

# **PLLatinum™ Ultra Low Power Dual Frequency Synthesizer for RF Personal Communications LMX2330U 2.5 GHz/600 MHz, LMX2331U 2.0 GHz/600 MHz, LMX2332U 1.2 GHz/600 MHz**

Check for Samples: [LMX2330U](#), [LMX2331U](#), [LMX2332U](#)

## FEATURES

- **Ultra Low Current Consumption**
- **Upgrade and Compatible to LMX233xL Family**
- **2.7V to 5.5V Operation**
- **Selectable Synchronous or Asynchronous Powerdown Mode:**
  - $I_{CC-PWDN} = 1 \mu A$  typical
- **Selectable Dual Modulus Prescaler:**
  - LMX2330U RF: 32/33 or 64/65
  - LMX2331U RF: 64/65 or 128/129
  - LMX2332U RF: 64/65 or 128/129
  - LMX2330U/31U/32U IF: 8/9 or 16/17
- **Selectable Charge Pump TRI-STATE Mode**
- **Programmable Charge Pump Current Levels**
  - RF and IF: 0.95 or 3.8 mA
- **Selectable Fastlock Mode for the RF Synthesizer**
- **Push-Pull Analog Lock Detect Output**
- **Available in 20-Pin TSSOP, 24-Pin LGA, and 20-Pin ULGA**

## APPLICATIONS

- **Mobile Handsets**
  - (GSM, GPRS, W-CDMA, CDMA, PCS, AMPS, PDC, DCS)
- **Cordless Handsets**
  - (DECT, DCT)
- **Wireless Data**
- **Cable TV Tuners**

## DESCRIPTION

The LMX233xU devices are high performance frequency synthesizers with integrated dual modulus prescalers. The LMX233xU devices are designed for use as RF and IF local oscillators for dual conversion radio transceivers.

A 32/33 or a 64/65 prescale ratio can be selected for the 2.5 GHz LMX2330U RF synthesizer. A 64/65 or a 128/129 prescale ratio can be selected for both the LMX2331U and LMX2332U RF synthesizers. The IF circuitry contains an 8/9 or a 16/17 prescaler. Using a proprietary digital phase locked loop technique, the LMX233xU devices generate very stable, low noise control signals for RF and IF voltage controlled oscillators. Both the RF and IF synthesizers include a two-level programmable charge pump. The RF synthesizer has dedicated Fastlock circuitry.

Serial data is transferred to the devices via a three-wire interface (Data, LE, Clock). Supply voltages from 2.7V to 5.5V are supported. The LMX233xU family features ultra low current consumption:

LMX2330U (2.5 GHz)—3.3 mA, LMX2331U (2.0 GHz) —2.9 mA, LMX2332U (1.2 GHz)—2.5 mA at 3.0V.

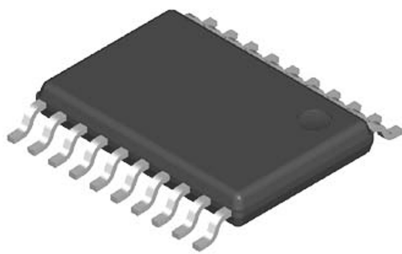
The LMX233xU devices are available in 20-Pin TSSOP, 24-Pin LGA, and 20-Pin ULGA surface mount plastic packages.



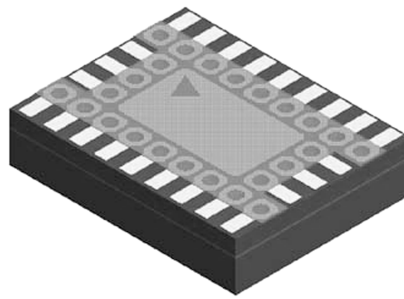
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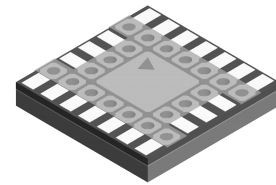
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**Figure 1. Thin Shrink Small Outline Package (PW0020A)**

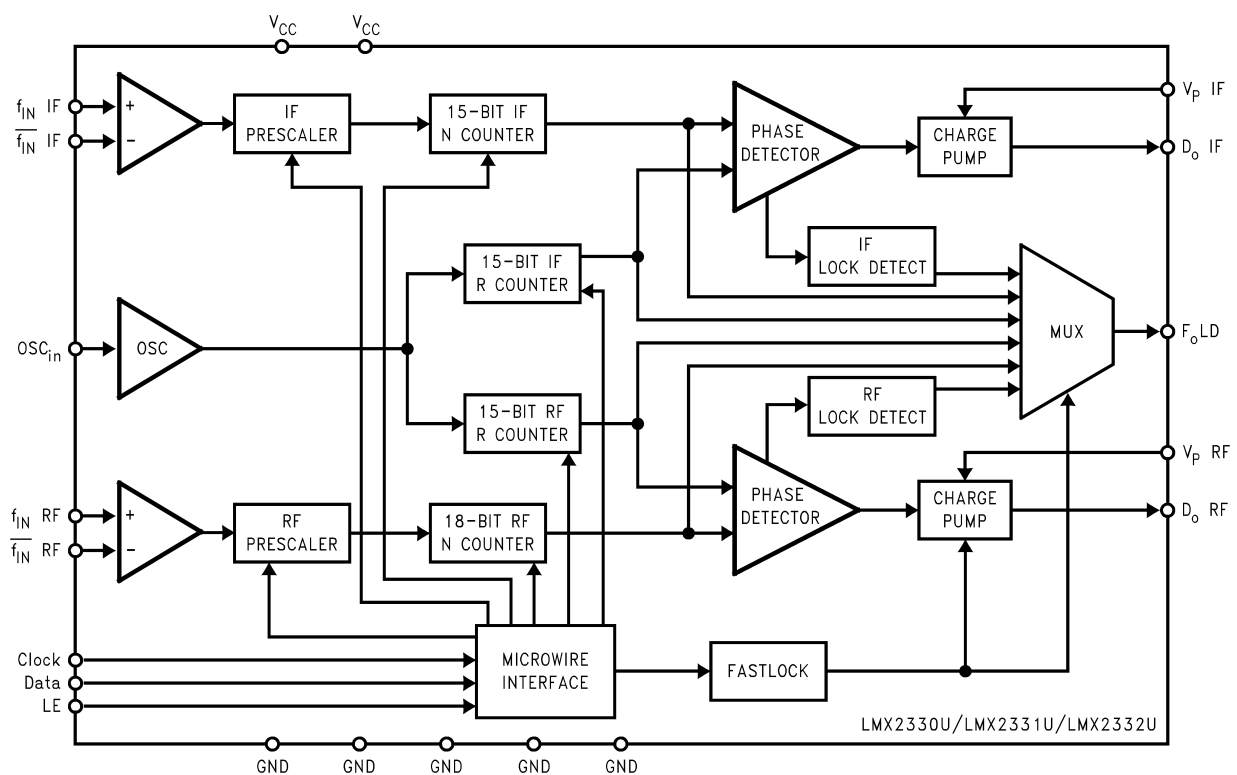


**Figure 2. LGA (NPH0024A)**



**Figure 3. ULGA (NPE0020A)**

## Functional Block Diagram



## Connection Diagrams

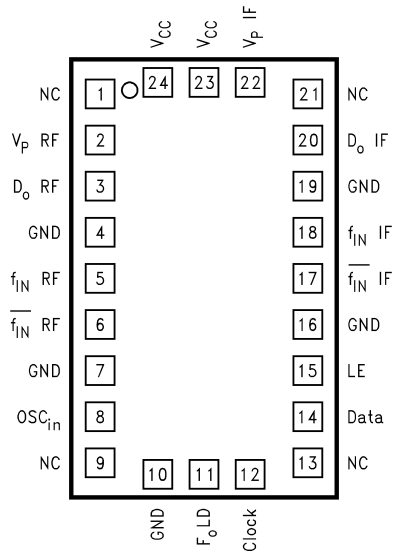


Figure 4. LGA (NPH) (Top View)

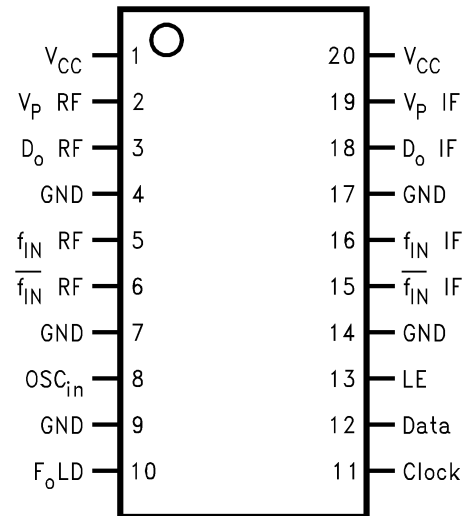


Figure 5. Thin Shrink Small Outline Package (PW) (Top View)

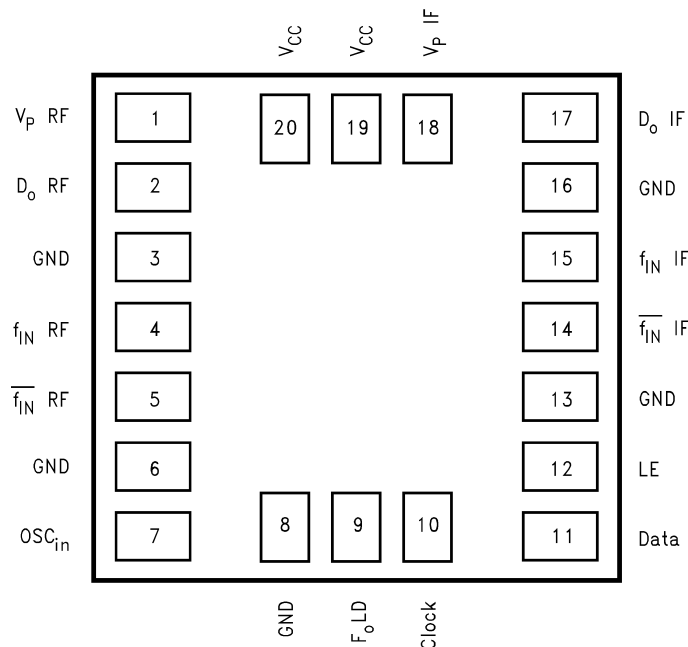
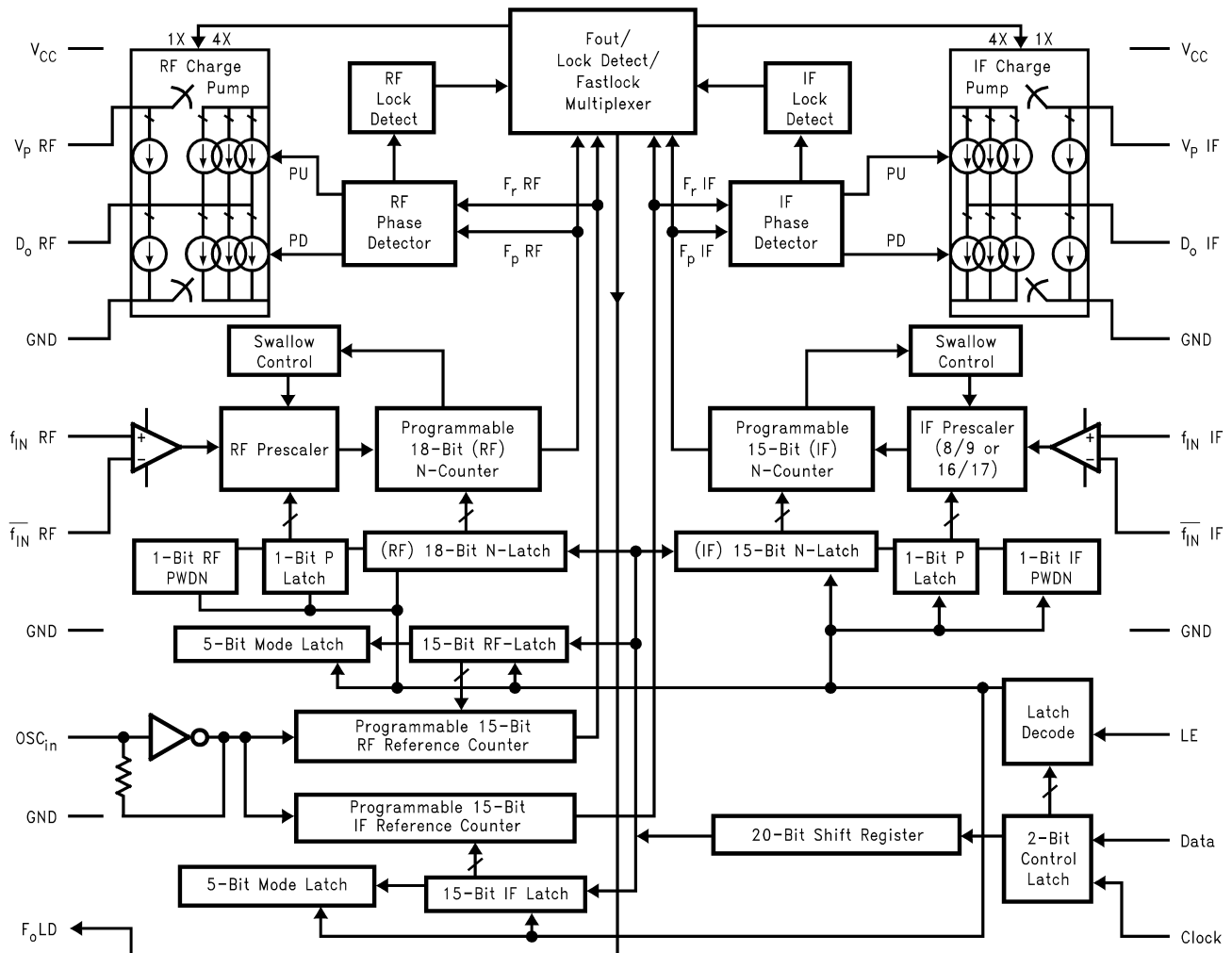


Figure 6. ULGA (NPE) (Top View)

## PIN DESCRIPTIONS

| Pin Name           | Pin No.<br>20-Pin ULGA | Pin No.<br>24-Pin LGA | Pin No.<br>20-Pin TSSOP | I/O | Description                                                                                                                                                                                                                                                                          |
|--------------------|------------------------|-----------------------|-------------------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| V <sub>CC</sub>    | 20                     | 24                    | 1                       | —   | Power supply bias for the RF PLL analog and digital circuits. V <sub>CC</sub> may range from 2.7V to 5.5V. Bypass capacitors should be placed as close as possible to this pin and be connected directly to the ground plane.                                                        |
| V <sub>P</sub> RF  | 1                      | 2                     | 2                       | —   | RF PLL charge pump power supply. Must be $\geq V_{CC}$ .                                                                                                                                                                                                                             |
| D <sub>O</sub> RF  | 2                      | 3                     | 3                       | O   | RF PLL charge pump output. The output is connected to the external loop filter, which drives the input of the VCO.                                                                                                                                                                   |
| GND                | 3                      | 4                     | 4                       | —   | Ground for the RF PLL digital circuitry.                                                                                                                                                                                                                                             |
| f <sub>IN</sub> RF | 4                      | 5                     | 5                       | I   | RF PLL prescaler input. Small signal input from the VCO.                                                                                                                                                                                                                             |
| $\bar{f}_{IN}$ RF  | 5                      | 6                     | 6                       | I   | RF PLL prescaler complementary input. For single ended operation, this pin should be AC grounded. The LMX233xU RF PLL can be driven differentially when the bypass capacitor is omitted.                                                                                             |
| GND                | 6                      | 7                     | 7                       | —   | Ground for the RF PLL analog circuitry.                                                                                                                                                                                                                                              |
| OSC <sub>in</sub>  | 7                      | 8                     | 8                       | I   | Reference oscillator input. The input has an approximate V <sub>CC</sub> /2 threshold and can be driven from an external CMOS or TTL logic gate.                                                                                                                                     |
| GND                | 8                      | 10                    | 9                       | —   | Ground for the IF PLL digital circuits, MICROWIRE, F <sub>o</sub> LD, and oscillator circuits.                                                                                                                                                                                       |
| F <sub>o</sub> LD  | 9                      | 11                    | 10                      | O   | Programmable multiplexed output pin. Functions as a general purpose CMOS TRI-STATE output, RF/IF PLL push-pull analog lock detect output, N and R divider output or Fastlock output, which connects a parallel resistor to the external loop filter.                                 |
| Clock              | 10                     | 12                    | 11                      | I   | MICROWIRE Clock input. High impedance CMOS input. Data is clocked into the 22-bit shift register on the rising edge of Clock.                                                                                                                                                        |
| Data               | 11                     | 14                    | 12                      | I   | MICROWIRE Data input. High impedance CMOS input. Binary serial data. The MSB of Data is shifted in first. The last two bits are the control bits.                                                                                                                                    |
| LE                 | 12                     | 15                    | 13                      | I   | MICROWIRE Latch Enable input. High impedance CMOS input. When LE transitions HIGH, Data stored in the shift register is loaded into one of 4 internal control registers.                                                                                                             |
| GND                | 13                     | 16                    | 14                      | —   | Ground for the IF PLL analog circuitry.                                                                                                                                                                                                                                              |
| $\bar{f}_{IN}$ IF  | 14                     | 17                    | 15                      | I   | IF PLL prescaler complementary input. For single ended operation, this pin should be AC grounded. The LMX233xU IF PLL can be driven differentially when the bypass capacitor is omitted.                                                                                             |
| f <sub>IN</sub> IF | 15                     | 18                    | 16                      | I   | IF PLL prescaler input. Small signal input from the VCO.                                                                                                                                                                                                                             |
| GND                | 16                     | 19                    | 17                      | —   | Ground for the IF PLL digital circuitry, MICROWIRE, F <sub>o</sub> LD, and oscillator circuits.                                                                                                                                                                                      |
| D <sub>O</sub> IF  | 17                     | 20                    | 18                      | O   | IF PLL charge pump output. The output is connected to the external loop filter, which drives the input of the VCO.                                                                                                                                                                   |
| V <sub>P</sub> IF  | 18                     | 22                    | 19                      | —   | IF PLL charge pump power supply. Must be $\geq V_{CC}$ .                                                                                                                                                                                                                             |
| V <sub>CC</sub>    | 19                     | 23                    | 20                      | —   | Power supply bias for the IF PLL analog and digital circuits, MICROWIRE, F <sub>o</sub> LD, and oscillator circuits. V <sub>CC</sub> may range from 2.7V to 5.5V. Bypass capacitors should be placed as close as possible to this pin and be connected directly to the ground plane. |
| NC                 | X                      | 1, 9, 13, 21          | X                       | —   | No connect.                                                                                                                                                                                                                                                                          |

## Detailed Block Diagram



A 64/65 or 128/129 prescaler ratio can be selected for the LMX2331U and LMX2332U RF synthesizers. A 32/33 or 64/65 prescaler ratio can be selected for the LMX2330U RF synthesizer.

$V_{CC}$  supplies power to the RF and IF prescalers, RF and IF feedback dividers, RF and IF reference dividers, RF and IF phase detectors, the  $OSC_{in}$  buffer, MICROWIRE, and  $F_{0LD}$  circuitry.

$V_P$  RF and  $V_P$  IF supply power to the charge pumps. They can be run separately as long as  $V_P$  RF  $\geq V_{CC}$  and  $V_P$  IF  $\geq V_{CC}$ .



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

### Absolute Maximum Ratings<sup>(1)(2)(3)(4)</sup>

|                                         |                       |                        |
|-----------------------------------------|-----------------------|------------------------|
| Power Supply Voltage                    | $V_{CC}$ to GND       | –0.3V to +6.5V         |
|                                         | $V_P$ RF to GND       | –0.3V to +6.5V         |
|                                         | $V_P$ IF to GND       | –0.3V to +6.5V         |
| Voltage on any pin to GND ( $V_I$ )     | $V_I$ must be < +6.5V | –0.3V to $V_{CC}+0.3V$ |
| Storage Temperature Range ( $T_S$ )     |                       | –65°C to +150°C        |
| Lead Temperature (solder 4 s) ( $T_L$ ) |                       | +260°C                 |
| TSSOP $\theta_{JA}$ Thermal Impedance   |                       | 114.5°C/W              |
| LGA $\theta_{JA}$ Thermal Impedance     |                       | 112°C/W                |

- (1) This device is a high performance RF integrated circuit with an ESD rating <2 kV and is ESD sensitive. Handling and assembly of this device should only be done at ESD protected work stations.
- (2) GND = 0V
- (3) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Recommended Operating Conditions indicate conditions for which the device is intended to be functional, but do not ensure specific performance limits. For ensured specifications and test conditions, refer to the Electrical Characteristics section. The ensured specifications apply only for the conditions listed.
- (4) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/ Distributors for availability and specifications.

### Recommended Operating Conditions<sup>(1)</sup>

|                                 |                 |                   |
|---------------------------------|-----------------|-------------------|
| Power Supply Voltage            | $V_{CC}$ to GND | +2.7V to +5.5V    |
|                                 | $V_P$ RF to GND | $V_{CC}$ to +5.5V |
|                                 | $V_P$ IF to GND | $V_{CC}$ to +5.5V |
| Operating Temperature ( $T_A$ ) |                 | –40°C to +85°C    |

- (1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Recommended Operating Conditions indicate conditions for which the device is intended to be functional, but do not ensure specific performance limits. For ensured specifications and test conditions, refer to the Electrical Characteristics section. The ensured specifications apply only for the conditions listed.

## Electrical Characteristics

 $V_{CC} = V_P$  RF =  $V_P$  IF = 3.0V,  $-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ , unless otherwise specified

| Symbol                                               | Parameter                                                                        | Conditions | Value                                                                                         |      |       | Units  |     |
|------------------------------------------------------|----------------------------------------------------------------------------------|------------|-----------------------------------------------------------------------------------------------|------|-------|--------|-----|
|                                                      |                                                                                  |            | Min                                                                                           | Typ  | Max   |        |     |
| I <sub>CC</sub> PARAMETERS                           |                                                                                  |            |                                                                                               |      |       |        |     |
| I <sub>CCRF + IF</sub>                               | Power Supply Current, RF + IF Synthesizers                                       | LMX2330U   | Clock, Data and LE = GND<br>OSC <sub>in</sub> = GND<br>PWDN RF Bit = 0<br>PWDN IF Bit = 0     |      | 3.3   | 4.3    | mA  |
|                                                      |                                                                                  | LMX2331U   |                                                                                               |      | 2.9   | 3.8    | mA  |
|                                                      |                                                                                  | LMX2332U   |                                                                                               |      | 2.5   | 3.3    | mA  |
| I <sub>CCRF</sub>                                    | Power Supply Current, RF Synthesizer Only                                        | LMX2330U   | Clock, Data and LE = GND<br>OSC <sub>in</sub> = GND<br>PWDN RF Bit = 0<br>PWDN IF Bit = 1     |      | 2.3   | 3.0    | mA  |
|                                                      |                                                                                  | LMX2331U   |                                                                                               |      | 1.9   | 2.5    | mA  |
|                                                      |                                                                                  | LMX2332U   |                                                                                               |      | 1.5   | 2.0    | mA  |
| I <sub>CCIF</sub>                                    | Power Supply Current, IF Synthesizer Only                                        | LMX233xU   | Clock, Data and LE = GND<br>OSC <sub>in</sub> = GND<br>PWDN RF Bit = 1<br>PWDN IF Bit = 0     |      | 1.0   | 1.3    | mA  |
| I <sub>CC-PWDN</sub>                                 | Powerdown Current                                                                | LMX233xU   | Clock, Data and LE = GND<br>OSC <sub>in</sub> = GND<br>PWDN RF Bit = 1<br>PWDN IF Bit = 1     |      | 1.0   | 10.0   | μA  |
| RF SYNTHESIZER PARAMETERS                            |                                                                                  |            |                                                                                               |      |       |        |     |
| f <sub>IN</sub> RF                                   | RF Operating Frequency                                                           | LMX2330U   |                                                                                               | 500  |       | 2500   | MHz |
|                                                      |                                                                                  | LMX2331U   |                                                                                               | 200  |       | 2000   | MHz |
|                                                      |                                                                                  | LMX2332U   |                                                                                               | 100  |       | 1200   | MHz |
| N <sub>RF</sub>                                      | RF N Divider Range                                                               |            | Prescaler = 32/33 <sup>(1)</sup>                                                              | 96   |       | 65631  |     |
|                                                      |                                                                                  |            | Prescaler = 64/65 <sup>(1)</sup>                                                              | 192  |       | 131135 |     |
|                                                      |                                                                                  |            | Prescaler = 128/129 <sup>(1)</sup>                                                            | 384  |       | 262143 |     |
| R <sub>RF</sub>                                      | RF R Divider Range                                                               |            |                                                                                               | 3    |       | 32767  |     |
| F <sub>φRF</sub>                                     | RF Phase Detector Frequency                                                      |            |                                                                                               |      |       | 10     | MHz |
| P <sub>f<sub>IN</sub></sub> RF                       | RF Input Sensitivity                                                             |            | 2.7V ≤ V <sub>CC</sub> ≤ 3.0V <sup>(2)</sup>                                                  | -15  |       | 0      | dBm |
|                                                      |                                                                                  |            | 3.0 < V <sub>CC</sub> ≤ 5.5V <sup>(2)</sup>                                                   | -10  |       | 0      | dBm |
| ID <sub>0</sub> RF SOURCE                            | RF Charge Pump Output Source Current                                             |            | VD <sub>0</sub> RF = V <sub>P</sub> RF/2<br>ID <sub>0</sub> RF Bit = 0 <sup>(3)</sup>         |      | -0.95 |        | mA  |
|                                                      |                                                                                  |            | VD <sub>0</sub> RF = V <sub>P</sub> RF/2<br>ID <sub>0</sub> RF Bit = 1 <sup>(3)</sup>         |      | -3.80 |        | mA  |
| ID <sub>0</sub> RF SINK                              | RF Charge Pump Output Sink Current                                               |            | VD <sub>0</sub> RF = V <sub>P</sub> RF/2<br>ID <sub>0</sub> RF Bit = 0 <sup>(3)</sup>         |      | 0.95  |        | mA  |
|                                                      |                                                                                  |            | VD <sub>0</sub> RF = V <sub>P</sub> RF/2<br>ID <sub>0</sub> RF Bit = 1 <sup>(3)</sup>         |      | 3.80  |        | mA  |
| ID <sub>0</sub> RF TRI-STATE                         | RF Charge Pump Output TRI-STATE Current                                          |            | 0.5V ≤ VD <sub>0</sub> RF ≤ V <sub>P</sub> RF - 0.5V <sup>(3)</sup>                           | -2.5 |       | 2.5    | nA  |
| ID <sub>0</sub> RF SINK Vs ID <sub>0</sub> RF SOURCE | RF Charge Pump Output Sink Current Vs Charge Pump Output Source Current Mismatch |            | VD <sub>0</sub> RF = V <sub>P</sub> RF/2<br>T <sub>A</sub> = +25°C <sup>(4)</sup>             |      | 3     | 10     | %   |
| ID <sub>0</sub> RF Vs VD <sub>0</sub> RF             | RF Charge Pump Output Current Magnitude Variation Vs Charge Pump Output Voltage  |            | 0.5V ≤ VD <sub>0</sub> RF ≤ V <sub>P</sub> RF - 0.5V<br>T <sub>A</sub> = +25°C <sup>(4)</sup> |      | 10    | 15     | %   |
| ID <sub>0</sub> RF Vs T <sub>A</sub>                 | RF Charge Pump Output Current Magnitude Variation Vs Temperature                 |            | VD <sub>0</sub> RF = V <sub>P</sub> RF/2 <sup>(4)</sup>                                       |      | 10    |        | %   |

(1) Some of the values in this range are illegal divide ratios (B < A). To obtain continuous legal division, the Minimum Divide Ratio must be calculated. Use  $N \geq P * (P-1)$ , where P is the value of the prescaler selected.

(2) Refer to the [Figure 41](#)

(3) Refer to the [Figure 40](#)

(4) Refer to [Charge Pump Current Specification Definitions](#) for details on how these measurements are made.

**Electrical Characteristics (continued)**
 $V_{CC} = V_P$  RF =  $V_P$  IF = 3.0V,  $-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ , unless otherwise specified

| Symbol                                                 | Parameter                                                                        |                                                                                               | Conditions | Value                 |       |                     | Units           |
|--------------------------------------------------------|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|------------|-----------------------|-------|---------------------|-----------------|
|                                                        |                                                                                  |                                                                                               |            | Min                   | Typ   | Max                 |                 |
| IF SYNTHESIZER PARAMETERS                              |                                                                                  |                                                                                               |            |                       |       |                     |                 |
| f <sub>IN</sub> IF                                     | IF Operating Frequency                                                           | LMX2330U                                                                                      |            | 45                    |       | 600                 | MHz             |
|                                                        |                                                                                  | LMX2331U                                                                                      |            | 45                    |       | 600                 | MHz             |
|                                                        |                                                                                  | LMX2332U                                                                                      |            | 45                    |       | 600                 | MHz             |
| N <sub>IF</sub>                                        | IF N Divider Range                                                               | Prescaler = 8/9 <sup>(5)</sup>                                                                |            | 24                    |       | 16391               |                 |
|                                                        |                                                                                  | Prescaler = 16/17 <sup>(5)</sup>                                                              |            | 48                    |       | 32767               |                 |
| R <sub>IF</sub>                                        | IF R Divider Range                                                               |                                                                                               |            | 3                     |       | 32767               |                 |
| F <sub>φIF</sub>                                       | IF Phase Detector Frequency                                                      |                                                                                               |            |                       |       | 10                  | MHz             |
| Pf <sub>IN</sub> IF                                    | IF Input Sensitivity                                                             | 2.7V ≤ V <sub>CC</sub> ≤ 5.5V <sup>(6)</sup>                                                  |            | -10                   |       | 0                   | dBm             |
| ID <sub>0</sub> IF SOURCE                              | IF Charge Pump Output Source Current                                             | VD <sub>0</sub> IF = V <sub>P</sub> IF/2<br>ID <sub>0</sub> IF Bit = 0 <sup>(7)</sup>         |            |                       | -0.95 |                     | mA              |
|                                                        |                                                                                  | VD <sub>0</sub> IF = V <sub>P</sub> IF/2<br>ID <sub>0</sub> IF Bit = 1 <sup>(7)</sup>         |            |                       | -3.80 |                     | mA              |
| ID <sub>0</sub> IF SINK                                | IF Charge Pump Output Sink Current                                               | VD <sub>0</sub> IF = V <sub>P</sub> IF/2<br>ID <sub>0</sub> IF Bit = 0 <sup>(7)</sup>         |            |                       | 0.95  |                     | mA              |
|                                                        |                                                                                  | VD <sub>0</sub> IF = V <sub>P</sub> IF/2<br>ID <sub>0</sub> IF Bit = 1 <sup>(7)</sup>         |            |                       | 3.80  |                     | mA              |
| ID <sub>0</sub> IF TRI-STATE                           | IF Charge Pump Output TRI-STATE Current                                          | 0.5V ≤ VD <sub>0</sub> IF ≤ V <sub>P</sub> IF - 0.5V <sup>(7)</sup>                           |            | -2.5                  |       | 2.5                 | nA              |
| ID <sub>0</sub> IF SINK Vs ID <sub>0</sub> IF SOURCE   | IF Charge Pump Output Sink Current Vs Charge Pump Output Source Current Mismatch | VD <sub>0</sub> IF = V <sub>P</sub> IF/2<br>T <sub>A</sub> = +25°C <sup>(8)</sup>             |            |                       | 3     | 10                  | %               |
| ID <sub>0</sub> IF Vs VD <sub>0</sub> IF               | IF Charge Pump Output Current Magnitude Variation Vs Charge Pump Output Voltage  | 0.5V ≤ VD <sub>0</sub> IF ≤ V <sub>P</sub> IF - 0.5V<br>T <sub>A</sub> = +25°C <sup>(8)</sup> |            |                       | 10    | 15                  | %               |
| ID <sub>0</sub> IF Vs T <sub>A</sub>                   | IF Charge Pump Output Current Magnitude Variation Vs Temperature                 | VD <sub>0</sub> IF = V <sub>P</sub> IF/2 <sup>(8)</sup>                                       |            |                       | 10    |                     | %               |
| OSCILLATOR PARAMETERS                                  |                                                                                  |                                                                                               |            |                       |       |                     |                 |
| F <sub>OSC</sub>                                       | Oscillator Operating Frequency                                                   |                                                                                               |            | 2                     |       | 40                  | MHz             |
| V <sub>OSC</sub>                                       | Oscillator Sensitivity                                                           | See <sup>(9)</sup>                                                                            |            | 0.5                   |       | V <sub>CC</sub>     | V <sub>PP</sub> |
| I <sub>OSC</sub>                                       | Oscillator Input Current                                                         | V <sub>OSC</sub> = V <sub>CC</sub> = 5.5V                                                     |            |                       |       | 100                 | μA              |
|                                                        |                                                                                  | V <sub>OSC</sub> = 0V, V <sub>CC</sub> = 5.5V                                                 |            | -100                  |       |                     | μA              |
| DIGITAL INTERFACE (Data, LE, Clock, F <sub>0</sub> LD) |                                                                                  |                                                                                               |            |                       |       |                     |                 |
| V <sub>IH</sub>                                        | High-Level Input Voltage                                                         |                                                                                               |            | 0.8 V <sub>CC</sub>   |       |                     | V               |
| V <sub>IL</sub>                                        | Low-Level Input Voltage                                                          |                                                                                               |            |                       |       | 0.2 V <sub>CC</sub> | V               |
| I <sub>IH</sub>                                        | High-Level Input Current                                                         | V <sub>IH</sub> = V <sub>CC</sub> = 5.5V                                                      |            | -1.0                  |       | 1.0                 | μA              |
| I <sub>IL</sub>                                        | Low-Level Input Current                                                          | V <sub>IL</sub> = 0V, V <sub>CC</sub> = 5.5V                                                  |            | -1.0                  |       | 1.0                 | μA              |
| V <sub>OH</sub>                                        | High-Level Output Voltage                                                        | I <sub>OH</sub> = -500 μA                                                                     |            | V <sub>CC</sub> - 0.4 |       |                     | V               |
| V <sub>OL</sub>                                        | Low-Level Output Voltage                                                         | I <sub>OL</sub> = 500 μA                                                                      |            |                       |       | 0.4                 | V               |

(5) Some of the values in this range are illegal divide ratios ( $B < A$ ). To obtain continuous legal division, the Minimum Divide Ratio must be calculated. Use  $N \geq P * (P-1)$ , where P is the value of the prescaler selected.

(6) Refer to the [Figure 41](#)

(7) Refer to the [Figure 40](#)

(8) Refer to [Charge Pump Current Specification Definitions](#) for details on how these measurements are made.

(9) Refer to the [Figure 42](#)

## Electrical Characteristics (continued)

 $V_{CC} = V_P$  RF =  $V_P$  IF = 3.0V,  $-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ , unless otherwise specified

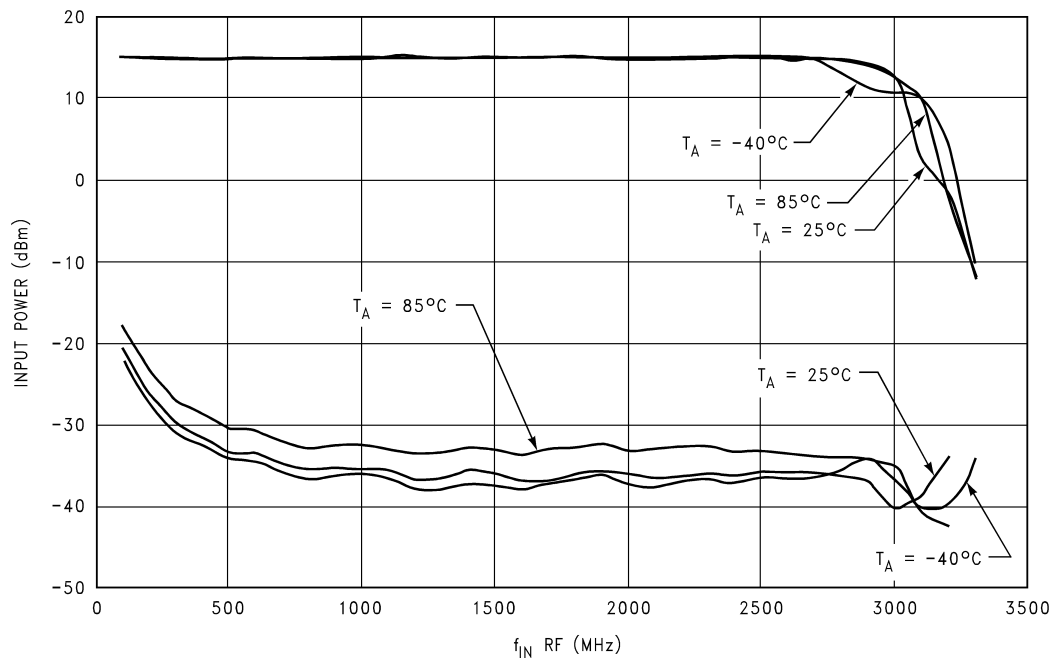
| Symbol                      | Parameter                                                          |          | Conditions                                                                                                                                                                                                                                                                                   | Value |        |     | Units      |
|-----------------------------|--------------------------------------------------------------------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|--------|-----|------------|
|                             |                                                                    |          |                                                                                                                                                                                                                                                                                              | Min   | Typ    | Max |            |
| MICROWIRE INTERFACE         |                                                                    |          |                                                                                                                                                                                                                                                                                              |       |        |     |            |
| t <sub>CS</sub>             | Data to Clock Set Up Time                                          |          | See <sup>(10)</sup>                                                                                                                                                                                                                                                                          | 50    |        |     | ns         |
| t <sub>CH</sub>             | Data to Clock Hold Time                                            |          | See <sup>(10)</sup>                                                                                                                                                                                                                                                                          | 10    |        |     | ns         |
| t <sub>CWH</sub>            | Clock Pulse Width HIGH                                             |          | See <sup>(10)</sup>                                                                                                                                                                                                                                                                          | 50    |        |     | ns         |
| t <sub>CWL</sub>            | Clock Pulse Width LOW                                              |          | See <sup>(10)</sup>                                                                                                                                                                                                                                                                          | 50    |        |     | ns         |
| t <sub>ES</sub>             | Clock to Load Enable Set Up Time                                   |          | See <sup>(10)</sup>                                                                                                                                                                                                                                                                          | 50    |        |     | ns         |
| t <sub>EW</sub>             | Latch Enable Pulse Width                                           |          | See <sup>(10)</sup>                                                                                                                                                                                                                                                                          | 50    |        |     | ns         |
| PHASE NOISE CHARACTERISTICS |                                                                    |          |                                                                                                                                                                                                                                                                                              |       |        |     |            |
| L <sub>N</sub> (f) RF       | RF Synthesizer Normalized Phase Noise Contribution <sup>(11)</sup> |          | TCXO Reference Source<br>ID <sub>0</sub> RF Bit = 1                                                                                                                                                                                                                                          |       | -212.0 |     | dBc/<br>Hz |
| L(f) RF                     | RF Synthesizer Single Side Band Phase Noise Measured               | LMX2330U | f <sub>IN</sub> RF = 2450 MHz<br>f = 1 kHz Offset<br>F <sub>ΦRF</sub> = 200 kHz<br>Loop Bandwidth = 7.5 kHz<br>N = 12250<br>F <sub>OSC</sub> = 10 MHz<br>V <sub>OSC</sub> = 0.632 V <sub>PP</sub><br>ID <sub>0</sub> RF Bit = 1<br>PWDN IF Bit = 1<br>T <sub>A</sub> = +25°C <sup>(12)</sup> |       | -77.24 |     | dBc/<br>Hz |
|                             |                                                                    | LMX2331U | f <sub>IN</sub> RF = 1960 MHz<br>f = 1 kHz Offset<br>F <sub>ΦRF</sub> = 200 kHz<br>Loop Bandwidth = 15 kHz<br>N = 9800<br>F <sub>OSC</sub> = 10 MHz<br>V <sub>OSC</sub> = 0.632 V <sub>PP</sub><br>ID <sub>0</sub> RF Bit = 1<br>PWDN IF Bit = 1<br>T <sub>A</sub> = +25°C <sup>(12)</sup>   |       | -79.18 |     | dBc/<br>Hz |
|                             |                                                                    | LMX2332U | f <sub>IN</sub> RF = 900 MHz<br>f = 1 kHz Offset<br>F <sub>ΦRF</sub> = 200 kHz<br>Loop Bandwidth = 12 kHz<br>N = 4500<br>F <sub>OSC</sub> = 10 MHz<br>V <sub>OSC</sub> = 0.632 V <sub>PP</sub><br>ID <sub>0</sub> RF Bit = 1<br>PWDN IF Bit = 1<br>T <sub>A</sub> = +25°C <sup>(12)</sup>    |       | -85.94 |     | dBc/<br>Hz |
| L <sub>N</sub> (f) IF       | IF Synthesizer Normalized Phase Noise Contribution <sup>(11)</sup> |          | TCXO Reference Source<br>ID <sub>0</sub> IF Bit = 1                                                                                                                                                                                                                                          |       | -212.0 |     | dBc/<br>Hz |
| L(f) IF                     | IF Synthesizer Single Side Band Phase Noise Measured               | LMX233xU | f <sub>IN</sub> IF = 200 MHz<br>f = 1 kHz Offset<br>F <sub>ΦIF</sub> = 200 kHz<br>Loop Bandwidth = 18 kHz<br>N = 1000<br>F <sub>OSC</sub> = 10 MHz<br>V <sub>OSC</sub> = 0.632 V <sub>PP</sub><br>ID <sub>0</sub> IF Bit = 1<br>PWDN RF Bit = 1<br>T <sub>A</sub> = +25°C <sup>(12)</sup>    |       | -99.00 |     | dBc/<br>Hz |

(10) Refer to the [LMX233xU Serial Data Input Timing](#) section

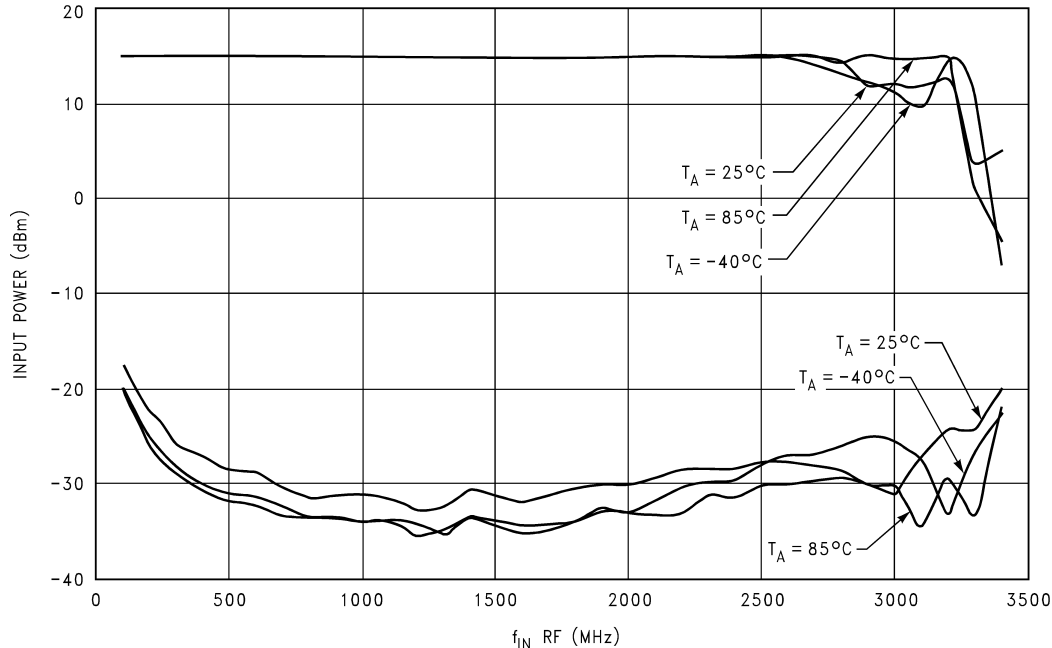
(11) Normalized Phase Noise Contribution is defined as :  $L_N(f) = L(f) - 20 \log(N) - 10 \log(F_{\phi})$ , where L(f) is defined as the single side band phase noise measured at an offset frequency, f, in a 1 Hz bandwidth. The offset frequency, f, must be chosen sufficiently smaller than the PLL's loop bandwidth, yet large enough to avoid substantial phase noise contribution from the reference source. N is the value selected for the feedback divider and  $F_{\phi}$  is the RF/IF phase detector comparison frequency.

(12) The synthesizer phase noise is measured with the LMX2330TMEB/LMX2330SLBEB/LMX2330SLEEB Evaluation boards and the HP8566B Spectrum Analyzer.

### Typical Performance Characteristics Sensitivity

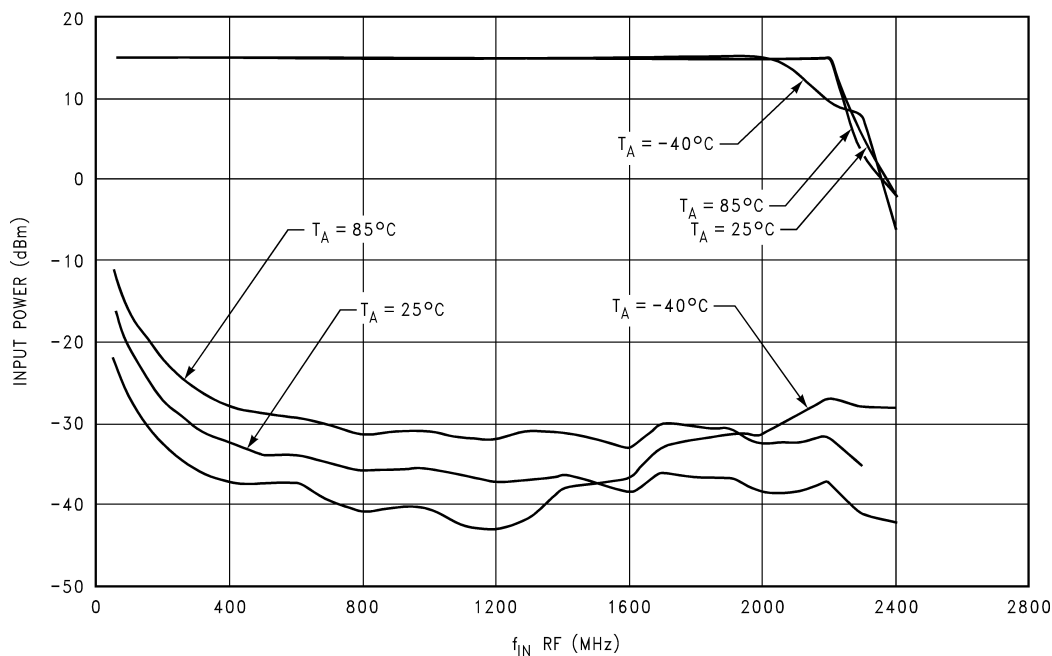


**Figure 7. LMX2330U  $f_{IN}$  RF Input Power Vs Frequency**  
 $V_{CC} = V_P$  RF = 3.0V

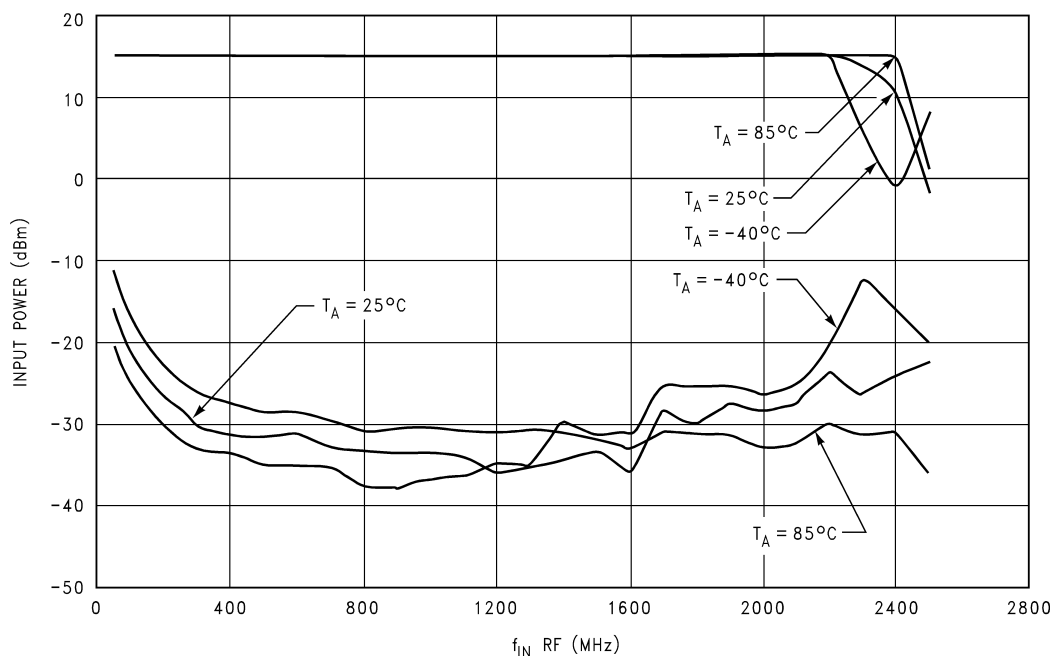


**Figure 8. LMX2330U  $f_{IN}$  RF Input Power Vs Frequency**  
 $V_{CC} = V_P$  RF = 5.5V

### Typical Performance Characteristics Sensitivity (continued)

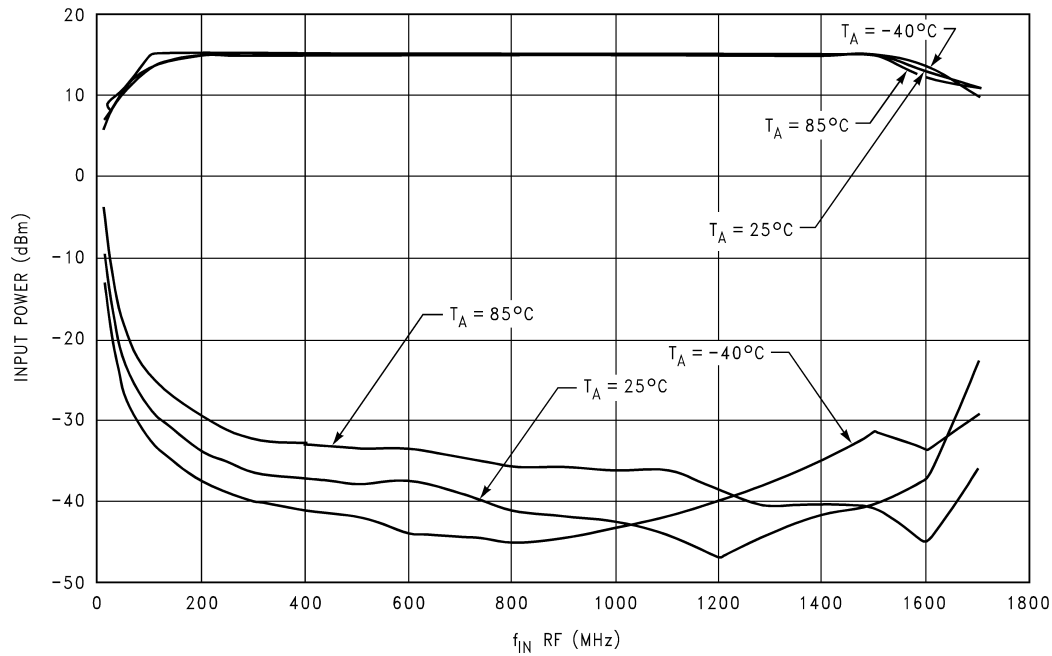


**Figure 9. LMX2331U  $f_{IN}$  RF Input Power Vs Frequency**  
 $V_{CC} = V_P$  RF = 3.0V

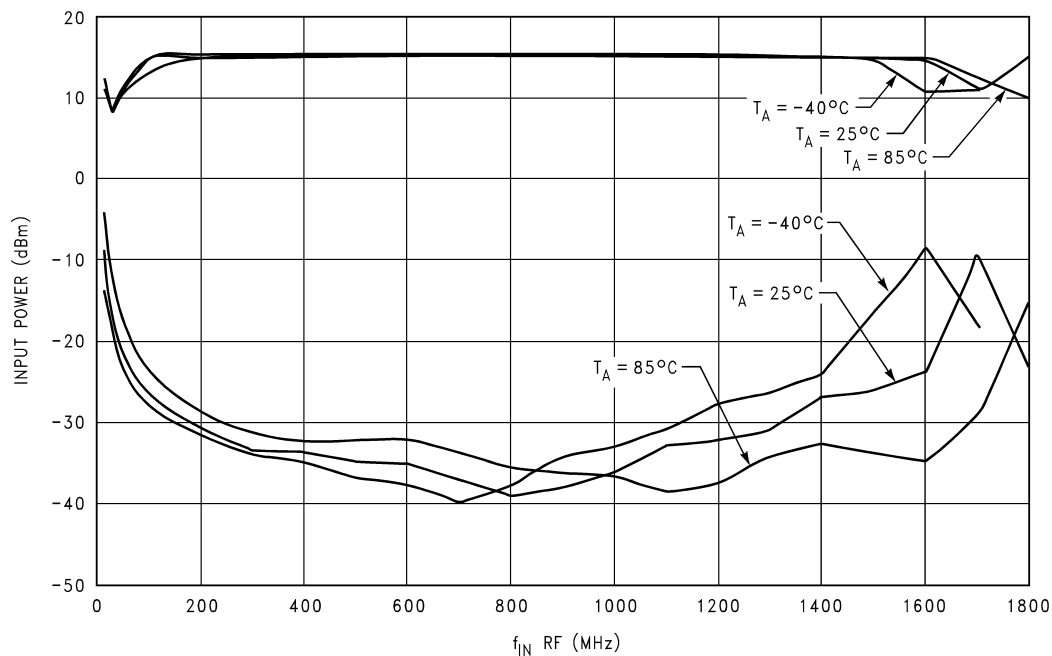


**Figure 10. LMX2331U  $f_{IN}$  RF Input Power Vs Frequency**  
 $V_{CC} = V_P$  RF = 5.5V

### Typical Performance Characteristics Sensitivity (continued)

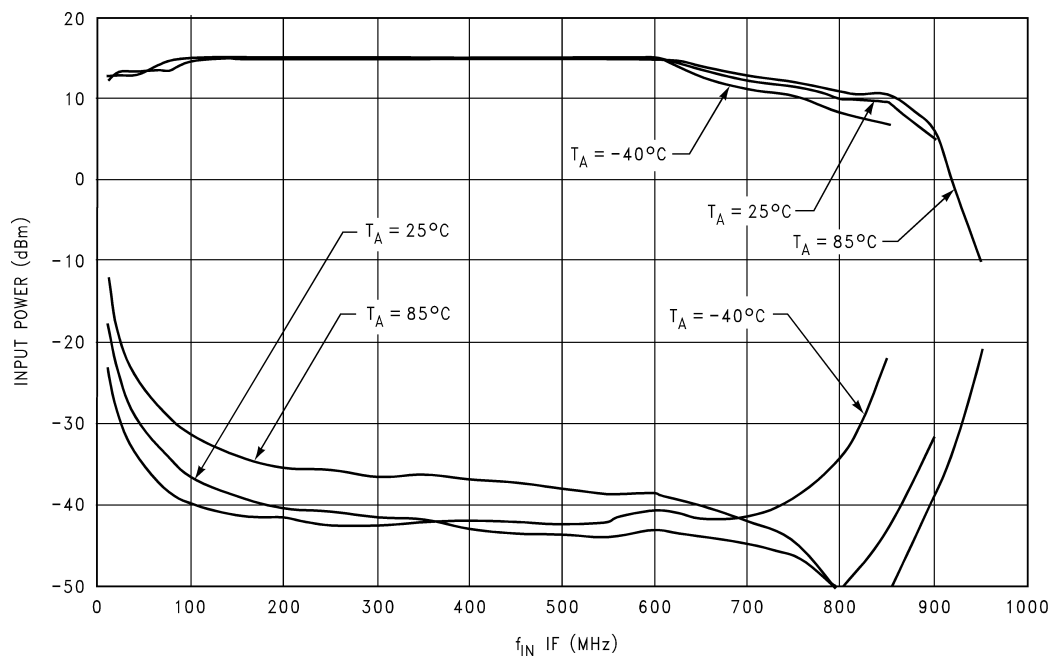


**Figure 11. LMX2332U  $f_{IN}$  RF Input Power Vs Frequency**  
 $V_{CC} = V_P$  RF = 3.0V

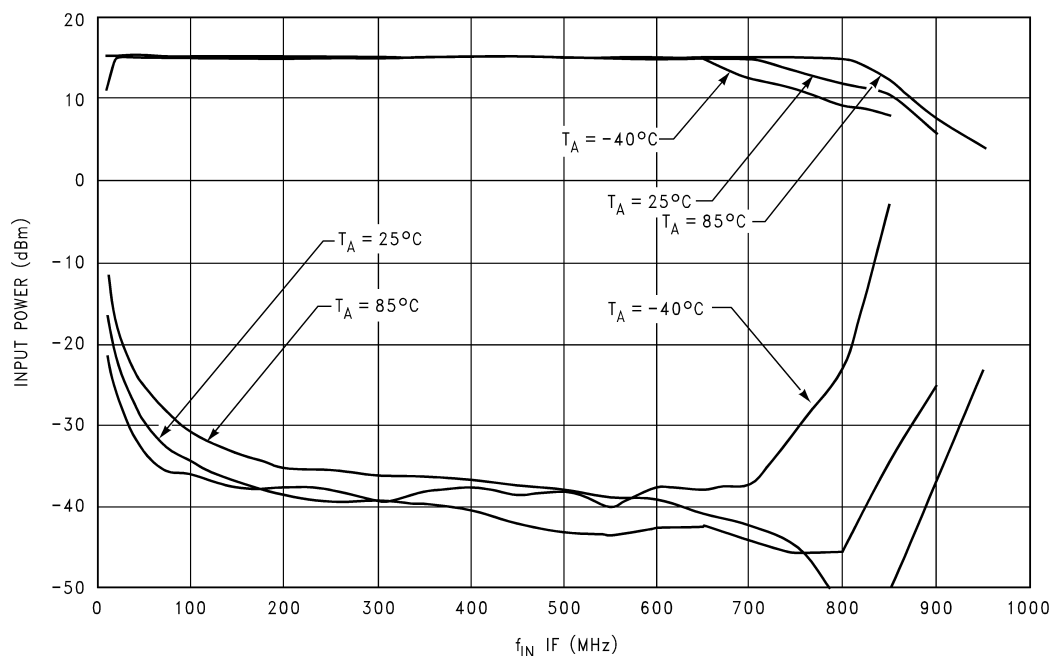


**Figure 12. LMX2332U  $f_{IN}$  RF Input Power Vs Frequency**  
 $V_{CC} = V_P$  RF = 5.5V

### Typical Performance Characteristics Sensitivity (continued)

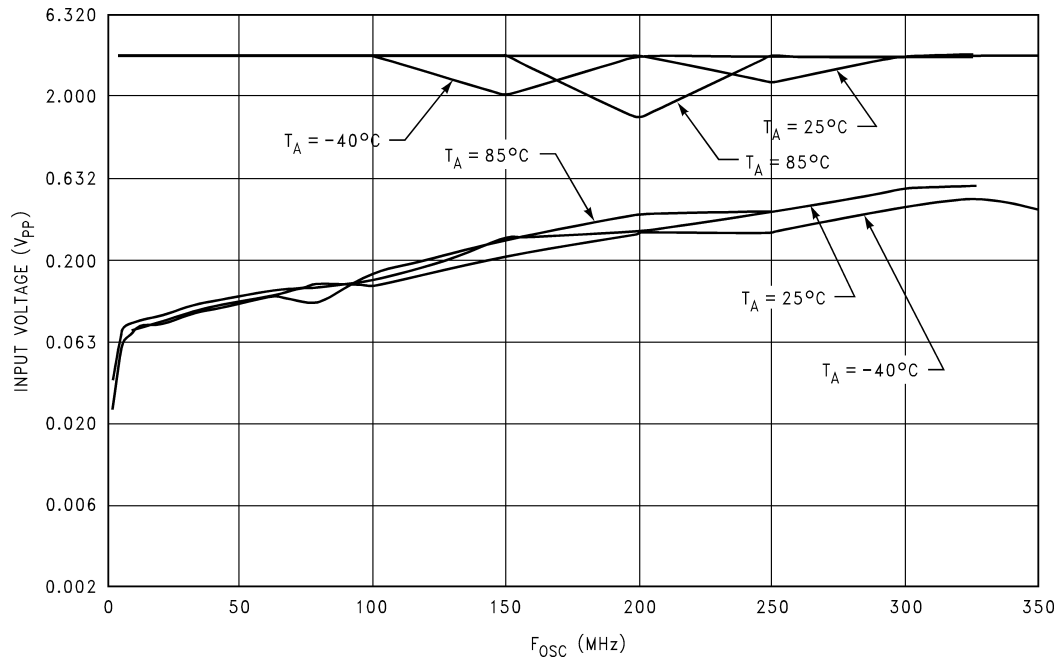


**Figure 13. LMX233xU  $f_{IN}$  IF Input Power Vs Frequency**  
 $V_{CC} = V_P$  IF = 3.0V

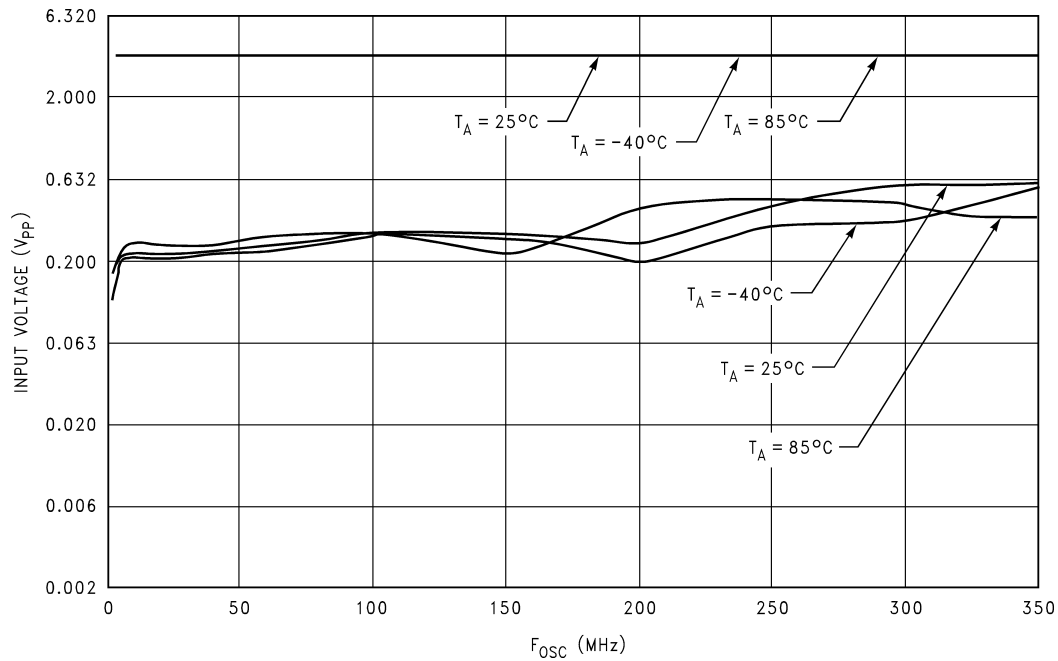


**Figure 14. LMX233xU  $f_{IN}$  IF Input Power Vs Frequency**  
 $V_{CC} = V_P$  IF = 5.5V

### Typical Performance Characteristics Sensitivity (continued)

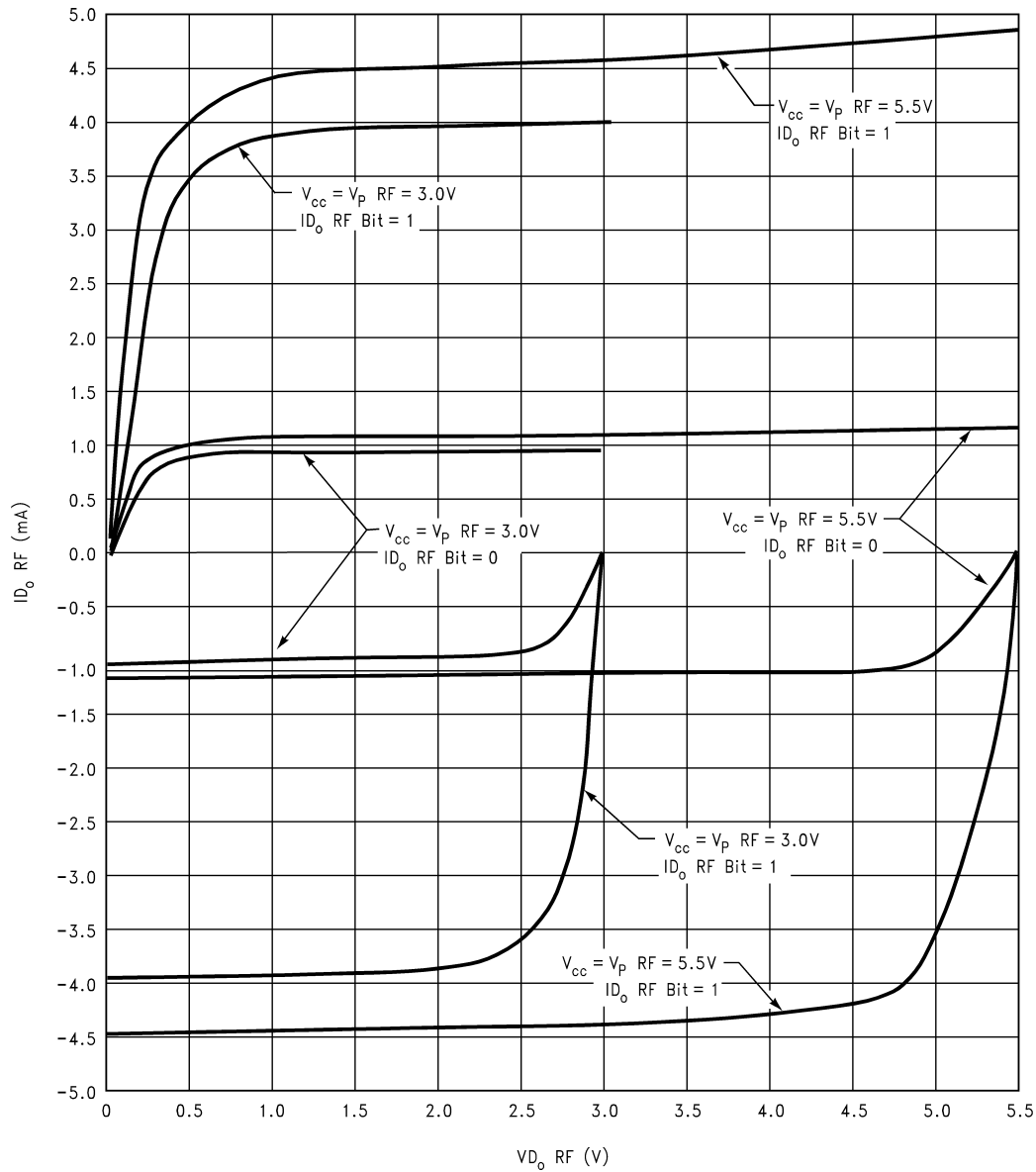


**Figure 15. LMX233xU OSC<sub>in</sub> Input Voltage Vs Frequency**  
**V<sub>CC</sub> = 3.0V**



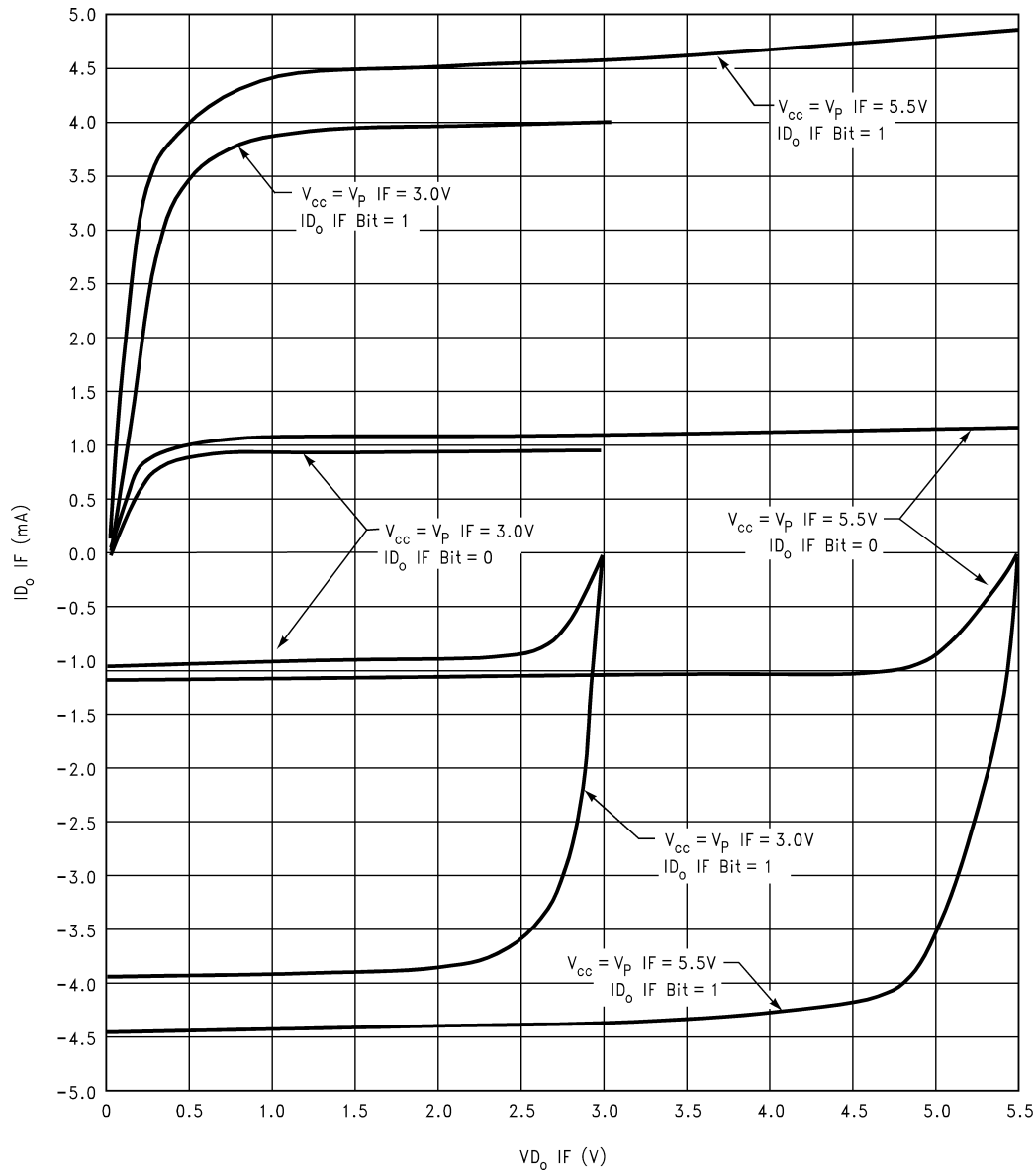
**Figure 16. LMX233xU OSC<sub>in</sub> Input Voltage Vs Frequency**  
**V<sub>CC</sub> = 5.5V**

### Typical Performance Characteristics Charge Pump



**Figure 17. LMX233xU RF Charge Pump Sweeps**  
 $-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$

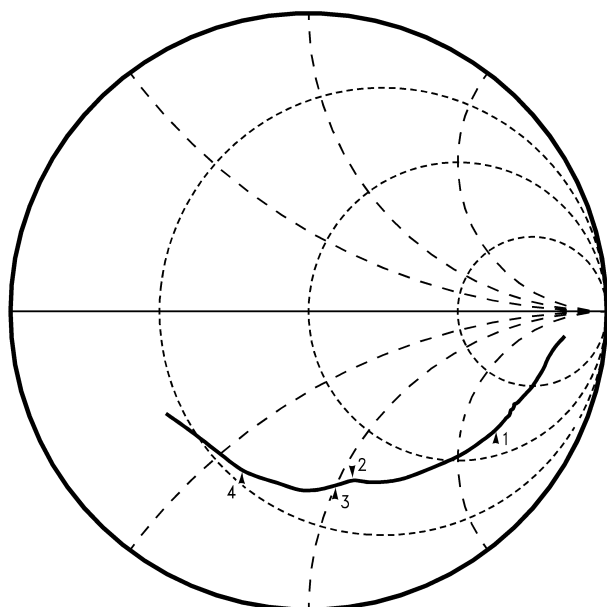
### Typical Performance Characteristics Charge Pump (continued)



**Figure 18. LMX233xU IF Charge Pump Sweeps**  
 $-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$

### Typical Performance Characteristics Input Impedance

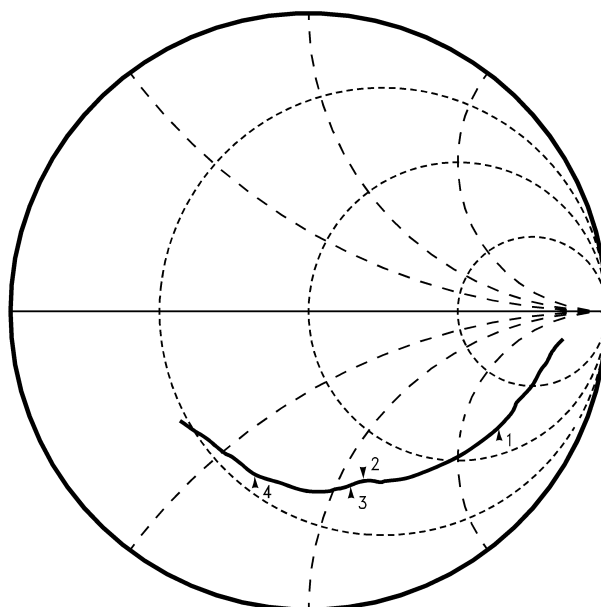
LMX233xU TSSOP  $f_{IN}$  RF Input Impedance  
 $V_{CC}=3.0V$ ,  $T_A = +25^{\circ}C$



Marker 1 = 900 MHz  
Marker 2 = 1800 MHz  
Marker 3 = 1900 MHz  
Marker 4 = 2500 MHz

**Figure 19.**

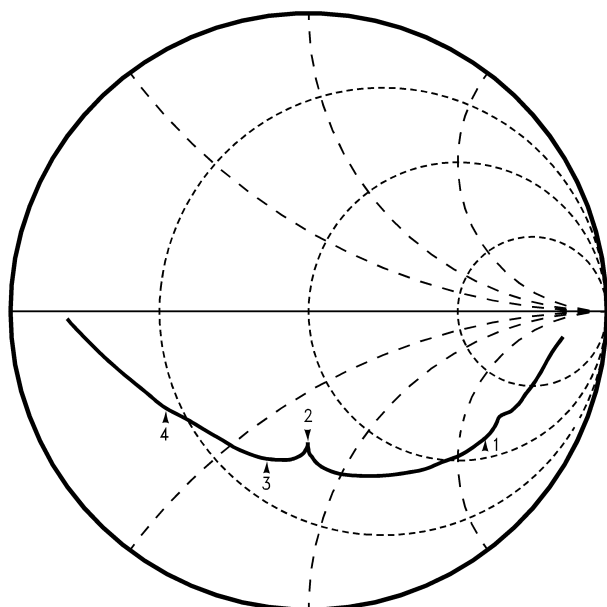
LMX233xU TSSOP  $f_{IN}$  RF Input Impedance  
 $V_{CC}=5.5V$ ,  $T_A = +25^{\circ}C$



Marker 1 = 900 MHz  
Marker 2 = 1800 MHz  
Marker 3 = 1900 MHz  
Marker 4 = 2500 MHz

**Figure 20.**

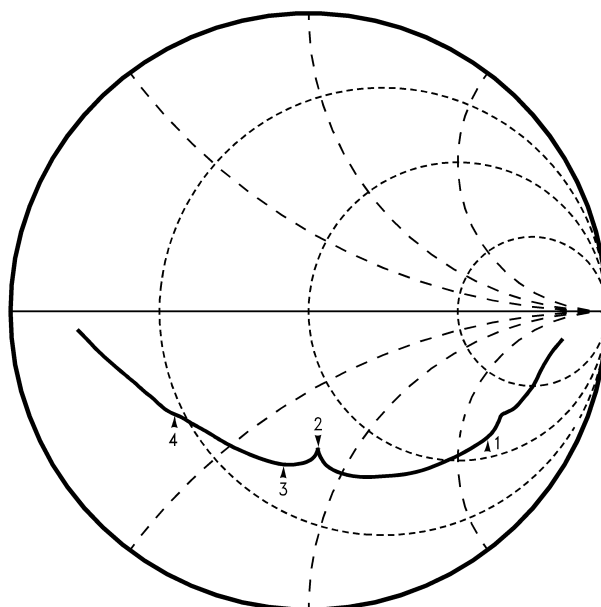
LMX233xU LGA  $f_{IN}$  RF Input Impedance  
 $V_{CC}=3.0V$ ,  $T_A = +25^{\circ}C$



Marker 1 = 900 MHz  
Marker 2 = 1800 MHz  
Marker 3 = 1900 MHz  
Marker 4 = 2500 MHz

**Figure 21.**

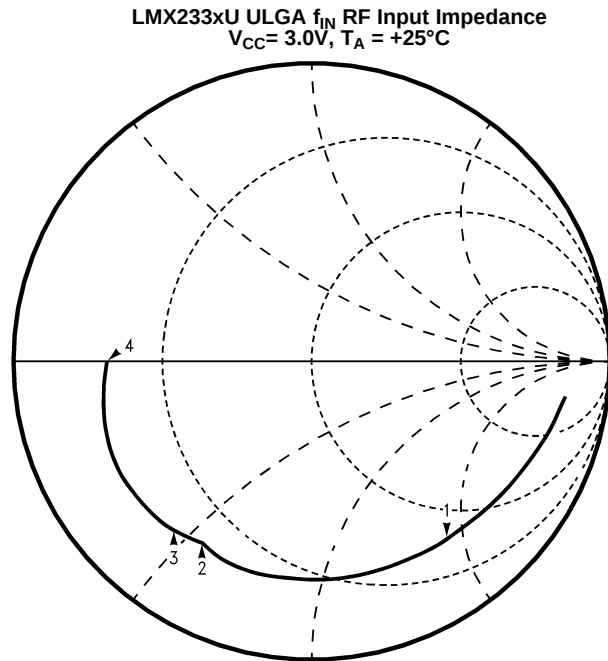
LMX233xU LGA  $f_{IN}$  RF Input Impedance  
 $V_{CC}=5.5V$ ,  $T_A = +25^{\circ}C$



Marker 1 = 900 MHz  
Marker 2 = 1800 MHz  
Marker 3 = 1900 MHz  
Marker 4 = 2500 MHz

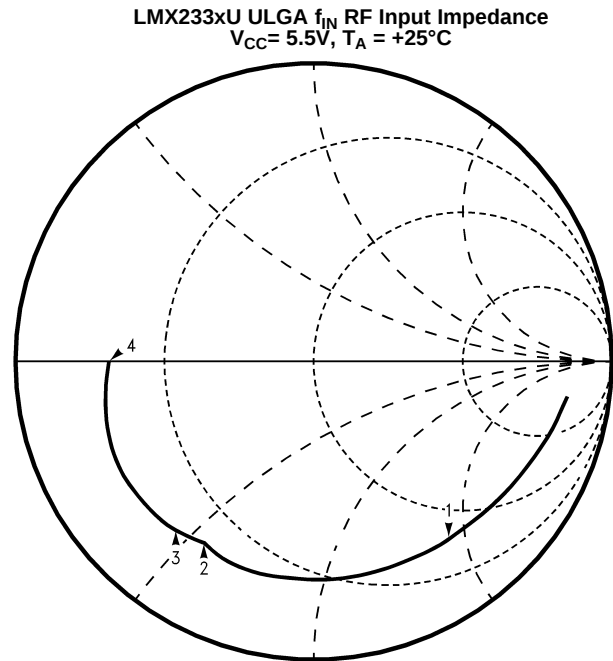
**Figure 22.**

**LMX233xU TSSOP and LMX233xU LGA  $f_{IN}$  RF Input Impedance Table****Figure 23.**



Marker 1 = 900 MHz  
Marker 2 = 1800 MHz  
Marker 3 = 1900 MHz  
Marker 4 = 2500 MHz

**Figure 24.**



Marker 1 = 900 MHz  
Marker 2 = 1800 MHz  
Marker 3 = 1900 MHz  
Marker 4 = 2500 MHz

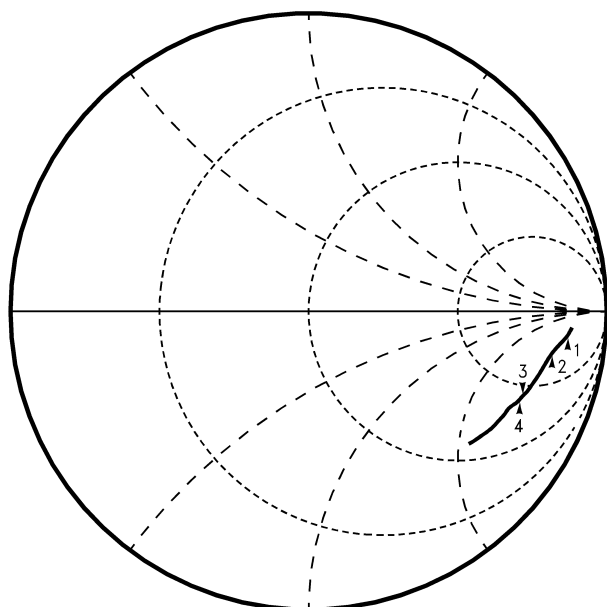
**Figure 25.**

LMX233xU ULGA  $f_{IN}$  RF Input Impedance Table

| $f_{IN}$ RF<br>(MHz) | LMX233xU ULGA $Z_{f_{IN}}$ RF                         |                 |                                       |                                       |                                             |                                                       |                 |                                       |                                       |                                             |
|----------------------|-------------------------------------------------------|-----------------|---------------------------------------|---------------------------------------|---------------------------------------------|-------------------------------------------------------|-----------------|---------------------------------------|---------------------------------------|---------------------------------------------|
|                      | $V_{CC} = V_P$ RF = 3.0V ( $T_A = 25^\circ\text{C}$ ) |                 |                                       |                                       |                                             | $V_{CC} = V_P$ RF = 5.5V ( $T_A = 25^\circ\text{C}$ ) |                 |                                       |                                       |                                             |
|                      | $  \Gamma  $                                          | $\angle \Gamma$ | Re<br>$Z_{f_{IN}}$ RF<br>( $\Omega$ ) | Im<br>$Z_{f_{IN}}$ RF<br>( $\Omega$ ) | $  Z_{f_{IN}} \text{ RF}  $<br>( $\Omega$ ) | $  \Gamma  $                                          | $\angle \Gamma$ | Re<br>$Z_{f_{IN}}$ RF<br>( $\Omega$ ) | Im<br>$Z_{f_{IN}}$ RF<br>( $\Omega$ ) | $  Z_{f_{IN}} \text{ RF}  $<br>( $\Omega$ ) |
| 100                  | 0.86                                                  | -8.57           | 335.53                                | -330.26                               | 470.80                                      | 0.86                                                  | -8.61           | 333.98                                | -330.26                               | 469.70                                      |
| 200                  | 0.83                                                  | -13.59          | 206.36                                | -258.74                               | 330.95                                      | 0.83                                                  | -13.55          | 207.11                                | -258.92                               | 331.57                                      |
| 300                  | 0.81                                                  | -18.53          | 143.19                                | -214.36                               | 257.79                                      | 0.81                                                  | -18.45          | 144.05                                | -214.75                               | 258.59                                      |
| 400                  | 0.80                                                  | -23.67          | 103.09                                | -183.95                               | 210.86                                      | 0.80                                                  | -23.63          | 103.36                                | -184.12                               | 211.15                                      |
| 500                  | 0.79                                                  | -29.24          | 76.58                                 | -157.24                               | 174.89                                      | 0.79                                                  | -29.07          | 77.30                                 | -157.87                               | 175.78                                      |
| 600                  | 0.77                                                  | -34.87          | 61.79                                 | -133.64                               | 147.24                                      | 0.77                                                  | -34.64          | 62.46                                 | -134.31                               | 148.12                                      |
| 700                  | 0.76                                                  | -40.52          | 50.03                                 | -116.97                               | 127.23                                      | 0.76                                                  | -40.33          | 50.42                                 | -117.43                               | 127.80                                      |
| 800                  | 0.76                                                  | -46.45          | 39.82                                 | -103.86                               | 111.24                                      | 0.76                                                  | -46.18          | 40.22                                 | -104.42                               | 111.89                                      |
| <b>900</b>           | <b>0.75</b>                                           | <b>-53.27</b>   | <b>32.87</b>                          | <b>-90.33</b>                         | <b>96.13</b>                                | <b>0.75</b>                                           | <b>-52.89</b>   | <b>33.27</b>                          | <b>-90.97</b>                         | <b>96.86</b>                                |
| 1000                 | 0.74                                                  | -60.04          | 27.98                                 | -79.30                                | 84.09                                       | 0.74                                                  | -59.70          | 28.24                                 | -79.77                                | 84.63                                       |
| 1100                 | 0.73                                                  | -66.62          | 24.49                                 | -70.27                                | 74.42                                       | 0.73                                                  | -66.10          | 24.81                                 | -70.90                                | 75.11                                       |
| 1200                 | 0.73                                                  | -74.07          | 20.63                                 | -62.00                                | 65.34                                       | 0.73                                                  | -73.57          | 20.85                                 | -62.52                                | 65.91                                       |
| 1300                 | 0.73                                                  | -81.67          | 17.67                                 | -54.66                                | 57.45                                       | 0.73                                                  | -81.15          | 17.85                                 | -55.13                                | 57.95                                       |
| 1400                 | 0.73                                                  | -89.59          | 15.34                                 | -47.95                                | 50.34                                       | 0.73                                                  | -88.94          | 15.51                                 | -48.47                                | 50.89                                       |
| 1500                 | 0.73                                                  | -97.85          | 13.48                                 | -41.75                                | 43.87                                       | 0.73                                                  | -97.12          | 13.63                                 | -42.27                                | 44.41                                       |
| 1600                 | 0.73                                                  | -106.72         | 11.96                                 | -35.80                                | 37.74                                       | 0.73                                                  | -105.87         | 12.09                                 | -36.34                                | 38.30                                       |
| 1700                 | 0.72                                                  | -115.82         | 11.22                                 | -30.21                                | 32.22                                       | 0.72                                                  | -114.76         | 11.35                                 | -30.82                                | 32.84                                       |
| <b>1800</b>          | <b>0.70</b>                                           | <b>-123.41</b>  | <b>11.28</b>                          | <b>-25.85</b>                         | <b>28.20</b>                                | <b>0.70</b>                                           | <b>-122.28</b>  | <b>11.40</b>                          | <b>-26.45</b>                         | <b>28.80</b>                                |
| <b>1900</b>          | <b>0.72</b>                                           | <b>-130.68</b>  | <b>9.80</b>                           | <b>-22.22</b>                         | <b>24.29</b>                                | <b>0.72</b>                                           | <b>-129.92</b>  | <b>9.86</b>                           | <b>-22.61</b>                         | <b>24.66</b>                                |
| 2000                 | 0.74                                                  | -140.55         | 8.41                                  | -17.48                                | 19.39                                       | 0.74                                                  | -139.88         | 8.44                                  | -17.80                                | 19.70                                       |
| 2100                 | 0.74                                                  | -150.74         | 7.97                                  | -12.74                                | 15.03                                       | 0.74                                                  | -150.01         | 7.99                                  | -13.07                                | 15.32                                       |
| 2200                 | 0.73                                                  | -160.86         | 8.02                                  | -8.22                                 | 11.48                                       | 0.73                                                  | -160.03         | 8.04                                  | -8.58                                 | 11.76                                       |
| 2300                 | 0.71                                                  | -170.43         | 8.54                                  | -4.06                                 | 9.46                                        | 0.71                                                  | -169.62         | 8.55                                  | -4.41                                 | 9.62                                        |
| 2400                 | 0.69                                                  | -179.08         | 9.17                                  | -0.39                                 | 9.18                                        | 0.69                                                  | -178.32         | 9.17                                  | -0.71                                 | 9.20                                        |
| <b>2500</b>          | <b>0.67</b>                                           | <b>172.38</b>   | <b>9.92</b>                           | <b>3.20</b>                           | <b>10.43</b>                                | <b>0.67</b>                                           | <b>173.11</b>   | <b>9.91</b>                           | <b>2.89</b>                           | <b>10.33</b>                                |

Figure 26.

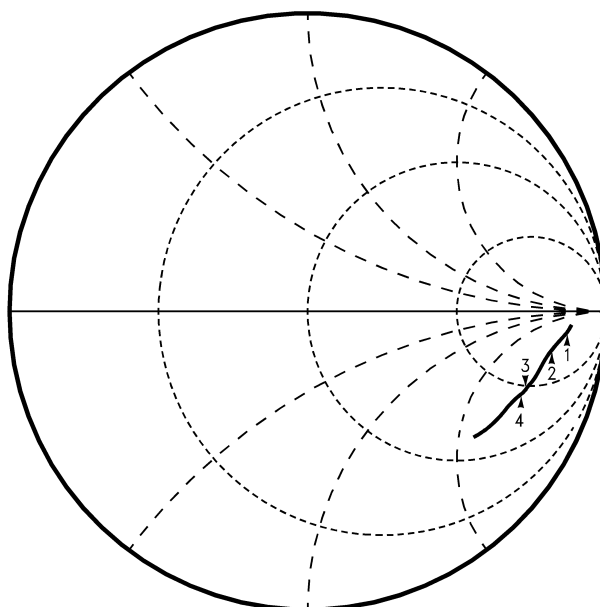
LMX233xU TSSOP  $f_{IN}$  IF Input Impedance  
 $V_{CC} = 3.0V$ ,  $T_A = +25^\circ C$



Marker 1 = 50 MHz  
Marker 2 = 200 MHz  
Marker 3 = 500 MHz  
Marker 4 = 600 MHz

**Figure 27.**

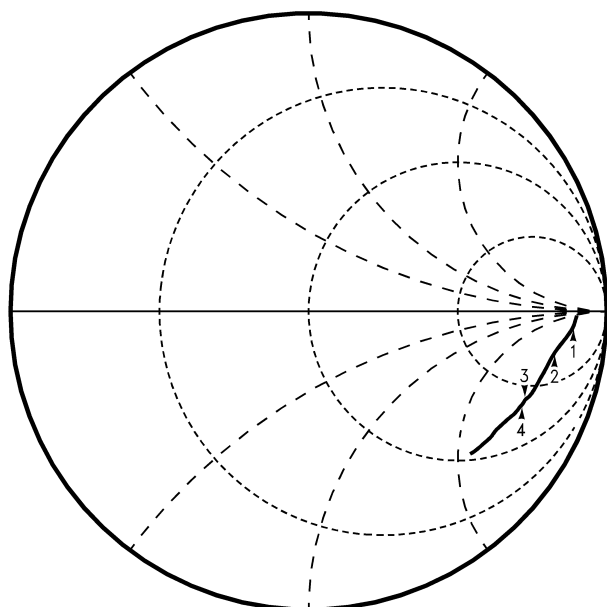
LMX233xU TSSOP  $f_{IN}$  IF Input Impedance  
 $V_{CC} = 5.5V$ ,  $T_A = +25^\circ C$



Marker 1 = 50 MHz  
Marker 2 = 200 MHz  
Marker 3 = 500 MHz  
Marker 4 = 600 MHz

**Figure 28.**

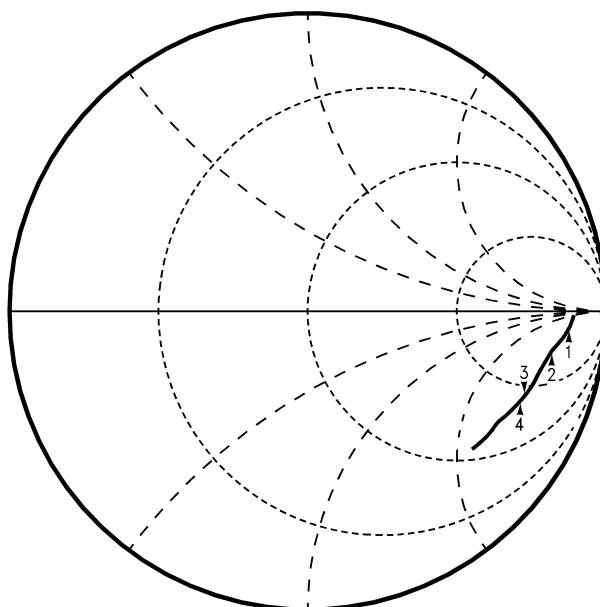
LMX233xU LGA  $f_{IN}$  IF Input Impedance  
 $V_{CC} = 3.0V$ ,  $T_A = +25^\circ C$



Marker 1 = 50 MHz  
Marker 2 = 200 MHz  
Marker 3 = 500 MHz  
Marker 4 = 600 MHz

**Figure 29.**

LMX233xU LGA  $f_{IN}$  IF Input Impedance  
 $V_{CC} = 5.5V$ ,  $T_A = +25^\circ C$



Marker 1 = 50 MHz  
Marker 2 = 200 MHz  
Marker 3 = 500 MHz  
Marker 4 = 600 MHz

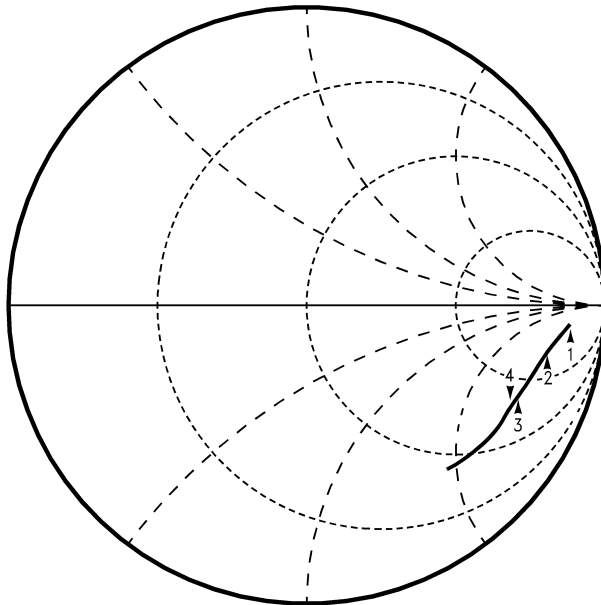
**Figure 30.**

LMX233xU TSSOP and LMX233xU LGA  $f_{IN}$  IF Input Impedance Table

| $f_{IN}$ IF<br>(MHz) | LMX233xU TSSOP $Z_{f_{IN}}$ IF                        |                 |                                     |                                          |                                     |                                                       |                 |                                     |                                          |                                     | LMX233xU LGA $Z_{f_{IN}}$ IF                          |                 |                                     |                                          |                                     |                                                       |                 |                                     |                                          |                                     |
|----------------------|-------------------------------------------------------|-----------------|-------------------------------------|------------------------------------------|-------------------------------------|-------------------------------------------------------|-----------------|-------------------------------------|------------------------------------------|-------------------------------------|-------------------------------------------------------|-----------------|-------------------------------------|------------------------------------------|-------------------------------------|-------------------------------------------------------|-----------------|-------------------------------------|------------------------------------------|-------------------------------------|
|                      | $V_{CC} = V_P$ IF = 3.0V ( $T_A = 25^\circ\text{C}$ ) |                 |                                     |                                          |                                     | $V_{CC} = V_P$ IF = 5.5V ( $T_A = 25^\circ\text{C}$ ) |                 |                                     |                                          |                                     | $V_{CC} = V_P$ IF = 3.0V ( $T_A = 25^\circ\text{C}$ ) |                 |                                     |                                          |                                     | $V_{CC} = V_P$ IF = 5.5V ( $T_A = 25^\circ\text{C}$ ) |                 |                                     |                                          |                                     |
|                      | $  \Gamma  $                                          | $\angle \Gamma$ | $R_{Z_{f_{IN}}}$<br>IF ( $\Omega$ ) | $\angle_{Z_{f_{IN}}}$<br>IF ( $\Omega$ ) | $  Z_{f_{IN}}  $<br>IF ( $\Omega$ ) | $  \Gamma  $                                          | $\angle \Gamma$ | $R_{Z_{f_{IN}}}$<br>IF ( $\Omega$ ) | $\angle_{Z_{f_{IN}}}$<br>IF ( $\Omega$ ) | $  Z_{f_{IN}}  $<br>IF ( $\Omega$ ) | $  \Gamma  $                                          | $\angle \Gamma$ | $R_{Z_{f_{IN}}}$<br>IF ( $\Omega$ ) | $\angle_{Z_{f_{IN}}}$<br>IF ( $\Omega$ ) | $  Z_{f_{IN}}  $<br>IF ( $\Omega$ ) | $  \Gamma  $                                          | $\angle \Gamma$ | $R_{Z_{f_{IN}}}$<br>IF ( $\Omega$ ) | $\angle_{Z_{f_{IN}}}$<br>IF ( $\Omega$ ) | $  Z_{f_{IN}}  $<br>IF ( $\Omega$ ) |
| 50                   | 0.884                                                 | -3.93           | 621.523                             | -345.924                                 | 711.305                             | 0.885                                                 | -3.81           | 630.568                             | -340.995                                 | 716.864                             | 0.899                                                 | -1.69           | 874.934                             | -242.583                                 | 907.940                             | 0.899                                                 | -1.67           | 874.127                             | -239.189                                 | 906.261                             |
| 75                   | 0.873                                                 | -5.30           | 503.424                             | -340.786                                 | 607.923                             | 0.873                                                 | -5.18           | 511.352                             | -338.259                                 | 613.107                             | 0.891                                                 | -3.44           | 683.122                             | -354.024                                 | 769.408                             | 0.891                                                 | -3.33           | 692.599                             | -349.036                                 | 775.577                             |
| 100                  | 0.861                                                 | -6.42           | 429.629                             | -319.996                                 | 535.704                             | 0.861                                                 | -6.24           | 438.666                             | -318.001                                 | 541.805                             | 0.880                                                 | -4.98           | 535.334                             | -360.736                                 | 645.533                             | 0.879                                                 | -4.85           | 543.967                             | -357.157                                 | 650.739                             |
| 125                  | 0.851                                                 | -7.27           | 384.494                             | -301.186                                 | 488.414                             | 0.852                                                 | -7.10           | 391.664                             | -300.482                                 | 493.650                             | 0.868                                                 | -6.23           | 445.309                             | -339.295                                 | 559.840                             | 0.868                                                 | -6.06           | 454.188                             | -337.263                                 | 565.715                             |
| 150                  | 0.844                                                 | -8.11           | 349.099                             | -288.744                                 | 453.038                             | 0.844                                                 | -7.90           | 356.461                             | -287.182                                 | 457.753                             | 0.858                                                 | -7.26           | 388.975                             | -319.049                                 | 503.085                             | 0.858                                                 | -7.07           | 397.015                             | -317.892                                 | 508.603                             |
| 175                  | 0.837                                                 | -8.85           | 322.082                             | -276.707                                 | 424.622                             | 0.837                                                 | -8.57           | 330.546                             | -275.058                                 | 430.020                             | 0.850                                                 | -8.18           | 348.616                             | -303.517                                 | 462.229                             | 0.850                                                 | -7.98           | 356.200                             | -303.914                                 | 468.233                             |
| 200                  | 0.832                                                 | -9.54           | 300.314                             | -268.356                                 | 402.745                             | 0.832                                                 | -9.22           | 309.296                             | -267.480                                 | 408.913                             | 0.843                                                 | -9.07           | 316.481                             | -291.646                                 | 430.369                             | 0.844                                                 | -8.84           | 324.033                             | -291.128                                 | 435.606                             |
| 225                  | 0.827                                                 | -10.29          | 279.576                             | -260.995                                 | 382.467                             | 0.827                                                 | -9.95           | 288.264                             | -260.187                                 | 388.322                             | 0.838                                                 | -9.93           | 289.893                             | -282.342                                 | 404.666                             | 0.839                                                 | -9.66           | 297.640                             | -282.345                                 | 410.254                             |
| 250                  | 0.823                                                 | -11.04          | 261.205                             | -254.758                                 | 364.870                             | 0.823                                                 | -10.64          | 270.659                             | -254.417                                 | 371.462                             | 0.834                                                 | -10.77          | 267.263                             | -274.027                                 | 382.780                             | 0.834                                                 | -10.45          | 275.672                             | -273.085                                 | 388.034                             |
| 275                  | 0.819                                                 | -11.80          | 244.399                             | -248.227                                 | 348.350                             | 0.818                                                 | -11.38          | 253.507                             | -247.511                                 | 354.299                             | 0.830                                                 | -11.63          | 247.024                             | -265.175                                 | 362.407                             | 0.829                                                 | -11.24          | 256.102                             | -265.264                                 | 368.719                             |
| 300                  | 0.814                                                 | -12.58          | 228.964                             | -241.239                                 | 332.597                             | 0.815                                                 | -12.14          | 237.587                             | -241.965                                 | 339.109                             | 0.826                                                 | -12.50          | 228.671                             | -257.705                                 | 344.532                             | 0.826                                                 | -12.08          | 237.603                             | -257.879                                 | 350.652                             |
| 325                  | 0.812                                                 | -13.36          | 214.910                             | -236.082                                 | 319.251                             | 0.811                                                 | -12.84          | 224.277                             | -236.738                                 | 326.106                             | 0.823                                                 | -13.38          | 212.305                             | -250.287                                 | 328.203                             | 0.822                                                 | -12.90          | 221.471                             | -251.212                                 | 334.899                             |
| 350                  | 0.807                                                 | -14.18          | 201.728                             | -228.591                                 | 304.874                             | 0.807                                                 | -13.62          | 210.927                             | -230.202                                 | 312.223                             | 0.819                                                 | -14.23          | 198.231                             | -242.453                                 | 313.176                             | 0.819                                                 | -13.73          | 206.868                             | -244.557                                 | 320.316                             |
| 375                  | 0.804                                                 | -14.98          | 189.889                             | -223.629                                 | 293.373                             | 0.804                                                 | -14.44          | 198.121                             | -224.602                                 | 299.497                             | 0.816                                                 | -15.21          | 183.656                             | -234.712                                 | 298.025                             | 0.815                                                 | -14.63          | 192.740                             | -236.735                                 | 305.274                             |
| 400                  | 0.801                                                 | -15.85          | 178.372                             | -217.315                                 | 281.144                             | 0.801                                                 | -15.20          | 187.401                             | -219.200                                 | 288.388                             | 0.812                                                 | -16.09          | 172.185                             | -227.189                                 | 285.066                             | 0.812                                                 | -15.48          | 180.755                             | -229.880                                 | 292.433                             |
| 425                  | 0.797                                                 | -16.72          | 167.895                             | -211.342                                 | 269.915                             | 0.797                                                 | -16.02          | 176.917                             | -213.413                                 | 277.208                             | 0.809                                                 | -17.02          | 160.959                             | -220.345                                 | 272.873                             | 0.808                                                 | -16.36          | 169.600                             | -222.898                                 | 280.085                             |
| 450                  | 0.794                                                 | -17.57          | 158.542                             | -205.691                                 | 259.700                             | 0.794                                                 | -16.81          | 167.586                             | -208.198                                 | 267.267                             | 0.805                                                 | -17.99          | 150.694                             | -213.253                                 | 261.124                             | 0.805                                                 | -17.28          | 158.914                             | -216.102                                 | 268.242                             |
| 475                  | 0.790                                                 | -18.41          | 150.375                             | -199.750                                 | 250.026                             | 0.791                                                 | -17.67          | 158.301                             | -202.585                                 | 257.099                             | 0.802                                                 | -18.98          | 141.126                             | -206.449                                 | 250.075                             | 0.802                                                 | -18.16          | 149.611                             | -210.221                                 | 258.024                             |
| 500                  | 0.787                                                 | -19.24          | 142.803                             | -194.502                                 | 241.295                             | 0.787                                                 | -18.43          | 150.871                             | -197.426                                 | 248.474                             | 0.799                                                 | -19.92          | 132.835                             | -200.384                                 | 240.414                             | 0.799                                                 | -19.09          | 140.765                             | -204.004                                 | 247.856                             |
| 525                  | 0.783                                                 | -20.10          | 135.793                             | -188.890                                 | 232.635                             | 0.783                                                 | -19.20          | 144.065                             | -192.240                                 | 240.231                             | 0.796                                                 | -20.90          | 125.186                             | -193.960                                 | 230.851                             | 0.796                                                 | -20.03          | 132.797                             | -197.693                                 | 238.154                             |
| 550                  | 0.779                                                 | -20.93          | 129.745                             | -183.353                                 | 224.616                             | 0.780                                                 | -19.97          | 137.814                             | -187.051                                 | 232.338                             | 0.793                                                 | -21.89          | 118.197                             | -187.808                                 | 221.906                             | 0.792                                                 | -20.97          | 125.698                             | -191.502                                 | 229.070                             |
| 575                  | 0.775                                                 | -21.73          | 124.298                             | -178.182                                 | 217.253                             | 0.776                                                 | -20.75          | 131.867                             | -182.250                                 | 224.954                             | 0.789                                                 | -22.85          | 112.161                             | -181.851                                 | 213.658                             | 0.789                                                 | -21.92          | 118.871                             | -185.881                                 | 220.640                             |
| 600                  | 0.770                                                 | -22.59          | 119.110                             | -172.763                                 | 209.843                             | 0.771                                                 | -21.53          | 126.693                             | -176.798                                 | 217.506                             | 0.785                                                 | -23.86          | 106.393                             | -175.910                                 | 205.581                             | 0.785                                                 | -22.85          | 113.154                             | -180.132                                 | 212.723                             |

Figure 31.

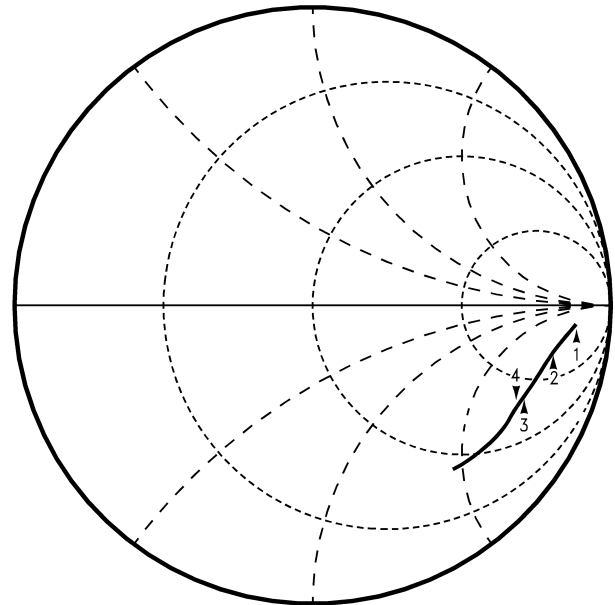
**LMX233xU ULGA  $f_{IN}$  IF Input Impedance**  
 $V_{CC} = 3.0V$ ,  $T_A = +25^\circ C$



Marker 1 = 50 MHz  
Marker 2 = 200 MHz  
Marker 3 = 500 MHz  
Marker 4 = 600 MHz

**Figure 32.**

**LMX233xU ULGA  $f_{IN}$  IF Input Impedance**  
 $V_{CC} = 5.5V$ ,  $T_A = +25^\circ C$



Marker 1 = 50 MHz  
Marker 2 = 200 MHz  
Marker 3 = 500 MHz  
Marker 4 = 600 MHz

**Figure 33.**

LMX233xU ULGA  $f_{IN}$  IF Input Impedance Table

| $f_{IN}$ IF<br>(MHz) | LMX233xU ULGA $Z_{f_{IN}IF}$                          |                 |                                      |                                      |                                  |                                                       |                 |                                      |                                      |                                  |
|----------------------|-------------------------------------------------------|-----------------|--------------------------------------|--------------------------------------|----------------------------------|-------------------------------------------------------|-----------------|--------------------------------------|--------------------------------------|----------------------------------|
|                      | $V_{CC} = V_P$ IF = 3.0V ( $T_A = 25^\circ\text{C}$ ) |                 |                                      |                                      |                                  | $V_{CC} = V_P$ IF = 5.5V ( $T_A = 25^\circ\text{C}$ ) |                 |                                      |                                      |                                  |
|                      | $  \Gamma  $                                          | $\angle \Gamma$ | Re<br>$Z_{f_{IN}IF}$<br>( $\Omega$ ) | Im<br>$Z_{f_{IN}IF}$<br>( $\Omega$ ) | $ Z_{f_{IN}IF} $<br>( $\Omega$ ) | $  \Gamma  $                                          | $\angle \Gamma$ | Re<br>$Z_{f_{IN}IF}$<br>( $\Omega$ ) | Im<br>$Z_{f_{IN}IF}$<br>( $\Omega$ ) | $ Z_{f_{IN}IF} $<br>( $\Omega$ ) |
| 50                   | 0.89                                                  | -4.56           | 586.15                               | -398.99                              | 709.057                          | 0.89                                                  | -4.47           | 593.52                               | -396.04                              | 713.521                          |
| 75                   | 0.87                                                  | -5.99           | 460.41                               | -343.89                              | 574.669                          | 0.87                                                  | -5.94           | 463.18                               | -343.08                              | 576.407                          |
| 100                  | 0.86                                                  | -7.21           | 392.16                               | -325.10                              | 509.397                          | 0.86                                                  | -7.14           | 395.29                               | -324.53                              | 511.442                          |
| 125                  | 0.85                                                  | -8.17           | 349.02                               | -303.86                              | 462.760                          | 0.85                                                  | -8.15           | 349.77                               | -303.76                              | 463.257                          |
| 150                  | 0.84                                                  | -9.27           | 309.63                               | -284.63                              | 420.576                          | 0.84                                                  | -9.07           | 315.84                               | -284.12                              | 424.831                          |
| 175                  | 0.83                                                  | -10.05          | 286.09                               | -266.39                              | 390.911                          | 0.83                                                  | -10.01          | 287.15                               | -266.33                              | 391.651                          |
| 200                  | 0.83                                                  | -11.08          | 259.93                               | -266.55                              | 372.306                          | 0.83                                                  | -10.88          | 264.82                               | -266.71                              | 375.850                          |
| 225                  | 0.82                                                  | -11.94          | 241.30                               | -249.92                              | 347.397                          | 0.82                                                  | -11.78          | 244.69                               | -250.08                              | 349.881                          |
| 250                  | 0.82                                                  | -12.68          | 226.25                               | -248.62                              | 336.156                          | 0.82                                                  | -12.63          | 227.23                               | -248.73                              | 336.903                          |
| 275                  | 0.81                                                  | -13.75          | 208.36                               | -233.29                              | 312.791                          | 0.81                                                  | -13.55          | 211.78                               | -233.74                              | 315.416                          |
| 300                  | 0.81                                                  | -14.72          | 192.62                               | -230.56                              | 300.430                          | 0.81                                                  | -14.48          | 196.38                               | -231.31                              | 303.431                          |
| 325                  | 0.80                                                  | -15.64          | 181.38                               | -217.32                              | 283.068                          | 0.80                                                  | -15.43          | 184.29                               | -217.93                              | 285.405                          |
| 350                  | 0.80                                                  | -16.65          | 168.09                               | -214.06                              | 272.169                          | 0.80                                                  | -16.32          | 172.30                               | -215.19                              | 275.668                          |
| 375                  | 0.80                                                  | -17.56          | 157.13                               | -210.69                              | 262.830                          | 0.80                                                  | -17.37          | 159.34                               | -211.42                              | 264.743                          |
| 400                  | 0.79                                                  | -18.53          | 149.15                               | -199.24                              | 248.883                          | 0.79                                                  | -18.32          | 151.35                               | -199.96                              | 250.784                          |
| 425                  | 0.79                                                  | -19.54          | 139.12                               | -195.59                              | 240.020                          | 0.79                                                  | -19.31          | 141.33                               | -196.44                              | 241.998                          |
| 450                  | 0.79                                                  | -20.53          | 130.12                               | -191.80                              | 231.770                          | 0.79                                                  | -20.28          | 132.32                               | -192.77                              | 233.814                          |
| 475                  | 0.78                                                  | -21.62          | 123.81                               | -181.72                              | 219.888                          | 0.78                                                  | -21.28          | 126.52                               | -182.91                              | 222.403                          |
| 500                  | 0.78                                                  | -22.58          | 116.56                               | -178.29                              | 213.012                          | 0.78                                                  | -22.24          | 119.06                               | -179.52                              | 215.410                          |
| 525                  | 0.77                                                  | -23.62          | 111.89                               | -169.59                              | 203.177                          | 0.77                                                  | -23.27          | 114.24                               | -170.73                              | 205.428                          |
| 550                  | 0.77                                                  | -24.52          | 106.14                               | -166.63                              | 197.557                          | 0.77                                                  | -24.17          | 108.33                               | -167.78                              | 199.714                          |
| 575                  | 0.77                                                  | -25.49          | 100.37                               | -163.40                              | 191.761                          | 0.77                                                  | -25.82          | 98.50                                | -162.29                              | 189.848                          |
| 600                  | 0.77                                                  | -26.55          | 94.54                                | -159.86                              | 185.721                          | 0.77                                                  | -26.14          | 96.74                                | -161.23                              | 188.022                          |

Figure 34.

**LMX233xU TSSOP OSC<sub>in</sub> Input Impedance Vs Frequency**  
**T<sub>A</sub> = +25°C**

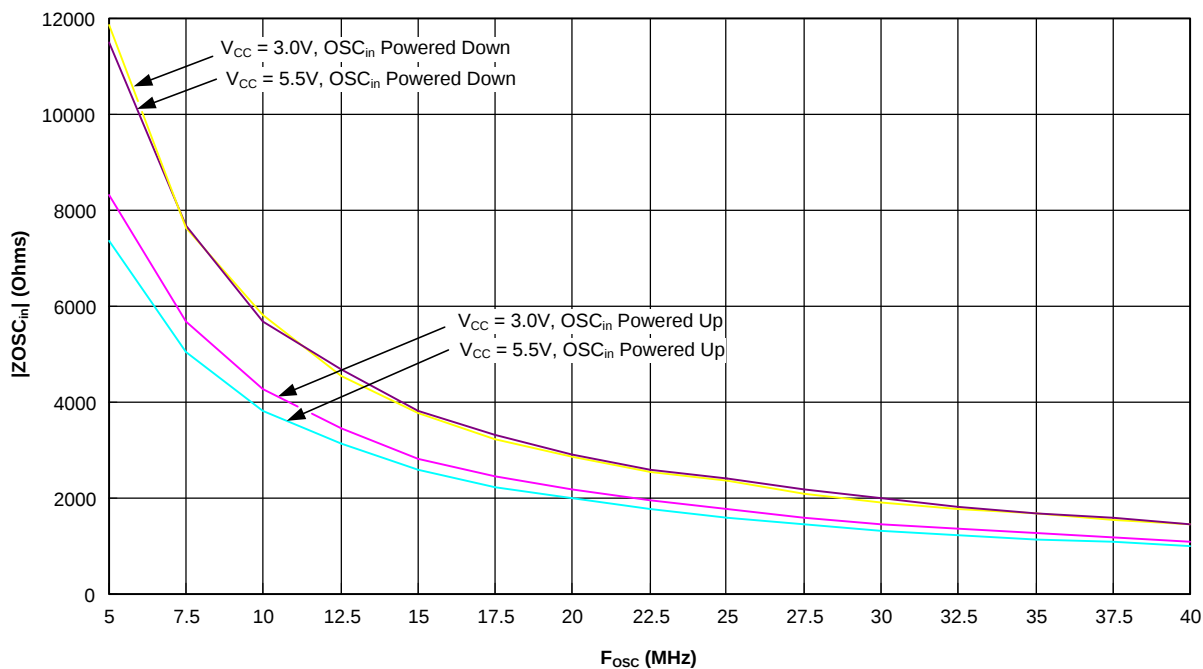


Figure 35.

**LMX233xU LGA OSC<sub>in</sub> Input Impedance Vs Frequency**  
**T<sub>A</sub> = +25°C**

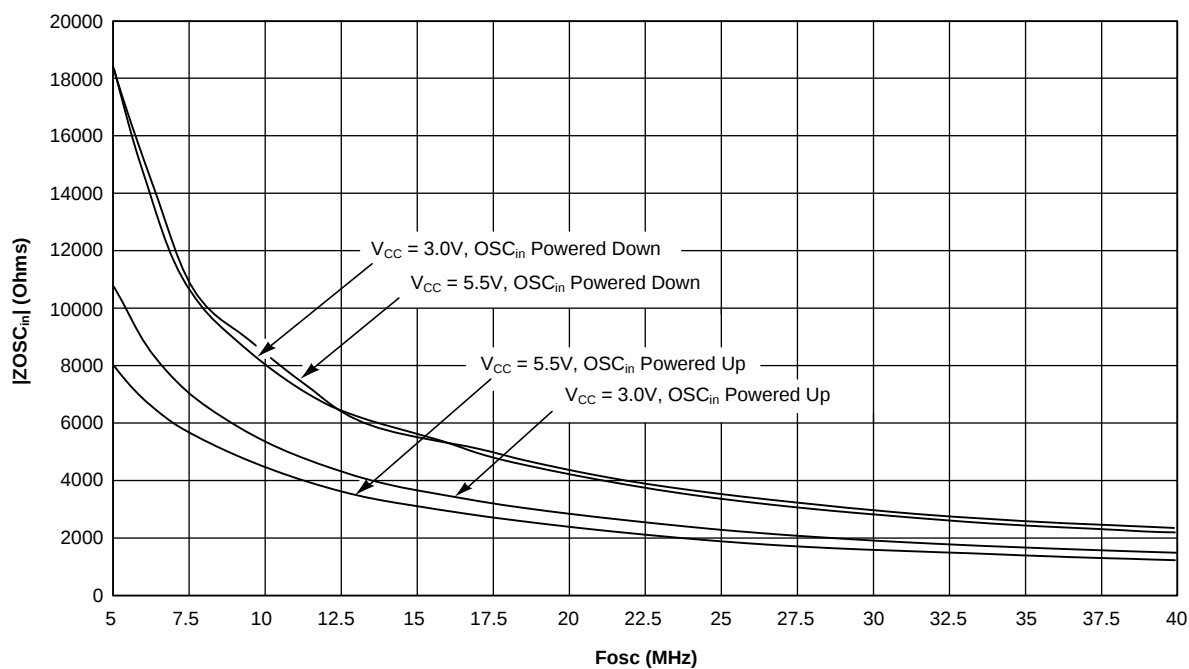


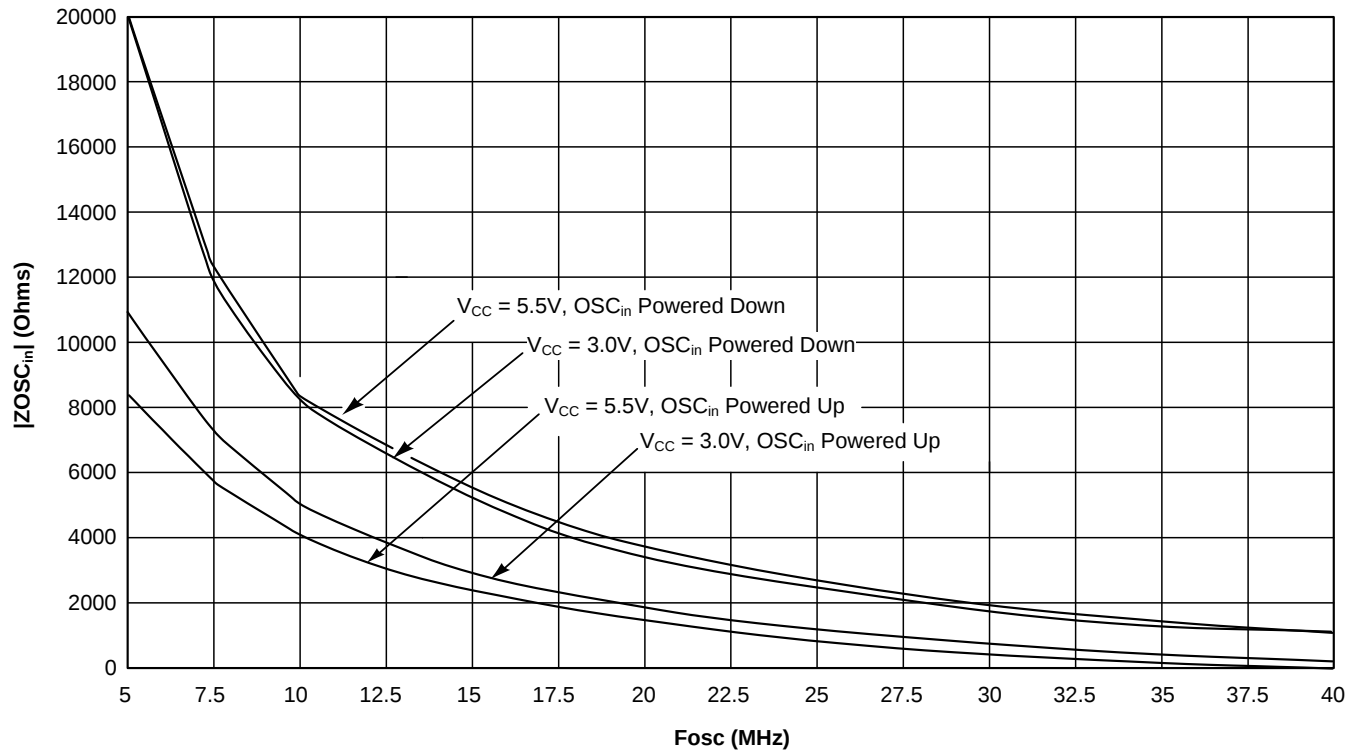
Figure 36.

LMX233xU TSSOP and LMX233xU LGA OSC<sub>in</sub> Input Impedance Table

| F <sub>osc</sub><br>(MHz) | LMX233xU TSSOP ZOSC <sub>in</sub>              |                                 |                             |                                          |                                 |                             |                                                |                                 |                             |                                          |                                 |                             | LMX233xU LGA ZOSC <sub>in</sub>                |                                 |                             |                                          |                                 |                             |                                                |                                 |                             |                                          |                                 |                             |
|---------------------------|------------------------------------------------|---------------------------------|-----------------------------|------------------------------------------|---------------------------------|-----------------------------|------------------------------------------------|---------------------------------|-----------------------------|------------------------------------------|---------------------------------|-----------------------------|------------------------------------------------|---------------------------------|-----------------------------|------------------------------------------|---------------------------------|-----------------------------|------------------------------------------------|---------------------------------|-----------------------------|------------------------------------------|---------------------------------|-----------------------------|
|                           | V <sub>CC</sub> = 3.0V (T <sub>A</sub> = 25°C) |                                 |                             |                                          |                                 |                             | V <sub>CC</sub> = 5.5V (T <sub>A</sub> = 25°C) |                                 |                             |                                          |                                 |                             | V <sub>CC</sub> = 3.0V (T <sub>A</sub> = 25°C) |                                 |                             |                                          |                                 |                             | V <sub>CC</sub> = 5.5V (T <sub>A</sub> = 25°C) |                                 |                             |                                          |                                 |                             |
|                           | OSC <sub>in</sub> BUFFER<br>POWERED UP         |                                 |                             | OSC <sub>in</sub> BUFFER<br>POWERED DOWN |                                 |                             | OSC <sub>in</sub> BUFFER<br>POWERED UP         |                                 |                             | OSC <sub>in</sub> BUFFER<br>POWERED DOWN |                                 |                             | OSC <sub>in</sub> BUFFER<br>POWERED UP         |                                 |                             | OSC <sub>in</sub> BUFFER<br>POWERED DOWN |                                 |                             | OSC <sub>in</sub> BUFFER<br>POWERED UP         |                                 |                             | OSC <sub>in</sub> BUFFER<br>POWERED DOWN |                                 |                             |
|                           | Re<br>ZOSC <sub>in</sub><br>(Ω)                | Im<br>ZOSC <sub>in</sub><br>(Ω) | ZOSC <sub>in</sub>  <br>(Ω) | Re<br>ZOSC <sub>in</sub><br>(Ω)          | Im<br>ZOSC <sub>in</sub><br>(Ω) | ZOSC <sub>in</sub>  <br>(Ω) | Re<br>ZOSC <sub>in</sub><br>(Ω)                | Im<br>ZOSC <sub>in</sub><br>(Ω) | ZOSC <sub>in</sub>  <br>(Ω) | Re<br>ZOSC <sub>in</sub><br>(Ω)          | Im<br>ZOSC <sub>in</sub><br>(Ω) | ZOSC <sub>in</sub>  <br>(Ω) | Re<br>ZOSC <sub>in</sub><br>(Ω)                | Im<br>ZOSC <sub>in</sub><br>(Ω) | ZOSC <sub>in</sub>  <br>(Ω) | Re<br>ZOSC <sub>in</sub><br>(Ω)          | Im<br>ZOSC <sub>in</sub><br>(Ω) | ZOSC <sub>in</sub>  <br>(Ω) | Re<br>ZOSC <sub>in</sub><br>(Ω)                | Im<br>ZOSC <sub>in</sub><br>(Ω) | ZOSC <sub>in</sub>  <br>(Ω) | Re<br>ZOSC <sub>in</sub><br>(Ω)          | Im<br>ZOSC <sub>in</sub><br>(Ω) | ZOSC <sub>in</sub>  <br>(Ω) |
|                           |                                                |                                 |                             |                                          |                                 |                             |                                                |                                 |                             |                                          |                                 |                             |                                                |                                 |                             |                                          |                                 |                             |                                                |                                 |                             |                                          |                                 |                             |
| 5.0                       | 2291.113                                       | -8000.376                       | 8321.972                    | 985.863                                  | -11825.209                      | 11866.234                   | 2832.878                                       | -6774.525                       | 7342.982                    | 1246.071                                 | -11436.600                      | 11504.282                   | 5107.688                                       | -9526.374                       | 10809.27                    | 4154.104                                 | -18073.24                       | 18544.50                    | 4698.960                                       | -6544.007                       | 8056.318                    | 4154.104                                 | -18073.24                       | 18544.50                    |
| 7.5                       | 1202.389                                       | -5538.197                       | 5667.218                    | 294.460                                  | -7640.322                       | 7645.994                    | 1267.479                                       | -4861.053                       | 5023.579                    | 520.098                                  | -7675.309                       | 7692.910                    | 2249.061                                       | -6544.475                       | 6920.146                    | 1571.331                                 | -10205.48                       | 10325.74                    | 2626.329                                       | -4998.105                       | 5646.119                    | 1812.311                                 | -10602.90                       | 10756.68                    |
| 10.0                      | 791.970                                        | -4218.658                       | 4292.353                    | 266.942                                  | -5793.060                       | 5799.207                    | 739.926                                        | -3754.673                       | 3826.886                    | 484.656                                  | -5659.675                       | 5680.388                    | 1664.886                                       | -5170.920                       | 5432.335                    | 1066.661                                 | -8350.651                       | 8418.499                    | 1625.723                                       | -4209.219                       | 4512.261                    | 976.808                                  | -8800.590                       | 8854.633                    |
| 12.5                      | 527.664                                        | -3418.978                       | 3459.456                    | 197.874                                  | -4547.094                       | 4551.397                    | 544.280                                        | -3078.845                       | 3126.584                    | 196.239                                  | -4665.169                       | 4669.295                    | 1048.750                                       | -4245.537                       | 4373.153                    | 727.756                                  | -6341.105                       | 6382.730                    | 1182.342                                       | -3466.982                       | 3663.045                    | 899.697                                  | -6248.932                       | 6313.367                    |
| 15.0                      | 343.020                                        | -2817.993                       | 2838.794                    | 161.801                                  | -3761.566                       | 3765.044                    | 416.644                                        | -2536.243                       | 2570.238                    | 160.236                                  | -3799.626                       | 3803.003                    | 872.629                                        | -3558.426                       | 3663.861                    | 442.319                                  | -5658.273                       | 5675.536                    | 856.006                                        | -2977.931                       | 3098.519                    | 436.542                                  | -5712.788                       | 5729.443                    |
| 17.5                      | 316.446                                        | -2439.647                       | 2460.085                    | 141.326                                  | -3203.351                       | 3206.467                    | 309.867                                        | -2192.584                       | 2214.372                    | 196.400                                  | -3305.741                       | 3311.570                    | 691.377                                        | -3158.030                       | 3232.825                    | 296.061                                  | -4799.917                       | 4809.039                    | 697.781                                        | -2605.886                       | 2697.692                    | 309.618                                  | -4985.007                       | 4994.613                    |
| 20.0                      | 228.526                                        | -2179.146                       | 2191.096                    | 63.505                                   | -2879.931                       | 2880.631                    | 227.640                                        | -1974.267                       | 1987.347                    | 73.816                                   | -2917.281                       | 2918.215                    | 559.597                                        | -2791.912                       | 2847.441                    | 194.872                                  | -4242.475                       | 4246.948                    | 554.417                                        | -2318.961                       | 2384.315                    | 303.378                                  | -4345.597                       | 4356.174                    |
| 22.5                      | 211.659                                        | -1932.535                       | 1944.091                    | 98.108                                   | -2543.330                       | 2545.222                    | 214.873                                        | -1741.101                       | 1754.310                    | 103.131                                  | -2608.411                       | 2610.449                    | 442.147                                        | -2512.522                       | 2551.129                    | 186.123                                  | -3777.847                       | 3782.429                    | 485.437                                        | -2041.170                       | 2098.100                    | 168.163                                  | -3935.873                       | 3939.464                    |
| 25.0                      | 163.618                                        | -1762.903                       | 1770.480                    | 89.270                                   | -2340.221                       | 2341.923                    | 169.812                                        | -1589.814                       | 1598.857                    | 67.246                                   | -2388.967                       | 2389.913                    | 444.524                                        | -2261.024                       | 2304.307                    | 170.072                                  | -3402.400                       | 3406.648                    | 424.599                                        | -1865.270                       | 1912.986                    | 174.460                                  | -3506.895                       | 3511.232                    |
| 27.5                      | 163.733                                        | -1589.620                       | 1598.030                    | 69.675                                   | -2106.253                       | 2107.405                    | 160.401                                        | -1435.713                       | 1444.646                    | 69.923                                   | -2161.702                       | 2162.832                    | 367.245                                        | -2060.013                       | 2092.491                    | 191.739                                  | -3114.867                       | 3120.763                    | 379.086                                        | -1714.793                       | 1756.195                    | 159.273                                  | -3213.478                       | 3217.422                    |
| 30.0                      | 148.446                                        | -1463.071                       | 1470.583                    | 81.310                                   | -1926.889                       | 1928.604                    | 141.501                                        | -1314.929                       | 1322.520                    | 67.843                                   | -1984.769                       | 1985.928                    | 356.692                                        | -1893.442                       | 1926.747                    | 188.280                                  | -2837.317                       | 2843.557                    | 357.340                                        | -1567.979                       | 1608.182                    | 157.424                                  | -2934.223                       | 2938.443                    |
| 32.5                      | 130.683                                        | -1340.206                       | 1346.562                    | 46.548                                   | -1750.824                       | 1751.443                    | 121.612                                        | -1213.403                       | 1219.482                    | 37.610                                   | -1812.700                       | 1813.090                    | 348.916                                        | -1776.540                       | 1810.480                    | 129.014                                  | -2664.486                       | 2667.608                    | 332.065                                        | -1461.571                       | 1498.818                    | 157.389                                  | -2780.469                       | 2784.920                    |
| 35.0                      | 126.059                                        | -1255.034                       | 1261.349                    | 38.046                                   | -1662.230                       | 1662.666                    | 116.385                                        | -1131.429                       | 1137.399                    | 45.646                                   | -1689.748                       | 1690.365                    | 302.932                                        | -1648.356                       | 1675.961                    | 95.424                                   | -2471.170                       | 2473.011                    | 299.913                                        | -1358.120                       | 1390.840                    | 125.530                                  | -2600.472                       | 2603.500                    |
| 37.5                      | 115.848                                        | -1178.954                       | 1184.632                    | 37.202                                   | -1547.816                       | 1548.263                    | 109.381                                        | -1064.461                       | 1070.066                    | 36.346                                   | -1591.439                       | 1591.854                    | 300.020                                        | -1549.601                       | 1578.377                    | 117.732                                  | -2331.694                       | 2334.664                    | 284.654                                        | -1274.370                       | 1305.774                    | 144.727                                  | -2419.904                       | 2424.228                    |
| 40.0                      | 108.280                                        | -1089.931                       | 1095.296                    | 36.351                                   | -1439.460                       | 1439.919                    | 100.267                                        | -985.544                        | 990.631                     | 39.180                                   | -1470.482                       | 1471.004                    | 281.334                                        | -1454.298                       | 1481.260                    | 81.318                                   | -2182.473                       | 2183.987                    | 273.323                                        | -1199.918                       | 1230.654                    | 152.283                                  | -2302.913                       | 2307.942                    |

Figure 37.

**LMX233xU ULGA OSC<sub>in</sub> Input Impedance Vs Frequency**  
**T<sub>A</sub> = +25°C**



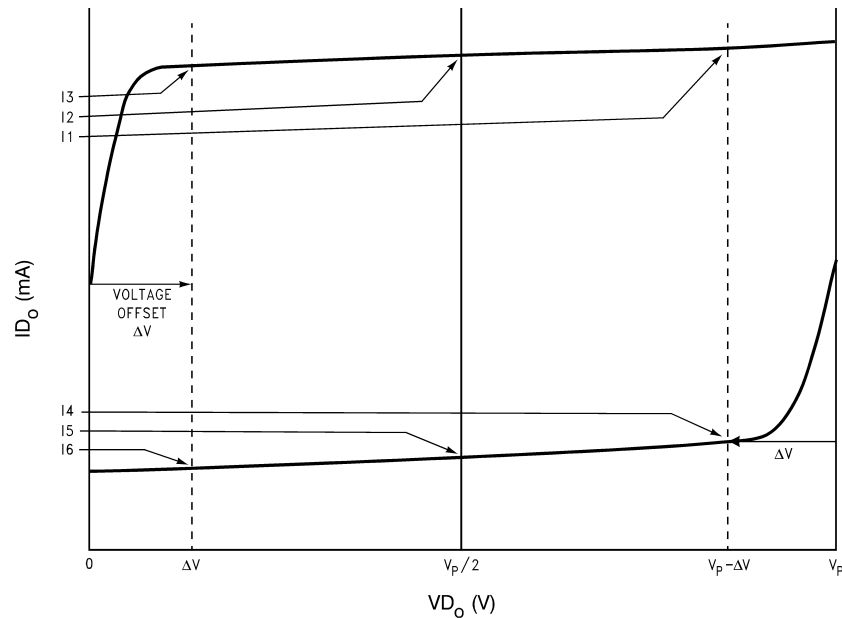
**Figure 38.**

LMX233xU ULGA OSC<sub>in</sub> Input Impedance Table

| LMX233xU ULGA ZOC <sub>in</sub>                |                                 |                              |                                          |                                 |                              |                             |                                                |                              |                             |                                          |                              |                             |
|------------------------------------------------|---------------------------------|------------------------------|------------------------------------------|---------------------------------|------------------------------|-----------------------------|------------------------------------------------|------------------------------|-----------------------------|------------------------------------------|------------------------------|-----------------------------|
| V <sub>CC</sub> = 3.0V (T <sub>A</sub> = 25°C) |                                 |                              |                                          |                                 |                              |                             | V <sub>CC</sub> = 5.5V (T <sub>A</sub> = 25°C) |                              |                             |                                          |                              |                             |
| OSC <sub>in</sub> BUFFER<br>POWERED UP         |                                 |                              | OSC <sub>in</sub> BUFFER<br>POWERED DOWN |                                 |                              |                             | OSC <sub>in</sub> BUFFER<br>POWERED UP         |                              |                             | OSC <sub>in</sub> BUFFER<br>POWERED DOWN |                              |                             |
| F <sub>osc</sub><br>(MHz)                      | Re<br>ZOSC <sub>in</sub><br>(Ω) | Im<br>ZOSC <sub>in</sub> (Ω) | ZOSC <sub>in</sub>  <br>(Ω)              | Re<br>ZOSC <sub>in</sub><br>(Ω) | Im<br>ZOSC <sub>in</sub> (Ω) | ZOSC <sub>in</sub>  <br>(Ω) | Re<br>ZOSC <sub>in</sub><br>(Ω)                | Im<br>ZOSC <sub>in</sub> (Ω) | ZOSC <sub>in</sub>  <br>(Ω) | Re<br>ZOSC <sub>in</sub><br>(Ω)          | Im<br>ZOSC <sub>in</sub> (Ω) | ZOSC <sub>in</sub>  <br>(Ω) |
| 5.0                                            | 5918.57                         | -9897.80                     | 11532.39                                 | 1822.62                         | -19947.73                    | 20030.82                    | 4982.73                                        | -7668.32                     | 9144.98                     | 2478.02                                  | -19591.11                    | 19747.21                    |
| 7.5                                            | 3097.46                         | -7441.43                     | 8060.35                                  | 2238.93                         | -12114.22                    | 12319.38                    | 2742.97                                        | -6062.16                     | 6653.85                     | 2483.54                                  | -12531.99                    | 12775.71                    |
| 10.0                                           | 1695.22                         | -5720.83                     | 5966.72                                  | 998.16                          | -9046.84                     | 9101.74                     | 1582.29                                        | -4875.36                     | 5125.70                     | 1064.38                                  | -9063.97                     | 9126.25                     |
| 12.5                                           | 1241.03                         | -4759.14                     | 4918.29                                  | 660.39                          | -7338.93                     | 7368.58                     | 1150.39                                        | -4034.66                     | 4195.46                     | 621.48                                   | -7679.86                     | 7704.97                     |
| 15.0                                           | 820.55                          | -3955.33                     | 4039.55                                  | 471.57                          | -6142.40                     | 6160.48                     | 861.48                                         | -3448.80                     | 3554.76                     | 591.34                                   | -6481.87                     | 6508.79                     |
| 17.5                                           | 646.18                          | -3417.20                     | 3477.76                                  | 317.24                          | -5165.41                     | 5175.14                     | 599.49                                         | -3009.04                     | 3068.18                     | 154.67                                   | -5518.01                     | 5520.17                     |
| 20.0                                           | 520.20                          | -3006.22                     | 3050.90                                  | 223.35                          | -4567.95                     | 4573.41                     | 491.78                                         | -2647.38                     | 2692.67                     | 120.99                                   | -4867.07                     | 4868.57                     |
| 22.5                                           | 459.63                          | -2666.05                     | 2705.38                                  | 219.57                          | -4040.96                     | 4046.92                     | 396.64                                         | -2342.62                     | 2375.96                     | 137.85                                   | -4301.63                     | 4303.84                     |
| 25.0                                           | 391.21                          | -2398.19                     | 2429.89                                  | 172.20                          | -3664.77                     | 3668.81                     | 323.46                                         | -2108.25                     | 2132.92                     | 89.00                                    | -3864.60                     | 3865.62                     |
| 27.5                                           | 348.79                          | -2210.66                     | 2238.01                                  | 169.02                          | -3291.50                     | 3295.84                     | 312.14                                         | -1920.70                     | 1945.90                     | 114.48                                   | -3476.68                     | 3478.56                     |
| 30.0                                           | 285.07                          | -1996.71                     | 2016.96                                  | 110.02                          | -3005.42                     | 3007.43                     | 260.59                                         | -1763.82                     | 1782.97                     | 121.11                                   | -3185.26                     | 3187.56                     |
| 32.5                                           | 267.83                          | -1847.30                     | 1866.61                                  | 117.14                          | -2725.46                     | 2727.97                     | 239.41                                         | -1612.35                     | 1630.02                     | 111.70                                   | -2876.34                     | 2878.50                     |
| 35.0                                           | 252.27                          | -1719.32                     | 1737.73                                  | 114.38                          | -2558.44                     | 2561.00                     | 222.16                                         | -1503.76                     | 1520.08                     | 115.42                                   | -2690.37                     | 2692.84                     |
| 37.5                                           | 224.94                          | -1639.80                     | 1655.15                                  | 70.31                           | -2408.64                     | 2409.67                     | 191.46                                         | -1422.88                     | 1435.71                     | 48.06                                    | -2550.41                     | 2550.86                     |
| 40.0                                           | 208.96                          | -1512.91                     | 1527.27                                  | 76.50                           | -2242.79                     | 2244.09                     | 180.75                                         | -1329.24                     | 1341.47                     | 72.61                                    | -2353.73                     | 2354.85                     |

Figure 39.

### Charge Pump Current Specification Definitions



I1 = Charge Pump Sink Current at  $VD_0 = V_P - \Delta V$

I2 = Charge Pump Sink Current at  $VD_0 = V_P/2$

I3 = Charge Pump Sink Current at  $VD_0 = \Delta V$

I4 = Charge Pump Source Current at  $VD_0 = V_P - \Delta V$

I5 = Charge Pump Source Current at  $VD_0 = V_P/2$

I6 = Charge Pump Source Current at  $VD_0 = \Delta V$

$\Delta V$  = Voltage offset from the positive and negative rails. Dependent on the VCO tuning range relative to  $V_{CC}$  and GND. Typical values are between 0.5V and 1.0V.

$V_P$  refers to either  $V_P$  RF or  $V_P$  IF

$VD_0$  refers to either  $VD_0$  RF or  $VD_0$  IF

$ID_0$  refers to either  $ID_0$  RF or  $ID_0$  IF

### Charge Pump Output Current Magnitude Variation Vs Charge Pump Output Voltage

$$ID_0 \text{ Vs } VD_0 = \frac{(|I1| - |I3|)}{(|I1| + |I3|)} \times 100\%$$

$$= \frac{(|I4| - |I6|)}{(|I4| + |I6|)} \times 100\%$$

(1)

### Charge Pump Output Sink Current Vs Charge Pump Output Source Current Mismatch

$$ID_0 \text{ SINK Vs } ID_0 \text{ SOURCE} = \frac{|I2| - |I5|}{\frac{1}{2}(|I2| + |I5|)} \times 100\%$$

(2)

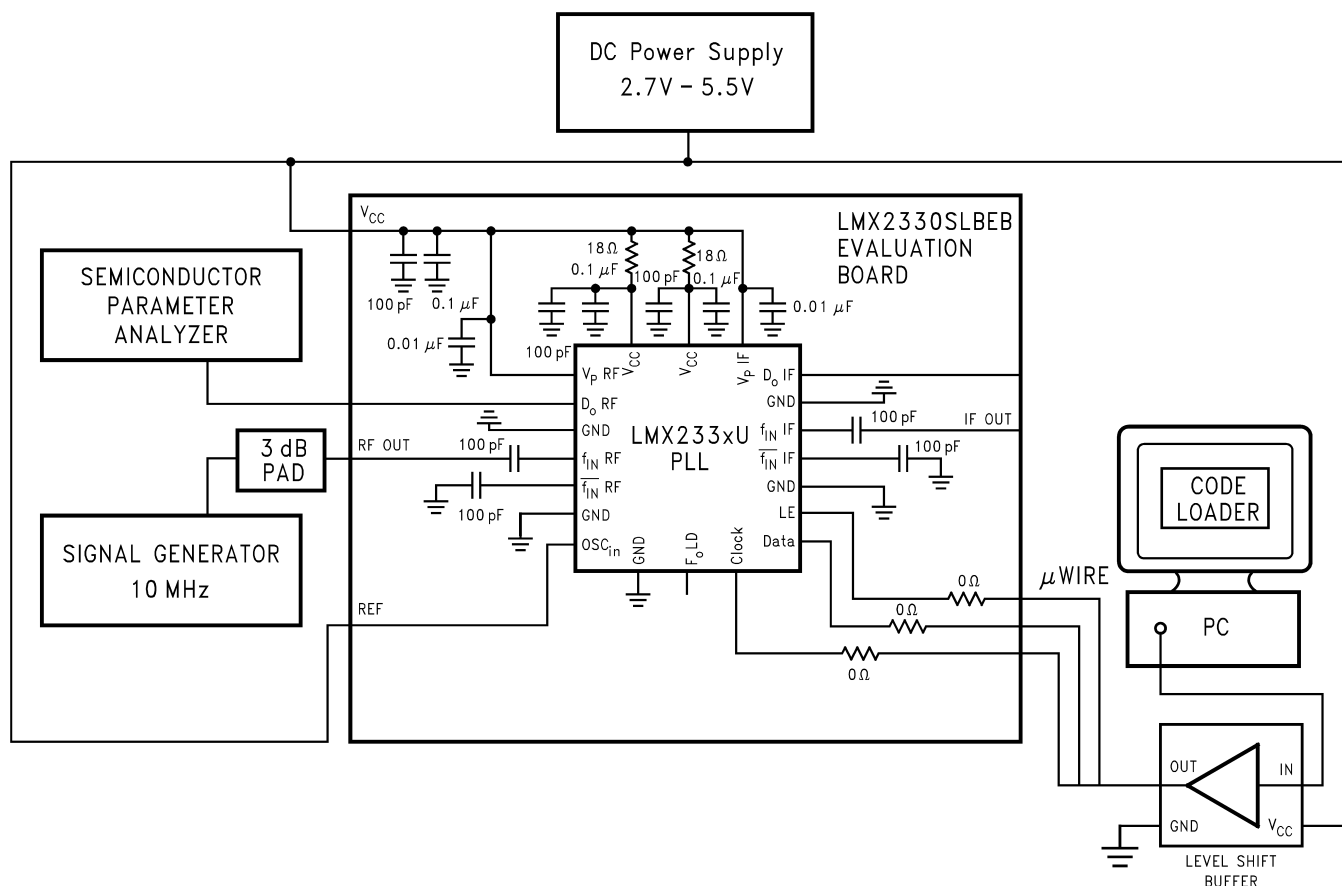
### Charge Pump Output Current Magnitude Variation Vs Temperature

$$ID_0 \text{ Vs } T_A = \frac{|I2|_{T_A=25^\circ C} - |I2|_{T_A=25^\circ C}}{|I2|_{T_A=25^\circ C}} \times 100\%$$

$$= \frac{|I5|_{T_A=25^\circ C} - |I5|_{T_A=25^\circ C}}{|I5|_{T_A=25^\circ C}} \times 100\%$$

(3)

### Test Setups



**Figure 40. LMX233xU Charge Pump Test Setup**

The block diagram in [Figure 40](#) illustrates the setup required to measure the LMX233xU device's RF charge pump sink current. The same setup is used for the LMX2330TMEB/ LMX2330SLEEB Evaluation Boards. The IF charge pump measurement setup is similar to the RF charge pump measurement setup. The purpose of this test is to assess the functionality of the RF charge pump.

This setup uses an open loop configuration. A power supply is connected to  $V_{CC}$  and swept from 2.7V to 5.5V. By means of a signal generator, a 10 MHz signal is typically applied to the  $f_{IN}$  RF pin. The signal is one of two inputs to the phase detector. The 3 dB pad provides a 50  $\Omega$  match between the PLL and the signal generator. The  $OSC_{in}$  pin is tied to  $V_{CC}$ . This establishes the other input to the phase detector. Alternatively, this input can be tied directly to the ground plane. With the  $D_O$  RF pin connected to a Semiconductor Parameter Analyzer in this way, the sink, source, and TRI-STATE currents can be measured by simply toggling the **Phase Detector Polarity** and **Charge Pump State** states in Code Loader. Similarly, the LOW and HIGH currents can be measured by switching the **Charge Pump Gain's** state between **1X** and **4X** in Code Loader.

Let  $F_r$  represent the frequency of the signal applied to the  $OSC_{in}$  pin, which is simply zero in this case (DC), and let  $F_p$  represent the frequency of the signal applied to the  $f_{IN}$  RF pin. The phase detector is sensitive to the rising edges of  $F_r$  and  $F_p$ . Assuming positive VCO characteristics; the charge pump turns ON and sinks current when the first rising edge of  $F_p$  is detected. Since  $F_r$  has no rising edge, the charge pump continues to sink current indefinitely.

Toggling the **Phase Detector Polarity** state to negative VCO characteristics allows the measurement of the RF charge pump source current. Likewise, selecting **TRI-STATE** (TRI-STATE  $ID_O$  RF Bit = 1) for **Charge Pump State** in Code Loader facilitates the measurement of the TRI-STATE current.

The measurements are repeated at different temperatures, namely  $T_A = -40^\circ\text{C}$ ,  $+25^\circ\text{C}$ , and  $+85^\circ\text{C}$ .

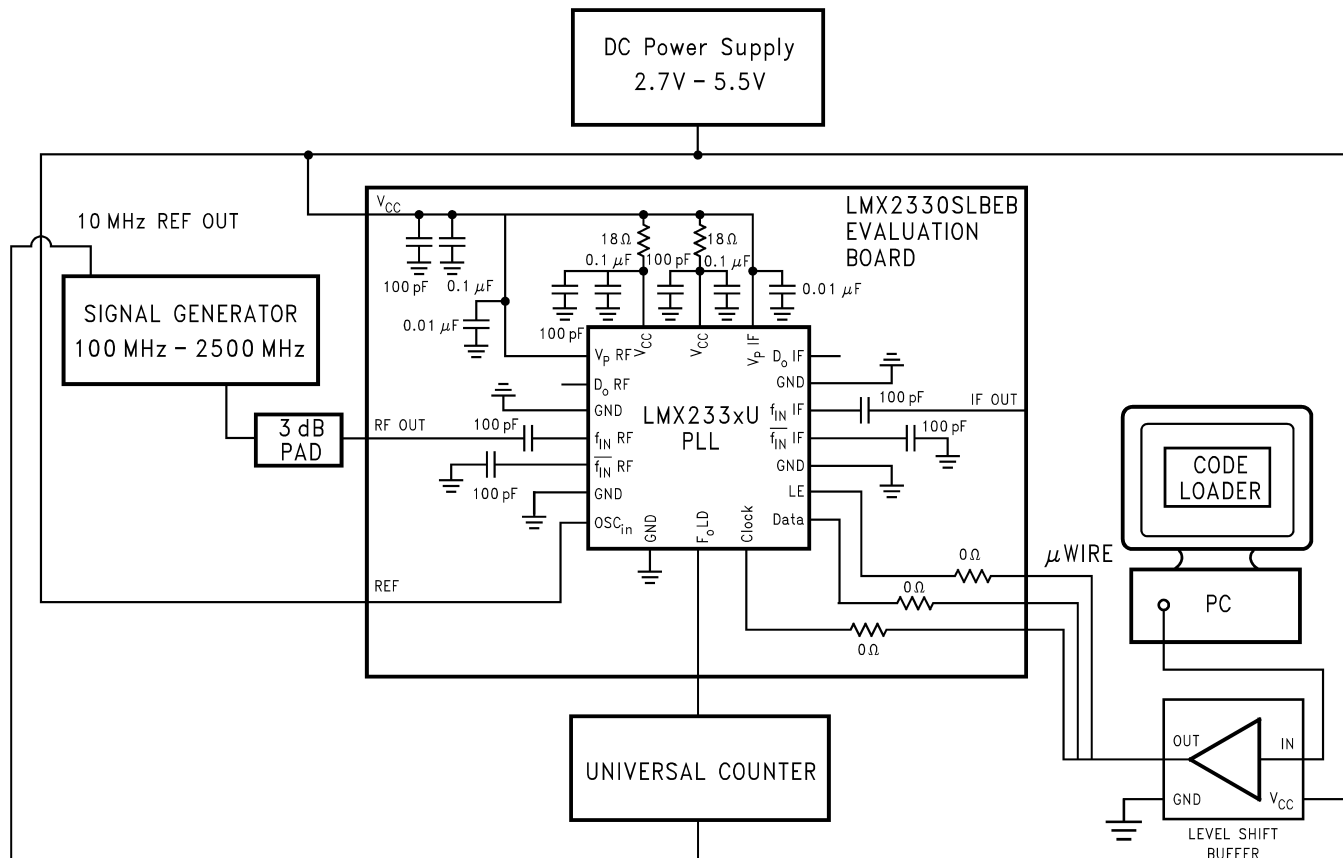
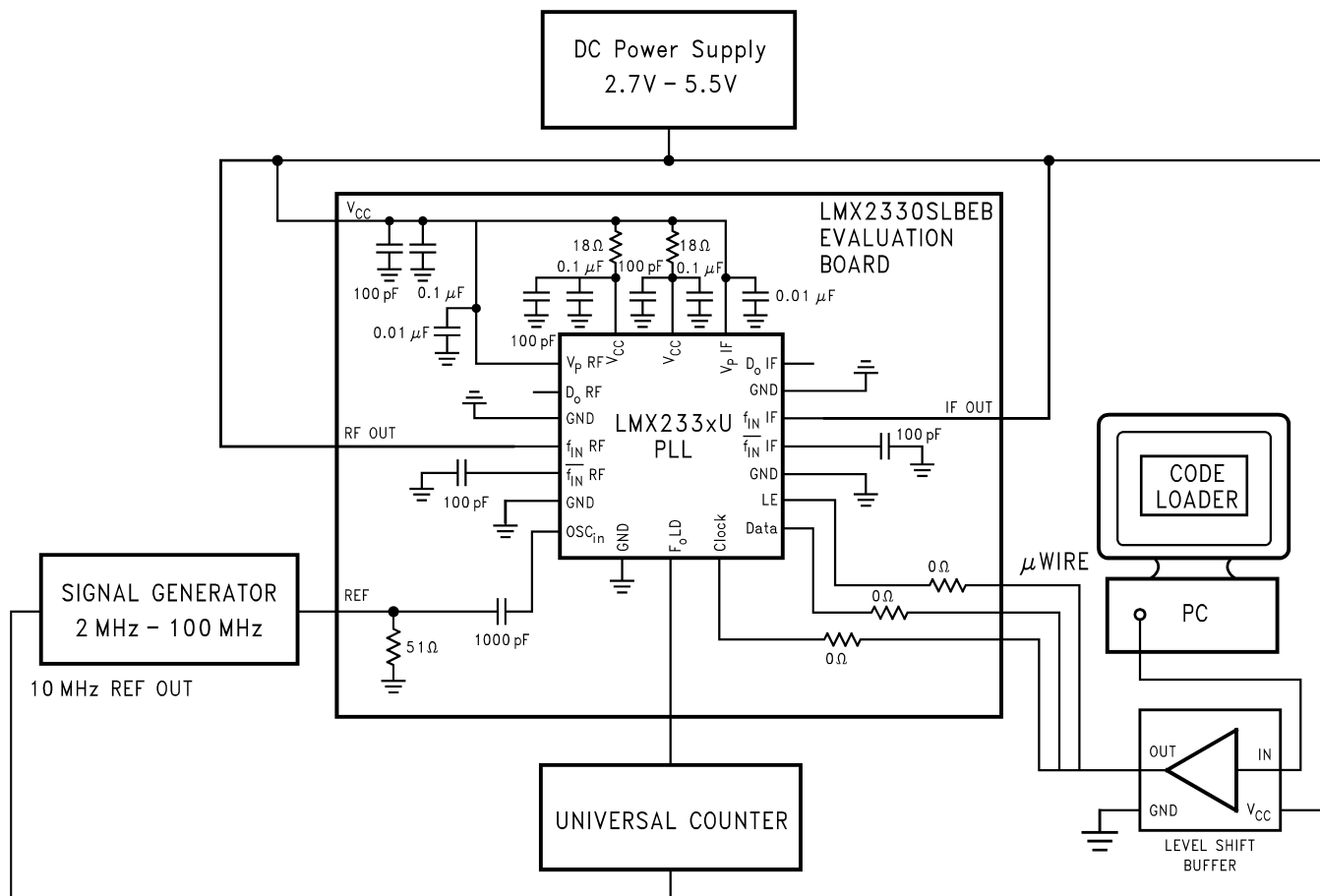


Figure 41. LMX233xU  $f_{IN}$  Sensitivity Test Setup

The block diagram in Figure 41 illustrates the setup required to measure the LMX233xU device's RF input sensitivity level. The same setup is used for the LMX2330TMEB/ LMX2330SLEEB Evaluation Boards. The IF input sensitivity test setup is similar to the RF sensitivity test setup. The purpose of this test is to measure the acceptable signal level to the  $f_{IN}$  RF input of the PLL chip. Outside the acceptable signal range, the feedback divider begins to divide incorrectly and miscount the frequency.

The setup uses an open loop configuration. A power supply is connected to  $V_{CC}$  and swept from 2.7V to 5.5V. The IF PLL is powered down (PWDN IF Bit = 1). By means of a signal generator, an RF signal is applied to the  $f_{IN}$  RF pin. The 3 dB pad provides a 50  $\Omega$  match between the PLL and the signal generator. The  $OSC_{in}$  pin is tied to  $V_{CC}$ . The N value is typically set to 10000 in Code Loader, i.e. RF N\_CNTRB Word = 156 and RF N\_CNTRA Word = 16 for PRE RF Bit = 1 (LMX2330U) or PRE RF = 0 (LMX2331U and LMX2332U). The feedback divider output is routed to the  $F_oLD$  pin by selecting the **RF PLL N Divider Output** word ( $F_oLD$  Word = 6 or 14) in Code Loader. A Universal Counter is connected to the  $F_oLD$  pin and tied to the 10 MHz reference output of the signal generator. The output of the feedback divider is thus monitored and should be equal to  $f_{IN} RF / N$ .

The  $f_{IN}$  RF input frequency and power level are then swept with the signal generator. The measurements are repeated at different temperatures, namely  $T_A = -40^\circ C$ ,  $+25^\circ C$ , and  $+85^\circ C$ . Sensitivity is reached when the frequency error of the divided RF input is greater than or equal to 1 Hz. The power attenuation from the cable and the 3 dB pad must be accounted for. The feedback divider will actually miscount if too much or too little power is applied to the  $f_{IN}$  RF input. Therefore, the allowed input power level will be bounded by the upper and lower sensitivity limits. In a typical application, if the power level to the  $f_{IN}$  RF input approaches the sensitivity limits, this can introduce spurs and degradation in phase noise. When the power level gets even closer to these limits, or exceeds it, then the RF PLL loses lock.



**Figure 42. LMX233xU OSC<sub>in</sub> Sensitivity Test Setup**

The block diagram above in [Figure 42](#) illustrates the setup required to measure the LMX233xU device's  $OSC_{in}$  buffer sensitivity level. The same setup is used for the LMX2330TMEB/ LMX2330SLEEB Evaluation Boards. This setup is similar to the  $f_{IN}$  sensitivity setup except that the signal generator is now connected to the  $OSC_{in}$  pin and both  $f_{IN}$  pins are tied to  $V_{CC}$ . The  $51\ \Omega$  shunt resistor matches the  $OSC_{in}$  input to the signal generator. The R counter is typically set to 1000, i.e. RF R\_CNTR Word = 1000 or IF R\_CNTR Word = 1000. The reference divider output is routed to the  $F_{0LD}$  pin by selecting the **RF PLL R Divider Output** word ( $F_{0LD}$  Word = 2 or 10) or the **IF PLL R Divider Output** word ( $F_{0LD}$  Word = 1 or 9) in Code Loader. Similarly, a Universal Counter is connected to the  $F_{0LD}$  pin and is tied to the 10 MHz reference output from the signal generator. The output of the reference divider is monitored and should be equal to  $OSC_{in}/ RF\ R\_CNTR$  or  $OSC_{in}/ IF\ R\_CNTR$ .

Again,  $V_{CC}$  is swept from 2.7V to 5.5V. The  $OSC_{in}$  input frequency and voltage level are then swept with the signal generator. The measurements are repeated at different temperatures, namely  $T_A = -40^{\circ}C$ ,  $+25^{\circ}C$ , and  $+85^{\circ}C$ . Sensitivity is reached when the frequency error of the divided input signal is greater than or equal to 1 Hz.

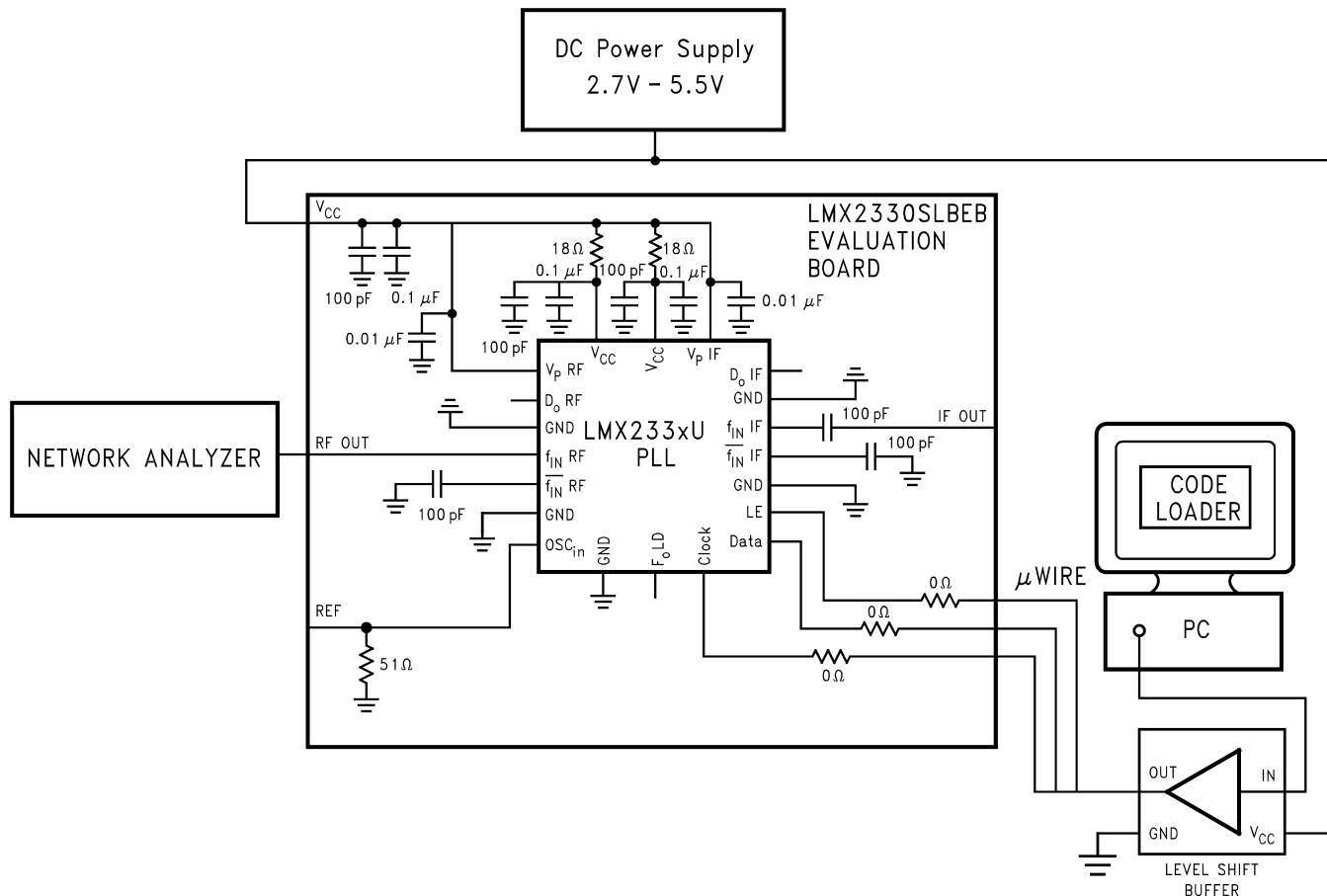


Figure 43. LMX233xU  $f_{IN}$  Impedance Test Setup

The block diagram above [Figure 43](#) illustrates the setup required to measure the LMX233xU device's RF input impedance. The IF input impedance and reference oscillator impedance setups are very much similar. The same setup is used for the LMX2330TMEB/ LMX2330SLEEB Evaluation Boards. Measuring the device's input impedance facilitates the design of appropriate matching networks to match the PLL to the VCO, or in more critical situations, to the characteristic impedance of the printed circuit board (PCB) trace, to prevent undesired transmission line effects.

Before the actual measurements are taken, the Network Analyzer needs to be calibrated, i.e. the error coefficients need to be calculated. Therefore, three standards will be used to calculate these coefficients: an **open**, **short** and a **matched load**. A 1-port calibration is implemented here.

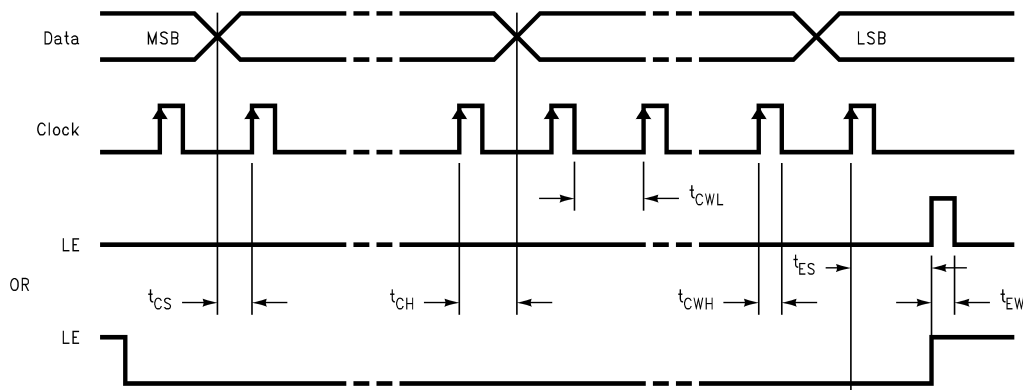
To calculate the coefficients, the PLL chip is first removed from the PCB. The Network Analyzer port is then connected to the RF OUT connector of the evaluation board and the desired operating frequency is set. The typical frequency range selected for the LMX233xU device's RF synthesizer is from 100 MHz to 2500 MHz. The standards will be located down the length of the RF OUT transmission line. The transmission line adds electrical length and acts as an offset from the reference plane of the Network Analyzer; therefore, it must be included in the calibration. Although not shown, 0  $\Omega$  resistors are used to complete the RF OUT transmission line (trace).

To implement an **open** standard, the end of the RF OUT trace is simply left open. To implement a **short** standard, a 0  $\Omega$  resistor is placed at the end of the RF OUT transmission line. Last of all, to implement a **matched load** standard, two 100  $\Omega$  resistors in parallel are placed at the end of the RF OUT transmission line. The Network Analyzer calculates the calibration coefficients based on the measured  $S_{11}$  parameters. With this all done, calibration is now complete.

The PLL chip is then placed on the PCB. A power supply is connected to  $V_{CC}$  and swept from 2.7V to 5.5V. The  $OSC_{in}$  pin is tied to the ground plane. Alternatively, the  $OSC_{in}$  pin can be tied to  $V_{CC}$ . In this setup, the complementary input (fin RF) is AC coupled to ground. With the Network Analyzer still connected to RF OUT, the measured  $f_{IN}$  RF impedance is displayed.

The impedance of the reference oscillator is measured when the oscillator buffer is powered up (PWDN RF Bit = 0 or PWDN IF Bit = 0), and when the oscillator buffer is powered down (PWDN RF Bit = 1 and PWDN IF Bit = 1).

### LMX233xU Serial Data Input Timing



1. Data is clocked into the 22-bit shift register on the rising edge of Clock
2. The MSB of Data is shifted in first.

### Functional Description

The basic phase-lock-loop (PLL) configuration consists of a high-stability crystal reference oscillator, a frequency synthesizer such as the Texas Instruments LMX233xU, a voltage controlled oscillator (VCO), and a passive loop filter. The frequency synthesizer includes a phase detector, current mode charge pump, programmable reference R and feedback N frequency dividers. The VCO frequency is established by dividing the crystal reference signal down via the reference divider to obtain a comparison reference frequency. This reference signal,  $F_r$ , is then presented to the input of a phase/frequency detector and compared with the feedback signal,  $F_p$ , which was obtained by dividing the VCO frequency down by way of the feedback divider. The phase/frequency detector measures the phase error between the  $F_r$  and  $F_p$  signals and outputs control signals that are directly proportional to the phase error. The charge pump then pumps charge into or out of the loop filter based on the magnitude and direction of the phase error. The loop filter converts the charge into a stable control voltage for the VCO. The phase/frequency detector's function is to adjust the voltage presented to the VCO until the feedback signal's frequency and phase match that of the reference signal. When this "Phase-Locked" condition exists, the VCO frequency will be N times that of the comparison frequency, where N is the feedback divider ratio.

### REFERENCE OSCILLATOR INPUT

The reference oscillator frequency for both the RF and IF PLLs is provided from an external reference via the  $OSC_{in}$  pin. The reference buffer circuit supports input frequencies from 5 to 40 MHz with a minimum input sensitivity of  $0.5 V_{PP}$ . The reference buffer circuit has an approximate  $V_{CC}/2$  input threshold and can be driven from an external CMOS or TTL logic gate. Typically, the  $OSC_{in}$  pin is connected to the output of a crystal oscillator.

### REFERENCE DIVIDERS (R COUNTERS)

The reference dividers divide the reference input signal,  $OSC_{in}$ , by a factor of R. The output of the reference divider circuits feeds the reference input of the phase detector. This reference input to the phase detector is often referred to as the comparison frequency. The divide ratio should be chosen such that the maximum phase comparison frequency ( $F_{\phi RF}$  or  $F_{\phi IF}$ ) of 10 MHz is not exceeded.

The RF and IF reference dividers are each comprised of 15-bit CMOS binary counters that support a continuous integer divide ratio from 3 to 32767. The RF and IF reference divider circuits are clocked by the output of the reference buffer circuit which is common to both.

## PRESCALERS

The  $f_{IN}$  RF ( $f_{IN}$  IF) and  $\bar{f}_{IN}$  RF ( $\bar{f}_{IN}$  IF) input pins drive the input of a bipolar, differential-pair amplifier. The output of the bipolar, differential-pair amplifier drives a chain of ECL D-type flip-flops in a dual modulus configuration. The output of the prescaler is used to clock the subsequent feedback dividers. The RF and IF PLL complementary inputs can be driven differentially, or the negative input can be AC coupled to ground through an external capacitor for single ended configuration. A 32/33 or a 64/65 prescale ratio can be selected for the 2.5 GHz LMX2330U RF synthesizer. A 64/65 or a 128/129 prescale ratio can be selected for both the LMX2331U and LMX2332U RF synthesizers. The IF circuitry contains an 8/9 or a 16/17 prescaler.

## PROGRAMMABLE FEEDBACK DIVIDERS (N COUNTERS)

The programmable feedback dividers operate in concert with the prescalers to divide the input signal,  $f_{IN}$ , by a factor of N. The output of the programmable reference divider is provided to the feedback input of the phase detector circuit. The divide ratio should be chosen such that the maximum phase comparison frequency ( $F_{\phi RF}$  or  $F_{\phi IF}$ ) of 10 MHz is not exceeded.

The programmable feedback divider circuit is comprised of an A counter (swallow counter) and a B counter (programmable binary counter). The RF N\_CNTRA counter is a 7-bit CMOS swallow counter, programmable from 0 to 127. The IF N\_CNTRA counter is also a 7-bit CMOS swallow counter, but programmable from 0 to 15. The three most significant bits are 'don't cares' in this case. The RF N\_CNTRB and IF N\_CNTRB counters are both 11-bit CMOS binary counters, programmable from 3 to 2047. A continuous integer divide ratio is achieved if  $N \geq P * (P-1)$ , where P is the value of the prescaler selected. Divide ratios less than the minimum continuous divide ratio are achievable as long as the binary programmable counter value is greater than the swallow counter value ( $N_{CNTRB} \geq N_{CNTRA}$ ). Refer to [IF N\\_CNTRA\[6:0\]](#), [RF N\\_CNTRB\[6:0\]](#), [RF N\\_CNTRA\[6:0\]](#), and [RF N\\_CNTRB\[6:0\]](#) for details on how to program the N\_CNTRA and N\_CNTRB counters. The following equations are useful in determining and programming a particular value of N:

$$N = (P \times N_{CNTRB}) + N_{CNTRA} \quad (4)$$

$$f_{IN} = N \times F_{\phi}$$

where

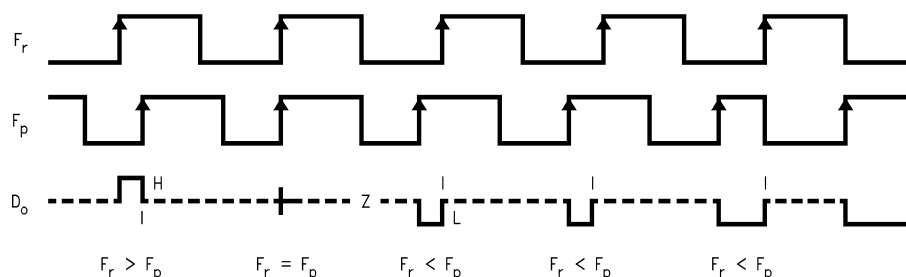
- $F_{\phi}$ : RF or IF phase detector comparison frequency
- $f_{IN}$ : RF or IF input frequency
- N\_CNTRA: RF or IF A counter value
- N\_CNTRB: RF or IF B counter value
- P: Preset modulus of the dual modulus prescaler  
 LMX2330U RF synthesizer: P = 32 or 64  
 LMX2331U RF synthesizer: P = 64 or 128  
 LMX2332U RF synthesizer: P = 64 or 128  
 LMX233xU IF synthesizer: P = 8 or 16

(5)

## PHASE/FREQUENCY DETECTORS

The RF and IF phase/frequency detectors are driven from their respective N and R counter outputs. The maximum frequency for both the RF and IF phase detector inputs is 10 MHz. The phase/frequency detector outputs control the respective charge pumps. The polarity of the pump-up or pump-down control signals are programmed using the **PD\_POL RF** or **PD\_POL IF** control bits, depending on whether the RF or IF VCO characteristics are positive or negative. Refer to [PD\\_POL IF](#), [IF Synthesizer Phase Detector Polarity IF R\[17\]](#) and [PD\\_POL RF](#), [RF Synthesizer Phase Detector Polarity RF R\[17\]](#) for more details. The phase/frequency detectors have a detection range of  $-2\pi$  to  $+2\pi$ . The phase/frequency detectors also receive a feedback signal from the charge pump in order to eliminate dead zone.

## PHASE COMPARATOR AND INTERNAL CHARGE PUMP CHARACTERISTICS



The minimum width of the pump-up and pump-down current pulses occur at the D<sub>o</sub> RF or D<sub>o</sub> IF pins when the loop is phase locked.

The diagram assumes positive VCO characteristics, i.e. PD\_POL RF or PD\_POL IF = 1.

F<sub>r</sub> is the phase detector input from the reference divider (R counter).

F<sub>p</sub> is the phase detector input from the programmable feedback divider (N counter).

D<sub>o</sub> refers to either the RF or IF charge pump output.

## CHARGE PUMPS

The charge pump directs charge into or out of an external loop filter. The loop filter converts the charge into a stable control voltage which is applied to the tuning input of the VCO. The charge pump steers the VCO control voltage towards V<sub>p</sub> RF or V<sub>p</sub> IF during pump-up events and towards GND during pump-down events. When locked, D<sub>o</sub> RF or D<sub>o</sub> IF are primarily in a TRI-STATE mode with small corrections occurring at the phase comparator rate. The charge pump output current magnitude can be selected by toggling the ID<sub>o</sub> RF or ID<sub>o</sub> IF control bits.

## MICROWIRE SERIAL INTERFACE

The programmable register set is accessed via the MICROWIRE serial interface. The interface is comprised of three signal pins: Clock, Data and LE (Latch Enable). Serial data is clocked into the 22-bit shift register on the rising edge of Clock. The last two bits decode the internal control register address. When LE transitions HIGH, data stored in the shift register is loaded into one of four control registers depending on the state of the address bits. The MSB of Data is loaded in first. The synthesizers can be programmed even in power down mode. A complete programming description is provided in [Programming Description](#).

## MULTI-FUNCTION OUTPUTS

The LMX233xU device's F<sub>o</sub>LD output pin is a multi-function output that can be configured as the RF FastLock output, a push-pull analog lock detect output, counter reset, or used to monitor the output of the various reference divider (R counter) or feedback divider (N counter) circuits. The F<sub>o</sub>LD control word is used to select the desired output function. When the PLL is in powerdown mode, the F<sub>o</sub>LD output is pulled to a LOW state. A complete programming description of the multi-function output is provided in [FoLD\[3:0\] Multi-Function Output Select](#).

### Push-Pull Analog Lock Detect Output

An analog lock detect status generated from the phase detector is available on the F<sub>o</sub>LD output pin if selected. The lock detect output goes HIGH when the charge pump is inactive. It goes LOW when the charge pump is active during a comparison cycle. When viewed with an oscilloscope, narrow negative pulses are observed when the charge pump turns on. The lock detect output signal is a push-pull configuration.

Three separate lock detect signals are routed to the multiplexer. Two of these monitor the 'lock' status of the individual synthesizers. The third detects the condition when both the RF and IF synthesizers are in a 'locked state'. External circuitry however, is required to provide a steady DC signal to indicate when the PLL is in a locked state. Refer to [FoLD\[3:0\] Multi-Function Output Select](#) for details on how to program the different lock detect options.

## Open Drain FastLock Output

The LMX233xU Fastlock feature allows faster loop response time during lock acquisition. The loop response time (lock time) can be approximately halved if the loop bandwidth is doubled. In order to achieve this, the same gain/phase relationship at twice the loop bandwidth must be maintained. This can be achieved by increasing the charge pump current from 0.95 mA ( $ID_0$  RF Bit = 0) in the steady state mode, to 3.8 mA ( $ID_0$  RF Bit = 1) in Fastlock. When the  $F_{oLD}$  output is configured as a FastLock output, an open drain device is enabled. The open drain device switches in a parallel resistor  $R2'$  to ground, of equal value to resistor  $R2$  of the external loop filter. The loop bandwidth is effectively doubled and stability is maintained. Once locked to the correct frequency, the PLL will return to a steady state condition. Refer to [FoLD\[3:0\] Multi-Function Output Select](#) for details on how to configure the  $F_{oLD}$  output to an open drain Fastlock output.

## Counter Reset

Three separate counter reset functions are provided. When the  $F_{oLD}$  is programmed to **Reset IF Counters**, both the IF feedback divider and the IF reference divider are held at their load point. When the **Reset RF Counters** is programmed, both the RF feedback divider and the RF reference divider are held at their load point. When the **Reset All Counters** mode is enabled, all feedback dividers and reference dividers are held at their load point. When the device is programmed to normal operation, both the feedback divider and reference divider are enabled and resume counting in 'close' alignment to each other. Refer to [FoLD\[3:0\] Multi-Function Output Select](#) for more details.

## Reference Divider and Feedback Divider Output

The outputs of the various N and R dividers can be monitored by selecting the appropriate  $F_{oLD}$  word. This is essential when performing  $OSC_{in}$  or  $f_{IN}$  sensitivity measurements. Refer to the [Test Setups](#) section for more details. Refer to [FoLD\[3:0\] Multi-Function Output Select](#) for more details on how to route the appropriate divider output to the  $F_{oLD}$  pin.

## POWER CONTROL

Each synthesizer in the LMX233xU device is individually power controlled by device powerdown bits. The powerdown word is comprised of the **PWDN RF (PWDN IF)** bit, in conjunction with the **TRI-STATE  $ID_0$  RF (TRI-STATE  $ID_0$  IF)** bit. The powerdown control word is used to set the operating mode of the device. Refer to [TRI-STATE  \$ID\_0\$  IF](#), [PWDN IF](#), [TRI-STATE  \$ID\_0\$  RF](#), and [PWDN RF](#) for details on how to program the RF or IF powerdown bits.

When either the RF synthesizer or the IF synthesizer enters the powerdown mode, the respective prescaler, phase detector, and charge pump circuit are disabled. The  $D_0$  RF ( $D_0$  IF),  $f_{IN}$  RF ( $f_{IN}$  IF), and  $\overline{f_{IN}}$  RF ( $\overline{f_{IN}}$  IF) pins are all forced to a high impedance state. The reference divider and feedback divider circuits are held at the load point during powerdown. The oscillator buffer is disabled when both the RF and IF synthesizers are powered down. The  $OSC_{in}$  pin is forced to a HIGH state through an approximate 100 k $\Omega$  resistance when this condition exists. When either synthesizer is activated, the respective prescaler, phase detector, charge pump circuit, and the oscillator buffer are all powered up. The feedback divider, and the reference divider are held at load point. This allows the reference oscillator, feedback divider, reference divider and prescaler circuitry to reach proper bias levels. After a finite delay, the feedback and reference dividers are enabled and they resume counting in 'close' alignment (the maximum error is one prescaler cycle). The MICROWIRE control register remains active and capable of loading and latching data while in the powerdown mode.

## Synchronous Powerdown Mode

In this mode, the powerdown function is gated by the charge pump. When the device is configured for synchronous powerdown, the device will enter the powerdown mode upon completion of the next charge pump pulse event.

## Asynchronous Powerdown Mode

In this mode, the powerdown function is NOT gated by the completion of a charge pump pulse event. When the device is configured for asynchronous powerdown, the part will go into powerdown mode immediately.

| TRI-STATE ID <sub>0</sub> | PWDN | Operating Mode                                         |
|---------------------------|------|--------------------------------------------------------|
| 0                         | 0    | PLL Active, Normal Operation                           |
| 1                         | 0    | PLL Active, Charge Pump Output in High Impedance State |
| 0                         | 1    | Synchronous Powerdown                                  |
| 1                         | 1    | Asynchronous Powerdown                                 |

TRI-STATE ID<sub>0</sub> refers to either the TRI-STATE ID<sub>0</sub> RF or TRI-STATE ID<sub>0</sub> IF bit .

PWDN refers to either the PWDN RF or PWDN IF bit.

## Programming Description

### MICROWIRE INTERFACE

The 22-bit shift register is loaded via the MICROWIRE interface. The shift register consists of a 20-bit *Data[19:0] Field* and a 2-bit *Address[1:0] Field* as shown below. The Address Field is used to decode the internal control register address. When LE transitions HIGH, data stored in the shift register is loaded into one of 4 control registers depending on the state of the address bits. The MSB of Data is loaded in first. The Data Field assignments are shown in [CONTROL REGISTER CONTENT MAP](#).

|            |  |  |  |  |  |  |  |  |  |              |   |  |  |  |  |  |  |  |  |  |     |
|------------|--|--|--|--|--|--|--|--|--|--------------|---|--|--|--|--|--|--|--|--|--|-----|
| MSB        |  |  |  |  |  |  |  |  |  |              |   |  |  |  |  |  |  |  |  |  | LSB |
| Data[19:0] |  |  |  |  |  |  |  |  |  | Address[1:0] |   |  |  |  |  |  |  |  |  |  |     |
| 21         |  |  |  |  |  |  |  |  |  | 2            | 1 |  |  |  |  |  |  |  |  |  | 0   |

### CONTROL REGISTER LOCATION

The address bits Address[1:0] decode the internal register address. The table below shows how the address bits are mapped into the target control register.

| Address[1:0]<br>Field |   | Target<br>Register |
|-----------------------|---|--------------------|
| 0                     | 0 | IF R               |
| 0                     | 1 | IF N               |
| 1                     | 0 | RF R               |
| 1                     | 1 | RF N               |

## CONTROL REGISTER CONTENT MAP

The control register content map describes how the bits within each control register are allocated to specific control functions.

| Reg. | Most Significant Bit   |                        |                                            |                       |                  |                 | SHIFT REGISTER BIT LOCATION |    |    |    |    |    |                 |   |   |   |   |   |   |   | Least Significant Bit |   |  |  |
|------|------------------------|------------------------|--------------------------------------------|-----------------------|------------------|-----------------|-----------------------------|----|----|----|----|----|-----------------|---|---|---|---|---|---|---|-----------------------|---|--|--|
|      | 21                     | 20                     | 19                                         | 18                    | 17               | 16              | 15                          | 14 | 13 | 12 | 11 | 10 | 9               | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1                     | 0 |  |  |
|      | Data Field             |                        |                                            |                       |                  |                 |                             |    |    |    |    |    |                 |   |   |   |   |   |   |   | Address Field         |   |  |  |
| IF R | F <sub>0</sub> L<br>D0 | F <sub>0</sub> L<br>D2 | TRI-<br>STA<br>TE<br>ID <sub>0</sub><br>IF | ID <sub>0</sub><br>IF | PD_<br>POL<br>IF | IF R_CNTR[14:0] |                             |    |    |    |    |    |                 |   |   |   |   |   |   |   | 0                     | 0 |  |  |
| IF N | PW<br>DN<br>IF         | PR<br>E<br>IF          | IF N_CNTRB[10:0]                           |                       |                  |                 |                             |    |    |    |    |    | IF N_CNTRA[6:0] |   |   |   |   |   | 0 | 1 |                       |   |  |  |
| RF R | F <sub>0</sub> L<br>D1 | F <sub>0</sub> L<br>D3 | TRI-<br>STA<br>TE<br>ID <sub>0</sub><br>RF | ID <sub>0</sub><br>RF | PD_<br>POL<br>RF | RF R_CNTR[14:0] |                             |    |    |    |    |    |                 |   |   |   |   |   |   |   | 1                     | 0 |  |  |
| RF N | PW<br>DN<br>RF         | PR<br>E<br>RF          | RF N_CNTRB[10:0]                           |                       |                  |                 |                             |    |    |    |    |    | RF N_CNTRA[6:0] |   |   |   |   |   | 1 | 1 |                       |   |  |  |

## IF R REGISTER

The IF R register contains the IF R\_CNTR, PD\_POL IF, ID<sub>0</sub> IF, and TRI-STATE ID<sub>0</sub> IF control words, in addition to two bits that compose the F<sub>0</sub>LD control word. The detailed descriptions and programming information for each control word is discussed in the following sections. IF R\_CNTR[14:0]

| Reg. | Most Significant Bit   |                    |                                     |                    |                  |                 | SHIFT REGISTER BIT LOCATION |    |    |    |    |    |   |   |   |   |   |   |   |   | Least Significant Bit |   |  |  |
|------|------------------------|--------------------|-------------------------------------|--------------------|------------------|-----------------|-----------------------------|----|----|----|----|----|---|---|---|---|---|---|---|---|-----------------------|---|--|--|
|      | 21                     | 20                 | 19                                  | 18                 | 17               | 16              | 15                          | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1                     | 0 |  |  |
|      | Data Field             |                    |                                     |                    |                  |                 |                             |    |    |    |    |    |   |   |   |   |   |   |   |   | Address Field         |   |  |  |
| IF R | F <sub>0</sub> LD<br>0 | F <sub>0</sub> LD2 | TRI-<br>STATE<br>ID <sub>0</sub> IF | ID <sub>0</sub> IF | PD_<br>POL<br>IF | IF R_CNTR[14:0] |                             |    |    |    |    |    |   |   |   |   |   |   |   |   | 0                     | 0 |  |  |

## F R\_CNTR[14:0] IF Synthesizer Programmable Reference Divider (R Counter) IF R[2:16]

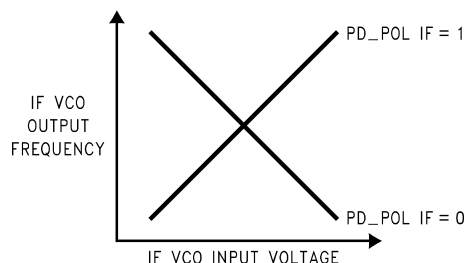
The IF reference divider (IF R\_CNTR) can be programmed to support divide ratios from 3 to 32767. Divide ratios less than 3 are prohibited.

| Divide Ratio | IF R_CNTR[14:0] |    |    |    |    |   |   |   |   |   |   |   |   |   |   |
|--------------|-----------------|----|----|----|----|---|---|---|---|---|---|---|---|---|---|
|              | 14              | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 3            | 0               | 0  | 0  | 0  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4            | 0               | 0  | 0  | 0  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| •            | •               | •  | •  | •  | •  | • | • | • | • | • | • | • | • | • | • |
| 32767        | 1               | 1  | 1  | 1  | 1  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

### PD\_POL IF, IF Synthesizer Phase Detector Polarity IF R[17]

The PD\_POL IF bit is used to control the IF synthesizer's phase detector polarity based on the VCO tuning characteristics.

| Control Bit | Register Location | Description                | Function                               |                                        |
|-------------|-------------------|----------------------------|----------------------------------------|----------------------------------------|
|             |                   |                            | 0                                      | 1                                      |
| PD_POL IF   | IF R[17]          | IF Phase Detector Polarity | IF VCO Negative Tuning Characteristics | IF VCO Positive Tuning Characteristics |



**Figure 44. IF VCO Characteristics**

### ID<sub>0</sub> IF, IF Synthesizer Charge Pump Current Gain IF R[18]

The ID<sub>0</sub> IF bit controls the IF synthesizer's charge pump gain. Two current levels are available.

| Control Bit        | Register Location | Description                 | Function       |                 |
|--------------------|-------------------|-----------------------------|----------------|-----------------|
|                    |                   |                             | 0              | 1               |
| ID <sub>0</sub> IF | IF R[18]          | IF Charge Pump Current Gain | LOW<br>0.95 mA | HIGH<br>3.80 mA |

### TRI-STATE ID<sub>0</sub> IF, IF Synthesizer Charge Pump Tri-state Current IF R[19]

The TRI-STATE ID<sub>0</sub> IF bit allows the charge pump to be switched between a normal operating mode and a high impedance output state. This happens asynchronously with the change in the TRI-STATE ID<sub>0</sub> IF bit.

Furthermore, the TRI-STATE ID<sub>0</sub> IF bit operates in conjunction with the PWDN IF bit to set a synchronous or an asynchronous powerdown mode.

| Control Bit                  | Register Location | Description                      | Function                        |                                               |
|------------------------------|-------------------|----------------------------------|---------------------------------|-----------------------------------------------|
|                              |                   |                                  | 0                               | 1                                             |
| TRI-STATE ID <sub>0</sub> IF | IF R[19]          | IF Charge Pump TRI-STATE Current | IF Charge Pump Normal Operation | IF Charge Pump Output in High Impedance State |

## IF N REGISTER

The IF N register contains the IF N\_CNTRA, IF N\_CNTRB, PRE IF, and PWDN IF control words. The IF N\_CNTRA and IF N\_CNTRB control words are used to setup the programmable feedback divider. The detailed description and programming information for each control word is discussed in the following sections.

| Reg. | SHIFT REGISTER BIT LOCATION |        |                  |    |    |    |    |    |    |    |    |    |   |                 |   |   |   |   |   |   |               | Least Significant Bit |  |
|------|-----------------------------|--------|------------------|----|----|----|----|----|----|----|----|----|---|-----------------|---|---|---|---|---|---|---------------|-----------------------|--|
|      | 21                          | 20     | 19               | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8               | 7 | 6 | 5 | 4 | 3 | 2 | 1             | 0                     |  |
|      | Data Field                  |        |                  |    |    |    |    |    |    |    |    |    |   |                 |   |   |   |   |   |   | Address Field |                       |  |
| IF N | PWDN IF                     | PRE IF | IF N_CNTRB[10:0] |    |    |    |    |    |    |    |    |    |   | IF N_CNTRA[6:0] |   |   |   |   |   | 0 | 1             |                       |  |

**IF N\_CNTRA[6:0] IF Synthesizer Swallow Counter (A Counter) IF N[2:8]**

The IF N\_CNTRA control word is used to setup the IF synthesizer's A counter. The A counter is a 7-bit swallow counter used in the programmable feedback divider. The IF N\_CNTRA control word can be programmed to values ranging from 0 to 15. The three most significant bits are 'don't care bits' in this case.

| Divide Ratio | IF N_CNTRA[6:0] |   |   |   |   |   |   |
|--------------|-----------------|---|---|---|---|---|---|
|              | 6               | 5 | 4 | 3 | 2 | 1 | 0 |
| 0            | X               | X | X | 0 | 0 | 0 | 0 |
| 1            | X               | X | X | 0 | 0 | 0 | 1 |
| •            | •               | • | • | • | • | • | • |
| 15           | X               | X | X | 1 | 1 | 1 | 1 |

**IF N\_CNTRB[10:0] IF Synthesizer Programmable Binary Counter (B Counter) IF N[9:19]**

The IF N\_CNTRB control word is used to setup the IF synthesizer's B counter. The B counter is an 11-bit programmable binary counter used in the programmable feedback divider. The IF N\_CNTRB control word can be programmed to values ranging from 3 to 2047.

| Divide Ratio | IF N_CNTRB[10:0] |   |   |   |   |   |   |   |   |   |   |
|--------------|------------------|---|---|---|---|---|---|---|---|---|---|
|              | 10               | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 3            | 0                | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4            | 0                | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| •            | •                | • | • | • | • | • | • | • | • | • | • |
| 2047         | 1                | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**PRE IF**
**IF Synthesizer Prescaler Select**
**IF N[20]**

The IF synthesizer utilizes a selectable dual modulus prescaler.

| Control Bit | Register Location | Description         | Function               |                          |
|-------------|-------------------|---------------------|------------------------|--------------------------|
|             |                   |                     | 0                      | 1                        |
| PRE IF      | IF N[20]          | IF Prescaler Select | 8/9 Prescaler Selected | 16/17 Prescaler Selected |

**PWDN IF IF Synthesizer Powerdown IF N[21]**

The PWDN IF bit is used to switch the IF PLL between a powered up and powered down mode.

Furthermore, the PWDN IF bit operates in conjunction with the TRI-STATE ID<sub>0</sub> IF bit to set a synchronous or an asynchronous powerdown mode.

| Control Bit | Register Location | Description  | Function      |                  |
|-------------|-------------------|--------------|---------------|------------------|
|             |                   |              | 0             | 1                |
| PWDN IF     | IF N[21]          | IF Powerdown | IF PLL Active | IF PLL Powerdown |

**RF R REGISTER**

The RF R register contains the RF R\_CNTR, PD\_POL RF, ID<sub>0</sub> RF, and TRI-STATE ID<sub>0</sub> RF control words, in addition to two bits that compose the F<sub>0</sub>LD control word. The detailed descriptions and programming information for each control word is discussed in the following sections.

| Reg. | Most Significant Bit   |                    |                                     |                    |                  |                 | SHIFT REGISTER BIT LOCATION |    |    |    |    |    |   |   |   |   |   |   |   |   | Least Significant Bit |   |  |  |  |  |
|------|------------------------|--------------------|-------------------------------------|--------------------|------------------|-----------------|-----------------------------|----|----|----|----|----|---|---|---|---|---|---|---|---|-----------------------|---|--|--|--|--|
|      | 21                     | 20                 | 19                                  | 18                 | 17               | 16              | 15                          | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1                     | 0 |  |  |  |  |
|      | Data Field             |                    |                                     |                    |                  |                 |                             |    |    |    |    |    |   |   |   |   |   |   |   |   | Address Field         |   |  |  |  |  |
| RF R | F <sub>0</sub> LD<br>1 | F <sub>0</sub> LD3 | TRI-<br>STATE<br>ID <sub>0</sub> RF | ID <sub>0</sub> RF | PD_<br>POL<br>RF | RF R_CNTR[14:0] |                             |    |    |    |    |    |   |   |   |   |   |   |   |   | 1                     | 0 |  |  |  |  |

**RF R\_CNTR[14:0] RF Synthesizer Programmable Reference Divider (R Counter) RF R [2:16]**

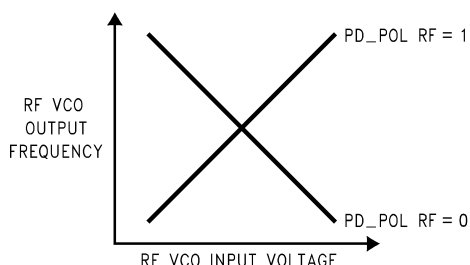
The RF reference divider (RF R\_CNTR) can be programmed to support divide ratios from 3 to 32767. Divide ratios less than 3 are prohibited.

| Divide Ratio | RF R_CNTR[14:0] |    |    |    |    |   |   |   |   |   |   |   |   |   |   |
|--------------|-----------------|----|----|----|----|---|---|---|---|---|---|---|---|---|---|
|              | 14              | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 3            | 0               | 0  | 0  | 0  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4            | 0               | 0  | 0  | 0  | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| •            | •               | •  | •  | •  | •  | • | • | • | • | • | • | • | • | • | • |
| 32767        | 1               | 1  | 1  | 1  | 1  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**PD\_POL RF, RF Synthesizer Phase Detector Polarity RF R[17]**

The PD\_POL RF bit is used to control the RF synthesizer's phase detector polarity based on the VCO tuning characteristics.

| Control Bit | Register Location | Description                | Function                               |                                        |
|-------------|-------------------|----------------------------|----------------------------------------|----------------------------------------|
|             |                   |                            | 0                                      | 1                                      |
| PD_POL RF   | RF R[17]          | RF Phase Detector Polarity | RF VCO Negative Tuning Characteristics | RF VCO Positive Tuning Characteristics |



**Figure 45. RF VCO Characteristics**

**ID<sub>0</sub> RF, RF Synthesizer Charge Pump Current Gain RF R[18]**

The ID<sub>0</sub> RF bit controls the RF synthesizer's charge pump gain. Two current levels are available.

| Control Bit        | Register Location | Description                 | Function       |                 |
|--------------------|-------------------|-----------------------------|----------------|-----------------|
|                    |                   |                             | 0              | 1               |
| ID <sub>0</sub> RF | RF R[18]          | RF Charge Pump Current Gain | LOW<br>0.95 mA | HIGH<br>3.80 mA |

**TRI-STATE ID<sub>0</sub> RF, RF Synthesizer Charge Pump TRI-STATE Current RF R[19]**

The TRI-STATE ID<sub>0</sub> RF bit allows the charge pump to be switched between a normal operating mode and a high impedance output state. This happens asynchronously with the change in the TRI-STATE ID<sub>0</sub> RF bit.

Furthermore, the TRI-STATE ID<sub>0</sub> RF bit operates in conjunction with the PWDN RF bit to set a synchronous or an asynchronous powerdown mode.

| Control Bit                  | Register Location | Description                      | Function                        |                                               |
|------------------------------|-------------------|----------------------------------|---------------------------------|-----------------------------------------------|
|                              |                   |                                  | 0                               | 1                                             |
| TRI-STATE ID <sub>0</sub> RF | RF R[19]          | RF Charge Pump TRI-STATE Current | RF Charge Pump Normal Operation | RF Charge Pump Output in High Impedance State |

## RF N REGISTER

The RF N register contains the RF N\_CNTRA, RF N\_CNTRB, PRE RF, and PWDN RF control words. The RF N\_CNTRA and RF N\_CNTRB control words are used to setup the programmable feedback divider. The detailed description and programming information for each control word is discussed in the following sections.

| Reg. | SHIFT REGISTER BIT LOCATION |           |                  |    |    |    |    |    |    |    |                       |    |   |                 |   |   |   |   |   |   |                      |   |
|------|-----------------------------|-----------|------------------|----|----|----|----|----|----|----|-----------------------|----|---|-----------------|---|---|---|---|---|---|----------------------|---|
|      | Most Significant Bit        |           |                  |    |    |    |    |    |    |    | Least Significant Bit |    |   |                 |   |   |   |   |   |   |                      |   |
|      | 21                          | 20        | 19               | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11                    | 10 | 9 | 8               | 7 | 6 | 5 | 4 | 3 | 2 | 1                    | 0 |
|      | <i>Data Field</i>           |           |                  |    |    |    |    |    |    |    |                       |    |   |                 |   |   |   |   |   |   | <i>Address Field</i> |   |
| RF N | PWDN<br>RF                  | PRE<br>RF | RF N_CNTRB[10:0] |    |    |    |    |    |    |    |                       |    |   | RF N_CNTRA[6:0] |   |   |   |   |   |   | 1                    | 1 |

### RF N\_CNTRA[6:0] RF Synthesizer Swallow Counter (A Counter) RF N[2:8]

The RF N\_CNTRA control word is used to setup the RF synthesizer's A counter. The A counter is a 7-bit swallow counter used in the programmable feedback divider. The RF N\_CNTRA control word can be programmed to values ranging from 0 to 127.

| Divide Ratio | RF N_CNTRA[6:0] |   |   |   |   |   |   |
|--------------|-----------------|---|---|---|---|---|---|
|              | 6               | 5 | 4 | 3 | 2 | 1 | 0 |
| 0            | 0               | 0 | 0 | 0 | 0 | 0 | 0 |
| 1            | 0               | 0 | 0 | 0 | 0 | 0 | 1 |
| •            | •               | • | • | • | • | • | • |
| 127          | 1               | 1 | 1 | 1 | 1 | 1 | 1 |

### RF N\_CNTRB[10:0] RF Synthesizer Programmable Binary Counter (B Counter) RF N[9:19]

The RF N\_CNTRB control word is used to setup the RF synthesizer's B counter. The B counter is an 11-bit programmable binary counter used in the programmable feedback divider. The RF N\_CNTRB control word can be programmed to values ranging from 3 to 2047.

| Divide Ratio | RF N_CNTRB[10:0] |   |   |   |   |   |   |   |   |   |   |
|--------------|------------------|---|---|---|---|---|---|---|---|---|---|
|              | 10               | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 3            | 0                | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4            | 0                | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| •            | •                | • | • | • | • | • | • | • | • | • | • |
| 2047         | 1                | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

### PRE RF, RF Synthesizer Prescaler Select RF N[20]

The RF synthesizer utilizes a selectable dual modulus prescaler.

**Table 1. LMX2330U RF Synthesizer Prescaler Select**

| Control Bit | Register Location | Description         | Function                 |                          |
|-------------|-------------------|---------------------|--------------------------|--------------------------|
|             |                   |                     | 0                        | 1                        |
| PRE RF      | RF N[20]          | RF Prescaler Select | 32/33 Prescaler Selected | 64/65 Prescaler Selected |

**Table 2. LMX2331U and LMX2332U RF Synthesizer Prescaler Select**

| Control Bit | Register Location | Description         | Function                 |                            |
|-------------|-------------------|---------------------|--------------------------|----------------------------|
|             |                   |                     | 0                        | 1                          |
| PRE RF      | RF N[20]          | RF Prescaler Select | 64/65 Prescaler Selected | 128/129 Prescaler Selected |

**PWDN RF, RF Synthesizer Powerdown RF N[21]**

The PWDN RF bit is used to switch the RF PLL between a powered up and powered down mode.

Furthermore, the PWDN RF bit operates in conjunction with the TRI-STATE ID<sub>0</sub> RF bit to set a synchronous or an asynchronous powerdown mode.

| Control Bit | Register Location | Description  | Function      |                  |
|-------------|-------------------|--------------|---------------|------------------|
|             |                   |              | 0             | 1                |
| PWDN RF     | RF N[21]          | RF Powerdown | RF PLL Active | RF PLL Powerdown |

**F<sub>0</sub>LD[3:0] MULTI-FUNCTION OUTPUT SELECT [RF R[20], IF R[20], RF R[21], IF R[21]]**

The F<sub>0</sub>LD control word is used to select which signal is routed to the F<sub>0</sub>LD pin.

| F <sub>0</sub> LD3 | F <sub>0</sub> LD2 | F <sub>0</sub> LD1 | F <sub>0</sub> LD0 | F <sub>0</sub> LD Output State                 |
|--------------------|--------------------|--------------------|--------------------|------------------------------------------------|
| 0                  | 0                  | 0                  | 0                  | LOW Logic State Output                         |
| 0                  | 0                  | 0                  | 1                  | IF PLL R Divider Output, Push-Pull Output      |
| 0                  | 0                  | 1                  | 0                  | RF PLL R Divider Output, Push-Pull Output      |
| 0                  | 0                  | 1                  | 1                  | Open Drain Fastlock Output                     |
| 0                  | 1                  | 0                  | 0                  | IF PLL Analog Lock Detect, Push-Pull Output    |
| 0                  | 1                  | 0                  | 1                  | IF PLL N Divider Output, Push-Pull Output      |
| 0                  | 1                  | 1                  | 0                  | RF PLL N Divider Output, Push-Pull Output      |
| 0                  | 1                  | 1                  | 1                  | Reset IF Counters, LOW Logic State Output      |
| 1                  | 0                  | 0                  | 0                  | RF Analog Lock Detect, Push-Pull Output        |
| 1                  | 0                  | 0                  | 1                  | IF PLL R Divider Output, Push-Pull Output      |
| 1                  | 0                  | 1                  | 0                  | RF PLL R Divider Output, Push-Pull Output      |
| 1                  | 0                  | 1                  | 1                  | Reset RF Counters, LOW Logic State Output      |
| 1                  | 1                  | 0                  | 0                  | RF and IF Analog Lock Detect, Push-Pull Output |
| 1                  | 1                  | 0                  | 1                  | IF PLL N Divider Output, Push-Pull Output      |
| 1                  | 1                  | 1                  | 0                  | RF PLL N Divider Output, Push-Pull Output      |
| 1                  | 1                  | 1                  | 1                  | Reset All Counters, LOW Logic State Output     |

**REVISION HISTORY**

| <b>Changes from Revision F (April 2013) to Revision G</b>  | <b>Page</b>        |
|------------------------------------------------------------|--------------------|
| • Changed layout of National Data Sheet to TI format ..... | <a href="#">44</a> |

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