



SiGe High-Linearity, 815MHz to 995MHz Downconversion Mixer with LO Buffer/Switch

MAX9986

General Description

The MAX9986 high-linearity downconversion mixer provides 10dB gain, +23.6dBm IIP3, and 9.3dB NF for 815MHz to 995MHz base-station receiver applications. With a 960MHz to 1180MHz LO frequency range, this particular mixer is ideal for high-side LO injection receiver architectures. Low-side LO injection is supported by the MAX9984, which is pin-for-pin and functionally compatible with the MAX9986.

In addition to offering excellent linearity and noise performance, the MAX9986 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 MAX9986 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 MAX9986 is also functionally compatible with the MAX9993.

The MAX9986 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
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

- ◆ 815MHz to 995MHz RF Frequency Range
- ◆ 960MHz to 1180MHz LO Frequency Range (MAX9986)
- ◆ 570MHz to 850MHz LO Frequency Range (MAX9984)
- ◆ 50MHz to 250MHz IF Frequency Range
- ◆ 10dB Conversion Gain
- ◆ +23.6dBm Input IP3
- ◆ +12dBm Input 1dB Compression Point
- ◆ 9.3dB Noise Figure
- ◆ 67dBc 2LO-2RF Spurious Rejection at PRF = -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 49dB 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
MAX9986ETP	-40°C to +85°C	20 Thin QFN-EP* 5mm x 5mm	T2055-3
MAX9986ETP-T	-40°C to +85°C	20 Thin QFN-EP* 5mm x 5mm	T2055-3
MAX9986ETP+D	-40°C to +85°C	20 Thin QFN-EP* 5mm x 5mm	T2055-3
MAX9986ETP+TD	-40°C to +85°C	20 Thin QFN-EP* 5mm x 5mm	T2055-3

*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.



SiGe High-Linearity, 815MHz to 995MHz Downconversion Mixer with LO Buffer/Switch

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

(MAX9986 *Typical Application Circuit*, V_{CC} = +4.75V to +5.25V, no RF signal applied, IF+ and IF- outputs pulled up to V_{CC} through inductive chokes, R₁ = 953Ω, R₂ = 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

(MAX9986 *Typical Application Circuit*, 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 995MHz, f_{LO} = 960MHz to 1180MHz, f_{IF} = 160MHz, f_{LO} > f_{RF}, 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} = 1070MHz, 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		995	MHz
LO Frequency Range	f _{LO}	(Note 2)	960		1180	MHz
		MAX9984	570		850	
IF Frequency Range	f _{IF}	(Note 2)	50		250	MHz
Conversion Gain	G _C	T _C = +25°C	9	10	11	dB
Gain Variation Over Temperature		T _C = -40°C to +85°C		-0.007		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		±0.15		dB
Input Compression Point	P _{1dB}	(Note 3)		12		dBm
Input Third-Order Intercept Point	IIP3	Two tones: f _{RF1} = 910MHz, f _{RF2} = 911MHz, P _{RF} = -5dBm/tone, f _{LO} = 1070MHz, P _{LO} = 0dBm, T _A = +25°C	21	23.6		dBm
Input IP3 Variation Over Temperature		T _C = +25°C to -40°C		-1.7		dB
		T _C = +25°C to +85°C		+1.0		

SiGe High-Linearity, 815MHz to 995MHz Downconversion Mixer with LO Buffer/Switch

MAX9986

AC ELECTRICAL CHARACTERISTICS (continued)

(MAX9986 *Typical Application Circuit*, $V_{CC} = +4.75V$ to $+5.25V$, RF and LO ports are driven from 50Ω sources, $P_{LO} = -3dBm$ to $+3dBm$, $P_{RF} = -5dBm$, $f_{RF} = 815MHz$ to $995MHz$, $f_{LO} = 960MHz$ to $1180MHz$, $f_{IF} = 160MHz$, $f_{LO} > f_{RF}$, $T_C = -40^\circ C$ to $+85^\circ C$, unless otherwise noted. Typical values are at $V_{CC} = +5V$, $P_{RF} = -5dBm$, $P_{LO} = 0dBm$, $f_{RF} = 910MHz$, $f_{LO} = 1070MHz$, $f_{IF} = 160MHz$, $T_C = +25^\circ C$, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Noise Figure	NF	Single sideband, $f_{IF} = 190MHz$			9.3		dB
Noise Figure Under-Blocking		$f_{RF} = 900MHz$ (no signal) $f_{LO} = 1090MHz$ $f_{BLOCKER} = 990MHz$ $f_{IF} = 190MHz$ (Note 4)	$P_{BLOCKER} = +8dBm$		19		dB
			$P_{BLOCKER} = +11dBm$		24		
Small-Signal Compression Under-Blocking Condition		$P_{FUNDAMENTAL} = -5dBm$ $f_{FUNDAMENTAL} = 910MHz$ $f_{BLOCKER} = 911MHz$	$P_{BLOCKER} = +8dBm$		0.3		dB
			$P_{BLOCKER} = +11dBm$		2		
LO Drive				-3		+3	dBm
Spurious Response at IF	2 x 2	2LO-2RF	$P_{RF} = -10dBm$		67		dBc
			$P_{RF} = -5dBm$		62		
	3 x 3	3LO-3RF	$P_{RF} = -10dBm$		87		
			$P_{RF} = -5dBm$		77		
LO1 to LO2 Isolation		$P_{LO} = +3dBm$ $T_C = +25^\circ C$ (Note 5)	LO2 selected	42	49		dB
			LO1 selected	42	50		
LO Leakage at RF Port		$P_{LO} = +3dBm$			-47		dBm
LO Leakage at IF Port		$P_{LO} = +3dBm$			-30		dBm
RF-to-IF Isolation					46		dB
LO Switching Time		50% of LOSEL to IF settled to within 2°			50		ns
RF Port Return Loss					20		dB
LO Port Return Loss		LO1/2 port selected, LO2/1 and IF terminated			27		dB
		LO1/2 port unselected, LO2/1 and IF terminated			26		
IF Port Return Loss		LO driven at $0dBm$, RF terminated into 50Ω , differential 200Ω			22		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: Compression point characterized. It is advisable not to operate continuously the mixer RF input above $+12dBm$.

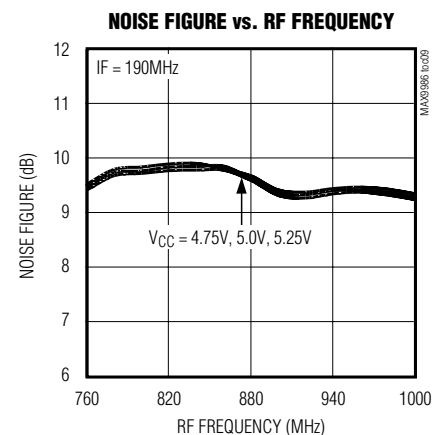
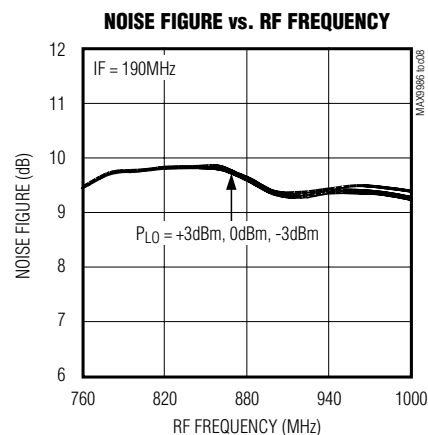
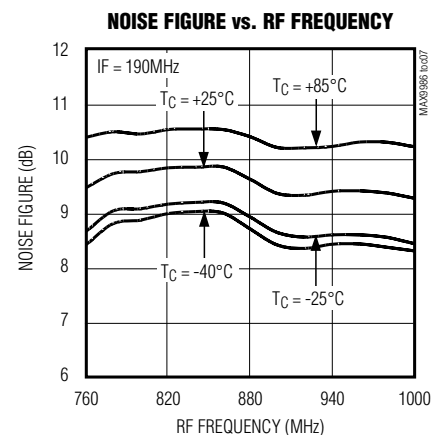
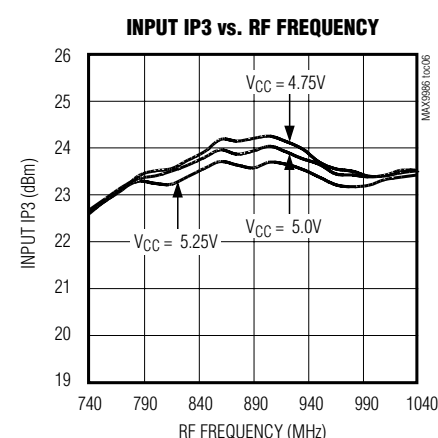
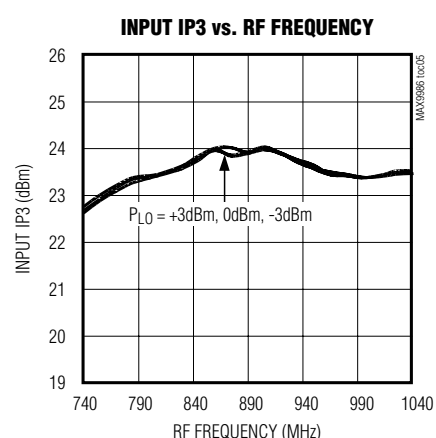
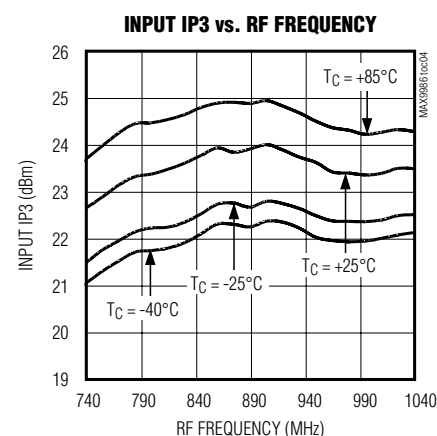
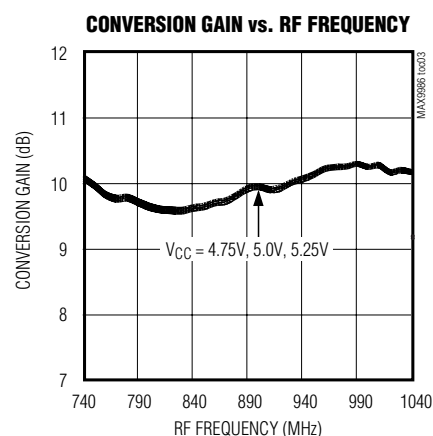
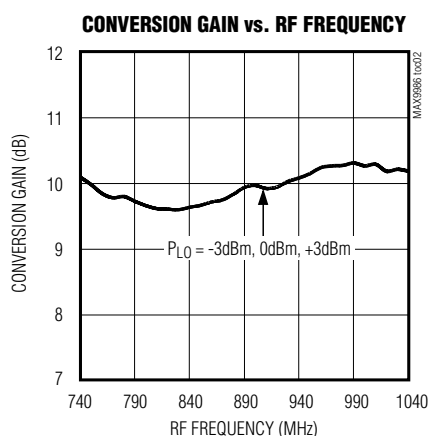
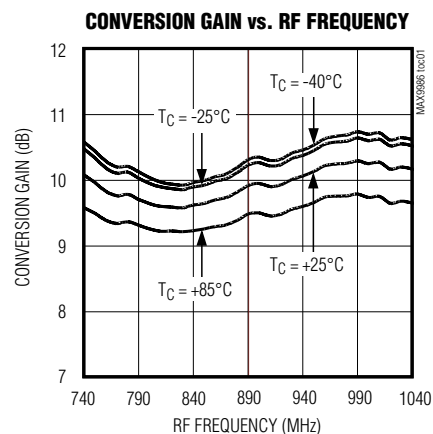
Note 4: Measured with external LO source noise filtered so the noise floor is $-174dBm/Hz$. This specification reflects the effects of all SNR degradations in the mixer, including the LO noise as defined in Maxim Application Note 2021.

Note 5: Guaranteed by design and characterization.

SiGe High-Linearity, 815MHz to 995MHz Downconversion Mixer with LO Buffer/Switch

Typical Operating Characteristics

(MAX9986 Typical Application Circuit, $V_{CC} = +5.0V$, $P_{LO} = 0dBm$, $P_{RF} = -5dBm$, $f_{LO} > f_{RF}$, $f_{IF} = 160MHz$, unless otherwise noted.)



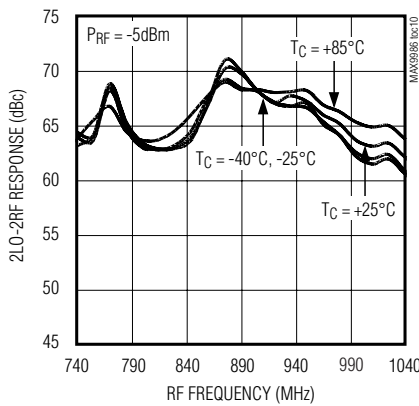
SiGe High-Linearity, 815MHz to 995MHz Downconversion Mixer with LO Buffer/Switch

Typical Operating Characteristics (continued)

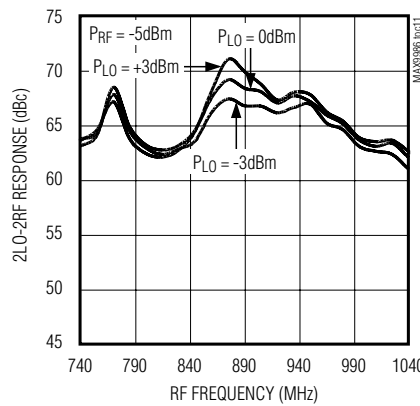
(MAX9986 Typical Application Circuit, $V_{CC} = +5.0V$, $P_{LO} = 0dBm$, $P_{RF} = -5dBm$, $f_{LO} > f_{RF}$, $f_{IF} = 160MHz$, unless otherwise noted.)

MAX9986

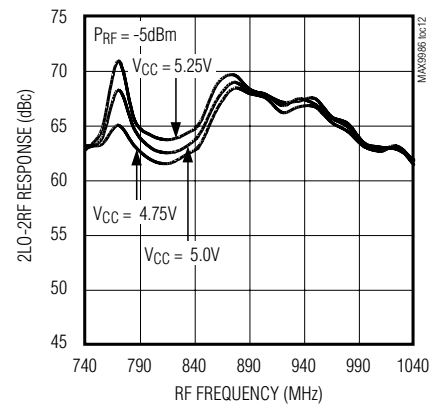
2LO-2RF RESPONSE vs. RF FREQUENCY



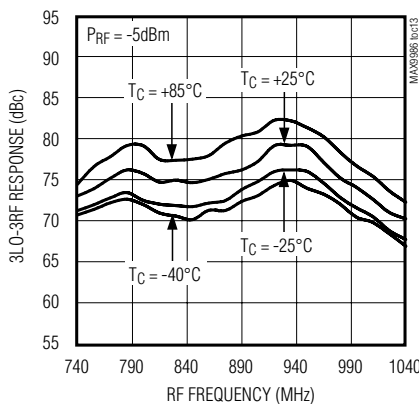
2LO-2RF RESPONSE vs. RF FREQUENCY



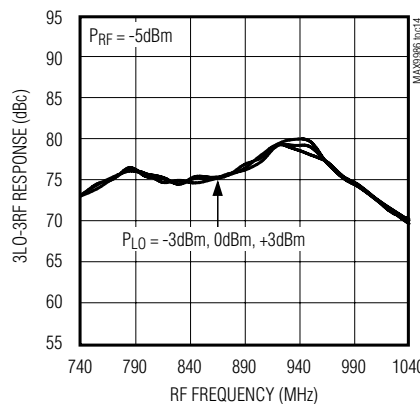
2LO-2RF RESPONSE vs. RF FREQUENCY



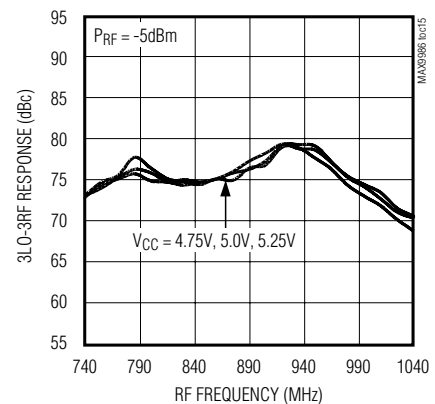
3LO-3RF RESPONSE vs. RF FREQUENCY



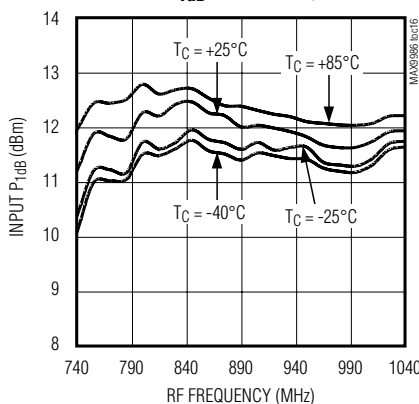
3LO-3RF RESPONSE vs. RF FREQUENCY



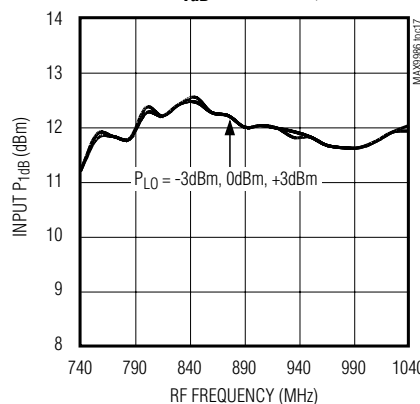
3LO-3RF RESPONSE vs. RF FREQUENCY



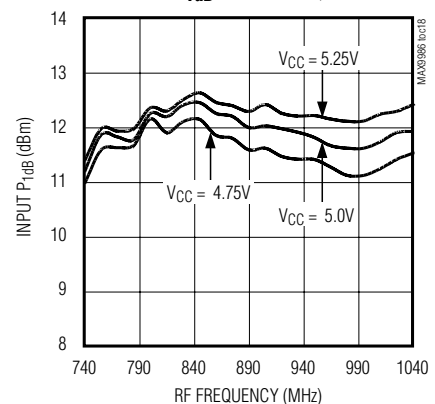
INPUT P_{1dB} vs. RF FREQUENCY



INPUT P_{1dB} vs. RF FREQUENCY



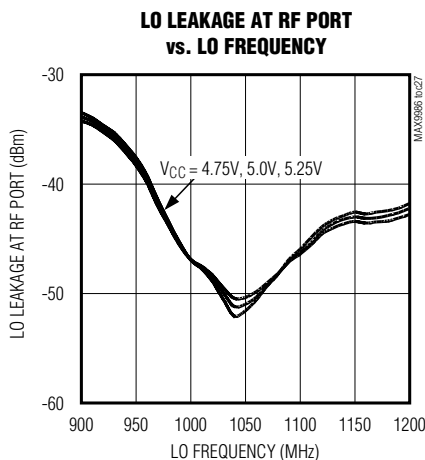
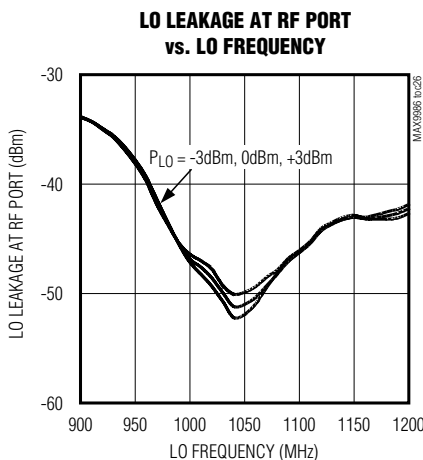
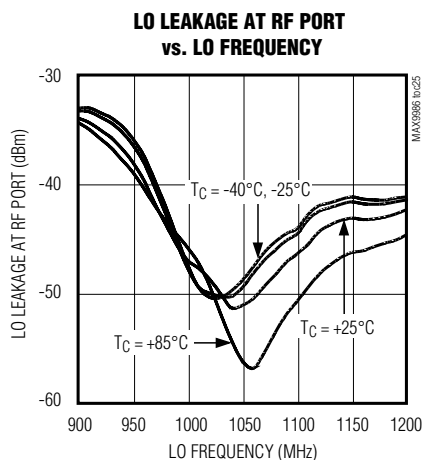
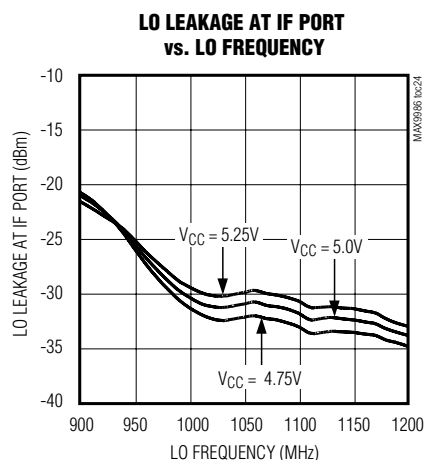
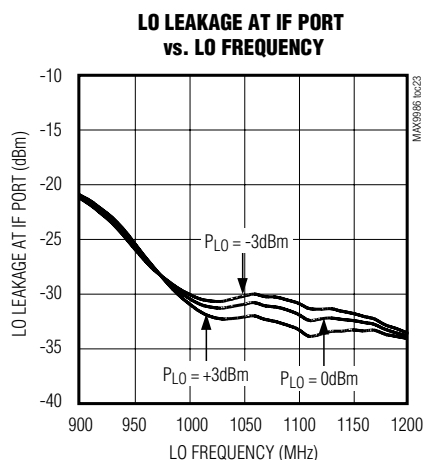
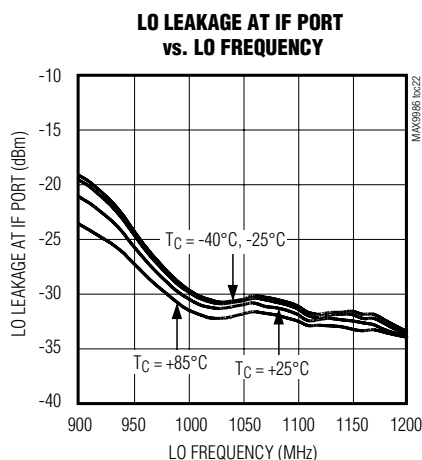
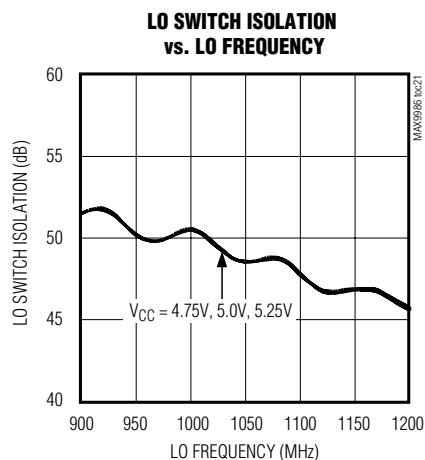
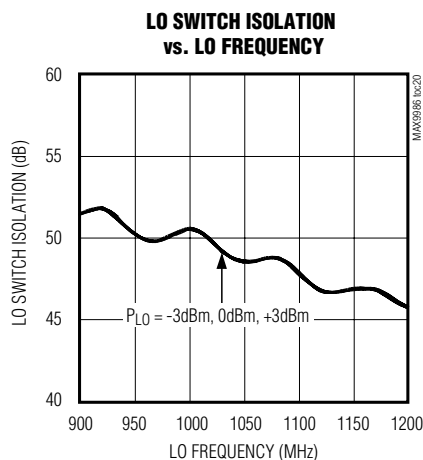
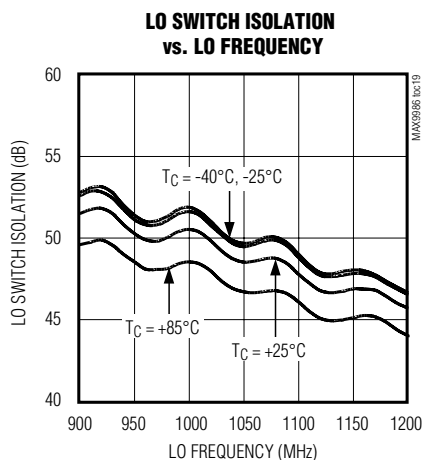
INPUT P_{1dB} vs. RF FREQUENCY



SiGe High-Linearity, 815MHz to 995MHz Downconversion Mixer with LO Buffer/Switch

Typical Operating Characteristics (continued)

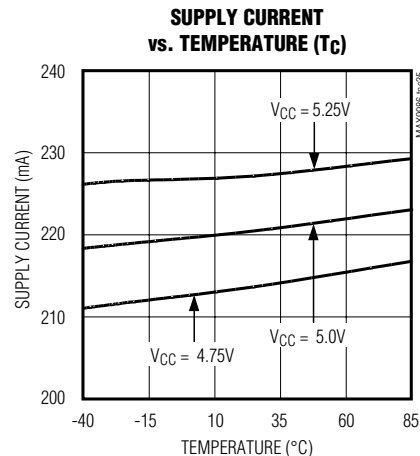
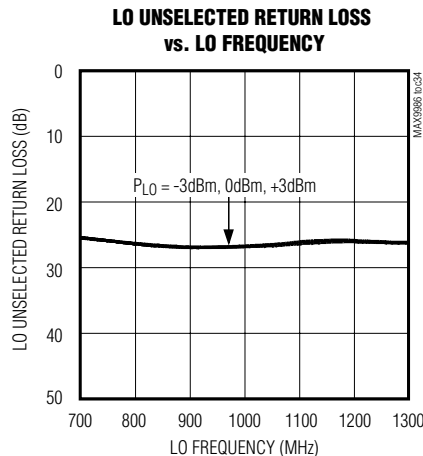
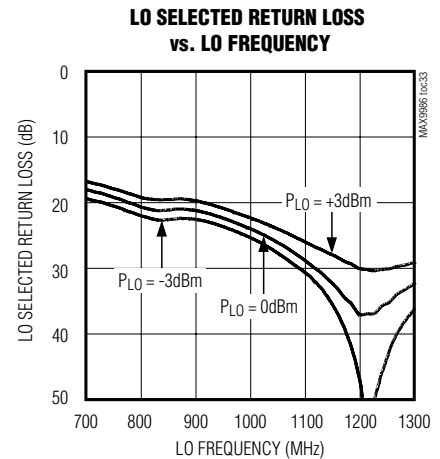
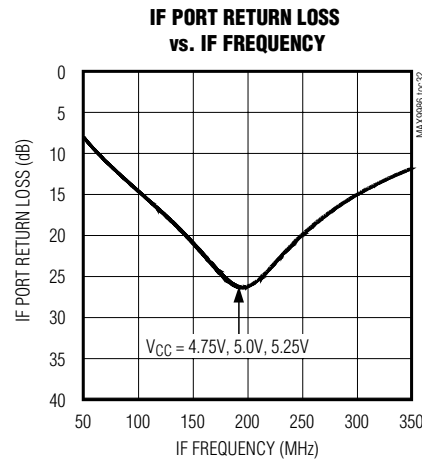
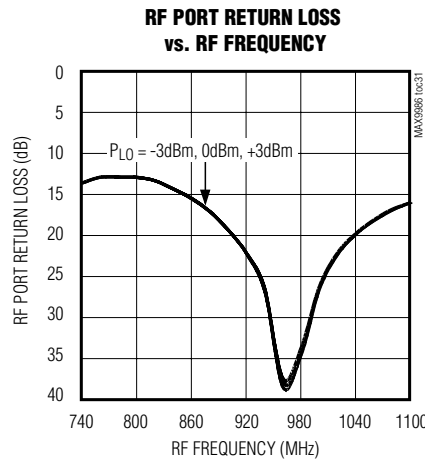
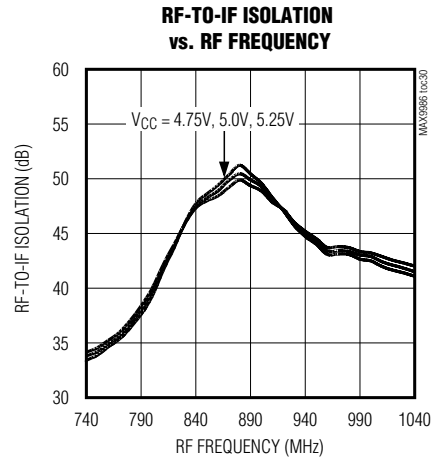
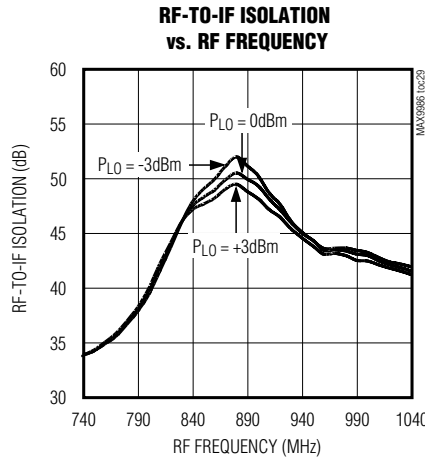
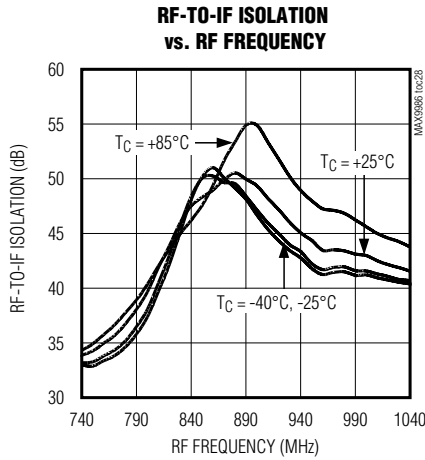
(MAX9986 Typical Application Circuit, $V_{CC} = +5.0V$, $P_{LO} = 0dBm$, $P_{RF} = -5dBm$, $f_{LO} > f_{RF}$, $f_{IF} = 160MHz$, unless otherwise noted.)



SiGe High-Linearity, 815MHz to 995MHz Downconversion Mixer with LO Buffer/Switch

Typical Operating Characteristics (continued)

(MAX9986 Typical Application Circuit, $V_{CC} = +5.0V$, $P_{LO} = 0dBm$, $P_{RF} = -5dBm$, $f_{LO} > f_{RF}$, $f_{IF} = 160MHz$, unless otherwise noted.)



SiGe High-Linearity, 815MHz to 995MHz Downconversion Mixer with LO Buffer/Switch

Pin Description

PIN	NAME	FUNCTION
1, 6, 8, 14	VCC	Power-Supply Connection. Bypass each VCC pin to GND with capacitors as shown in the <i>Typical Application Circuit</i> .
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 <i>Typical Application Circuit</i> .
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, 30nH 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 VCC through an RF choke (see the <i>Typical Application Circuit</i>).
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 MAX9986 high-linearity downconversion mixer provides 10dB of conversion gain and +23.6dBm 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 49dB 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 MAX9986'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 MAX9986 is specified to operate over a 815MHz to 995MHz RF frequency range, a 960MHz to 1180MHz 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.

RF Input and Balun

The MAX9986 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 MAX9986 is ideally suited for high-side LO injection applications with a 960MHz to 1180MHz LO frequency range. For a device with a 570MHz to 850MHz LO frequency range, refer to the MAX9984 data sheet. As an added feature, the MAX9986 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 VCC 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, 815MHz to 995MHz 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 MAX9986 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, 2LO-2RF rejection, and NF performance is typically 23.6dBm, 67dBc, and 9.3dB, respectively.

Differential IF Output Amplifier

The MAX9986 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 2LO-2RF rejection performance. Single-ended IF applications require a 4:1 balun to transform the 200 Ω differential output impedance to a 50 Ω single-ended output.

Applications Information

Input and Output Matching

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

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*).

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 $\pm 1\%$ bias resistor values are not readily available, substitute standard $\pm 5\%$ 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 MAX9986 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 MAX9986'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 MAX9986 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

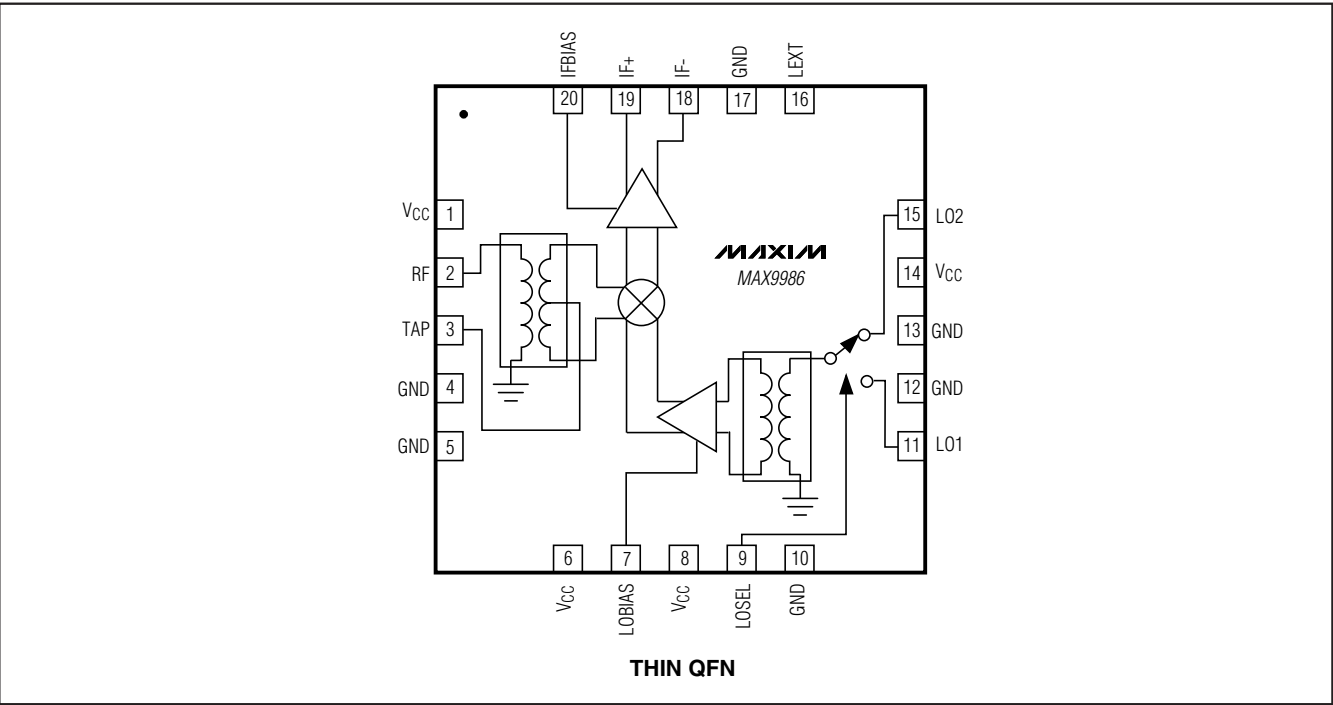
PROCESS: SiGe BiCMOS

SiGe High-Linearity, 815MHz to 995MHz Downconversion Mixer with LO Buffer/Switch

Table 1. Component List Referring to the Typical Application Circuit

COMPONENT	VALUE	DESCRIPTION
L1, L2	330nH	Wire-wound high-Q inductors (0805)
L3	30nH	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
U1	MAX9986	Maxim IC

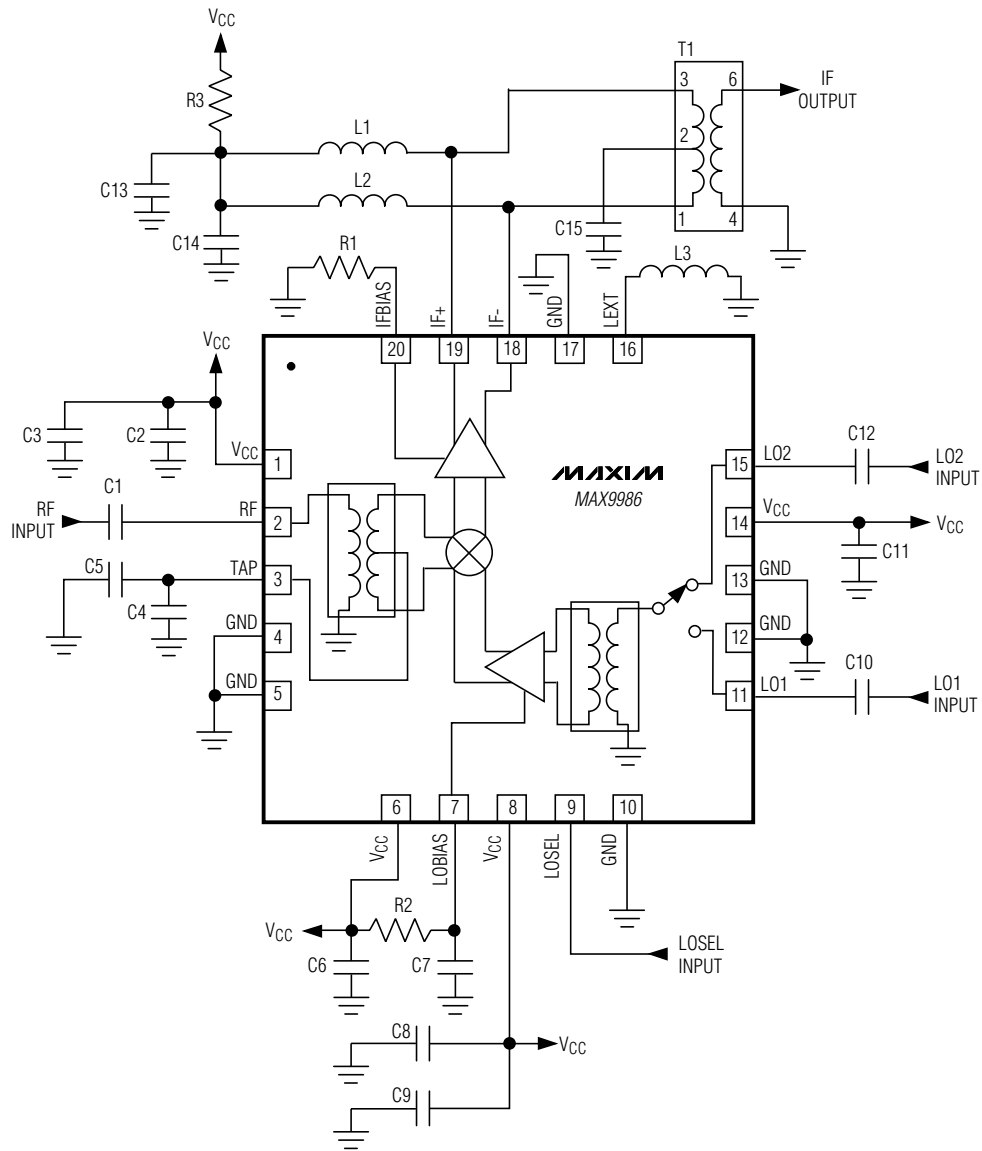
Pin Configuration/Functional Diagram



SiGe High-Linearity, 815MHz to 995MHz Downconversion Mixer with LO Buffer/Switch

Typical Application Circuit

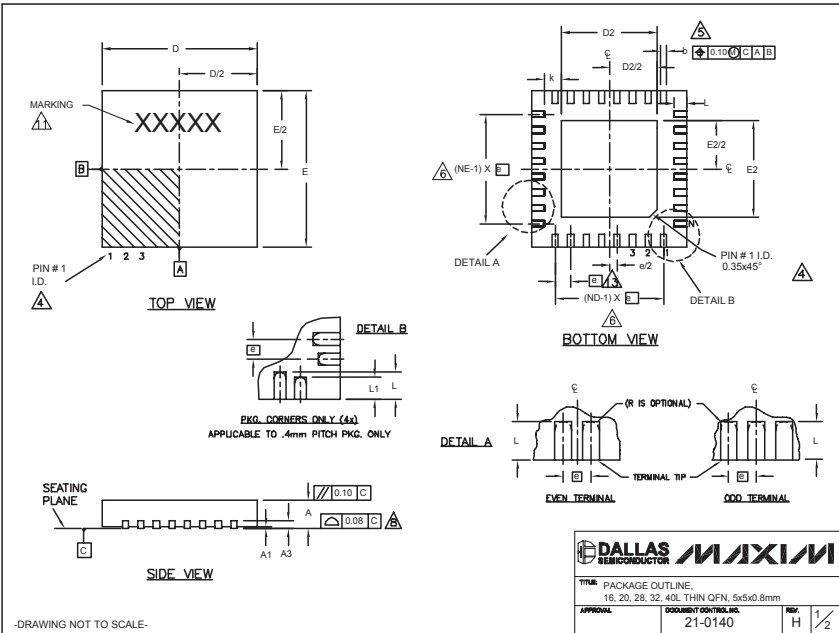
MAX9986



SiGe High-Linearity, 815MHz to 995MHz Downconversion Mixer with LO Buffer/Switch

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	0.20	0.25	0.30
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	--	YES				
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				

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 JEDEC 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.

-DRAWING NOT TO SCALE-



TITLE: PACKAGE OUTLINE,
16 20 28 32 40 48 56 64 80 96 112 128 144 160 176 192 208 224 240 256 272 288 304 320 336 352 368 384 400 416 432 448 464 480 496 512 528 544 560 576 592 608 624 640 656 672 688 704 720 736 752 768 784 800 816 832 848 864 880 896 912 928 944 960 976 992 1008 1024 1040 1056 1072 1088 1104 1120 1136 1152 1168 1184 1200 1216 1232 1248 1264 1280 1296 1312 1328 1344 1360 1376 1392 1408 1424 1440 1456 1472 1488 1504 1520 1536 1552 1568 1584 1600 1616 1632 1648 1664 1680 1696 1712 1728 1744 1760 1776 1792 1808 1824 1840 1856 1872 1888 1904 1920 1936 1952 1968 1984 2000 2016 2032 2048 2064 2080 2096 2112 2128 2144 2160 2176 2192 2208 2224 2240 2256 2272 2288 2304 2320 2336 2352 2368 2384 2400 2416 2432 2448 2464 2480 2496 2512 2528 2544 2560 2576 2592 2608 2624 2640 2656 2672 2688 2704 2720 2736 2752 2768 2784 2800 2816 2832 2848 2864 2880 2896 2912 2928 2944 2960 2976 2992 3008 3024 3040 3056 3072 3088 3104 3120 3136 3152 3168 3184 3200 3216 3232 3248 3264 3280 3296 3312 3328 3344 3360 3376 3392 3408 3424 3440 3456 3472 3488 3504 3520 3536 3552 3568 3584 3600 3616 3632 3648 3664 3680 3696 3712 3728 3744 3760 3776 3792 3808 3824 3840 3856 3872 3888 3904 3920 3936 3952 3968 3984 4000 4016 4032 4048 4064 4080 4096 4112 4128 4144 4160 4176 4192 4208 4224 4240 4256 4272 4288 4304 4320 4336 4352 4368 4384 4400 4416 4432 4448 4464 4480 4496 4512 4528 4544 4560 4576 4592 4608 4624 4640 4656 4672 4688 4704 4720 4736 4752 4768 4784 4800 4816 4832 4848 4864 4880 4896 4912 4928 4944 4960 4976 4992 5008 5024 5040 5056 5072 5088 5104 5120 5136 5152 5168 5184 5200 5216 5232 5248 5264 5280 5296 5312 5328 5344 5360 5376 5392 5408 5424 5440 5456 5472 5488 5504 5520 5536 5552 5568 5584 5600 5616 5632 5648 5664 5680 5696 5712 5728 5744 5760 5776 5792 5808 5824 5840 5856 5872 5888 5904 5920 5936 5952 5968 5984 6000 6016 6032 6048 6064 6080 6096 6112 6128 6144 6160 6176 6192 6208 6224 6240 6256 6272 6288 6304 6320 6336 6352 6368 6384 6400 6416 6432 6448 6464 6480 6496 6512 6528 6544 6560 6576 6592 6608 6624 6640 6656 6672 6688 6704 6720 6736 6752 6768 6784 6800 6816 6832 6848 6864 6880 6896 6912 6928 6944 6960 6976 6992 7008 7024 7040 7056 7072 7088 7104 7120 7136 7152 7168 7184 7200 7216 7232 7248 7264 7280 7296 7312 7328 7344 7360 7376 7392 7408 7424 7440 7456 7472 7488 7504 7520 7536 7552 7568 7584 7600 7616 7632 7648 7664 7680 7696 7712 7728 7744 7760 7776 7792 7808 7824 7840 7856 7872 7888 7904 7920 7936 7952 7968 7984 8000 8016 8032 8048 8064 8080 8096 8112 8128 8144 8160 8176 8192 8208 8224 8240 8256 8272 8288 8304 8320 8336 8352 8368 8384 8400 8416 8432 8448 8464 8480 8496 8512 8528 8544 8560 8576 8592 8608 8624 8640 8656 8672 8688 8704 8720 8736 8752 8768 8784 8800 8816 8832 8848 8864 8880 8896 8912 8928 8944 8960 8976 8992 9008 9024 9040 9056 9072 9088 9104 9120 9136 9152 9168 9184 9200 9216 9232 9248 9264 9280 9296 9312 9328 9344 9360 9376 9392 9408 9424 9440 9456 9472 9488 9504 9520 9536 9552 9568 9584 9600 9616 9632 9648 9664 9680 9696 9712 9728 9744 9760 9776 9792 9808 9824 9840 9856 9872 9888 9904 9920 9936 9952 9968 9984 10000 10016 10032 10048 10064 10080 10096 10112 10128 10144 10160 10176 10192 10208 10224 10240 10256 10272 10288 10304 10320 10336 10352 10368 10384 10400 10416 10432 10448 10464 10480 10496 10512 10528 10544 10560 10576 10592 10608 10624 10640 10656 10672 10688 10704 10720 10736 10752 10768 10784 10800 10816 10832 10848 10864 10880 10896 10912 10928 10944 10960 10976 10992 11008 11024 11040 11056 11072 11088 11104 11120 11136 11152 11168 11184 11200 11216 11232 11248 11264 11280 11296 11312 11328 11344 11360 11376 11392 11408 11424 11440 11456 11472 11488 11504 11520 11536 11552 11568 11584 11600 11616 11632 11648 11664 11680 11696 11712 11728 11744 11760 11776 11792 11808 11824 11840 11856 11872 11888 11904 11920 11936 11952 11968 11984 12000 12016 12032 12048 12064 12080 12096 12112 12128 12144 12160 12176 12192 12208 12224 12240 12256 12272 12288 12304 12320 12336 12352 12368 12384 12400 12416 12432 12448 12464 12480 12496 12512 12528 12544 12560 12576 12592 12608 12624 12640 12656 12672 12688 12704 12720 12736 12752 12768 12784 12800 12816 12832 12848 12864 12880 12896 12912 12928 12944 12960 12976 12992 13008 13024 13040 13056 13072 13088 13104 13120 13136 13152 13168 13184 13200 13216 13232 13248 13264 13280 13296 13312 13328 13344 13360 13376 13392 13408 13424 13440 13456 13472 13488 13504 13520 13536 13552 13568 13584 13600 13616 13632 13648 13664 13680 13696 13712 13728 13744 13760 13776 13792 13808 13824 13840 13856 13872 13888 13904 13920 13936 13952 13968 13984 14000 14016 14032 14048 14064 14080 14096 14112 14128 14144 14160 14176 14192 14208 14224 14240 14256 14272 14288 14304 14320 14336 14352 14368 14384 14400 14416 14432 14448 14464 14480 14496 14512 14528 14544 14560 14576 14592 14608 14624 14640 14656 14672 14688 14704 14720 14736 14752 14768 14784 14800 14816 14832 14848 14864 14880 14896 14912 14928 14944 14960 14976 14992 15008 15024 15040 15056 15072 15088 15104 15120 15136 15152 15168 15184 15200 15216 15232 15248 15264 15280 15296 15312 15328 15344 15360 15376 15392 15408 15424 15440 15456 15472 15488 15504 15520 15536 15552 15568 15584 15600 15616 15632 15648 15664 15680 15696 15712 15728 15744 15760 15776 15792 15808 15824 15840 15856 15872 15888 15904 15920 15936 15952 15968 15984 16000 16016 16032 16048 16064 16080 16096 16112 16128 16144 16160 16176 16192 16208 16224 16240 16256 16272 16288 16304 16320 16336 16352 16368 16384 16400 16416 16432 16448 16464 16480 16496 16512 16528 16544 16560 16576 16592 16608 16624 16640 16656 16672 16688 16704 16720 16736 16752 16768 16784 16800 16816 16832 16848 16864 16880 16896 16912 16928 16944 16960 16976 16992 17008 17024 17040 17056 17072 17088 17104 17120 17136 17152 17168 17184 17200 17216 17232 17248 17264 17280 17296 17312 17328 17344 17360 17376 17392 17408 17424 17440 17456 17472 17488 17504 17520 17536 17552 17568 17584 17600 17616 17632 17648 17664 17680 17696 17712 17728 17744 17760 17776 17792 17808 17824 17840 17856 17872 17888 17904 17920 17936 17952 17968 17984 18000 18016 18032 18048 18064 18080 18096 18112 18128 18144 18160 18176 18192 18208 18224 18240 18256 18272 18288 18304 18320 18336 18352 18368 18384 18400 18416 18432 18448 18464 18480 18496 18512 18528 18544 18560 18576 18592 18608 18624 18640 18656 18672 18688 18704 18720 18736 18752 18768 18784 18800 18816 18832 18848 18864 18880 18896 18912 18928 18944 18960 18976 18992 19008 19024 19040 19056 19072 19088 19104 19120 19136 19152 19168 19184 19200 19216 19232 19248 19264 19280 19296 19312 19328 19344 19360 19376 19392 19408 19424 19440 19456 19472 19488 19504 19520 19536 19552 19568 19584 19600 19616 19632 19648 19664 19680 19696 19712 19728 19744 19760 19776 19792 19808 19824 19840 19856 19872 19888 19904 19920 19936 19952 19968 19984 20000 20016 20032 20048 20064 20080 20096 20112 20128 20144 20160 20176 20192 20208 20224 20240 20256 20272 20288 20304 20320 20336 20352 20368 20384 20400 20416 20432 20448 20464 20480 20496 20512 20528 20544 20560 20576 20592 20608 20624 20640 20656 20672 20688 20704 20720 20736 20752 20768 20784 20800 20816 20832 20848 20864 20880 20896 20912 20928 20944 20960 20976 20992 21008 21024 21040 21056 21072 21088 21104 21120 21136 21152 21168 21184 21200 21216 21232 21248 21264 21280 21296 21312 21328 21344 21360 21376 21392 21408 21424 21440 21456 21472 21488 21504 21520 21536 21552 21568 21584 21600 21616 21632 21648 21664 21680 21696 21712 21728 21744 21760 21776 21792 21808 21824 21840 21856 21872 21888 21904 21920 21936 21952 21968 21984 22000 22016 22032 22048 22064 22080 22096 22112 22128 22144 22160 22176 22192 22208 22224 22240 22256 22272 22288 22304 22320 22336 22352 22368 22384 22400 22416 22432 22448 22464 22480 22496 22512 22528 22544 22560 22576 22592 22608 22624 22640 22656 22672 22688 22704 22720 22736 22752 22768 22784 22800 22816 22832 22848 22864 22880 22896 22912 22928 22944 22960 22976 22992 23008 23024 23040 23056 23072 23088 23104 23120 23136 23152 23168 23184 23200 23216 23232 23248 23264 23280 23296 23312 23328 23344 23360 23376 23392 23408 23424 23440 23456 23472 23488 23504 23520 23536 23552 23568 23584 23600 23616 23632 23648 23664 23680 23696 23712 23728 23744 23760 23776 23792 23808 23824 23840 23856 23872 23888 23904 23920 23936 23952 23968 23984 24000

Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

12 Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 408-737-7600