19-4679; Rev 0; 8/09

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/downconverters 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°C to +85°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

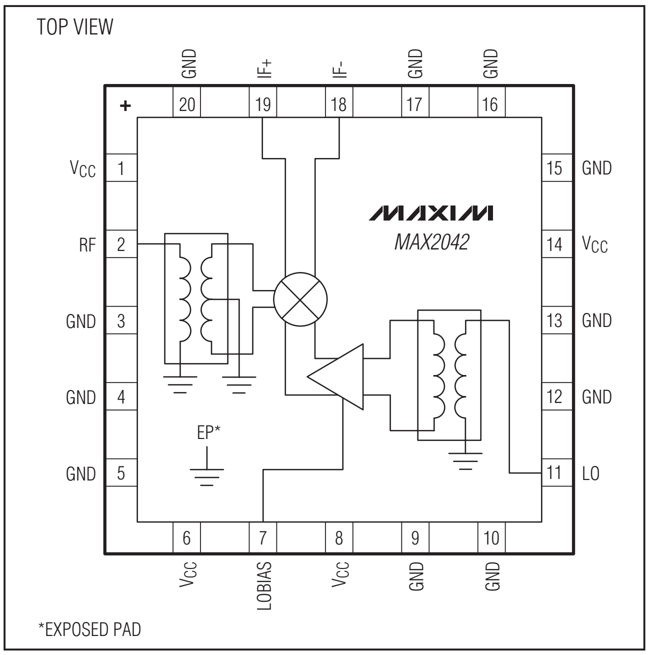
PART	TEMP RANGE	PIN-PACKAGE
MAX2042ETP+	-40°C to +85°C	20 Thin QFN-EP*
MAX2042ETP+T	-40°C to +85°C	20 Thin QFN-EP*

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

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 P_{RF} = -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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SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

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 are DC shorted to GND through a balun).....................50mA
Continuous Power Dissipation (Note 1) 5.0W
θ_{JA} (Notes 2, 3)........................ +38°C/W
θ_{JC} (Notes 1, 3)........................ +13°C/W
Operating Case Temperature Range (Note 4)..................... -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 AC 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	150	mA

+3.3V SUPPLY DC ELECTRICAL CHARACTERISTICS

(*Typical Application Circuit*, V_{CC} = +3.0V to +3.6V, no input AC signals. T_C = -40°C to +85°C, unless otherwise noted. Typical values are at V_{CC} = +3.3V, T_C = +25°C, all parameters are production tested.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage	V_{CC}		3.0	3.3	3.6	V
Supply Current	I_{CC}			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_{LO}	(Notes 5, 6)	1800		2800	MHz
IF Frequency	f_{IF}	Using M/A-Com MABAES0029 1:1 transformer as defined in the *Typical Application Circuit*, IF matching components affect the IF frequency range (Notes 5, 6)	50		500	MHz
LO Drive	P_{LO}	(Notes 5, 6)	-3	0	+3	dBm

+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 50Ω 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°C to +85°C. Typical values are for T_C = +25°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	L_C	f_{RF} = 2300MHz to 2900MHz, T_C = +25°C (Note 8)	6.7	7.2	8.1	dB
Loss Variation vs. Frequency	ΔL_C	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	TC_{CL}	T_C = -40°C to +85°C		0.0071		dB/°C
Single Sideband Noise Figure	NF_{SSB}	No blockers present		7.3		dB
Noise Figure Temperature Coefficient	TC_{NF}	f_{RF} = 2300MHz to 2900MHz, single side-band, no blockers present, T_C = -40°C to +85°C		0.019		dB/°C
Noise Figure Under Blocking	NF_B	+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°C (Notes 5, 9)		20.8	25	dB
Input 1dB Compression Point	IP_{1dB}	T_C = +25°C (Notes 5, 10); f_{RF} = 2300MHz	22.5	23.4		dBm
		T_C = +25°C (Notes 5, 10); f_{RF} = 2600MHz	20.6	22.1		
		T_C = +25°C (Notes 5, 10); f_{RF} = 2900MHz	17.6	20.7		
Third-Order Input Intercept Point	IIP3	$P_{RF1} = P_{RF2}$ = 0dBm/tone, P_{LO} = 0dBm, T_C = +25°C; f_{RF1} = 2300MHz, f_{RF2} = 2301MHz, f_{LO} = 2000MHz (Note 5)	34	36		dBm
		$P_{RF1} = P_{RF2}$ = 0dBm/tone, P_{LO} = 0dBm, T_C = +25°C; f_{RF1} = 2600MHz, f_{RF2} = 2601MHz, f_{LO} = 2300MHz (Note 8)	31	34		
		$P_{RF1} = P_{RF2}$ = 0dBm/tone, P_{LO} = 0dBm, T_C = +25°C; 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, $P_{RF1} = P_{RF2}$ = 0dBm/tone, T_C = -40°C to +85°C		±0.5		dB
2RF - 2LO Spur Rejection	2 x 2	$f_{SPUR} = f_{LO}$ + 150MHz (Note 5); P_{RF} = -10dBm	64	70		dBc
		$f_{SPUR} = f_{LO}$ + 150MHz (Note 5); P_{RF} = 0dBm	54	60		
3RF - 3LO Spur Rejection	3 x 3	$f_{SPUR} = f_{LO}$ + 100MHz (Note 5); P_{RF} = -10dBm	80	92		dBc
		$f_{SPUR} = f_{LO}$ + 100MHz (Note 5); P_{RF} = 0dBm	60	72		
RF Input Return Loss	RL_{RF}	LO on and IF terminated into a matched impedance		17		dB
LO Input Return Loss	RL_{LO}	RF and IF terminated into a matched impedance		15		dB

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

+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 50Ω 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°C to +85°C. Typical values are for T_C = +25°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		Ω
IF Output Return Loss	RL_{IF}	RF terminated into 50Ω, LO driven by 50Ω source, IF transformed to 50Ω using external components shown in the *Typical Application Circuit*		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 50Ω sources. Typical values are for T_C = +25°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	ΔL_C	f_{RF} = 2300MHz to 2900MHz, any 100MHz band		0.2		dB
Conversion Loss Temperature Coefficient	TC_{CL}	T_C = -40°C to +85°C		0.008		dB/°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°C to +85°C		0.019		dB/°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°C to +85°C		±0.25		dB
2RF - 2LO Spur Rejection	2 x 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 x 3	P_{RF} = -10dBm, f_{SPUR} = f_{LO} + 100MHz		87		dBc
		P_{RF} = 0dBm, f_{SPUR} = f_{LO} + 100MHz		67		

+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°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
RF Input Return Loss	RL_{RF}	LO on and IF terminated into a matched impedance		15		dB
LO Input Return Loss	RL_{LO}	RF and IF terminated into a matched impedance		12		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 50Ω source, IF transformed to 50Ω using external components shown in the *Typical Application Circuit*		18		dB
Minimum RF-to-IF Isolation		f_{RF} = 2300MHz to 2900MHz, P_{LO} = +3dBm		36		dB
Maximum LO Leakage at RF Port		f_{LO} = 1800MHz to 2800MHz, P_{LO} = +3dBm		-24.5		dBm
Maximum 2LO Leakage at RF Port		f_{LO} = 1800MHz to 2800MHz, P_{LO} = +3dBm		-24		dBm
Maximum LO Leakage at IF Port		f_{LO} = 1800MHz to 2800MHz, P_{LO} = +3dBm		-20		dBm

+5.0V SUPPLY AC ELECTRICAL CHARACTERISTICS (UPCONVERTER OPERATION)

(*Typical Application Circuit* with tuning elements outlined in **Table 2**, V_{CC} = +4.75V to +5.25V, RF and LO ports are driven from 50Ω sources, P_{LO} = -3dBm to +3dBm, P_{IF} = 0dBm, f_{RF} = 2300MHz to 2900MHz, f_{IF} =200MHz, f_{LO} = 2100MHz to 2700MHz, f_{RF} > f_{LO}, T_C = -40°C to +85°C. Typical values are for T_C = +25°C, V_{CC} = +5.0V, P_{IF} = 0dBm, P_{LO} = 0dBm, f_{RF} = 2600MHz, f_{LO} = 2400MHz, f_{IF} = 200MHz. 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_C	(Note 8)		6.8		dB
Loss Variation vs. Frequency	ΔL_C	f_{RF} = 2300MHz to 2960MHz, any 100MHz band		0.2		dB
Conversion Loss Temperature Coefficient	TC_{CL}	T_C = -40°C to +85°C		0.007		dB/°C
Input 1dB Compression Point	IP_{1dB}	(Note 10)		22.7		dBm
Third-Order Input Intercept Point	IIP3	f_{IF1} = 200MHz, f_{IF2} = 201MHz, P_{IF1} = P_{IF2} = 0dBm/tone, f_{LO} = 2400MHz, P_{LO} = 0dBm, T_C = +25°C (Note 8)	30	32.4		dBm
IIP3 Variation with T_C		f_{IF1} = 200MHz, f_{IF2} = 201MHz, P_{IF1} = P_{IF2} = 0dBm/tone, f_{LO} = 2400MHz, P_{LO} = 0dBm, T_C = -40°C to +85°C		±0.5		dB
LO ± 2IF Spur Rejection	1 x 2	LO - 2IF		70		dBc
		LO + 2IF		67		
LO ± 3IF Spur Rejection	1 x 3	LO - 3IF		82		dBc
		LO + 3IF		77		
Output Noise Floor		P_{OUT} = 0dBm (Note 9)		-163		dBm/Hz

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

+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_C = +25°C, V_{CC} = +3.3V, P_{IF} = 0dBm, P_{LO} = 0dBm, f_{RF} = 2600MHz, f_{LO} = 2400MHz, f_{IF} = 200MHz, unless otherwise noted.) (Note 7)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small-Signal Conversion Loss	L_C			6.8		dB
Loss Variation vs. Frequency	ΔL_C	f_{RF} = 2300MHz to 2900MHz, any 100MHz band		0.15		dB
Conversion Loss Temperature Coefficient	TC_{CL}	T_C = -40°C to +85°C		0.008		dB/°C
Input 1dB Compression Point	IP_{1dB}	(Note 10)		19		dBm
Third-Order Input Intercept Point	IIP3	f_{IF1} = 200MHz, f_{IF2} = 201MHz, P_{IF1} = P_{IF2} = 0dBm/tone		29.5		dBm
IIP3 Variation with T_C		f_{IF1} = 200MHz, f_{IF2} = 201MHz, P_{IF1} = P_{IF2} = 0dBm/tone, f_{LO} = 2400MHz, P_{LO} = 0dBm, T_C = -40°C to +85°C		±0.75		dB
LO ± 2IF Spur Rejection	1 x 2	LO - 2IF		72		dBc
		LO + 2IF		70		
LO ± 3IF Spur Rejection	1 x 3	LO - 3IF		73		dBc
		LO + 3IF		70		
Output Noise Floor		P_{OUT} = 0dBm (Note 9)		-160		dBm/Hz

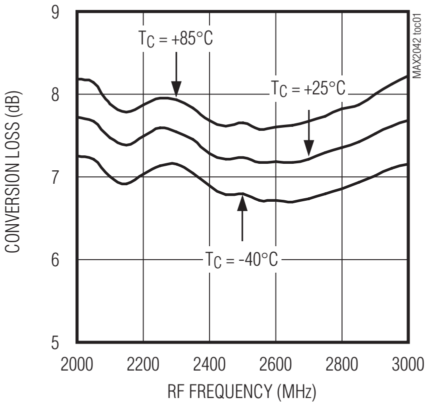
Note 5: Not production tested.
Note 6: Operation outside this range is possible, but with degraded performance of some parameters. See the *Typical Operating Characteristics*.
Note 7: All limits reflect losses of external components, including a 0.5dB loss at f_{IF} = 300MHz due to the 1:1 impedance 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.

Typical Operating Characteristics

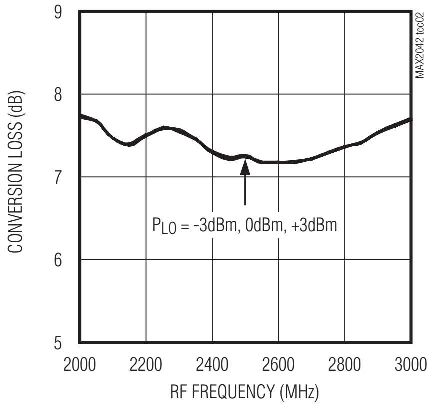
(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = +5.0V**, $f_{RF} > f_{LO}$, f_{IF} = 300MHz, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

+5.0V Downconverter Curves

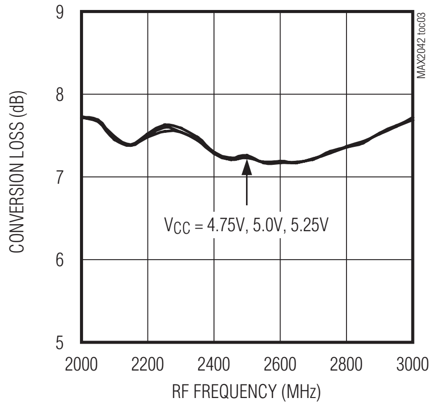
CONVERSION LOSS vs. RF FREQUENCY



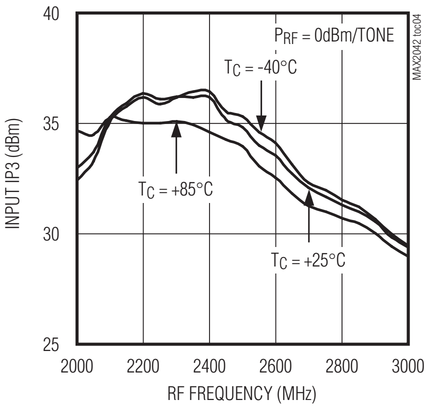
CONVERSION LOSS vs. RF FREQUENCY



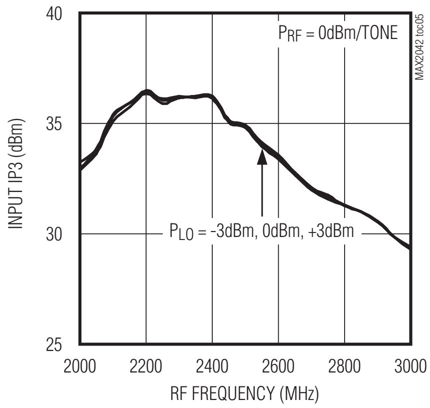
CONVERSION LOSS vs. RF FREQUENCY



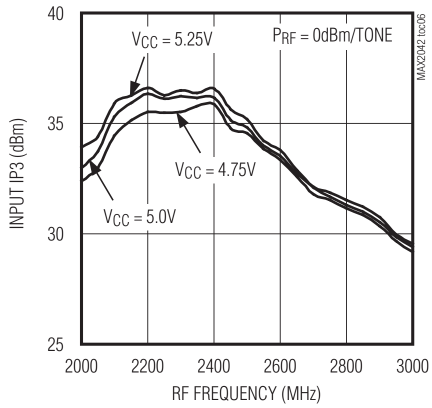
INPUT IP3 vs. RF FREQUENCY



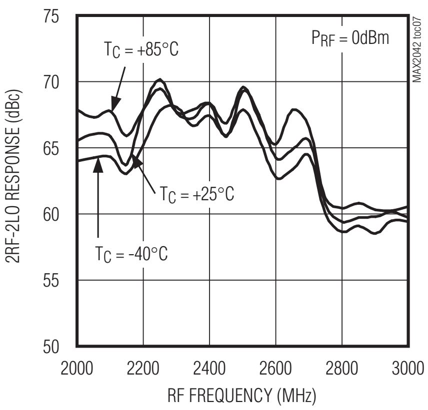
INPUT IP3 vs. RF FREQUENCY



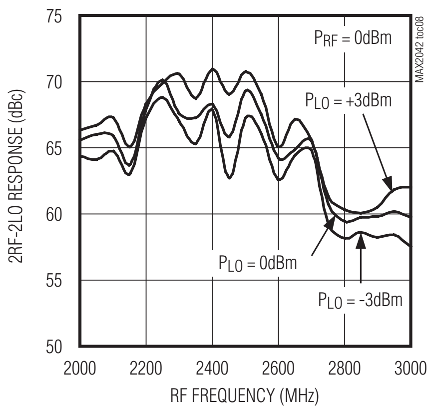
INPUT IP3 vs. RF FREQUENCY



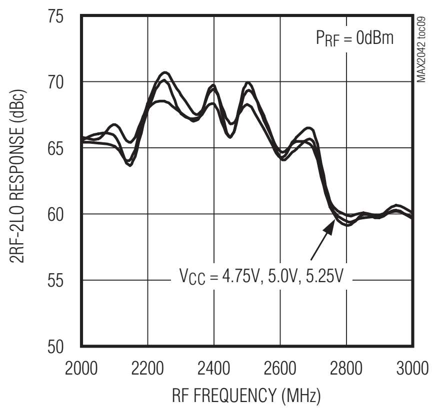
2RF-2LO RESPONSE vs. RF FREQUENCY



2RF-2LO RESPONSE vs. RF FREQUENCY



2RF-2LO RESPONSE vs. RF FREQUENCY



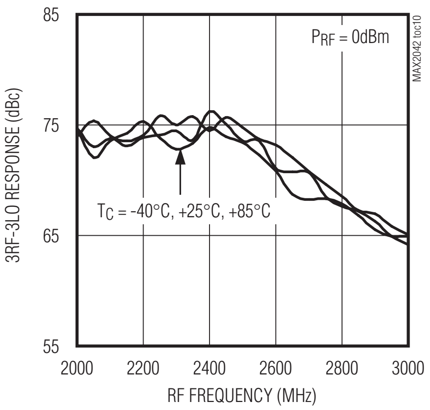
SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

Typical Operating Characteristics (continued)

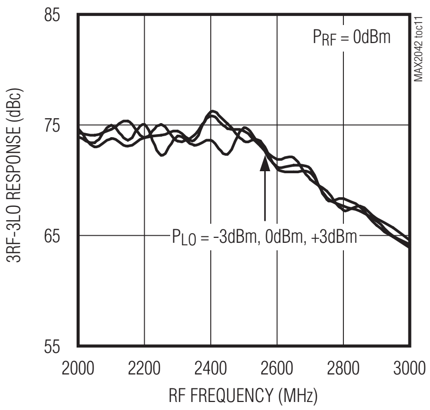
(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = +5.0V**, $f_{RF} > f_{LO}$, f_{IF} = 300MHz, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

+5.0V Downconverter Curves

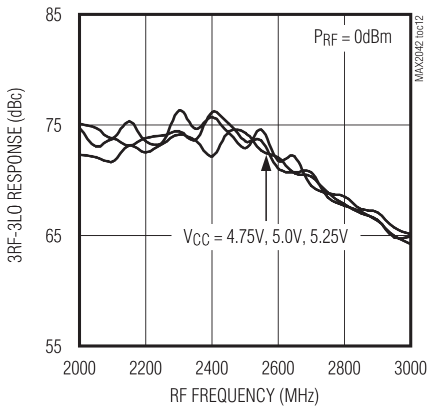
3RF-3LO RESPONSE vs. RF FREQUENCY



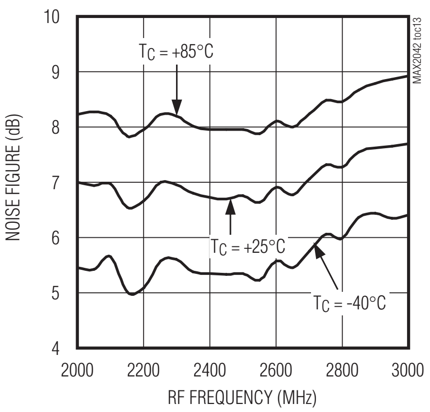
3RF-3LO RESPONSE vs. RF FREQUENCY



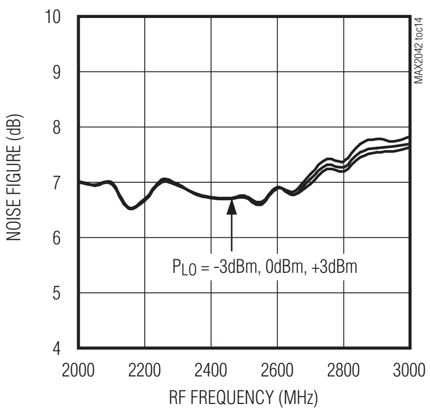
3RF-3LO RESPONSE vs. RF FREQUENCY



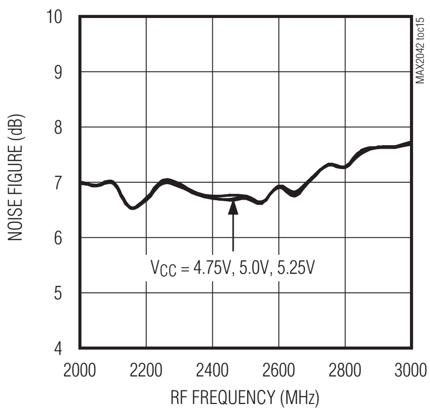
NOISE FIGURE vs. RF FREQUENCY



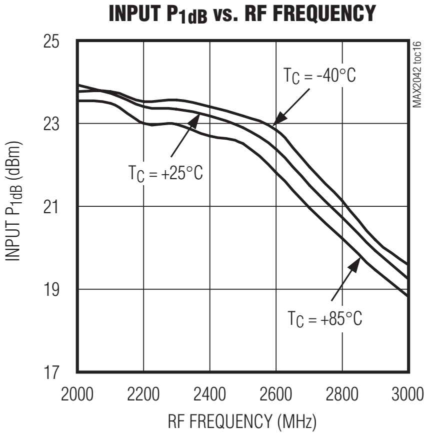
NOISE FIGURE vs. RF FREQUENCY



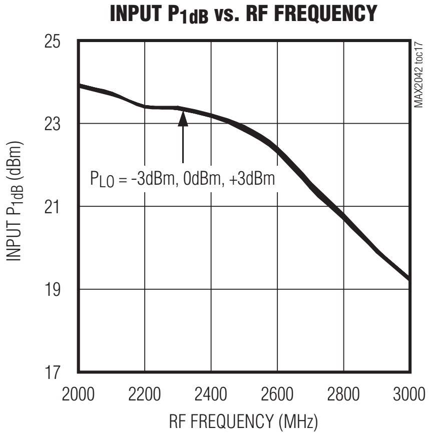
NOISE FIGURE vs. RF FREQUENCY



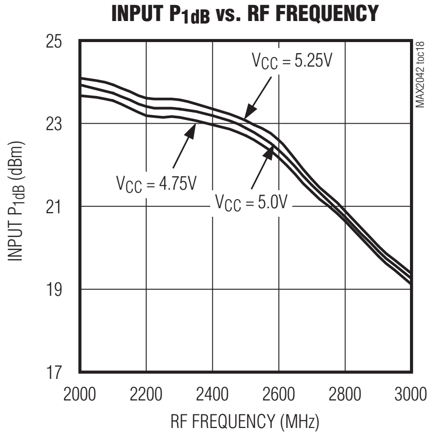
INPUT P_{1dB} vs. RF FREQUENCY



INPUT P_{1dB} vs. RF FREQUENCY



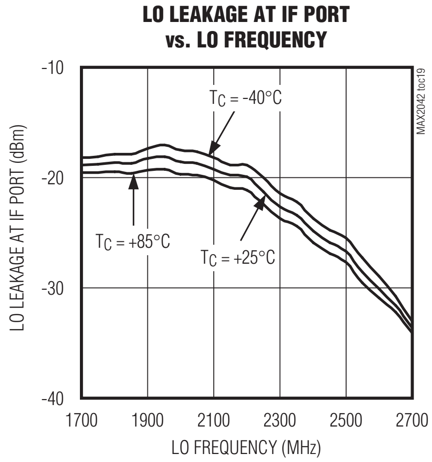
INPUT P_{1dB} vs. RF FREQUENCY

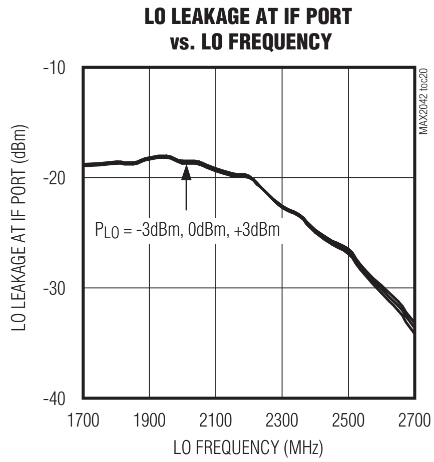


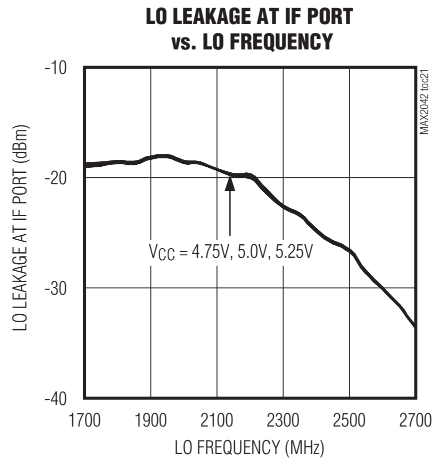
Typical Operating Characteristics (continued)

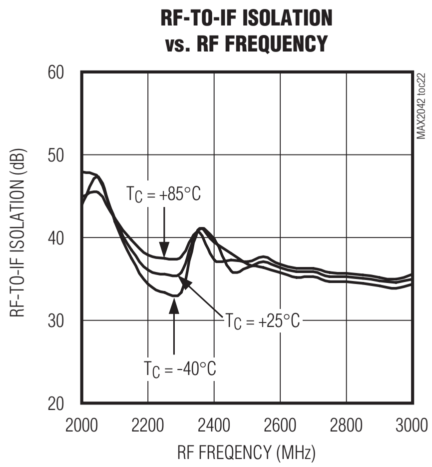
(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = +5.0V**, $f_{RF} > f_{LO}$, f_{IF} = 300MHz, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

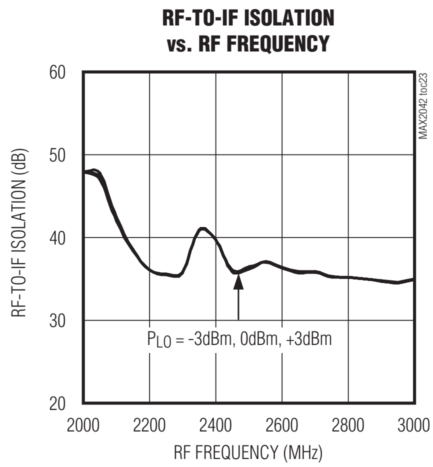
+5.0V Downconverter Curves

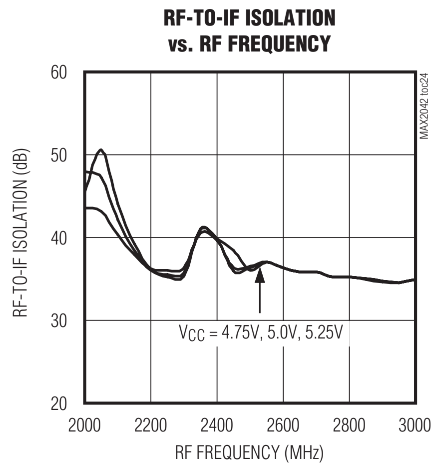


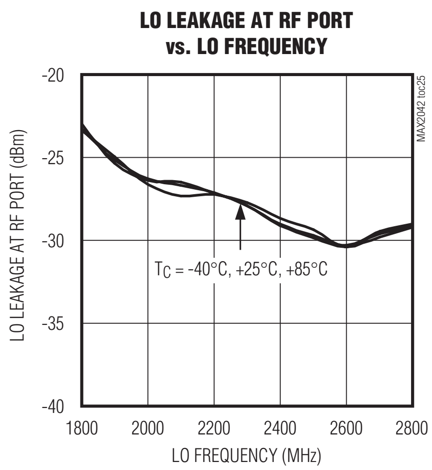


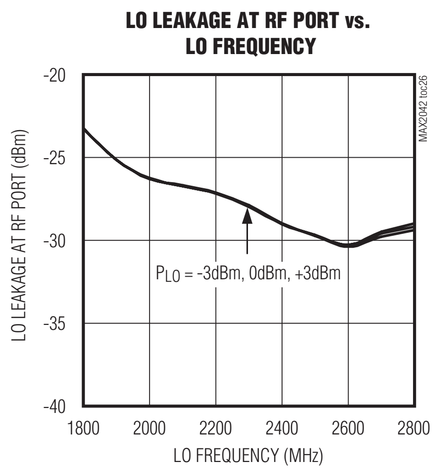


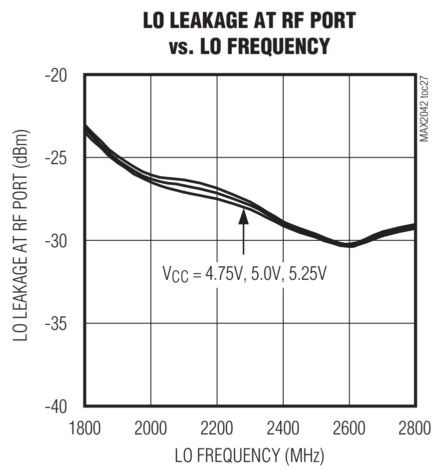












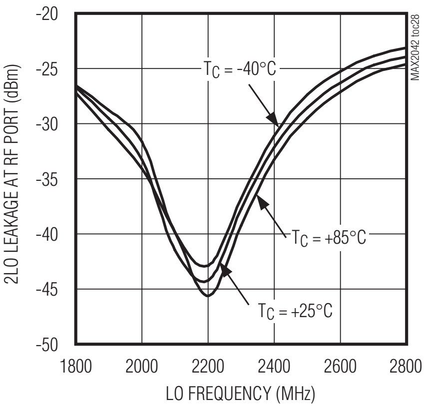
SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

Typical Operating Characteristics (continued)

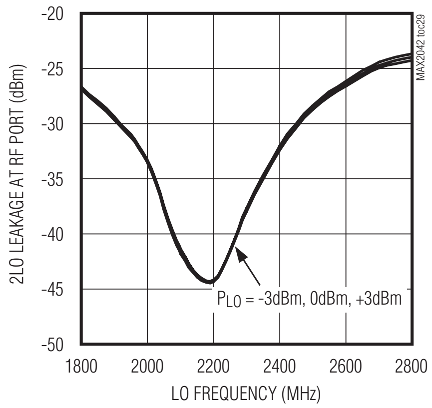
(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = +5.0V**, $f_{RF} > f_{LO}$, f_{IF} = 300MHz, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

+5.0V Downconverter Curves

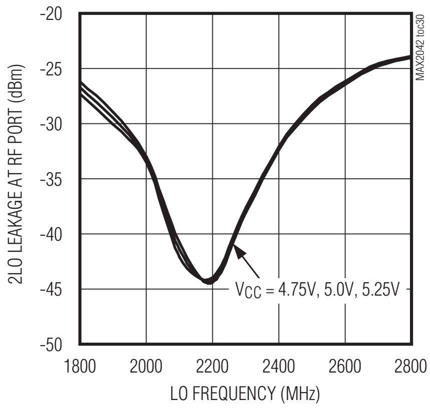
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



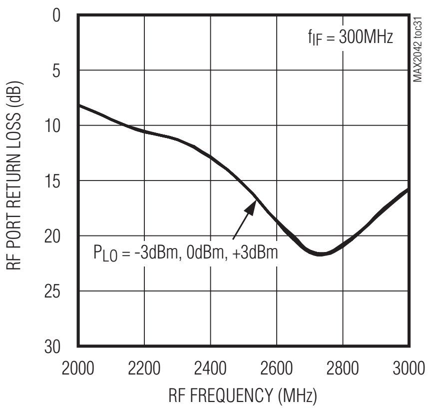
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



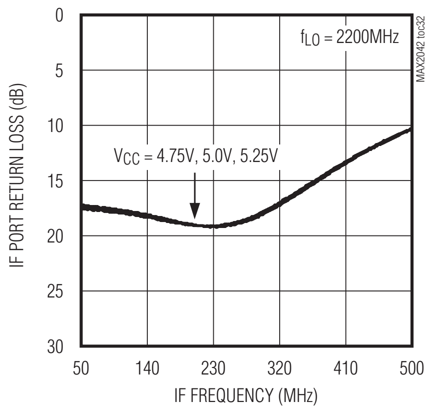
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



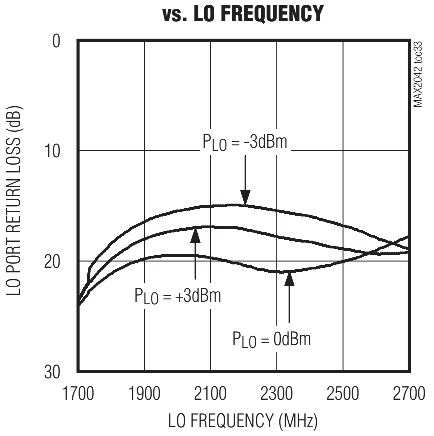
RF PORT RETURN LOSS vs. RF FREQUENCY



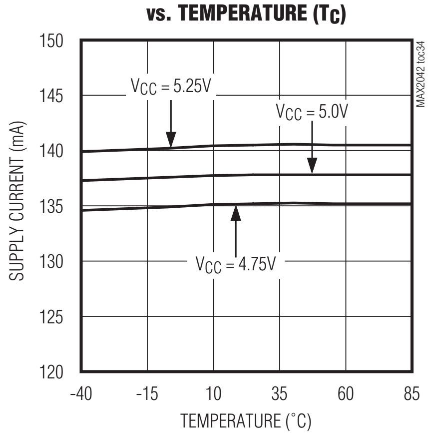
IF PORT RETURN LOSS vs. IF FREQUENCY



LO PORT RETURN LOSS vs. LO FREQUENCY



SUPPLY CURRENT vs. TEMPERATURE (T_C)

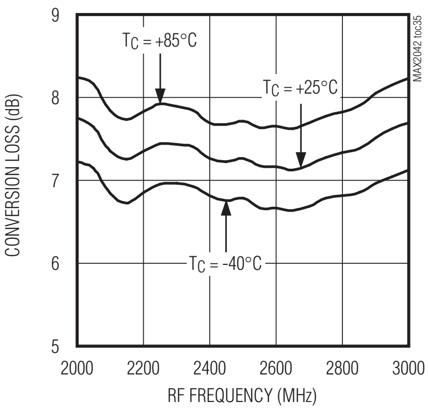


Typical Operating Characteristics (continued)

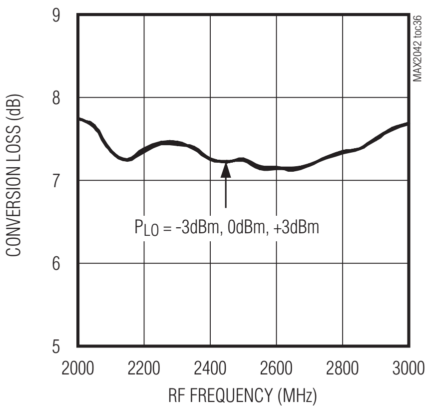
(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = +3.3V**, $f_{RF} > f_{LO}$, f_{IF} = 300MHz, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

+3.3V Downconverter Curves

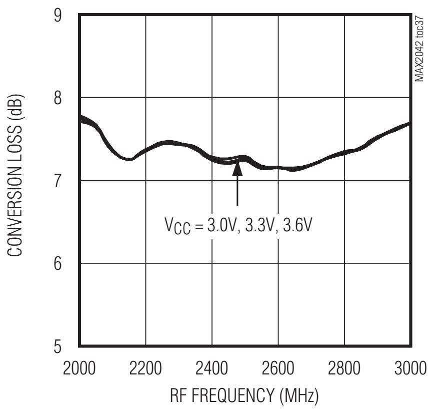
CONVERSION LOSS vs. RF FREQUENCY



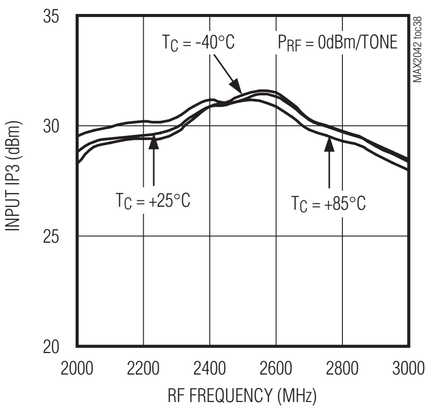
CONVERSION LOSS vs. RF FREQUENCY



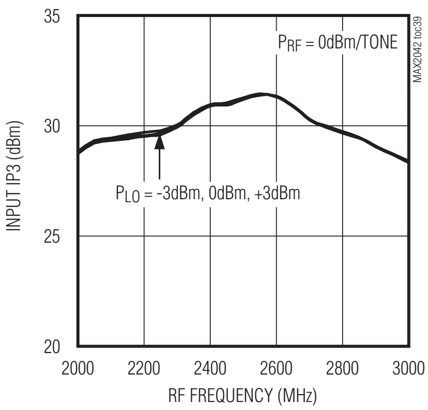
CONVERSION LOSS vs. RF FREQUENCY



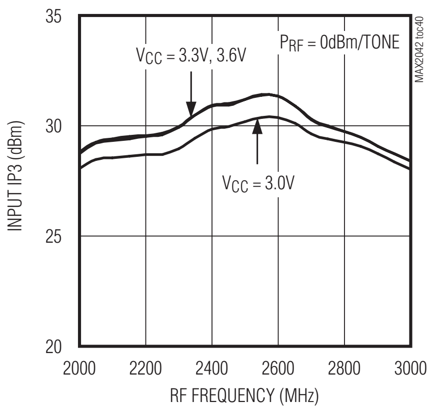
INPUT IP3 vs. RF FREQUENCY



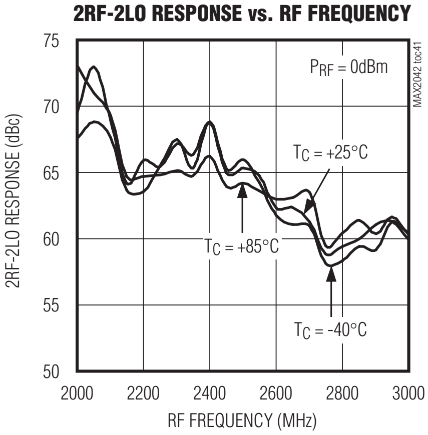
INPUT IP3 vs. RF FREQUENCY



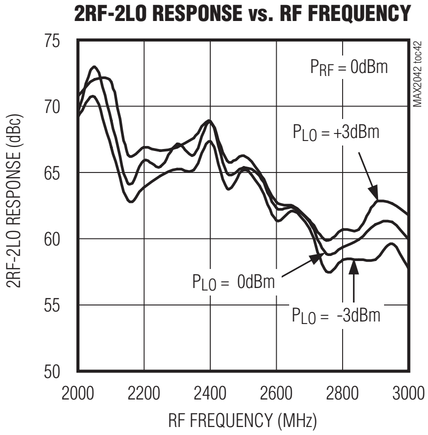
INPUT IP3 vs. RF FREQUENCY



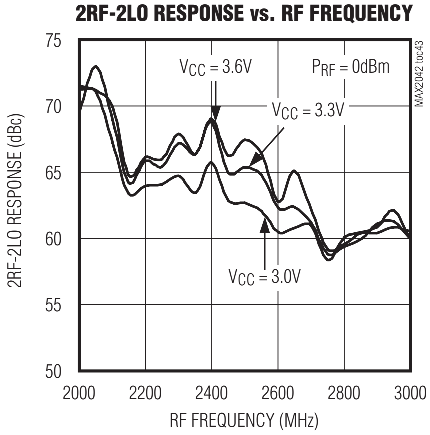
2RF-2LO RESPONSE vs. RF FREQUENCY



2RF-2LO RESPONSE vs. RF FREQUENCY



2RF-2LO RESPONSE vs. RF FREQUENCY



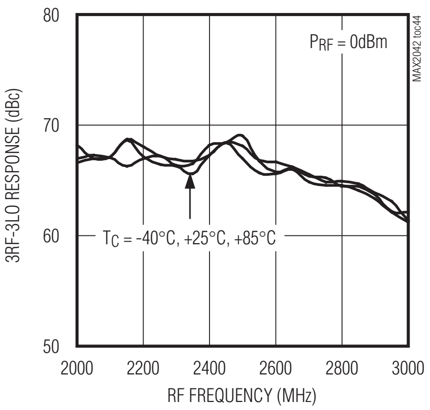
SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

Typical Operating Characteristics (continued)

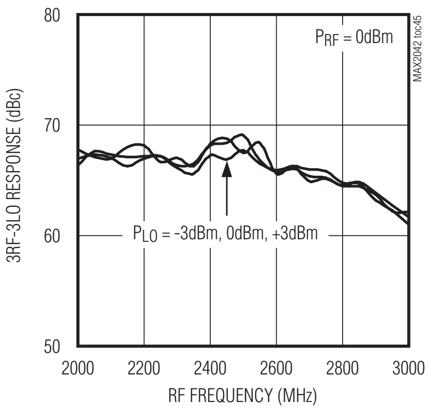
(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = +3.3V**, $f_{RF} > f_{LO}$, f_{IF} = 300MHz, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

+3.3V Downconverter Curves

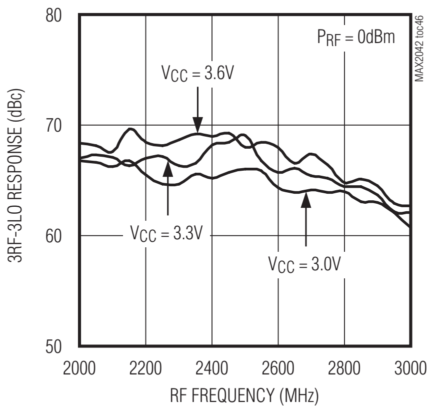
3RF-3LO RESPONSE vs. RF FREQUENCY



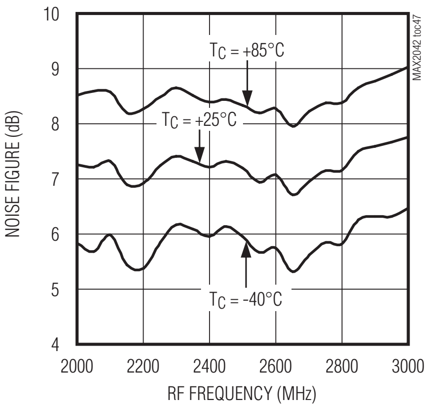
3RF-3LO RESPONSE vs. RF FREQUENCY



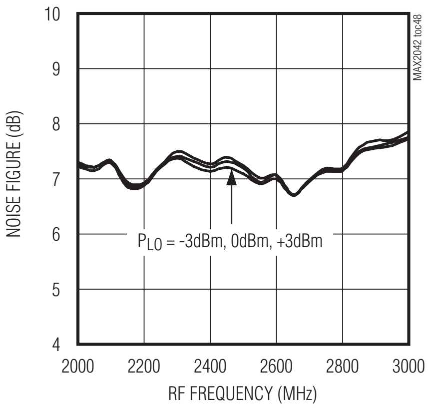
3RF-3LO RESPONSE vs. RF FREQUENCY



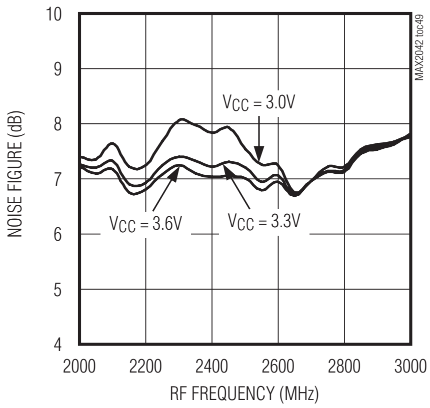
NOISE FIGURE vs. RF FREQUENCY



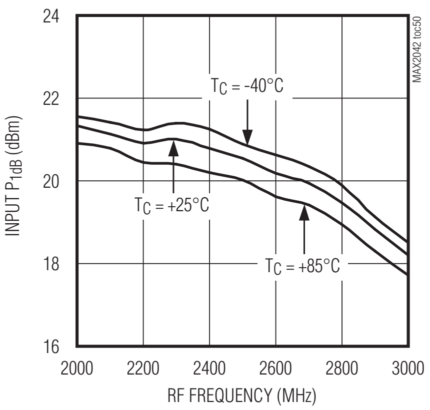
NOISE FIGURE vs. RF FREQUENCY



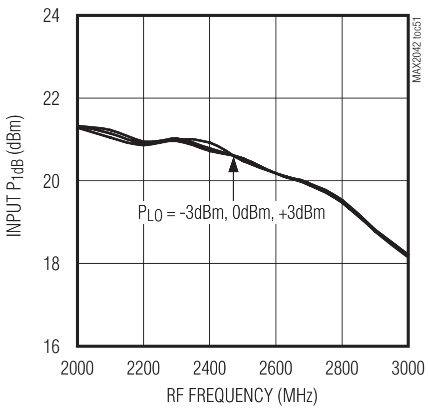
NOISE FIGURE vs. RF FREQUENCY



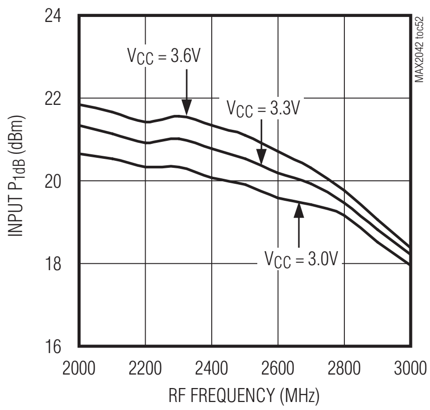
INPUT P_{1dB} vs. RF FREQUENCY



INPUT P_{1dB} vs. FREQUENCY



INPUT P_{1dB} vs. FREQUENCY

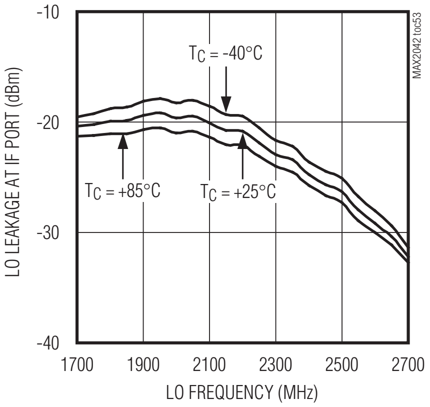


Typical Operating Characteristics (continued)

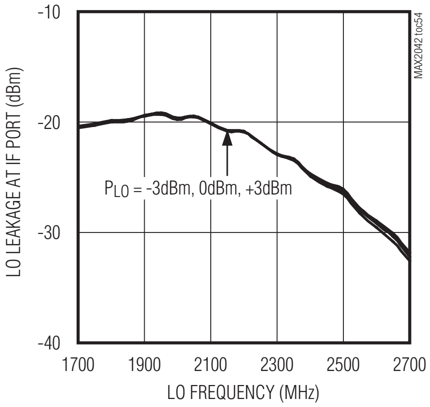
(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = +3.3V**, $f_{RF} > f_{LO}$, f_{IF} = 300MHz, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

+3.3V Downconverter Curves

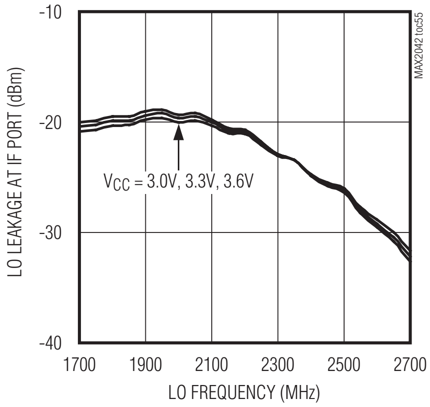
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



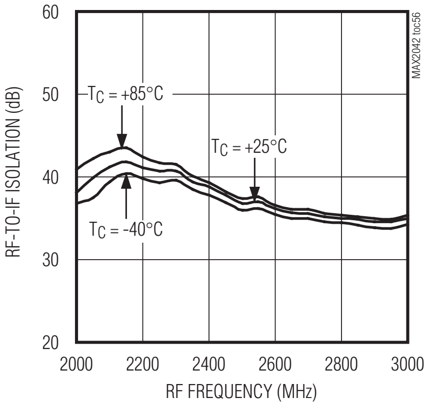
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



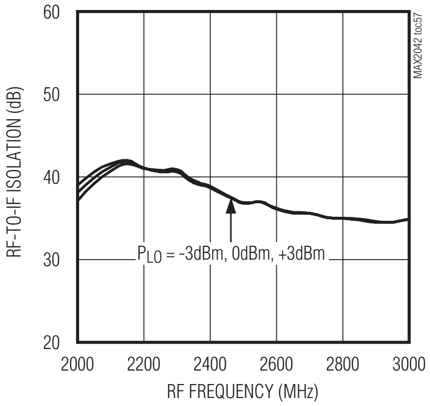
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



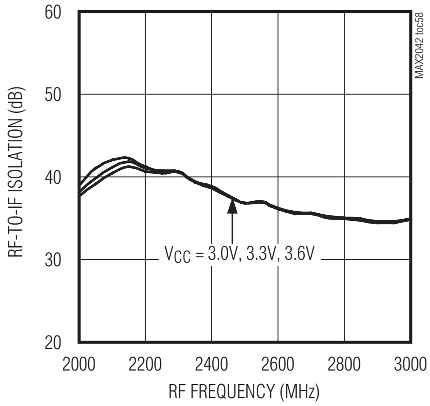
RF-TO-IF ISOLATION vs. RF FREQUENCY



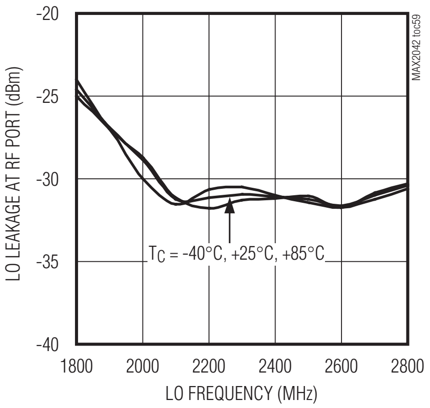
RF-TO-IF ISOLATION vs. RF FREQUENCY



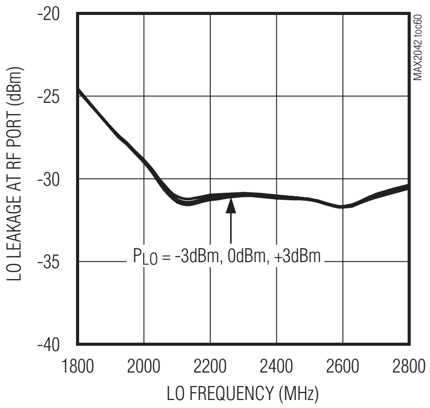
RF-TO-IF ISOLATION vs. RF FREQUENCY



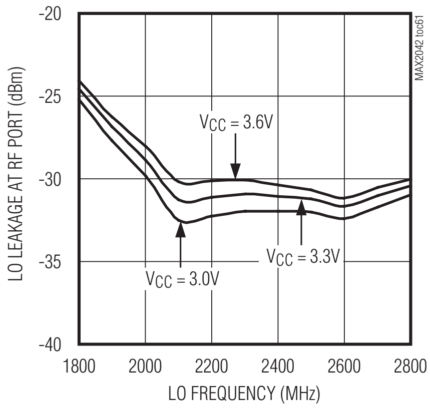
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



LO LEAKAGE AT RF PORT vs. LO FREQUENCY



LO LEAKAGE AT RF PORT vs. LO FREQUENCY



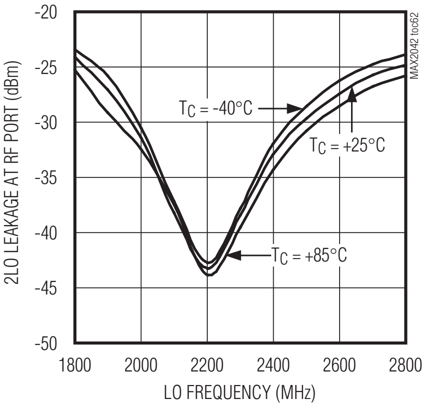
SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

Typical Operating Characteristics (continued)

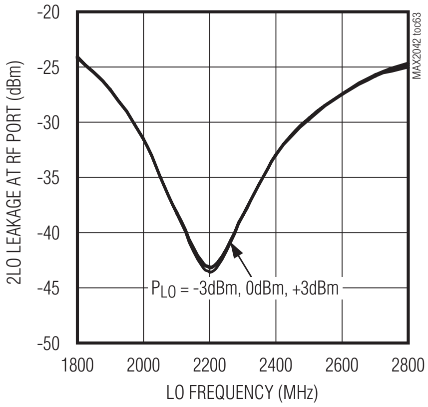
(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = +3.3V**, $f_{RF} > f_{LO}$, f_{IF} = 300MHz, P_{RF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

+3.3V Downconverter Curves

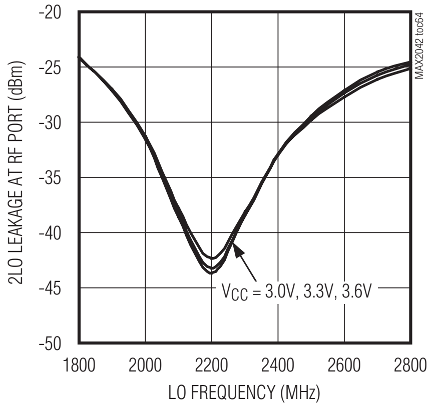
2LO LEAKAGE AT RF PORT vs. FREQUENCY



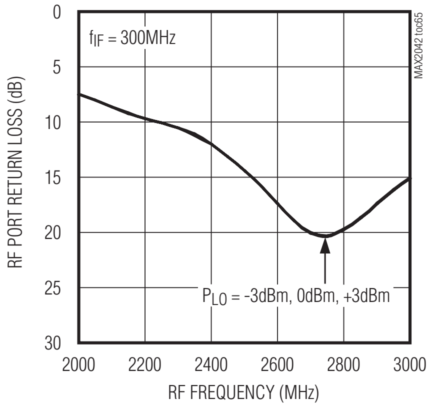
2LO LEAKAGE AT RF PORT vs. FREQUENCY



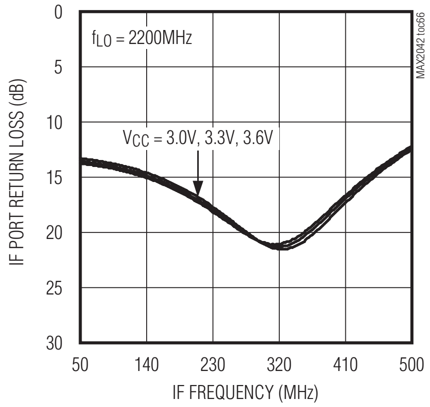
2LO LEAKAGE AT RF PORT vs. FREQUENCY



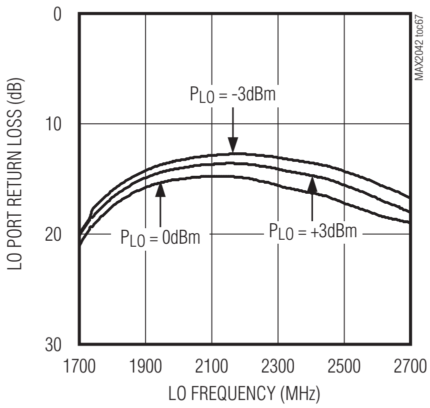
RF PORT RETURN LOSS vs. RF FREQUENCY



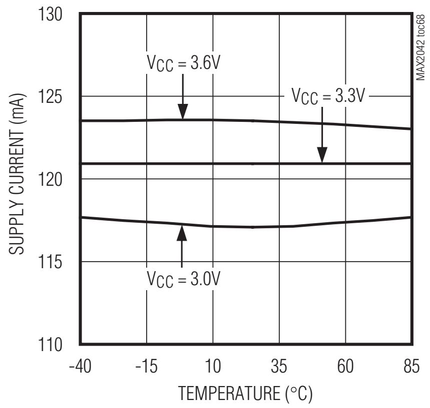
IF PORT RETURN LOSS vs. IF FREQUENCY



LO PORT RETURN LOSS vs. LO FREQUENCY



SUPPLY CURRENT vs. TEMPERATURE



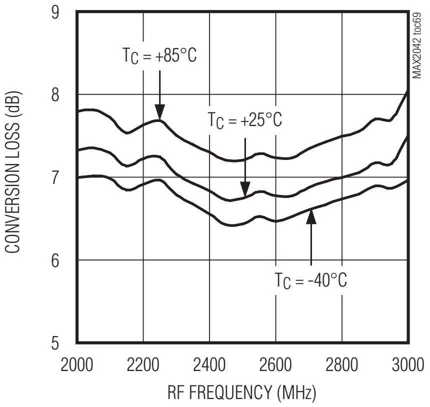
SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

Typical Operating Characteristics (continued)

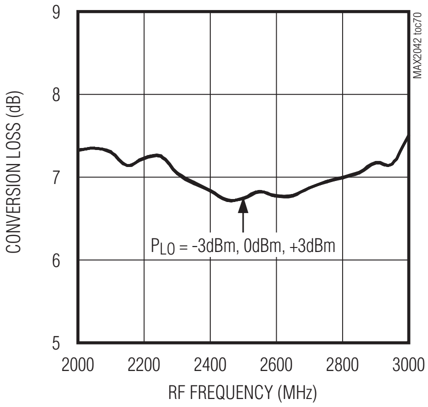
(*Typical Application Circuit* with tuning elements outlined in **Table 2, V_{CC} = +5.0V**, $f_{RF} = f_{LO} + f_{IF}$, f_{IF} = 200MHz, P_{IF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

+5.0V Upconverter Curves

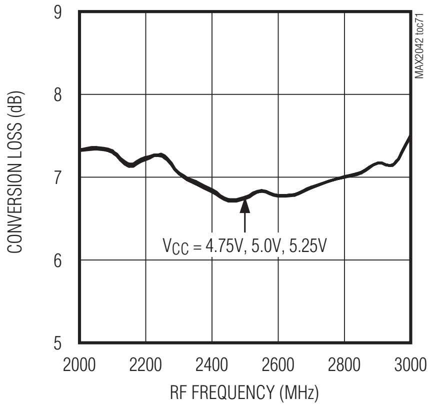
CONVERSION LOSS vs. RF FREQUENCY



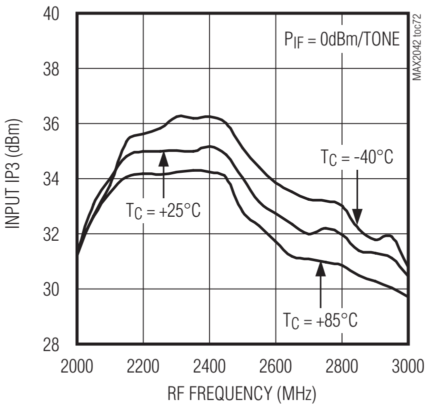
CONVERSION LOSS vs. RF FREQUENCY



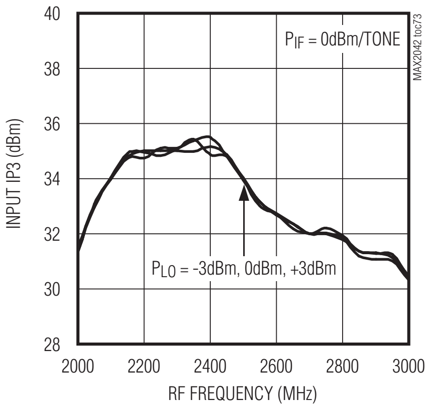
CONVERSION LOSS vs. RF FREQUENCY



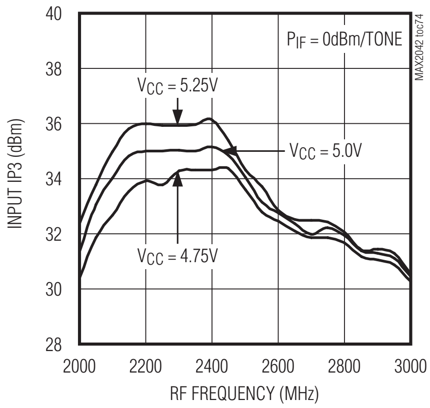
INPUT IP3 vs. RF FREQUENCY



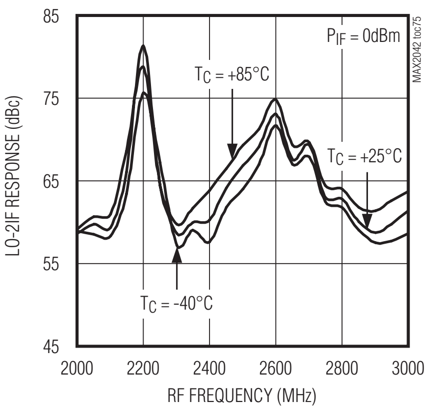
INPUT IP3 vs. RF FREQUENCY



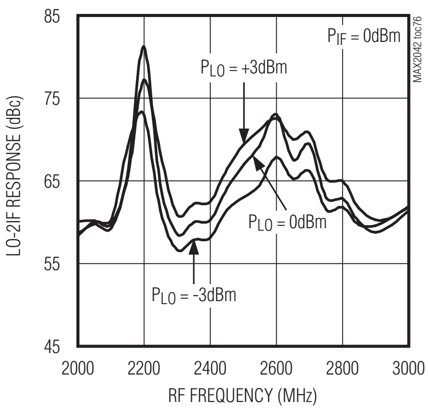
INPUT IP3 vs. RF FREQUENCY



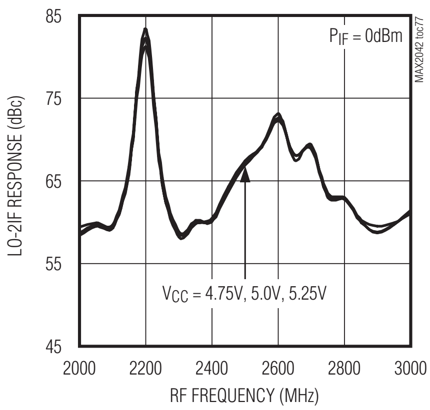
LO-2IF RESPONSE vs. RF FREQUENCY



LO-2IF RESPONSE vs. RF FREQUENCY



LO-2IF RESPONSE vs. RF FREQUENCY



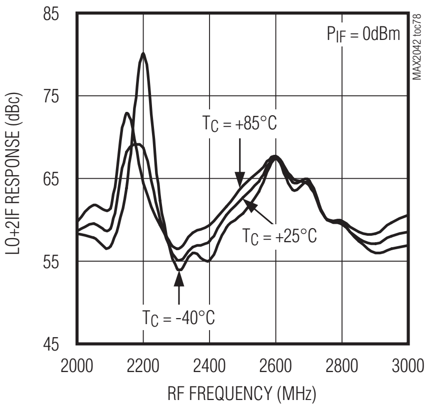
SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

Typical Operating Characteristics (continued)

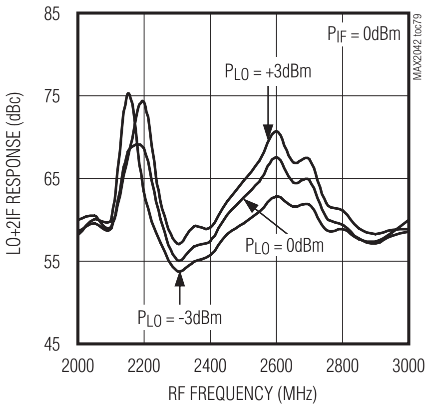
(*Typical Application Circuit* with tuning elements outlined in **Table 2, V_{CC} = +5.0V**, $f_{RF} = f_{LO} + f_{IF}$, f_{IF} = 200MHz, P_{IF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

+5.0V Upconverter Curves

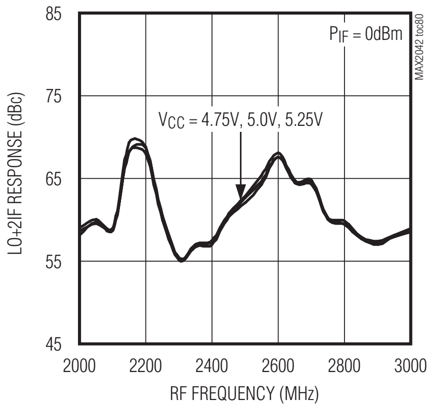
LO+2IF RESPONSE vs. RF FREQUENCY



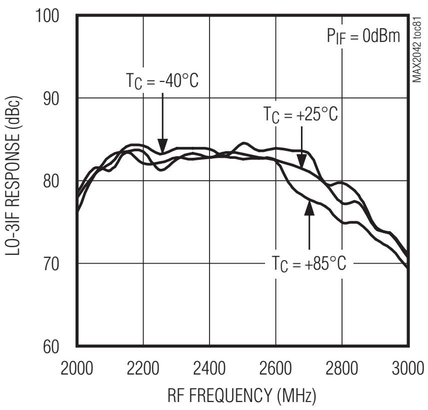
LO+2IF RESPONSE vs. RF FREQUENCY



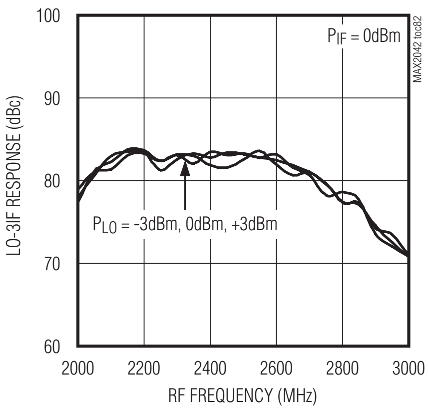
LO+2IF RESPONSE vs. RF FREQUENCY



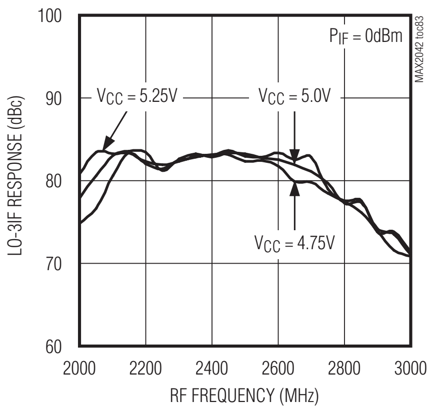
LO-3IF RESPONSE vs. RF FREQUENCY



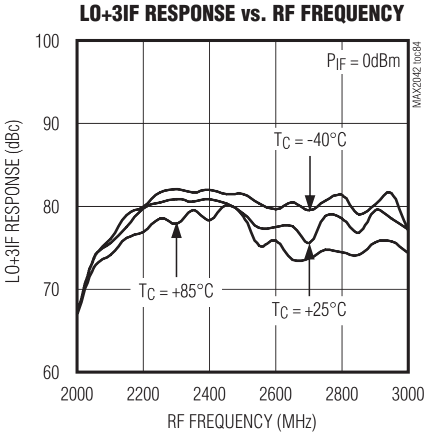
LO-3IF RESPONSE vs. RF FREQUENCY



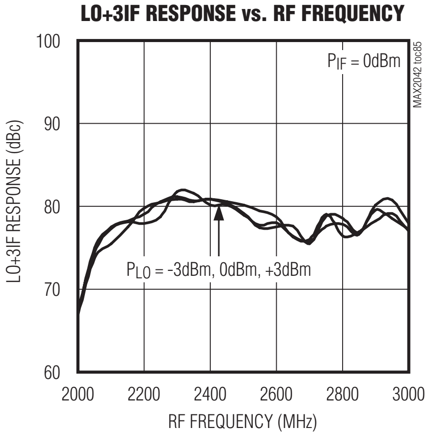
LO-3IF RESPONSE vs. RF FREQUENCY



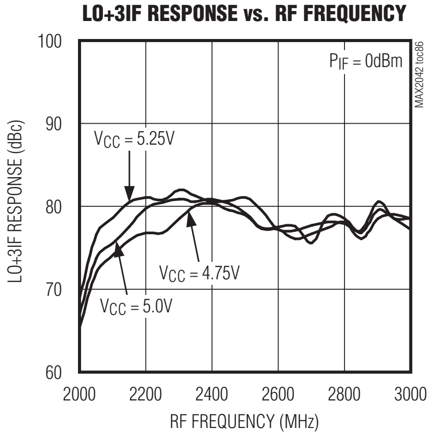
LO+3IF RESPONSE vs. RF FREQUENCY



LO+3IF RESPONSE vs. RF FREQUENCY



LO+3IF RESPONSE vs. RF FREQUENCY

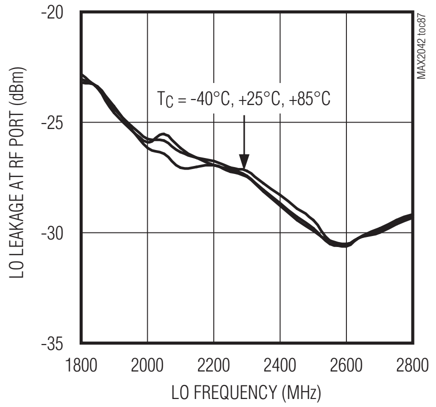


Typical Operating Characteristics (continued)

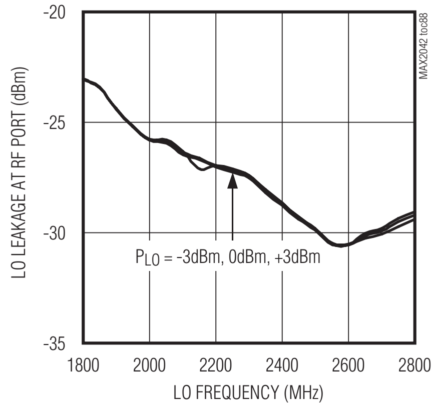
(*Typical Application Circuit* with tuning elements outlined in **Table 2, V_{CC} = +5.0V**, $f_{RF} = f_{LO} + f_{IF}$, f_{IF} = 200MHz, P_{IF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

+5.0V Upconverter Curves

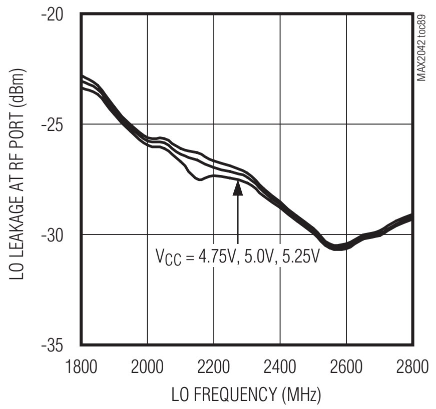
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



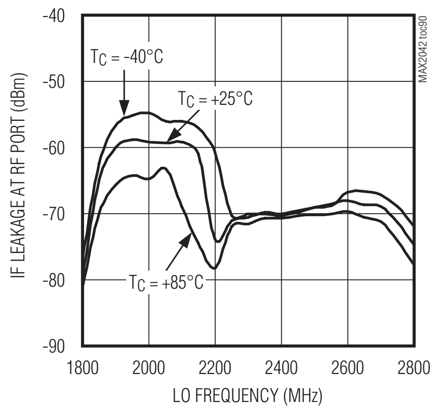
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



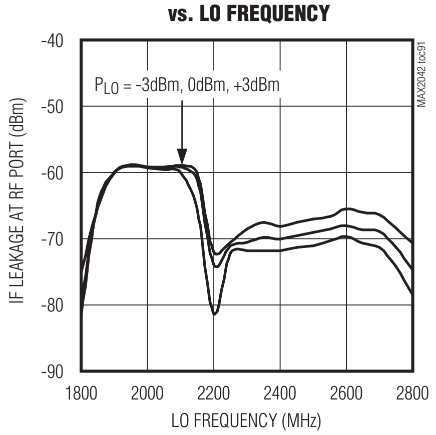
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



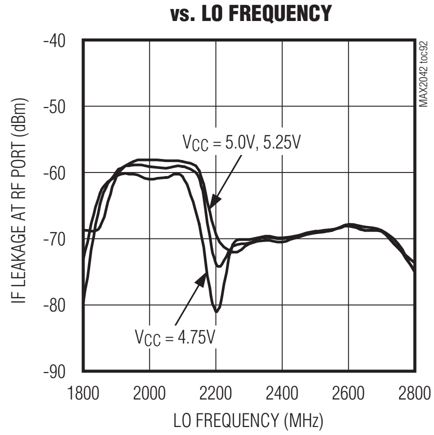
IF LEAKAGE AT RF PORT vs. LO FREQUENCY



IF LEAKAGE AT RF PORT vs. LO FREQUENCY



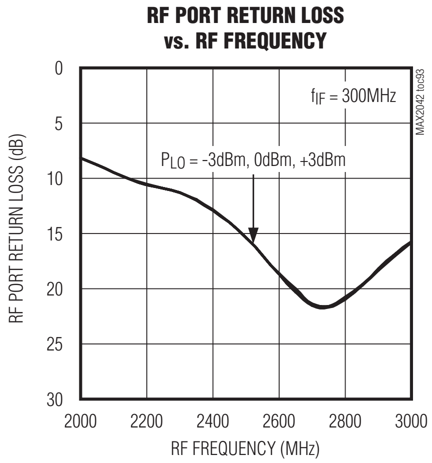
IF LEAKAGE AT RF PORT vs. LO FREQUENCY

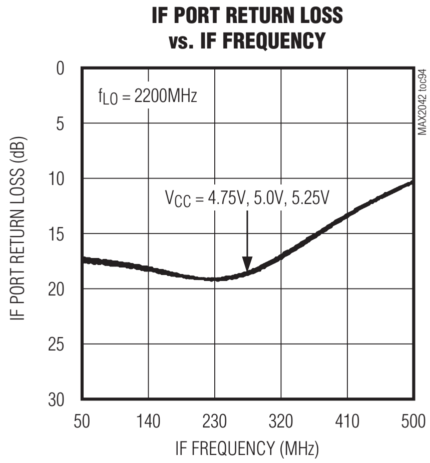


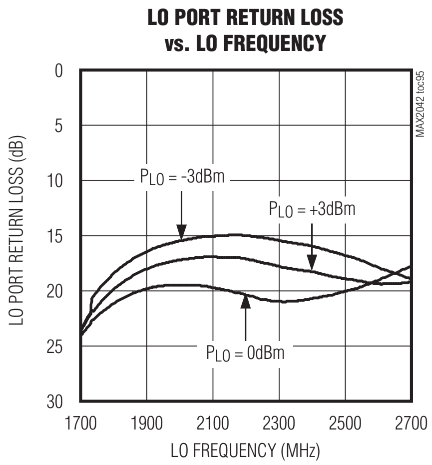
Typical Operating Characteristics (continued)

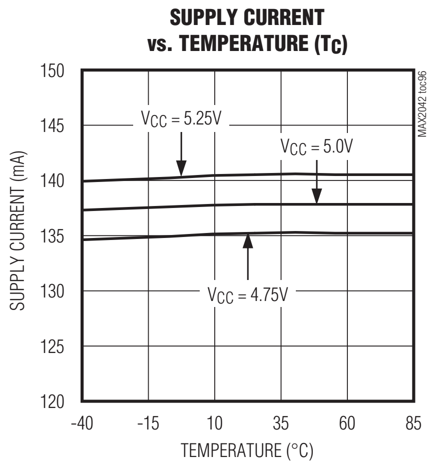
(*Typical Application Circuit* with tuning elements outlined in **Table 2, V_{CC} = +5.0V**, $f_{RF} = f_{LO} + f_{IF}$, f_{IF} = 200MHz, P_{IF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

+5.0V Upconverter Curves







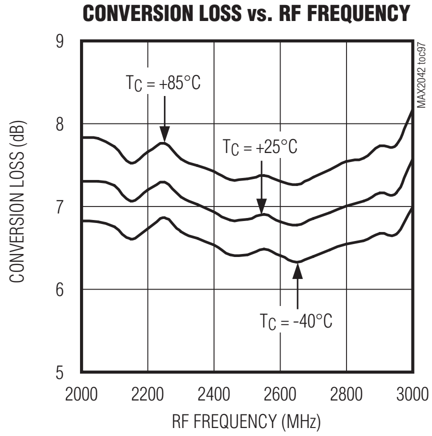


Typical Operating Characteristics (continued)

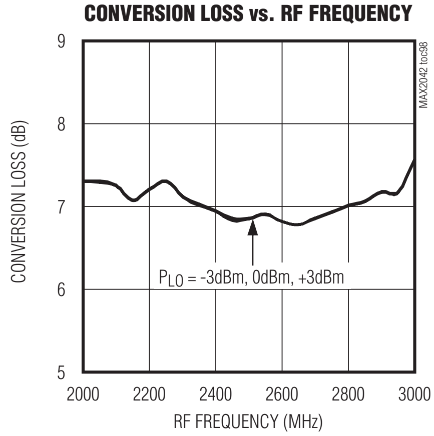
(*Typical Application Circuit* with tuning elements outlined in **Table 2, V_{CC} = +3.3V**, $f_{RF} = f_{LO} + f_{IF}$, f_{IF} = 200MHz, P_{IF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

+3.3V Upconverter Curves

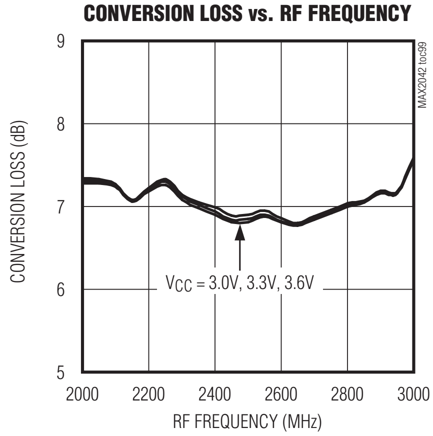
CONVERSION LOSS vs. RF FREQUENCY



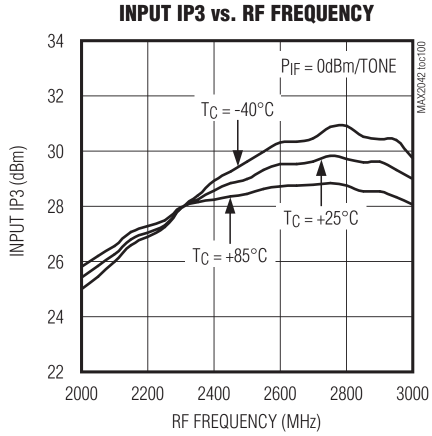
CONVERSION LOSS vs. RF FREQUENCY



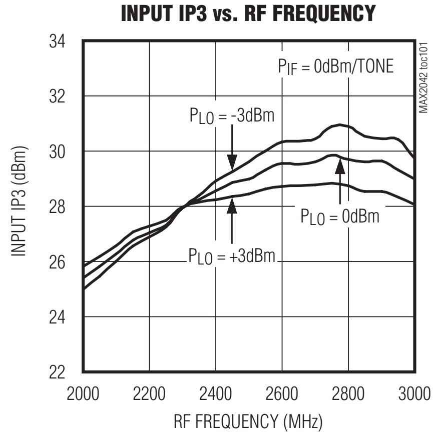
CONVERSION LOSS vs. RF FREQUENCY



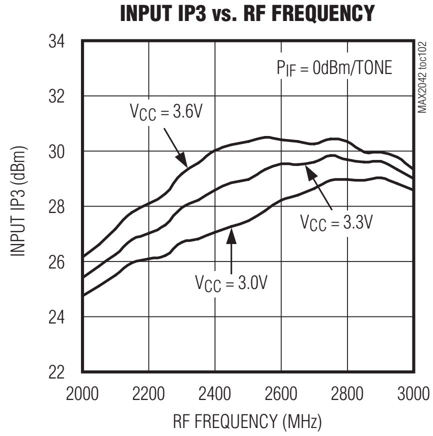
INPUT IP3 vs. RF FREQUENCY



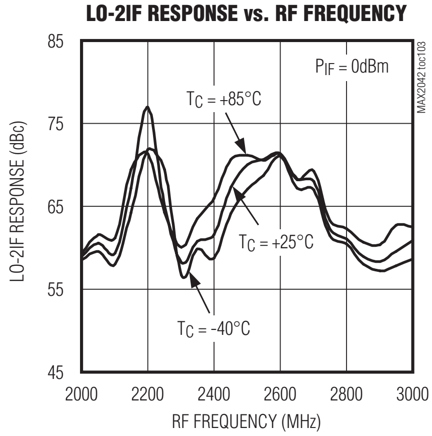
INPUT IP3 vs. RF FREQUENCY



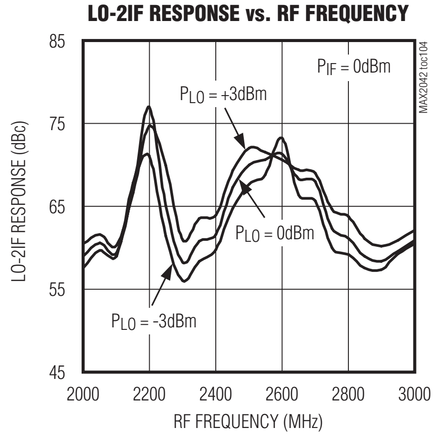
INPUT IP3 vs. RF FREQUENCY



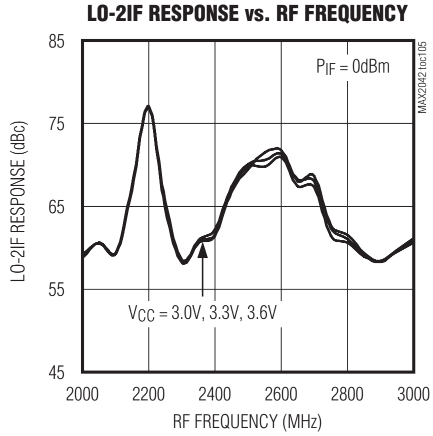
LO-2IF RESPONSE vs. RF FREQUENCY



LO-2IF RESPONSE vs. RF FREQUENCY



LO-2IF RESPONSE vs. RF FREQUENCY



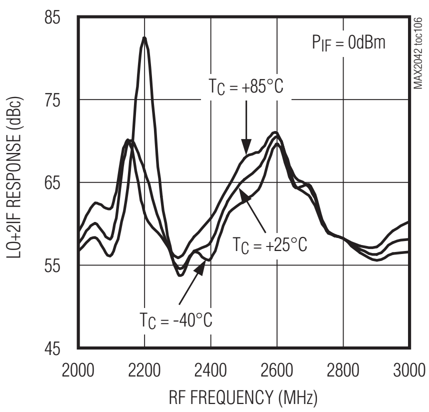
SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion Mixer with LO Buffer

Typical Operating Characteristics (continued)

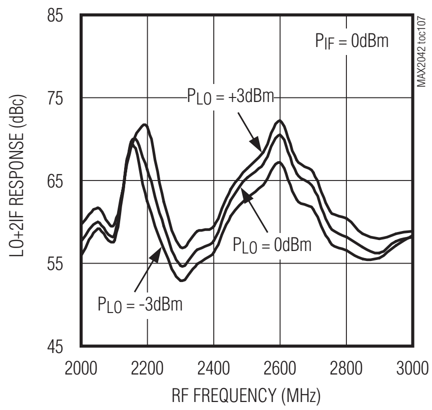
(*Typical Application Circuit* with tuning elements outlined in **Table 2, V_{CC} = +3.3V**, $f_{RF} = f_{LO} + f_{IF}$, f_{IF} = 200MHz, P_{IF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

+3.3V Upconverter Curves

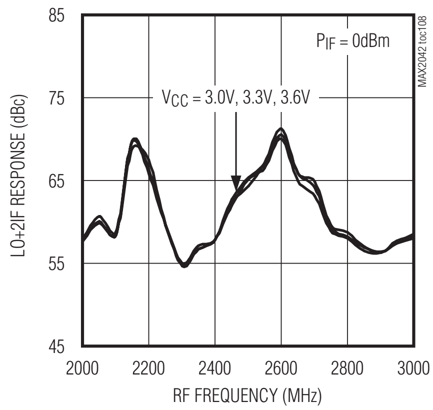
LO+2IF RESPONSE vs. RF FREQUENCY



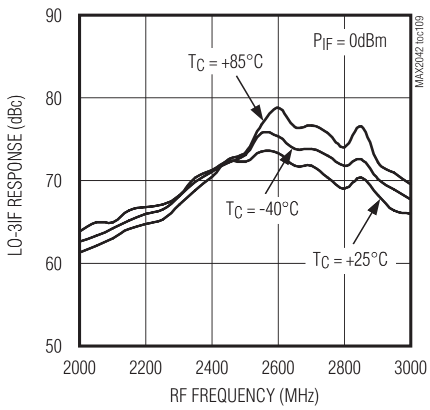
LO+2IF RESPONSE vs. RF FREQUENCY



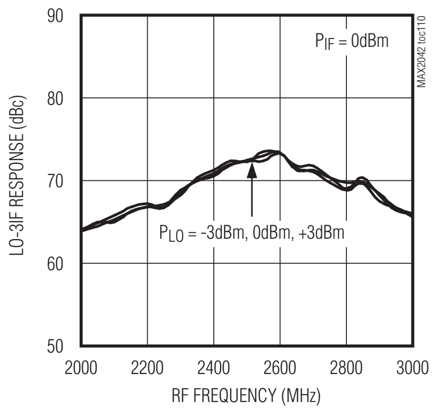
LO+2IF RESPONSE vs. RF FREQUENCY



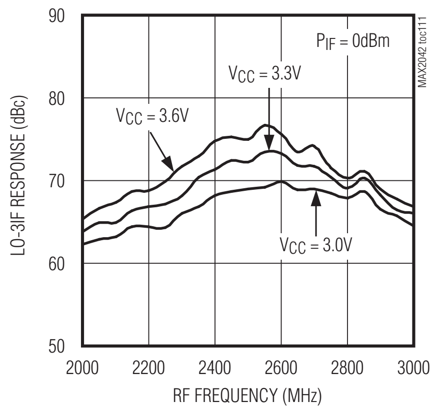
LO-3IF RESPONSE vs. RF FREQUENCY



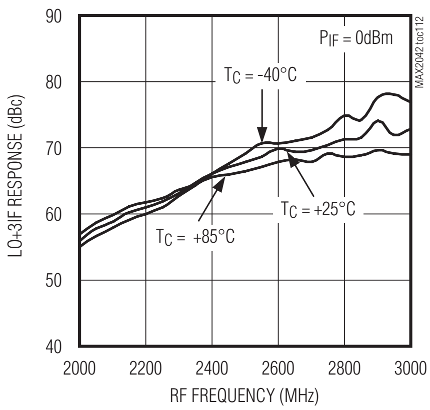
LO-3IF RESPONSE vs. RF FREQUENCY



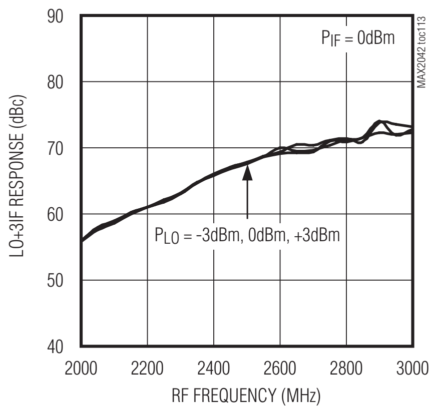
LO-3IF RESPONSE vs. RF FREQUENCY



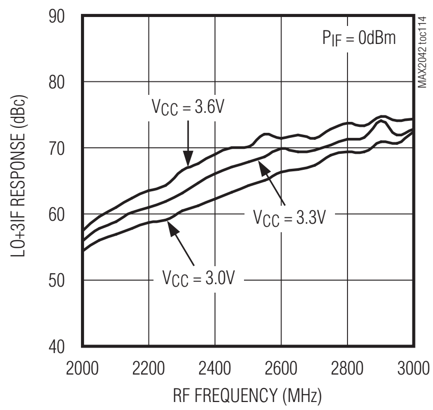
LO+3IF RESPONSE vs. RF FREQUENCY



LO+3IF RESPONSE vs. RF FREQUENCY



LO+3IF RESPONSE vs. RF FREQUENCY

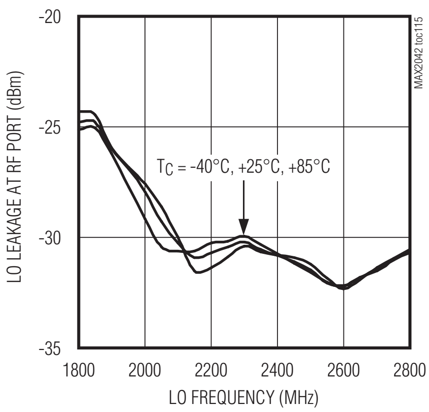


Typical Operating Characteristics (continued)

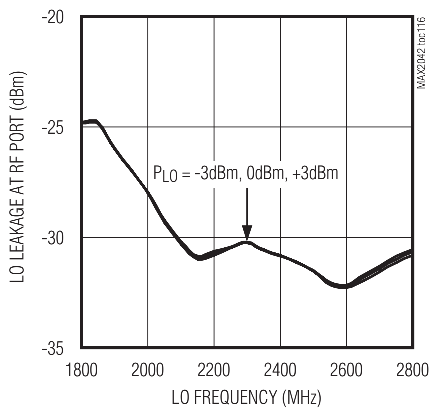
(*Typical Application Circuit* with tuning elements outlined in **Table 2, V_{CC} = +3.3V**, $f_{RF} = f_{LO} + f_{IF}$, f_{IF} = 200MHz, P_{IF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

+3.3V Upconverter Curves

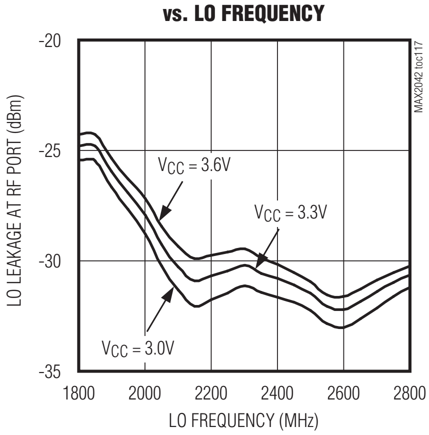
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



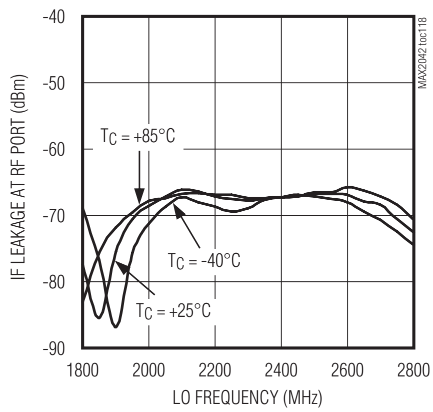
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



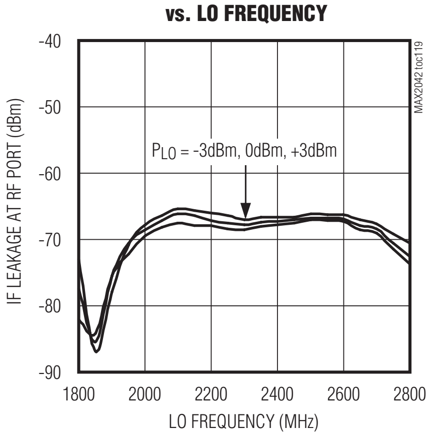
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



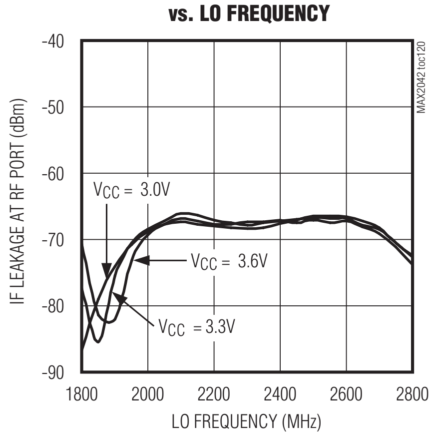
IF LEAKAGE AT RF PORT vs. LO FREQUENCY



IF LEAKAGE AT RF PORT vs. LO FREQUENCY



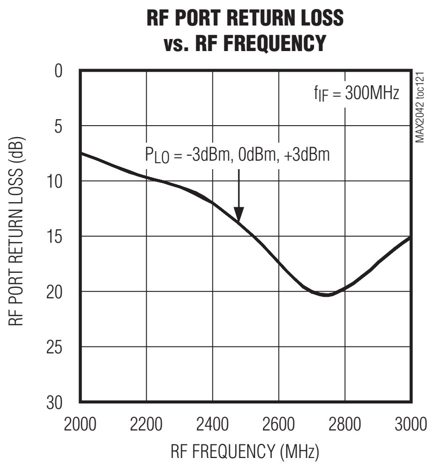
IF LEAKAGE AT RF PORT vs. LO FREQUENCY

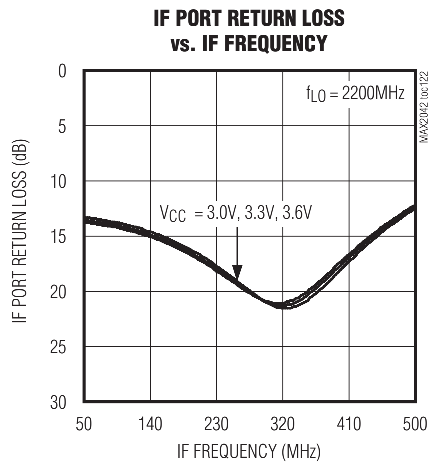


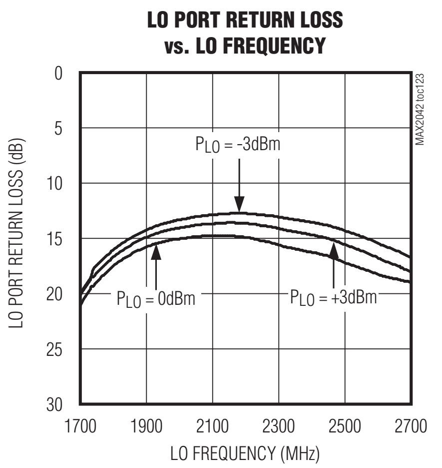
Typical Operating Characteristics (continued)

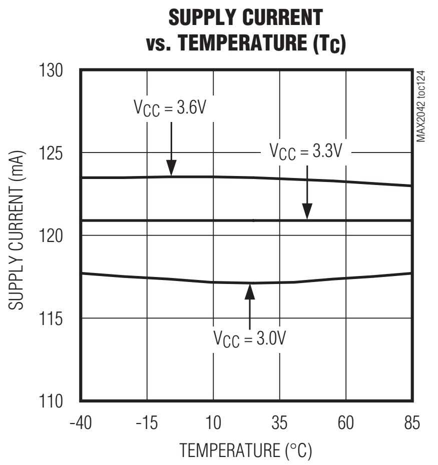
(*Typical Application Circuit* with tuning elements outlined in **Table 2, V_{CC} = +3.3V**, $f_{RF} = f_{LO} + f_{IF}$, f_{IF} = 200MHz, P_{IF} = 0dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

+3.3V Upconverter Curves









Pin Description

PIN	NAME	FUNCTION
1, 6, 8, 14	VCC	Power Supply. Bypass to GND with 0.01µF capacitors as close as possible to the pin.
2	RF	Single-Ended 50Ω RF Input. 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 698Ω ±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 50Ω. 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.

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 50Ω 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 50Ω 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 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 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 50Ω differential interface to a 50Ω 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 1kΩ resistor from IF+ to ground.

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 2000MHz to 3000MHz. The LO input is internally matched to 50Ω; use a 2pF DC-blocking capacitor to cover operations spanning the 1800MHz to 2800MHz 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*).

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 ±1% resistors are not readily available, substitute with ±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.

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. The MAX2042 evaluation kit can be used as a reference for board layout. Gerber files are available upon request at **www.maxim-ic.com**.

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 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

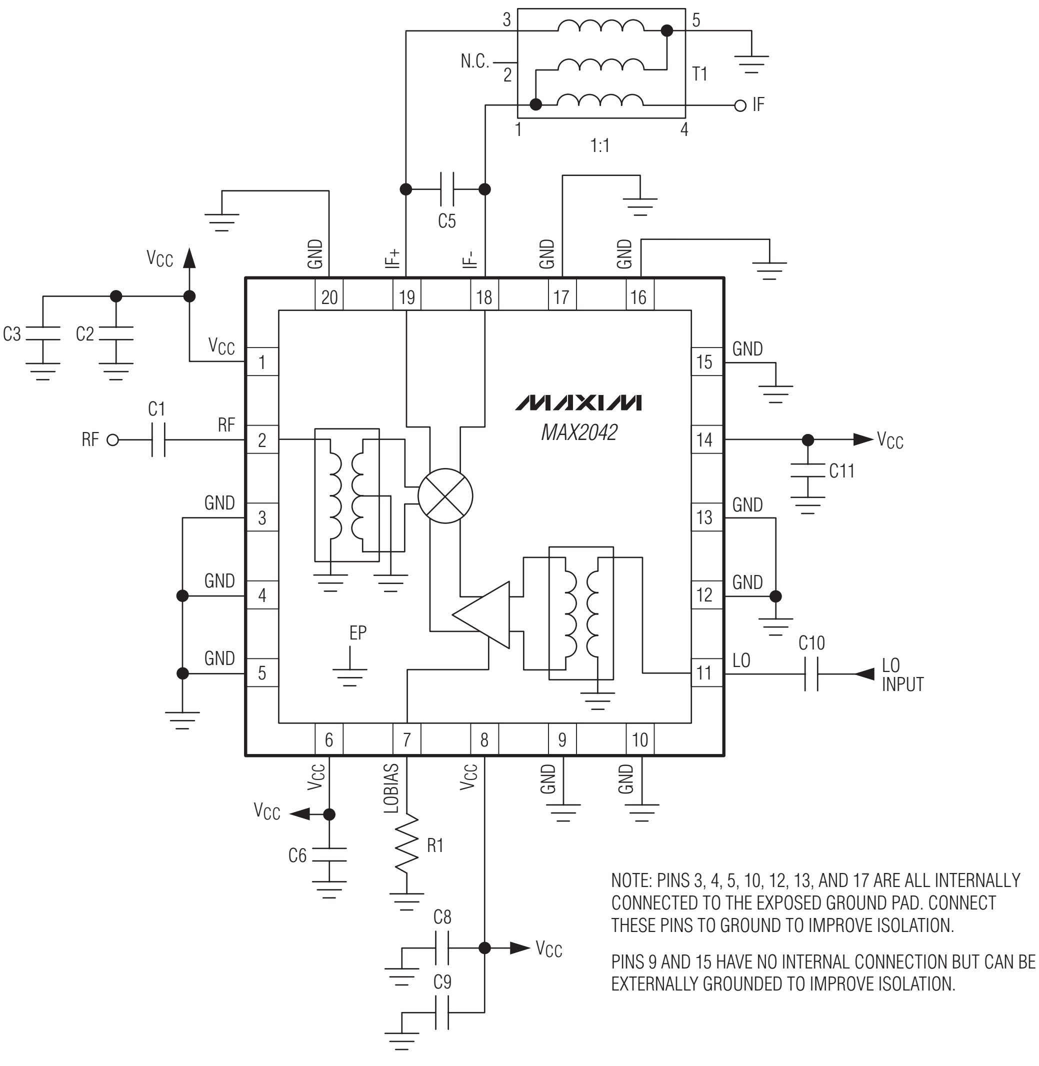
DESIGNATION	QTY	DESCRIPTION	COMPONENT SUPPLIER
C1	1	8.2pF microwave capacitor (0402)	Murata Electronics North America, Inc.
C2, C6, C8, C11	4	0.01µF microwave capacitors (0402)	Murata Electronics North America, Inc.
C3, C9	0	Not installed, capacitors	—
C5	0	Not installed, capacitor	—
C10	1	2pF microwave capacitor (0402)	Murata Electronics North America, Inc.
R1	1	698Ω ±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	0.01µF 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	698Ω ±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



Chip Information

PROCESS: SiGe BiCMOS

Package Information

For the latest package outline information and land patterns, go to **www.maxim-ic.com/packages**.

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