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EVALUATION KIT
AVAILABLE

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

WiMAX is a trademark of WiMAX Forum.

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 PRF = -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.



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

ABSOLUTE MAXIMUM RATINGS

V _{CC} to GND.....	-0.3V to +5.5V	θ _{JA} (Notes 2, 3).....	+38°C/W
IF+, IF-, LOBIAS, IFBIAS to GND.....	-0.3V to (V _{CC} + 0.3V)	θ _{JC} (Notes 1, 3).....	+13°C/W
RF, LO Input Power.....	+12dBm	Operating Case Temperature Range	
RF, LO Current		(Note 4).....	T _C = -40°C to +85°C
(RF and LO is DC shorted to GND through balun).....	50mA	Junction Temperature	+150°C
Continuous Power Dissipation (Note 1)	5W	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 <i>Typical Application Circuit</i> , 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 <i>Typical Application Circuit</i> , IF matching components affect the IF frequency range (Notes 5, 6)	50		250	
LO Drive	P _{LO}		-3	0	+3	dBm

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

MAX19998

5.0V SUPPLY AC ELECTRICAL CHARACTERISTICS— $f_{RF} = 3100\text{MHz}$ to 3900MHz , LOW-SIDE LO INJECTION

(Typical Application Circuit, with tuning elements outlined in Table 1, $R_1 = 698\Omega$, $R_2 = 604\Omega$, $V_{CC} = 4.75\text{V}$ to 5.25V , RF and LO ports are driven from 50Ω sources, $P_{LO} = -3\text{dBm}$ to $+3\text{dBm}$, $P_{RF} = -5\text{dBm}$, $f_{RF} = 3100\text{MHz}$ to 3900MHz , $f_{IF} = 300\text{MHz}$, $f_{LO} = 2800\text{MHz}$ to 3600MHz , $f_{RF} > f_{LO}$, $T_C = -40^\circ\text{C}$ to $+85^\circ\text{C}$. Typical values are for $T_C = +25^\circ\text{C}$, $V_{CC} = 5.0\text{V}$, $P_{RF} = -5\text{dBm}$, $P_{LO} = 0\text{dBm}$, $f_{RF} = 3500\text{MHz}$, $f_{LO} = 3200\text{MHz}$, $f_{IF} = 300\text{MHz}$. All parameters are guaranteed by design and characterization, unless otherwise noted.) (Note 7)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small-Signal Conversion Gain	G _C	$T_C = +25^\circ\text{C}$ (Notes 8, 9)	7.6	8.7	9.4	dB
Gain Variation vs. Frequency	ΔG_C	$f_{RF} = 3100\text{MHz}$ to 3900MHz , any 100MHz band		0.15		dB
		$f_{RF} = 3100\text{MHz}$ to 3900MHz , any 200MHz band		0.3		
Conversion Gain Temperature Coefficient	T _{CCG}	$f_{RF} = 3100\text{MHz}$ to 3900MHz , $T_C = -40^\circ\text{C}$ to $+85^\circ\text{C}$		-0.01		dB/°C
Input 1dB Compression Point	IP _{1dB}	(Note 10)	10.0	11.4		dBm
Third-Order Input Intercept Point	IIP ₃	$f_{RF1} - f_{RF2} = 1\text{MHz}$, $P_{RF1} = P_{RF2} = -5\text{dBm/tone}$, $T_C = +25^\circ\text{C}$ (Note 9)	22	24.3		dBm
IIP ₃ Variation with T _C		$f_{RF} = 3100\text{MHz}$ to 3900MHz , $f_{RF1} - f_{RF2} = 1\text{MHz}$, $P_{RF1} = P_{RF2} = -5\text{dBm/tone}$, $T_C = -40^\circ\text{C}$ to $+85^\circ\text{C}$		±0.2		dBm
Single-Sideband Noise Figure	NF _{SSB}	No blockers present (Note 5)		9.7	12.5	dB
		No blockers present, $T_C = +25^\circ\text{C}$ (Note 5)		9.7	11.0	
Noise Figure Temperature Coefficient	T _{CNF}	Single sideband, no blockers present, $T_C = -40^\circ\text{C}$ to $+85^\circ\text{C}$		0.018		dB/°C
Noise Figure Under Blocking	NFB	+8dBm blocker tone applied to RF port, $f_{RF} = 3500\text{MHz}$, $f_{LO} = 3200\text{MHz}$, $f_{BLOCKER} = 3750\text{MHz}$, $P_{LO} = 0\text{dBm}$, $V_{CC} = +5.0\text{V}$, $T_C = +25^\circ\text{C}$ (Notes 5, 11)		21	25	dB
2RF - 2LO Spur Rejection	2 x 2	$f_{SPUR} = f_{LO} + 150\text{MHz}$	$P_{RF} = -10\text{dBm}$ (Note 5)	63	67	dBc
			$P_{RF} = -5\text{dBm}$ (Note 9)	58	62	
3RF - 3LO Spur Rejection	3 x 3	$f_{SPUR} = f_{LO} + 100\text{MHz}$	$P_{RF} = -10\text{dBm}$ (Note 5)	80	85	dBc
			$P_{RF} = -5\text{dBm}$ (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.	$f_{IF} = 450\text{MHz}$, $L_1 = L_2 = 120\text{nH}$	20		dB
			$f_{IF} = 350\text{MHz}$, $L_1 = L_2 = 270\text{nH}$	20		
			$f_{IF} = 300\text{MHz}$, $L_1 = L_2 = 390\text{nH}$	20		

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

5.0V SUPPLY AC ELECTRICAL CHARACTERISTICS— $f_{RF} = 3100\text{MHz}$ to 3900MHz , LOW-SIDE LO INJECTION (continued)

(Typical Application Circuit, with tuning elements outlined in Table 1, $R_1 = 698\Omega$, $R_2 = 604\Omega$, $V_{CC} = 4.75\text{V}$ to 5.25V , RF and LO ports are driven from 50Ω sources, $P_{LO} = -3\text{dBm}$ to $+3\text{dBm}$, $P_{RF} = -5\text{dBm}$, $f_{RF} = 3100\text{MHz}$ to 3900MHz , $f_{IF} = 300\text{MHz}$, $f_{LO} = 2800\text{MHz}$ to 3600MHz , $f_{RF} > f_{LO}$, $T_C = -40^\circ\text{C}$ to $+85^\circ\text{C}$. Typical values are for $T_C = +25^\circ\text{C}$, $V_{CC} = 5.0\text{V}$, $P_{RF} = -5\text{dBm}$, $P_{LO} = 0\text{dBm}$, $f_{RF} = 3500\text{MHz}$, $f_{LO} = 3200\text{MHz}$, $f_{IF} = 300\text{MHz}$. All parameters are guaranteed by design and characterization, unless otherwise noted.) (Note 7)

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

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

(Typical Application Circuit, with tuning elements outlined in Table 1, $R_1 = 845\Omega$, $R_2 = 1.1\text{k}\Omega$, RF and LO ports are driven from 50Ω sources, $f_{RF} > f_{LO}$. Typical values are for $T_C = +25^\circ\text{C}$, $V_{CC} = 3.3\text{V}$, $P_{RF} = -5\text{dBm}$, $P_{LO} = 0\text{dBm}$, $f_{RF} = 3500\text{MHz}$, $f_{LO} = 3200\text{MHz}$, $f_{IF} = 300\text{MHz}$, 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	$f_{RF} = 3100\text{MHz}$ to 3900MHz , any 100MHz band		0.15		dB
Conversion Gain Temperature Coefficient	T_{CCG}	$f_{RF} = 3100\text{MHz}$ to 3900MHz , $T_C = -40^\circ\text{C}$ to $+85^\circ\text{C}$		-0.01		dB/ $^\circ\text{C}$
Input 1dB Compression Point	IP_{1dB}	(Note 10)		7.7		dBm
Third-Order Input Intercept Point	IIP3	$f_{RF1} - f_{RF2} = 1\text{MHz}$, $P_{RF1} = P_{RF2} = -5\text{dBm/ tone}$		20.1		dBm
IIP3 Variation with T_C		$f_{RF1} - f_{RF2} = 1\text{MHz}$, $P_{RF1} = P_{RF2} = -5\text{dBm/ tone}$, $T_C = -40^\circ\text{C}$ to $+85^\circ\text{C}$		± 0.2		dB
Single-Sideband Noise Figure	NF_{SSB}	No blockers present		9.3		dB
Noise Figure Temperature Coefficient	T_{CNF}	Single sideband, no blockers present, $T_C = -40^\circ\text{C}$ to $+85^\circ\text{C}$		0.018		dB/ $^\circ\text{C}$
2RF - 2LO Spur Rejection	2 x 2	$f_{SPUR} = f_{LO} + 150\text{MHz}$	$P_{RF} = -10\text{dBm}$	64		dBc
			$P_{RF} = -5\text{dBm}$	59		
3RF - 3LO Spur Rejection	3 x 3	$f_{SPUR} = f_{LO} + 100\text{MHz}$	$P_{RF} = -10\text{dBm}$	74		dBc
			$P_{RF} = -5\text{dBm}$	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

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

MAX19998

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

(Typical Application Circuit, with tuning elements outlined in Table 1, $R_1 = 845\Omega$, $R_2 = 1.1k\Omega$, RF and LO ports are driven from 50Ω sources, $f_{RF} > f_{LO}$. Typical values are for $T_C = +25^\circ\text{C}$, $V_{CC} = 3.3\text{V}$, $P_{RF} = -5\text{dBm}$, $P_{LO} = 0\text{dBm}$, $f_{RF} = 3500\text{MHz}$, $f_{LO} = 3200\text{MHz}$, $f_{IF} = 300\text{MHz}$, 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.		17		dB
		$f_{IF} = 450\text{MHz}$, $L_1 = L_2 = 120\text{nH}$		17		
		$f_{IF} = 350\text{MHz}$, $L_1 = L_2 = 270\text{nH}$		17		
RF-to-IF Isolation		$f_{RF} = 3100\text{MHz}$ to 3900MHz , $P_{LO} = +3\text{dBm}$		27		dB
LO Leakage at RF Port		$f_{LO} = 2800\text{MHz}$ to 3600MHz , $P_{LO} = +3\text{dBm}$		-30		dBm
2LO Leakage at RF Port		$f_{LO} = 2800\text{MHz}$ to 3600MHz , $P_{LO} = +3\text{dBm}$		-26.5		dBm
LO Leakage at IF Port		$f_{LO} = 2800\text{MHz}$ to 3600MHz , $P_{LO} = +3\text{dBm}$		-27.5		dBm

5.0V SUPPLY AC ELECTRICAL CHARACTERISTICS— $f_{RF} = 3100\text{MHz}$ to 3900MHz , HIGH-SIDE LO INJECTION

(Typical Application Circuit, with tuning elements outlined in Table 1, $R_1 = 698\Omega$, $R_2 = 604\Omega$, $V_{CC} = 4.75\text{V}$ to 5.25V , RF and LO ports are driven from 50Ω sources, $P_{LO} = -3\text{dBm}$ to $+3\text{dBm}$, $P_{RF} = -5\text{dBm}$, $f_{RF} = 3100\text{MHz}$ to 3900MHz , $f_{IF} = 300\text{MHz}$, $f_{LO} = 3400\text{MHz}$ to 4200MHz , $f_{RF} < f_{LO}$, $T_C = -40^\circ\text{C}$ to $+85^\circ\text{C}$. Typical values are for $T_C = +25^\circ\text{C}$, $V_{CC} = 5.0\text{V}$, $P_{RF} = -5\text{dBm}$, $P_{LO} = 0\text{dBm}$, $f_{RF} = 3500\text{MHz}$, $f_{LO} = 3800\text{MHz}$, $f_{IF} = 300\text{MHz}$, unless otherwise noted.) (Note 7)

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

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

5.0V SUPPLY AC ELECTRICAL CHARACTERISTICS— $f_{RF} = 3100\text{MHz}$ to 3900MHz , HIGH-SIDE LO INJECTION (continued)

(Typical Application Circuit, with tuning elements outlined in Table 1, $R_1 = 698\Omega$, $R_2 = 604\Omega$, $V_{CC} = 4.75\text{V}$ to 5.25V , RF and LO ports are driven from 50Ω sources, $P_{LO} = -3\text{dBm}$ to $+3\text{dBm}$, $P_{RF} = -5\text{dBm}$, $f_{RF} = 3100\text{MHz}$ to 3900MHz , $f_{IF} = 300\text{MHz}$, $f_{LO} = 3400\text{MHz}$ to 4200MHz , $f_{RF} < f_{LO}$, $T_C = -40^\circ\text{C}$ to $+85^\circ\text{C}$. Typical values are for $T_C = +25^\circ\text{C}$, $V_{CC} = 5.0\text{V}$, $P_{RF} = -5\text{dBm}$, $P_{LO} = 0\text{dBm}$, $f_{RF} = 3500\text{MHz}$, $f_{LO} = 3800\text{MHz}$, $f_{IF} = 300\text{MHz}$, 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.	$f_{IF} = 450\text{MHz}$, $L_1 = L_2 = 120\text{nH}$		20		dB
			$f_{IF} = 350\text{MHz}$, $L_1 = L_2 = 270\text{nH}$		20		
			$f_{IF} = 300\text{MHz}$, $L_1 = L_2 = 390\text{nH}$		20		
RF-to-IF Isolation		$P_{LO} = +3\text{dBm}$			30		dB
LO Leakage at RF Port		$P_{LO} = +3\text{dBm}$			-30.3		dBm
2LO Leakage at RF Port		$P_{LO} = +3\text{dBm}$			-19		dBm
LO Leakage at IF Port		$P_{LO} = +3\text{dBm}$			-23		dBm

5.0V SUPPLY AC ELECTRICAL CHARACTERISTICS— $f_{RF} = 2300\text{MHz}$ to 2900MHz , HIGH-SIDE LO INJECTION

(Typical Application Circuit, with tuning elements outlined in Table 1, $R_1 = 698\Omega$, $R_2 = 604\Omega$, $V_{CC} = 4.75\text{V}$ to 5.25V , RF and LO ports are driven from 50Ω sources, $P_{LO} = -3\text{dBm}$ to $+3\text{dBm}$, $P_{RF} = -5\text{dBm}$, $f_{RF} = 2300\text{MHz}$ to 2900MHz , $f_{IF} = 300\text{MHz}$, $f_{LO} = 2600\text{MHz}$ to 3200MHz , $f_{RF} < f_{LO}$, $T_C = -40^\circ\text{C}$ to $+85^\circ\text{C}$. Typical values are for $T_C = +25^\circ\text{C}$, $V_{CC} = 5.0\text{V}$, $P_{RF} = -5\text{dBm}$, $P_{LO} = 0\text{dBm}$, $f_{RF} = 2600\text{MHz}$, $f_{LO} = 2900\text{MHz}$, $f_{IF} = 300\text{MHz}$, unless otherwise noted.) (Note 7)

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

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

MAX19998

5.0V SUPPLY AC ELECTRICAL CHARACTERISTICS— $f_{RF} = 2300\text{MHz}$ to 2900MHz , HIGH-SIDE LO INJECTION (continued)

(Typical Application Circuit, with tuning elements outlined in Table 1, $R_1 = 698\Omega$, $R_2 = 604\Omega$, $V_{CC} = 4.75\text{V}$ to 5.25V , RF and LO ports are driven from 50Ω sources, $P_{LO} = -3\text{dBm}$ to $+3\text{dBm}$, $P_{RF} = -5\text{dBm}$, $f_{RF} = 2300\text{MHz}$ to 2900MHz , $f_{IF} = 300\text{MHz}$, $f_{LO} = 2600\text{MHz}$ to 3200MHz , $f_{RF} < f_{LO}$, $T_C = -40^\circ\text{C}$ to $+85^\circ\text{C}$. Typical values are for $T_C = +25^\circ\text{C}$, $V_{CC} = 5.0\text{V}$, $P_{RF} = -5\text{dBm}$, $P_{LO} = 0\text{dBm}$, $f_{RF} = 2600\text{MHz}$, $f_{LO} = 2900\text{MHz}$, $f_{IF} = 300\text{MHz}$, unless otherwise noted. (Note 7)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
IIP3 Variation with T_C		$f_{RF} = 2300\text{MHz}$ to 2900MHz , $f_{RF1} - f_{RF2} = 1\text{MHz}$, $P_{RF1} = P_{RF2} = -5\text{dBm/ tone}$, $T_C = -40^\circ\text{C}$ to $+85^\circ\text{C}$			± 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, $T_C = -40^\circ\text{C}$ to $+85^\circ\text{C}$			0.018		dB/ $^\circ\text{C}$
2LO - 2RF Spur Rejection	2 x 2	$f_{SPUR} = f_{LO} - 50\text{MHz}$	$P_{RF} = -10\text{dBm}$		77		dBc
			$P_{RF} = -5\text{dBm}$		72		
3LO - 3RF Spur Rejection	3 x 3	$f_{SPUR} = f_{LO} - 100\text{MHz}$	$P_{RF} = -10\text{dBm}$		86		dBc
			$P_{RF} = -5\text{dBm}$		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 <i>Typical Application Circuit</i> . See the <i>Typical Operating Characteristics</i> for performance vs. inductor values.	$f_{IF} = 450\text{MHz}$, $L_1 = L_2 = 120\text{nH}$		25		dB
			$f_{IF} = 350\text{MHz}$, $L_1 = L_2 = 270\text{nH}$		25		
			$f_{IF} = 300\text{MHz}$, $L_1 = L_2 = 390\text{nH}$		25		
RF-to-IF Isolation		$P_{LO} = +3\text{dBm}$			45		dB
LO Leakage at RF Port		$P_{LO} = +3\text{dBm}$			-28.8		dBm
2LO Leakage at RF Port		$P_{LO} = +3\text{dBm}$			-42.3		dBm
LO Leakage at IF Port		$P_{LO} = +3\text{dBm}$			-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 $f_{IF} = 300\text{MHz}$ 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.

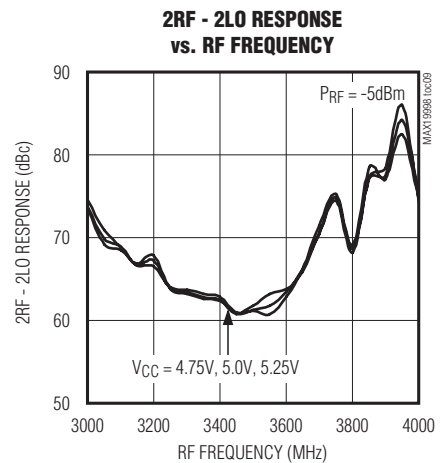
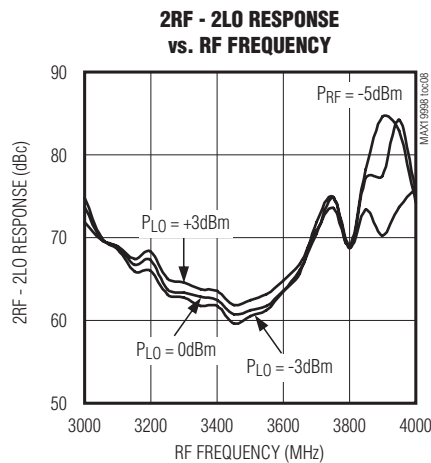
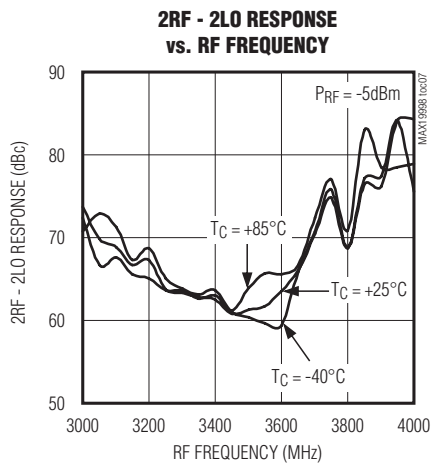
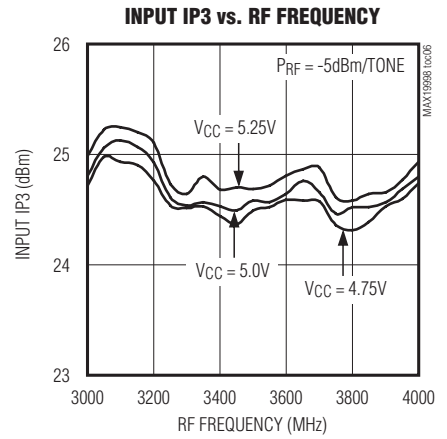
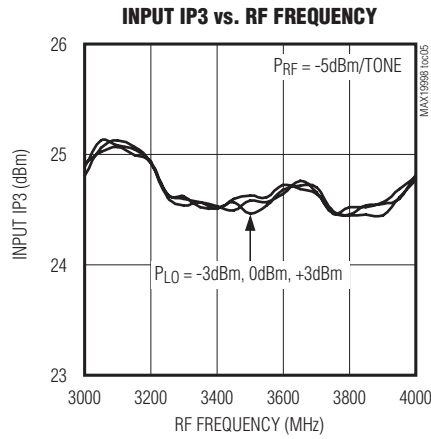
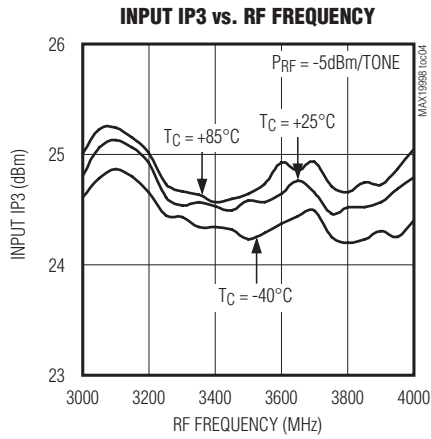
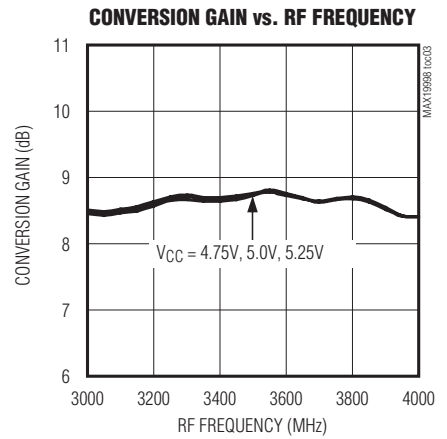
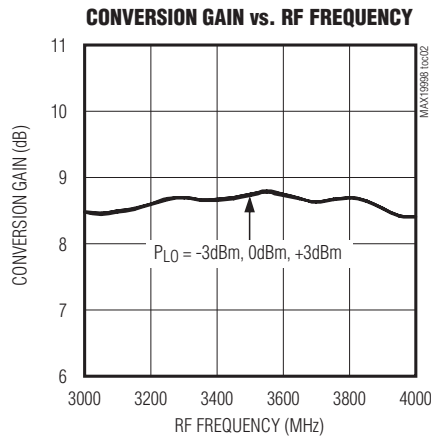
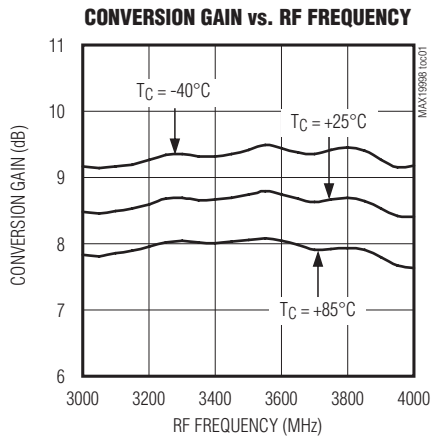
Note 10: Maximum reliable continuous input power applied to the RF port of this device is $+12\text{dBm}$ from a 50Ω source.

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, $P_{RF} = -5dBm$, $P_{LO} = 0dBm$, $T_C = +25^\circ C$, unless otherwise noted.)

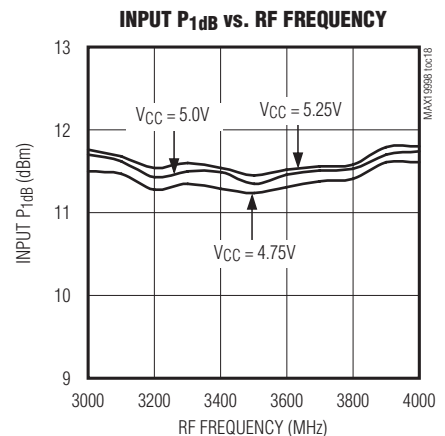
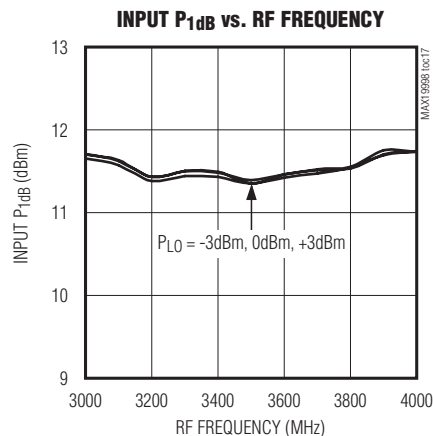
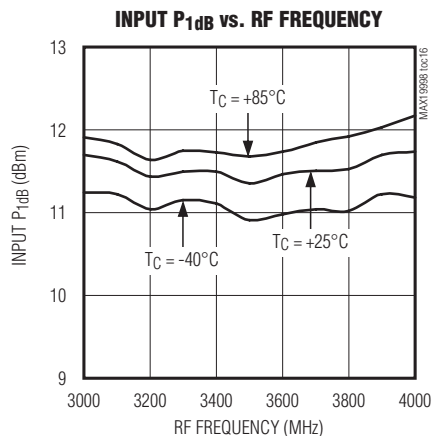
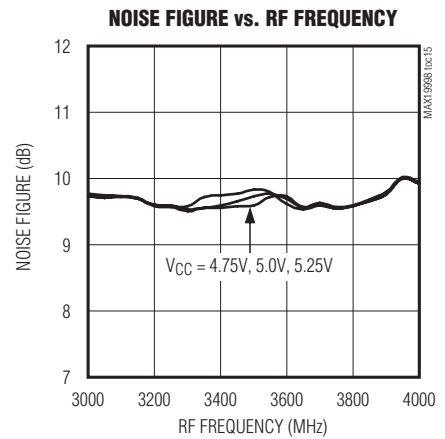
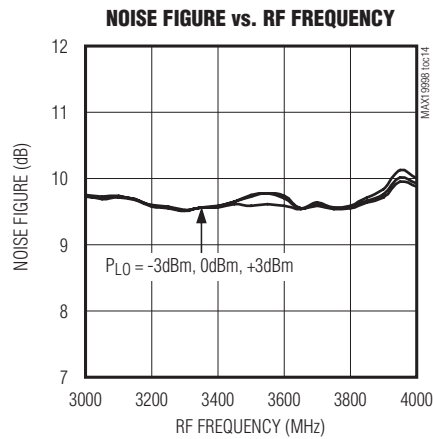
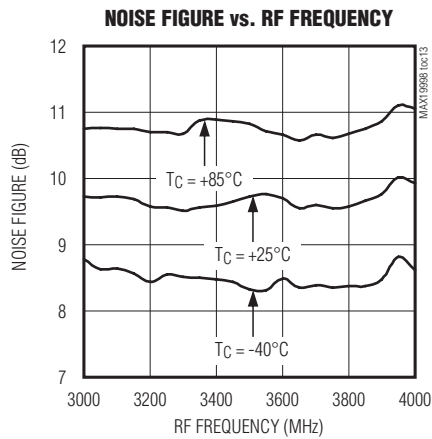
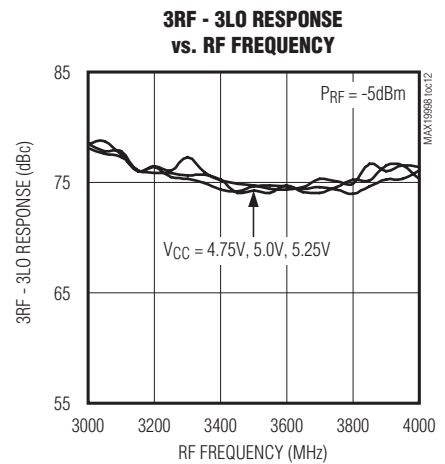
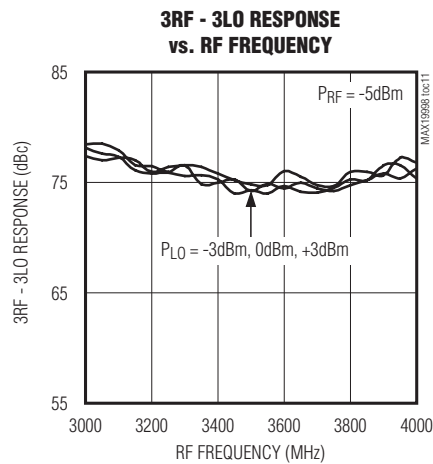
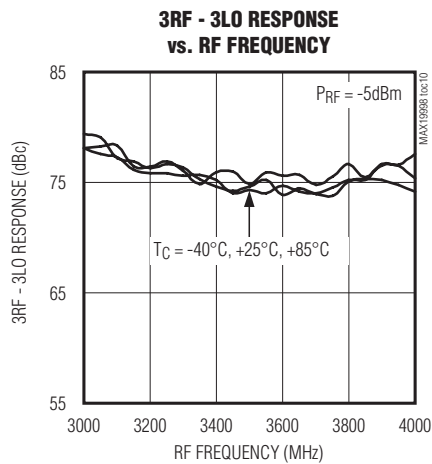


SiGe, High-Linearity, 2300MHz to 4000MHz Downconversion Mixer with LO Buffer

Typical Operating Characteristics (continued)

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

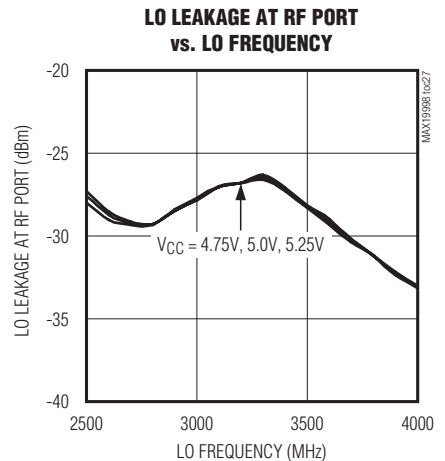
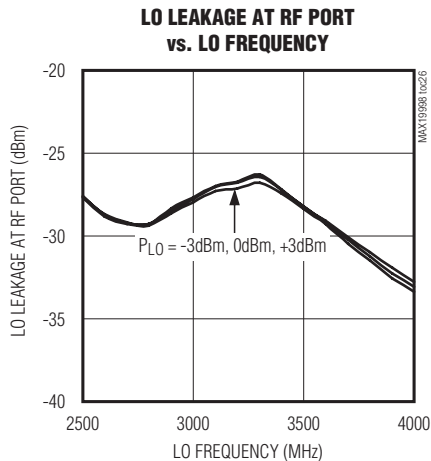
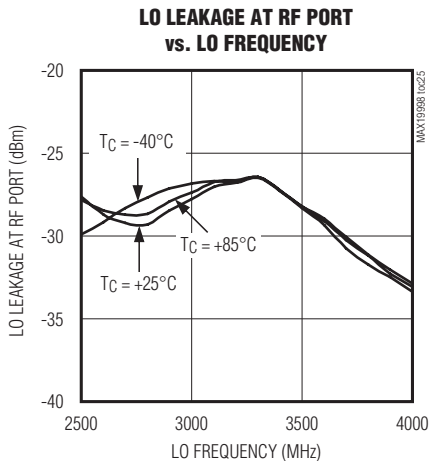
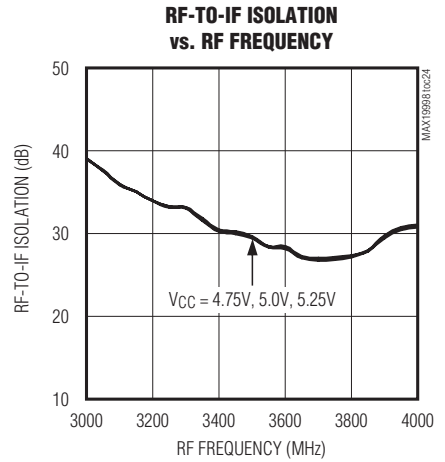
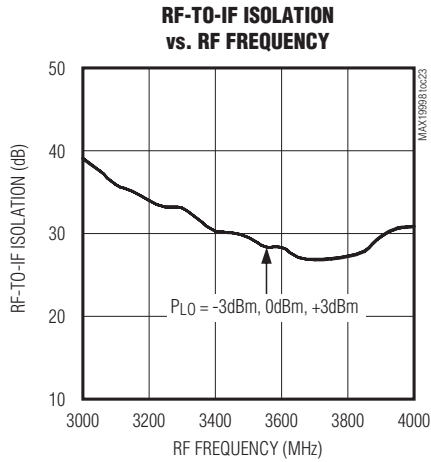
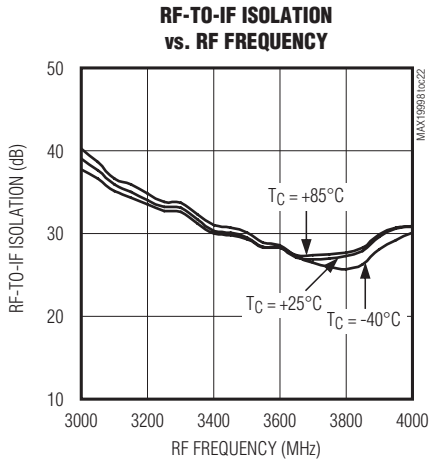
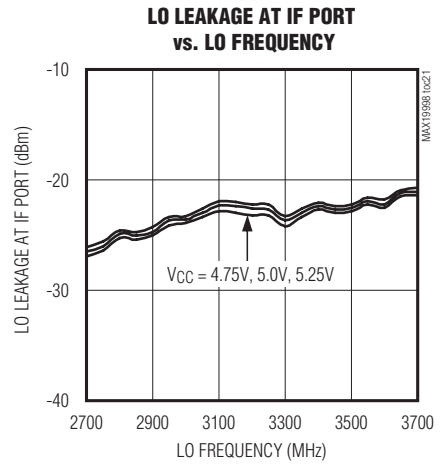
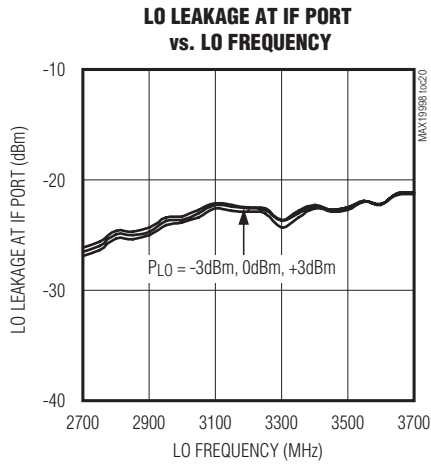
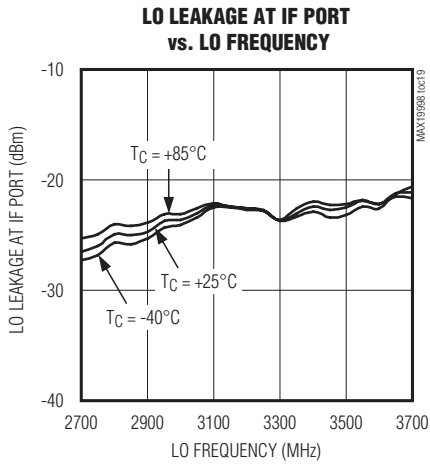
MAX19998



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, $P_{RF} = -5dBm$, $P_{LO} = 0dBm$, $T_C = +25^\circ C$, unless otherwise noted.)

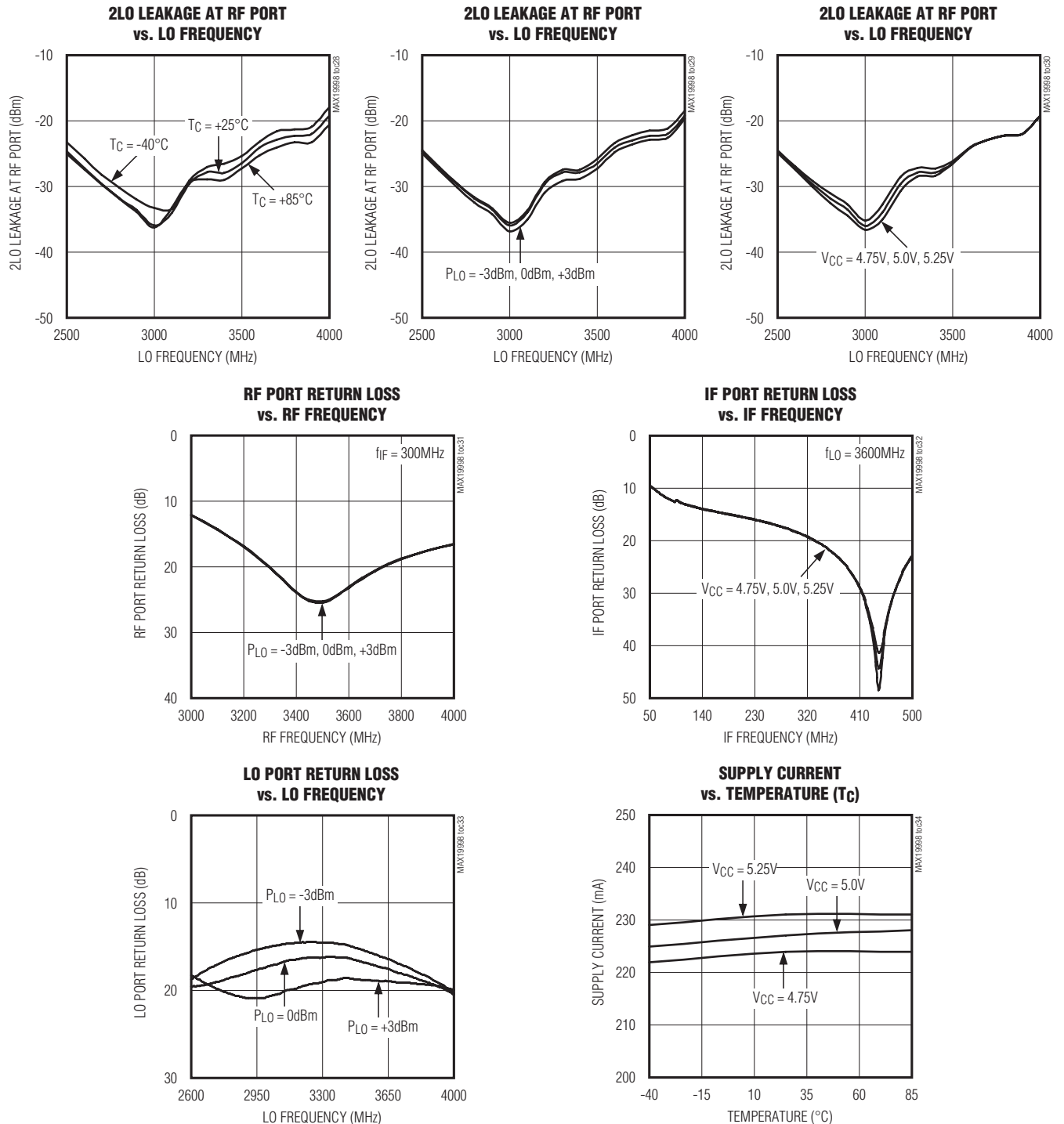


SiGe, High-Linearity, 2300MHz to 4000MHz Downconversion Mixer with LO Buffer

MAX19998

Typical Operating Characteristics (continued)

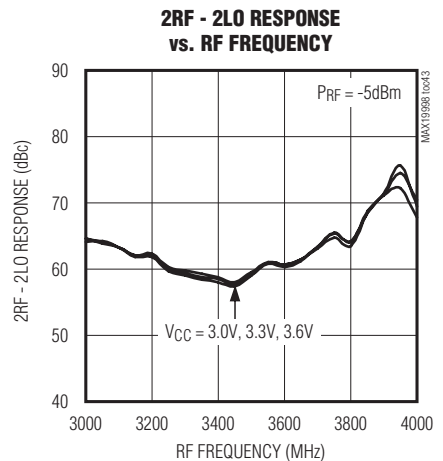
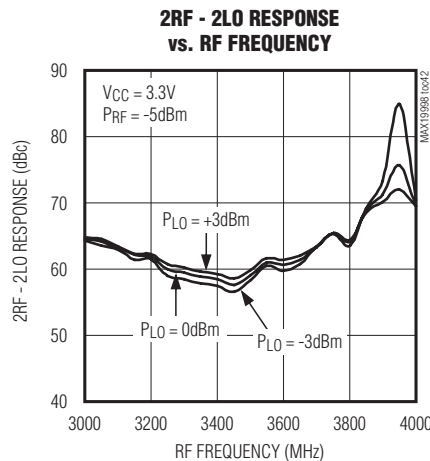
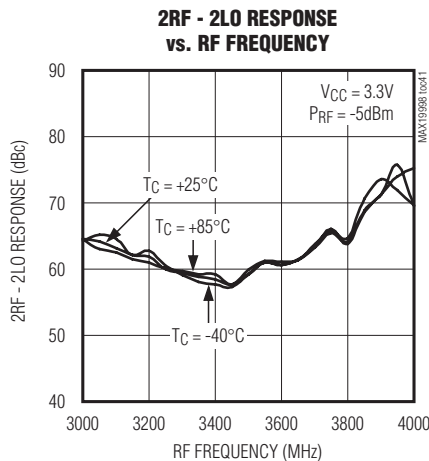
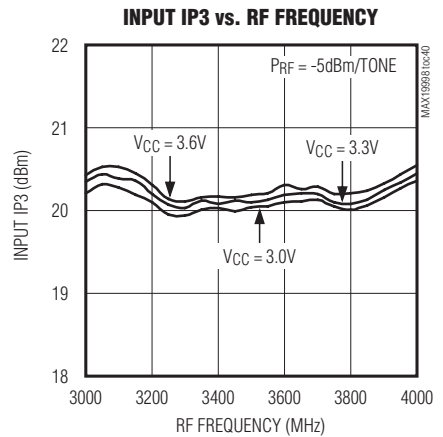
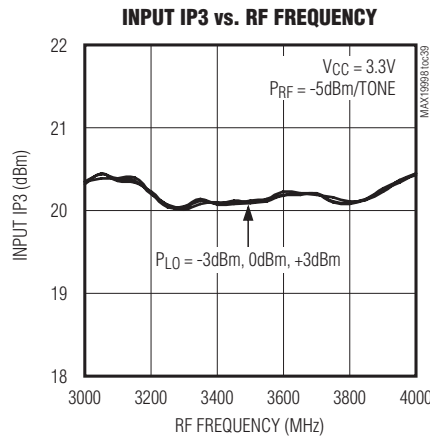
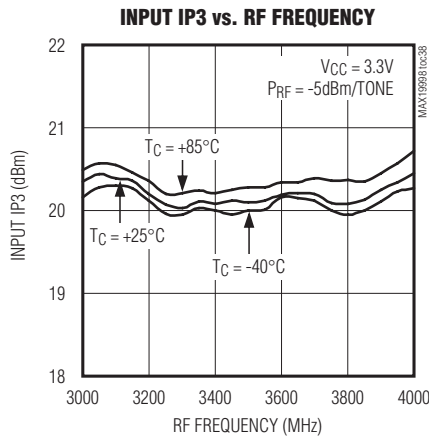
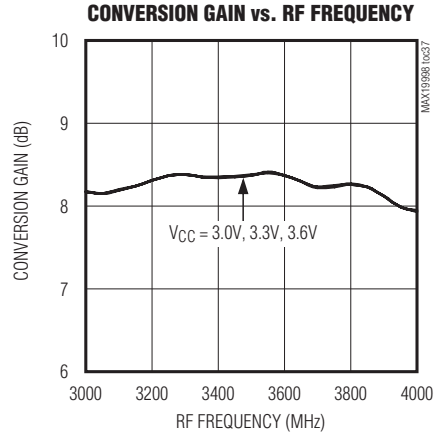
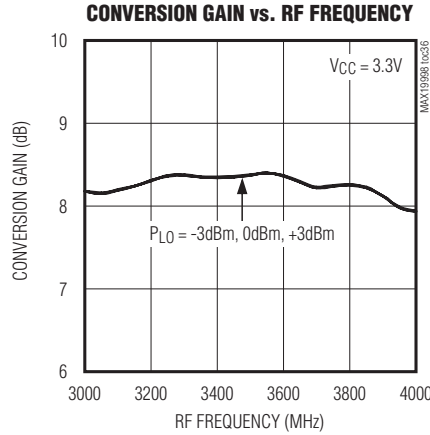
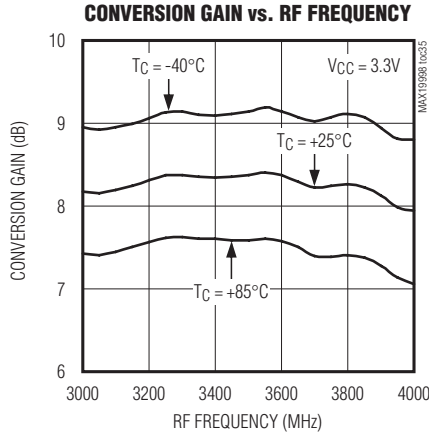
(Typical Application Circuit with tuning elements outlined in Table 1, $V_{CC} = 5.0V$, $f_{RF} = 3100MHz$ to $3900MHz$, LO is low-side injected for a $300MHz$ IF, $P_{RF} = -5dBm$, $P_{LO} = 0dBm$, $T_C = +25^\circ C$, unless otherwise noted.)



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, $V_{CC} = 3.3V$, $f_{RF} = 3100MHz$ to $3900MHz$, LO is low-side injected for a 300MHz IF, $P_{RF} = -5dBm$, $P_{LO} = 0dBm$, $T_C = +25^\circ C$, unless otherwise noted.)

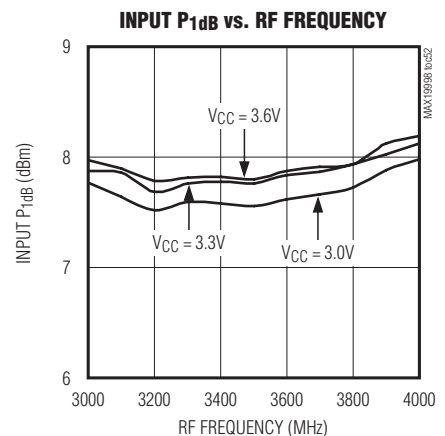
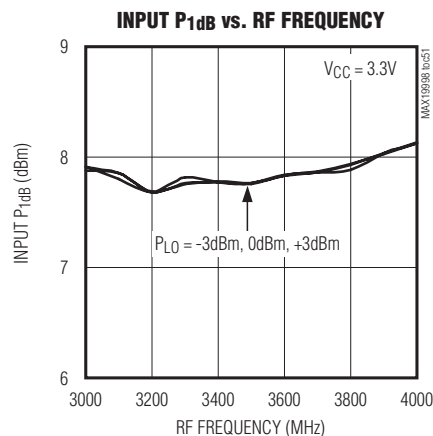
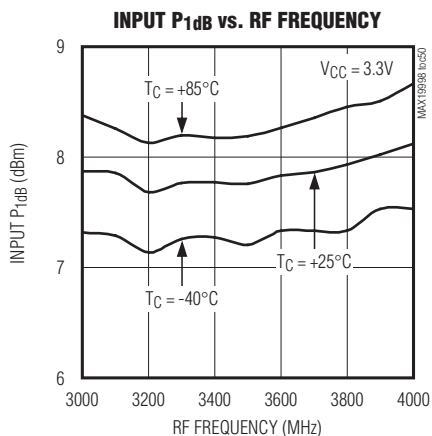
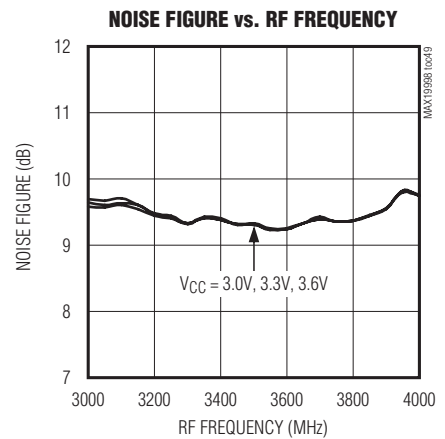
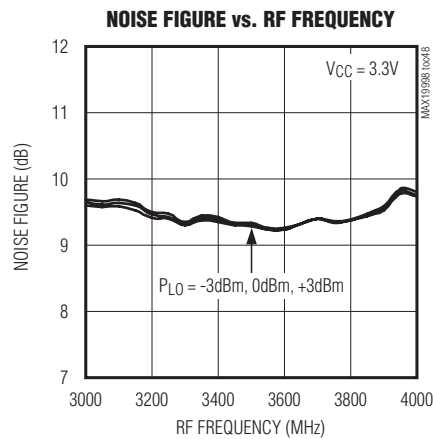
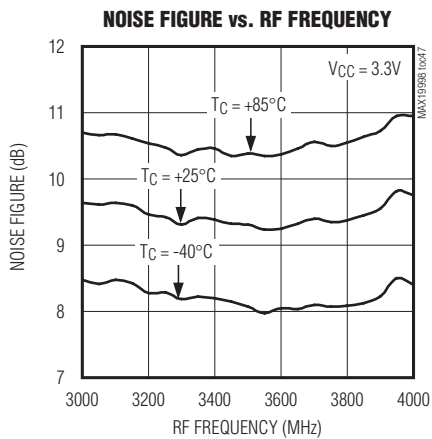
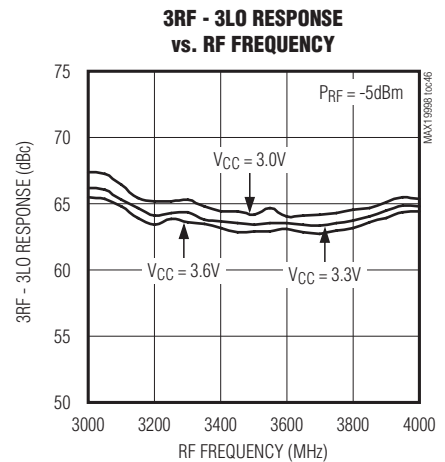
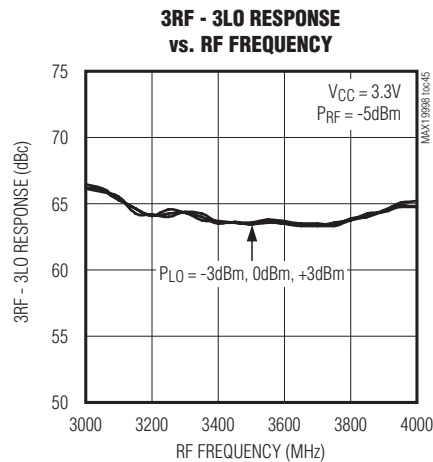
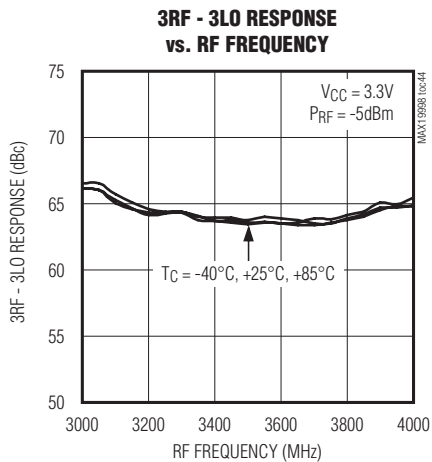


SiGe, High-Linearity, 2300MHz to 4000MHz Downconversion Mixer with LO Buffer

Typical Operating Characteristics (continued)

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

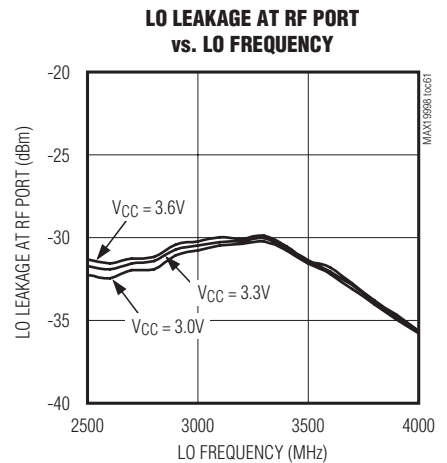
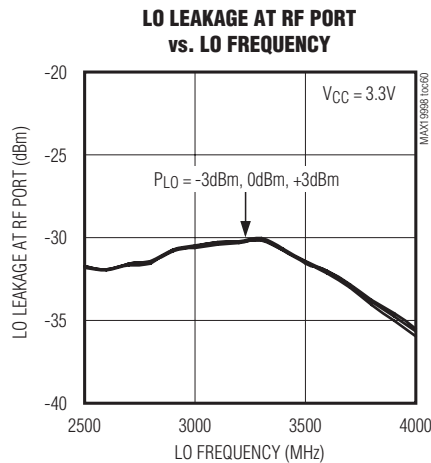
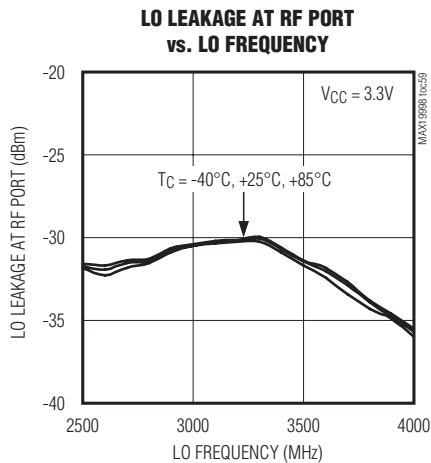
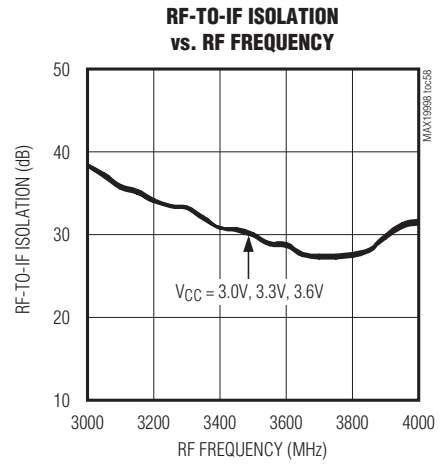
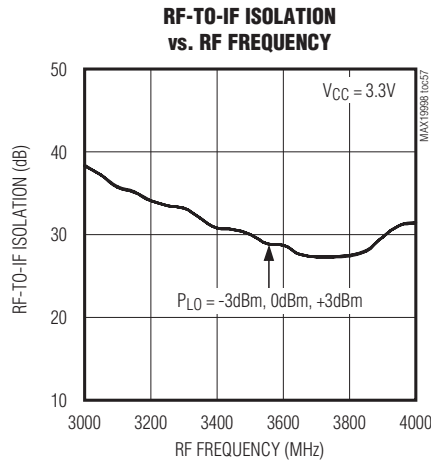
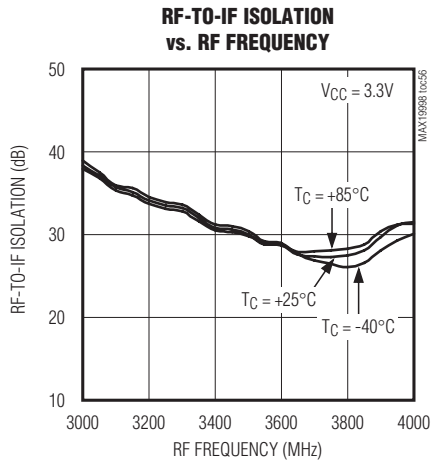
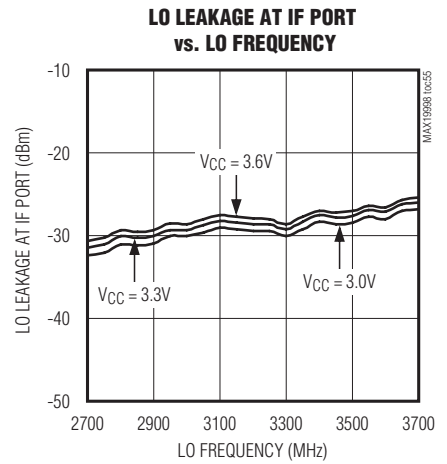
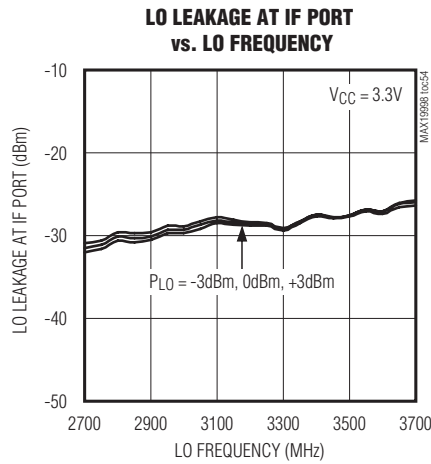
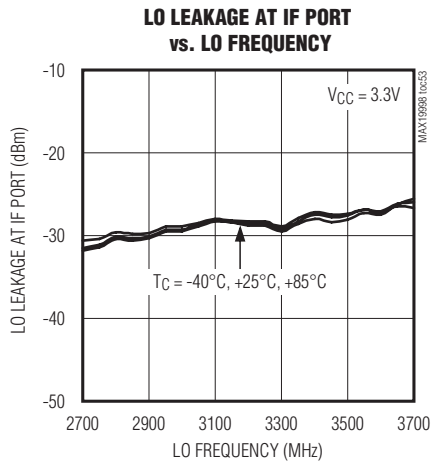
MAX19998



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, $P_{RF} = -5dBm$, $P_{LO} = 0dBm$, $T_C = +25^\circ C$, unless otherwise noted.)

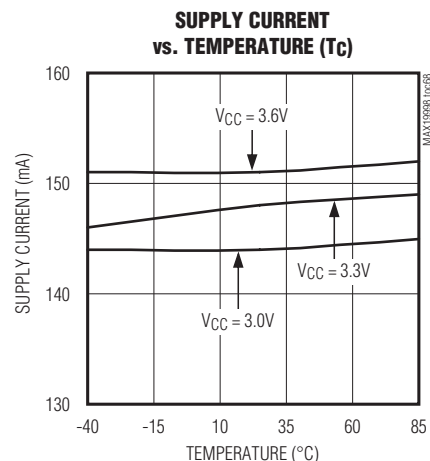
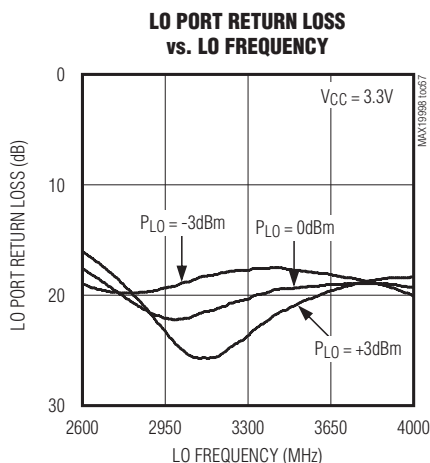
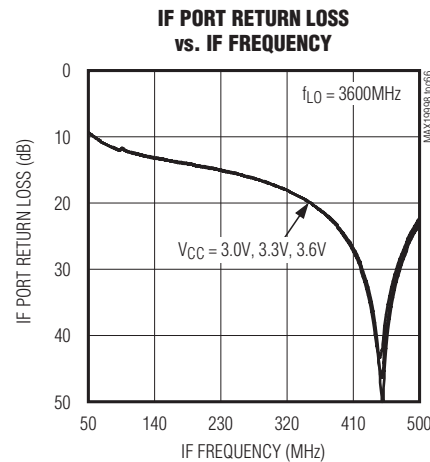
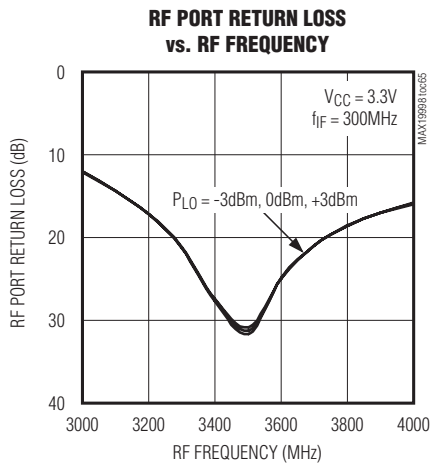
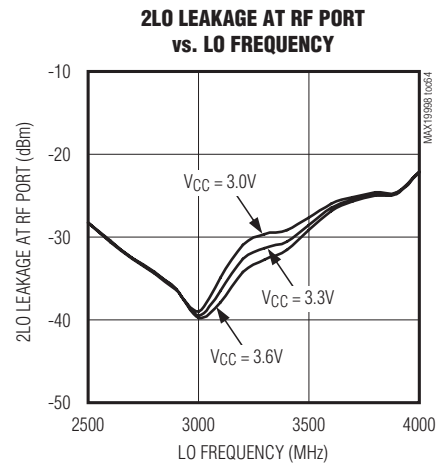
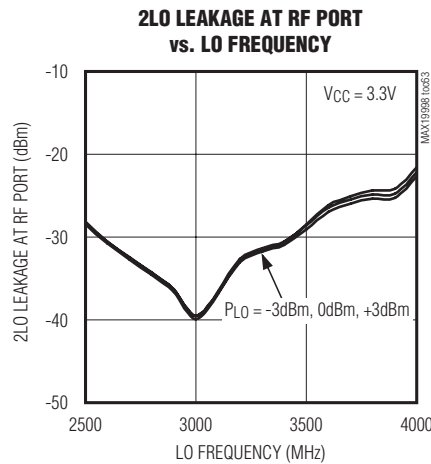
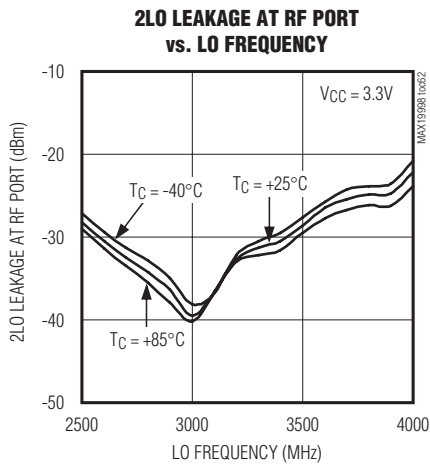


SiGe, High-Linearity, 2300MHz to 4000MHz Downconversion Mixer with LO Buffer

MAX19998

Typical Operating Characteristics (continued)

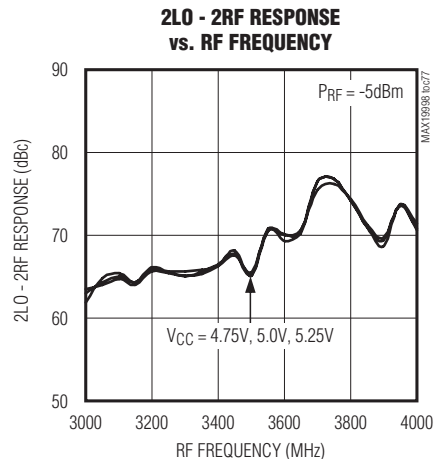
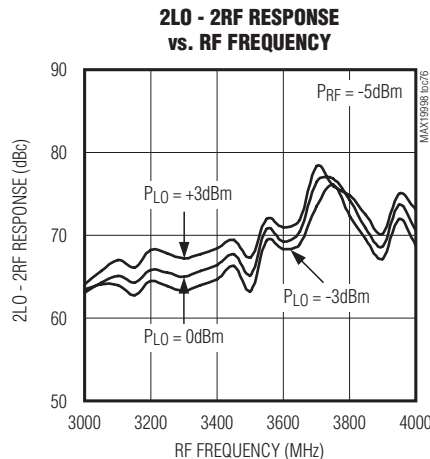
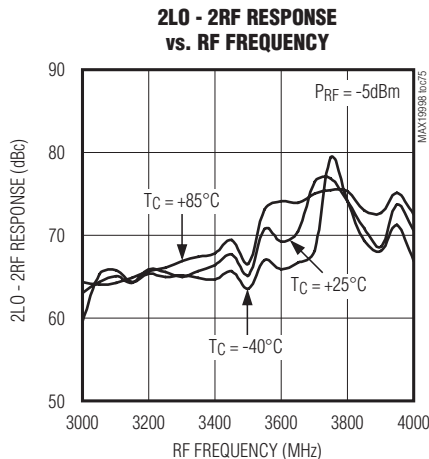
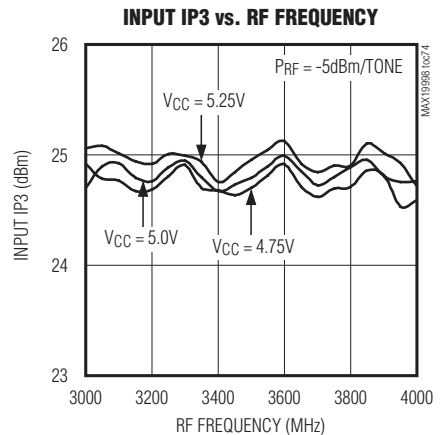
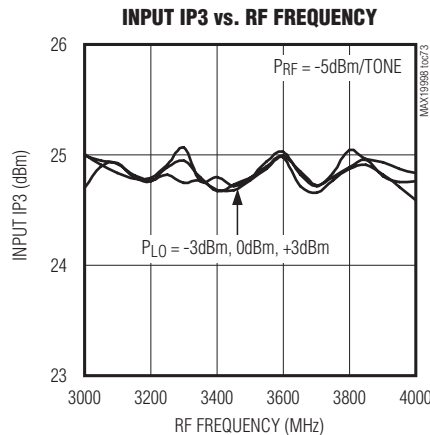
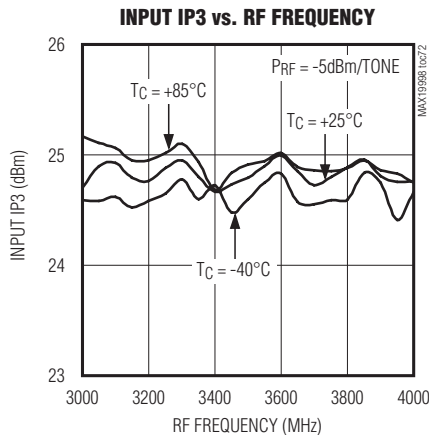
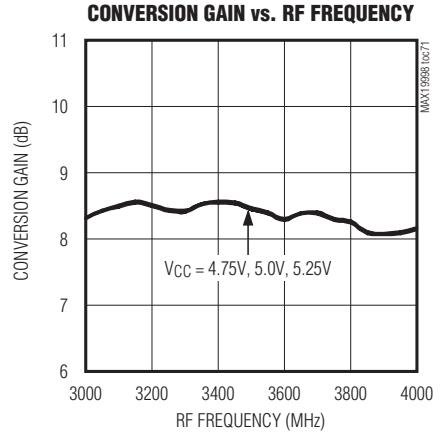
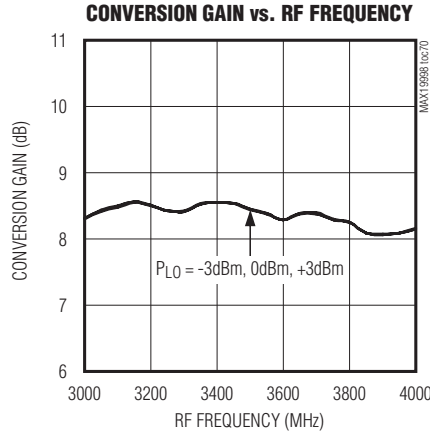
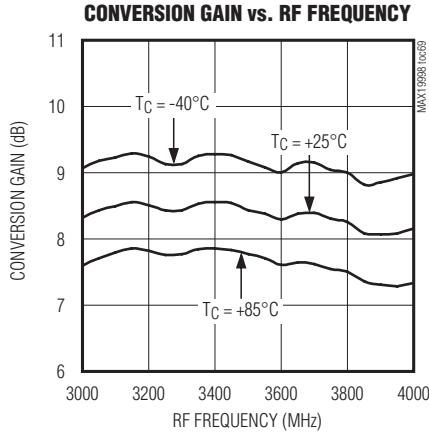
(Typical Application Circuit with tuning elements outlined in Table 1, $V_{CC} = 3.3V$, $f_{RF} = 3100MHz$ to $3900MHz$, LO is low-side injected for a $300MHz$ IF, $P_{RF} = -5dBm$, $P_{LO} = 0dBm$, $T_C = +25^\circ C$, unless otherwise noted.)



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, $V_{CC} = 5.0V$, $f_{RF} = 3100MHz$ to $3900MHz$, LO is high-side injected for a 300MHz IF, $P_{RF} = -5dBm$, $P_{LO} = 0dBm$, $T_C = +25^\circ C$, unless otherwise noted.)

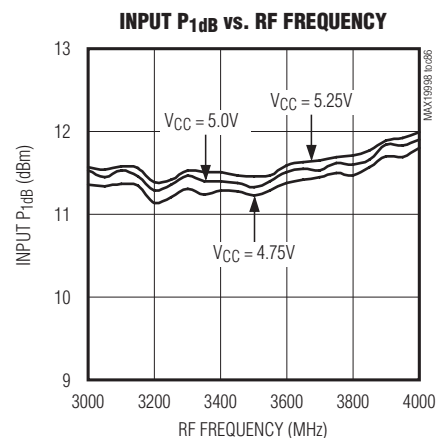
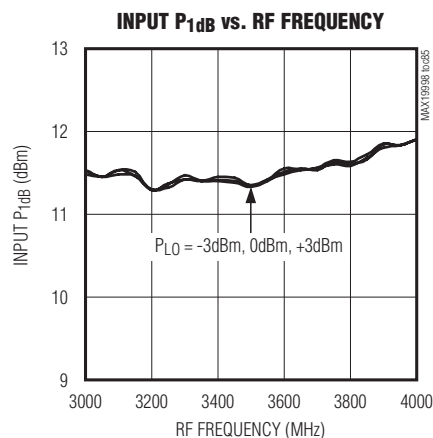
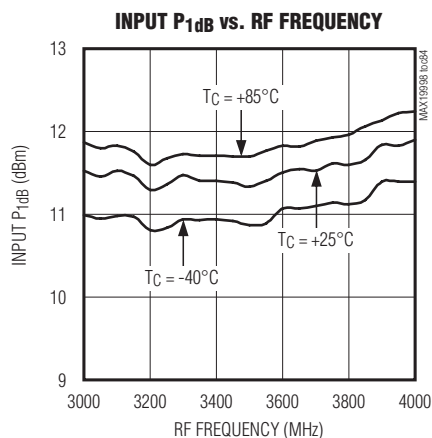
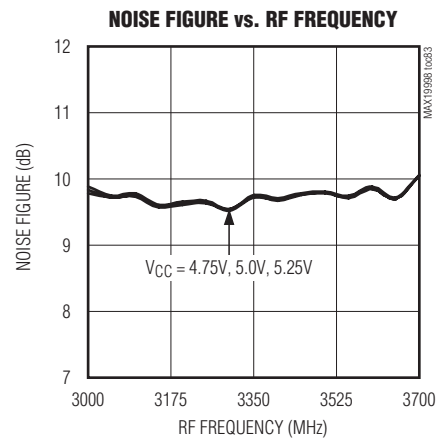
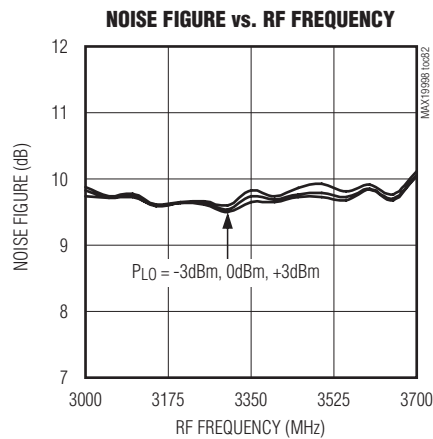
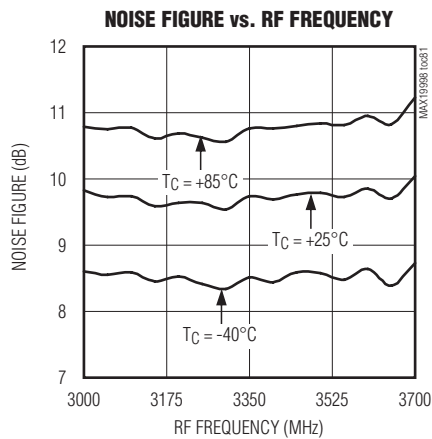
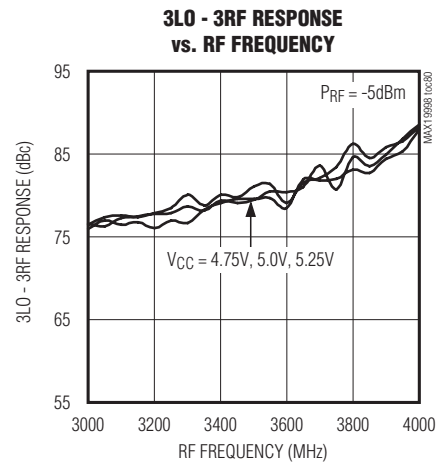
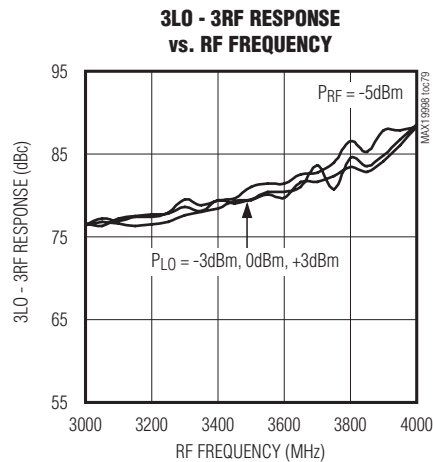
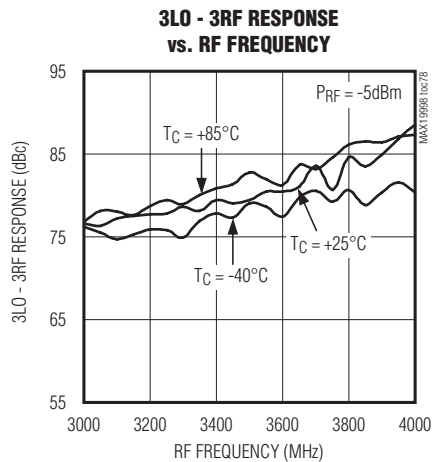


SiGe, High-Linearity, 2300MHz to 4000MHz Downconversion Mixer with LO Buffer

MAX19998

Typical Operating Characteristics (continued)

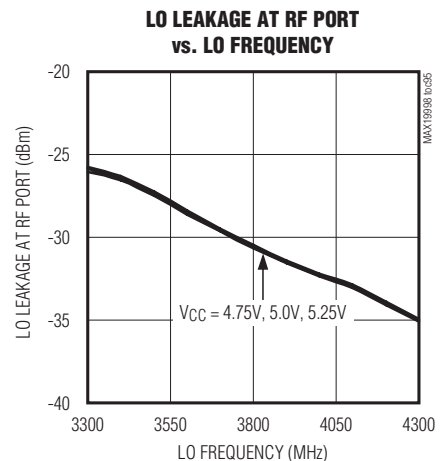
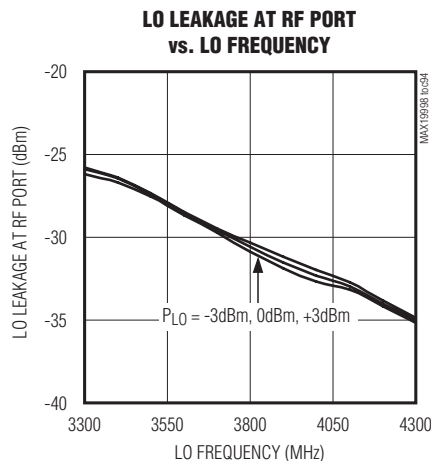
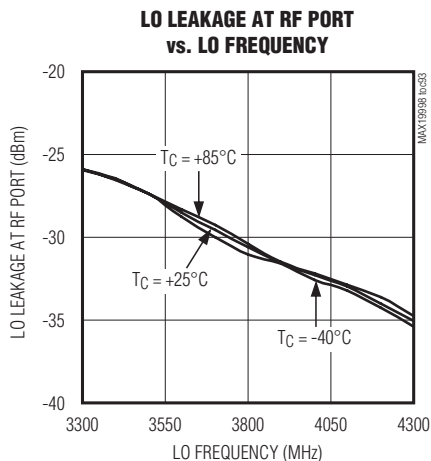
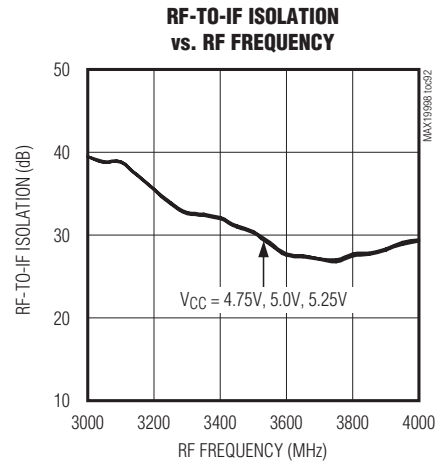
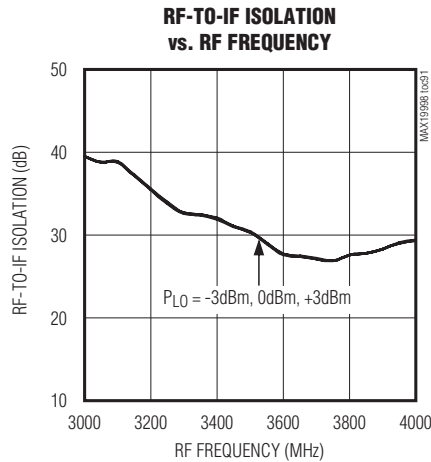
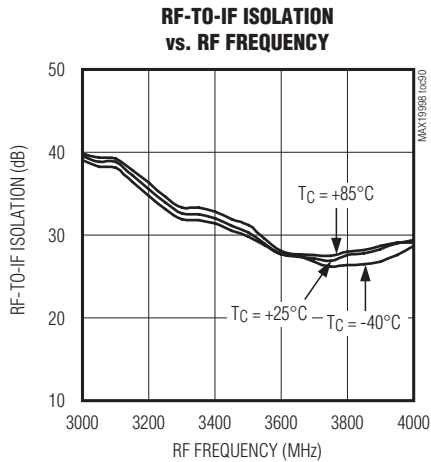
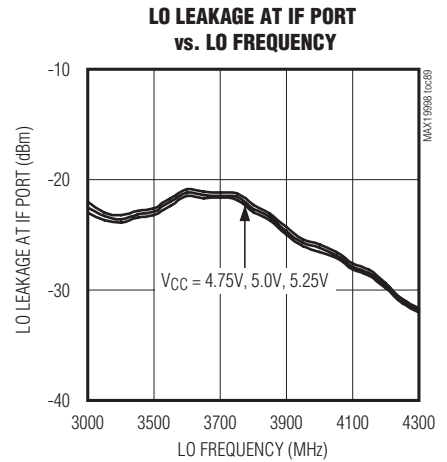
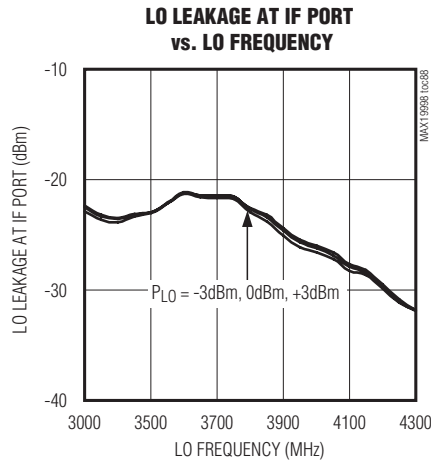
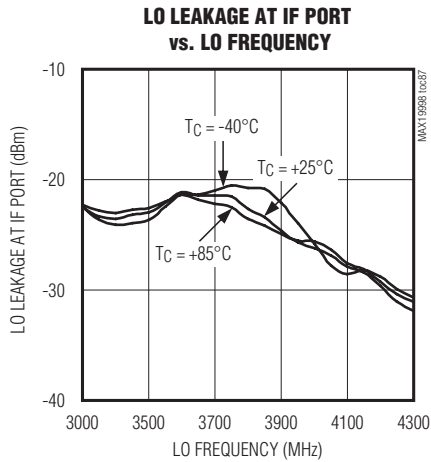
(Typical Application Circuit with tuning elements outlined in Table 1, $V_{CC} = 5.0V$, $f_{RF} = 3100MHz$ to $3900MHz$, LO is high-side injected for a 300MHz IF, $P_{RF} = -5dBm$, $P_{LO} = 0dBm$, $T_C = +25^\circ C$, unless otherwise noted.)



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, $V_{CC} = 5.0V$, $f_{RF} = 3100MHz$ to $3900MHz$, LO is high-side injected for a 300MHz IF, $P_{RF} = -5dBm$, $P_{LO} = 0dBm$, $T_C = +25^\circ C$, unless otherwise noted.)

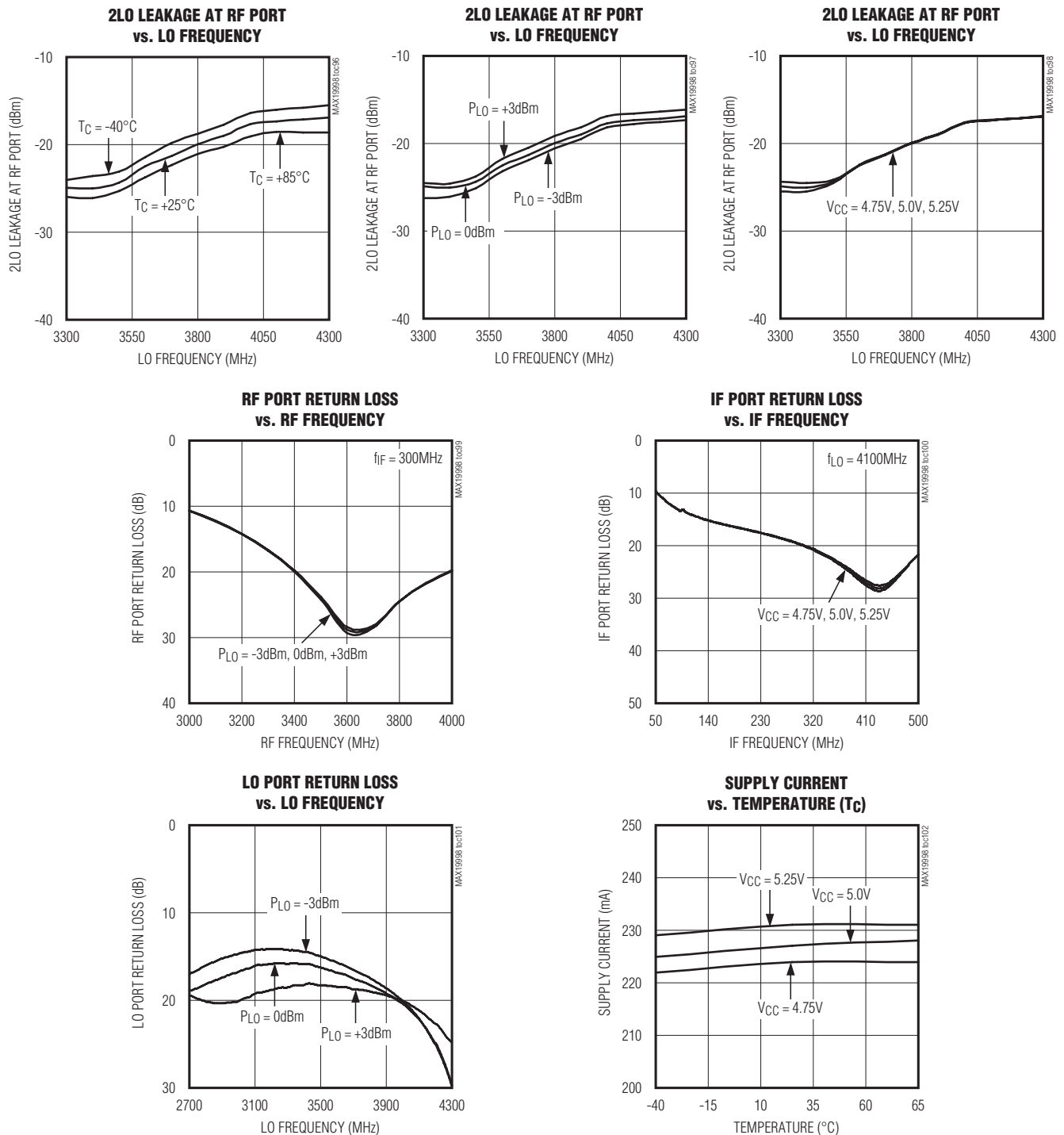


SiGe, High-Linearity, 2300MHz to 4000MHz Downconversion Mixer with LO Buffer

MAX19998

Typical Operating Characteristics (continued)

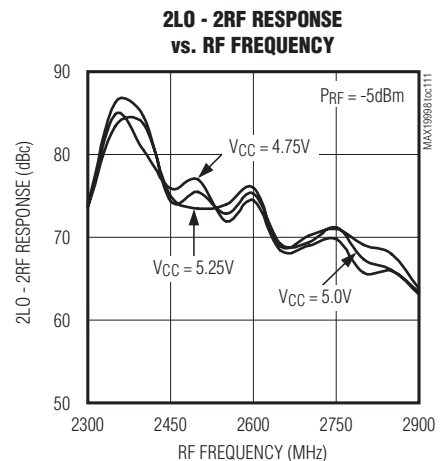
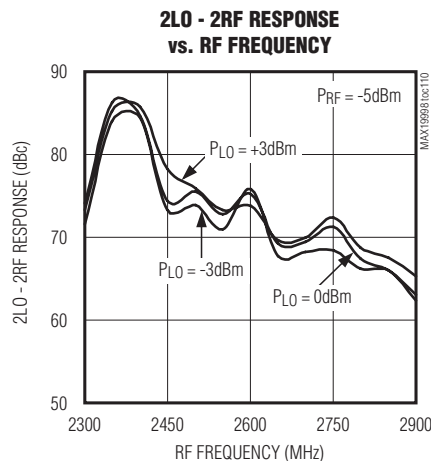
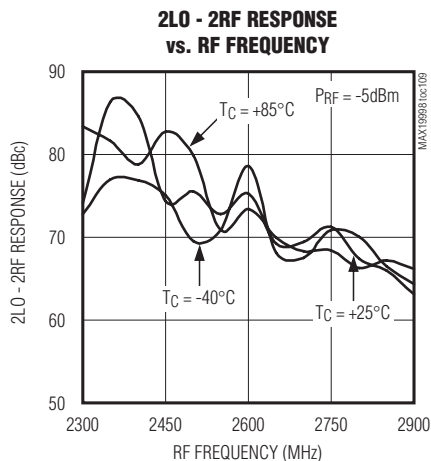
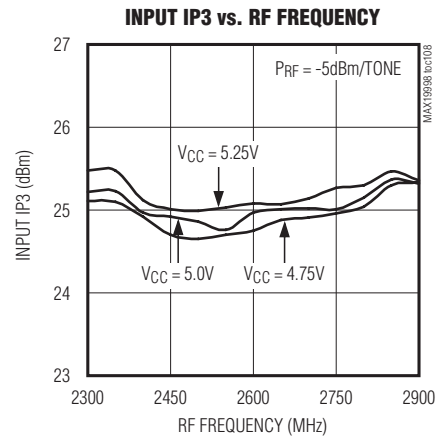
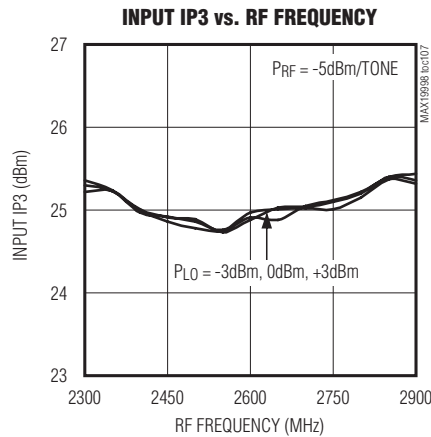
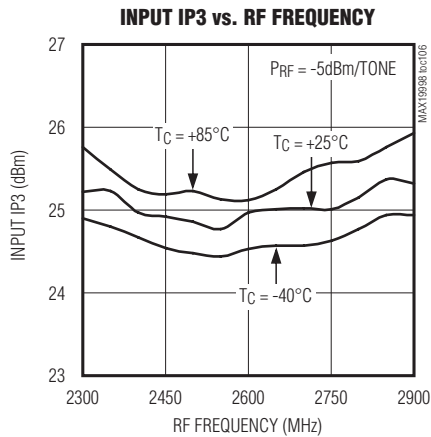
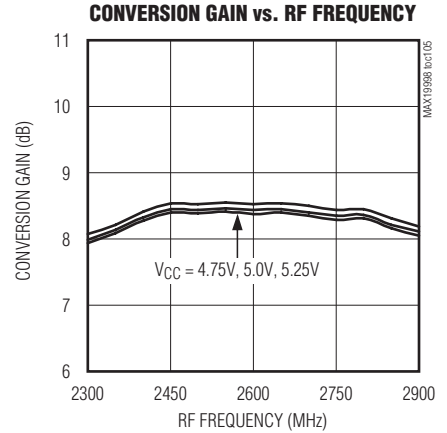
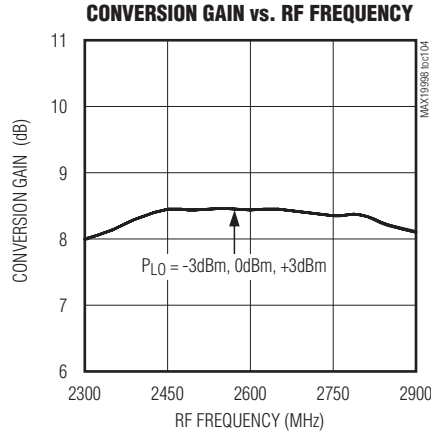
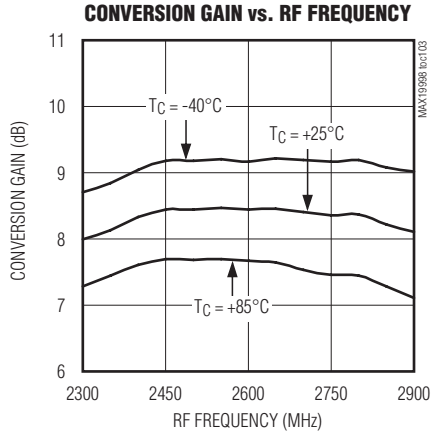
(Typical Application Circuit with tuning elements outlined in Table 1, $V_{CC} = 5.0V$, $f_{RF} = 3100MHz$ to $3900MHz$, LO is high-side injected for a 300MHz IF, $P_{RF} = -5dBm$, $P_{LO} = 0dBm$, $T_C = +25^\circ C$, unless otherwise noted.)



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, $P_{RF} = -5dBm$, $P_{LO} = 0dBm$, $T_C = +25^\circ C$, unless otherwise noted.)

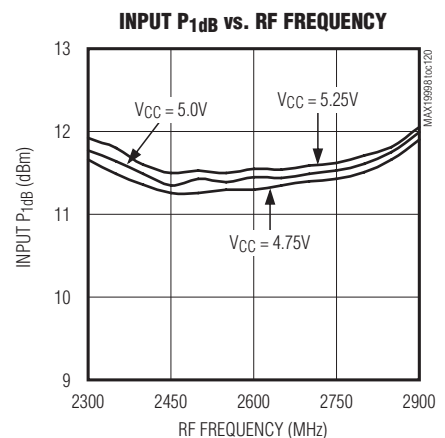
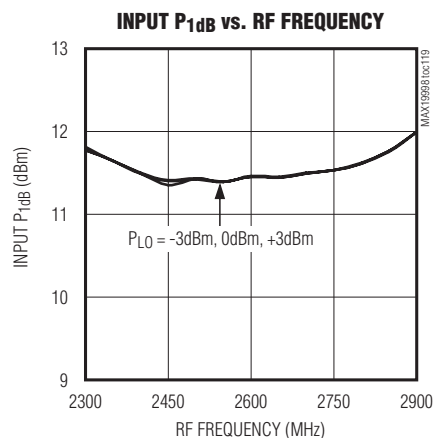
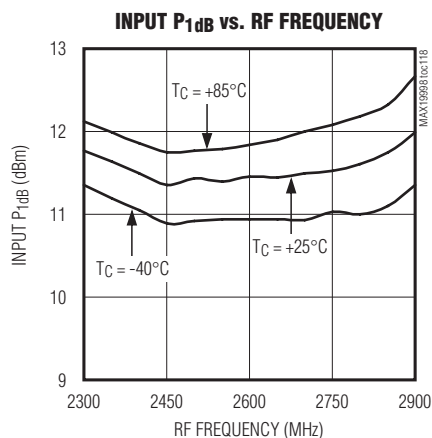
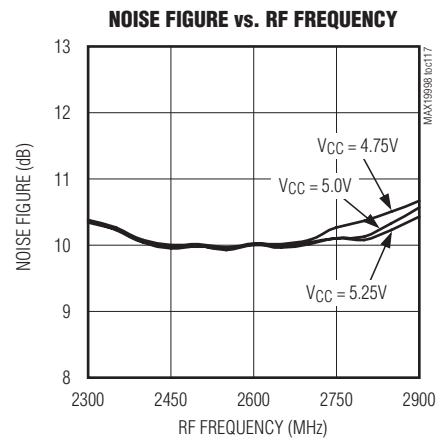
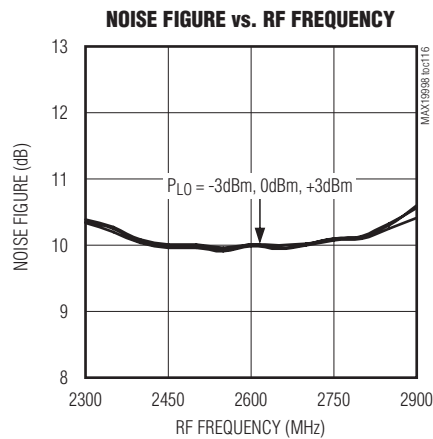
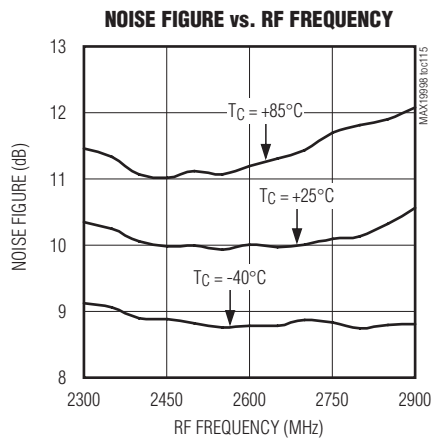
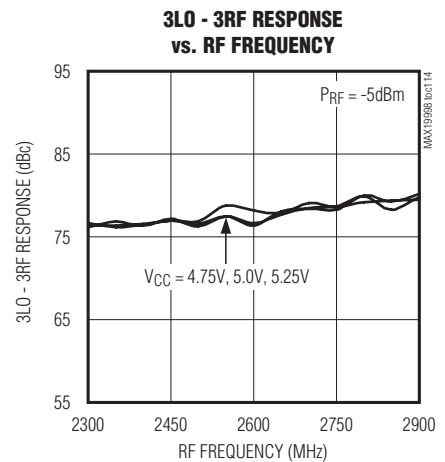
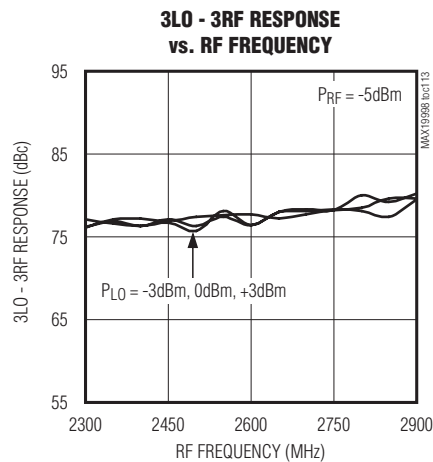
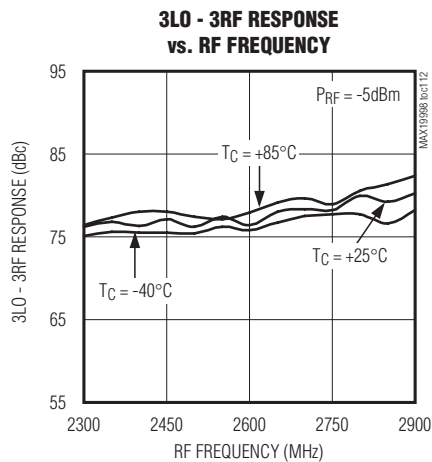


SiGe, High-Linearity, 2300MHz to 4000MHz Downconversion Mixer with LO Buffer

MAX19998

Typical Operating Characteristics (continued)

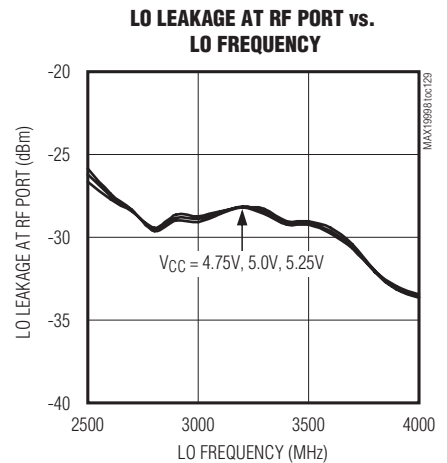
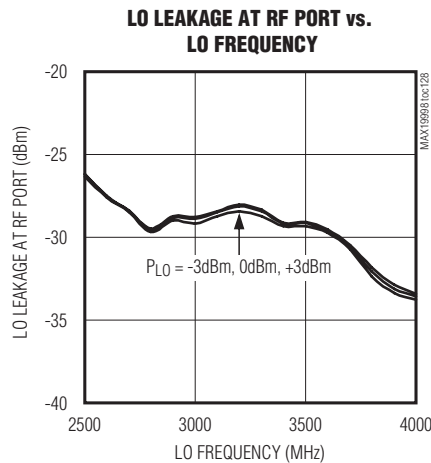
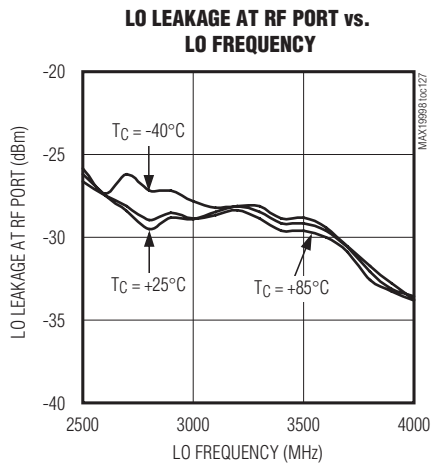
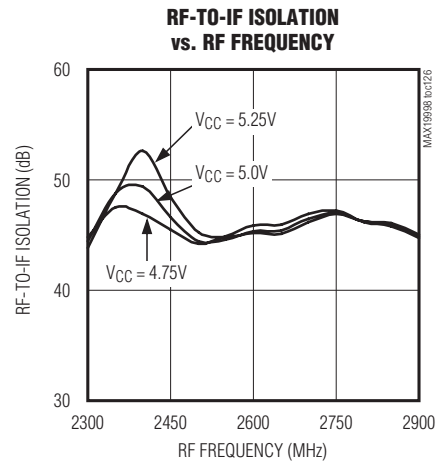
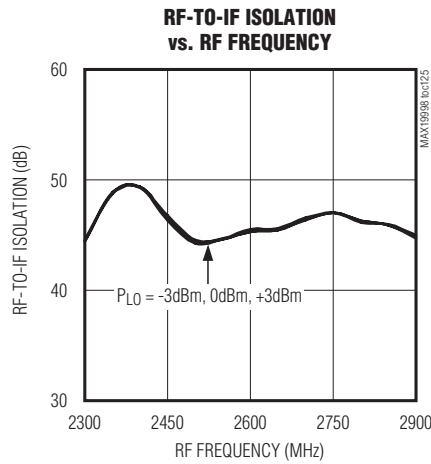
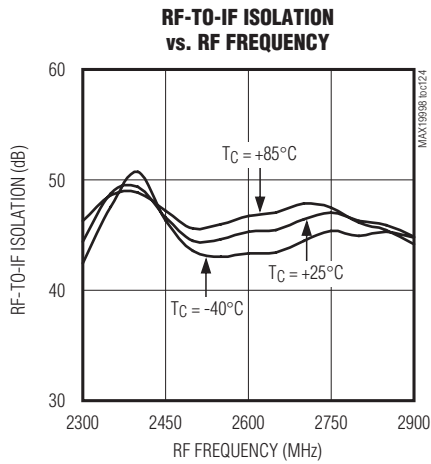
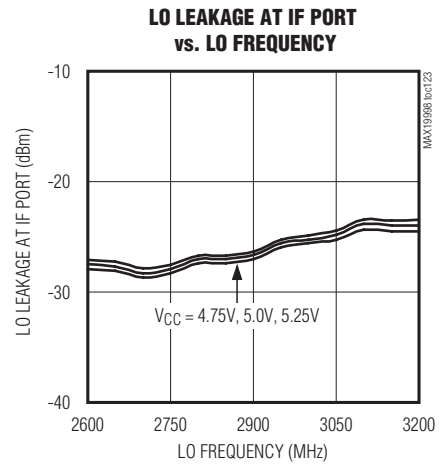
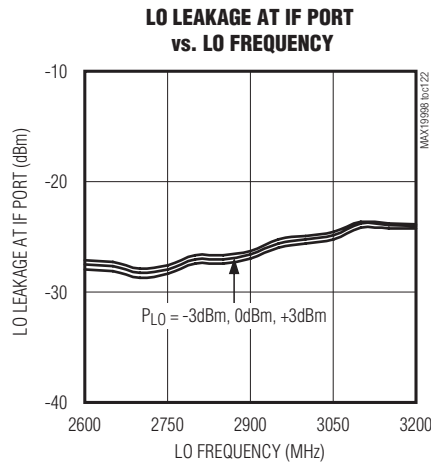
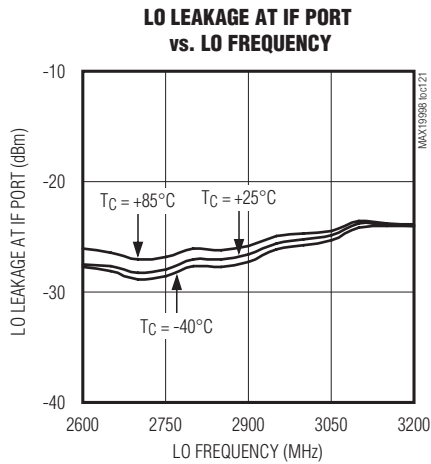
(Typical Application Circuit with tuning elements outlined in Table 1, $V_{CC} = 5.0V$, $f_{RF} = 2300MHz$ to $2900MHz$, LO is high-side injected for a 300MHz IF, $P_{RF} = -5dBm$, $P_{LO} = 0dBm$, $T_C = +25^\circ C$, unless otherwise noted.)



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, $P_{RF} = -5dBm$, $P_{LO} = 0dBm$, $T_C = +25^\circ C$, unless otherwise noted.)

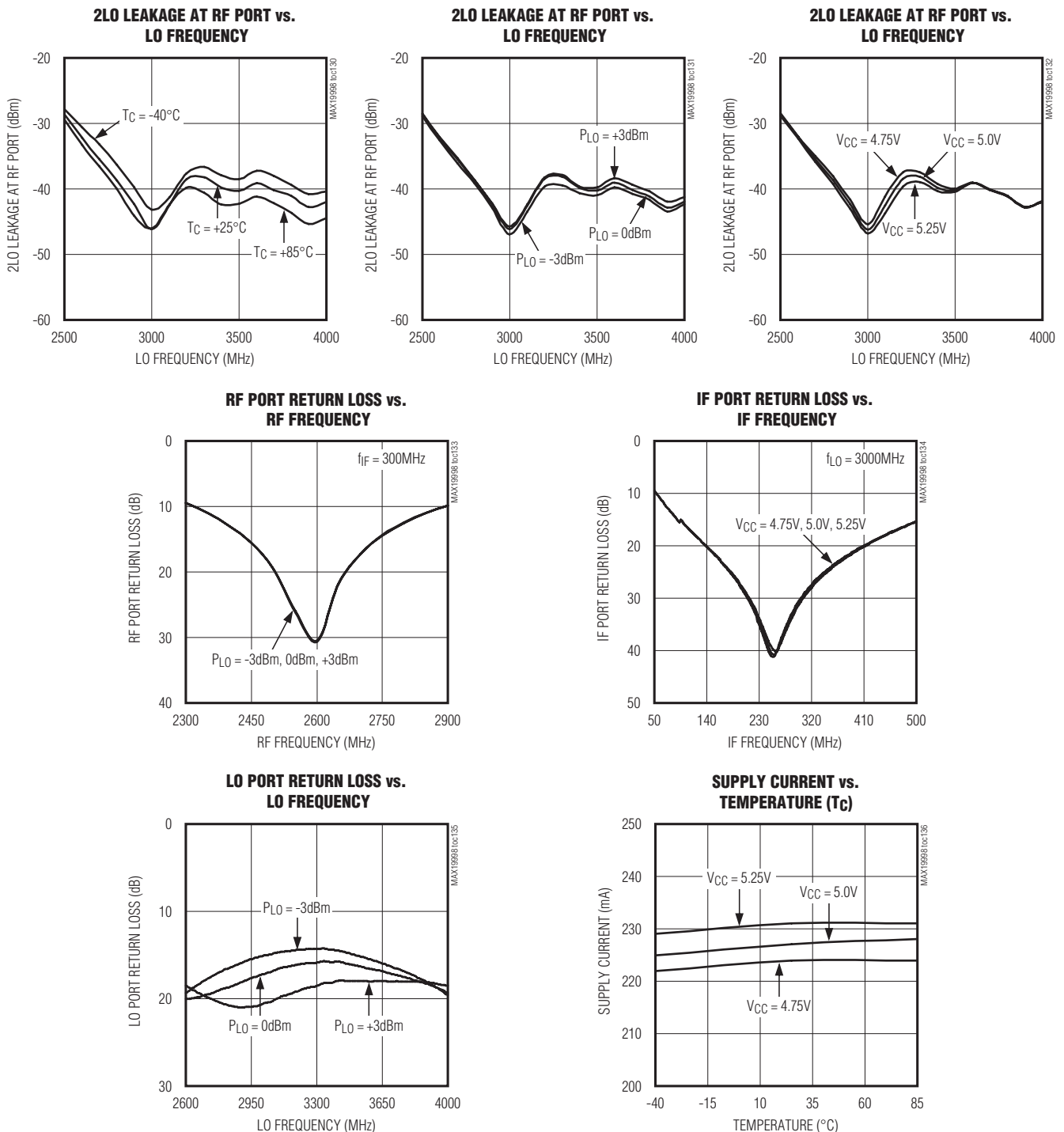


SiGe, High-Linearity, 2300MHz to 4000MHz Downconversion Mixer with LO Buffer

MAX19998

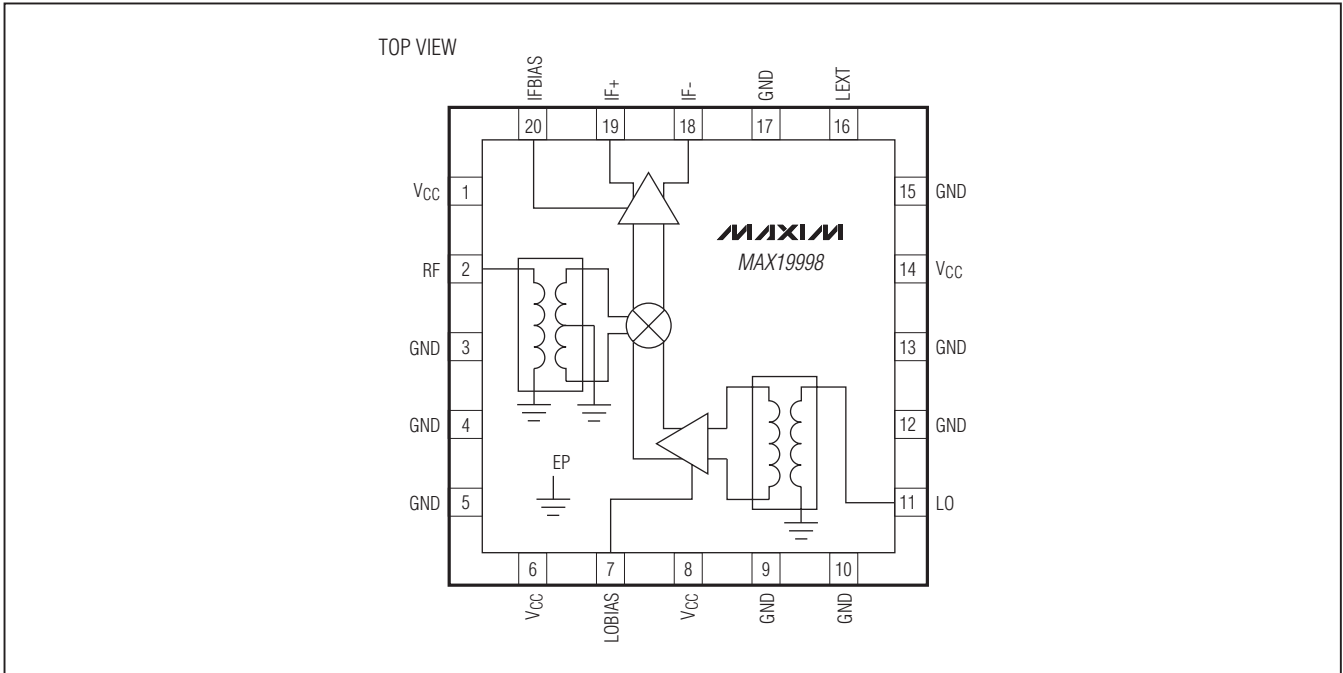
Typical Operating Characteristics (continued)

(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, $P_{RF} = -5dBm$, $P_{LO} = 0dBm$, $T_C = +25^\circ C$, unless otherwise noted.)



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

Pin Configuration/Functional Diagram



Pin Description

PIN	NAME	FUNCTION
1, 6, 8, 14	VCC	Power Supply. Bypass to GND with 0.01 μ F capacitors as close as possible to the pin.
2	RF	Single-Ended 50 Ω 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 604 Ω (5V, 230mA bias condition) from LOBIAS to ground.
11	LO	Local Oscillator Input. This input is internally matched to 50 Ω . 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 VCC (see the <i>Typical Application Circuit</i>).
20	IFBIAS	IF Amplifier Bias Control. IF bias resistor connection for the IF amplifier. Connect a 698 Ω (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.

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

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 50 Ω 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 50 Ω 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 50 Ω , 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 VCC.

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 200 Ω differential IF impedance to a 50 Ω 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 50 Ω 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 200 Ω (differential). For evaluation, an external low-loss 4:1 (impedance ratio) balun transforms this impedance down to a 50 Ω 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 $\pm 1\%$ resistors are not readily available, substitute with $\pm 5\%$ resistors.

Significant reductions in power consumption can also be realized by operating the mixer with an optional supply voltage of 3.3V. Doing so reduces the overall power consumption by 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.