GaAs MMIC Fundamental Mixer, 6 GHz to 26 GHz

Data Sheet **HMC773A**

FEATURES

Conversion loss: 9 dB
Local oscillator (LO) to radio frequency (RF) isolation: 37 dB
LO to intermediate frequency (IF) isolation: 37 dB
RF to intermediate frequency (IF) isolation: 20 dB
Input third-order intercept (IP3): 20 dBm
Input second-order intercept (IP3): 50 dBm
Input power for 1 dB compression (P1dB): 10 dBm
IF bandwidth: dc to 8 GHz
Passive: no dc bias required
12-lead ceramic, 3 mm × 3 mm LCC package

APPLICATIONS

Point-to-point radios
Point-to-multipoint radios and VSAT
Test equipment and sensors
Military end use

GENERAL DESCRIPTION

The HMC773A is a general-purpose, double balanced mixer in a leadless RoHS compliant LCC package that can be used as an upconverter or downconverter from 6 GHz to 26 GHz. This mixer requires no external components or matching circuitry.

The HMC773A provides excellent LO to RF and LO to IF suppression due to optimized balun structures. The mixer operates with LO drive levels above 13 dBm. The HMC773A eliminates the need for wire bonding, allowing use of surface-mount manufacturing techniques.

FUNCTIONAL BLOCK DIAGRAM

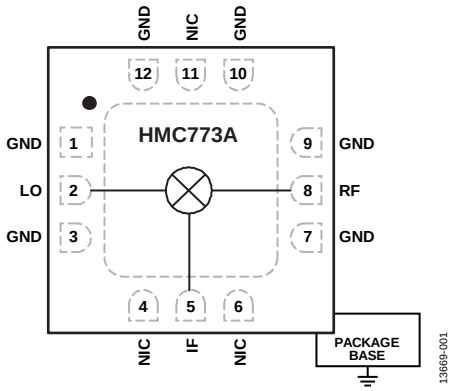

Figure 1.

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Technical Support **www.analog.com**

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REVISION HISTORY

9/15—v.00.0715 to Rev. A

This Hittite Microwave Products data sheet has been reformatted to meet the styles and standards of Analog Devices, Inc.

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SPECIFICATIONS

ELECTRICAL SPECIFICATIONS

T_A = 25°C, IF = 500 MHz, LO drive = 13 dBm, RF frequency range = 6.0 GHz to 16.0 GHz, all measurements performed as a downconverter with the upper sideband selected, unless otherwise noted.

Table 1.

Parameter	Symbol	Min	Typ	Max	Unit
FREQUENCY RANGE					
Radio Frequency	RF	6		16	GHz
Local Oscillator	LO	6		16	GHz
Intermediate Frequency	IF	dc		8	GHz
CONVERSION LOSS			9	12	dB
ISOLATION					
LO to RF		31	37		dB
LO to IF		31	37		dB
RF to IF		5	11		dB
INPUT THIRD-ORDER INTERCEPT	IP3	13	17		dBm
INPUT SECOND-ORDER INTERCEPT	IP2		45		dBm
INPUT POWER					
1 dB Compression	P1dB		10		dBm
RETURN LOSS					
RF Port			12		dB
LO Port			12		dB

T_A = 25°C, IF = 500 MHz, LO drive = 13 dBm, RF frequency range = 16.0 GHz to 26.0 GHz, all measurements performed as a downconverter with the upper sideband selected, unless otherwise noted.

Table 2.

Parameter	Symbol	Min	Typ	Max	Unit
FREQUENCY RANGE					
Radio Frequency	RF	16		26	GHz
Local Oscillator	LO	16		26	GHz
Intermediate Frequency	IF	dc		8	GHz
CONVERSION LOSS			9	12	dB
ISOLATION					
LO to RF		31	37		dB
LO to IF		31	37		dB
RF to IF		10	20		dB
INPUT THIRD-ORDER INTERCEPT	IP3	15	20		dBm
INPUT SECOND-ORDER INTERCEPT	IP2		50		dBm
INPUT POWER					
1 dB Compression	P1dB		10		dBm
RETURN LOSS					
RF Port			10		dB
LO Port			12		dB

ABSOLUTE MAXIMUM RATINGS

Table 3.

Parameter	Rating
RF Input Power	21 dBm
LO Input Power	21 dBm
Channel Temperature	175°C
Continuous P_{DISS} (T = 85°C) (Derate 4.44 mw/°C Above 85°C)	400 mW
Thermal Resistance (Channel to Ground Paddle)	225°C/W
Maximum Peak Reflow Temperature	260°C
Storage Temperature Range	−65°C to +150°C
Operating Temperature Range	−40°C to +85°C
ESD Sensitivity (Human Body Model)	2000 V (Class 2)

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.

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

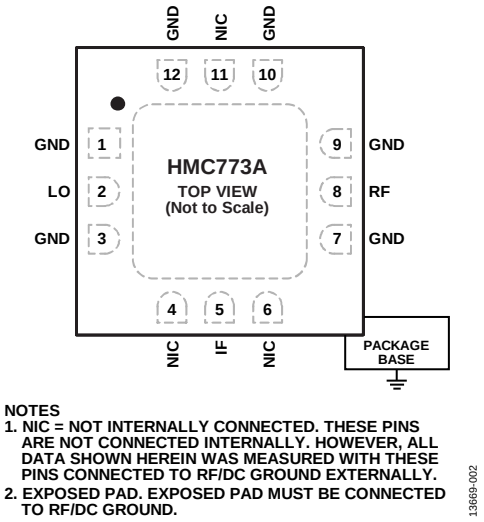


Figure 2. Pin Configuration

Table 4. Pin Function Descriptions

Pin No.	Mnemonic	Description
1, 3, 7, 9, 10, 12	GND	Ground. Connect these pins and package bottom to RF/dc ground. See Figure 3 for the GND interface schematic.
2	LO	Local Oscillator Port. This pin is ac-coupled and matched to 50 Ω. See Figure 4 for the LO interface schematic.
4, 6, 11	NIC	Not Internally Connected. These pins are not connected internally. However, all data shown herein was measured with these pins connect to RF/dc ground externally.
5	IF	Intermediate Frequency Port. This pin is dc-coupled. For applications not requiring operation to dc, block this pin externally using a series capacitor with a value that passes the necessary IF frequency range. For operation to dc, to prevent device malfunction or failure, this pin must not source or sink more than 2 mA of current. See Figure 5 for the IF interface schematic.
8	RF	Radio Frequency Port. This pin is ac-coupled and matched to 50 Ω. See Figure 6 for the RF interface schematic.
	EP	Exposed Pad. The exposed pad must be connected to RF/dc ground.

INTERFACE SCHEMATICS

Figure 3. GND Interface

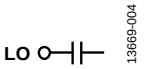


Figure 4. LO Interface

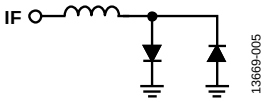


Figure 5. IF Interface

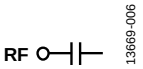


Figure 6. RF Interface

TYPICAL PERFORMANCE CHARACTERISTICS

DOWNCONVERTER, UPPER SIDEBAND, IF = 500 MHz

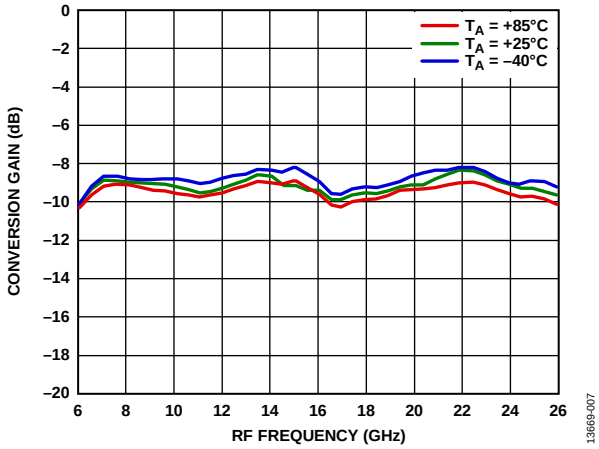


Figure 7. Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

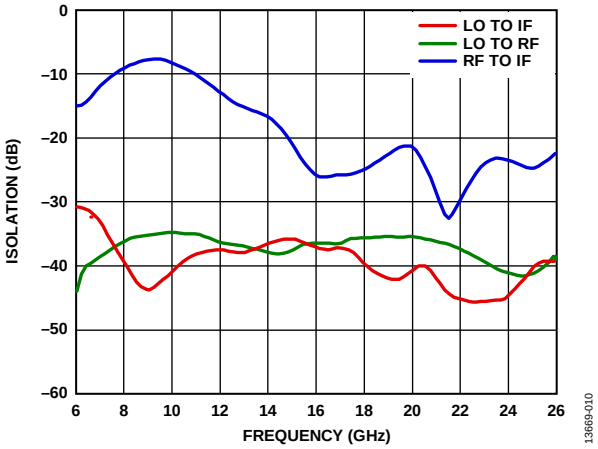


Figure 10. Isolation vs. Frequency

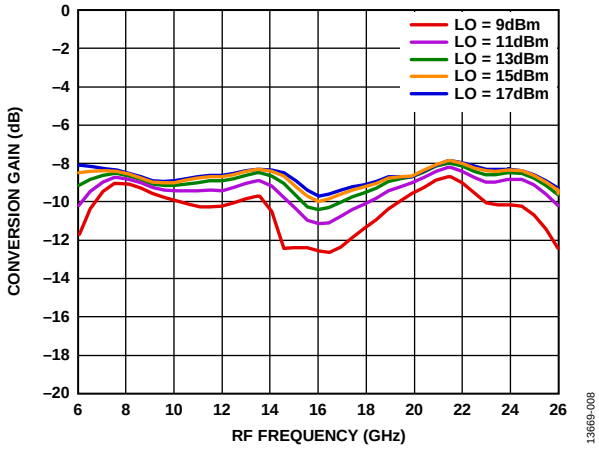


Figure 8. Conversion Gain vs. RF Frequency at Various LO Drives

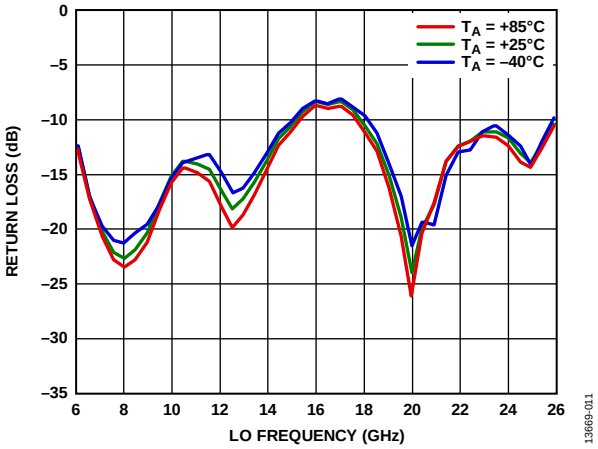


Figure 11. LO Port Return Loss vs. LO Frequency, LO Drive = 13 dBm

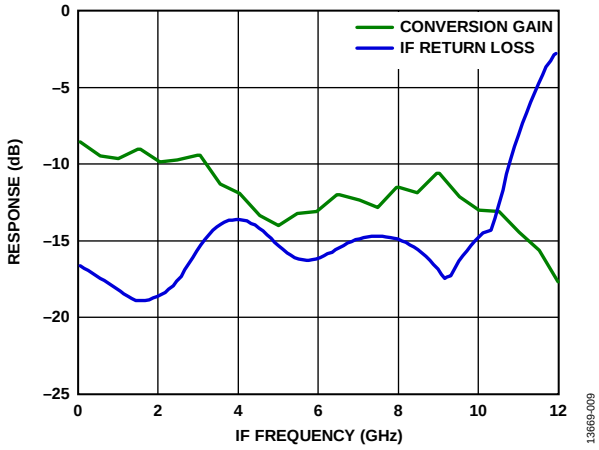


Figure 9. Conversion Gain and IF Return Loss Response vs. IF Frequency, LO Drive = 13 dBm

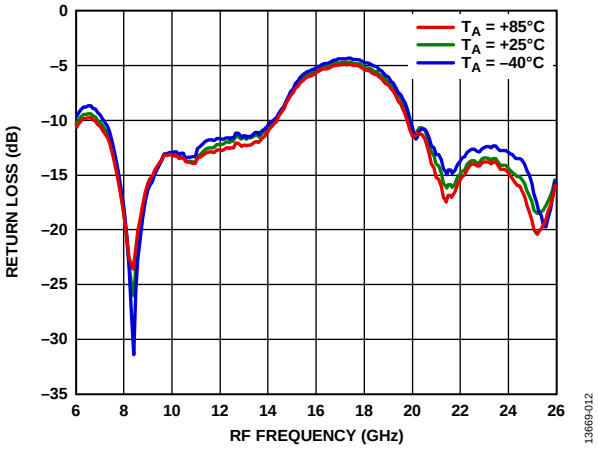


Figure 12. RF Port Return Loss vs. RF Frequency, LO Frequency = 16 GHz, LO Drive = 13 dBm

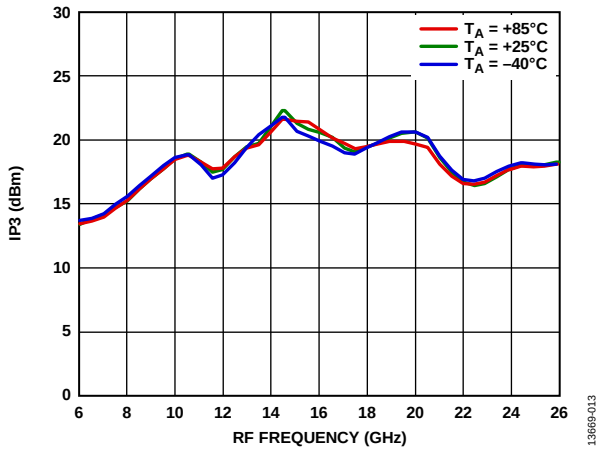
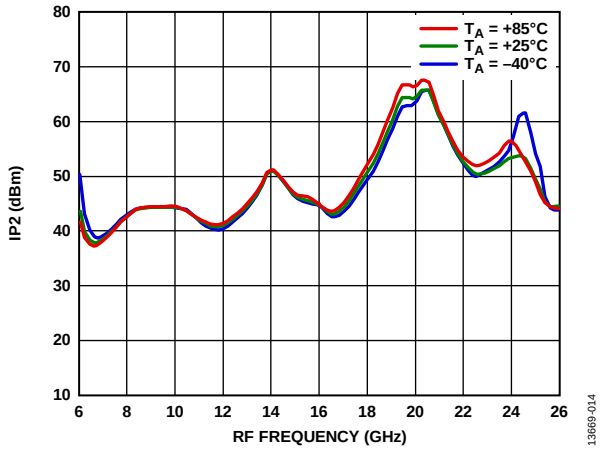


Figure 13. Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm



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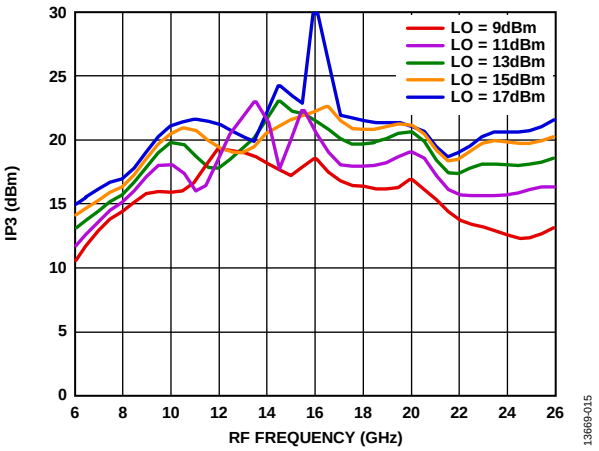

Figure 15. Input IP3 vs. RF Frequency at Various LO Drives

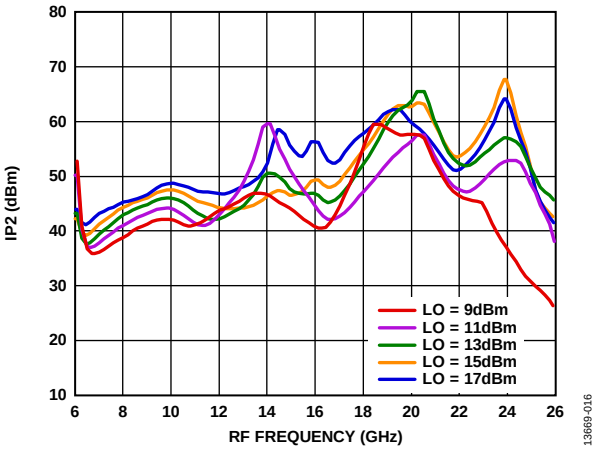

Figure 16. Input IP2 vs. RF Frequency at Various LO Drives

DOWNCONVERTER, UPPER SIDEBAND, IF = 3000 MHz

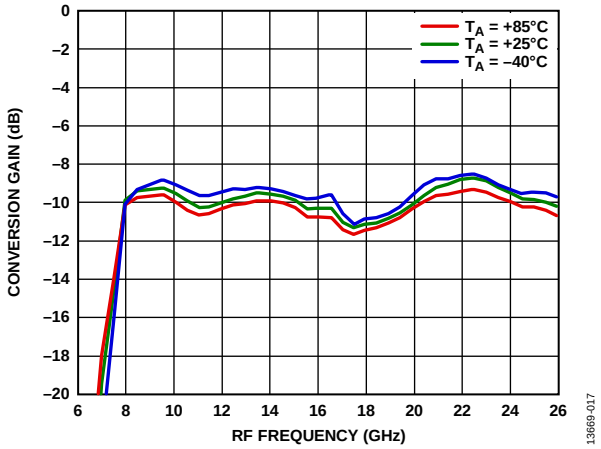

Figure 17. Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

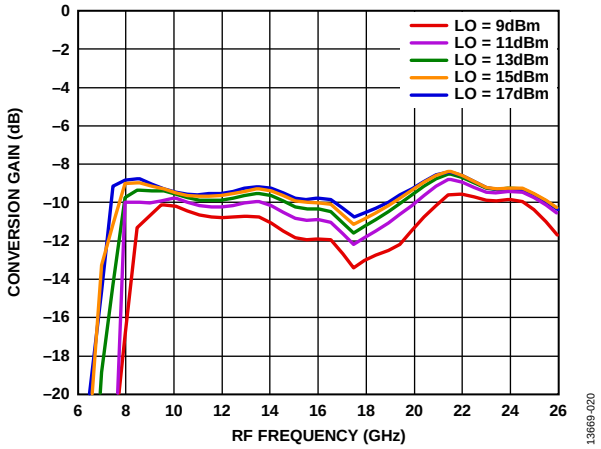

Figure 20. Conversion Gain vs. RF Frequency at Various LO Drives

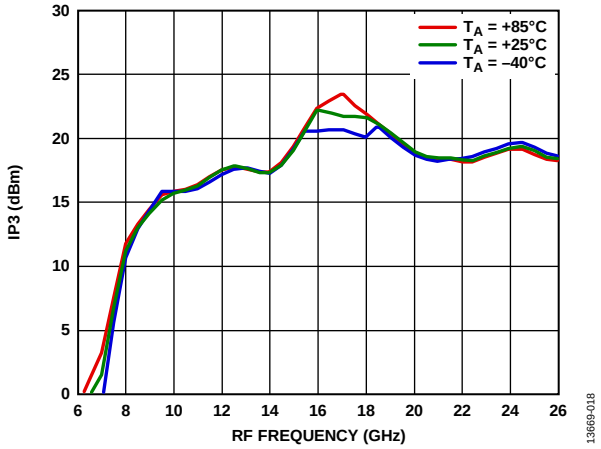

Figure 18. Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

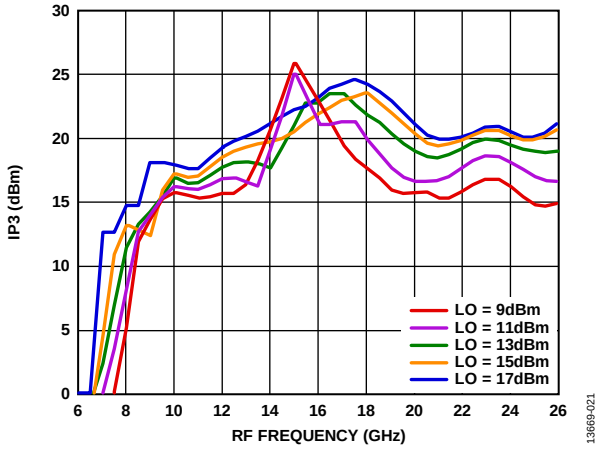

Figure 21. Input IP3 vs. RF Frequency at Various LO Drives

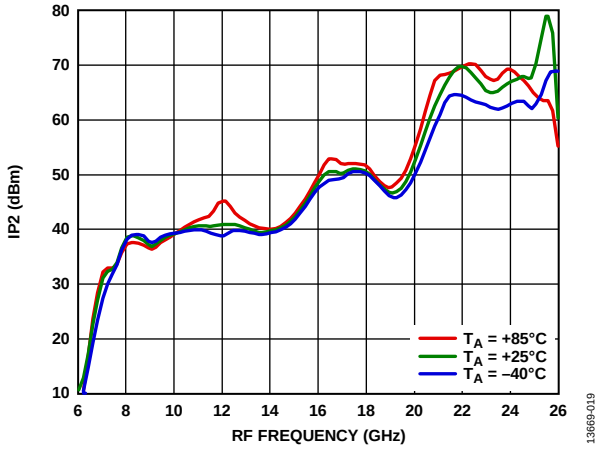

Figure 19. Input IP2 vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

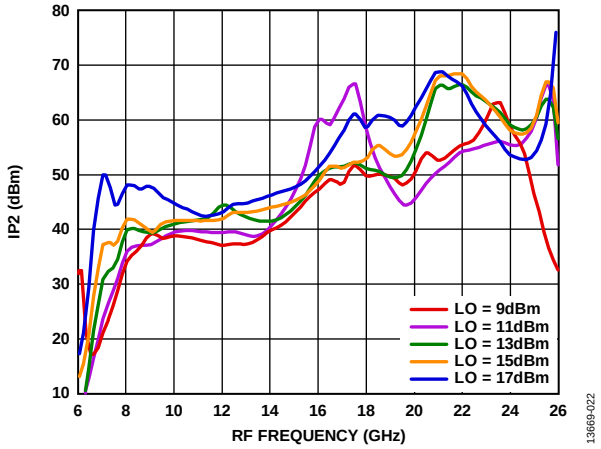

Figure 22. Input IP2 vs. RF Frequency at Various LO Drives

DOWNCONVERTER, UPPER SIDEBAND, IF = 7000 MHz

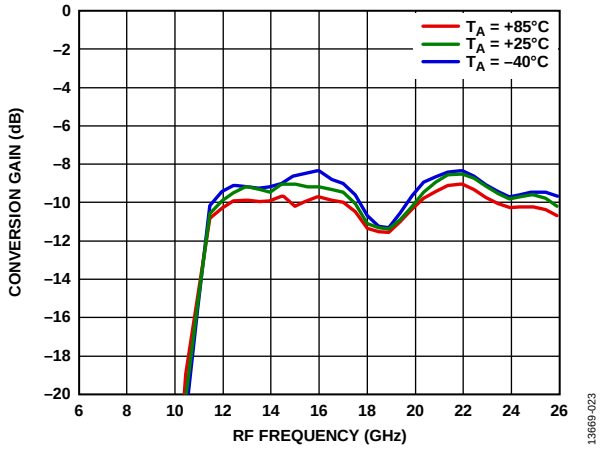

Figure 23. Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

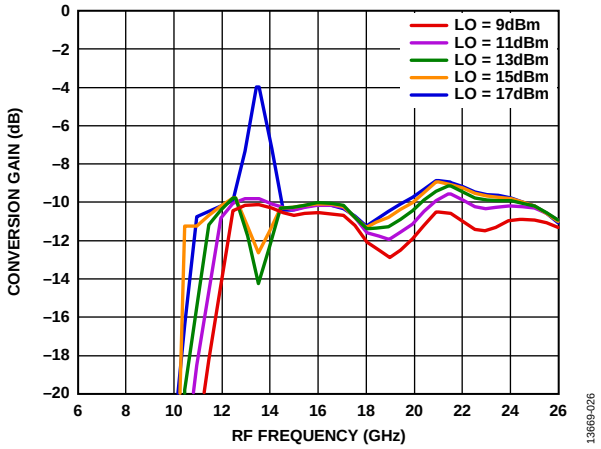

Figure 26. Conversion Gain vs. RF Frequency at Various LO Drives

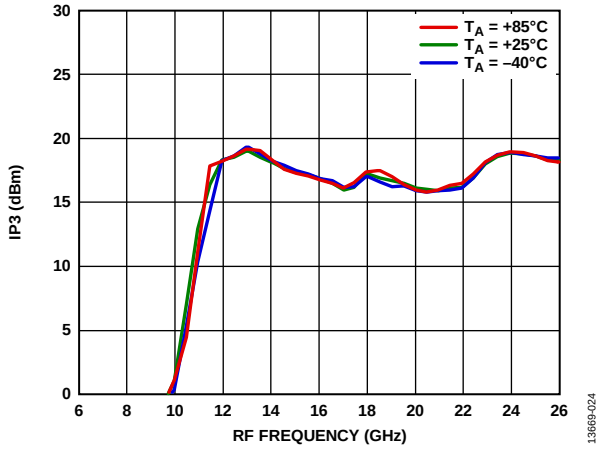

Figure 24. Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

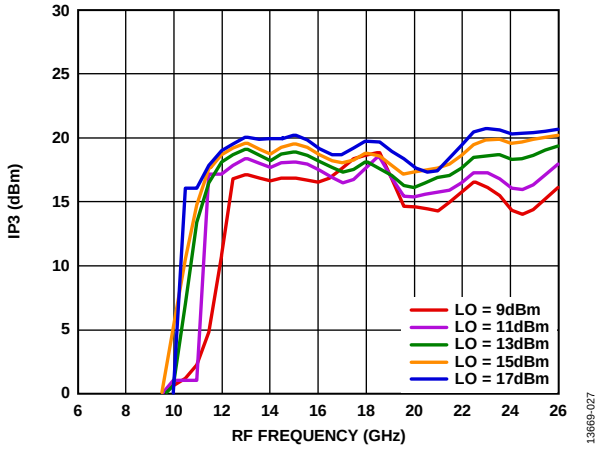

Figure 27. Input IP3 vs. RF Frequency at Various LO Drives

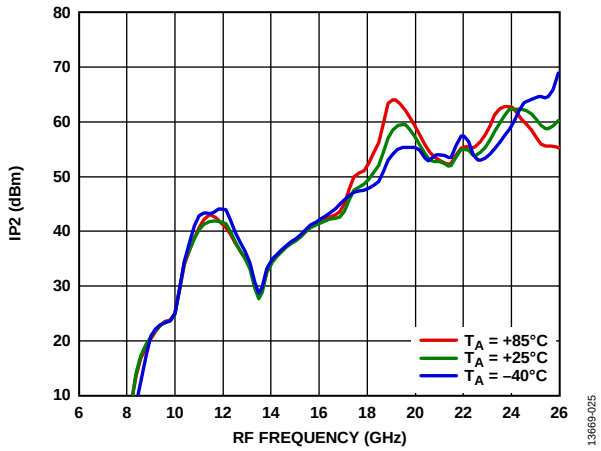

Figure 25. Input IP2 vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

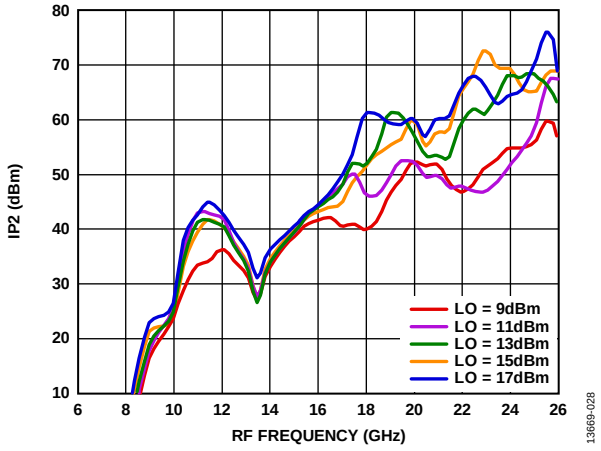

Figure 28. Input IP2 vs. RF Frequency at Various LO Drives

DOWNCONVERTER, LOWER SIDEBAND, IF = 500 MHz

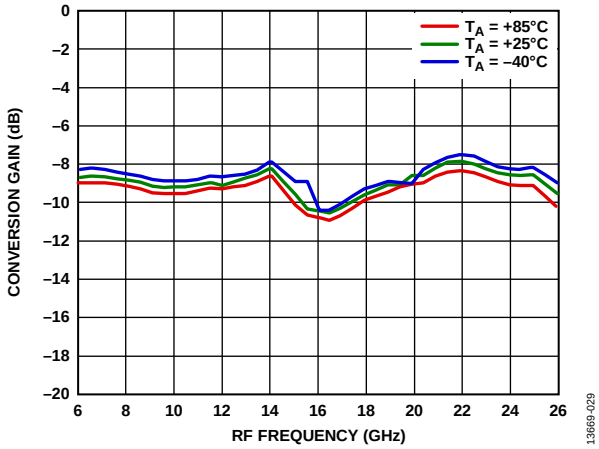

Figure 29. Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

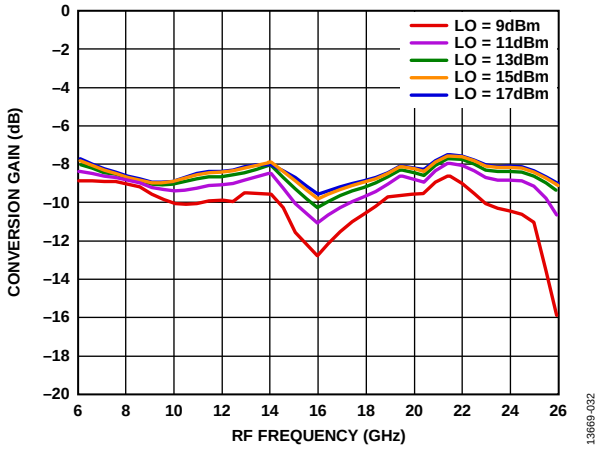

Figure 32. Conversion Gain vs. RF Frequency at Various LO Drives

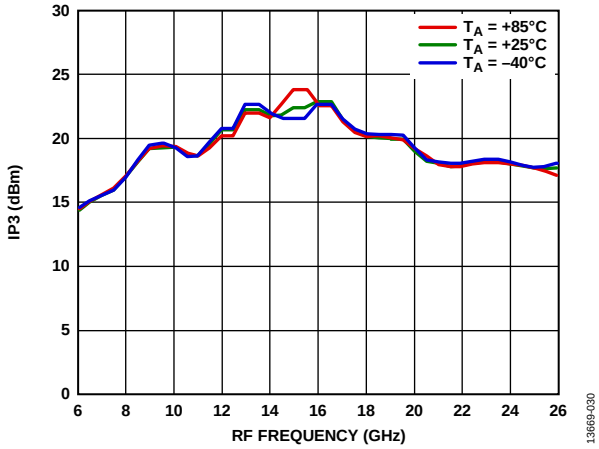

Figure 30. Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

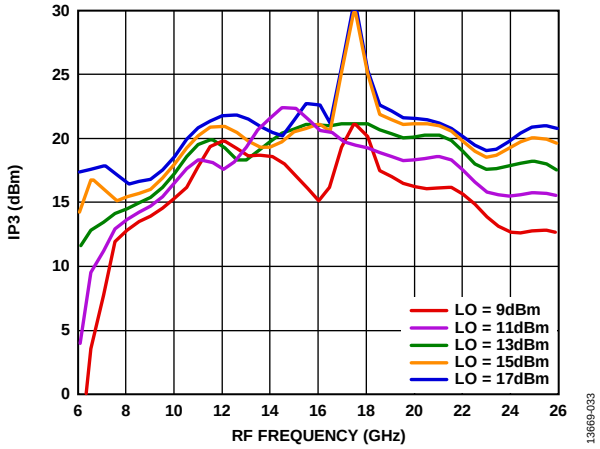

Figure 33. Input IP3 vs. RF Frequency at Various LO Drives

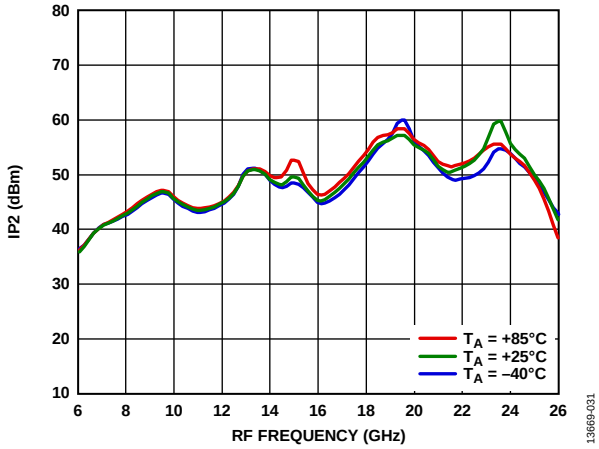

Figure 31. Input IP2 vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

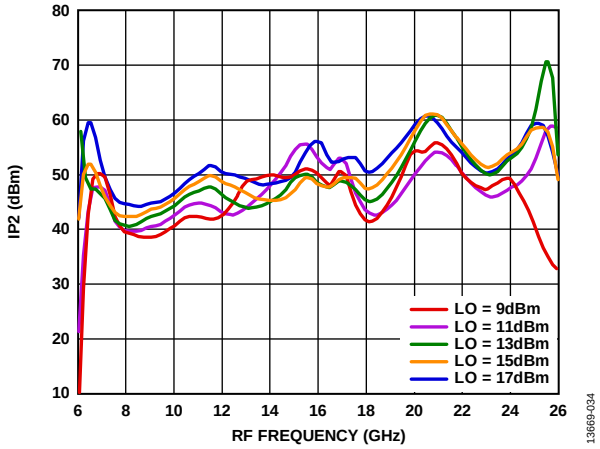

Figure 34. Input IP2 vs. RF Frequency at Various LO Drives

DOWNCONVERTER, LOWER SIDEBAND, IF = 3000 MHz

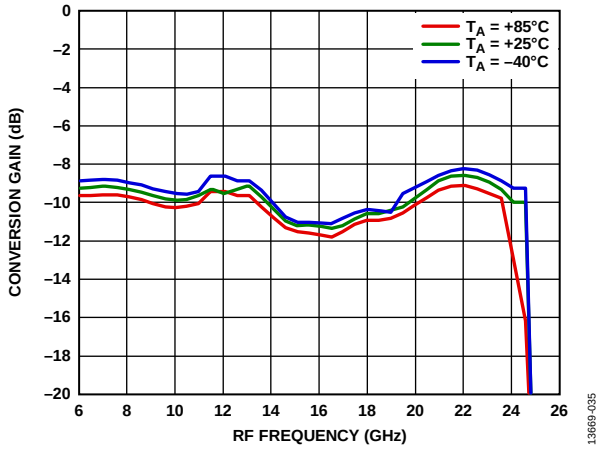

Figure 35. Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

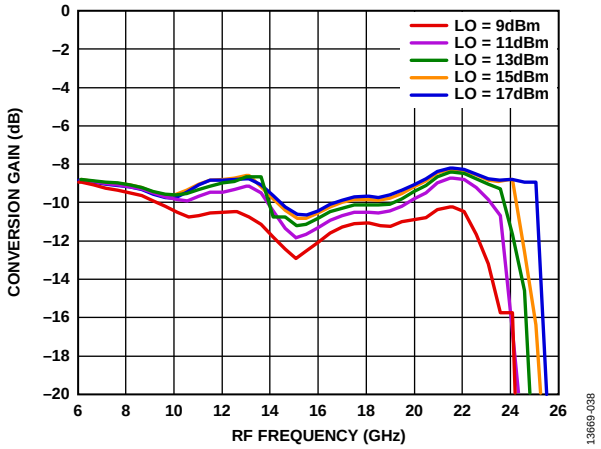

Figure 38. Conversion Gain vs. RF Frequency at Various LO Drives

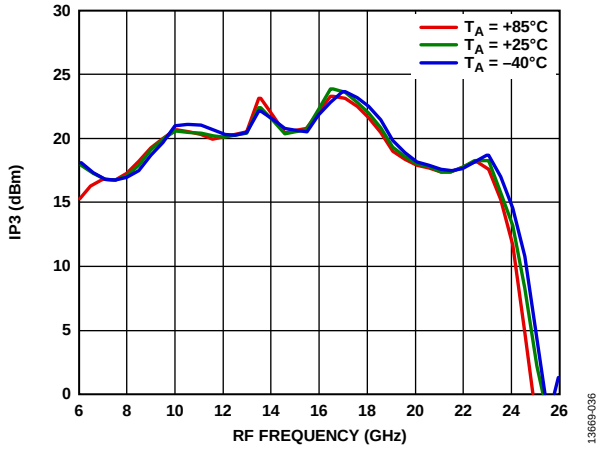

Figure 36. Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

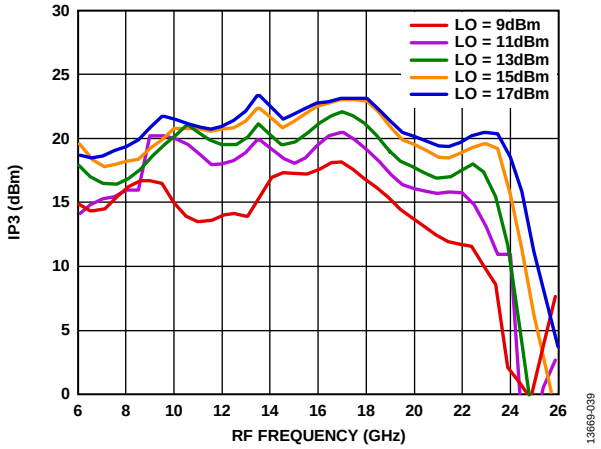

Figure 39. Input IP3 vs. RF Frequency at Various LO Drives

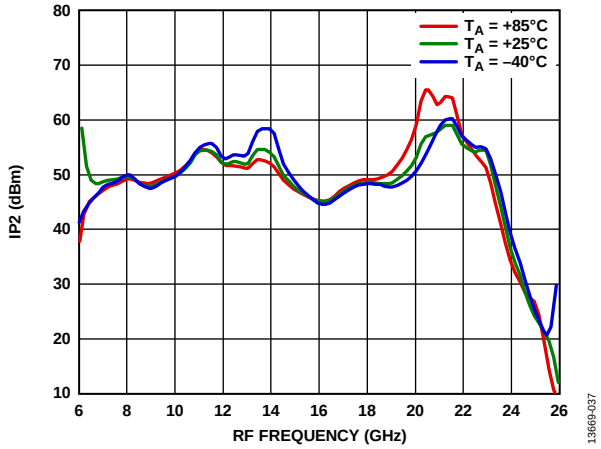

Figure 37. Input IP2 vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

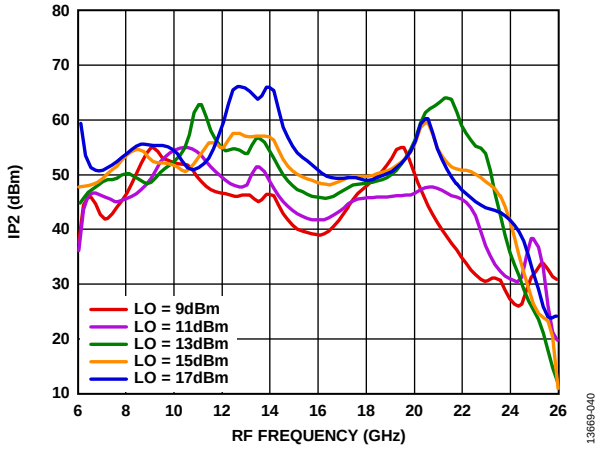

Figure 40. Input IP2 vs. RF Frequency at Various LO Drives

DOWNCONVERTER, LOWER SIDEBAND, IF = 7000 MHz

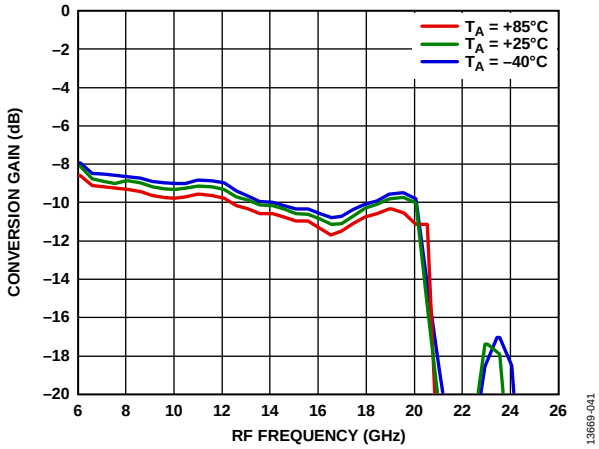

Figure 41. Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

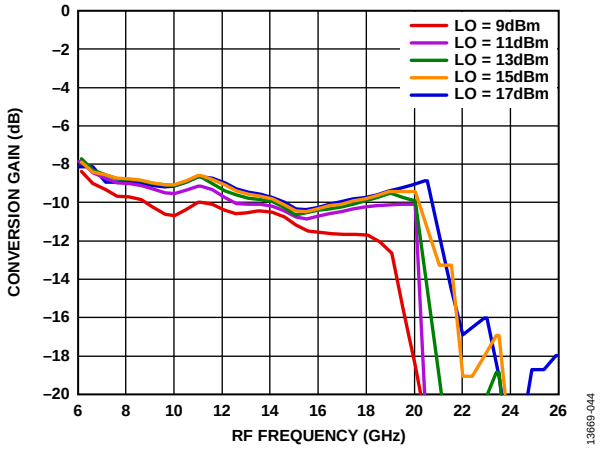

Figure 44. Conversion Gain vs. RF Frequency at Various LO Drives

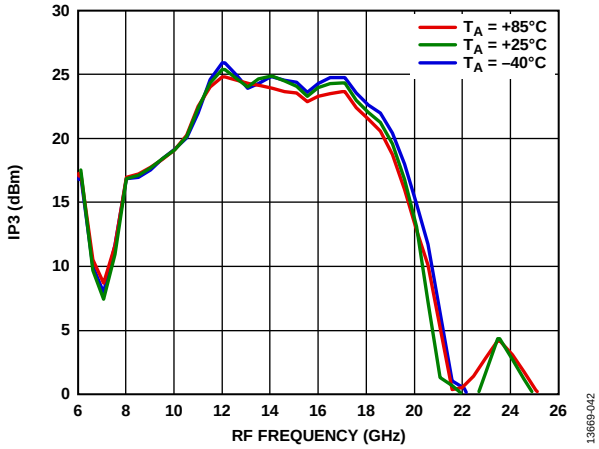

Figure 42. Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

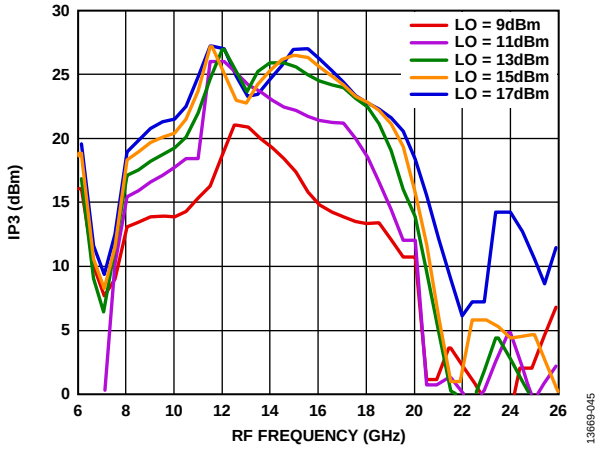

Figure 45. Input IP3 vs. RF Frequency at Various LO Drives

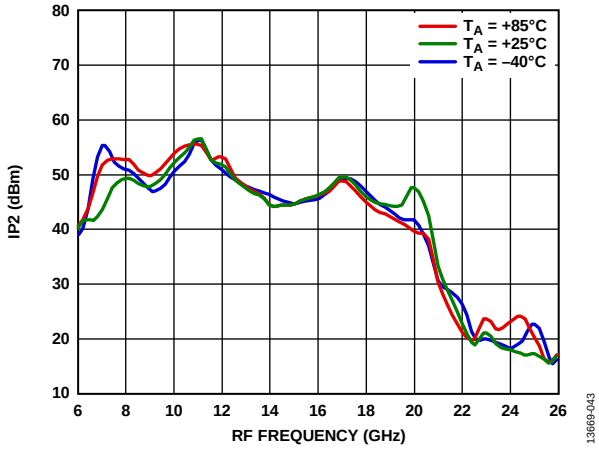

Figure 43. Input IP2 vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

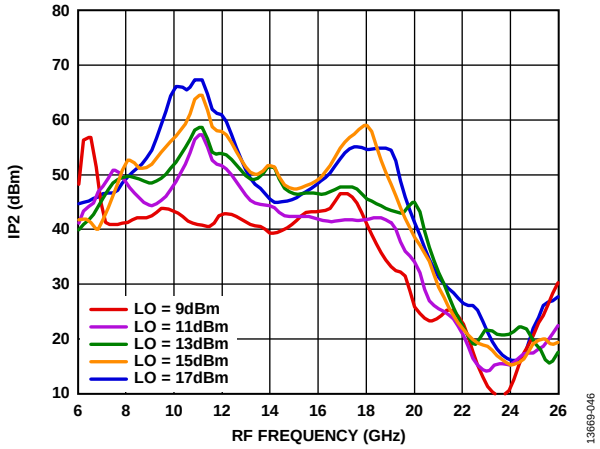

Figure 46. Input IP2 vs. RF Frequency at Various LO Drives

DOWNCONVERTER, P1dB PERFORMANCE, LO DRIVE = 13 dBm

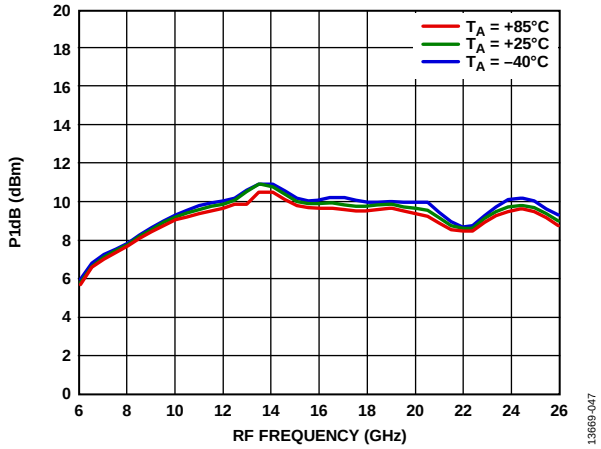

Figure 47. Input P1dB vs. RF Frequency at Various Temperatures, IF = 500 MHz, Upper Sideband

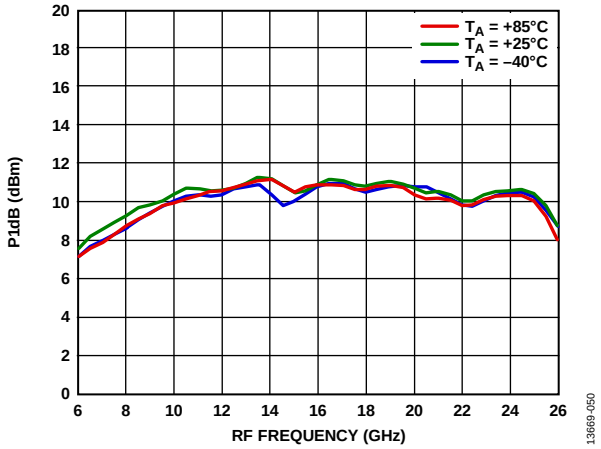

Figure 50. Input P1dB vs. RF Frequency at Various Temperatures, IF = 500 MHz, Lower Sideband

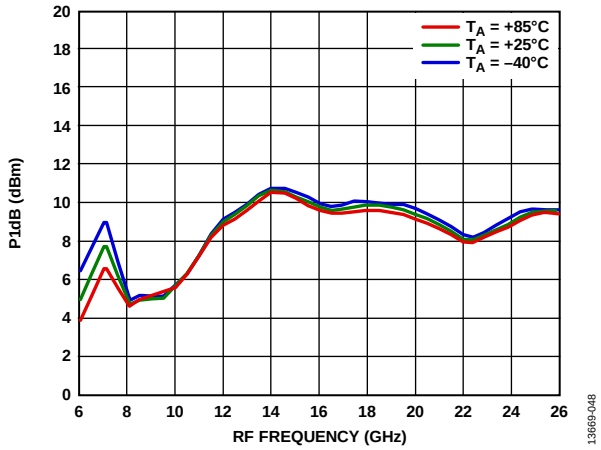

Figure 48. Input P1dB vs. RF Frequency at Various Temperatures, IF = 3000 MHz, Upper Sideband

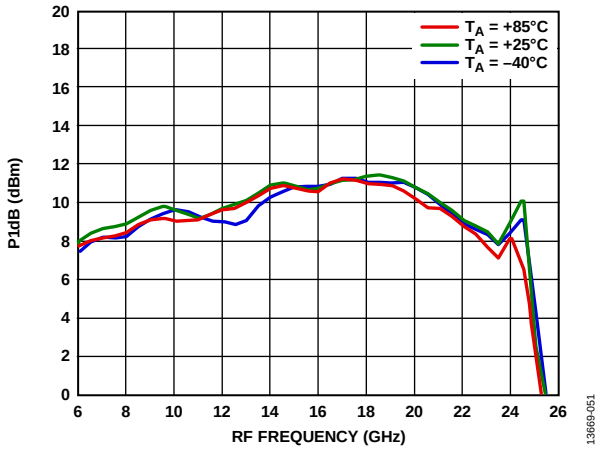

Figure 51. Input P1dB vs. RF Frequency at Various Temperatures, IF = 3000 MHz, Lower Sideband

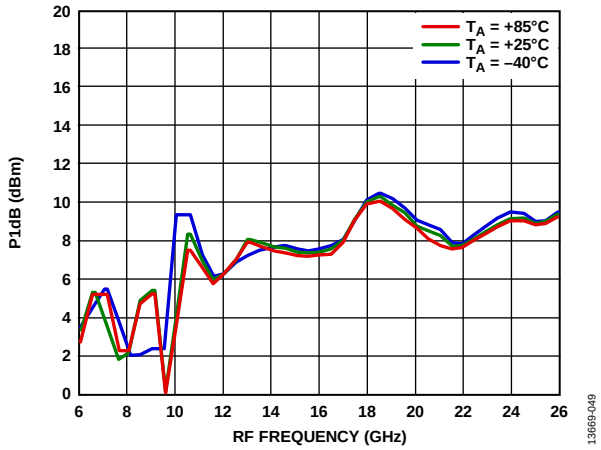

Figure 49. Input P1dB vs. RF Frequency at Various Temperatures, IF = 7000 MHz, Upper Sideband

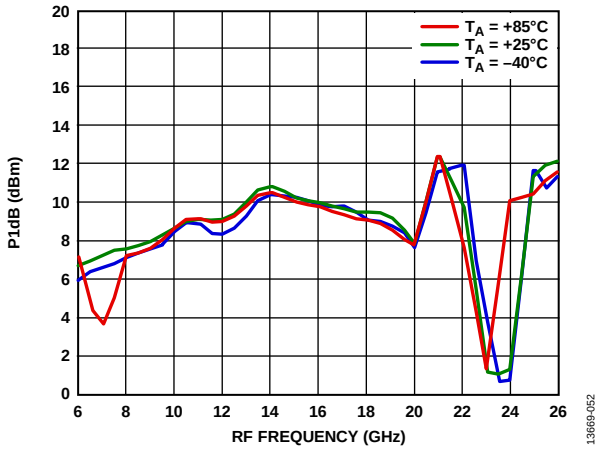

Figure 52. Input P1dB vs. RF Frequency at Various Temperatures, IF = 7000 MHz, Lower Sideband

UPCONVERTER, UPPER SIDEBAND, IF = 500 MHz

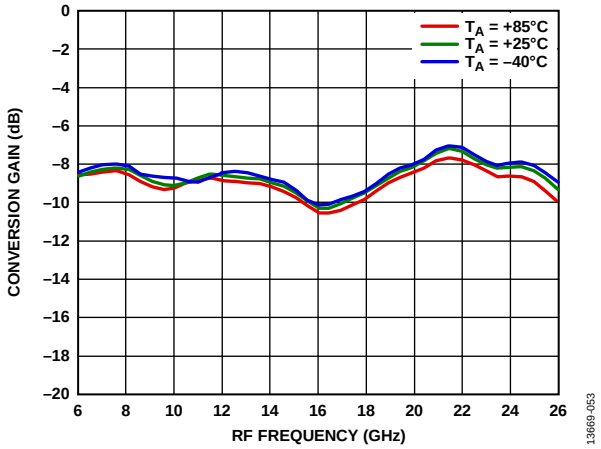

Figure 53. Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

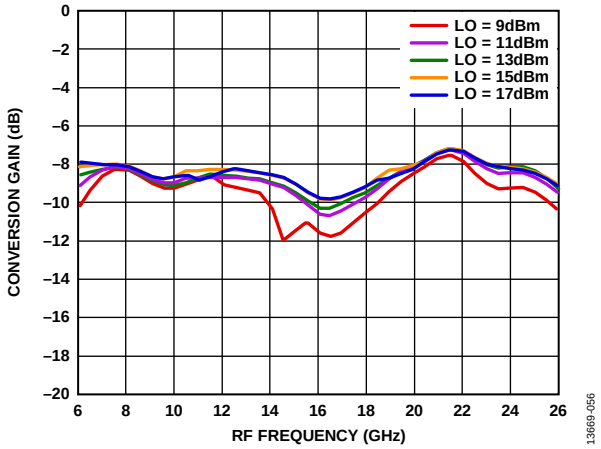

Figure 56. Conversion Gain vs. RF Frequency at Various LO Drives

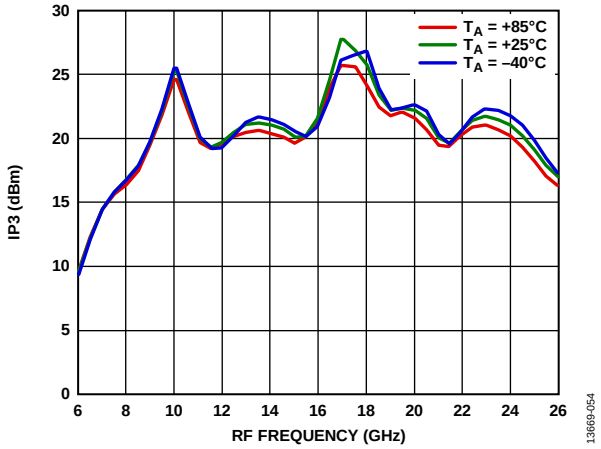

Figure 54. Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

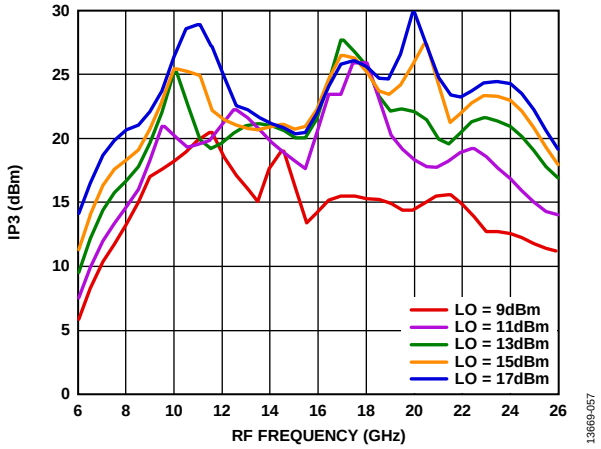

Figure 57. Input IP3 vs. RF Frequency at Various LO Drives

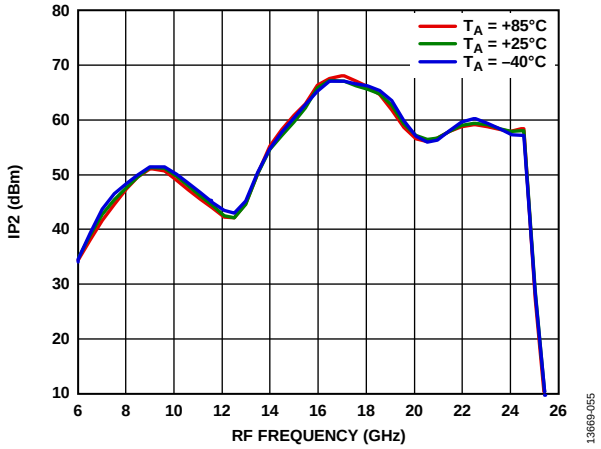

Figure 55. Input IP2 vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

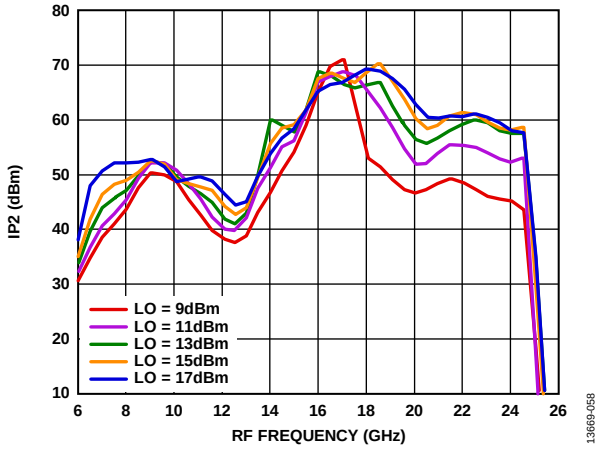

Figure 58. Input IP2 vs. RF Frequency at Various LO Drives

UPCONVERTER, UPPER SIDEBAND, IF = 3000 MHz

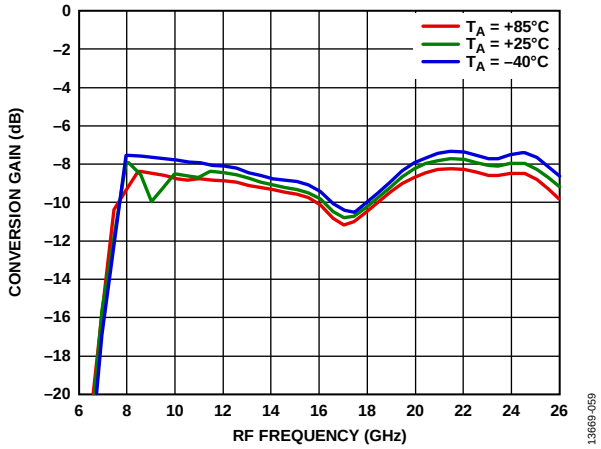

Figure 59. Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

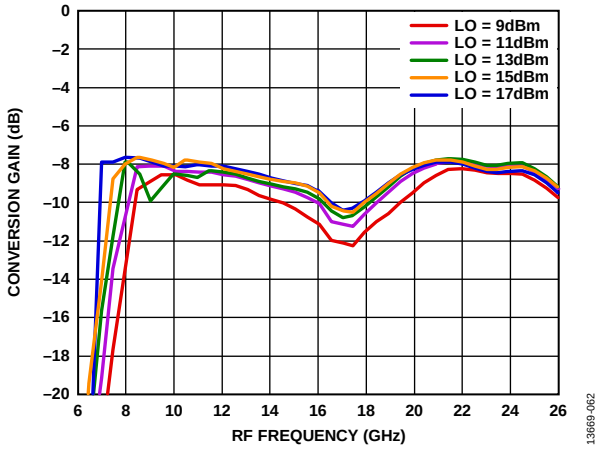

Figure 62. Conversion Gain vs. RF Frequency at Various LO Drives

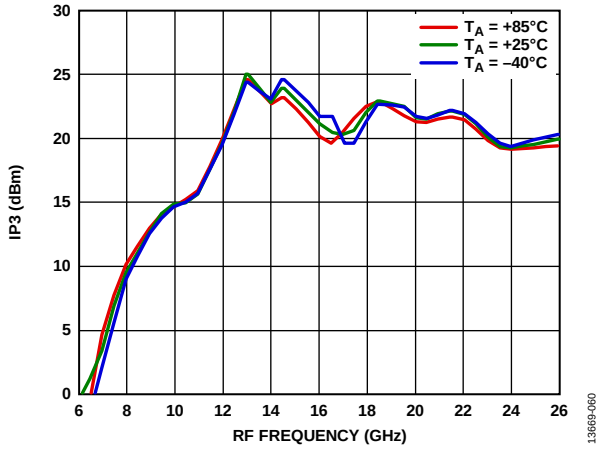

Figure 60. Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

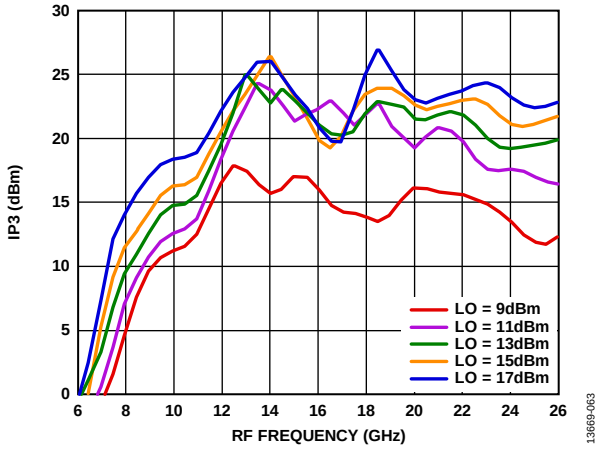

Figure 63. Input IP3 vs. RF Frequency at Various LO Drives

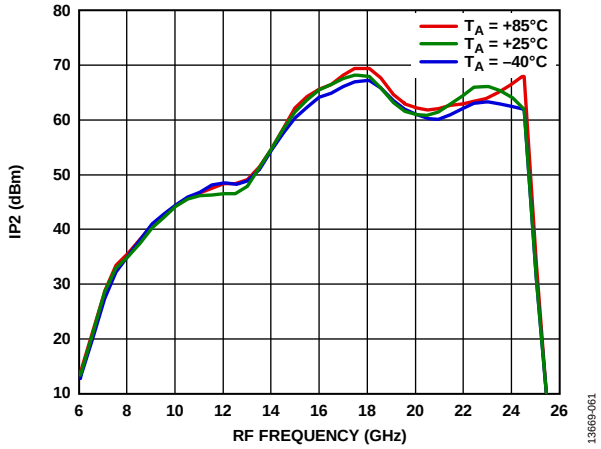

Figure 61. Input IP2 vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

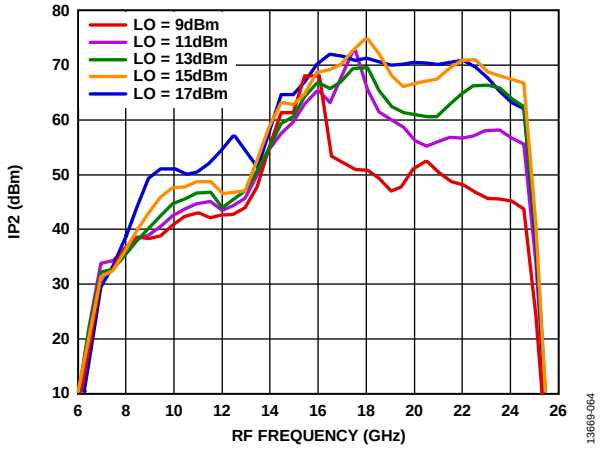

Figure 64. Input IP2 vs. RF Frequency at Various LO Drives

UPCONVERTER, UPPER SIDEBAND, IF = 7000 MHz

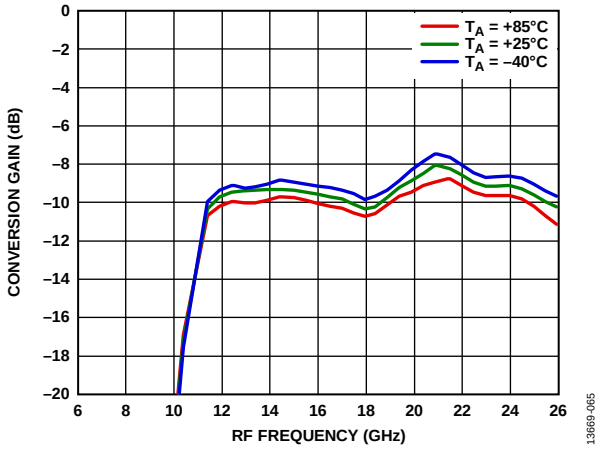

Figure 65. Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

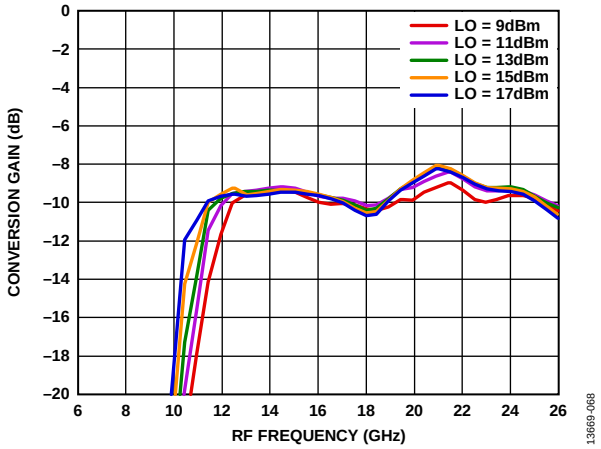

Figure 68. Conversion Gain vs. RF Frequency at Various LO Drives

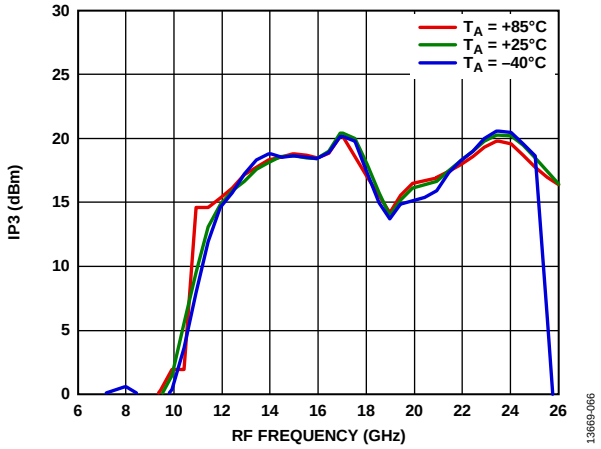

Figure 66. Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

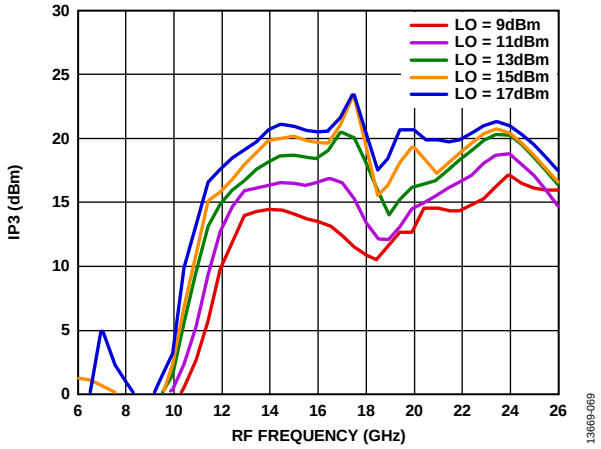

Figure 69. Input IP3 vs. RF Frequency at Various LO Drives

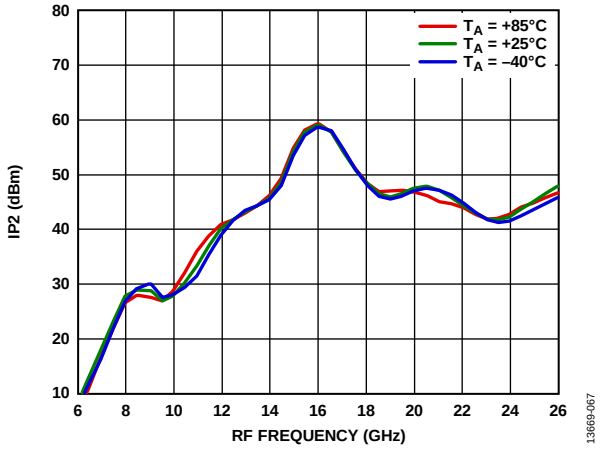

Figure 67. Input IP2 vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

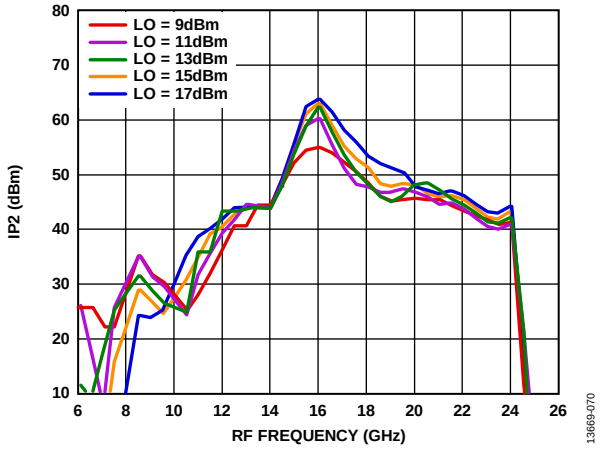

Figure 70. Input IP2 vs. RF Frequency at Various LO Drives

UPCONVERTER, LOWER SIDEBAND, IF = 500 MHz

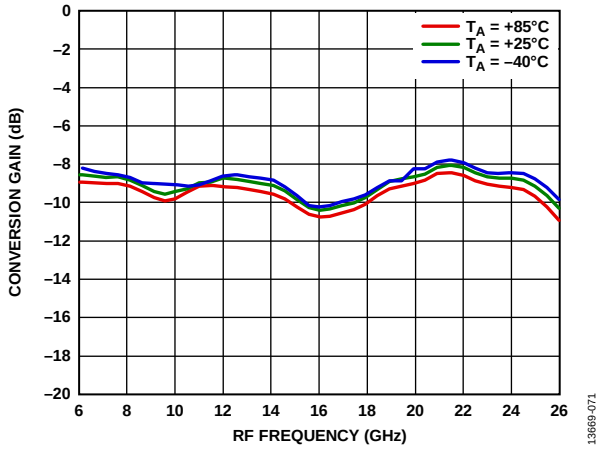

Figure 71. Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

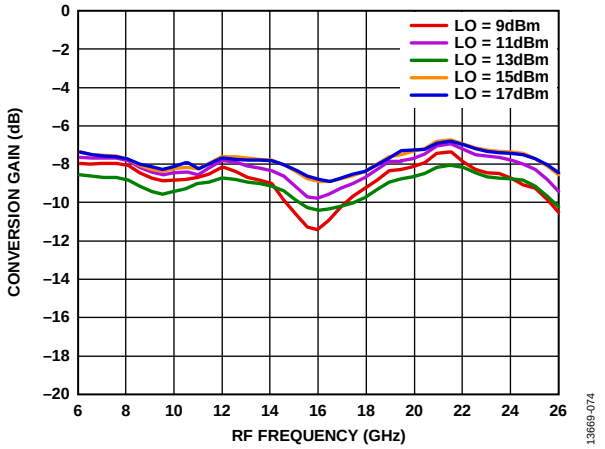

Figure 74. Conversion Gain vs. RF Frequency at Various LO Drives

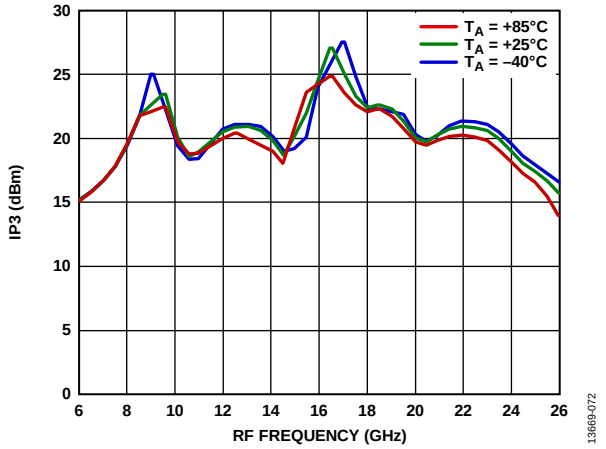

Figure 72. Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

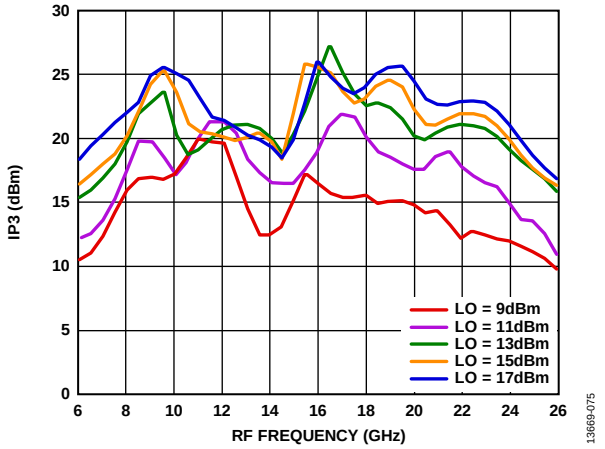

Figure 75. Input IP3 vs. RF Frequency at Various LO Drives

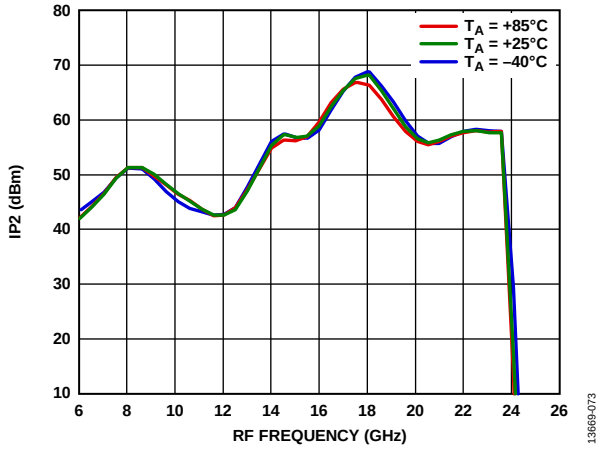

Figure 73. Input IP2 vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

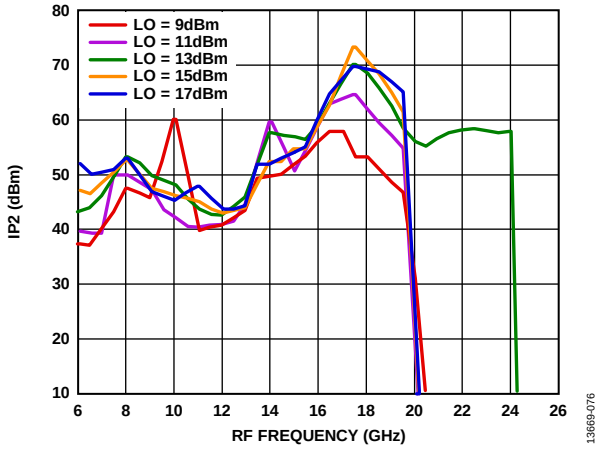

Figure 76. Input IP2 vs. RF Frequency at Various LO Drives

UPCONVERTER, LOWER SIDEBAND, IF = 3000 MHz

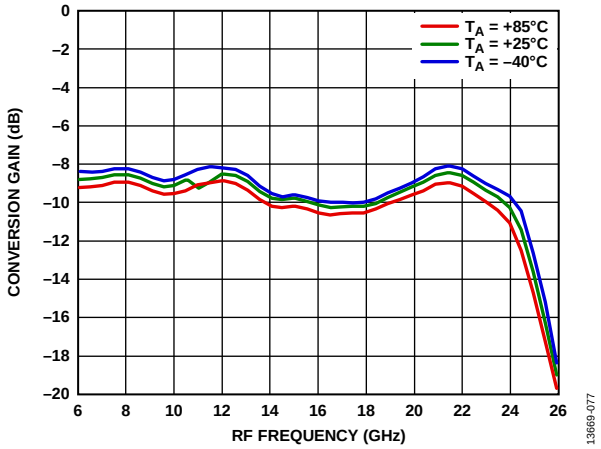

Figure 77. Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

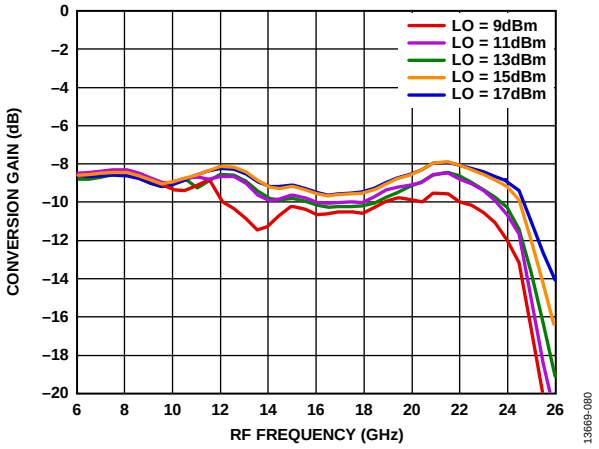

Figure 80. Conversion Gain vs. RF Frequency at Various LO Drives

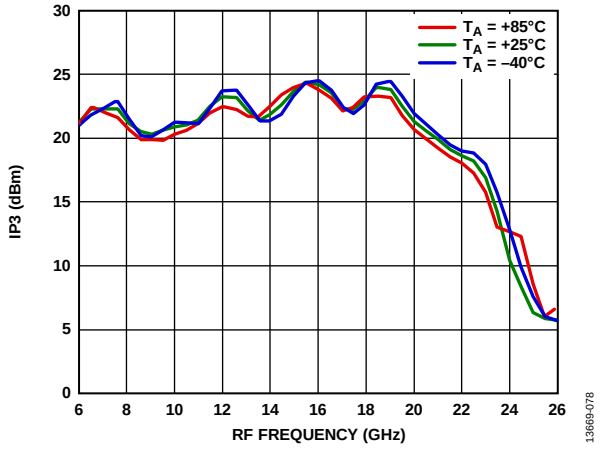

Figure 78. Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

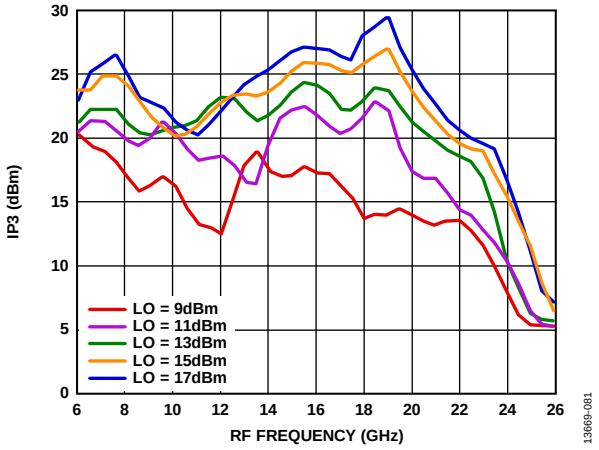

Figure 81. Input IP3 vs. RF Frequency at Various LO Drives

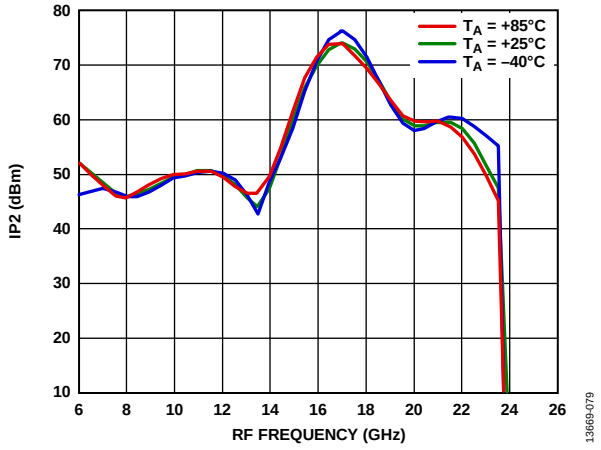

Figure 79. Input IP2 vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

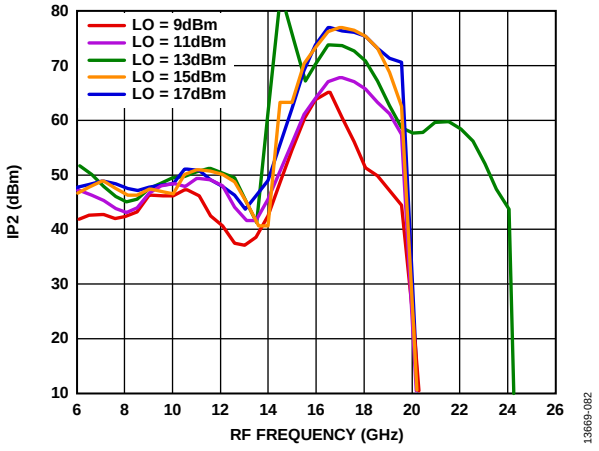

Figure 82. Input IP2 vs. RF Frequency at Various LO Drives

UPCONVERTER, LOWER SIDEBAND, IF = 7000 MHz

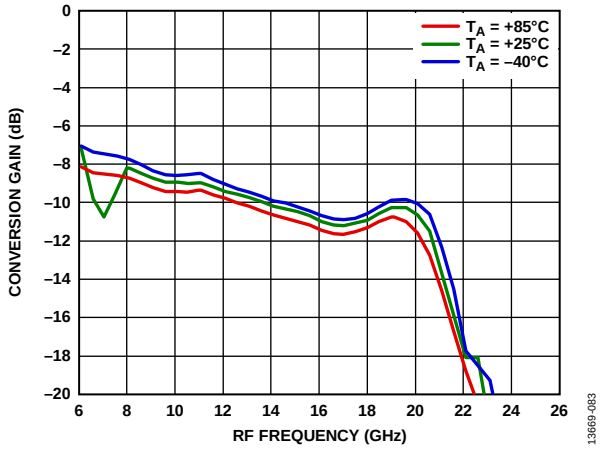

Figure 83. Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

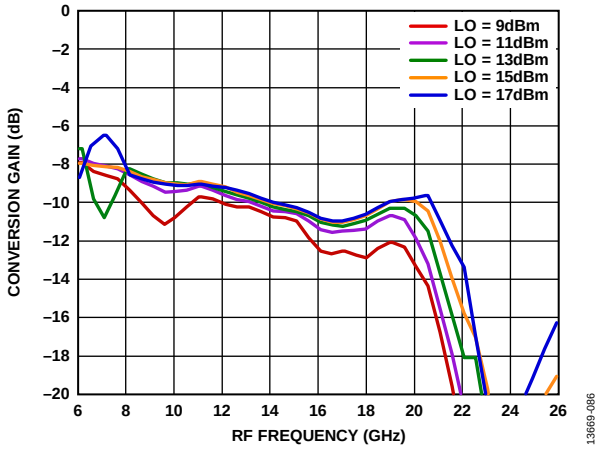

Figure 86. Conversion Gain vs. RF Frequency at Various LO Drives

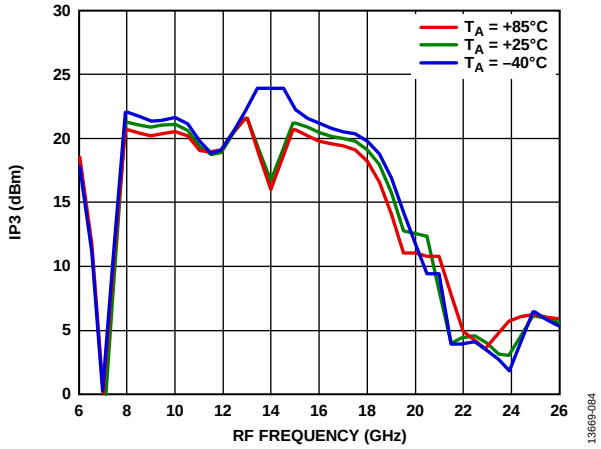

Figure 84. Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

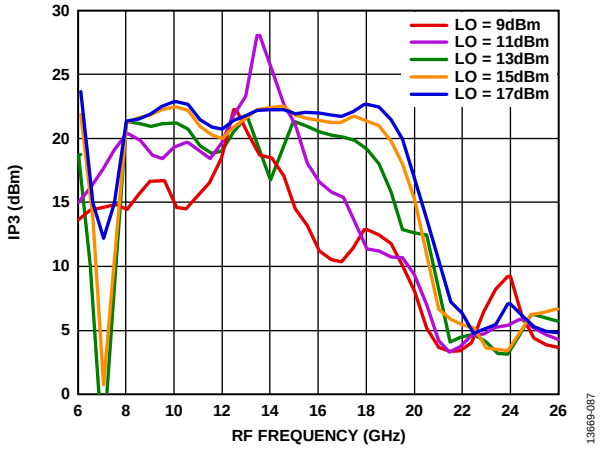

Figure 87. Input IP3 vs. RF Frequency at Various LO Drives

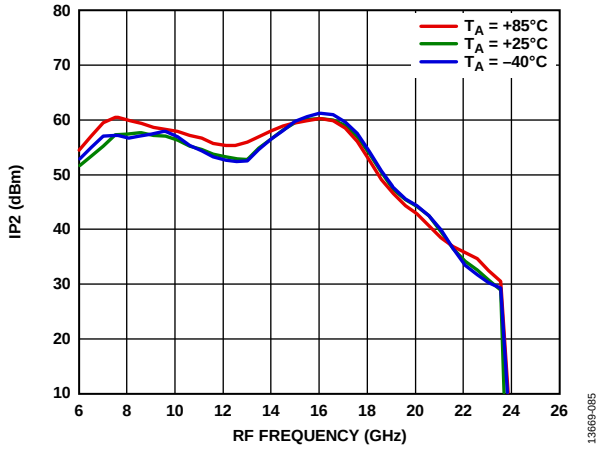

Figure 85. Input IP2 vs. RF Frequency at Various Temperatures, LO Drive = 13 dBm

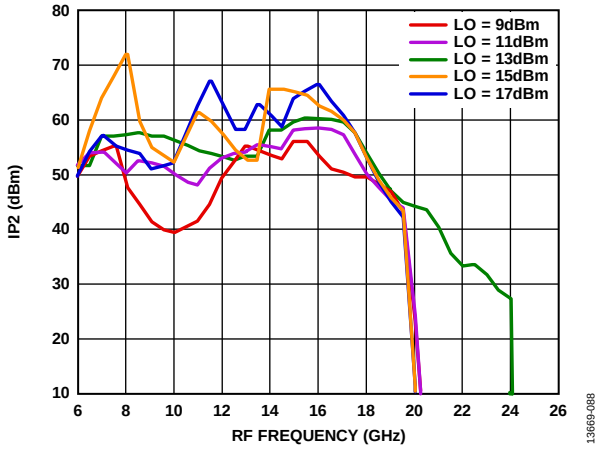

Figure 88. Input IP2 vs. RF Frequency at Various LO Drives

SPURIOUS PERFORMANCE

M × N Spurious Outputs

Spurious values are (M × RF) − (N × LO). The RF frequency = 9 GHz and RF input power = −10 dBm.

The LO frequency = 8 GHz and the LO input power = 13 dBm. Mixer spurious products are measured in dBc from the IF output power level.

		N × LO					
		0	**1**	**2**	**3**	**4**	**5**
M × RF	**0**		+14.2	+35	+32.1	+50.3	+61.4
	1	−1.9		+17.7	+31.1	+32.8	+61.2
	2	+83	+55.3	+60	+59.6	+73.7	+87.9
	3	+82.6	+86.1	+68	+68.5	+61.9	+85.9
	4	+76	+86.7	+82.1	+77.4	+74.9	+75.8
	5	+69.3	+74.7	+85.3	+87	+85.1	+62

THEORY OF OPERATION

The HMC773A is a general-purpose, double balanced mixer that can be used as an upconverter or a downconverter from 6 GHz to 26 GHZ.

When used a downconverter, the HMC773A downconverts radio frequencies (RF) between 6 GHz and 26 GHz to intermediate frequencies (IF) between 0 GHz and 8 GHz.

When used as an upconverter, the mixer upconverts intermediate frequencies between 0 GHz and 8 GHz to radio frequencies between 6 GHz and 26 GHz.

The mixer performs well with LO drives above 13 dBm, and it provides excellent LO to RF and LO to IF suppression due to optimized balun structures.

A typical application circuit is shown in Figure 89. The HMC773A is a passive device and does not require any external components.

APPLICATIONS INFORMATION

APPLICATION CIRCUIT AND EVALUATION PRINTED CIRCUIT BOARD (PCB)

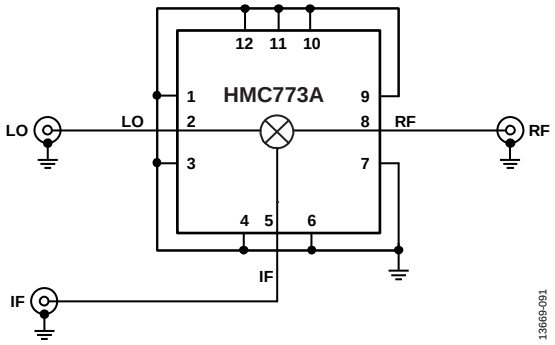

Figure 89. Typical Application Circuit

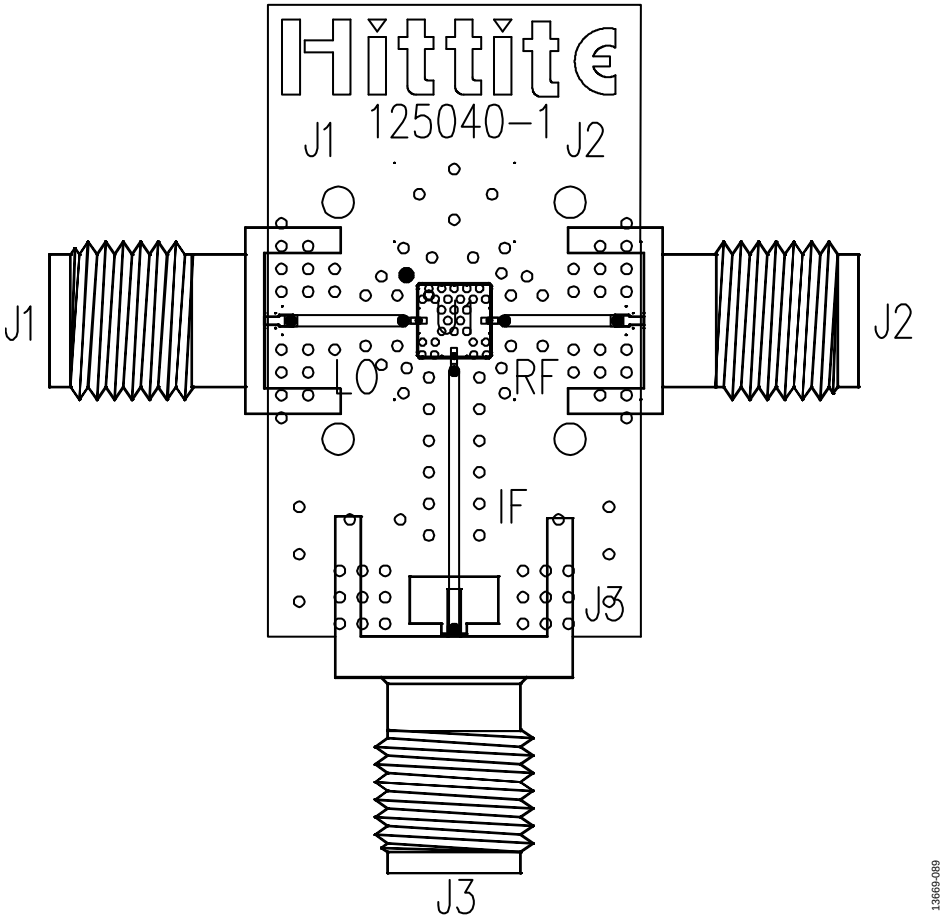

Figure 90. Evaluation PCB

BILL OF MATERIALS

Use RF circuit design techniques for the circuit board used in the application. Provide 50 Ω impedance for the signal lines and connect the package ground leads and exposed paddle directly to the ground plane, similar to that shown in Figure 90. Use a sufficient number of via holes to connect the top and bottom ground planes. The evaluation circuit board shown is available from Analog Devices, Inc., upon request.

Table 5. Bill of Materials for Evaluation PCB EV1HMC773ALC3B

Item	Description
J1, J2	SRI SMA connector.
J3	Johnson SMA connector.
U1	HMC773ALC3B mixer.
PCB	125040 evaluation PCB. Circuit board material: Rogers 4350.

OUTLINE DIMENSIONS

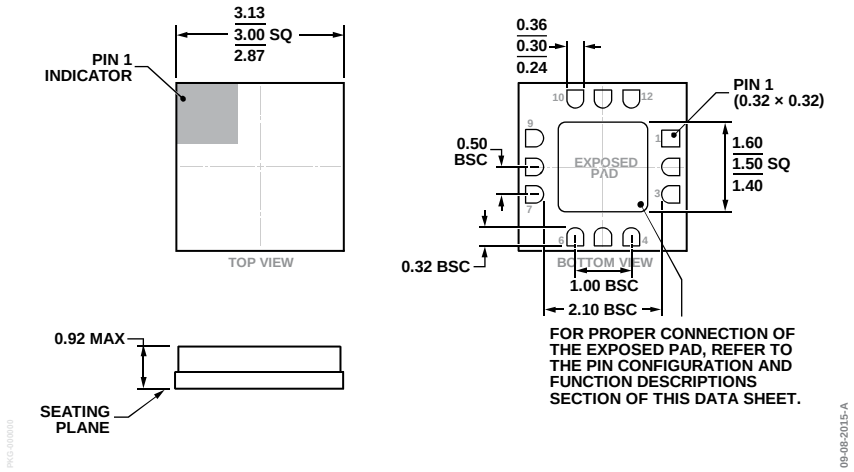

Figure 91. 12-Terminal Ceramic Leadless Chip Carrier [LCC]
(HE-12-1)
Dimensions shown in millimeters

ORDERING GUIDE

Model	Temperature	MSL Rating[1]	Description[2]	Package Option	Package Marking[3]
HMC773ALC3B	−40°C to +85°C	MSL3	12-Terminal Ceramic Leadless Chip Carrier [LCC]	HE-12-1	H773A XXXX
HMC773ALC3BTR	−40°C to +85°C	MSL3	12-Terminal Ceramic Leadless Chip Carrier [LCC]	HE-12-1	H773A XXXX
EV1HMC773ALC3B			Evaluation PCB Assembly		

[1] The maximum peak reflow temperature is 260°C.
[2] HMC773ALC3B and HMC773ALC3BTR body package material is alumina ceramic and the lead finish is gold over nickel.
[3] HMC773ALC3B and HMC773ALC3BTR 4-digit lot number is represented by XXXX.