19-4402; Rev 1; 5/09

SiGe, High-Linearity, 2000MHz to 3900MHz Downconversion Mixer with LO Buffer

General Description

The MAX19996A single, high-linearity downconversion mixer provides 8.7dB conversion gain, +24.5dBm IIP3, and 9.8dB noise figure for 2000MHz to 3900MHz WCS, LTE, WiMAX™, and MMDS wireless infrastructure applications. With an ultra-wide LO frequency range of 2100MHz to 4000MHz, the MAX19996A can be used in either low-side or high-side LO injection architectures for virtually all 2.5GHz and 3.5GHz applications. For a 2.5GHz variant tuned specifically for low-side injection, refer to the MAX19996 data sheet.

In addition to offering excellent linearity and noise performance, the MAX19996A also yields a high level of component integration. This device includes a double-balanced passive mixer core, an IF amplifier, and an LO buffer. On-chip baluns are also integrated to allow for single-ended RF and LO inputs. The MAX19996A requires a nominal LO drive of 0dBm, and supply current is typically 230mA at V_{CC} = 5.0V, or 150mA at V_{CC} = 3.3V.

The MAX19996A is pin compatible with the MAX19996 2000MHz to 3000MHz mixer. The device is also pin similar with the MAX9984/MAX9986/MAX9986A 400MHz to 1000MHz mixers and the MAX9993/MAX9994/MAX9996 1700MHz to 2200MHz mixers, making this entire family of downconverters ideal for applications where a common PCB layout is used for multiple frequency bands.

The MAX19996A is available in a compact 5mm x 5mm, 20-pin thin QFN 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

3.5GHz WiMAX and LTE Base Stations

Fixed Broadband Wireless Access

Wireless Local Loop

Private Mobile Radios

Military Systems

Features

- **2000MHz to 3900MHz RF Frequency Range**
- **2100MHz to 4000MHz LO Frequency Range**
- **50MHz to 500MHz IF Frequency Range**
- **8.7dB Conversion Gain**
- **9.8dB Noise Figure**
- **+24.5dBm Typical Input IP3**
- **11dBm Typical Input 1dB Compression Point**
- **67dBc Typical 2LO-2RF 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 MAX19996 2000MHz to 3000MHz Mixer**
- **Pin Similar with the MAX9993/MAX9994/MAX9996 Series of 1700MHz to 2200MHz Mixers and the MAX9984/MAX9986/MAX9986A Series of 400MHz to 1000MHz Mixers**
- **Single 5.0V or 3.3V Supply**
- **External Current-Setting Resistors Provide Option for Operating Device in Reduced-Power/Reduced-Performance Mode**

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX19996AETP+	-40°C to +85°C	20 Thin QFN-EP*
MAX19996AETP+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.

Pin Configuration/Functional Diagram appears at end of data sheet.

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ABSOLUTE MAXIMUM RATINGS

V_{CC} to GND ....-0.3V to +5.5V
IF+, IF-, LO to GND ....-0.3V to (V_{CC} + 0.3V)
RF, LO Input Power ....+12dBm
RF, LO Current (RF and LO is 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)..........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 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}			230	245	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, parameters are guaranteed by design and not production tested, 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		150		mA

RECOMMENDED AC OPERATING CONDITIONS

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
RF Frequency Range	f_{RF}	*Typical Application Circuit* with C1 = 8.2pF, see Table 1 for details (Note 5)	2000		3000	MHz
		Typical Application Circuit with C1 = 1.5pF, see Table 1 for details (Note 5)	3000		3900	
LO Frequency	f_{LO}	(Note 5)	2100		4000	MHz
IF Frequency	f_{IF}	Using Mini-Circuits TC4-1W-17 4:1 transformer as defined in the *Typical Application Circuit*, IF matching components affect the IF frequency range (Note 5)	100		500	MHz
		Using Mini-Circuits TC4-1W-7A 4:1 transformer as defined in the *Typical Application Circuit*, IF matching components affect the IF frequency range (Note 5)	50		250	
LO Drive	P_{LO}		-3	0	+3	dBm

5.0V SUPPLY AC ELECTRICAL CHARACTERISTICS—f_{RF} = 2300MHz TO 2900MHz, HIGH-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} = -5dBm, f_{RF} = 2300MHz to 2900MHz, f_{IF} = 300MHz, f_{LO} = 2600MHz to 3200MHz, $f_{RF} < f_{LO}$, T_C = -40°C to +85°C. Typical values are for T_C = +25°C, V_{CC} = 5.0V, P_{LO} = 0dBm, f_{RF} = 2600MHz, f_{LO} = 2900MHz, f_{IF} = 300MHz. All parameters are guaranteed by design and characterization, unless otherwise noted.) (Note 6)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small-Signal Conversion Gain		f_{RF} = 2300MHz to 2900MHz, T_C = +25°C (Note 7)	7.9	8.7	9.2	dB
Gain Variation vs. Frequency	ΔG_C	f_{RF} = 2305MHz to 2360MHz		0.1		dB
		f_{RF} = 2500MHz to 2570MHz		0.1		
		f_{RF} = 2570MHz to 2620MHz		0.1		
		f_{RF} = 2500MHz to 2690MHz		0.2		
		f_{RF} = 2700MHz to 2900MHz		0.3		
Conversion Gain Temperature Coefficient	TC_{CG}	T_C = -40°C to +85°C		-0.012		dB/°C
Single Sideband Noise Figure	NF_{SSB}	No blockers present		9.8	12	dB
		f_{RF} = 2600MHz, f_{IF} = 300MHz, P_{LO} = 0dBm, V_{CC} = +5.0V, T_C = +25°C, no blockers present		9.8	10.5	
Noise Figure Temperature Coefficient	TC_{NF}	f_{RF} = 2300MHz to 2900MHz, single sideband, no blockers present, T_C = -40°C to +85°C		0.018		dB/°C
Noise Figure Under Blocking	NF_B	+8dBm blocker tone applied to RF port, f_{RF} = 2600MHz, f_{LO} = 2900MHz, $f_{BLOCKER}$ = 2400MHz, P_{LO} = 0dBm, V_{CC} = +5.0V, T_C = +25°C (Note 8)		18	22	dB

5.0V SUPPLY AC ELECTRICAL CHARACTERISTICS—f_{RF} = 2300MHz TO 2900MHz, HIGH-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} = -5dBm, f_{RF} = 2300MHz to 2900MHz, f_{IF} = 300MHz, f_{LO} = 2600MHz to 3200MHz, $f_{RF} < f_{LO}$, T_C = -40°C to +85°C. Typical values are for T_C = +25°C, V_{CC} = 5.0V, P_{LO} = 0dBm, f_{RF} = 2600MHz, f_{LO} = 2900MHz, f_{IF} = 300MHz. All parameters are guaranteed by design and characterization, unless otherwise noted.) (Note 6)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Input 1dB Compression Point	IP_{1dB}	T_C = +25°C (Note 9)		9.5	11		dBm
		f_{RF} = 2600MHz T_C = +25°C (Notes 7, 9)		10	11		
Third-Order Input Intercept Point	IIP3	f_{RF1} - f_{RF2} = 1MHz, P_{RF1} = P_{RF2} = -5dBm, T_C = +25°C (Note 7)		22.5	24.5		dBm
IIP3 Variation with T_C		f_{RF} = 2300MHz to 2900MHz, f_{RF1} - f_{RF2} = 1MHz, P_{RF1} = P_{RF2} = -5dBm, T_C = -40°C to +85°C			±0.3		dB
2LO-2RF Spur Rejection	2 x 2	f_{SPUR} = f_{LO} - 150MHz	P_{RF} = -10dBm	60	67		dBc
			P_{RF} = -5dBm	55	62		
3LO-3RF Spur Rejection	3 x 3	f_{SPUR} = f_{LO} - 100MHz	P_{RF} = -10dBm	75	85		dBc
			P_{RF} = -5dBm	65	75		
RF Input Return Loss	RL_{RF}	LO on and IF terminated into a matched impedance			17.5		dB
LO Input Return Loss	RL_{LO}	RF and IF terminated into a matched impedance			19.5		dB
IF Output Impedance	Z_{IF}	Nominal differential impedance at the IC's IF outputs			200		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*; see the *Typical Operating Characteristics* for performance vs. inductor values	f_{IF} = 450MHz, L1 = L2 = 120nH		25		dB
			f_{IF} = 350MHz, L1 = L2 = 270nH		25		
			f_{IF} = 300MHz, L1 = L2 = 390nH		25		
RF-to-IF Isolation		P_{LO} = +3dBm (Note 7)		27	30		dB
LO Leakage at RF Port		P_{LO} = +3dBm			-28.6	-22.8	dBm
2LO Leakage at RF Port		P_{LO} = +3dBm			-29.7		dBm
LO Leakage at IF Port		P_{LO} = +3dBm (Note 7)			-28.4		dBm

3.3V SUPPLY AC ELECTRICAL CHARACTERISTICS—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 for T_C = +25°C, V_{CC} = 3.3V, P_{LO} = 0dBm, f_{RF} = 2600MHz, f_{LO} = 2900MHz, f_{IF} = 300MHz, unless otherwise noted.) (Note 6)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Small-Signal Conversion Gain	G_C				8.3		dB
Gain Variation vs. Frequency	ΔG_C	f_{RF} = 2300MHz to 2900MHz, any 100MHz band			0.15		dB
Conversion Gain Temperature Coefficient	TC_{CG}	T_C = -40°C to +85°C			-0.012		dB/°C
Single Sideband Noise Figure	NF_{SSB}	No blockers present			9.6		dB
Noise Figure Temperature Coefficient	TC_{NF}	Single sideband, no blockers present, T_C = -40°C to +85°C			0.018		dB/°C
Input 1dB Compression Point	IP_{1dB}	(Note 9)			7.75		dBm
Third-Order Input Intercept Point	IIP3	f_{RF1} = 2600MHz, f_{RF2} = 2601MHz, P_{RF1} = P_{RF2} = -5dBm			19.7		dBm
IIP3 Variation with T_C		f_{RF1} = 2600MHz, f_{RF2} = 2601MHz, P_{RF1} = P_{RF2} = -5dBm, T_C = -40°C to +85°C			±0.5		dB
2LO-2RF Spur Rejection	2 x 2	f_{SPUR} = f_{LO} - 150MHz	P_{RF} = -10dBm		64		dBc
			P_{RF} = -5dBm		59		
3LO-3RF Spur Rejection	3 x 3	f_{SPUR} = f_{LO} - 100MHz	P_{RF} = -10dBm		74		dBc
			P_{RF} = -5dBm		64		
RF Input Return Loss	RL_{RF}	LO on and IF terminated into a matched impedance			17.5		dB
LO Input Return Loss	RL_{LO}	RF and IF terminated into a matched impedance			19.5		dB
IF Output Impedance	Z_{IF}	Nominal differential impedance at the IC's IF outputs			200		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*; see the *Typical Operating Characteristics* for performance vs. inductor values	f_{IF} = 450MHz, L1 = L2 = 120nH		25		dB
			f_{IF} = 350MHz, L1 = L2 = 270nH		25		
			f_{IF} = 300MHz, L1 = L2 = 390nH		25		
RF-to-IF Isolation		f_{RF} = 2300MHz to 2900MHz, P_{LO} = +3dBm			38		dB
LO Leakage at RF Port		f_{LO} = 2600MHz to 3200MHz, P_{LO} = +3dBm			-30		dBm
2LO Leakage at RF Port		f_{LO} = 2600MHz to 3200MHz, P_{LO} = +3dBm			-31		dBm
LO Leakage at IF Port		f_{LO} = 2600MHz to 3200MHz, P_{LO} = +3dBm			-34		dBm

5.0V SUPPLY AC ELECTRICAL CHARACTERISTICS—f_{RF} = 2300MHz TO 2900MHz, 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} = -5dBm, 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_{LO} = 0dBm, f_{RF} = 2600MHz, f_{LO} = 2300MHz, f_{IF} = 300MHz, all parameters are guaranteed by design and characterization, unless otherwise noted.) (Note 6)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Small-Signal Conversion Gain	G_C	f_{RF} = 2300MHz to 2900MHz, T_C = +25°C (Note 7)		8.2	8.9	9.5	dB
Gain Variation vs. Frequency	ΔG_C	f_{RF} = 2300MHz to 2900MHz, any 100MHz band			0.1		dB
Conversion Gain Temperature Coefficient	TC_{CG}	T_C = -40°C to +85°C			-0.012		dB/°C
Single Sideband Noise Figure	NF_{SSB}	No blockers present			9.5	12.5	dB
		f_{RF} = 2600MHz, f_{IF} = 300MHz, P_{LO} = 0dBm, V_{CC} = +5.0V, T_C = +25°C, no blockers present			9.5	10.5	
Noise Figure Temperature Coefficient	TC_{NF}	Single sideband, no blockers present, T_C = -40°C to +85°C			0.018		dB/°C
Input 1dB Compression Point	IP_{1dB}	T_C = +25°C (Note 9)		9.5	10.7		dBm
Third-Order Input Intercept Point	IIP3	f_{RF1} - f_{RF2} = 1MHz, P_{RF1} = P_{RF2} = -5dBm, T_C = +25°C (Note 7)		22	24.05		dBm
IIP3 Variation with T_C		f_{RF} = 2300MHz to 2900MHz, P_{RF1} = P_{RF2} = -5dBm, T_C = -40°C to +85°C			±0.5		dB
2RF-2LO Spur Rejection	2 x 2	f_{SPUR} = f_{LO} + 150MHz	P_{RF} = -10dBm	63	68		dBc
			P_{RF} = -5dBm	58	63		
3RF-3LO Spur Rejection	3 x 3	f_{SPUR} = f_{LO} + 100MHz	P_{RF} = -10dBm	79	84		dBc
			P_{RF} = -5dBm	69	74		
RF Input Return Loss	RL_{RF}	LO on and IF terminated into a matched impedance			19		dB
LO Input Return Loss	RL_{LO}	RF and IF terminated into a matched impedance			18		dB
IF Output Impedance	Z_{IF}	Nominal differential impedance at the IC's IF outputs			200		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*; see the *Typical Operating Characteristics* for performance vs. inductor values	f_{IF} = 450MHz, L1 = L2 = 120nH		25		dB
			f_{IF} = 350MHz, L1 = L2 = 270nH		25		
			f_{IF} = 300MHz, L1 = L2 = 390nH		25		
RF-to-IF Isolation		f_{RF} = 2600MHz, P_{LO} = +3dBm		29	36		dB
LO Leakage at RF Port		f_{LO} = 1800MHz to 2900MHz, P_{LO} = +3dBm			-28	-20	dBm
2LO Leakage at RF Port		f_{LO} = 1800MHz to 2900MHz, P_{LO} = +3dBm			-29	-19	dBm
LO Leakage at IF Port		f_{LO} = 1800MHz to 2900MHz, P_{LO} = +3dBm			-24		dBm

5.0V SUPPLY AC ELECTRICAL CHARACTERISTICS—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} = -5dBm, f_{RF} = 3100MHz to 3900MHz, f_{IF} = 300MHz, f_{LO} = 2800MHz to 3600MHz, $f_{RF} > f_{LO}$, T_C = -40°C to +85°C. Typical values are for T_C = +25°C, V_{CC} = 5.0V, P_{LO} = 0dBm, f_{RF} = 3500MHz, f_{LO} = 3200MHz, f_{IF} = 300MHz. All parameters are guaranteed by design and characterization, unless otherwise noted.) (Note 6)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small-Signal Conversion Gain	G_C	T_C = +25°C (Note 7)	7.5	8.0	8.5	dB
Gain Variation vs. Frequency	ΔG_C	f_{RF} = 3450MHz to 3750MHz, any 100MHz band		0.15		dB
		f_{RF} = 3450MHz to 3750MHz, any 200MHz band		0.3		dB
Conversion Gain Temperature Coefficient	TC_{CG}	T_C = -40°C to +85°C		-0.012		dB/°C
Single Sideband Noise Figure	NF_{SSB}	No blockers present		10.5	13.5	dB
		f_{RF} = 3500MHz, f_{IF} = 300MHz, P_{LO} = 0dBm, V_{CC} = +5.0V, T_C = +25°C, no blockers present		10.5	11.6	dB
Noise Figure Temperature Coefficient	TC_{NF}	f_{RF} = 3100MHz to 3900MHz, single sideband, no blockers present, T_C = -40°C to +85°C		0.018		dB/°C
Noise Figure Under Blocking	NF_B	+8dBm blocker tone applied to RF port, f_{RF} = 3500MHz, f_{LO} = 3200MHz, $f_{BLOCKER}$ = 3750MHz, P_{LO} = 0dBm, V_{CC} = +5.0V, T_C = +25°C (Note 8)		18.7	21	dB
Input 1dB Compression Point	IP_{1dB}	f_{RF} = 3500MHz (Note 9)	10	12		dBm
Third-Order Input Intercept Point	IIP3	$f_{RF1} - f_{RF2}$ = 1MHz, $P_{RF1} = P_{RF2}$ = -5dBm (Note 7)	23	25		dBm
IIP3 Variation with T_C		f_{RF} = 3100MHz to 3900MHz, f_{IF} = 300MHz, $f_{RF1} - f_{RF2}$ = 1MHz, $P_{RF1} = P_{RF2}$ = -5dBm, T_C = -40°C to +85°C		±0.3		dB
2RF-2LO Spur Rejection	2 x 2	$f_{SPUR} = f_{LO}$ + 150MHz; P_{RF} = -10dBm	60	69		dBc
		$f_{SPUR} = f_{LO}$ + 150MHz; P_{RF} = -5dBm	55	64		dBc
3RF-3LO Spur Rejection	3 x 3	$f_{SPUR} = f_{LO}$ + 100MHz; P_{RF} = -10dBm	78	86		dBc
		$f_{SPUR} = f_{LO}$ + 100MHz; P_{RF} = -5dBm	68	76		dBc
RF Input Return Loss	RL_{RF}	LO on and IF terminated into a matched impedance		20		dB
LO Input Return Loss	RL_{LO}	RF and IF terminated into a matched impedance		16.5		dB
IF Output Impedance	Z_{IF}	Nominal differential impedance at the IC's IF outputs		200		Ω

5.0V SUPPLY AC ELECTRICAL CHARACTERISTICS—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} = -5dBm, f_{RF} = 3100MHz to 3900MHz, f_{IF} = 300MHz, f_{LO} = 2800MHz to 3600MHz, $f_{RF} > f_{LO}$, T_C = -40°C to +85°C. Typical values are for T_C = +25°C, V_{CC} = 5.0V, P_{LO} = 0dBm, f_{RF} = 3500MHz, f_{LO} = 3200MHz, f_{IF} = 300MHz. All parameters are guaranteed by design and characterization, unless otherwise noted.) (Note 6)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
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*; see the *Typical Operating Characteristics* for performance vs. inductor values	f_{IF} = 450MHz, L1 = L2 = 120nH		25		dB
			f_{IF} = 350MHz, L1 = L2 = 270nH		25		
			f_{IF} = 300MHz, L1 = L2 = 390nH		25		
RF-to-IF Isolation		f_{RF} = 2600MHz P_{LO} = +3dBm (Note 7)		23	27		dB
LO Leakage at RF Port		f_{LO} = 2800MHz to 3600MHz P_{LO} = +3dBm			-31	-20	dBm
2LO Leakage at RF Port		P_{LO} = +3dBm			-27		dBm
LO Leakage at IF Port		P_{LO} = +3dBm (Note 7)			-29.5	-20	dBm

+5.0V SUPPLY AC ELECTRICAL CHARACTERISTICS—f_{RF} = 3100MHz TO 3900MHz, HIGH-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, Typical values are for T_C = +25°C, V_{CC} = 5.0V, P_{LO} = 0dBm, f_{RF} = 3500MHz, f_{LO} = 3800MHz, f_{IF} = 300MHz. Parameters are guaranteed by design and not production tested.) (Note 6)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Small-Signal Conversion Gain	G_C				7.6		dB
Gain Variation vs. Frequency	ΔG_C	f_{RF} = 3450MHz to 3750MHz, any 100MHz band			0.15		dB
		f_{RF} = 3450MHz to 3750MHz, any 200MHz band			0.3		
Conversion Gain Temperature Coefficient	TC_{CG}	T_C = -40°C to +85°C			-0.012		dB/°C
Single Sideband Noise Figure	NF_{SSB}	No blockers present			10.9		dB
Noise Figure Temperature Coefficient	TC_{NF}	Single sideband, no blockers present, T_C = -40°C to +85°C			0.018		dB/°C
Input 1dB Compression Point	IP_{1dB}	(Note 9)			12.4		dBm
Third-Order Input Intercept Point	IIP3	f_{RF1} = 3500MHz, f_{RF2} = 3501MHz, P_{RF1} = P_{RF2} = -5dBm			24.7		dBm
IIP3 Variation with T_C		f_{RF1} = 3500MHz, f_{RF2} = 3501MHz, P_{RF1} = P_{RF2} = -5dBm, T_C = -40°C to +85°C			±0.5		dB
2LO-2RF Spur Rejection	2 x 2	f_{SPUR} = f_{LO} - 150MHz	P_{RF} = -10dBm		69		dBc
			P_{RF} = -5dBm		64		

+5.0V SUPPLY AC ELECTRICAL CHARACTERISTICS—f_{RF} = 3100MHz TO 3900MHz, HIGH-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, Typical values are for T_C = +25°C, V_{CC} = 5.0V, P_{LO} = 0dBm, f_{RF} = 3500MHz, f_{LO} = 3800MHz, f_{IF} = 300MHz. Parameters are guaranteed by design and not production tested.) (Note 6)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
3LO-3RF Spur Rejection	3 x 3	f_{SPUR} = f_{LO} - 100MHz	P_{RF} = -10dBm		90		dBc
			P_{RF} = -5dBm		80		
RF Input Return Loss	RL_{RF}	LO on and IF terminated into a matched impedance			22		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			200		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*; see the *Typical Operating Characteristics* for performance vs. inductor values	f_{IF} = 450MHz, L1 = L2 = 120nH		25		dB
			f_{IF} = 350MHz, L1 = L2 = 270nH		25		
			f_{IF} = 300MHz, L1 = L2 = 390nH		25		
RF-to-IF Isolation		f_{RF} = 3100MHz to 3700MHz, P_{LO} = +3dBm			26.6		dB
LO Leakage at RF Port		f_{LO} = 3400MHz to 4000MHz, P_{LO} = +3dBm			-38		dBm
2LO Leakage at RF Port		f_{LO} = 3400MHz to 4000MHz, P_{LO} = +3dBm			-13.5		dBm
LO Leakage at IF Port		f_{LO} = 3400MHz to 4000MHz, P_{LO} = +3dBm			-27		dBm

Note 5: Not production tested. 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 0.8dB loss at f_{IF} = 300MHz due to the 4:1 impedance transformer. Output measurements were taken at IF outputs of the *Typical Application Circuit*.

Note 7: 100% production tested for functional performance.

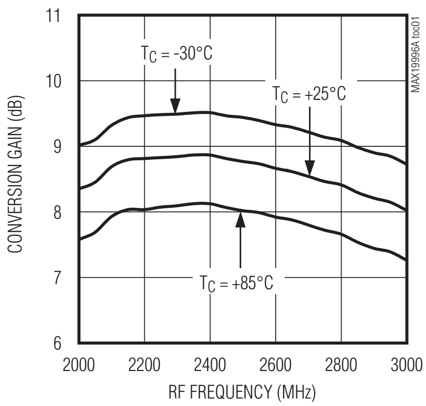
Note 8: Measured with external LO source noise filtered so that the noise floor is -174dBm/Hz. This specification reflects the effects of all SNR degradations in the mixer including the LO noise, as defined in Application Note 2021: *Specifications and Measurement of Local Oscillator Noise in Integrated Circuit Base Station Mixers*.

Note 9: Maximum reliable continuous input power applied to the RF port of this device is +12dBm from a 50Ω source.

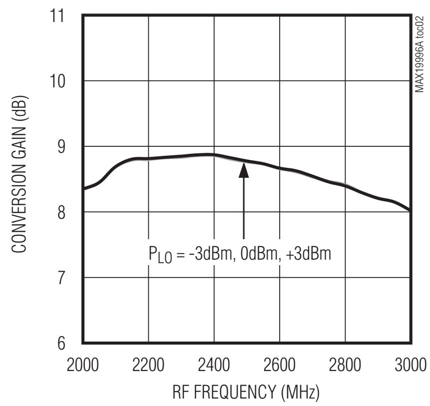
Typical Operating Characteristics

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 2000MHz to 3000MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

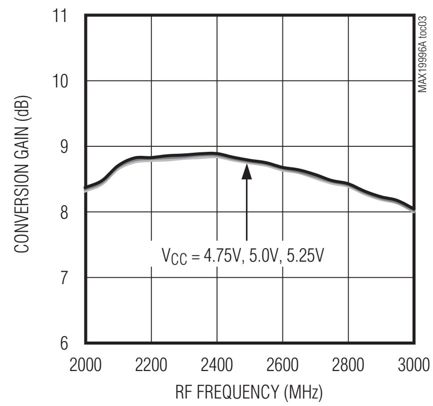
CONVERSION GAIN vs. RF FREQUENCY



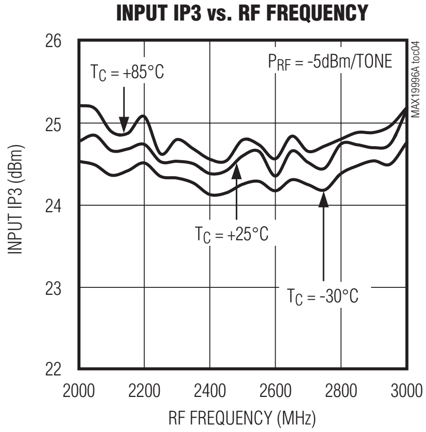
CONVERSION GAIN vs. RF FREQUENCY



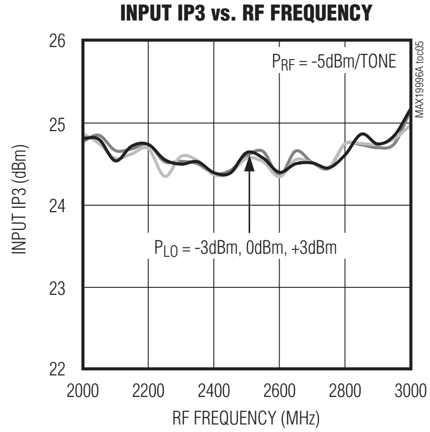
CONVERSION GAIN vs. RF FREQUENCY



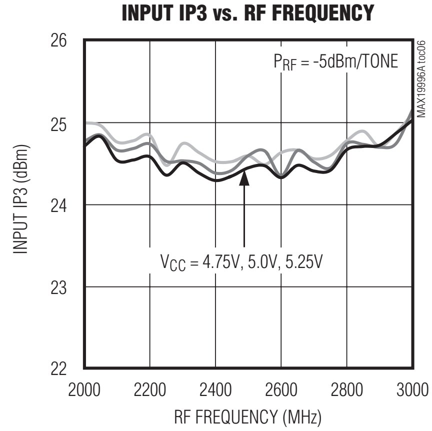
INPUT IP3 vs. RF FREQUENCY



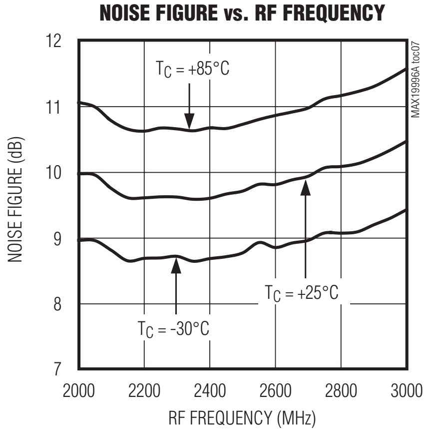
INPUT IP3 vs. RF FREQUENCY



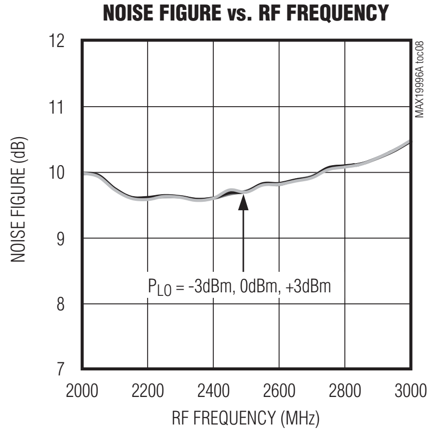
INPUT IP3 vs. RF FREQUENCY



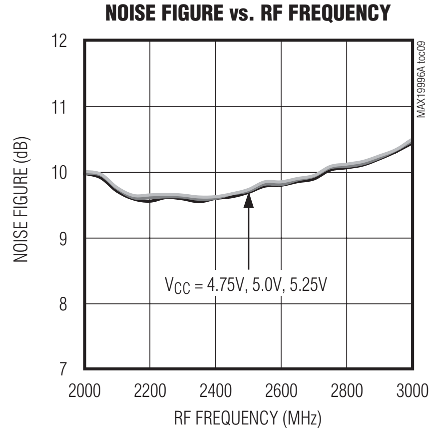
NOISE FIGURE vs. RF FREQUENCY



NOISE FIGURE vs. RF FREQUENCY



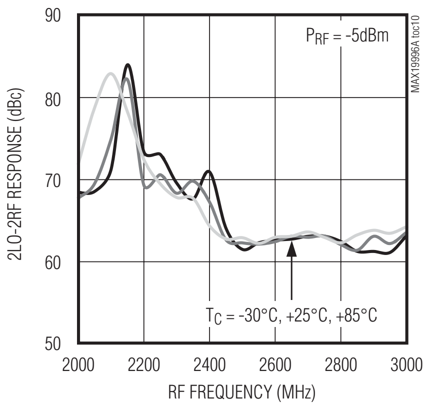
NOISE FIGURE vs. RF FREQUENCY



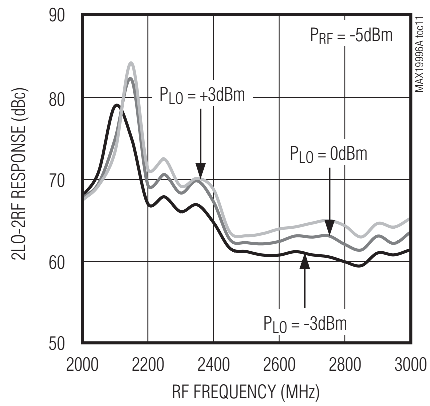
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 2000MHz to 3000MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

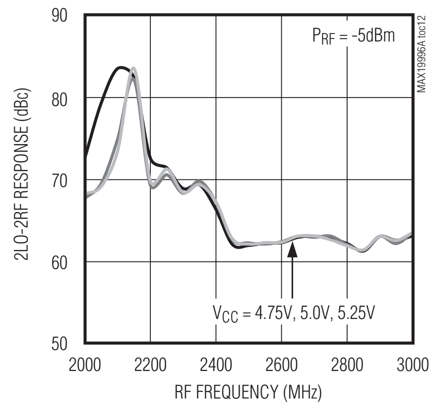
2LO-2RF RESPONSE vs. RF FREQUENCY



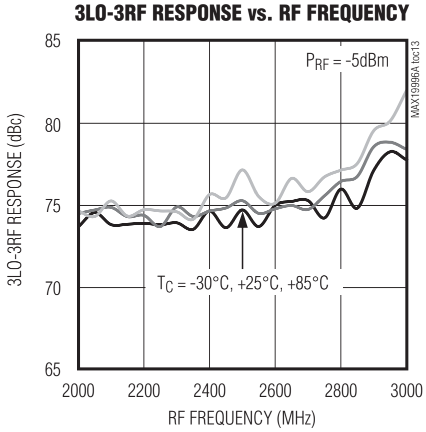
2LO-2RF RESPONSE vs. RF FREQUENCY



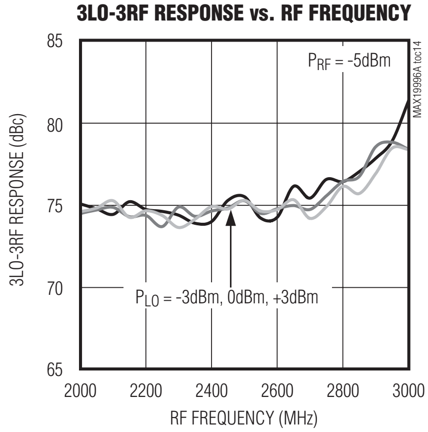
2LO-2RF RESPONSE vs. RF FREQUENCY



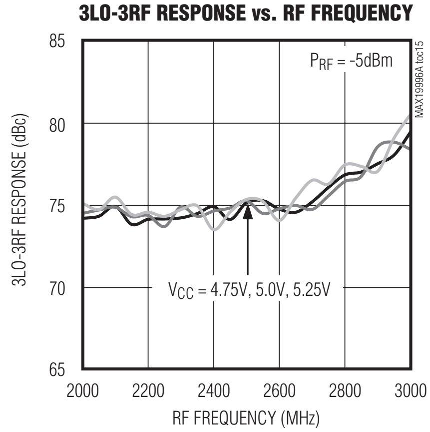
3LO-3RF RESPONSE vs. RF FREQUENCY



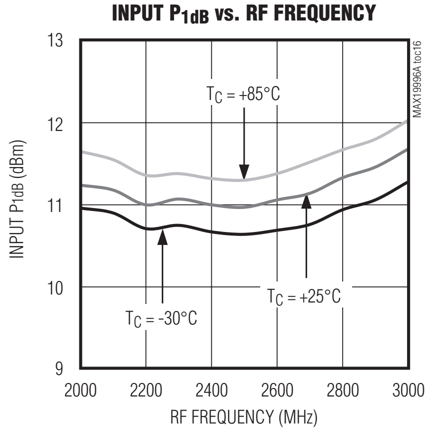
3LO-3RF RESPONSE vs. RF FREQUENCY



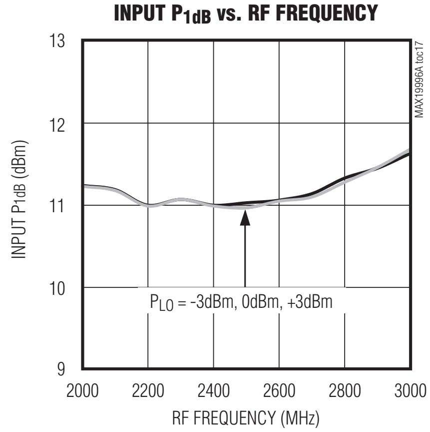
3LO-3RF RESPONSE vs. RF FREQUENCY



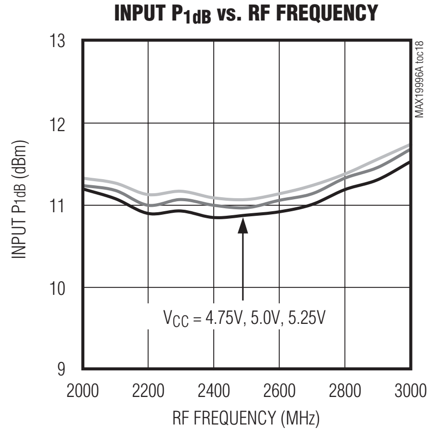
INPUT P_{1dB} vs. RF FREQUENCY



INPUT P_{1dB} vs. RF FREQUENCY



INPUT P_{1dB} vs. RF FREQUENCY

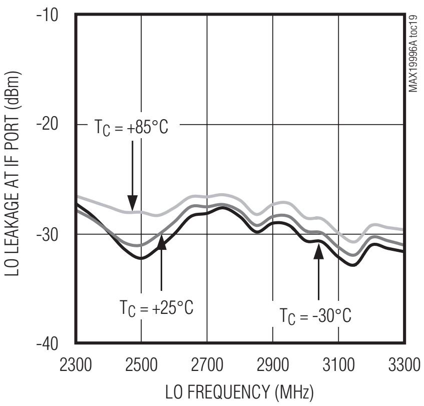


SiGe, High-Linearity, 2000MHz to 3900MHz Downconversion Mixer with LO Buffer

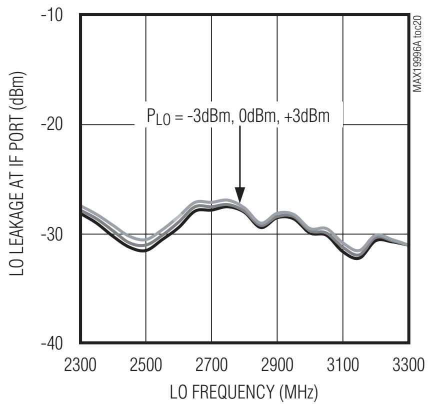
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 2000MHz to 3000MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

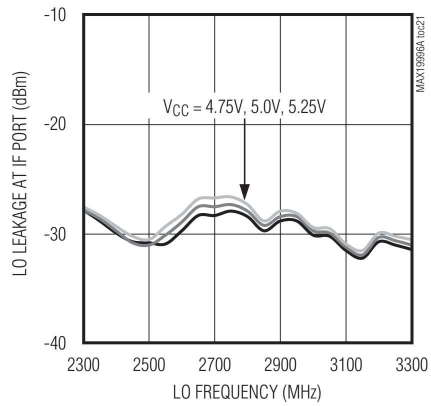
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



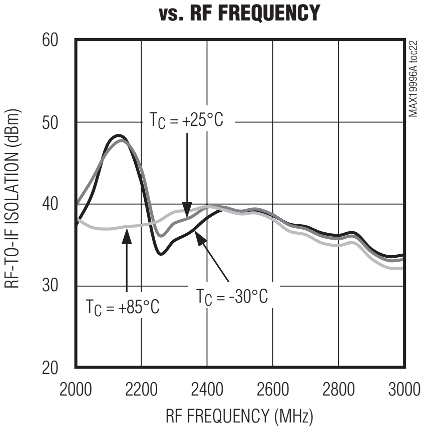
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



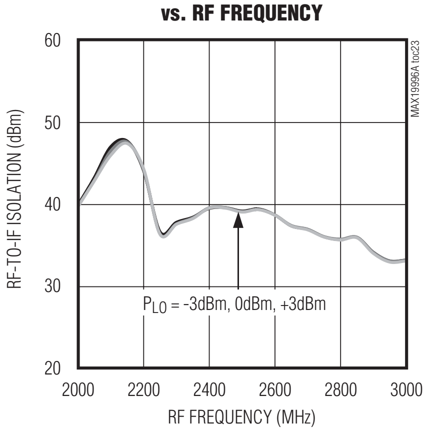
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



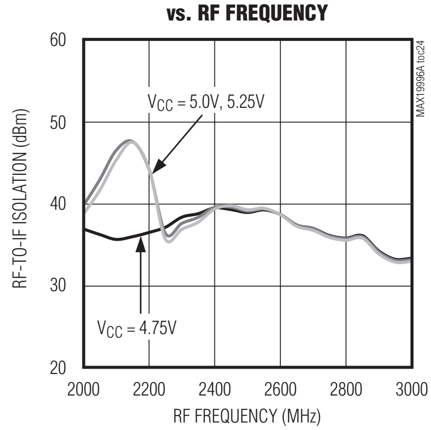
RF-TO-IF ISOLATION vs. RF FREQUENCY



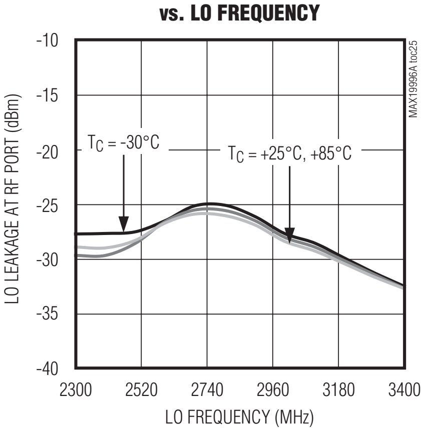
RF-TO-IF ISOLATION vs. RF FREQUENCY



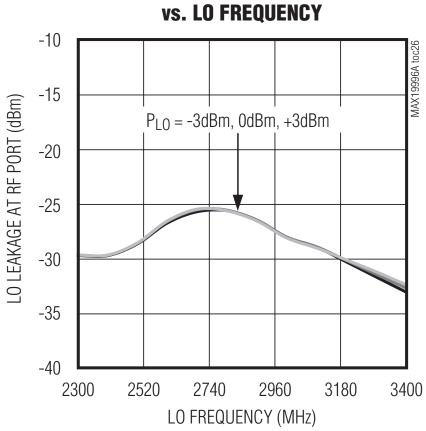
RF-TO-IF ISOLATION vs. RF FREQUENCY



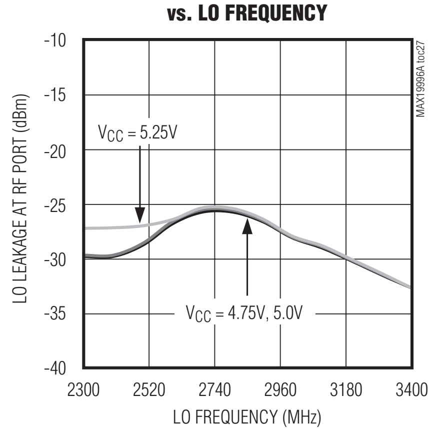
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



LO LEAKAGE AT RF PORT vs. LO FREQUENCY



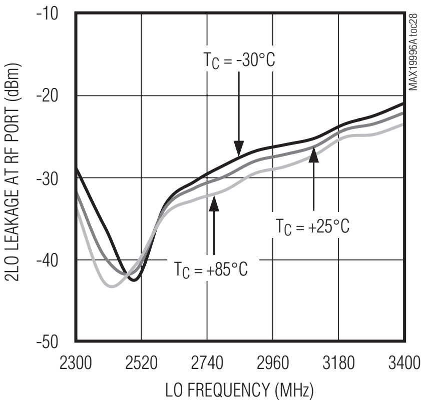
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



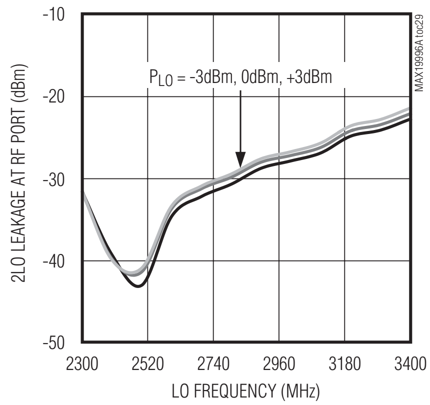
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 2000MHz to 3000MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

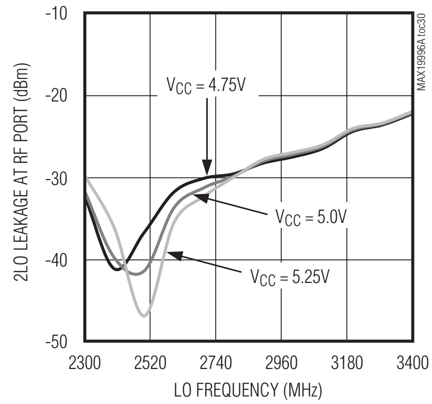
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



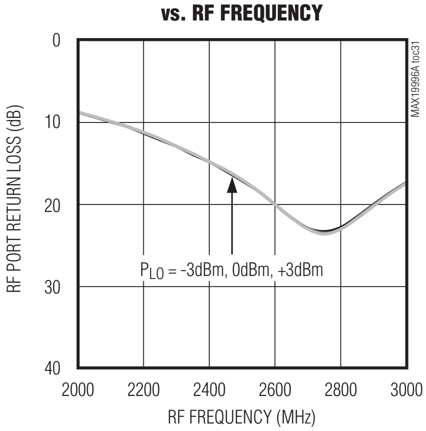
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



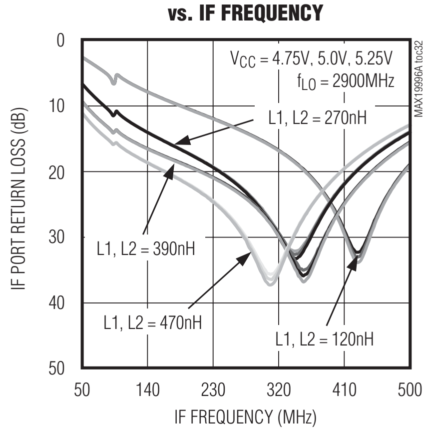
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



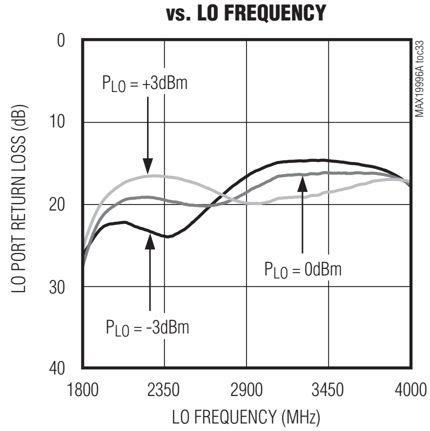
RF PORT RETURN LOSS vs. RF FREQUENCY



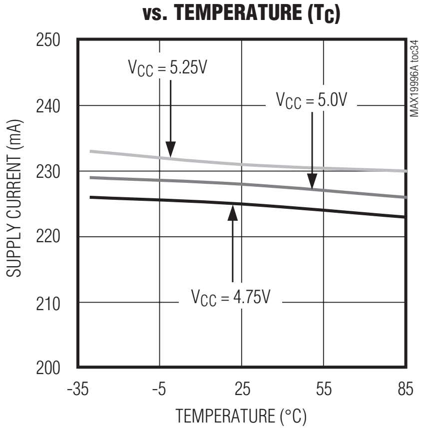
IF PORT RETURN LOSS vs. IF FREQUENCY



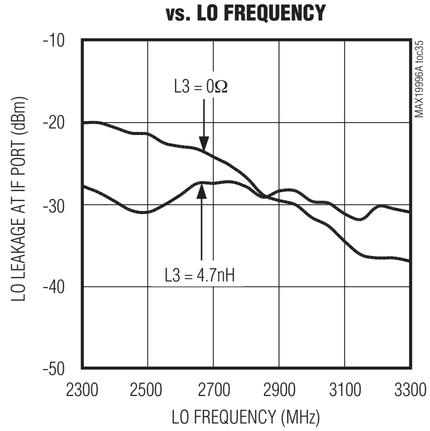
LO PORT RETURN LOSS vs. LO FREQUENCY



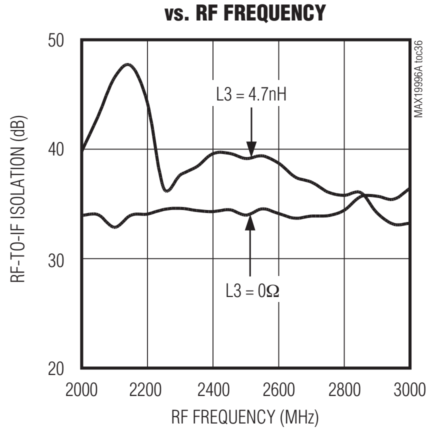
SUPPLY CURRENT vs. TEMPERATURE (T_C)



LO LEAKAGE AT IF PORT vs. LO FREQUENCY



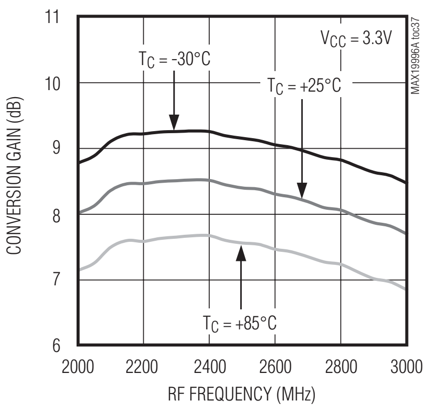
RF-TO-IF ISOLATION vs. RF FREQUENCY



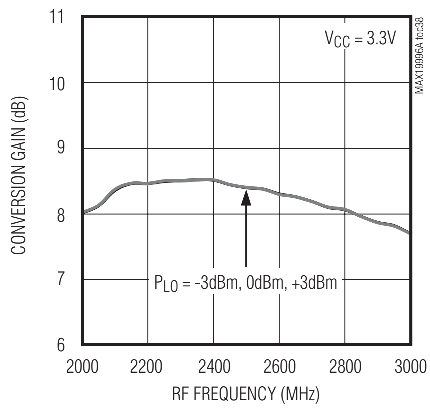
Typical Operating Characteristics

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 3.3V, f_{RF} = 2000MHz to 3000MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

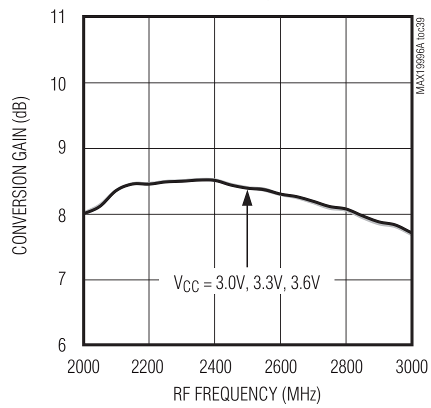
CONVERSION GAIN vs. RF FREQUENCY



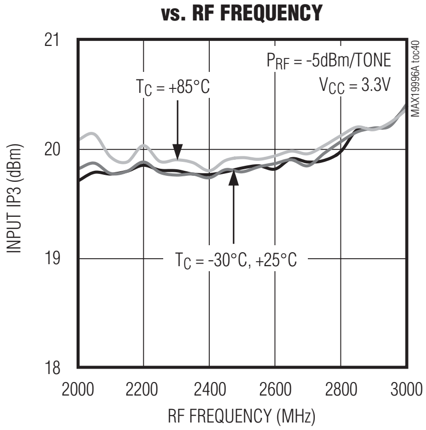
CONVERSION GAIN vs. RF FREQUENCY



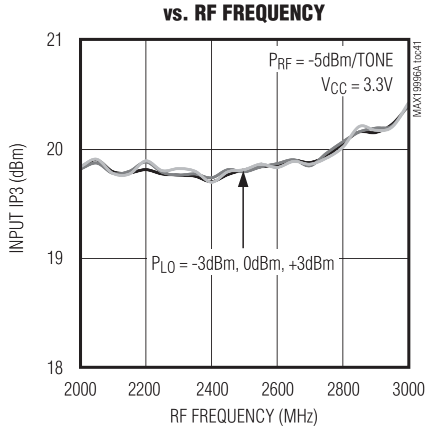
CONVERSION GAIN vs. RF FREQUENCY



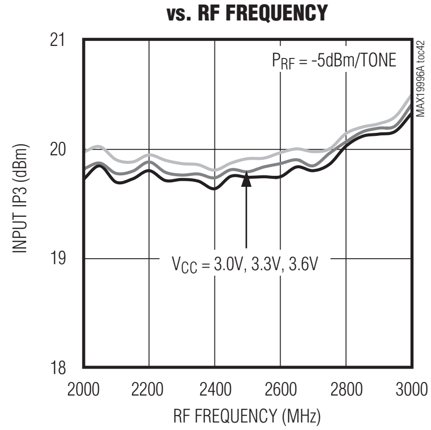
INPUT IP3 vs. RF FREQUENCY



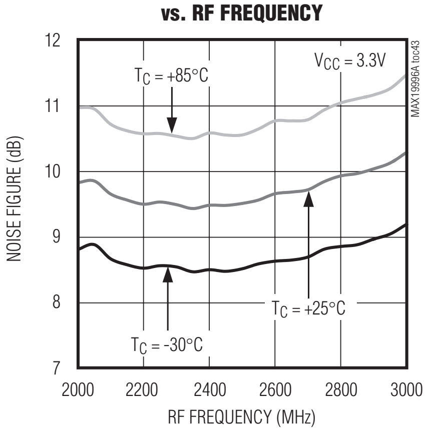
INPUT IP3 vs. RF FREQUENCY



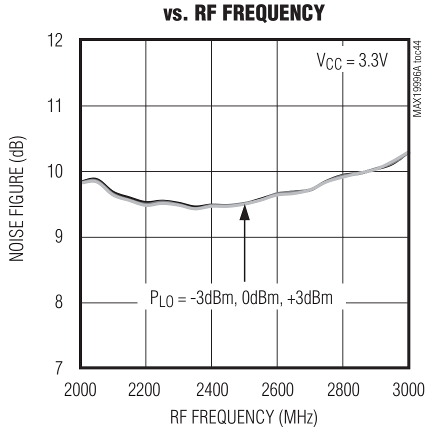
INPUT IP3 vs. RF FREQUENCY



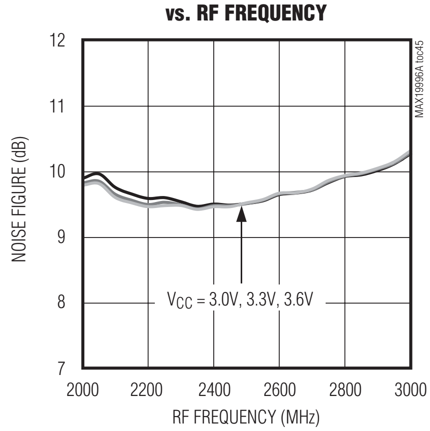
NOISE FIGURE vs. RF FREQUENCY



NOISE FIGURE vs. RF FREQUENCY



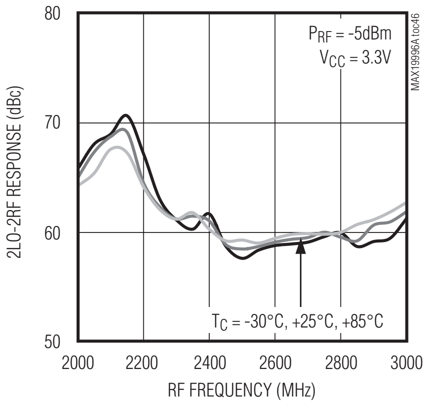
NOISE FIGURE vs. RF FREQUENCY



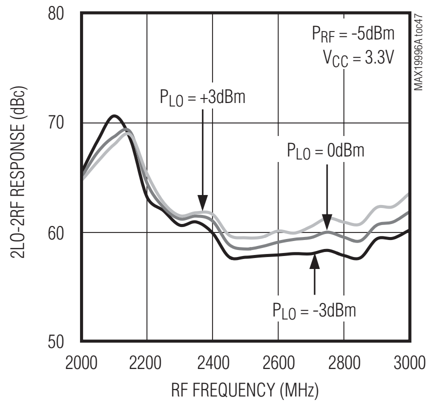
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 3.3V, f_{RF} = 2000MHz to 3000MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

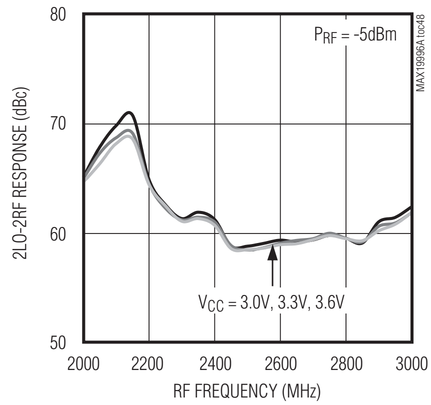
2LO-2RF RESPONSE vs. RF FREQUENCY



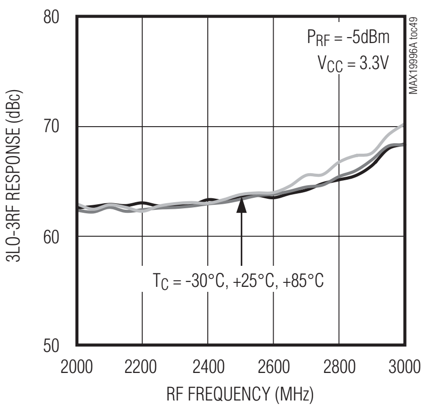
2LO-2RF RESPONSE vs. RF FREQUENCY



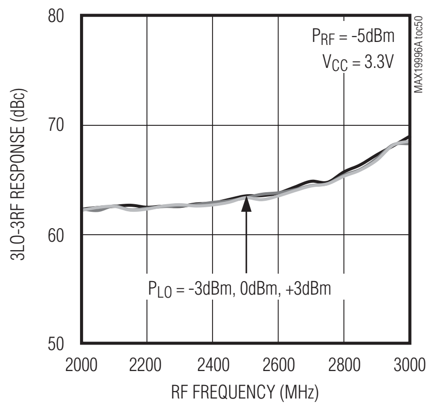
2LO-2RF RESPONSE vs. RF FREQUENCY



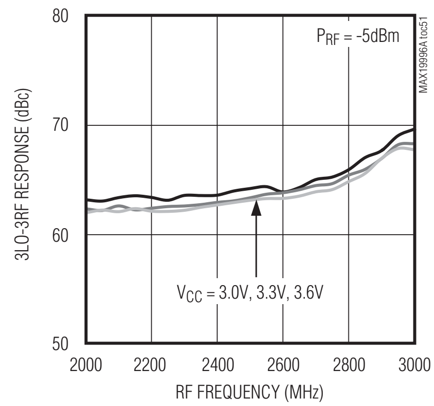
3LO-3RF RESPONSE vs. RF FREQUENCY



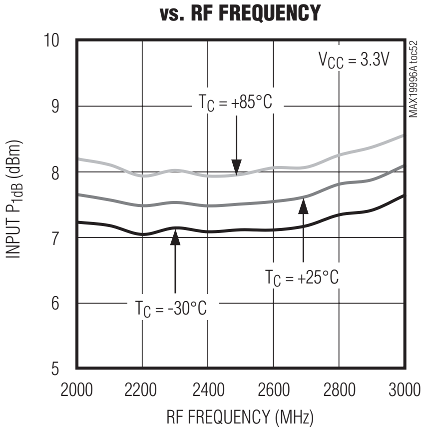
3LO-3RF RESPONSE vs. RF FREQUENCY



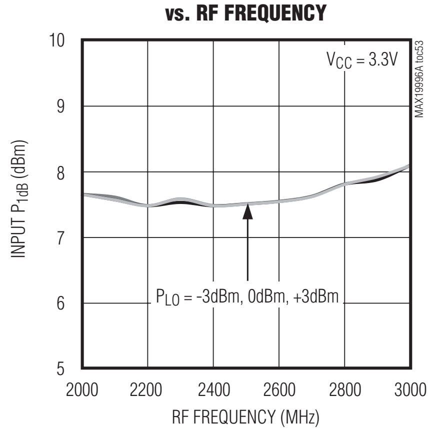
3LO-3RF RESPONSE vs. RF FREQUENCY



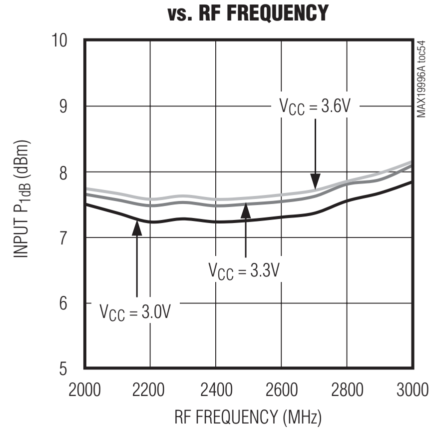
INPUT P_{1dB} vs. RF FREQUENCY



INPUT P_{1dB} vs. RF FREQUENCY



INPUT P_{1dB} vs. RF FREQUENCY

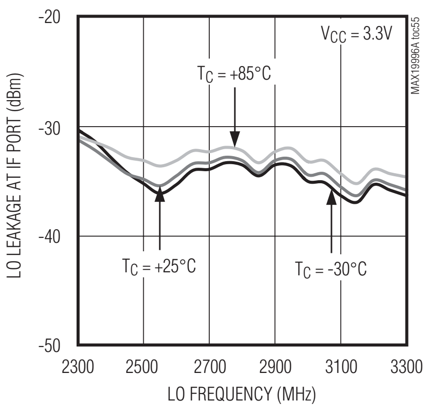


SiGe, High-Linearity, 2000MHz to 3900MHz Downconversion Mixer with LO Buffer

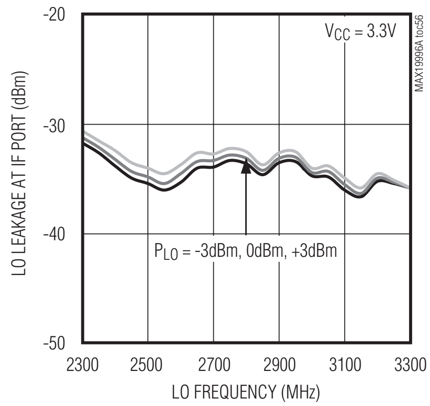
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 3.3V, f_{RF} = 2000MHz to 3000MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

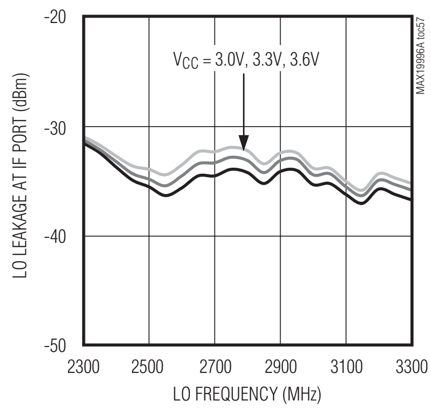
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



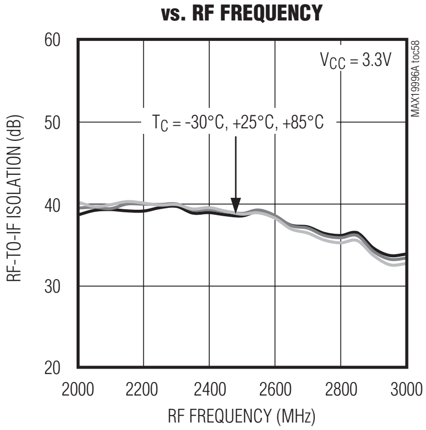
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



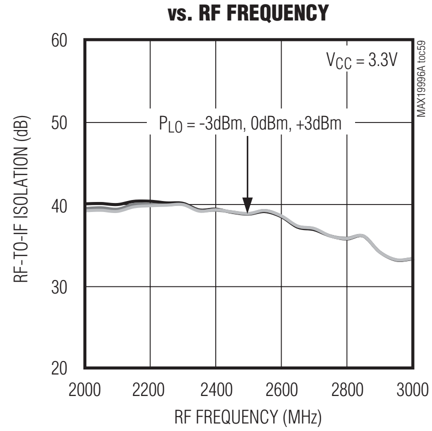
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



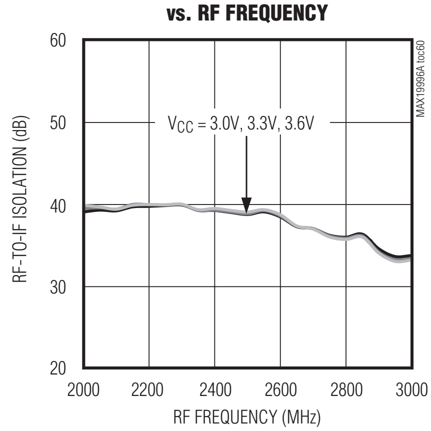
RF-TO-IF ISOLATION vs. RF FREQUENCY



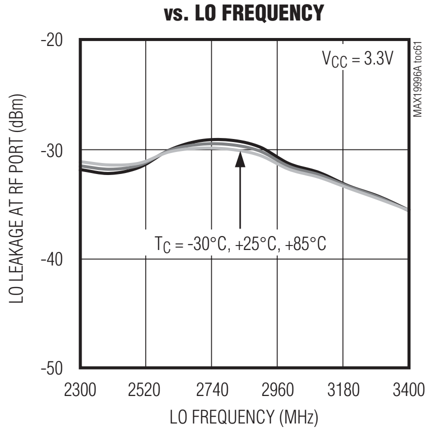
RF-TO-IF ISOLATION vs. RF FREQUENCY



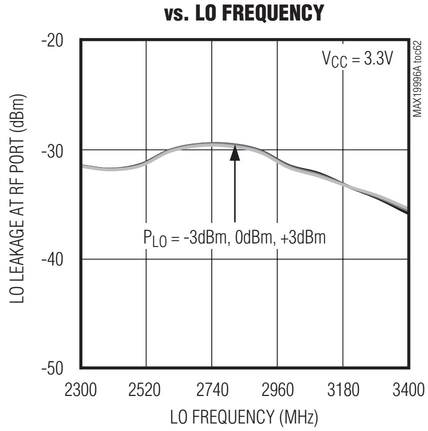
RF-TO-IF ISOLATION vs. RF FREQUENCY



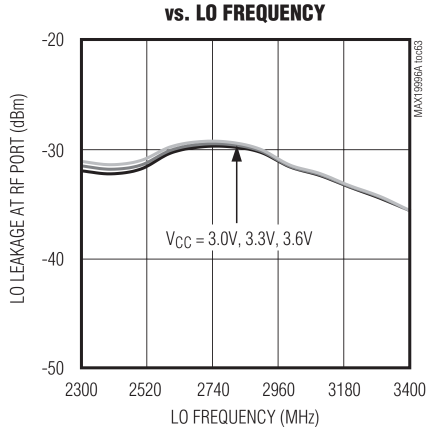
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



LO LEAKAGE AT RF PORT vs. LO FREQUENCY



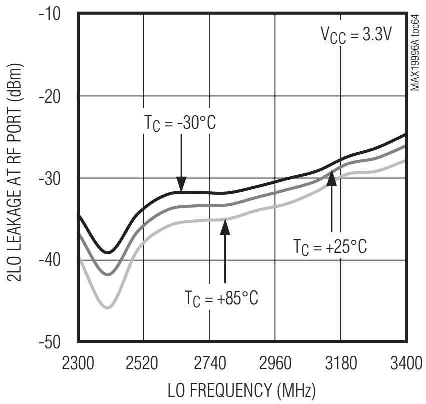
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



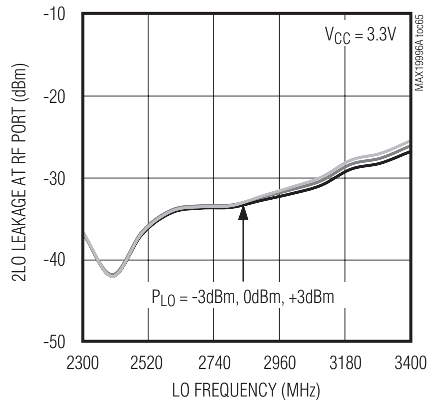
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 3.3V, f_{RF} = 2000MHz to 3000MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

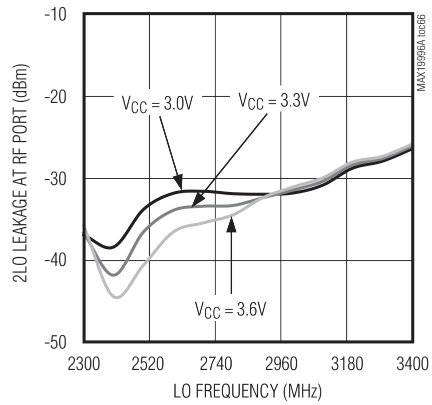
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



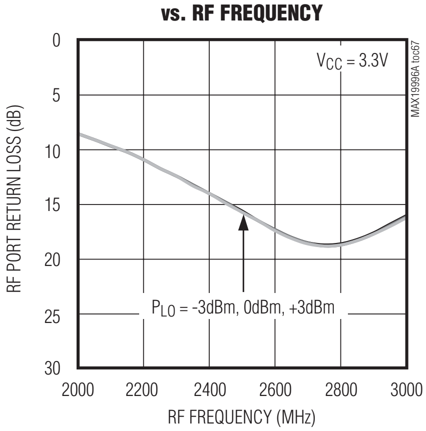
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



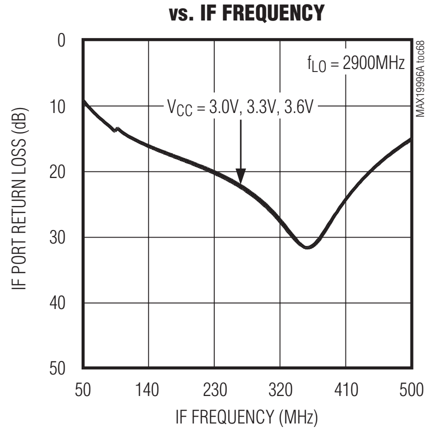
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



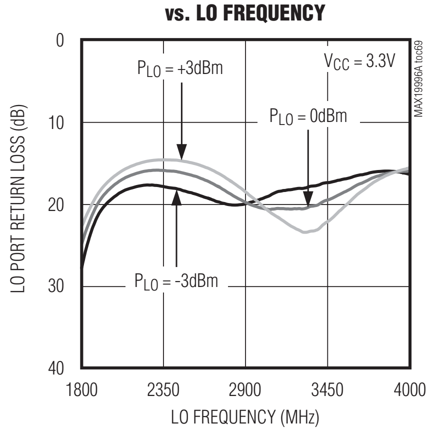
RF PORT RETURN LOSS vs. RF FREQUENCY



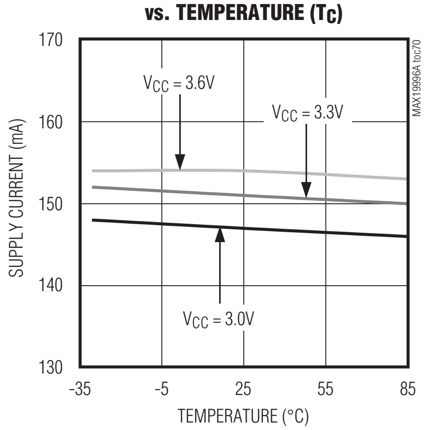
IF PORT RETURN LOSS vs. IF FREQUENCY



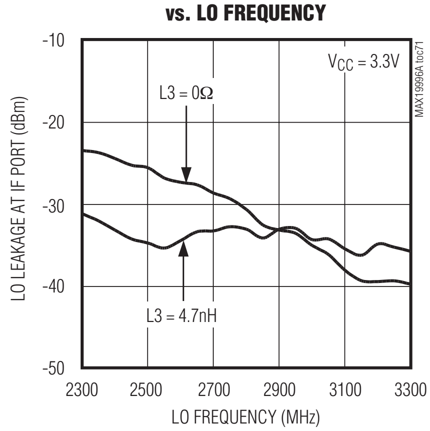
LO PORT RETURN LOSS vs. LO FREQUENCY



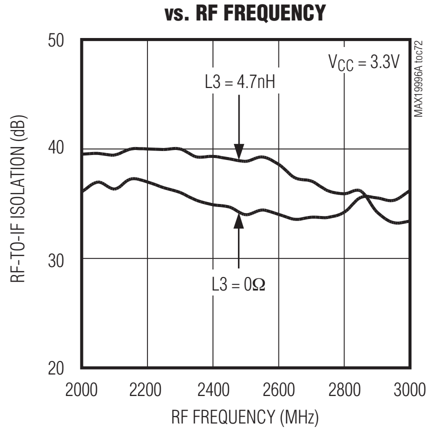
SUPPLY CURRENT vs. TEMPERATURE (T_C)



LO LEAKAGE AT IF PORT vs. LO FREQUENCY



RF-TO-IF ISOLATION vs. RF FREQUENCY

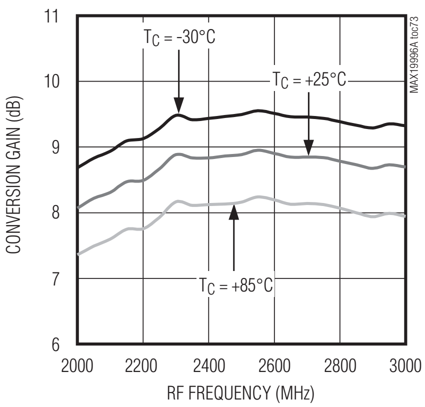


SiGe, High-Linearity, 2000MHz to 3900MHz Downconversion Mixer with LO Buffer

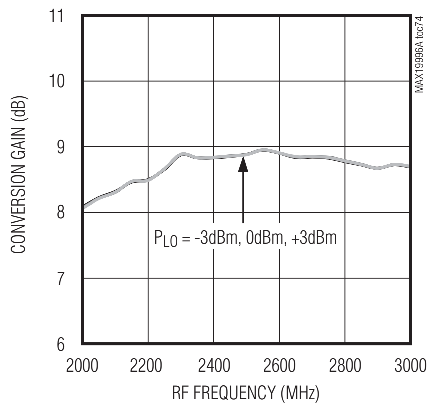
Typical Operating Characteristics

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 2000MHz to 3000MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

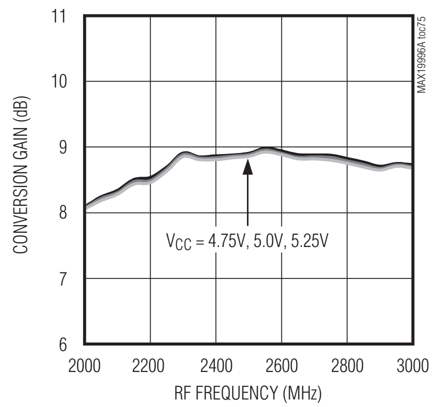
CONVERSION GAIN vs. RF FREQUENCY



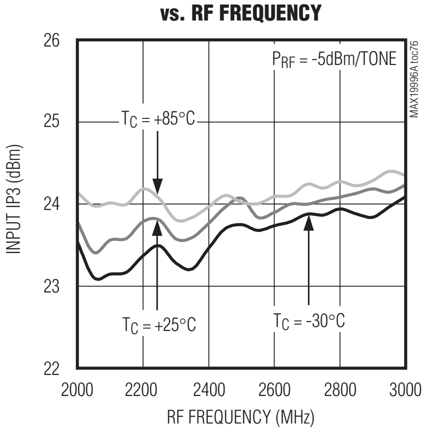
CONVERSION GAIN vs. RF FREQUENCY



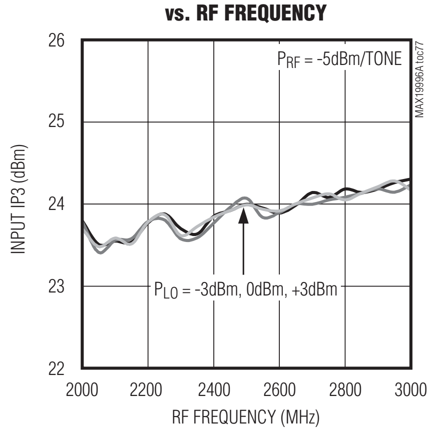
CONVERSION GAIN vs. RF FREQUENCY



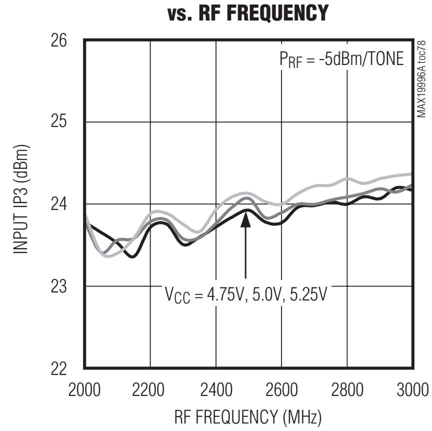
INPUT IP3 vs. RF FREQUENCY



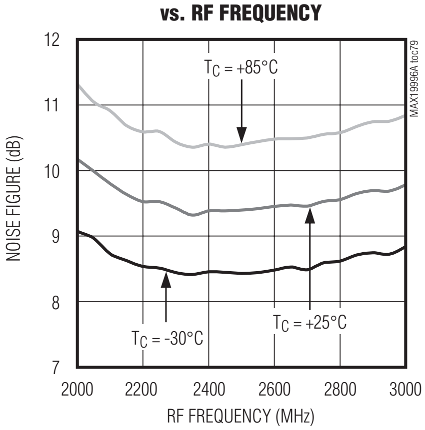
INPUT IP3 vs. RF FREQUENCY



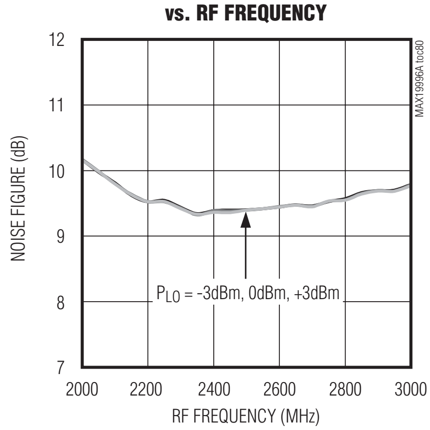
INPUT IP3 vs. RF FREQUENCY



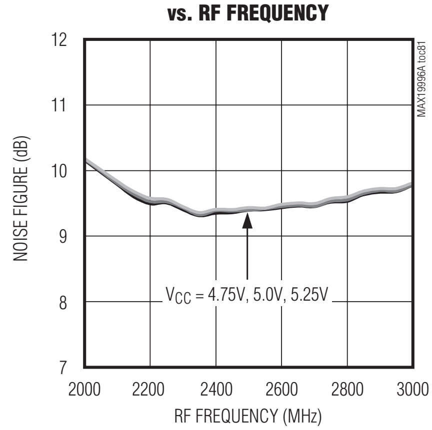
NOISE FIGURE vs. RF FREQUENCY



NOISE FIGURE vs. RF FREQUENCY



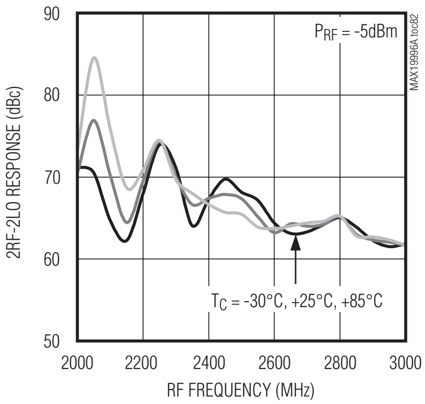
NOISE FIGURE vs. RF FREQUENCY



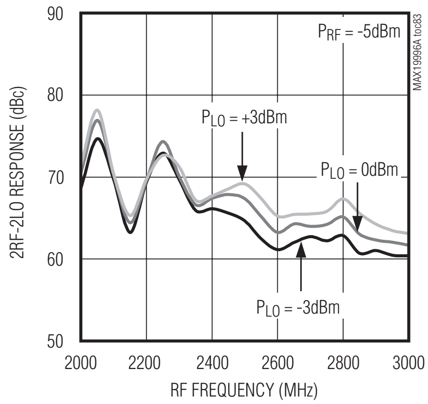
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 2000MHz to 3000MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

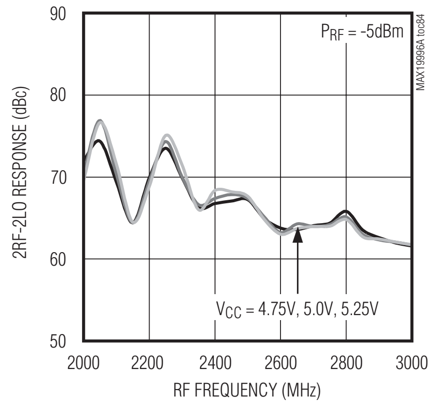
2RF-2LO RESPONSE vs. RF FREQUENCY



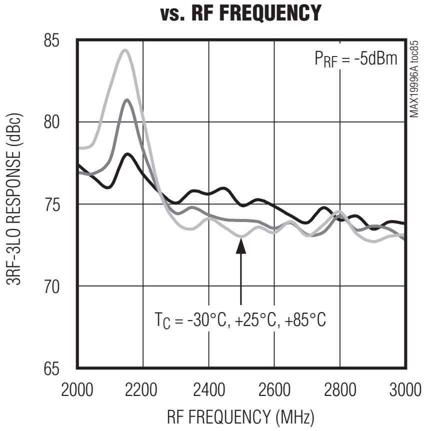
2RF-2LO RESPONSE vs. RF FREQUENCY



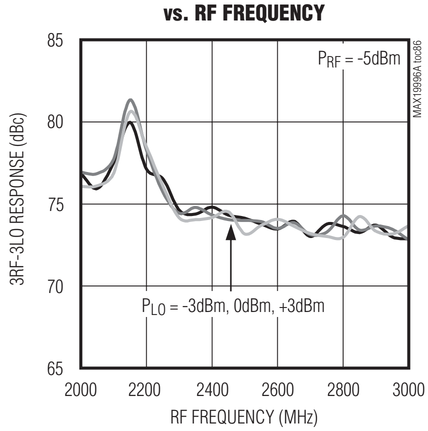
2RF-2LO RESPONSE vs. RF FREQUENCY



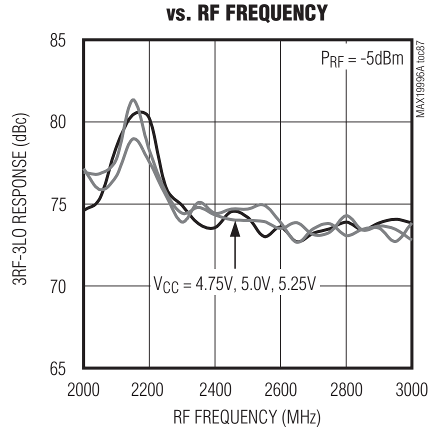
3RF-3LO RESPONSE vs. RF FREQUENCY



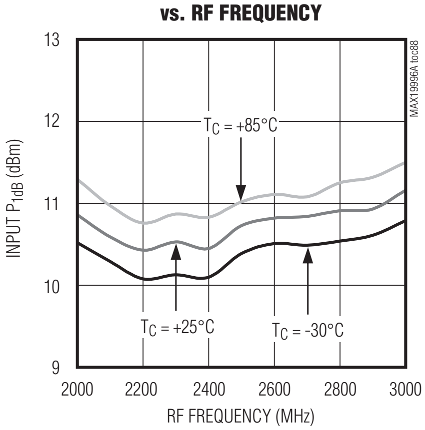
3RF-3LO RESPONSE vs. RF FREQUENCY



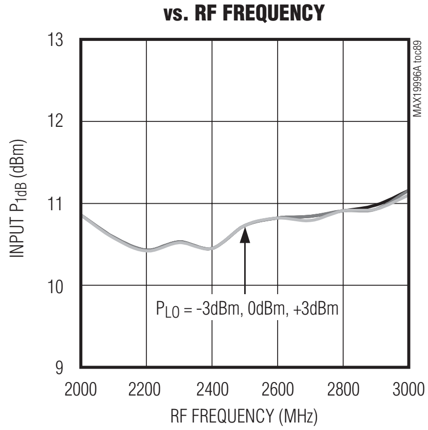
3RF-3LO RESPONSE vs. RF FREQUENCY



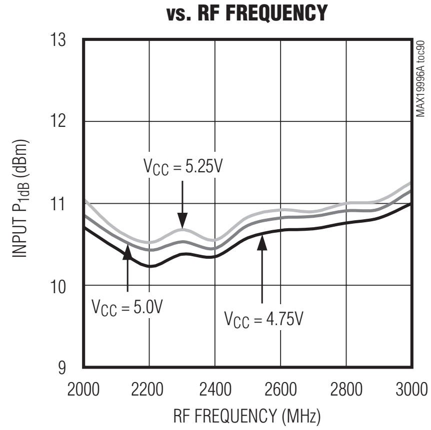
INPUT P_{1dB} vs. RF FREQUENCY



INPUT P_{1dB} vs. RF FREQUENCY



INPUT P_{1dB} vs. RF FREQUENCY

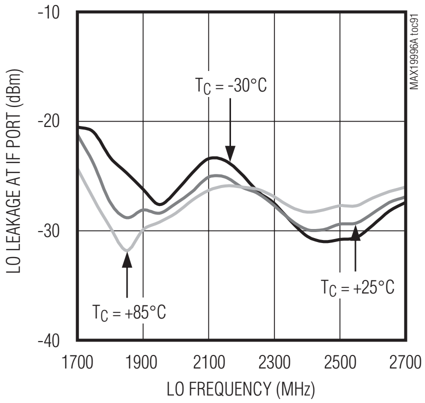


SiGe, High-Linearity, 2000MHz to 3900MHz Downconversion Mixer with LO Buffer

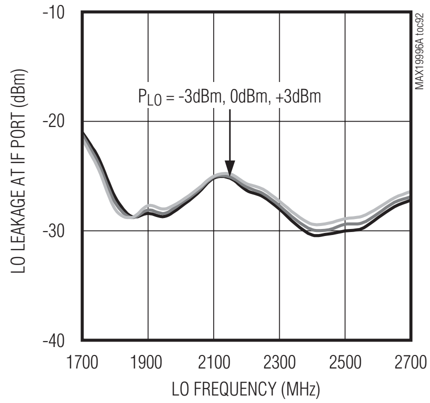
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 2000MHz to 3000MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

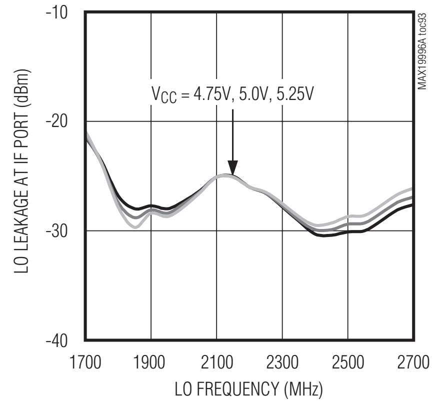
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



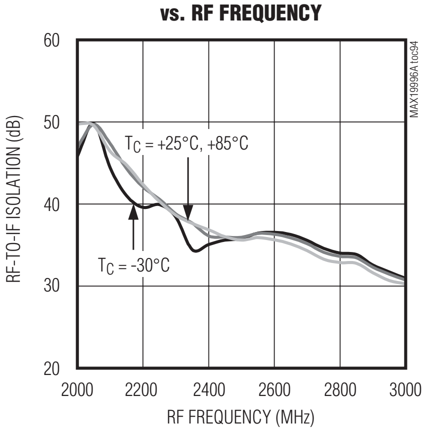
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



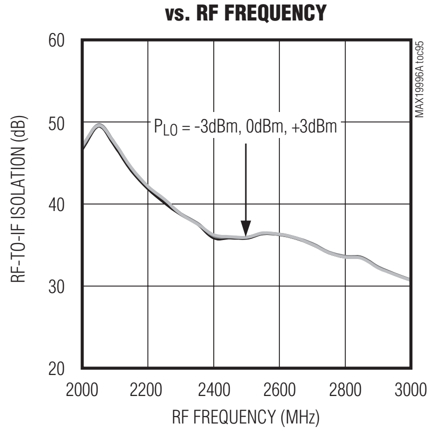
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



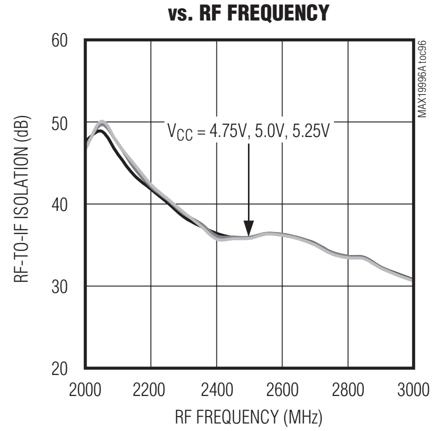
RF-TO-IF ISOLATION vs. RF FREQUENCY



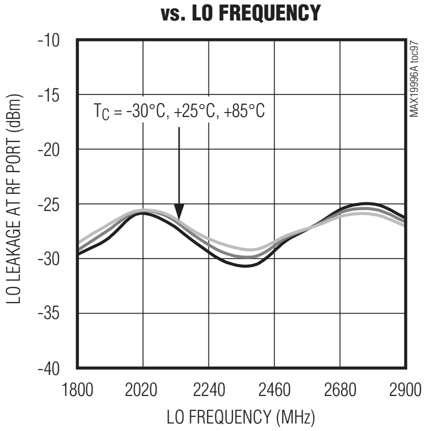
RF-TO-IF ISOLATION vs. RF FREQUENCY



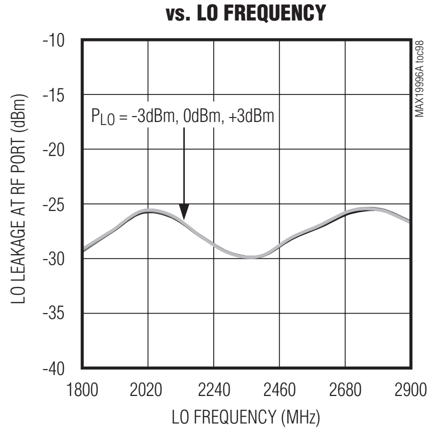
RF-TO-IF ISOLATION vs. RF FREQUENCY



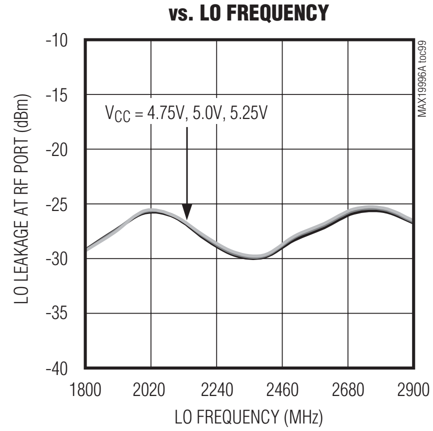
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



LO LEAKAGE AT RF PORT vs. LO FREQUENCY



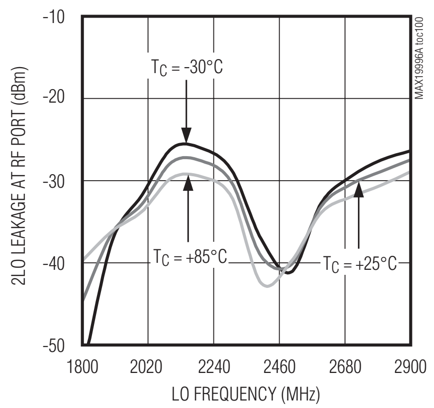
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



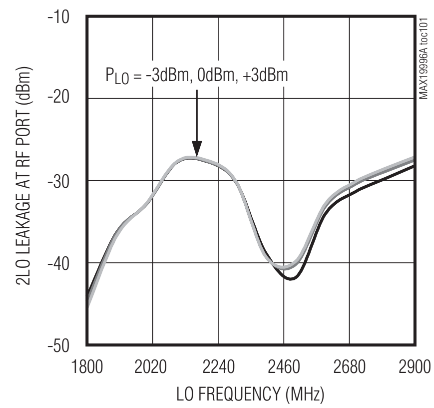
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 2000MHz to 3000MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

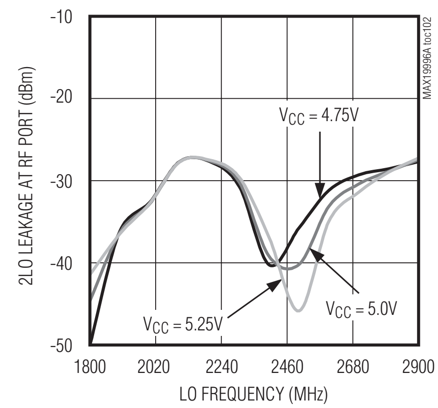
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



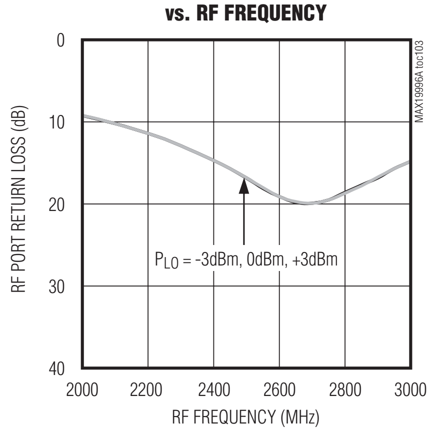
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



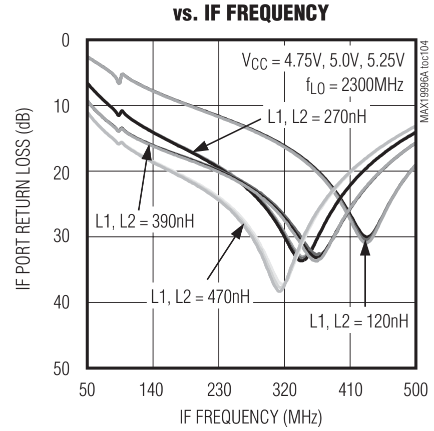
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



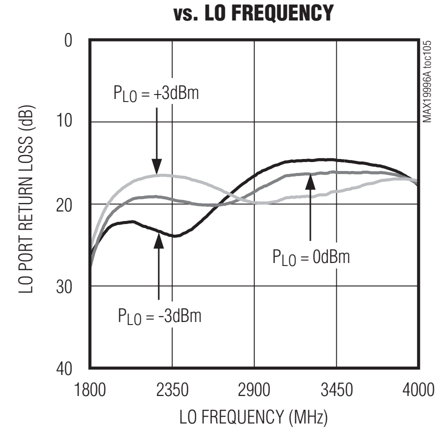
RF PORT RETURN LOSS vs. RF FREQUENCY



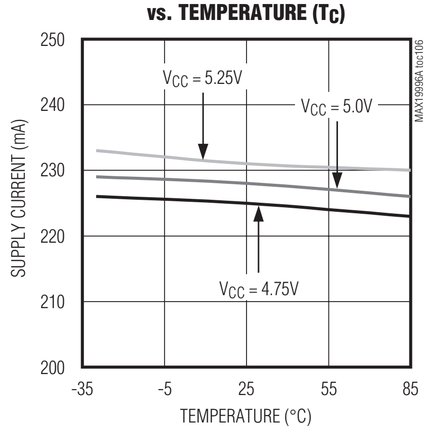
IF PORT RETURN LOSS vs. IF FREQUENCY



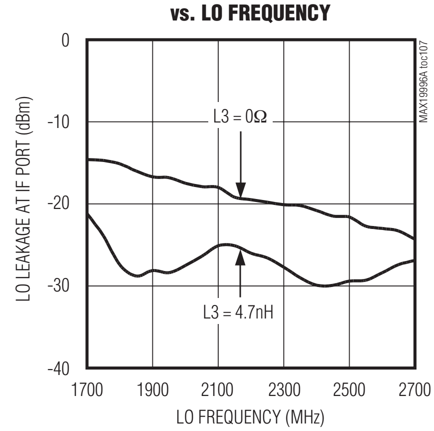
LO PORT RETURN LOSS vs. LO FREQUENCY



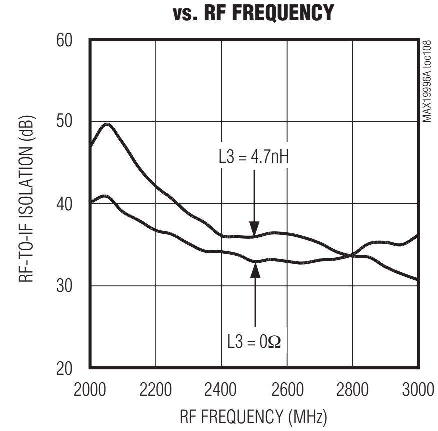
SUPPLY CURRENT vs. TEMPERATURE (T_C)



LO LEAKAGE AT IF PORT vs. LO FREQUENCY



RF-TO-IF ISOLATION vs. RF FREQUENCY

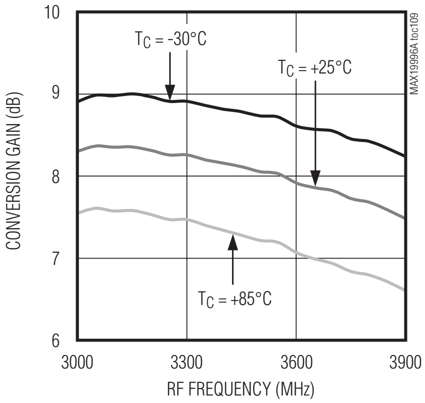


SiGe, High-Linearity, 2000MHz to 3900MHz Downconversion Mixer with LO Buffer

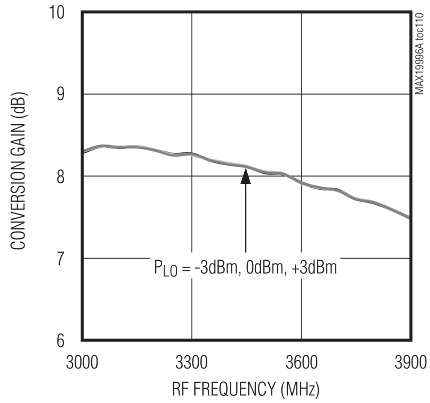
Typical Operating Characteristics

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 3000MHz to 3900MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

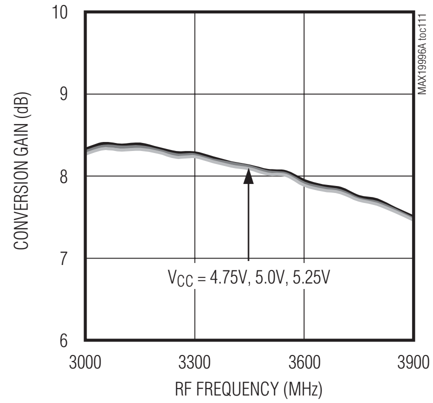
CONVERSION GAIN vs. RF FREQUENCY



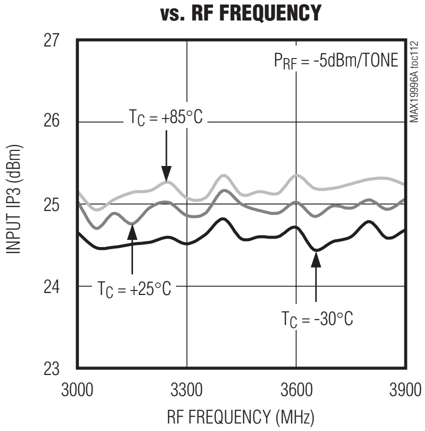
CONVERSION GAIN vs. RF FREQUENCY



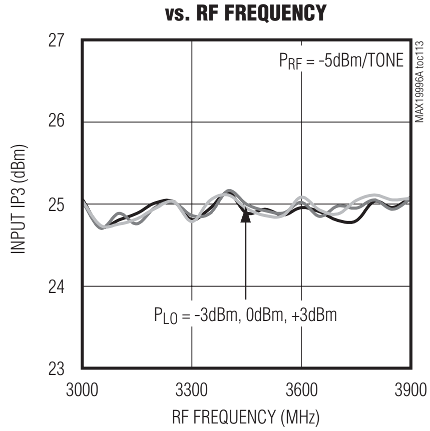
CONVERSION GAIN vs. RF FREQUENCY



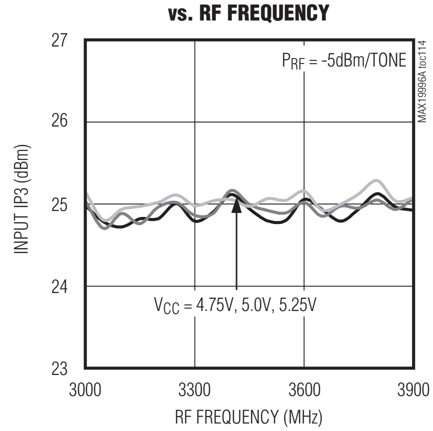
INPUT IP3 vs. RF FREQUENCY



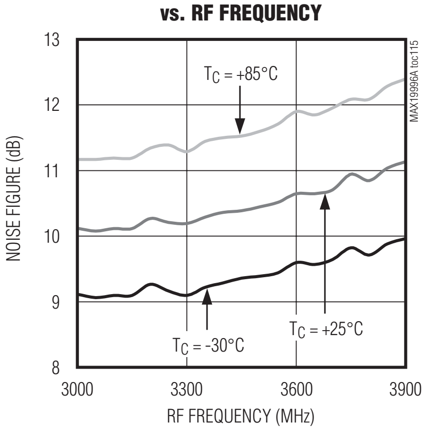
INPUT IP3 vs. RF FREQUENCY



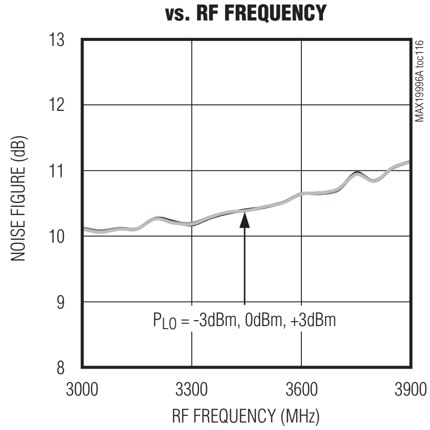
INPUT IP3 vs. RF FREQUENCY



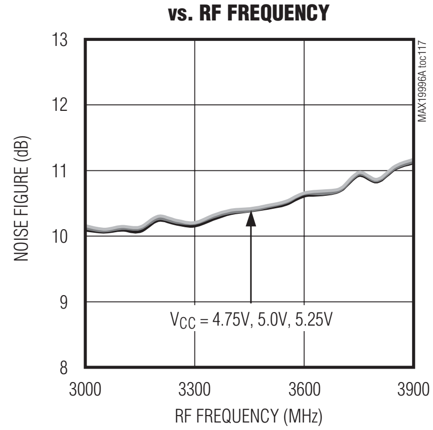
NOISE FIGURE vs. RF FREQUENCY



NOISE FIGURE vs. RF FREQUENCY



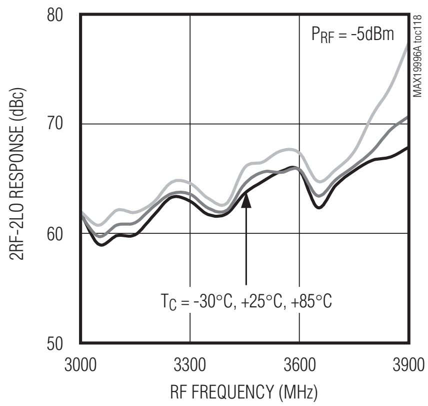
NOISE FIGURE vs. RF FREQUENCY



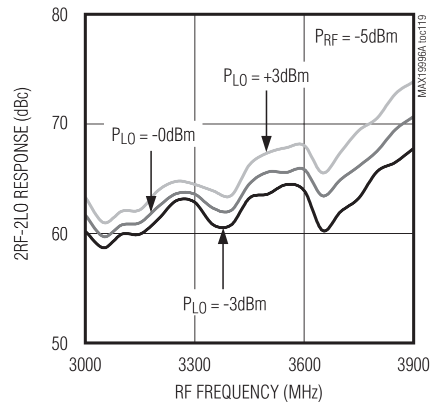
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 3000MHz to 3900MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

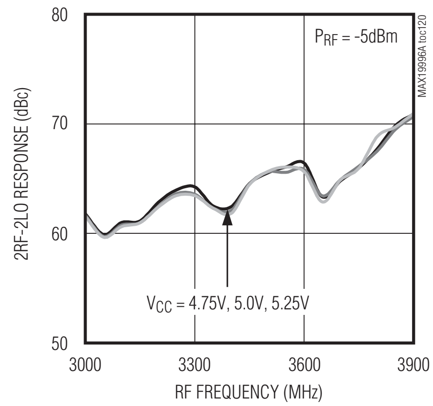
2RF-2LO RESPONSE vs. RF FREQUENCY



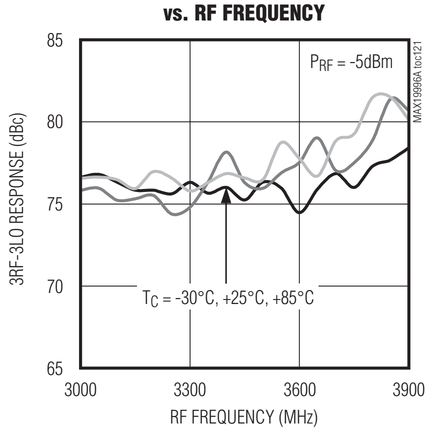
2RF-2LO RESPONSE vs. RF FREQUENCY



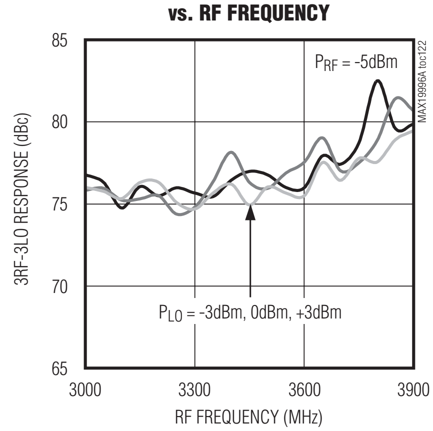
2RF-2LO RESPONSE vs. RF FREQUENCY



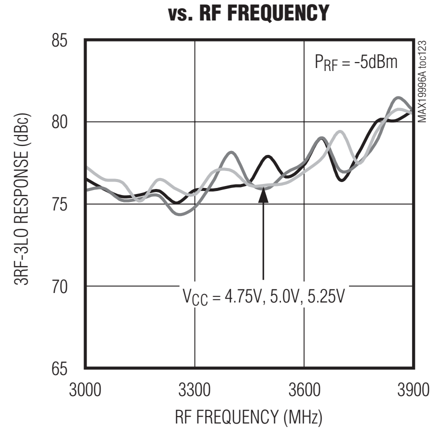
3RF-3LO RESPONSE vs. RF FREQUENCY



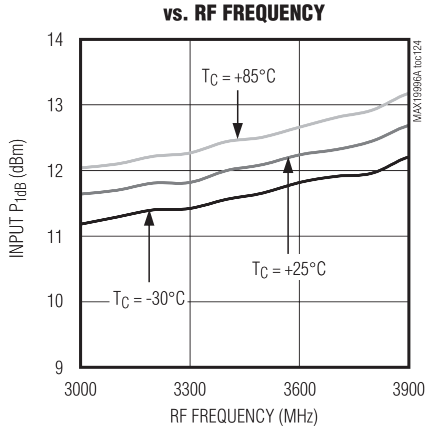
3RF-3LO RESPONSE vs. RF FREQUENCY



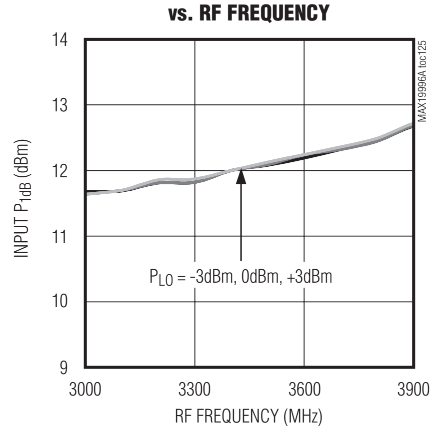
3RF-3LO RESPONSE vs. RF FREQUENCY



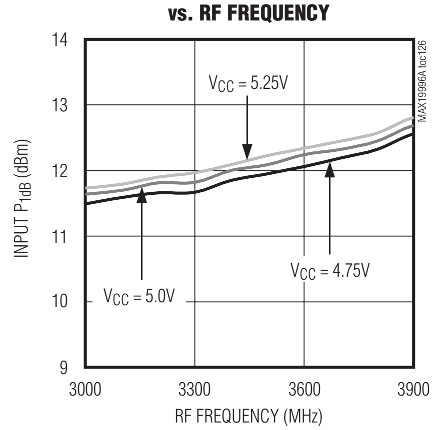
INPUT P_{1dB} vs. RF FREQUENCY



INPUT P_{1dB} vs. RF FREQUENCY



INPUT P_{1dB} vs. RF FREQUENCY

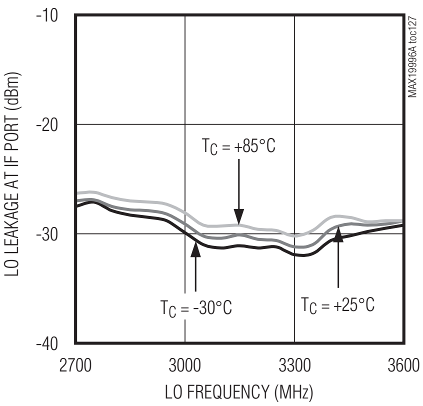


SiGe, High-Linearity, 2000MHz to 3900MHz Downconversion Mixer with LO Buffer

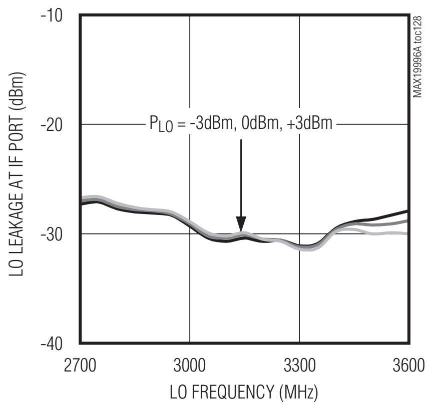
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 3000MHz to 3900MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

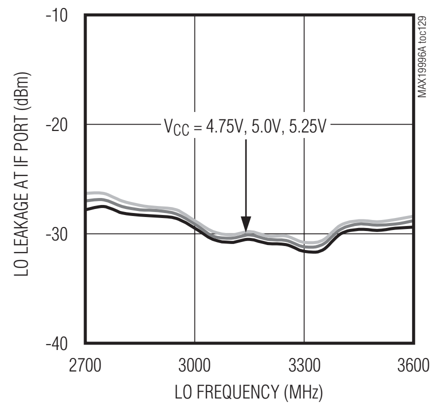
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



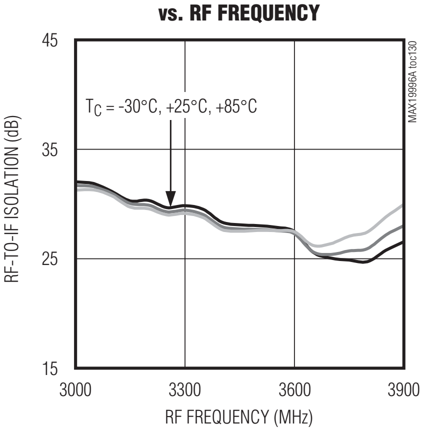
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



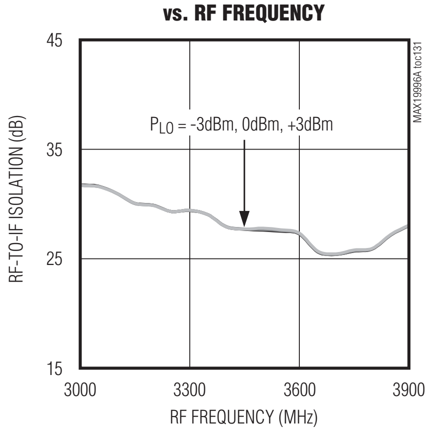
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



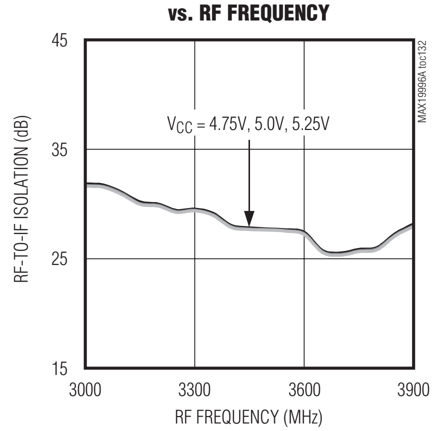
RF-TO-IF ISOLATION vs. RF FREQUENCY



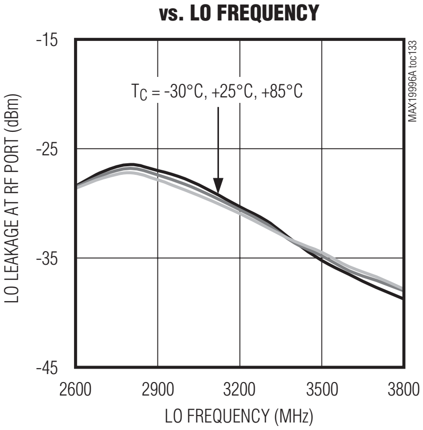
RF-TO-IF ISOLATION vs. RF FREQUENCY



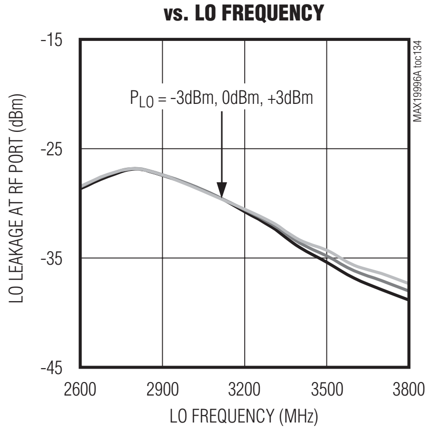
RF-TO-IF ISOLATION vs. RF FREQUENCY



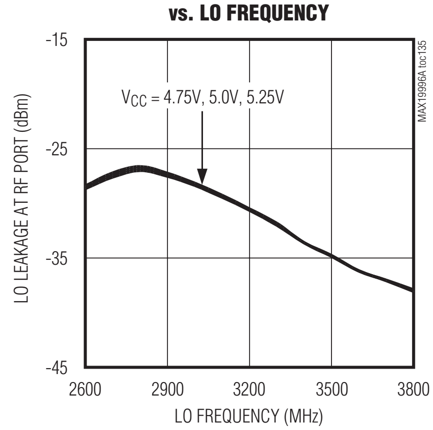
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



LO LEAKAGE AT RF PORT vs. LO FREQUENCY



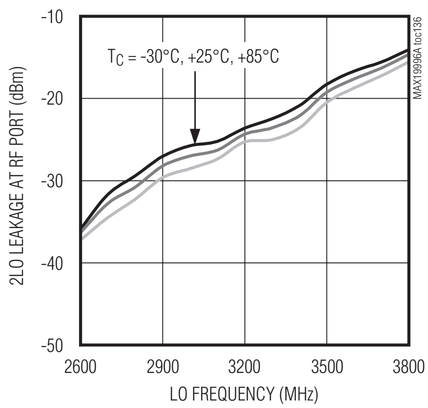
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



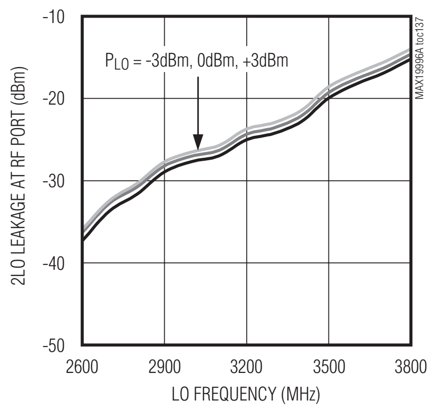
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 3000MHz to 3900MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

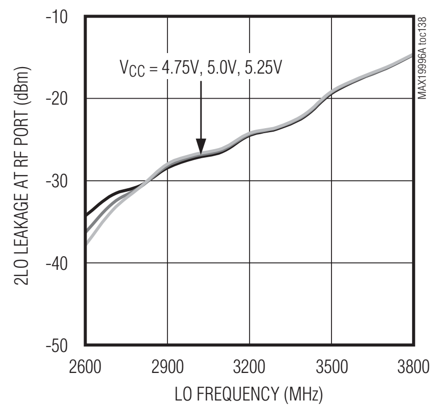
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



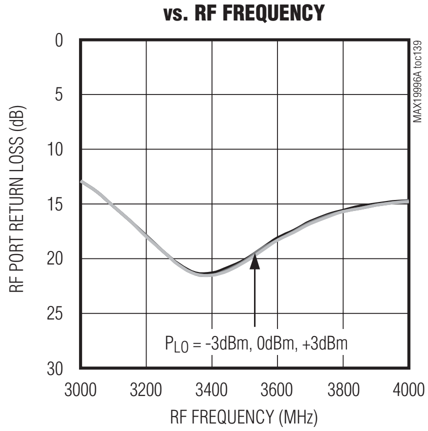
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



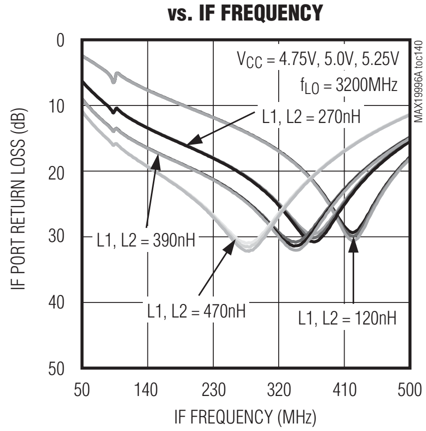
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



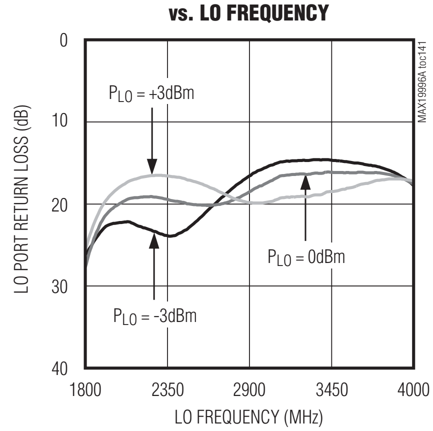
RF PORT RETURN LOSS vs. RF FREQUENCY



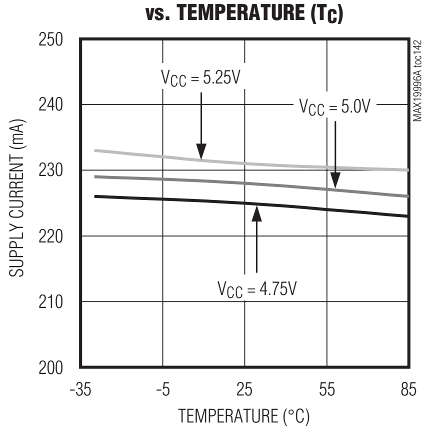
IF PORT RETURN LOSS vs. IF FREQUENCY



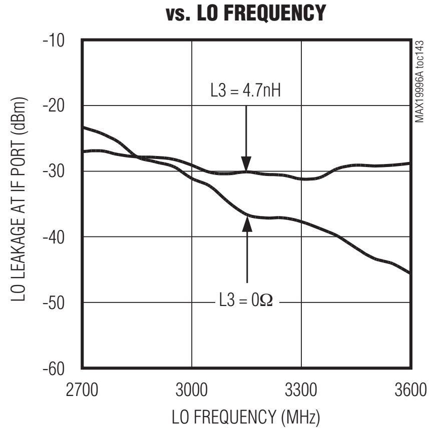
LO PORT RETURN LOSS vs. LO FREQUENCY



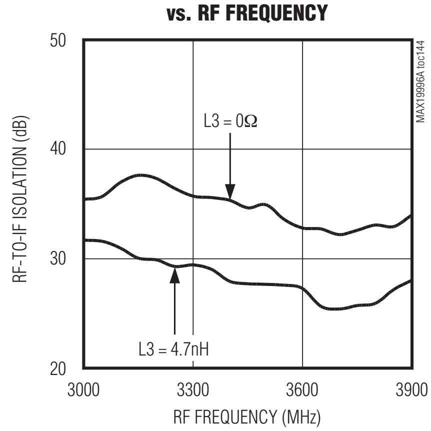
SUPPLY CURRENT vs. TEMPERATURE (T_C)



LO LEAKAGE AT IF PORT vs. LO FREQUENCY



RF-TO-IF ISOLATION vs. RF FREQUENCY

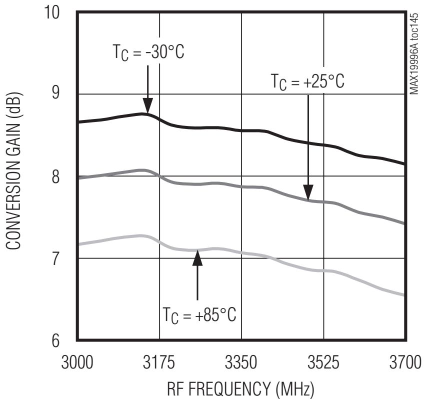


SiGe, High-Linearity, 2000MHz to 3900MHz Downconversion Mixer with LO Buffer

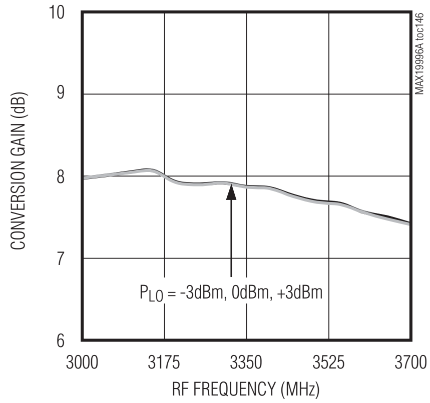
Typical Operating Characteristics

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 3000MHz to 3700MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

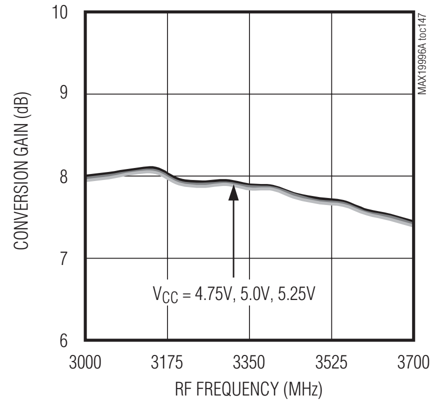
CONVERSION GAIN vs. RF FREQUENCY



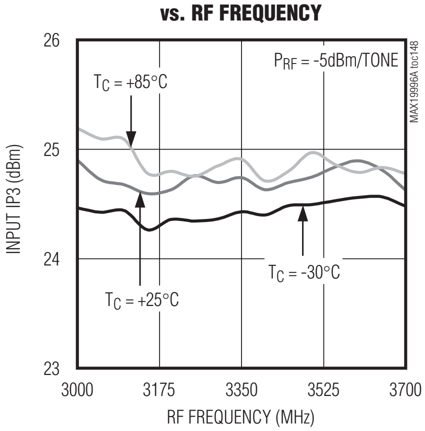
CONVERSION GAIN vs. RF FREQUENCY



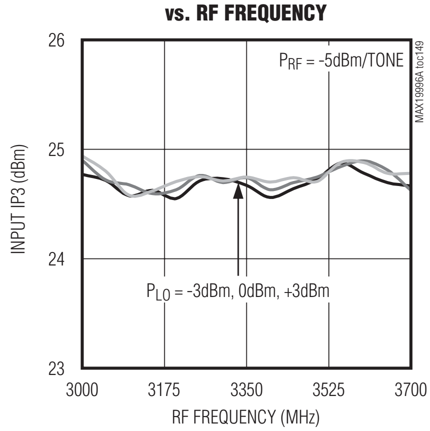
CONVERSION GAIN vs. RF FREQUENCY



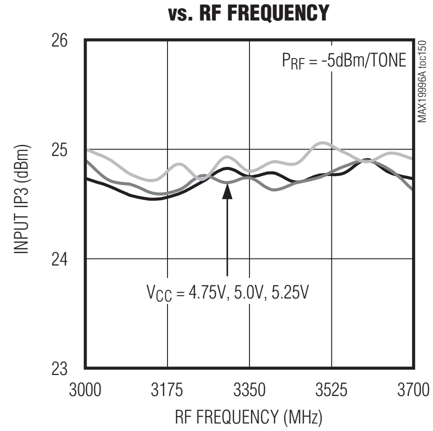
INPUT IP3 vs. RF FREQUENCY



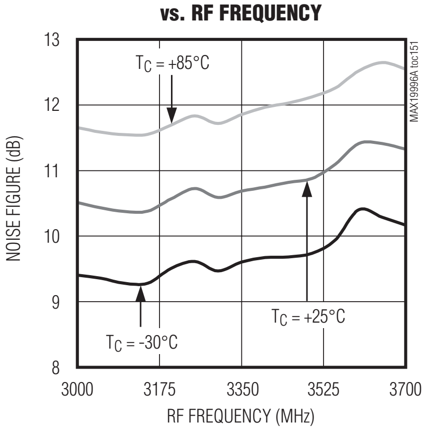
INPUT IP3 vs. RF FREQUENCY



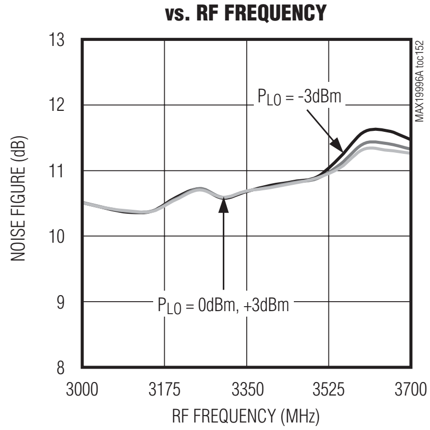
INPUT IP3 vs. RF FREQUENCY



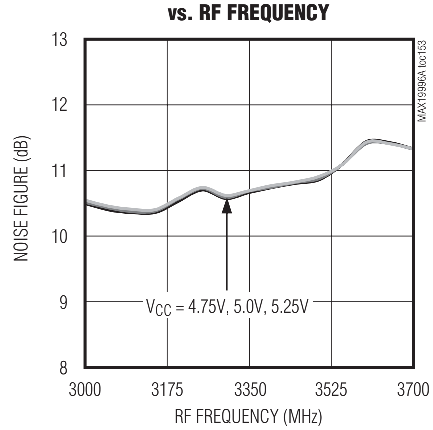
NOISE FIGURE vs. RF FREQUENCY



NOISE FIGURE vs. RF FREQUENCY



NOISE FIGURE vs. RF FREQUENCY

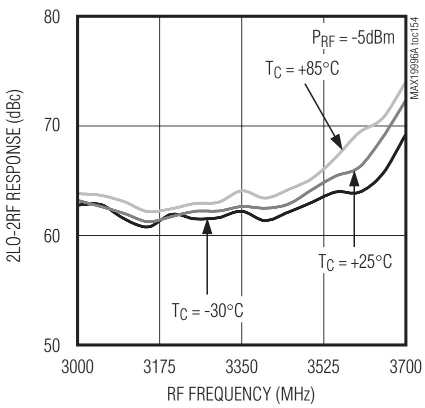


SiGe, High-Linearity, 2000MHz to 3900MHz Downconversion Mixer with LO Buffer

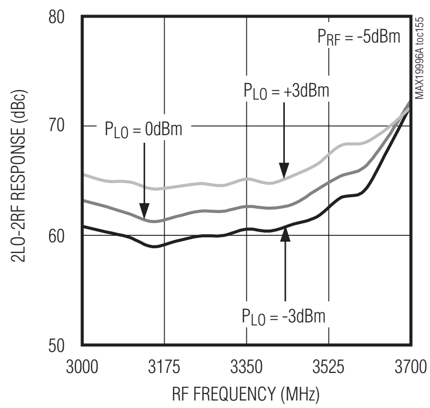
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 3000MHz to 3700MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

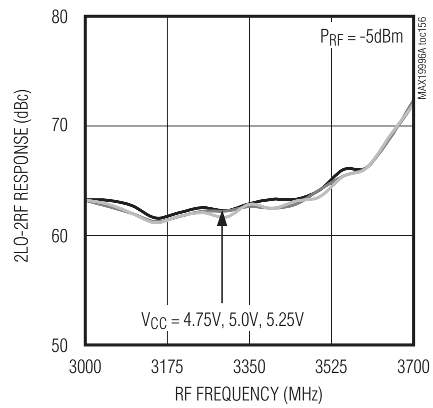
2LO-2RF RESPONSE vs. RF FREQUENCY



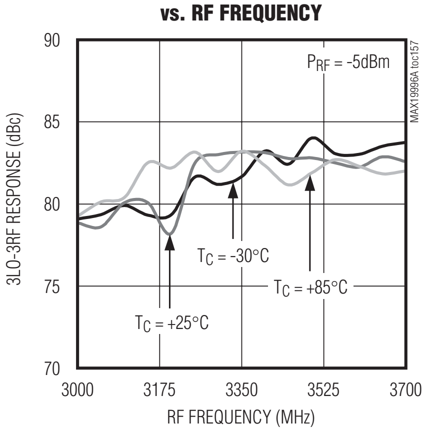
2LO-2RF RESPONSE vs. RF FREQUENCY



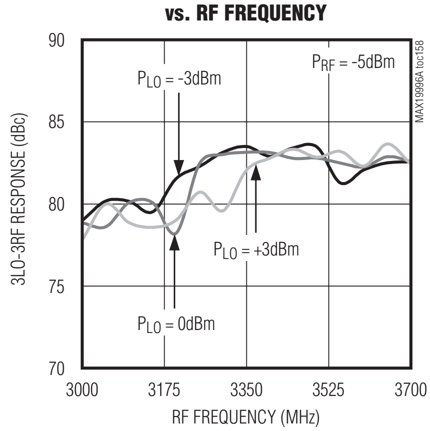
2LO-2RF RESPONSE vs. RF FREQUENCY



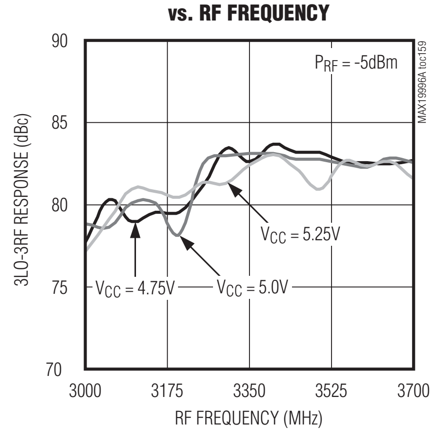
3LO-3RF RESPONSE vs. RF FREQUENCY



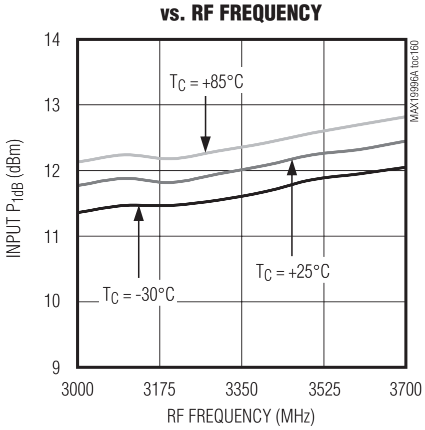
3LO-3RF RESPONSE vs. RF FREQUENCY



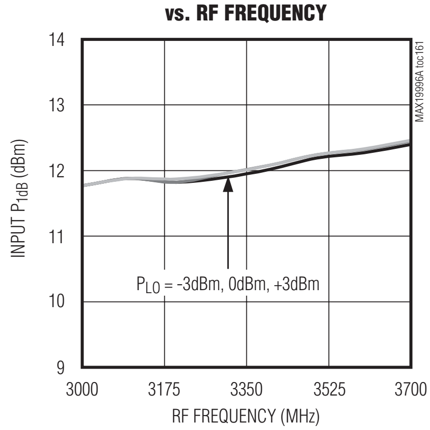
3LO-3RF RESPONSE vs. RF FREQUENCY



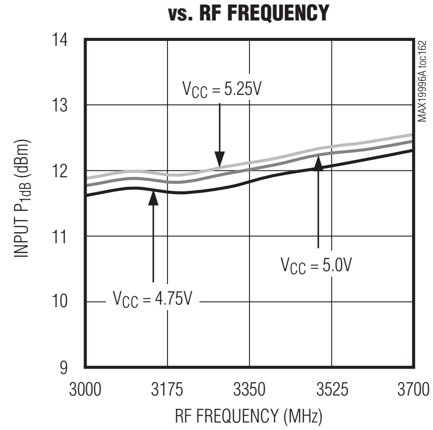
INPUT P_{1dB} vs. RF FREQUENCY



INPUT P_{1dB} vs. RF FREQUENCY



INPUT P_{1dB} vs. RF FREQUENCY

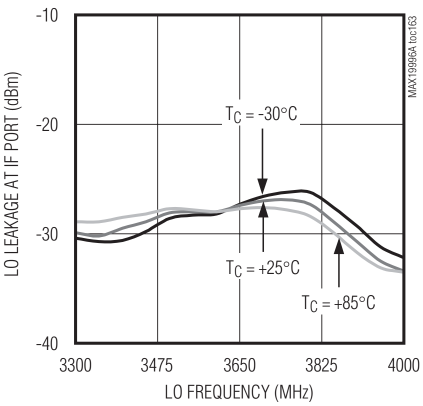


SiGe, High-Linearity, 2000MHz to 3900MHz Downconversion Mixer with LO Buffer

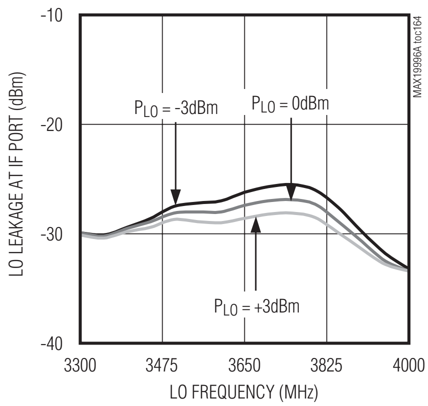
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 3000MHz to 3700MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

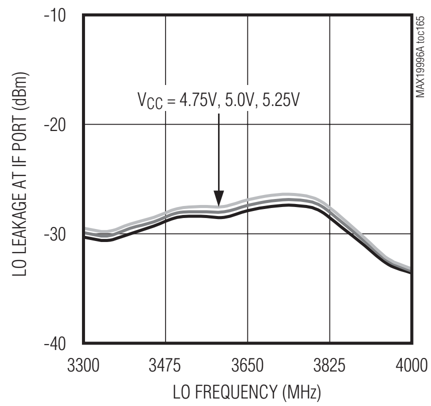
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



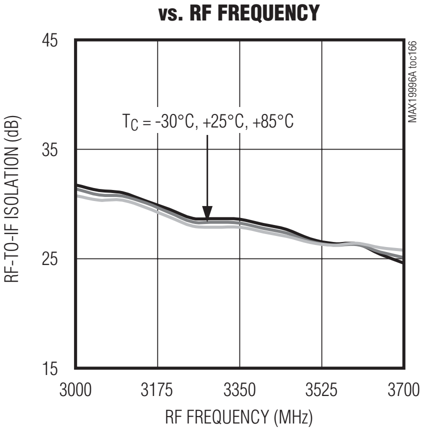
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



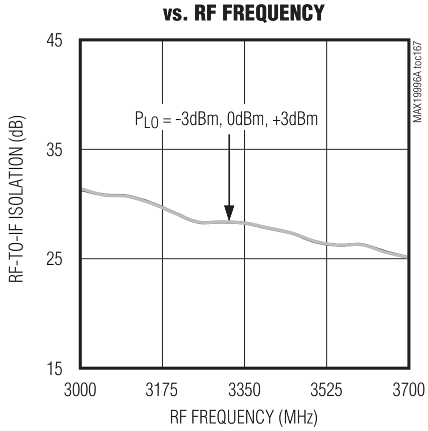
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



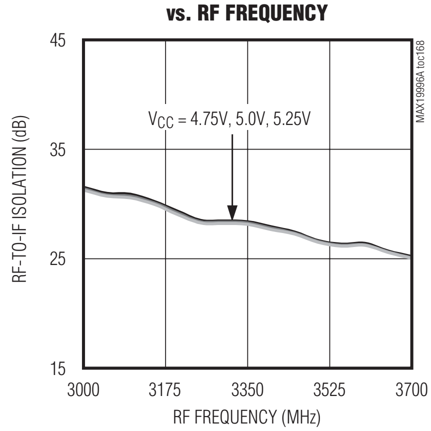
RF-TO-IF ISOLATION vs. RF FREQUENCY



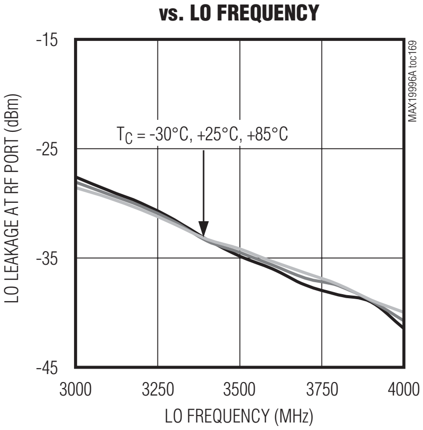
RF-TO-IF ISOLATION vs. RF FREQUENCY



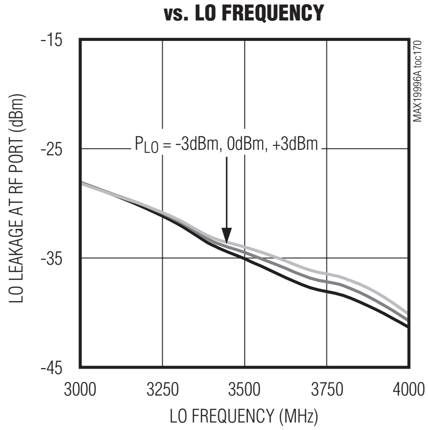
RF-TO-IF ISOLATION vs. RF FREQUENCY



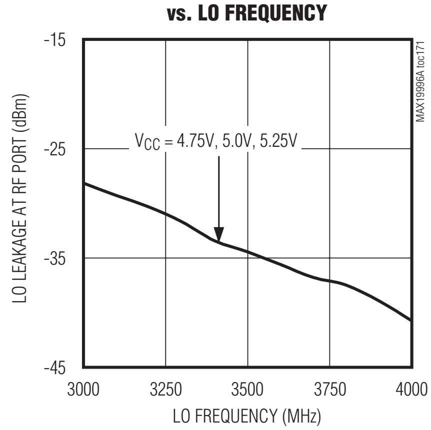
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



LO LEAKAGE AT RF PORT vs. LO FREQUENCY



LO LEAKAGE AT RF PORT vs. LO FREQUENCY

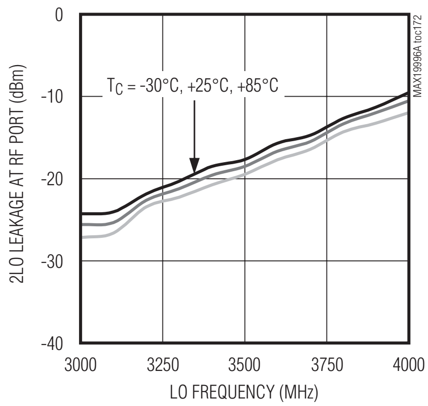


SiGe, High-Linearity, 2000MHz to 3900MHz Downconversion Mixer with LO Buffer

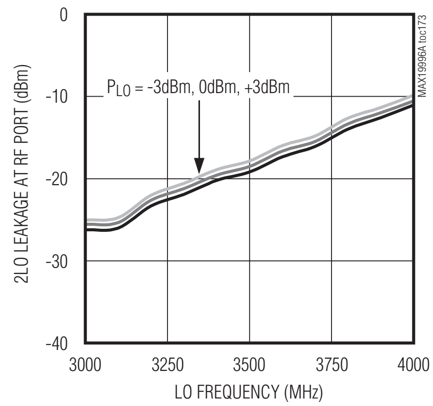
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 3000MHz to 3700MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

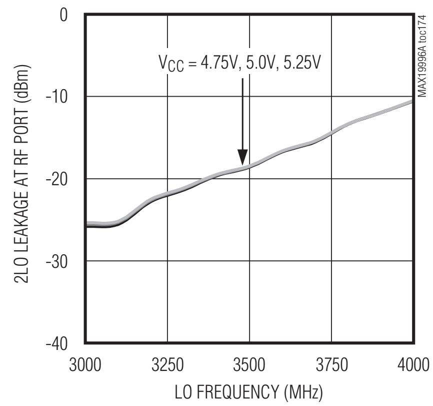
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



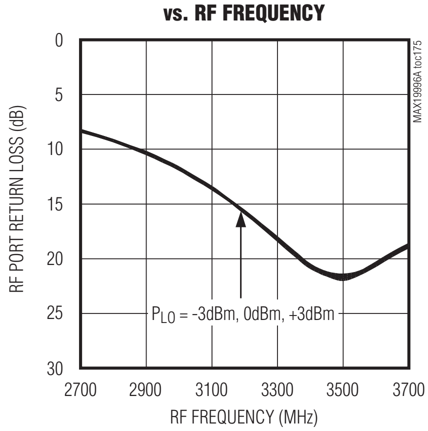
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



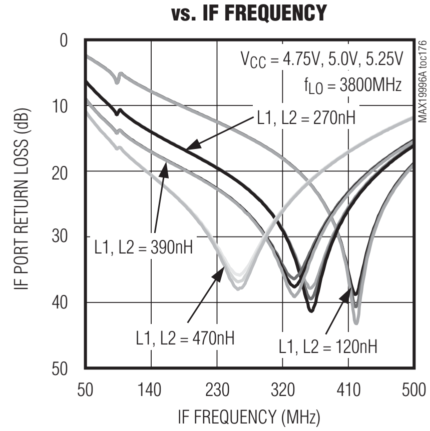
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



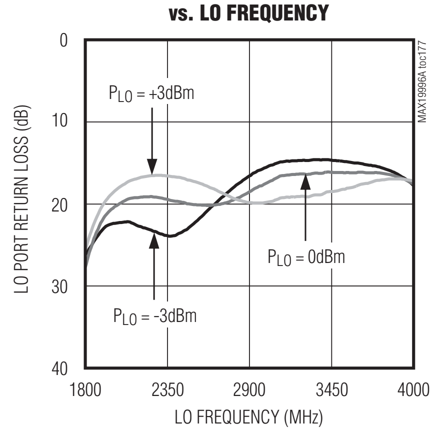
RF PORT RETURN LOSS vs. RF FREQUENCY



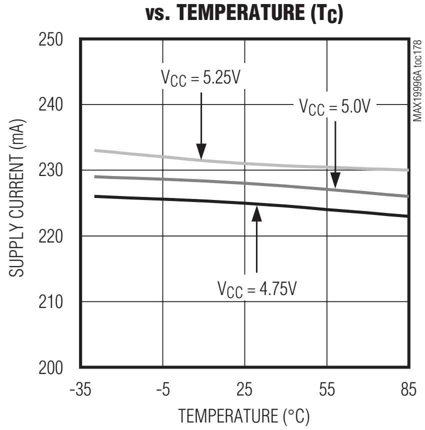
IF PORT RETURN LOSS vs. IF FREQUENCY



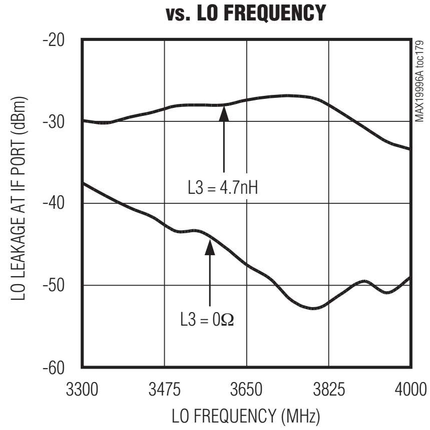
LO PORT RETURN LOSS vs. LO FREQUENCY



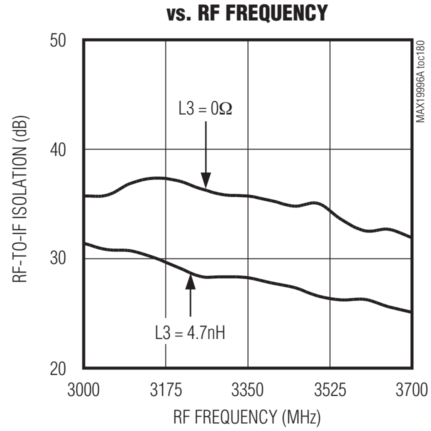
SUPPLY CURRENT vs. TEMPERATURE (T_C)



LO LEAKAGE AT IF PORT vs. LO FREQUENCY



RF-TO-IF ISOLATION vs. RF FREQUENCY



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. Internally matched and DC shorted to GND through a balun. Requires an input DC-blocking capacitor.
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 604Ω 1% (230mA bias condition) from LOBIAS to ground.
9, 15	N.C.	Not internally connected. Pins can be grounded.
11	LO	Local Oscillator Input. This input is internally matched to 50Ω. Requires an input DC-blocking capacitor.
16	LEXT	External Inductor Connection. Connect an inductor from this pin to ground to increase the RF-to-IF and LO-to-IF isolation (see the *Typical Operating Characteristics* for typical performance vs. inductor value).
18, 19	IF-, IF+	Mixer Differential IF Output. Connect pullup inductors from each of these pins to V_{CC} (see the *Typical Application Circuit*).
20	IFBIAS	IF Amplifier Bias Control. IF bias resistor connection for the IF amplifier. Connect a 698Ω 1% (230mA bias condition) from IFBIAS to GND.
—	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 high-side LO injection mixer in the 2300MHz to 2900MHz RF band, the MAX19996A provides 8.7dB of conversion gain and +24.5dBm of IIP3 with a typical noise figure of 9.8dB. 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 MAX19996A's input to a -3dBm to +3dBm range. The IF port incorporates a differential output, which is ideal for providing enhanced 2LO-2RF performance.

Specifications are guaranteed over broad frequency ranges to allow for use in WCS, LTE, WiMAX, and MMDS base stations. The MAX19996A is specified to operate over an RF input range of 2000MHz to 3900MHz, an LO range of 2100MHz to 4000MHz, and an IF range of 50MHz to 500MHz. The external IF components set 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 Input and Balun

The MAX19996A 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 14dB over the RF frequency range of 2300MHz to 2900MHz. A return loss of 15dB over the 3000MHz to 3900MHz range can be achieved by changing the DC-blocking capacitor to 1.5pF.

LO Inputs, Buffer, and Balun

With a broadband LO drive circuit spanning 2100MHz to 4000MHz, the MAX19996A 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 MAX19996A is a double-balanced, high-performance passive mixer. Exceptional linearity is provided by the large LO swing from the on-chip LO buffer. When combined with the integrated IF amplifiers, IIP3, 2LO-2RF rejection, and noise-figure performance are typically +24.5dBm, 67dBc, and 9.8dB, respectively.

Differential IF Output Amplifier

The MAX19996A 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 MAX19996A mixer is tuned for a 300MHz IF using 390nH external pullup bias inductors. Lower IF frequencies would require higher inductor values to maintain a good IF match. The differential, open-collector IF output ports require these inductors to be connected to V_{CC}.

Note that these differential ports are ideal for providing enhanced 2LO-2RF and 2RF-2LO performance. Single-ended IF applications require a 4:1 (impedance ratio) balun to transform the 200Ω differential IF impedance to a 50Ω single-ended system. Use the TC4-1W-17 4:1 transformer for IF frequencies above 200MHz and the TC4-1W-7A 4:1 transformer for frequencies below 200MHz. 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.

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. A 1.5pF capacitor value should be used to match the RF port for the 3000MHz to 3900MHz band. The LO input is internally matched to 50Ω; use a 2pF DC-blocking capacitor to cover operations spanning the 2100MHz to 4000MHz LO range. The IF output impedance is 200Ω (differential). For evaluation, an external low-loss 4:1 (impedance ratio) balun transforms this impedance down to a 50Ω single-ended output (see the *Typical Application Circuit*).

Reduced-Power Mode

The MAX19996A has two pins (LOBIAS, IFBIAS) that allow external resistors to set the internal bias currents. Nominal values for these resistors are given in Table 1. 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 with an optional supply voltage of 3.3V. Doing so reduces the overall power consumption by up to 57%. See the 3.3V *Supply AC Electrical Characteristics—f_{RF} = 2300M to 2900MHz, High-Side Lo Injection* table and the relevant 3.3V curves in the *Typical Operating Characteristics* section to evaluate the power vs. performance tradeoffs.

LEXT Inductor

Short LEXT to ground using a 0Ω resistor. For applications requiring improved RF-to-IF and LO-to-IF isolation, L3 can be changed to optimize performance (see the *Typical Operating Characteristics*). However, the load impedance presented to the mixer must be so that any capacitances from IF- and IF+ to ground do not exceed several picofarads to ensure stable operating conditions. Since approximately 90mA flows through LEXT, it is important to use a low-DCR wire-wound inductor.

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 so 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. The MAX19996A 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 Table 1.

Table 1. Component Values

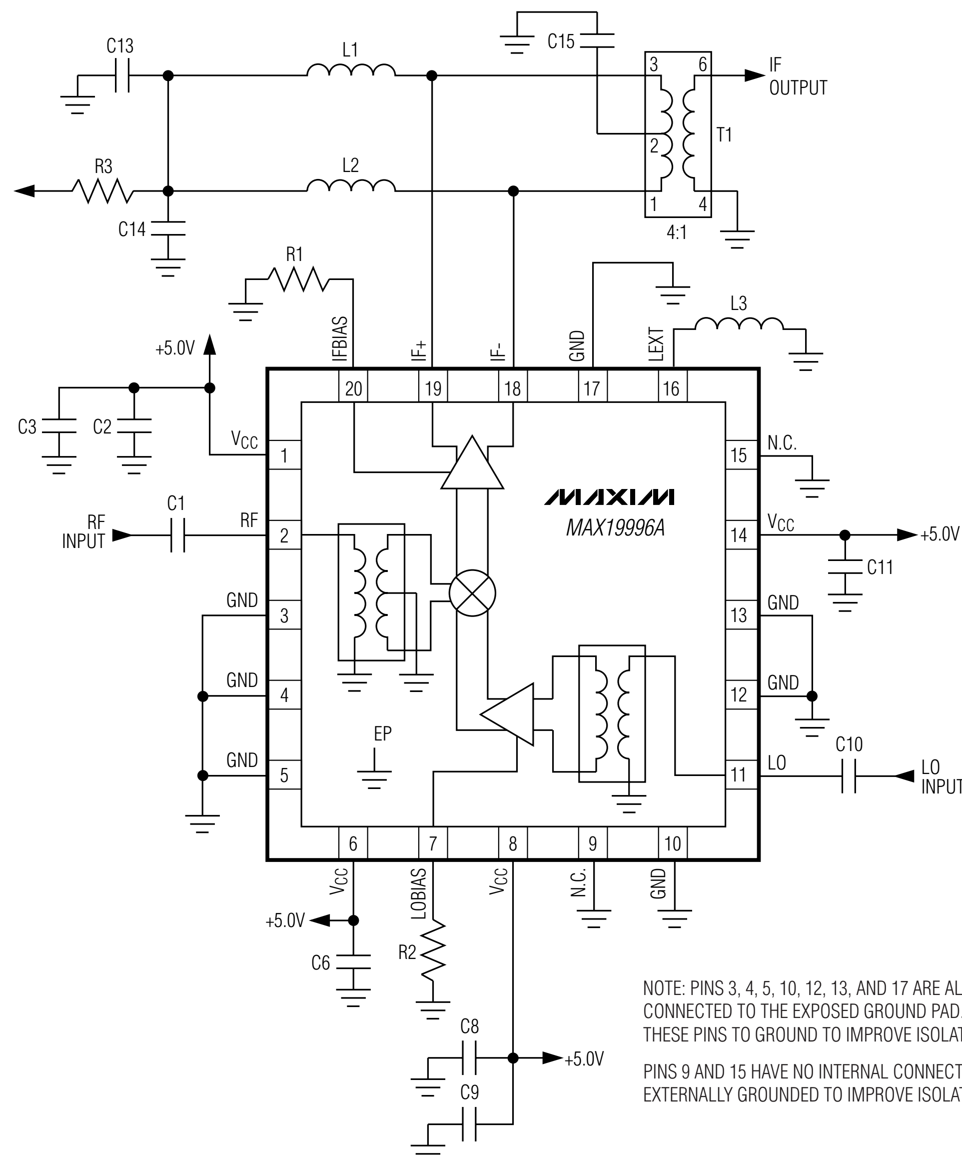
DESIGNATION	QTY	DESCRIPTION	COMPONENT SUPPLIER
C1	1	8.2pF microwave capacitor (0402). Use for RF frequencies ranging from 2000MHz to 3000MHz.	Murata Electronics North America, Inc.
		1.5pF microwave capacitor (0402). Use for RF frequencies ranging from 3000MHz to 3900MHz.	
C2, C6, C8, C11	4	0.01µF microwave capacitors (0402)	Murata Electronics North America, Inc.
C3, C9	0	Not installed, capacitors	—
C10	1	2pF microwave capacitor (0402)	Murata Electronics North America, Inc.
C13, C14	2	1000pF microwave capacitors (0402)	Murata Electronics North America, Inc.
C15	1	82pF microwave capacitor (0402)	Murata Electronics North America, Inc.
L1, L2	2	390nH wire-wound high-Q inductors* (0805) (see the *Typical Operating Characteristics*)	Coilcraft, Inc.
L3	1	4.7nH wire-wound high-Q inductor (0603)	Coilcraft, Inc.
R1	1	698Ω ±1% resistor (0402). Use for **V_{CC} = 5.0V** applications.	Digi-Key Corp.
		1.1kΩ ±1% resistor (0402). Use for **V_{CC} = 3.3V** applications.	
R2	1	604Ω ±1% resistor (0402). Use for **V_{CC} = 5.0V** applications.	Digi-Key Corp.
		845Ω±1% resistor (0402). Use for **V_{CC} = 3.3V** applications.	
R3	1	0Ω resistor (1206)	Digi-Key Corp.
T1	1	4:1 IF balun TC4-1W-17*	Mini-Circuits
U1	1	MAX19996A IC (20 TQFN-EP)	Maxim Integrated Products, Inc.

**Use 470nH inductors and TC4-1W-7A 4:1 balun for IF frequencies below 200MHz.*

Exposed Pad RF/Thermal Considerations

The exposed pad (EP) of the MAX19996A's 20-pin thin QFN-EP package provides a low thermal-resistance path to the die. It is important that the PCB on which the MAX19996A 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.

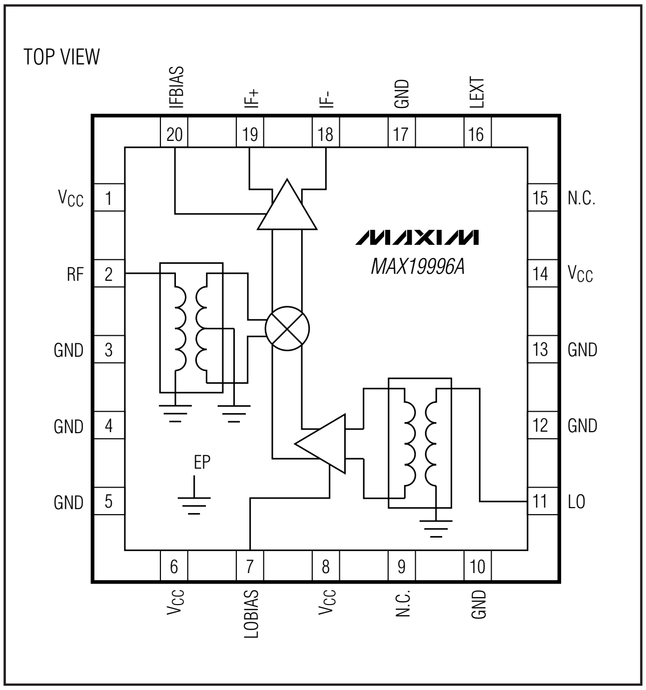
Typical Application Circuit



NOTE: PINS 3, 4, 5, 10, 12, 13, AND 17 ARE ALL INTERNALLY CONNECTED TO THE EXPOSED GROUND PAD. CONNECT THESE PINS TO GROUND TO IMPROVE ISOLATION.

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

Pin Configuration/ Functional Diagram



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 Thin QFN-EP	T2055+3	**21-0140**

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	1/09	Initial release	—
1	5/09	Updated *Electrical Characteristics* table limits	6