

# MAXIM

## CDMA + GPS LNA/Mixers

MAX2385/MAX2386

### General Description

The MAX2385/MAX2386 LNA/mixer ICs are designed for CDMA/cdma2000 1x and GPS applications. The MAX2385/MAX2386 are optimized for the Japanese 832MHz to 870MHz band, and can also be configured for the Korean/Chinese/U.S. 869MHz to 894MHz band.

To optimize linearity and current consumption, the CDMA LNA comprises four gain states. The high-gain LNA has a reduced supply-current mode for use when no transmit (Tx) signal is present, and a high linearity mode, which minimizes Tx cross-modulation in the presence of a large interfering signal during talk mode. Two low-gain modes, provide higher cascade IIP3 at lower current. The lowest gain setting provides an LNA bypass and an ultra-low chip current of 4mA. This significantly extends the phone's standby time and lowers the overall current consumption of the phone.

Gain-switching hysteresis can be adjusted by selection of an off-chip resistor, which sets the current and linearity in each mode to customize switchover points.

In GPS mode, the MAX2386 LNA offers high gain and the MAX2385 features lower current consumption with lower gain. The CDMA paths of the MAX2385/MAX2386 are identical.

The MAX2385/MAX2386 include an on-chip LO divider, which enables the use of one VCO module for both cellular and GPS modes. An on-chip LO buffer to drive the Tx upconverter further reduces system complexity.

### Applications

CDMA/cdma2000 1x Cellular Phones with GPS

**Pin Configuration/Functional Diagram/Typical Operating Circuit appears at end of data sheet.**

UCSP is a trademark of Maxim Products, Inc.

### Features

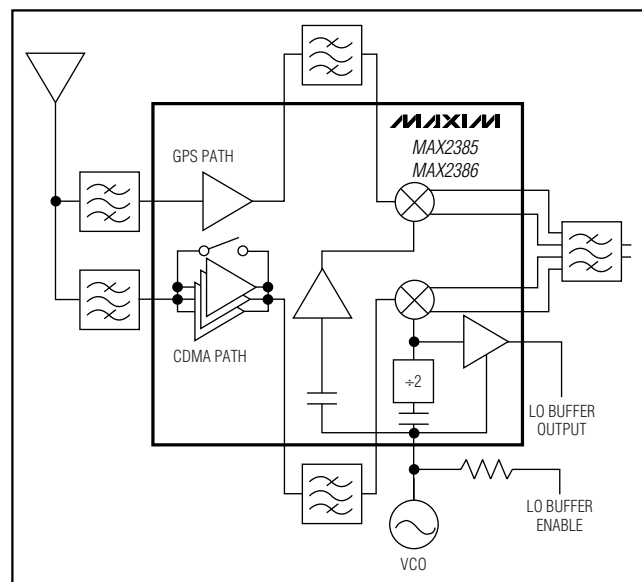
- ◆ Low Average Current Consumption: 4.5mA (CDMA)
- ◆ +2.7V to +3.6V Operation
- ◆ 2.0dB Cascade GPS Noise Figure
- ◆ 2.5 dB Cascade CDMA Noise Figure
- ◆ Adjustable IIP3
- ◆ LO Output Buffer to Drive Tx Upconverter
- ◆ 1µA Shutdown Current
- ◆ Tiny 2.1mm × 2.7mm Chip-Scale Package (UCSP™)
- ◆ Single VCO for GPS and CDMA Operation
- ◆ LO Divider Improves Phase Noise/Desensitization

### Ordering Information

PART	TEMP. RANGE	BUMP-PACKAGE
MAX2385EBP-T	-40°C to +85°C	5 × 4 UCSP*
MAX2386EBP-T	-40°C to +85°C	5 × 4 UCSP*

\*Requires a special solder temperature profile described in the Absolute Maximum Ratings section.

### Block Diagram



# CDMA + GPS LNA/Mixers

## ABSOLUTE MAXIMUM RATINGS

V <sub>CC</sub> to GND .....	-0.3V to +4.3V	Thermal Resistance from Junction to Ambient .....	+80°C/W
Digital Input Voltage to GND .....	-0.3V to V <sub>CC</sub> + 0.3V	Operating Temperature Range .....	-40°C to +85°C
RF Input Power .....	+12dBm	Junction Temperature .....	+150°C
Digital Input Current .....	±10mA	Storage Temperature Range .....	-65°C to +150°C
Continuous Power Dissipation		Bump Temperature (Soldering) (Note 1)	
5 × 4 UCSP (T <sub>A</sub> = +70°C, derate 1.2mW/°C above		Infrared (15s) .....	+220°C
T <sub>A</sub> = +70°C) .....	995mW	Vapor Phase (60s) .....	+215°C

**Note 1:** This device is constructed using a unique set of packaging techniques that impose a limit on the thermal profile the device can be exposed to during board level solder attach and rework. This limit permits only the use of the solder profiles recommended in the industry standard specification, JEDEC 020A, paragraph 7.6, Table 3 for IR/VPR and convection reflow. Preheating is required. Hand or wave soldering is not recommended.

*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

(V<sub>CC</sub> = +2.7 to +3.6V, R<sub>BIAS</sub> = 47kΩ, V<sub>IH</sub> = +2.0V, V<sub>IL</sub> = +0.6V, T<sub>A</sub> = -40°C to +85°C. Typical values are at +2.75V and T<sub>A</sub> = +25°C, unless otherwise noted.) (Note 2) (Table 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
CDMA Active Supply Current	I <sub>CC</sub>	ULG mode		3.7	4.5	mA
		LG mode	R <sub>BIAS</sub> = 47kΩ	6.5	7.6	
			R <sub>BIAS</sub> = 36kΩ (Note 3)	8.3	9.7	
		MG mode		10.2	11.8	
		HGLL		12.5	15.0	
		HGHL		17.4	20.9	
GPS Active Supply Current	I <sub>CC</sub>	MAX2385		9.6	11.6	mA
		MAX2386		16.9	22.3	
Shutdown Supply Current	I <sub>CC</sub>	SHDN mode		0.1	10	μA
Digital Input Logic High	V <sub>IH</sub>		2.0			V
Digital Input Logic Low	V <sub>IL</sub>				0.6	V
Digital Input Current			-25		25	μA
Additional Current for LO Buffer		BUFFEN = high		5.2	7.3	mA

# CDMA + GPS LNA/Mixers

MAX2385/MAX2386

## AC ELECTRICAL CHARACTERISTICS

(MAX2385/MAX2386 EV kit,  $V_{CC} = +2.75V$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ ,  $f_{RF} = 832MHz$  to  $870MHz$  (CDMA),  $f_{RF} = 1575.42MHz$  (GPS),  $f_{IF} = 110MHz$ ,  $f_{LO} = (f_{RF} - f_{IF}) \times 2$  (CDMA),  $f_{LO} = 1465.42MHz$  (GPS), LO input power =  $-12dBm$ ,  $50\Omega$  RF system impedance, IF matched to  $50\Omega$  load,  $R_{BIAS} = 47k\Omega$ ,  $V_{IH} = +2.0V$ ,  $V_{IL} = +0.6V$ . Typical values are at  $f_{RF} = 851MHz$ ,  $T_A = +25^{\circ}C$  (CDMA). (Note 3) (Table 1)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
<b>FREQUENCY RANGE</b>						
IF Frequency Range	(Note 4)		70		200	MHz
RF Frequency Range	CDMA mode (Note 5)		832		870	MHz
	GPS mode			1575.42		
LO Frequency Range	CDMA mode		1260	1482	1600	MHz
	GPS mode		1300	1465	1600	
<b>LNA PERFORMANCE</b>						
Gain	HGHL mode	$T_A = +25^{\circ}C$ , $f_{RF} = 851MHz$	13.8	15.0	16.5	dB
		(Note 6)	13.1			
	HGLL mode	$T_A = +25^{\circ}C$ , $f_{RF} = 851MHz$	12.4	14.0	15.4	
	MG mode	$T_A = +25^{\circ}C$ , $f_{RF} = 851MHz$	-0.6	0.7	2.0	
		(Note 6)	-1.4			
	LG/ULG mode	$T_A = +25^{\circ}C$ , $f_{RF} = 851MHz$	-6.2	-5.3	-4.4	
		(Note 6)	-7.1			
	GPS mode (MAX2385)	$T_A = +25^{\circ}C$ , $f_{RF} = 1575MHz$	16.6	18.5	20.4	
(Note 6)		14.5				
GPS mode (MAX2386)	$T_A = +25^{\circ}C$ , $f_{RF} = 1575MHz$	19.7	20.9	22.1		
	(Note 6)	16.8				
Noise Figure	$T_A = +25^{\circ}C$	HGHL mode		1.5	1.8	dB
		HGLL mode		1.5	1.8	
		MG mode		3.8	4.7	
		LG/ULG mode		8.2	9.5	
		GPS mode		1.7	1.9	
Noise Figure Change Over Temperature ( $T_A = +25^{\circ}C$ to $+85^{\circ}C$ )	HGHL mode			0.5		dB
	HGLL mode			0.5		
	MG mode			0.9		
	LG/ULG mode			1.0		
	GPS mode			0.5		

# CDMA + GPS LNA/Mixers

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## AC ELECTRICAL CHARACTERISTICS (continued)

(MAX2385/MAX2386 EV kit,  $V_{CC} = +2.75V$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ ,  $f_{RF} = 832MHz$  to  $870MHz$  (CDMA),  $f_{RF} = 1575.42MHz$  (GPS),  $f_{IF} = 110MHz$ ,  $f_{LO} = (f_{RF} - f_{IF}) \times 2$  (CDMA),  $f_{LO} = 1465.42MHz$  (GPS), LO input power =  $-12dBm$ ,  $50\Omega$  RF system impedance, IF matched to  $50\Omega$  load,  $R_{BIAS} = 47k\Omega$ ,  $V_{IH} = +2.0V$ ,  $V_{IL} = +0.6V$ . Typical values are at  $f_{RF} = 851MHz$ ,  $T_A = +25^{\circ}C$  (CDMA). (Note 3) (Table 1)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
IIP3 (Note 7)	HGHL mode, $P_{IN} = -25dBm/$ tone		4.5	7.4		dBm
	HGLL mode, $P_{IN} = -30dBm/$ tone		-0.2	3.5		
	MG mode, $P_{IN} = -20dBm/$ tone		9.2	14.1		
	LG/ULG mode, $P_{IN} = -20dBm/$ tone, $R_{BIAS} = 47k\Omega$		4.2	7.3		
	LG/ULG mode, $P_{IN} = -20dBm/$ tone, $R_{BIAS} = 36k\Omega$		7.7	10.4		
	GPS mode, $P_{IN} = -35dBm/$ tone	MAX2385		-5.0		
MAX2386			-6.6			
Reverse Isolation (S12)	HGHL mode		20			dB
<b>MIXER PERFORMANCE</b>						
Gain	HGHL/HGLL mode	$T_A = +25^{\circ}C$ , $f_{RF} = 851MHz$	9.9	11.7	13.5	dB
		(Note 6)	8.0			
	MG mode	$T_A = +25^{\circ}C$ , $f_{RF} = 851MHz$	9.6	11.3	13.1	
		(Note 6)	7.2			
	LG mode	$T_A = +25^{\circ}C$ , $f_{RF} = 851MHz$	9.1	11.0	12.8	
		(Note 6)	7.0			
	ULG mode	$T_A = +25^{\circ}C$ , $f_{RF} = 851MHz$	1.6	4.0	6.2	
		(Note 6)	-1.4			
	GPS mode (MAX2385)	$T_A = +25^{\circ}C$ , $f_{RF} = 1575MHz$	10.3	12.4	14.5	
		(Note 6)	9.9			
	GPS mode (MAX2386)	$T_A = +25^{\circ}C$ , $f_{RF} = 1575MHz$	12.3	13.8	15.3	
		(Note 6)	11.6			
Noise Figure	$T_A = +25^{\circ}C$	HGHL mode		9	10.2	
		HGLL mode		8.5	9.7	
		MG mode		8.4	9.6	
		LG/ULG mode		12.5	14.5	
		GPS mode		7.5	8.5	
IIP3 (Note 7)	CDMA $P_{IN} = -25dBm/$ tone	HGHL/HGLL mode	0.3	3.7		
		MG mode	-2.3	0.7		
		LG mode	-5.4	-1.5		
		ULG mode	-7.3	-2.8		
	GPS $P_{IN} = -35dBm/$ tone	MAX2385		-3.4		
		MAX2386		0		

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## AC ELECTRICAL CHARACTERISTICS (continued)

(MAX2385/MAX2386 EV kit,  $V_{CC} = +2.75V$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ ,  $f_{RF} = 832MHz$  to  $870MHz$  (CDMA),  $f_{RF} = 1575.42MHz$  (GPS),  $f_{IF} = 110MHz$ ,  $f_{LO} = (f_{RF} - f_{IF}) \times 2$  (CDMA),  $f_{LO} = 1465.42MHz$  (GPS), LO input power =  $-12dBm$ ,  $50\Omega$  RF system impedance, IF matched to  $50\Omega$  load,  $R_{BIAS} = 47k\Omega$ ,  $V_{IH} = +2.0V$ ,  $V_{IL} = +0.6V$ . Typical values are at  $f_{RF} = 851MHz$ ,  $T_A = +25^{\circ}C$  (CDMA). (Note 3) (Table 1)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
<b>LO SECTION</b>					
LO Input Power		-12	-10	-5	dBm
LO Leakage at LNA Input			-40		dBm
LO Output Power	BUFFEN = high, $100\Omega$ load	-10	-7		dBm
LO Output Noise Power	45MHz to 55MHz offset		-145	-143	dBc/Hz
LO Buffer Reverse Isolation			35		dB

**Note 2:** DC characteristics are production tested at  $T_A = +85^{\circ}C$ . DC specifications over temperature are guaranteed by design and characterization.

**Note 3:** Specifications are guaranteed by design and characterization.

**Note 4:** Operation over this frequency range requires each port to be rematched for the desired operating range. Performance at various frequencies is indicated by the S-parameter data in the *Typical Operating Characteristics*.

**Note 5:** Operation outside this range is possible, although not guaranteed by design and characterization.

**Note 6:** Guaranteed by production test at  $f_{MAX}$  (870MHz) and  $T_{MAX}$  ( $+85^{\circ}C$ ). For GPS mode,  $f_{MAX} = 1575.42MHz$ .

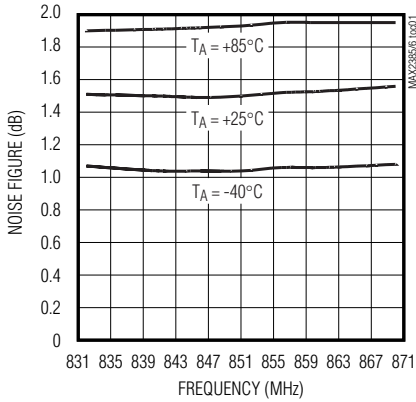
**Note 7:** Specifications are based on  $R_{BIAS} = 47k\Omega$ .  $I_{CC}$  for all LNAs and mixers is inversely proportional to  $R_{BIAS}$ . IIP3 can be traded for  $I_{CC}$  by selecting other values of  $R_{BIAS}$ . Two-tone IIP3 is measured with each tone input at the specified level separated by 900kHz.

# CDMA + GPS LNA/Mixers

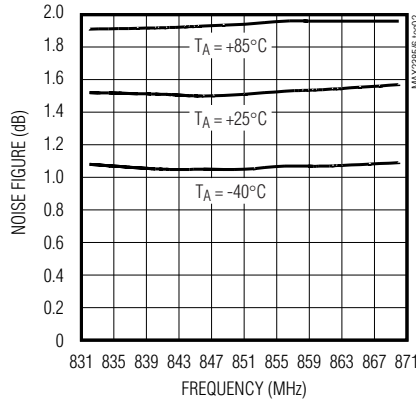
## Typical Operating Characteristics

(MAX2385/MAX2386 EV kit,  $V_{CC} = +2.75V$ ,  $f_{RF} = 851MHz$  (CDMA),  $f_{RF} = 1575MHz$  (GPS),  $f_{LO} = 1482MHz$  (CDMA),  $f_{LO} = 1465MHz$  (GPS),  $P_{LO} = -10dBm$ ,  $P_{MIXER} = -25dBm$  (CDMA),  $P_{MIXER} = -35dBm$  (GPS),  $P_{LNA(HGHL)} = -25dBm$ ,  $P_{LNA(HGLL)} = -30dBm$ ,  $P_{LNA(MG)} = P_{LNA(LG)} = -20dBm$ ,  $P_{LNA(GPS)} = -35dBm$ ,  $R_{BIAS} = 47k\Omega$ , and  $T_A = +25^\circ C$ , unless otherwise noted.)

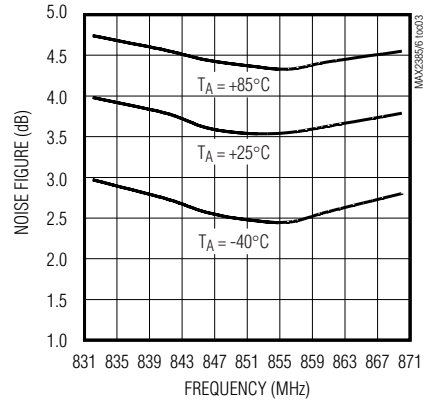
**LNA NOISE FIGURE (HGHL) vs. FREQUENCY**



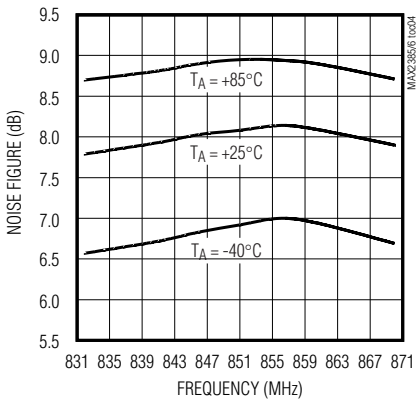
**LNA NOISE FIGURE (HGLL) vs. FREQUENCY**



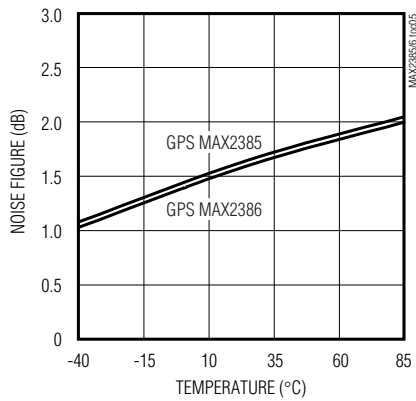
**LNA NOISE FIGURE (MG) vs. FREQUENCY**



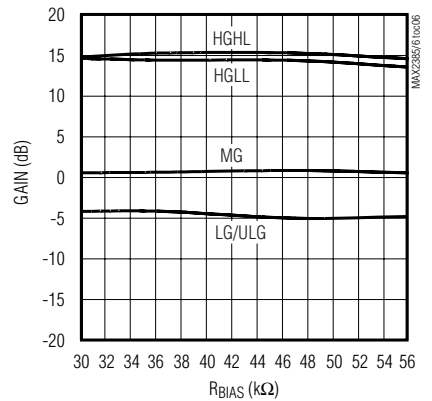
**LNA NOISE FIGURE (LG/ULG) vs. FREQUENCY**



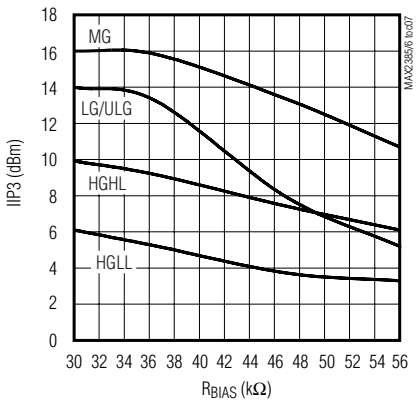
**LNA NOISE FIGURE (GPS) vs. TEMPERATURE**



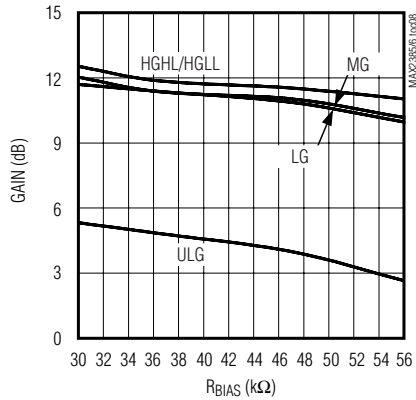
**LNA GAIN vs. RBIAS**



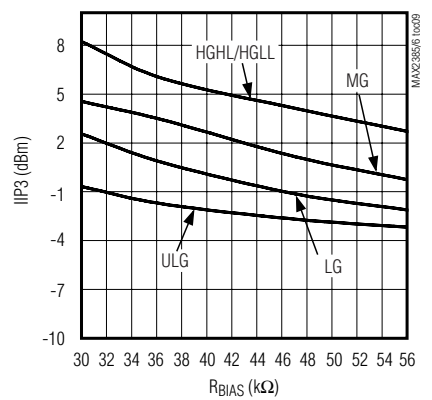
**LNA IIP3 vs. RBIAS**



**MIXER GAIN vs. RBIAS**



**MIXER IIP3 vs. RBIAS**

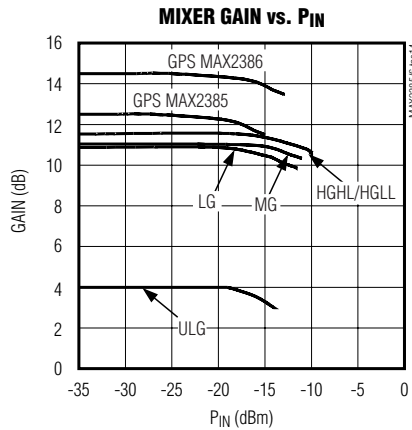
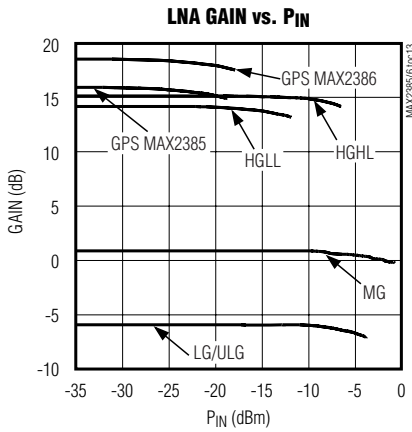
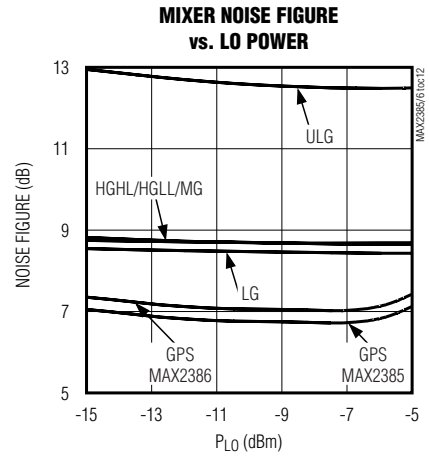
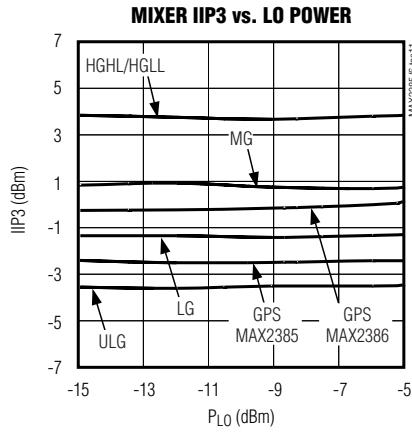
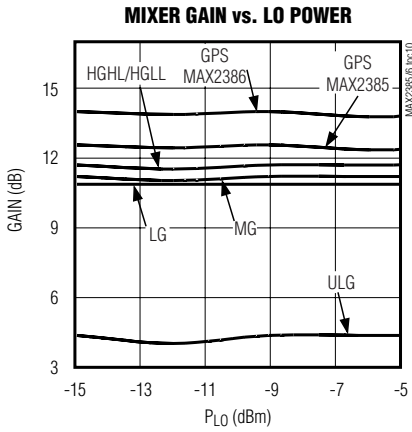


# CDMA + GPS LNA/Mixers

## Typical Operating Characteristics (continued)

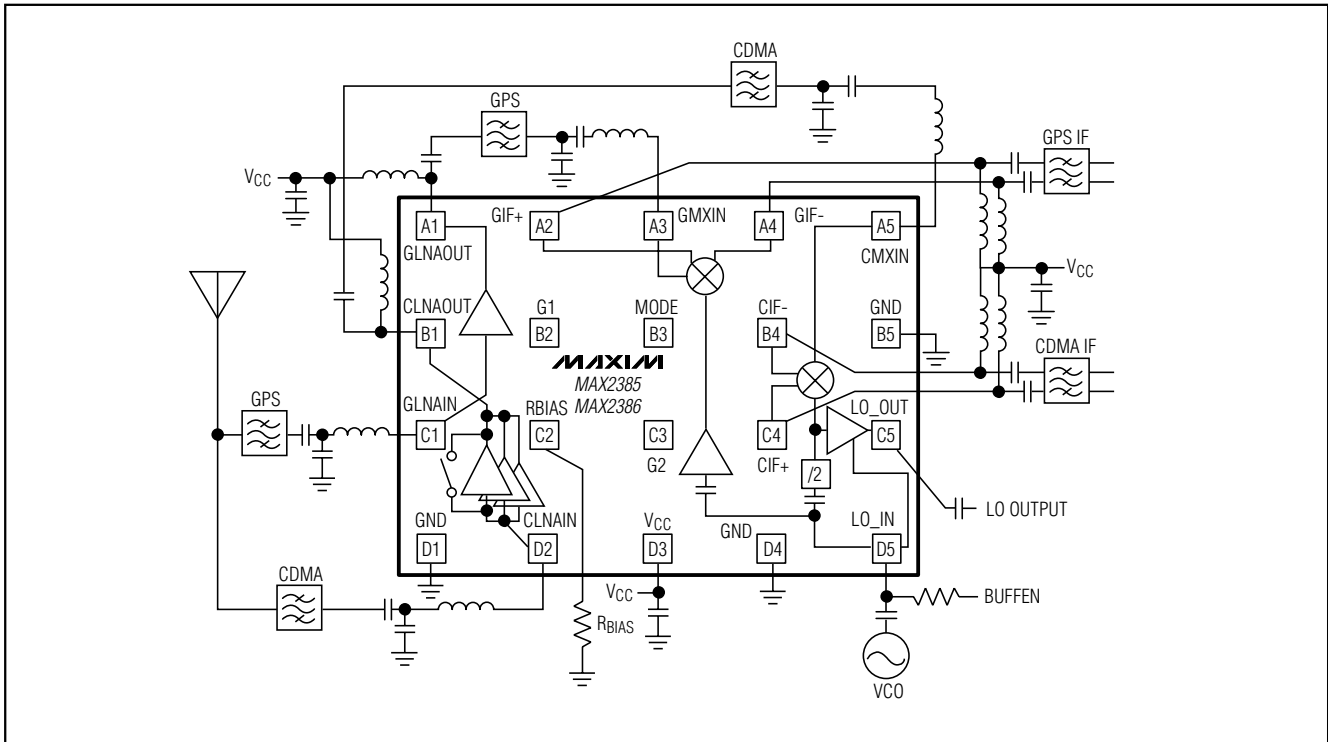
(MAX2385/MAX2386 EV kit,  $V_{CC} = +2.75V$ ,  $f_{RF} = 851MHz$  (CDMA),  $f_{RF} = 1575MHz$  (GPS),  $f_{LO} = 1482MHz$  (CDMA),  $f_{LO} = 1465MHz$  (GPS),  $P_{LO} = -10dBm$ ,  $P_{MIXER} = -25dBm$  (CDMA),  $P_{MIXER} = -35dBm$  (GPS),  $P_{LNA(HGHL)} = -25dBm$ ,  $P_{LNA(HGLL)} = -30dBm$ ,  $P_{LNA(MG)} = P_{LNA(LG)} = -20dBm$ ,  $P_{LNA(GPS)} = -35dBm$ ,  $R_{BIAS} = 47k\Omega$ , and  $T_A = +25^\circ C$ , unless otherwise noted.)

MAX2385/MAX2386



# CDMA + GPS LNA/Mixers

## Pin Configuration/Functional Diagram/Typical Operating Circuit



## Pin Description

PIN	NAME	FUNCTION
A1	GLNAOUT	GPS LNA Output Port. This port requires an external pullup inductor and series blocking capacitor, which are part of the matching network.
B1	CLNAOUT	CDMA LNA Output Port. This port requires an external pullup inductor and series blocking capacitor, which are part of the matching network.
C1	GLNAIN	GPS RF Input Port. Requires a blocking capacitor.
D1	GND	Ground
A2, A4	GIF+, GIF-	GPS Differential Output Port. Requires pullup inductors and blocking capacitors, which are used as part of the matching network.
B2	G1	Logic Input (Table 1)
C2	RBIAS	Bias Setting Pin. The DC voltage at this pin is a bandgap voltage (+1.2V). For nominal bias, connect 47kΩ resistor to ground. The value of this resistor can be adjusted to alter the linearity of the LNAs and mixers in all modes. See Figures 2 and 3 for resistor switching application circuits.
D2	CLNAIN	Cellular RF Input Port. Requires a blocking capacitor.
A3	GMIXIN	GPS Mixer Input Port. Requires a series blocking capacitor.
B3	MODE	Logic Input (Table 1)



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## Pin Description (continued)

PIN	NAME	FUNCTION
C3	G2	Logic Input (Table 1)
D3	V <sub>CC</sub>	+2.7 to +3.6V Supply Pin. Bypass with 100pF capacitor as close to the pin as possible.
B4, C4	CIF-, CIF+	CDMA Differential Output Port. Requires pullup inductors and blocking capacitors, which are used as part of the matching network.
D4	GND	Ground
A5	CMIXIN	CDMA Mixer Input Port. Requires a series blocking capacitor.
B5	GND	Ground
C5	LO_OUT	LO Buffer Output Port. Internally matched to 100Ω. Requires a series blocking capacitor.
D5	LO_IN	LO Input Port. Also LO buffer enable (BUFFEN). Apply logic signal through 10kΩ resistor. Set LO_IN high to enable the LO_OUT port. Set low to disable the LO_OUT port. AC-couple the LO input and DC-couple the buffer enable signal (see <i>Typical Operating Circuit</i> ).

## Detailed Description

The MAX2385/MAX2386 are ideal for CDMA + GPS applications. These devices contain two LNA/mixer pairs: one pair for CDMA operation and one pair for GPS operation. The MAX2385/MAX2386 feature seven modes of operation, including shutdown. Table 1 depicts each mode along with the corresponding LNA and mixer configuration.

These devices are ideal for Japanese cdma2000 1x applications. The RF frequency range is from 832MHz to 870MHz, and the IF frequency range is from 70MHz to 200MHz. In GPS mode, the RF frequency is

1575.42MHz. These devices can also be used for the Korean/Chinese/U.S. 869MHz to 894MHz band.

### CDMA LNA

The MAX2385/MAX2386 have four modes of CDMA LNA operation: high gain, high linearity (HGHL); high gain, low linearity (HGLL); midgain (MG); and low gain (LG). The logic inputs MODE, G1, and G2 allow selection between these modes (Table 1). Use HGHL mode when extra-high linearity is required for cross-modulation suppression. When cross-modulation is not a concern or the transmitter is off, use HGLL mode. In MG mode, the device is designed to meet CDMA linearity with interferers at -32dBm/tone. When

**Table 1. Mode Selection Truth Table**

MODES	CONTROL PINS			FUNCTION									
	G1	G2	MODE	LNA					MIXER				
				HGHL	HGLL	MG	LGHL	GPS	HG	MG	LG	UL	GPS
High Gain, High Linearity (HGHL)	0	0	1	•	—	—	—	—	•	—	—	—	—
High Gain, Low Linearity (HGLL)	1	1	0	—	•	—	—	—	•	—	—	—	—
Midgain (MG)	1	0	1	—	—	•	—	—	—	•	—	—	—
Low Gain (LG)	1	1	1	—	—	—	•	—	—	—	•	—	—
Ultra-Low Gain (ULG)	1	0	0	—	—	—	•	—	—	—	—	•	—
GPS	0	1	1	—	—	—	—	•	—	—	—	—	•
Shutdown (SHDN)	0	X	0	—	—	—	—	—	—	—	—	—	—

# CDMA + GPS LNA/Mixers

receiving large signals, use LG mode to significantly reduce current consumption (see the *RBIAS Switching* section).

### CDMA Downconverter

The CDMA mixer has four modes of operation for optimal performance and current conservation. The logic inputs MODE, G1, and G2 allow selection between the different modes (Table 1).

The mixer output appears at the differential CIF+ and CIF- pins. Each of these open-collector outputs requires an external pullup inductor to VCC for DC biasing. This port requires a matching network for coupling to an external IF filter.

To further reduce board complexity, the CDMA and GPS mixer outputs can be combined, eliminating one of the IF filters (Figure 1).

### LO Output Buffer

The LO\_IN pin controls the LO output buffer. This pin turns the open-collector LO output buffer on and off to conserve current consumption as needed (see *Pin Description* and *Typical Operating Circuits*).

### RF Inputs

The mixer inputs CMIX\_IN and GMIX\_IN are typically connected to the LNA output through an off-chip image-reject bandpass filter. The LNA inputs and outputs require external matching networks to 50Ω.

## Applications Information

### RBIAS Switching

Figures 2 and 3 show more sophisticated methods of varying the bias currents in different modes of operation. By adding a shunt resistor to RBIAS, the user can increase or decrease the total bias resistance (and therefore the bias current) in different modes, keeping in mind that the voltage at the RBIAS pin is +1.2V. Figure 2 uses a shunt resistor to decrease the total bias resistance (when RSHUNT is tied low). This method uses an additional DSP I/O control line. To avoid adding an extra I/O line to the system, the user can use the existing logic lines (MODE, G1, and G2). Figure 3 utilizes the G1 control pin, a transistor, and an additional resistor to change the bias current in certain modes. Both figures are simple ways to accommodate a wide range of power schemes.

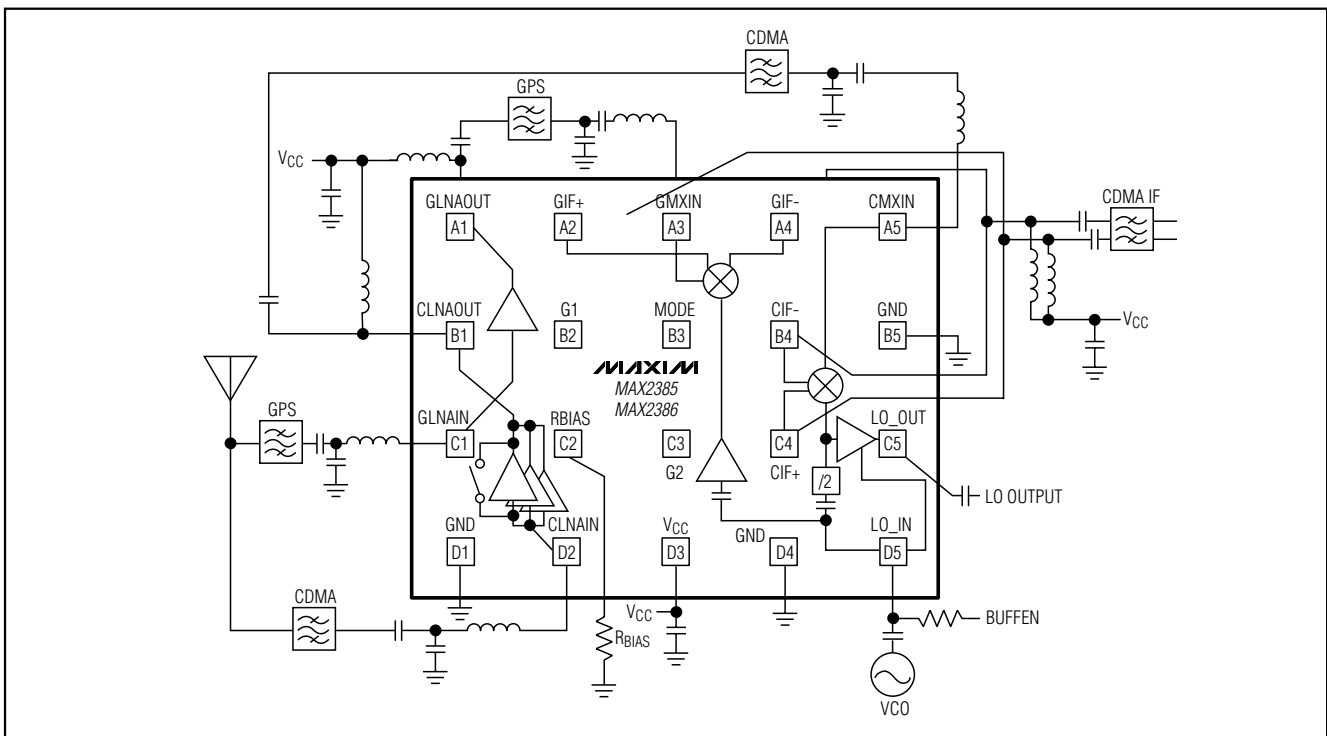


Figure 1. Typical Operating Circuit with CDMA and GPS Mixers Combined

## CDMA + GPS LNA/Mixers

MAX2385/MAX2386

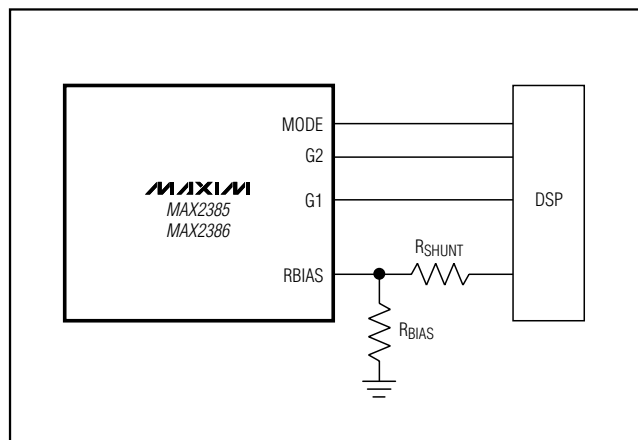


Figure 2. Variable Bias Current Application Circuit with Shunt Resistor (Using 4 DSP I/O Ports)

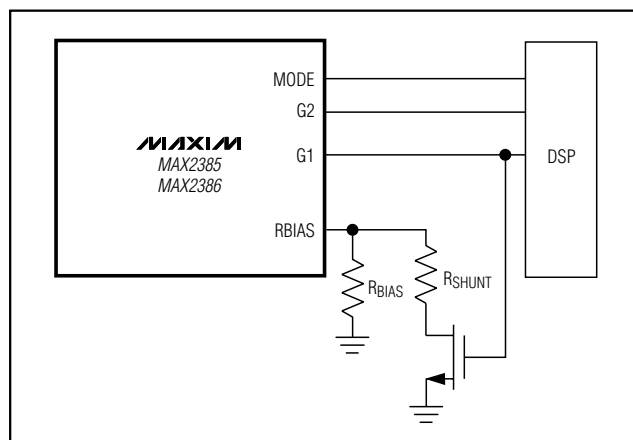


Figure 3. Variable Bias Current Application Circuit with Shunt Resistor and Transistor (Using 3 DSP I/O Ports)

### Layout

For the MAX2385/MAX2386, keep RF signal lines as short as possible to minimize losses and radiation. Always use controlled-impedance lines on all high-frequency inputs and outputs and use low-inductance connections to ground on all GND pins. At the mixer outputs, keep the differential lines together and of the same length to ensure signal balance.

For the best gain and noise performance, use high-Q (greater than 40) components for the LNA input matching circuit.

For the power supplies, a star topology works well to isolate different sections of the device. Each  $V_{CC}$  node has its own path to a central  $V_{CC}$ ; place decoupling capacitors that provide low impedance at the RF frequency of interest close to all  $V_{CC}$  connections. The central  $V_{CC}$  should have a large decoupling capacitor as well. (Use the MAX2385/MAX2386 EV kit as an example.)

### UCSP Reliability

The UCSP represents a unique package that greatly reduces board space compared to other packages. UCSP reliability is integrally linked to the user's assembly methods, circuit board material, and usage environ-

ment. Operating Life and Moisture Resistance remain uncompromised as they are primarily determined by the wafer-fabrication process. Mechanical stress performance is a greater consideration for a UCSP. UCSP solder joint contact integrity must be considered since the package is attached through direct solder contact to the user's PC board. Testing done to characterize the UCSP reliability performance shows that it is capable of performing reliably through environmental stresses. Results of environmental stress tests and additional usage data and recommendations are detailed in the UCSP application note, which can be found on Maxim's website, [www.maxim-ic.com](http://www.maxim-ic.com).

### Chip Information

TRANSISTOR COUNT: 882

# CDMA + GPS LNA/Mixers

MAX2385/MAX2386

**Table 2. CDMA LNA Input/Output S-Parameters**

(V<sub>CC</sub> = +2.75V, HGHL mode, P<sub>IN</sub> = -25dBm, T<sub>A</sub> = +25°C.)

FREQUENCY (MHz)	LNA (S11)		LNA (S21)		LNA (S12)		LNA (S22)	
	MAGNITUDE	PHASE	MAGNITUDE	PHASE	MAGNITUDE	PHASE	MAGNITUDE	PHASE
50	0.82104	-18.917	15.163	162.26	0.008859	61.194	0.93816	-8.524
100	0.79059	-35.311	14.116	146.34	0.014972	56.033	0.9	-15.727
200	0.72668	-61.742	11.39	120.52	0.022655	49.886	0.82915	-26.165
300	0.67807	-79.66	8.9718	99.984	0.028431	41.627	0.76987	-33.613
400	0.65661	-91.203	7.157	84.957	0.033642	37.358	0.74408	-39.372
500	0.64978	-99.023	5.7084	71.771	0.036502	32.065	0.73645	-44.949
600	0.65829	-104.2	4.7039	60.529	0.038605	27.6	0.74107	-50.121
700	0.67233	-108.36	3.9155	50.374	0.040918	22.124	0.74733	-55.876
800	0.68999	-111.47	3.2525	41.972	0.041445	20.385	0.7488	-60.721
900	0.702	-114.16	2.8111	34.401	0.042523	15.732	0.7551	-65.167
1000	0.71895	-116.44	2.3588	27.944	0.042027	15.121	0.76309	-69.283
1100	0.73319	-105.27	2.1266	31.814	0.041601	22.198	0.7667	-63.916
1200	0.74219	-106.33	1.825	28.21	0.039986	24.408	0.77436	-67.166
1300	0.74866	-107.28	1.6416	22.128	0.039224	23.437	0.77688	-70.727
1400	0.74754	-108.6	1.3985	19.782	0.036991	34.906	0.77974	-74.103
1500	0.73605	-110.8	1.2448	12.452	0.039238	38.898	0.77553	-77.75
1600	0.70134	-112.49	1.1067	12.494	0.045549	49.797	0.76585	-82.098
1700	0.6582	-112.85	0.95822	10.492	0.054447	48.936	0.74631	-86.403
1800	0.6033	-111.43	0.91231	12.519	0.067901	49.382	0.72062	-89.675
1900	0.57173	-106.57	0.88767	11.188	0.083089	39.015	0.7041	-91.673
2000	0.58916	-101.57	0.89238	6.1977	0.08768	26.514	0.70733	-93.886
2100	0.62231	-106.52	0.87333	-10.742	0.088886	5.5701	0.72648	-113.38
2200	0.65061	-107.79	0.82724	-15.813	0.08226	-1.5463	0.73464	-117.81
2300	0.66787	-109.78	0.75591	-20.723	0.075059	-8.1367	0.74428	-121.46
2400	0.6805	-112.17	0.72192	-29.025	0.075932	-12.349	0.75146	-124.61
2500	0.68889	-114.76	0.69034	-30.738	0.068259	-12.597	0.76003	-126.98
2600	0.68822	-117.18	0.63968	-40.185	0.069004	-18.123	0.76771	-128.85
2700	0.68522	-118.88	0.62919	-39.975	0.062396	-12.912	0.77449	-129.87
2800	0.67295	-119.94	0.54062	-53.183	0.065634	-19.789	0.77681	-130.85
2900	0.65681	-119.56	0.57411	-55.978	0.068559	-13.648	0.77386	-130.5
3000	0.6406	-116.75	0.47351	-68.632	0.073007	-23.644	0.76331	-130.75

# CDMA + GPS LNA/Mixers

MAX2385/MAX2386

**Table 3. MAX2385 GPS LNA Input/Output S-Parameters**

(V<sub>CC</sub> = +2.75V, P<sub>IN</sub> = -35dBm, T<sub>A</sub> = +25°C.)

FREQUENCY (MHz)	LNA (S11)		LNA (S21)		LNA (S12)		LNA (S22)	
	MAGNITUDE	PHASE	MAGNITUDE	PHASE	MAGNITUDE	PHASE	MAGNITUDE	PHASE
50	0.8881	-10.276	12.74	171.11	0.000854	-46.423	0.98314	-2.5681
100	0.87883	-19.876	12.522	162.24	0.001371	-126.02	0.97935	-5.5591
200	0.85269	-37.083	11.405	147.59	0.00223	90.404	0.97791	-9.7614
300	0.82551	-51.884	10.051	133.59	0.003701	-15.896	0.94946	-14.756
400	0.79436	-63.329	8.7681	123.73	0.002164	-175.91	0.94573	-19.049
500	0.78337	-72.116	7.5222	114.72	0.00311	138.82	0.9238	-22.814
600	0.76465	-78.478	6.5198	107.75	0.001366	-24.339	0.91664	-26.61
700	0.75639	-83.373	5.7296	101.89	0.004057	161.18	0.89418	-29.394
800	0.75274	-86.423	5.0437	97.629	0.004929	120.97	0.88958	-31.893
900	0.74643	-88.842	4.5469	93.487	0.004204	-166.83	0.87952	-34.284
1000	0.7484	-90.397	3.9871	90.549	0.005463	160.93	0.87286	-36.748
1100	0.75126	-84.499	3.7583	87.421	0.003834	152.9	0.87422	-43.23
1200	0.75045	-84.413	3.3761	86.774	0.007564	-171.16	0.86435	-46.442
1300	0.75019	-85.343	3.153	82.014	0.008098	175.38	0.85327	-48.168
1400	0.73538	-85.134	2.8377	82.496	0.008035	163.28	0.8562	-50.651
1500	0.73794	-85.398	2.6311	76.473	0.010423	169.5	0.85417	-54.145
1600	0.74538	-84.931	2.5096	77.268	0.011307	154.83	0.85631	-57.714
1700	0.74721	-85.902	2.3007	74.063	0.009457	-177.89	0.84548	-61.86
1800	0.74474	-86.965	2.2418	72.75	0.016112	168.47	0.8355	-65.064
1900	0.74265	-87.91	2.0474	69.84	0.012632	161.3	0.83073	-67.749
2000	0.74108	-88.363	1.9162	65.908	0.015341	171.63	0.84221	-70.646
2100	0.73645	-102.43	1.7839	49.151	0.019307	155.89	0.84753	-93.549
2200	0.73726	-104.01	1.6905	47.571	0.020637	155.74	0.85656	-96.187
2300	0.74534	-105.62	1.5469	47.693	0.01424	149.71	0.85279	-97.932
2400	0.74851	-106.99	1.429	42.865	0.022058	155.79	0.85584	-99.37
2500	0.7437	-109.08	1.4322	43.875	0.023264	162.52	0.85403	-99.414
2600	0.74111	-109.18	1.2847	39.437	0.029562	145.34	0.86433	-98.503
2700	0.73562	-109	1.348	42.59	0.030335	159.82	0.86743	-97.119
2800	0.73762	-108.7	1.1102	37.712	0.031365	148.42	0.87149	-94.704
2900	0.73003	-107.33	1.3082	37.893	0.03709	153.25	0.88967	-91.608
3000	0.72034	-104.98	1.1232	35.283	0.036386	149.03	0.91018	-88.371

# CDMA + GPS LNA/Mixers

MAX2385/MAX2386

**Table 4. MAX2386 GPS LNA Input/Output S-Parameters**

(V<sub>CC</sub> = +2.75V, P<sub>IN</sub> = -35dBm, T<sub>A</sub> = +25°C.)

FREQUENCY (MHz)	LNA (S11)		LNA (S21)		LNA (S12)		LNA (S22)	
	MAGNITUDE	PHASE	MAGNITUDE	PHASE	MAGNITUDE	PHASE	MAGNITUDE	PHASE
50	0.93093	-9.9234	9.3584	172.05	0.002323	-54.05	0.99417	-1.8979
100	0.92289	-19.653	9.2132	164.45	0.000496	57.839	0.99682	-4.5868
200	0.89539	-37.282	8.5374	150.4	0.00225	26.492	0.99239	-8.855
300	0.86825	-52.517	7.726	137.89	0.003334	21.881	0.96568	-13.228
400	0.84814	-63.866	6.875	128.59	0.004084	102.66	0.96299	-17.715
500	0.82959	-73.038	5.9132	119.99	0.001849	-140.39	0.94258	-21.386
600	0.80564	-79.88	5.2466	112.83	0.000774	148.15	0.91985	-25.462
700	0.79496	-85.049	4.6978	108.58	0.00295	170.05	0.89936	-28.606
800	0.78756	-88.974	4.1138	103.96	0.002164	122.22	0.88788	-30.729
900	0.78142	-91.371	3.7944	100.16	0.004646	139.17	0.87917	-32.896
1000	0.76891	-93.61	3.3492	96.82	0.0015	74.177	0.86275	-34.722
1100	0.77088	-89.176	3.0396	91.958	0.004438	168.05	0.85671	-43.739
1200	0.76408	-89.243	2.7793	90.924	0.005482	160.32	0.84645	-45.813
1300	0.76674	-89.051	2.6492	86.53	0.008324	-176.28	0.84257	-48.391
1400	0.75046	-89.091	2.4207	87.443	0.0095	153.3	0.83675	-50.311
1500	0.73704	-88.676	2.2241	81.067	0.01155	159.89	0.83713	-52.537
1600	0.74039	-88.323	2.1385	81.249	0.010586	168.2	0.83993	-55.649
1700	0.73209	-88.526	1.977	77.837	0.004729	158.14	0.82256	-60.202
1800	0.72622	-89.25	1.9477	75.755	0.012002	178.27	0.81745	-63.505
1900	0.71876	-89.705	1.7977	74.042	0.018606	-174.16	0.81525	-66.569
2000	0.70567	-103.91	1.642	56.109	0.01812	159.5	0.82317	-85.615
2100	0.69916	-104.37	1.5328	53.53	0.019806	146.88	0.81154	-88.54
2200	0.69426	-105.75	1.472	52.614	0.021388	155.43	0.83009	-91.792
2300	0.70075	-106.94	1.3837	51.155	0.023509	155.3	0.81304	-93.384
2400	0.68775	-108.09	1.2782	46.539	0.024414	161.94	0.83104	-93.847
2500	0.69363	-107.69	1.2919	46.734	0.02846	157.24	0.83166	-93.821
2600	0.68198	-108.89	1.1646	42.142	0.031474	152.73	0.83121	-92.19
2700	0.67769	-107.45	1.2674	43.275	0.038727	157.21	0.84505	-90.662
2800	0.66527	-106.26	1.0548	39.199	0.030616	158.41	0.85766	-88.492
2900	0.65156	-105.01	1.199	34.902	0.040846	155.88	0.8744	-84.945
3000	0.62987	-100.71	1.0408	33.545	0.046665	149.57	0.88394	-82.392

# CDMA + GPS LNA/Mixers

MAX2385/MAX2386

**Table 5. CDMA Mixer Input S11**

(V<sub>CC</sub> = +2.75V, HGHL mode, P<sub>IN</sub> = -25dBm, T<sub>A</sub> = +25°C.)

FREQUENCY (MHz)	MIXER (S11)	
	MAGNITUDE	PHASE
50	0.93046	-6.6632
100	0.92412	-13.133
200	0.90168	-24.229
300	0.8875	-32.661
400	0.87468	-40.11
500	0.86943	-45.949
600	0.86591	-50.181
700	0.8607	-53.579
800	0.85764	-55.96
900	0.85557	-57.434
1000	0.85053	-58.83
1100	0.84695	-35.068
1200	0.82035	-34.487
1300	0.79503	-32.441
1400	0.76968	-30.2
1500	0.75583	-27.952
1600	0.72199	-26.279
1700	0.7057	-25.567
1800	0.68058	-25.45
1900	0.64409	-27.348
2000	0.61607	-29.869
2100	0.58273	-33.144
2200	0.55117	-40.677
2300	0.53115	-50.662
2400	0.52487	-62.537
2500	0.54332	-73.998
2600	0.57729	-84.522
2700	0.61971	-92.905
2800	0.6639	-98.578
2900	0.70686	-101.6
3000	0.74855	-102.76

**Table 6. CDMA Mixer Output Differential S11**

(V<sub>CC</sub> = +2.75V, HGHL mode, P<sub>IN</sub> = -15dBm, T<sub>A</sub> = +25°C.)

FREQUENCY (MHz)	MIXER (S11)	
	MAGNITUDE	PHASE
10	1.00000	0.002397
100	0.999402	0.002001
200	1.00000	0.0013
300	0.998319	-0.00621
400	0.997316	-0.01524
500	0.993268	-0.03386
600	0.987986	-0.05857
700	0.987624	-0.10057
800	0.980803	-0.15007
900	0.958863	-0.24163
1000	0.900263	-0.37955

# CDMA + GPS LNA/Mixers

MAX2385/MAX2386

**Table 7. GPS Mixer Input S11**

(V<sub>CC</sub> = +2.75V, P<sub>IN</sub> = -35dBm, T<sub>A</sub> = +25°C.)

FREQUENCY (MHz)	MIXER (S11)	
	MAGNITUDE	PHASE
50	0.95129	-5.7747
100	0.98072	-13.23
200	0.7896	-17.621
300	0.85569	-25.573
400	0.86559	-32.411
500	0.86298	-36.828
600	0.86065	-40.63
700	0.85671	-42.573
800	0.83894	-44.002
900	0.84149	-43.389
1000	0.82442	-29.719
1100	0.81692	-27.815
1200	0.80344	-26.796
1300	0.79181	-25.83
1400	0.77083	-25.385
1500	0.75552	-26.72
1600	0.72526	-29.415
1700	0.70046	-34.652
1800	0.66881	-40.769
1900	0.65244	-49.746
2000	0.64631	-60.826
2100	0.64566	-90.805
2200	0.66798	-102.61
2300	0.71	-113.58
2400	0.74633	-123.91
2500	0.74105	-130.6
2600	0.75438	-132.27
2700	0.78455	-131.97
2800	0.79948	-130.92
2900	0.82474	-128.26
3000	0.84153	-124.77

**Table 8. GPS Mixer Output Differential S11**

(V<sub>CC</sub> = +2.75V, HGHL mode, P<sub>IN</sub> = -25dBm, T<sub>A</sub> = +25°C.)

FREQUENCY (MHz)	MIXER (S11)	
	MAGNITUDE	PHASE
10	1.00000	0.002458
100	0.998001	0.001452
200	1.00000	-0.0011
300	1.0000	-0.00689
400	0.997162	-0.01806
500	0.920826	-0.04242
600	0.989409	-0.07002
700	0.982752	-0.11838
800	0.975379	-0.18777
900	0.925681	-0.32983
1000	0.755068	-0.58182



## CDMA + GPS LNA/Mixers

MAX2385/MAX2386

**Table 9. CDMA LNA Typical Noise Parameters**

( $V_{CC} = +2.75V$ , HGHL mode,  $T_A = +25^{\circ}C$ , data from design simulation.)

FREQUENCY (MHz)	NF <sub>MIN</sub> (dB)	$\Gamma_{OPT}$	$\angle \Gamma_{OPT}$	R <sub>N</sub> ( $\Omega$ )
800	1.243	0.3512	96.93	8.528
810	1.251	0.3529	97.7	8.522
820	1.259	0.3547	98.47	8.516
830	1.267	0.3565	99.23	8.511
840	1.275	0.3583	99.98	8.506
850	1.283	0.36	100.7	8.501
860	1.292	0.3618	101.5	8.496
870	1.3	0.3636	102.2	8.491
880	1.308	0.3654	102.9	8.487
890	1.317	0.3672	103.6	8.483
900	1.326	0.369	104.3	8.479

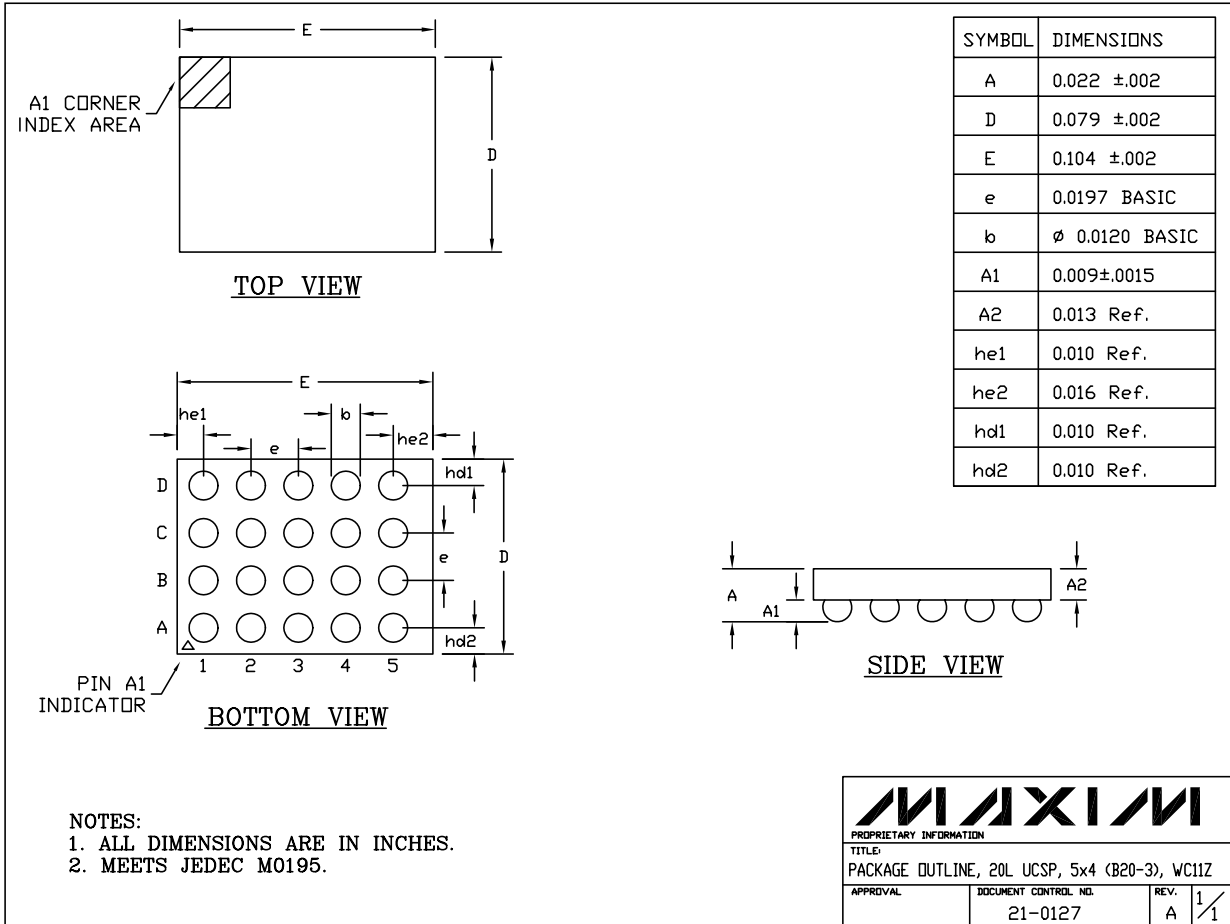
**Table 10. GPS LNA Typical Noise Parameters**

( $V_{CC} = +2.75V$ ,  $f_{RF} = 1575.42MHz$ , HGHL mode,  $T_A = +25^{\circ}C$ , data from design simulation.)

PART	NF <sub>MIN</sub> (dB)	$\Gamma_{OPT}$	$\angle \Gamma_{OPT}$	R <sub>N</sub> ( $\Omega$ )
MAX2385	1.43	0.443	94.2	11.47
MAX2386	1.33	0.382	91.5	10.00

# CDMA + GPS LNA/Mixers

## Package Information



20L UCSP/EPS

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.

18 \_\_\_\_\_ **Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 408-737-7600**