19-5002; Rev 0; 10/09

SiGe, High-Linearity, 2300MHz to 4000MHz Upconversion/Downconversion Mixer with LO Buffer

MAX2044

General Description

The MAX2044 single, high-linearity upconversion/downconversion mixer provides +32.5dBm input IP3, 8.5dB noise figure, and 7.7dB conversion loss for 2300MHz to 4000MHz LTE, WiMAX™, and MMDS wireless infrastructure applications. With an ultra-wide 2600MHz to 4300MHz LO frequency range, the MAX2044 can be used in either low-side or high-side LO injection architectures for virtually all 2.5GHz and 3.5GHz applications.

In addition to offering excellent linearity and noise performance, the MAX2044 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 MAX2044 requires a nominal LO drive of 0dBm, and supply current is typically 138mA at V_{CC} = 5.0V or 121mA at V_{CC} = 3.3V.

The MAX2044 is pin similar with the MAX2029/MAX2031 650MHz to 1000MHz mixers and the MAX2039/MAX2041/MAX2042 1700MHz to 3000MHz mixers, making this entire family of up/downconverters ideal for applications where a common PCB layout is used for multiple frequency bands.

The MAX2044 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°C to +85°C temperature range.

Applications

2.5GHz WiMAX and LTE Base Stations

2.7GHz MMDS Base Stations

3.5GHz WiMAX and LTE Base Stations

Fixed Broadband Wireless Access

Wireless Local Loop

Private Mobile Radios

Military Systems

Features

- **2300MHz to 4000MHz RF Frequency Range**
- **2600MHz to 4300MHz LO Frequency Range**
- **50MHz to 500MHz IF Frequency Range**
- **7.7dB Conversion Loss**
- **8.5dB Noise Figure**
- **+32.5dBm Typical Input IP3**
- **21dBm Typical Input 1dB Compression Point**
- **68dBc Typical 2RF - 2LO Spurious Rejection at P_{RF} = -10dBm**
- **Integrated LO Buffer**
- **Integrated RF and LO Baluns for Single-Ended Inputs**
- **Low -3dBm to +3dBm LO Drive**
- **Pin Similar with the MAX2029/MAX2031 Series of 650MHz to 1000MHz Mixers and the MAX2039/MAX2041/MAX2042 Series of 1700MHz to 3000MHz Mixers**
- **Single 5.0V or 3.3V Supply**
- **External Current-Setting Resistor Provides Option for Operating Device in Reduced-Power/Reduced-Performance Mode**

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX2044ETP+	-40°C to +85°C	20 Thin QFN-EP*
MAX2044ETP+T	-40°C to +85°C	20 Thin QFN-EP*

+Denotes a lead(Pb)-free/RoHS-compliant package.
**EP = Exposed pad.*
T = Tape and reel.

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ABSOLUTE MAXIMUM RATINGS

V_{CC} to GND....................-0.3V to +5.5V
IF+, IF-, LOBIAS to GND.......... -0.3V to (V_{CC} + 0.3V)
RF, LO Input Power.................. +20dBm
RF, LO Current (RF and LO is DC shorted to GND through a balun).............50mA
Continuous Power Dissipation (Note 1) 5W
θ_{JA} (Notes 2, 3)........................ +38°C/W
θ_{JC} (Notes 1, 3)........................ +13°C/W
Operating Case Temperature Range (Note 4) .... T_C = -40°C to +85°C
Junction Temperature ....+150°C
Storage Temperature Range............. -65°C to +150°C
Lead Temperature (soldering, 10s) ....+300°C

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**.

Note 4: T_C is the temperature on the exposed pad of the package. T_A 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_{CC} = 4.75V to 5.25V, no input RF or LO signals. T_C = -40°C to +85°C, unless otherwise noted. Typical values are at V_{CC} = 5.0V, T_C = +25°C, all parameters are production tested.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage	V_{CC}		4.75	5.0	5.25	V
Supply Current	I_{CC}			138	155	mA

3.3V SUPPLY DC ELECTRICAL CHARACTERISTICS

(*Typical Application Circuit*, V_{CC} = 3.0V to 3.6V, no input RF or LO signals. T_C = -40°C to +85°C, unless otherwise noted. Typical values are at V_{CC} = 3.3V, T_C = +25°C, parameters are guaranteed by design, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage	V_{CC}		3.0	3.3	3.6	V
Supply Current	I_{CC}	Total supply current, V_{CC} = 3.3V		121	135	mA

RECOMMENDED AC OPERATING CONDITIONS

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
RF Frequency Range	f_{RF}	*Typical Application Circuit* with C1 = 3.3nH and C12 = 0.3pF, see Table 1 for details (Note 5)	2300		3000	MHz
		Typical Application Circuit with C1 = 8.2pF and C12 not installed, see Table 1 for details (Note 5)	3000		4000	
LO Frequency	f_{LO}	(Note 5)	2600		4300	MHz
IF Frequency	f_{IF}	Using an M/A-Com MABAES0029 1:1 transformer as defined in the *Typical Application Circuit*, IF matching components affect the IF frequency range (Note 5)	50		500	MHz
LO Drive	P_{LO}	(Note 5)	-3	0	+3	dBm

5.0V SUPPLY AC ELECTRICAL CHARACTERISTICS (DOWNCONVERTER MODE, f_{RF} = 3100MHz to 3900MHz, LOW-SIDE LO INJECTION)

(*Typical Application Circuit* with tuning elements outlined in **Table 1**, V_{CC} = 4.75V to 5.25V, RF and LO ports are driven from 50Ω sources, P_{LO} = -3dBm to +3dBm, P_{RF} = 0dBm, f_{RF} = 3100MHz to 3900MHz, f_{LO} = 2800MHz to 3600MHz, f_{IF} = 300MHz, $f_{RF} > f_{LO}$, T_C = -40°C to +85°C. Typical values are at V_{CC} = 5.0V, P_{RF} = 0dBm, P_{LO} = 0dBm, f_{RF} = 3500MHz, f_{LO} = 3200MHz, f_{IF} = 300MHz, T_C = +25°C. All parameters are guaranteed by design, unless otherwise noted.) (Note 6)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Conversion Loss	L_C	T_C = +25°C (Notes 7, 8)	7.2	7.7	8.5	dB
Loss Variation vs. Frequency	ΔL_C	f_{RF} = 3100MHz to 3900MHz, over any 100MHz band		0.15		dB
		f_{RF} = 3100MHz to 3900MHz, over any 200MHz band		0.25		
Conversion Loss Temperature Coefficient	TC_{CL}	f_{RF} = 3100MHz to 3900MHz, T_C = -40°C to +85°C		0.01		dB/°C
Input Compression Point	IP_{1dB}	(Note 9)		21		dBm
Third-Order Input Intercept Point	IIP3	f_{RF1} - f_{RF2} = 1MHz, P_{RF} = 0dBm per tone (Note 7, 8)	28.3	32.5		dBm
		f_{RF} = 3500MHz, f_{RF1} - f_{RF2} = 1MHz, P_{RF} = 0dBm per tone. T_C = +25°C (Notes 7, 8)	30.0	32.5		
Third-Order Input Intercept Point Variation Over Temperature		f_{RF} = 3100MHz to 3900MHz, f_{IF} = 300MHz, f_{RF1} - f_{RF2} = 1MHz, P_{RF} = 0dBm per tone, T_C = -40°C to +85°C		±0.5		dBm
Noise Figure	NF_{SSB}	Single sideband, no blockers present (Notes 7, 10)		8.5	10	dB
		Single sideband, no blockers present, T_C = +25°C (Notes 7, 10)		8.5	9.2	
Noise Figure Temperature Coefficient	TC_{NF}	Single sideband, no blockers present, T_C = -40°C to +85°C		0.018		dB/°C
Noise Figure Under Blocking Conditions	NF_B	+8dBm blocker tone applied to RF port, $f_{BLOCKER}$ = 3750MHz, f_{RF} = 3500MHz, f_{LO} = 3200MHz, P_{LO} = 0dBm, V_{CC} = 5.0V, T_C = +25°C (Notes 7, 10, 11)		17.5	20	dB
2RF - 2LO Spurious Rejection	2 x 2	f_{SPUR} = f_{LO} + 150MHz, T_C = +25°C; P_{RF} = -10dBm (Notes 7, 10)	62	68		dBc
		f_{SPUR} = f_{LO} + 150MHz, T_C = +25°C; P_{RF} = 0dBm (Notes 7, 8)	52	58		
		f_{SPUR} = f_{LO} + 150MHz; P_{RF} = -10dBm (Notes 7, 10)	60	68		
		f_{SPUR} = f_{LO} + 150MHz; P_{RF} = 0dBm (Notes 7, 8)	50	58		

SiGe, High-Linearity, 2300MHz to 4000MHz Upconversion/Downconversion Mixer with LO Buffer

5.0V SUPPLY AC ELECTRICAL CHARACTERISTICS (DOWNCONVERTER MODE, f_{RF} = 3100MHz to 3900MHz, LOW-SIDE LO INJECTION) (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 50Ω sources, P_{LO} = -3dBm to +3dBm, P_{RF} = 0dBm, f_{RF} = 3100MHz to 3900MHz, f_{LO} = 2800MHz to 3600MHz, f_{IF} = 300MHz, f_{RF} > f_{LO}, T_C = -40°C to +85°C. Typical values are at V_{CC} = 5.0V, P_{RF} = 0dBm, P_{LO} = 0dBm, f_{RF} = 3500MHz, f_{LO} = 3200MHz, f_{IF} = 300MHz, T_C = +25°C. All parameters are guaranteed by design, unless otherwise noted.) (Note 6)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
3RF - 3LO Spurious Rejection	3 x 3	f_{SPUR} = f_{LO} + 100MHz, T_C = +25°C	P_{RF} = -10dBm (Notes 7, 10)	82	89		dBc
			P_{RF} = 0dBm (Notes 7, 8)	62	69		
		f_{SPUR} = f_{LO} + 100MHz	P_{RF} = -10dBm (Notes 7, 10)	81	89		
			P_{RF} = 0dBm (Notes 7, 8)	61	69		
RF Input Return Loss	RL_{RF}	LO on and IF terminated into a matched impedance			16		dB
LO Input Return Loss	RL_{LO}	RF and IF terminated into a matched impedance			14		dB
IF Output Impedance	Z_{IF}	Nominal differential impedance at the IC's IF outputs			50		Ω
IF Output Return Loss	RL_{IF}	RF terminated into 50Ω, LO driven by a 50Ω source, IF transformed to 50Ω using external components shown in the *Typical Application Circuit*			16		dB
RF-to-IF Isolation		f_{RF} = 3500MHz, P_{LO} = +3dBm (Note 8)		33	42		dB
LO Leakage at RF Port		f_{LO} = 2500MHz to 4000MHz, P_{LO} = +3dBm (Notes 7, 8)			-31		dBm
2LO Leakage at RF Port		P_{LO} = +3dBm			-35		dBm
LO Leakage at IF Port		P_{LO} = +3dBm (Note 8)			-28		dBm

MAXIM

3.3V SUPPLY AC ELECTRICAL CHARACTERISTICS (DOWNCONVERTER MODE, f_{RF} = 3100MHz to 3900MHz, LOW-SIDE LO INJECTION)

(*Typical Application Circuit* with tuning elements outlined in **Table 1**, RF and LO ports are driven from 50Ω sources. Typical values are at V_{CC} = 3.3V, P_{RF} = 0dBm, P_{LO} = 0dBm, f_{RF} = 3500MHz, f_{LO} = 3200MHz, f_{IF} = 300MHz, T_C = +25°C, unless otherwise noted.) (Note 6)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Conversion Loss	L_C				7.7		dB
Loss Variation vs. Frequency	ΔL_C	f_{RF} = 3100MHz to 3900MHz, over any 100MHz band			0.1		dB
Conversion Loss Temperature Coefficient	TC_{CL}	f_{RF} = 3100MHz to 3900MHz, T_C = -40°C to +85°C			0.009		dB/°C
Input Compression Point	IP_{1dB}	(Note 9)			19.5		dBm
Third-Order Input Intercept Point	IIP3	f_{RF1} - f_{RF2} = 1MHz, P_{RF} = 0dBm per tone			29.5		dBm
Third-Order Input Intercept Variation Over Temperature		f_{RF1} - f_{RF2} = 1MHz, P_{RF} = 0dBm per tone, T_C = -40°C to +85°C			±0.2		dB
Noise Figure	NF_{SSB}	Single sideband, no blockers present			8.5		dB
Noise Figure Temperature Coefficient	TC_{NF}	Single sideband, no blockers present, T_C = -40°C to +85°C			0.018		dB/°C
2RF - 2LO Spurious Rejection	2 x 2	f_{SPUR} = f_{LO} + 150MHz	P_{RF} = -10dBm		69		dBc
			P_{RF} = 0dBm		64		
3RF - 3LO Spurious Rejection	3 x 3	f_{SPUR} = f_{LO} + 100MHz	P_{RF} = -10dBm		73.3		dBc
			P_{RF} = 0dBm		63.3		
RF Input Return Loss	RL_{RF}	LO on and IF terminated into a matched impedance			18		dB
LO Input Return Loss	RL_{LO}	RF and IF terminated into a matched impedance			19		dB
IF Output Impedance	Z_{IF}	Nominal differential impedance at the IC's IF outputs			50		Ω
IF Output Return Loss	RL_{IF}	RF terminated into 50Ω, LO driven by a 50Ω source, IF transformed to 50Ω using external components shown in the *Typical Application Circuit*			14.5		dB
RF-to-IF Isolation		f_{RF} = 3100MHz to 3900MHz, P_{LO} = +3dBm			41		dB
LO Leakage at RF Port		f_{LO} = 2800MHz to 3600MHz, P_{LO} = +3dBm			-30		dBm
2LO Leakage at RF Port		f_{LO} = 2800MHz to 3600MHz, P_{LO} = +3dBm			-25.6		dBm
LO Leakage at IF Port		f_{LO} = 2800MHz to 3600MHz, P_{LO} = +3dBm			-27		dBm

SiGe, High-Linearity, 2300MHz to 4000MHz Upconversion/Downconversion Mixer with LO Buffer

5.0V SUPPLY AC ELECTRICAL CHARACTERISTICS (DOWNCONVERTER MODE, f_{RF} = 2300MHz to 2900MHz, HIGH-SIDE LO INJECTION)

(*Typical Application Circuit* with tuning elements outlined in **Table 1**, RF and LO ports are driven from 50Ω sources. Typical values are at V_{CC} = 5.0V, P_{RF} = 0dBm, P_{LO} = 0dBm, f_{RF} = 2600MHz, f_{LO} = 2900MHz, f_{IF} = 300MHz, T_C = +25°C, unless otherwise noted.) (Note 6)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Conversion Loss	L_C			8.1		dB
Loss Variation vs. Frequency	ΔL_C	f_{RF} = 2300MHz to 2900MHz, over any 100MHz band		0.15		dB
Conversion Loss Temperature Coefficient	TC_{CL}	f_{RF} = 2300MHz to 2900MHz, T_C = -40°C to +85°C		0.008		dB/°C
Third-Order Input Intercept Point	IIP3	f_{RF1} - f_{RF2} = 1MHz, P_{RF} = 0dBm per tone		34		dBm
Third-Order Input Intercept Variation Over Temperature		f_{RF1} - f_{RF2} = 1MHz, P_{RF} = 0dBm per tone, T_C = -40°C to +85°C		±0.2		dB
2LO - 2RF Spurious Rejection	2 x 2	f_{SPUR} = f_{LO} - 150MHz, P_{RF} = -10dBm		67		dBc
		f_{SPUR} = f_{LO} - 150MHz, P_{RF} = 0dBm		62		
3LO - 3RF Spurious Rejection	3 x 3	f_{SPUR} = f_{LO} - 100MHz, P_{RF} = -10dBm		79		dBc
		f_{SPUR} = f_{LO} - 100MHz, P_{RF} = 0dBm		69		
RF Input Return Loss	RL_{RF}	LO on and IF terminated into a matched impedance		23		dB
LO Input Return Loss	RL_{LO}	RF and IF terminated into a matched impedance		17		dB
IF Output Impedance	Z_{IF}	Nominal differential impedance at the IC's IF outputs		50		Ω
IF Output Return Loss	RL_{IF}	RF terminated into 50Ω, LO driven by a 50Ω source, IF transformed to 50Ω using external components shown in the *Typical Application Circuit*		13.6		dB
RF-to-IF Isolation		f_{RF} = 2300MHz to 2900MHz, P_{LO} = +3dBm		39		dB
LO Leakage at RF Port		f_{LO} = 2600MHz to 3200MHz, P_{LO} = +3dBm		-29.5		dBm
2LO Leakage at RF Port		f_{LO} = 2600MHz to 3200MHz, P_{LO} = +3dBm		-43		dBm
LO Leakage at IF Port		f_{LO} = 2600MHz to 3200MHz, P_{LO} = +3dBm		-28.6		dBm

5.0V SUPPLY AC ELECTRICAL CHARACTERISTICS (DOWNCONVERTER MODE, f_{RF} = 3100MHz to 3900MHz, HIGH-SIDE LO INJECTION)

(*Typical Application Circuit* with tuning elements outlined in **Table 1**, RF and LO ports are driven from 50Ω sources. Typical values are at V_{CC} = 5.0V, P_{RF} = 0dBm, P_{LO} = 0dBm, f_{RF} = 3500MHz, f_{LO} = 3800MHz, f_{IF} = 300MHz, T_C = +25°C, unless otherwise noted.) (Note 6)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Conversion Loss	L_C				7.8		dB
Loss Variation vs. Frequency	ΔL_C	f_{RF} = 3100MHz to 3900MHz, over any 100MHz band			0.15		dB
Conversion Loss Temperature Coefficient	TC_{CL}	f_{RF} = 3100MHz to 3900MHz, T_C = -40°C to +85°C			0.008		dB/°C
Third-Order Input Intercept Point	IIP3	f_{RF1} - f_{RF2} = 1MHz, P_{RF} = 0dBm per tone			31.5		dBm
Third-Order Input Intercept Variation Over Temperature		f_{RF1} - f_{RF2} = 1MHz, P_{RF} = 0dBm per tone, T_C = -40°C to +85°C			±0.2		dB
2LO - 2RF Spurious Rejection	2 x 2	f_{SPUR} = f_{LO} - 150MHz	P_{RF} = -10dBm		67		dBc
			P_{RF} = 0dBm		62		
3LO - 3RF Spurious Rejection	3 x 3	f_{SPUR} = f_{LO} - 100MHz	P_{RF} = -10dBm		76.7		dBc
			P_{RF} = 0dBm		66.7		
RF Input Return Loss	RL_{RF}	LO on and IF terminated into a matched impedance			17.7		dB
LO Input Return Loss	RL_{LO}	RF and IF terminated into a matched impedance			16.3		dB
IF Output Impedance	Z_{IF}	Nominal differential impedance at the IC's IF outputs			50		Ω
IF Output Return Loss	RL_{IF}	RF terminated into 50Ω, LO driven by a 50Ω source, IF transformed to 50Ω using external components shown in the *Typical Application Circuit*			15		dB
RF-to-IF Isolation		f_{RF} = 3100MHz to 3900MHz, P_{LO} = +3dBm			41		dB
LO Leakage at RF Port		f_{LO} = 3400MHz to 4200MHz, P_{LO} = +3dBm			-30		dBm
2LO Leakage at RF Port		f_{LO} = 3400MHz to 4200MHz, P_{LO} = +3dBm			-21		dBm
LO Leakage at IF Port		f_{LO} = 3400MHz to 4200MHz, P_{LO} = +3dBm			-27.2		dBm

5.0V SUPPLY AC ELECTRICAL CHARACTERISTICS (UPCONVERTER OPERATION, f_{RF} = 3100MHz to 3900MHz, LOW-SIDE LO INJECTION)

(*Typical Application Circuit* with tuning elements outlined in **Table 2**, RF and LO ports are driven from 50Ω sources. Typical values are for T_C = +25°C, V_{CC} = 5.0V, P_{IF} = 0dBm, P_{LO} = 0dBm, f_{RF} = 3500MHz, f_{LO} = 3300MHz, f_{IF} = 200MHz, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Conversion Loss	L_C			7.7		dB
Conversion Loss Variation vs. Frequency	ΔL_C	f_{RF} = 3100MHz to 3900MHz, over any 100MHz band		0.2		dB
		f_{RF} = 3100MHz to 3900MHz, over any 200MHz band		0.25		
Conversion Loss Temperature Coefficient	TC_{CL}	T_C = -40°C to +85°C		0.01		dB/°C
Input Third-Order Intercept Point	IIP3	f_{IF1} = 200MHz, f_{IF2} = 201MHz, P_{IF} = 0dBm/tone		33.5		dBm
IIP3 Variation with T_C		f_{IF1} = 200MHz, f_{IF2} = 201MHz, P_{IF} = 0dBm/tone, T_C = -40°C to +85°C		±0.2		dB
LO ± 2IF Spur	1 x 2	LO - 2IF		61.6		dBc
		LO + 2IF		60.2		
LO ± 3IF Spur	1 x 3	LO - 3IF		78.2		dBc
		LO + 3IF		80.3		
Output Noise Floor		P_{OUT} = 0dBm (Note 11)		-165		dBm/Hz

3.3V SUPPLY AC ELECTRICAL CHARACTERISTICS (UPCONVERTER OPERATION, f_{RF} = 3100MHz to 3900MHz, LOW-SIDE LO INJECTION)

(*Typical Application Circuit* with tuning elements outlined in **Table 2**, RF and LO ports are driven from 50Ω sources. Typical values are for T_C = +25°C, V_{CC} = 3.3V, P_{IF} = 0dBm, P_{LO} = 0dBm, f_{RF} = 3500MHz, f_{LO} = 3200MHz, f_{IF} = 200MHz, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Conversion Loss	L_C			8		dB
Conversion Loss Variation vs. Frequency	ΔL_C	f_{RF} = 3100MHz to 3900MHz, over any 100MHz band		0.2		dB
		f_{RF} = 3100MHz to 3900MHz, over any 200MHz band		0.25		
Conversion Loss Temperature Coefficient	TC_{CL}	T_C = -40°C to +85°C		0.01		dB/°C
Input Third-Order Intercept Point	IIP3	f_{IF1} = 200MHz, f_{IF2} = 201MHz, P_{IF} = 0dBm/tone		29.5		dBm
IIP3 Variation with T_C		f_{IF1} = 200MHz, f_{IF2} = 201MHz, P_{IF} = 0dBm/tone, T_C = -40°C to +85°C		±0.2		dB

3.3V SUPPLY AC ELECTRICAL CHARACTERISTICS (UPCONVERTER OPERATION, f_{RF} = 3100MHz to 3900MHz, LOW-SIDE LO INJECTION) (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 2**, RF and LO ports are driven from 50Ω sources. Typical values are for T_C = +25°C, V_{CC} = 3.3V, P_{IF} = 0dBm, P_{LO} = 0dBm, f_{RF} = 3500MHz, f_{LO} = 3200MHz, f_{IF} = 200MHz, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
LO ± 2IF Spur	1 x 2	LO - 2IF		58.9		dBc
		LO + 2IF		57.8		
LO ± 3IF Spur	1 x 3	LO - 3IF		69.4		dBc
		LO + 3IF		69.5		
Output Noise Floor		P_{OUT} = 0dBm (Note 11)		-165		dBm/Hz

Note 5: Operation outside this range is possible, but with degraded performance of some parameters. See the *Typical Operating Characteristics*.

Note 6: All limits reflect losses of external components, including a 0.5dB loss at f_{IF} = 300MHz due to the 1:1 impedance transformer. Output measurements were taken at IF outputs of the *Typical Application Circuit*.

Note 7: Guaranteed by design and characterization.

Note 8: 100% production tested for functional performance.

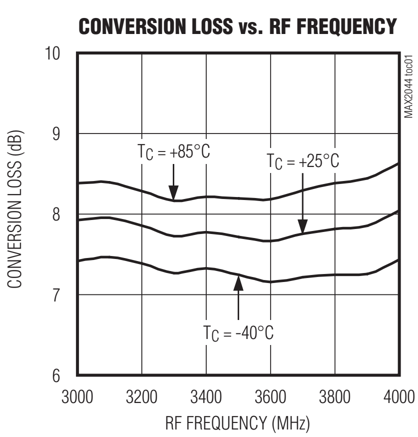
Note 9: Maximum reliable continuous input power applied to the RF or IF port of this device is +20dBm from a 50Ω source.

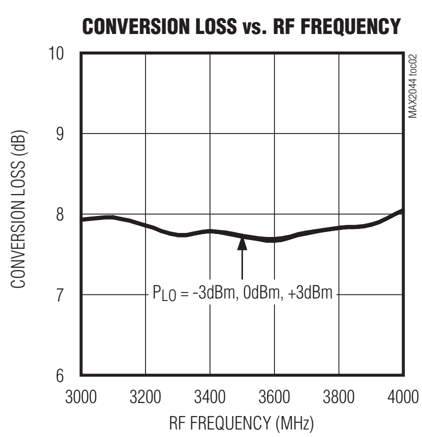
Note 10: Not production tested.

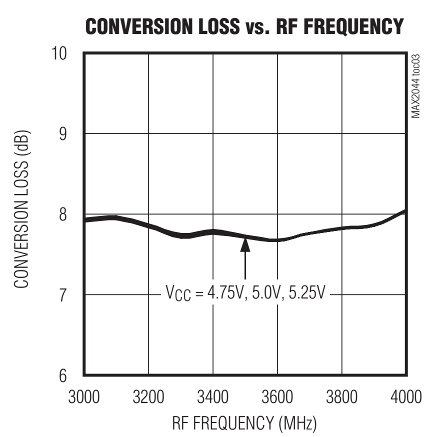
Note 11: Measured with external LO source noise filtered so the noise floor is -174dBm/Hz. This specification reflects the effects of all SNR degradations in the mixer, including the LO noise as defined in Application Note 2021: *Specifications and Measurement of Local Oscillator Noise in Integrated Circuit Base Station Mixers*.

Typical Operating Characteristics

(*Typical Application Circuit* with tuning elements outlined in **Table 1, Downconverter Mode, V_{CC} = 5.0V, f_{RF} = 3000MHz to 4000MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)





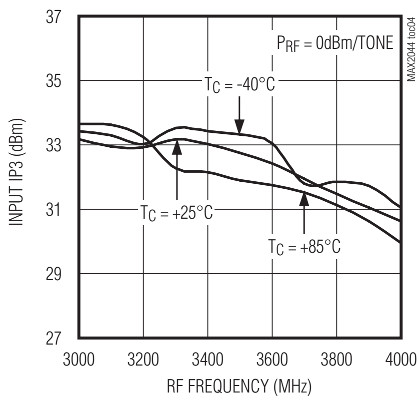


SiGe, High-Linearity, 2300MHz to 4000MHz Upconversion/Downconversion Mixer with LO Buffer

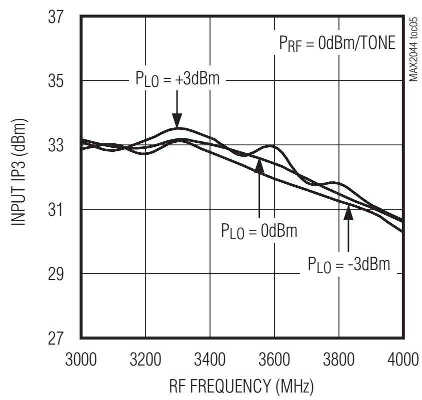
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, Downconverter Mode, V_{CC} = 5.0V, f_{RF} = 3000MHz to 4000MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

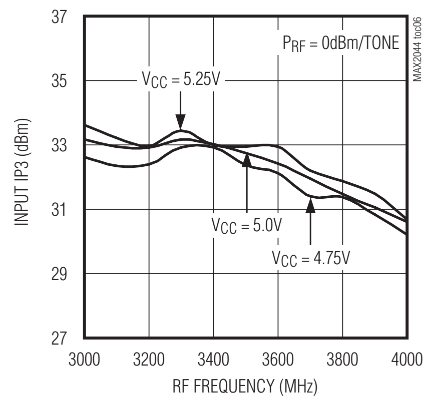
INPUT IP3 vs. RF FREQUENCY



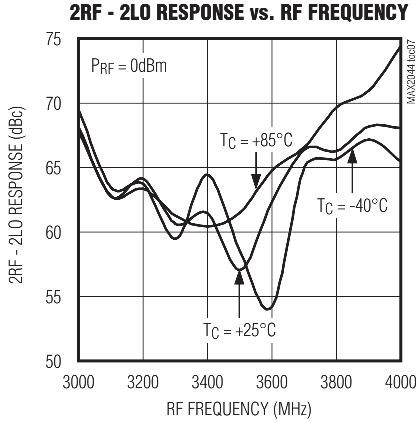
INPUT IP3 vs. RF FREQUENCY



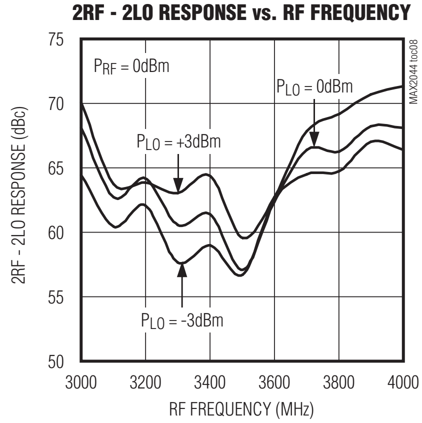
INPUT IP3 vs. RF FREQUENCY



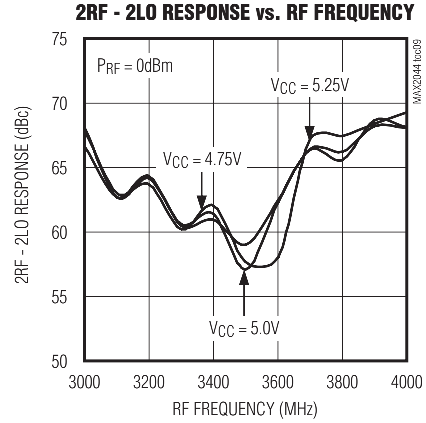
2RF - 2LO RESPONSE vs. RF FREQUENCY



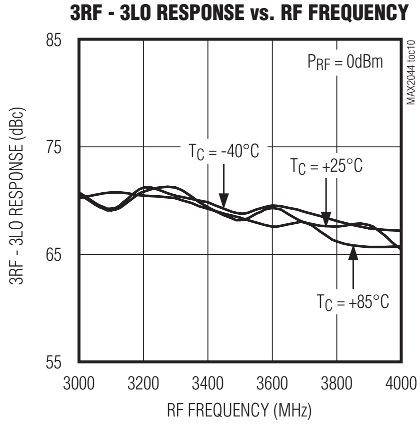
2RF - 2LO RESPONSE vs. RF FREQUENCY



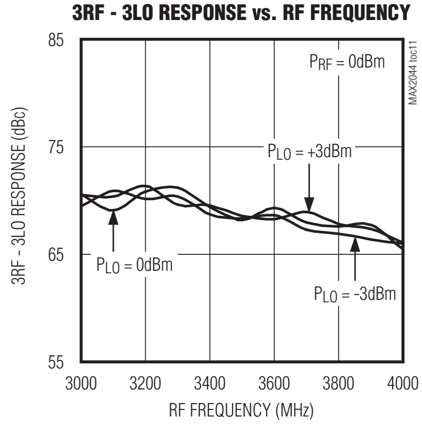
2RF - 2LO RESPONSE vs. RF FREQUENCY



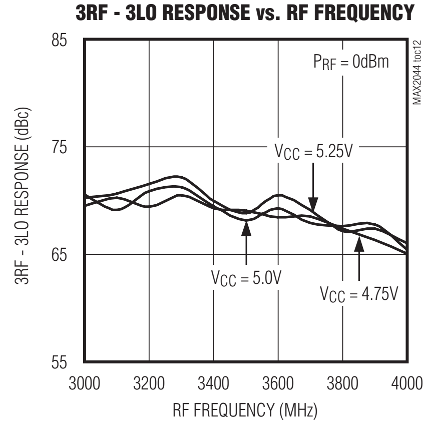
3RF - 3LO RESPONSE vs. RF FREQUENCY



3RF - 3LO RESPONSE vs. RF FREQUENCY



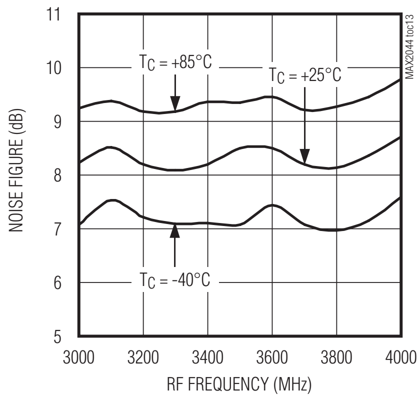
3RF - 3LO RESPONSE vs. RF FREQUENCY



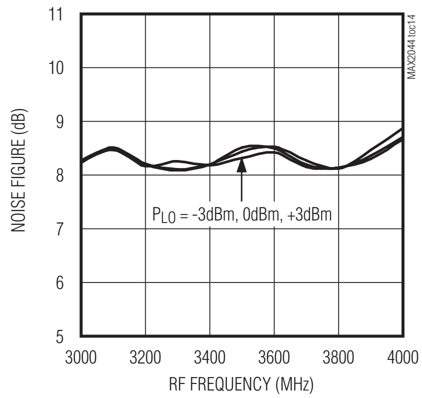
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, Downconverter Mode, V_{CC} = 5.0V, f_{RF} = 3000MHz to 4000MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

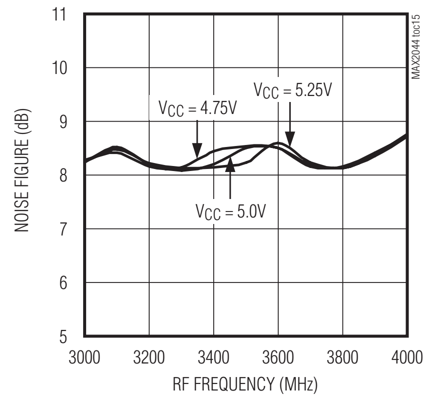
NOISE FIGURE vs. RF FREQUENCY



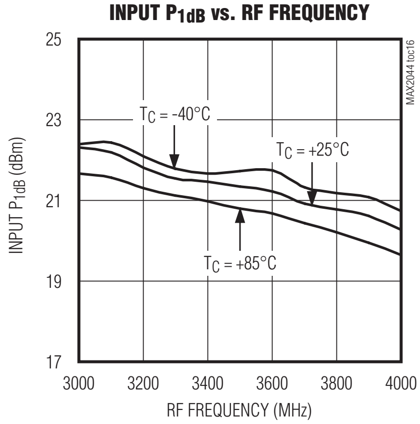
NOISE FIGURE vs. RF FREQUENCY



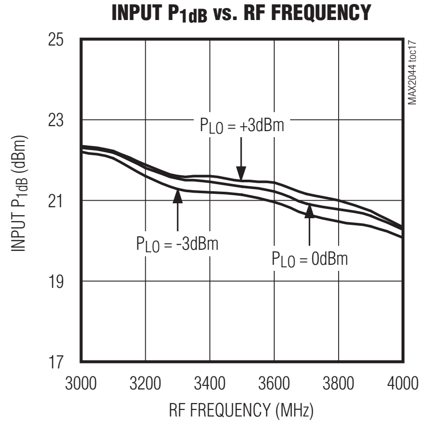
NOISE FIGURE vs. RF FREQUENCY



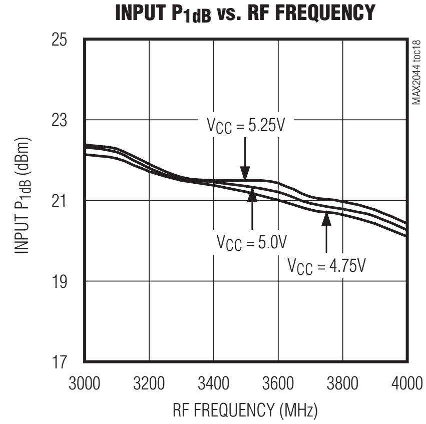
INPUT P_{1dB} vs. RF FREQUENCY



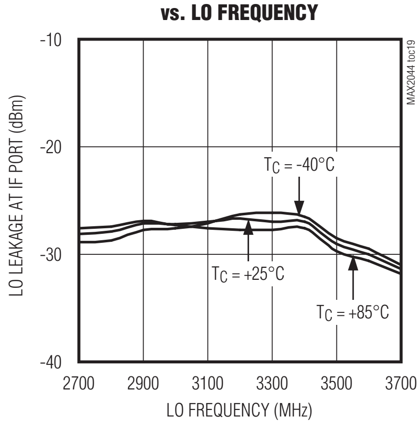
INPUT P_{1dB} vs. RF FREQUENCY



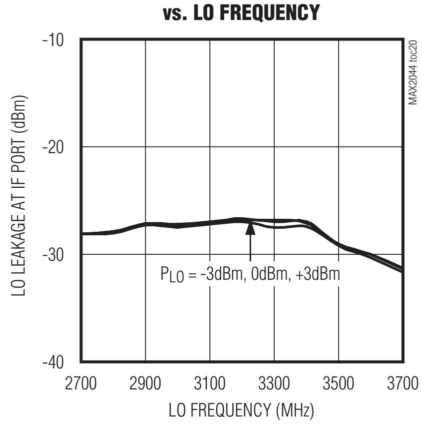
INPUT P_{1dB} vs. RF FREQUENCY



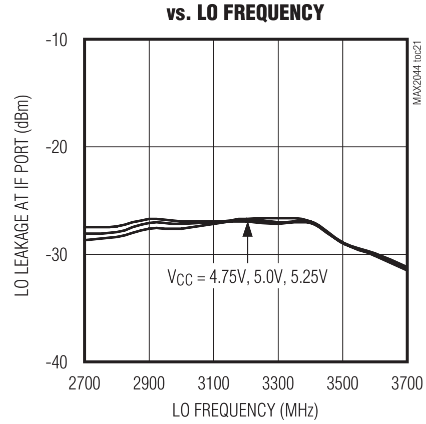
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



LO LEAKAGE AT IF PORT vs. LO FREQUENCY



LO LEAKAGE AT IF PORT vs. LO FREQUENCY

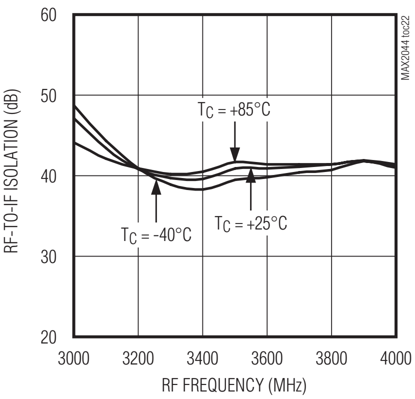


SiGe, High-Linearity, 2300MHz to 4000MHz Upconversion/Downconversion Mixer with LO Buffer

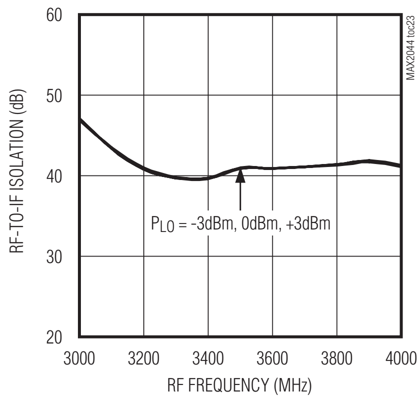
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, Downconverter Mode, V_{CC} = 5.0V, f_{RF} = 3000MHz to 4000MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

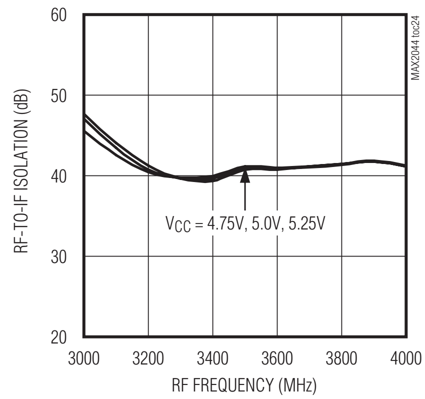
RF-TO-IF ISOLATION vs. RF FREQUENCY



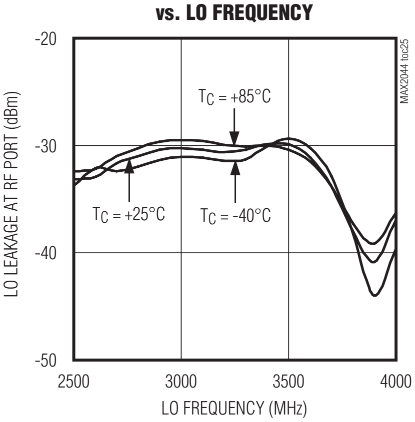
RF-TO-IF ISOLATION vs. RF FREQUENCY



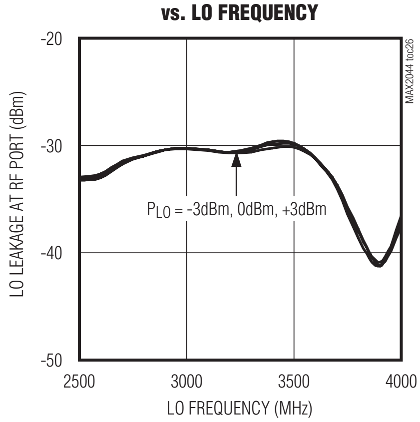
RF-TO-IF ISOLATION vs. RF FREQUENCY



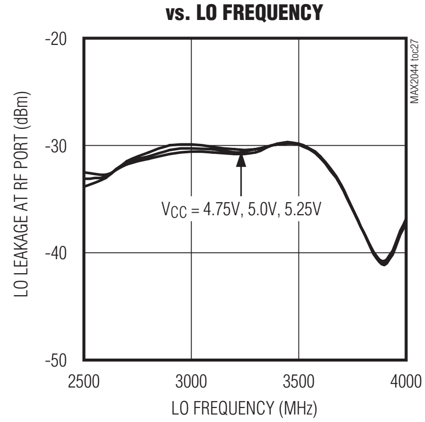
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



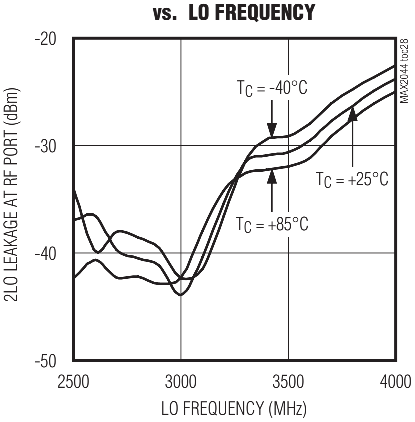
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



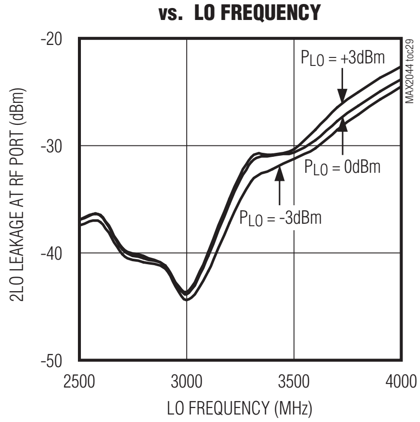
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



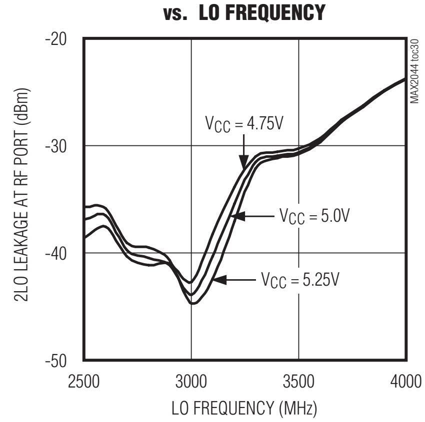
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



2LO LEAKAGE AT RF PORT vs. LO FREQUENCY

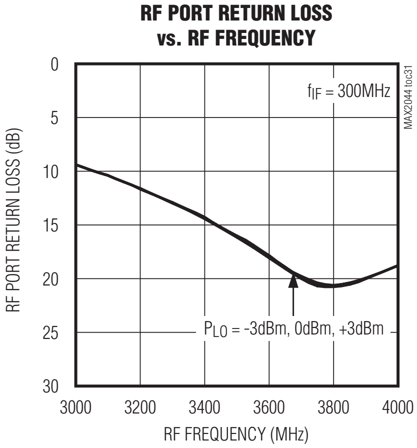


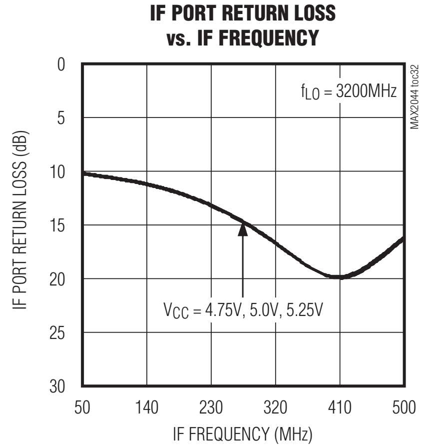
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY

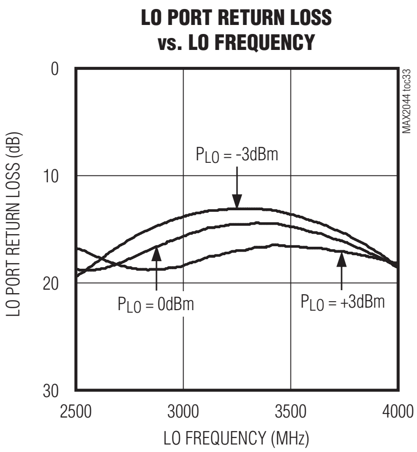


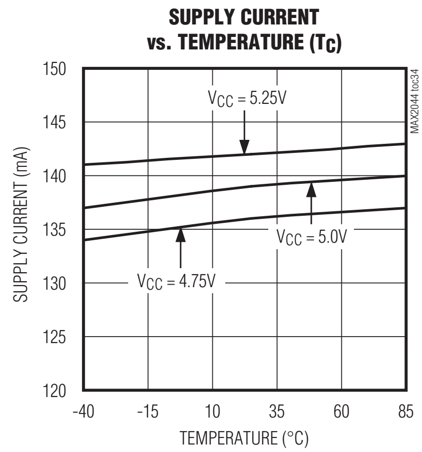
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, Downconverter Mode, V_{CC} = 5.0V, f_{RF} = 3000MHz to 4000MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)





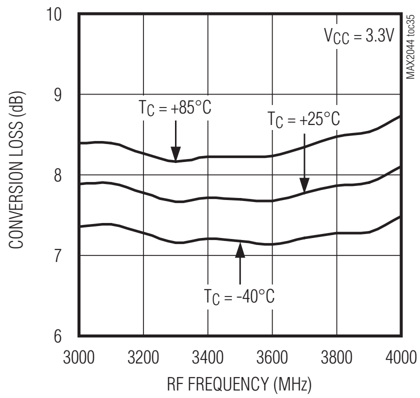




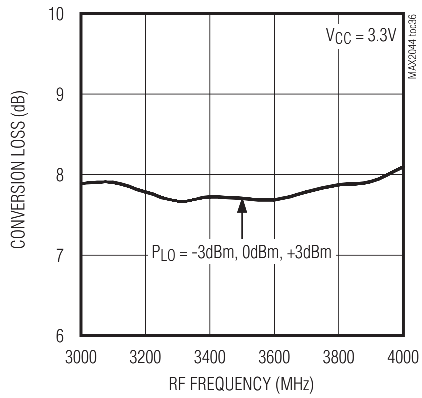
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, Downconverter Mode, V_{CC} = 3.3V, f_{RF} = 3000MHz to 4000MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

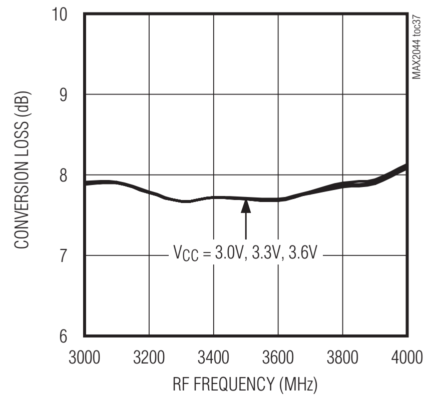
CONVERSION LOSS vs. RF FREQUENCY



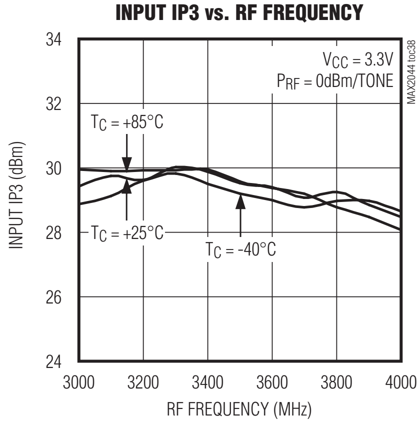
CONVERSION LOSS vs. RF FREQUENCY



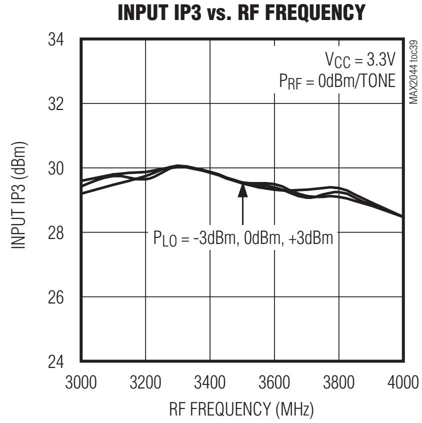
CONVERSION LOSS vs. RF FREQUENCY



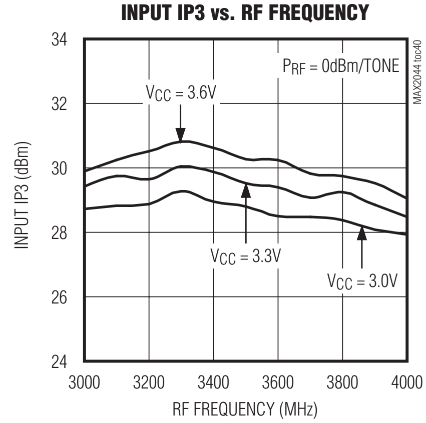
INPUT IP3 vs. RF FREQUENCY



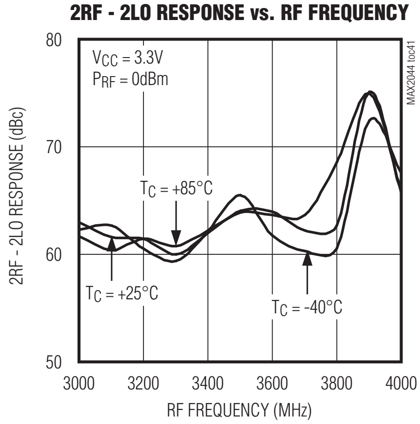
INPUT IP3 vs. RF FREQUENCY



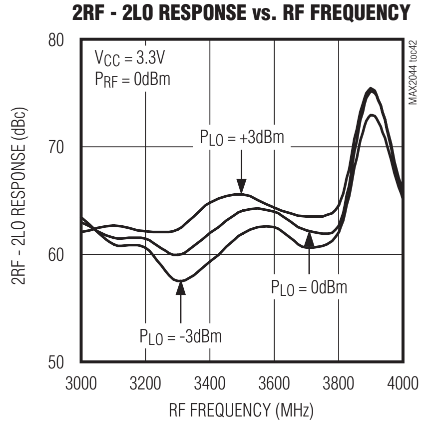
INPUT IP3 vs. RF FREQUENCY



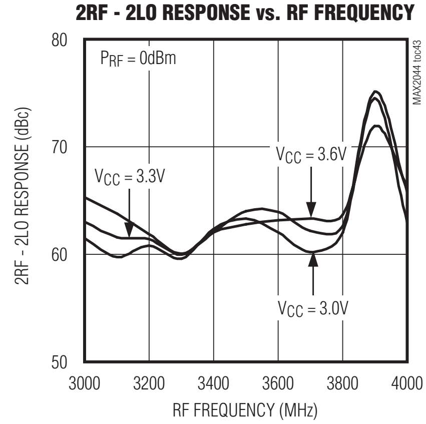
2RF - 2LO RESPONSE vs. RF FREQUENCY



2RF - 2LO RESPONSE vs. RF FREQUENCY



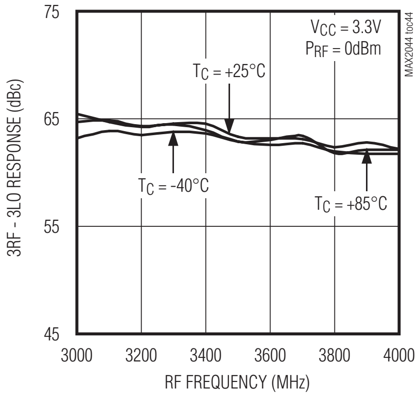
2RF - 2LO RESPONSE vs. RF FREQUENCY



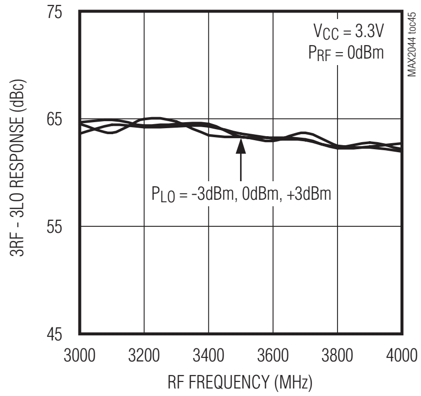
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, Downconverter Mode, V_{CC} = 3.3V, f_{RF} = 3000MHz to 4000MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

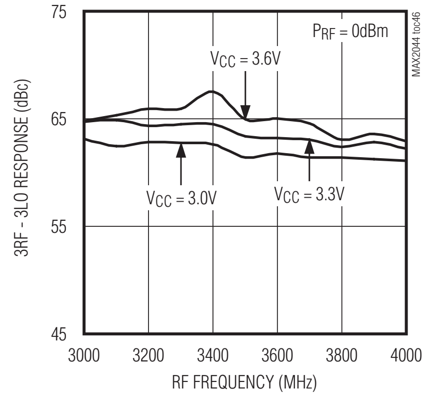
3RF - 3LO RESPONSE vs. RF FREQUENCY



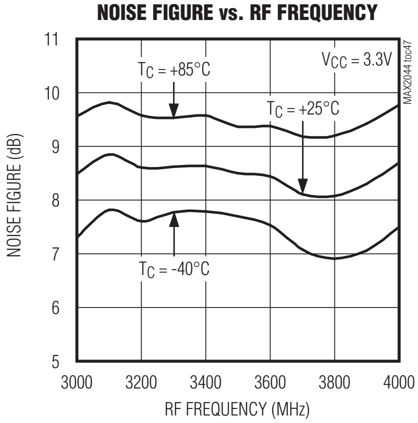
3RF - 3LO RESPONSE vs. RF FREQUENCY



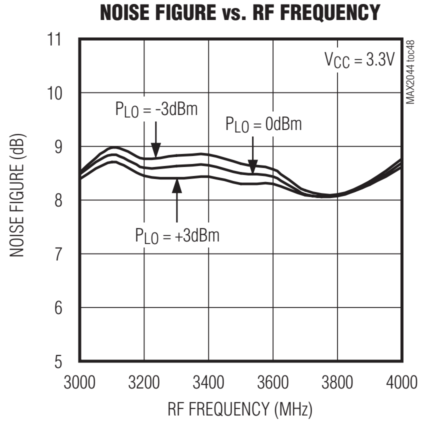
3RF - 3LO RESPONSE vs. RF FREQUENCY



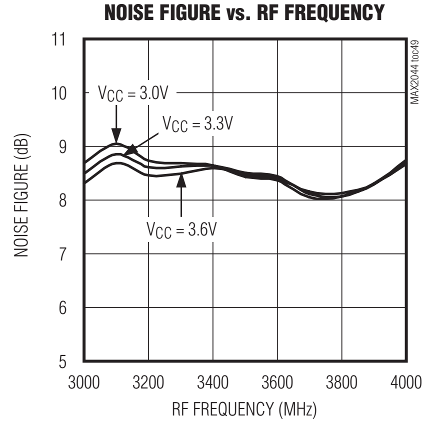
NOISE FIGURE vs. RF FREQUENCY



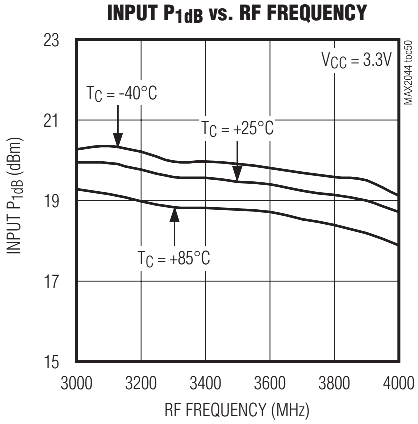
NOISE FIGURE vs. RF FREQUENCY



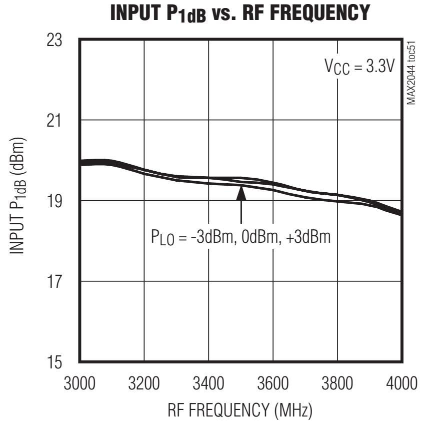
NOISE FIGURE vs. RF FREQUENCY



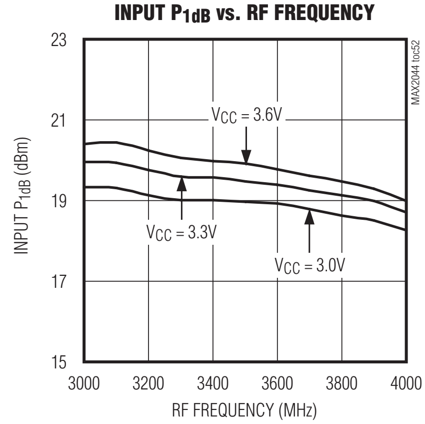
INPUT P_{1dB} vs. RF FREQUENCY



INPUT P_{1dB} vs. RF FREQUENCY



INPUT P_{1dB} vs. RF FREQUENCY

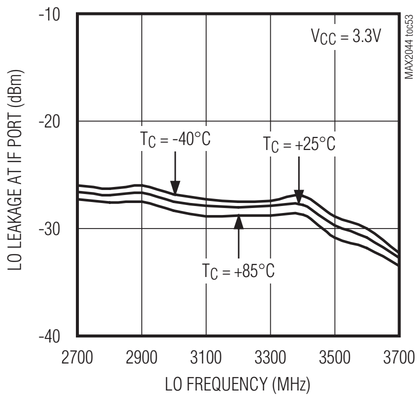


SiGe, High-Linearity, 2300MHz to 4000MHz Upconversion/Downconversion Mixer with LO Buffer

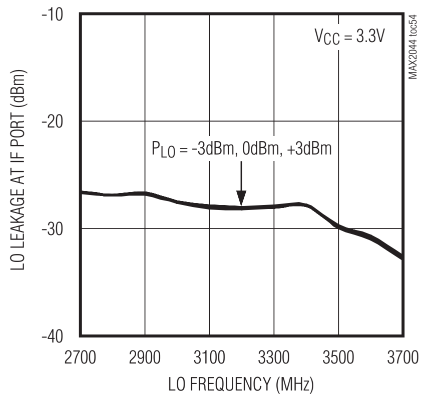
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, Downconverter Mode, V_{CC} = 3.3V, f_{RF} = 3000MHz to 4000MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

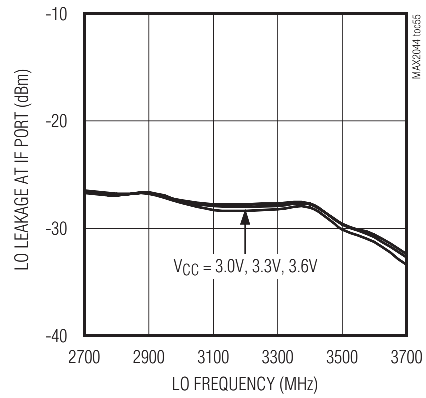
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



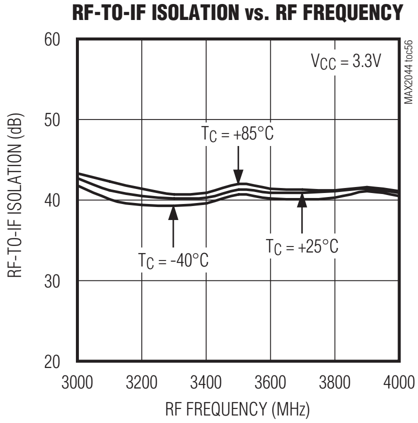
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



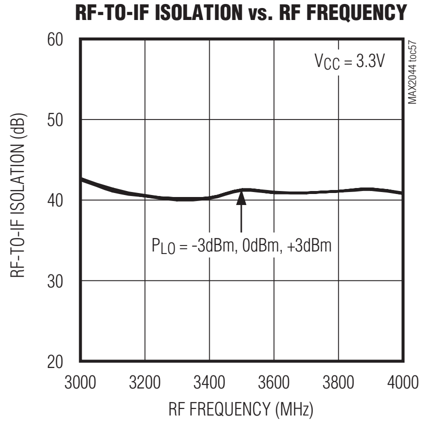
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



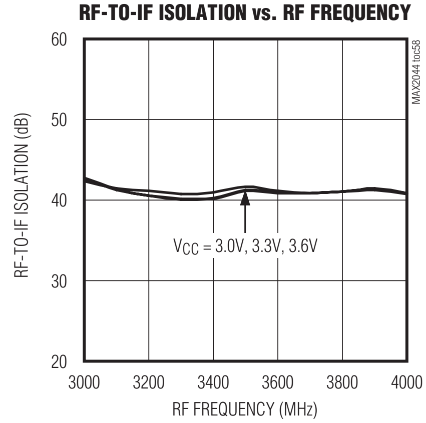
RF-TO-IF ISOLATION vs. RF FREQUENCY



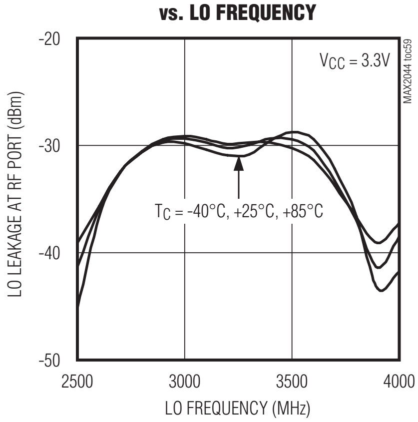
RF-TO-IF ISOLATION vs. RF FREQUENCY



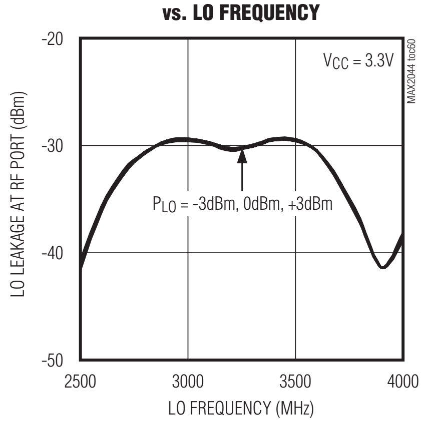
RF-TO-IF ISOLATION vs. RF FREQUENCY



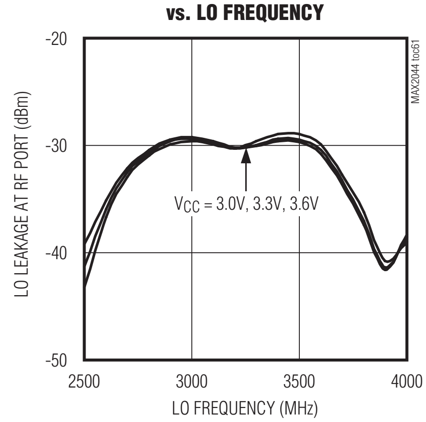
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



LO LEAKAGE AT RF PORT vs. LO FREQUENCY



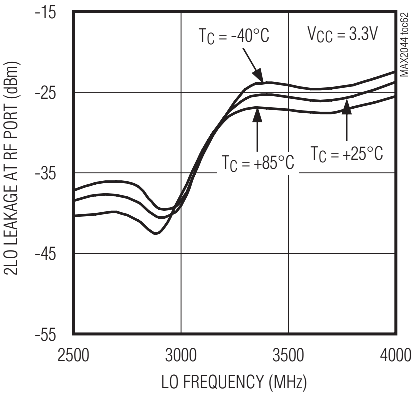
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



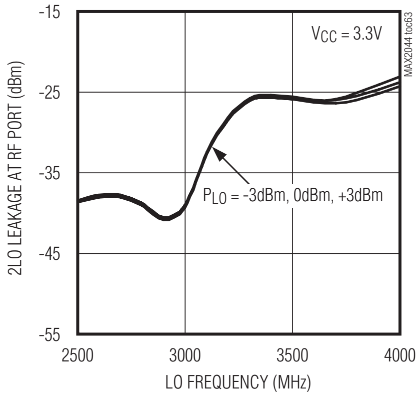
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, Downconverter Mode, V_{CC} = 3.3V, f_{RF} = 3000MHz to 4000MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

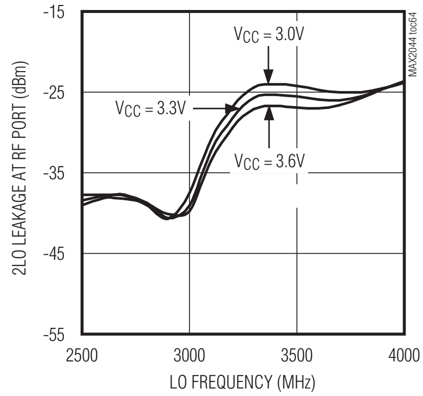
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



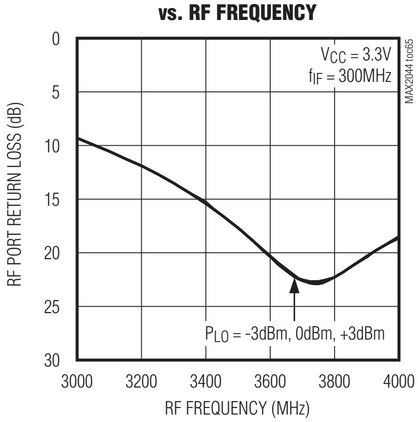
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



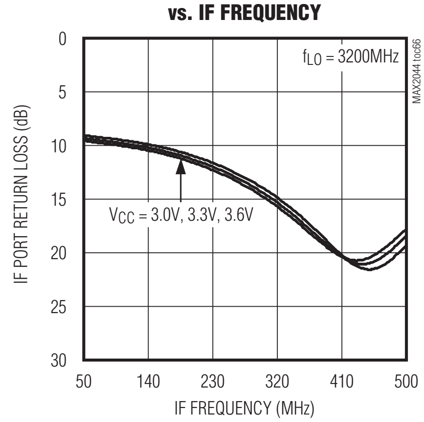
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



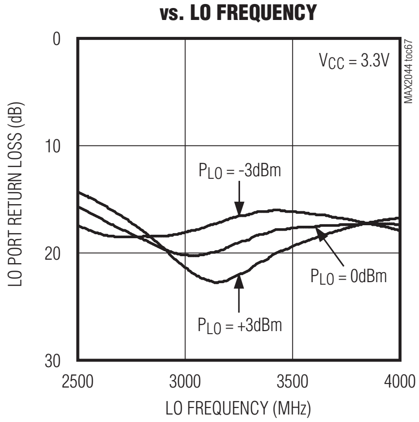
RF PORT RETURN LOSS vs. RF FREQUENCY



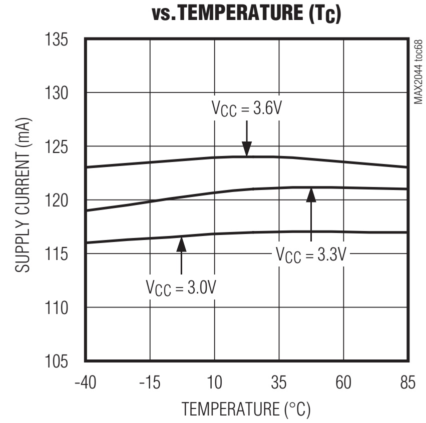
IF PORT RETURN LOSS vs. IF FREQUENCY



LO PORT RETURN LOSS vs. LO FREQUENCY



SUPPLY CURRENT vs.TEMPERATURE (T_C)

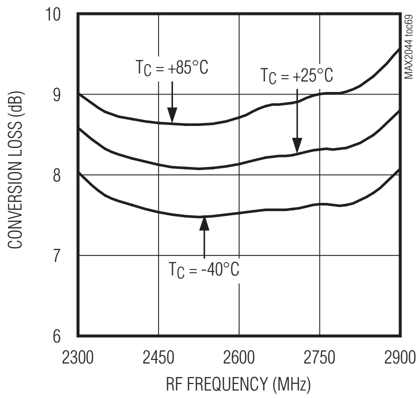


SiGe, High-Linearity, 2300MHz to 4000MHz Upconversion/Downconversion Mixer with LO Buffer

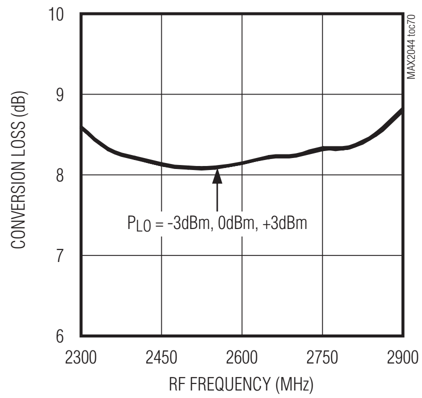
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, Downconverter Mode, V_{CC} = 5.0V, f_{RF} = 2300MHz to 2900MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

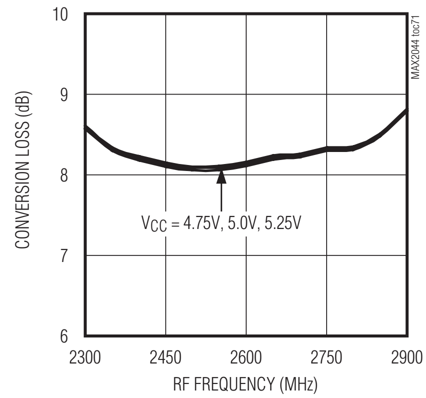
CONVERSION LOSS vs. RF FREQUENCY



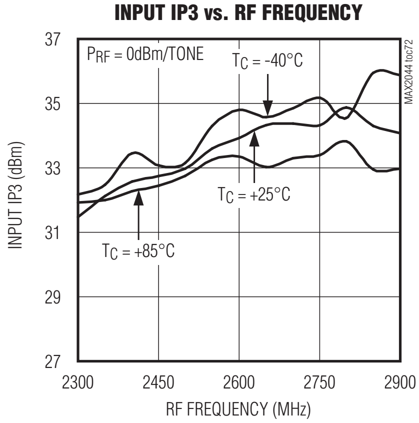
CONVERSION LOSS vs. RF FREQUENCY



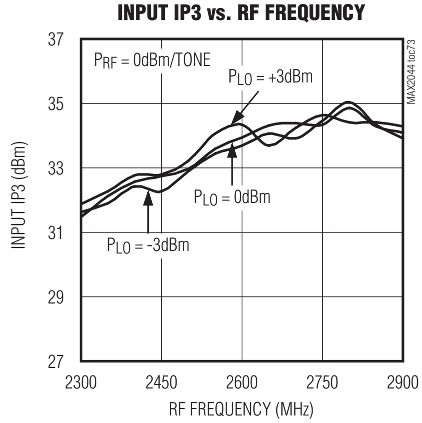
CONVERSION LOSS vs. RF FREQUENCY



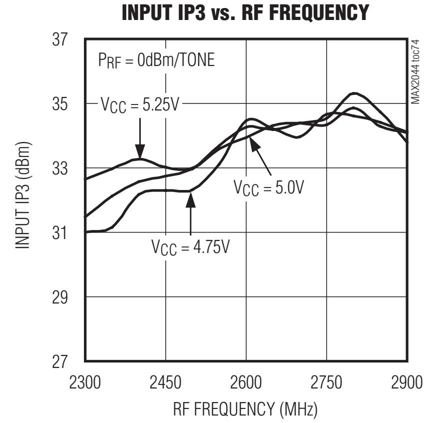
INPUT IP3 vs. RF FREQUENCY



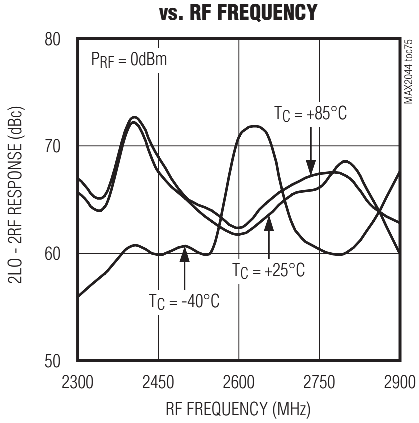
INPUT IP3 vs. RF FREQUENCY



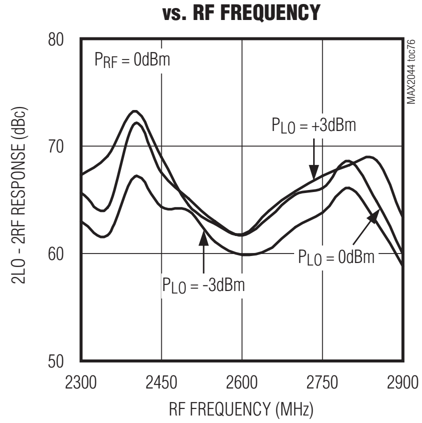
INPUT IP3 vs. RF FREQUENCY



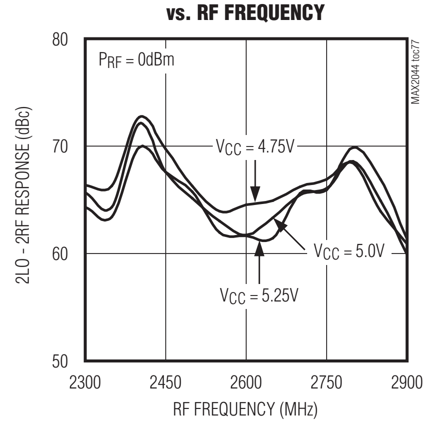
2LO - 2RF RESPONSE vs. RF FREQUENCY



2LO - 2RF RESPONSE vs. RF FREQUENCY



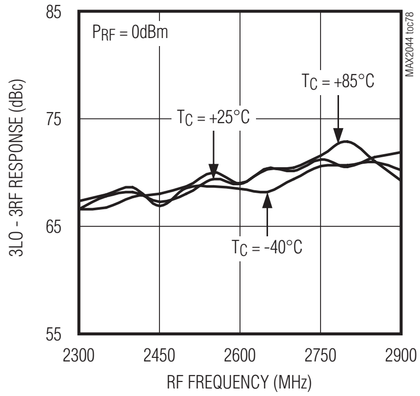
2LO - 2RF RESPONSE vs. RF FREQUENCY



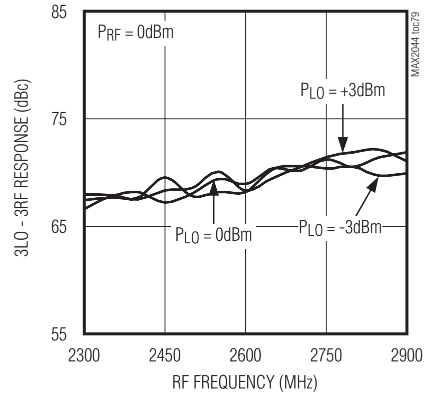
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, Downconverter Mode, V_{CC} = 5.0V, f_{RF} = 2300MHz to 2900MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

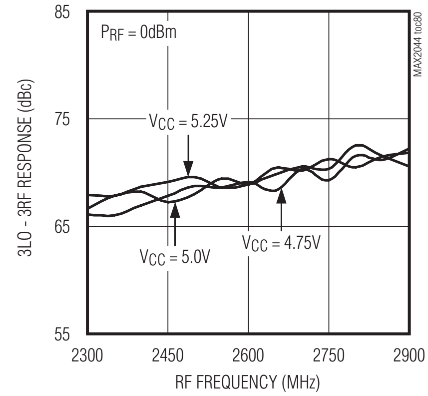
3LO - 3RF RESPONSE vs. RF FREQUENCY



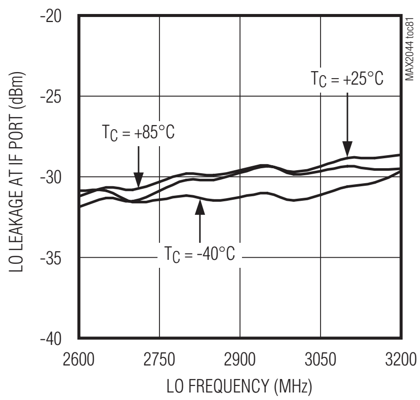
3LO - 3RF RESPONSE vs. RF FREQUENCY



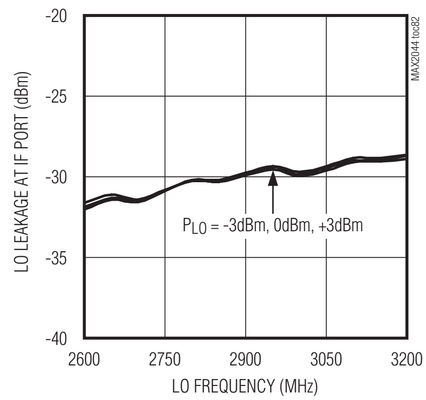
3LO - 3RF RESPONSE vs. RF FREQUENCY



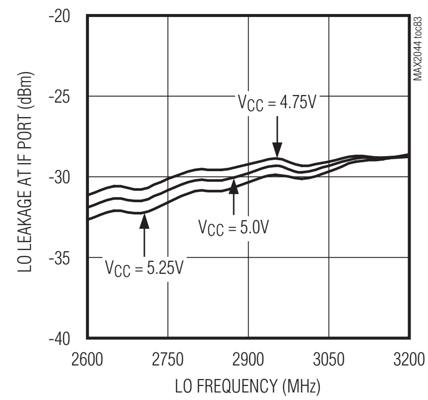
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



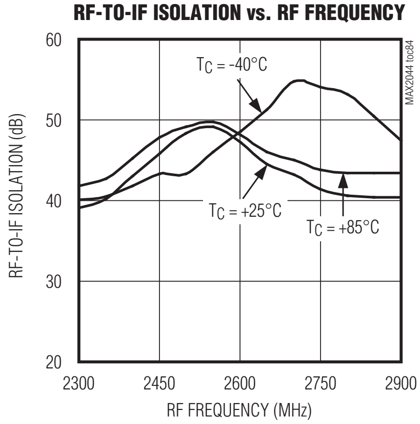
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



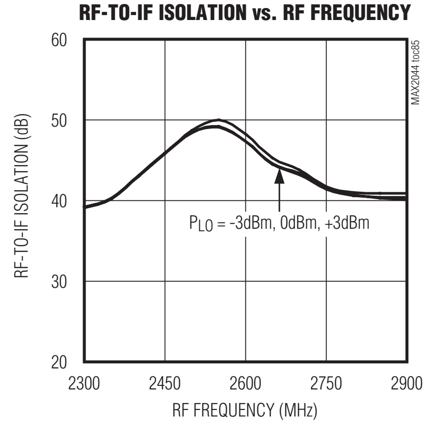
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



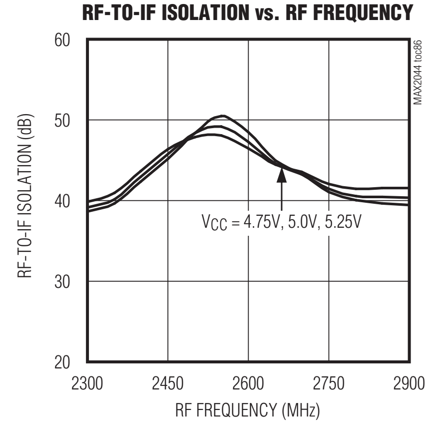
RF-TO-IF ISOLATION vs. RF FREQUENCY



RF-TO-IF ISOLATION vs. RF FREQUENCY



RF-TO-IF ISOLATION vs. RF FREQUENCY

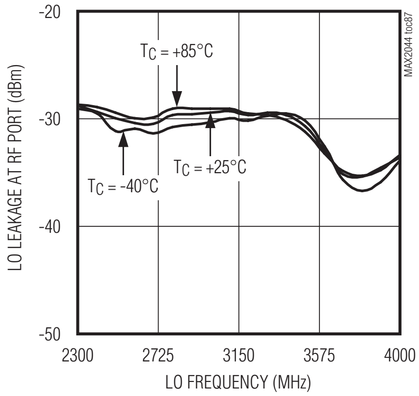


SiGe, High-Linearity, 2300MHz to 4000MHz Upconversion/Downconversion Mixer with LO Buffer

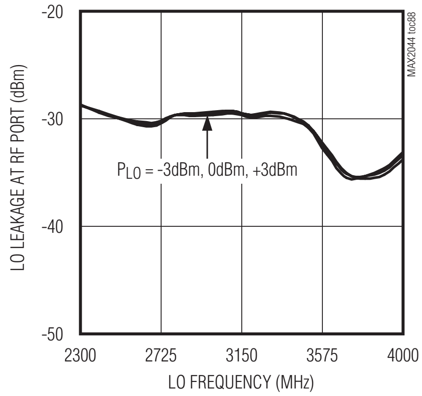
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, Downconverter Mode, V_{CC} = 5.0V, f_{RF} = 2300MHz to 2900MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

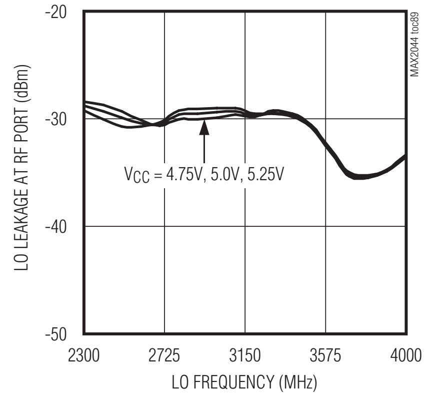
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



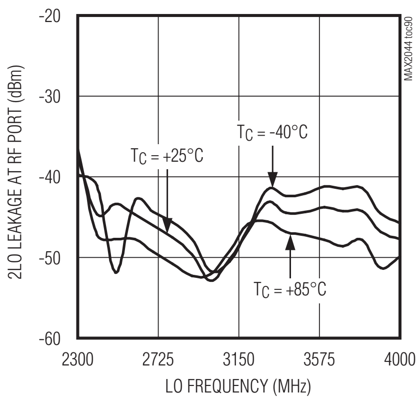
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



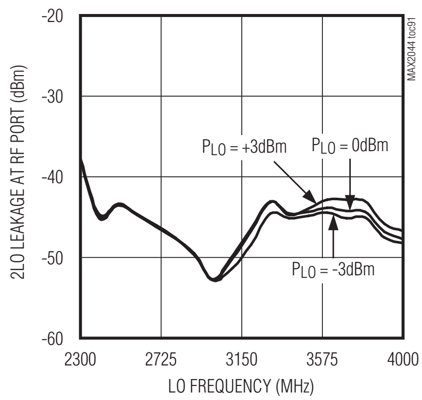
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



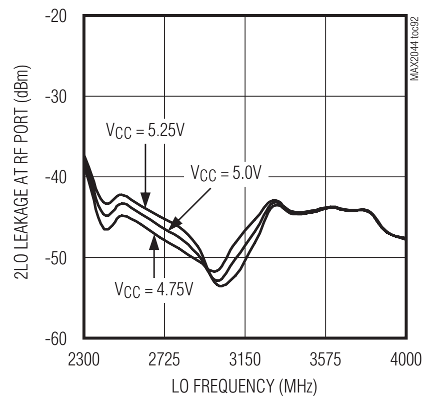
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



2LO LEAKAGE AT RF PORT vs. LO FREQUENCY

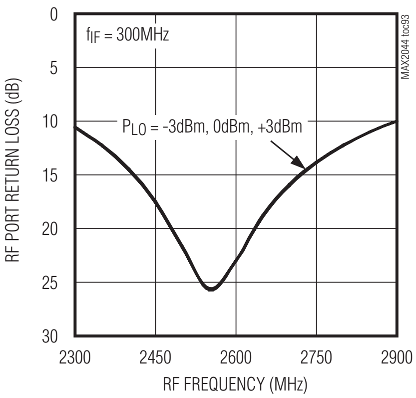


SiGe, High-Linearity, 2300MHz to 4000MHz Upconversion/Downconversion Mixer with LO Buffer

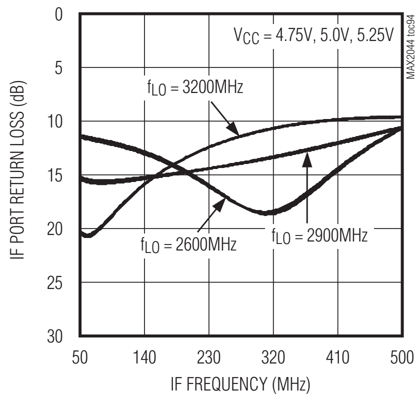
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, Downconverter Mode, V_{CC} = 5.0V, f_{RF} = 2300MHz to 2900MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

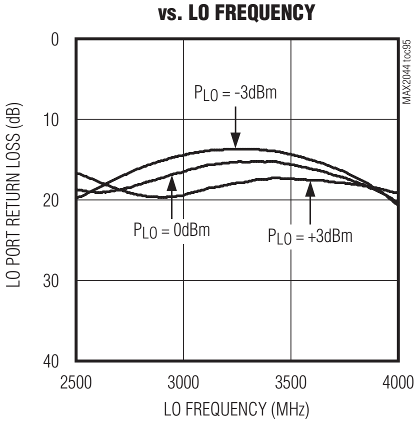
RF PORT RETURN LOSS vs. RF FREQUENCY



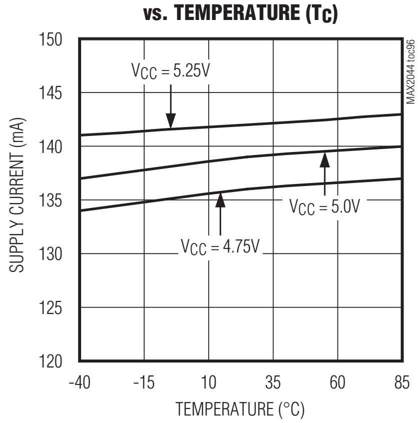
IF PORT RETURN LOSS vs. IF FREQUENCY



LO PORT RETURN LOSS vs. LO FREQUENCY



SUPPLY CURRENT vs. TEMPERATURE (T_C)

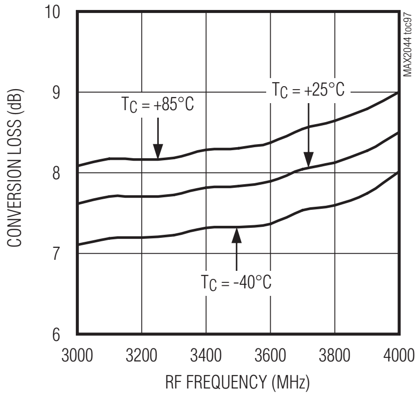


SiGe, High-Linearity, 2300MHz to 4000MHz Upconversion/Downconversion Mixer with LO Buffer

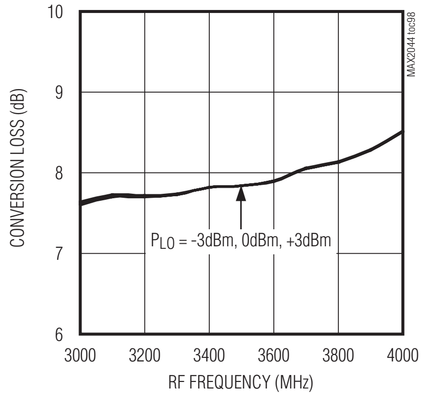
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, Downconverter Mode, V_{CC} = 5.0V, f_{RF} = 3000MHz to 4000MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

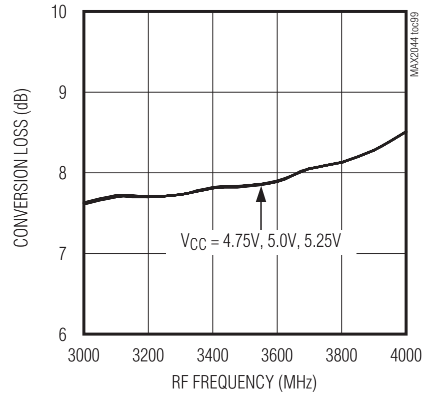
CONVERSION LOSS vs. RF FREQUENCY



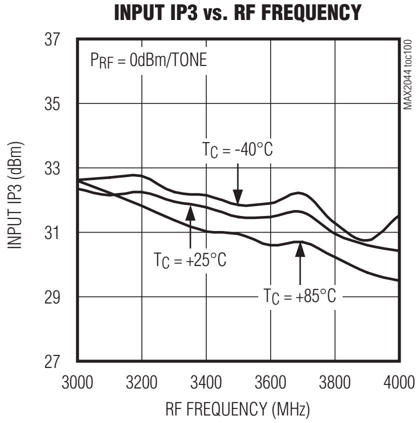
CONVERSION LOSS vs. RF FREQUENCY



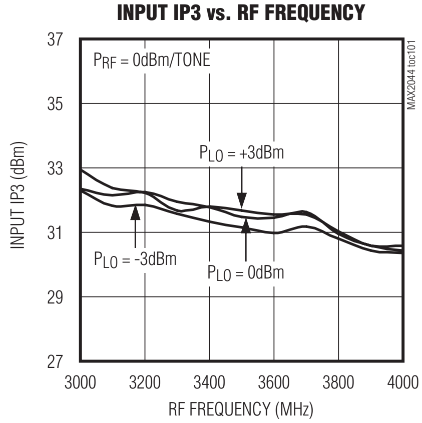
CONVERSION LOSS vs. RF FREQUENCY



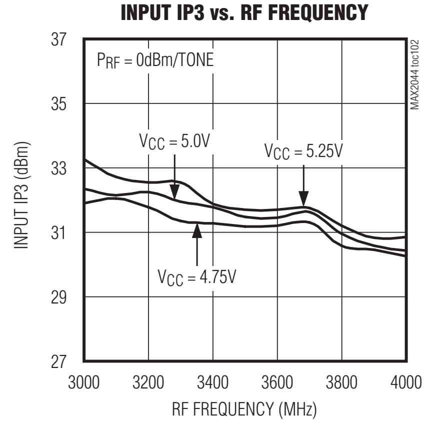
INPUT IP3 vs. RF FREQUENCY



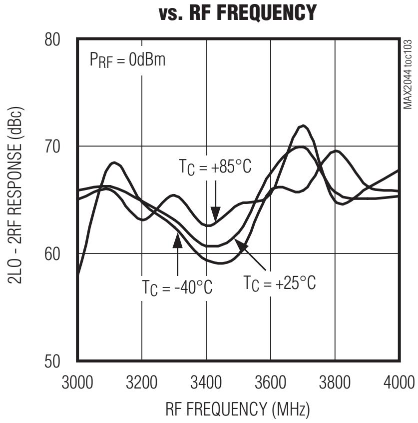
INPUT IP3 vs. RF FREQUENCY



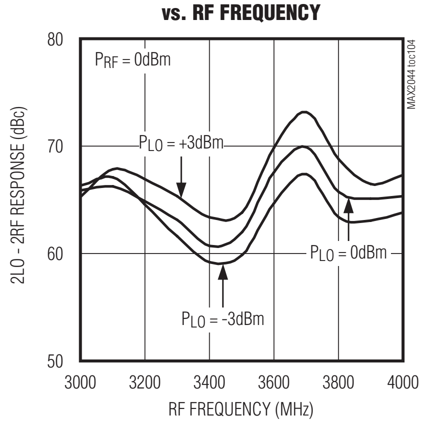
INPUT IP3 vs. RF FREQUENCY



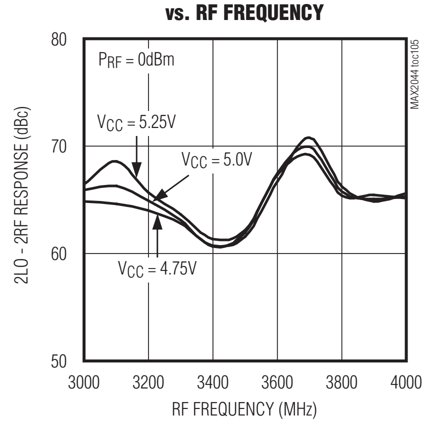
2LO - 2RF RESPONSE vs. RF FREQUENCY



2LO - 2RF RESPONSE vs. RF FREQUENCY



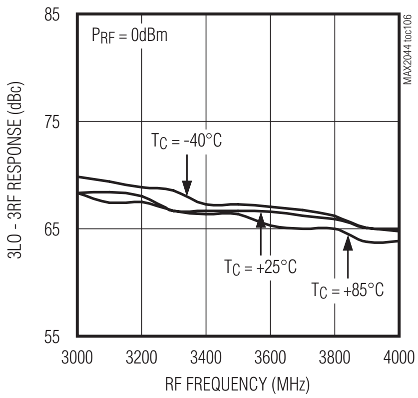
2LO - 2RF RESPONSE vs. RF FREQUENCY



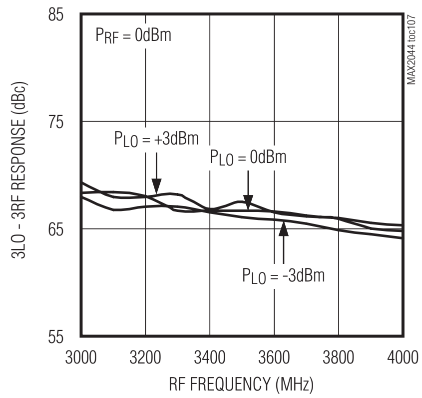
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, Downconverter Mode, V_{CC} = 5.0V, f_{RF} = 3000MHz to 4000MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

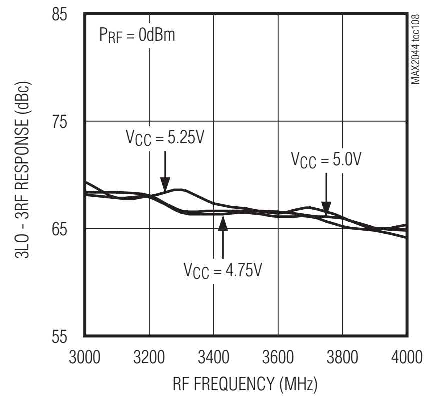
3LO - 3RF RESPONSE vs. RF FREQUENCY



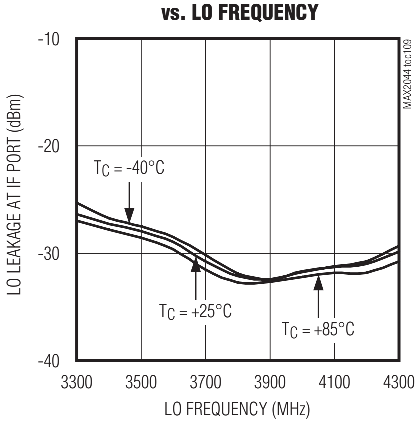
3LO - 3RF RESPONSE vs. RF FREQUENCY



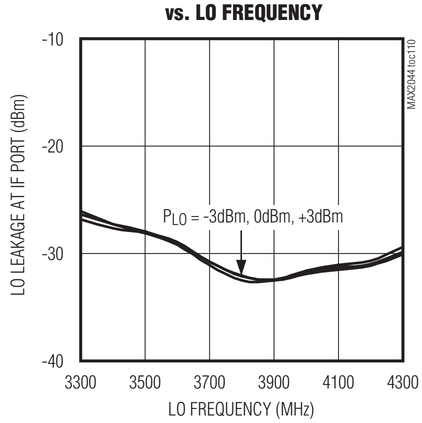
3LO - 3RF RESPONSE vs. RF FREQUENCY



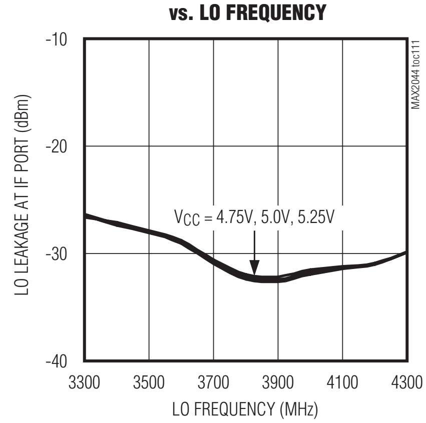
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



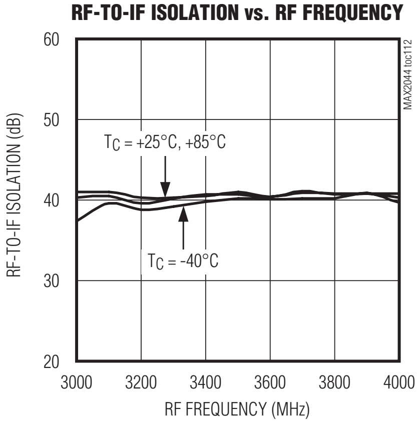
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



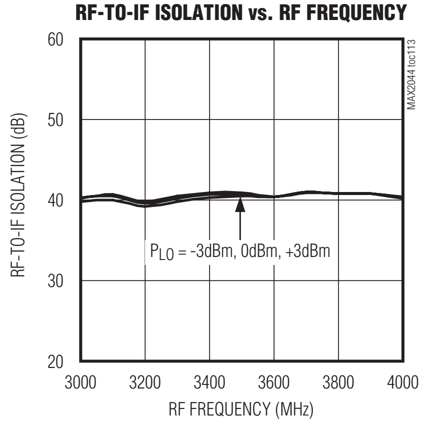
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



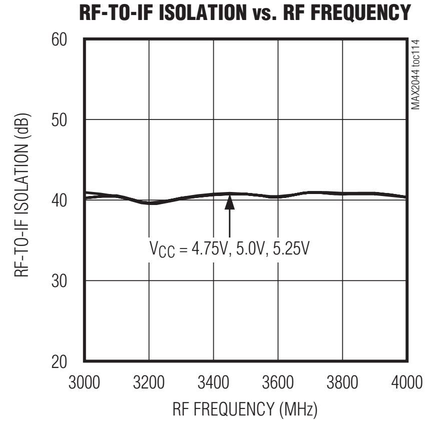
RF-TO-IF ISOLATION vs. RF FREQUENCY



RF-TO-IF ISOLATION vs. RF FREQUENCY



RF-TO-IF ISOLATION vs. RF FREQUENCY

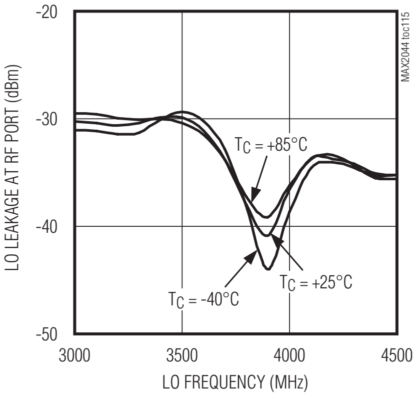


SiGe, High-Linearity, 2300MHz to 4000MHz Upconversion/Downconversion Mixer with LO Buffer

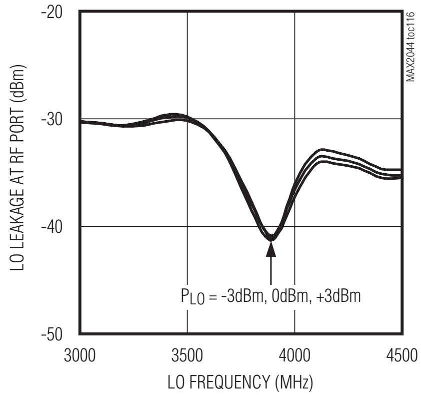
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, Downconverter Mode, V_{CC} = 5.0V, f_{RF} = 3000MHz to 4000MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

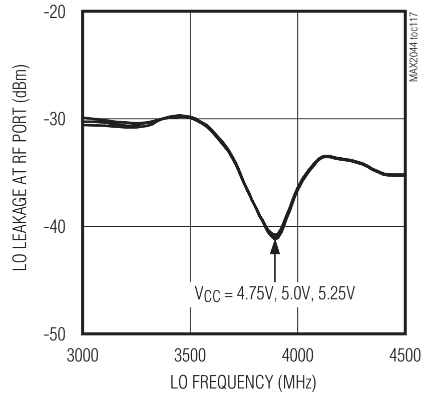
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



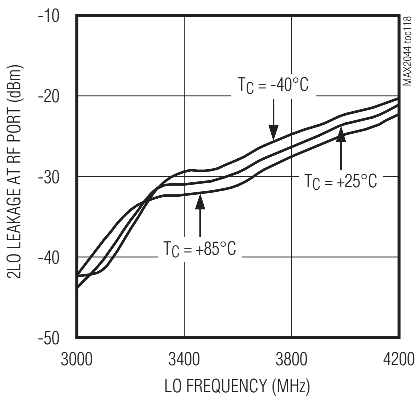
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



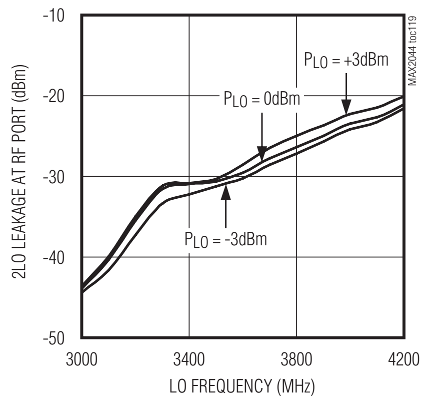
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



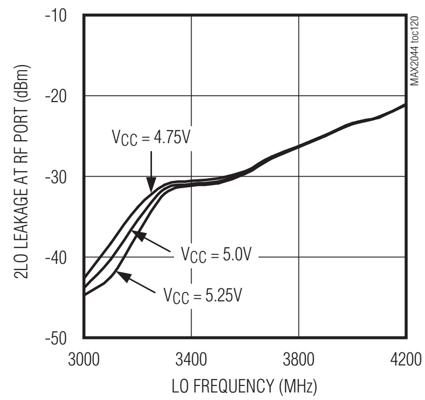
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



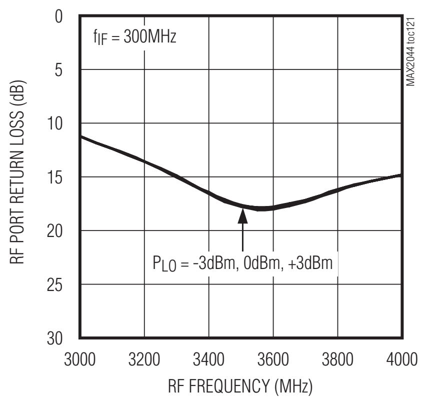
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



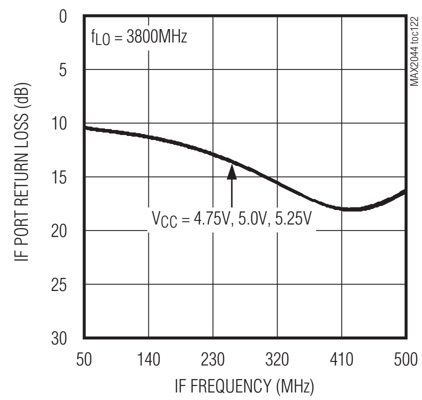
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, Downconverter Mode, V_{CC} = 5.0V, f_{RF} = 3000MHz to 4000MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

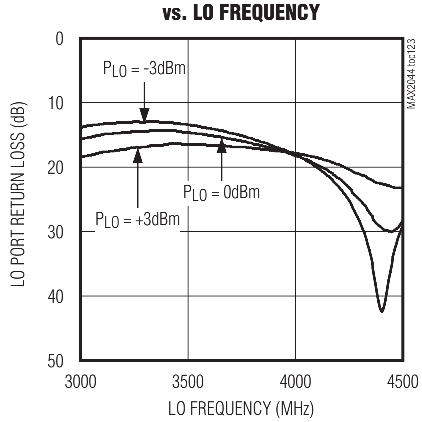
RF PORT RETURN LOSS vs. RF FREQUENCY



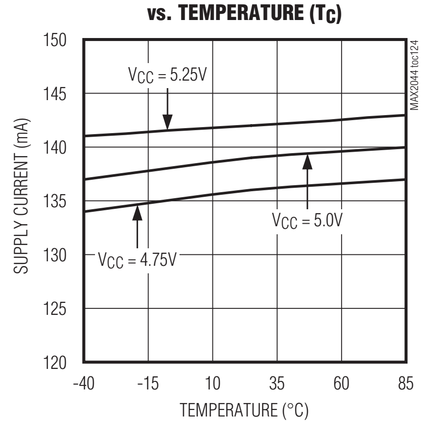
IF PORT RETURN LOSS vs. IF FREQUENCY



LO PORT RETURN LOSS vs. LO FREQUENCY



SUPPLY CURRENT vs. TEMPERATURE (T_C)

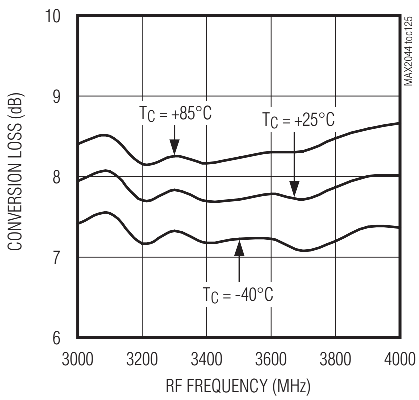


SiGe, High-Linearity, 2300MHz to 4000MHz Upconversion/Downconversion Mixer with LO Buffer

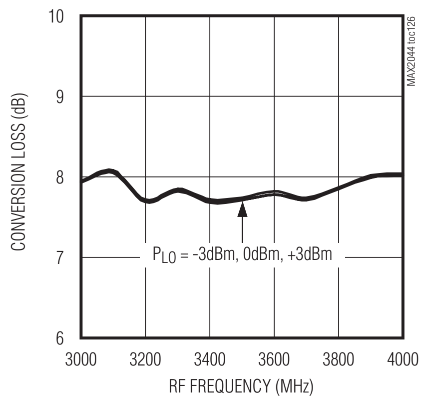
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 2, Upconverter Mode, V_{CC} = 5.0V, f_{RF} = 3000MHz to 4000MHz, LO is low-side injected,** f_{IF} = 200MHz, P_{IF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

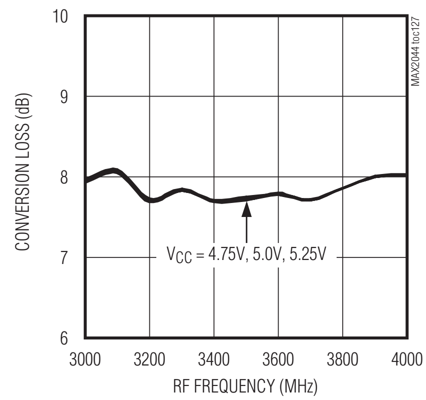
CONVERSION LOSS vs. RF FREQUENCY



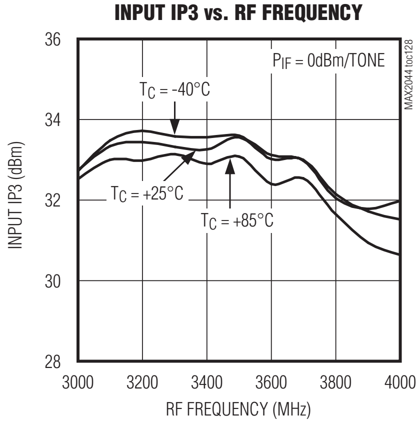
CONVERSION LOSS vs. RF FREQUENCY



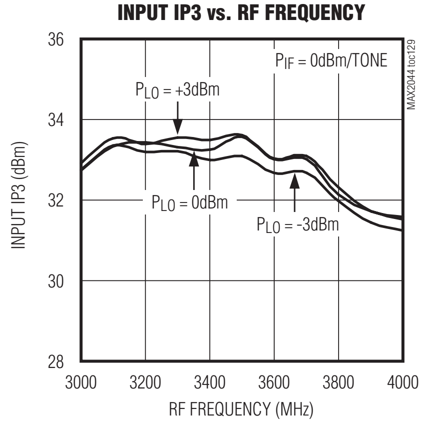
CONVERSION LOSS vs. RF FREQUENCY



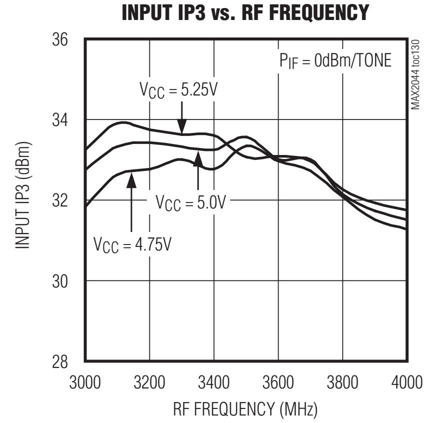
INPUT IP3 vs. RF FREQUENCY



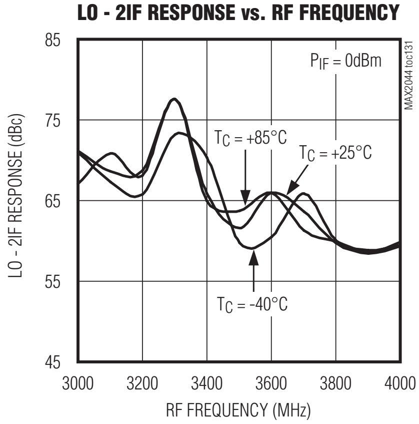
INPUT IP3 vs. RF FREQUENCY



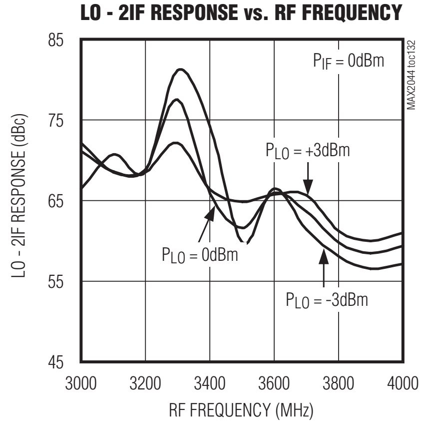
INPUT IP3 vs. RF FREQUENCY



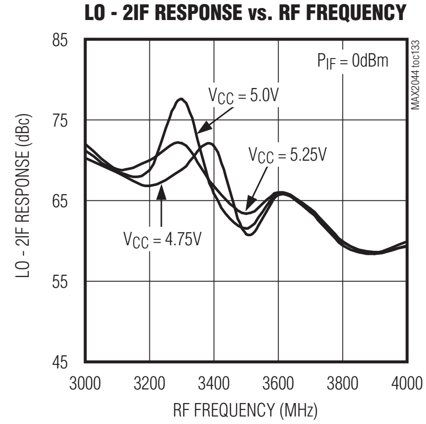
LO - 2IF RESPONSE vs. RF FREQUENCY



LO - 2IF RESPONSE vs. RF FREQUENCY



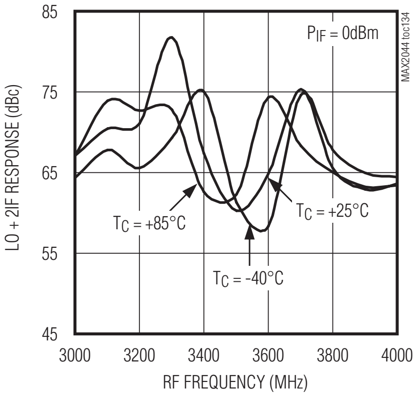
LO - 2IF RESPONSE vs. RF FREQUENCY



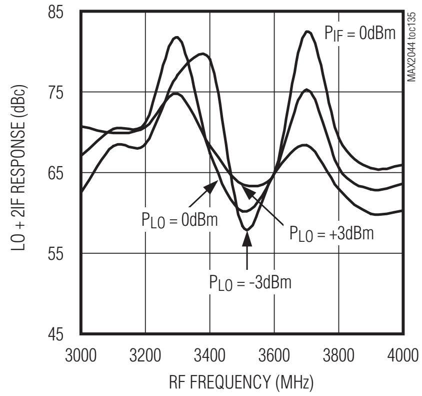
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 2, Upconverter Mode, V_{CC} = 5.0V, f_{RF} = 3000MHz to 4000MHz, LO is low-side injected,** f_{IF} = 200MHz, P_{IF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

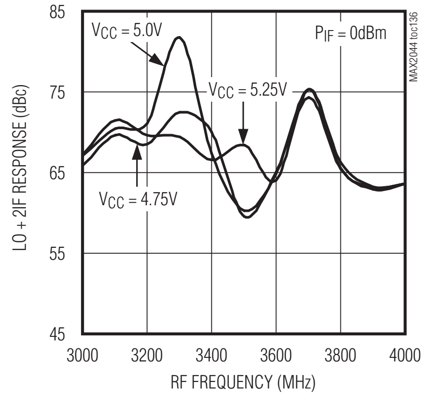
LO + 2IF RESPONSE vs. RF FREQUENCY



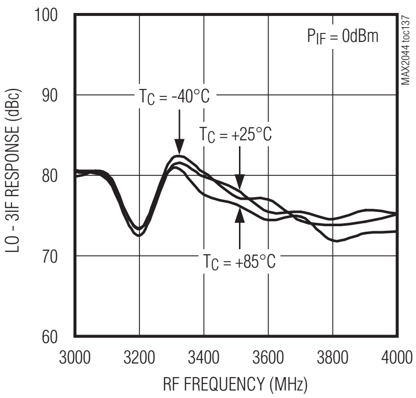
LO + 2IF RESPONSE vs. RF FREQUENCY



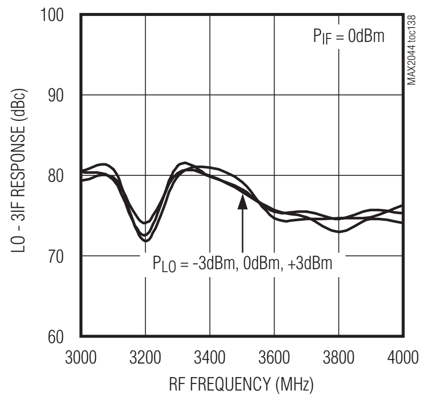
LO + 2IF RESPONSE vs. RF FREQUENCY



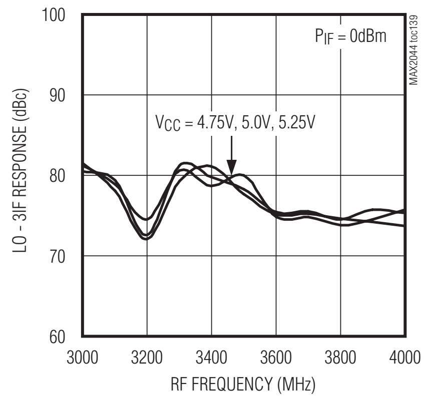
LO - 3IF RESPONSE vs. RF FREQUENCY



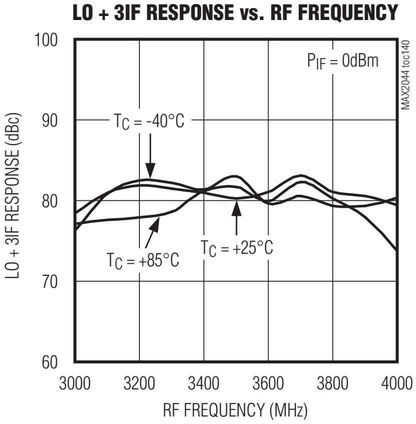
LO - 3IF RESPONSE vs. RF FREQUENCY



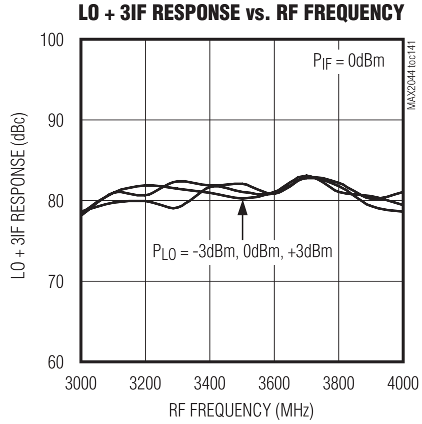
LO - 3IF RESPONSE vs. RF FREQUENCY



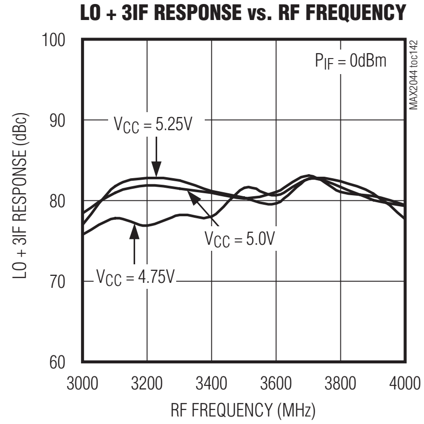
LO + 3IF RESPONSE vs. RF FREQUENCY



LO + 3IF RESPONSE vs. RF FREQUENCY



LO + 3IF RESPONSE vs. RF FREQUENCY

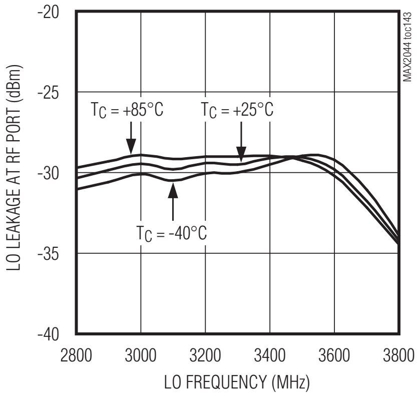


SiGe, High-Linearity, 2300MHz to 4000MHz Upconversion/Downconversion Mixer with LO Buffer

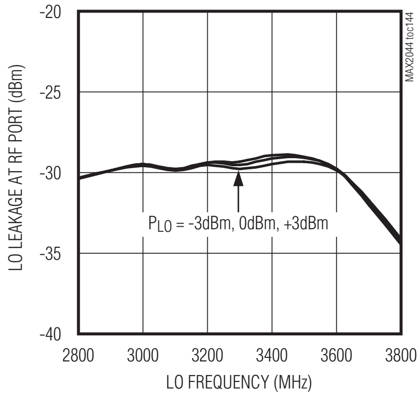
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 2, Upconverter Mode, V_{CC} = 5.0V, f_{RF} = 3000MHz to 4000MHz, LO is low-side injected,** f_{IF} = 200MHz, P_{IF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

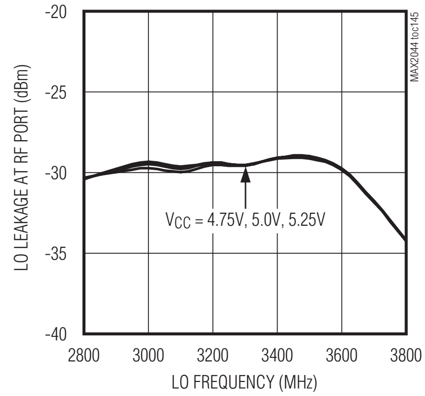
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



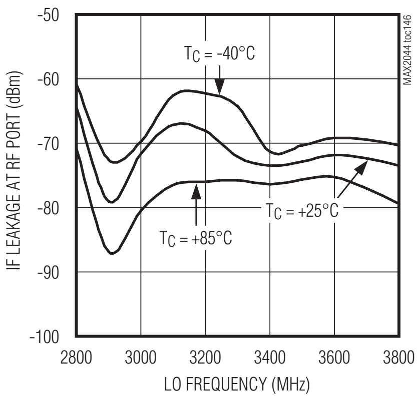
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



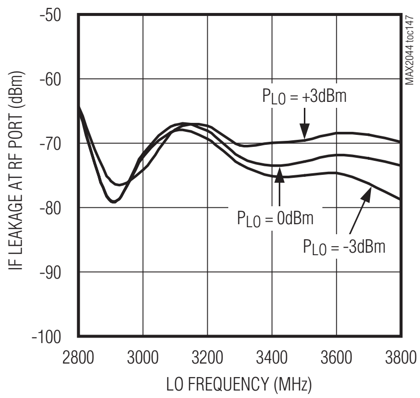
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



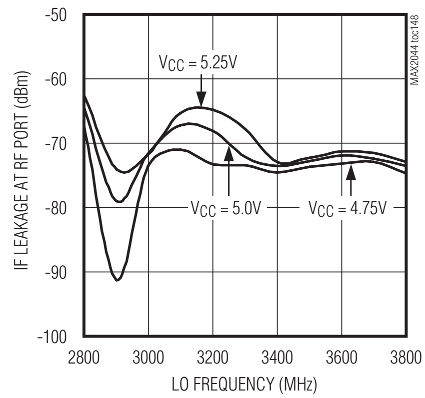
IF LEAKAGE AT RF PORT vs. LO FREQUENCY



IF LEAKAGE AT RF PORT vs. LO FREQUENCY

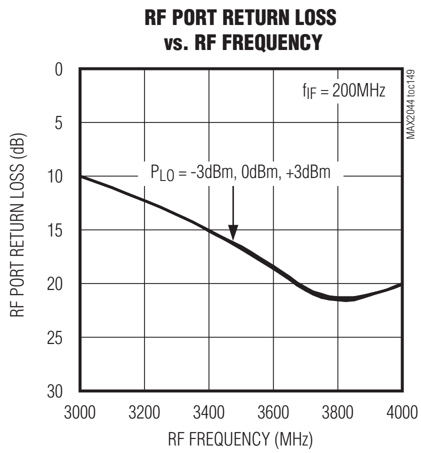


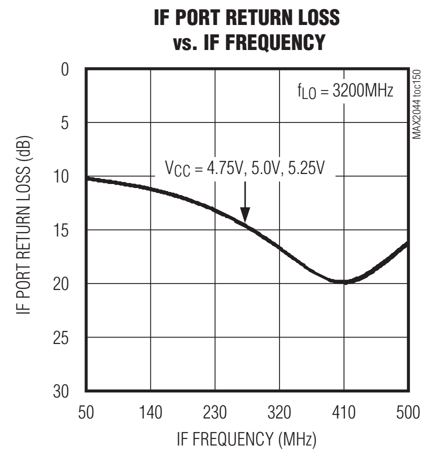
IF LEAKAGE AT RF PORT vs. LO FREQUENCY

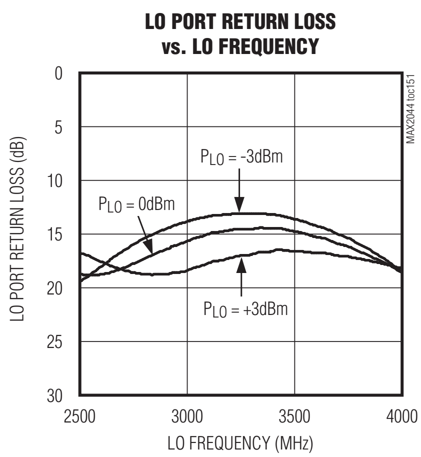


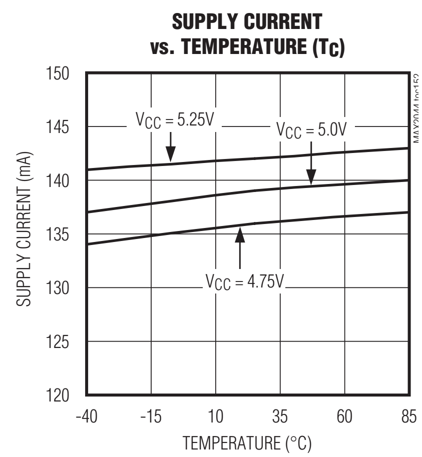
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 2, Upconverter Mode, V_{CC} = 5.0V, f_{RF} = 3000MHz to 4000MHz, LO is low-side injected,** f_{IF} = 200MHz, P_{IF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)







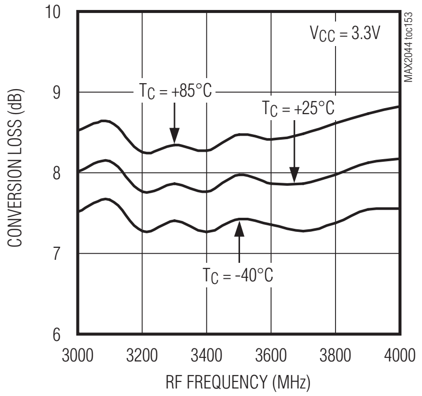


SiGe, High-Linearity, 2300MHz to 4000MHz Upconversion/Downconversion Mixer with LO Buffer

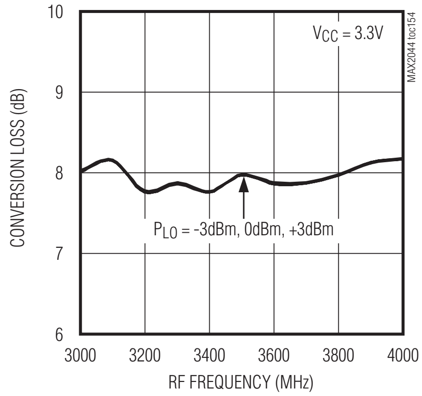
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 2, Upconverter Mode, V_{CC} = 3.3V, f_{RF} = 3000MHz to 4000MHz, LO is low-side injected,** f_{IF} = 200MHz, P_{IF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

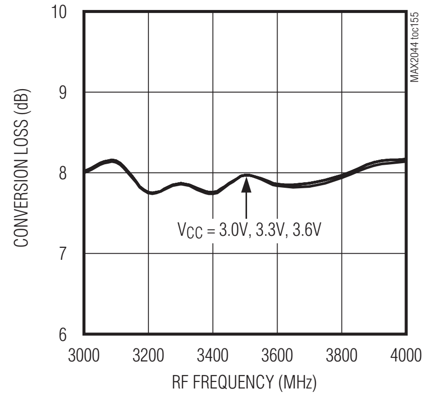
CONVERSION LOSS vs. RF FREQUENCY



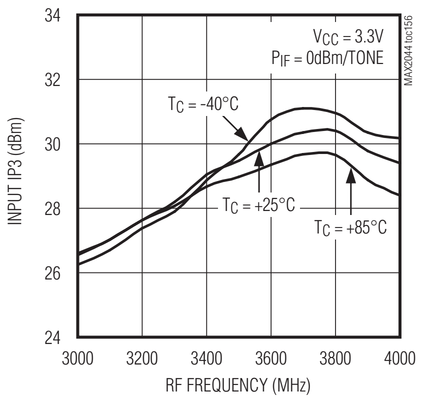
CONVERSION LOSS vs. RF FREQUENCY



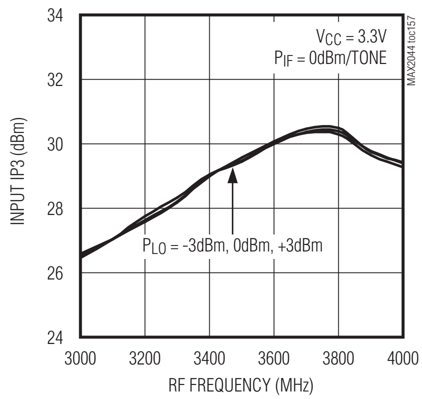
CONVERSION LOSS vs. RF FREQUENCY



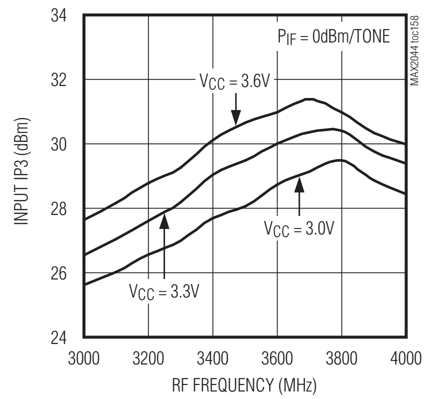
INPUT IP3 vs. RF FREQUENCY



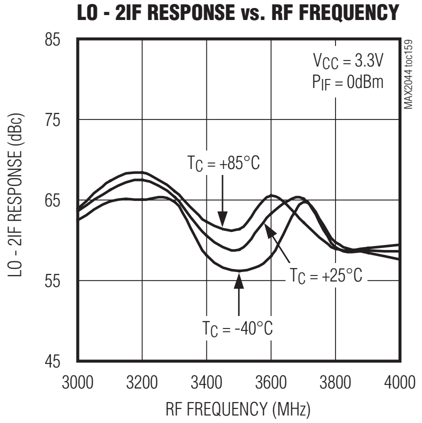
INPUT IP3 vs. RF FREQUENCY



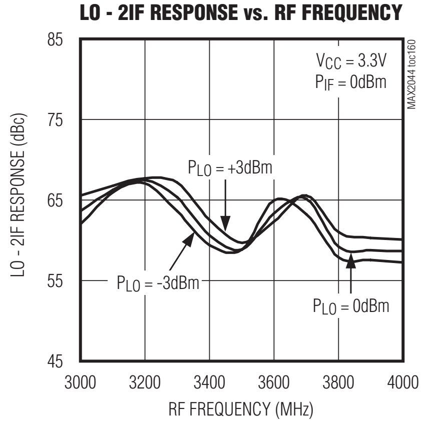
INPUT IP3 vs. RF FREQUENCY



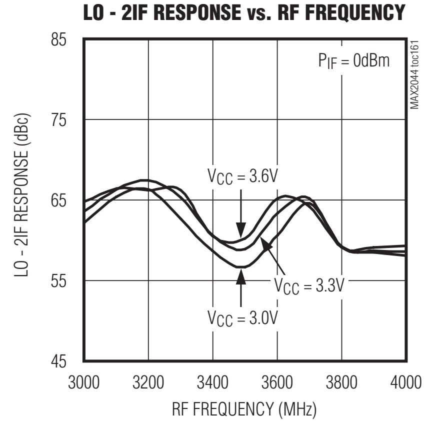
LO - 2IF RESPONSE vs. RF FREQUENCY



LO - 2IF RESPONSE vs. RF FREQUENCY



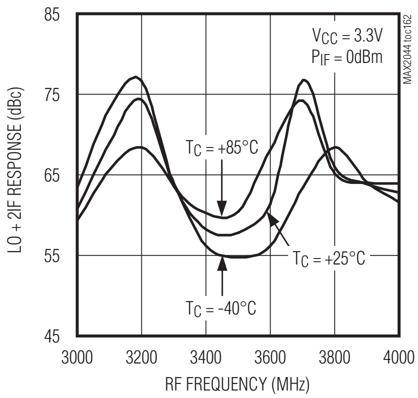
LO - 2IF RESPONSE vs. RF FREQUENCY



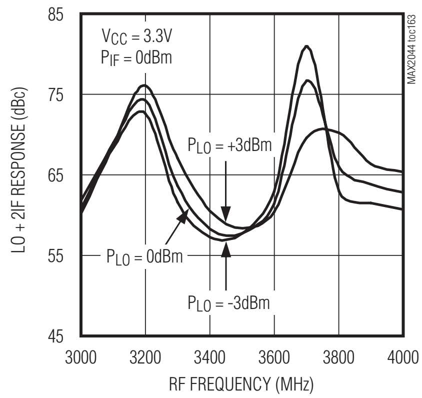
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 2, Upconverter Mode, V_{CC} = 3.3V, f_{RF} = 3000MHz to 4000MHz, LO is low-side injected,** f_{IF} = 200MHz, P_{IF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

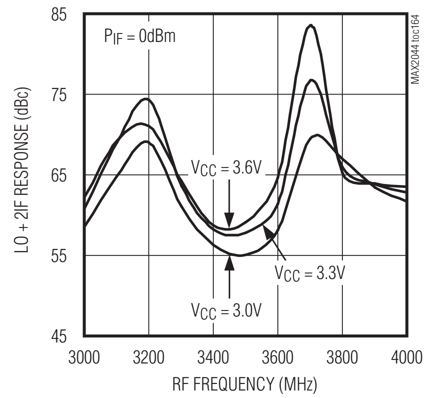
LO + 2IF RESPONSE vs. RF FREQUENCY



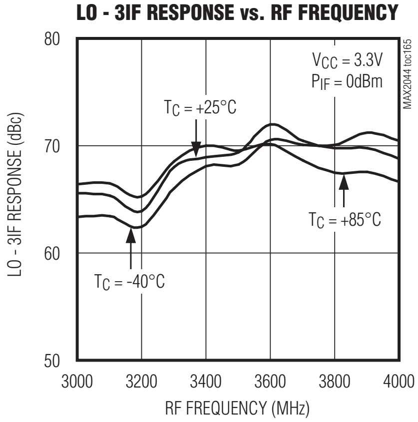
LO + 2IF RESPONSE vs. RF FREQUENCY



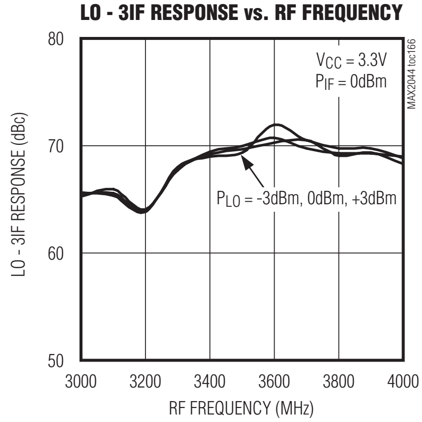
LO + 2IF RESPONSE vs. RF FREQUENCY



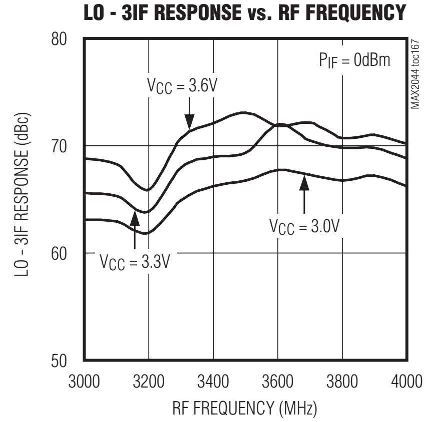
LO - 3IF RESPONSE vs. RF FREQUENCY



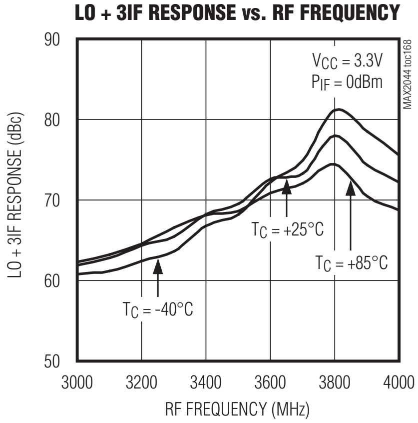
LO - 3IF RESPONSE vs. RF FREQUENCY



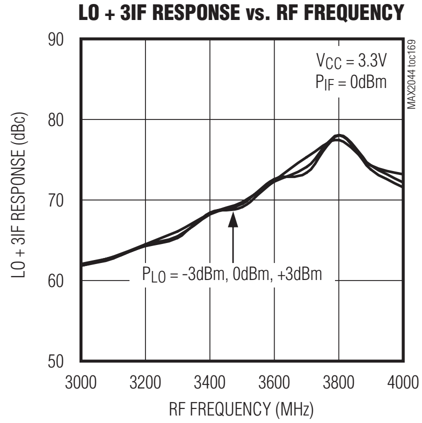
LO - 3IF RESPONSE vs. RF FREQUENCY



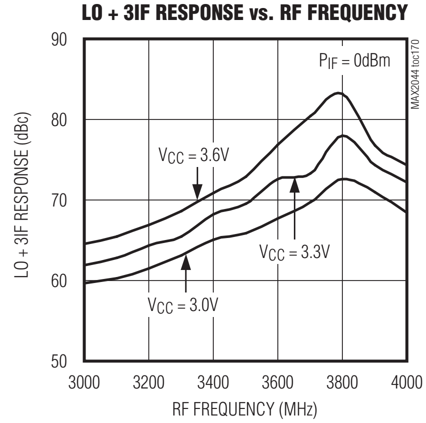
LO + 3IF RESPONSE vs. RF FREQUENCY



LO + 3IF RESPONSE vs. RF FREQUENCY



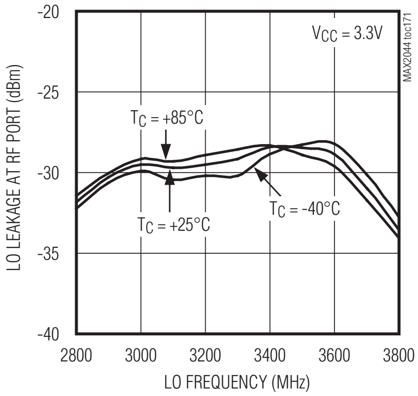
LO + 3IF RESPONSE vs. RF FREQUENCY



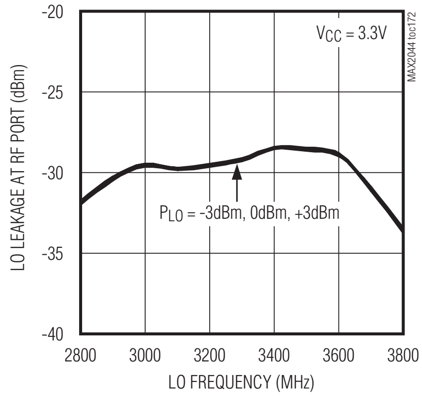
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 2, Upconverter Mode, V_{CC} = 3.3V, f_{RF} = 3000MHz to 4000MHz, LO is low-side injected,** f_{IF} = 200MHz, P_{IF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

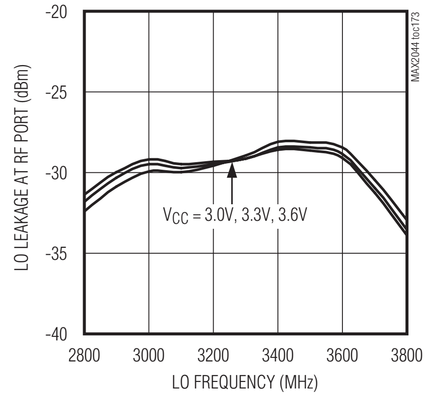
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



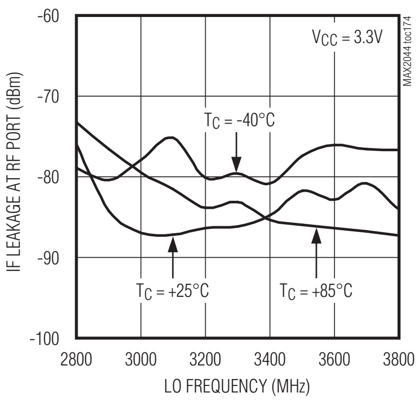
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



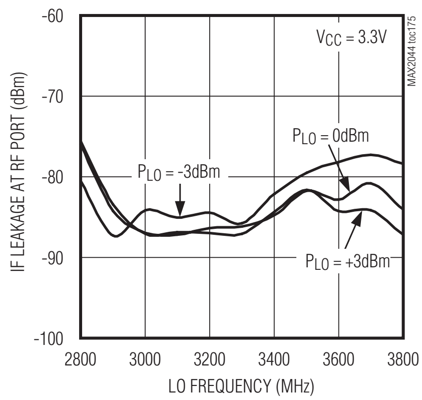
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



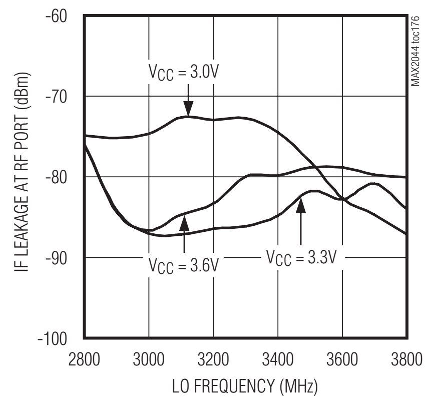
IF LEAKAGE AT RF PORT vs. LO FREQUENCY



IF LEAKAGE AT RF PORT vs. LO FREQUENCY



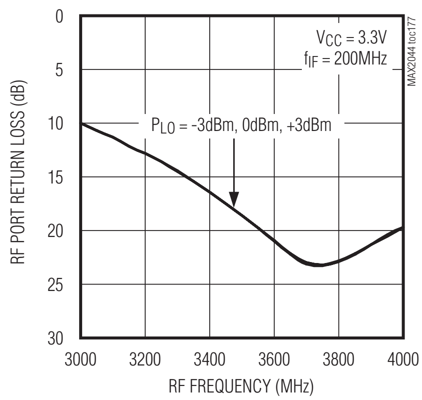
IF LEAKAGE AT RF PORT vs. LO FREQUENCY



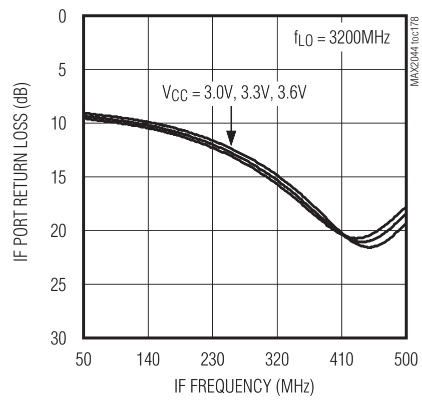
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 2, Upconverter Mode, V_{CC} = 3.3V, f_{RF} = 3000MHz to 4000MHz, LO is low-side injected,** f_{IF} = 200MHz, P_{IF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

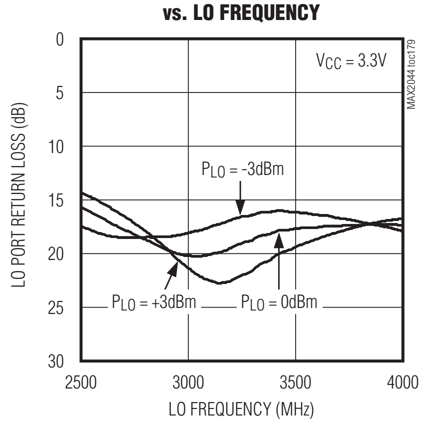
RF PORT RETURN LOSS vs. RF FREQUENCY



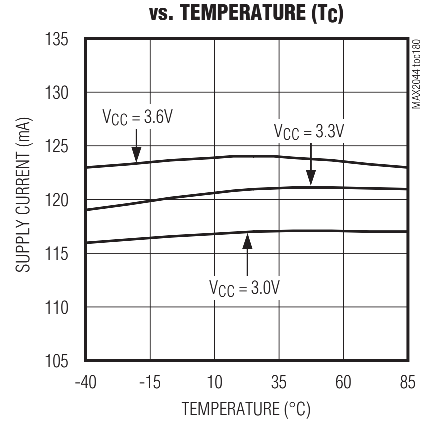
IF PORT RETURN LOSS vs. IF FREQUENCY



LO PORT RETURN LOSS vs. LO FREQUENCY

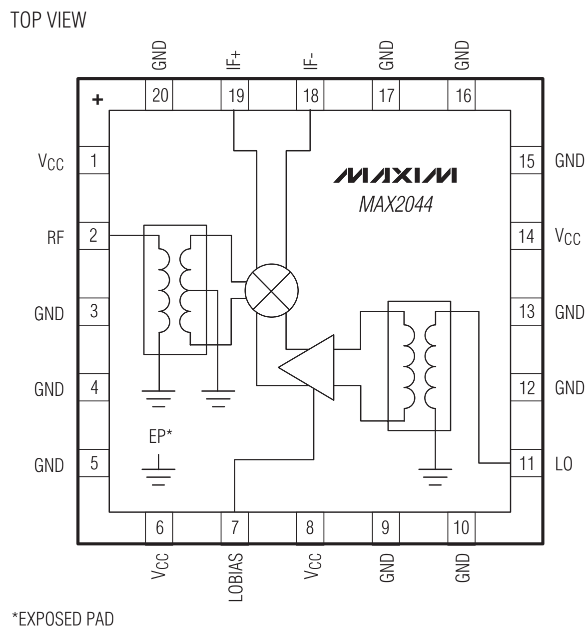


SUPPLY CURRENT vs. TEMPERATURE (T_C)



SiGe, High-Linearity, 2300MHz to 4000MHz Upconversion/Downconversion Mixer with LO Buffer

Pin Configuration/Functional Diagram



Pin Description

PIN	NAME	FUNCTION
1, 6, 8, 14	V_{CC}	Power Supply. Bypass to GND with 0.01µF capacitors as close as possible to the pin.
2	RF	Single-Ended 50Ω RF Input/Output. Internally matched and DC shorted to GND through a balun. Provide an input DC-blocking capacitor if required.
3, 9, 13, 15	GND	Ground. Not internally connected. Pins can be grounded.
4, 5, 10, 12, 17	GND	Ground. Internally connected to the exposed pad (EP). Connect all ground pins and the exposed pad together.
7	LOBIAS	LO Output Bias Resistor for LO Buffer. Connect a 698Ω 1% resistor (138mA bias condition) from LOBIAS to ground.
11	LO	Local Oscillator Input. This input is internally matched to 50Ω. Requires an input DC-blocking capacitor.
16, 20	GND	Ground. Connect pins to ground.
18, 19	IF-, IF+	Mixer Differential IF Output/Input. Provide DC-blocking capacitors if required. These ports are internally biased to $V_{CC}/2$.
—	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.

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Detailed Description

The MAX2044 is a high-linearity passive mixer targeting 2.5GHz and 3.5GHz wireless infrastructure applications. With an ultra-wide 2600MHz to 4300MHz LO frequency range, the MAX2044 can be used in either low-side or high-side LO injection architectures for virtually all WiMAX, LTE, and MMDS receive and transmit applications.

When used as a low-side LO injection downconverting mixer in the 3000MHz to 4000MHz band, the MAX2044 provides +32.5dBm of input IP3, with typical conversion loss and noise figure values of only 7.7dB and 8.5dB, respectively. The integrated baluns and matching circuitry allow for 50Ω single-ended interfaces to the RF and the LO port. The integrated LO buffer provides a high drive level to the mixer core, reducing the LO drive required at the MAX2044's input to a -3dBm to +3dBm range. The IF port incorporates a differential output, which is ideal for providing enhanced 2RF - 2LO or 2LO - 2RF performance.

Specifications are guaranteed over broad frequency ranges to allow for use in WiMAX, LTE, and MMDS base stations. The MAX2044 is specified to operate over a 2300MHz to 4000MHz RF input range, a 2600MHz to 4300MHz LO range, and a 50MHz to 500MHz IF range. Operation beyond these ranges is possible (see the *Typical Operating Characteristics* for additional information).

RF Input and Balun

The MAX2044 RF input provides a 50Ω match when combined with a series DC-blocking capacitor. This DC-blocking capacitor is 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 better than 13dB over the 3300MHz to 3900MHz RF frequency range. A return loss of 15dB over the 2400MHz to 2700MHz range is achievable by changing the input matching components per Tables 1 and 2. Other combinations of C1 and C12 can be used to optimize RF return loss in the 2300MHz to 4000MHz band.

LO Inputs, Buffer, and Balun

With a broadband LO drive circuit spanning 2600MHz to 4300MHz, the MAX2044 can be used in either low-side or high-side LO injection architectures for virtually all 2.5GHz and 3.5GHz applications. The LO input is internally matched to 50Ω, 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 MAX2044 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 +32.5dBm, 68dBc, and 8.5dB, respectively.

Differential IF Output

The MAX2044 has a 50MHz to 500MHz IF frequency range, where the low-end frequency depends on the frequency response of the external IF components.

The MAX2044's differential ports are ideal for providing enhanced 2RF - 2LO and 2LO - 2RF performance. Single-ended IF applications require a 1:1 (impedance ratio) balun to transform the 50Ω differential IF impedance to a 50Ω single-ended system. An MABAES0029 1:1 transformer is used to characterize the part and its loss is included in the data presented in this data sheet. The user can connect a differential IF amplifier or SAW filter to 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. Capacitors C4 and C7 are required DC blocks since the IF+ and IF- terminals are internally biased to $V_{CC}/2$.

Applications Information

Input and Output Matching

The RF input provides a 50Ω match when combined with a series DC-blocking capacitor. Use an 8.2pF capacitor value for RF frequencies ranging from 3000MHz to 4000MHz. See Tables 1 and 2 for alternative components that provide an excellent match over the 2300MHz to 3000MHz band. The LO input is internally matched to 50Ω; use a 2pF DC-blocking capacitor to cover operations spanning the 2600MHz to 4300MHz range. The IF output impedance is 50Ω (differential). For evaluation, an external low-loss 1:1 (impedance ratio) balun transforms this impedance down to a 50Ω single-ended output (see the *Typical Application Circuit*).

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Reduced-Power Mode

The MAX2044 has one pin (LOBIAS) that allows an external resistor to set the internal bias current. Nominal values for this resistor are shown in Tables 1 and 2. Larger value resistors can be used to reduce power dissipation at the expense of some performance loss. If ±1% resistors are not readily available, substitute with ±5% resistors.

Significant reductions in power consumption can also be realized by operating the mixer at a supply voltage of 3.3V. Doing so reduces the overall power consumption by typically 42%. 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 trade-offs.

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. The load impedance presented to the mixer must be such that any capacitance from both IF- and IF+ to ground does not exceed several picofarads. 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 V_{CC} pin with the capacitors shown in the *Typical Application Circuit* and see Table 1.

Table 1. Downconverter Mode Component Values

DESIGNATION	QTY	DESCRIPTION	COMPONENT SUPPLIER
C1	1	3.3nH microwave inductor (0402). Use for RF frequencies ranging from **2300MHz to 3000MHz**.	Coilcraft, Inc.
		8.2pF microwave capacitor (0402). Use for RF frequencies ranging from **3000MHz to 4000MHz**.	Murata Electronics North America, Inc.
C2, C6, C8, C11	4	0.01µF microwave capacitors (0402)	Murata Electronics North America, Inc.
C3, C9	0	Not installed, microwave capacitors (0402)	—
C4, C7	2	470pF microwave capacitors (0402)	Murata Electronics North America, Inc.
C5	0	Not installed, microwave capacitor (0402)	—
C10	1	2pF microwave capacitor (0402)	Murata Electronics North America, Inc.
C12	1	0.3pF microwave capacitor (0402). Use for RF frequencies ranging from **2300MHz to 3000MHz**.	Murata Electronics North America, Inc.
	0	Microwave capacitor (0402) not installed for RF frequencies ranging from **3000MHz to 4000MHz**.	—
R1	1	698Ω ±1% resistor (0402). Use for **V_{CC} = +5.0V** applications.	Digi-Key Corp.
		698Ω ±1% resistor (0402). Use for **V_{CC} = +3.3V** applications.	Digi-Key Corp.
T1	1	1:1 IF balun MABAES0029	M/A-Com
U1	1	MAX2044 IC (20 TQFN)	Maxim Integrated Products, Inc.

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Exposed Pad RF/Thermal Considerations

The exposed pad (EP) of the MAX2044's 20-pin thin QFN package provides a low thermal-resistance path to the die. It is important that the PCB on which the MAX2044 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 2. Upconverter Mode Component Values

DESIGNATION	QTY	DESCRIPTION	COMPONENT SUPPLIER
C1	1	3.3nH microwave inductor (0402). Use for RF frequencies ranging from **2300MHz to 3000MHz**.	Coilcraft, Inc.
		8.2pF microwave capacitor (0402). Use for RF frequencies ranging from **3000MHz to 4000MHz**.	Murata Electronics North America, Inc.
C2, C6, C8, C11	4	0.01µF microwave capacitors (0402)	Murata Electronics North America, Inc.
C3, C9	0	Not installed, microwave capacitors (0402)	—
C4, C7	2	470pF microwave capacitors (0402)	Murata Electronics North America, Inc.
C5	0	Not installed, microwave capacitor (0402)	—
C10	1	2pF microwave capacitor (0402)	Murata Electronics North America, Inc.
C12	1	0.3pF microwave capacitor (0402). Use for RF frequencies ranging from **2300MHz to 3000MHz**.	Murata Electronics North America, Inc.
	0	Microwave capacitor (0402) not installed for RF frequencies ranging from **3000MHz to 4000MHz**.	—
R1	1	698Ω ±1% resistor (0402). Use for V_{CC} **= +5.0V** applications.	Digi-Key Corp.
		698Ω ±1% resistor (0402). Use for V_{CC} **= +3.3V** applications.	Digi-Key Corp.
T1	1	1:1 IF balun MABAES0029	M/A-Com
U1	1	MAX2044 IC (20 TQFN)	Maxim Integrated Products, Inc.

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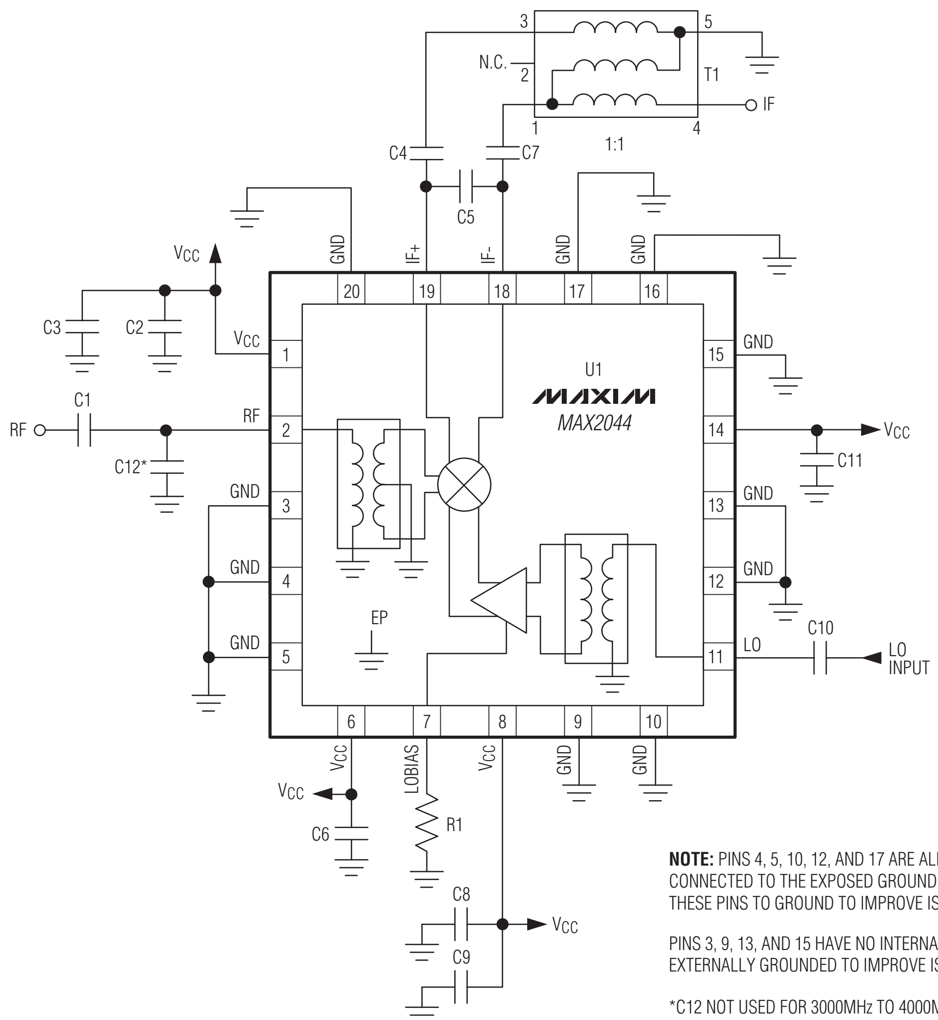
Typical Application Circuit



NOTE: PINS 4, 5, 10, 12, AND 17 ARE ALL INTERNALLY CONNECTED TO THE EXPOSED GROUND PAD. CONNECT THESE PINS TO GROUND TO IMPROVE ISOLATION.

PINS 3, 9, 13, AND 15 HAVE NO INTERNAL CONNECTION, BUT CAN BE EXTERNALLY GROUNDED TO IMPROVE ISOLATION.

*C12 NOT USED FOR 3000MHz TO 4000MHz APPLICATIONS.

Chip Information

PROCESS: SiGe BiCMOS

Package Information

For the latest package outline information and land patterns, go to **www.maxim-ic.com/packages**. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

PACKAGE TYPE	PACKAGE CODE	DOCUMENT NO.
20 TQFN-EP	T2055+3	21-0140