

## DOUBLE-BALANCED MIXER 8 - 16 GHz

### Typical Applications

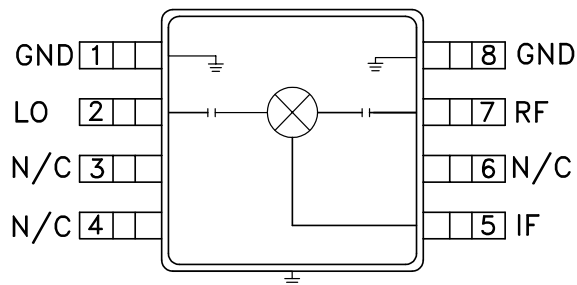
The HMC412BMS8GE is ideal for:

- Long Haul Radio Platforms
- Microwave Radio
- VSAT

### Features

- Conversion Loss: 8 dB
- Noise Figure: 8 dB
- LO to RF Isolation: 44 dB
- LO to IF Isolation: 38
- RF to IF Isolation: 29 dB
- Input Third-Order Intercept: 19 dB
- Input Power for 1 dB Compression: 10 dB
- No External Components
- MSOP8GE SMT Package

### Functional Diagram



### General Description

The HMC412BMS8GE is a passive double-balanced mixer that operates from 8 to 16 GHz. The HMC412BMS8GE operates with LO drive levels between 9 to 15 dBm and provides 8 dB of conversion loss across the entire specified frequency band. This mixer requires no external components or bias.

### Electrical Specifications, $T_A = +25\text{ }^\circ\text{C}$ , $IF = 1.45\text{ GHz}$ , $LO\text{ Power} = +13\text{ dBm}$ , $USB$ [1]

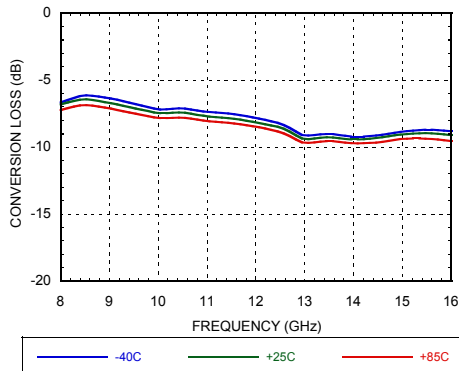
Parameter	Min.	Typ.	Max.	Units
RF Frequency Range	8		16	GHz
LO Frequency Range	8		16	GHz
IF Frequency Range	DC		2.5	GHz
Conversion Loss		8	11	dB
Noise Figure, Single Sideband (SSB)		8		dB
LO to RF Isolation		44		dB
LO to IF Isolation	32	38		dB
RF to IF Isolation		29		dB
Input Third-Order Intercept (IP3)	15	19		dBm
Input Power for 1 dB Compression (P1dB)		10		dBm

[1] Unless otherwise noted all measurements performed as down-converter with upper sideband selected,  $IF = 1.45\text{ GHz}$ ,  $RFIN = -5\text{ dBm}$

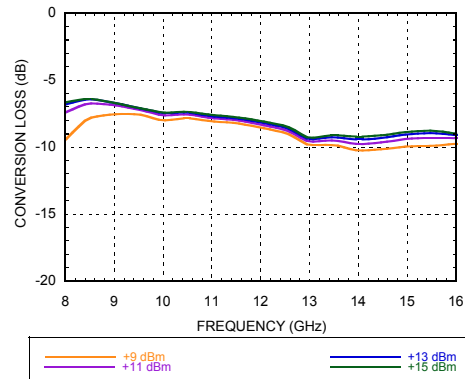
**DOUBLE-BALANCED MIXER**  
**8 - 16 GHz**

**Down-converter Performance, IF = 1450 MHz**

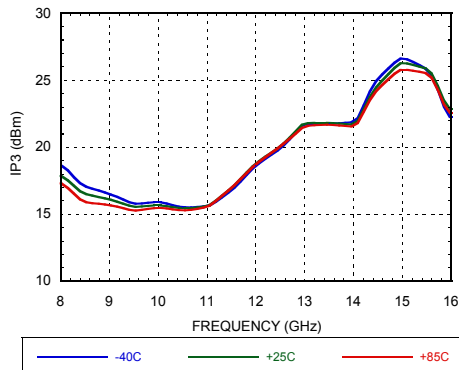
**Conversion Loss vs. Temperature**  
LO = +13 dBm, RFIN = -5 dBm, USB



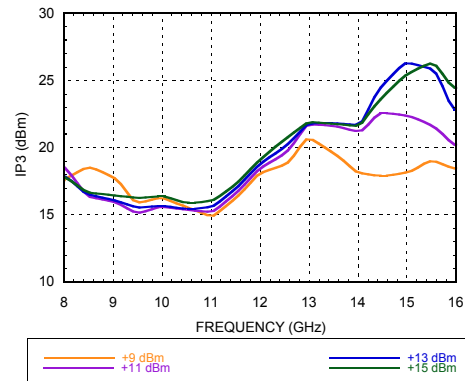
**Conversion Loss vs. LO Drive**  
RFIN = -5 dBm, USB, Ta = +25C



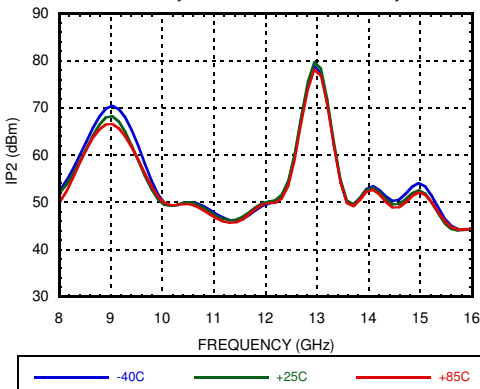
**Input IP3 vs. Temperature**  
LO = +13 dBm, RFIN = -5 dBm, USB



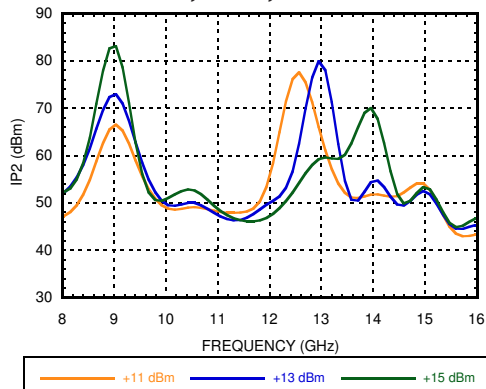
**Input IP3 vs. LO Drive**  
RFIN = -5 dBm, USB, Ta = +25C



**Input IP2 vs. Temperature**  
LO = +13 dBm, RFIN = -5 dBm, USB



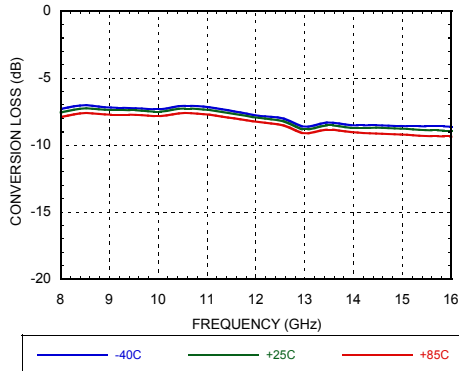
**Input IP2 vs. LO Drive**  
RFIN = -5 dBm, USB, Ta = +25C



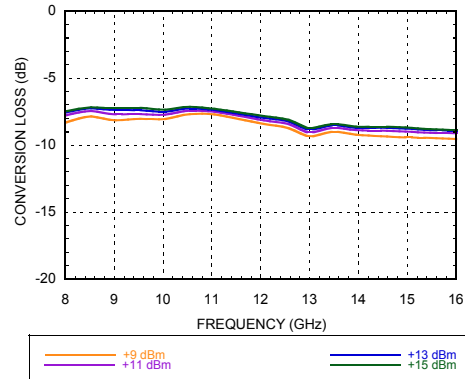
**DOUBLE-BALANCED MIXER  
8 - 16 GHz**

**Down-converter Performance, IF = 150 MHz**

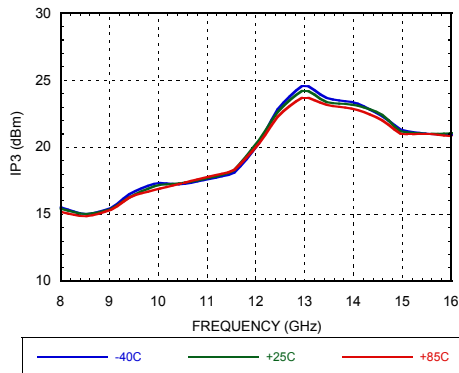
**Conversion Loss vs. Temperature**  
LO = +13 dBm, RFIN = -5 dBm, USB



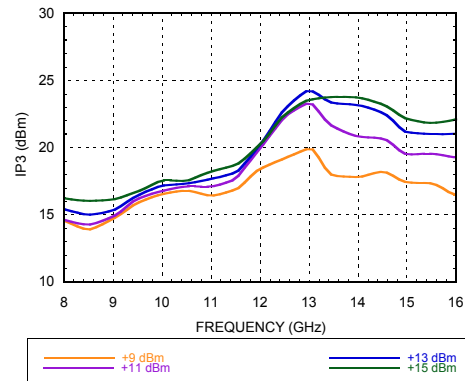
**Conversion Loss vs. LO Drive**  
RFIN = -5 dBm, USB, Ta = +25C



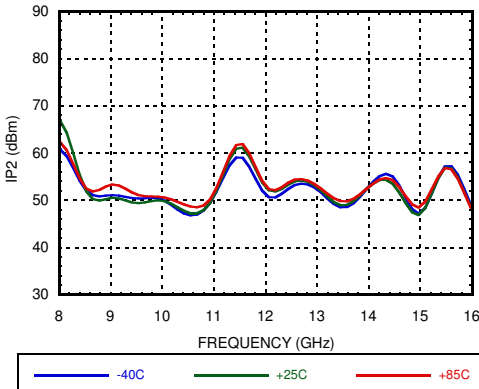
**Input IP3 vs. Temperature**  
LO = +13 dBm, RFIN = -5 dBm, USB



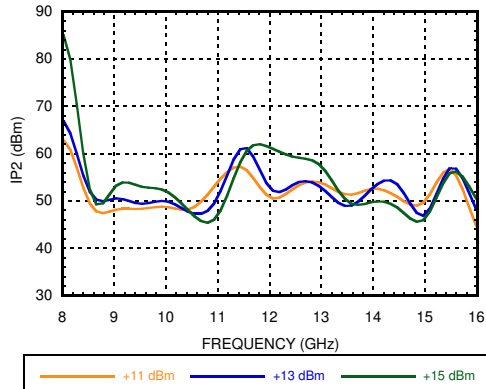
**Input IP3 vs. LO Drive**  
RFIN = -5 dBm, USB, Ta = +25C



**Input IP2 vs. Temperature**  
LO = +13 dBm, RFIN = -5 dBm, USB



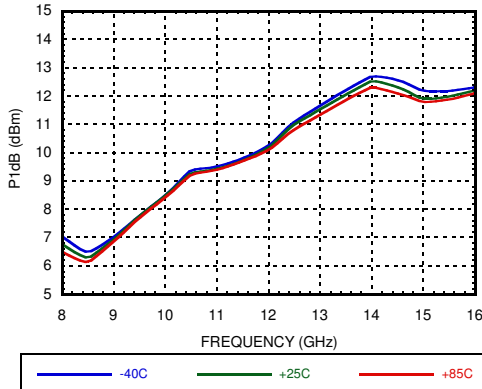
**Input IP2 vs. LO Drive**  
RFIN = -5 dBm, USB, Ta = +25C



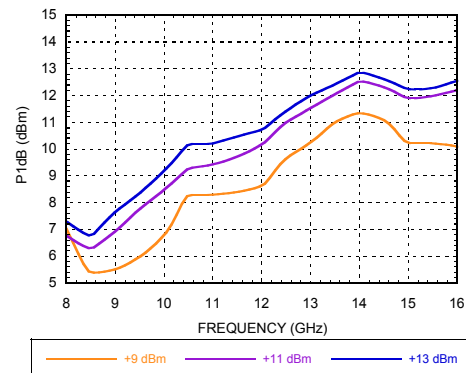
**DOUBLE-BALANCED MIXER**  
**8 - 16 GHz**

**Down-converter Performance, IF = 1450 MHz**

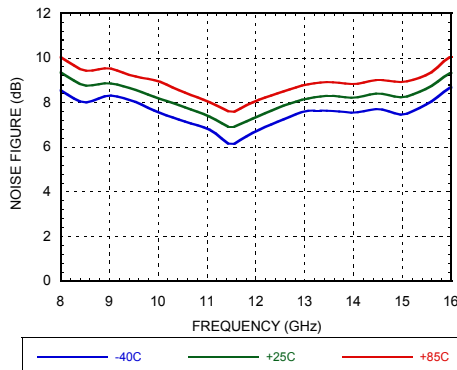
**Input P1dB vs. Temperature**  
LO Power = +13 dBm, USB



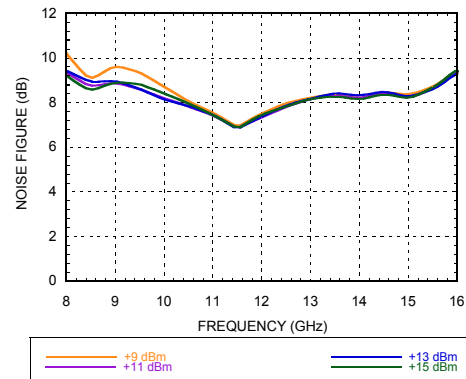
**Input P1dB vs. LO Power**  
USB, Ta = +25C



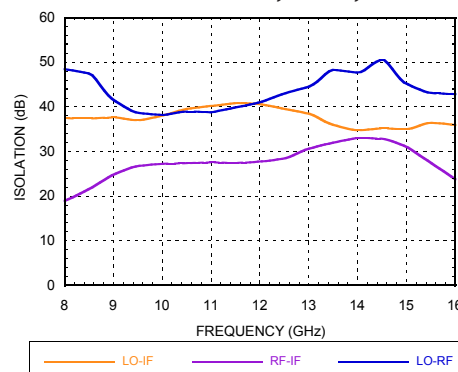
**Noise Figure vs. Temperature**  
LO = +13 dBm, RFIN = -5 dBm, USB



**Noise Figure vs. LO Power**  
RFIN = -5 dBm, USB, Ta = +25C



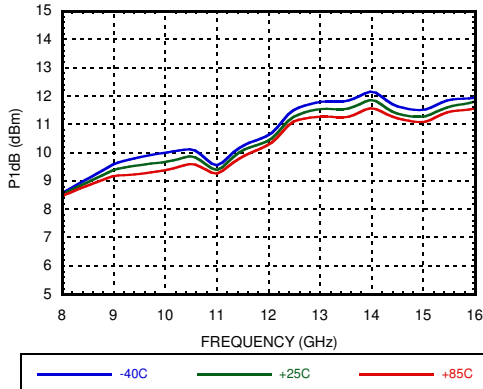
**LO to RF, LO to IF, and RF to IF Isolation**  
LO Power = +13 dBm, USB, Ta = +25C



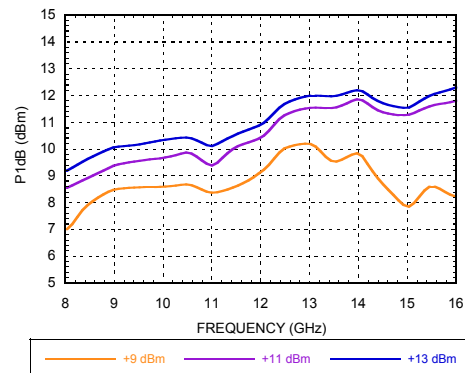
**DOUBLE-BALANCED MIXER**  
**8 - 16 GHz**

**Down-converter Performance, IF = 150 MHz**

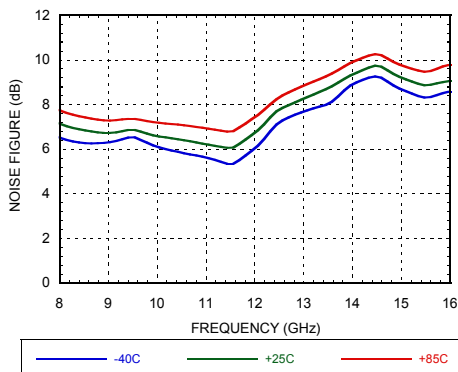
**Input P1dB vs. Temperature**  
**LO Power = +13 dBm, USB**



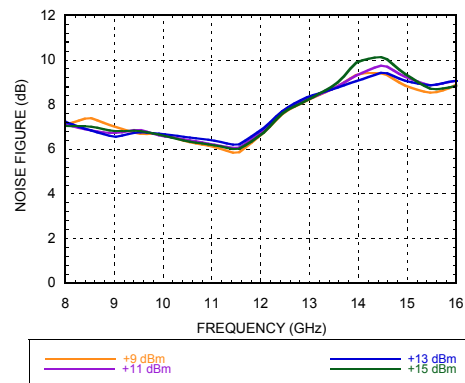
**Input P1dB vs. LO Power**  
**USB, Ta = +25C**



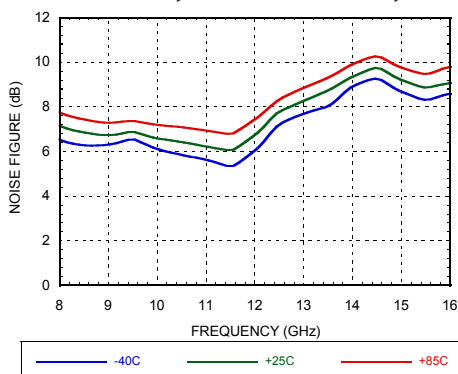
**Noise Figure vs. Temperature**  
**LO = +13 dBm, RFIN = -5 dBm, USB**



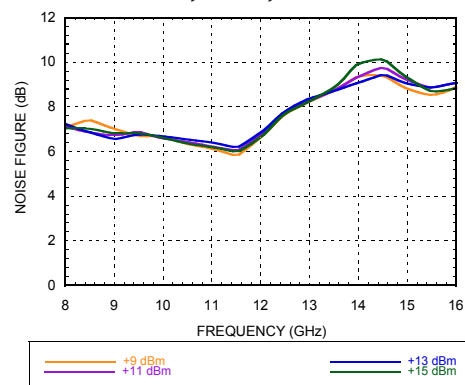
**Noise Figure vs. LO Power**  
**RFIN = -5 dBm, USB, Ta = +25C**



**Noise Figure vs. Temperature**  
**LO = +13 dBm, RFIN = -5 dBm, USB**



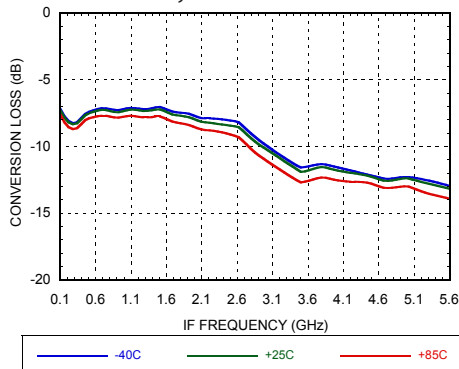
**Noise Figure vs. LO Power**  
**RFIN = -5 dBm, USB, Ta = +25C**



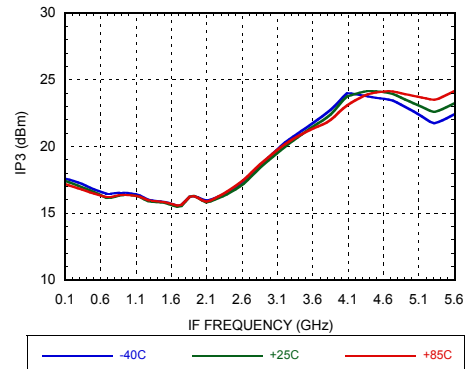
**DOUBLE-BALANCED MIXER  
8 - 16 GHz**

**Down-converter Performance**

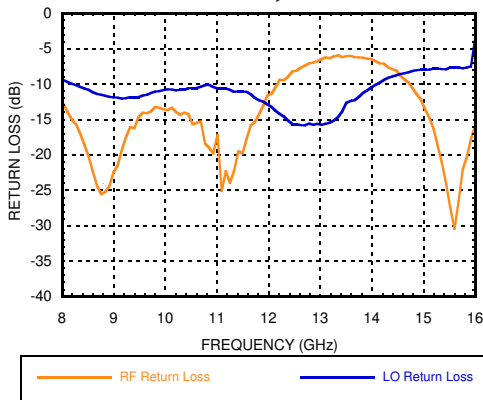
**Conversion Loss over IF Bandwidth, USB**  
RFIN = -5dBm, LO = 9.5 GHz @ +13 dBm



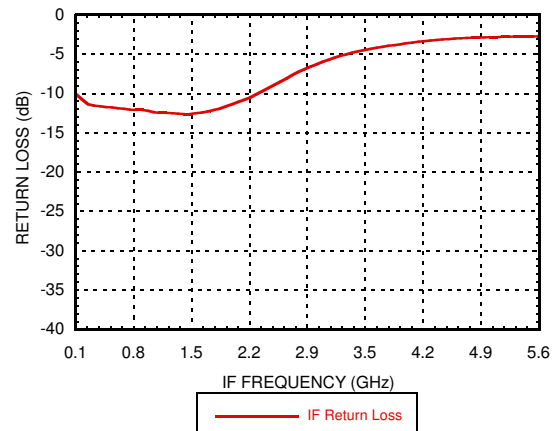
**Input IP3 over IF Bandwidth, USB**  
RFIN = -5dBm, LO = 9.5 GHz @ +13 dBm



**RF and LO Return Loss @ LO = 11 GHz,**  
LO Power = +13 dBm, Ta = +25C



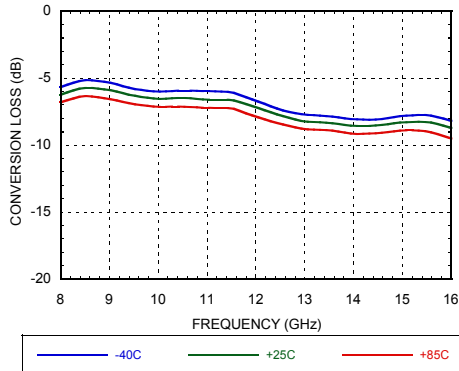
**IF Return Loss, Ta = +25C**



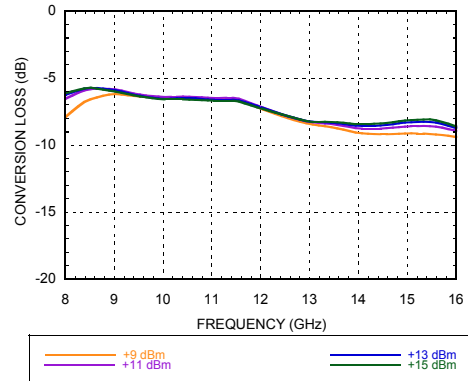
**DOUBLE-BALANCED MIXER  
8 - 16 GHz**

**Up-converter Performance, IF = 1450 MHz**

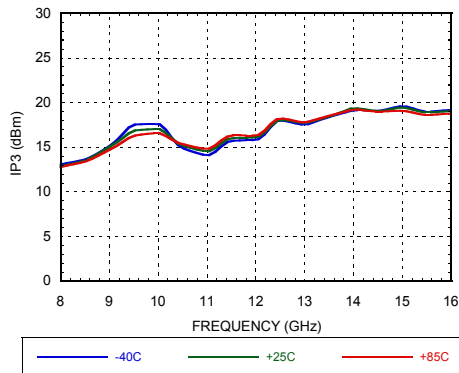
**Conversion Loss vs. Temperature**  
LO = +13 dBm, IFIN = -5 dBm, USB



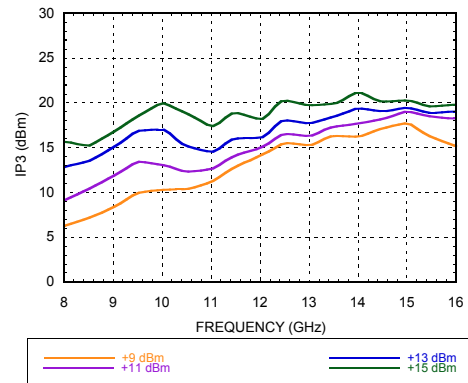
**Conversion Loss vs. LO Drive**  
IFIN = -5 dBm, USB, Ta = +25C



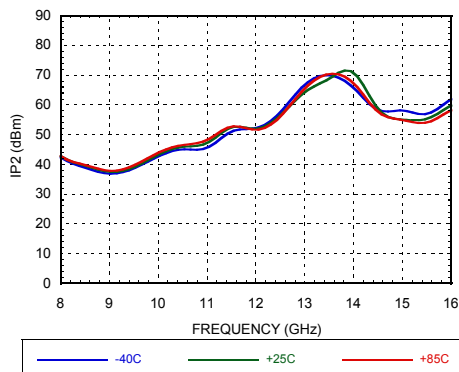
**Input IP3 vs. Temperature**  
LO = +13 dBm, IFIN = -5 dBm, USB



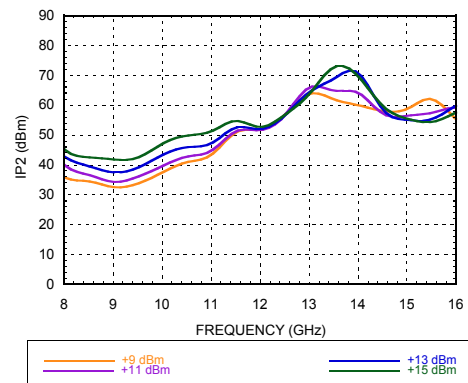
**Input IP3 vs. LO Drive**  
IFIN = -5 dBm, USB, Ta = +25C



**Input IP2 vs. Temperature**  
LO = +13 dBm, IFIN = -5 dBm, USB



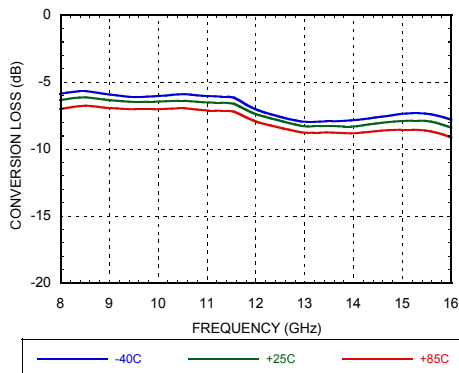
**Input IP2 vs. LO Drive**  
IFIN = -5 dBm, USB, Ta = +25C



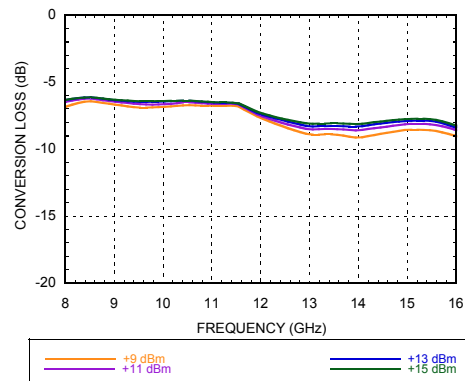
**DOUBLE-BALANCED MIXER  
8 - 16 GHz**

**Up-converter Performance, IF = 150 MHz**

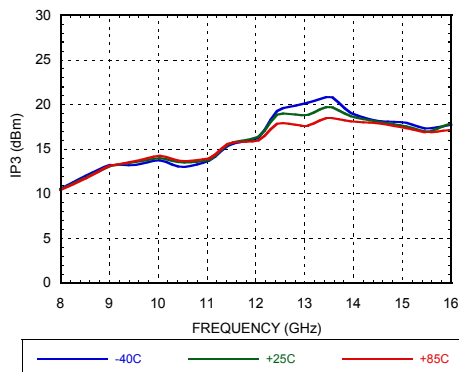
**Conversion Loss vs. Temperature**  
LO = +13 dBm, IFIN = -5 dBm, USB



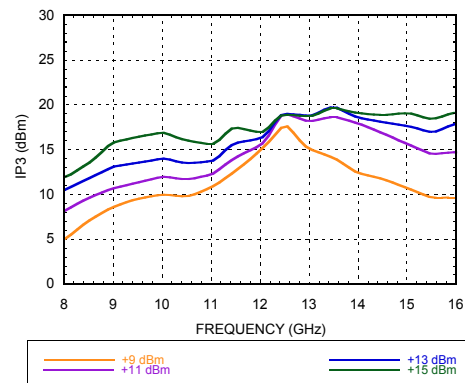
**Conversion Loss vs. LO Drive**  
IFIN = -5 dBm, USB, Ta = +25C



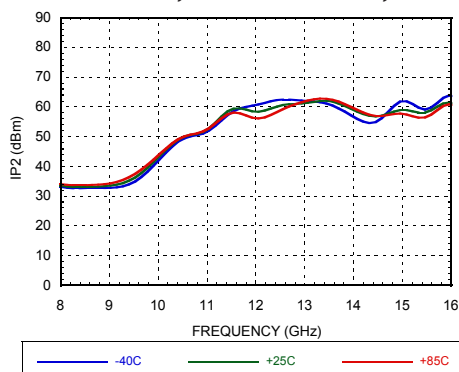
**Input IP3 vs. Temperature**  
LO = +13 dBm, IFIN = -5 dBm, USB



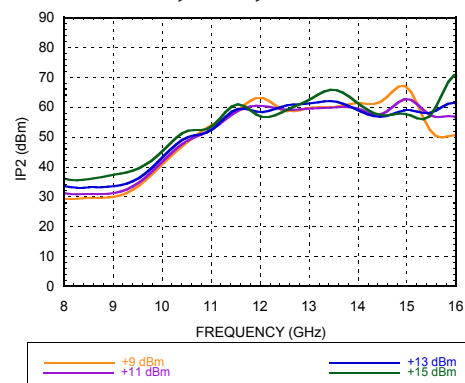
**Input IP3 vs. LO Drive**  
IFIN = -5 dBm, USB, Ta = +25C



**Input IP2 vs. Temperature**  
LO = +13 dBm, IFIN = -5 dBm, USB



**Input IP2 vs. LO Drive**  
IFIN = -5 dBm, USB, Ta = +25C





## DOUBLE-BALANCED MIXER 8 - 16 GHz

### Harmonics of LO

nLO Spur @ RF port				
LO Freq (GHz)	1	2	3	4
9	39	35	51	63
10.5	40	48	51	62
12	46	53	60	N/A
13.5	49	65	52	N/A
15	40	48	N/A	N/A
16	39	47	N/A	N/A
16.5	35	45	N/A	N/A

LO = +13 dBm  
All values in dBc below input LO level @ RF port

### MxN Spurious Outputs, IF = 1450 MHz

mRF	nLO					
	0	1	2	3	4	5
0	X	3.3	32	26	N/A	N/A
1	24	N/A	42	34	36	N/A
2	76	67	69	81	75	64
3	941	72	78	81	79.1	78
4	N/A	N/A	68	78	8	82
5	N/A	N/A	N/A	66	75	81

RF = 14.45 GHz @ -10 dBm  
LO = 13 GHz @ +13 dBm, USB  
All values in dBc relative to the IF. Measured as Down-converter  
Spurs values are (m x RF) - (n x LO)

### MxN Spurious Output, IF = 150 MHz

mRF	nLO					
	0	1	2	3	4	5
0	X	10.6	24	23	66	N/A
1	19	N/A	36	30	50	113
2	71	61	59	67	67	68
3	79	79	83	66	82	79
4	65	78	80	85	68	82
5	N/A	63	77	79	83	87

RF = 9.5 GHz @ -10 dBm  
LO = 9.65 GHz @ +13 dBm, LSB  
All values in dBc relative to the IF. Measured as Down-converter  
Spurs values are (m x RF) - (n x LO)

### MxN Spurious Output, IFin = 1450 MHz

mIF	nLO					
	0	1	2	3	4	5
0	X	8	16	N/A	N/A	N/A
1	26	N/A	34	N/A	N/A	N/A
2	79.3	54.7	71	N/A	N/A	N/A
3	87	78	78	N/A	N/A	N/A
4	84.5	82	70	N/A	N/A	N/A
5	81	81	73	N/A	N/A	N/A

RFout = 14.45 GHz, IF input power = -10 dBm  
LO = 15.9 GHz @ +13 dBm, LSB  
All values in dBc relative to the RFout. Measured as Up-converter  
Spurs values are (m x IF) - (n x LO)


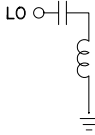
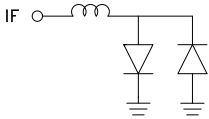
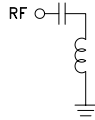
### MxN Spurious Output, IFin = 150 MHz

mIF	nLO					
	0	1	2	3	4	5
0	X	9.3	6	21	36.5	N/A
1	45.5	N/A	23	48	64	N/A
2	88	60	50	65	62	N/A
3	89	59	74.5	79	63.5	N/A
4	69	82.5	80.5	78	64	N/A
5	91	82.5	78.6	78	65	N/A

RFout = 9.5 GHz @ -10 dBm  
LO = 9.35 GHz @ +13 dBm, USB  
All values in dBc relative to the RFout. Measured as Up-converter  
Spurs values are (m x IF) - (n x LO)

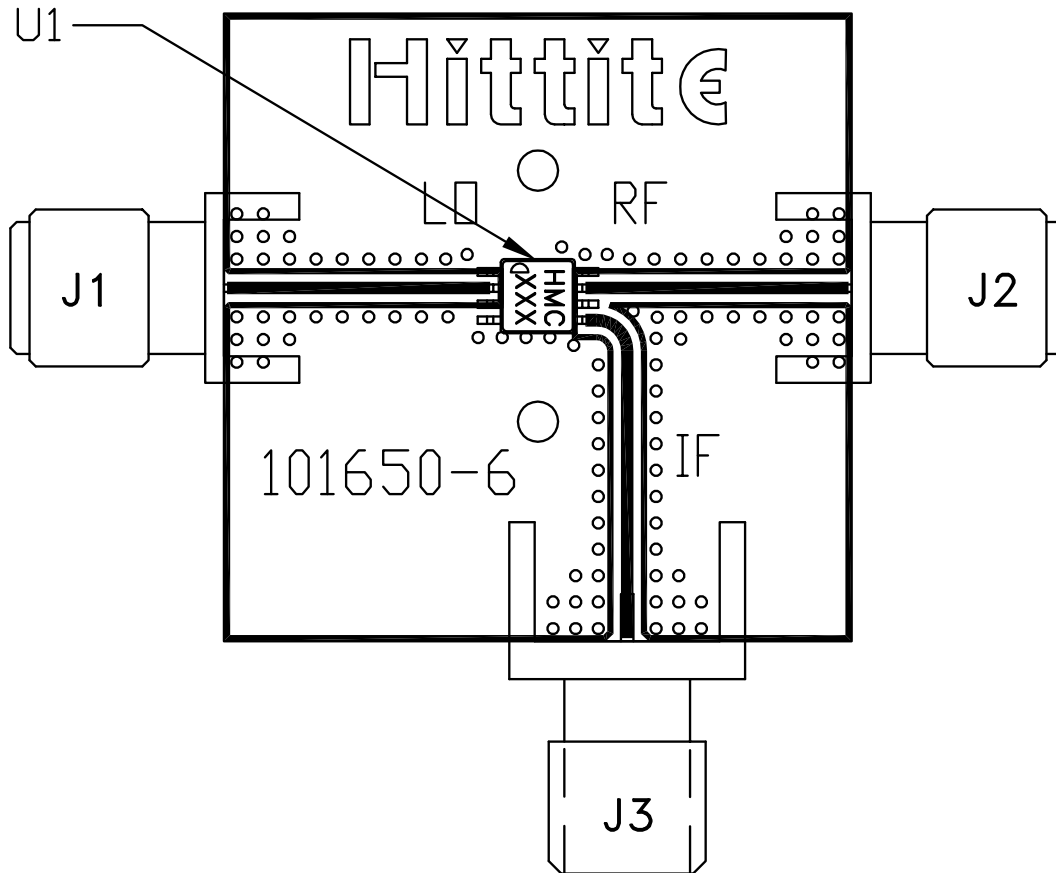
## DOUBLE-BALANCED MIXER 8 - 16 GHz

### Pin Descriptions

Pin Number	Function	Description	Interface Schematic
1, 8	GND	These pins and the exposed ground paddle must be connected to RF ground.	
2	LO	This pin is AC coupled and matched to 50 ohms.	
3, 4, 6	N/C	These pins are not connected internally.	
5	IF	This pin is DC coupled. For applications not requiring operation to DC, this port should be DC blocked externally using a series capacitor whose values has been chosen to pass the necessary IF frequency range. For operation to DC, this pin must not source/sink more than 6 mA of current or die non-funtion and possible die failure will result.	
7	RF	This pin is AC coupled and matched to 50 ohm.	

**DOUBLE-BALANCED MIXER  
8 - 16 GHz**

**Evaluation PCB**



**List of Materials for EV1HMC412BMS8G [1]**

Item	Description
J1 - J2	PCB Mount SMA RF Connector, SRI
J3	PCB Mount SMA Connector, Johnson
U1	HMC412BMS8GE MIXER
PCB [2]	101650 Evaluation Board

[1] Reference this number when ordering complete evaluation PCB

[2] Circuit Board Material: Rogers 4350

The circuit board used in the application should use RF circuit design techniques. Signal lines should have 50 Ohm impedance while the package ground leads and exposed paddle should be connected directly to the ground plane similar to that shown. A sufficient number of via holes should be used to connect the top and bottom ground planes. The evaluation circuit board shown is available from Analog Devices upon request.

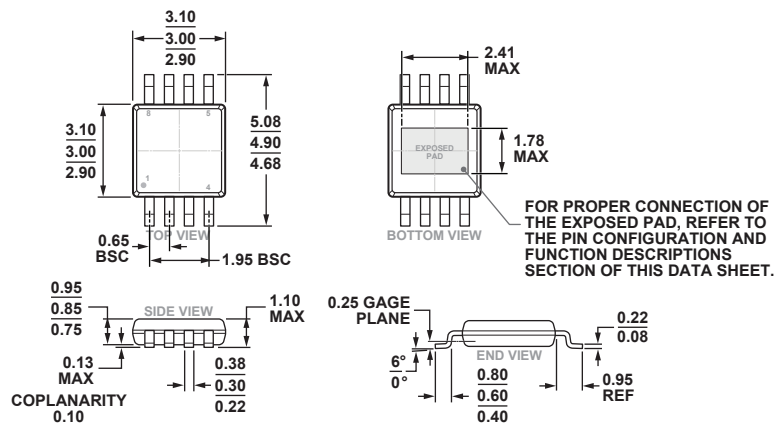
## DOUBLE-BALANCED MIXER 8 - 16 GHz

### Absolute Maximum Ratings

LO Input Power	+25 dBm
RF/IF input Power	+25 dBm
IF DC Current	±6 mA
Channel Temperature	150 °C
Continuous P <sub>diss</sub> (T=85 °C) (derate 4.3 mW/°C above 85 °C)	280 mW
Thermal Resistance (R <sub>TH</sub> ) (junction to ground paddle)	180 °C/W
Operating Temperature	-40 to +85 °C
Storage Temperature	-65 to +150 °C
ESD Sensitivity (HBM)	500 V (Class 1B)
ESD Sensitivity (FICDM)	1000 V (Class C3)



ELECTROSTATIC SENSITIVE DEVICE  
OBSERVE HANDLING PRECAUTIONS



COMPLIANT TO JEDEC STANDARDS MO-187-AA-T

8-Lead Mini Small Outline Package with Exposed Pad [MINI\_SO\_EP]  
(RH-8-4)

Dimensions shown in millimeters

### Package Information

Part Number	Package Body Material	Lead Finish	MSL Rating	Package Marking <sup>[2]</sup>
HMC412BMS8GE	RoHS-compliant Low Stress Injection Molded Plastic	100% matte Sn	MSL1 <sup>[1]</sup>	412B XXXX

[1] Max peak reflow temperature of 260 °C

[2] 4-Digit lot number XXXX