National Semiconductor™

OPERATING INSTRUCTIONS FOR THE NATIONAL SEMICONDUCTOR LMX2301 EVALUATION BOARD

SET-UP INSTRUCTIONS

The LMX2301 Evaluation Board is an implementation of the schematic shown as Figure 1. (**NOTE: The schematic in Figure 1 shows a component value for each component that is actually on the board. Any component shown in the schematic that does not have a component value is not actually on the board, but there is space for this component.)** The board, shown in Figure 2, consists of the LMX2301, a VCO, a loop filter, voltage and data pin headers.

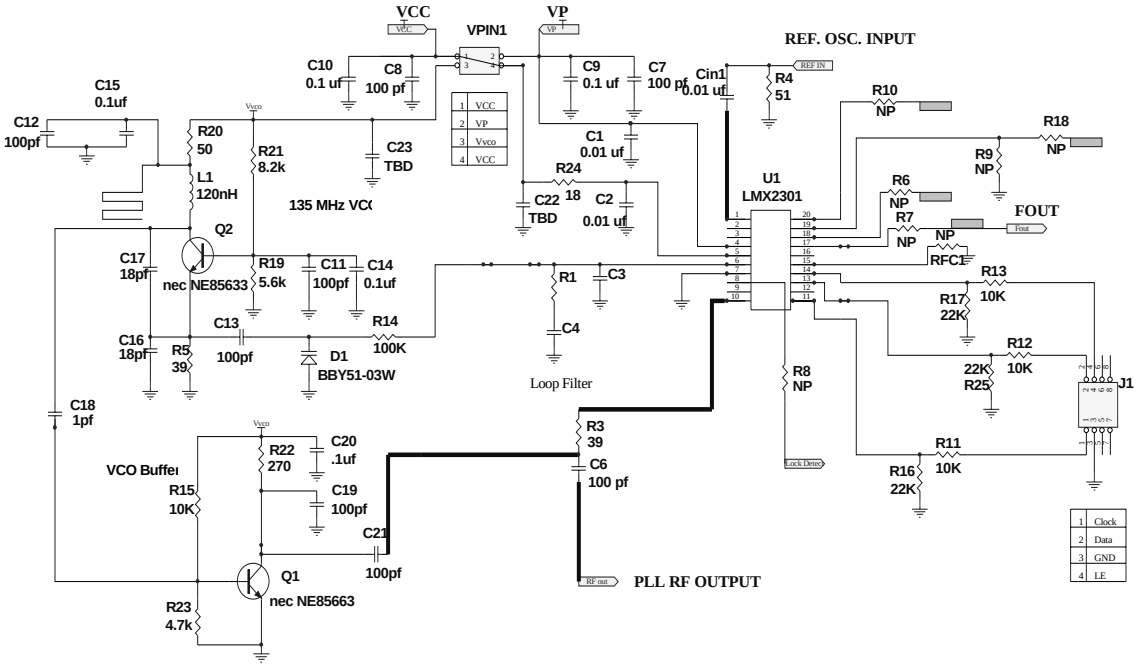


Figure 1 - Schematic for the LMX2301 Evaluation Board

Resistors denoted as O.C. / S.C. are for connecting various outputs to output pads or to ground by using OΩ resistors as shorts. The board has two kinds of interconnections. SMA flange mount connectors are supplied for the external reference and VCO output, power supply biasing and grounding. A four pin header allows VCC, VP, and Vvco to be driven off either a single voltage supply, or separately. An eight pin header is provided for programming of the PLL prescaler. The cable provided connects to the evaluation board pin header and the parallel port of a PC XT (or better) equivalent. Since most P.C.'s parallel port output level is 5 V, resitive 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.

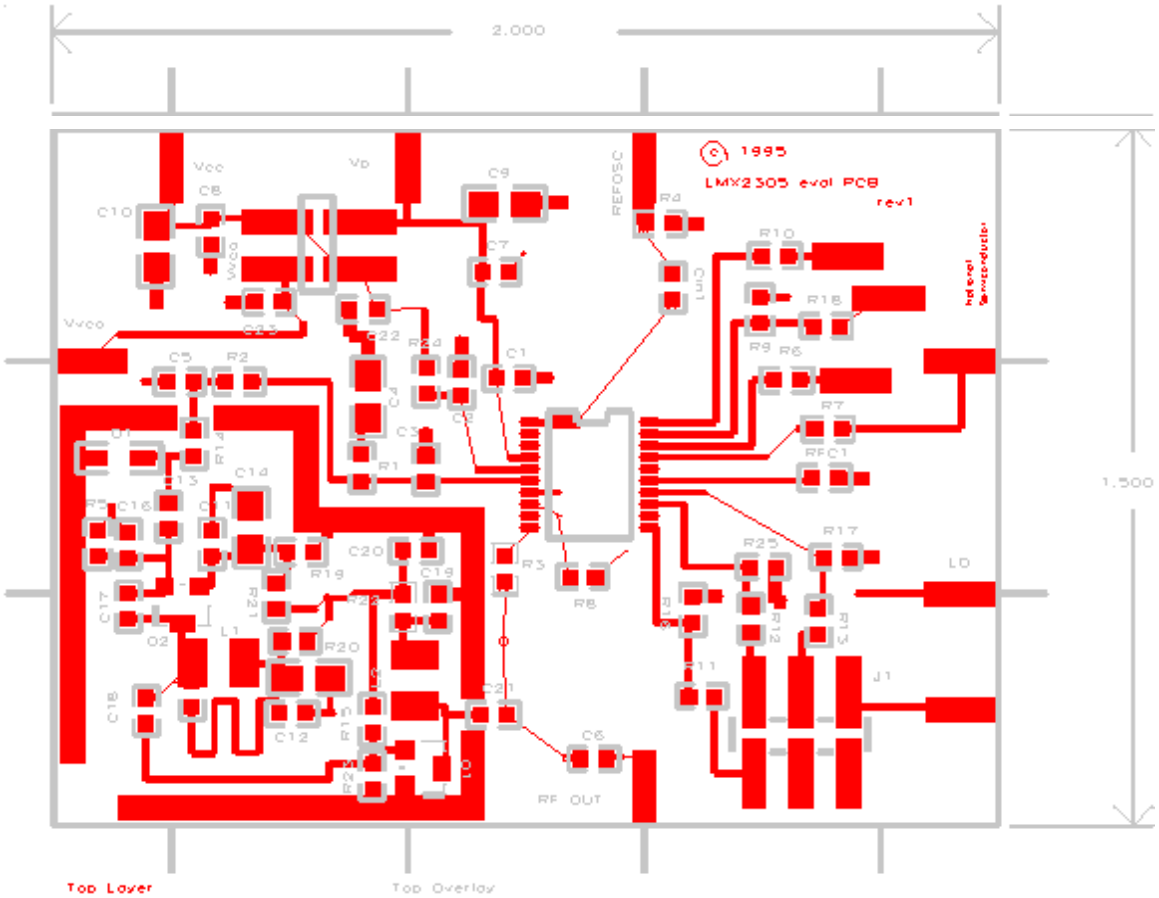
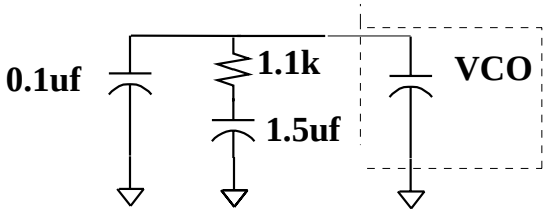


Figure 2 - Drawing of the LMX2301 Evaluation Board

The user should make the following connections to operate the evaluation board in standard mode: (1) Connect the VCO output **(PLL RF OUT)** to a spectrum analyzer, (2) Connect a reference input from 5 MHz to 30 MHz at 0 dBm to the **REF IN** port, (3) Connect the cable assembly to the parallel port of the PC and to the pin header on the evaluation board, (4) and connect a 5.0V power supply to the VCC SMA input. Connect the P.C. cable with the arrow on the connector facing the board. If you were holding the cable in your hand the sockets to the far left should attach to the pins on the board. With both jumpers on the 4 pin voltage pin header, 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 it will be used in a system.

The loop filter was designed for a 135 MHz LO application, with a crystal reference frequency of 10.000 MHz, and a comparison frequency of 100 KHz. Loop values for the integrator have been selected and placed in the loop in the configuration shown below. However, the evaluation board has been designed to accept more complex configurations.



USING LMX2301 SOFTWARE

Insert the diskette into drive a: or b:. The program may be operated from the floppy or may be copied onto a hard disk. Because the program uses extended precision real numbers in its calculations the program may not operate on some older DOS computers. A PC-AT or equivalent is recommended. The program may be started by typing LMX2301.

LMX2301 controls the LMX2301 Evaluation Board via a standard parallel port. A cable is provided to make the connection from the computer to the board. The program is intended to be easy to install and use, exercise the PLL, and demonstrate typical performance. It is not intended to be representative of the control code which the customer will implement within their application.

Upon power-up the program will detect the number and location of parallel ports available to the system. The user will be prompted to select one port. The evaluation program is menu driven. All menu selections may be made by pressing "Enter" when a menu is highlighted. Up, down, left and right arrows are used to change which menu id highlighted. Speed keys are also included for each active menu item. Use Speed keys by typing the letter displayed in red corresponding to the mode desired. The top menu pane consists of pull down menus titled "Set (F)requency", "Set (R)egister", "(T)uning", and "(Q)uit" where the speed keys are listed in parentheses. To exit from a menu at anytime press "Escape". A status pane is included at the bottom of the pane to give on-line help descriptions of highlighted menu items.

The program displays a block showing the present tuning parameters for VCO, Crystal Reference, and Phase detector reference frequency. Activate the "Set Frequency" pulldown menu to control these values. To the right of this block is the "Scratchpad", showing the values as you enter them. The program will issue a warning and a suggestion if a value is selected which does not maintain an integer relationship between the VCO or crystal frequency and the reference frequency. The suggestion will be the nearest value of the parameter just changed which will produce an integer relationship. The user may select this value, or any other, so long as the integer relationship is established. Upon successful selection of tuning parameters, the download values are calculated and loaded. The board must be powered up in order for the values to be loaded. If power is applied after the software is on or power is turned off for some reason all that is required is entering "Load Frequencies" to download the values.

The program displays, and allows modification of, the binary values for the VCO divider (P), Reference Divider(R), and control codes. To modify N or R directly, activate the "Set Register" menu, select the desired mode and use the arrow keys to move horizontally or to change values ("up" changes "0" to "1", "down" changes "1" to "0"). You may also type in "1" or "0".

Users will find items in the "Tuning" menu useful. In "Hand Tune" mode the user may step up or down in single increments by using the up or down arrows, or in increments of 10 by using the left and right arrows. Other steps, 2 up to 9, are taken by pressing any number from 2 to 9. Steps downward are taken by pressing the down or left arrow keys or by holding down the shift key when pressing any number from 2 to 9.

The "Switch" mode in the "Tuning" menu allows measurement of PLL switching time by initiating switching between the presently tuned frequency and a frequency an arbitrary number of steps away. In "Switch" mode, the user will be prompted for an integer (+ or -) number of steps and a delay (msec). The delay will allow the user to specify the time delay between switching. The "Enable" input forms a fairly good trigger (it is written twice, once for N and once for R). Load time will vary depending upon the processing speed of the computer being used.

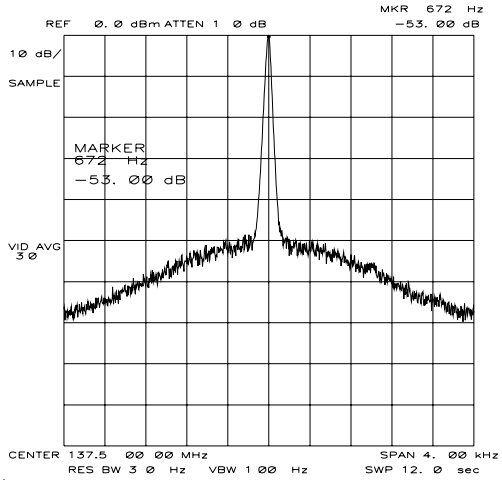
The "Auto Tune" mode in the "Tuning" menu allows the user to switch to a set frequency and specify the interval to step in. Entering this mode, the user will be prompted for an integer to step up to, an integer to step by and a delay (msec). The delay allows the user to specify the time delay between steps. This would allow a user to verify operation at all channels of interest.

The program is exited by choosing "Yes, Quit" in the "Quit" menu, which saves the current parameters in a log file. Any mode may be exited by pressing "Enter".

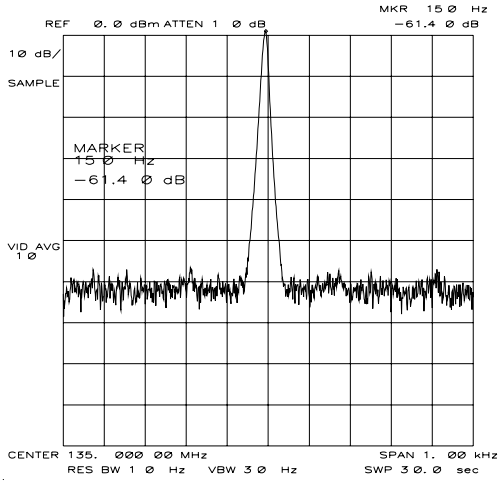
TYPICAL MEASURED PERFORMANCE OF THE LMX2301 EVALUATION BOARD

Normal operating parameters for the 135 - 140 MHz frequency range include spurious at less than -75 dBc, switching speed (for a 100kHz reference frequency and a step of 5 MHz) < 15 milliseconds. Phase noise is measured at -65 dBc/Hz at 150 Hz offset. Typical current draw at 3 volts is 6 mA (not including the 6 mA VCO). These parameters were measured on a very small sample size. All parameters are subject to change.

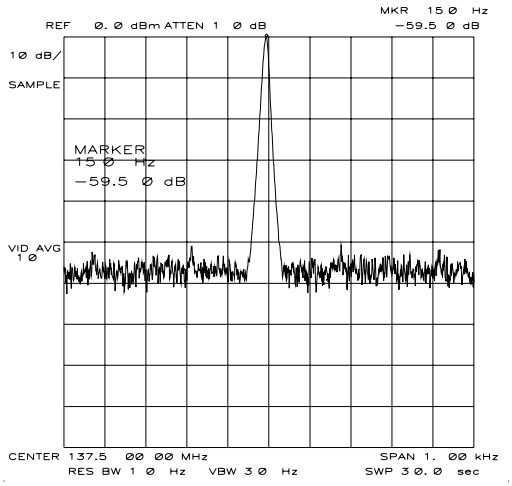
NOTE: Computer monitors and other lab equipment has been shown to cause noise spikes. If you see noise spikes on the signal try turning off the monitor or other equipment to verify that they are not the cause. Also noise may be getting onto the signal through the cable that connects to the parallel port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

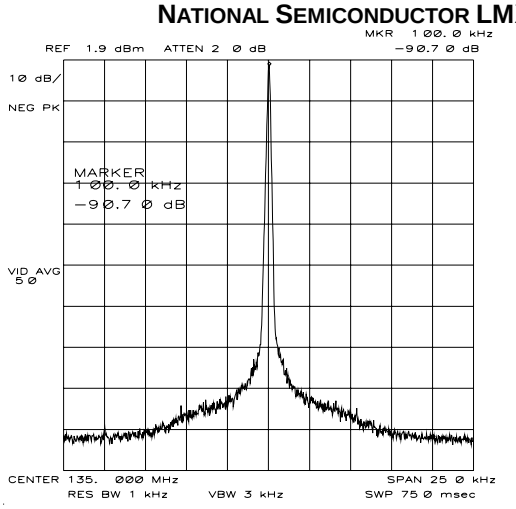


Loop Bandwidth



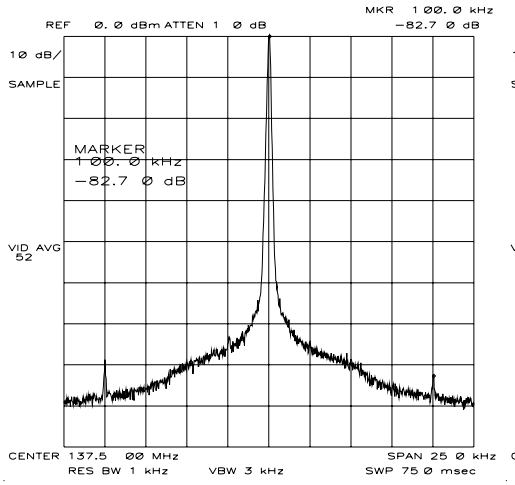
Phase Noise at Low end of Tuning Range

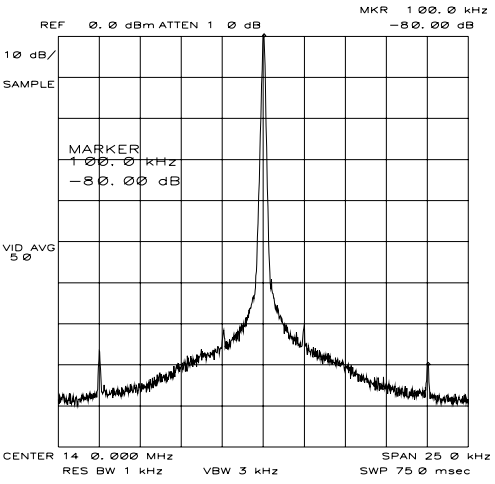




Phase Noise at Center Band

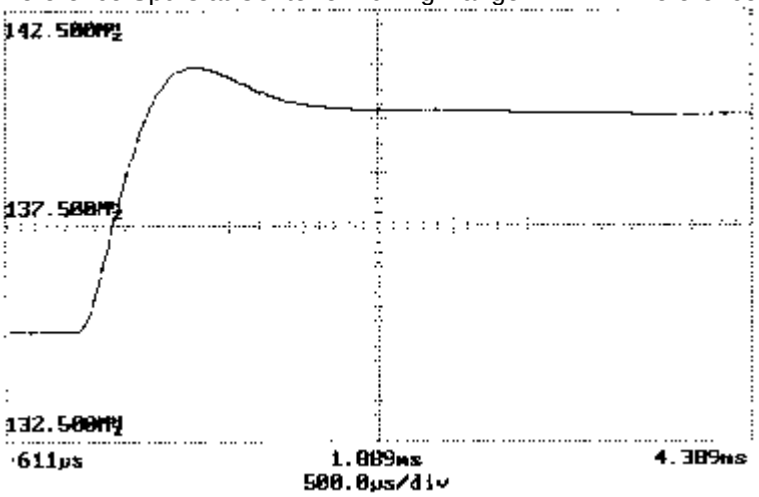
Reference Spurs at Low end of Tuning Range



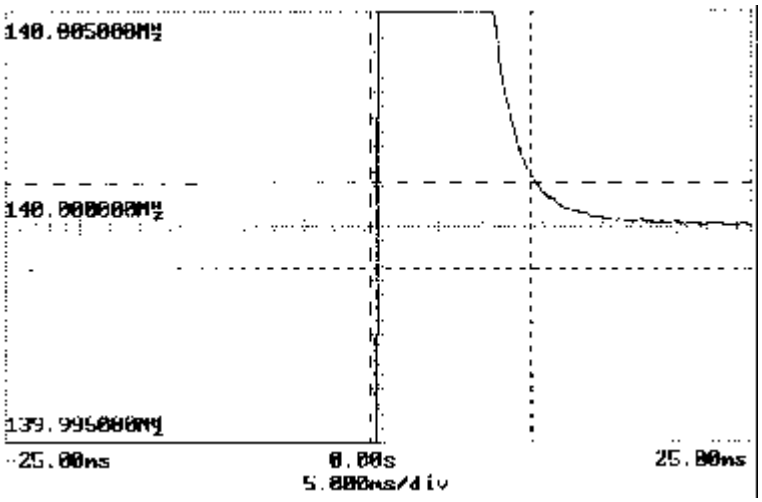


Reference Spurs at Center of Tuning Range

Reference Spurs at High end of Tuning Range



Switching Waveform From Low to High of Tuning Range



Transient Waveform Plot of Settling Time

Bill of Materials

Part	Used	PartType	Designators
1	3		C5 J1 VPIN1
2	3	.01uf	C1 C2 C3
3	1	.1uf	C4
4	4	.01uf	C20 C22 C23 Cin1
5	2	0.1uf	C14 C15
6	1	0 ohm	R2
7	1	1pf	C18
8	2	1uf	C9 C10
9	1	3.3K	R23
10	1	3.9K	R1
11	1	5.6K	R21
12	2	5.6pf	C16 C17
13	4	10K	R11 R12 R13 R15
14	1	18	R24
15	3	22K	R16 R17 R25
16	1	27pf	C21
17	1	39	R5
18	2	51	R4 R20
19	1	56K	R19
20	1	82nh	L2
21	1	100K	R14
22	7	100pf	C6 C7 C8 C11 C12 C13 R3
23	1	220nh	L1
24	1	680	R22
25	1	8200pf	C19
26	2	B12V105	Q1 Q2
27	1	BBY51-03W	D1
28	1	LMX2301	U1
29	8	NP	R6 R7 R8 R9 R10 R18 R26 RFC1