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LMX1601/02 Evaluation Board Operating Instructions

General Description

The LMX1601/02 Evaluation Board simplifies evaluation of the LMX1601 1 GHz/500 MHz or LMX1602 1 GHz/1 GHz PLLatinum dual frequency synthesizer. It enables all performance measurements with no additional support circuitry.

The board consists of a LMX1601 or LMX1602 device, a RF VCO module, and IF VCO & RF/IF loop filters built by discrete components. The SMA flange mount connectors are provided for external reference input, RF and IF VCO outputs, and the power and grounding connection. A cable assembly is bundled with the evaluation board for connecting to a PC through the parallel printer port. By means of MICROWIRE serial port emulation, the Code Loader software included can be run on a PC to facilitate the LMX1601/02 internal register programming for the evaluation and measurement.

Quick Start

The LMX1601/02 Evaluation Board is fully assembled and factory tested. Follow the instructions below to set up the hardware platform for the measurement of interest.

Recommended Test Equipment

- Spectrum analyzer with 10MHz reference output (operating frequency range >= 2 GHz)
- Modulation domain analyzer
- DC power supply with adjustable voltage outputs
- 10MHz signal source/generator (optional, in case no reference output from spectrum analyzer)

Connection and Setup

1. Connect the RF_OUT/IF_OUT output port to the input of a spectrum analyzer for phase noise and reference spur measurement or the input of a modulation analyzer for lock time measurement.

2. Connect a oscillator reference to the OSCin input port. It is advised to use a high quality reference source for an accurate and low noise measurement. A 10MHz reference is generally available from most of the spectrum analyzer at the reference output port.

3. Plug the DB25 connector end of the cable assembly to the parallel port of the PC. Connect the other end of the cable to the on-board 5x2 pin header. Refer to the "Data cable configuration" section of the "Applications Information, Code Loader Operation" for pin#1 position.

4. Verify that two jumper blocks are placed to shunt pin 1 & 2 and pin 3 & 4 to connect RF_VCO_Vcc and IF_VCO_Vcc respectively to Vcc_RF power source.

5. Turn on the DC power supply and adjust the voltage output to 3 Volt. Turn off supply.
6. Connect the DC power supply output to Vcc_RF port of evaluation board. Turn on supply.

7. Turn on the signal generator and set the reference output frequency to 10MHz.

8. Run the Code Loader software on the PC for LMX1601/02 register programming. Refer to Appendices C and E for more details.

Phase Noise Measurement Using A Spectrum Analyzer

1. Use the Code Loader software to set the desired frequency and to program the LMX1601/02 device. Refer to Appendix D for more details.

2. Set the spectrum analyzer to the desired center frequency, and adjust the span so the appropriate offset frequency can be viewed.

3. Turn ON the video averaging feature of the analyzer for better determination of the noise level.

4. The difference between the level of the carrier and the noise level minus 10[log(resolution bandwidth)] is equal to the phase noise in dBc/Hz. The resolution bandwidth can be read directly from the spectrum analyzer.

Reference Spur Measurement Using A Spectrum Analyzer

1. Use the Code Loader software to set the desired frequency and to program the LMX1601/02 device. Refer to Appendix D for more details.

2. Set the spectrum analyzer to the desired center frequency, and set the span to allow the reference sidebands to be viewed. For example, the span can be set to 500 kHz during RF VCO measurement as its loop filter design is based on 200 kHz reference frequency.

3. The reference spur is the difference between the level of the PLL tone (at the center frequency) and the level of the reference spur (at the center frequency +/- the reference frequency).

Lock Time Measurement Using A Modulation Domain Analyzer

1. Decide the maximum and minimum frequency to be switched alternately. The VCO operating frequency range can be obtained in Appendix D. Enter Burst Mode menu of Code Loader software to create a macro to program the LMX1601/02 to the maximum and minimum frequency alternatively over time. It is necessary

to put a sufficient delay between PLL programming (i.e. 10,000). Refer to the "Burst Mode configuration and operation" section of the "Application Information, Code Loader Operation" for more details.

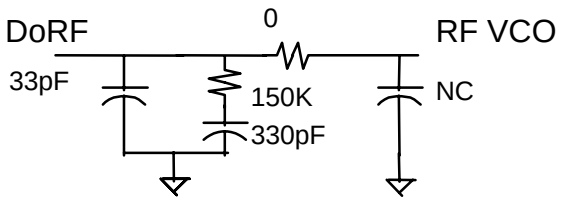
2. Set the center frequency of the modulation domain analyzer to be half-way between the maximum and minimum frequencies. Set the frequency span to cover the entire frequency range from maximum to minimum. Then a switching signal should be seen on the screen.

3. Set the center frequency to be the trigger condition for One-Shot mode. Press [Start/Stop] button to capture the switching curve. Adjust the frequency and time scale accordingly to get a close-up plot for detailed information.

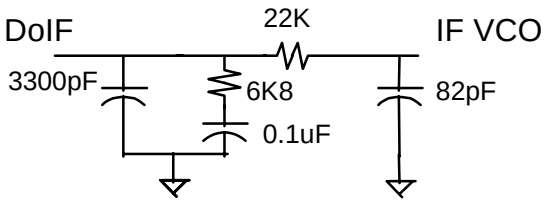
4. The lock time is the time difference between the point the frequency starts to change and the point that the PLL frequency settles within +/- 1 kHz range.

Loop Filter Illustration

A type 2 second and third order passive loop filter configuration for RF PLL and IF PLL are employed respectively on the LMX1601/02 evaluation board. The RF loop filter was designed assuing a 13 kHz loop bandwidth, 50 degree phase margin, 200 kHz reference frequency, and low gain charge pump mode. The IF loop filter was designed for a 50 kHz reference frequency for high charge pump current mode. The actual implementations are shown as below:



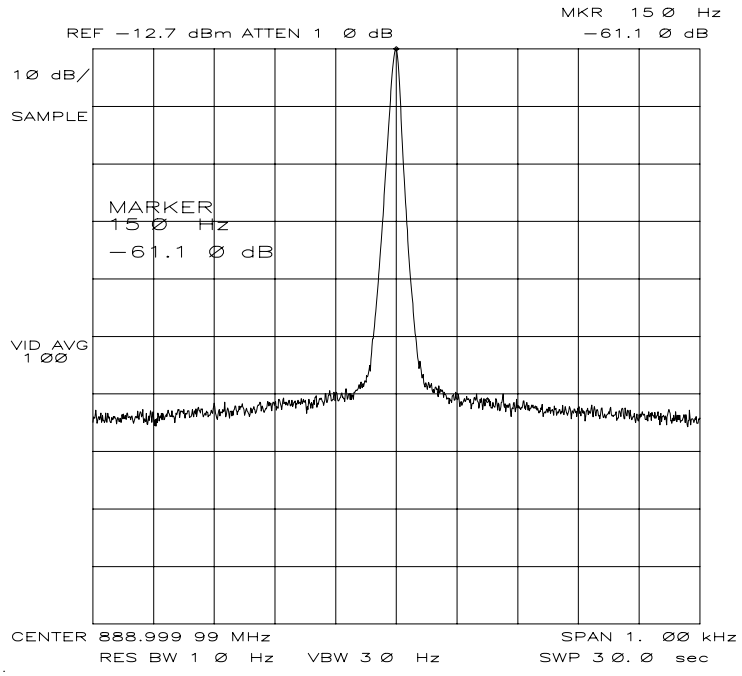
RF LOOP FILTER



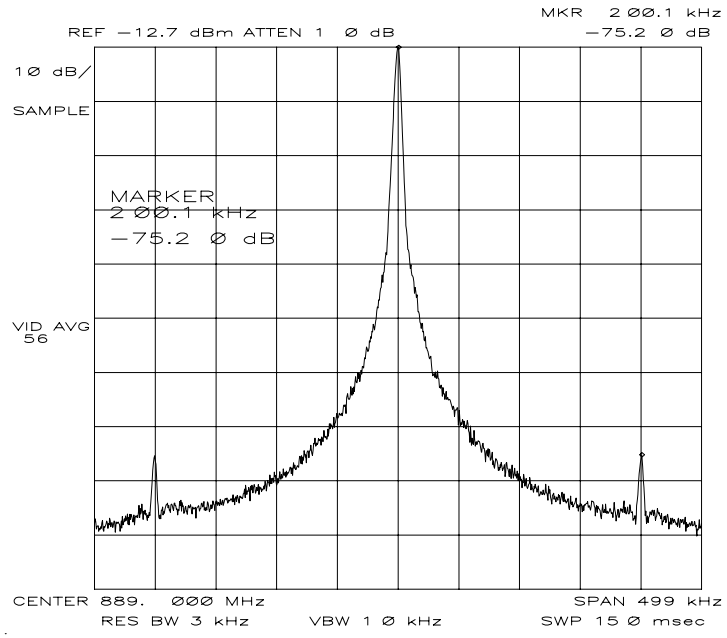
IF LOOP FILTER

LMX1601/02 Performance Measurement Result – A Typical Example

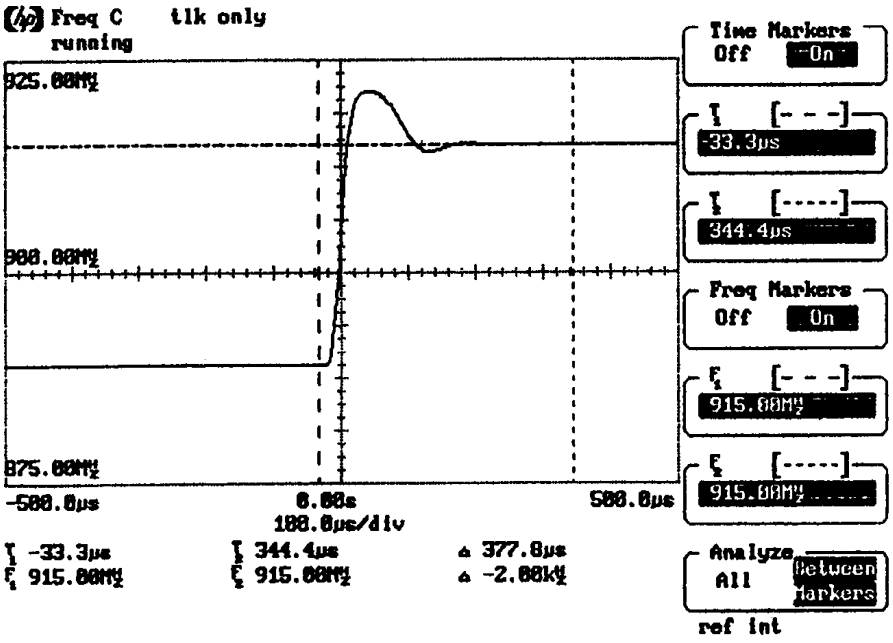
Phase Noise Measurement Result (@100Hz = -71.1 dBc/Hz)



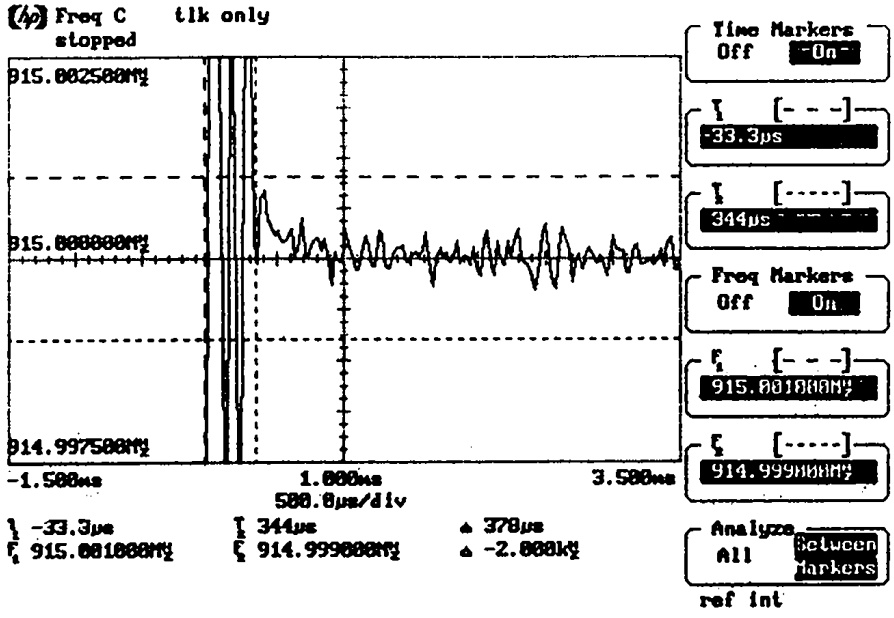
Reference Spur Measurement Result (@200KHz = -75.2dBc)



Lock Time Measurement Result

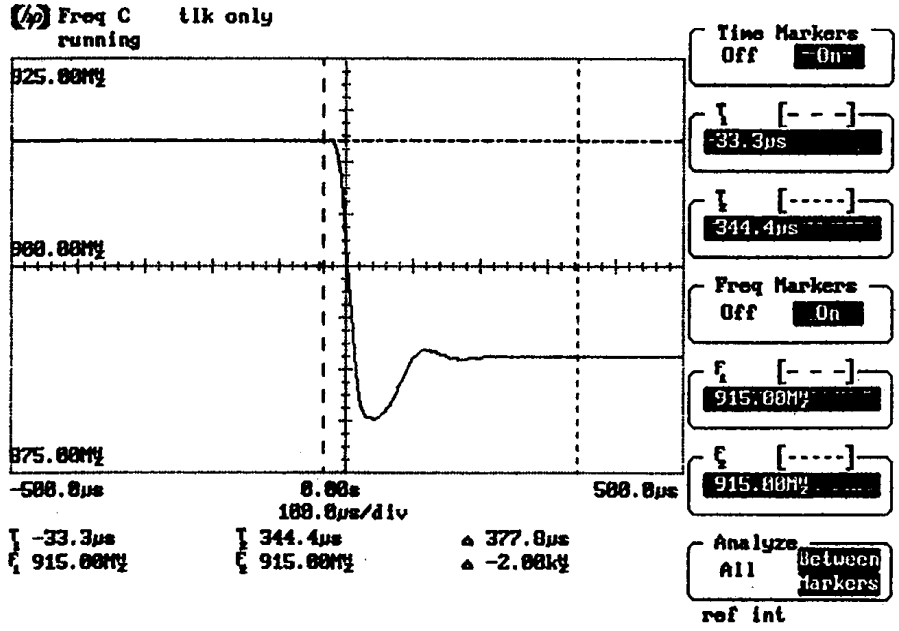


Positive Frequency Switching Waveform

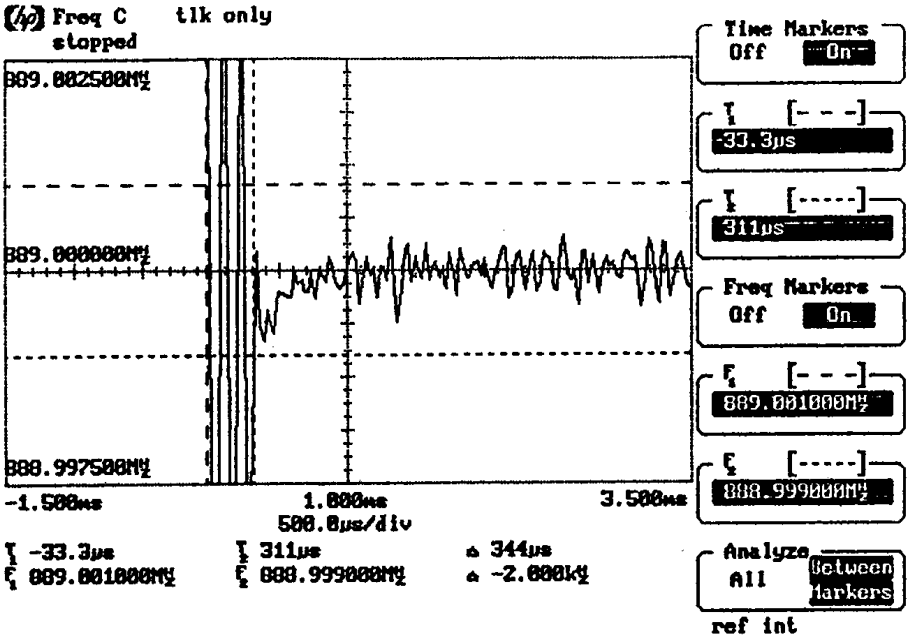


Positive Lock Time to within 1 kHz Range

Lock Time Measurement Result (Cont.)



Negative Frequency Switching Waveform



Negative Lock Time to within 1kHz Range

Measurement Conditions

The LMX1601/02 Evaluation Board has been tested to meet the typical performance criteria as shown below:

Testing Condition

VCC Operating Voltage	:	3.0 Volt
RF VCO Tuning Range	:	889 - 915 MHz
RF Comparison Frequency	:	200 kHz
IF VCO Tuning Range	:	Typical 200 MHz (See back of the evaluation board and Code Loader diskette label for the exact tuning frequency.)
IF Comparison Frequency	:	50 kHz

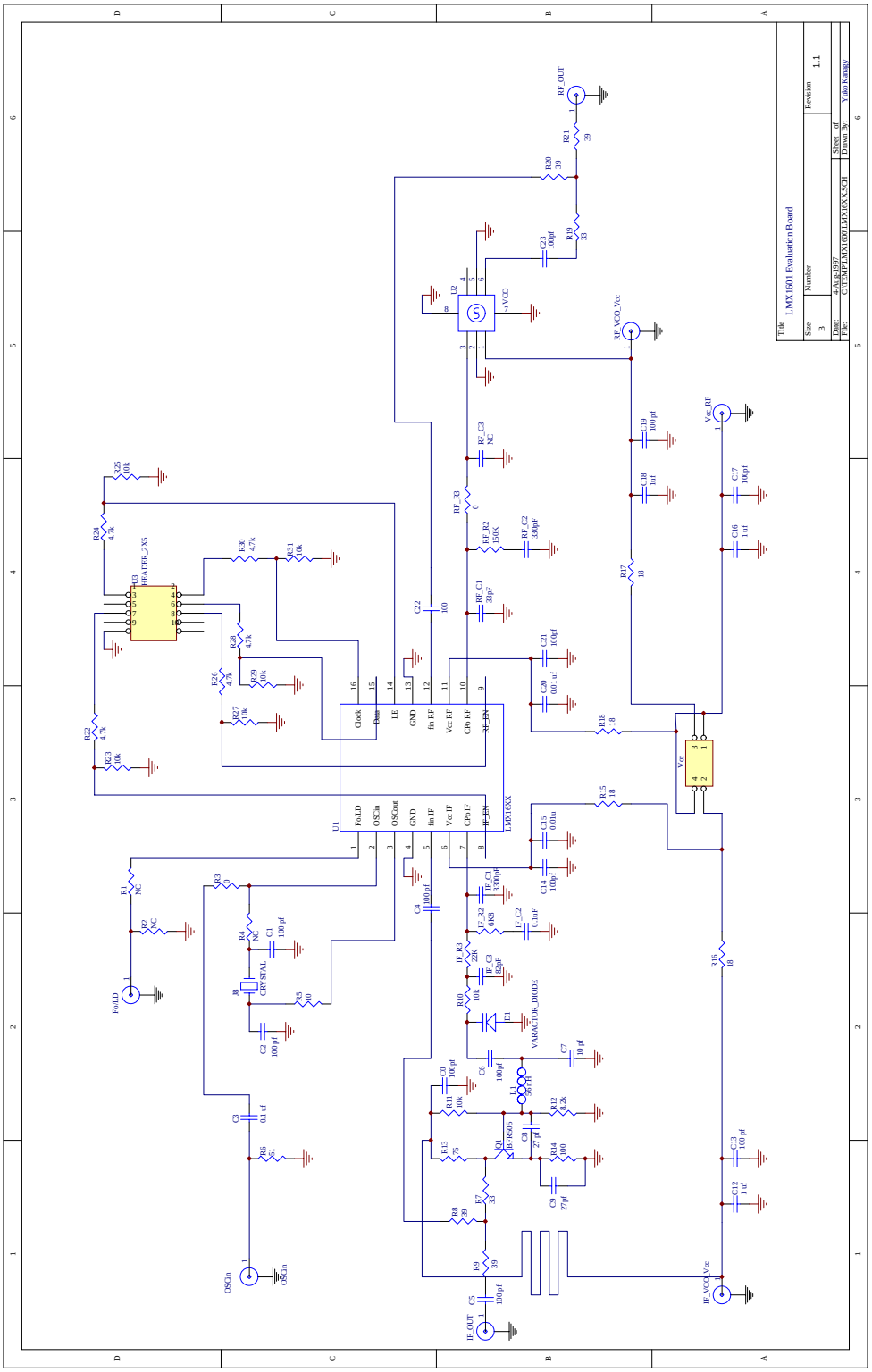
Typical Performance Criteria

RF VCO Phase Noise	:	Less than -55 dBc/Hz @ 100Hz
RF VCO Reference Spur	:	Less than -60 dBc @ 200 kHz
RF VCO Lock Time	:	Less than 600 uS (within +/- 1 kHz settling frequency)

Remark

Computer monitors and other lab equipment has been shown to cause noise spikes. If you see noise spikes on the signal, try turning off the monitor or other equipment to verify that they are not the cause. Also noise may be getting onto the signal through the cable that connects to the parallel port of the computer.

Appendix A : LMX1601/02 Evaluation Board Schematic Diagram



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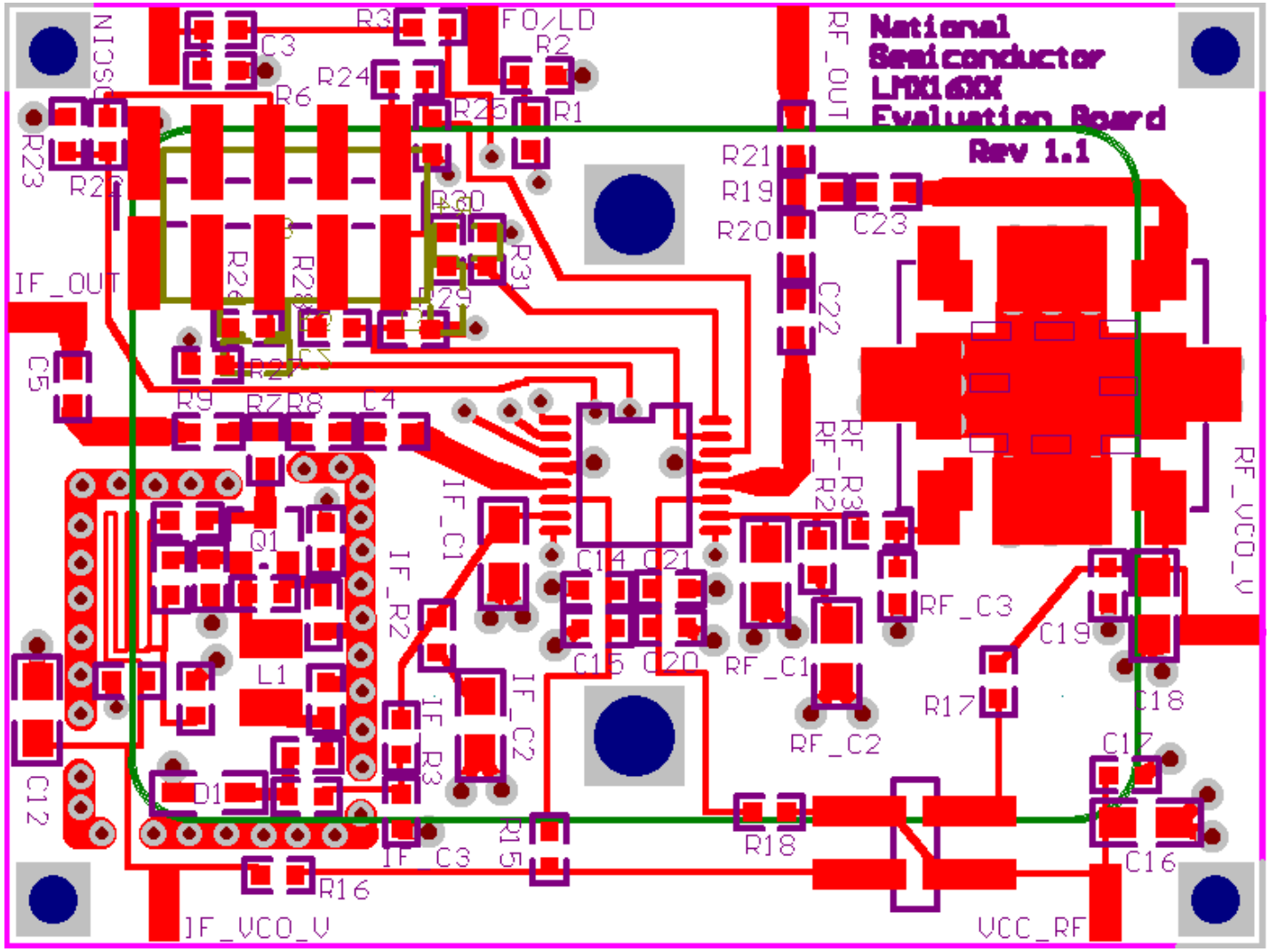
Appendix B : LMX1601/02 Evaluation Board Layout



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Appendix C - How To Setup Code Loader Software

The LMX1600/01/02 Evaluation board is designed so that port setup is required to be configured as follows except for the **Port Address**. The **Port Address** should be selected according to the user PC parallel port.

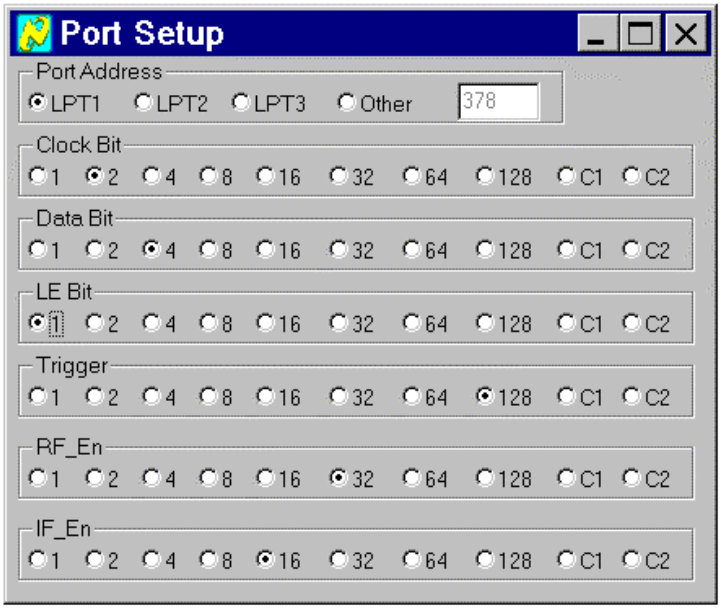

FIGURE C-1: PORT SETUP FOR LMX160X EVALUATION BOARD

Appendix D - LMX1600/01/02 Code Loader Quick Reference

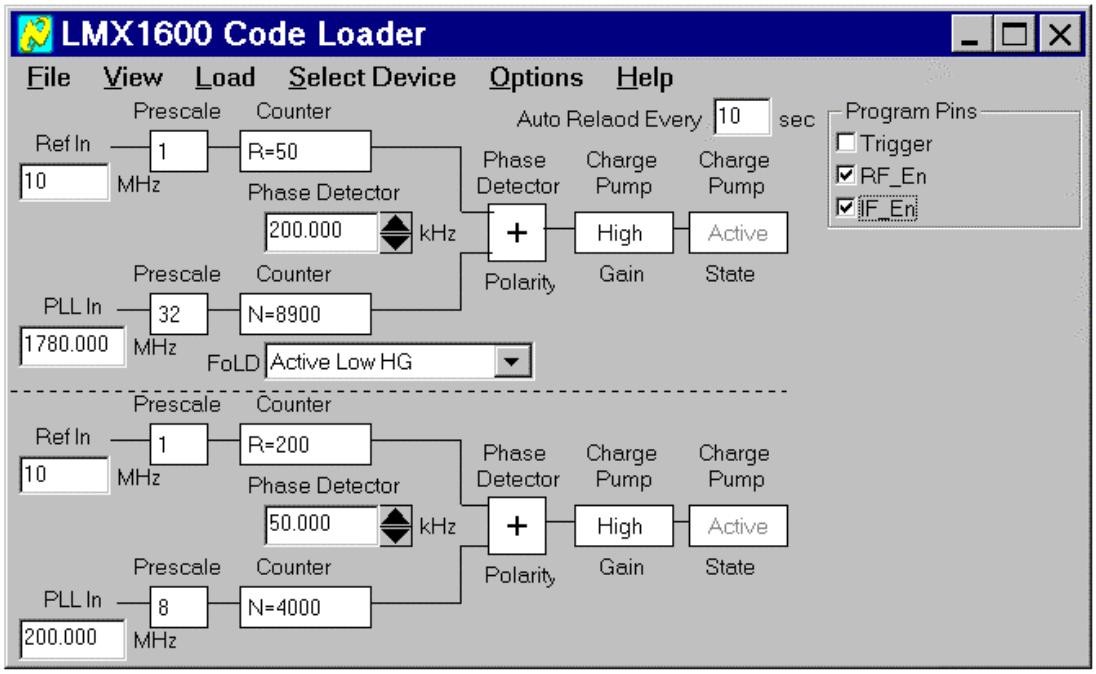

FIGURE D-1: "CODE LOADER" MAIN MENU FOR LMX1600

The parameters above the dotted line are for the main RF PLL, and the parameters below are for the auxiliary IF PLL in the main menu. All parameter values or states can be changed except the charge pump states and R counter prescalers. The parameter boxes can be changed by just clicking on or by clicking on and entering new values. The user must press **Enter** on the keyboard after the parameters are changed. Only registers for which the new changes are relevant are loaded when the **Enter** is pressed. To load all registers in both RF and IF PLLs, select the **Load - PLL** pull down menu or enter Ctrl + L.

Ref In - TCXO or reference crystal oscillator input. NSC's normal LMX1600/01/02 evaluation board is designed for a 10 MHz TCXO. The RF and IF Ref In frequencies are required to be the same. The user is advised to use a high quality crystal reference for an accurate and low noise measurement. A high quality 10 MHz reference signal is generally available from the most of spectrum analyzer reference output port or signal generator reference output port.

Phase Detector - Phase detector (comparator) frequency. NSC's normal LMX1600/01/02 evaluation boards are designed for a 200 kHz **RF** PLL phase detector frequency and a 50 kHz **IF** PLL phase detector frequency. The component values of the loop filter require redesign if the user wishes to use other phase detector frequency.

PLL In - VCO output frequency (PLL fin input frequency). Operating frequencies for the VCO's used on NSC's normal LMX1600/01/02 evaluation boards are as follows:

	VCO used	Operating frequency range [MHz]
LMX1600	Murata 1780	1770 - 1790
LMX1601/02	Varil 2549	889 - 915

The **IF** tuning frequency range is noted at the bottom of the evaluation board or on the code loader diskette label. It is usually around 200 MHz.

The user is allowed to enter a frequency within the VCO operating frequency range. The component values of the loop filter should be redesigned if the user wishes to use other VCOs.

Prescale - Prescaler value of the counters. There is no prescaler used in the R counter indicated by 1. Availability of the prescaler values depends on the user's device type. Refer to the data book for the available prescaler values. The prescaler value can be changed by clicking on the **Prescale** box.

Phase Detector Polarity - The polarity can be changed by clicking on the "+" or "-". Refer to the data sheet for the description of this function.

Charge Pump Gain - Charge pump output current. The LMX1600/01/02 have high and low charge pump gain modes. The modes can be changed by clicking on "High" or "Low". The LMX1600 evaluation loop filter is designed for the "High" charge pump gain, and the LMX1601/02 is designed for "Low" gain mode.

Auto Reload Every [XX] sec - Time interval the program reloads all the counters. The user enables the reload function by selecting **Options - Auto Reload** from the pull down menu.

Program Pins - Trigger - External Trigger for the programming port. The programming port assigned for **Trigger** becomes high when selected and port goes low when not selected.

Program Pins - RF_En - RF Enable pin. The RF PLL is enabled when it is selected.

Program Pins - IF_En - IF Enable pin. The IF PLL is enabled when it is selected.

FoLD - FoLD pin output and OSCin internal buffer mode selection. The FoLD pull-down menu is shown below.

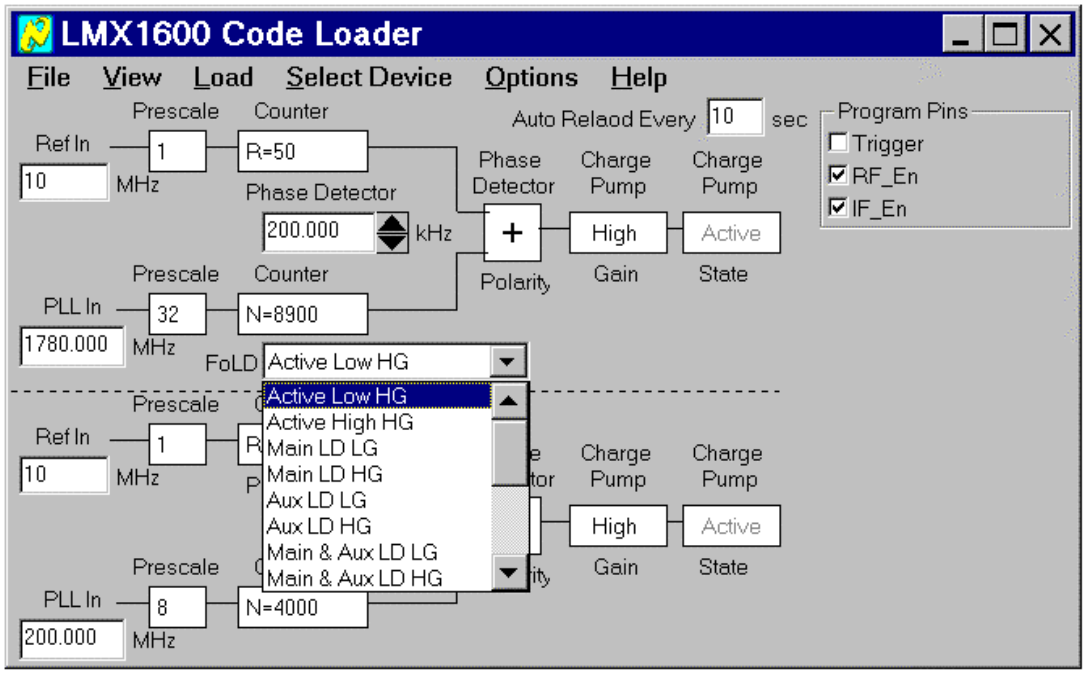

FIGURE D-2: **FOLD** SELECTION

Refer to the data book for a description of the FoLD output selections. The **HG** and **LG** at the end of each selection indicate the high and low gain mode of the OSCin buffer. If the user is using an external TCXO or reference crystal oscillator, the HG or LG can be selected. If the user is building a reference crystal oscillator using the internal OSCin buffer, the HG should be selected.