INTRODUCTION

In order to assist in your evaluation of National Semiconductor's LMX160X series dual PLL, a blank printed circuit board is included with this product sample kit. The PCB is designed to reduce the time required to construct a working evaluation environment for the LMX160X while still providing the flexibility needed to create a circuit that matches your specific application. This document provides the information necessary to populate the board, build the parallel interface cable that allows PC control of the board, and download PC compatible control software from National. The documentation also includes set-up and operating instructions for the hardware and software. Finally, a troubleshooting section is provided.

PREPARING THE EVALUATION BOARD HARDWARE

The LMX1600/LMX1601/LMX1602 Evaluation Board is an implementation of the schematic shown in Appendix A. The board, shown in Appendix B, consists of locations for an LMX160X series dual PLL, a modular RF VCO, a discrete IF VCO, and their respective loop filters. Space for a ten pin header is provided for MICROWIRE™ programming of the PLL divider ratios. A ribbon cable connects to the evaluation board pin header and the parallel port of a PC with Windows 3.1, Windows 95, or Windows NT (or better).

A bill of materials list for the board can be found in Appendix C. Loop filter components and the RF VCO are not listed in the bill of materials. These components are determined by the user depending upon the customer's application. A list of VCO manufacturers can be found in Appendix D of this document. Information on loop filter design can be found in the Application Note (AN-1001), **"An Analysis and Performance Evaluation of a Passive Filter Design Technique for Charge Pump Phase-Locked Loops"** which is also included in the product sample kit. The IF VCO is built from discrete components (these components are listed in the bill of materials). It is designed for a center frequency of approximately 200 MHz. Its output power ranges from 0 to -3 dBm.

The board has two kinds of interconnections. SMA or SMC connectors should be used for the external reference and VCO output, while power supply biasing and ground can be attached to the board either by mounting connectors or by directly soldering to the pads. Both Vcc voltages (IF and RF) must be supplied for proper PLL operation even if one of the PLLs is not used. Resistor denoted as NC (No connect) in the schematic are for connecting various outputs to output pads or to ground by using 0 Ω resistors as shorts.

A simple ten wire interface cable can be used to interface the evaluation board and a PC with Windows 3.1, Windows 95, and Windows NT (or better). The cable, which is described in Appendix E, connects from the PC's parallel port to the ten pin header on the evaluation board. The cable provides the MICROWIRE™ signals (i.e. Data, Clock, LE, RF_EN, and IF_EN) needed to program the LMX160X series PLL. Since most PC's parallel ports have an output level of 5V, pads for resistive dividers on the Clock, Data, and Load Enable are also included. This will allow low voltage operation of the PLL without overdriving the MICROWIRE™ inputs.

The RF VCO is assumed AC coupled. Resistor R20 in the schematic increases impedance so that VCO output power is provided to the load rather than the PLL. Typical values are 10 Ω to 200 Ω depending on the VCO power level. Fin RF real impedance ranges from 40 Ω to 100 Ω. A 50 Ω termination is often used on test boards to allow use of a signal generator as the external reference oscillator. For actual manufactured products, a TTL or CMOS clock is typically used and no terminating resistor is required. OSCin may be AC or DC coupled. AC coupling is recommended because the input circuit provides its own bias. Proper use of grounds and power supply decoupling is essential to achieve a high level of performance. Pads for power supply decoupling capacitors are provided.

The LMX160X are static sensitive devices. It should be handled only at static free work stations.

USING THE EVALUATION BOARD

Hardware Set-Up Instructions

The user should make the following connections to operate the evaluation board in standard mode:

(1) Connect the VCO output **(RF OUT)** to a spectrum analyzer.

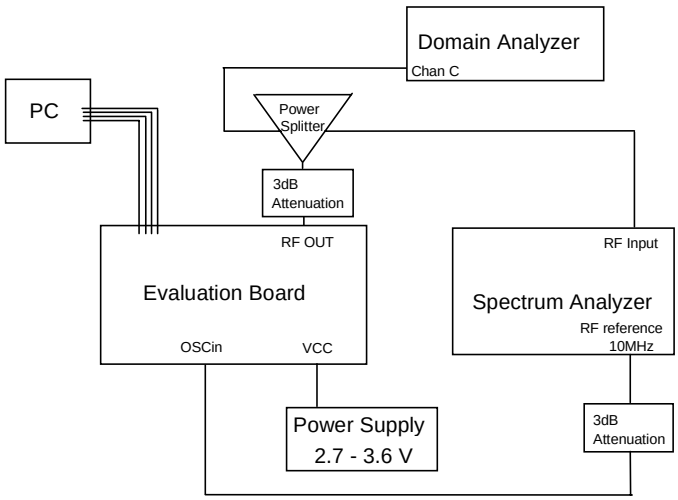
(2) Connect a reference input within the range 5 MHz to 40 MHz at 0 dBm to the **OSCin** port.

(3) Connect the interface cable to the parallel port of the PC and to the pin header on the evaluation board.

(4) Connect a power supply to the Vcc input (2.7 - 3.6 V depending on your application). With both jumpers on the 4 pin voltage headers, the VCO and the PLL will run off the same supply.

The board is now ready to operate. This configuration is for evaluation purposes only and is not meant to show how the PLL would be used in a system.

The following block diagram shows a typical equipment set-up for evaluating a LMX160X series PLL. The Spectrum Analyzer can be used to obtain phase noise and reference spur measurements. The Domain Analyzer is used for lock time measurements. For more details on PLL measurements, please see National Semiconductor Application Note AN-885, "Introduction to Single Chip Microwave PLLs".



Obtaining the Evaluation Software

The evaluation board software can be obtained through the National Semiconductor web page.

http://www.national.com/models/

The evaluation software is called Code Loader. There are different choices of the software depending on the user's Windows version (i.e. Windows 3.1, Windows 95, and Windows NT).

Using the Evaluation Software

Refer to the "Code Loader Operation" document explains how to setup and use the software. The appendices A and B for the "Code loader Operation" document include specific instructions for the LMX160X programming.

TROUBLESHOOTING TIPS

- Using magnification, visually inspect the board for cold solder joints, broken, misplaced or partially soldered components, and solder bridges. These items are common causes for partially or non-working boards.

- Verify that the correct voltage levels for Vcc and VCO are actually getting to the places they need to (i.e. measure the voltage at the PLL and VCO pins, not at the edges of the board). Also verify that the Jumpers are set properly for the number of power supplies being used (i.e. if only one supply is being used, all two power supply jumpers should be in place).

- Verify that OSCin is getting the proper XTAL frequency and that OSCout is an amplified version of it. Both OSCin and OSCout should have a DC offset.

- Verify that the LMX160X is getting the proper programming signals by putting the software in “switch” mode and probing the CLOCK, DATA, and LE pins with an oscilloscope. Also verify that the programming signals are at the appropriate level for your application (i.e. if your application is a 3V one, make sure that the 5 volt signals from the PC are being resistively divided so that they don’t overdrive the PLL inputs.)

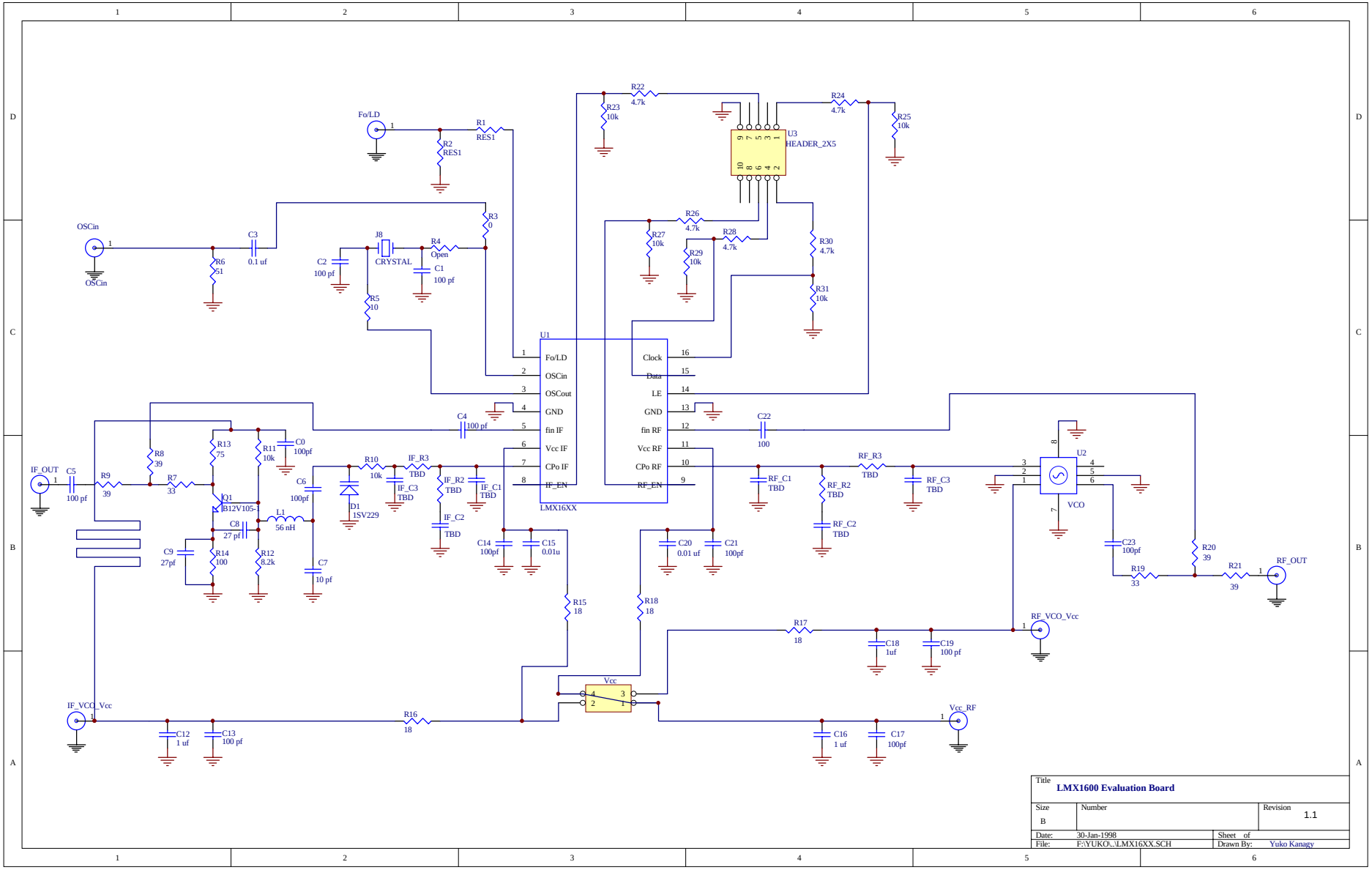
- When de-bugging one side (IF or RF) of the dual PLL, power down the other side to facilitate the process.

- Verify proper values for VCO frequency, Reference frequency, and crystal frequency in the evaluation software. Also verify that the RF and IF VCOs are powered up and enabled. This is also controlled by the software.

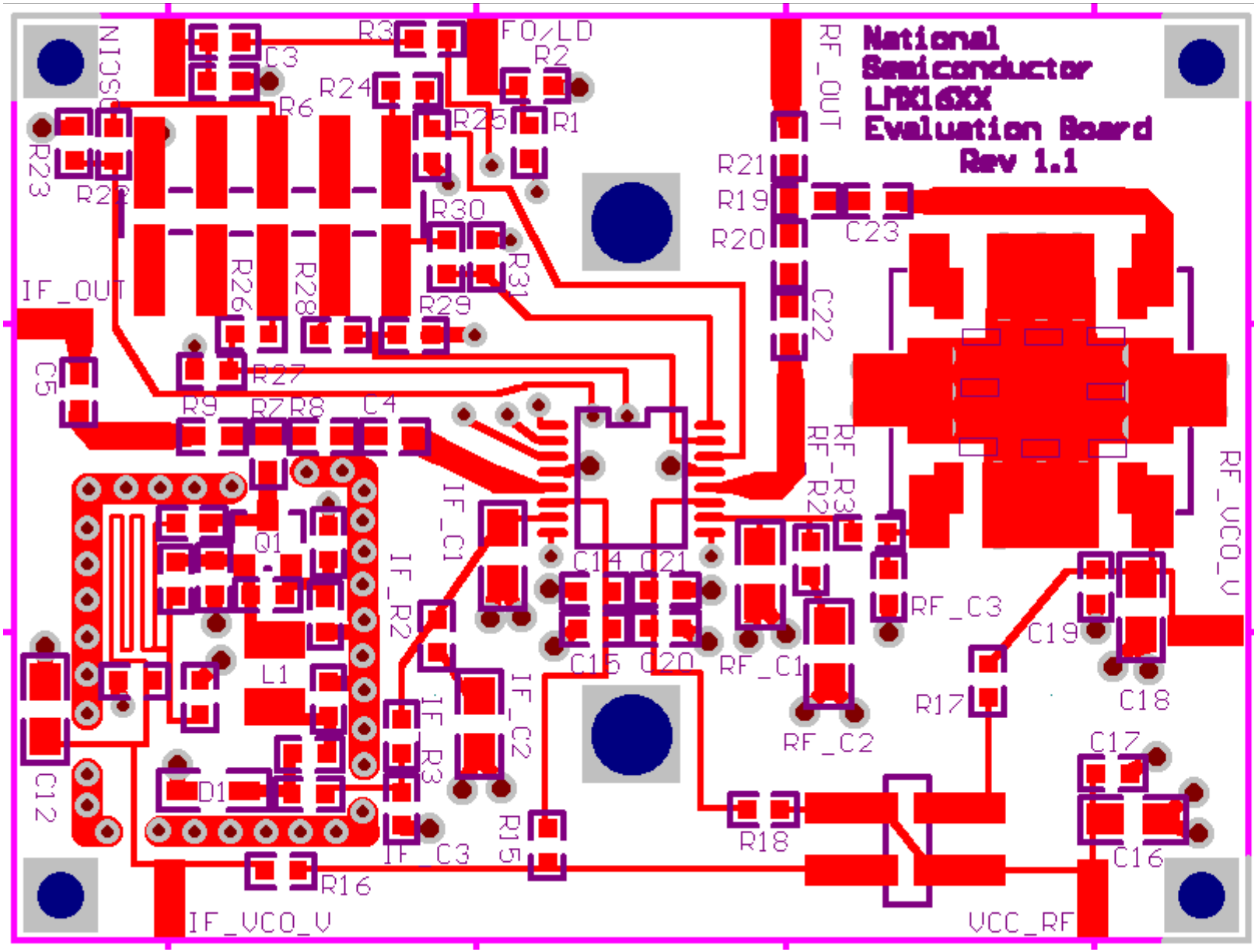
- Verify proper operation of the divider outputs (Fr and Fp). These outputs are made available by programming the Fo/LD pin via software.

- Computer monitors and other lab equipment have 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: LMX160X Evaluation Board Schematic



APPENDIX B: LMX160X Evaluation Board



APPENDIX C: LMX160X Evaluation Board - Bill of Materials

QTY	DESCRIPTION	SIZE	LOCATION
1	0.1 uF	805	C3
2	0.01 uF	603	C15, C20
1	1SV229	SOD323	D1
3	1 uF	805	C12, C16, C18
5	4.7 kΩ	603	R22, R24, R26, R28, R30
1	8.2 kΩ	603	R12
1	10 Ω	603	R5
7	10 kΩ	603	R10, R11, R23, R25, R27, R29, R31
1	10 pF	603	C7
4	18 Ω	603	R15, R16, R17, R18
2	27 pF	603	C8, C9
2	33 Ω	603	R7, R19
4	39 Ω	603	R8, R9, R20, R21
1	51 Ω	603	R6
1	56 nH	1008	L1
1	75 Ω	603	R13
1	100 Ω	603	R14
1	100 pF	603	C0,C1 C2 C4 C5 C6, C13, C14 C17 C19 C21 C22 C23
1	B12V105-1	SOT23	Q1
2	Shunts 0.100” Doublewipe contacts		
1	Surface mount Header 0.100” X 0.100” Double Row, 10 position		
1	Surface mount Header 0.100” X 0.100” Double Row, 4 position		
7	SMA PC Mount End Launch Jack Receptacles for RF out, RF in, IF out, VpIF, VpRF, VCC		

APPENDIX D: VCO Suppliers

ALPS Electric CO., LTD.
1-7 Yukigaya Otsuka-Cho
Ota-Ku Tokyo, Japan 143
Phone: (03) 3726-1211
FAX: (03) 3728-1741

ALPS Components
8141 Kaiser Blvd.
Anaheim, Ca. 92808
Phone (714) 279-1554
Fax (714) 279-1570

Prime Electro Products Co.
(Northern California ALPS Distributor)
653 East Campbell Ave. Suite #2
Campbell, CA 95008
Phone: (408) 374-0707

muRata Manufacturing CO., LTD.
26-10 2-Chome, Tenjin,
Nagaokakyo-shi
Kyoto 617, Japan
Phone: 075-951-9111
FAX: 075-954-7720

muRata Marketing Communications
2200 Lake Park Dr.
Smyrna, GA 30080
Phone: (404) 436-1300
FAX: (404) 436-3030

muRata Europe
Phone: 44 252 811666

Varil
11101 East 51st Ave.
Denver, Co. 80239
Phone (303) 371-1560
Fax (303) 371-0845

APPENDIX E: Parallel port to MICROWIRE™ Interface Cable

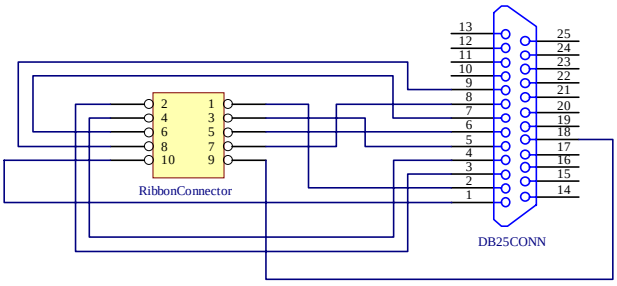
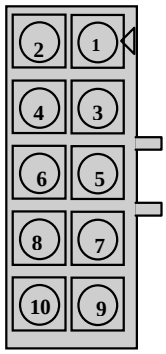


Figure 1: Data cable schematic



Ribbon Cable Connector
Female 0.100" X 0.100"
Double Row 10 Positions
Bottom View

Figure 2: Ribbon connector pin configuration

Ribbon Connector Pin:	DB25 Connector Pin:
1	2(D0)
2	3(D1)
3	5(D3)
4	4(D2)
5	6(D4)
6	7(D5)
7	8(D6)
8	9(D7)
9	18(GND)
10	1(D8)

Table 1: Data cable pin-to-pin connection list