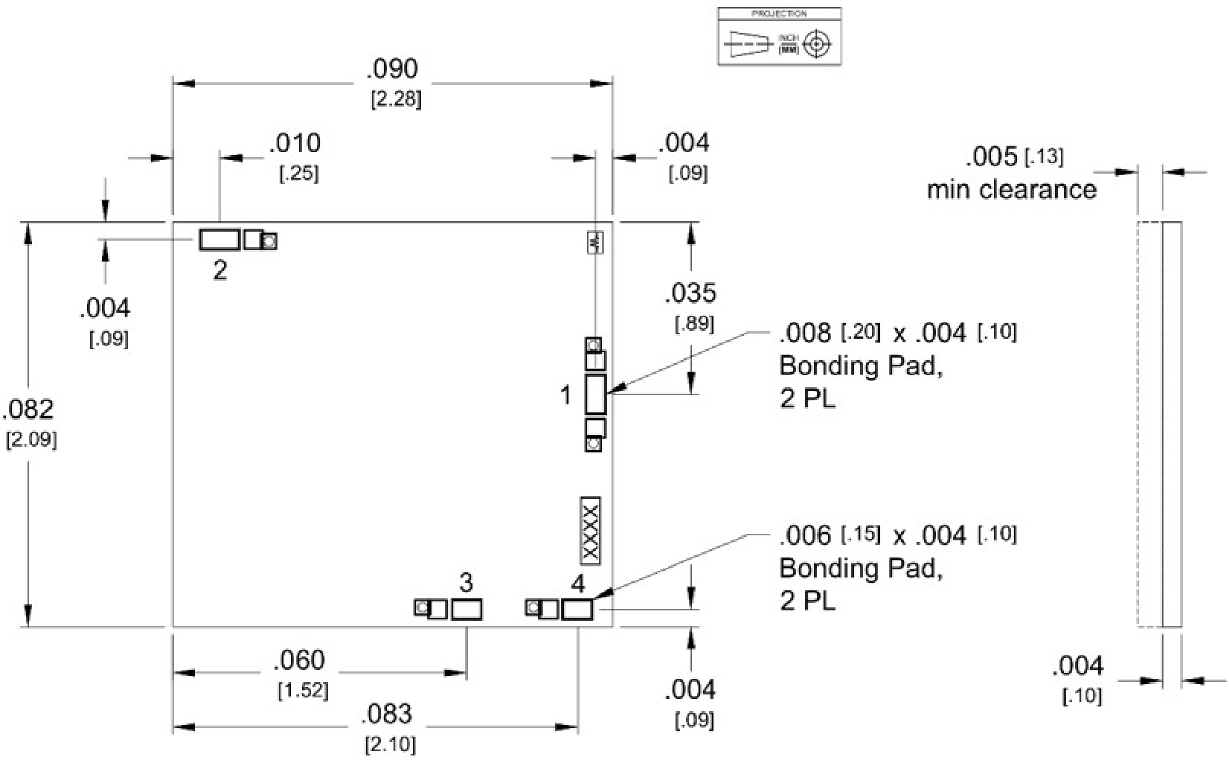
Do not attempt to clean the chip with a liquid cleaning system or expose the bare chips to liquid. Once the ESD sensitive bags the chips are stored in are opened, chips should be stored in a dry nitrogen atmosphere.

Bonding Diagram



Mechanical Data

Outline Drawing



1. CH Substrate material is 0.004 in thick GaAs.
2. I/O trace finish is 4.2 microns Au. Ground plane finish is 5 microns Au.
3. XXXX denotes circuit number.

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