

# SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

## General Description

The MAX2042 single, high-linearity upconversion/downconversion mixer provides +36dBm IIP3, 7.3dB noise figure, and 7.2dB conversion loss for 2000MHz to 3000MHz WCS, LTE, WiMAX™, and MMDS wireless infrastructure applications. With a wide LO frequency range of 1800MHz to 2800MHz, this particular mixer is ideal for low-side LO injection receiver and transmitter architectures. High-side LO injection is supported by the MAX2042A, which is pin-pin and functionally compatible with the MAX2042.

In addition to offering excellent linearity and noise performance, the MAX2042 also yields a high level of component integration. This device includes a double-balanced passive mixer core, an LO buffer, and on-chip baluns that allow for single-ended RF and LO inputs. The MAX2042 requires a nominal LO drive of 0dBm, and supply current is typically 138mA at  $V_{CC} = +5.0V$  or 120mA at  $V_{CC} = +3.3V$ .

The MAX2042 is pin compatible with the MAX2042A 2000MHz to 3900MHz mixer. The device is also pin similar with the MAX2029/MAX2031 650MHz to 1000MHz mixers, the MAX2039/MAX2041 1700MHz to 3000MHz mixers, and the MAX2044/MAX2044A 3000MHz to 4000MHz mixers, making this entire family of up/down-converters ideal for applications where a common PCB layout is used for multiple frequency bands.

The MAX2042 is available in a compact 20-pin thin QFN (5mm x 5mm) package with an exposed pad. Electrical performance is guaranteed over the extended  $-40^{\circ}C$  to  $+85^{\circ}C$  temperature range.

## Applications

- 2.3GHz WCS Base Stations
- 2.5GHz WiMAX and LTE Base Stations
- 2.7GHz MMDS Base Stations
- Fixed Broadband Wireless Access
- Wireless Local Loop
- Private Mobile Radios
- Military Systems

## Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX2042ETP+	$-40^{\circ}C$ to $+85^{\circ}C$	20 Thin QFN-EP*
MAX2042ETP+T	$-40^{\circ}C$ to $+85^{\circ}C$	20 Thin QFN-EP*

+Denotes a lead(Pb)-free/RoHS-compliant package.

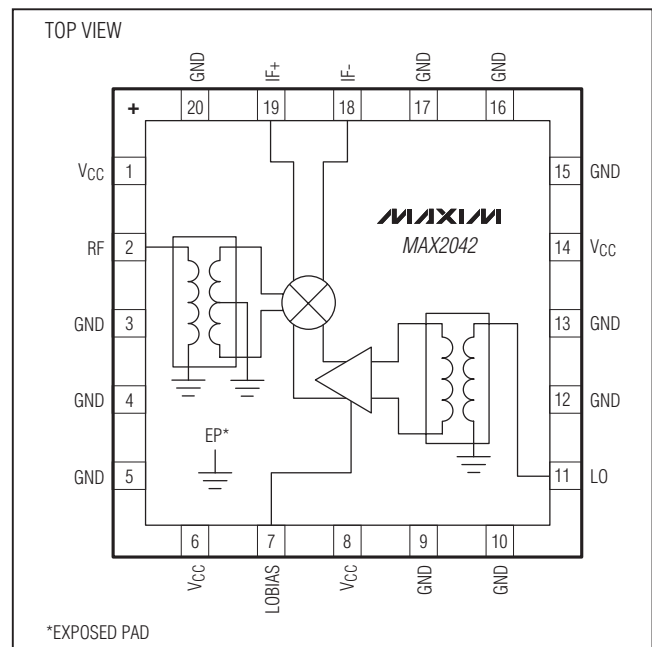
\*EP = Exposed pad.

T = Tape and reel.

## Features

- ◆ 2000MHz to 3000MHz RF Frequency Range
- ◆ 1800MHz to 2800MHz LO Frequency Range
- ◆ 50MHz to 500MHz IF Frequency Range
- ◆ 7.2dB Conversion Loss
- ◆ 7.3dB Noise Figure
- ◆ +36dBm Typical IIP3
- ◆ +23.4dBm Typical Input 1dB Compression Point
- ◆ 70dBc Typical 2RF - 2LO Spurious Rejection at PRF = -10dBm
- ◆ Integrated LO Buffer
- ◆ Integrated RF and LO Baluns for Single-Ended Inputs
- ◆ Low -3dBm to +3dBm LO Drive
- ◆ Pin Compatible with the MAX2042A 2000MHz to 3900MHz High-Side LO Injection Mixer
- ◆ Pin Similar with the MAX2029/MAX2031 650MHz to 1000MHz Mixers, MAX2039/MAX2041 1700MHz to 3000MHz Mixers, and MAX2044/MAX2044A 3000MHz to 4000MHz Mixers
- ◆ Single +5.0V or +3.3V Supply
- ◆ External Current-Setting Resistor Provides Option for Operating Device in Reduced-Power/Reduced-Performance Mode

## Pin Configuration/ Functional Diagram



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## ABSOLUTE MAXIMUM RATINGS

V <sub>CC</sub> to GND.....	-0.3V to +5.5V	θ <sub>JC</sub> (Notes 1, 3).....	+13°C/W
IF+, IF-, LOBIAS to GND.....	-0.3V to (V <sub>CC</sub> + 0.3V)	Operating Case Temperature Range (Note 4).....	-40°C to +85°C
RF, LO Input Power.....	+20dBm	Junction Temperature .....	+150°C
RF, LO Current (RF and LO are DC shorted to GND through a balun).....	50mA	Storage Temperature Range.....	-65°C to +150°C
Continuous Power Dissipation (Note 1) .....	5.0W	Lead Temperature (soldering, 10s) .....	+300°C
θ <sub>JA</sub> (Notes 2, 3).....	+38°C/W		

**Note 1:** Based on junction temperature  $T_J = T_C + (\theta_{JC} \times V_{CC} \times I_{CC})$ . This formula can be used when the temperature of the exposed pad is known while the device is soldered down to a PCB. See the *Applications Information* section for details. The junction temperature must not exceed +150°C.

**Note 2:** Junction temperature  $T_J = T_A + (\theta_{JA} \times V_{CC} \times I_{CC})$ . This formula can be used when the ambient temperature of the PCB is known. The junction temperature must not exceed +150°C.

**Note 3:** Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to [www.maxim-ic.com/thermal-tutorial](http://www.maxim-ic.com/thermal-tutorial).

**Note 4:** T<sub>C</sub> is the temperature on the exposed pad of the package. T<sub>A</sub> is the ambient temperature of the device and PCB.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## +5.0V SUPPLY DC ELECTRICAL CHARACTERISTICS

(Typical Application Circuit, V<sub>CC</sub> = +4.75V to +5.25V, no input AC signals. T<sub>C</sub> = -40°C to +85°C, unless otherwise noted. Typical values are at V<sub>CC</sub> = +5.0V, T<sub>C</sub> = +25°C, all parameters are production tested.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage	V <sub>CC</sub>		4.75	5.0	5.25	V
Supply Current	I <sub>CC</sub>			138	150	mA

## +3.3V SUPPLY DC ELECTRICAL CHARACTERISTICS

(Typical Application Circuit, V<sub>CC</sub> = +3.0V to +3.6V, no input AC signals. T<sub>C</sub> = -40°C to +85°C, unless otherwise noted. Typical values are at V<sub>CC</sub> = +3.3V, T<sub>C</sub> = +25°C, all parameters are production tested.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage	V <sub>CC</sub>		3.0	3.3	3.6	V
Supply Current	I <sub>CC</sub>			120	135	mA

## RECOMMENDED AC OPERATING CONDITIONS

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
RF Frequency Range		Typical Application Circuit with C1 = 8.2pF, see Table 1 for details (Notes 5, 6)	2000		3000	MHz
LO Frequency	f <sub>LO</sub>	(Notes 5, 6)	1800		2800	MHz
IF Frequency	f <sub>IF</sub>	Using M/A-Com MABAES0029 1:1 transformer as defined in the <i>Typical Application Circuit</i> , IF matching components affect the IF frequency range (Notes 5, 6)	50		500	MHz
LO Drive	P <sub>LO</sub>	(Notes 5, 6)	-3	0	+3	dBm

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## +5.0V SUPPLY AC ELECTRICAL CHARACTERISTICS (DOWNCONVERTER OPERATION)

(Typical Application Circuit with tuning elements outlined in **Table 1**,  $V_{CC} = +4.75V$  to  $+5.25V$ , RF and LO ports are driven from  $50\Omega$  sources,  $P_{LO} = -3dBm$  to  $+3dBm$ ,  $P_{RF} = 0dBm$ ,  $f_{RF} = 2300MHz$  to  $2900MHz$ ,  $f_{IF} = 300MHz$ ,  $f_{LO} = 2000MHz$  to  $2600MHz$ ,  $f_{RF} > f_{LO}$ ,  $T_C = -40^\circ C$  to  $+85^\circ C$ . Typical values are for  $T_C = +25^\circ C$ ,  $V_{CC} = +5.0V$ ,  $P_{RF} = 0dBm$ ,  $P_{LO} = 0dBm$ ,  $f_{RF} = 2300MHz$ ,  $f_{LO} = 2300MHz$ ,  $f_{IF} = 300MHz$ . All parameters are guaranteed by design and characterization, unless otherwise noted.) (Note 7)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small-Signal Conversion Loss	LC	$f_{RF} = 2300MHz$ to $2900MHz$ , $T_C = +25^\circ C$ (Note 8)	6.7	7.2	8.1	dB
Loss Variation vs. Frequency	$\Delta LC$	$f_{RF} = 2305MHz$ to $2360MHz$		0.15		dB
		$f_{RF} = 2500MHz$ to $2570MHz$		0.15		
		$f_{RF} = 2570MHz$ to $2620MHz$		0.15		
		$f_{RF} = 2500MHz$ to $2690MHz$		0.15		
		$f_{RF} = 2700MHz$ to $2900MHz$		0.20		
Conversion Loss Temperature Coefficient	TCCL	$T_C = -40^\circ C$ to $+85^\circ C$		0.0071		dB/ $^\circ C$
Single Sideband Noise Figure	NFSSB	No blockers present		7.3		dB
Noise Figure Temperature Coefficient	TCNF	$f_{RF} = 2300MHz$ to $2900MHz$ , single sideband, no blockers present, $T_C = -40^\circ C$ to $+85^\circ C$		0.019		dB/ $^\circ C$
Noise Figure Under Blocking	NFB	+8dBm blocker tone applied to RF port, $f_{RF} = 2600MHz$ , $f_{LO} = 2300MHz$ , $f_{BLOCKER} = 2795MHz$ , $P_{LO} = 0dBm$ , $V_{CC} = 5.0V$ , $T_C = +25^\circ C$ (Notes 5, 9)		20.8	25	dB
Input 1dB Compression Point	IP1dB	$T_C = +25^\circ C$ (Notes 5, 10)	$f_{RF} = 2300MHz$	22.5	23.4	dBm
			$f_{RF} = 2600MHz$	20.6	22.1	
			$f_{RF} = 2900MHz$	17.6	20.7	
Third-Order Input Intercept Point	IIP3	PRF1 = PRF2 = 0dBm/tone, $P_{LO} = 0dBm$ , $T_C = +25^\circ C$	$f_{RF1} = 2300MHz$ , $f_{RF2} = 2301MHz$ , $f_{LO} = 2000MHz$ (Note 5)	34	36	dBm
			$f_{RF1} = 2600MHz$ , $f_{RF2} = 2601MHz$ , $f_{LO} = 2300MHz$ (Note 8)	31	34	
			$f_{RF1} = 2900MHz$ , $f_{RF2} = 2901MHz$ , $f_{LO} = 2600MHz$ (Note 5)	28	30	
IIP3 Variation with $T_C$		$f_{RF} = 2300MHz$ to $2900MHz$ , $f_{RF1} - f_{RF2} = 1MHz$ , $PRF1 = PRF2 = 0dBm$ / tone, $T_C = -40^\circ C$ to $+85^\circ C$		$\pm 0.5$		dB
2RF - 2LO Spur Rejection	2 x 2	$f_{SPUR} = f_{LO} + 150MHz$ (Note 5)	PRF = -10dBm	64	70	dBc
			PRF = 0dBm	54	60	
3RF - 3LO Spur Rejection	3 x 3	$f_{SPUR} = f_{LO} + 100MHz$ (Note 5)	PRF = -10dBm	80	92	dBc
			PRF = 0dBm	60	72	
RF Input Return Loss	RLRF	LO on and IF terminated into a matched impedance		17		dB
LO Input Return Loss	RLLO	RF and IF terminated into a matched impedance		15		dB

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## +5.0V SUPPLY AC ELECTRICAL CHARACTERISTICS (DOWNCONVERTER OPERATION) (continued)

(Typical Application Circuit with tuning elements outlined in **Table 1**,  $V_{CC} = +4.75V$  to  $+5.25V$ , RF and LO ports are driven from  $50\Omega$  sources,  $P_{LO} = -3dBm$  to  $+3dBm$ ,  $P_{RF} = 0dBm$ ,  $f_{RF} = 2300MHz$  to  $2900MHz$ ,  $f_{IF} = 300MHz$ ,  $f_{LO} = 2000MHz$  to  $2600MHz$ ,  $f_{RF} > f_{LO}$ ,  $T_C = -40^\circ C$  to  $+85^\circ C$ . Typical values are for  $T_C = +25^\circ C$ ,  $V_{CC} = +5.0V$ ,  $P_{RF} = 0dBm$ ,  $P_{LO} = 0dBm$ ,  $f_{RF} = 2300MHz$ ,  $f_{LO} = 2300MHz$ ,  $f_{IF} = 300MHz$ . All parameters are guaranteed by design and characterization, unless otherwise noted.) (Note 7)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
IF Output Impedance	$Z_{IF}$	Nominal differential impedance at the IC's IF outputs		50		$\Omega$
IF Output Return Loss	$RL_{IF}$	RF terminated into $50\Omega$ , LO driven by $50\Omega$ source, IF transformed to $50\Omega$ using external components shown in the <i>Typical Application Circuit</i>		18		dB
RF-to-IF Isolation		$P_{LO} = +3dBm$ (Note 8)	30	37		dB
LO Leakage at RF Port		$f_{LO} = 2000MHz$ to $2800MHz$ , $P_{LO} = +3dBm$ (Note 8)		-28	-22	dBm
2LO Leakage at RF Port		$P_{LO} = +3dBm$		-36		dBm
LO Leakage at IF Port		$f_{LO} = 2000MHz$ to $2800MHz$ , $P_{LO} = +3dBm$ (Note 8)		-24.2	-16	dBm

## +3.3V SUPPLY AC ELECTRICAL CHARACTERISTICS (DOWNCONVERTER OPERATION)

(Typical Application Circuit with tuning elements outlined in **Table 1**, RF and LO ports are driven from  $50\Omega$  sources. Typical values are for  $T_C = +25^\circ C$ ,  $V_{CC} = +3.3V$ ,  $P_{RF} = 0dBm$ ,  $P_{LO} = 0dBm$ ,  $f_{RF} = 2600MHz$ ,  $f_{LO} = 2300MHz$ ,  $f_{IF} = 300MHz$ , unless otherwise noted.) (Note 7)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small-Signal Conversion Loss	$L_C$	(Note 8)		7.2		dB
Loss Variation vs. Frequency	$\Delta L_C$	$f_{RF} = 2300MHz$ to $2900MHz$ , any 100MHz band		0.2		dB
Conversion Loss Temperature Coefficient	$TC_{CL}$	$T_C = -40^\circ C$ to $+85^\circ C$		0.008		dB/ $^\circ C$
Single Sideband Noise Figure	$NF_{SSB}$	No blockers present		7.5		dB
Noise Figure Temperature Coefficient	$TC_{NF}$	Single sideband, no blockers present, $T_C = -40^\circ C$ to $+85^\circ C$		0.019		dB/ $^\circ C$
Input 1dB Compression Point	$IP_{1dB}$	(Note 10)		20		dBm
Third-Order Input Intercept Point	$IIP3$	$f_{RF1} = 2600MHz$ , $f_{RF2} = 2601MHz$ , $P_{RF1} = P_{RF2} = 0dBm/$ tone		31		dBm
$IIP3$ Variation with $T_C$		$f_{RF1} = 2600MHz$ , $f_{RF2} = 2601MHz$ , $P_{RF1} = P_{RF2} = 0dBm/$ tone, $T_C = -40^\circ C$ to $+85^\circ C$		$\pm 0.25$		dB
2RF - 2LO Spur Rejection	$2 \times 2$	$P_{RF} = -10dBm$ , $f_{SPUR} = f_{LO} + 150MHz$		72		dBc
		$P_{RF} = 0dBm$ , $f_{SPUR} = f_{LO} + 150MHz$		62		
3RF - 3LO Spur Rejection	$3 \times 3$	$P_{RF} = -10dBm$ , $f_{SPUR} = f_{LO} + 100MHz$		87		dBc
		$P_{RF} = 0dBm$ , $f_{SPUR} = f_{LO} + 100MHz$		67		

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## +3.3V SUPPLY AC ELECTRICAL CHARACTERISTICS (DOWNCONVERTER OPERATION) (continued)

(Typical Application Circuit with tuning elements outlined in **Table 1**, RF and LO ports are driven from 50Ω sources. Typical values are for  $T_C = +25^\circ\text{C}$ ,  $V_{CC} = +3.3\text{V}$ ,  $P_{RF} = 0\text{dBm}$ ,  $P_{LO} = 0\text{dBm}$ ,  $f_{RF} = 2600\text{MHz}$ ,  $f_{LO} = 2300\text{MHz}$ ,  $f_{IF} = 300\text{MHz}$ , unless otherwise noted.) (Note 7)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
RF Input Return Loss	RLRF	LO on and IF terminated into a matched impedance		15		dB
LO Input Return Loss	RLLO	RF and IF terminated into a matched impedance		12		dB
IF Output Impedance	Z <sub>IF</sub>	Nominal differential impedance at the IC's IF outputs		50		Ω
IF Output Return Loss	RLIF	RF terminated into 50Ω, LO driven by 50Ω source, IF transformed to 50Ω using external components shown in the <i>Typical Application Circuit</i>		18		dB
Minimum RF-to-IF Isolation		$f_{RF} = 2300\text{MHz to } 2900\text{MHz}$ , $P_{LO} = +3\text{dBm}$		36		dB
Maximum LO Leakage at RF Port		$f_{LO} = 1800\text{MHz to } 2800\text{MHz}$ , $P_{LO} = +3\text{dBm}$		-24.5		dBm
Maximum 2LO Leakage at RF Port		$f_{LO} = 1800\text{MHz to } 2800\text{MHz}$ , $P_{LO} = +3\text{dBm}$		-24		dBm
Maximum LO Leakage at IF Port		$f_{LO} = 1800\text{MHz to } 2800\text{MHz}$ , $P_{LO} = +3\text{dBm}$		-20		dBm

## +5.0V SUPPLY AC ELECTRICAL CHARACTERISTICS (UPCONVERTER OPERATION)

(Typical Application Circuit with tuning elements outlined in **Table 2**,  $V_{CC} = +4.75\text{V to } +5.25\text{V}$ , RF and LO ports are driven from 50Ω sources,  $P_{LO} = -3\text{dBm to } +3\text{dBm}$ ,  $P_{IF} = 0\text{dBm}$ ,  $f_{RF} = 2300\text{MHz to } 2900\text{MHz}$ ,  $f_{IF} = 200\text{MHz}$ ,  $f_{LO} = 2100\text{MHz to } 2700\text{MHz}$ ,  $f_{RF} > f_{LO}$ ,  $T_C = -40^\circ\text{C to } +85^\circ\text{C}$ . Typical values are for  $T_C = +25^\circ\text{C}$ ,  $V_{CC} = +5.0\text{V}$ ,  $P_{IF} = 0\text{dBm}$ ,  $P_{LO} = 0\text{dBm}$ ,  $f_{RF} = 2600\text{MHz}$ ,  $f_{LO} = 2400\text{MHz}$ ,  $f_{IF} = 200\text{MHz}$ . All parameters are guaranteed by design and characterization, unless otherwise noted.) (Note 7)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small-Signal Conversion Loss	L <sub>C</sub>	(Note 8)		6.8		dB
Loss Variation vs. Frequency	ΔL <sub>C</sub>	$f_{RF} = 2300\text{MHz to } 2960\text{MHz}$ , any 100MHz band		0.2		dB
Conversion Loss Temperature Coefficient	TC <sub>CL</sub>	$T_C = -40^\circ\text{C to } +85^\circ\text{C}$		0.007		dB/°C
Input 1dB Compression Point	IP <sub>1dB</sub>	(Note 10)		22.7		dBm
Third-Order Input Intercept Point	IIP3	$f_{IF1} = 200\text{MHz}$ , $f_{IF2} = 201\text{MHz}$ , $P_{IF1} = P_{IF2} = 0\text{dBm/ tone}$ , $f_{LO} = 2400\text{MHz}$ , $P_{LO} = 0\text{dBm}$ , $T_C = +25^\circ\text{C}$ (Note 8)	30	32.4		dBm
IIP3 Variation with $T_C$		$f_{IF1} = 200\text{MHz}$ , $f_{IF2} = 201\text{MHz}$ , $P_{IF1} = P_{IF2} = 0\text{dBm/ tone}$ , $f_{LO} = 2400\text{MHz}$ , $P_{LO} = 0\text{dBm}$ , $T_C = -40^\circ\text{C to } +85^\circ\text{C}$		±0.5		dB
LO ± 2IF Spur Rejection	1 × 2	LO - 2IF		70		dBc
		LO + 2IF		67		
LO ± 3IF Spur Rejection	1 × 3	LO - 3IF		82		dBc
		LO + 3IF		77		
Output Noise Floor		$P_{OUT} = 0\text{dBm}$ (Note 9)		-163		dBm/Hz

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## +3.3V SUPPLY AC ELECTRICAL CHARACTERISTICS (UPCONVERTER OPERATION)

(Typical Application Circuit with tuning elements outlined in **Table 2**, RF and LO ports are driven from 50Ω sources. Typical values are for T<sub>C</sub> = +25°C, V<sub>CC</sub> = +3.3V, P<sub>IF</sub> = 0dBm, P<sub>LO</sub> = 0dBm, f<sub>RF</sub> = 2600MHz, f<sub>LO</sub> = 2400MHz, f<sub>IF</sub> = 200MHz, unless otherwise noted.) (Note 7)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small-Signal Conversion Loss	LC			6.8		dB
Loss Variation vs. Frequency	ΔLC	f <sub>RF</sub> = 2300MHz to 2900MHz, any 100MHz band		0.15		dB
Conversion Loss Temperature Coefficient	TCCL	T <sub>C</sub> = -40°C to +85°C		0.008		dB/°C
Input 1dB Compression Point	IP <sub>1dB</sub>	(Note 10)		19		dBm
Third-Order Input Intercept Point	IIP3	f <sub>IF1</sub> = 200MHz, f <sub>IF2</sub> = 201MHz, P <sub>IF1</sub> = P <sub>IF2</sub> = 0dBm/tone		29.5		dBm
IIP3 Variation with T <sub>C</sub>		f <sub>IF1</sub> = 200MHz, f <sub>IF2</sub> = 201MHz, P <sub>IF1</sub> = P <sub>IF2</sub> = 0dBm/tone, f <sub>LO</sub> = 2400MHz, P <sub>LO</sub> = 0dBm, T <sub>C</sub> = -40°C to +85°C		±0.75		dB
LO ± 2IF Spur Rejection	1 × 2	LO - 2IF		72		dBc
		LO + 2IF		70		
LO ± 3IF Spur Rejection	1 × 3	LO - 3IF		73		dBc
		LO + 3IF		70		
Output Noise Floor		P <sub>OUT</sub> = 0dBm (Note 9)		-160		dBm/Hz

**Note 5:** Not production tested.

**Note 6:** Operation outside this range is possible, but with degraded performance of some parameters. See the *Typical Operating Characteristics*.

**Note 7:** All limits reflect losses of external components, including a 0.5dB loss at f<sub>IF</sub> = 300MHz due to the 1:1 impedance transformer. Output measurements were taken at IF outputs of the *Typical Application Circuit*.

**Note 8:** 100% production tested for functional performance.

**Note 9:** Measured with external LO source noise filtered so that the noise floor is -174dBm/Hz. This specification reflects the effects of all SNR degradations in the mixer including the LO noise, as defined in Application Note 2021: *Specifications and Measurement of Local Oscillator Noise in Integrated Circuit Base Station Mixers*.

**Note 10:** Maximum reliable continuous input power applied to the RF port of this device is +20dBm from a 50Ω source.

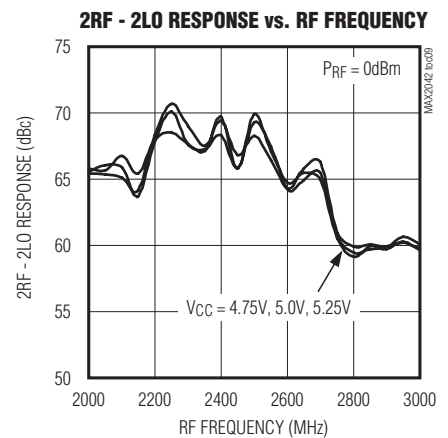
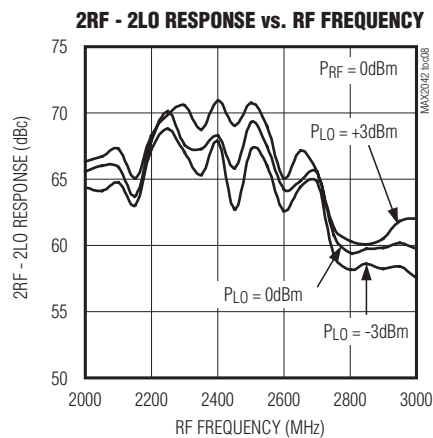
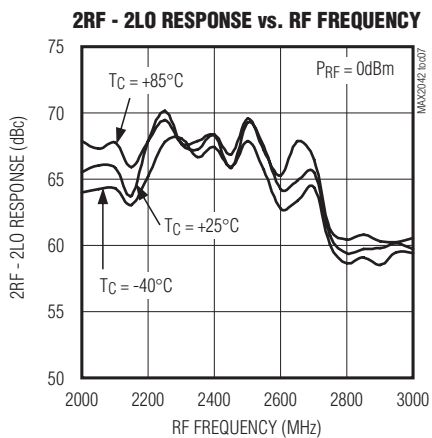
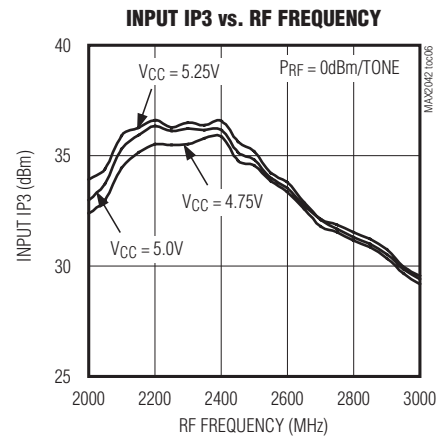
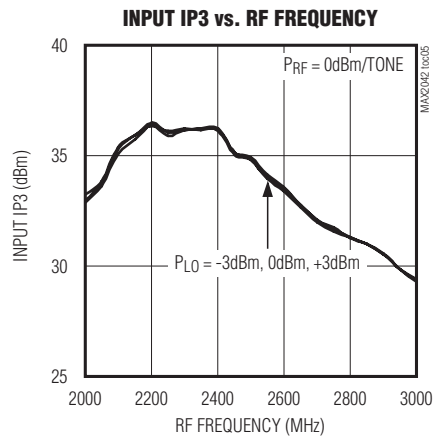
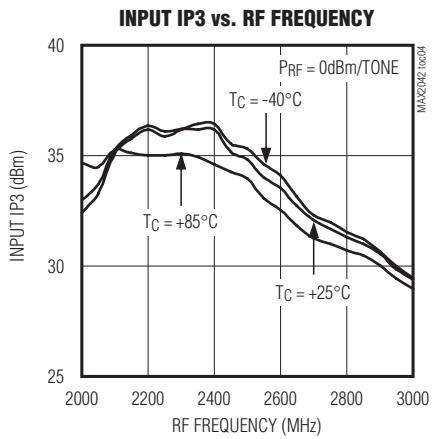
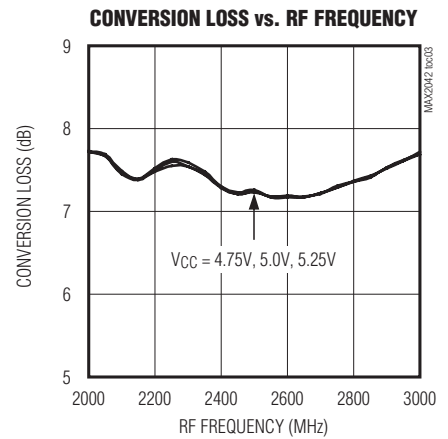
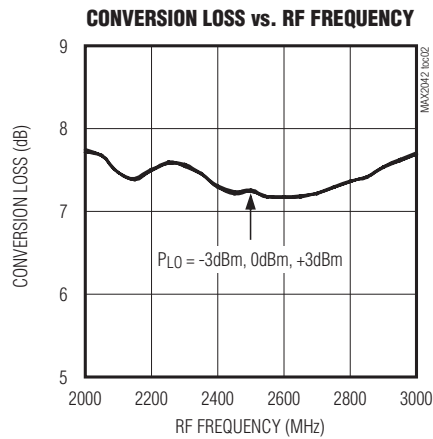
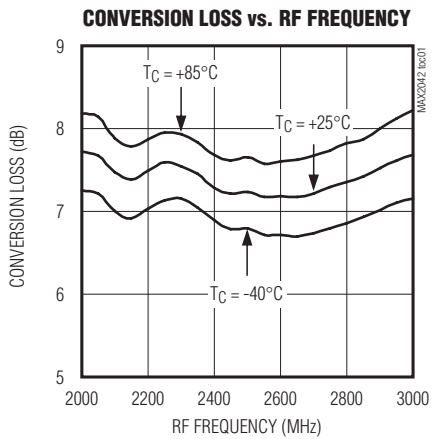
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MAX2042

## Typical Operating Characteristics

(Typical Application Circuit with tuning elements outlined in Table 1,  $V_{CC} = +5.0V$ ,  $f_{RF} > f_{LO}$ ,  $f_{IF} = 300MHz$ ,  $P_{RF} = 0dBm$ ,  $P_{LO} = 0dBm$ ,  $T_C = +25^\circ C$ , unless otherwise noted.)

### +5.0V Downconverter Curves

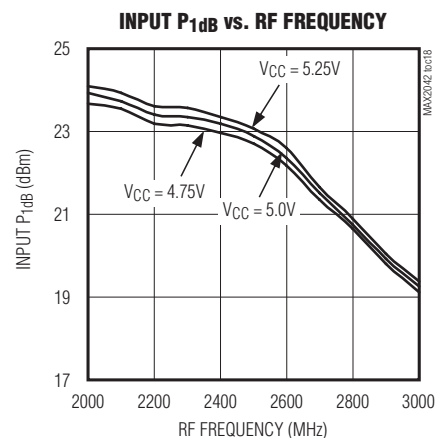
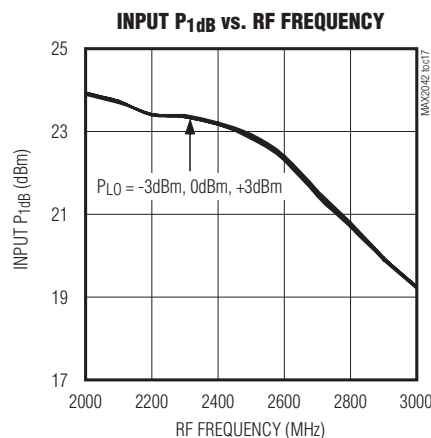
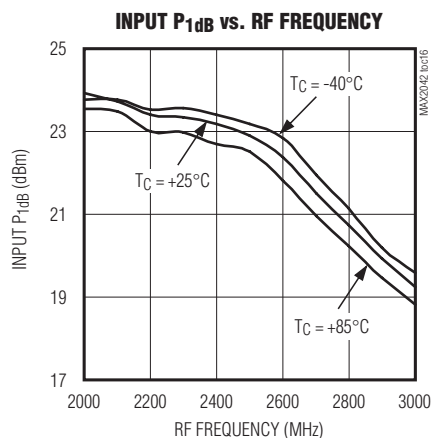
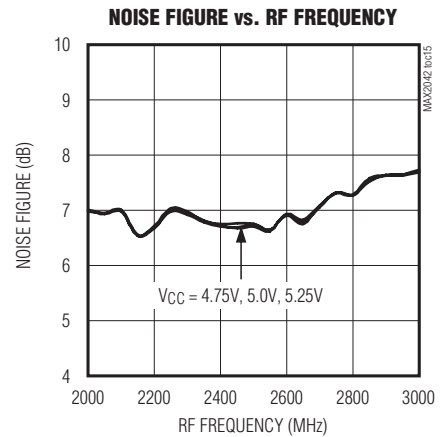
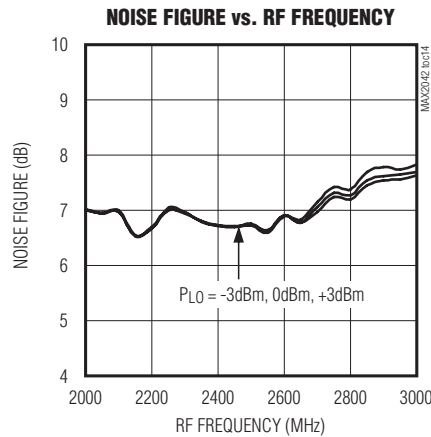
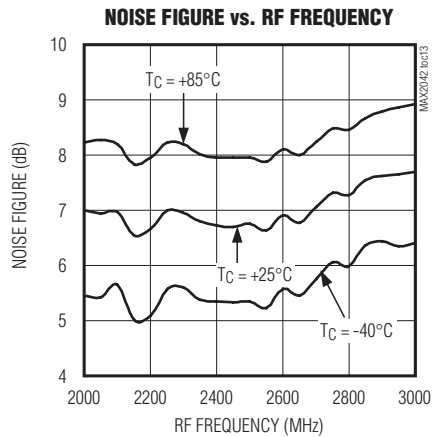
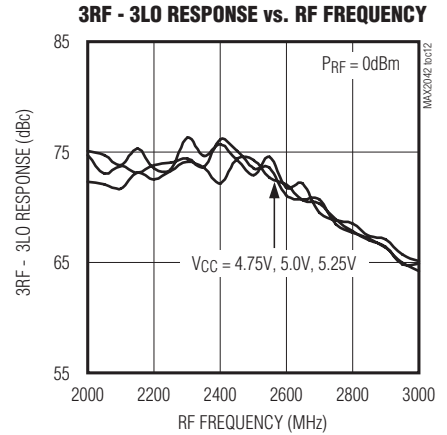
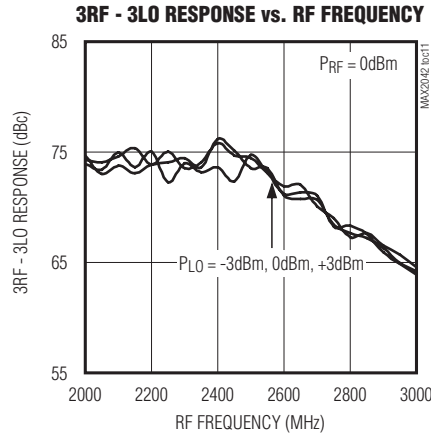
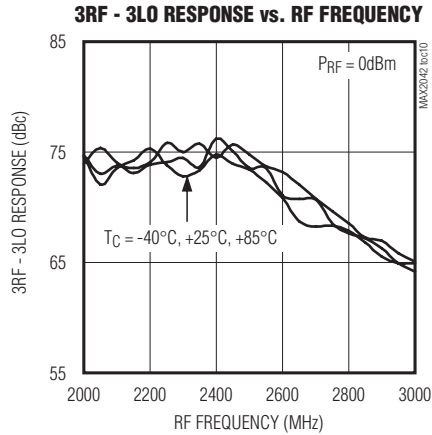


# SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

## Typical Operating Characteristics (continued)

(Typical Application Circuit with tuning elements outlined in Table 1,  $V_{CC} = +5.0V$ ,  $f_{RF} > f_{LO}$ ,  $f_{IF} = 300MHz$ ,  $P_{RF} = 0dBm$ ,  $P_{LO} = 0dBm$ ,  $T_C = +25^\circ C$ , unless otherwise noted.)

### +5.0V Downconverter Curves





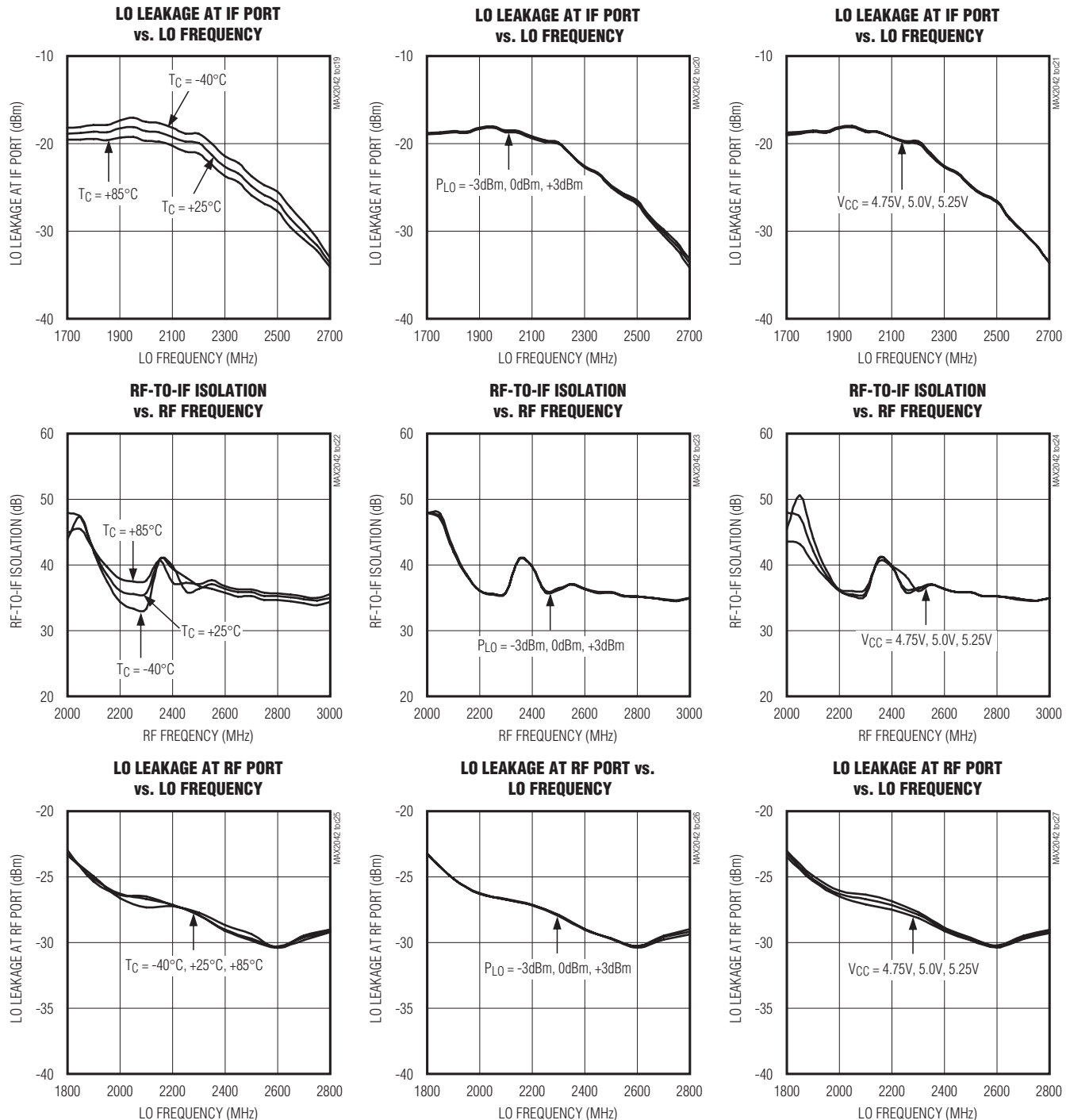
# SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

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## Typical Operating Characteristics (continued)

(Typical Application Circuit with tuning elements outlined in Table 1,  $V_{CC} = +5.0V$ ,  $f_{RF} > f_{LO}$ ,  $f_{IF} = 300MHz$ ,  $P_{RF} = 0dBm$ ,  $P_{LO} = 0dBm$ ,  $T_C = +25^\circ C$ , unless otherwise noted.)

### +5.0V Downconverter Curves

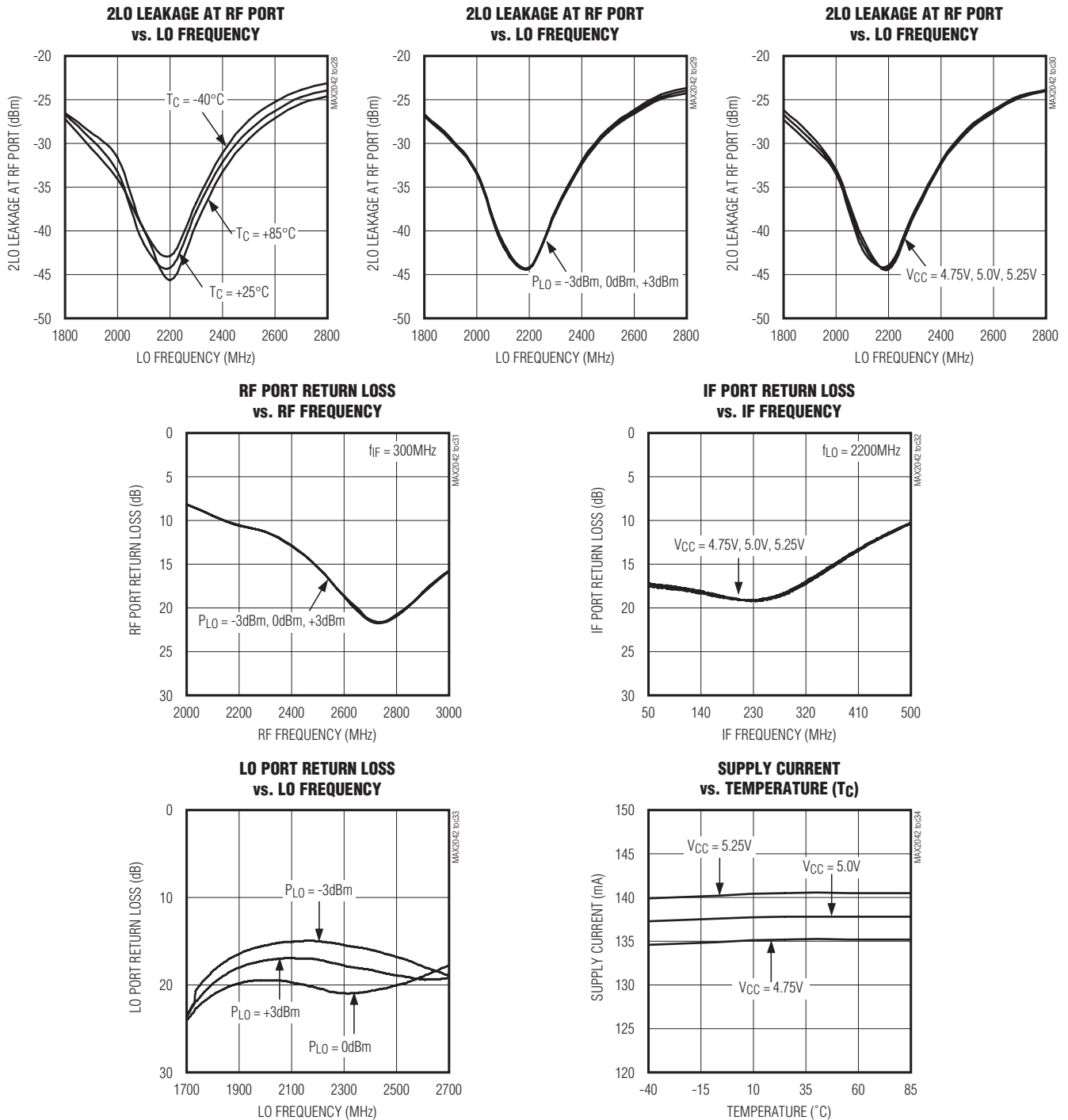


# SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

## Typical Operating Characteristics (continued)

(Typical Application Circuit with tuning elements outlined in Table 1,  $V_{CC} = +5.0V$ ,  $f_{RF} > f_{LO}$ ,  $f_{IF} = 300MHz$ ,  $P_{RF} = 0dBm$ ,  $P_{LO} = 0dBm$ ,  $T_C = +25^\circ C$ , unless otherwise noted.)

### +5.0V Downconverter Curves



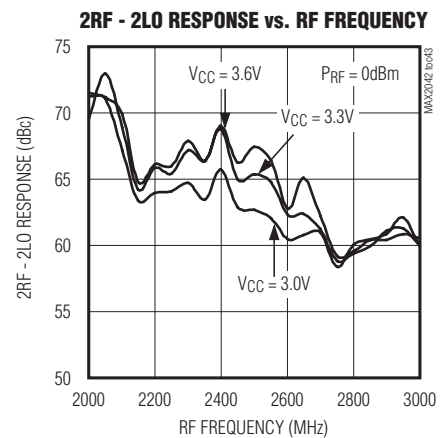
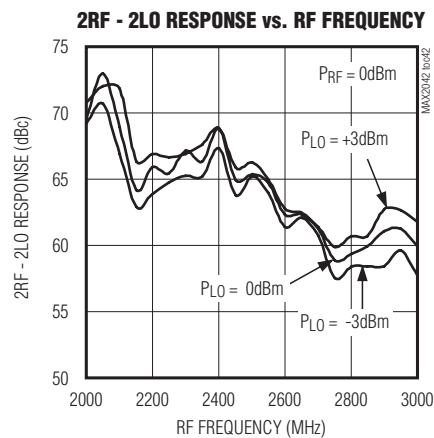
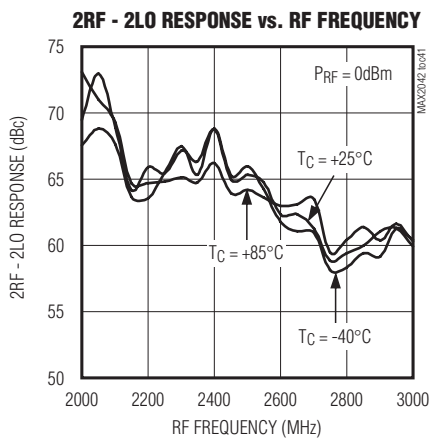
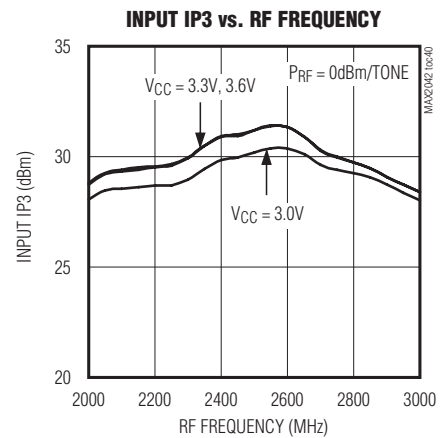
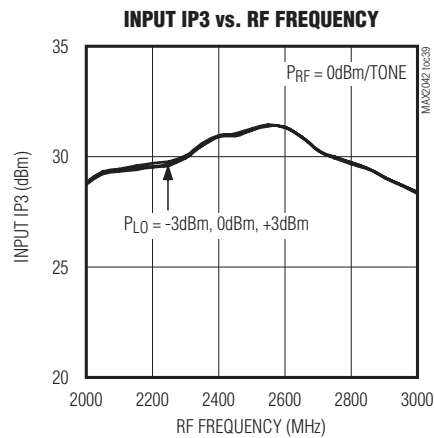
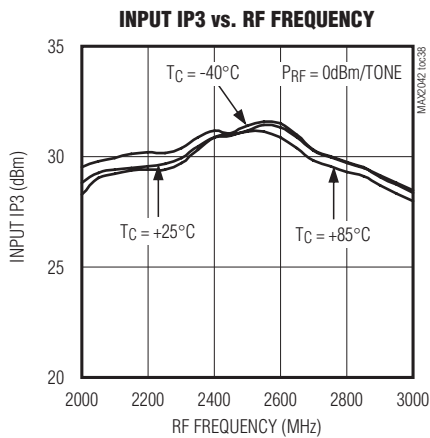
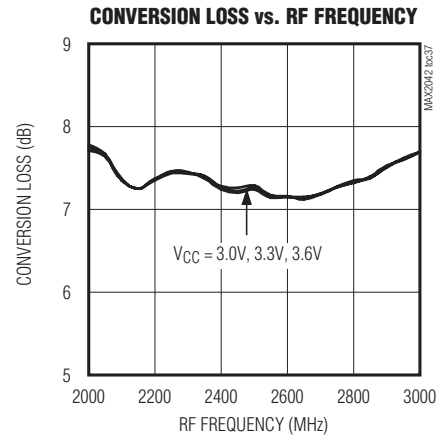
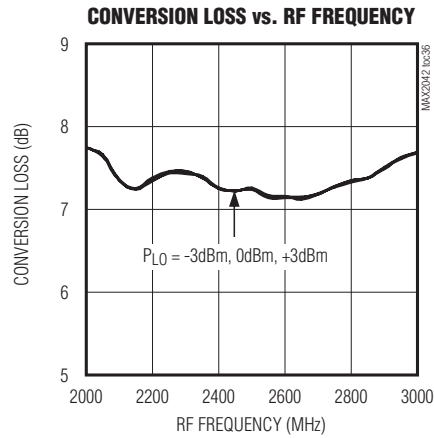
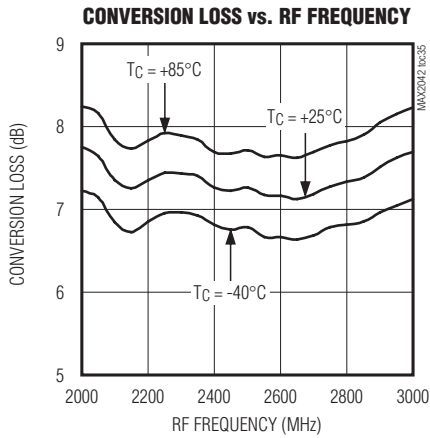
# SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

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## Typical Operating Characteristics (continued)

(Typical Application Circuit with tuning elements outlined in Table 1,  $V_{CC} = +3.3V$ ,  $f_{RF} > f_{LO}$ ,  $f_{IF} = 300MHz$ ,  $P_{RF} = 0dBm$ ,  $P_{LO} = 0dBm$ ,  $T_C = +25^\circ C$ , unless otherwise noted.)

### +3.3V Downconverter Curves

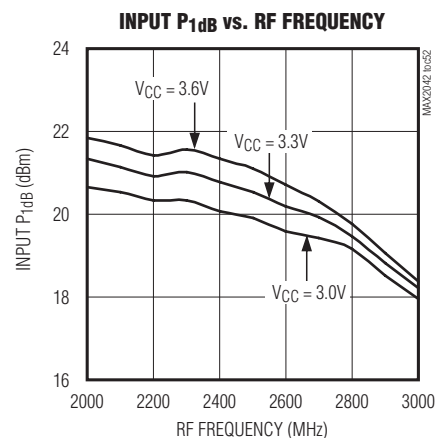
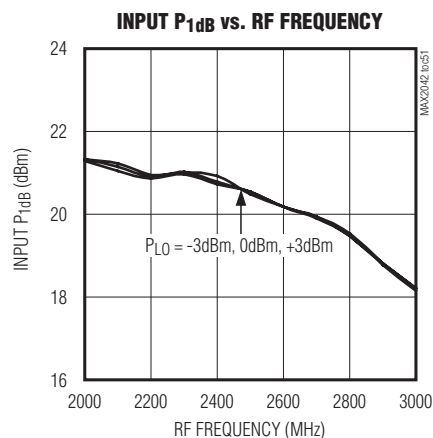
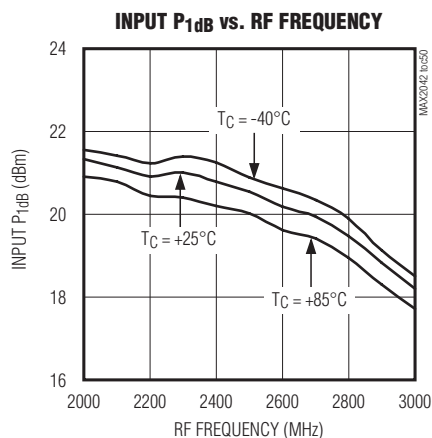
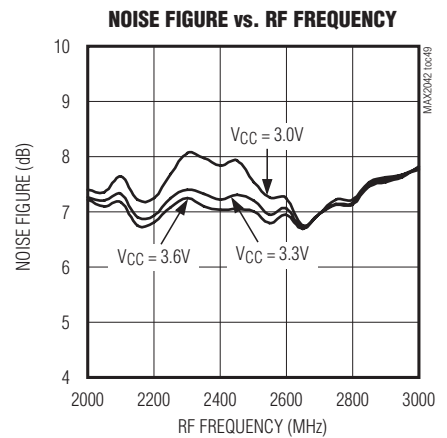
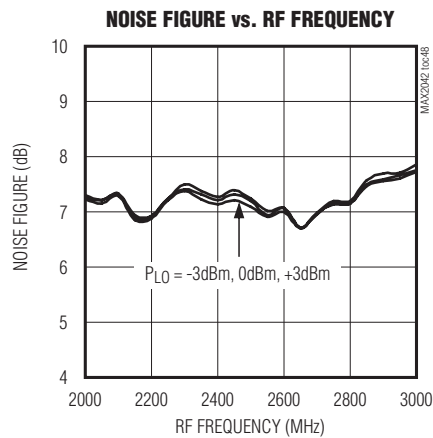
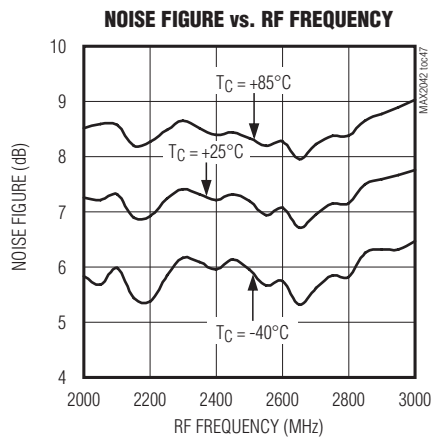
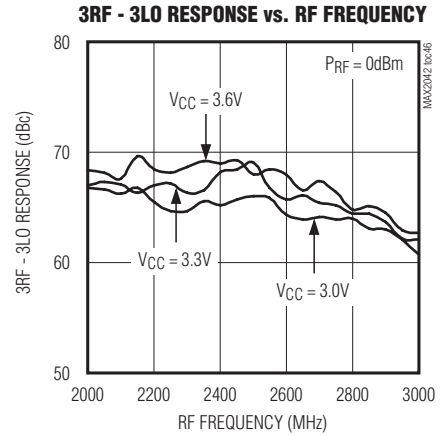
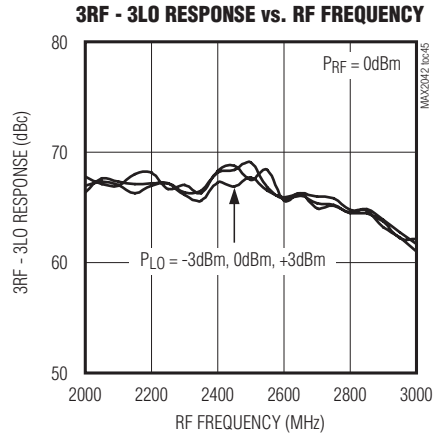
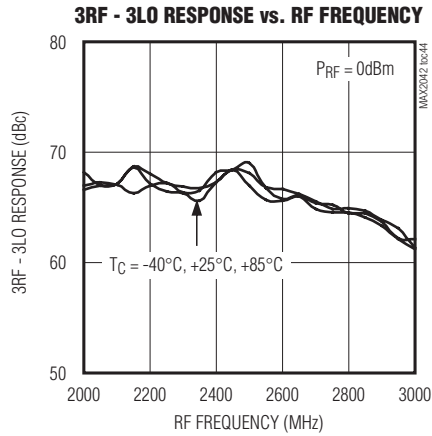


# SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

## Typical Operating Characteristics (continued)

(Typical Application Circuit with tuning elements outlined in Table 1,  $V_{CC} = +3.3V$ ,  $f_{RF} > f_{LO}$ ,  $f_{IF} = 300MHz$ ,  $P_{RF} = 0dBm$ ,  $P_{LO} = 0dBm$ ,  $T_C = +25^\circ C$ , unless otherwise noted.)

### +3.3V Downconverter Curves



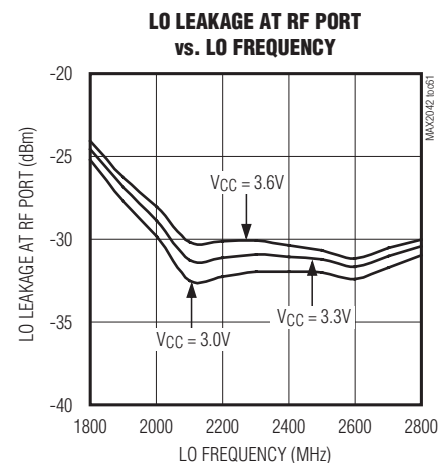
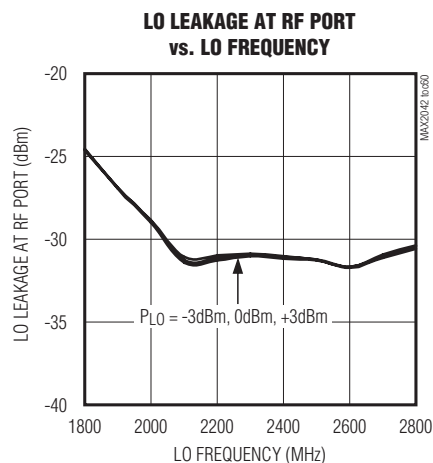
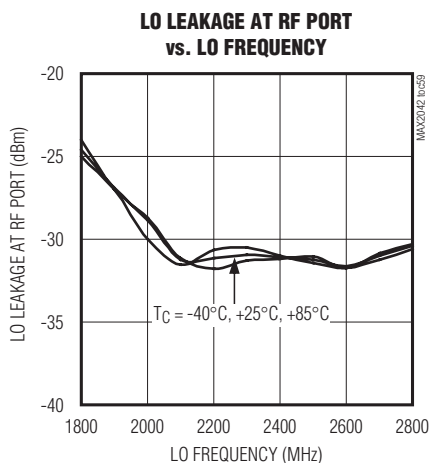
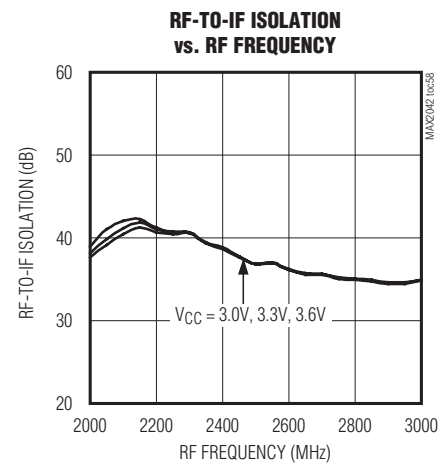
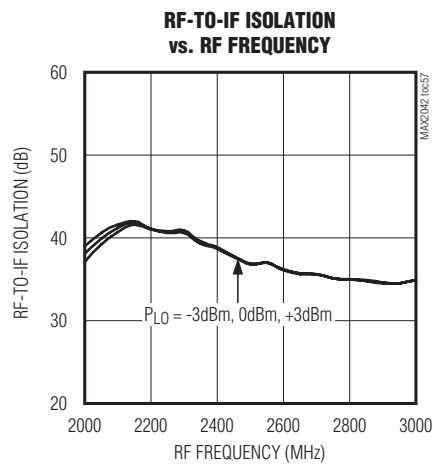
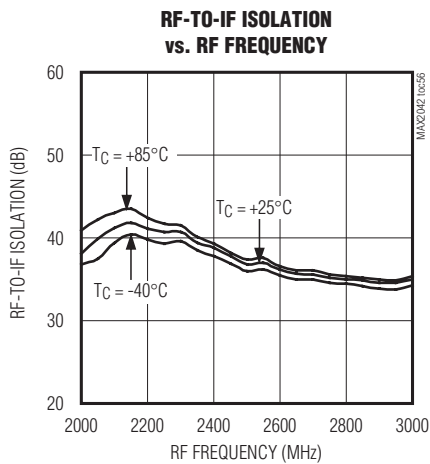
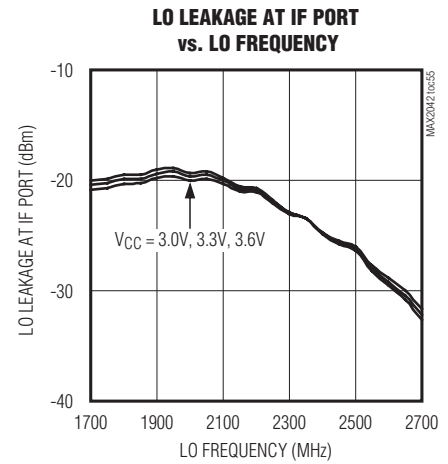
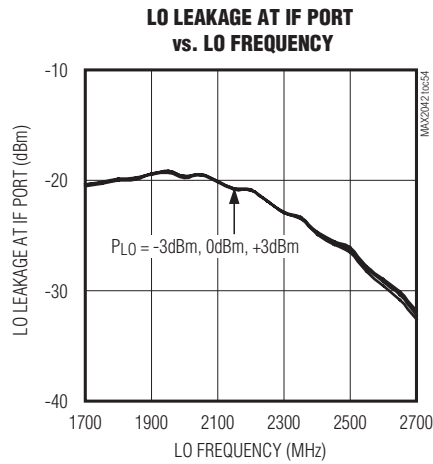
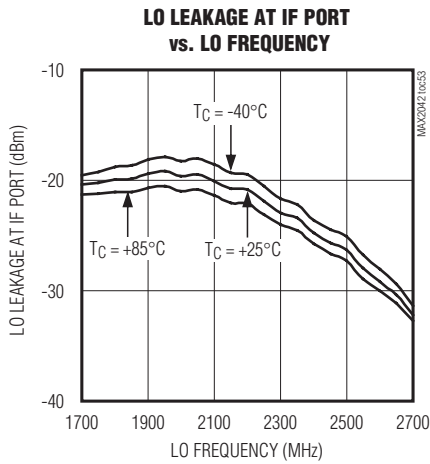
# SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

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## Typical Operating Characteristics (continued)

(Typical Application Circuit with tuning elements outlined in Table 1,  $V_{CC} = +3.3V$ ,  $f_{RF} > f_{LO}$ ,  $f_{IF} = 300MHz$ ,  $P_{RF} = 0dBm$ ,  $P_{LO} = 0dBm$ ,  $T_C = +25^\circ C$ , unless otherwise noted.)

### +3.3V Downconverter Curves

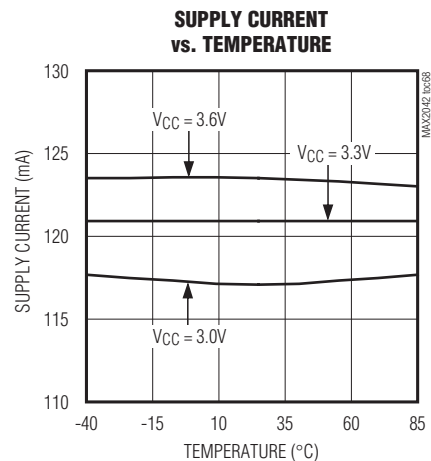
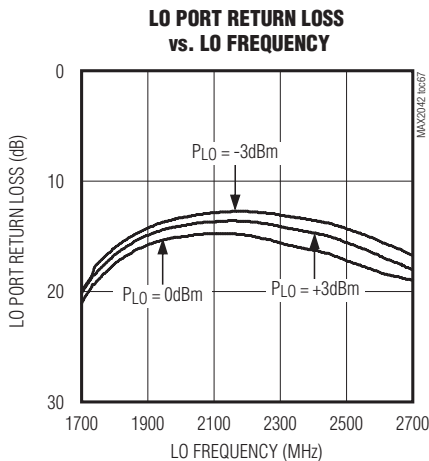
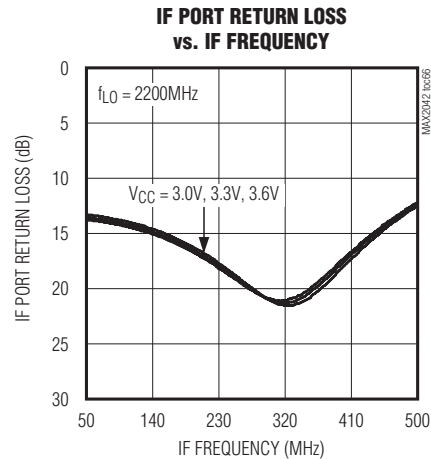
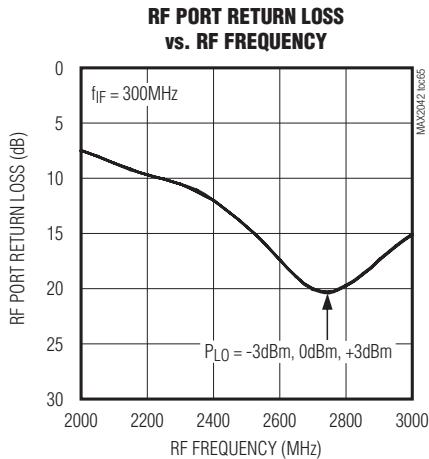
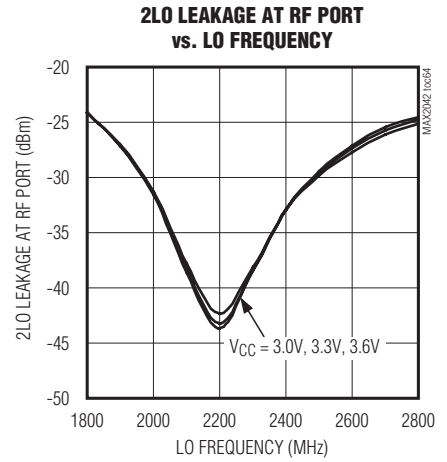
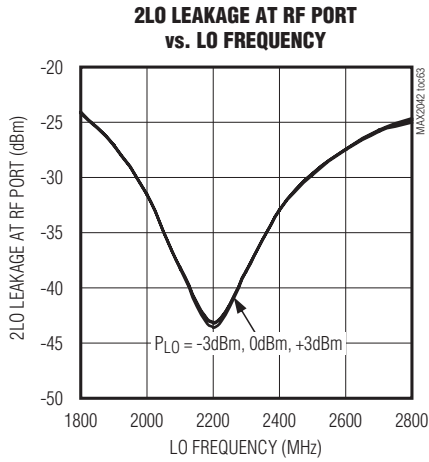
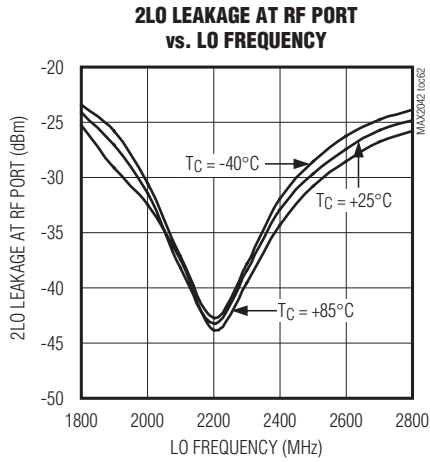


# SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

## Typical Operating Characteristics (continued)

(Typical Application Circuit with tuning elements outlined in Table 1,  $V_{CC} = +3.3V$ ,  $f_{RF} > f_{LO}$ ,  $f_{IF} = 300MHz$ ,  $P_{RF} = 0dBm$ ,  $P_{LO} = 0dBm$ ,  $T_C = +25^\circ C$ , unless otherwise noted.)

### +3.3V Downconverter Curves



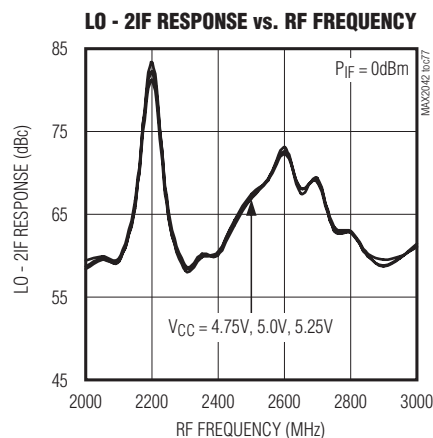
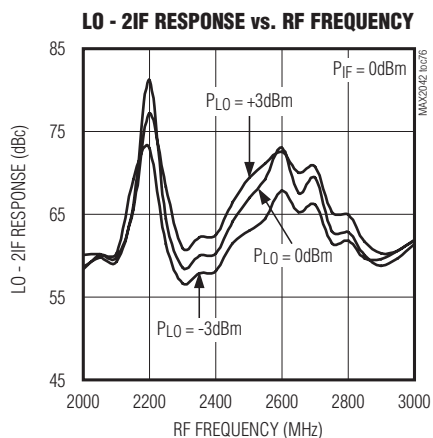
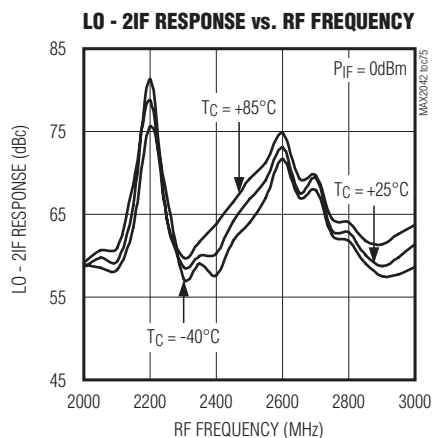
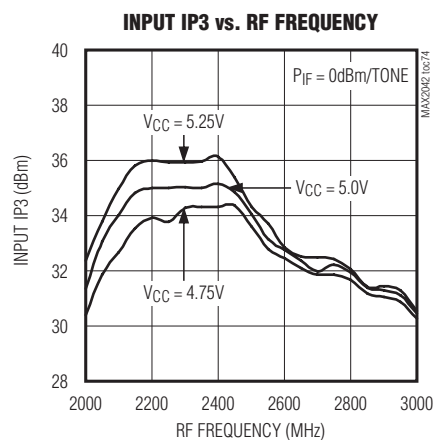
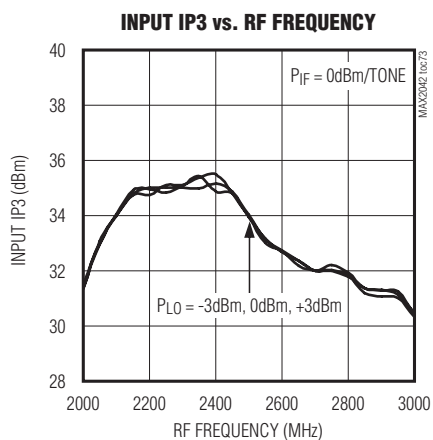
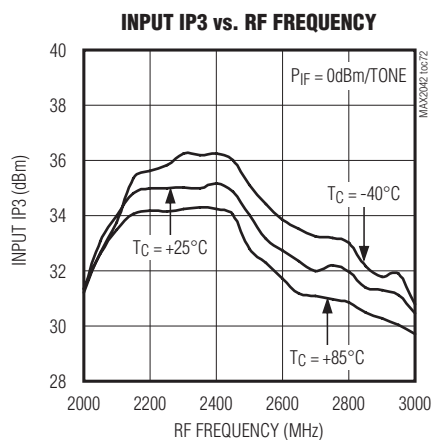
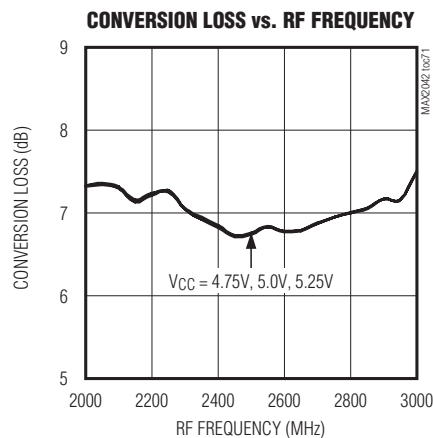
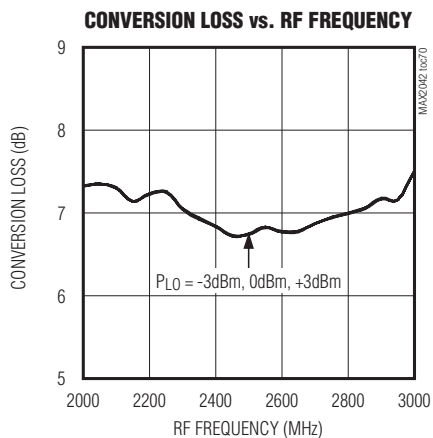
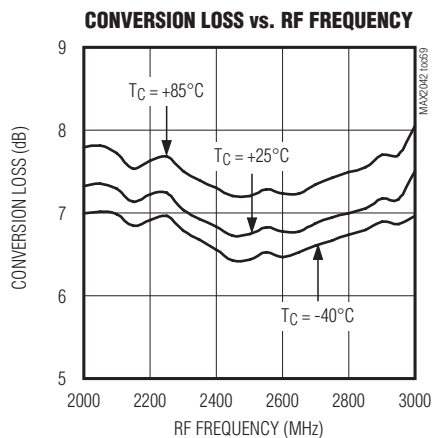
# SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

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## Typical Operating Characteristics (continued)

(Typical Application Circuit with tuning elements outlined in Table 2,  $V_{CC} = +5.0V$ ,  $f_{RF} = f_{LO} + f_{IF}$ ,  $f_{IF} = 200MHz$ ,  $P_{IF} = 0dBm$ ,  $P_{LO} = 0dBm$ ,  $T_C = +25^\circ C$ , unless otherwise noted.)

### +5.0V Upconverter Curves

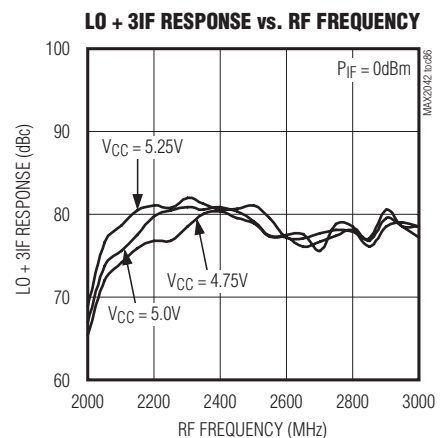
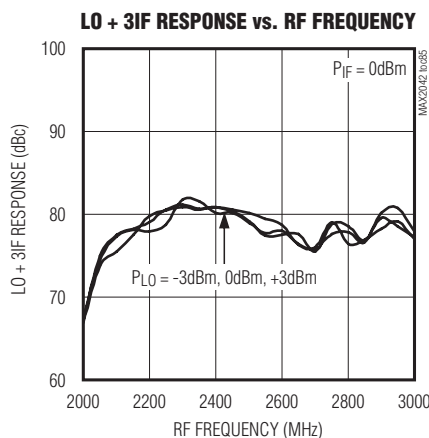
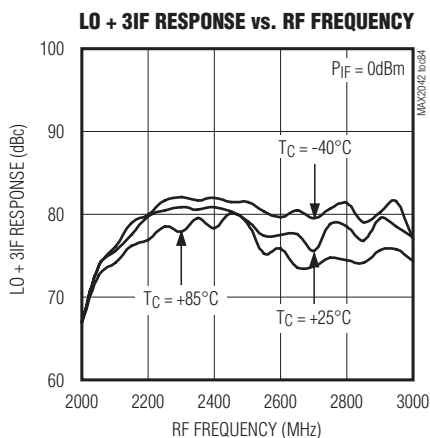
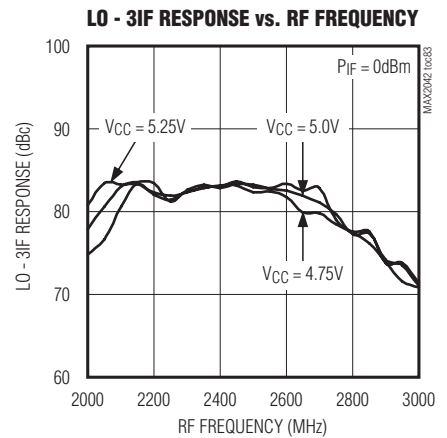
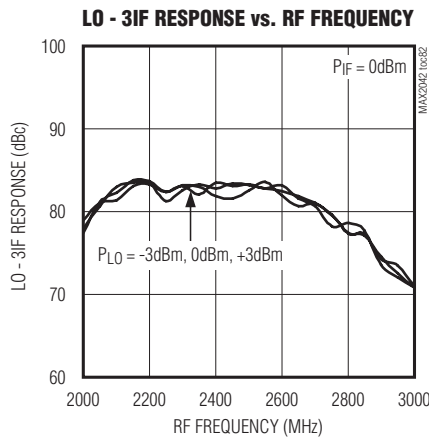
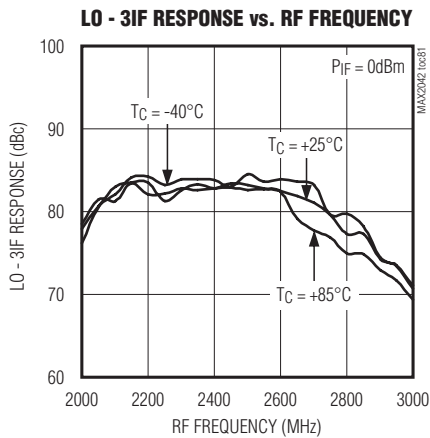
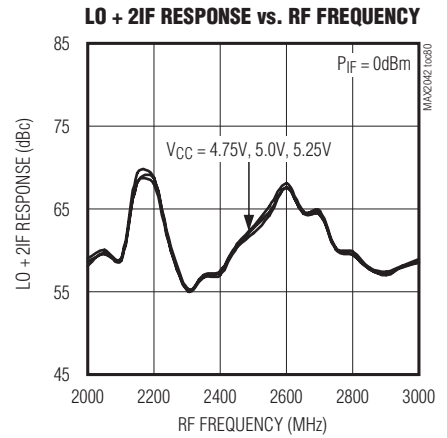
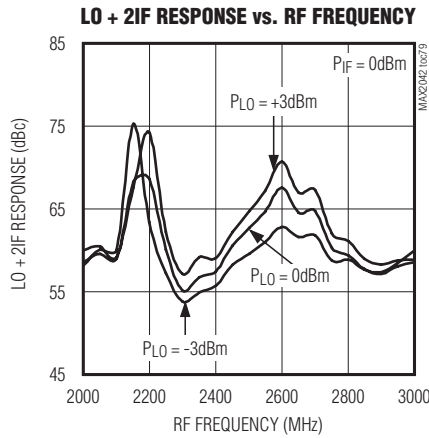
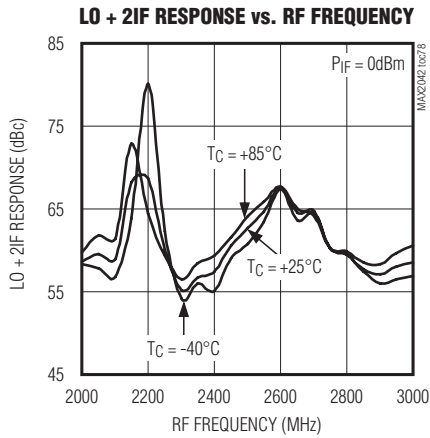


# SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

## Typical Operating Characteristics (continued)

(Typical Application Circuit with tuning elements outlined in Table 2,  $V_{CC} = +5.0V$ ,  $f_{RF} = f_{LO} + f_{IF}$ ,  $f_{IF} = 200MHz$ ,  $P_{IF} = 0dBm$ ,  $P_{LO} = 0dBm$ ,  $T_C = +25^\circ C$ , unless otherwise noted.)

### +5.0V Upconverter Curves



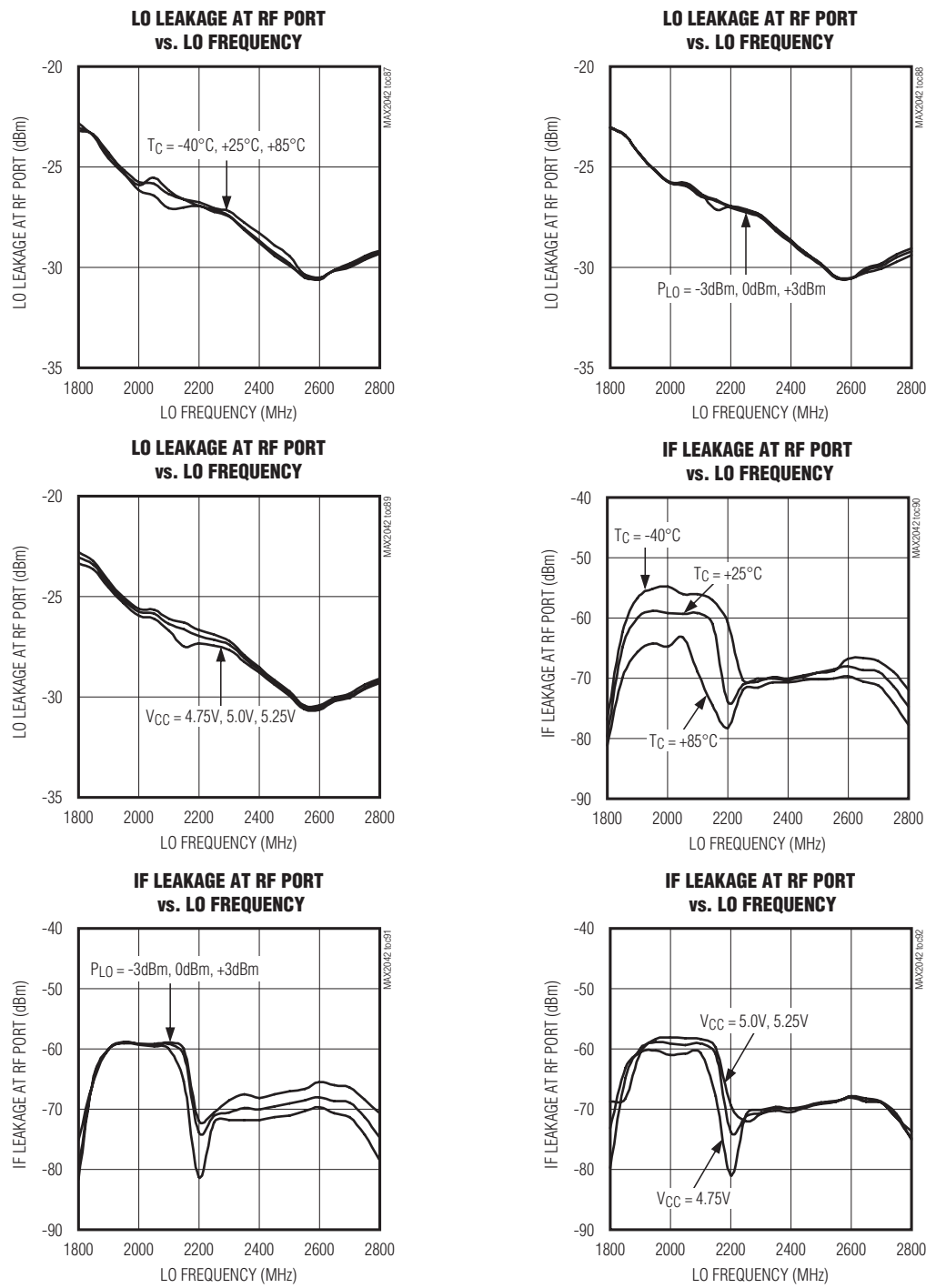


# SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

## Typical Operating Characteristics (continued)

(Typical Application Circuit with tuning elements outlined in Table 2,  $V_{CC} = +5.0V$ ,  $f_{RF} = f_{LO} + f_{IF}$ ,  $f_{IF} = 200MHz$ ,  $P_{IF} = 0dBm$ ,  $P_{LO} = 0dBm$ ,  $T_C = +25^\circ C$ , unless otherwise noted.)

### +5.0V Upconverter Curves

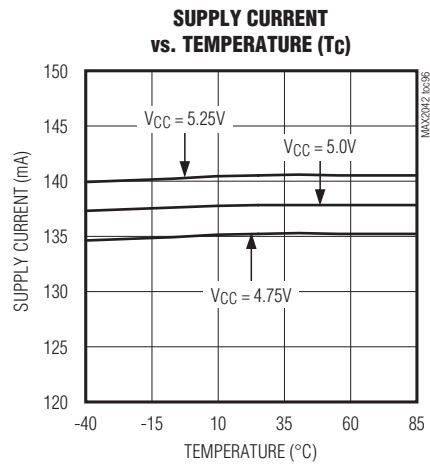
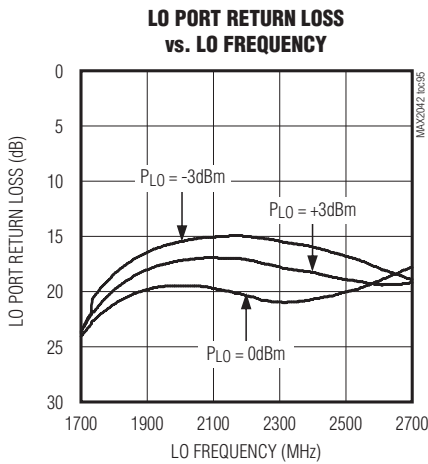
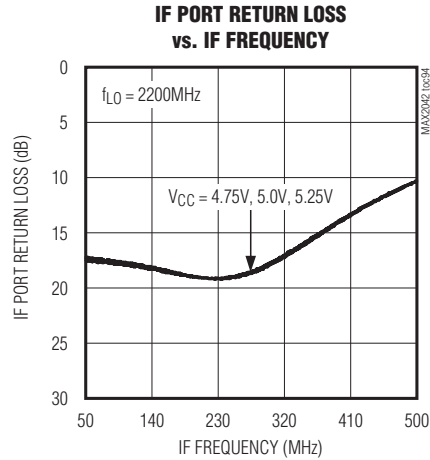
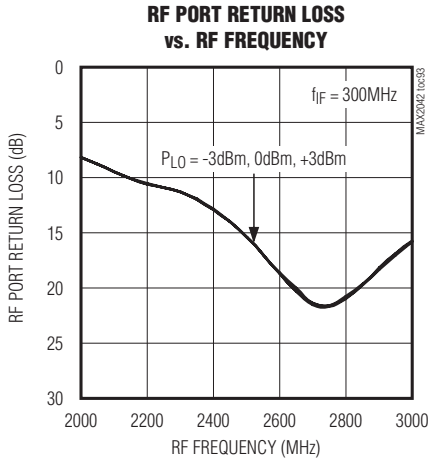


# SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

## Typical Operating Characteristics (continued)

(Typical Application Circuit with tuning elements outlined in Table 2,  $V_{CC} = +5.0V$ ,  $f_{RF} = f_{LO} + f_{IF}$ ,  $f_{IF} = 200MHz$ ,  $P_{IF} = 0dBm$ ,  $P_{LO} = 0dBm$ ,  $T_C = +25^\circ C$ , unless otherwise noted.)

### +5.0V Upconverter Curves



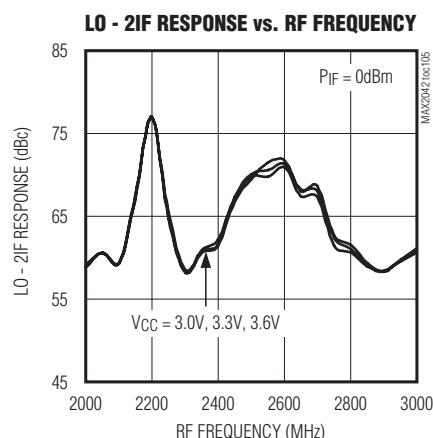
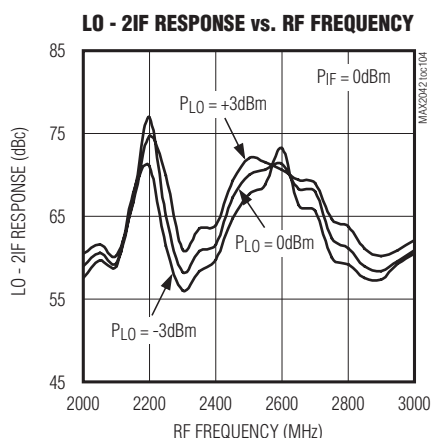
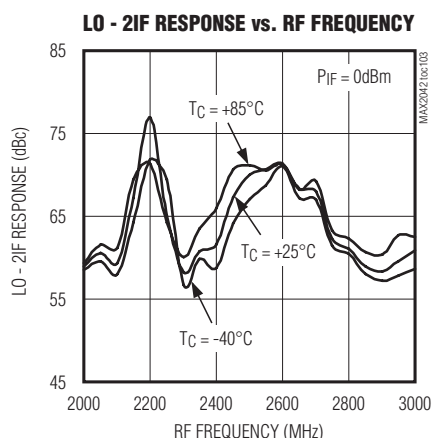
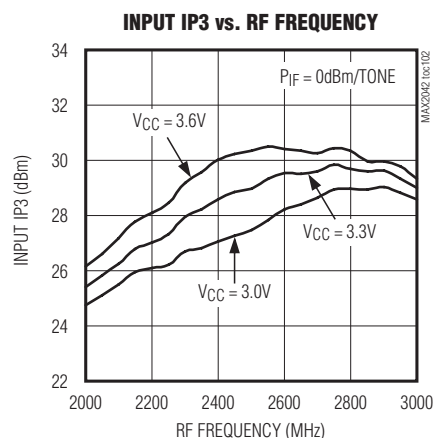
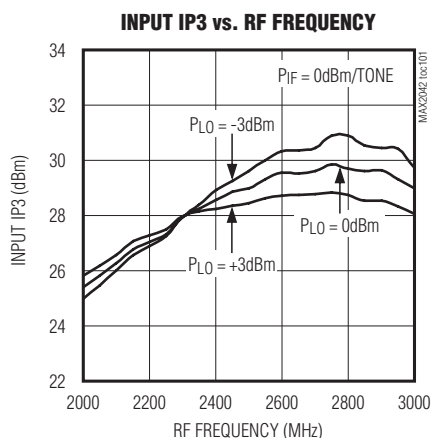
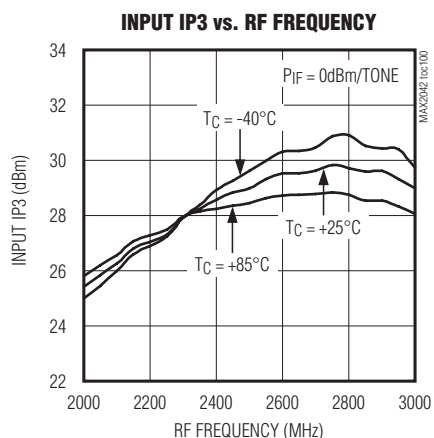
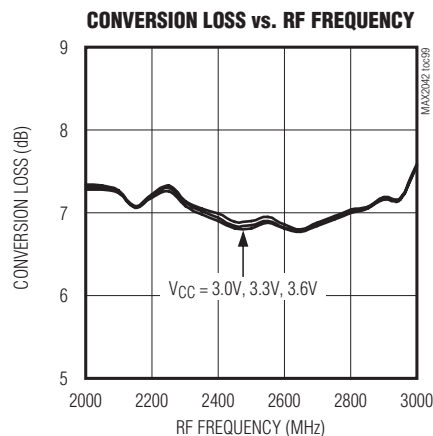
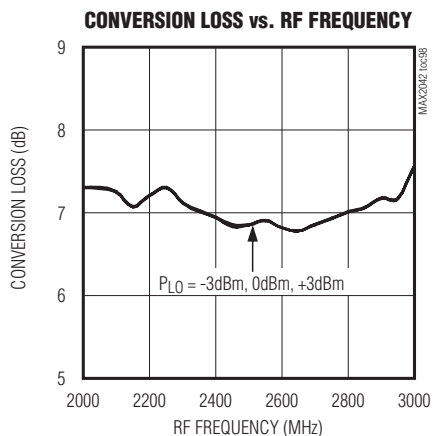
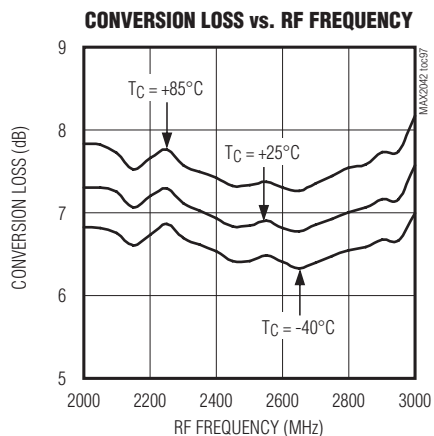
# SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

MAX2042

## Typical Operating Characteristics (continued)

(Typical Application Circuit with tuning elements outlined in Table 2,  $V_{CC} = +3.3V$ ,  $f_{RF} = f_{LO} + f_{IF}$ ,  $f_{IF} = 200MHz$ ,  $P_{IF} = 0dBm$ ,  $P_{LO} = 0dBm$ ,  $T_C = +25^\circ C$ , unless otherwise noted.)

### +3.3V Upconverter Curves

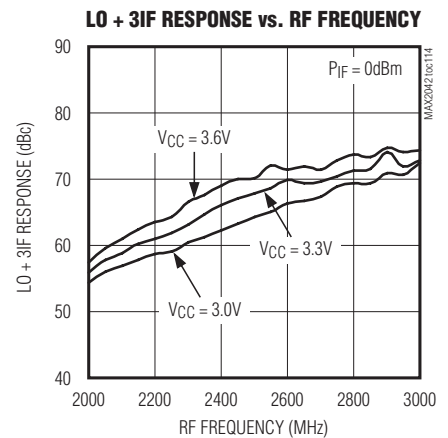
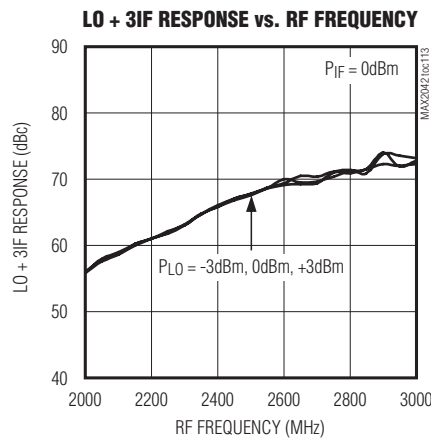
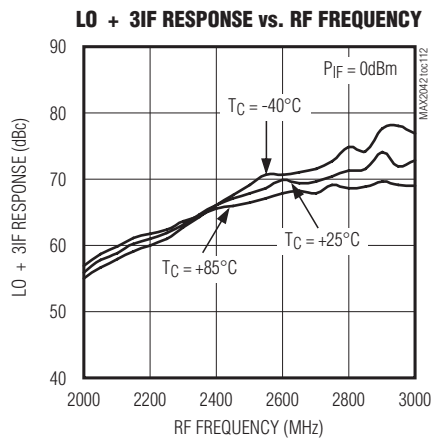
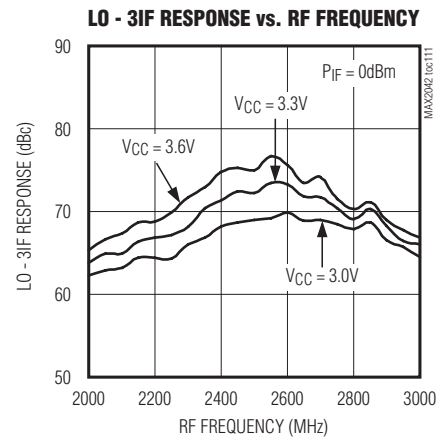
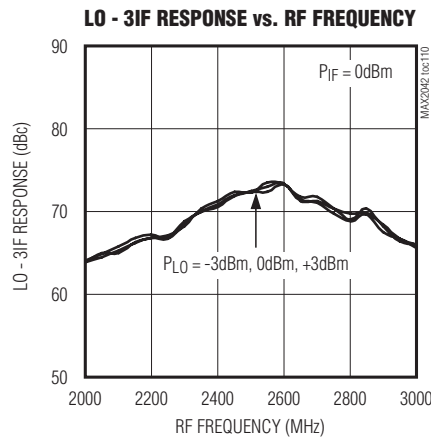
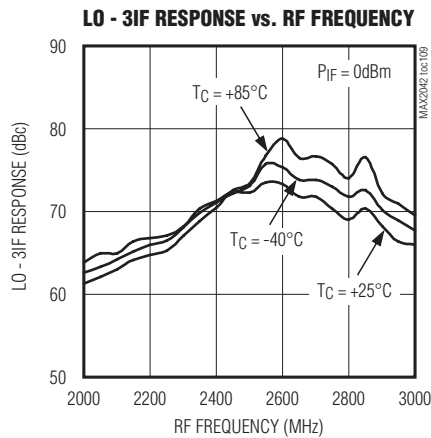
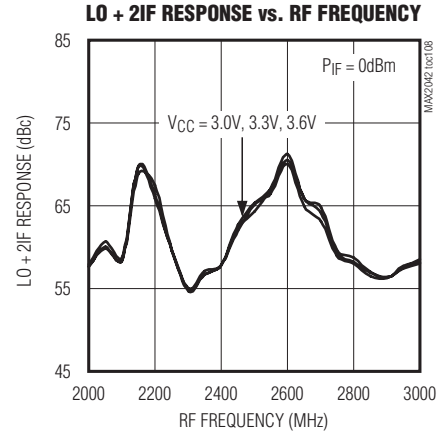
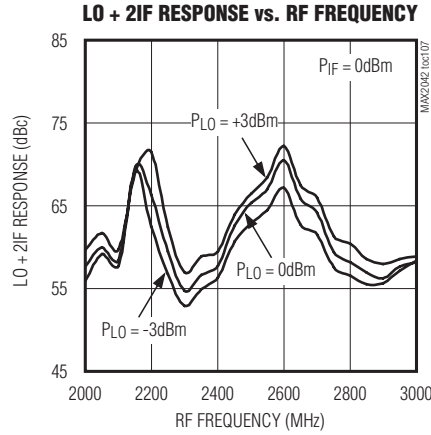
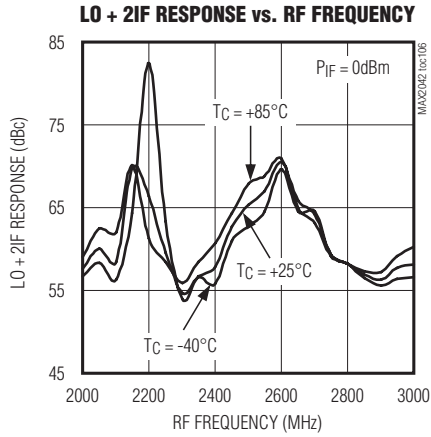


# SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

## Typical Operating Characteristics (continued)

(Typical Application Circuit with tuning elements outlined in Table 2,  $V_{CC} = +3.3V$ ,  $f_{RF} = f_{LO} + f_{IF}$ ,  $f_{IF} = 200MHz$ ,  $P_{IF} = 0dBm$ ,  $P_{LO} = 0dBm$ ,  $T_C = +25^\circ C$ , unless otherwise noted.)

### +3.3V Upconverter Curves

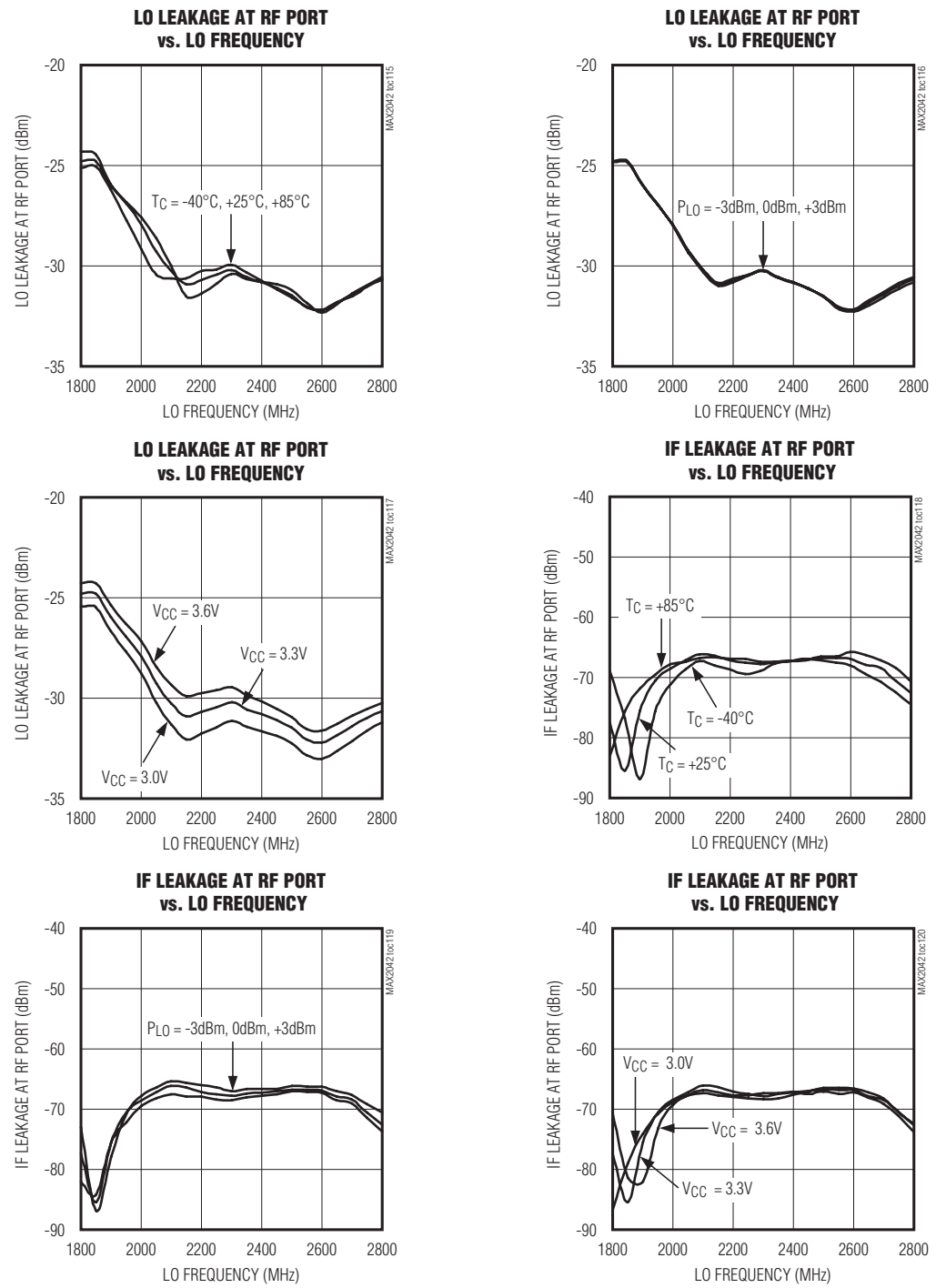


# SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

## Typical Operating Characteristics (continued)

(Typical Application Circuit with tuning elements outlined in Table 2,  $V_{CC} = +3.3V$ ,  $f_{RF} = f_{LO} + f_{IF}$ ,  $f_{IF} = 200MHz$ ,  $P_{IF} = 0dBm$ ,  $P_{LO} = 0dBm$ ,  $T_C = +25^\circ C$ , unless otherwise noted.)

### +3.3V Upconverter Curves

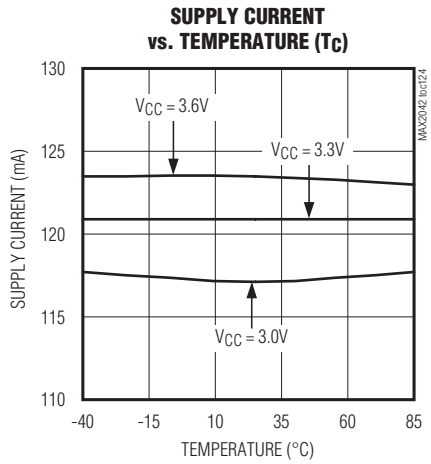
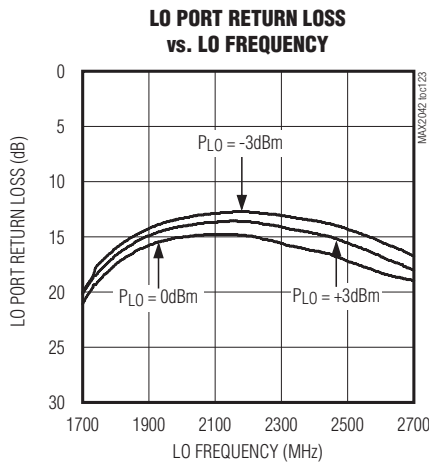
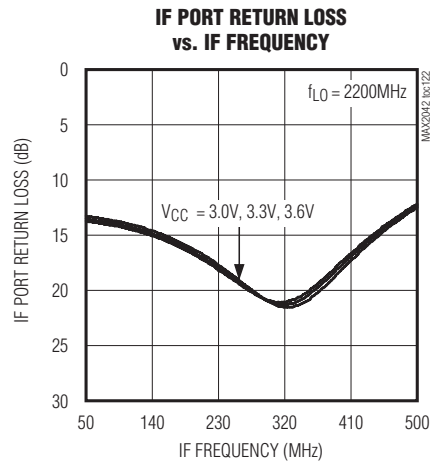
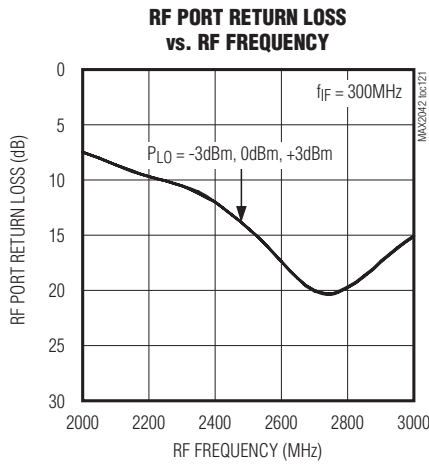


# SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

## Typical Operating Characteristics (continued)

(Typical Application Circuit with tuning elements outlined in Table 2,  $V_{CC} = +3.3V$ ,  $f_{RF} = f_{LO} + f_{IF}$ ,  $f_{IF} = 200MHz$ ,  $P_{IF} = 0dBm$ ,  $P_{LO} = 0dBm$ ,  $T_C = +25^\circ C$ , unless otherwise noted.)

### +3.3V Upconverter Curves



# SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

## Pin Description

PIN	NAME	FUNCTION
1, 6, 8, 14	VCC	Power Supply. Bypass to GND with 0.01 $\mu$ F capacitors as close as possible to the pin.
2	RF	Single-Ended 50 $\Omega$ RF Input/Output. Internally matched and DC shorted to GND through a balun. Provide a DC-blocking capacitor if required. Capacitor also provides some RF match tuning.
3, 4, 5, 10, 12, 13, 17	GND	Ground. Internally connected to the exposed pad. Connect all ground pins and the exposed pad (EP) together.
7	LOBIAS	LO Amplifier Bias Control. Output bias resistor for the LO buffer. Connect a 698 $\Omega$ $\pm$ 1% resistor (nominal bias condition) from LOBIAS to ground. The maximum current seen by this resistor is 3mA.
9, 15	GND	Ground. Not internally connected. Ground these pins or leave unconnected.
11	LO	Local Oscillator Input. This input is internally matched to 50 $\Omega$ . Requires an input DC-blocking capacitor. Capacitor also provides some LO match tuning.
16, 20	GND	Ground. Connect all ground pins and the exposed pad (EP) together.
18, 19	IF-, IF+	Mixer Differential IF Output/Input
—	EP	Exposed Pad. Internally connected to GND. Solder this exposed pad to a PCB pad that uses multiple ground vias to provide heat transfer out of the device into the PCB ground planes. These multiple via grounds are also required to achieve the noted RF performance.

MAX2042

# SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

## Detailed Description

When used as a low-side LO injection mixer in the 2300MHz to 2900MHz band, the MAX2042 provides +36dBm of IIP3, with typical noise figure and conversion loss values of only 7.3dB and 7.2dB, respectively. The integrated baluns and matching circuitry allow for 50 $\Omega$  single-ended interfaces to the RF and the LO ports. The integrated LO buffer provides a high drive level to the mixer core, reducing the LO drive required at the MAX2042's input to a -3dBm to +3dBm range. The IF port incorporates a differential interface, which is ideal for providing enhanced 2RF - 2LO performance.

Specifications are guaranteed over broad frequency ranges to allow for use in WCS, LTE, WiMAX, and MMDS base stations. The MAX2042 is specified to operate over an RF input range of 2000MHz to 3000MHz, an LO range of 1800MHz to 2800MHz, and an IF range of 50MHz to 500MHz. The external IF transformer sets the lower frequency range (see the *Typical Operating Characteristics* for details). Operation beyond these ranges is possible (see the *Typical Operating Characteristics* for additional information).

### RF Interface and Balun

The MAX2042 RF input provides a 50 $\Omega$  match when combined with a series DC-blocking capacitor. This DC-blocking capacitor required as the input is internally DC shorted to ground through the on-chip balun. When using an 8.2pF DC-blocking capacitor, the RF port input return loss is typically 15dB over the RF frequency range of 2500MHz to 2900MHz.

### LO Inputs, Buffer, and Balun

The MAX2042 is optimized for low-side LO injection applications with an 1800MHz to 2800MHz LO frequency range. The LO input is internally matched to 50 $\Omega$ , requiring only a 2pF DC-blocking capacitor. A two-stage internal LO buffer allows for a -3dBm to +3dBm LO input power range. The on-chip low-loss balun, along with an LO buffer, drives the double-balanced mixer. All interfacing and matching components from the LO inputs to the IF outputs are integrated on-chip.

### High-Linearity Mixer

The core of the MAX2042 is a double-balanced, high-performance passive mixer. Exceptional linearity is provided by the large LO swing from the on-chip LO buffer. IIP3, 2RF - 2LO rejection, and noise-figure performance are typically +36dBm, 70dBc, and 7.3dB, respectively.

### Differential IF Interface

The MAX2042 has an IF frequency range of 50MHz to 500MHz, where the low-end frequency depends on the frequency response of the external IF components.

The MAX2042's differential ports are ideal for providing enhanced 2RF - 2LO performance. The user can use a differential IF amplifier or SAW filter on the mixer IF port, but a DC block is required on both IF+/IF- ports to keep external DC from entering the IF ports of the mixer. Typical applications typically use a 1:1 transformer such as the MABAES0029 to transform the 50 $\Omega$  differential interface to a 50 $\Omega$  single-ended interface. The loss of this transformer is included in the data presented in this data sheet. In addition, the IF interface directly supports single-ended AC-coupled signals into or out of IF+ by shorting IF- to ground, and a 1k $\Omega$  resistor from IF+ to ground.

## Applications Information

### Input and Output Matching

The RF input provides a 50 $\Omega$  match when combined with a series DC-blocking capacitor. Use an 8.2pF capacitor value for RF frequencies ranging from 2000MHz to 3000MHz. The LO input is internally matched to 50 $\Omega$ ; use a 2pF DC-blocking capacitor to cover operations spanning the 1800MHz to 2800MHz range. The IF output impedance is 50 $\Omega$  (differential). For evaluation, an external low-loss 1:1 (impedance ratio) balun transforms this impedance down to a 50 $\Omega$  single-ended output (see the *Typical Application Circuit*).

### Reduced-Power Mode

The MAX2042 has one pin (LOBIAS) that allows an external resistor to set the internal bias current. A nominal value for this resistor is shown in Tables 1 and 2. Larger value resistors can be used to reduce power dissipation at the expense of some performance loss. See the *Typical Operating Characteristics* to evaluate the power vs. performance tradeoff. If  $\pm 1\%$  resistors are not readily available, substitute with  $\pm 5\%$  resistors.

Significant reductions in power consumption can also be realized by operating the mixer with an optional supply voltage of +3.3V. Doing so reduces the overall power consumption by up to 43%. See the +3.3V Supply AC Electrical Characteristics table and the relevant +3.3V curves in the *Typical Operating Characteristics* section to evaluate the power vs. performance tradeoffs.



# SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

## Layout Considerations

A properly designed PCB is an essential part of any RF/microwave circuit. Keep RF signal lines as short as possible to reduce losses, radiation, and inductance. For the best performance, route the ground pin traces directly to the exposed pad under the package. The PCB exposed pad **MUST** be connected to the ground plane of the PCB. It is suggested that multiple vias be used to connect this pad to the lower-level ground planes. This method provides a good RF/thermal conduction path for the device. Solder the exposed pad on the bottom of the device package to the PCB.

## Power-Supply Bypassing

Proper voltage-supply bypassing is essential for high-frequency circuit stability. Bypass each VCC pin with the capacitors shown in the *Typical Application Circuit* and see Tables 1 and 2.

## Exposed Pad RF/Thermal Considerations

The exposed pad (EP) of the MAX2042's 20-pin thin QFN package provides a low thermal-resistance path to the die. It is important that the PCB on which the MAX2042 is mounted be designed to conduct heat from the EP. In addition, provide the EP with a low-inductance path to electrical ground. The EP **MUST** be soldered to a ground plane on the PCB, either directly or through an array of plated via holes.

**Table 1. Downconverter Mode Component Values**

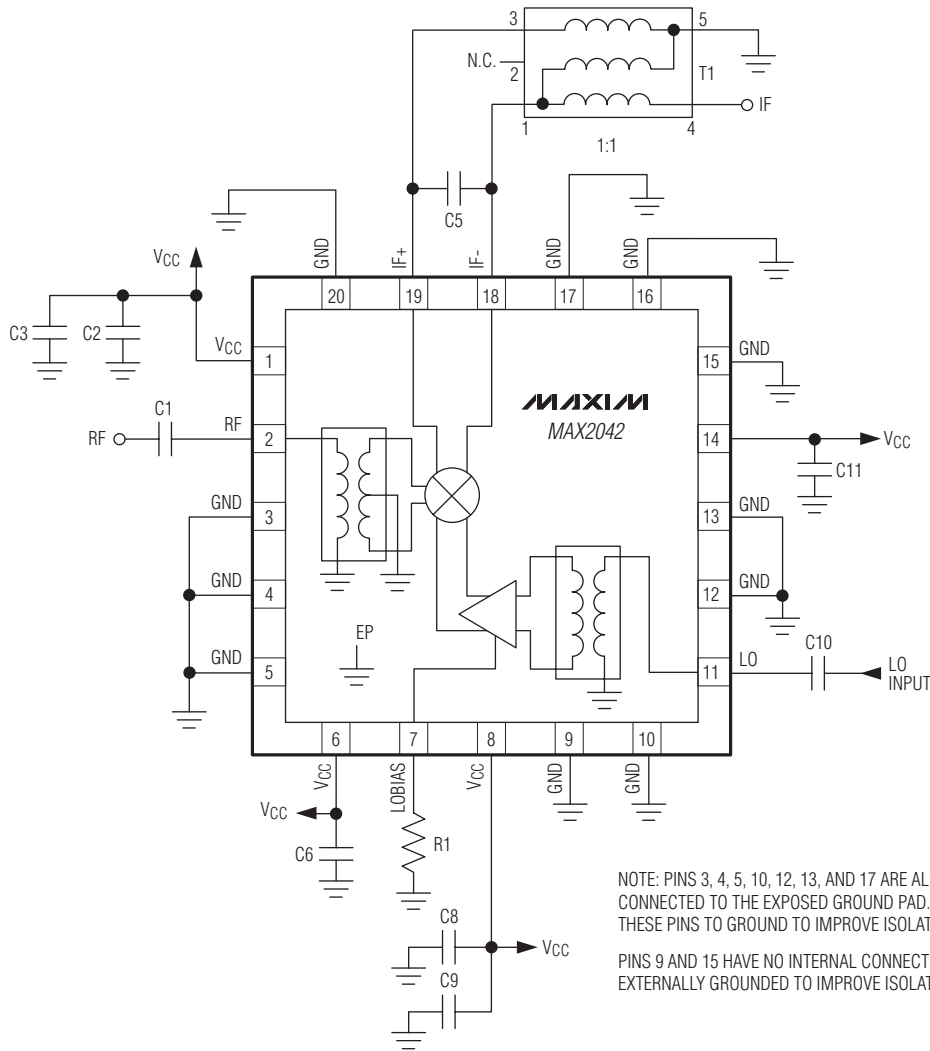
DESIGNATION	QTY	DESCRIPTION	COMPONENT SUPPLIER
C1	1	8.2pF microwave capacitor (0402)	Murata Electronics North America, Inc.
C2, C6, C8, C11	4	0.01 $\mu$ F microwave capacitors (0402)	Murata Electronics North America, Inc.
C3, C9	0	Not installed, capacitors	—
C5	0	Not installed, capacitor	—
C10	1	2pF microwave capacitor (0402)	Murata Electronics North America, Inc.
R1	1	698 $\Omega$ $\pm$ 1% resistor (0402)	Digi-Key Corp.
T1	1	1:1 IF balun MABAES0029	M/A-Com, Inc.
U1	1	MAX2042 IC (20 TQFN)	Maxim Integrated Products, Inc.

**Table 2. Upconverter Mode Component Values**

DESIGNATION	QTY	DESCRIPTION	COMPONENT SUPPLIER
C1	1	8.2pF microwave capacitor (0402)	Murata Electronics North America, Inc.
C2, C6, C8, C11	4	0.01 $\mu$ F microwave capacitors (0402)	Murata Electronics North America, Inc.
C3, C9	0	Not installed, capacitors	—
C5	0	Not installed, capacitor	—
C10	1	2pF microwave capacitor (0402)	Murata Electronics North America, Inc.
R1	1	698 $\Omega$ $\pm$ 1% resistor (0402)	Digi-Key Corp.
T1	1	1:1 IF balun MABAES0029	M/A-Com, Inc.
U1	1	MAX2042 IC (20 TQFN)	Maxim Integrated Products, Inc.

# SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

## Typical Application Circuit



# SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

## Chip Information

PROCESS: SiGe BiCMOS

## Package Information

For the latest package outline information and land patterns, go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).

PACKAGE TYPE	PACKAGE CODE	DOCUMENT NO.
20 TQFN-EP	T2055+3	<a href="#">21-0140</a>

MAX2042

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