

Keywords: W-CDMA, LNA, low noise amplifier, 190MHz IF, UMTS, UMTS receiver

## APPLICATION NOTE 486

# MAX2388 at 190MHz IF for WCDMA

Aug 29, 2002

*Abstract: Bench measurement data is provided for the MAX2387 WCDMA low-noise amplifier (LNA) and mixer for a 2140MHz RF and 190MHz IF. The IF output has been re-matched for 190MHz, and the new bill of materials is provided.*

## Additional Information

- [Wireless Product Line Page](#)
- [Quick View Data Sheet for the MAX2387/MAX2388/MAX2389](#)
- [Applications Technical Support](#)



[Click here for an overview of the wireless components used in a typical radio transceiver.](#)

## Introduction to the MAX238X

The MAX2387, MAX2388, and MAX2389 are members of a family of receive front-end devices designed for WCDMA application. They integrate a low-noise amplifier (LNA) and a high-linearity downconvert mixer in an ultra-small package. The MAX2387 and MAX2388 include a local oscillator (LO) input buffer, whereas the MAX2389 eliminates the LO buffer to provide lower current consumption.

All devices feature a high-gain and low-gain mode of operation, with a 32dB gain step for the MAX2387 and an 18dB gain step for the MAX2388/MAX2389. The ICs also include a shutdown mode for powering-down the IC.

The mixer's 3rd-order nonlinearity performance can be adjusted using an external bias resistor through the BIAS\_SET pin to obtain balance between desired linearity and acceptable current consumption. For the MAX2387 and MAX2388, mixer performance is optimized for a -10dBm typical drive at the LO input buffer port. The MAX2389's mixer performance is optimized for a -4dBm typical drive at the LO input port. The LO port for all versions is configurable for either single-ended or differential operation.

## Measured Performance

Most of the measurement data shown below were taken on the MAX2388 with 190MHz intermediate frequency (IF) at  $V_{CC} = 2.8V$ . The MAX2387 and MAX2389 were verified to have similar performance.

**Test Conditions:**

1.  $V_{CC} = 2.8V$
2. RF input power = -30dBm
3. RF frequency = 2140MHz; LO frequency = 2330MHz
4. Two-tone spacing = 1MHz

5. LO power = -10dBm (-4dBm for MAX2389)

**Table 1. LNA Measurements**

| Parameter | High Gain | Low Gain            | Units | Comments  |
|-----------|-----------|---------------------|-------|---|
| Gain      | 14.6      | -2.8 ( -17 MAX2387) | dB    | LNA input loss = 0.2dB and LNA output loss = 0.2dB have been de-embedded from the measurements. |
| NF        | 1.8       | 7.0                 | dB    | LNA input loss = 0.2dB has been de-embedded from the measurement.                               |
| IIP3      | 3.5       | 1.0                 | dBm   | Measured with RF = -20dBm at low-gain mode  |
| S11       | -10.5     | -12.9               | dB    | $10 \cdot \log_{10}( S_{11} )$  |
| S22       | -13.5     | -16.5               | dB    | $10 \cdot \log_{10}( S_{22} )$  |
| S12       | -25.4     | -12.1               | dB    | $10 \cdot \log_{10}( S_{12} )$  |
| Icc       | 9.9       | 6.8                 | mA    |   |

**Table 2. Mixer Measurements**

| Parameter             | High Gain | Low Gain | Units | Comments  |
|-----------------------|-----------|----------|-------|---|
| Gain                  | 10.5      | 9.5      | dB    | Mixer input loss = 0.2 and IF balun insertion loss = 1.0dB have been de-embedded. |
| NF                    | 6.8       | 6.2      | dB    | Mixer input loss = 0.2dB has been de-embedded from the measurement.               |
| IIP3                  | 10.0      | 1.8      | dBm   |   |
| IIP2                  | 17.0      | 16.8     | dBm   | With single-ended LO drive  |
| IIP2                  | 31.2      | 30.5     | dBm   | With differential LO drive  |
| LO Leakage at IF Port | -25.5     | -25.5    | dBm   | LO = -10 dBm @2330MHz MAX2387/88  |
| LO Leakage at RF Port | -45       | -45      | dBm   | LO = -10 dBm @2330MHz MAX2387/88  |

**Table 3. S-Parameters of the LNA at High-Gain Mode**

| Frequency<br>(GHz) | S11     |            | S21     |            | S12     |            | S22     |            |
|--------------------|---------|------------|---------|------------|---------|------------|---------|------------|
|                    | Mag(dB) | Phase(Deg) | Mag(dB) | Phase(Deg) | Mag(dB) | Phase(Deg) | Mag(dB) | Phase(Deg) |
| 1.0                | -2.1286 | -58.278    | 12.847  | 133.75     | -32.155 | 74.423     | -0.945  | -23.033    |
| 1.1                | -2.3856 | -62.382    | 12.331  | 131.49     | -32.022 | 80.579     | -0.964  | -25.008    |
| 1.2                | -2.6618 | -65.862    | 12.154  | 128        | -31.585 | 73.547     | -1.089  | -24.881    |
| 1.3                | -2.855  | 69.138     | 11.703  | 126.22     | -30.677 | 77.068     | -1.285  | -25.903    |
| 1.4                | -3.1572 | -72.628    | 11.296  | 123.77     | -31.095 | 76.873     | -1.325  | -26.516    |
| 1.5                | -3.4104 | -75.839    | 11.253  | 120.6      | -30.572 | 75.955     | -1.467  | -26.709    |
| 1.6                | -3.7441 | -78.872    | 11.206  | 121.03     | -30.134 | 77.315     | -1.625  | -27.577    |
| 1.7                | -4.1285 | -82.259    | 10.622  | 117.69     | -30.08  | 80.001     | -1.798  | -28.049    |
| 1.8                | -4.3986 | -85.465    | 10.986  | 116.13     | -29.453 | 82.934     | -1.925  | -29.221    |
| 1.9                | -4.7755 | -89.3      | 10.436  | 115.06     | -29.922 | 83.366     | -2.098  | -29.713    |
| 2.0                | -5.2184 | -92.921    | 10.444  | 110.19     | -29.151 | 84.624     | -2.267  | -30.994    |
| 2.1                | -5.6356 | -96.942    | 10.353  | 108.99     | -28.898 | 86.776     | -2.345  | -32.867    |
| 2.2                | -6.0176 | -101       | 10.29   | 105.5      | -28.514 | 87.56      | -2.451  | -35.262    |
| 2.3                | -6.4621 | -106.27    | 10.58   | 104.32     | -27.631 | 89.437     | -2.685  | -38.079    |
| 2.4                | -6.9126 | -111.35    | 9.8114  | 100.88     | -27.764 | 88.93      | -2.835  | -42.528    |
| 2.5                | -7.2807 | -117.04    | 10.106  | 95.216     | -27.384 | 88.897     | -3.018  | -46.811    |
| 2.6                | -7.7233 | -122.7     | 9.7148  | 95.186     | -26.945 | 88.47      | -3.077  | -51.827    |
| 2.7                | -7.9908 | -130.37    | 9.0991  | 88.322     | -26.888 | 93.211     | -3.077  | -57.443    |
| 2.8                | -8.2315 | -137.57    | 9.6216  | 84.239     | -26.285 | 89.688     | -3.257  | -63.369    |
| 2.9                | -8.2342 | -144.27    | 9.0162  | 85.306     | -26.094 | 95.284     | -3.305  | -69.697    |
| 3.0                | -8.3826 | -151.69    | 8.5833  | 77.645     | -26.065 | 91.953     | -3.198  | -75.708    |

### Mixer OIM3 versus RF Input Power

Test conditions are the same for the gain, IIP3, and NF measurements stated previously.

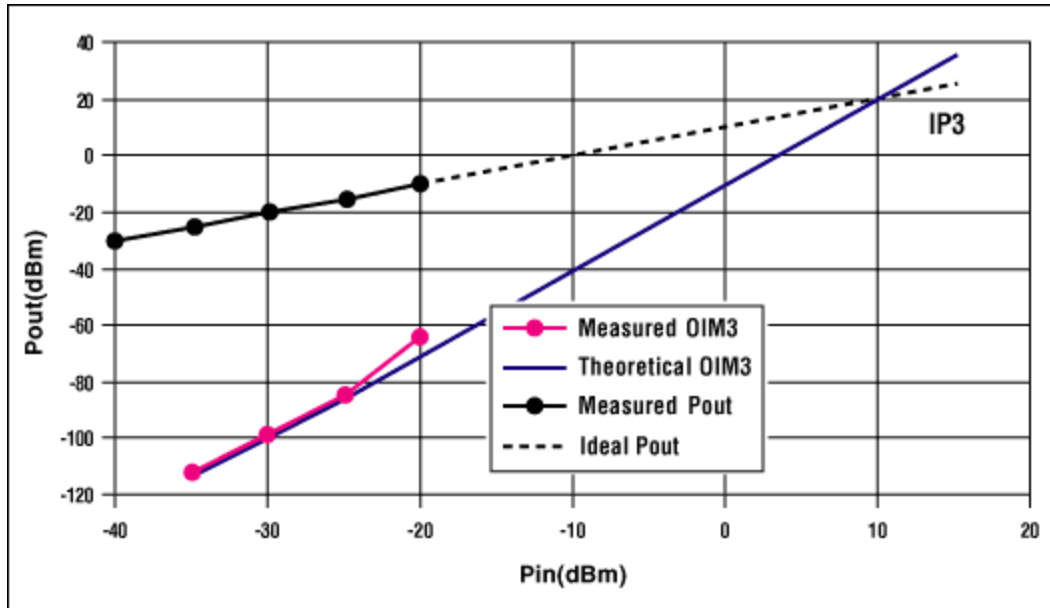


Figure 1. MAX2388 mixer IIM3 versus pin.

### Mixer IIP3 versus V<sub>CC</sub>

The mixer features very high linearity with low current consumption. Feedback is the novel technique used to improve IIP3 with low current consumption. However, the feedback is optimized at V<sub>CC</sub> = 2.7V. If V<sub>CC</sub> deviates from 2.7V, IIP3 does not obtain the optimum value of approximately +12dBm. The following figure shows the IIP3 change versus V<sub>CC</sub>.

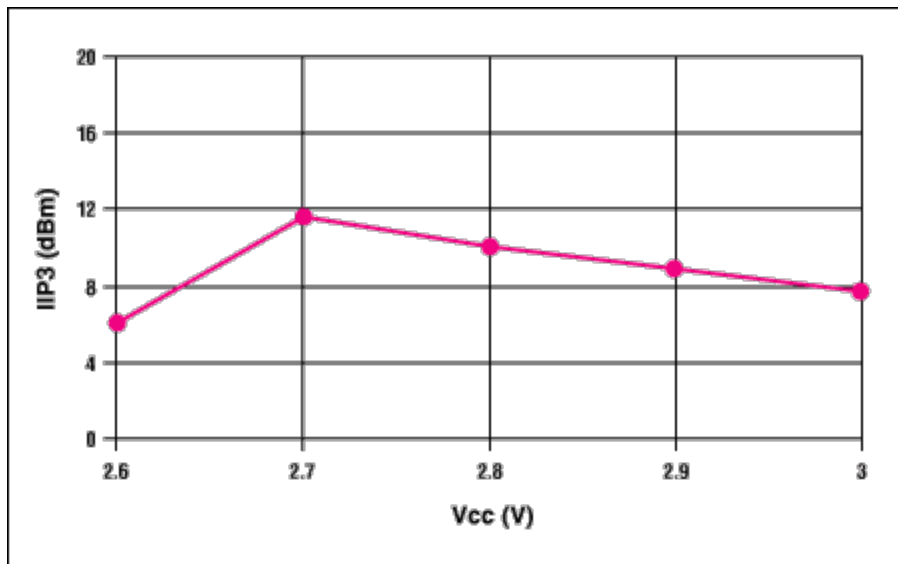


Figure 2. Mixer IIP3 versus V<sub>CC</sub>.

## Test Setup

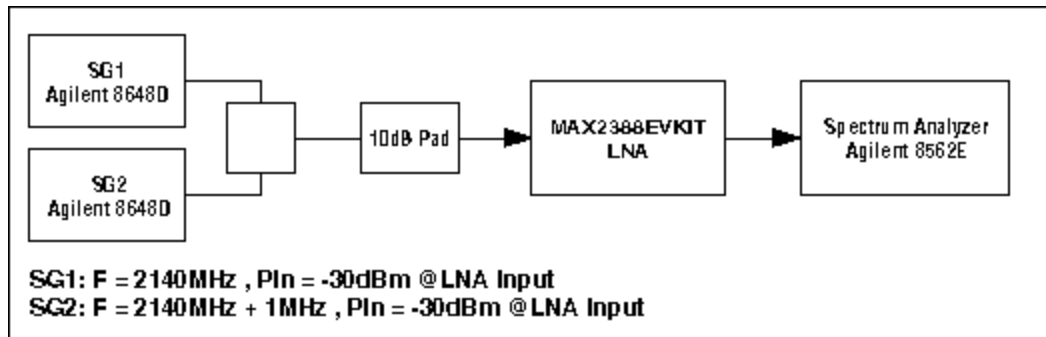


Figure 3. MAX2388 LNA IIP3 measurement.

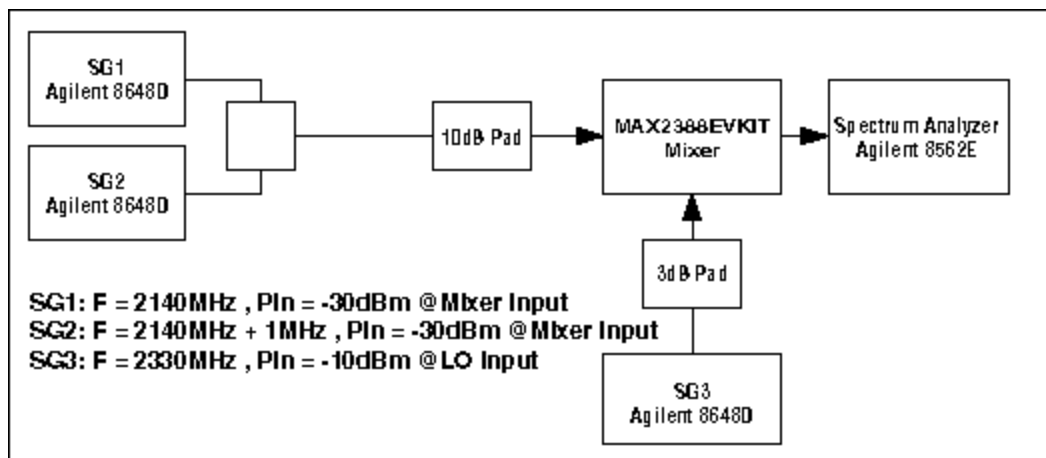


Figure 4. MAX2388 mixer IIP3 measurement.

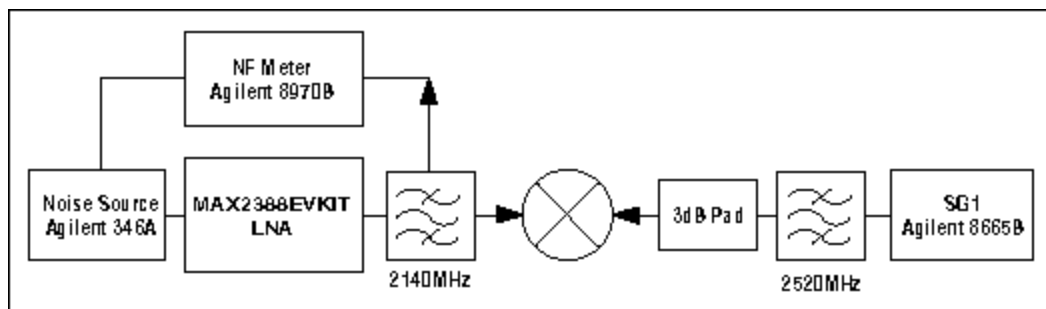


Figure 5. MAX2388 LNA NF measurement.

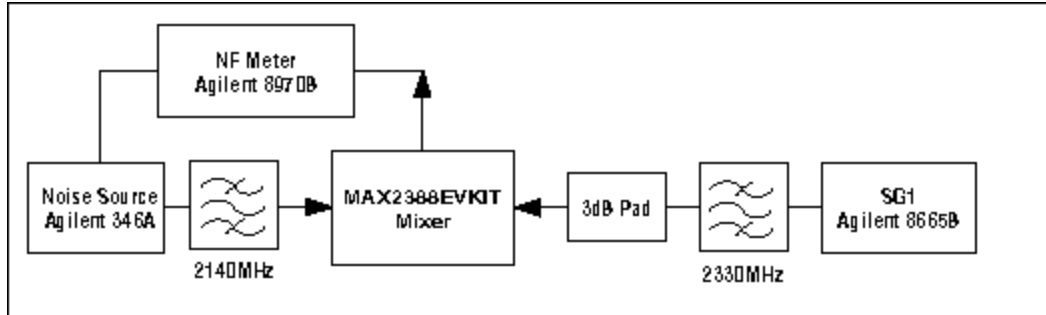


Figure 6. MAX2388 mixer NF measurement.

[Bill of Materials for 190MHz IF Match of the Mixer \(PDF, 11K\)](#)  
[MAX2387 Evaluation Kit \(PDF, 45K\)](#)

#### Related Parts

|         |                      |
|---------|----------------------|
| MAX2387 | W-CDMA LNA/Mixer ICs |
| MAX2388 | W-CDMA LNA/Mixer ICs |
| MAX2389 | W-CDMA LNA/Mixer ICs |

#### More Information

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