1.5 GHz to 4.5 GHz, GaAs, MMIC, Double Balanced Mixer

Data Sheet **HMC213BMS8E**

FEATURES

Passive: no dc bias required
Conversion loss: 10 dB typical
Input IP3: 21 dBm typical
RoHS compliant, ultraminiature package: 8-lead MSOP

APPLICATIONS

Base stations
Personal Computer Memory Card International Association (PCMCIA) transceivers
Wireless local loops

FUNCTIONAL BLOCK DIAGRAM

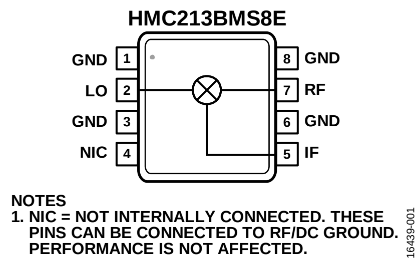

Figure 1.

GENERAL DESCRIPTION

The HMC213BMS8E is an ultraminiature double balanced mixer in a plastic, 8-lead mini small outline package (MSOP). This passive monolithic microwave integrated circuit (MMIC) mixer is constructed of gallium arsenide (GaAs) Schottky diodes and novel planar transformer baluns on the chip. The device can be used as an upconverter, downconverter, biphase demodulator or modulator, or phase comparator. The consistent MMIC performance improves system operation and ensures regulatory compliance.

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REVISION HISTORY

2/2018—Revision 0: Initial Version

SPECIFICATIONS

Ambient temperature (T_A) = 25°C, IF = 100 MHz, LO = 13 dBm, upper sideband. All measurements performed as a downconverter on the evaluation printed circuit board (PCB), unless otherwise noted.

Table 1.

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
FREQUENCY RANGE						
RF	RF	1.5		4.5	GHz	
LO Input	LO	1.5		4.5	GHz	
IF	IF	DC		1.5	GHz	
LO AMPLITUDE		9	13	15	dBm	
1.5 GHz TO 4.5 GHz PERFORMANCE						LO = 13 dBm
Downconverter	IF_{OUT}					
Conversion Loss			10	11	dB	
Input Third-Order Intercept	IP3	16	21		dBm	
Input 1 dB Compression Point	P1dB		11		dBm	
Upconverter	IF_{IN}					IF_{IN} = 100 MHz
Conversion Loss			10		dB	
Input Third-Order Intercept	IP3		17		dBm	
Input 1 dB Compression Point	P1dB		8		dBm	
Isolation						
RF to IF		8	13		dB	
LO to RF		27	32		dB	
LO to IF		23	30		dB	
1.7 GHz TO 3.6 GHz PERFORMANCE						LO = 10 dBm
Downconverter	IF_{OUT}					
Conversion Loss			10.5		dB	
Input Third-Order Intercept	IP3		19		dBm	
Input 1 dB Compression Point	P1dB		10.5		dBm	
Upconverter	IF_{IN}					IF_{IN} = 100 MHz
Conversion Loss			9		dB	
Input Third-Order Intercept	IP3		12		dBm	
Input 1 dB Compression Point	P1dB		6		dBm	
Isolation						
RF to IF			13		dB	
LO to RF			31		dB	
LO to IF			27		dB	

ABSOLUTE MAXIMUM RATINGS

Table 2.

Parameter	Rating
RF Input Power	13 dBm
LO Input Power	27 dBm
IF Input Power	13 dBm
IF Source/Sink Current	9 mA
Reflow Temperature	260°C
Continuous Power Dissipation, P_{DISS} (T_A = 85°C, Derate 15.9 mW/°C Above 85°C)	1.424 W
Maximum Junction Temperature	175°C
Operating Temperature Range	−40°C to +85°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature Range	−65°C to +150°C
Electrostatic Discharge (ESD) Sensitivity	
Human Body Model	2000 V
Field Induced Charged Device Model	1250 V

Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only; functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

THERMAL RESISTANCE

Thermal performance is directly linked to PCB design and operating environment. Careful attention to PCB thermal design is required.

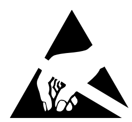
θ_{JA} is the natural convection junction to ambient thermal resistance measured in a one cubic foot sealed enclosure. θ_{JC} is the junction to case thermal resistance.

Table 3. Thermal Resistance

Package Type	θ_{JA}	θ_{JC}	Unit
RM-8[1]	165.6	63	°C/W

[1] See JEDEC standard JESD51-2 for additional information on optimizing the thermal impedance (PCB with 3 × 3 vias).

ESD CAUTION



ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

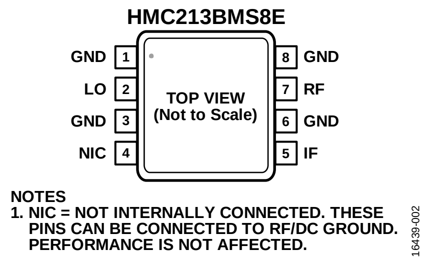


Figure 2. Pin Configuration

Table 4. Pin Function Descriptions

Pin No.	Mnemonic	Description
1, 3, 6, 8	GND	Ground. Connect these pins to RF/dc ground.
2	LO	Local Oscillator (LO) Port. This pin is ac-coupled and matched to 50 Ω.
4	NIC	Not Internally Connected. These pins can be connected to RF/dc ground. Performance is not affected.
5	IF	Intermediate Frequency (IF) Port. This pin is dc-coupled. For applications not requiring operation to dc, dc block this port externally using a series capacitor of a value chosen to pass the necessary IF frequency range. For operation to dc, this pin must not source or sink more than 9 mA of current or die malfunction and possible die failure can result. See Figure 5 for the interface schematic.
7	RF	Radio Frequency (RF) Port. This pin is ac-coupled and matched to 50 Ω.

INTERFACE SCHEMATICS

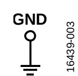


Figure 3. GND Interface Schematic

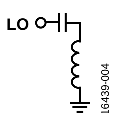


Figure 4. LO Interface Schematic

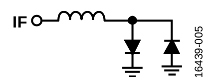


Figure 5. IF Interface Schematic

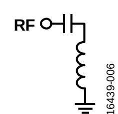


Figure 6. RF Interface Schematic

TYPICAL PERFORMANCE CHARACTERISTICS

DOWNCONVERTER PERFORMANCE

IF_{OUT} = 100 MHz, Upper Sideband

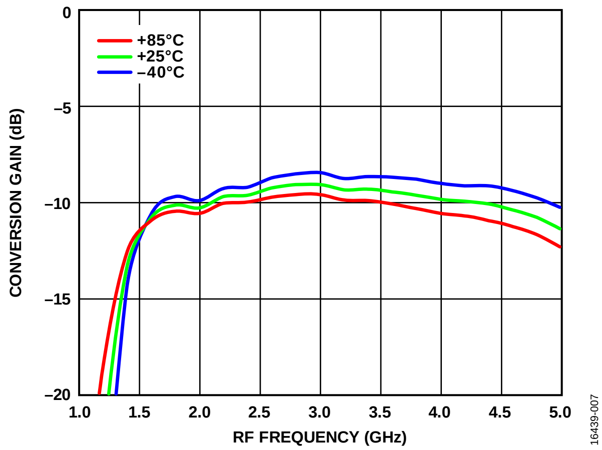


Figure 7. Conversion Gain vs. RF Frequency at Various Temperatures, LO = 13 dBm

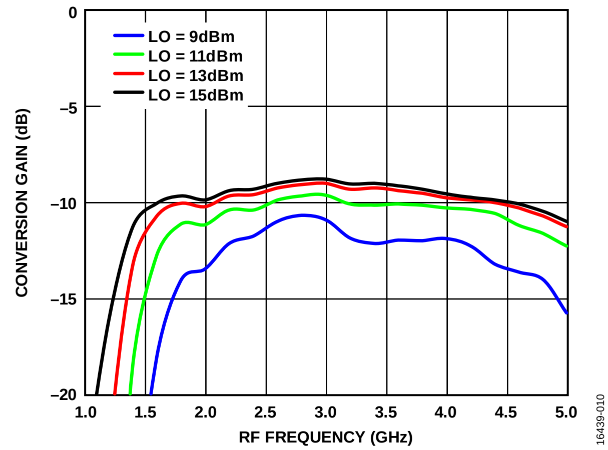


Figure 10. Conversion Gain vs. RF Frequency at Various LO Power Levels, T_A = 25°C

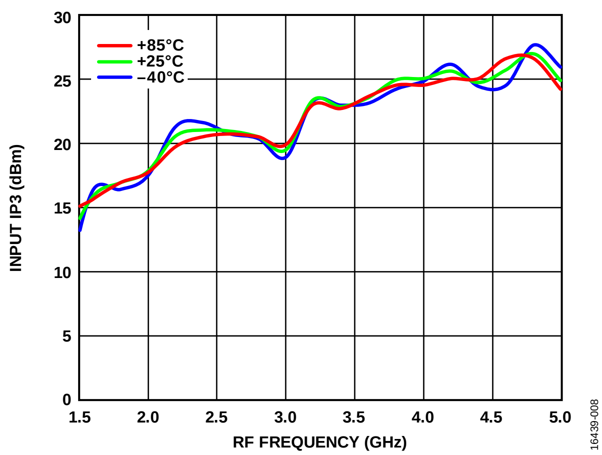


Figure 8. Input IP3 vs. RF Frequency at Various Temperatures, LO = 13 dBm

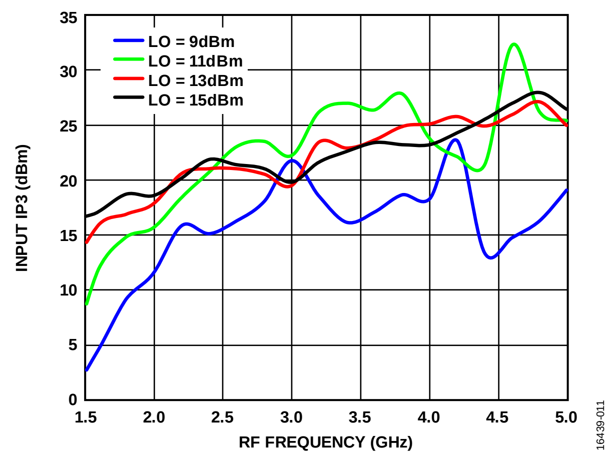


Figure 11. Input IP3 vs. RF Frequency at Various LO Power Levels, T_A = 25°C

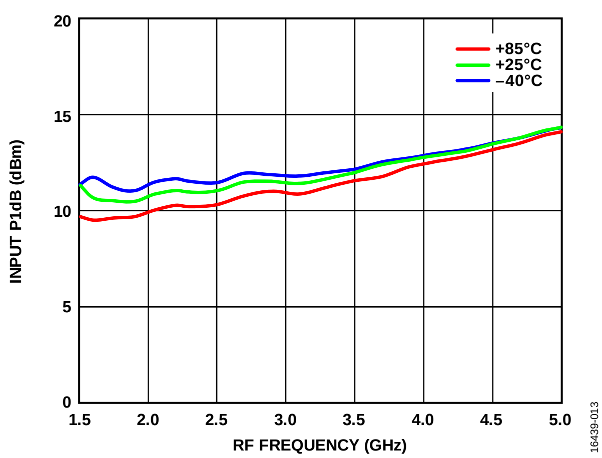


Figure 9. Input P1dB vs. RF Frequency at Various Temperatures, LO = 13 dBm

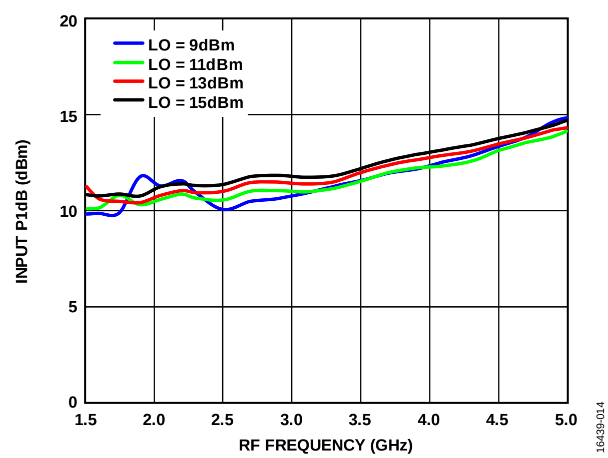


Figure 12. Input P1dB vs. RF Frequency at Various LO Power Levels, T_A = 25°C

IF_{OUT} = 100 MHz, Lower Sideband

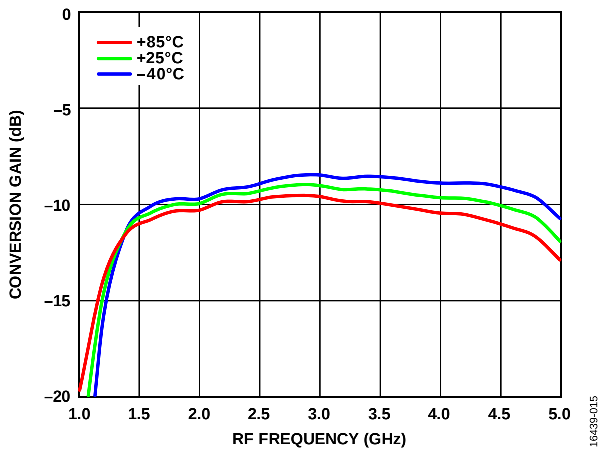


Figure 13. Conversion Gain vs. RF Frequency at Various Temperatures, LO = 13 dBm

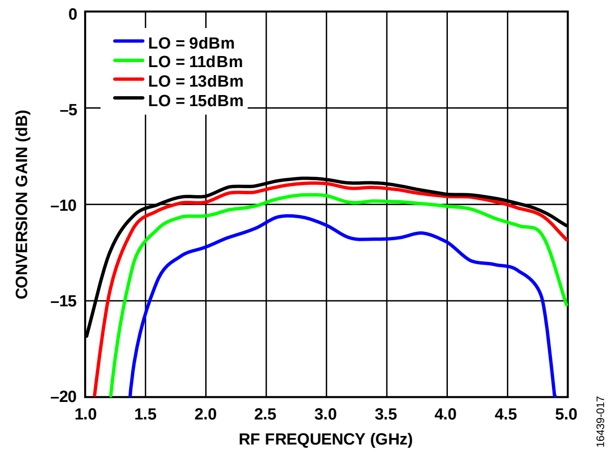


Figure 15. Conversion Gain vs. RF Frequency at Various LO Power Levels, T_A = 25°C

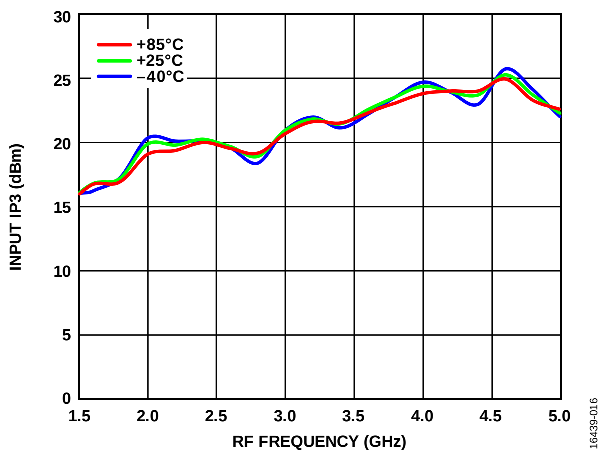


Figure 14. Input IP3 vs. RF Frequency at Various Temperatures, LO = 13 dBm

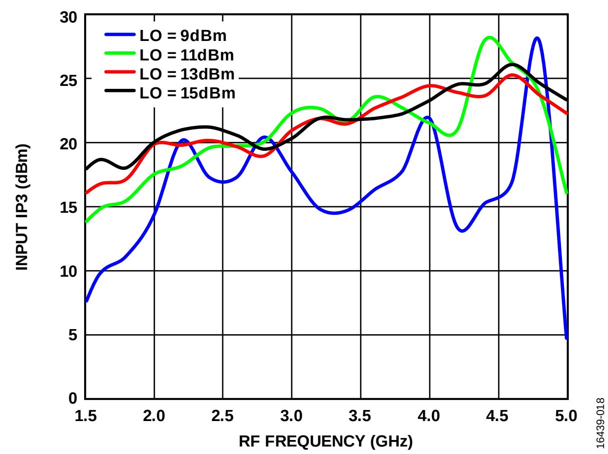


Figure 16. Input IP3 vs. RF Frequency at Various LO Power Levels, T_A = 25°C

IF_{OUT} = 1500 MHz, Upper Sideband

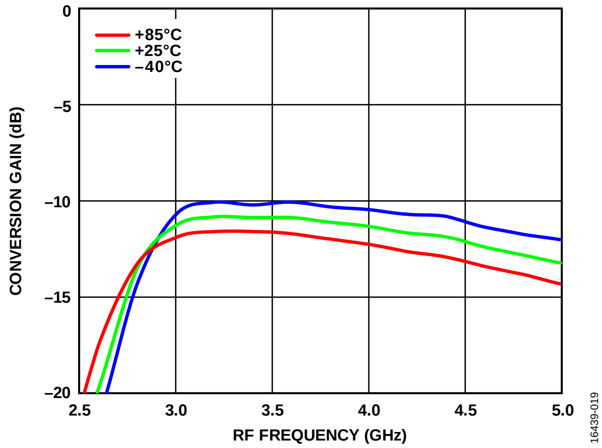


Figure 17. Conversion Gain vs. RF Frequency at Various Temperatures, LO = 13 dBm

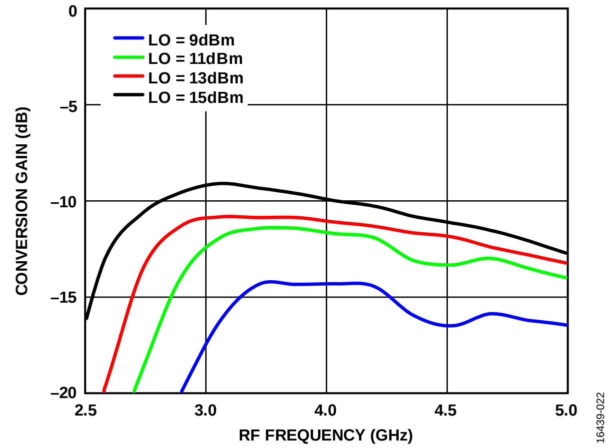


Figure 20. Conversion Gain vs. RF Frequency at Various LO Power Levels, T_A = 25°C

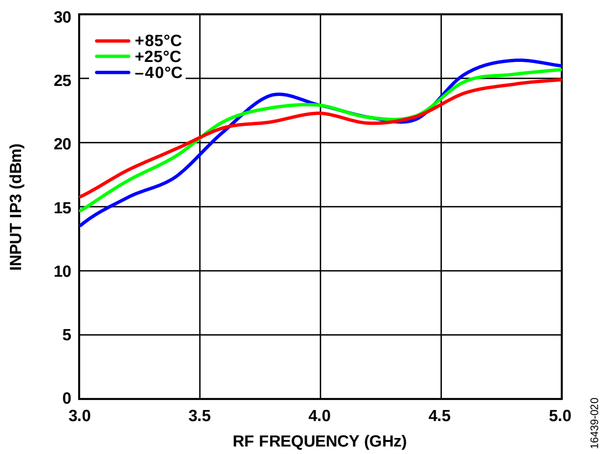


Figure 18. Input IP3 vs. RF Frequency at Various Temperatures, LO = 13 dBm

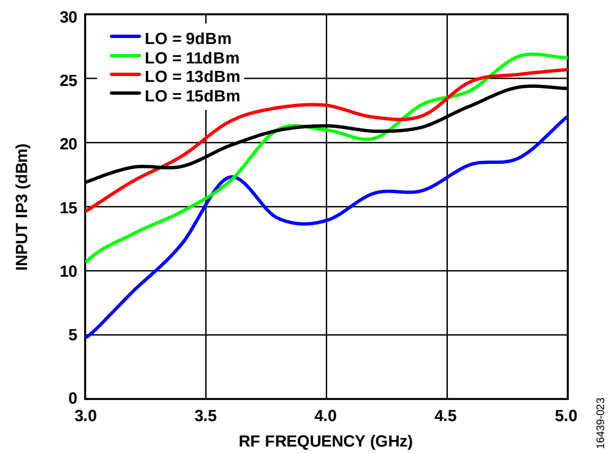


Figure 21. Input IP3 vs. RF Frequency at Various LO Power Levels, T_A = 25°C

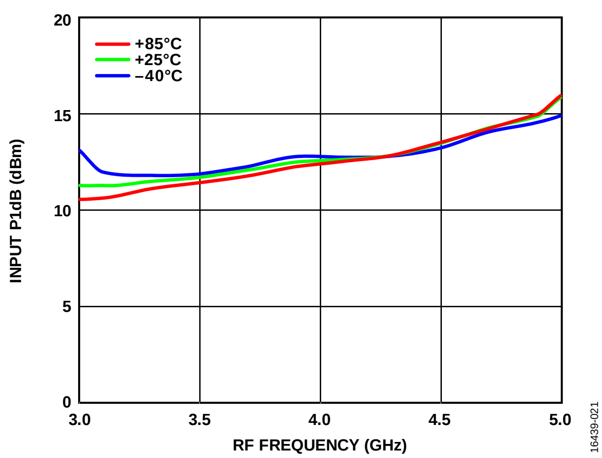


Figure 19. Input P1dB vs. RF Frequency at Various Temperatures, LO = 13 dBm

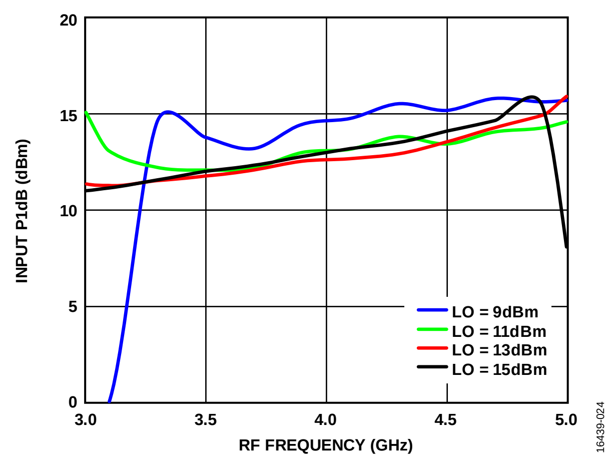


Figure 22. Input P1dB vs. RF Frequency at Various LO Power Levels, T_A = 25°C

IF_{OUT} = 1500 MHz, Lower Sideband

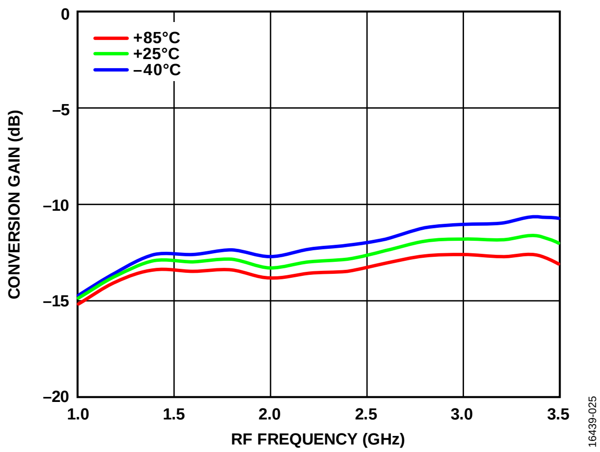


Figure 23. Conversion Gain vs. RF Frequency at Various Temperatures, LO = 13 dBm

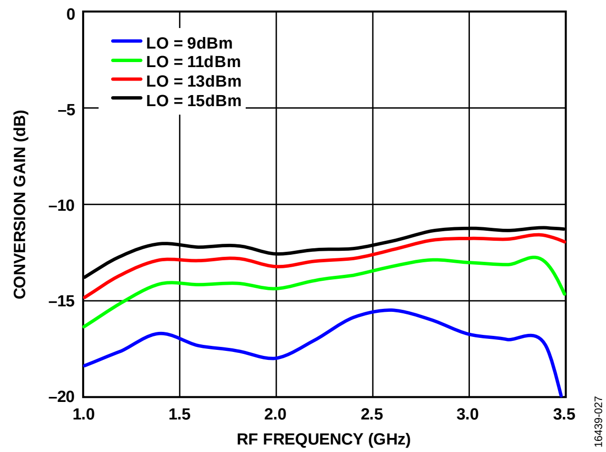


Figure 25. Conversion Gain vs. RF Frequency at Various LO Power Levels, T_A = 25°C

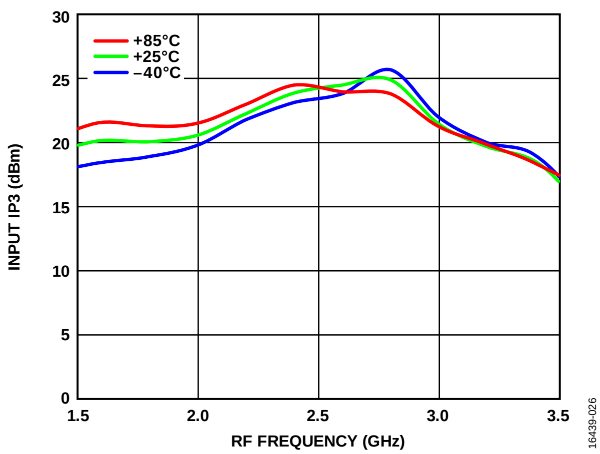


Figure 24. Input IP3 vs. RF Frequency at Various Temperatures, LO = 13 dBm

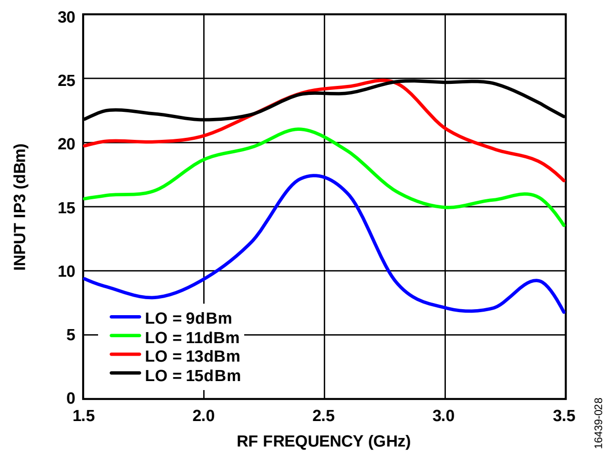


Figure 26. Input IP3 vs. RF Frequency at Various LO Power Levels, T_A = 25°C

UPCONVERTER PERFORMANCE

IF$_{IN}$ = 100 MHz, Upper Sideband

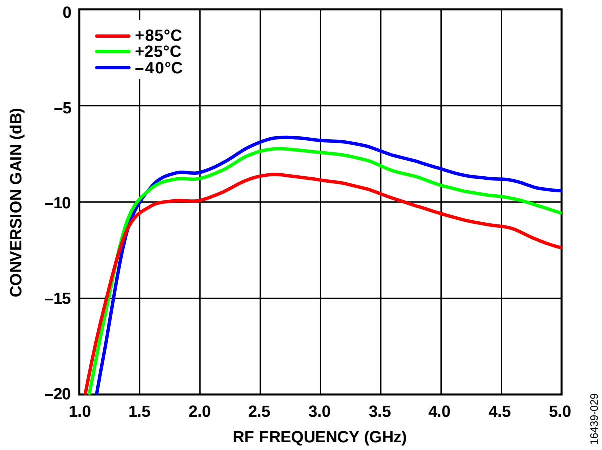


Figure 27. Conversion Gain vs. RF Frequency at Various Temperatures, LO = 13 dBm

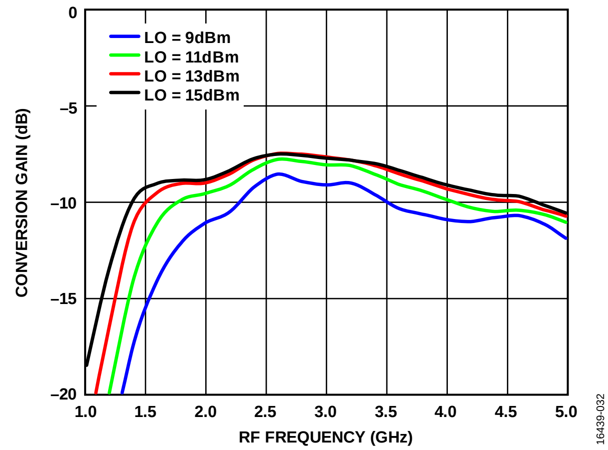


Figure 30. Conversion Gain vs. RF Frequency at Various LO Power Levels, T_A = 25°C

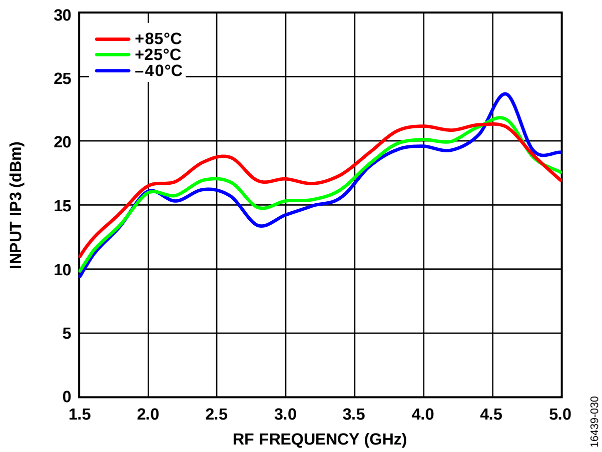


Figure 28. Input IP3 vs. RF Frequency at Various Temperatures, LO = 13 dBm

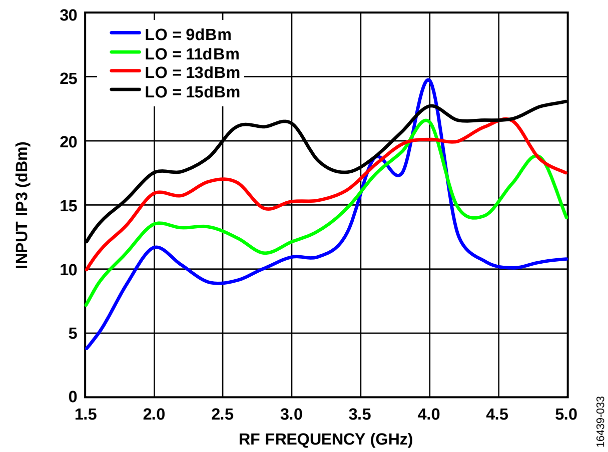


Figure 31. Input IP3 vs. RF Frequency at Various LO Power Levels, T_A = 25°C

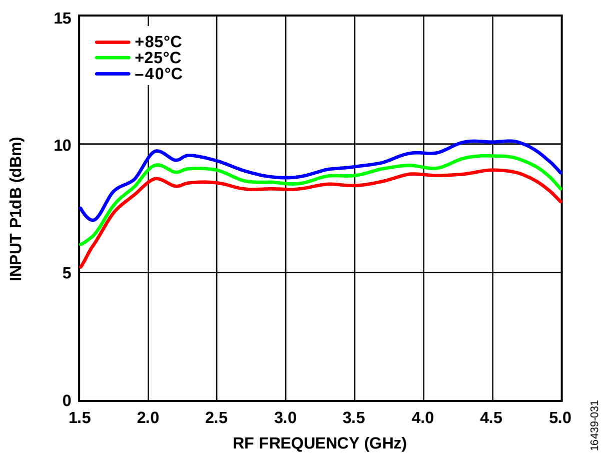


Figure 29. Input P1dB vs. RF Frequency at Various Temperatures, LO = 13 dBm

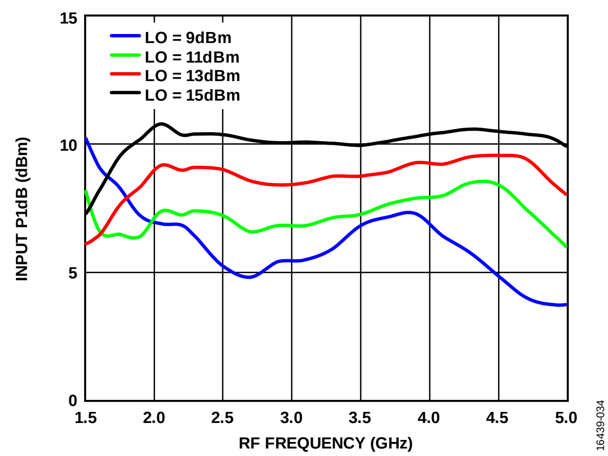


Figure 32. Input P1dB vs. RF Frequency at Various LO Power Levels, T_A = 25°C

IF_{IN} = 100 MHz, Lower Sideband

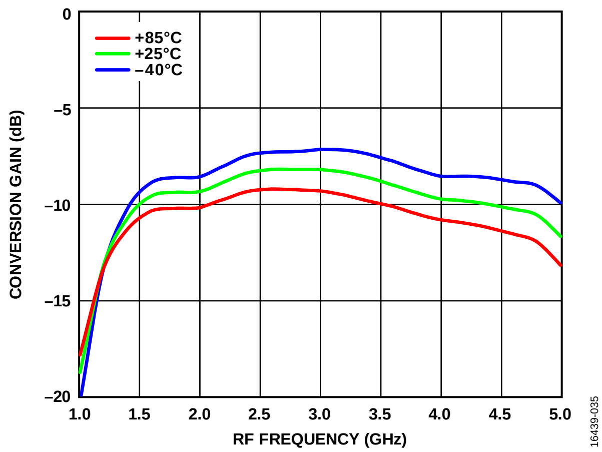


Figure 33. Conversion Gain vs. RF Frequency at Various Temperatures, LO = 13 dBm

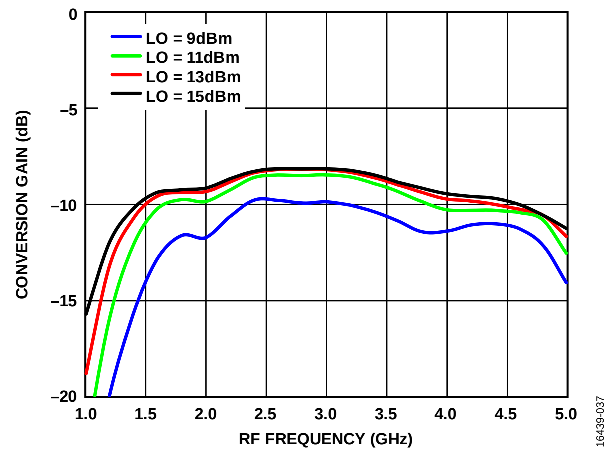


Figure 35. Conversion Gain vs. RF Frequency at Various LO Power Levels, T_A = 25°C

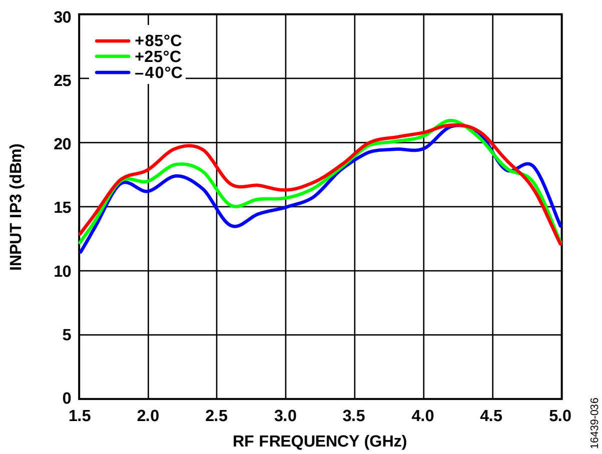


Figure 34. Input IP3 vs. RF Frequency at Various Temperatures, LO = 13 dBm

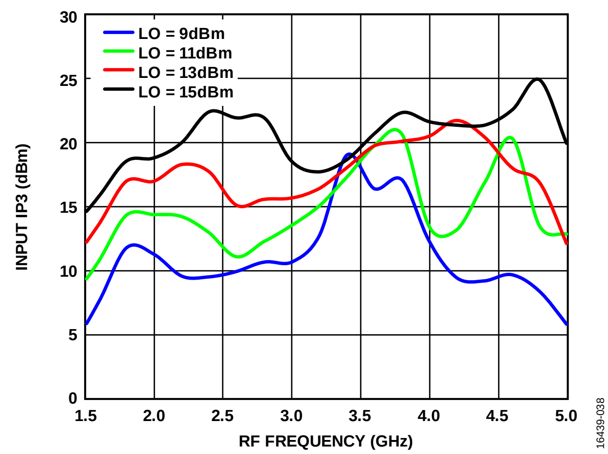


Figure 36. Input IP3 vs. RF Frequency at Various LO Power Levels, T_A = 25°C

IF_{IN} = 1500 MHz, Upper Sideband

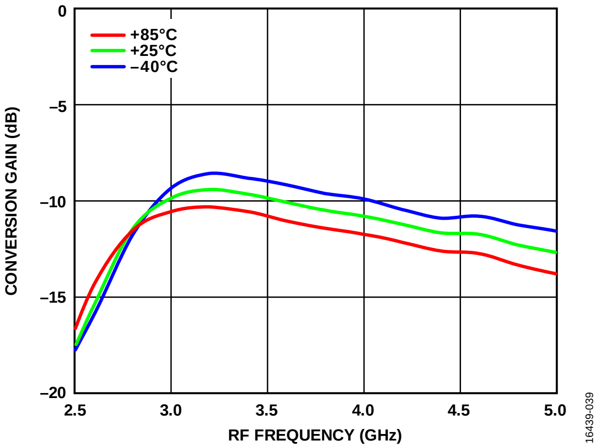


Figure 37. Conversion Gain vs. RF Frequency at Various Temperatures, LO = 13 dBm

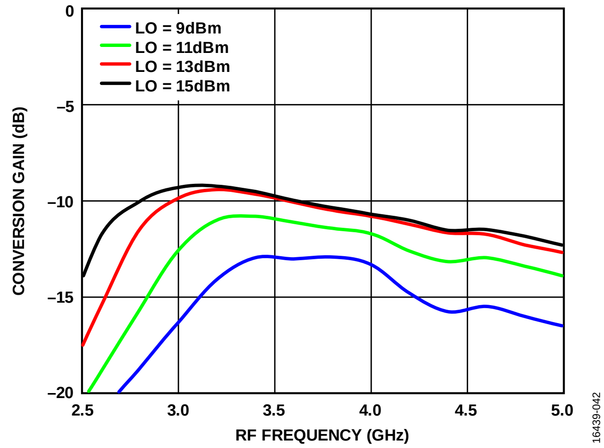


Figure 40. Conversion Gain vs. RF Frequency at Various LO Power Levels, T_A = 25°C

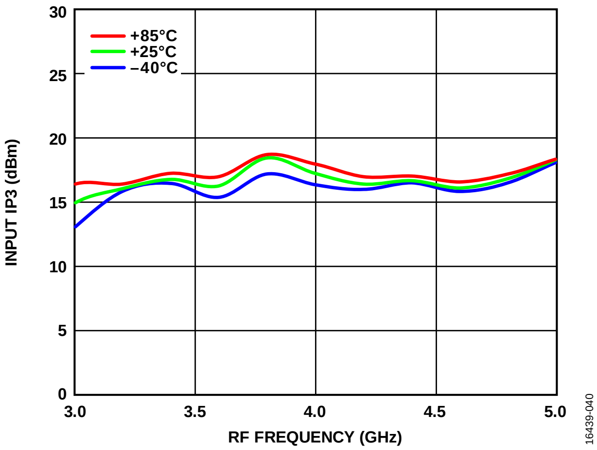


Figure 38. Input IP3 vs. RF Frequency at Various Temperatures, LO = 13 dBm

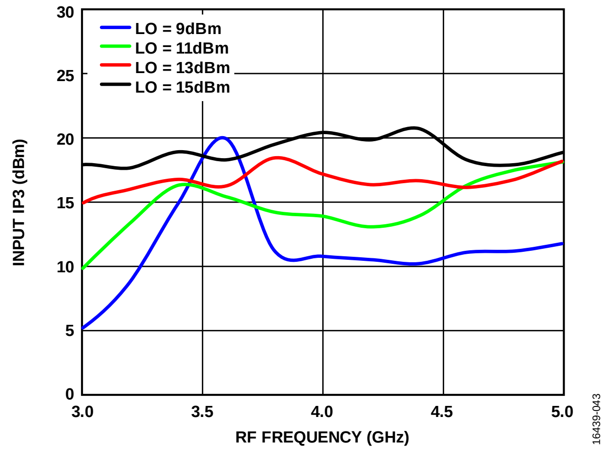


Figure 41. Input IP3 vs. RF Frequency at Various LO Power Levels, T_A = 25°C

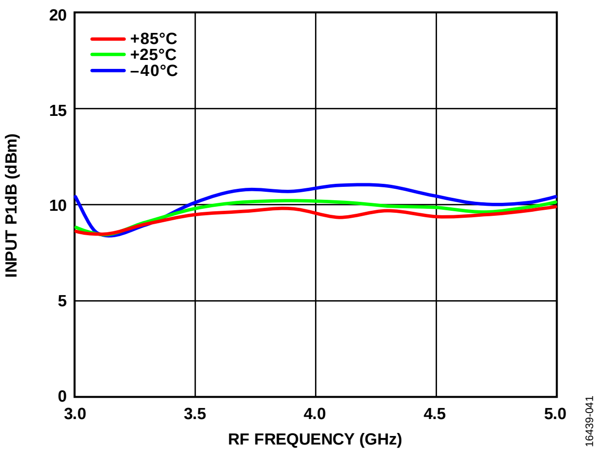


Figure 39. Input P1dB vs. RF Frequency at Various Temperatures, LO = 13 dBm

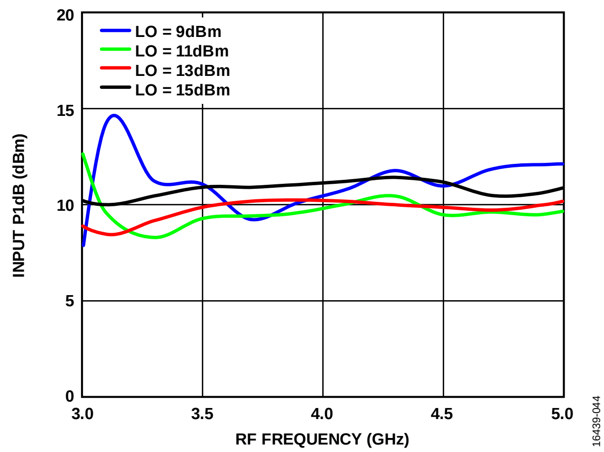


Figure 42. Input P1dB vs. RF Frequency at Various LO Power Levels, T_A = 25°C

IF_{IN} = 1500 MHz, Lower Sideband

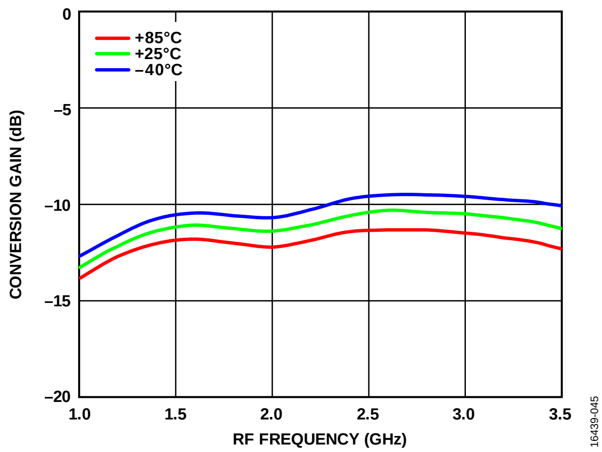


Figure 43. Conversion Gain vs. RF Frequency at Various Temperatures, LO = 13 dBm

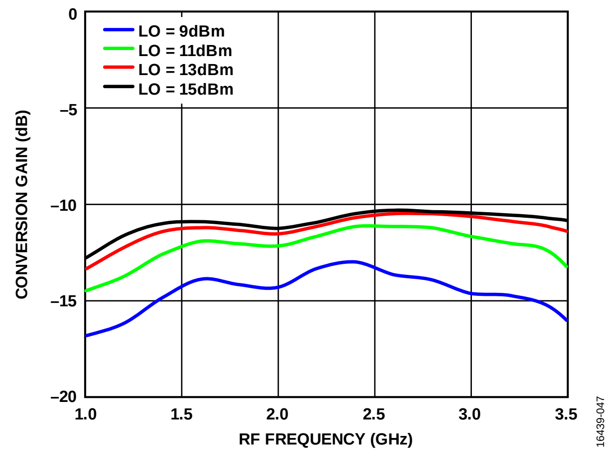


Figure 45. Conversion Gain vs. RF Frequency at Various LO Power Levels, T_A = 25°C

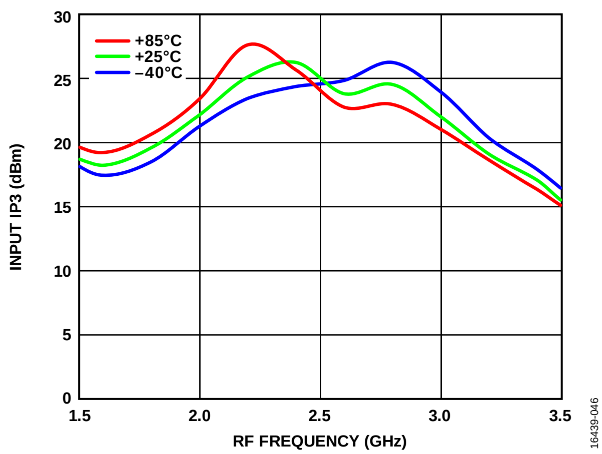


Figure 44. Input IP3 vs. RF Frequency at Various Temperatures, LO = 13 dBm

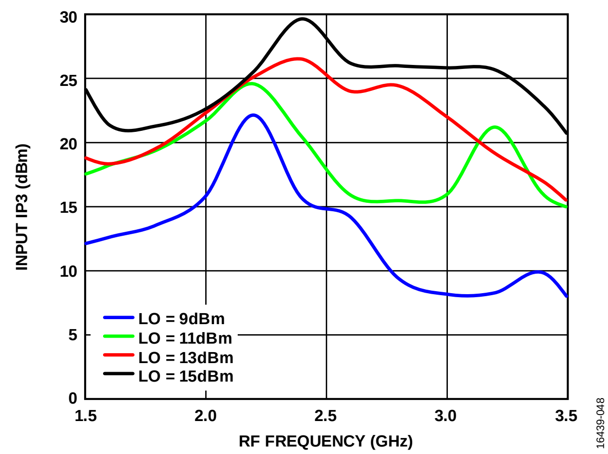


Figure 46. Input IP3 vs. RF Frequency at Various LO Power Levels, T_A = 25°C

ISOLATION AND RETURN LOSS

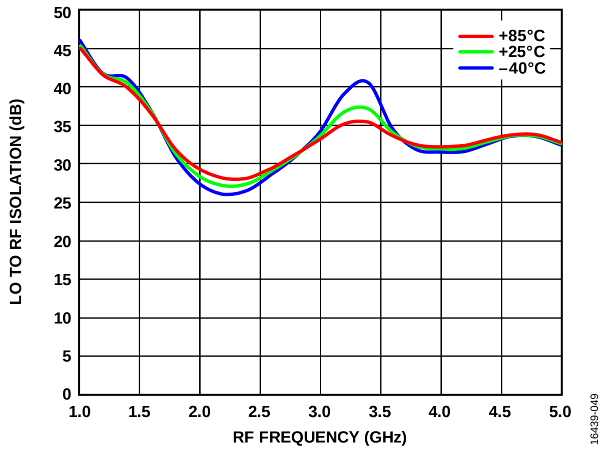


Figure 47. LO to RF Isolation vs. RF Frequency at Various Temperatures, LO = 13 dBm

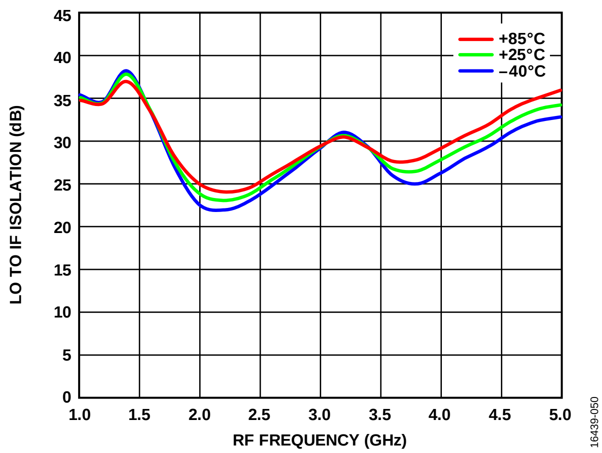


Figure 48. LO to IF Isolation vs. RF Frequency at Various Temperatures, LO = 13 dBm

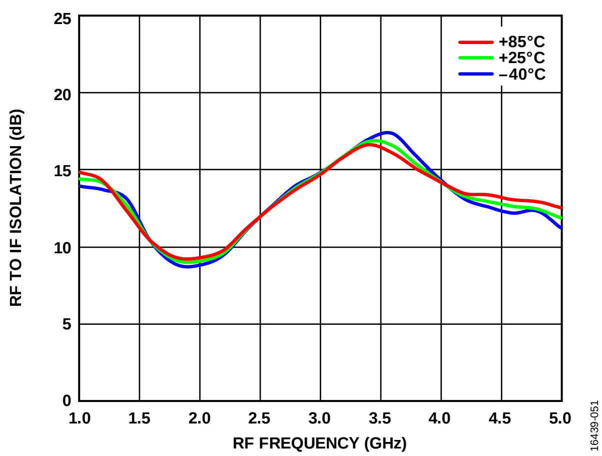


Figure 49. RF to IF Isolation vs. RF Frequency at Various Temperatures, LO = 13 dBm

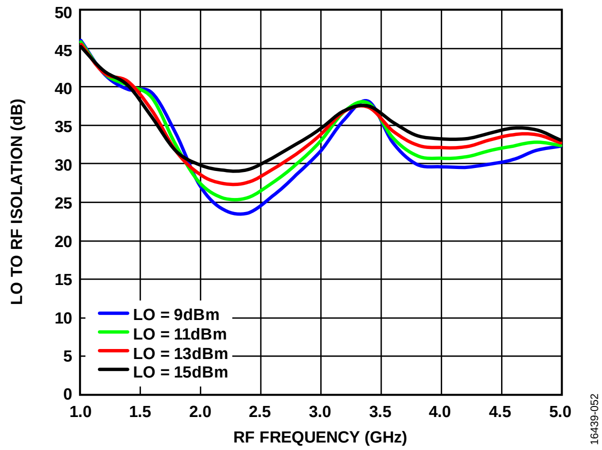


Figure 50. LO to RF Isolation vs. RF Frequency at Various LO Power levels, T_A = 25°C

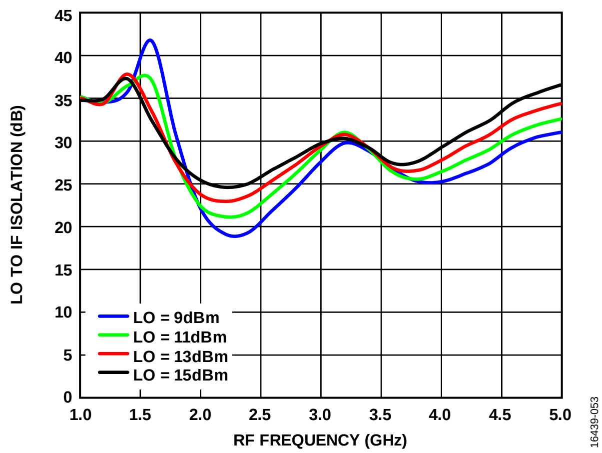


Figure 51. LO to IF Isolation vs. RF Frequency at Various LO Power Levels, T_A = 25°C

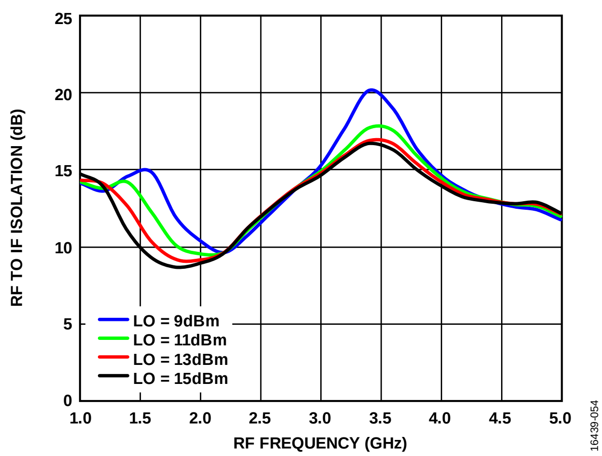


Figure 52. RF to IF Isolation vs. RF Frequency at Various LO Power Levels, T_A = 25°C

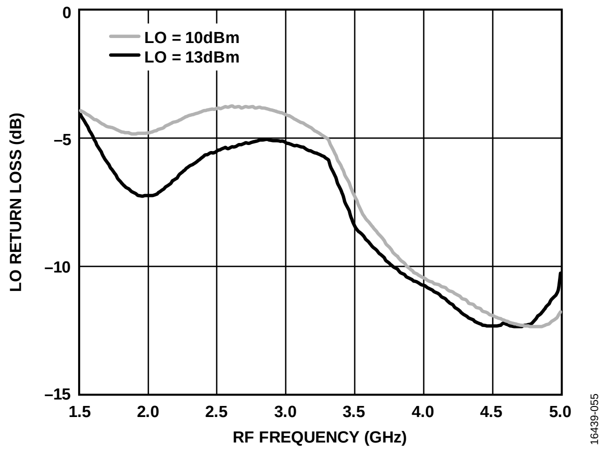


Figure 53. LO Return Loss vs. RF Frequency, T_A = 25°C, LO = 10 dBm and 13 dBm

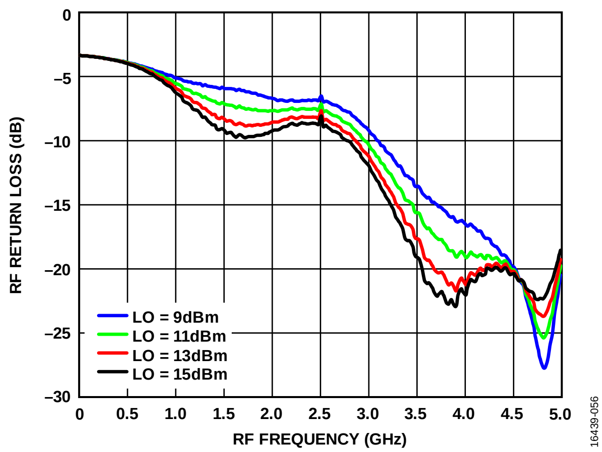


Figure 54. RF Return Loss vs. RF Frequency at Various LO Power Levels, LO at 2.5 GHz, T_A = 25°C

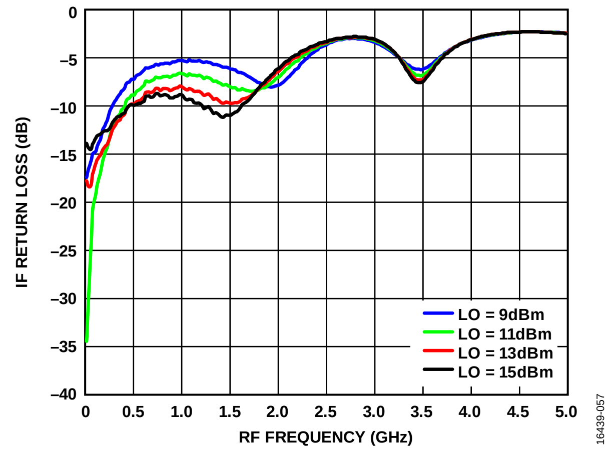


Figure 55. IF Return Loss vs. RF Frequency at Various LO Power Levels, LO at 2.5 GHz, T_A = 25°C

IF BANDWIDTH—DOWNCONVERTER

LO = 1.8 GHz

Upper sideband (low-side LO).

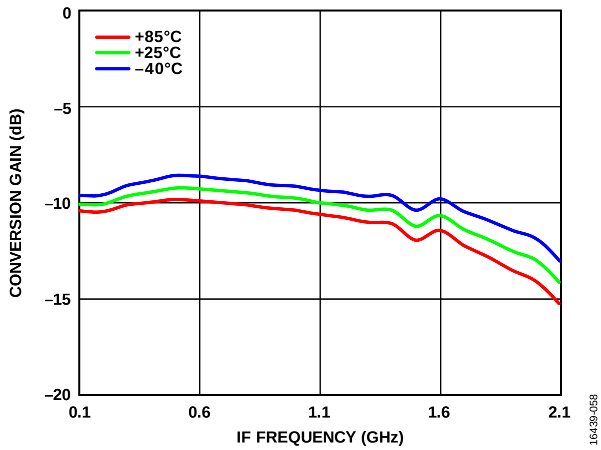


Figure 56. Conversion Gain vs. IF Frequency at Various Temperatures, LO = 13 dBm

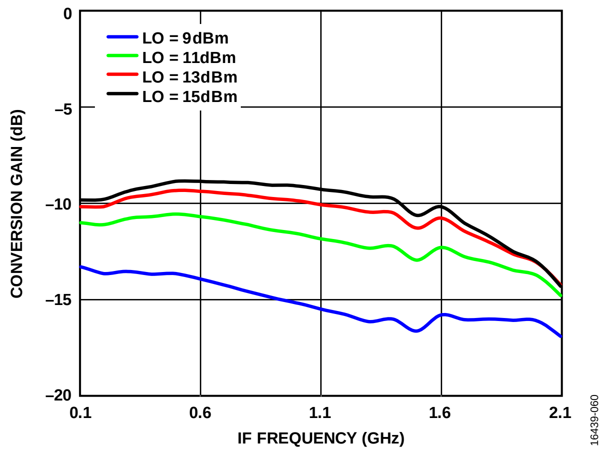


Figure 58. Conversion Gain vs. IF Frequency at Various LO Power Levels, T_A = 25°C

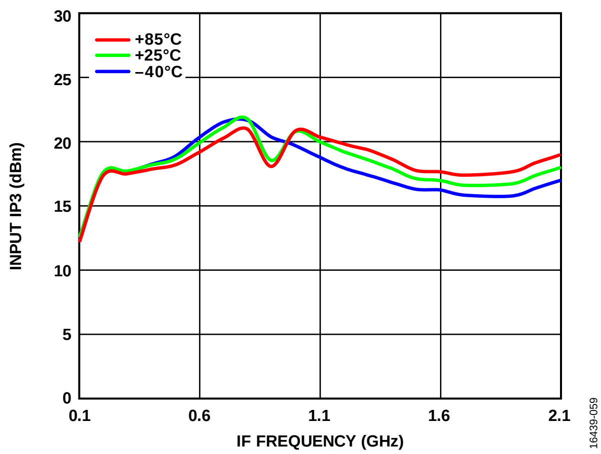


Figure 57. Input IP3 vs. IF Frequency at Various Temperatures, LO = 13 dBm

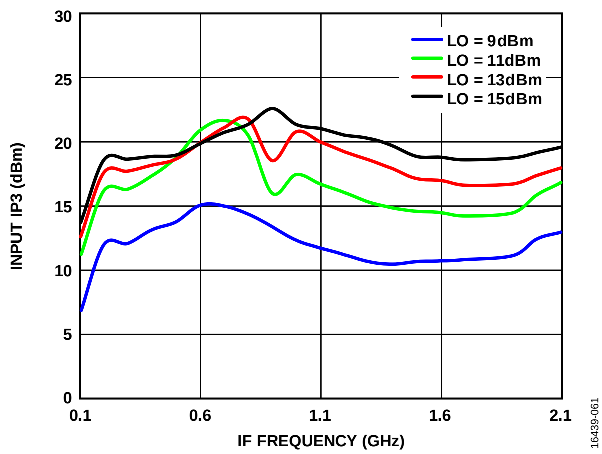


Figure 59. Input IP3 vs. IF Frequency at Various LO Power Levels, T_A = 25°C

LO = 4.4 GHz

Lower sideband (high-side LO).

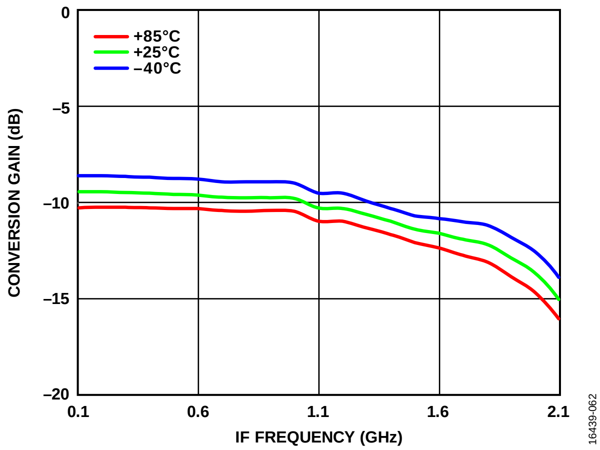


Figure 60. Conversion Gain vs. IF Frequency at Various Temperatures, LO = 13 dBm

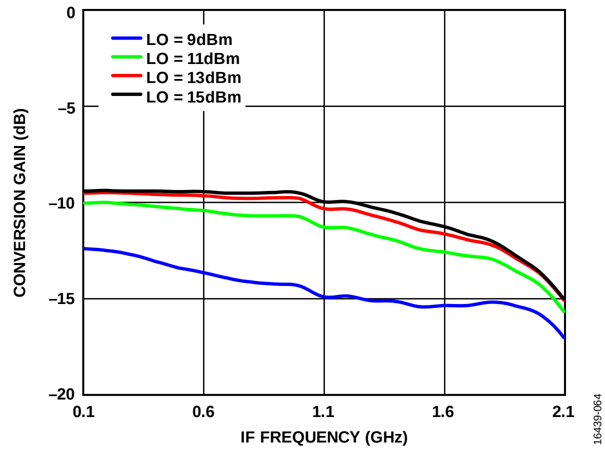


Figure 62. Conversion Gain vs. IF Frequency at Various LO Power Levels, T_A = 25°C

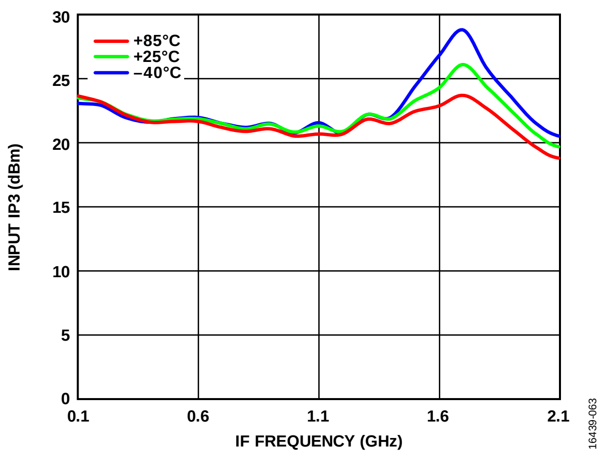


Figure 61. Input IP3 at vs. IF Frequency at Various Temperatures, LO = 13 dBm

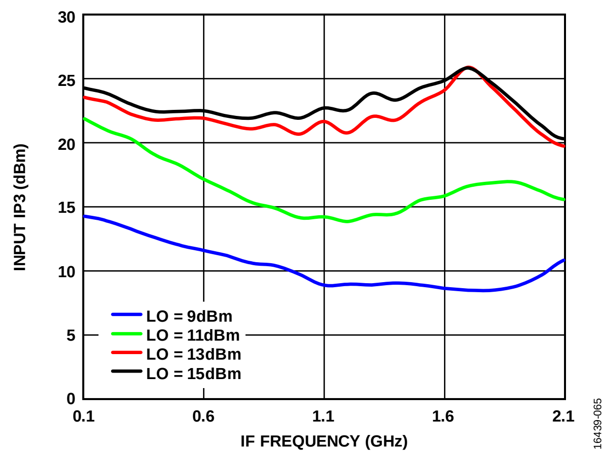


Figure 63. Input IP3 vs. IF Frequency at Various LO Power Levels, T_A = 25°C

SPURIOUS AND HARMONICS PERFORMANCE

Mixer spurious products are measured in dBc from either the RF pin or the IF pin output power level. N/A means not applicable.

LO Harmonics

LO = 13 dBm, and all values in dBc below input LO level and measured at RF port. N/A means not applicable.

Table 5. LO Harmonics at RF

	N × LO Spur at RF Port (dBc)			
LO Frequency (GHz)	**1**	**2**	**3**	**4**
1.5	37	41	57	77
2.0	28	27	49	60
2.5	29	26	45	51
3.0	31	31	35	49
3.5	32	38	50	48
4.0	31	37	39	63
4.5	34	36	40	58
5.0	34	40	46	59

Downconverter M × N Spurious Outputs

Spur values are (M × RF) − (N × LO).

RF = 3.5 GHz at −10 dBm, LO = 3.6 GHz at 13 dBm.

		N × LO				
		0	**1**	**2**	**3**	**4**
M × RF	**0**	N/A	−6	+5	+17	+25
	1	+6	0	+29	+37	+42
	2	+63	+55	+55	+55	+66
	3	+80	+78	+77	+83	+79
	4	+77	+79	+79	+82	+86

Upconverter M × N Spurious Outputs

Spur values are (M × IF_{IN}) + (N × LO).

IF_{IN} = 100 MHz at −10 dBm, LO = 3.6 GHz at 13 dBm.

		N × LO				
		0	**1**	**2**	**3**	**4**
M × IF	**−4**	88	84	82	81	77
	−3	89	73	79	79	78
	−2	77	51	59	64	59
	−1	38	0	42	37	40
	0	N/A	0	8	20	19
	+1	38	0	44	36	40
	+2	76	51	61	64	60
	+3	90	66	79	79	79
	+4	89	81	79	80	79

THEORY OF OPERATION

The HMC213BMS8E is an ultraminiature, double balanced mixer that can be used as an upconverter or a downconverter from 1.5 GHz to 4.5 GHz.

When used as a downconverter, the HMC213BMS8E downconverts RF values between 1.5 GHz and 4.5 GHz to IF values between dc and 1.5 GHz.

When used as an upconverter, the mixer upconverts IF values between dc and 1.5 GHz to RF between 1.5 GHz and 4.5 GHz

APPLICATIONS INFORMATION

TYPICAL APPLICATION CIRCUIT

Figure 64 shows the typical application circuit for the HMC213BMS8E. The HMC213BMS8E is a passive device and does not require any external components. The LO and RF pins are internally ac-coupled. The IF pin is internally dc-coupled. When IF operation to dc is not required, use of an external series capacitor of a value chosen to pass the necessary IF frequency range is recommended. When IF operation to dc is required, do not exceed the IF source and sink current rating specified in the Absolute Maximum Ratings section.

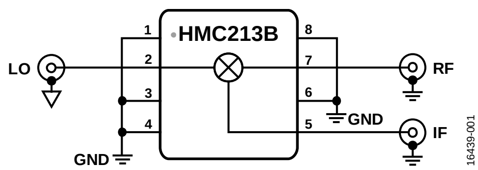


Figure 64. Typical Application Circuit

EVALUATION PCB INFORMATION

Use RF circuit design techniques for the PCB. Ensure that signal lines have 50 Ω impedance. Connect the package ground leads directly to the ground plane (see Figure 65). Use a sufficient number of via holes to connect the top and bottom ground planes. The evaluation circuit board shown in Figure 65 is available from Analog Devices, Inc., upon request.

Table 6. Bill of Materials

Item	Description
J1, J2, J3	PCB mount SMA RF connectors
U1	HMC213BMS8E
PCB[1]	101650-6 evaluation board on Rogers 4350

[1] 101650-6 is the raw bare PCB identifier. Reference EV1HMC213BMS8 when ordering the complete evaluation PCB.

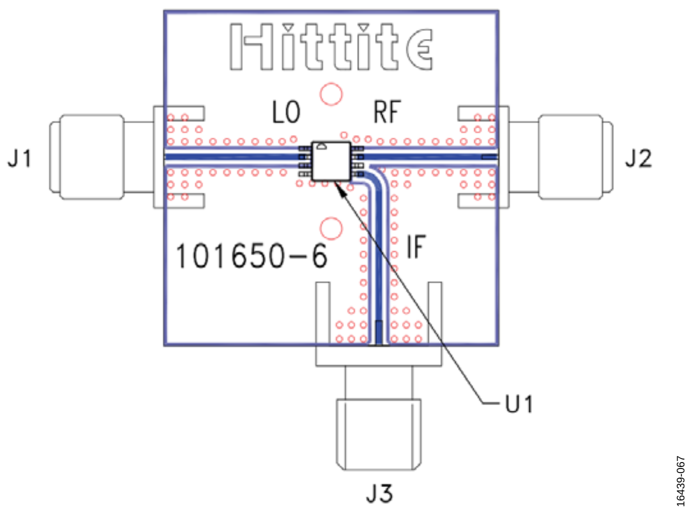


Figure 65. Evaluation PCB Top Layer

OUTLINE DIMENSIONS

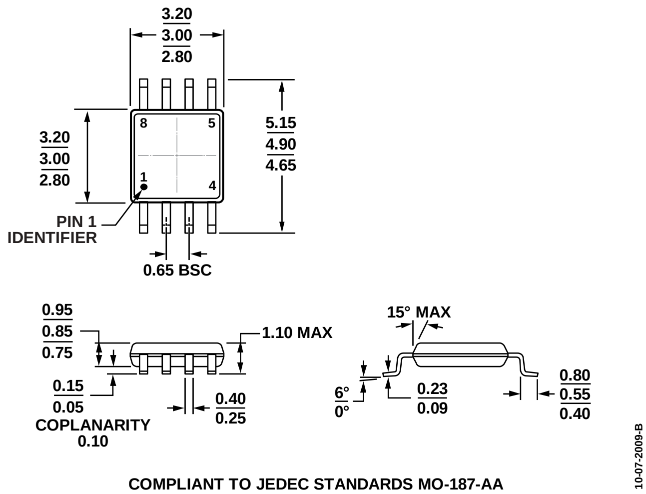


Figure 66. 8-Lead Mini Small Outline Package [MSOP]
(RM-8)
Dimensions shown in millimeters

ORDERING GUIDE

Model[1]	Temperature Range	Moisture Sensitivity Level (MSL) Rating	Package Description	Package Option
HMC213BMS8E	−40°C to +85°C	MSL1	8-Lead Mini Small Outline Package [MSOP]	RM-8
HMC213BMS8ETR	−40°C to +85°C	MSL1	8-Lead Mini Small Outline Package [MSOP]	RM-8
EV1HMC213BMS8			Evaluation PCB	

[1] The HMC213BMS8E and HMC213BMS8ETR are RoHS compliant parts.
[1] The peak reflow temperature is 260°C. See Table 2 in the Absolute Maximum Ratings section.