



# Quadruple-Mode PCS/Cellular/GPS LNA/Mixers

## General Description

The MAX2351/MAX2354/MAX2358/MAX2359/MAX2530/MAX2531/MAX2537/MAX2538 family of single- and multi-band LNA/mixer ICs is optimized for CDMA, GSM, and TDMA applications in both cellular and PCS bands. In addition, the MAX2530/MAX2531/MAX2537/MAX2538 ICs feature a GPS LNA/mixer signal path for E911 and traveler assistance applications. The cellular and PCS signals can be routed to either IF port. For example, one IF port can be connected to an IF filter with 30kHz bandwidth, while the other port can drive an IF filter with a wider bandwidth. The GPS band has its own IF port.

To optimize dynamic range at minimum current, the MAX2351/MAX2354/MAX2358/MAX2359/MAX2530/MAX2531/MAX2537/MAX2538 implement multiple LNA and mixer states, including high gain/high linearity, high gain/low linearity, midgain, low gain, and ultra-low gain. In high-gain/high-linearity mode, the high-IP3 LNA minimizes desensitization in the presence of a large interfering signal. For the other gain states, the LNA current is reduced to improve standby time. Each band is implemented with a separate mixer to optimize performance for the specific band, and each mixer provides multiple linearity modes to optimize linearity and current consumption. The ultra-low gain mode operates with very little current, which results in significant power savings because the handset typically spends most of its time in this mode.

## Applications

Triple-Band, Quadruple-Mode PCS/Cellular Handsets  
Single-Band Handsets  
E911 and Traveler Assistance Through GPS  
GSM/TDMA Cellular Phones

## Selector Guide

| PART    | CELL | PCS | GPS | CELL VCO         | PCS VCO          |
|---------|------|-----|-----|------------------|------------------|
| MAX2351 | ✓    | ✓   | —   | Input            | Internal doubler |
| MAX2354 | ✓    | —   | —   | Input            | —                |
| MAX2358 | ✓    | ✓   | —   | Internal divider | Input            |
| MAX2359 | —    | ✓   | —   | —                | Input            |
| MAX2530 | ✓    | ✓   | ✓   | Input            | Input            |
| MAX2531 | ✓    | ✓   | ✓   | Input            | Internal doubler |
| MAX2537 | ✓    | —   | ✓   | Internal divider | Input            |
| MAX2538 | ✓    | ✓   | ✓   | Internal divider | Input            |

## Features

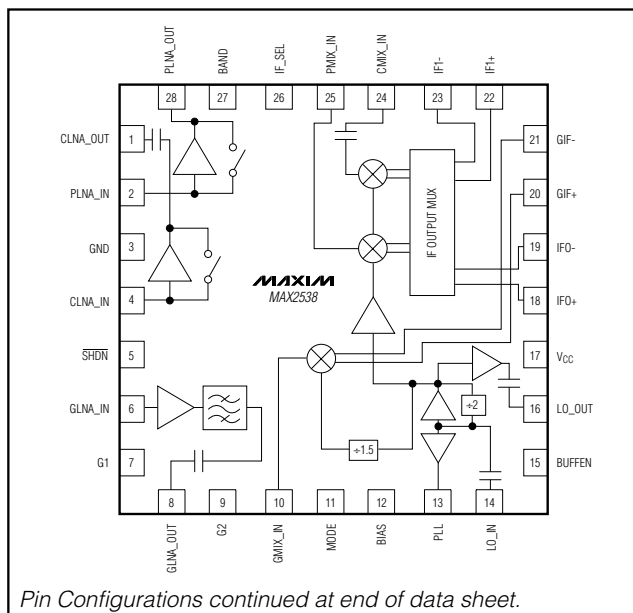
- ◆ Eliminate Up to 35 External Components
- ◆ Low LNA Noise Figure
  - PCS: 1.2dB
  - Cellular: 0.9dB
  - GPS: 1.0dB
- ◆ No External GPS VCO Required
- ◆ No Interstage GPS SAW Filter Required
- ◆ Triple Band, Quadruple Mode
- ◆ Ultra-Low Current: <10mA Average in CDMA Phones
- ◆ Small 28-Pin QFN Package (5mm × 5mm)

## Ordering Information

| PART       | TEMP RANGE     | PIN-PACKAGE     |
|------------|----------------|-----------------|
| MAX2351ETI | -40°C to +85°C | 28 Thin QFN-EP* |
| MAX2354ETI | -40°C to +85°C | 28 Thin QFN-EP* |
| MAX2358ETI | -40°C to +85°C | 28 Thin QFN-EP* |
| MAX2359ETI | -40°C to +85°C | 28 Thin QFN-EP* |
| MAX2530ETI | -40°C to +85°C | 28 Thin QFN-EP* |
| MAX2531ETI | -40°C to +85°C | 28 Thin QFN-EP* |
| MAX2537ETI | -40°C to +85°C | 28 Thin QFN-EP* |
| MAX2538ETI | -40°C to +85°C | 28 Thin QFN-EP* |

\*EP = exposed pad.

## Pin Configurations



Pin Configurations continued at end of data sheet.



# Quadruple-Mode PCS/Cellular/GPS LNA/Mixers

## ABSOLUTE MAXIMUM RATINGS

V<sub>CC</sub> to GND .....-0.3V to +4.3V  
 Digital Input Voltage to GND .....-0.3V to (V<sub>CC</sub> + 0.3V)  
 LNA Input (Low-Gain Mode) Level .....15dBm  
 LO Input Level .....5dBm  
 Digital Input Current .....10mA  
 Continuous Power Dissipation (T<sub>A</sub> = +70°C)  
   28-Pin QFN-EP (derate 21mW/°C  
   above +70°C) .....1.6W

Operating Temperature Range .....-40°C to +85°C  
 Junction Temperature .....+150°C  
 Storage Temperature Range .....-65°C to +150°C  
 Lead Temperature (soldering 10s) .....+300°C

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> = 2.7V to 3.3V, R<sub>BIAS</sub> = 20kΩ, T<sub>A</sub> = -40°C to +85°C. Typical values are at V<sub>CC</sub> = 2.75V and T<sub>A</sub> = +25°C, unless otherwise noted.) (Note 1)

| PARAMETER                                     |                                | CONDITIONS                      |  | MIN  | TYP  | MAX | UNITS |
|-----------------------------------------------|--------------------------------|---------------------------------|--|------|------|-----|-------|
| PCS MODE (see Table 1 for abbreviations)      |                                |                                 |  |      |      |     |       |
| Operating Supply Current                      | ULG                            | MAX2358/MAX2359/MAX2530/MAX2538 |  | 7.4  | 9.0  | mA  |       |
|                                               |                                | MAX2351/MAX2531                 |  | 8.1  | 10   |     |       |
|                                               | LG                             | MAX2358/MAX2359/MAX2530/MAX2538 |  | 8.6  | 11   |     |       |
|                                               |                                | MAX2351/MAX2531                 |  | 9.3  | 11.5 |     |       |
|                                               | HGHL                           | MAX2358/MAX2359/MAX2530/MAX2538 |  | 26.5 | 32   |     |       |
|                                               |                                | MAX2351/MAX2531                 |  | 27.2 | 33   |     |       |
| CELLULAR MODE (see Table 1 for abbreviations) |                                |                                 |  |      |      |     |       |
| Operating Supply Current                      | ULG                            | MAX2351/MAX2354/MAX2530/MAX2531 |  | 6.5  | 8.5  | mA  |       |
|                                               |                                | MAX2358/MAX2537/MAX2538         |  | 7.7  | 9.5  |     |       |
|                                               | LG                             | MAX2351/MAX2354/MAX2530/MAX2531 |  | 13.9 | 17   |     |       |
|                                               |                                | MAX2358/MAX2537/MAX2538         |  | 15.1 | 18.5 |     |       |
|                                               | MG                             | MAX2354/MAX2530                 |  | 23.5 | 28   |     |       |
|                                               |                                | MAX2351/MAX2531                 |  | 21.5 | 26   |     |       |
|                                               |                                | MAX2358/MAX2537/MAX2538         |  | 24.7 | 29.5 |     |       |
|                                               | HGLL                           | MAX2351/MAX2354/MAX2530/MAX2531 |  | 20.6 | 26   |     |       |
|                                               |                                | MAX2358/MAX2537/MAX2538         |  | 21.8 | 27.5 |     |       |
|                                               | HGHL                           | MAX2354/MAX2530                 |  | 27.7 | 35   |     |       |
|                                               |                                | MAX2351/MAX2531                 |  | 25.7 | 33.5 |     |       |
|                                               |                                | MAX2358/MAX2537/MAX2538         |  | 28.9 | 36   |     |       |
| GPS MODE (MAX2530/MAX2531/MAX2538)            |                                |                                 |  |      |      |     |       |
| Operating Supply Current                      | PLL = low                      | MAX2530/MAX2537/MAX2538         |  | 18.9 | 23   | mA  |       |
|                                               |                                | MAX2531                         |  | 19.6 | 24   |     |       |
| SHUTDOWN MODE                                 |                                |                                 |  |      |      |     |       |
| Shutdown Supply Current                       | SHDN = low, BUFFEN = PLL = low |                                 |  | 20   |      | μA  |       |
| ALL MODES                                     |                                |                                 |  |      |      |     |       |
| Digital Input Logic High                      |                                |                                 |  | 1.8  |      | V   |       |
| Digital Input Logic Low                       |                                |                                 |  | 0.6  |      | V   |       |

# Quadruple-Mode PCS/Cellular/GPS LNA/Mixers

MAX2351/4/8/9/MAX2530/1/7/8

## DC ELECTRICAL CHARACTERISTICS (continued)

( $V_{CC} = 2.7V$  to  $3.3V$ ,  $R_{BIAS} = 20k\Omega$ ,  $T_A = -40^\circ C$  to  $+85^\circ C$ . Typical values are at  $V_{CC} = 2.75V$  and  $T_A = +25^\circ C$ , unless otherwise noted.) (Note 1)

| PARAMETER                            |                                                          | CONDITIONS                                              | MIN | TYP | MAX | UNITS   |
|--------------------------------------|----------------------------------------------------------|---------------------------------------------------------|-----|-----|-----|---------|
| Digital Input Current                |                                                          | Measured at guaranteed logic threshold                  | -10 |     | +10 | $\mu A$ |
| Additional Current for LO_OUT Buffer |                                                          | BUFFEN = high, cellular and PCS modes, $P_{LO} = -7dBm$ |     | 2.4 | 3.5 | mA      |
| Buffer-Only Mode Supply Mode         | $\overline{SHDN}$ = low, BUFFEN = high, $P_{LO} = -7dBm$ | PCS MAX2358/MAX2359/MAX2530/MAX2538                     |     | 5.4 | 7   | mA      |
|                                      |                                                          | PCS MAX2351/MAX2531                                     |     | 6.1 | 7.5 |         |
|                                      |                                                          | CELL MAX2351/MAX2354/MAX2530/MAX2531                    |     | 4.7 | 6.5 |         |
|                                      |                                                          | CELL MAX2358/MAX2537/MAX2538                            |     | 5.9 | 7.5 |         |
| PLL-Only Mode                        | $\overline{SHDN}$ = low, PLL = high, $P_{LO} = -7dBm$    |                                                         |     | 3.2 | 4.5 | mA      |

## AC ELECTRICAL CHARACTERISTICS

(EV kits to evaluate the MAX2351/MAX2354/MAX2358/MAX2359/MAX2530/MAX2531/MAX2357/MAX2538,  $f_{CELL} = 869MHz$  to  $894MHz$ ,  $f_{PCS} = 1930MHz$  to  $1990MHz$ ,  $f_{GPS} = 1575.42MHz$  (MAX2530/MAX2531/MAX2537/MAX2538),  $f_{IF} = 183.6MHz$ , high-side LO for all except GPS,  $50\Omega$  system impedance,  $V_{CC} = 2.7V$  to  $3.3V$ ,  $R_{BIAS} = 20k\Omega$ ,  $R_{IF0} = R_{IF1} = 3.3k\Omega$ ,  $R_{GIF} = 8.2k\Omega$ , LO input power =  $-10dBm$ ,  $T_A = -40^\circ C$  to  $+85^\circ C$ . Typical values are at  $f_{CELL} = 881MHz$ ,  $f_{PCS} = 1960MHz$ ,  $V_{CC} = 2.75V$ , LO input power =  $-7dBm$ , unless otherwise noted.) (Note 2)

| PARAMETER                                       |  | CONDITIONS                                                      |        | MIN                             | TYP   | MAX  | UNITS |    |
|-------------------------------------------------|--|-----------------------------------------------------------------|--------|---------------------------------|-------|------|-------|----|
| OVERALL PERFORMANCE                             |  |                                                                 |        |                                 |       |      |       |    |
| IF Frequency Range                              |  | IF0 and IF1 (Note 3)                                            |        | 70                              | 183.6 | 400  | MHz   |    |
| GPS IF Frequency Range                          |  | GIF (Note 3)                                                    |        | 110                             | 183.6 | 225  | MHz   |    |
| Cellular RF Frequency Range                     |  | (Note 1)                                                        |        | 869                             |       | 894  | MHz   |    |
| PCS RF Frequency Range                          |  | (Note 1)                                                        |        | 1930                            |       | 1990 | MHz   |    |
| LO Leakage to LNA inputs                        |  |                                                                 |        |                                 |       | -40  | dBm   |    |
| LO Output Power                                 |  | Cell, BUFFEN = high, 50Ω load, LO input power = -10dBm (Note 1) |        | -10                             | -5    |      | dBm   |    |
|                                                 |  | PCS, BUFFEN = high, 50Ω load, LO input power = -10dBm (Note 1)  |        | -11                             | -7    |      |       |    |
| PLL Output Power                                |  |                                                                 |        | -12                             |       |      | dBm   |    |
| LNA PERFORMANCE (see Table 1 for abbreviations) |  |                                                                 |        |                                 |       |      |       |    |
| LNA Gain<br>(Note 1)                            |  | CELL                                                            | HGHL   | T <sub>A</sub> = +25°C          | 13.8  | 15   | 16.0  | dB |
|                                                 |  |                                                                 |        | T <sub>A</sub> = -40°C to +85°C | 13.3  |      | 16.5  |    |
|                                                 |  |                                                                 | HGLL   | T <sub>A</sub> = +25°C          | 13.5  | 14.5 | 15.5  |    |
|                                                 |  |                                                                 |        | T <sub>A</sub> = -40°C to +85°C | 13.0  |      | 16.0  |    |
|                                                 |  |                                                                 | MG     | T <sub>A</sub> = +25°C          | 1.0   | 1.9  | 3.0   |    |
|                                                 |  |                                                                 |        | T <sub>A</sub> = -40°C to +85°C | 0.5   |      | 3.0   |    |
|                                                 |  |                                                                 | LG/ULG | T <sub>A</sub> = +25°C          | -6    | -4.9 | -4    |    |
|                                                 |  |                                                                 |        | T <sub>A</sub> = -40°C to +85°C | -6.5  |      | -3.5  |    |

# Quadruple-Mode PCS/Cellular/GPS LNA/Mixers

## AC ELECTRICAL CHARACTERISTICS (continued)

(EV kits to evaluate the MAX2351/MAX2354/MAX2358/MAX2359/MAX2530/MAX2531/MAX2357/MAX2538,  $f_{CELL} = 869\text{MHz}$  to  $894\text{MHz}$ ,  $f_{PCS} = 1930\text{MHz}$  to  $1990\text{MHz}$ ,  $f_{GPS} = 1575.42\text{MHz}$  (MAX2530/MAX2531/MAX2537/MAX2538),  $f_{IF} = 183.6\text{MHz}$ , high-side LO for all except GPS,  $50\Omega$  system impedance,  $V_{CC} = 2.7\text{V}$  to  $3.3\text{V}$ ,  $R_{BIAS} = 20\text{k}\Omega$ ,  $R_{IF0} = R_{IF1} = 3.3\text{k}\Omega$ ,  $R_{GIF} = 8.2\text{k}\Omega$ , LO input power =  $-10\text{dBm}$ ,  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ . Typical values are at  $f_{CELL} = 881\text{MHz}$ ,  $f_{PCS} = 1960\text{MHz}$ ,  $V_{CC} = 2.75\text{V}$ , LO input power =  $-7\text{dBm}$ , unless otherwise noted.) (Note 2)

| PARAMETER            | CONDITIONS          |                                                                 |                                                                       | MIN                                                                   | TYP  | MAX  | UNITS |
|----------------------|---------------------|-----------------------------------------------------------------|-----------------------------------------------------------------------|-----------------------------------------------------------------------|------|------|-------|
| LNA Gain<br>(Note 1) | PCS                 | HGHL                                                            | T <sub>A</sub> = +25°C                                                | 15                                                                    | 16   | 17   | dB    |
|                      |                     |                                                                 | T <sub>A</sub> = -40°C to +85°C                                       | 14.5                                                                  |      | 17.5 |       |
|                      |                     | LG/ULG                                                          | T <sub>A</sub> = +25°C                                                | -5.5                                                                  | -4.5 | -3.2 |       |
|                      |                     |                                                                 | T <sub>A</sub> = -40°C to +85°C                                       | -6                                                                    | -4.5 | -3.2 |       |
|                      | GPS                 | T <sub>A</sub> = +25°C                                          | 16                                                                    | 17.7                                                                  | 19   |      |       |
|                      |                     | T <sub>A</sub> = -40°C to +85°C                                 | 15.5                                                                  |                                                                       | 20   |      |       |
| LNA Noise Figure     | CELL                | HGHL/<br>HGLL                                                   | T <sub>A</sub> = +25°C                                                |                                                                       | 0.9  | 1.2  | dB    |
|                      |                     |                                                                 | Change over temperature from<br>T <sub>A</sub> = +25°C to +85°C       |                                                                       | 0.2  |      |       |
|                      |                     | MG                                                              | T <sub>A</sub> = +25°C                                                |                                                                       | 2.0  | 2.5  |       |
|                      |                     | LG/ULG                                                          | T <sub>A</sub> = +25°C                                                |                                                                       | 5.0  | 6.5  |       |
|                      | PCS                 | HGHL                                                            | T <sub>A</sub> = +25°C                                                |                                                                       | 1.2  | 1.5  |       |
|                      |                     |                                                                 | Change over temperature from<br>T <sub>A</sub> = +25°C to +85°C       |                                                                       | 0.2  |      |       |
|                      |                     | LG/ULG                                                          | T <sub>A</sub> = +25°C                                                |                                                                       | 5.5  | 7.0  |       |
|                      | GPS                 | T <sub>A</sub> = +25°C                                          |                                                                       | 1.0                                                                   | 1.3  |      |       |
|                      |                     | Change over temperature from<br>T <sub>A</sub> = +25°C to +85°C |                                                                       | 0.2                                                                   |      |      |       |
|                      | LNA IP3<br>(Note 4) | CELL                                                            | HGHL                                                                  | P <sub>IN</sub> = -25dBm, T <sub>A</sub> = -40°C to +85°C<br>(Note 1) | 9.5  | 13   |       |
| HGLL                 |                     |                                                                 | P <sub>IN</sub> = -25dBm, T <sub>A</sub> = -40°C to +85°C             | 6.5                                                                   | 12.2 |      |       |
| MG                   |                     |                                                                 | P <sub>IN</sub> = -25dBm, T <sub>A</sub> = -40°C to +85°C             | 13.5                                                                  | 17   |      |       |
| LG/ULG               |                     |                                                                 | P <sub>IN</sub> = -15dBm, T <sub>A</sub> = -40°C to +85°C             | 20                                                                    | 24.6 |      |       |
| PCS                  |                     | HGHL                                                            | P <sub>IN</sub> = -25dBm, T <sub>A</sub> = -40°C to +85°C<br>(Note 1) | 8                                                                     | 12   |      |       |
|                      |                     | LG/ULG                                                          | P <sub>IN</sub> = -15dBm, T <sub>A</sub> = -40°C to +85°C             | 20                                                                    | 24.4 |      |       |
| GPS                  |                     |                                                                 | P <sub>IN</sub> = -25dBm, T <sub>A</sub> = -40°C to +85°C             | 0                                                                     | 4.6  |      |       |
|                      |                     |                                                                 |                                                                       |                                                                       |      |      |       |

# Quadruple-Mode PCS/Cellular/GPS LNA/Mixers

MAX2351/4/8/9/MAX2530/1/7/8

## AC ELECTRICAL CHARACTERISTICS (continued)

(EV kits to evaluate the MAX2351/MAX2354/MAX2358/MAX2359/MAX2530/MAX2531/MAX2357/MAX2538,  $f_{CELL} = 869\text{MHz}$  to  $894\text{MHz}$ ,  $f_{PCS} = 1930\text{MHz}$  to  $1990\text{MHz}$ ,  $f_{GPS} = 1575.42\text{MHz}$  (MAX2530/MAX2531/MAX2537/MAX2538),  $f_{IF} = 183.6\text{MHz}$ , high-side LO for all except GPS,  $50\Omega$  system impedance,  $V_{CC} = 2.7\text{V}$  to  $3.3\text{V}$ ,  $R_{BIAS} = 20\text{k}\Omega$ ,  $R_{IF0} = R_{IF1} = 3.3\text{k}\Omega$ ,  $R_{GIF} = 8.2\text{k}\Omega$ , LO input power =  $-10\text{dBm}$ ,  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ . Typical values are at  $f_{CELL} = 881\text{MHz}$ ,  $f_{PCS} = 1960\text{MHz}$ ,  $V_{CC} = 2.75\text{V}$ , LO input power =  $-7\text{dBm}$ , unless otherwise noted.) (Note 2)

| PARAMETER                                                | CONDITIONS |                        |                                                                 | MIN  | TYP  | MAX  | UNITS |
|----------------------------------------------------------|------------|------------------------|-----------------------------------------------------------------|------|------|------|-------|
| MIXER PERFORMANCE (see Tables 1 and 2 for abbreviations) |            |                        |                                                                 |      |      |      |       |
| Mixer Gain<br>(Note 1)                                   | CELL       | HGHL/<br>MG            | T <sub>A</sub> = +25°C                                          | 9.5  | 12.5 | 15.0 | dB    |
|                                                          |            |                        | T <sub>A</sub> = -40°C to +85°C                                 | 8.5  |      | 16   |       |
|                                                          |            | HGLL/<br>LG            | T <sub>A</sub> = +25°C                                          | 9.0  | 12   | 14.5 |       |
|                                                          |            |                        | T <sub>A</sub> = -40°C to +85°C                                 | 8    |      | 15.5 |       |
|                                                          |            | ULG                    | T <sub>A</sub> = +25°C                                          | 6    | 10   | 12.5 |       |
|                                                          |            |                        | T <sub>A</sub> = -40°C to +85°C                                 | 5    |      | 14   |       |
|                                                          | PCS        | HGHL                   | T <sub>A</sub> = +25°C                                          | 10.0 | 13   | 16.5 |       |
|                                                          |            |                        | T <sub>A</sub> = -40°C to +85°C                                 | 8.5  |      | 16.5 |       |
|                                                          |            | LG                     | T <sub>A</sub> = +25°C                                          | 8.0  | 12   | 14.5 |       |
|                                                          |            |                        | T <sub>A</sub> = -40°C to +85°C                                 | 6.5  | 12   | 14.5 |       |
|                                                          |            | ULG                    | T <sub>A</sub> = +25°C                                          | 7.5  | 11   | 13.5 |       |
|                                                          |            |                        | T <sub>A</sub> = -40°C to +85°C                                 | 6.0  |      | 14.5 |       |
|                                                          | GPS        |                        | T <sub>A</sub> = +25°C                                          | 12.0 | 15   | 17.5 |       |
|                                                          |            |                        | T <sub>A</sub> = -40°C to +85°C                                 | 10   | 13   | 19   |       |
| Mixer Noise<br>Figure                                    | CELL       | HGHL/<br>MG            | T <sub>A</sub> = +25°C                                          |      | 8    | 9.5  | dB    |
|                                                          |            |                        | Change over temperature from<br>T <sub>A</sub> = +25°C to +85°C |      | 0.3  |      |       |
|                                                          |            | HGLL/<br>LG            | T <sub>A</sub> = +25°C                                          |      | 7.2  | 9    |       |
|                                                          |            |                        |                                                                 |      |      |      |       |
|                                                          | PCS        | HGHL                   | T <sub>A</sub> = +25°C                                          |      | 7    | 8.5  |       |
|                                                          |            |                        | Change over temperature from<br>T <sub>A</sub> = +25°C to +85°C |      | 0.3  |      |       |
|                                                          |            | LG                     | T <sub>A</sub> = +25°C                                          |      | 6.2  | 7.5  |       |
|                                                          |            |                        |                                                                 |      |      |      |       |
|                                                          | ULG        | T <sub>A</sub> = +25°C |                                                                 | 6    | 7.5  |      |       |
|                                                          |            |                        |                                                                 |      |      |      |       |
|                                                          | GPS        |                        | T <sub>A</sub> = +25°C                                          |      | 7.2  | 9    |       |
|                                                          |            |                        | Change over temperature from<br>T <sub>A</sub> = +25°C to +85°C |      | 0.5  |      |       |

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## AC ELECTRICAL CHARACTERISTICS (continued)

(EV kits to evaluate the MAX2351/MAX2354/MAX2358/MAX2359/MAX2530/MAX2531/MAX2357/MAX2538,  $f_{CELL} = 869\text{MHz}$  to  $894\text{MHz}$ ,  $f_{PCS} = 1930\text{MHz}$  to  $1990\text{MHz}$ ,  $f_{GPS} = 1575.42\text{MHz}$  (MAX2530/MAX2531/MAX2537/MAX2538),  $f_{IF} = 183.6\text{MHz}$ , high-side LO for all except GPS,  $50\Omega$  system impedance,  $V_{CC} = 2.7\text{V}$  to  $3.3\text{V}$ ,  $R_{BIAS} = 20\text{k}\Omega$ ,  $R_{IF0} = R_{IF1} = 3.3\text{k}\Omega$ ,  $R_{GIF} = 8.2\text{k}\Omega$ , LO input power =  $-10\text{dBm}$ ,  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ . Typical values are at  $f_{CELL} = 881\text{MHz}$ ,  $f_{PCS} = 1960\text{MHz}$ ,  $V_{CC} = 2.75\text{V}$ , LO input power =  $-7\text{dBm}$ , unless otherwise noted.) (Note 2)

| PARAMETER             | CONDITIONS |             |                                                                                   |                                     | MIN  | TYP  | MAX | UNITS |
|-----------------------|------------|-------------|-----------------------------------------------------------------------------------|-------------------------------------|------|------|-----|-------|
| Mixer IP3<br>(Note 4) | CELL       | HGHL/<br>MG | MAX2354/MAX2358/MAX2530/<br>MAX2537/MAX2538,<br>P <sub>IN</sub> = -20dBm (Note 1) |                                     | 6    | 7.8  | dBm |       |
|                       |            |             | MAX2351/MAX2531, P <sub>IN</sub> = -20dBm                                         |                                     | 4    | 6.5  |     |       |
|                       |            | HGLL/<br>LG | P <sub>IN</sub> = -20dBm                                                          |                                     | 3.5  | 6.5  |     |       |
|                       |            |             | ULG                                                                               | P <sub>IN</sub> = -20dBm            |      | -4.5 |     | -2.2  |
|                       | PCS        | HGHL        | P <sub>IN</sub> = -20dBm<br>(Note 1)                                              | MAX2358/MAX2359/<br>MAX2530/MAX2538 | 3    | 5    |     |       |
|                       |            |             |                                                                                   | MAX2351/MAX2531                     | 2.5  | 4.5  |     |       |
|                       |            | LG          | P <sub>IN</sub> = -20dBm                                                          |                                     | -4.5 | -1.8 |     |       |
|                       |            | ULG         | P <sub>IN</sub> = -20dBm                                                          |                                     | -7   | -3.6 |     |       |
|                       | GPS        |             | P <sub>IN</sub> = -20dBm                                                          |                                     | -3   | 0.5  |     |       |

**Note 1:** Guaranteed at  $T_A = +25^\circ\text{C}$  and  $T_A = +85^\circ\text{C}$  by production test, and guaranteed by design and characterization at  $T_A = -40^\circ\text{C}$ .

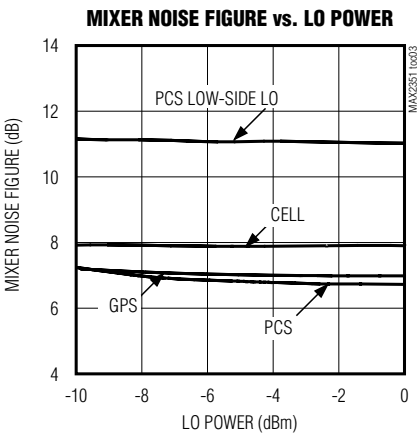
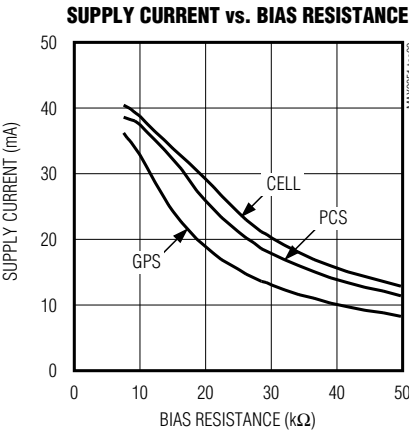
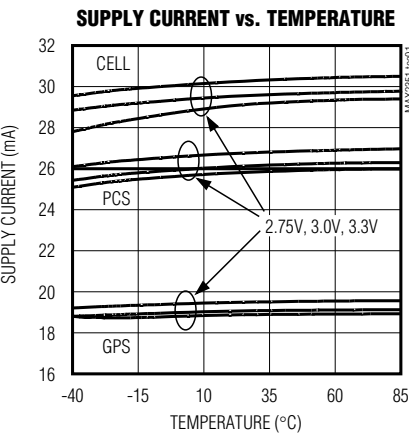
**Note 2:** Minimum and maximum specs are guaranteed by design and characterization, unless otherwise noted.

**Note 3:** Operating over this frequency range requires the ports to be rematched for the desired operating frequency.

**Note 4:** Two-tone separation is  $900\text{kHz}$  cellular,  $1.25\text{MHz}$  for PCS, and  $1\text{MHz}$  for GPS.

## Typical Operating Characteristics

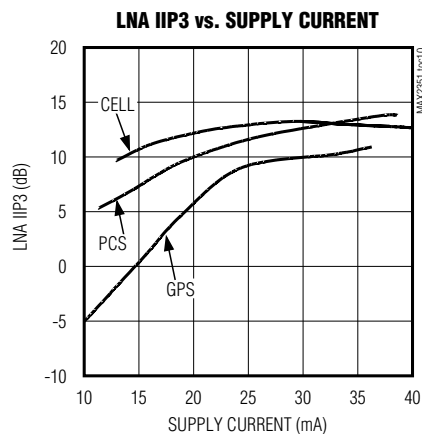
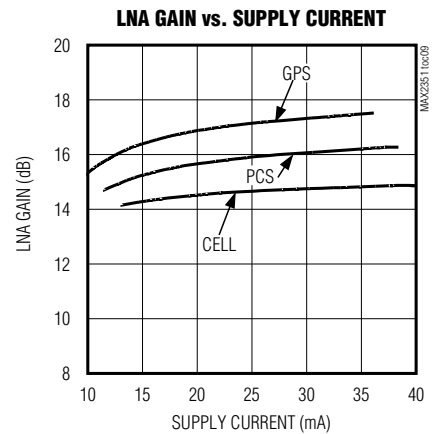
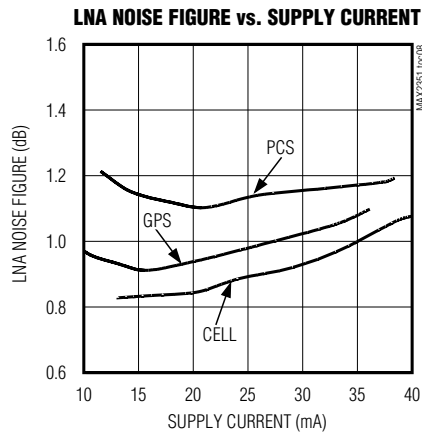
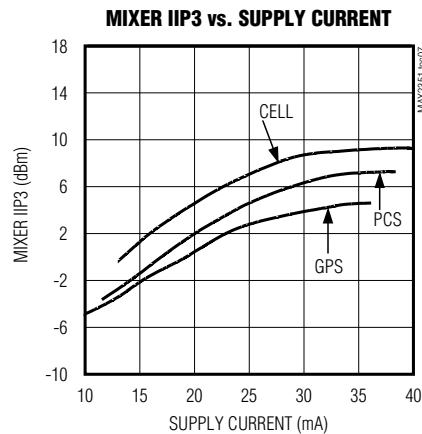
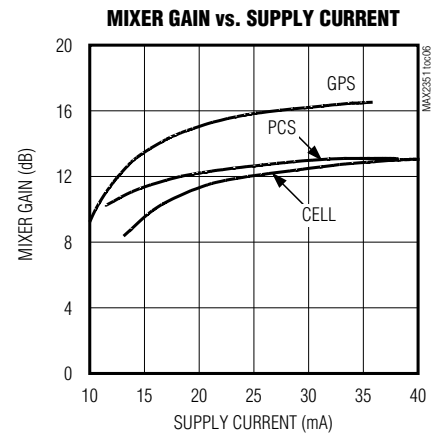
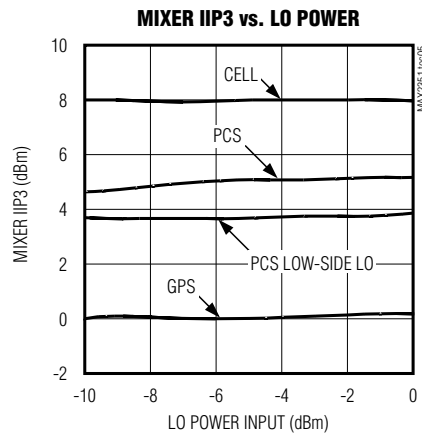
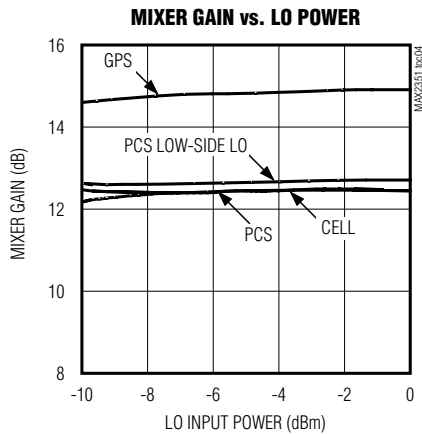
(MAX2538 EV kit,  $f_{IF} = 183.6\text{MHz}$ , high-side LO for all modes except GPS,  $50\Omega$  system impedance,  $R_{BIAS} = 20\text{k}\Omega$ ,  $R_{IF0} = R_{IF1} = 3.3\text{k}\Omega$ ,  $R_{GIF} = 8.2\text{k}\Omega$ ,  $f_{CELL} = 881\text{MHz}$ ,  $f_{PCS} = 1960\text{MHz}$ ,  $f_{GPS} = 1575.42\text{MHz}$ ,  $V_{CC} = 2.75\text{V}$ , LO input power =  $-7\text{dBm}$ , HGHL mode,  $T_A = +25^\circ\text{C}$ , unless otherwise noted.)



# Quadruple-Mode PCS/Cellular/GPS LNA/Mixers

## Typical Operating Characteristics (continued)

(MAX2538 EV kit,  $f_{IF} = 183.6\text{MHz}$ , high-side LO for all modes except GPS,  $50\Omega$  system impedance,  $R_{BIAS} = 20\text{k}\Omega$ ,  $R_{IF0} = R_{IF1} = 3.3\text{k}\Omega$ ,  $R_{GIF} = 8.2\text{k}\Omega$ ,  $f_{CELL} = 881\text{MHz}$ ,  $f_{PCS} = 1960\text{MHz}$ ,  $f_{GPS} = 1575.42\text{MHz}$ ,  $V_{CC} = 2.75\text{V}$ , LO input power =  $-7\text{dBm}$ , HGHL mode,  $T_A = +25^\circ\text{C}$ , unless otherwise noted.)



# Quadruple-Mode PCS/Cellular/GPS LNA/Mixers

## Pin Description

| PIN                |                    |                |                               |         | NAME                     | FUNCTION                                                                                                                                                                                                                           |
|--------------------|--------------------|----------------|-------------------------------|---------|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| MAX2351<br>MAX2358 | MAX2354            | MAX2359        | MAX2530<br>MAX2531<br>MAX2538 | MAX2537 |                          |                                                                                                                                                                                                                                    |
| 1                  | 1                  | —              | 1                             | 1       | CLNA_OUT                 | Cellular LNA Output. Internally matched to 50Ω including an on-chip DC-blocking capacitor.                                                                                                                                         |
| 2                  | —                  | 2              | 2                             | —       | PLNA_IN                  | PCS LNA Input. Requires a DC-blocking capacitor that can be used as part of the matching network.                                                                                                                                  |
| 3                  | 3, 27              | 3              | 3                             | 3       | GND                      | Ground                                                                                                                                                                                                                             |
| 4                  | 4                  | —              | 4                             | 4       | CLNA_IN                  | Cellular LNA Input. Requires a DC-blocking capacitor that can be used as part of the matching network.                                                                                                                             |
| 5                  | 5                  | 5              | 5                             | 5       | $\overline{\text{SHDN}}$ | Shutdown Logic Input. A logic low shuts off the device, except LO_OUT and PLL buffers, which are controlled by BUFFEN and PLL pins, respectively.                                                                                  |
| 6, 8               | 2, 6, 8            | 1, 4, 6, 8, 24 | —                             | 2       | N.C./GND                 | Pin can be grounded or left open-circuit.                                                                                                                                                                                          |
| —                  | —                  | —              | 6                             | 6       | GLNA_IN                  | GPS LNA Input. Requires a DC-blocking capacitor, which can be used as part of the matching network.                                                                                                                                |
| 7                  | 7                  | 7              | 7                             | 7       | G1                       | Operating Mode Logic Input. Sets device operating modes. See Table 2 for details.                                                                                                                                                  |
| —                  | —                  | —              | 8                             | 8       | GLNA_OUT                 | GPS LNA Output. Internally matched to 50Ω including an on-chip DC-blocking capacitor.                                                                                                                                              |
| 9                  | 9                  | 9              | 9                             | 9       | G2                       | Operating Mode Logic Input. Sets device operating modes. See Table 2 for details.                                                                                                                                                  |
| 10, 20, 21         | 10, 20, 21, 25, 28 | 10, 20, 21, 27 | —                             | 25, 28  | I.C.                     | Internally Connected. Do not make connections to this pin.                                                                                                                                                                         |
| —                  | —                  | —              | 10                            | 10      | GMIX_IN                  | GPS Mixer Input. Requires a DC-blocking capacitor, which can be used as an interstage coupling capacitor.                                                                                                                          |
| 11                 | 11                 | 11             | 11                            | 11      | MODE                     | Operating Mode Logic Input. Sets device operating modes. See Table 2 for details.                                                                                                                                                  |
| 12                 | 12                 | 12             | 12                            | 12      | BIAS                     | Bias Setting Pin. For nominal bias, connect a 20kΩ resistor to ground. Adjust R <sub>BIAS</sub> to alter the linearity of the mixers and LNAs.                                                                                     |
| 13                 | 13                 | 13             | 13                            | 13      | PLL                      | Dual-Function Pin. LO buffer output port for driving an external PLL synthesizer. A logic high (through a 10kΩ resistor) enables the PLL buffer. A logic low disables the PLL buffer. Leave open if not used. If open, PLL is low. |
| 14                 | 14                 | 14             | 14                            | 14      | LO_IN                    | LO Input. Internally matched to 50Ω, including DC-blocking capacitor.                                                                                                                                                              |
| 15                 | 15                 | 15             | 15                            | 15      | BUFFEN                   | LO Buffer Enable Logic Input. A logic high enables the external LO buffer port. Floats low.                                                                                                                                        |



# Quadruple-Mode PCS/Cellular/GPS LNA/Mixers

## Pin Description (continued)

| PIN                |         |         |                               |         | NAME            | FUNCTION                                                                                                                                                                                             |
|--------------------|---------|---------|-------------------------------|---------|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| MAX2351<br>MAX2358 | MAX2354 | MAX2359 | MAX2530<br>MAX2531<br>MAX2538 | MAX2537 |                 |                                                                                                                                                                                                      |
| 16                 | 16      | 16      | 16                            | 16      | LO_OUT          | PCS and Cellular LO Output. Output frequency is equal to mixer LO frequency. Internally matched with DC-blocking capacitor. If not used, connect pin to ground or leave open.                        |
| 17                 | 17      | 17      | 17                            | 17      | V <sub>CC</sub> | 2.7V to 3.3V Supply Pin. Connect a 100pF bypass capacitor as close as possible to the pin.                                                                                                           |
| 18, 19             | 18, 19  | 18, 19  | 18, 19                        | 18, 19  | IF0+, IF0-      | Differential IF Output Port 0. Requires a pullup inductor and a DC-blocking capacitor at each pin, which can be used as part of the matching network. If not used, connect pins to V <sub>CC</sub> . |
| —                  | —       | —       | 20, 21                        | 20, 21  | GIF+, GIF-      | GPS IF Output. Requires a pullup inductor and a DC-blocking capacitor at each pin, which can be used as part of the matching network. If not used, connect pins to V <sub>CC</sub> .                 |
| 22, 23             | 22, 23  | 22, 23  | 22, 23                        | 22, 23  | IF1+, IF1-      | Differential IF Output Port 1. Requires a pullup inductor and a DC-blocking capacitor at each pin, which can be used as part of the matching network. If not used, connect pins to V <sub>CC</sub> . |
| 24                 | 24      | —       | 24                            | 24      | CMIX_IN         | Cellular Mixer Input. Internally matched to 50Ω, including an on-chip DC-blocking capacitor.                                                                                                         |
| 25                 | —       | 25      | 25                            | —       | PMIX_IN         | PCS Mixer Input. Internally matched to 50Ω. Requires a DC-blocking capacitor.                                                                                                                        |
| 26                 | 26      | 26      | 26                            | 26      | IF_SEL          | IF Select Logic Input. Logic low selects IF0 port, and logic high selects IF1 port.                                                                                                                  |
| 27                 | —       | —       | 27                            | 27      | BAND            | BAND Logic Input. See Table 2 for details.                                                                                                                                                           |
| 28                 | —       | 28      | 28                            | —       | PLNA_OUT        | PCS LNA Output. Requires a pullup inductor and a DC-blocking capacitor, which can be used as part of the matching network.                                                                           |
| EP                 | EP      | EP      | EP                            | EP      | Exposed         | Exposed Pad. RF and DC ground.                                                                                                                                                                       |

## Detailed Description

### Signal Paths and Operation Modes

The MAX2351/MAX2354/MAX2358/MAX2359/MAX2530/MAX2531/MAX2537/MAX2538 have multiple RF signal paths. The cellular signal path has five modes of operation using a 4-gain-mode LNA and a 3-gain-mode mixer. Similarly, the PCS signal path has four modes of operation made up of a 2-gain-mode LNA and a 3-gain-mode mixer. The cellular and PCS mixer's IF output can be routed to either the IF0 or IF1 port. The GPS signal path consists of a single-mode GPS, LNA, and mixer, which has a dedicated IF output port. Tables 1 and 2 summarize the modes of operation.

### Low-Noise Amplifiers

The MAX2351/MAX2358/MAX2530/MAX2531/MAX2538 incorporate three LNA signal paths for the cellular, PCS, and GPS bands. Using Maxim's latest advanced BiCMOS SiGe process, these LNAs deliver 1dB noise figure for cellular, PCS, and GPS bands. The cellular band LNAs have four modes of operation: high gain/high linearity (HGHL), high gain/low linearity (HGLL), midgain (MG), and low gain (LG). The PCS band LNAs have two modes of operation: high gain/high linearity and low gain. The GPS LNA has only one mode.

The BAND input selects the frequency band. The G1, G2, and MODE pins are logic inputs that control the LNA modes (see Table 2). Use HGHL mode when high

# Quadruple-Mode PCS/Cellular/GPS LNA/Mixers

LNA linearity is required for cross-modulation suppression. Use HGLL mode when the transmitter is off and cross-modulation is not a concern. The LNAs are designed to minimize input VSWR when changing modes. Use low-gain mode for receiving large signals and when high sensitivity is not required. The cellular band provides an additional gain mode (MG) for improved IP3 margin in CDMA medium-level interference condition.

## Downconverters

The downconverters in these devices are double-balanced mixers. The cellular and PCS mixers have three gain modes: high linearity, low linearity, and low gain. The cellular and PCS mixers can route the IF signal to either IF0 or IF1 port. IF\_SEL = low routes the IF signal to IF0 port; IF\_SEL = high routes the IF signal to IF1 port. The GPS mixer has only one mode, and it has a dedicated IF port (Table 2). All mixer inputs include on-chip matching networks to reduce the external component count.

## LO Generation

Table 3 shows the options for the LO generation. The on-chip LO divider or multiplier allows triple-band operation with a single VCO. The MAX2351 and MAX2531 have an LO multiplier that doubles the cellular band VCO for PCS band operation. Conversely, the MAX2358, MAX2537, and MAX2538 include an LO divider that divides the PCS VCO frequency down to cellular frequency band. The GPS LO is generated by a fractional frequency scaler, which enables a single VCO for operation in all three bands. The MAX2530 is designed for operation with a dual-band VCO.

The PLL buffer output is provided for phase-locked loop operation. The PLL pin serves two functions: RF output signal for phase-locked loop operation and logic input to enable or disable this buffer. A logic high applied to this pin enables the PLL buffer; a logic low disables the buffer.

A buffered LO output is provided to drive a transmit upconverter. It is controlled by the BUFFEN input. For time-division duplex applications, the buffer is available to drive the transmitter even when the rest of the chip is shut down. The port is internally AC-coupled, so a DC-blocking capacitor is not required.

## Bias Control

The bias control input (BIAS pin) controls the IC bias current. Typically, connect a 20k $\Omega$  resistor to ground for normal operation. Smaller bias resistor values increase the supply current and linearity.

## Applications Information

### Cascaded LNA/Mixer Performance

The LNA and mixer design optimizes cascaded performance in all gain and linearity modes. In high-gain/high-linearity mode, both the LNA and mixer have low noise figure, high gain, and high linearity. In this mode, the LNA has extra-high linearity for superior cross-modulation suppression. The high-gain/low-linearity mode is used when the transmitter is off and cross-modulation is not a concern. In the ultra-low-gain mode, the received signal is strong enough that sensitivity is not the limiting factor. This mode focuses on minimizing supply current. Tables 4, 5, 6 summarize the cascaded performance.

### LNAs

The LNA inputs require external matching networks to optimize gain, linearity, noise figure, and return loss. A simple LC match is sufficient as shown in the *Typical Application Circuit*. The cellular and GPS LNA outputs are internally matched. The PCS LNA output requires an inductor pullup to VCC and a series capacitor as external matching elements. Table 7, 8, 9 show the S-parameters for each LNA. Tables 13, 14, 15 show LNA noise parameters.

### Mixers

All mixer inputs are internally matched. The GPS and PCS mixer inputs require a DC-blocking capacitor; the cellular mixer does not. All IF outputs must be inductively pulled up to VCC. The inductive pullup may be used as part of the matching network. Because the differential IF output port is high impedance, a load resistor is typically used to ease the matching and establish the gain. A 3.3k $\Omega$  resistor is recommended for IF0 and IF1, and 8.2k $\Omega$  for the GIF port. The equivalent parallel RC impedance of the IF ports is typically 12.2k $\Omega$  in parallel with 0.75pF. Tables 10, 11, 12 show S-parameters for the mixer input points.

**Table 1. Abbreviation for LNA and Mixer Modes**

| ABBREVIATION | MODE                     |
|--------------|--------------------------|
| HGHL         | High gain/high linearity |
| HGLL         | High gain/low linearity  |
| MG           | Midgain                  |
| LG           | Low gain                 |
| ULG          | Ultra-low gain           |
| HL           | High linearity           |
| LL           | Low linearity            |

# Quadruple-Mode PCS/Cellular/GPS LNA/Mixers

**Table 2. Modes of Operation**

| BAND     | OPERATION MODE | LNA  | MIXER | IF PORT    | G2 | G1 | MODE | BAND |
|----------|----------------|------|-------|------------|----|----|------|------|
| Cellular | HGHL           | HGHL | HL    | IF0 or IF1 | 0  | 0  | 1    | 0    |
|          | HGLL           | HGLL | LL    | IF0 or IF1 | 0  | 0  | 0    | 0    |
|          | MG             | MG   | HL    | IF0 or IF1 | 0  | 1  | X    | 0    |
|          | LG             | LG   | LL    | IF0 or IF1 | 1  | 1  | X    | 0    |
|          | ULG            | LG   | LG    | IF0 or IF1 | 1  | 0  | X    | 0    |
| PCS      | HGHL           | HGHL | HL    | IF0 or IF1 | 0  | 0  | 1    | 1    |
|          | LG             | LG   | LL    | IF0 or IF1 | 1  | 1  | X    | 1    |
|          | ULG            | LG   | LG    | IF0 or IF1 | 1  | 0  | X    | 1    |
| GPS*     | GPS            | GPS  | GPS   | GIF        | 0  | 0  | 0    | 1    |

\*MAX2530/MAX2531/MAX2537/MAX2538 only.

X = Don't care.

**Table 3. LO Frequency Plan**

| PART    | VCO FREQUENCY              | CELLULAR LO FREQUENCY | PCS LO FREQUENCY   | GPS LO FREQUENCY |
|---------|----------------------------|-----------------------|--------------------|------------------|
| MAX2351 | Cell Band VCO              | $f_{VCO}$             | $2 \times f_{VCO}$ | —                |
| MAX2354 | Cell Band VCO              | $f_{VCO}$             | —                  | —                |
| MAX2358 | PCS Band VCO               | $0.5 \times f_{VCO}$  | $f_{VCO}$          | —                |
| MAX2359 | PCS Band VCO               | —                     | $f_{VCO}$          | —                |
| MAX2530 | Cell and PCS Dual-Band VCO | $f_{VCO}$             | $f_{VCO}$          | $(2/3) f_{VCO}$  |
| MAX2531 | Cell Band VCO              | $f_{VCO}$             | $2 \times f_{VCO}$ | $(4/3) f_{VCO}$  |
| MAX2537 | PCS Band VCO               | $0.5 \times f_{VCO}$  | —                  | $(2/3) f_{VCO}$  |
| MAX2538 | PCS Band VCO               | $0.5 \times f_{VCO}$  | $f_{VCO}$          | $(2/3) f_{VCO}$  |

## GPS Interstage

The GPS LNA and mixer include on-chip resonant tanks that can be used instead of a saw filter for image suppression. These tanks are coupled by an external L-C network between pins 8 and 10 as shown in the *Typical Application Circuit*.

## Layout Considerations

Keep RF signal lines as short as possible to minimize losses and radiation. Use controlled impedance on all high-frequency traces. Use high-Q (>40) components for the LNA input-matching circuit to achieve the lowest possible noise figure. At the mixer outputs, keep the differential signal lines together and of equal length to ensure signal balance. For proper operation, solder the exposed paddle evenly to the ground plane. Use abundant ground vias between RF traces to minimize undesired coupling.

# Quadruple-Mode PCS/Cellular/GPS LNA/Mixers

**Table 4. Typical Cascade Performance of Cellular-Band Receiver with 2.5dB Interstage Loss (RBIAS = 20kΩ)**

| PARAMETER                                             | HGHL  | HGLL  | MG    | LG    | ULG   |
|-------------------------------------------------------|-------|-------|-------|-------|-------|
| Conversion Gain (dB)                                  | 25.00 | 24.00 | 12.00 | 4.50  | 2.50  |
| Noise Figure (dB)                                     | 1.91  | 1.79  | 9.10  | 14.50 | 14.50 |
| Input IP3 (dBm)                                       | -5.14 | -6.21 | 7.75  | 13.59 | 5.44  |
| Supply Current (mA) (MAX2351/MAX2354/MAX2530/MAX2531) | 27.70 | 20.60 | 23.50 | 13.90 | 6.50  |
| Supply Current (mA) (MAX2358/MAX2537/MAX2538)         | 28.90 | 21.80 | 24.70 | 15.10 | 7.70  |

**Table 5. Typical Cascade Performance of PCS-Band Receiver with 2.5dB Interstage Loss (RBIAS = 20kΩ)**

| PARAMETER                                                    | HGHL  | LG    | ULG   |
|--------------------------------------------------------------|-------|-------|-------|
| Conversion Gain (dB)                                         | 26.00 | 4.50  | 4.00  |
| Noise Figure (dB)                                            | 1.72  | 13.16 | 13.16 |
| Input IP3 (dBm)                                              | -8.54 | +5.44 | +3.46 |
| Supply Current (mA)<br>(MAX2358/MAX2359/<br>MAX2530/MAX2538) | 26.50 | 8.60  | 7.40  |
| Supply Current (mA)<br>(MAX2351/MAX2531)                     | 27.20 | 9.30  | 8.10  |

**Table 6. Typical Cascade Performance of GPS Band (RBIAS = 20kΩ)**

| PARAMETER                                            | WITH 2.5dB<br>INTERSTAGE<br>SAW LOSS | WITH LC<br>INTERSTAGE<br>MATCH |
|------------------------------------------------------|--------------------------------------|--------------------------------|
| Conversion Gain (dB)                                 | 30.50                                | 29.09                          |
| Noise Figure (dB)                                    | 1.32                                 | 1.99                           |
| Input IP3 (dBm)                                      | -15.05                               | -14.35                         |
| Supply Current (mA)<br>(MAX2530/MAX2537/<br>MAX2538) | 18.90                                | 18.90                          |
| Supply Current (mA)<br>(MAX2531)                     | 19.60                                | 19.60                          |
| Image Suppression (dB)                               | 25                                   | 15                             |

# Quadruple-Mode PCS/Cellular/GPS LNA/Mixers

Table 7. S-Parameters for Cellular LNA in HGHL Mode

| FREQUENCY<br>(Hz) | S11    |                | S21    |                | S12    |                | S22    |                |
|-------------------|--------|----------------|--------|----------------|--------|----------------|--------|----------------|
|                   | MAG    | PHASE<br>(DEG) | MAG    | PHASE<br>(DEG) | MAG    | PHASE<br>(DEG) | MAG    | PHASE<br>(DEG) |
| 100M              | 835m   | -15.10         | 554.2m | -115.6         | 736.4μ | 121.10         | 995.1m | -8.043         |
| 200M              | 779.9m | -25.60         | 874.9m | -120.1         | 1.099m | 119.60         | 986.1m | -16.150        |
| 300M              | 748.7m | -35.09         | 1.301  | -121.0         | 1.65m  | 175.20         | 971.9m | -24.720        |
| 400M              | 729.4m | -44.95         | 1.883  | -127.0         | 5.01m  | 197.80         | 949.1m | -34.160        |
| 500M              | 709.9m | -55.94         | 2.599  | -137.2         | 11.55m | 195.50         | 909.9m | -44.900        |
| 600M              | 687.1m | -68.06         | 3.396  | -150.1         | 22.25m | 188.20         | 845m   | -57.540        |
| 700M              | 640.3m | -81.90         | 4.244  | -166.0         | 37.71m | 175.90         | 735.4m | -72.430        |
| 800M              | 557.8m | -96.31         | 4.959  | -184.3         | 56.79m | 160.40         | 570.6m | -89.160        |
| 810M              | 547.6m | -97.70         | 5.341  | -203.5         | 76.06m | 158.70         | 365.8m | -106.200       |
| 820M              | 537.1m | -99.06         | 5.358  | -205.4         | 77.86m | 157.10         | 344.5m | -107.800       |
| 830M              | 526.3m | -100.4         | 5.37   | -207.3         | 79.62m | 155.40         | 323.3m | -109.500       |
| 840M              | 515.2m | -101.70        | 5.379  | -209.1         | 81.34m | 153.70         | 302.2m | -111.100       |
| 850M              | 503.9m | -103.00        | 5.385  | -211.0         | 83.03m | 152.10         | 281.1m | -112.600       |
| 860M              | 492.5m | -104.20        | 5.386  | -212.8         | 84.68m | 150.40         | 260.2m | -114.200       |
| 870M              | 480.8m | -105.40        | 5.385  | -214.6         | 86.29m | 148.70         | 239.5m | -115.700       |
| 880M              | 469.1m | -106.50        | 5.38   | -216.4         | 87.85m | 147.10         | 218.9m | -117.200       |
| 890M              | 457.2m | -107.60        | 5.372  | -218.1         | 89.38m | 145.40         | 198.6m | -118.700       |
| 900M              | 445.3m | -108.60        | 5.362  | -219.9         | 90.86m | 143.70         | 178.6m | -120.100       |
| 1G                | 330.5m | -115.10        | 5.348  | -221.6         | 92.3m  | 128.00         | 158.9m | -121.500       |
| 1.25G             | 207.7m | -94.89         | 4.556  | -256.9         | 116m   | 97.48          | 216.9m | 27.620         |
| 1.5G              | 283.4m | -86.74         | 3.71   | -281.6         | 129.9m | 76.60          | 412.3m | 9.951          |
| 1.75G             | 382.4m | -99.91         | 3.071  | -301.6         | 135.2m | 60.00          | 529.5m | -2.140         |
| 2G                | 492m   | -120.90        | 2.536  | -320.9         | 132.1m | 44.58          | 628.6m | -12.040        |
| 2.25G             | 629.8m | -149.50        | 1.933  | -342.4         | 110m   | 29.61          | 739.7m | -22.720        |
| 2.5G              | 762.5m | -190.70        | 989.2m | -364.5         | 49.89m | 50.28          | 853.3m | -38.460        |
| 2.75G             | 703.3m | -242.40        | 549.2m | -289.0         | 128.9m | 89.36          | 833.5m | -58.420        |
| 3G                | 490m   | -287.30        | 1.273  | -295.0         | 198.4m | 69.98          | 707.4m | -70.290        |
| 3.25G             | 335.7m | -321.00        | 1.579  | -312.0         | 238m   | 55.30          | 626.1m | -75.550        |
| 3.5G              | 258.5m | -352.10        | 1.697  | -326.7         | 264.9m | 43.14          | 575.5m | -78.930        |
| 3.75G             | 212.7m | -22.90         | 1.723  | -338.6         | 284m   | 32.81          | 549.8m | -81.490        |
| 4G                | 189.9m | -51.60         | 1.729  | -348.9         | 298.7m | 23.80          | 536.3m | -84.470        |

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# Quadruple-Mode PCS/Cellular/GPS LNA/Mixers

Table 8. S-Parameters for PCS LNA in HGHL Mode

| FREQUENCY<br>(Hz) | S11    |                | S21    |                | S12    |                | S22    |                |
|-------------------|--------|----------------|--------|----------------|--------|----------------|--------|----------------|
|                   | MAG    | PHASE<br>(DEG) | MAG    | PHASE<br>(DEG) | MAG    | PHASE<br>(DEG) | MAG    | PHASE<br>(DEG) |
| 100M              | 826.3m | -18.04         | 28.510 | 163.100        | 8.437m | 86.50          | 947.8m | -7.457         |
| 200M              | 730m   | -33.35         | 25.050 | 141.400        | 15.81m | 72.78          | 870.8m | -25.890        |
| 300M              | 623.7m | -44.60         | 21.350 | 125.200        | 21.38m | 64.46          | 795.4m | -38.050        |
| 400M              | 530.6m | -52.40         | 18.100 | 112.300        | 25.89m | 58.80          | 740.8m | -47.460        |
| 500M              | 508.6m | -55.46         | 14.650 | 106.400        | 25.66m | 58.70          | 583.3m | -53.250        |
| 600M              | 419.8m | -62.24         | 13.410 | 94.840         | 32.75m | 54.65          | 657.3m | -58.520        |
| 700M              | 379.3m | -65.01         | 11.750 | 87.380         | 36.18m | 52.16          | 647.1m | -64.100        |
| 800M              | 351.2m | -67.46         | 10.450 | 80.970         | 39.47m | 50.17          | 642.7m | -68.980        |
| 900M              | 329.5m | -69.90         | 9.419  | 75.050         | 42.7m  | 48.26          | 643.4m | -73.540        |
| 1G                | 310.7m | -72.33         | 8.565  | 69.280         | 45.59m | 46.42          | 647.5m | -77.870        |
| 1.1G              | 293.7m | -74.30         | 7.822  | 63.670         | 48.5m  | 44.57          | 652.1m | -81.950        |
| 1.2G              | 280.4m | -75.57         | 7.158  | 58.350         | 51.34m | 42.79          | 657.4m | -85.690        |
| 1.3G              | 271.9m | -76.33         | 6.573  | 53.390         | 54.13m | 40.96          | 663.8m | -89.130        |
| 1.4G              | 267.7m | -76.88         | 6.065  | 48.740         | 56.8m  | 39.06          | 672.2m | -92.320        |
| 1.5G              | 266.6m | -77.55         | 5.622  | 44.290         | 59.33m | 37.14          | 682.5m | -95.320        |
| 1.6G              | 267.8m | -78.48         | 5.233  | 40.010         | 61.75m | 35.20          | 693.8m | -98.200        |
| 1.7G              | 270.5m | -79.62         | 4.887  | 35.860         | 64.01m | 33.18          | 705.1m | -101.000       |
| 1.8G              | 274.6m | -80.87         | 4.576  | 31.840         | 66.01m | 31.12          | 715.9m | -103.600       |
| 1.9G              | 280.4m | -82.23         | 4.296  | 27.970         | 67.69m | 29.12          | 726.3m | -106.100       |
| 1.91G             | 281.1m | -82.38         | 4.270  | 27.600         | 67.84m | 28.93          | 727.3m | -106.300       |
| 1.92G             | 281.8m | -82.53         | 4.244  | 27.220         | 67.99m | 28.74          | 728.4m | -106.600       |
| 1.93G             | 282.5m | -82.68         | 4.218  | 26.840         | 68.14m | 28.55          | 729.4m | -106.800       |
| 1.94G             | 283.2m | -82.82         | 4.192  | 26.470         | 68.28m | 28.36          | 730.4m | -107.000       |
| 1.95G             | 284m   | -82.98         | 4.167  | 26.090         | 68.43m | 28.18          | 731.5m | -107.300       |
| 1.96G             | 284.8m | -83.13         | 4.142  | 25.720         | 68.57m | 27.99          | 732.5m | -107.500       |
| 1.97G             | 285.6m | -83.29         | 4.117  | 25.350         | 68.71m | 27.81          | 733.5m | -107.700       |
| 1.98G             | 286.4m | -83.45         | 4.093  | 24.980         | 68.85m | 27.63          | 734.5m | -108.000       |
| 1.99G             | 287.2m | -83.61         | 4.069  | 24.610         | 68.99m | 27.45          | 735.6m | -108.200       |
| 2G                | 288m   | -83.77         | 4.045  | 24.250         | 69.12m | 27.27          | 736.6m | -108.400       |
| 2.1G              | 297.2m | -85.53         | 3.818  | 20.650         | 70.37m | 25.57          | 747m   | -110.600       |
| 2.2G              | 307.7m | -87.49         | 3.614  | 17.180         | 71.48m | 24.03          | 757.6m | -112.700       |
| 2.3G              | 319.5m | -89.65         | 3.429  | 13.830         | 72.5m  | 22.66          | 768.5m | -114.600       |
| 2.4G              | 332.6m | -92.00         | 3.264  | 10.590         | 73.47m | 21.46          | 779.7m | -116.600       |
| 2.5G              | 346.9m | -94.53         | 3.116  | 7.455          | 74.47m | 20.45          | 791.3m | -118.400       |
| 2.6G              | 362.5m | -97.25         | 2.984  | 4.420          | 75.59m | 19.61          | 803.2m | -120.300       |
| 2.7G              | 379.7m | -100.20        | 2.870  | 1.4740         | 76.93m | 18.96          | 815.5m | -122.100       |
| 2.8G              | 398.1m | -103.60        | 2.775  | -1.475         | 78.78m | 18.45          | 828.4m | -124.000       |
| 2.9G              | 415.5m | -107.70        | 2.697  | -4.627         | 81.42m | 17.73          | 840.5m | -126.000       |
| 3G                | 428.9m | -112.50        | 2.622  | -8.150         | 84.47m | 16.44          | 849.8m | -127.900       |

# Quadruple-Mode PCS/Cellular/GPS LNA/Mixers

Table 9. S-Parameters for GPS LNA

| FREQUENCY<br>(Hz) | S11    |                | S21    |                | S12    |                | S22    |                |
|-------------------|--------|----------------|--------|----------------|--------|----------------|--------|----------------|
|                   | MAG    | PHASE<br>(DEG) | MAG    | PHASE<br>(DEG) | MAG    | PHASE<br>(DEG) | MAG    | PHASE<br>(DEG) |
| 100M              | 897m   | -8.953         | 391.4m | -106.5         | 279.4μ | 142.10         | 996.2m | -6.446         |
| 200M              | 878.4m | -17.210        | 640.8m | -109.6         | 645.4μ | 131.50         | 989.8m | -12.850        |
| 300M              | 859m   | -25.060        | 892.3m | -106.4         | 883.4μ | 150.50         | 980.7m | -19.390        |
| 400M              | 839.1m | -32.680        | 1.231  | -104.0         | 1.579m | 178.90         | 968.7m | -26.200        |
| 500M              | 818.7m | -40.390        | 1.691  | -104.3         | 3.26m  | 191.20         | 953.2m | -33.480        |
| 600M              | 802.3m | -47.710        | 2.249  | -107.0         | 5.893m | 194.80         | 933.8m | -41.400        |
| 700M              | 787.6m | -55.560        | 2.97   | -111.9         | 10m    | 192.70         | 907.6m | -50.410        |
| 800M              | 772m   | -64.070        | 3.867  | -119.2         | 15.78m | 187.20         | 869.1m | -60.940        |
| 900M              | 751.1m | -73.420        | 4.916  | -129.2         | 23.39m | 179.40         | 810.1m | -73.480        |
| 1G                | 718.6m | -83.770        | 6.029  | -141.6         | 32.81m | 169.50         | 720.9m | -88.550        |
| 1.1G              | 666.6m | -94.890        | 7.037  | -155.9         | 43.28m | 157.90         | 596.2m | -106.500       |
| 1.2G              | 593.1m | -105.900       | 7.742  | -171.2         | 53.35m | 145.40         | 444.7m | -128.200       |
| 1.3G              | 506.2m | -115.600       | 8.033  | -186.2         | 61.65m | 133.30         | 293.1m | -156.200       |
| 1.4G              | 419.5m | -123.100       | 7.955  | -199.9         | 67.69m | 122.40         | 186.2m | -199.700       |
| 1.5G              | 344m   | -127.900       | 7.64   | -211.7         | 71.78m | 113.30         | 177.6m | -255.300       |
| 1.51G             | 337.2m | -128.200       | 7.601  | -212.8         | 72.11m | 112.50         | 181.8m | -260.000       |
| 1.52G             | 330.7m | -128.500       | 7.561  | -213.9         | 72.43m | 111.70         | 186.6m | -264.400       |
| 1.53G             | 324.3m | -128.800       | 7.52   | -214.9         | 72.73m | 110.90         | 191.8m | -268.500       |
| 1.54G             | 318m   | -129.000       | 7.479  | -216.0         | 73.03m | 110.10         | 197.4m | -272.400       |
| 1.55G             | 311.9m | -129.300       | 7.437  | -217.0         | 73.32m | 109.30         | 203.3m | -276.000       |
| 1.56G             | 306m   | -129.500       | 7.394  | -218.0         | 73.59m | 108.60         | 209.5m | -279.500       |
| 1.57G             | 300.2m | -129.600       | 7.351  | -219.0         | 73.86m | 107.90         | 215.8m | -282.700       |
| 1.58G             | 294.6m | -129.800       | 7.307  | -219.9         | 74.12m | 107.20         | 222.3m | -285.700       |
| 1.59G             | 289.2m | -129.900       | 7.263  | -220.9         | 74.38m | 106.50         | 228.9m | -288.500       |
| 1.6G              | 283.9m | -130.000       | 7.219  | -221.8         | 74.62m | 105.80         | 235.5m | -291.100       |
| 1.7G              | 239.4m | -130.000       | 6.777  | -230.4         | 76.78m | 99.70          | 300.4m | -311.100       |
| 1.8G              | 208m   | -128.700       | 6.359  | -237.7         | 78.68m | 94.75          | 356.2m | -324.000       |
| 1.9G              | 186m   | -126.900       | 5.979  | -244.1         | 80.58m | 90.66          | 401.9m | -333.500       |
| 2G                | 170.2m | -124.800       | 5.637  | -249.9         | 82.6m  | 87.15          | 439.3m | -341.000       |
| 2.1G              | 158.8m | -122.800       | 5.328  | -255.0         | 84.75m | 84.05          | 469.6m | -347.300       |
| 2.2G              | 150.9m | -120.900       | 5.05   | -259.7         | 86.99m | 81.26          | 494.3m | -352.800       |
| 2.3G              | 145.5m | -119.300       | 4.802  | -264.0         | 89.28m | 78.68          | 514.2m | -357.600       |
| 2.4G              | 142.1m | -118.200       | 4.58   | -268.0         | 91.57m | 76.29          | 530m   | -2.000         |
| 2.5G              | 139.8m | -117.500       | 4.382  | -271.7         | 93.8m  | 74.07          | 542.2m | -6.000         |
| 2.6G              | 138.3m | -117.200       | 4.204  | -275.2         | 95.98m | 72.04          | 551.3m | -9.700         |
| 2.7G              | 137m   | -117.400       | 4.044  | -278.5         | 98.11m | 70.19          | 558m   | -13.100        |
| 2.8G              | 133.5m | -117.700       | 3.895  | -281.8         | 100.1m | 68.60          | 562.3m | -16.100        |
| 2.9G              | 128.4m | -114.600       | 3.727  | -285.1         | 102.5m | 67.51          | 567m   | -18.600        |
| 3G                | 139.9m | -109.200       | 3.557  | -287.2         | 106m   | 66.24          | 574.8m | -21.200        |

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# Quadruple-Mode PCS/Cellular/GPS LNA/Mixers

Table 9. S-Parameters for GPS LNA (continued)

| FREQUENCY<br>(Hz) | S11    |                | S21   |                | S12    |                | S22    |                |
|-------------------|--------|----------------|-------|----------------|--------|----------------|--------|----------------|
|                   | MAG    | PHASE<br>(DEG) | MAG   | PHASE<br>(DEG) | MAG    | PHASE<br>(DEG) | MAG    | PHASE<br>(DEG) |
| 3.1G              | 162.7m | -110.6         | 3.458 | -288.7         | 109.3m | 64.45          | 579.9m | -24.1          |
| 3.2G              | 182.9m | -117.0         | 3.422 | -290.4         | 111.8m | 62.71          | 581.1m | -26.8          |
| 3.3G              | 193.1m | -126.3         | 3.422 | -293.0         | 113.9m | 61.32          | 580.5m | -29.2          |
| 3.4G              | 187.8m | -135.5         | 3.405 | -296.5         | 116.3m | 60.27          | 580.1m | -31.4          |
| 3.5G              | 173.9m | -141.5         | 3.340 | -300.1         | 119.1m | 59.34          | 580.8m | -33.4          |
| 3.6G              | 161.5m | -144.5         | 3.251 | -303.4         | 122.2m | 58.40          | 581.9m | -35.3          |
| 3.7G              | 153.7m | -145.6         | 3.161 | -306.2         | 125.5m | 57.45          | 582.9m | -37.3          |
| 3.8G              | 150m   | -146.3         | 3.080 | -308.8         | 128.9m | 56.54          | 584m   | -39.1          |
| 3.9G              | 149.2m | -146.9         | 3.008 | -311.2         | 132.4m | 55.68          | 585.3m | -41.0          |
| 4G                | 150.3m | -147.8         | 2.945 | -313.5         | 136.2m | 54.86          | 587m   | -42.7          |

Table 10. S-Parameters for Cellular Mixer in High-Linearity Mode

| FREQUENCY<br>(Hz) | S11    |             |
|-------------------|--------|-------------|
|                   | MAG    | PHASE (DEG) |
| 100M              | 997.8m | -6.397      |
| 200M              | 993.1m | -13.080     |
| 300M              | 984.5m | -20.480     |
| 400M              | 968.2m | -29.270     |
| 500M              | 941.8m | -40.340     |
| 600M              | 879m   | -56.150     |
| 700M              | 739.9m | -80.690     |
| 800M              | 475.4m | -123.700    |
| 810M              | 444.8m | -129.900    |
| 820M              | 414.7m | -136.700    |
| 830M              | 385.9m | -144.100    |
| 840M              | 359.1m | -152.300    |
| 850M              | 335.2m | -161.200    |
| 860M              | 314.9m | -170.900    |
| 870M              | 299.3m | -181.400    |

| FREQUENCY<br>(MHz) | S11    |             |
|--------------------|--------|-------------|
|                    | MAG    | PHASE (DEG) |
| 880M               | 289m   | -192.4      |
| 890M               | 284.4m | -203.5      |
| 900M               | 285.5m | -214.6      |
| 1G                 | 451.9m | -286.0      |
| 1.25G              | 734.2m | -337.2      |
| 1.5G               | 815.1m | -356.3      |
| 1.75G              | 846.4m | -8.0        |
| 2G                 | 860.2m | -16.9       |
| 2.25G              | 864.6m | -16.9       |
| 2.5G               | 862m   | -16.9       |
| 2.75G              | 850.6m | -16.9       |
| 3G                 | 846.6m | -16.9       |
| 3.25G              | 857.1m | -16.9       |
| 3.5G               | 860.5m | -16.9       |
| 3.75G              | 857.2m | -16.9       |
| 4G                 | 849.3m | -16.9       |



# Quadruple-Mode PCS/Cellular/GPS LNA/Mixers

Table 11. S-Parameters for PCS Mixer in High Linearity Mode

| FREQUENCY<br>(Hz) | S11    |             |
|-------------------|--------|-------------|
|                   | MAG    | PHASE (DEG) |
| 100M              | 949.1m | -3.234      |
| 200M              | 942.3m | -6.090      |
| 300M              | 933.3m | -8.977      |
| 400M              | 922.8m | -11.780     |
| 500M              | 904.9m | -14.700     |
| 600M              | 895.6m | -17.390     |
| 700M              | 881.2m | -20.300     |
| 800M              | 863.9m | -23.310     |
| 900M              | 845.8m | -26.410     |
| 1G                | 826.6m | -29.830     |
| 1.1G              | 804m   | -33.700     |
| 1.2G              | 776.7m | -38.130     |
| 1.3G              | 742.2m | -43.330     |
| 1.4G              | 696.8m | -49.580     |
| 1.5G              | 635.2m | -57.090     |
| 1.6G              | 554.4m | -66.040     |
| 1.7G              | 454.4m | -77.180     |
| 1.8G              | 335.7m | -92.710     |
| 1.9G              | 207.5m | -120.400    |
| 1.91G             | 195.6m | -124.700    |
| 1.92G             | 184.3m | -129.500    |
| 1.93G             | 173.7m | -134.800    |
| 1.94G             | 164.1m | -140.700    |
| 1.95G             | 155.7m | -147.200    |

| FREQUENCY<br>(Hz) | S11    |             |
|-------------------|--------|-------------|
|                   | MAG    | PHASE (DEG) |
| 1.96G             | 148.7m | -154.3      |
| 1.97G             | 143.5m | -162.0      |
| 1.98G             | 140.2m | -170.2      |
| 1.99G             | 139.2m | -178.6      |
| 2G                | 140.4m | -187.2      |
| 2.1G              | 244.9m | -246.7      |
| 2.2G              | 402.9m | -273.1      |
| 2.3G              | 551.8m | -290.0      |
| 2.4G              | 675.8m | -302.9      |
| 2.5G              | 773.9m | -313.4      |
| 2.6G              | 851.9m | -322.3      |
| 2.7G              | 911.7m | -330.3      |
| 2.8G              | 948.5m | -337.6      |
| 2.9G              | 964m   | -343.9      |
| 3G                | 964.3m | -349.2      |
| 3.1G              | 956.1m | -353.4      |
| 3.2G              | 944.9m | -356.6      |
| 3.3G              | 934.5m | -359.1      |
| 3.4G              | 928m   | -1.0        |
| 3.5G              | 926.9m | -2.7        |
| 3.6G              | 929.9m | -4.2        |
| 3.7G              | 934.9m | -5.8        |
| 3.8G              | 939.9m | -7.4        |
| 3.9G              | 944.2m | -9.1        |
| 4G                | 947.8m | -10.6       |

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# **Quadruple-Mode PCS/Cellular/GPS LNA/Mixers**

**Table 12. S-Parameters for GPS Mixer in High Linearity Mode**

| FREQUENCY<br>(Hz) | S11    |             |
|-------------------|--------|-------------|
|                   | MAG    | PHASE (DEG) |
| 100M              | 955.2m | -3.662      |
| 200M              | 947.6m | -6.944      |
| 300M              | 938m   | -10.250     |
| 400M              | 926.8m | -13.550     |
| 500M              | 910.8m | -16.840     |
| 600M              | 896m   | -20.300     |
| 700M              | 877.6m | -23.970     |
| 800M              | 854.6m | -27.950     |
| 900M              | 825.7m | -32.250     |
| 1G                | 790.1m | -37.090     |
| 1.1G              | 743.8m | -42.690     |
| 1.2G              | 681.1m | -49.330     |
| 1.3G              | 594.6m | -57.350     |
| 1.4G              | 474.7m | -67.280     |
| 1.5G              | 307.7m | -79.620     |
| 1.51G             | 288.2m | -80.960     |
| 1.52G             | 268.2m | -82.330     |
| 1.53G             | 247.7m | -83.700     |
| 1.54G             | 226.8m | -85.080     |
| 1.55G             | 205.4m | -86.460     |
| 1.56G             | 183.7m | -87.840     |
| 1.57G             | 161.5m | -89.200     |
| 1.58G             | 139m   | -90.520     |
| 1.59G             | 116.2m | -91.770     |

| FREQUENCY<br>(Hz) | S11    |             |
|-------------------|--------|-------------|
|                   | MAG    | PHASE (DEG) |
| 1.6G              | 93.14m | -92.870     |
| 1.7G              | 143.3m | 67.370      |
| 1.8G              | 357.5m | 53.140      |
| 1.9G              | 522.6m | 40.470      |
| 2G                | 639m   | 30.150      |
| 2.1G              | 718.6m | 21.880      |
| 2.2G              | 772.8m | 15.230      |
| 2.3G              | 811.4m | 9.874       |
| 2.4G              | 842.9m | 5.410       |
| 2.5G              | 869.8m | 1.356       |
| 2.6G              | 890.8m | -2.443      |
| 2.7G              | 906.1m | -5.968      |
| 2.8G              | 916.8m | -9.216      |
| 2.9G              | 924m   | -12.200     |
| 3G                | 928.9m | -14.940     |
| 3.1G              | 932.3m | -17.490     |
| 3.2G              | 934.5m | -19.880     |
| 3.3G              | 935.8m | -22.150     |
| 3.4G              | 936.4m | -24.300     |
| 3.5G              | 936.4m | -26.360     |
| 3.6G              | 936m   | -28.340     |
| 3.7G              | 935.3m | -30.240     |
| 3.8G              | 934.3m | -32.080     |
| 3.9G              | 933.1m | -33.880     |
| 4G                | 931.7m | -35.620     |

# Quadruple-Mode PCS/Cellular/GPS LNA/Mixers

**Table 13. Noise Parameters for Cellular LNA in HGHL Mode**

| FREQUENCY (MHz) | NF <sub>MIN</sub> (dB) | Γ <sub>OPT</sub> | ∠Γ <sub>OPT</sub> | R <sub>N</sub> (Ω) |
|-----------------|------------------------|------------------|-------------------|--------------------|
| 700             | 0.75                   | 0.15             | 107               | 4.0                |
| 800             | 0.76                   | 0.16             | 117               | 3.9                |
| 810             | 0.76                   | 0.16             | 118               | 3.9                |
| 820             | 0.76                   | 0.17             | 119               | 3.8                |
| 830             | 0.76                   | 0.17             | 120               | 3.8                |
| 840             | 0.77                   | 0.17             | 121               | 3.8                |
| 850             | 0.77                   | 0.17             | 122               | 3.8                |
| 860             | 0.78                   | 0.17             | 123               | 3.8                |
| 870             | 0.77                   | 0.17             | 123               | 3.8                |
| 880             | 0.77                   | 0.17             | 124               | 3.8                |
| 890             | 0.77                   | 0.17             | 125               | 3.7                |
| 900             | 0.78                   | 0.18             | 126               | 3.7                |
| 1000            | 0.79                   | 0.19             | 134               | 3.6                |

**Table 14. Noise Parameters for PCS LNA in HGHL Mode**

| FREQUENCY (MHz) | NF <sub>MIN</sub> (dB) | Γ <sub>OPT</sub> | ∠Γ <sub>OPT</sub> | R <sub>N</sub> (Ω) |
|-----------------|------------------------|------------------|-------------------|--------------------|
| 1800            | 0.89                   | 0.22             | -123              | 4.3                |
| 1900            | 0.89                   | 0.19             | -129              | 4.2                |
| 1910            | 0.89                   | 0.19             | -130              | 4.2                |
| 1920            | 0.89                   | 0.19             | -131              | 4.2                |
| 1930            | 0.89                   | 0.18             | -131              | 4.2                |
| 1940            | 0.90                   | 0.18             | -133              | 4.1                |
| 1950            | 0.90                   | 0.18             | -134              | 4.1                |
| 1960            | 0.90                   | 0.18             | -134              | 4.1                |
| 1970            | 0.90                   | 0.18             | -135              | 4.1                |
| 1980            | 0.90                   | 0.18             | -136              | 4.1                |
| 1990            | 0.90                   | 0.18             | -137              | 4.1                |
| 2000            | 0.90                   | 0.17             | -138              | 4.1                |
| 2100            | 0.91                   | 0.17             | -147              | 4.0                |

**Table 15. Noise Parameters for GPS LNA in HGHL Mode**

| FREQUENCY (MHz) | NF <sub>MIN</sub> (dB) | Γ <sub>OPT</sub> | ∠Γ <sub>OPT</sub> | R <sub>N</sub> (Ω) |
|-----------------|------------------------|------------------|-------------------|--------------------|
| 1400            | 0.71                   | 0.20             | 78                | 4.7                |
| 1500            | 0.73                   | 0.19             | 84                | 4.6                |
| 1510            | 0.74                   | 0.19             | 85                | 4.6                |
| 1520            | 0.74                   | 0.19             | 85                | 4.6                |
| 1530            | 0.74                   | 0.19             | 86                | 4.6                |
| 1540            | 0.74                   | 0.19             | 86                | 4.6                |
| 1550            | 0.75                   | 0.19             | 87                | 4.6                |
| 1560            | 0.75                   | 0.19             | 87                | 4.6                |
| 1570            | 0.75                   | 0.19             | 88                | 4.6                |
| 1580            | 0.75                   | 0.19             | 88                | 4.6                |

## Chip Information

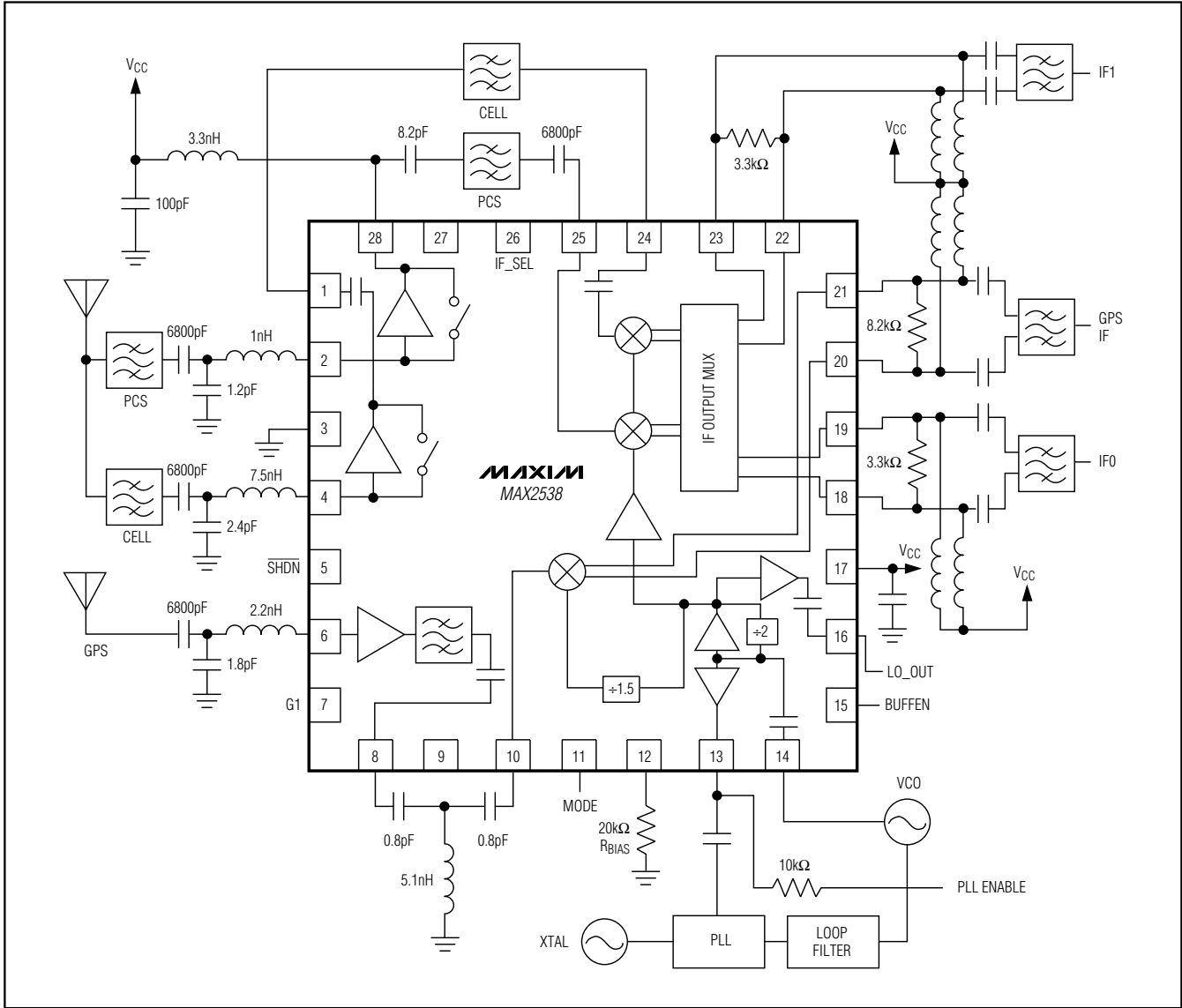
TRANSISTOR COUNT: 2538

PROCESS: BiCMOS

MAX2351/4/8/9/MAX2530/1/7/8

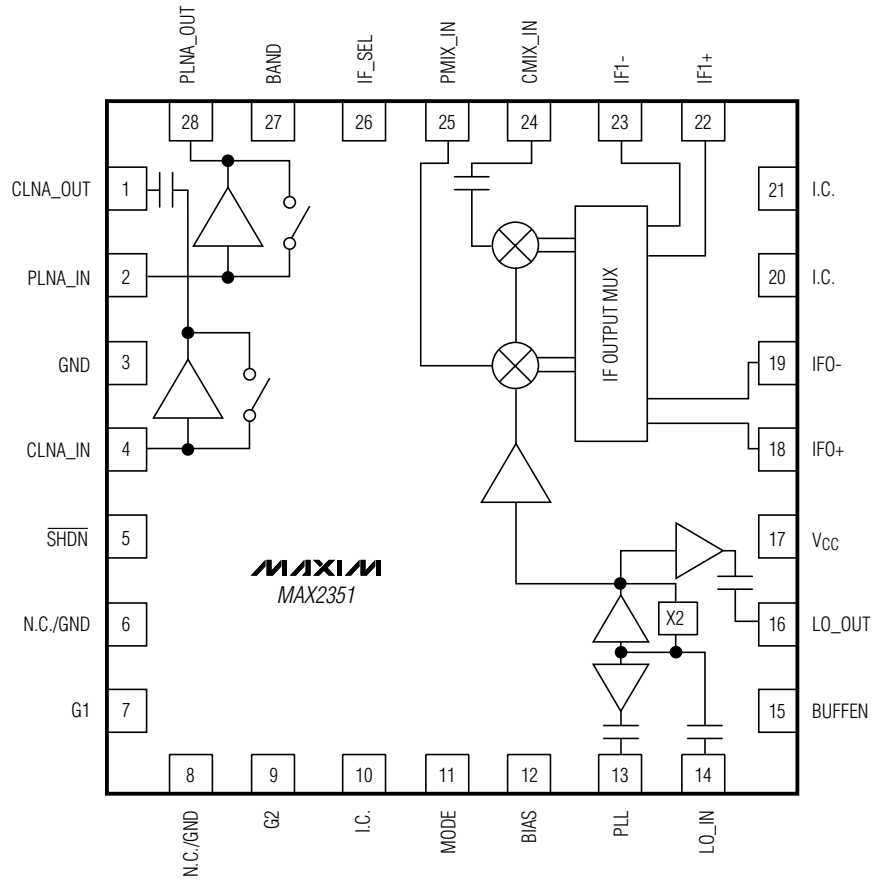
# Quadruple-Mode PCS/Cellular/GPS LNA/Mixers

Typical Application Circuit



# Quadruple-Mode PCS/Cellular/GPS LNA/Mixers

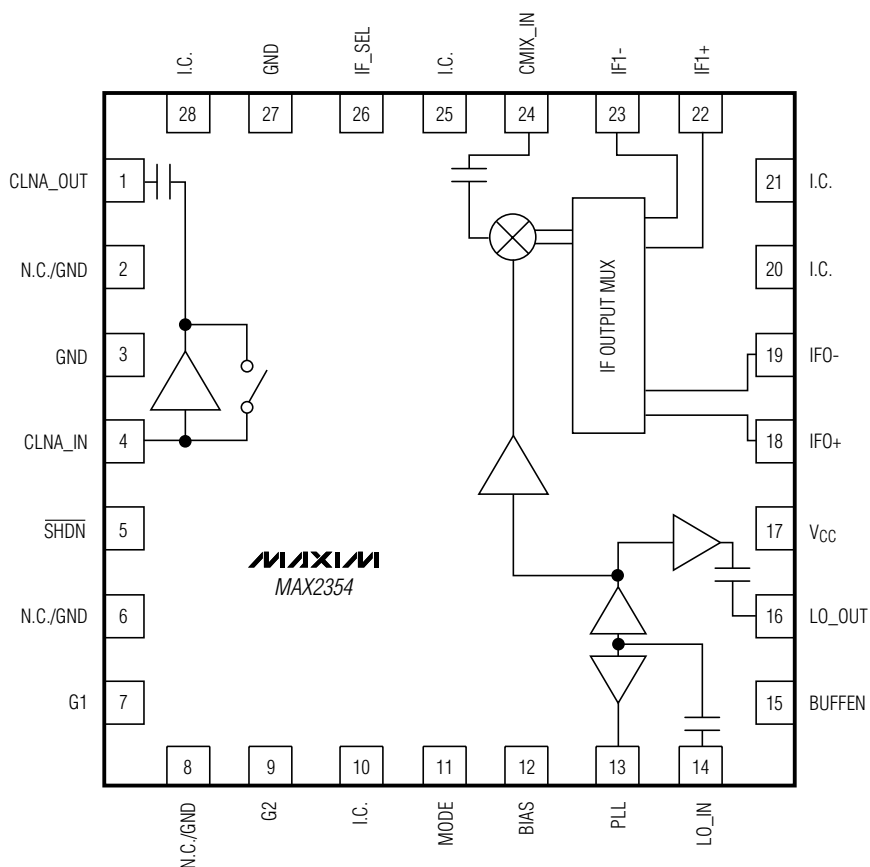
## Pin Configurations (continued)



MAX2351/4/8/9/MAX2530/1/7/8

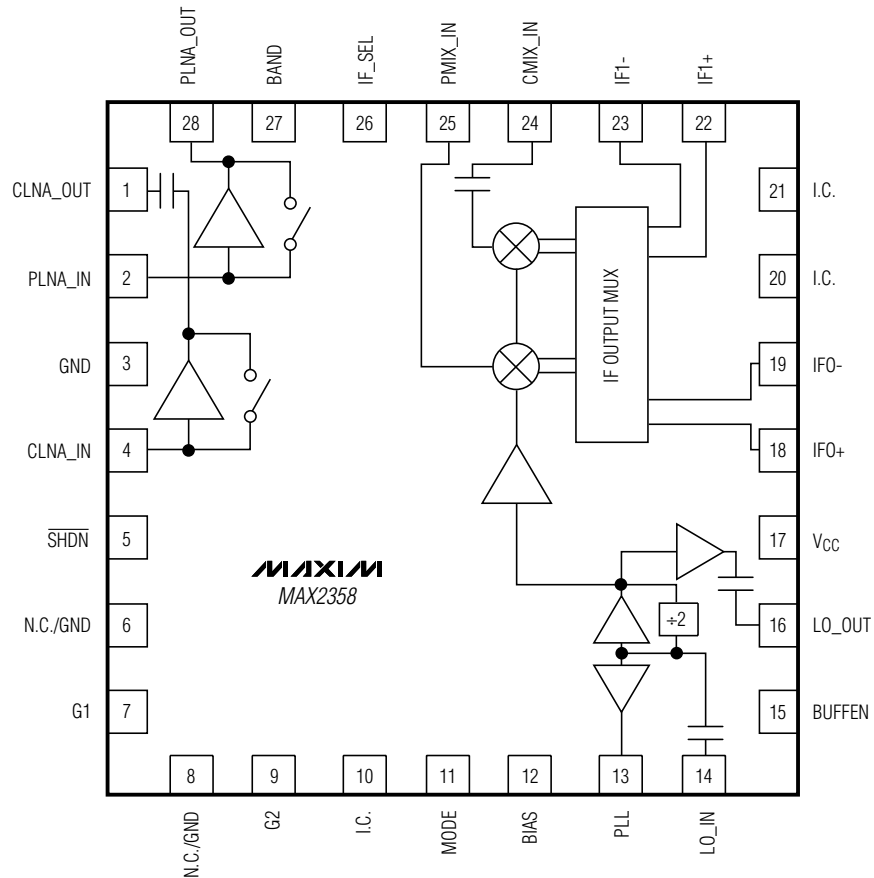
# **Quadruple-Mode PCS/Cellular/GPS LNA/Mixers**

## **Pin Configurations (continued)**



# Quadruple-Mode PCS/Cellular/GPS LNA/Mixers

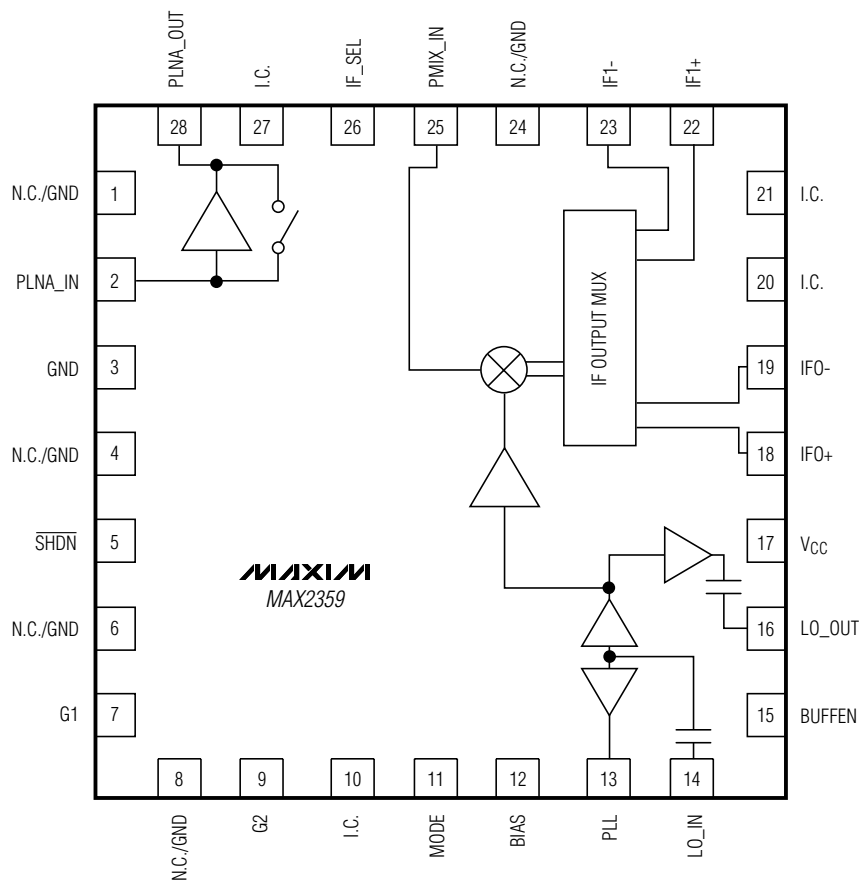
## Pin Configurations (continued)



MAX2351/4/8/9/MAX2530/1/7/8

# **Quadruple-Mode PCS/Cellular/GPS LNA/Mixers**

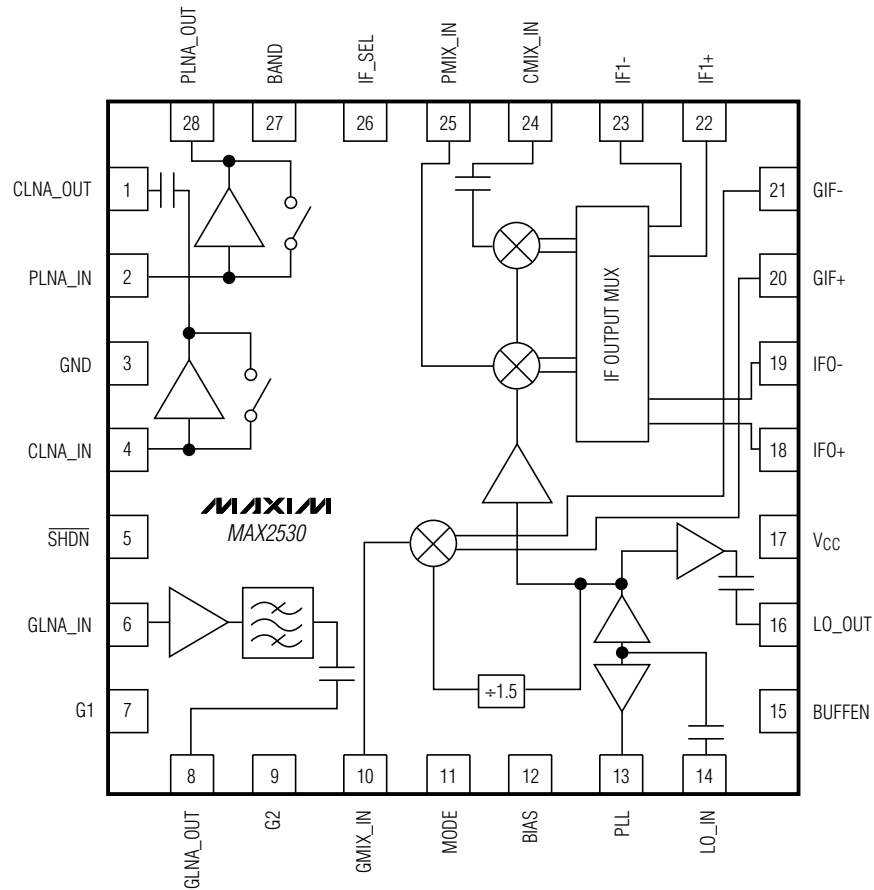
## **Pin Configurations (continued)**





# Quadruple-Mode PCS/Cellular/GPS LNA/Mixers

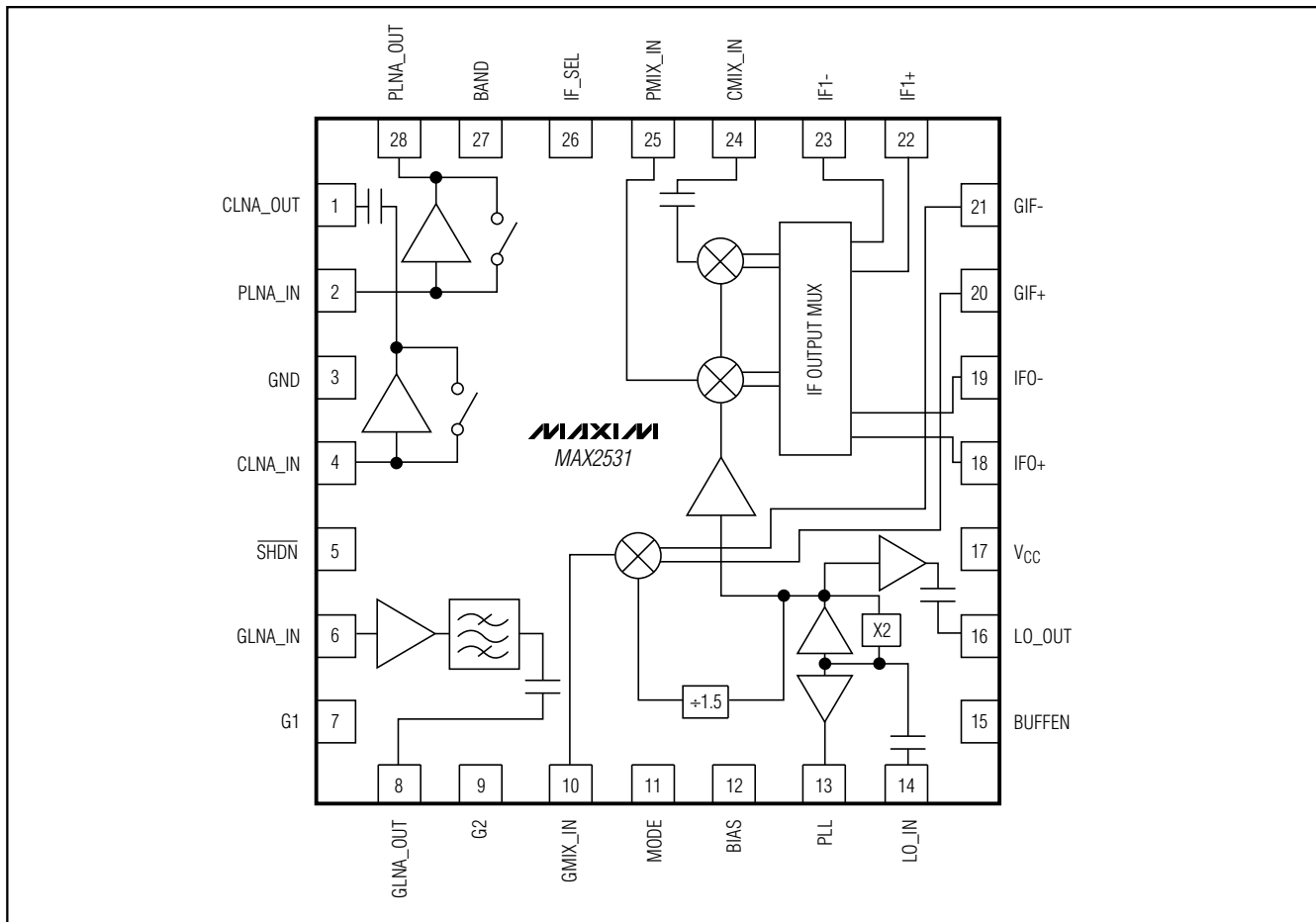
## Pin Configurations (continued)



MAX2351/4/8/9/MAX2530/1/7/8

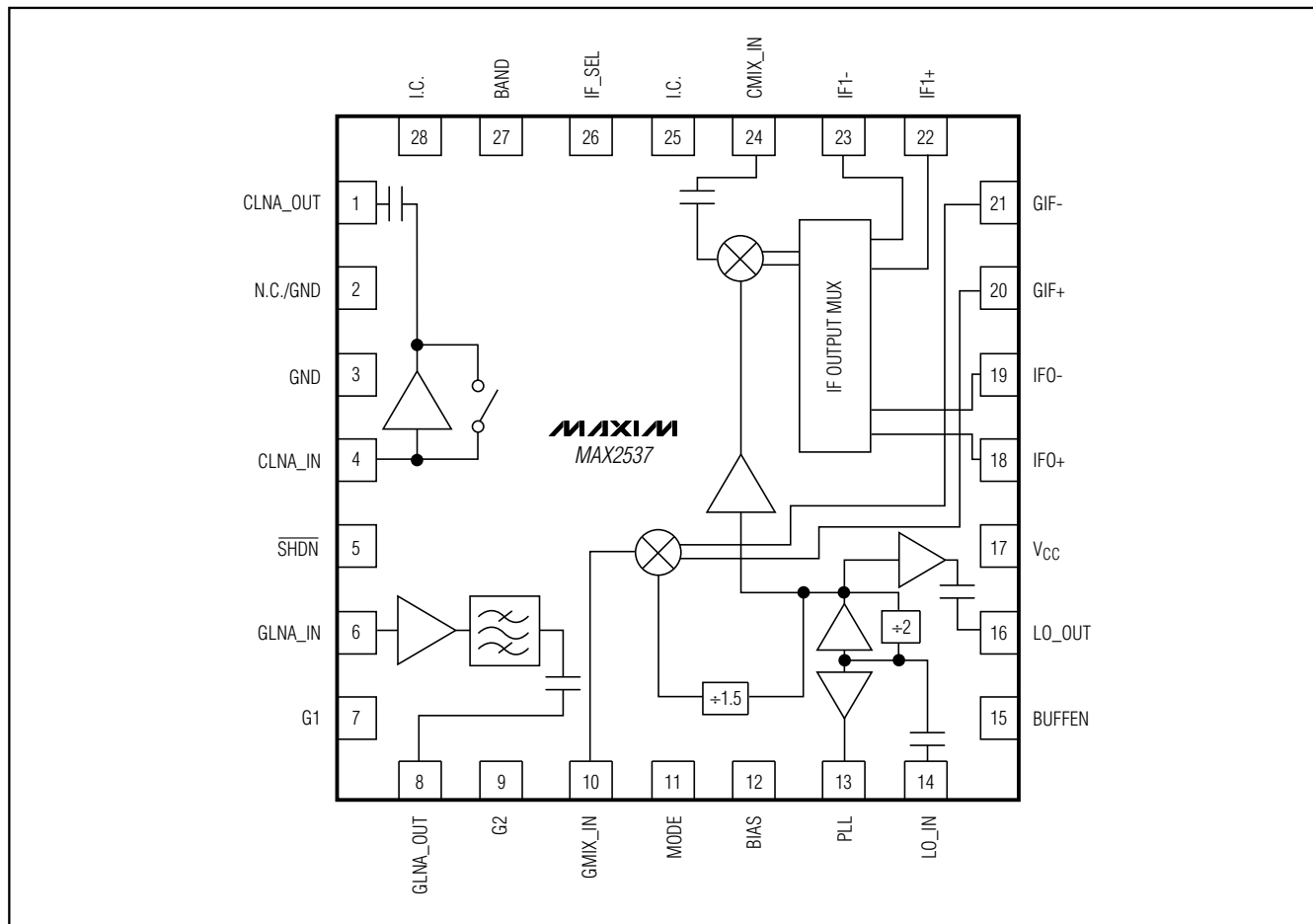
# Quadruple-Mode PCS/Cellular/GPS LNA/Mixers

## Pin Configurations (continued)



# Quadruple-Mode PCS/Cellular/GPS LNA/Mixers

## Pin Configurations (continued)



MAX2351/4/8/9/MAX2530/1/7/8

## Package Information

For the latest package outline information, go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).

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