

## FEATURES

**Passive, wideband I/Q mixer**  
**RF and LO range: 20 GHz to 42 GHz**  
**Wide IF bandwidth of dc to 5 GHz**  
**Single-ended RF, LO, and IF**  
**Conversion loss: 10 dB typical, from 20 GHz to 32 GHz**  
**Image rejection: 25 dB typical, from 20 GHz to 32 GHz**  
**Noise figure: 12 dB typical, from 20 GHz to 32 GHz**  
**Input IP3 (downconverter): 24 dBm typical, from 20 GHz to 32 GHz**  
**Input P1dB (downconverter) compression: 15 dBm typical, from 20 GHz to 32 GHz**  
**Input IP2: 56 dB typical, from 20 GHz to 32 GHz**  
**LO to RF isolation: 42 dB typical, from 20 GHz to 32 GHz**  
**LO to IFx isolation: 51 dB typical, from 20 GHz to 32 GHz**  
**RF to IF isolation: 30 dB typical, from 20 GHz to 32 GHz**  
**Amplitude balance:  $\pm 3$  dB typical**  
**Phase balance (downconverter):  $\pm 11^\circ$  typical**  
**RF return loss: 14 dB typical**  
**LO return loss: 11 dB typical**  
**IFx return loss: 20 dB typical**  
**Die size: 2.160 mm  $\times$  1.430 mm  $\times$  0.102 mm**

## APPLICATIONS

**Test and measurement instrumentation**  
**Military, radar, aerospace, and defense applications**  
**Microwave point to point base stations**

## GENERAL DESCRIPTION

The HMC8192-Die is a passive, wideband, inphase/quadrature (I/Q), monolithic microwave integrated circuit (MMIC) mixer that can be used either as an image rejection mixer for receiver operations or as a single-sideband upconverter for transmitter operations. With a radio frequency (RF) and local oscillator (LO) range of 20 GHz to 42 GHz, and an intermediate frequency (IF) bandwidth of dc to 5 GHz, the HMC8192-Die is ideal for applications requiring a wide frequency range, excellent RF performance, and a simple design with fewer components. A single HMC8192-Die can replace multiple narrow-band mixers in a design.

The inherent I/Q architecture of the HMC8192-Die offers excellent image rejection, typically better than 25 dBc,

## FUNCTIONAL BLOCK DIAGRAM

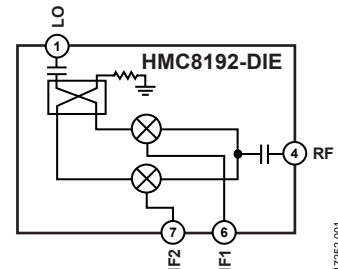


Figure 1.

eliminating the need for additional filtering of unwanted sidebands. The mixer also provides excellent LO to RF and LO to IFx isolation of 42 dB and 51 dB, respectively, from 20 GHz to 32 GHz, and reduces the effect of LO leakage to ensure signal integrity.

As a passive mixer, the HMC8192-Die does not require any dc power sources. The HMC8192-Die offers a lower noise figure compared to an active mixer, ensuring superior dynamic range for high performance and precision applications.

The HMC8192-Die is fabricated on a gallium arsenide (GaAs), metal semiconductor field effect transistor (MESFET) process and uses Analog Devices, Inc., mixer cells and a 90° hybrid. The HMC8192-Die operates over a  $-55^\circ\text{C}$  to  $+85^\circ\text{C}$  temperature range.

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## REVISION HISTORY

3/2019—Revision 0: Initial Version

## SPECIFICATIONS

### 20 GHz TO 32 GHz

$T_A = 25^\circ\text{C}$ , IF = 100 MHz, LO drive = 18 dBm, all measurements performed as a downconverter with upper sideband selected, external  $90^\circ$  hybrid at the IFx ports, and LO amplifier in line with lab bench LO source, unless otherwise noted.

Table 1.

Parameter	Symbol	Min	Typ	Max	Unit
<b>FREQUENCY</b>					
Radio	RF	20		32	GHz
LO	$f_{LO}$	20		32	GHz
Intermediate	IF	DC		5	GHz
<b>LO DRIVE LEVEL</b>					
		16	18	20	dBm
<b>RF PERFORMANCE AS DOWNCONVERTER</b>					
Conversion Loss			10	12	dB
Image Rejection		15	25		dBc
Single-Sideband Noise Figure	SSB NF		12		dB
Input Third-Order Intercept	IP3	22	24		dBm
Input 1 dB Compression Point	P1dB		15		dBm
Input Second-Order Intercept	IP2		56		dBm
Amplitude Balance <sup>1</sup>			$\pm 3$		dB
Phase Balance <sup>1</sup>			$\pm 11$		Degrees
<b>RF PERFORMANCE AS UPCONVERTER</b>					
Conversion Loss			7		dB
Sideband Rejection			19		dBc
Input Third-Order Intercept	IP3		21		dBm
Input 1 dB Compression Point	P1dB		13		dBm
<b>ISOLATION PERFORMANCE</b>					
LO to RF		36	42		dB
LO to IFx <sup>1</sup>			51		dB
RF to IF <sup>1</sup>			30		dB
<b>RETURN LOSS PERFORMANCE<sup>1</sup></b>					
RF			14		dB
LO			11		dB
IFx			20		dB

<sup>1</sup> Measurements taken without  $90^\circ$  hybrid at the IFx ports.

**32 GHz TO 42 GHz**

$T_A = 25^\circ\text{C}$ , IF = 100 MHz, LO drive = 18 dBm, all measurements performed as downconverter with upper sideband selected, external  $90^\circ$  hybrid at the IFx ports, and LO amplifier in line with lab bench LO source, unless otherwise noted.

**Table 2.**

Parameter	Symbol	Min	Typ	Max	Unit
<b>FREQUENCY</b>					
Radio	RF	32		42	GHz
LO	$f_{LO}$	32		42	GHz
Intermediate	IF	DC		5	GHz
<b>LO DRIVE LEVEL</b>					
		16	18	20	dBm
<b>RF PERFORMANCE AS DOWNCONVERTER</b>					
Conversion Loss			13	15.5	dB
Image Rejection		12	18		dBc
Single-Sideband Noise Figure	SSB NF		16		dB
Input Third-Order Intercept	IP3	17	24		dBm
Input 1 dB Compression Point	P1dB		16		dBm
Input Second-Order Intercept	IP2		46		dBm
Amplitude Balance <sup>1</sup>			$\pm 3$		dB
Phase Balance <sup>1</sup>			$\pm 11$		Degrees
<b>RF PERFORMANCE AS UPCONVERTER</b>					
Conversion Loss			8		dB
Sideband Rejection			15		dBc
Input Third-Order Intercept	IP3		17		dBm
Input 1 dB Compression Point	P1dB		12		dBm
<b>ISOLATION PERFORMANCE</b>					
LO to RF		34	41		dB
LO to IFx <sup>1</sup>			55		dB
RF to IF <sup>1</sup>			34		dB
<b>RETURN LOSS PERFORMANCE<sup>1</sup></b>					
RF			14		dB
LO			11		dB
IFx			20		dB

<sup>1</sup> Measurements taken without  $90^\circ$  hybrid at the IFx ports.

## ABSOLUTE MAXIMUM RATINGS

Table 3.

Parameter	Rating
RF Input Power	23 dBm
LO Input Power	23 dBm
IF Input Power	23 dBm
IF Source or Sink Current	3 mA
Continuous Power Dissipation, $P_{DISS}$ ( $T_A = 85^\circ\text{C}$ , Derate 7.2 mW/ $^\circ\text{C}$ Above $85^\circ\text{C}$ ) <sup>1</sup>	647 mW
Maximum Junction Temperature ( $T_J$ )	175 $^\circ\text{C}$
Operating Temperature Range	-55 $^\circ\text{C}$ to +85 $^\circ\text{C}$
Storage Temperature Range	-65 $^\circ\text{C}$ to +150 $^\circ\text{C}$
Electrostatic Discharge Sensitivity	
Human Body Model	4000 V
Field Induced Charged Device Model	1250 V

<sup>1</sup>  $P_{DISS}$  is a theoretical number calculated by  $(T_J - 85^\circ\text{C})/\theta_{JC}$ .

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 printed circuit board (PCB) design and operating environment. Careful attention to PCB thermal design is required.

$\theta_{JC}$  is the junction to case thermal resistance.

Table 4. Thermal Resistance

Package Type	$\theta_{JC}$	Unit
C-7-6	139	$^\circ\text{C}/\text{W}$

## 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

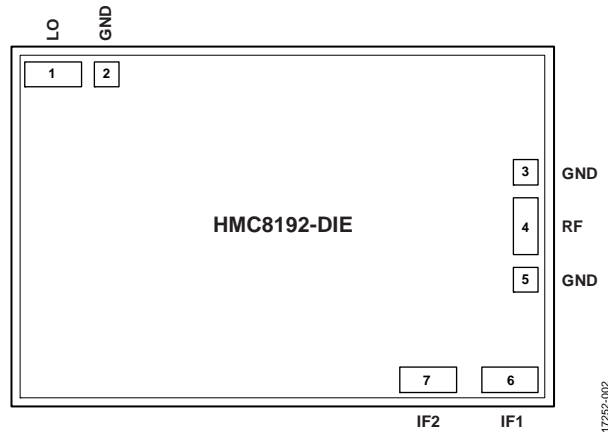


Figure 2. Pin Configuration

Table 5. Pin Function Descriptions

Pin No.	Mnemonic	Description
1	LO	LO Input. This pin is ac-coupled and matched to 50 Ω. See Figure 3 for the interface schematic.
2, 3, 5, Die Bottom	GND	Ground Connections. These pins and the die bottom must be connected to RF and dc ground. See Figure 4 for the interface schematic.
4	RF	RF Input/Output. This pin is ac-coupled and matched to 50 Ω. See Figure 5 for the interface schematic.
6, 7	IF1, IF2	First and Second Quadrature IF Input/Output Pins. These pins are dc-coupled. For applications not requiring operation to dc, use an off-chip dc blocking capacitor. For operations to dc, these pins must not source or sink more than 3 mA of current. Otherwise, the device may not function and may fail. See Figure 6 for the interface schematic.

## INTERFACE SCHEMATICS

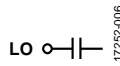


Figure 3. LO Interface Schematic

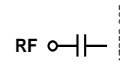


Figure 5. RF Interface Schematic



Figure 4. GND Interface Schematic

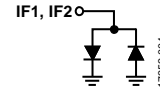


Figure 6. IF1 and IF2 Interface Schematic

# TYPICAL PERFORMANCE CHARACTERISTICS

## DOWNCONVERTER PERFORMANCE

*IF = 100 MHz, Upper Sideband (Low-Side LO)*

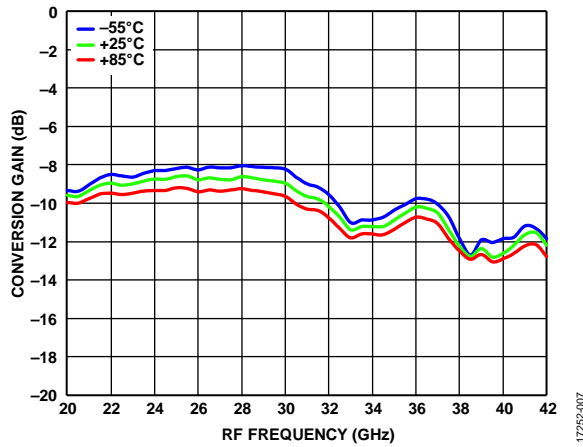


Figure 7. Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

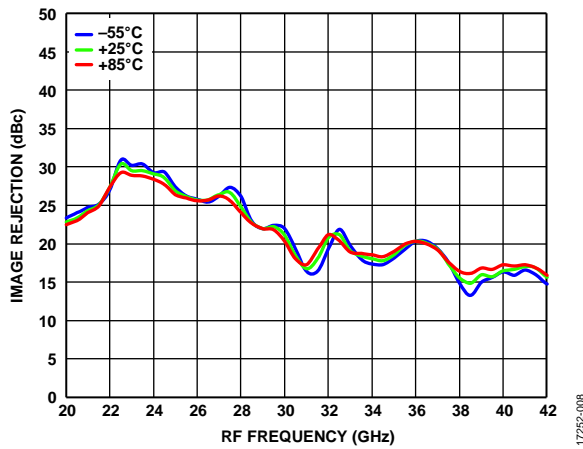


Figure 8. Image Rejection vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

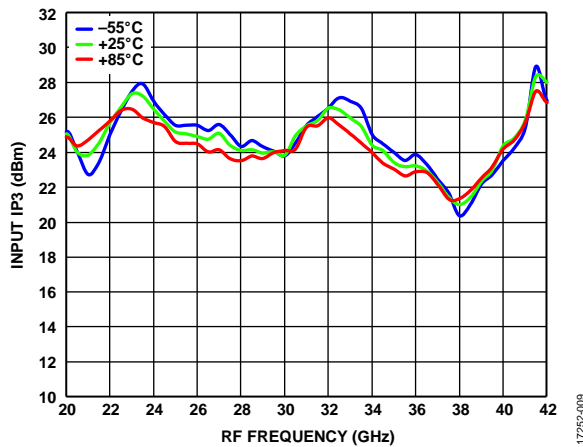


Figure 9. Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

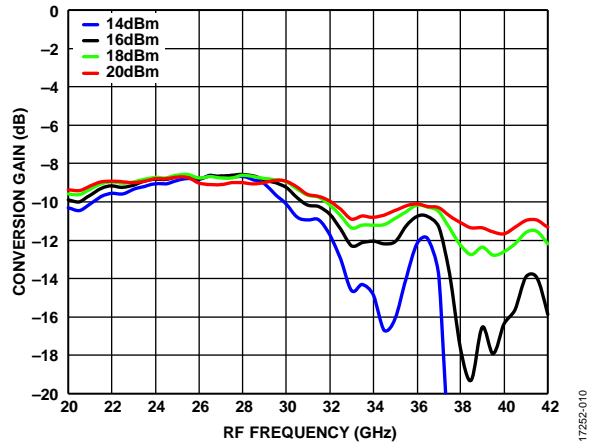


Figure 10. Conversion Gain vs. RF Frequency at Various LO Drives,  $T_A = 25^\circ\text{C}$

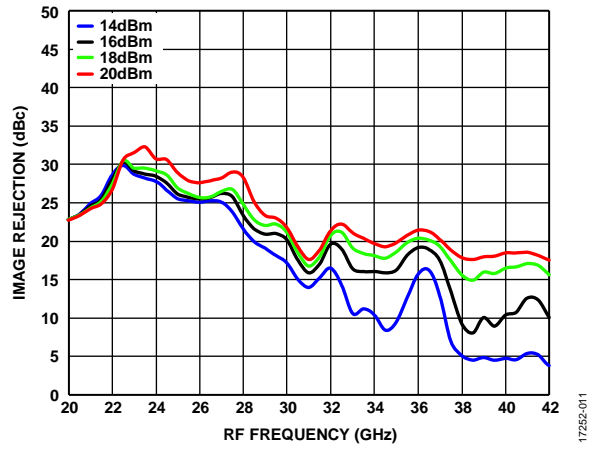


Figure 11. Image Rejection vs. RF Frequency at Various LO Drives,  $T_A = 25^\circ\text{C}$

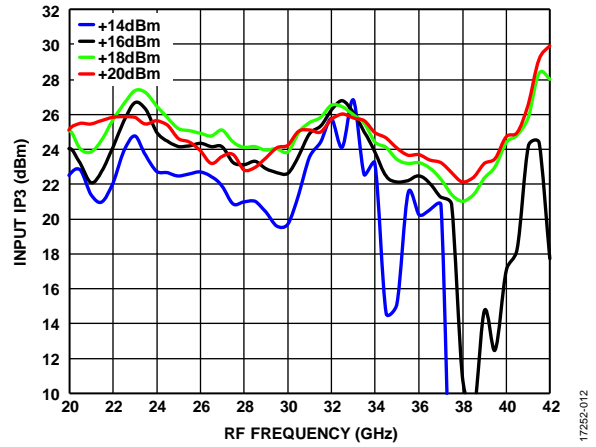


Figure 12. Input IP3 vs. RF Frequency at Various LO Drives,  $T_A = 25^\circ\text{C}$

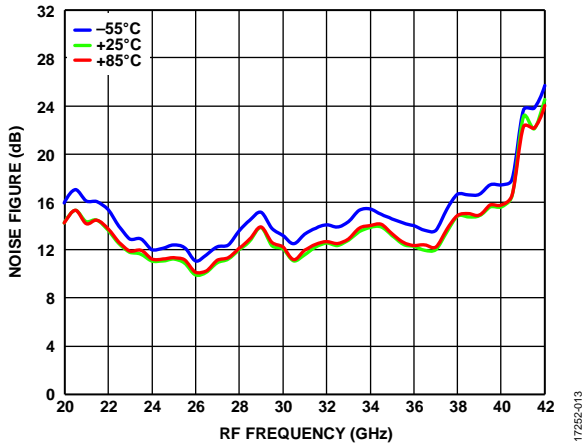


Figure 13. Noise Figure vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

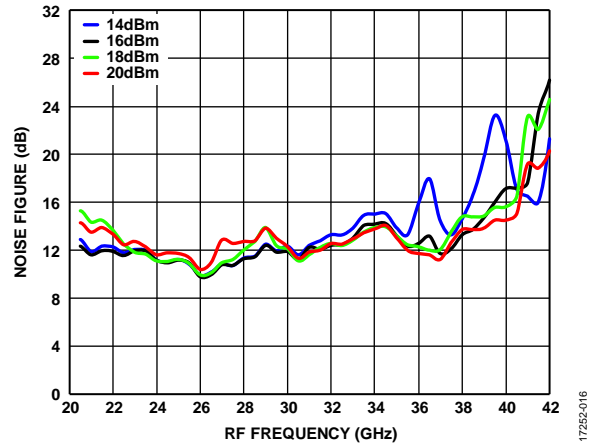


Figure 16. Noise Figure vs. RF Frequency at Various LO Drives,  $T_A = 25^\circ\text{C}$

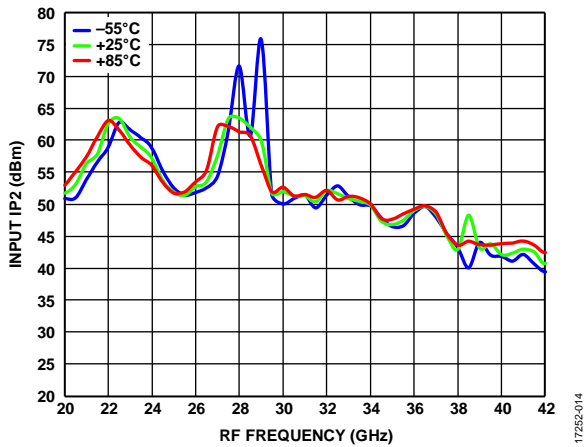


Figure 14. Input IP2 vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

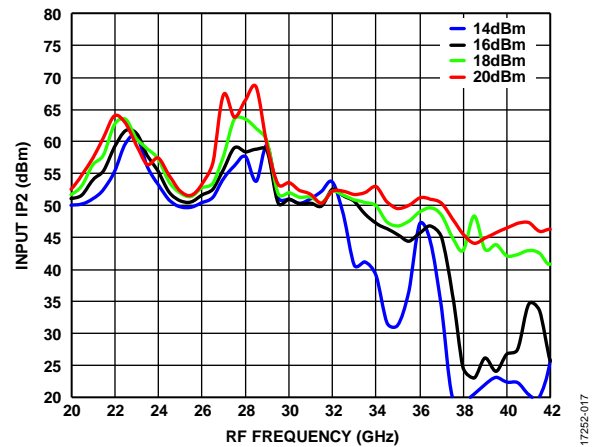


Figure 17. Input IP2 vs. RF Frequency at Various LO Drives,  $T_A = 25^\circ\text{C}$

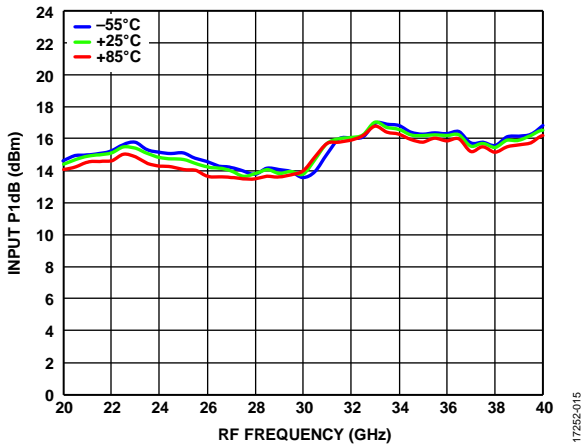


Figure 15. Input P1dB vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm



**UPCONVERTER PERFORMANCE**

*IF = 100 MHz, Upper Sideband*

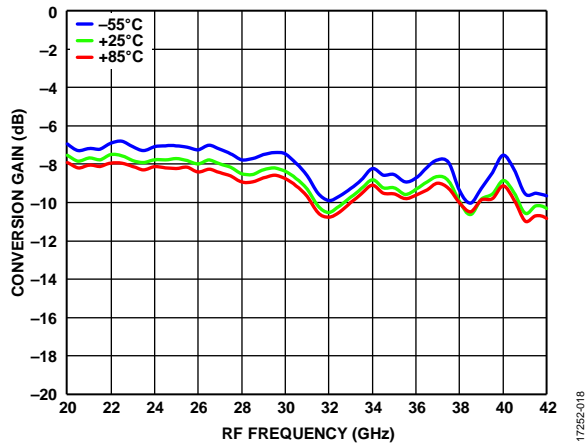


Figure 18. Conversion Gain vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

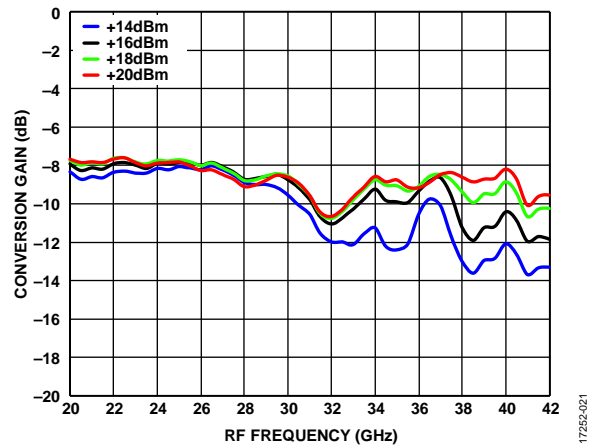


Figure 21. Conversion Gain vs. RF Frequency at Various LO Drives,  $T_A = 25^\circ\text{C}$

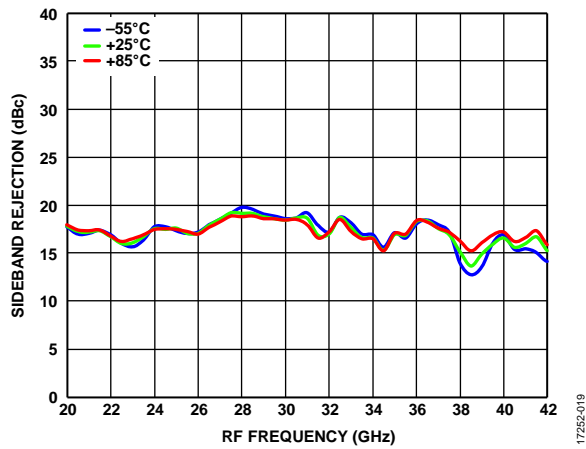


Figure 19. Sideband Rejection vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

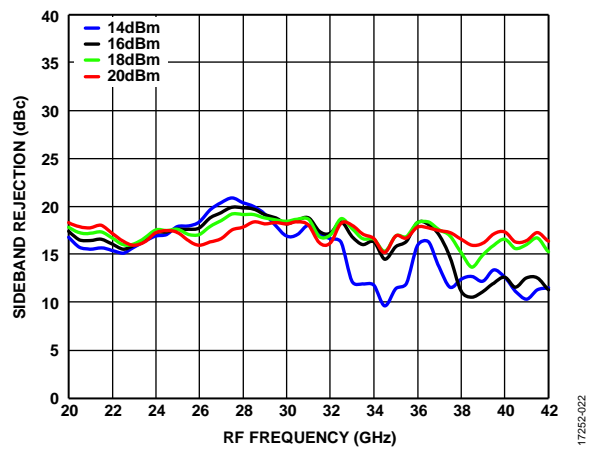


Figure 22. Sideband Rejection vs. RF Frequency at Various LO Drives,  $T_A = 25^\circ\text{C}$

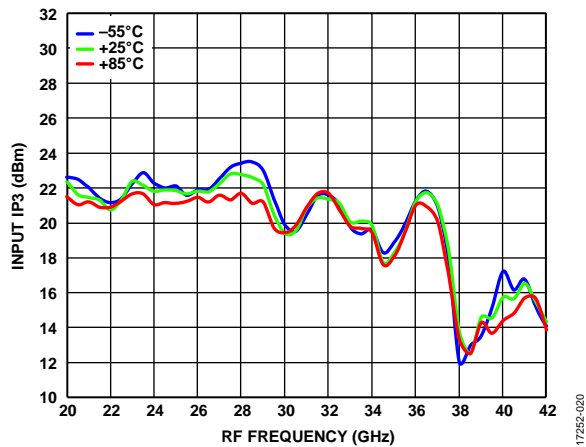


Figure 20. Input IP3 vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

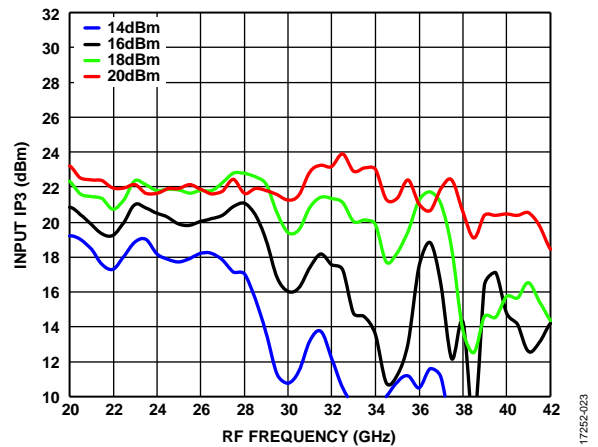


Figure 23. Input IP3 vs. RF Frequency at Various LO Drives,  $T_A = 25^\circ\text{C}$

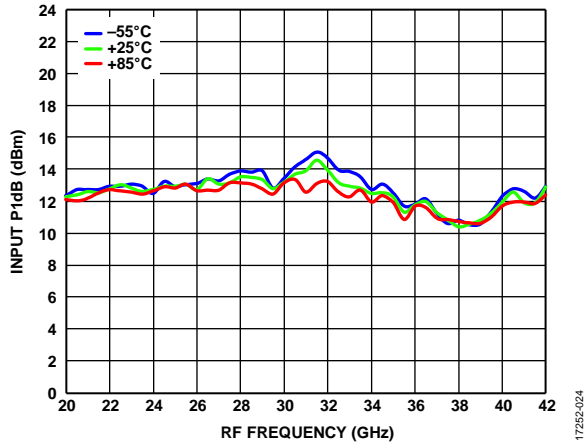


Figure 24. Input P1dB vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

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**ISOLATION AND RETURN LOSS WITHOUT EXTERNAL 90° HYBRID AT THE IF<sub>x</sub> PORTS**

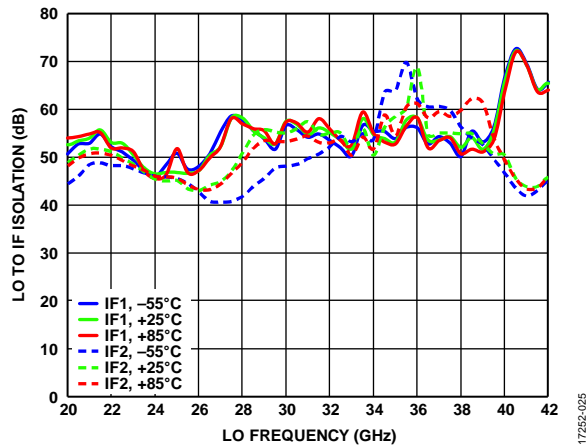


Figure 25. LO to IF Isolation vs. LO Frequency at Various Temperatures, IF = 100 MHz, LO Drive = 18 dBm

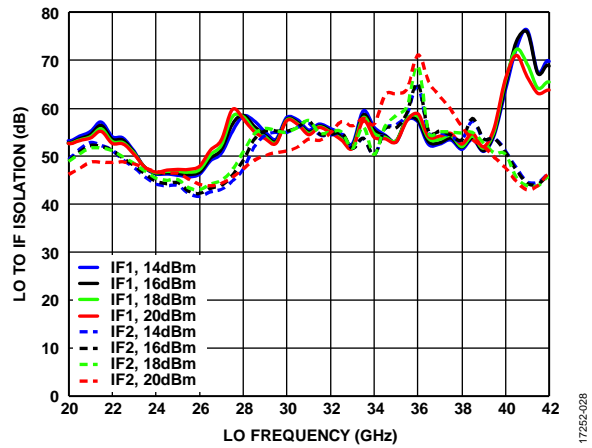


Figure 28. LO to IF Isolation vs. LO Frequency at Various LO Drives, IF = 100 MHz, T<sub>A</sub> = 25°C

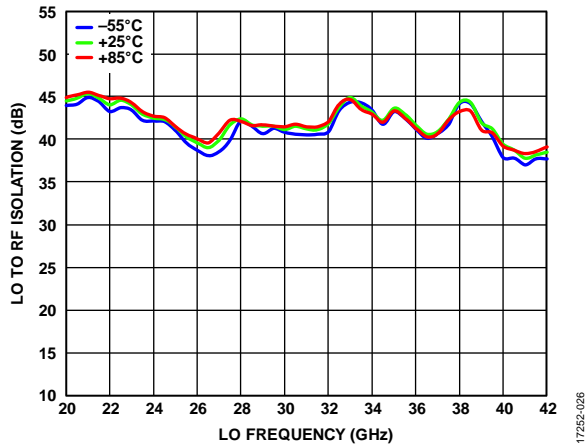


Figure 26. LO to RF Isolation vs. LO Frequency at Various Temperatures, IF = 100 MHz, LO Drive = 18 dBm

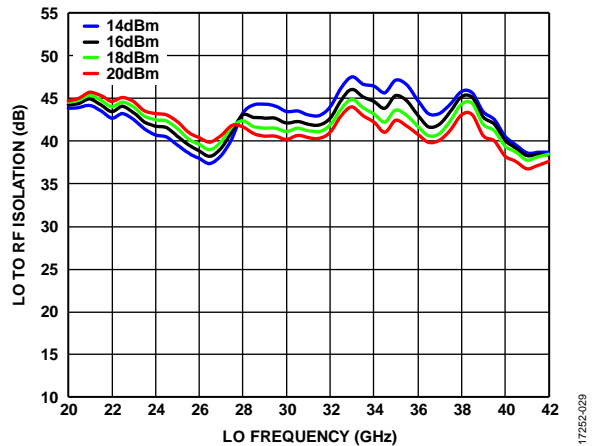


Figure 29. LO to RF Isolation vs. LO Frequency at Various LO Drives, IF = 100 MHz, T<sub>A</sub> = 25°C

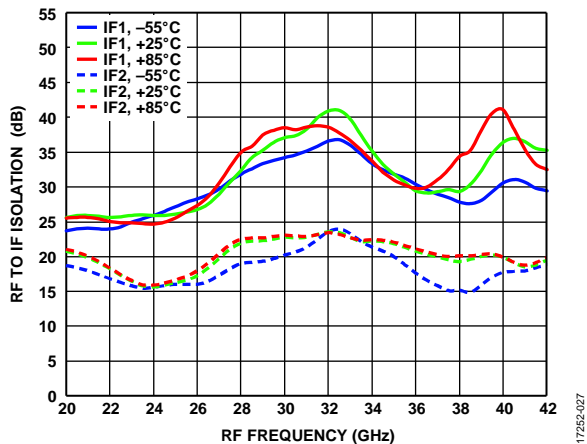


Figure 27. RF to IF Isolation vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm

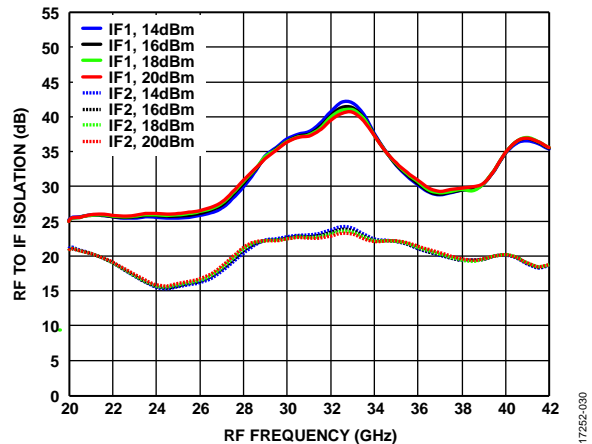


Figure 30. RF to IF Isolation vs. RF Frequency at Various LO Drives, T<sub>A</sub> = 25°C

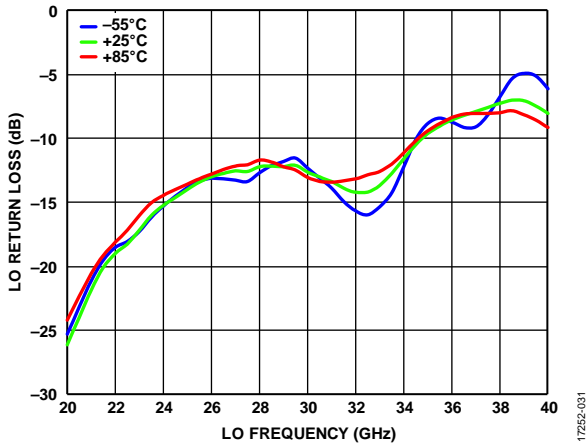


Figure 31. LO Return Loss vs. LO Frequency at Various Temperatures, LO Drive = 18 dBm

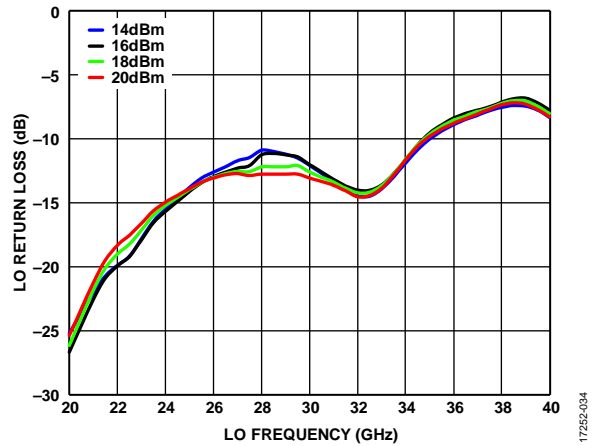


Figure 34. LO Return Loss vs. LO Frequency at Various LO Drives

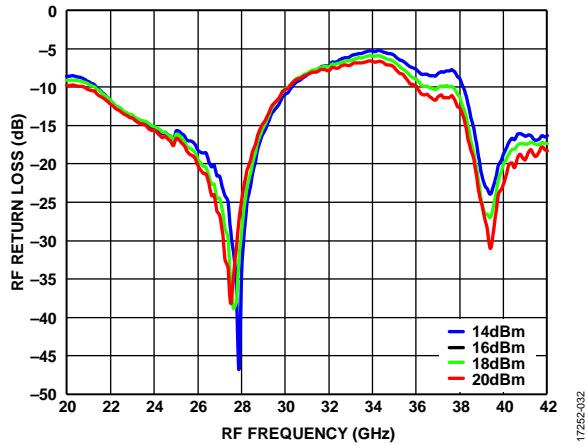


Figure 32. RF Return Loss vs. RF Frequency at Various Temperatures, LO Frequency = 32 GHz, LO Drive = 18 dBm

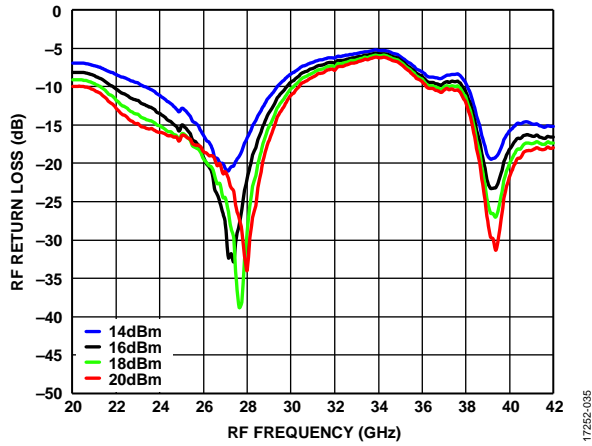


Figure 35. RF Return Loss vs. RF Frequency at Various LO Drives, LO Frequency = 32 GHz

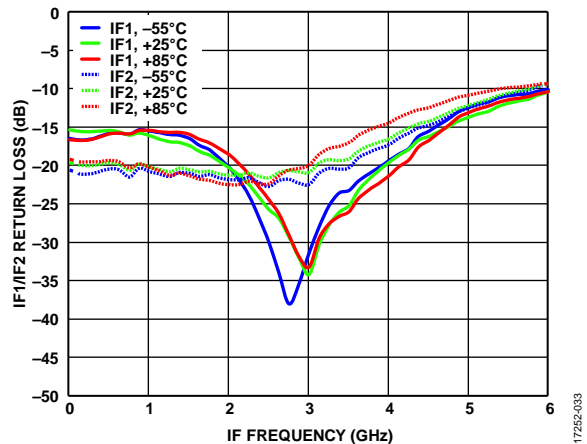


Figure 33. IF1/IF2 Return Loss vs. IF Frequency at Various Temperatures, LO Frequency = 32 GHz, LO Drive = 18 dBm

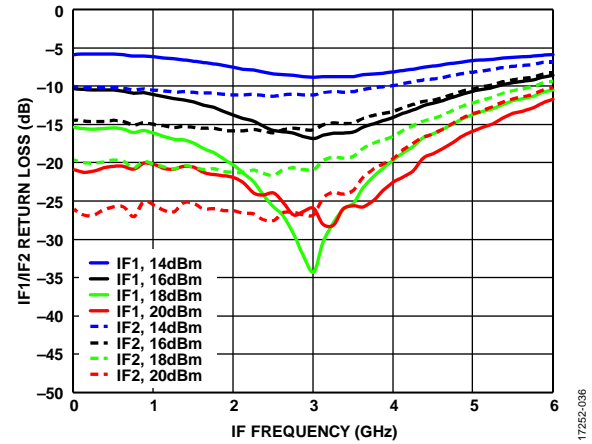


Figure 36. IF1/IF2 Return Loss vs. IF Frequency at Various LO Drives, LO Frequency = 32 GHz

**IF BANDWIDTH PERFORMANCE**

**Downconverter, Upper Sideband (Low-Side LO)**

Data over the IF frequency was taken without an external 90° hybrid at the IFx ports.

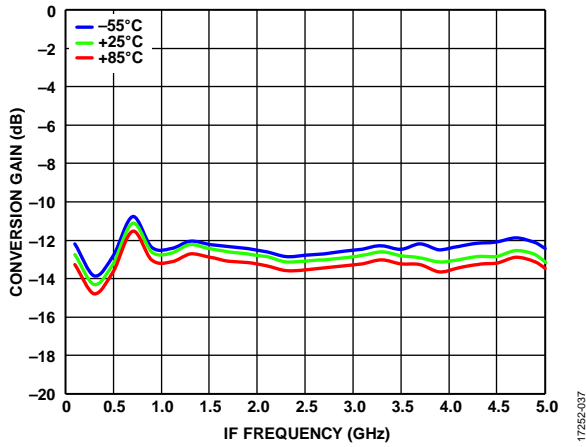


Figure 37. Conversion Gain vs. IF Frequency at Various Temperatures, LO Drive = 18 dBm at 32 GHz

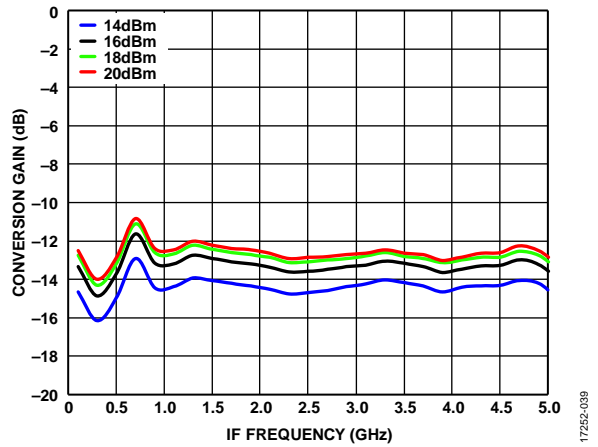


Figure 39. Conversion Gain vs. IF Frequency at Various LO Drives, LO Frequency = 32 GHz, T<sub>A</sub> = 25°C

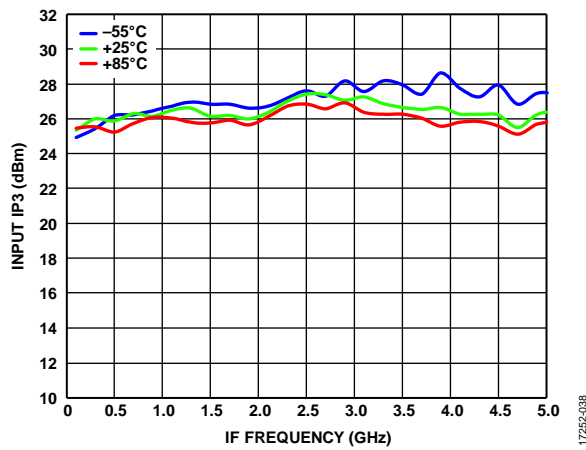


Figure 38. Input IP3 vs. IF Frequency at Various Temperatures, LO Drive = 18 dBm at 32 GHz

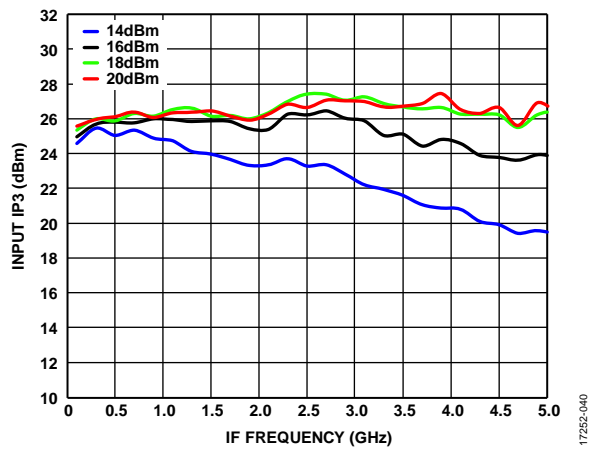


Figure 40. Input IP3 vs. IF Frequency at Various LO Drives, LO Frequency = 32 GHz, T<sub>A</sub> = 25°C

**Downconverter, Lower Sideband (High-Side LO)**

Data over the IF frequency was taken without an external 90° hybrid at the IFx ports.

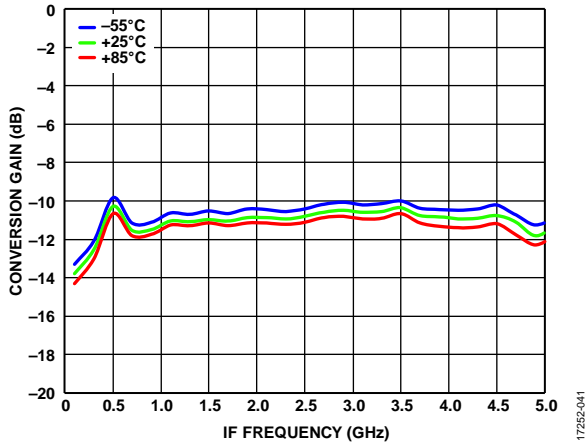


Figure 41. Conversion Gain vs. IF Frequency at Various Temperatures, LO Drive = 18 dBm at 32 GHz

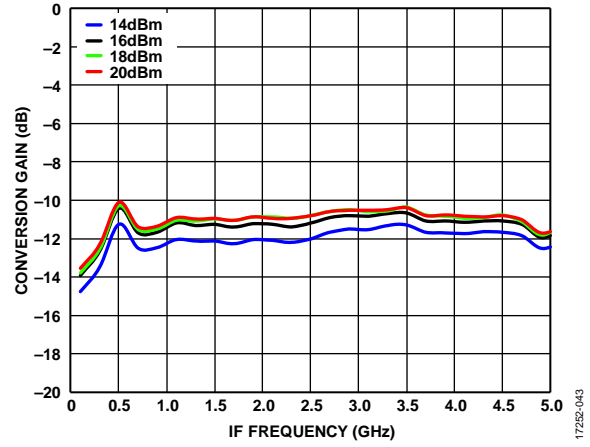


Figure 43. Conversion Gain vs. IF Frequency at Various LO Drives, LO Frequency = 32 GHz, T<sub>A</sub> = 25°C

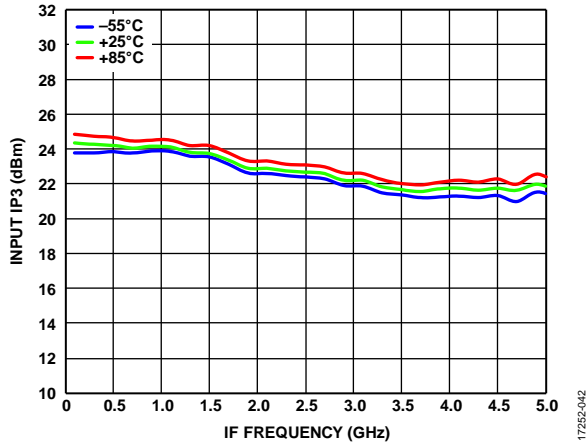


Figure 42. Input IP3 vs. IF Frequency at Various Temperatures, LO Drive = 18 dBm at 32 GHz

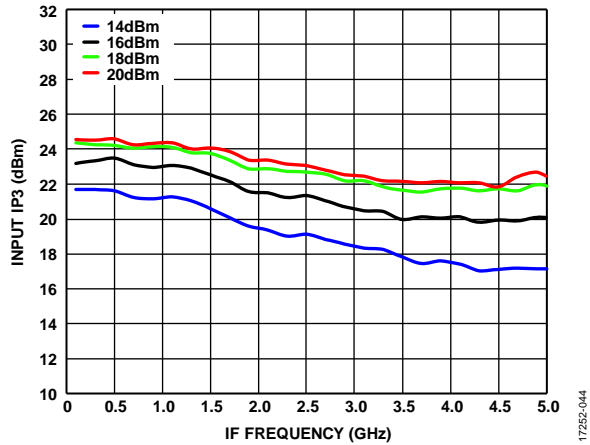


Figure 44. Input IP3 vs. IF Frequency at Various LO Drives, LO Frequency = 32 GHz, T<sub>A</sub> = 25°C

**AMPLITUDE AND PHASE IMBALANCE PERFORMANCE: DOWNCONVERTER, UPPER SIDEBAND (LOW-SIDE LO)**

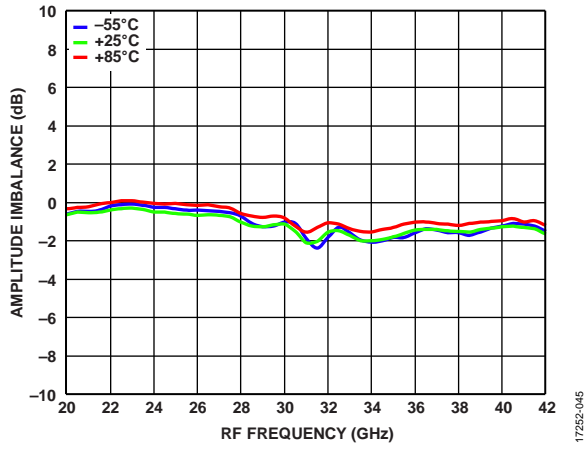


Figure 45. Amplitude Imbalance vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm, IF = 100 MHz

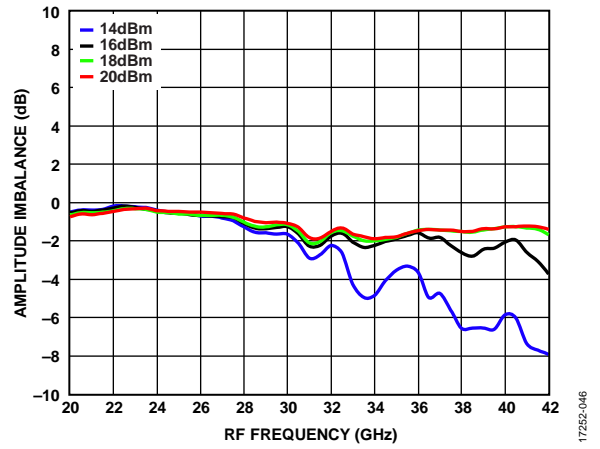


Figure 47. Amplitude Imbalance vs. RF Frequency at Various LO Drives, IF = 100 MHz, T<sub>A</sub> = 25°C

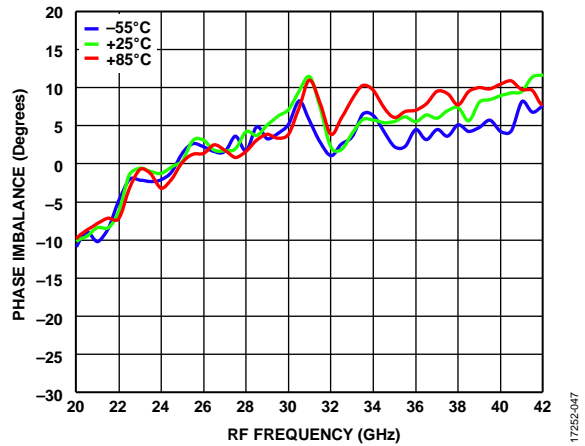


Figure 46. Phase Imbalance vs. RF Frequency at Various Temperatures, LO Drive = 18 dBm, IF = 100 MHz

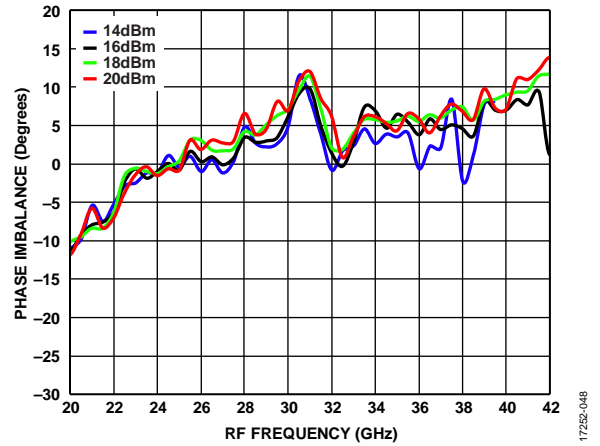


Figure 48. Phase Imbalance vs. RF Frequency at Various LO Drives, IF = 100 MHz, T<sub>A</sub> = 25°C

**SPURIOUS AND HARMONICS PERFORMANCE**

Data was taken without an IF hybrid at the IFx ports. N/A means not applicable.

**Downconverter M × N Spurious Outputs**

Mixer spurious products are measured in dBc from the IF output power level, unless otherwise specified. Spur values are (M × RF) – (N × LO).

IF = 100 MHz, RF = 20,000 MHz, LO = 19,900 MHz, RF power = –10 dBm, LO power = 18 dBm, and T<sub>A</sub> = 25°C.

		N × LO					
		0	1	2	3	4	5
M × RF	0	N/A	6	39	N/A	N/A	N/A
	1	6	0	37	5	N/A	N/A
	2	60	66	64	80	67	N/A
	3	N/A	70	78	66	79	70
	4	N/A	N/A	71	79	95	78
	5	N/A	N/A	N/A	71	82	92

IF = 100 MHz, RF = 30,000 MHz, LO = 29,900 MHz, RF power = –10 dBm, LO power = 18 dBm, and T<sub>A</sub> = 25°C.

		N × LO					
		0	1	2	3	4	5
M × RF	0	N/A	12	N/A	N/A	N/A	N/A
	1	9	0	42	N/A	N/A	N/A
	2	N/A	75	71	74	N/A	N/A
	3	N/A	N/A	77	84	75	N/A
	4	N/A	N/A	N/A	77	95	77
	5	N/A	N/A	N/A	N/A	76	95

IF = 100 MHz, RF = 40,000 MHz, LO = 39,900 MHz, RF power = –10 dBm, LO power = 18 dBm, and T<sub>A</sub> = 25°C.

		N × LO					
		0	1	2	3	4	5
M × RF	0	N/A	8	N/A	N/A	N/A	N/A
	1	3	0	28	N/A	N/A	N/A
	2	N/A	67	58	67	N/A	N/A
	3	N/A	N/A	68	74	66	N/A
	4	N/A	N/A	N/A	68	90	67
	5	N/A	N/A	N/A	N/A	68	92

IF = 100 MHz, RF = 20,000 MHz, LO = 20,100 MHz, RF power = –10 dBm, LO power = 18 dBm, and T<sub>A</sub> = 25°C.

		N × LO					
		0	1	2	3	4	5
M × RF	0	N/A	6	32	N/A	N/A	N/A
	1	6	0	40	59	N/A	N/A
	2	59	66	64	77	68	N/A
	3	N/A	69	79	65	78	68
	4	N/A	N/A	68	78	95	81
	5	N/A	N/A	N/A	70	81	94

IF = 100 MHz, RF = 30,000 MHz, LO = 31,100 MHz, RF power = –10 dBm, LO power = 18 dBm, and T<sub>A</sub> = 25°C.

		N × LO					
		0	1	2	3	4	5
M × RF	0	N/A	13	N/A	N/A	N/A	N/A
	1	8	0	39	N/A	N/A	N/A
	2	N/A	76	68	76	N/A	N/A
	3	N/A	N/A	77	87	76	N/A
	4	N/A	N/A	N/A	75	97	75
	5	N/A	N/A	N/A	N/A	78	96

IF = 100 MHz, RF = 40,000 MHz, LO = 40,100 MHz, RF power = –10 dBm, LO power = 18 dBm, and T<sub>A</sub> = 25°C.

		N × LO					
		0	1	2	3	4	5
M × RF	0	N/A	8	N/A	N/A	N/A	N/A
	1	1	0	28	N/A	N/A	N/A
	2	N/A	67	57	65	N/A	N/A
	3	N/A	N/A	68	67	66	N/A
	4	N/A	N/A	N/A	67	83	66
	5	N/A	N/A	N/A	N/A	67	90





## THEORY OF OPERATION

The HMC8192-Die is a passive, wideband, I/Q MMIC mixer that can be used either as an image rejection mixer for receiver operations or as a single-sideband upconverter for transmitter operations. The RF and LO range from 20 GHz to 42 GHz and the IF ranges from dc to 5 GHz.

The HMC8192-Die offers excellent image rejection due to its I/Q architecture design. This mixer is also excellent at LO to RF and LO to IF isolation and reduces the effect of LO leakage due to its double balanced architecture.

The HMC8192-Die is a passive mixer and does not require any dc power sources. As a result, the HMC8192-Die offers a lower noise figure compared to an active mixer, which also ensures

superior dynamic range for high performance and precision applications.

The HMC8192-Die is fabricated on a GaAs MESFET process and uses Analog Devices mixer cells and a 90° hybrid. The HMC8192-Die operates over a -55°C to +85°C temperature range.

For both upconversion and downconversion, an external 90° hybrid is required. See the Applications Information section for details on interfacing with an external 90° hybrid as well as information about switching between upconverter and downconverter modes and how to select sidebands in each mode.

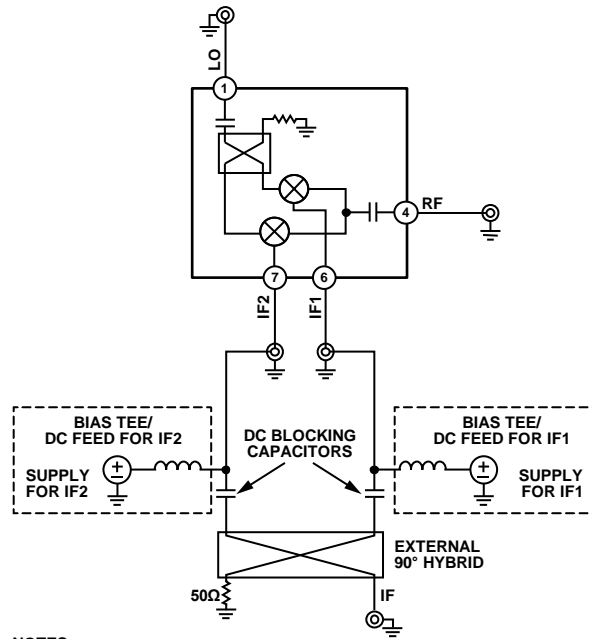
### APPLICATIONS INFORMATION

Figure 49 shows the typical application circuit for the HMC8192-Die. To select the appropriate sideband, an external 90° hybrid is needed. For applications not requiring operation to dc, use an off-chip dc blocking capacitor. For applications that require the LO signal at the output to be suppressed, use a bias tee or RF feed as shown in Figure 49. Ensure that the source or sink current used for LO suppression is less than 3 mA for each IFx port to prevent damage to the device. The common-mode voltage for each IFx port is 0 V.

To select the upper sideband when using the HMC8192-Die as an upconverter, connect the IF1 pin to the 90° port of the hybrid and connect the IF2 pin to the 0° port of the hybrid. To

select the lower sideband, connect the IF1 pin to the 0° port of the hybrid and the IF2 pin to the 90° port of the hybrid. The input is from the sum port of the hybrid, and the difference port is 50 Ω terminated.

To select the upper sideband (low-side LO) when using the HMC8192-Die as a downconverter, connect the IF1 pin to the 0° port of the hybrid and connect the IF2 pin to the 90° port of the hybrid. To select the lower sideband (high-side LO), connect the IF1 pin to the 90° port of the hybrid and the IF2 pin to the 0° port of the hybrid. The output is from the sum port of the hybrid, and the difference port is 50 Ω terminated.



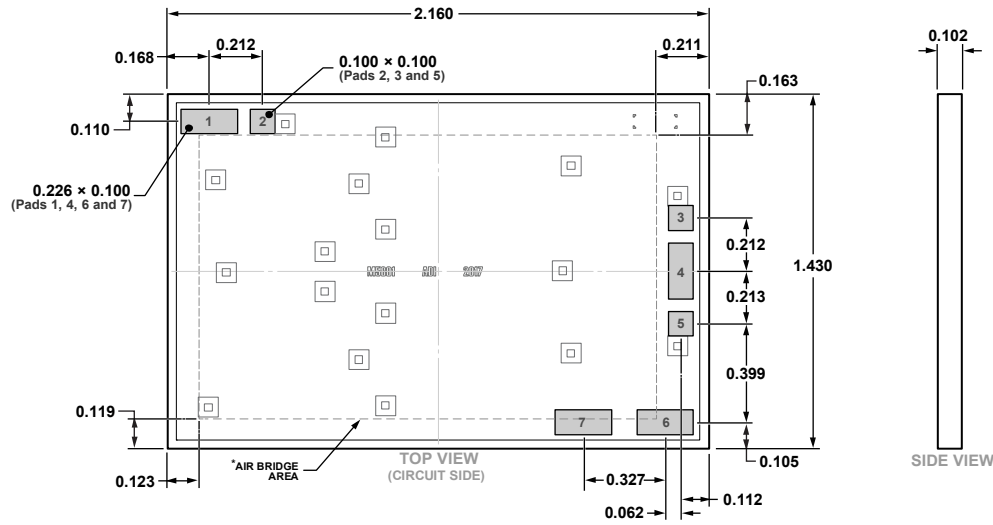
NOTES  
 1. DASHED SECTIONS ARE OPTIONAL AND MEANT FOR LO NULLING.

Figure 49. Typical Applications Circuit

17252-04B



# OUTLINE DIMENSIONS



\*This die utilizes fragile air bridges. Any pickup tools used must not contact this area.

Figure 52. 7-Pad Bare Die [CHIP]  
(C-7-6)  
Dimensions shown in millimeters

09-27-2018-A

## ORDERING GUIDE

Model <sup>1</sup>	Temperature Range	Package Description	Package Option
HMC8192	-55°C to +85°C	7-Pad Bare Die [CHIP]	C-7-6
HMC8192-SX	-55°C to +85°C	7-Pad Bare Die [CHIP]	C-7-6

<sup>1</sup> The HMC8192 and the HMC8192-SX are RoHS compliant parts.