19-3648; Rev 0; 4/05

EVALUATION KIT AVAILABLE

SiGe High-Linearity, 400MHz to 1000MHz Downconversion Mixer with LO Buffer/Switch

General Description

The MAX9984 high-linearity downconversion mixer provides 8.1dB gain, +25dBm IIP3, and 9.3dB NF for 400MHz to 1000MHz base-station receiver applications*. With an optimized 570MHz to 850MHz LO frequency range, this particular mixer is ideal for low-side LO injection receiver architectures in the cellular band. High-side LO injection is supported by the MAX9986, which is pin-for-pin and functionally compatible with the MAX9984.

In addition to offering excellent linearity and noise performance, the MAX9984 also yields a high level of component integration. This device includes a double-balanced passive mixer core, an IF amplifier, a dual-input LO selectable switch, and an LO buffer. On-chip baluns are also integrated to allow for single-ended RF and LO inputs. The MAX9984 requires a nominal LO drive of 0dBm, and supply current is guaranteed to be below 265mA.

The MAX9984/MAX9986 are pin compatible with the MAX9994/MAX9996 1700MHz to 2200MHz mixers, making this entire family of downconverters ideal for applications where a common PC board layout is used for both frequency bands. The MAX9984 is also functionally compatible with the MAX9993.

The MAX9984 is available in a compact, 20-pin, thin QFN package (5mm x 5mm) with an exposed paddle. Electrical performance is guaranteed over the extended -40°C to +85°C temperature range.

Applications

850MHz W-CDMA Base Stations

GSM 850/GSM 900 2G and 2.5G EDGE Base Stations

cdmaOne™ and cdma2000® Base Stations

iDEN® Base Stations

400MHz to 700MHz OFDM/WiMAX CPE and Base-Station Equipment

Predistortion Receivers

Fixed Broadband Wireless Access

Wireless Local Loop

Private Mobile Radios

Military Systems

Microwave Links

Digital and Spread-Spectrum Communication Systems

cdma2000 is a registered trademark of the Telecommunications Industry Association.
cdmaOne is a trademark of CDMA Development Group.
iDEN is a registered trademark of Motorola, Inc.

Features

- ♦ **400MHz to 1000MHz RF Frequency Range***
- ♦ **325MHz to 850MHz LO Frequency Range* (MAX9984)**
- ♦ **960MHz to 1180MHz LO Frequency Range (MAX9986)**
- ♦ **50MHz to 250MHz IF Frequency Range**
- ♦ **8.1dB Conversion Gain**
- ♦ **+25dBm Input IP3**
- ♦ **+13dBm Input 1dB Compression Point**
- ♦ **9.3dB Noise Figure**
- ♦ **71dBc 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**
- ♦ **Built-In SPDT LO Switch with 54dB LO1 to LO2 Isolation and 50ns Switching Time**
- ♦ **Pin Compatible with MAX9994/MAX9996 1700MHz to 2200MHz Mixers**
- ♦ **Functionally Compatible with MAX9993**
- ♦ **External Current-Setting Resistors Provide Option for Operating Mixer in Reduced Power/Reduced Performance Mode**
- ♦ **Lead-Free Package Available**

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	PKG CODE
MAX9984ETP	-40°C to +85°C	20 Thin QFN-EP** 5mm × 5mm	T2055-3
MAX9984ETP-T	-40°C to +85°C	20 Thin QFN-EP** 5mm × 5mm	T2055-3
MAX9984ETP+D	-40°C to +85°C	20 Thin QFN-EP** 5mm × 5mm	T2055-3
MAX9984ETP+TD	-40°C to +85°C	20 Thin QFN-EP** 5mm × 5mm	T2055-3

For an RF frequency range below 815MHz (LO frequency below 570MHz), appropriate tuning is required. See Table 2 for details.
***EP = Exposed paddle.*
+ = Lead free. D = Dry pack. T = Tape-and-reel.

Pin Configuration/Functional Diagram and Typical Application Circuit appear at end of data sheet.

ABSOLUTE MAXIMUM RATINGS

V_{CC} to GND ....-0.3V to +5.5V
IF+, IF-, LOBIAS, LOSEL, IFBIAS to GND...-0.3V to (V_{CC} + 0.3V)
TAP ....-0.3V to +1.4V
LO1, LO2, LEXT to GND..........-0.3V to +0.3V
RF, LO1, LO2 Input Power ....+12dBm
RF (RF is DC shorted to GND through a balun) 50mA
Continuous Power Dissipation (T_A = +70°C)
20-Pin Thin QFN-EP (derate 26.3mW/°C above +70°C)..........2.1W

θ_{JA} ....+38°C/W
θ_{JC} ....+13°C/W
Operating Temperature Range (Note A) ....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 A: T_C is the temperature on the exposed paddle of the package.

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.

DC ELECTRICAL CHARACTERISTICS

(MAX9984 *Typical Application Circuit,* using component values in Table 1, V_{CC} = +4.75V to +5.25V, no RF signal applied, IF+ and IF- outputs pulled up to V_{CC} through inductive chokes, R_1 = 953Ω, R_2 = 619Ω, T_C = -40°C to +85°C, unless otherwise noted. Typical values are at V_{CC} = +5V, T_C = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage	V_{CC}		4.75	5.00	5.25	V
Supply Current	I_{CC}			222	265	mA
LO_SEL Input-Logic Low	V_{IL}				0.8	V
LO_SEL Input-Logic High	V_{IH}		2			V

AC ELECTRICAL CHARACTERISTICS

(MAX9984 *Typical Application Circuit,* using component values in Table 1, V_{CC} = +4.75V to +5.25V, RF and LO ports are driven from 50Ω sources, P_{LO} = -3dBm to +3dBm, P_{RF} = -5dBm, f_{RF} = 815MHz to 1000MHz, f_{LO} = 570MHz to 850MHz, f_{IF} = 160MHz, f_{RF} > f_{LO}, T_C = -40°C to +85°C, unless otherwise noted. Typical values are at V_{CC} = +5V, P_{RF} = -5dBm, P_{LO} = 0dBm, f_{RF} = 910MHz, f_{LO} = 750MHz, f_{IF} = 160MHz, T_C = +25°C, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
RF Frequency Range	f_{RF}	(Note 2)	815		1000	MHz
		(Notes 2, 3)	400			
LO Frequency Range	f_{LO}	(Note 2)	570		850	MHz
		(Notes 2, 3)	325			
		MAX9986	960		1180	
IF Frequency Range	f_{IF}	(Note 2)	50		250	MHz
Conversion Gain	G_C	f_{RF} = 910MHz, f_{LO} = 750MHz, T_C = +25°C	7.2	8.1	9.2	dB
Gain Variation Over Temperature		T_C = -40°C to +85°C		-0.0079		dB/°C
Conversion Gain Flatness		Flatness over any one of three frequency bands: f_{RF} = 824MHz to 849MHz f_{RF} = 869MHz to 894MHz f_{RF} = 880MHz to 915MHz		±0.25		dB
Input Compression Point	P_{1dB}	(Note 4)		13		dBm
Input Third-Order Intercept Point	IIP3	f_{LO} = 570MHz to 850MHz, f_{IF} = 160MHz, P_{LO} = 0dBm, T_C = +25°C (Note 5)	19			dBm
		Two tones: f_{RF1} = 910MHz, f_{RF2} = 911MHz, P_{RF} = -5dBm/tone, f_{LO} = 750MHz, P_{LO} = 0dBm, T_C = +25°C	22	25		

AC ELECTRICAL CHARACTERISTICS (continued)

(MAX9984 *Typical Application Circuit,* using component values in Table 1, V_{CC} = +4.75V to +5.25V, RF and LO ports are driven from 50Ω sources, P_{LO} = -3dBm to +3dBm, P_{RF} = -5dBm, f_{RF} = 815MHz to 1000MHz, f_{LO} = 570MHz to 850MHz, f_{IF} = 160MHz, f_{RF} > f_{LO}, T_C = -40°C to +85°C, unless otherwise noted. Typical values are at V_{CC} = +5V, P_{RF} = -5dBm, P_{LO} = 0dBm, f_{RF} = 910MHz, f_{LO} = 750MHz, f_{IF} = 160MHz, T_C = +25°C, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Input IP3 Variation Over Temperature		T_C = +25°C to -40°C			-1.5		dB
		T_C = +25°C to +85°C			+0.8		
Noise Figure	NF	Single sideband, f_{IF} = 190MHz			9.3		dB
Noise Figure Under-Blocking		f_{RF} = 900MHz (no signal) f_{LO} = 1090MHz $f_{BLOCKER}$ = 981MHz f_{IF} = 190MHz (Note 6)	$P_{BLOCKER}$ = +8dBm		19		dB
			$P_{BLOCKER}$ = +11dBm		24		
Small-Signal Compression Under-Blocking Condition		$P_{FUNDAMENTAL}$ = -5dBm $f_{FUNDAMENTAL}$ = 910MHz $f_{BLOCKER}$ = 911MHz	$P_{BLOCKER}$ = +8dBm		0.25		dB
			$P_{BLOCKER}$ = +11dBm		0.6		
LO Drive				-3		+3	dBm
Spurious Response at IF	2 x 2	2RF-2LO	P_{RF} = -10dBm		71		dBc
			P_{RF} = -5dBm		66		
	3 x 3	3RF-3LO	P_{RF} = -10dBm		87		
			P_{RF} = -5dBm		82		
LO1 to LO2 Isolation		P_{LO} = +3dBm T_C = +25°C (Note 5)	LO2 selected	47	54		dB
			LO1 selected	47	60		
LO Leakage at RF Port		P_{LO} = +3dBm			-32		dBm
LO Leakage at IF Port		P_{LO} = +3dBm			-23		dBm
RF-to-IF Isolation		P_{LO} = +3dBm			54		dB
LO Switching Time		50% of LOSEL to IF settled to within 2°			50		ns
RF Port Return Loss					14		dB
LO Port Return Loss		LO1/2 port selected, LO2/1 and IF terminated			23		dB
		LO1/2 port unselected, LO2/1 and IF terminated			20		
IF Port Return Loss		LO driven at 0dBm, RF terminated into 50Ω, differential 200Ω			16		dB

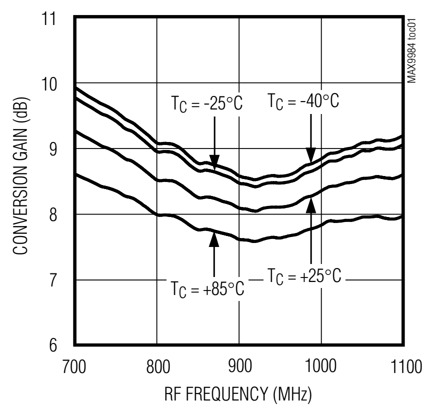
Note 1: All limits include external component losses. Output measurements taken at IF output of the *Typical Application Circuit*.
Note 2: Operation outside this range is possible, but with degraded performance of some parameters.
Note 3: See Table 2 for component list required for 400MHz to 500MHz operation. For operation from 500MHz to 800MHz, appropriate tuning is required; please contact the factory for support.
Note 4: Compression point characterized. It is advisable not to operate continuously the mixer RF input above +12dBm.
Note 5: Guaranteed by design and characterization.
Note 6: Measured with external LO source noise filtered so the noise floor is -174dBm/Hz. This specification reflects the effects of all SNR degradations in the mixer, including the LO noise as defined in Maxim Application Note 2021.

SiGe High-Linearity, 400MHz to 1000MHz Downconversion Mixer with LO Buffer/Switch

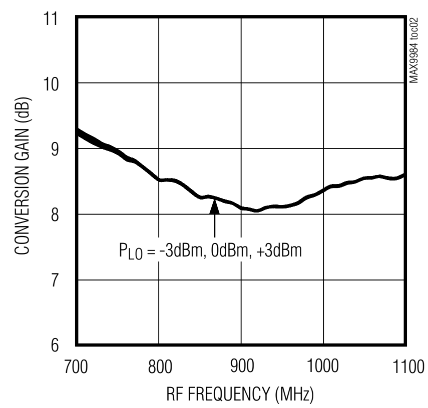
Typical Operating Characteristics

(MAX9984 *Typical Application Circuit,* using component values in Table 1, V_{CC} = +5.0V, P_{LO} = 0dBm, P_{RF} = -5dBm, $\mathbf{f_{RF} > f_{LO}, f_{IF}}$ = **160MHz**, unless otherwise noted.)

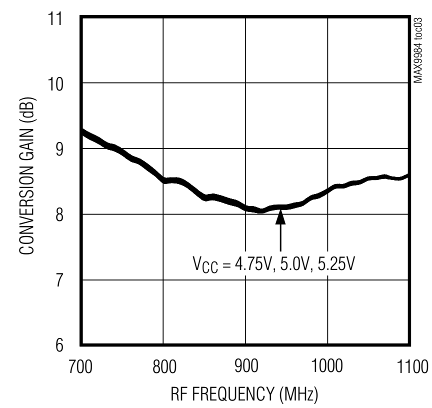
CONVERSION GAIN vs. RF FREQUENCY



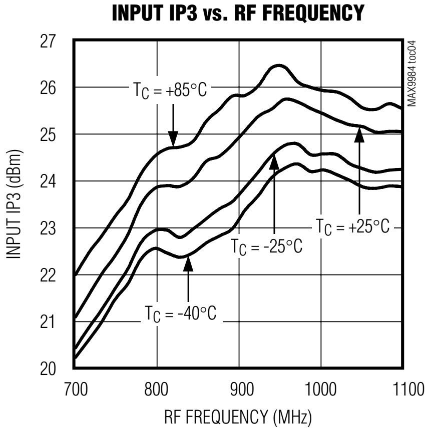
CONVERSION GAIN vs. RF FREQUENCY



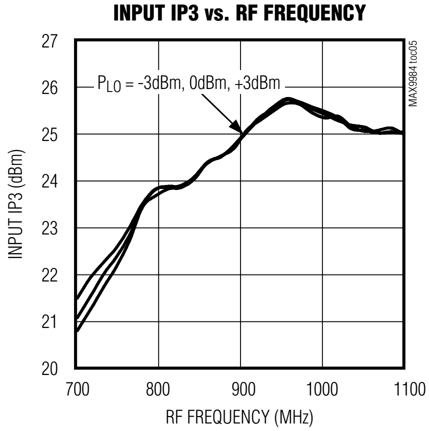
CONVERSION GAIN vs. RF FREQUENCY



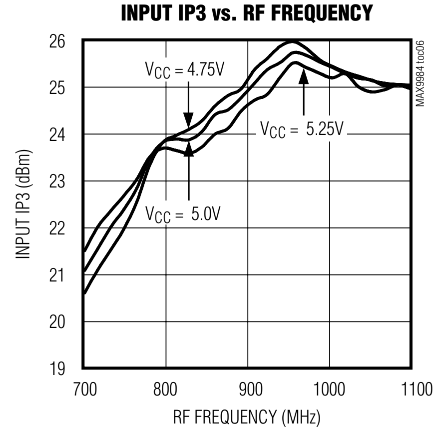
INPUT IP3 vs. RF FREQUENCY



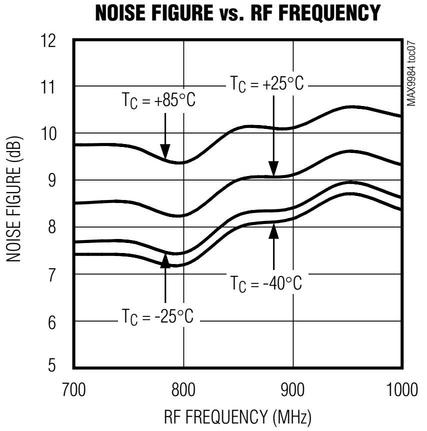
INPUT IP3 vs. RF FREQUENCY



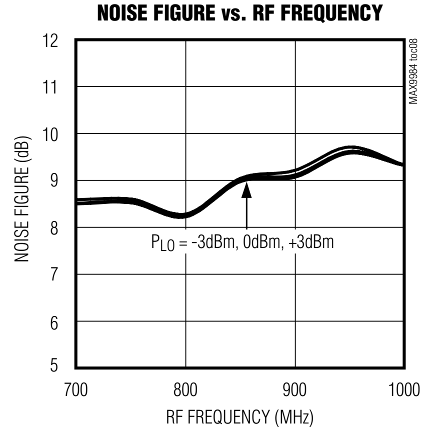
INPUT IP3 vs. RF FREQUENCY



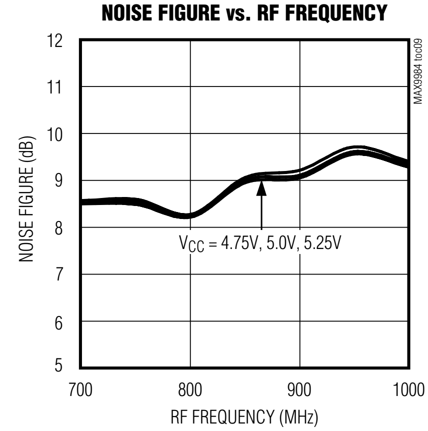
NOISE FIGURE vs. RF FREQUENCY



NOISE FIGURE vs. RF FREQUENCY



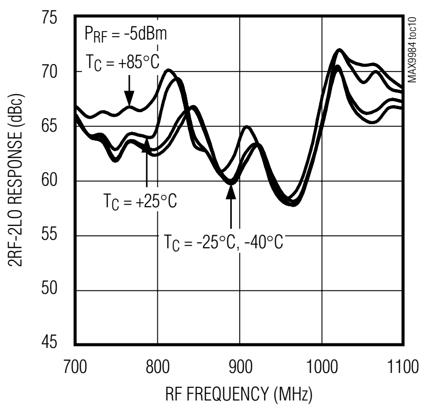
NOISE FIGURE vs. RF FREQUENCY



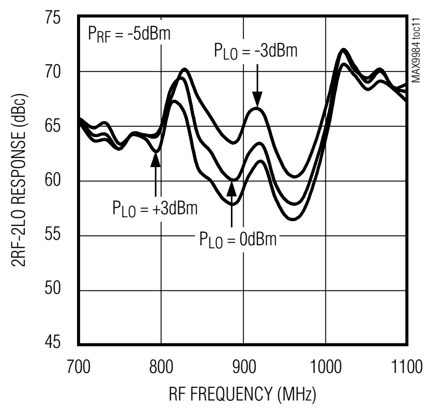
Typical Operating Characteristics (continued)

(MAX9984 *Typical Application Circuit,* using component values in Table 1, V_{CC} = +5.0V, P_{LO} = 0dBm, P_{RF} = -5dBm, $\mathbf{f_{RF} > f_{LO}, f_{IF}}$ **= 160MHz**, unless otherwise noted.)

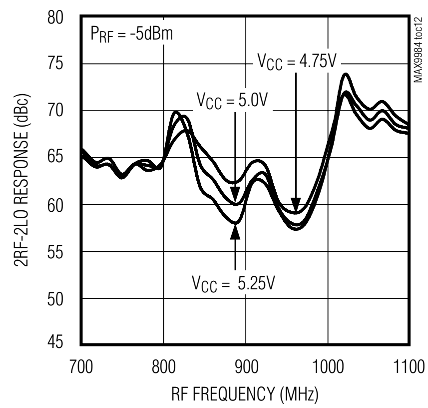
2RF-2LO RESPONSE vs. RF FREQUENCY



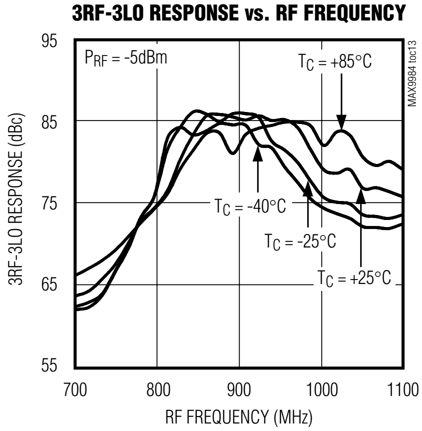
2RF-2LO RESPONSE vs. RF FREQUENCY



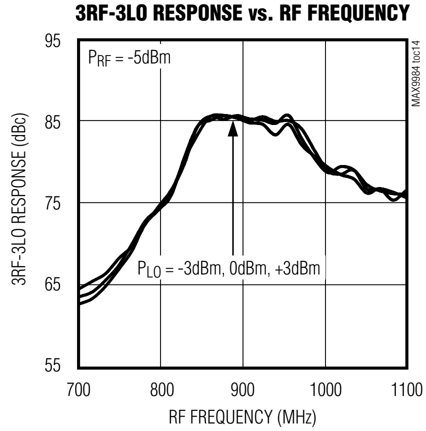
2RF-2LO RESPONSE vs. RF FREQUENCY



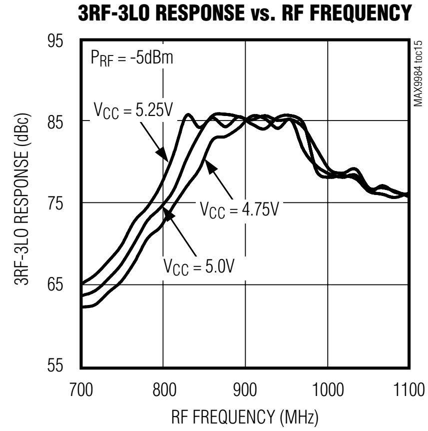
3RF-3LO RESPONSE vs. RF FREQUENCY



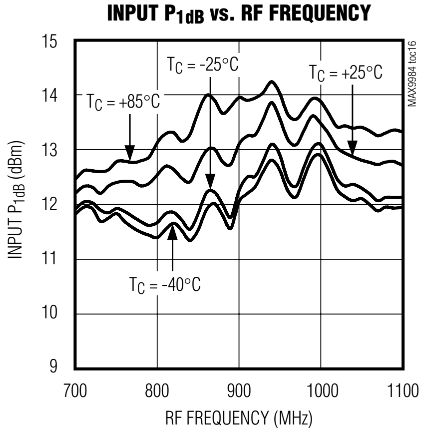
3RF-3LO RESPONSE vs. RF FREQUENCY



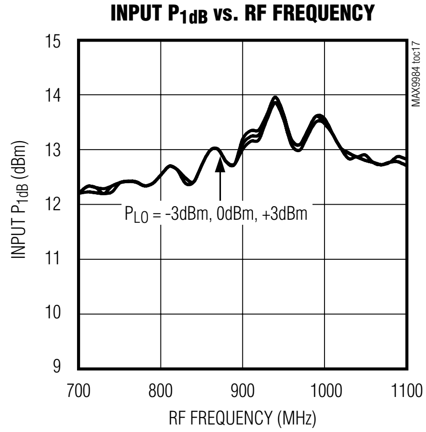
3RF-3LO RESPONSE vs. RF FREQUENCY



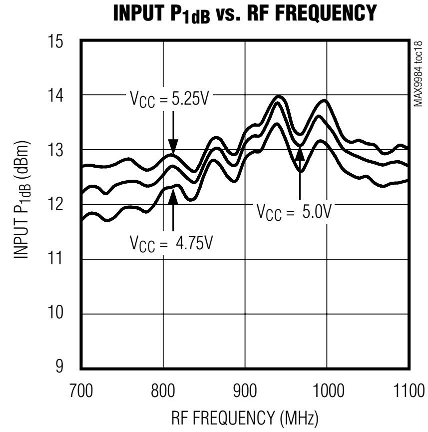
INPUT P_{1dB} vs. RF FREQUENCY



INPUT P_{1dB} vs. RF FREQUENCY



INPUT P_{1dB} vs. RF FREQUENCY

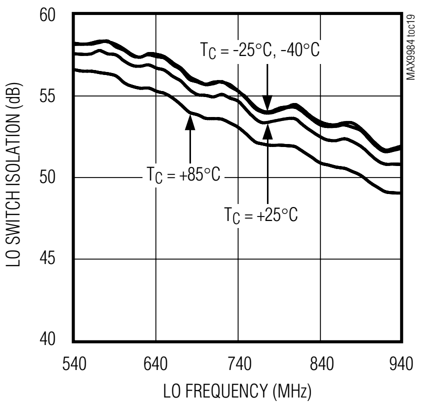


SiGe High-Linearity, 400MHz to 1000MHz Downconversion Mixer with LO Buffer/Switch

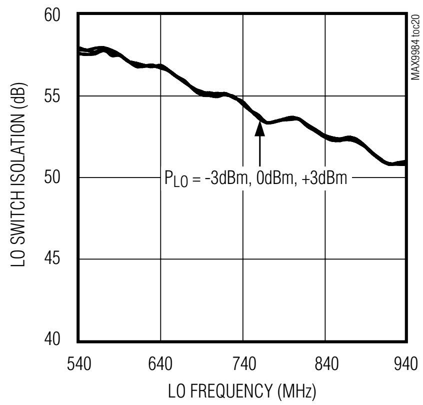
Typical Operating Characteristics (continued)

(MAX9984 *Typical Application Circuit,* using component values in Table 1, V_{CC} = +5.0V, P_{LO} = 0dBm, P_{RF} = -5dBm, $\mathbf{f_{RF} > f_{LO}, f_{IF}}$ **= 160MHz**, unless otherwise noted.)

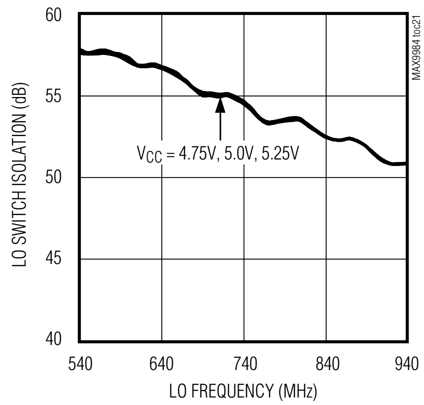
LO SWITCH ISOLATION vs. LO FREQUENCY



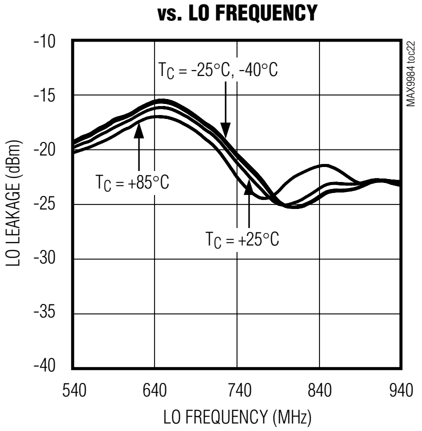
LO SWITCH ISOLATION vs. LO FREQUENCY



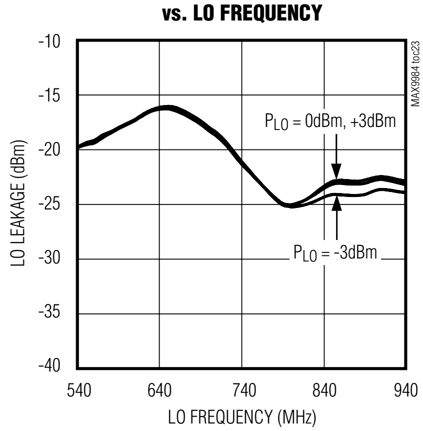
LO SWITCH ISOLATION vs. LO FREQUENCY



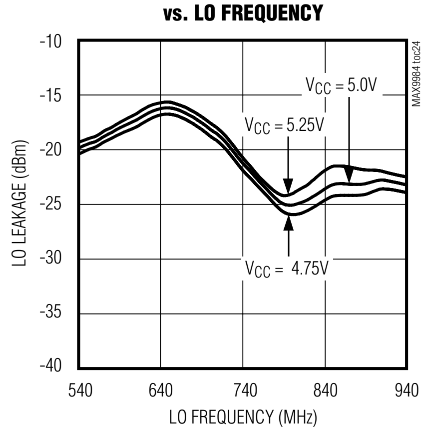
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



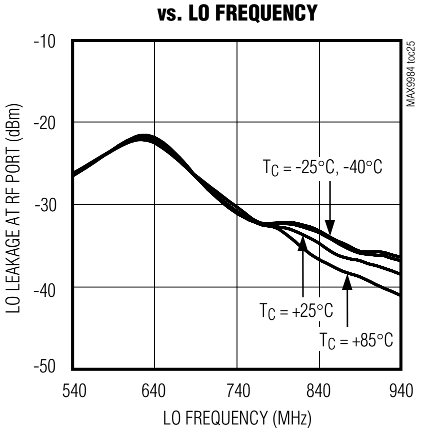
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



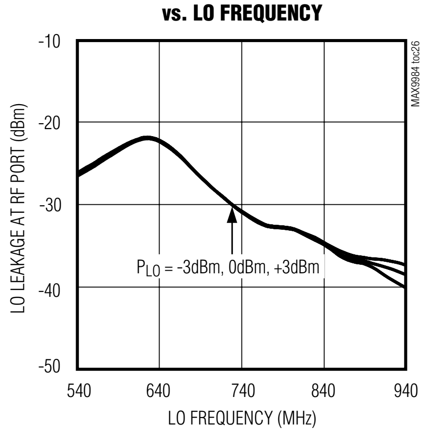
LO LEAKAGE AT IF PORT vs. LO FREQUENCY



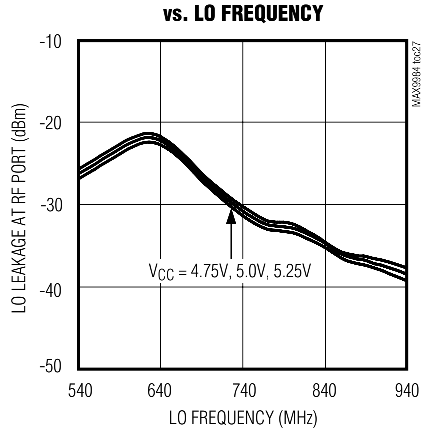
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



LO LEAKAGE AT RF PORT vs. LO FREQUENCY



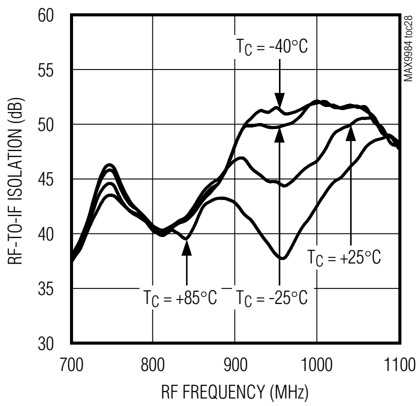
LO LEAKAGE AT RF PORT vs. LO FREQUENCY



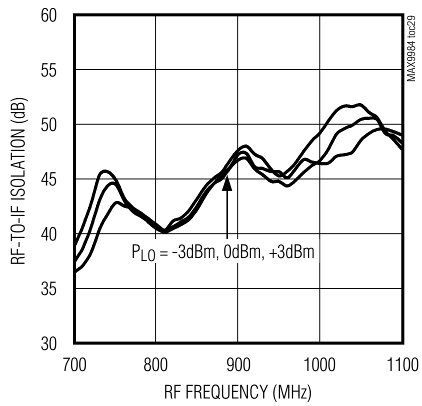
Typical Operating Characteristics (continued)

(MAX9984 *Typical Application Circuit,* using component values in Table 1, V_{CC} = +5.0V, P_{LO} = 0dBm, P_{RF} = -5dBm, **$f_{RF} > f_{LO}$, f_{IF} = 160MHz**, unless otherwise noted.)

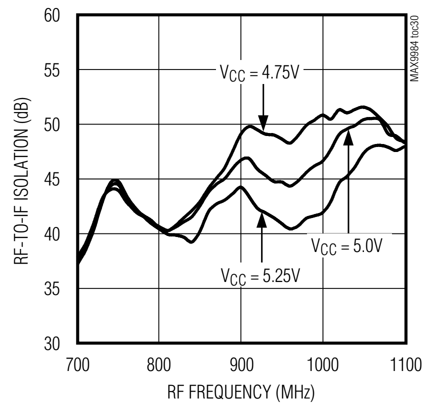
RF-TO-IF ISOLATION vs. RF FREQUENCY



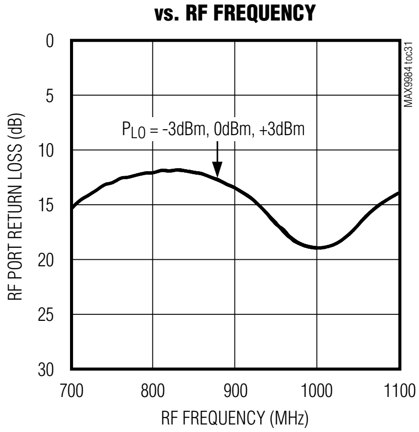
RF-TO-IF ISOLATION vs. RF FREQUENCY



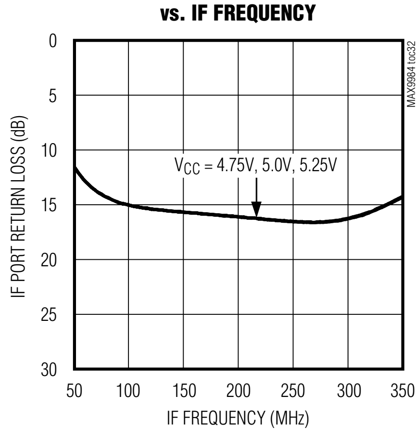
RF-TO-IF ISOLATION vs. RF FREQUENCY



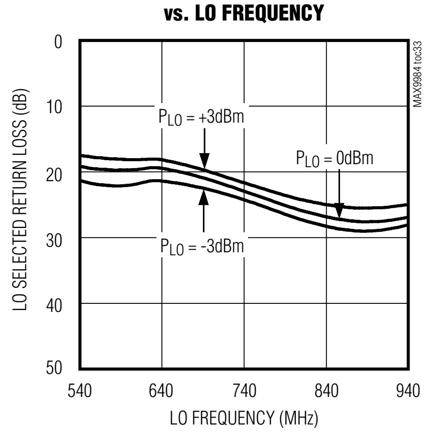
RF PORT RETURN LOSS vs. RF FREQUENCY



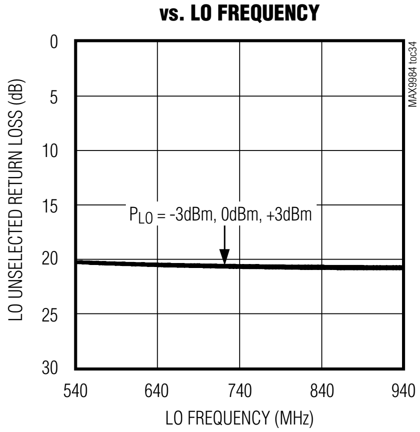
IF PORT RETURN LOSS vs. IF FREQUENCY



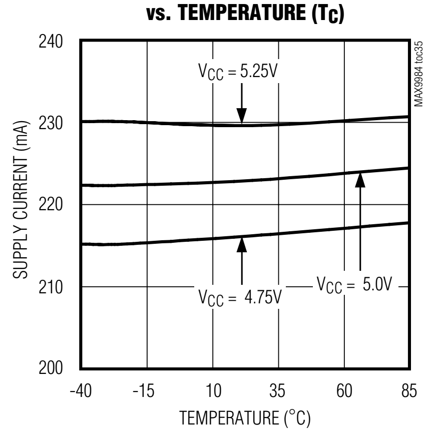
LO SELECTED RETURN LOSS vs. LO FREQUENCY



LO UNSELECTED RETURN LOSS vs. LO FREQUENCY



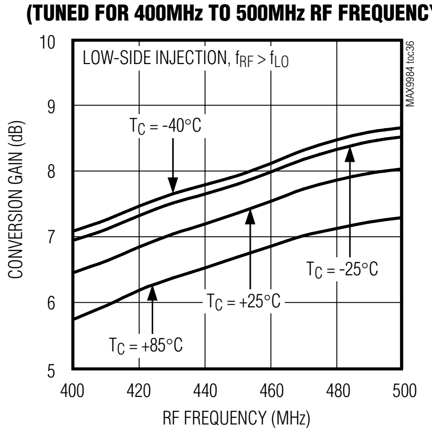
SUPPLY CURRENT vs. TEMPERATURE (T_C)



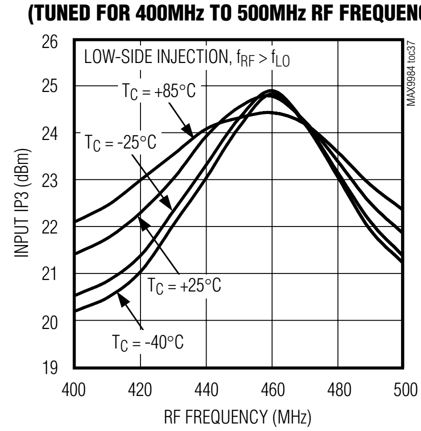
Typical Operating Characteristics

(MAX9984 *Typical Application Circuit,* using component values in Table 2, V_{CC} = +5.0V, P_{LO} = 0dBm, P_{RF} = -5dBm, $\mathbf{f_{IF}}$ **= 75MHz**, unless otherwise noted.)

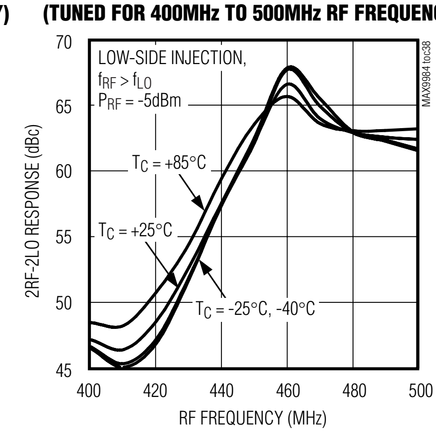
CONVERSION GAIN vs. RF FREQUENCY (TUNED FOR 400MHz TO 500MHz RF FREQUENCY)



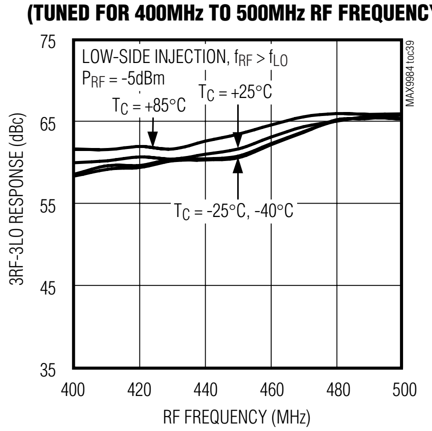
INPUT IP3 vs. RF FREQUENCY (TUNED FOR 400MHz TO 500MHz RF FREQUENCY)



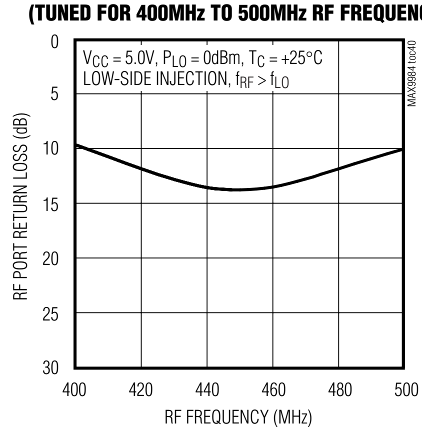
2RF-2LO RESPONSE vs. RF FREQUENCY (TUNED FOR 400MHz TO 500MHz RF FREQUENCY)



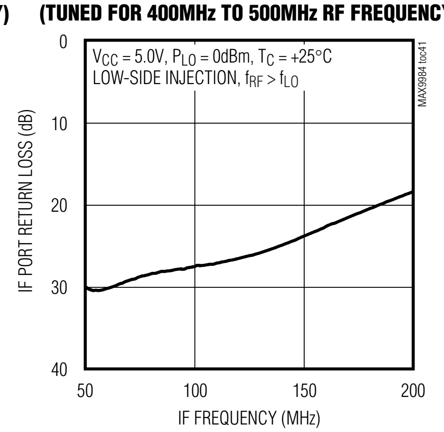
3RF-3LO RESPONSE vs. RF FREQUENCY (TUNED FOR 400MHz TO 500MHz RF FREQUENCY)



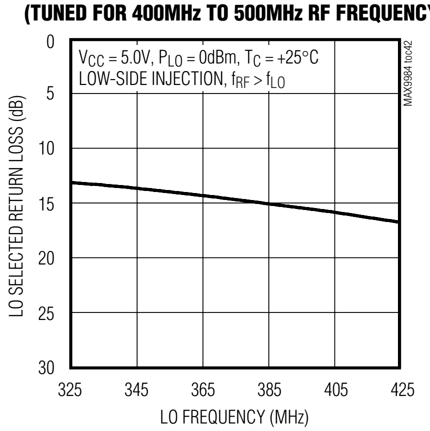
RF PORT RETURN LOSS vs. RF FREQUENCY (TUNED FOR 400MHz TO 500MHz RF FREQUENCY)



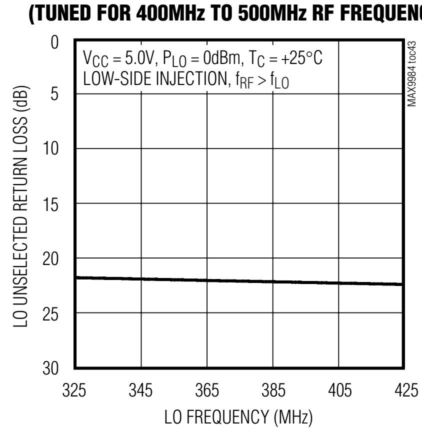
IF PORT RETURN LOSS vs. IF FREQUENCY (TUNED FOR 400MHz TO 500MHz RF FREQUENCY)



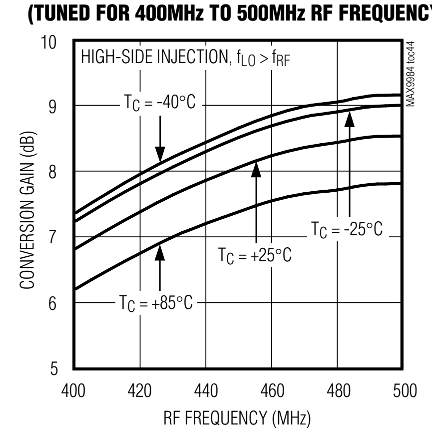
LO SELECTED RETURN LOSS vs. LO FREQUENCY (TUNED FOR 400MHz TO 500MHz RF FREQUENCY)



LO UNSELECTED RETURN LOSS vs. LO FREQUENCY (TUNED FOR 400MHz TO 500MHz RF FREQUENCY)



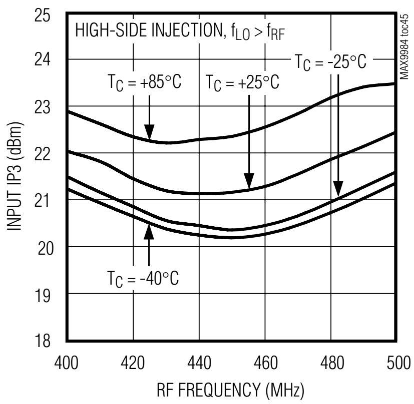
CONVERSION GAIN vs. RF FREQUENCY (TUNED FOR 400MHz TO 500MHz RF FREQUENCY)



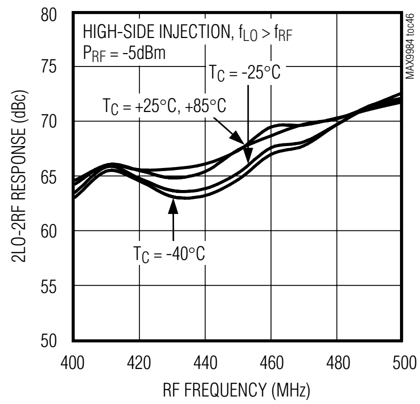
Typical Operating Characteristics (continued)

(MAX9984 *Typical Application Circuit,* using component values in Table 2, V_{CC} = +5.0V, P_{LO} = 0dBm, P_{RF} = -5dBm, $\mathbf{f_{IF}}$ **= 75MHz**, unless otherwise noted.)

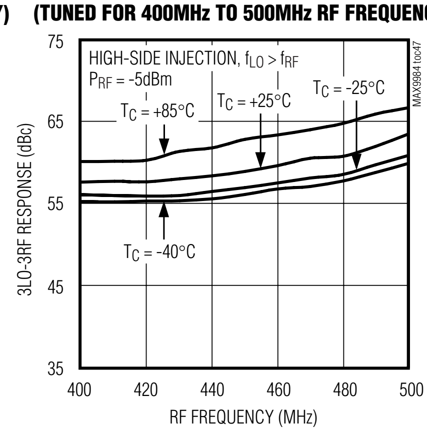
INPUT IP3 vs. RF FREQUENCY (TUNED FOR 400MHz TO 500MHz RF FREQUENCY)



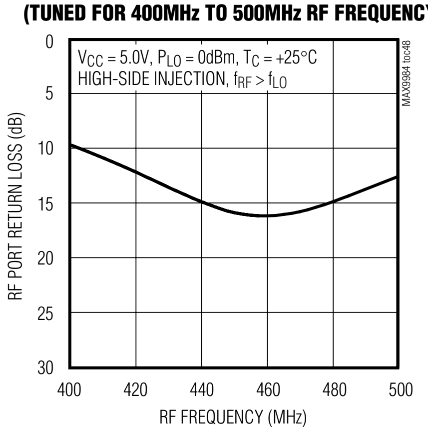
2LO-2RF RESPONSE vs. RF FREQUENCY (TUNED FOR 400MHz TO 500MHz RF FREQUENCY)



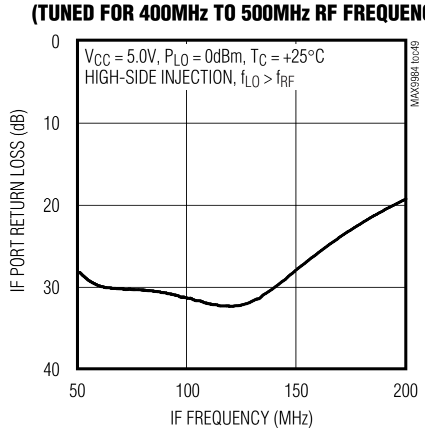
3LO-3RF RESPONSE vs. RF FREQUENCY (TUNED FOR 400MHz TO 500MHz RF FREQUENCY)



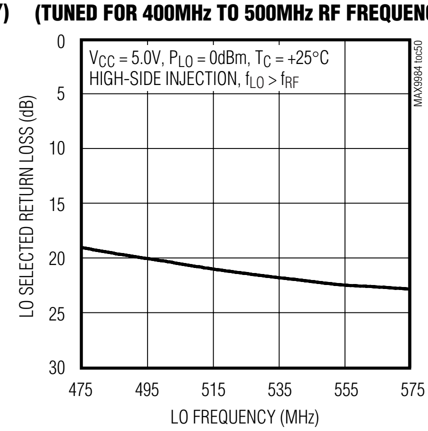
RF PORT RETURN LOSS vs. RF FREQUENCY (TUNED FOR 400MHz TO 500MHz RF FREQUENCY)



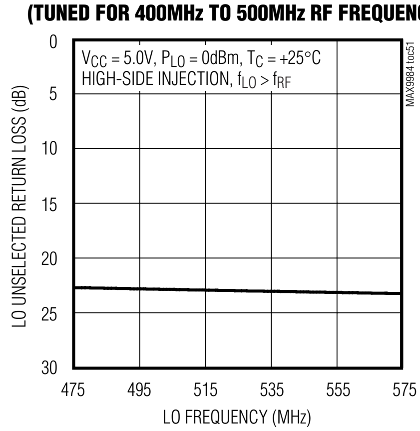
IF PORT RETURN LOSS vs. IF FREQUENCY (TUNED FOR 400MHz TO 500MHz RF FREQUENCY)



LO SELECTED RETURN LOSS vs. LO FREQUENCY (TUNED FOR 400MHz TO 500MHz RF FREQUENCY)



LO UNSELECTED RETURN LOSS vs. LO FREQUENCY (TUNED FOR 400MHz TO 500MHz RF FREQUENCY)



Pin Description

PIN	NAME	FUNCTION
1, 6, 8, 14	V_{CC}	Power-Supply Connection. Bypass each V_{CC} pin to GND with capacitors as shown in the *Typical Application Circuit*.
2	RF	Single-Ended 50Ω RF Input. This port is internally matched and DC shorted to GND through a balun. Requires an external DC-blocking capacitor.
3	TAP	Center Tap of the Internal RF Balun. Bypass to GND with capacitors close to the IC, as shown in the *Typical Application Circuit*.
4, 5, 10, 12, 13, 17	GND	Ground
7	LOBIAS	Bias Resistor for Internal LO Buffer. Connect a 619Ω ±1% resistor from LOBIAS to the power supply.
9	LOSEL	Local Oscillator Select. Logic control input for selecting LO1 or LO2.
11	LO1	Local Oscillator Input 1. Drive LOSEL low to select LO1.
15	LO2	Local Oscillator Input 2. Drive LOSEL high to select LO2.
16	LEXT	External Inductor Connection. Connect a low-ESR, 47nH inductor from LEXT to GND. This inductor carries approximately 140mA DC current.
18, 19	IF-, IF+	Differential IF Outputs. Each output requires external bias to V_{CC} through an RF choke (see the *Typical Application Circuit*).
20	IFBIAS	IF Bias Resistor Connection for IF Amplifier. Connect a 953Ω ±1% resistor from IFBIAS to GND.
EP	GND	Exposed Ground Paddle. Solder the exposed paddle to the ground plane using multiple vias.

Detailed Description

The MAX9984 high-linearity downconversion mixer provides 8.1dB of conversion gain and +25dBm of IIP3, with a typical 9.3dB noise figure. The integrated baluns and matching circuitry allow for 50Ω single-ended interfaces to the RF and the two LO ports. A single-pole, double-throw (SPDT) switch provides 50ns switching time between the two LO inputs with 54dB of LO-to-LO isolation. Furthermore, the integrated LO buffer provides a high drive level to the mixer core, reducing the LO drive required at the MAX9984's inputs to a -3dBm to +3dBm range. The IF port incorporates a differential output, which is ideal for providing enhanced IIP2 performance.

Specifications are guaranteed over broad frequency ranges to allow for use in cellular band GSM, cdma2000, iDEN, and W-CDMA 2G/2.5G/3G base stations. The MAX9984 is optimized to operate over a 815MHz to 1000MHz RF frequency range, a 570MHz to 850MHz LO frequency range, and a 50MHz to 250MHz IF frequency range. Operation beyond these ranges is possible; see the *Typical Operating Characteristics* for additional details. For operation at a 400MHz to 500MHz RF frequency range, see the *Typical Operating Characteristics* and Table 2 for details.

RF Input and Balun

The MAX9984 RF input is internally matched to 50Ω, requiring no external matching components. A DC-blocking capacitor is required because the input is internally DC shorted to ground through the on-chip balun.

LO Inputs, Buffer, and Balun

The MAX9984 is ideally suited for low-side LO injection applications with an optimized 570MHz to 850MHz LO frequency range. Appropriate tuning allows for an LO frequency range below 570MHz (RF frequency below 815MHz). For a device with a 960MHz to 1180MHz LO frequency range, refer to the MAX9986 data sheet. As an added feature, the MAX9984 includes an internal LO SPDT switch that can be used for frequency-hopping applications. The switch selects one of the two single-ended LO ports, allowing the external oscillator to settle on a particular frequency before it is switched in. LO switching time is typically less than 50ns, which is more than adequate for virtually all GSM applications. If frequency hopping is not employed, set the switch to either of the LO inputs. The switch is controlled by a digital input (LOSEL): logic-high selects LO2, logic-low selects LO1. To avoid damage to the part, voltage must be applied to V_{CC} before digital logic is applied to LOSEL. LO1 and LO2 inputs are internally matched to 50Ω, requiring only a 82pF DC-blocking capacitor.

SiGe High-Linearity, 400MHz to 1000MHz Downconversion Mixer with LO Buffer/Switch

A two-stage internal LO buffer allows a wide input power range for the LO drive. All guaranteed specifications are for an LO signal power from -3dBm to +3dBm. 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 MAX9984 is a double-balanced, high-performance passive mixer. Exceptional linearity is provided by the large LO swing from the on-chip LO buffer. When combined with the integrated IF amplifiers, the cascaded IIP3, 2RF-2LO rejection, and NF performance is typically 25dBm, 71dBc, and 9.3dB, respectively.

Differential IF Output Amplifier

The MAX9984 mixer has a 50MHz to 250MHz IF frequency range. The differential, open-collector IF output ports require external pullup inductors to V_{CC}. Note that these differential outputs are ideal for providing enhanced 2RF-2LO rejection performance. Single-ended IF applications require a 4:1 balun to transform the 200Ω differential output impedance to a 50Ω single-ended output.

Applications Information

Input and Output Matching

The RF and LO inputs are internally matched to 50Ω. No matching components are required for an 815MHz to 1000MHz RF frequency range. RF and LO inputs require only DC-blocking capacitors for interfacing.

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*).

Capacitor C_P is used at the RF input port to tune the mixer down to operate in the 400MHz to 500MHz RF frequency range (see Table 2). Operation between 500MHz to 815MHz would require a smaller capacitor C_P. Contact the factory for details.

Bias Resistors

Bias currents for the LO buffer and the IF amplifier are optimized by fine tuning resistors R1 and R2. If reduced current is required at the expense of performance, contact the factory for details. If the ±1% bias resistor values are not readily available, substitute standard ±5% values.

LEXT Inductor

LEXT serves to improve the LO-to-IF and RF-to-IF leakage. The inductance value can be adjusted by the user to optimize the performance for a particular frequency band. Since approximately 140mA flows through this inductor, it is important to use a low-DCR wire-wound coil.

If the LO-to-IF and RF-to-IF leakage are not critical parameters, the inductor can be replaced by a short circuit to ground.

Layout Considerations

A properly designed PC board is an essential part of any RF/microwave circuit. Keep RF signal lines as short as possible to reduce losses, radiation, and inductance. For the best performance, route the ground pin traces directly to the exposed pad under the package. The PC board exposed pad **MUST** be connected to the ground plane of the PC board. 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 PC board. The MAX9984 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 and TAP with the capacitors shown in the *Typical Application Circuit*; see Table 1. Place the TAP bypass capacitor to ground within 100 mils of the TAP pin.

Exposed Pad RF/Thermal Considerations

The exposed paddle (EP) of the MAX9984's 20-pin thin QFN-EP package provides a low thermal-resistance path to the die. It is important that the PC board on which the MAX9984 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 PC board, either directly or through an array of plated via holes.

Chip Information

TRANSISTOR COUNT: 1017

PROCESS: SiGe BiCMOS

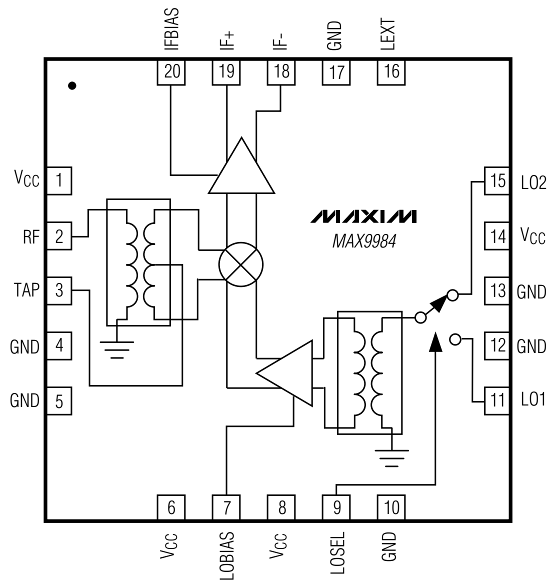
Table 1. Component List Referring to the Typical Application Circuit for 815MHz to 1000MHz RF Frequency Operation

COMPONENT	VALUE	DESCRIPTION
L1, L2	330nH	Wire-wound high-Q inductors (0805)
L3	47nH	Wire-wound high-Q inductor (0603)
C1	10pF	Microwave capacitor (0603)
C2, C4, C7, C8, C10, C11, C12	82pF	Microwave capacitors (0603)
C3, C5, C6, C9, C13, C14	0.01µF	Microwave capacitors (0603)
C15	220pF	Microwave capacitor (0402)
R1	953Ω	±1% resistor (0603)
R2	619Ω	±1% resistor (0603)
R3	3.57Ω	±1% resistor (1206)
T1	4:1 balun	IF balun (TC4-1W-7A)
U1	MAX9984	Maxim IC

Table 2. Component List Referring to the Typical Application Circuit for 400MHz to 995MHz RF Frequency Operation

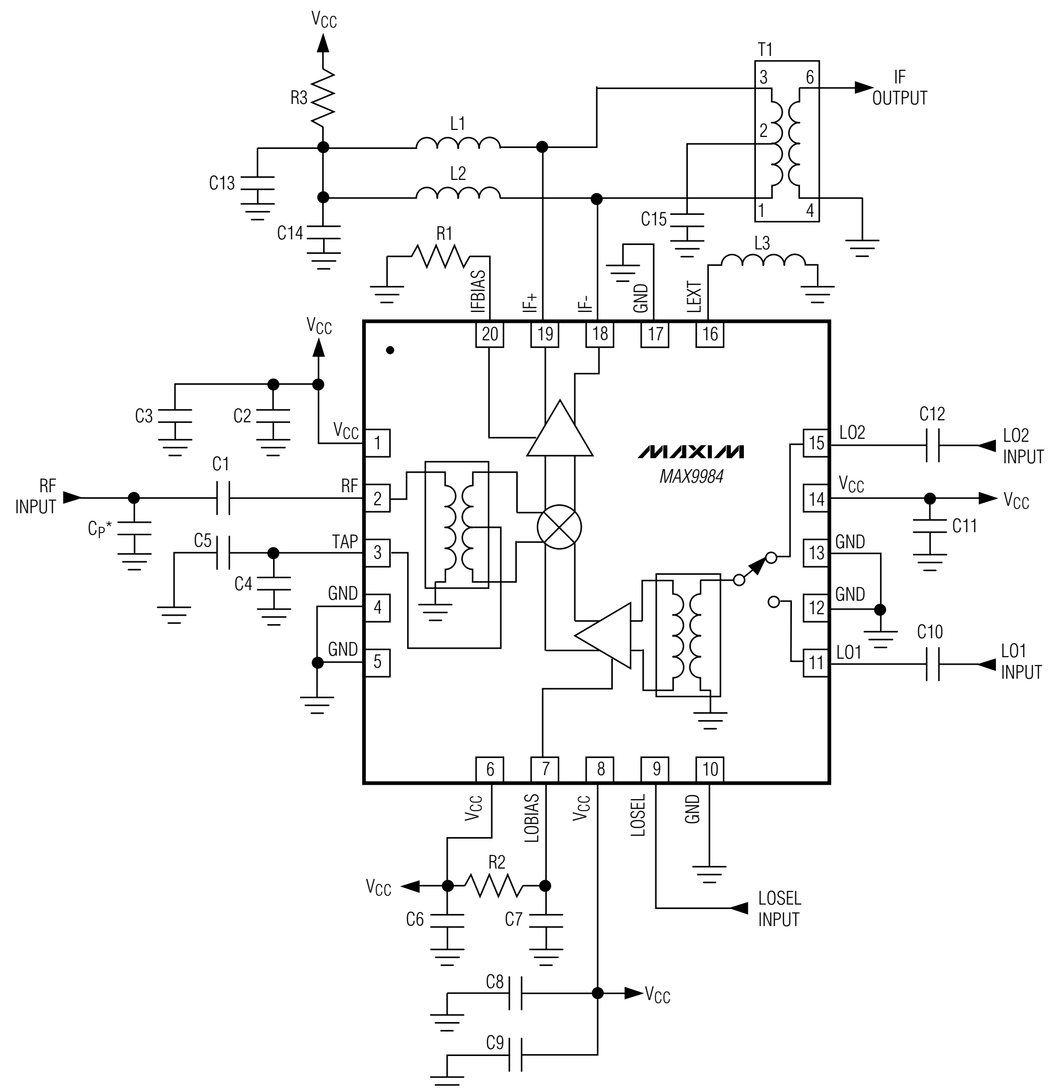
COMPONENT	VALUE	DESCRIPTION
L1, L2	820nH	Wire-wound high-Q inductors (0805)
L3	47nH	Wire-wound high-Q inductor (0603)
C_P	7pF	Microwave capacitor (0603)
C1	56pF	Microwave capacitor (0603)
C2, C4, C7, C8, C10, C11, C12	220pF	Microwave capacitors (0603)
C3, C5, C6, C9, C13, C14	10nF	Microwave capacitors (0603)
C15	220pF	Microwave capacitor (0402)
R1	953Ω	±1% resistor (0603)
R2	619Ω	±1% resistor (0603)
R3	3.57Ω	±1% resistor (1206)
T1	4:1 balun	IF balun (TC4-1W-7A)
U1	MAX9984	Maxim IC

Pin Configuration/Functional Diagram



THIN QFN

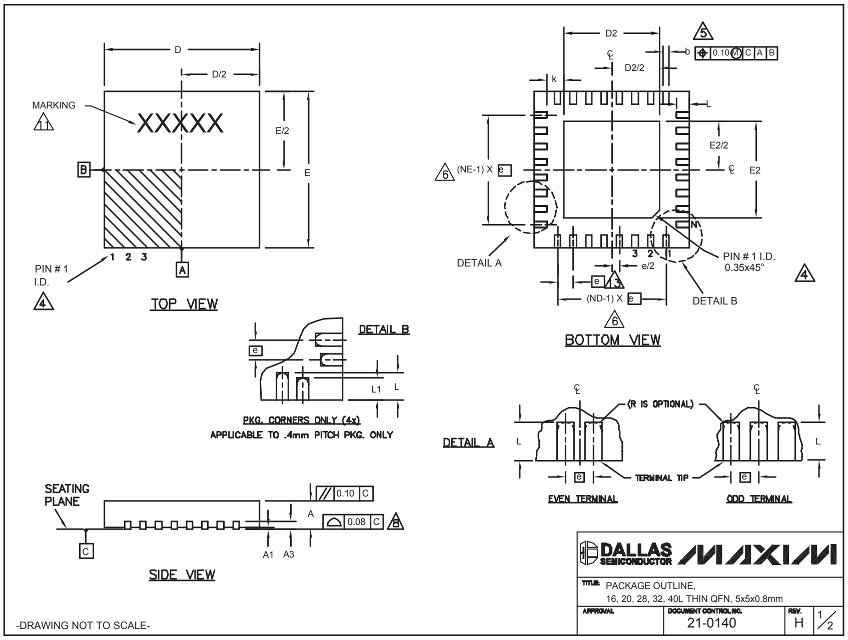
Typical Application Circuit



*CP NEEDED FOR 400MHz TO 500MHz RF FREQUENCY OPERATION. SEE TABLE 2.

Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to **www.maxim-ic.com/packages**.)



COMMON DIMENSIONS															
PKG.	16L 5x5			20L 5x5			28L 5x5			32L 5x5			40L 5x5		
SYMBOL	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.70	0.75	0.80	0.70	0.75	0.80	0.70	0.75	0.80	0.70	0.75	0.80	0.70	0.75	0.80
A1	0	0.02	0.05	0	0.02	0.05	0	0.02	0.05	0	0.02	0.05	0	0.02	0.05
A3	0.20 REF.			0.20 REF.			0.20 REF.			0.20 REF.			0.20 REF.		
b	0.25	0.30	0.35	0.25	0.30	0.35	0.20	0.25	0.30	0.20	0.25	0.30	0.15	0.20	0.25
D	4.90	5.00	5.10	4.90	5.00	5.10	4.90	5.00	5.10	4.90	5.00	5.10	4.90	5.00	5.10
E	4.90	5.00	5.10	4.90	5.00	5.10	4.90	5.00	5.10	4.90	5.00	5.10	4.90	5.00	5.10
e	0.80 BSC.			0.65 BSC.			0.50 BSC.			0.50 BSC.			0.40 BSC.		
k	0.25	-	-	0.25	-	-	0.25	-	-	0.25	-	-	0.25	0.35	0.45
L	0.30	0.40	0.50	0.45	0.55	0.65	0.45	0.55	0.65	0.30	0.40	0.50	0.40	0.50	0.60
L1	-	-	-	-	-	-	-	-	-	-	-	-	0.30	0.40	0.50
N	16			20			28			32			40		
ND	4			5			7			8			10		
NE	4			5			7			8			10		
JEDEC	WHHB			WHHC			WHHD-1			WHHD-2			-----		

EXPOSED PAD VARIATIONS								
PKG. CODES	D2			E2			L	DOWN BONDS ALLOWED
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	±0.15	
T1655-1	3.00	3.10	3.20	3.00	3.10	3.20	**	NO
T1655-2	3.00	3.10	3.20	3.00	3.10	3.20	**	YES
T1655N-1	3.00	3.10	3.20	3.00	3.10	3.20	**	NO
T2055-2	3.00	3.10	3.20	3.00	3.10	3.20	**	NO
T2055-3	3.00	3.10	3.20	3.00	3.10	3.20	**	YES
T2055-4	3.00	3.10	3.20	3.00	3.10	3.20	**	NO
T2055-5	3.15	3.25	3.35	3.15	3.25	3.35	0.40	YES
T2855-1	3.15	3.25	3.35	3.15	3.25	3.35	**	NO
T2855-2	2.60	2.70	2.80	2.60	2.70	2.80	**	NO
T2855-3	3.15	3.25	3.35	3.15	3.25	3.35	**	YES
T2855-4	2.60	2.70	2.80	2.60	2.70	2.80	**	YES
T2855-5	2.60	2.70	2.80	2.60	2.70	2.80	**	NO
T2855-6	3.15	3.25	3.35	3.15	3.25	3.35	**	NO
T2855-7	2.60	2.70	2.80	2.60	2.70	2.80	**	YES
T2855-8	3.15	3.25	3.35	3.15	3.25	3.35	0.40	YES
T2855N-1	3.15	3.25	3.35	3.15	3.25	3.35	**	NO
T3255-2	3.00	3.10	3.20	3.00	3.10	3.20	**	NO
T3255-3	3.00	3.10	3.20	3.00	3.10	3.20	**	YES
T3255-4	3.00	3.10	3.20	3.00	3.10	3.20	**	NO
T3255N-1	3.00	3.10	3.20	3.00	3.10	3.20	**	NO
T4055-1	3.20	3.30	3.40	3.20	3.30	3.40	**	YES

** SEE COMMON DIMENSIONS TABLE

NOTES:

1. DIMENSIONING & TOLERANCING CONFORM TO ASME Y14.5M-1994.
2. ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES.
3. N IS THE TOTAL NUMBER OF TERMINALS.
4. THE TERMINAL #1 IDENTIFIER AND TERMINAL NUMBERING CONVENTION SHALL CONFORM TO JESD 95-1 SPP-012. DETAILS OF TERMINAL #1 IDENTIFIER ARE OPTIONAL, BUT MUST BE LOCATED WITHIN THE ZONE INDICATED. THE TERMINAL #1 IDENTIFIER MAY BE EITHER A MOLD OR MARKED FEATURE.
5. DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.25 mm AND 0.30 mm FROM TERMINAL TIP.
6. ND AND NE REFER TO THE NUMBER OF TERMINALS ON EACH D AND E SIDE RESPECTIVELY.
7. DEPOPULATION IS POSSIBLE IN A SYMMETRICAL FASHION.
8. COPLANARITY APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS.
9. DRAWING CONFORMS TO JEDEC MO220, EXCEPT EXPOSED PAD DIMENSION FOR T2855-1, T2855-3, AND T2855-6.
10. WARPAGE SHALL NOT EXCEED 0.10 mm.
11. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
12. NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.
13. LEAD CENTERLINES TO BE AT TRUE POSITION AS DEFINED BY BASIC DIMENSION "e", ±0.05.

DALLAS SEMICONDUCTOR MAXIM

TITLE: PACKAGE OUTLINE, 16, 20, 28, 32, 40L THIN QFN, 5x5x0.8mm

APPROVAL | DOCUMENT CONTROL NO. 21-0140 | REV. H | 2/2

-DRAWING NOT TO SCALE-

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