19-4827; Rev 0; 10/09

EVALUATION KIT AVAILABLE

MAXIM

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

MAX19998

General Description

The MAX19998 single, high-linearity downconversion mixer provides 8.7dB of conversion gain, +24.3dBm input IP3, +11.3dBm 1dB input compression point, and a noise figure of 9.7dB for 2300MHz to 4000MHz WiMAX™, LTE, and MMDS receiver applications. With an ultra-wide LO 2600MHz to 4300MHz frequency range, the MAX19998 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 high-side injection, refer to the MAX19996A.

In addition to offering excellent linearity and noise performance, the MAX19998 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 MAX19998 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 MAX19998 is pin compatible with the MAX19996/MAX19996A 2000MHz to 3900MHz mixer family. 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 MAX19998 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

2.5GHz WiMAX and LTE Base Stations

2.7GHz MMDS Base Stations

3.5GHz WiMAX and LTE Base Stations

Fixed Broadband Wireless Access

Wireless Local Loop

Private Mobile Radios

Military Systems

Features

- **2300MHz to 4000MHz RF Frequency Range**
- **2600MHz to 4300MHz LO Frequency Range**
- **50MHz to 500MHz IF Frequency Range**
- **8.7dB Conversion Gain**
- **9.7dB Noise Figure**
- **+24.3dBm Typical Input IP3**
- **+11.3dBm Typical Input 1dB Compression Point**
- **67dBc 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 MAX19996/MAX19996A 2000MHz to 3900MHz Mixers**
- **Pin Similar with the MAX9984/MAX9986/MAX9986A Series of 400MHz to 1000MHz Mixers and the MAX9993/MAX9994/MAX9996 Series of 1700MHz to 2200MHz 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
MAX19998ETP+	-40°C to +85°C	20 Thin QFN-EP*
MAX19998ETP+T	-40°C to +85°C	20 Thin QFN-EP*

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

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For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

ABSOLUTE MAXIMUM RATINGS

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

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

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

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

Note 4: T_C is the temperature on the exposed pad of the package. T_A is the ambient temperature of the device and PCB.

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

5.0V SUPPLY DC ELECTRICAL CHARACTERISTICS

(*Typical Application Circuit,* **R1 = 698Ω, R2 = 604Ω**, V_{CC} = 4.75V to 5.25V, no input RF or LO signals. T_C = -40°C to +85°C, unless otherwise noted. Typical values are at V_{CC} = 5.0V, T_C = +25°C, all parameters are production tested.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage	V_{CC}		4.75	5.0	5.25	V
Supply Current	I_{CC}	Total supply current		230	247	mA

3.3V SUPPLY DC ELECTRICAL CHARACTERISTICS

(*Typical Application Circuit*, **R1 = 845Ω, R2 = 1.1kΩ**, V_{CC} = 3.0V to 3.6V, no input RF or LO signals. T_C = -40°C to +85°C, unless otherwise noted. Typical values are at V_{CC} = 3.3V, T_C = +25°C, parameters are guaranteed by design, unless otherwise noted.) (Note 5)

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		150		mA

RECOMMENDED AC OPERATING CONDITIONS

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
RF Frequency Range	f_{RF}	(Notes 5, 6)	2300		4000	MHz
LO Frequency	f_{LO}	(Notes 5, 6)	2600		4300	MHz
IF Frequency	f_{IF}	Using a Mini-Circuits TC4-1W-17 4:1 transformer as defined in the *Typical Application Circuit*, IF matching components affect the IF frequency range (Notes 5, 6)	100		500	MHz
		Using a Mini-Circuits TC4-1W-7A 4:1 transformer as defined in the *Typical Application Circuit*, IF matching components affect the IF frequency range (Notes 5, 6)	50		250	
LO Drive	P_{LO}		-3	0	+3	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, **R1 = 698Ω, R2 = 604Ω**, 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_{RF} = -5dBm, P_{LO} = 0dBm, f_{RF} = 3500MHz, f_{LO} = 3200MHz, 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 Gain	G_C	T_C = +25°C (Notes 8, 9)		7.6	8.7	9.4	dB
Gain Variation vs. Frequency	ΔG_C	f_{RF} = 3100MHz to 3900MHz, any 100MHz band			0.15		dB
		f_{RF} = 3100MHz to 3900MHz, any 200MHz band			0.3		
Conversion Gain Temperature Coefficient	TC_{CG}	f_{RF} = 3100MHz to 3900MHz, T_C = -40°C to +85°C			-0.01		dB/°C
Input 1dB Compression Point	IP_{1dB}	(Note 10)		10.0	11.4		dBm
Third-Order Input Intercept Point	IIP3	f_{RF1} - f_{RF2} = 1MHz, P_{RF1} = P_{RF2} = -5dBm/tone, T_C = +25°C (Note 9)		22	24.3		dBm
IIP3 Variation with T_C		f_{RF} = 3100MHz to 3900MHz, f_{RF1} - f_{RF2} = 1MHz, P_{RF1} = P_{RF2} = -5dBm/tone, T_C = -40°C to +85°C			±0.2		dBm
Single-Sideband Noise Figure	NF_{SSB}	No blockers present (Note 5)			9.7	12.5	dB
		No blockers present, T_C = +25°C (Note 5)			9.7	11.0	
Noise Figure Temperature Coefficient	TC_{NF}	Single sideband, no blockers present, T_C = -40°C to +85°C			0.018		dB/°C
Noise Figure Under Blocking	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 (Notes 5, 11)			21	25	dB
2RF - 2LO Spur Rejection	2 x 2	f_{SPUR} = f_{LO} + 150MHz	P_{RF} = -10dBm (Note 5)	63	67		dBc
			P_{RF} = -5dBm (Note 9)	58	62		
3RF - 3LO Spur Rejection	3 x 3	f_{SPUR} = f_{LO} + 100MHz	P_{RF} = -10dBm (Note 5)	80	85		dBc
			P_{RF} = -5dBm (Note 9)	70	75		
RF Input Return Loss	RL_{RF}	LO on and IF terminated into a matched impedance			25		dB
LO Input Return Loss	RL_{LO}	RF and IF terminated into a matched impedance			16		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		20		dB
			f_{IF} = 350MHz, L1 = L2 = 270nH		20		
			f_{IF} = 300MHz, L1 = L2 = 390nH		20		

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, **R1 = 698Ω, R2 = 604Ω**, 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_{RF} = -5dBm, P_{LO} = 0dBm, f_{RF} = 3500MHz, f_{LO} = 3200MHz, f_{IF} = 300MHz. All parameters are guaranteed by design and characterization, unless otherwise noted.) (Note 7)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
RF-to-IF Isolation		f_{RF} = 3500MHz, P_{LO} = +3dBm (Note 9)	27	29.5		dB
LO Leakage at RF Port		f_{LO} = 2800MHz to 3600MHz, P_{LO} = +3dBm (Note 9)		-26		dBm
2LO Leakage at RF Port		P_{LO} = +3dBm		-29		dBm
LO Leakage at IF Port		P_{LO} = +3dBm (Note 9)		-22		dBm

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

(*Typical Application Circuit*, with tuning elements outlined in Table 1, **R1 = 845Ω, R2 = 1.1kΩ**, RF and LO ports are driven from 50Ω sources, $f_{RF} > f_{LO}$. Typical values are for T_C = +25°C, V_{CC} = 3.3V, P_{RF} = -5dBm, P_{LO} = 0dBm, f_{RF} = 3500MHz, f_{LO} = 3200MHz, f_{IF} = 300MHz, unless otherwise noted.) (Note 7)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Small-Signal Conversion Gain	G_C				8.4		dB
Gain Variation vs. Frequency	ΔG_C	f_{RF} = 3100MHz to 3900MHz, any 100MHz band			0.15		dB
Conversion Gain Temperature Coefficient	TC_{CG}	f_{RF} = 3100MHz to 3900MHz, T_C = -40°C to +85°C			-0.01		dB/°C
Input 1dB Compression Point	IP_{1dB}	(Note 10)			7.7		dBm
Third-Order Input Intercept Point	IIP3	f_{RF1} - f_{RF2} = 1MHz, P_{RF1} = P_{RF2} = -5dBm/tone			20.1		dBm
IIP3 Variation with T_C		f_{RF1} - f_{RF2} = 1MHz, P_{RF1} = P_{RF2} = -5dBm/tone, T_C = -40°C to +85°C			±0.2		dB
Single-Sideband Noise Figure	NF_{SSB}	No blockers present			9.3		dB
Noise Figure Temperature Coefficient	TC_{NF}	Single sideband, no blockers present, T_C = -40°C to +85°C			0.018		dB/°C
2RF - 2LO Spur Rejection	2 x 2	f_{SPUR} = f_{LO} + 150MHz	P_{RF} = -10dBm		64		dBc
			P_{RF} = -5dBm		59		
3RF - 3LO 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			30		dB
LO Input Return Loss	RL_{LO}	RF and IF terminated into a matched impedance			20		dB
IF Output Impedance	Z_{IF}	Nominal differential impedance at the IC's IF outputs			200		Ω

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

(*Typical Application Circuit*, with tuning elements outlined in Table 1, **R1 = 845Ω, R2 = 1.1kΩ**, RF and LO ports are driven from 50Ω sources, $f_{RF} > f_{LO}$. Typical values are for T_C = +25°C, V_{CC} = 3.3V, P_{RF} = -5dBm, P_{LO} = 0dBm, f_{RF} = 3500MHz, f_{LO} = 3200MHz, f_{IF} = 300MHz, unless otherwise noted.) (Note 7)

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		17		dB
			f_{IF} = 350MHz, L1 = L2 = 270nH		17		
			f_{IF} = 300MHz, L1 = L2 = 390nH		17		
RF-to-IF Isolation		f_{RF} = 3100MHz to 3900MHz, P_{LO} = +3dBm			27		dB
LO Leakage at RF Port		f_{LO} = 2800MHz to 3600MHz, P_{LO} = +3dBm			-30		dBm
2LO Leakage at RF Port		f_{LO} = 2800MHz to 3600MHz, P_{LO} = +3dBm			-26.5		dBm
LO Leakage at IF Port		f_{LO} = 2800MHz to 3600MHz, P_{LO} = +3dBm			-27.5		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, **R1 = 698Ω, R2 = 604Ω**, 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} = 3400MHz to 4200MHz, $f_{RF} < f_{LO}$, T_C = -40°C to +85°C. Typical values are for T_C = +25°C, V_{CC} = 5.0V, P_{RF} = -5dBm, P_{LO} = 0dBm, f_{RF} = 3500MHz, f_{LO} = 3800MHz, f_{IF} = 300MHz, unless otherwise noted.) (Note 7)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Small-Signal Conversion Gain	G_C	T_C = +25°C			8.4		dB
Gain Variation vs. Frequency	ΔG_C	f_{RF} = 3100MHz to 3900MHz, any 100MHz band			0.15		dB
		f_{RF} = 3100MHz to 3900MHz, any 200MHz band			0.3		
Conversion Gain Temperature Coefficient	TC_{CG}	f_{RF} = 3100MHz to 3900MHz, T_C = -40°C to +85°C			-0.01		dB/°C
Input 1dB Compression Point	IP_{1dB}	(Note 10)			11.4		dBm
Third-Order Input Intercept Point	IIP3	$f_{RF1} - f_{RF2}$ = 1MHz, $P_{RF1} = P_{RF2}$ = -5dBm/tone, T_C = +25°C			24.8		dBm
IIP3 Variation with T_C		f_{RF} = 3100MHz to 3900MHz, $f_{RF1} - f_{RF2}$ = 1MHz, $P_{RF1} = P_{RF2}$ = -5dBm/tone, T_C = -40°C to +85°C			±0.2		dBm
Single-Sideband Noise Figure	NF_{SSB}	No blockers present			9.8		dB
Noise Figure Temperature Coefficient	TC_{NF}	Single sideband, no blockers present, T_C = -40°C to +85°C			0.018		dB/°C
2LO - 2RF Spur Rejection	2 x 2	$f_{SPUR} = f_{LO}$ - 150MHz	P_{RF} = -10dBm		70		dBc
			P_{RF} = -5dBm		65		
3LO - 3RF Spur Rejection	3 x 3	$f_{SPUR} = f_{LO}$ - 100MHz	P_{RF} = -10dBm		89		dBc
			P_{RF} = -5dBm		79		

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, **R1 = 698Ω, R2 = 604Ω**, 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} = 3400MHz to 4200MHz, 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} = -5dBm, P_{LO} = 0dBm, f_{RF} = 3500MHz, f_{LO} = 3800MHz, 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			24		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		20		dB
			f_{IF} = 350MHz, L1 = L2 = 270nH		20		
			f_{IF} = 300MHz, L1 = L2 = 390nH		20		
RF-to-IF Isolation		P_{LO} = +3dBm			30		dB
LO Leakage at RF Port		P_{LO} = +3dBm			-30.3		dBm
2LO Leakage at RF Port		P_{LO} = +3dBm			-19		dBm
LO Leakage at IF Port		P_{LO} = +3dBm			-23		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, **R1 = 698Ω, R2 = 604Ω**, 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_{RF} = -5dBm, P_{LO} = 0dBm, f_{RF} = 2600MHz, f_{LO} = 2900MHz, f_{IF} = 300MHz, unless otherwise noted.) (Note 7)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small-Signal Conversion Gain	G_C	T_C = +25°C		8.4		dB
Gain Variation vs. Frequency	ΔG_C	f_{RF} = 2300MHz to 2900MHz, any 100MHz band		0.15		dB
		f_{RF} = 2300MHz to 2900MHz, any 200MHz band		0.3		
Conversion Gain Temperature Coefficient	TC_{CG}	f_{RF} = 2300MHz to 2900MHz, T_C = -40°C to +85°C		-0.01		dB/°C
Input 1dB Compression Point	IP_{1dB}	(Note 10)		11.4		dBm
Third-Order Input Intercept Point	IIP3	f_{RF1} - f_{RF2} = 1MHz, P_{RF1} = P_{RF2} = -5dBm/tone, T_C = +25°C		25.0		dBm

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, **R1 = 698Ω, R2 = 604Ω**, 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_{RF} = -5dBm, P_{LO} = 0dBm, f_{RF} = 2600MHz, f_{LO} = 2900MHz, f_{IF} = 300MHz, unless otherwise noted. (Note 7)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
IIP3 Variation with T_C		f_{RF} = 2300MHz to 2900MHz, f_{RF1} - f_{RF2} = 1MHz, P_{RF1} = P_{RF2} = -5dBm/tone, T_C = -40°C to +85°C			±0.2		dBm
Single-Sideband Noise Figure	NF_{SSB}	No blockers present			10.0		dB
Noise Figure Temperature Coefficient	TC_{NF}	Single sideband, no blockers present, T_C = -40°C to +85°C			0.018		dB/°C
2LO - 2RF Spur Rejection	2 x 2	f_{SPUR} = f_{LO} - 50MHz	P_{RF} = -10dBm		77		dBc
			P_{RF} = -5dBm		72		
3LO - 3RF Spur Rejection	3 x 3	f_{SPUR} = f_{LO} - 100MHz	P_{RF} = -10dBm		86		dBc
			P_{RF} = -5dBm		76		
RF Input Return Loss	RL_{RF}	LO on and IF terminated into a matched impedance			30		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		P_{LO} = +3dBm			45		dB
LO Leakage at RF Port		P_{LO} = +3dBm			-28.8		dBm
2LO Leakage at RF Port		P_{LO} = +3dBm			-42.3		dBm
LO Leakage at IF Port		P_{LO} = +3dBm			-26.3		dBm

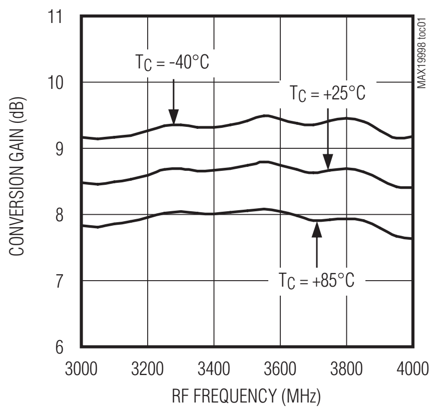
Note 5: Not production tested.
Note 6: Operation outside this range is possible, but with degraded performance of some parameters. See the *Typical Operating Characteristics*.
Note 7: All limits reflect losses of external components, including a 0.8dB loss at f_{IF} = 300MHz due to the 4:1 impedance transformer. Output measurements were taken at IF outputs of the *Typical Application Circuit*.
Note 8: Guaranteed by design and characterization.
Note 9: 100% production tested for functional performance.
Note 10: Maximum reliable continuous input power applied to the RF port of this device is +12dBm from a 50Ω source.
Note 11: 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.*

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

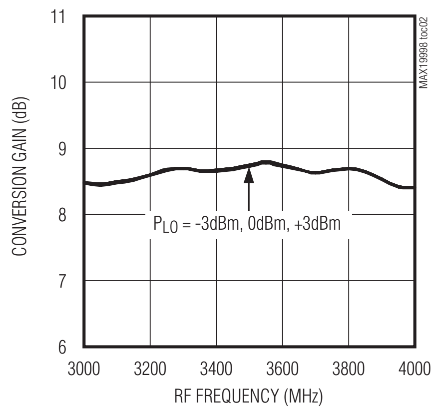
Typical Operating Characteristics

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 3100MHz to 3900MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

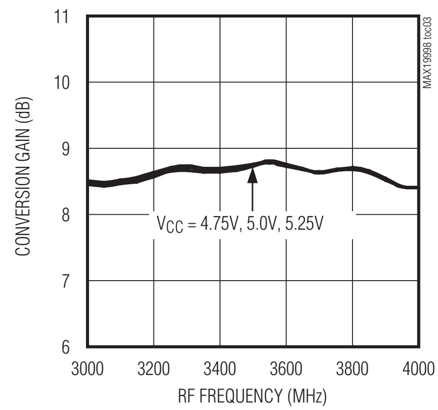
CONVERSION GAIN vs. RF FREQUENCY



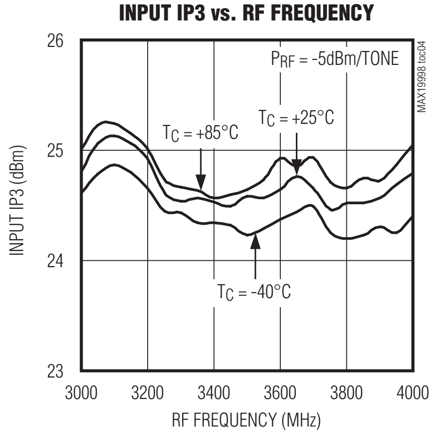
CONVERSION GAIN vs. RF FREQUENCY



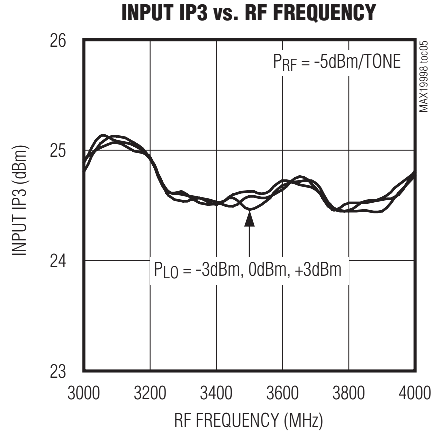
CONVERSION GAIN vs. RF FREQUENCY



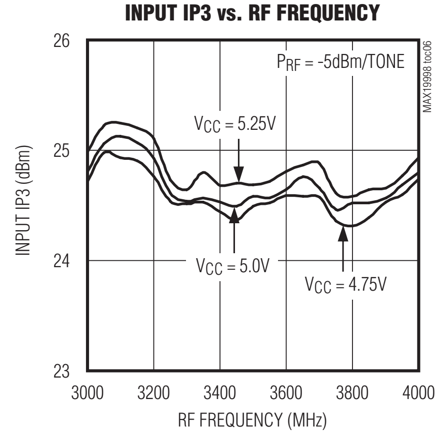
INPUT IP3 vs. RF FREQUENCY



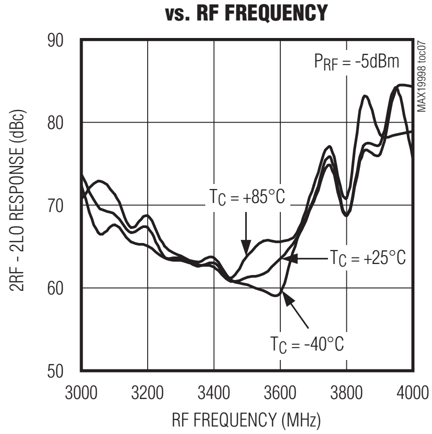
INPUT IP3 vs. RF FREQUENCY



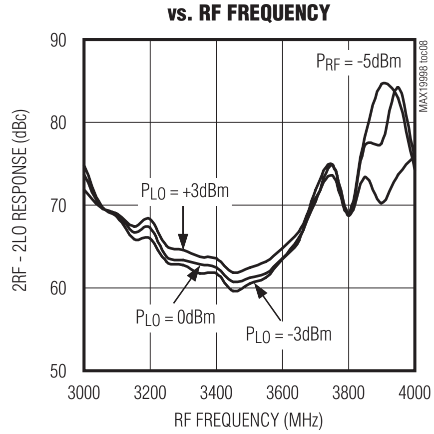
INPUT IP3 vs. RF FREQUENCY



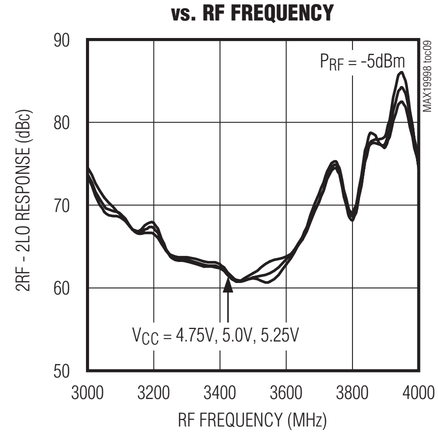
2RF - 2LO RESPONSE vs. RF FREQUENCY



2RF - 2LO RESPONSE vs. RF FREQUENCY



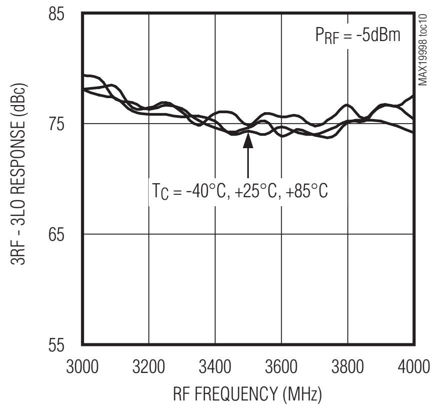
2RF - 2LO RESPONSE vs. RF FREQUENCY



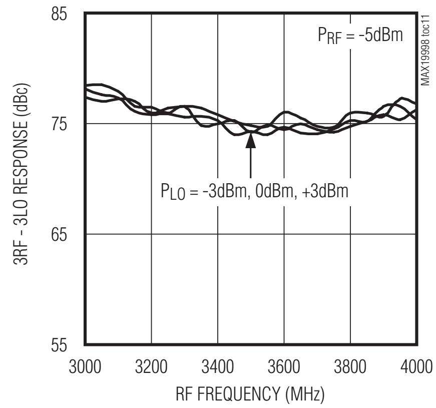
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 3100MHz to 3900MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

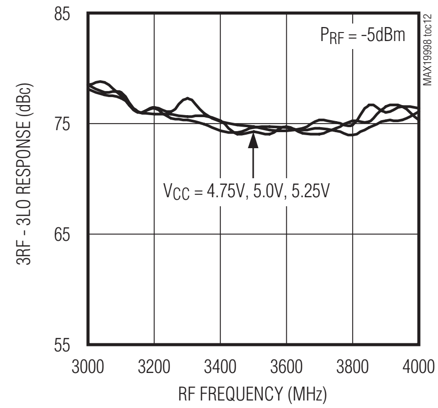
3RF - 3LO RESPONSE vs. RF FREQUENCY



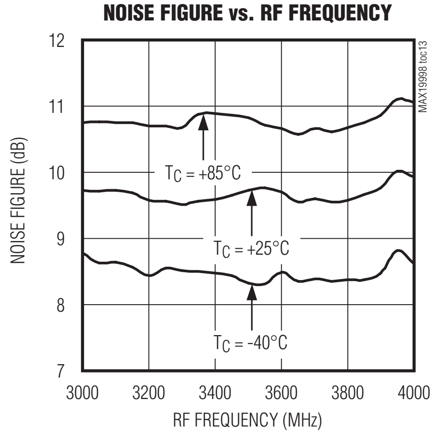
3RF - 3LO RESPONSE vs. RF FREQUENCY



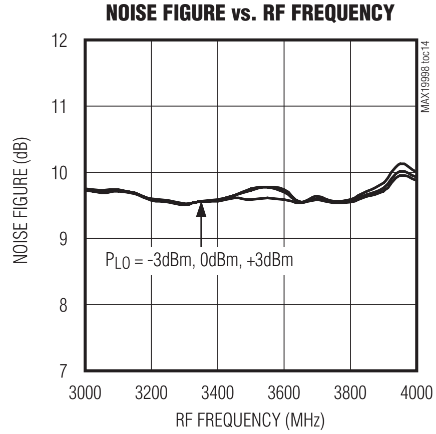
3RF - 3LO RESPONSE vs. RF FREQUENCY



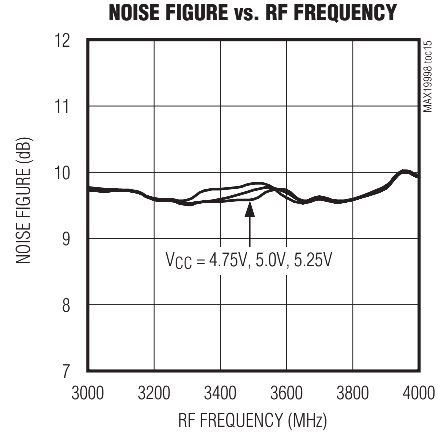
NOISE FIGURE vs. RF FREQUENCY



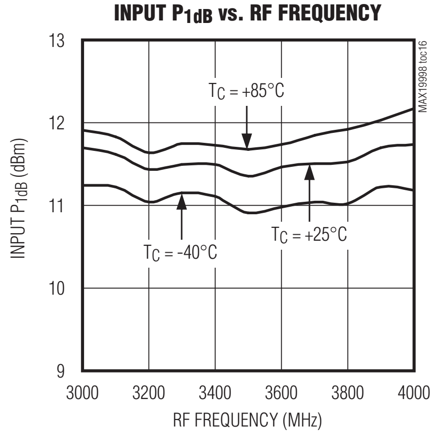
NOISE FIGURE vs. RF FREQUENCY



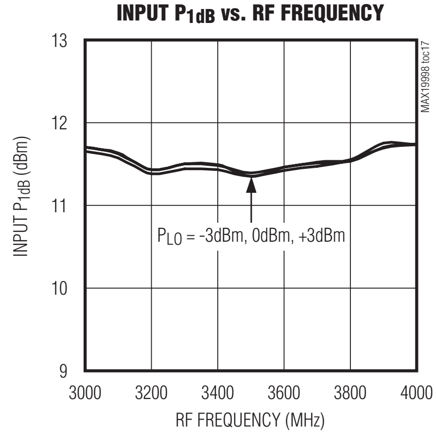
NOISE FIGURE vs. RF FREQUENCY



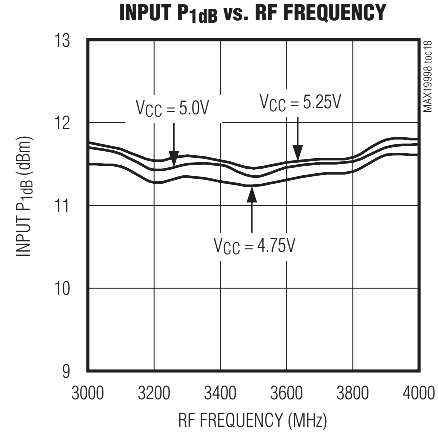
INPUT P_{1dB} vs. RF FREQUENCY



INPUT P_{1dB} vs. RF FREQUENCY



INPUT P_{1dB} vs. RF FREQUENCY

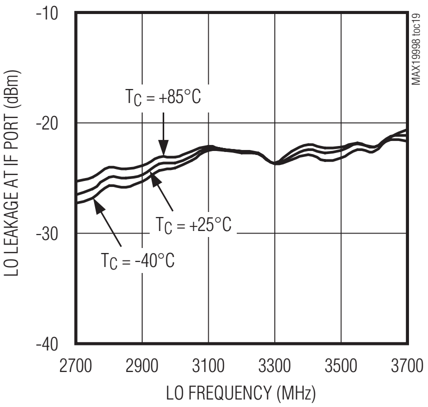


SiGe, High-Linearity, 2300MHz to 4000MHz Downconversion Mixer with LO Buffer

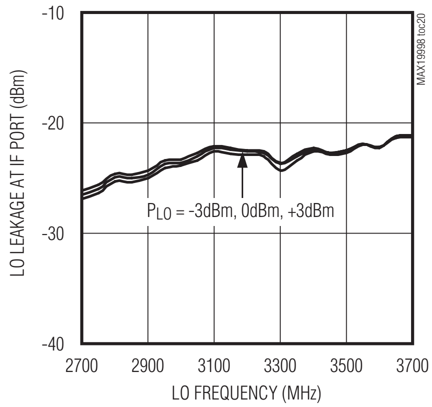
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 3100MHz to 3900MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

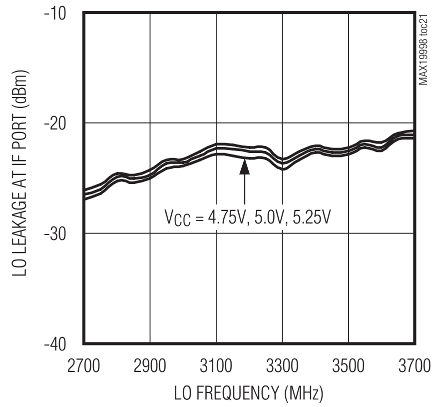
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



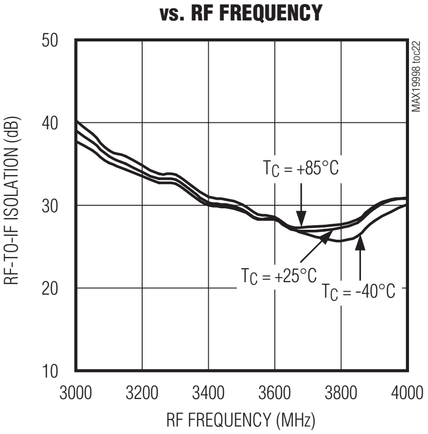
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



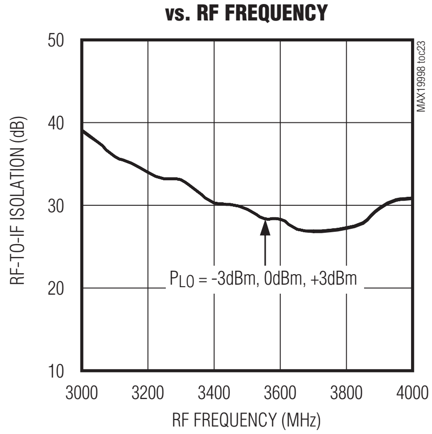
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



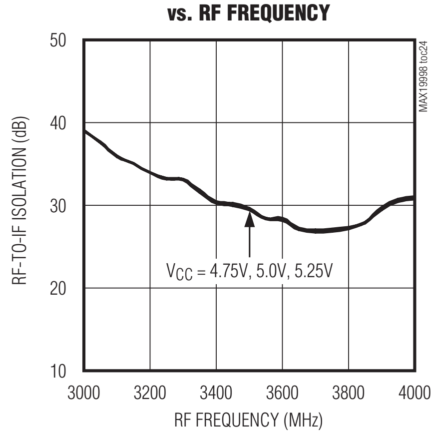
RF-TO-IF ISOLATION vs. RF FREQUENCY



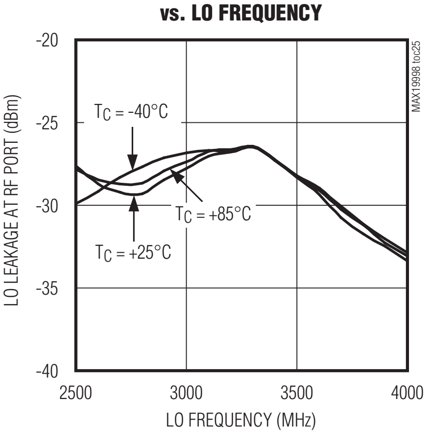
RF-TO-IF ISOLATION vs. RF FREQUENCY



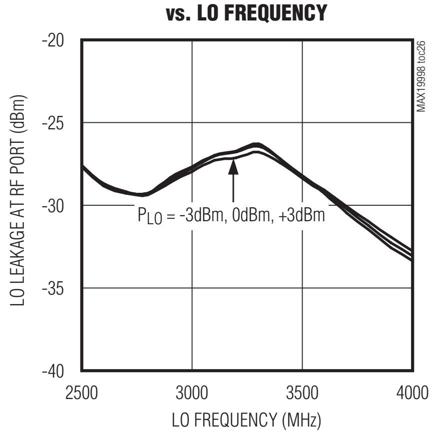
RF-TO-IF ISOLATION vs. RF FREQUENCY



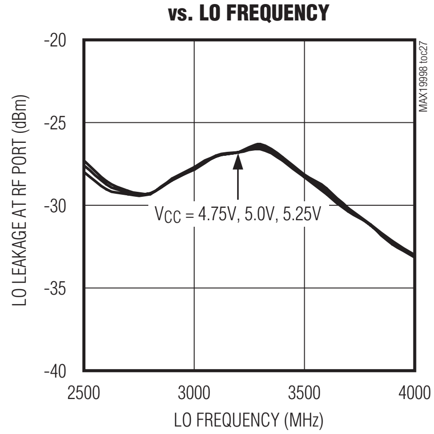
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



LO LEAKAGE AT RF PORT vs. LO FREQUENCY



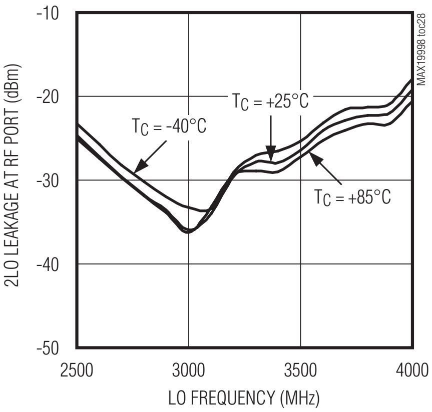
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



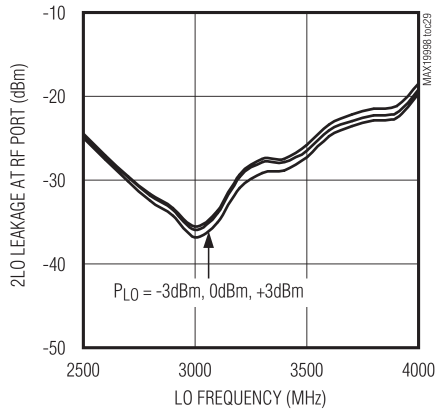
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 3100MHz to 3900MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

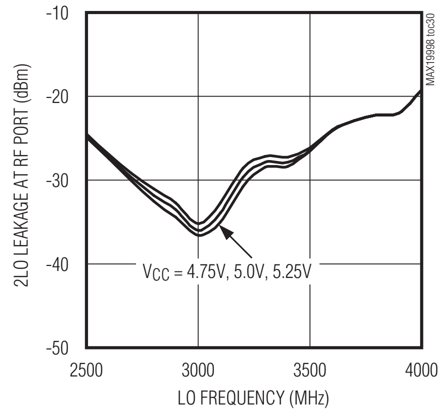
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



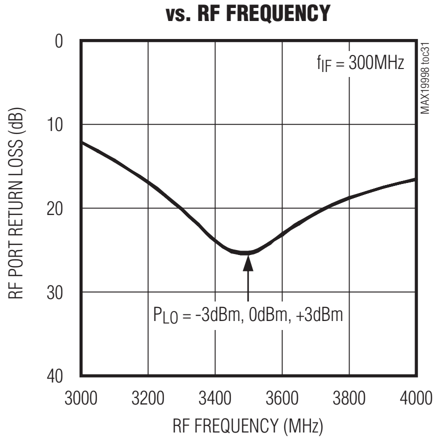
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



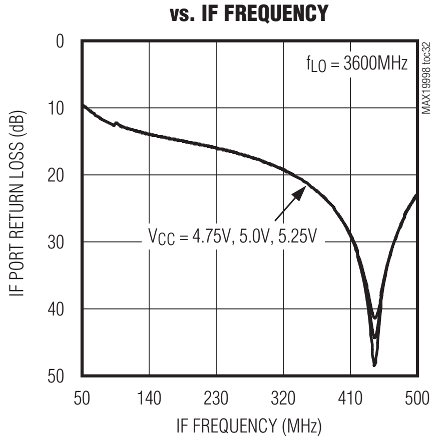
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



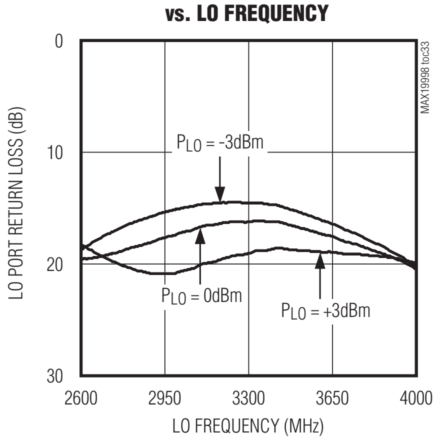
RF PORT RETURN LOSS vs. RF FREQUENCY



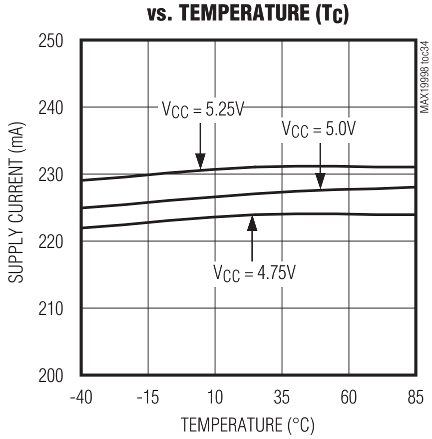
IF PORT RETURN LOSS vs. IF FREQUENCY



LO PORT RETURN LOSS vs. LO FREQUENCY



SUPPLY CURRENT vs. TEMPERATURE (T_C)

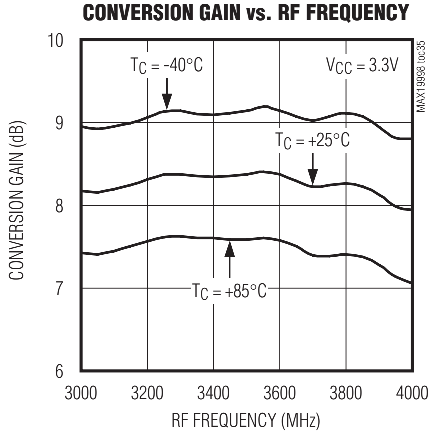


SiGe, High-Linearity, 2300MHz to 4000MHz Downconversion Mixer with LO Buffer

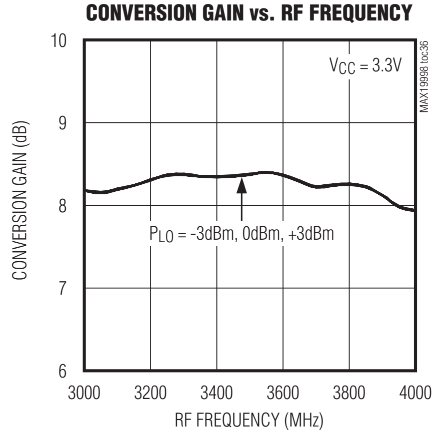
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 3.3V, f_{RF} = 3100MHz to 3900MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

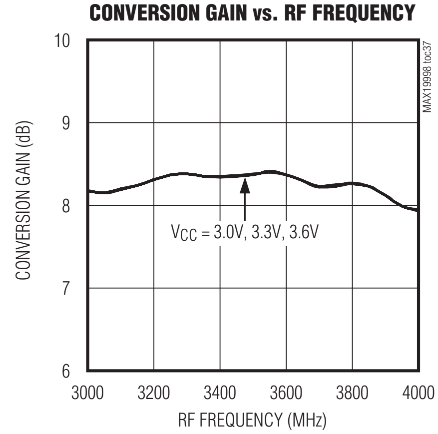
CONVERSION GAIN vs. RF FREQUENCY



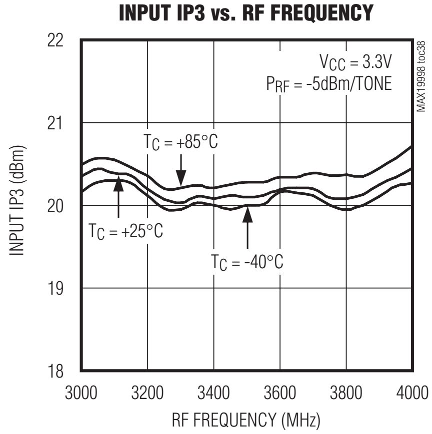
CONVERSION GAIN vs. RF FREQUENCY



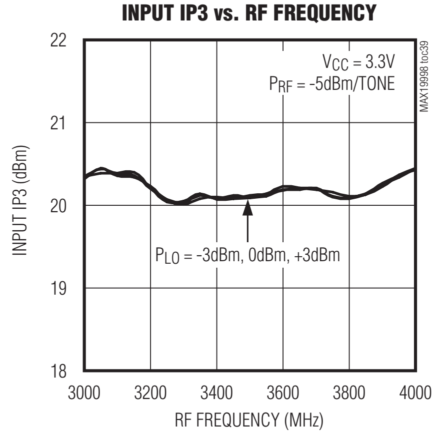
CONVERSION GAIN vs. RF FREQUENCY



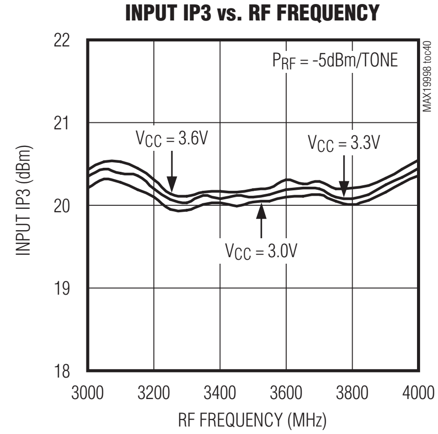
INPUT IP3 vs. RF FREQUENCY



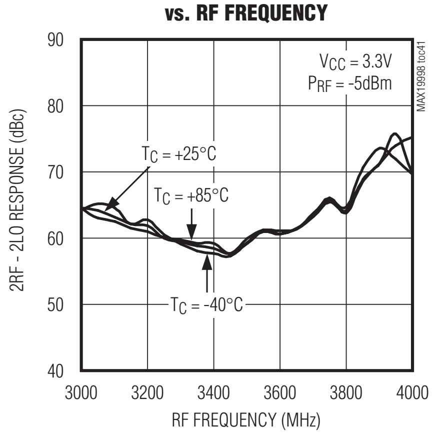
INPUT IP3 vs. RF FREQUENCY



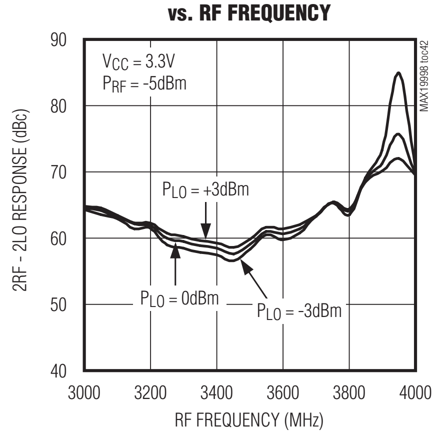
INPUT IP3 vs. RF FREQUENCY



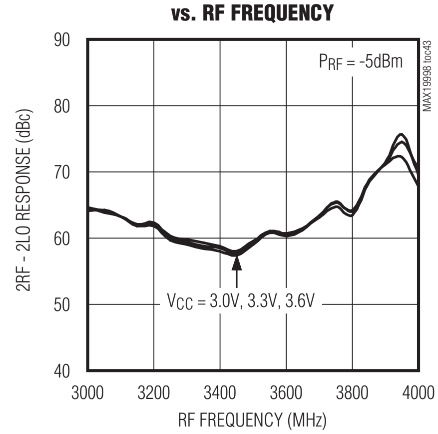
2RF - 2LO RESPONSE vs. RF FREQUENCY



2RF - 2LO RESPONSE vs. RF FREQUENCY



2RF - 2LO RESPONSE vs. RF FREQUENCY

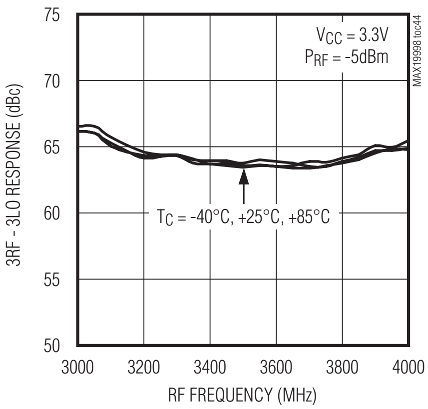


SiGe, High-Linearity, 2300MHz to 4000MHz Downconversion Mixer with LO Buffer

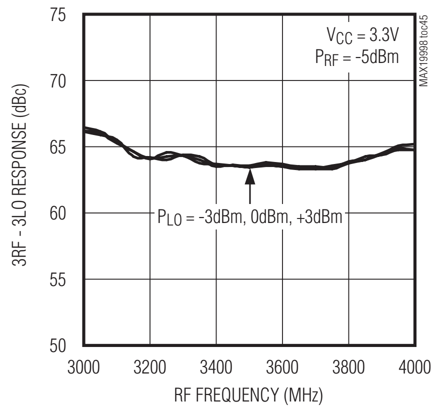
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 3.3V, f_{RF} = 3100MHz to 3900MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

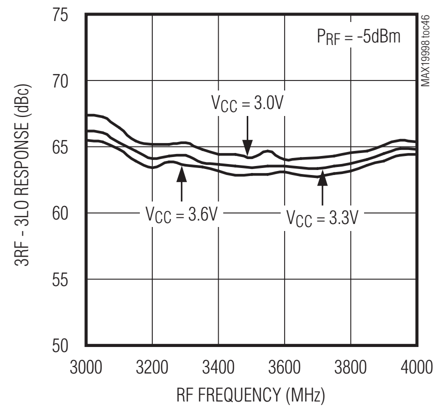
3RF - 3LO RESPONSE vs. RF FREQUENCY



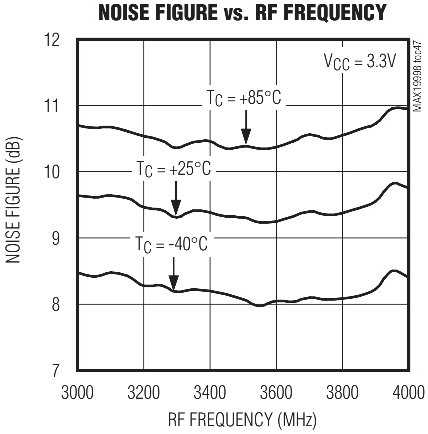
3RF - 3LO RESPONSE vs. RF FREQUENCY



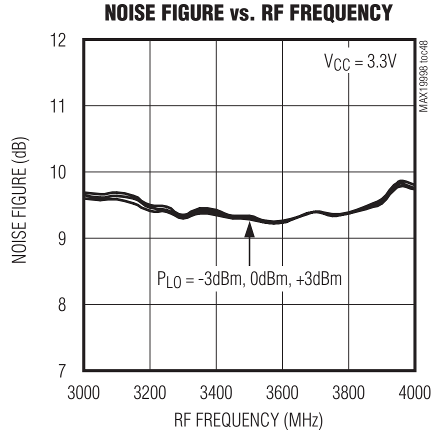
3RF - 3LO RESPONSE vs. RF FREQUENCY



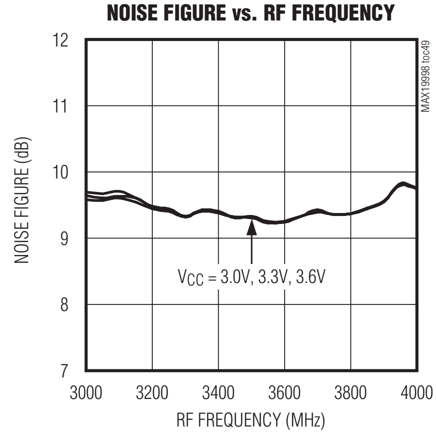
NOISE FIGURE vs. RF FREQUENCY



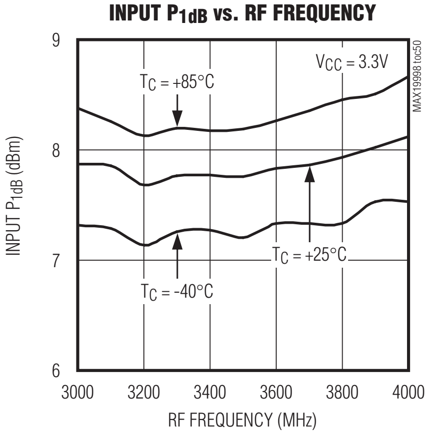
NOISE FIGURE vs. RF FREQUENCY



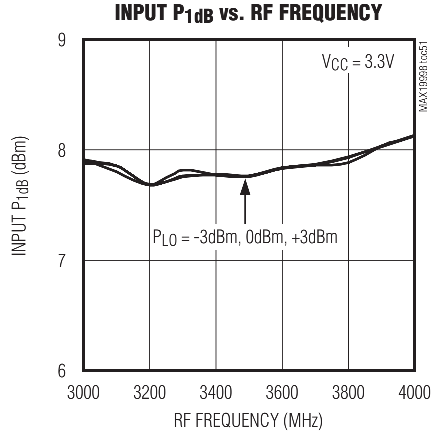
NOISE FIGURE vs. RF FREQUENCY



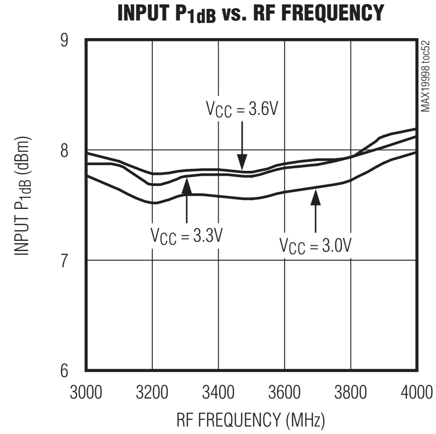
INPUT P_{1dB} vs. RF FREQUENCY



INPUT P_{1dB} vs. RF FREQUENCY



INPUT P_{1dB} vs. RF FREQUENCY

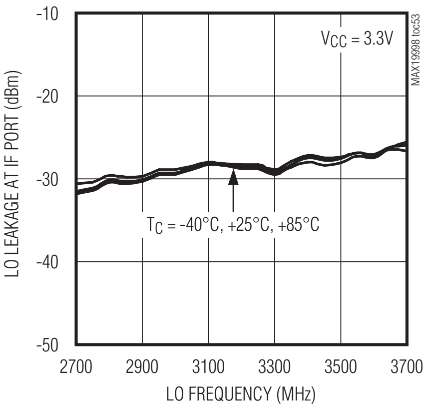


SiGe, High-Linearity, 2300MHz to 4000MHz Downconversion Mixer with LO Buffer

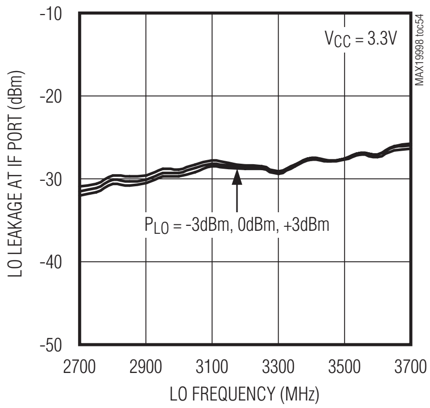
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 3.3V, f_{RF} = 3100MHz to 3900MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

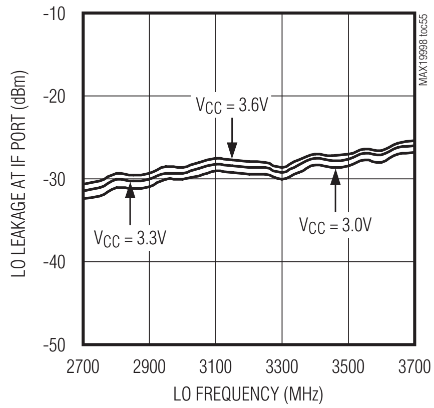
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



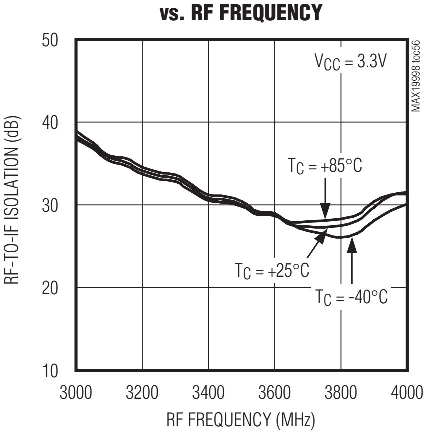
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



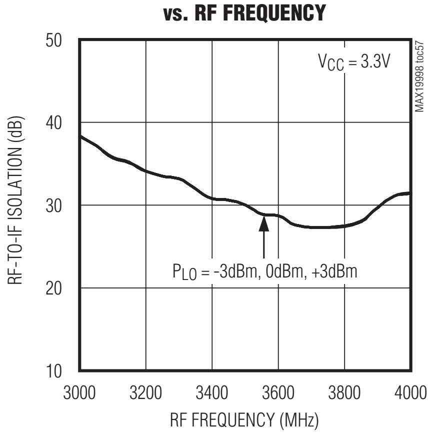
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



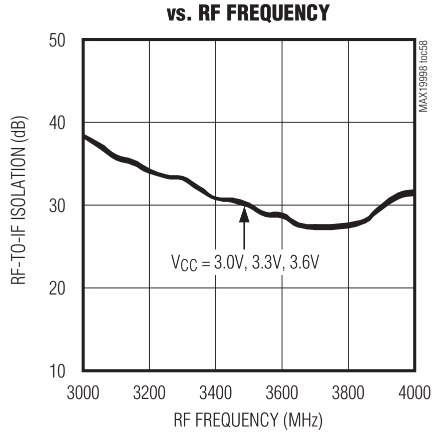
RF-TO-IF ISOLATION vs. RF FREQUENCY



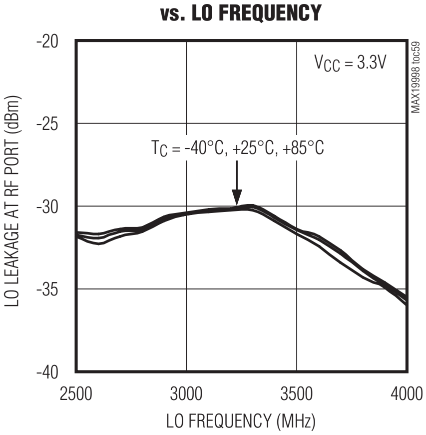
RF-TO-IF ISOLATION vs. RF FREQUENCY



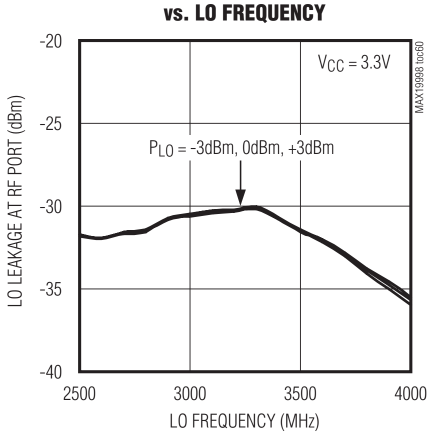
RF-TO-IF ISOLATION vs. RF FREQUENCY



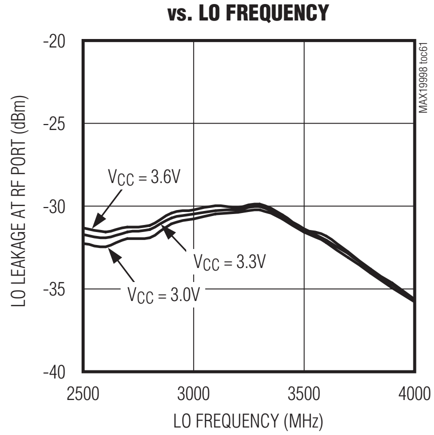
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



LO LEAKAGE AT RF PORT vs. LO FREQUENCY



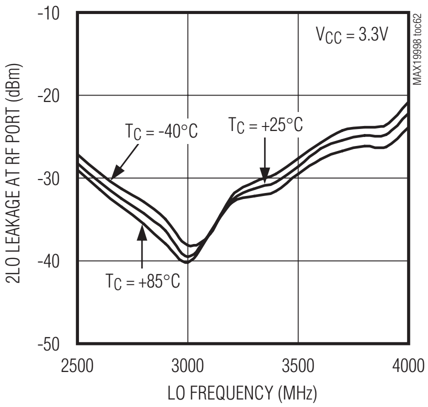
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



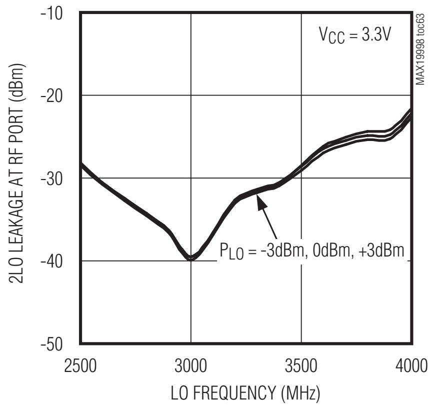
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 3.3V, f_{RF} = 3100MHz to 3900MHz, LO is low-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

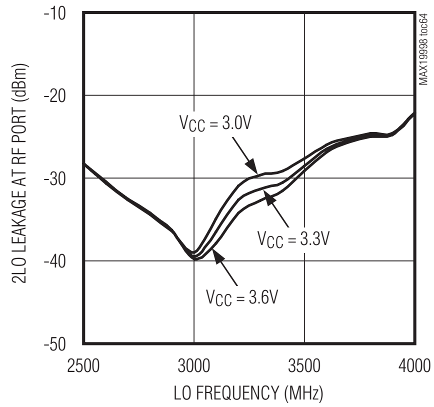
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



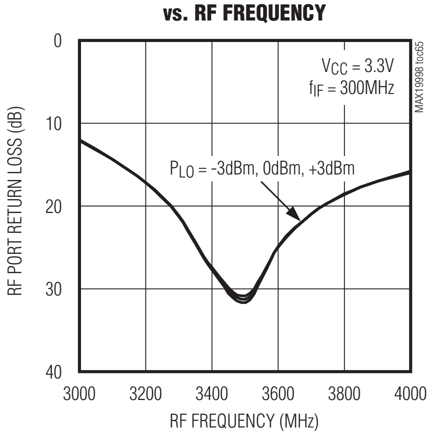
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



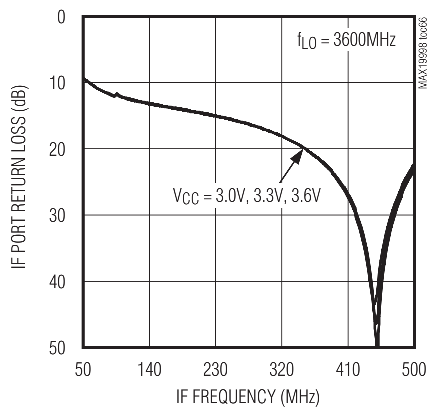
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



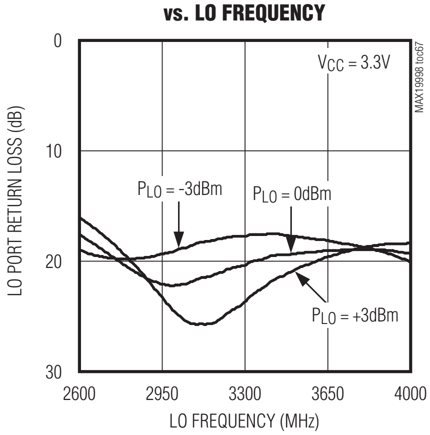
RF PORT RETURN LOSS vs. RF FREQUENCY



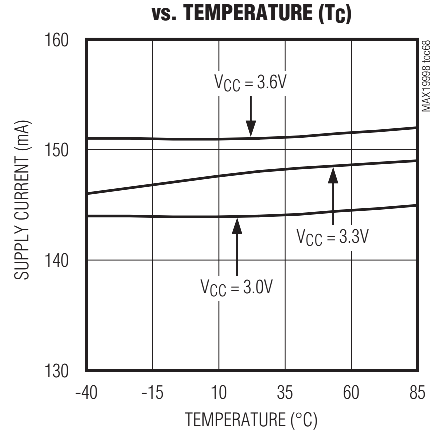
IF PORT RETURN LOSS vs. IF FREQUENCY



LO PORT RETURN LOSS vs. LO FREQUENCY



SUPPLY CURRENT vs. TEMPERATURE (T_C)

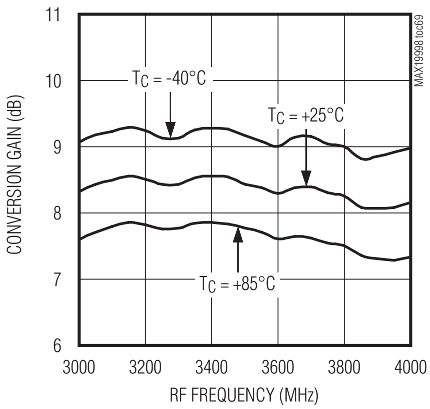


SiGe, High-Linearity, 2300MHz to 4000MHz Downconversion Mixer with LO Buffer

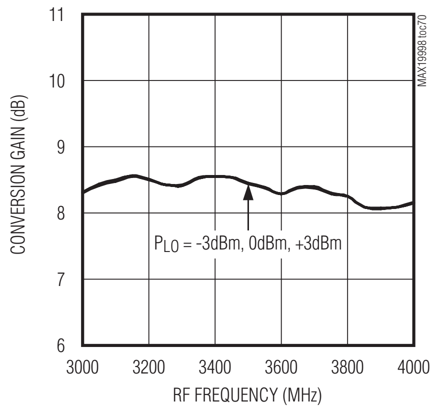
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 3100MHz to 3900MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

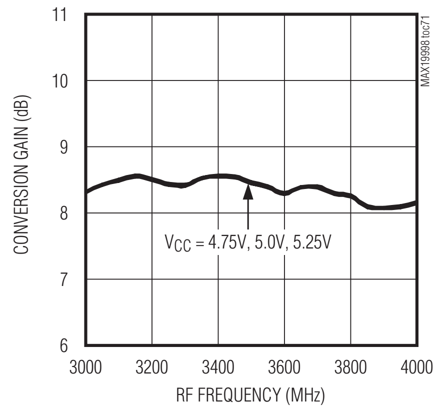
CONVERSION GAIN vs. RF FREQUENCY



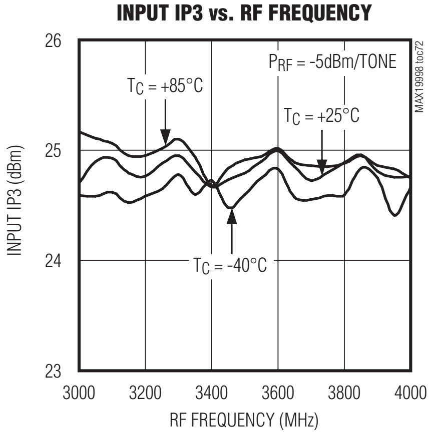
CONVERSION GAIN vs. RF FREQUENCY



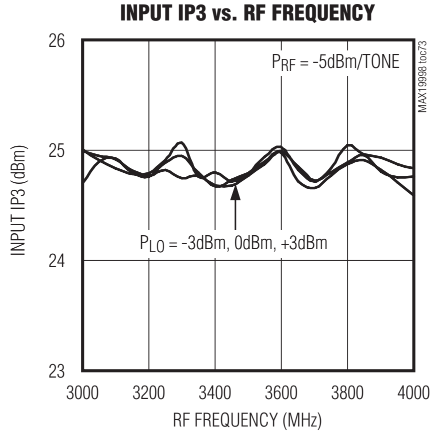
CONVERSION GAIN vs. RF FREQUENCY



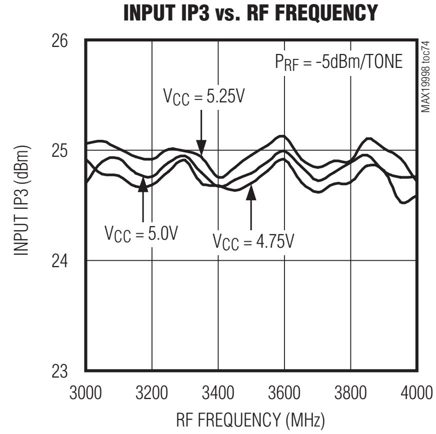
INPUT IP3 vs. RF FREQUENCY



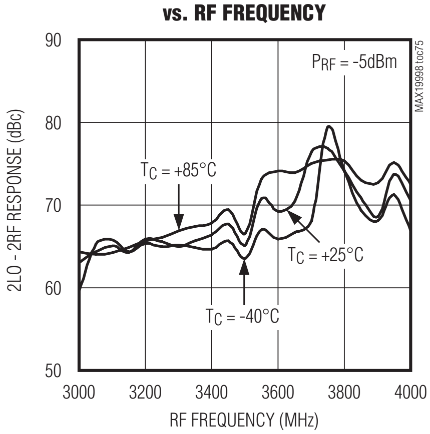
INPUT IP3 vs. RF FREQUENCY



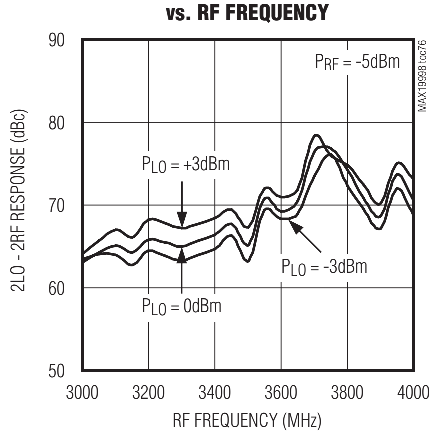
INPUT IP3 vs. RF FREQUENCY



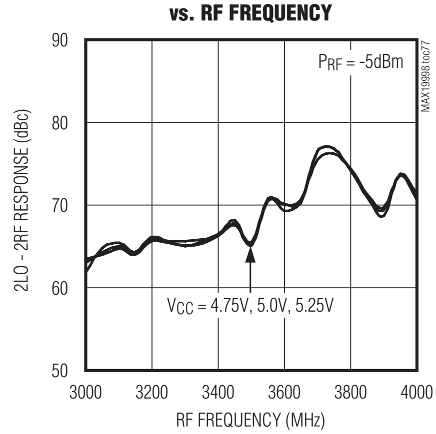
2LO - 2RF RESPONSE vs. RF FREQUENCY



2LO - 2RF RESPONSE vs. RF FREQUENCY



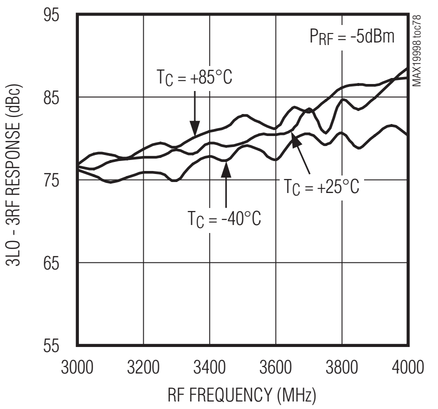
2LO - 2RF RESPONSE vs. RF FREQUENCY



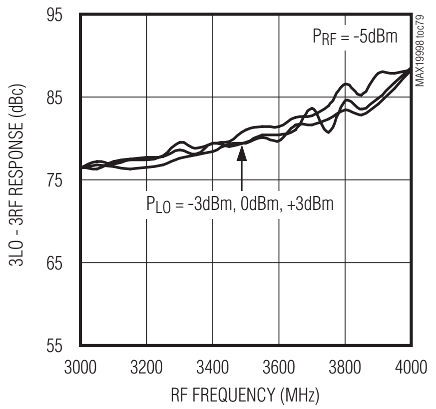
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 3100MHz to 3900MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

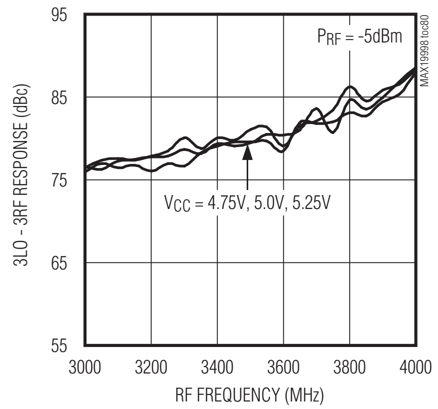
3LO - 3RF RESPONSE vs. RF FREQUENCY



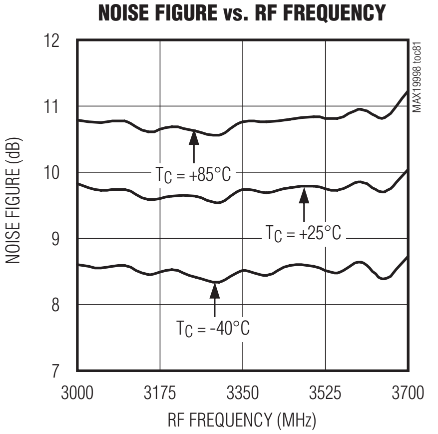
3LO - 3RF RESPONSE vs. RF FREQUENCY



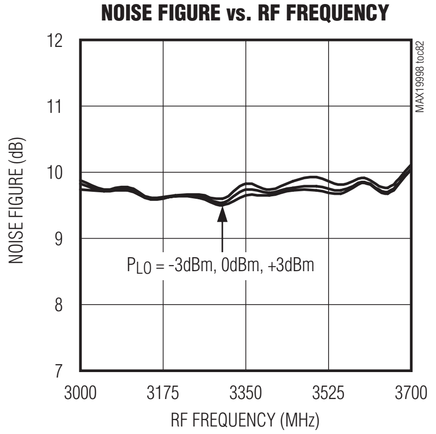
3LO - 3RF RESPONSE vs. RF FREQUENCY



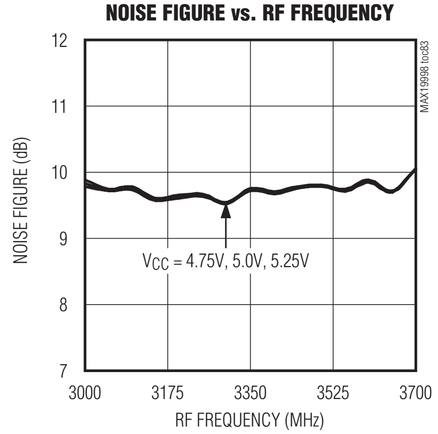
NOISE FIGURE vs. RF FREQUENCY



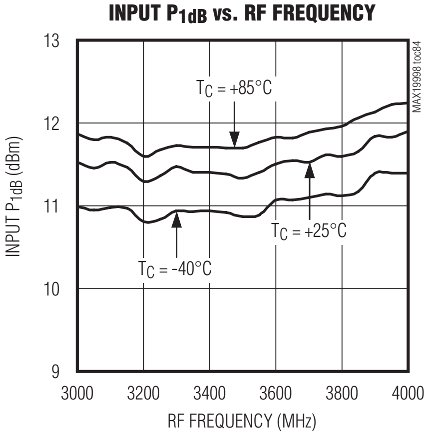
NOISE FIGURE vs. RF FREQUENCY



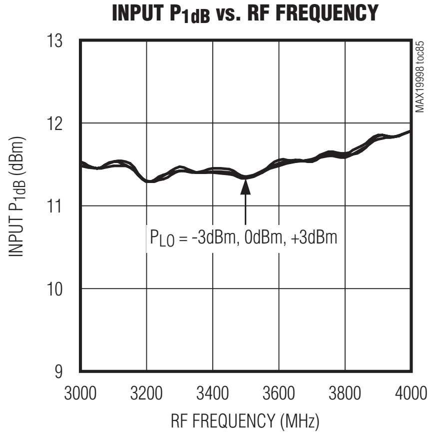
NOISE FIGURE vs. RF FREQUENCY



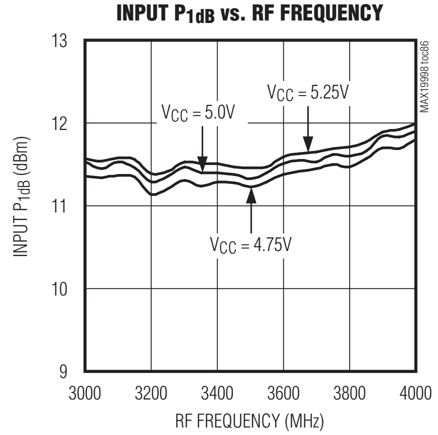
INPUT P_{1dB} vs. RF FREQUENCY



INPUT P_{1dB} vs. RF FREQUENCY



INPUT P_{1dB} vs. RF FREQUENCY

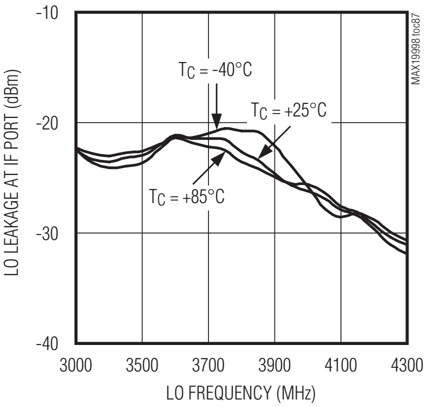


SiGe, High-Linearity, 2300MHz to 4000MHz Downconversion Mixer with LO Buffer

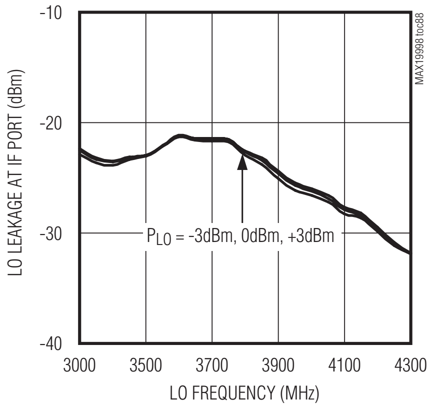
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 3100MHz to 3900MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

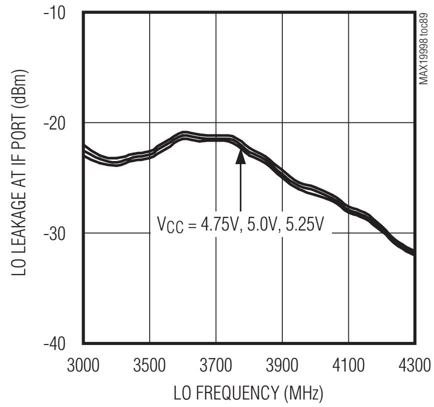
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



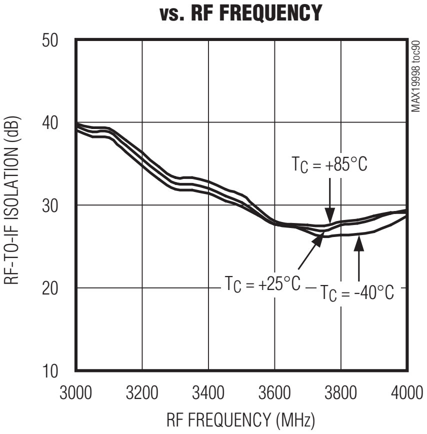
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



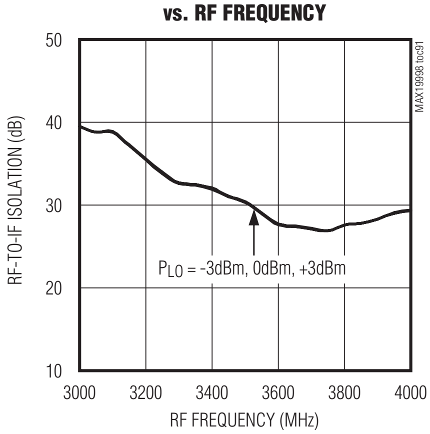
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



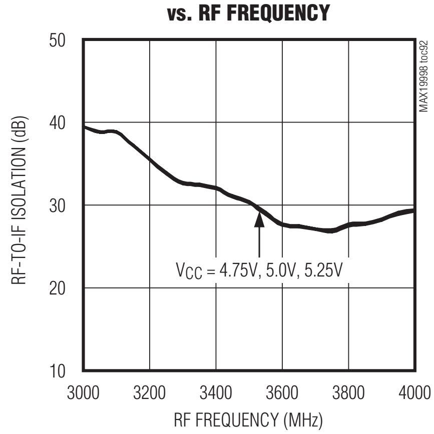
RF-TO-IF ISOLATION vs. RF FREQUENCY



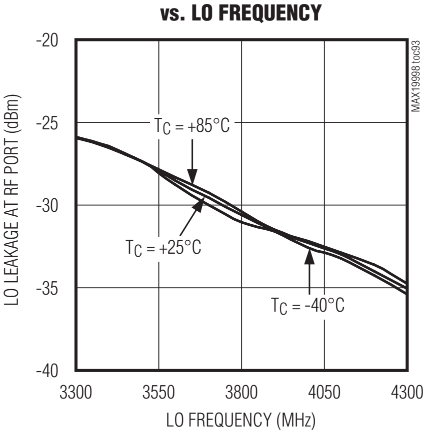
RF-TO-IF ISOLATION vs. RF FREQUENCY



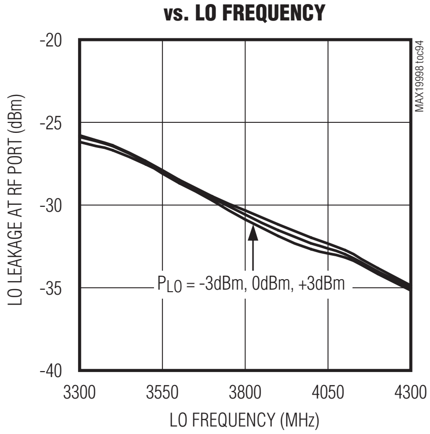
RF-TO-IF ISOLATION vs. RF FREQUENCY



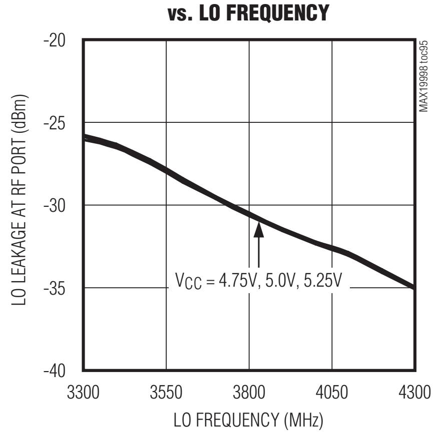
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



LO LEAKAGE AT RF PORT vs. LO FREQUENCY



LO LEAKAGE AT RF PORT vs. LO FREQUENCY

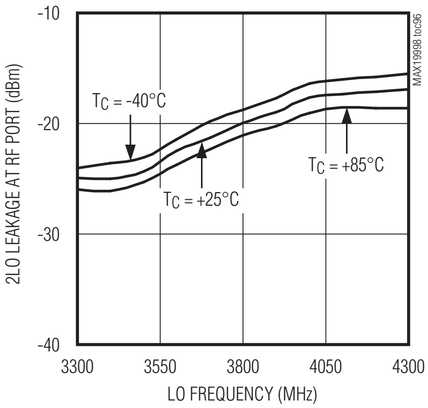


SiGe, High-Linearity, 2300MHz to 4000MHz Downconversion Mixer with LO Buffer

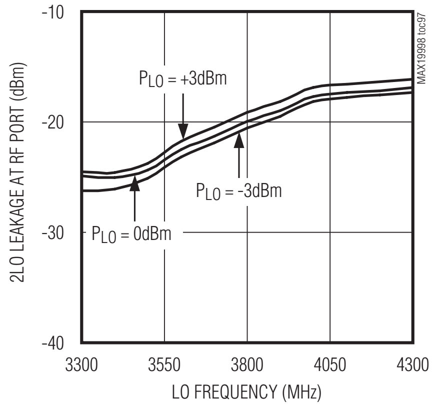
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 3100MHz to 3900MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

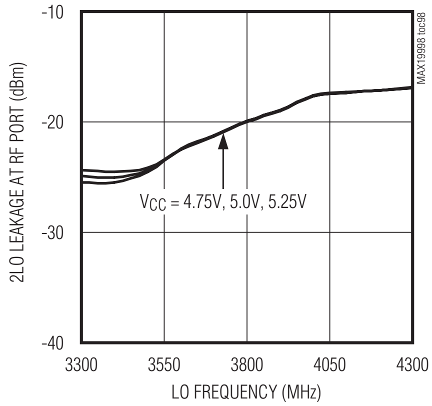
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



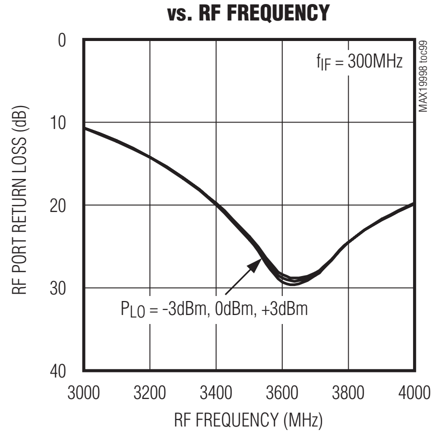
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



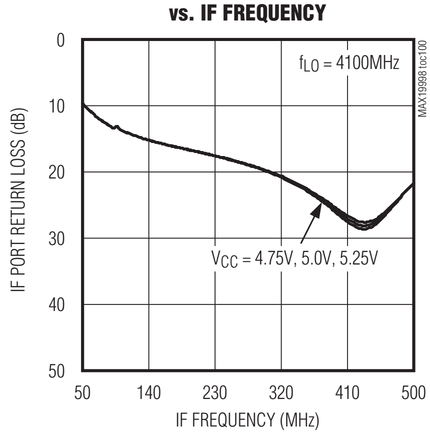
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



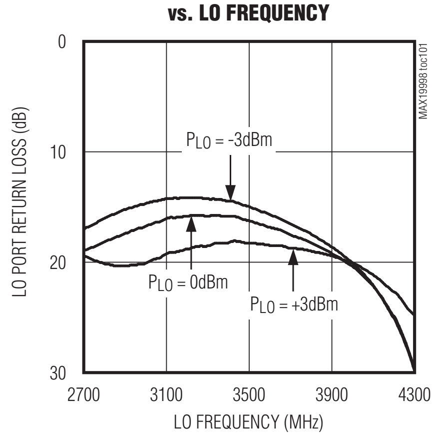
RF PORT RETURN LOSS vs. RF FREQUENCY



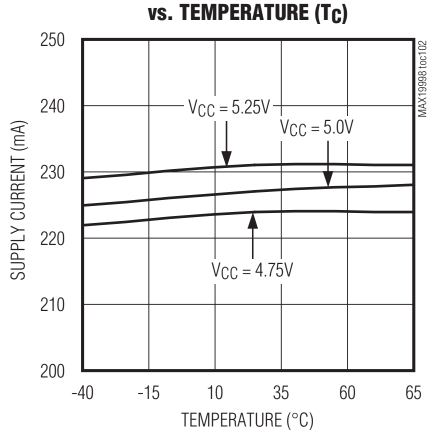
IF PORT RETURN LOSS vs. IF FREQUENCY



LO PORT RETURN LOSS vs. LO FREQUENCY



SUPPLY CURRENT vs. TEMPERATURE (T_C)

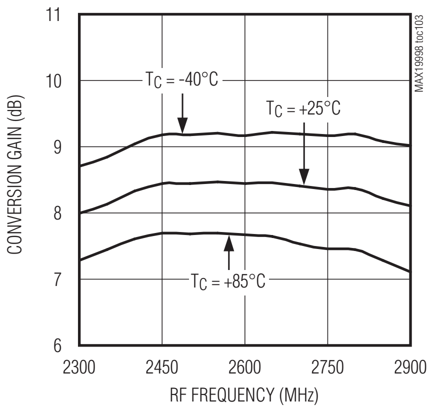


SiGe, High-Linearity, 2300MHz to 4000MHz Downconversion Mixer with LO Buffer

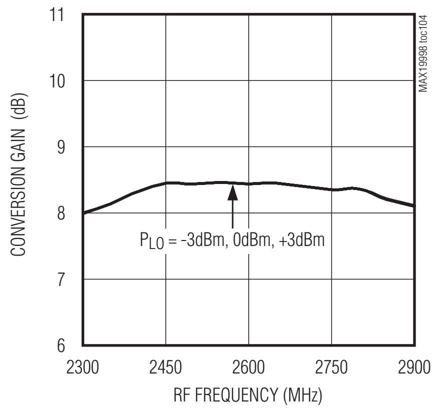
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 2300MHz to 2900MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

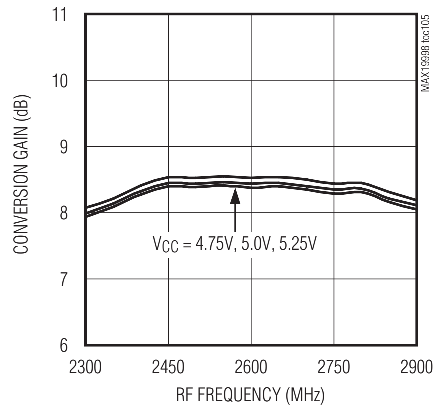
CONVERSION GAIN vs. RF FREQUENCY



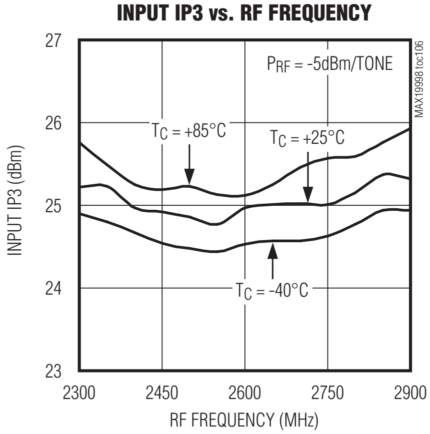
CONVERSION GAIN vs. RF FREQUENCY



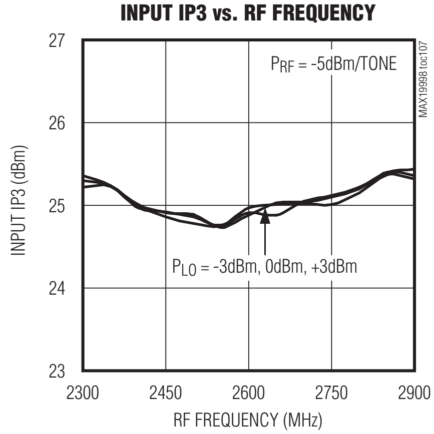
CONVERSION GAIN vs. RF FREQUENCY



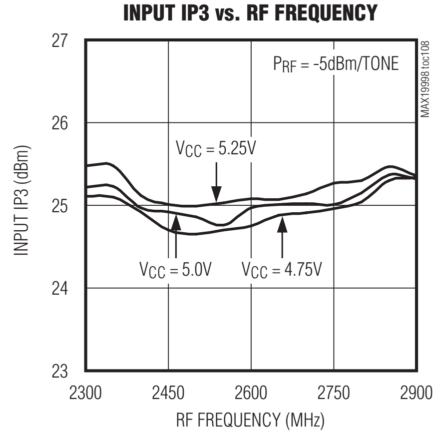
INPUT IP3 vs. RF FREQUENCY



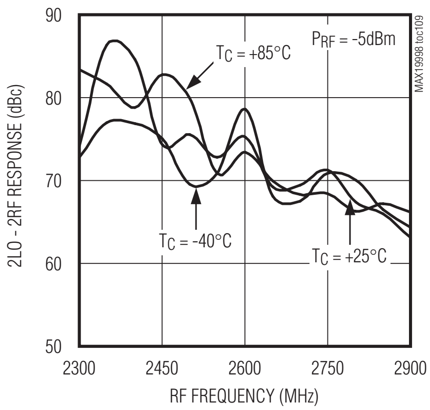
INPUT IP3 vs. RF FREQUENCY



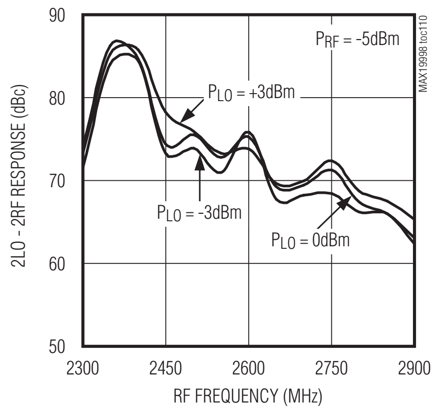
INPUT IP3 vs. RF FREQUENCY



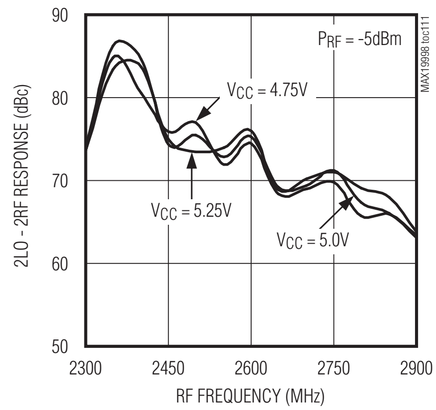
2LO - 2RF RESPONSE vs. RF FREQUENCY



2LO - 2RF RESPONSE vs. RF FREQUENCY

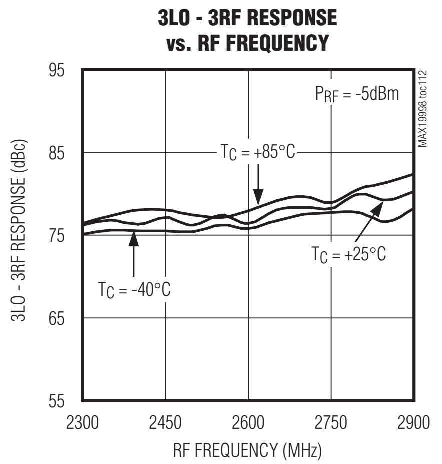


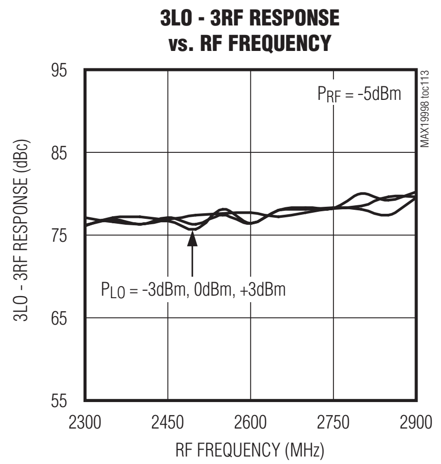
2LO - 2RF RESPONSE vs. RF FREQUENCY

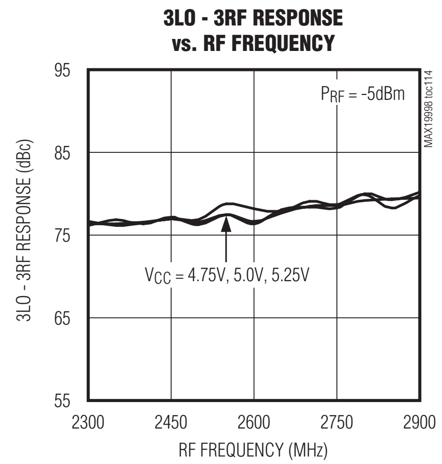


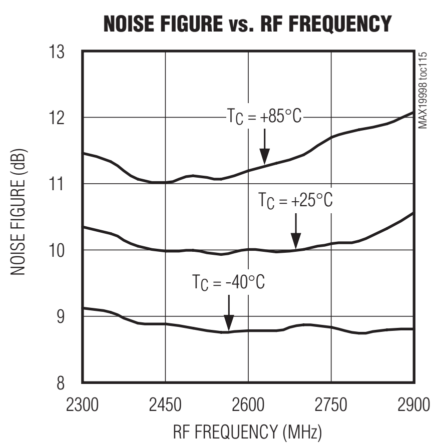
Typical Operating Characteristics (continued)

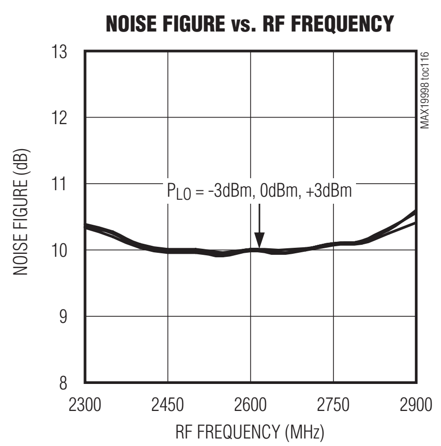
(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 2300MHz to 2900MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

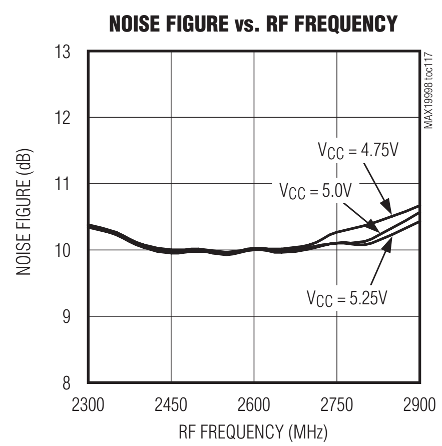


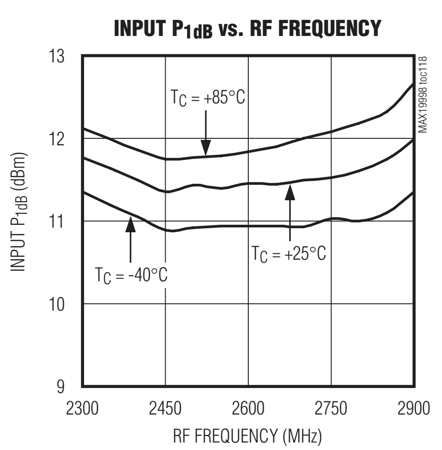


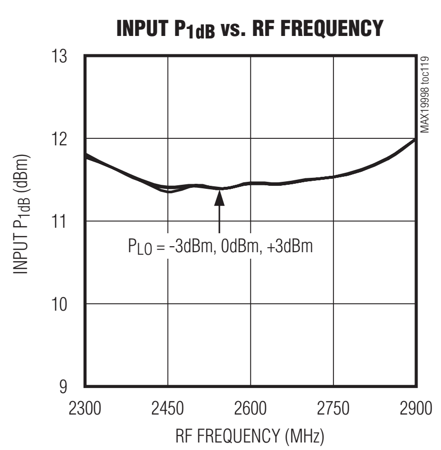


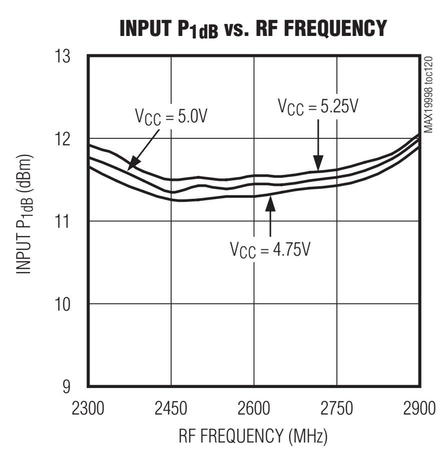










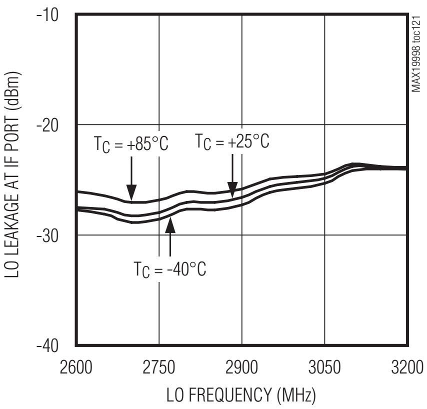


SiGe, High-Linearity, 2300MHz to 4000MHz Downconversion Mixer with LO Buffer

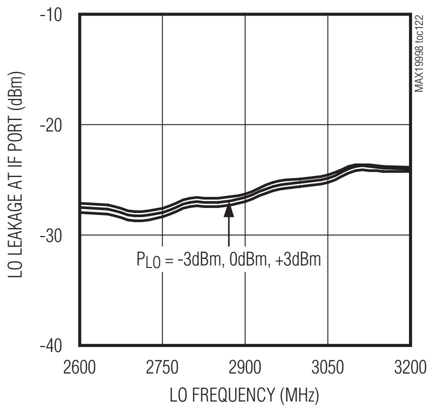
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 2300MHz to 2900MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

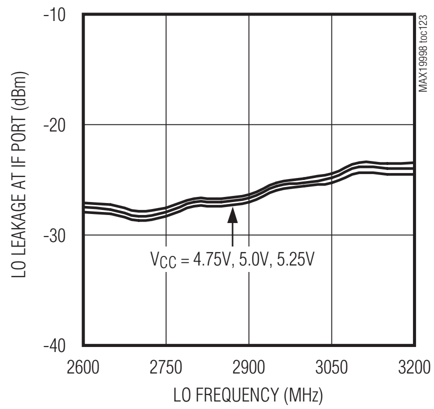
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



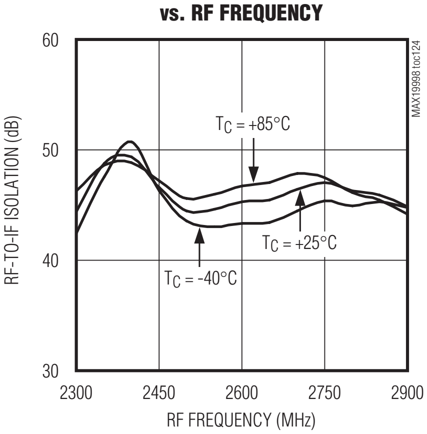
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



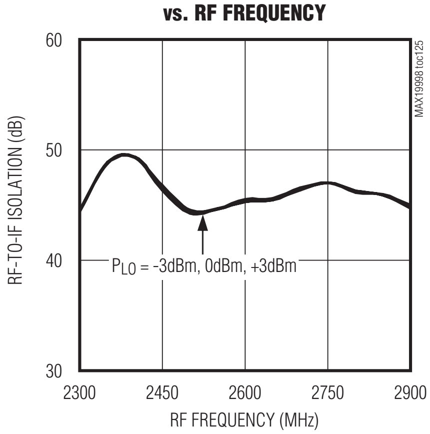
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



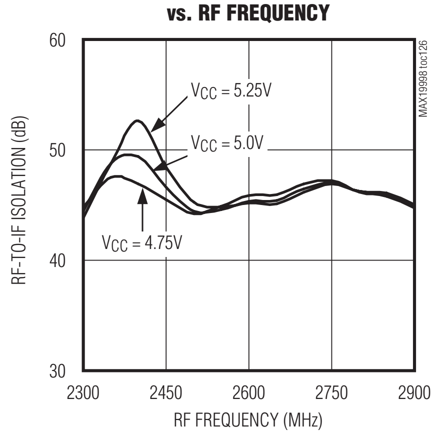
RF-TO-IF ISOLATION vs. RF FREQUENCY



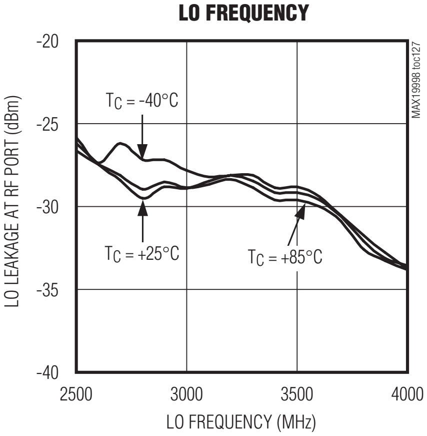
RF-TO-IF ISOLATION vs. RF FREQUENCY



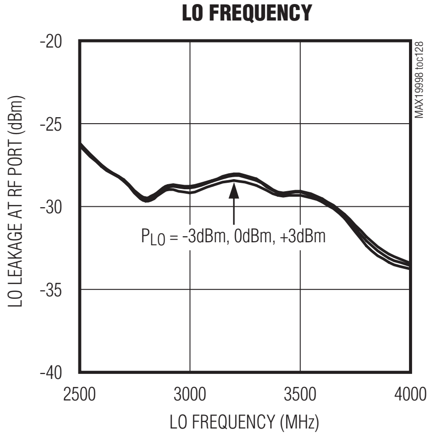
RF-TO-IF ISOLATION vs. RF FREQUENCY



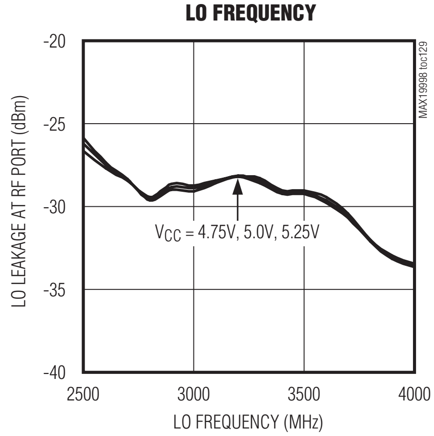
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



LO LEAKAGE AT RF PORT vs. LO FREQUENCY



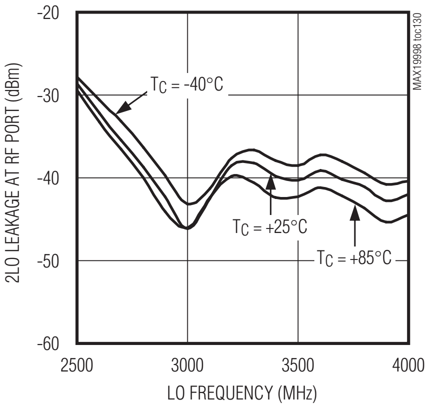
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



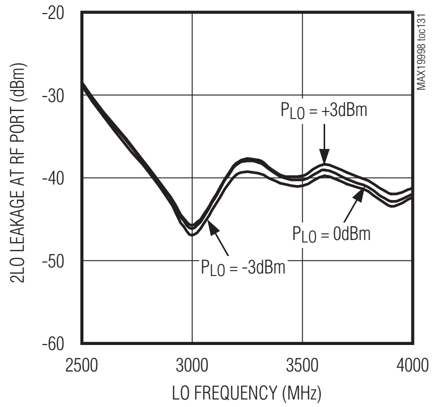
Typical Operating Characteristics (continued)

(*Typical Application Circuit* with tuning elements outlined in **Table 1, V_{CC} = 5.0V, f_{RF} = 2300MHz to 2900MHz, LO is high-side injected** for a 300MHz IF, P_{RF} = -5dBm, P_{LO} = 0dBm, T_C = +25°C, unless otherwise noted.)

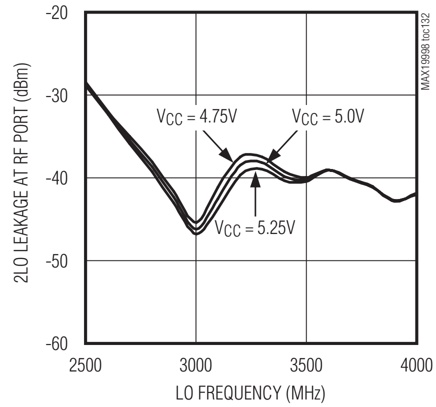
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



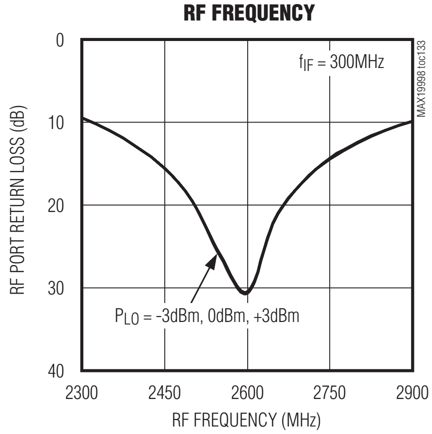
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



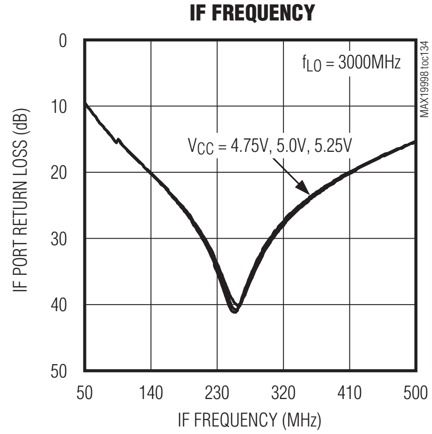
2LO LEAKAGE AT RF PORT vs. LO FREQUENCY



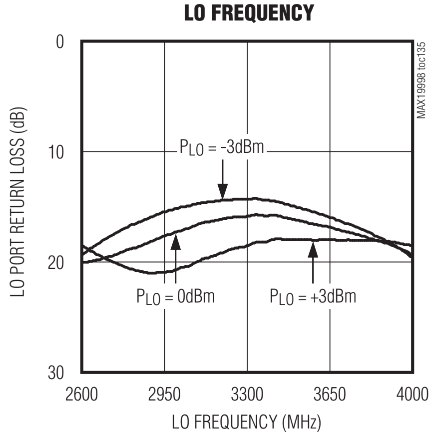
RF PORT RETURN LOSS vs. RF FREQUENCY



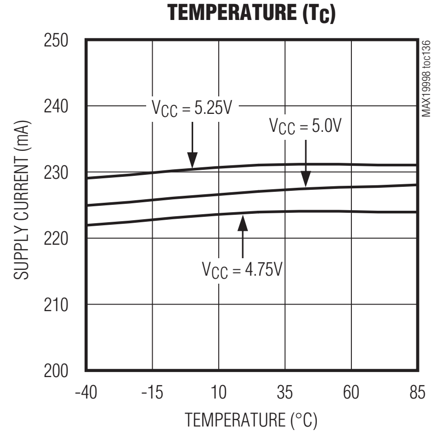
IF PORT RETURN LOSS vs. IF FREQUENCY



LO PORT RETURN LOSS vs. LO FREQUENCY

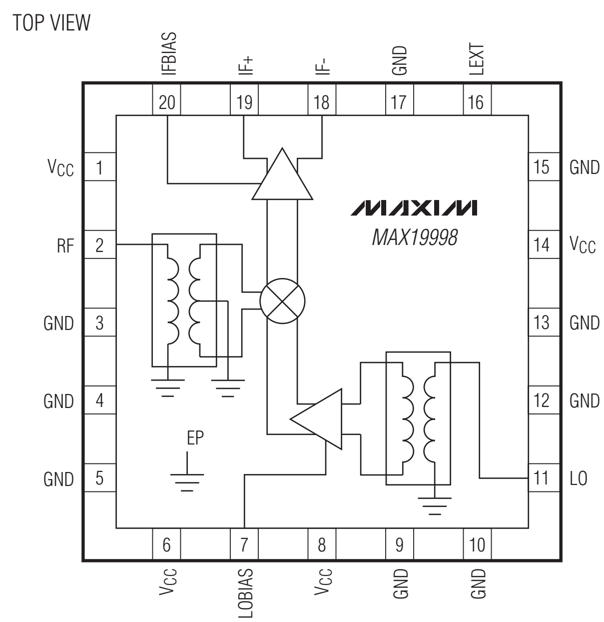


SUPPLY CURRENT vs. TEMPERATURE (T_C)



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

Pin Configuration/Functional Diagram



Pin Description

PIN	NAME	FUNCTION
1, 6, 8, 14	V_{CC}	Power Supply. Bypass to GND with 0.01µF capacitors as close as possible to the pin.
2	RF	Single-Ended 50Ω RF Input. Internally matched and DC shorted to GND through a balun. Provide an input DC-blocking capacitor if required.
3, 9, 13, 15	GND	Ground. Not internally connected. Pins can be grounded.
4, 5, 10, 12, 17	GND	Ground. Internally connected to the exposed pad. 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 (5V, 230mA bias condition) from LOBIAS to ground.
11	LO	Local Oscillator Input. This input is internally matched to 50Ω. Requires an input DC-blocking capacitor.
16	LEXT	External Inductor Connection. Connect a low-ESR 4.7nH inductor from this pin to ground to increase the RF-to-IF and LO-to-IF isolation. Connect this pin directly to ground to reduce the component count at the expense of reduced RF-to-IF and LO-to-IF isolation.
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 (5V, 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

The MAX19998 provides high linearity and low noise figure for a multitude of 2300MHz to 4000MHz WiMAX, LTE, and MMDS base-station applications. This device operates over a 2600MHz to 4300MHz LO range and a 50MHz to 500MHz IF range. Integrated baluns and matching circuitry allow 50Ω single-ended interfaces to the RF and LO ports. The integrated LO buffer provides a high drive level to the mixer core, reducing the LO drive required at the MAX19998's input to a range of -3dBm to +3dBm. The IF port incorporates a differential output, which is ideal for providing enhanced 2RF - 2LO and 2LO - 2RF performance.

RF Input and Balun

The MAX19998 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 17dB over the RF frequency range of 3200MHz to 3900MHz. See Table 1 for lower band tuning.

LO Inputs, Buffer, and Balun

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 MAX19998 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 amplifier, IIP3, 2RF - 2LO rejection, and noise-figure performance are typically +24.3dBm, 67dBc, and 9.7dB, respectively, for low-side LO injection architectures covering the 3000MHz to 4000MHz RF band.

Differential IF Output Amplifier

The MAX19998 has a 50MHz to 500MHz IF frequency range, where the low-end frequency depends on the frequency response of the external IF components. The MAX19998 mixer is tuned for a 300MHz IF using 390nH external pullup bias inductors. Lower IF frequencies would require higher L1 and L2 inductor values to maintain a good IF match. The differential, open-collector IF output ports require that these inductors be connected to V_{CC}.

Note that these differential ports are ideal for providing enhanced 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 and LO inputs provide 50Ω matches when combined with the proper tuning. Use an 8.2pF capacitor value on the RF port for frequencies ranging from 3000MHz to 4000MHz. Use a 3.3nH series inductor and a 0.3pF shunt capacitor on the RF port for frequencies ranging from 2300MHz to 2900MHz. On the LO port, use a 2pF DC-blocking capacitor to cover operations spanning the 2600MHz to 4300MHz 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 MAX19998 has two pins (LOBIAS, IFBIAS) that allow external resistors to set the internal bias currents. See Table 1 for nominal values for these resistors. 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 57% (typ). See the *3.3V Supply AC Electrical Characteristics* table and the relevant 3.3V curves in the *Typical Operating Characteristics* section to evaluate the power vs. performance trade-offs.

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 such that any capacitances from IF- and IF+ to ground do not exceed several picofarads to ensure stable operating conditions. Since approximately 120mA 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 such that any capacitance from both IF- and IF+ to ground does not exceed several picofarads. For the best performance, route the ground pin traces directly to the exposed pad under the package. The PCB exposed pad **MUST** be connected to the ground plane of the PCB. It is suggested that multiple vias be used to connect this pad to the lower level ground planes. This method provides a good RF/thermal-conduction path for the device. Solder the exposed pad on the bottom of the device package to the PCB. The MAX19998 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 Table 1 for component values.

Table 1. Component Values

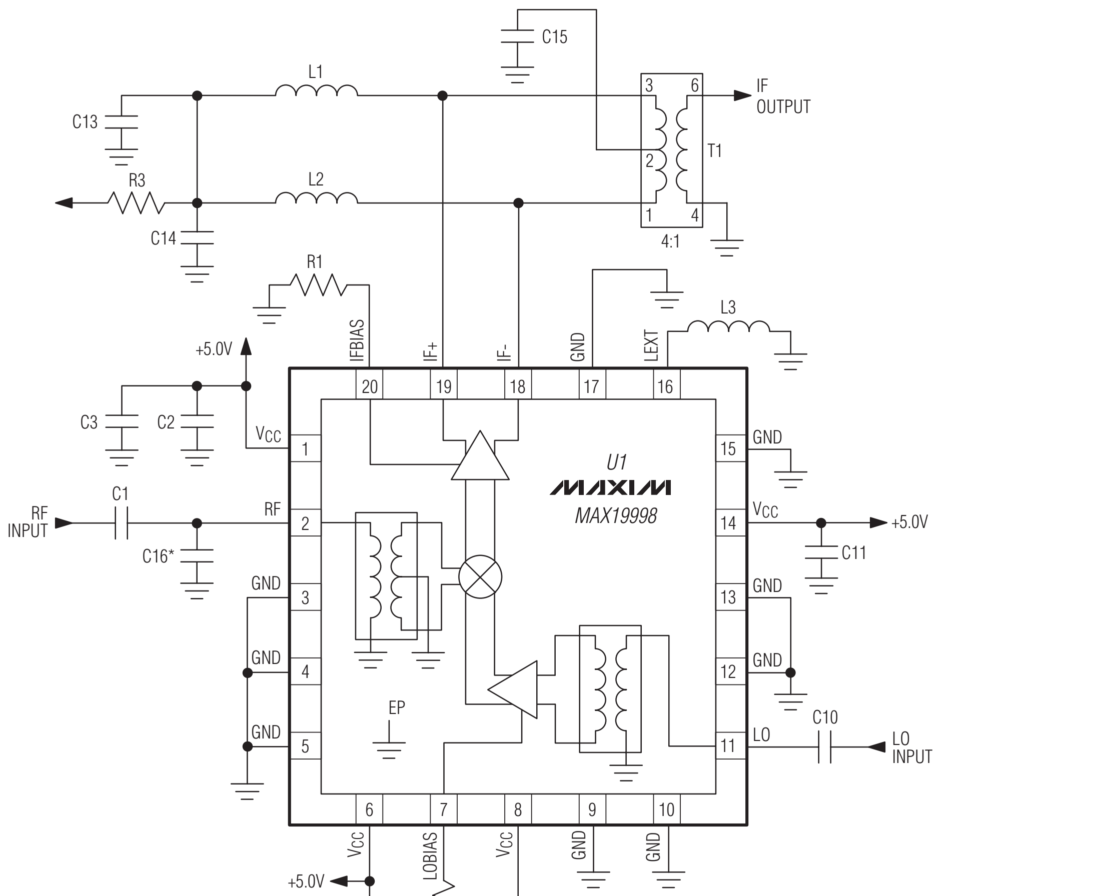
DESIGNATION	QTY	DESCRIPTION	COMPONENT SUPPLIER
C1	1	8.2pF microwave capacitor (0402). Use for RF frequencies ranging from 3000MHz to 4000MHz.	Murata Electronics North America, Inc.
		3.3nH microwave inductor (0402). Use for RF frequencies ranging from 2300MHz to 2900MHz.	Coilcraft, Inc.
C2, C6, C8, C11	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.
C16	1	Not installed for RF frequencies ranging from 3000MHz to 4000MHz	—
		0.3pF microwave capacitor (0402). Use for RF frequencies ranging from 2300MHz to 2900MHz.	Murata Electronics North America, Inc.
L1, L2	2	390nH wire-wound high-Q inductors* (0805)	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.
		845Ω ±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.
		1.1kΩ ±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	MAX19998 IC (20 Thin QFN-EP)	Maxim Integrated Products, Inc.

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

Exposed Pad RF/Thermal Considerations

The exposed pad (EP) of the MAX19998'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 MAX19998 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 4, 5, 10, 12, AND 17 ARE ALL INTERNALLY CONNECTED TO THE EXPOSED GROUND PAD. CONNECT THESE PINS TO GROUND TO IMPROVE ISOLATION.

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

*C16 NOT USED FOR 3000MHz TO 4000MHz APPLICATIONS.

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

Chip Information

PROCESS: SiGe BiCMOS

Package Information

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

PACKAGE TYPE	PACKAGE CODE	DOCUMENT NO.
20 Thin QFN-EP	T2055+3	**21-0140**

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