National Semiconductor™

PLLATINUM™ EVALUATION BOARD
LMX2336/LMX2336L

INTRODUCTION

In order to assist in your evaluation of National Semiconductor's LMX2336/LMX2336L 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 LMX2336/LMX2336L 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 LMX2336/LMX2336L Evaluation Board is an implementation of the schematic shown in Appendix A. The board, shown in Appendix B, consists of locations for an LMX2336/LMX2336L series dual PLL, two modular RF VCOs and their respective loop filters. Space for a six 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 XT (or better).

A bill of materials list for the board can be found in Appendix C. Loop filter components and the RF VCOs are not listed in the bill of materials. These components are determined by the user depending upon his/her 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 board also includes the ability to make use of the selectable Fastlock mode of the LMX2336/LMX2336L. For information on Fastlock, see the Application Note (AN-1000), **"A Fast Locking Scheme for PLL Frequency Synthesizers"** which is included in the product sample kit.

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. A 4-pin allows VCC, VP, and Vvco to be driven separately or from the same power supply. VP must be greater than or equal to Vcc. Resistors denoted as O.C. / S.C. (Open Circuit / Short Circuit) in the schematic are for connecting various outputs to output pads or to ground by using OΩ resistors as shorts.

A simple four wire interface cable can be used to interface a PC XT (or better) and the evaluation board. The cable, which is described in Appendix E, connects from the PC's parallel port to the six pin header on the evaluation board. The cable provides the MICROWIRE™ signals (i.e. Data, Clock, and Load Enable) needed to program the LMX2336/LMX2336L 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. Resistors R5 and R8 in the schematic increase impedance so that VCO output power is provided to the load rather than the PLL. Typical values are 10Ω to 200Ω depending on the VCO power level. Fin RF real impedance ranges from 40Ω to 100Ω. A 50Ω 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.

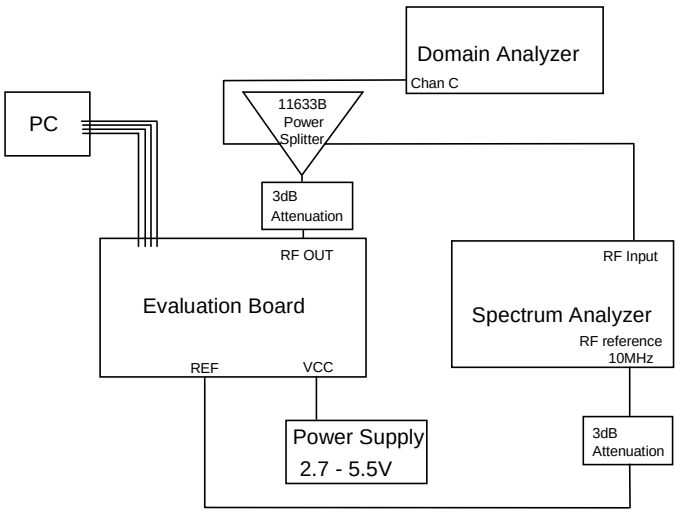
The LMX2336/LMX2336L is a static sensitive device. It should be handled only at static free work stations.

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 **REF IN** port, (3) Connect the interface cable to the parallel port of the PC and to the pin header on the evaluation board, (4) and connect a power supply to the VCC input (2.7 -5.5 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 **LMX2336/LMX2336L** 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.



Using the Evaluation Software

Because the evaluation software uses extended precision real numbers in its calculations, they may not operate on some older DOS computers. A PC-AT or equivalent is recommended. Although the programs can be run from a DOS shell in Windows 3.1, the preferred method is to run them directly from DOS. Windows 3.1 interrupts can cause variances in the delay time between frequency switches when in the

"Switch" tuning mode (see below).

The evaluation programs control the **LMX2336/LMX2336L** Evaluation Board via a standard parallel port (see Appendix E). The programs are intended to be easy to install and use, exercise the PLL, and demonstrate typical performance. They are not intended to be representative of the control code which the customer will implement within their application.

Upon power-up, the programs will detect the number and location of parallel ports available to the system. The user will be prompted to select one port. The evaluation programs are 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. The Speed keys are used 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", "(M)odes", "Fo/(L)D", and "(Q)uit" where the speed keys are listed in parentheses. To exit from a menu at anytime press "Escape". A status panel is included at the bottom of the screen to give on-line help descriptions of highlighted menu items.

The programs display a block showing the present tuning parameters for VCO, Crystal Reference, and Phase detector reference frequency for the RF1 PLL. To display and edit the second PLL select "RF2 P(L)L" under the "Modes" pulldown menu. 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 programs 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 to download the values for both PLL's. is entering "Load Dual PLL"

The program displays, and allows modification of, the binary values for the VCO divider (N), Reference Divider(R), and control codes. In the **LMX2336/LMX2336L** software, the value of P (either 64 or 128) shows the present status of the prescaler control bit which enables either the 64/65 prescaler or the 128/129 prescaler. When an N value is entered which is invalid for P=64, the program will display an error message and automatically switch to P=128. To modify N, R or P 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 allows a user to verify operation at all channels of interest.

The "Modes" menu is used to toggle the PLL between different states. The menu items are interactive and change with the state of the PLL. Choosing the first menu item (either "RF1 PLL" or "RF2 PLL") switches the active display from the RF1 PLL to the RF2 PLL, or vice versa. The second menu item toggles the slope of the phase detector between "PD = Positive" and "PD = Negative". "Icp = 1(4) mA" switches between the high and low current charge pump output. The "Power Down (Up)" selection powers down (or up) the currently displayed PLL only. Selecting the last menu item under modes "Do Tri-State (Active)" toggles the PLL charge pump in and out of Tri-State mode.

The "Fo/LD" menu is specifically used to control the state of the frequency divider/ lock detect/ Fastlock output pin. The user may select the Fastlock mode, as well as disable the output, or select one of seven output states which allow monitoring either the R or N divider outputs, or lock detect for each PLL. While selecting Fastlock mode, the user will be pompted for a delay time in milleseconds, and ‘Fast Lock’ will appear in the active mode display. Upon using the switching mode with Fastlock activated, the part will stay in the 4mA Fastlock mode with R2’ switched in to ground for the programmed number of milleseconds and then revert to the 1mA mode with the FoLD input a high impedance. Keep in mind the number of milleseconds actually delayed may vary from computer to computer, and is more accurate when the program is run directly from DOS.

The programs are 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".

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, Vp 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 four power supply jumpers should be in place and Rshunt should be a 0 Ω resistor).

- 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.

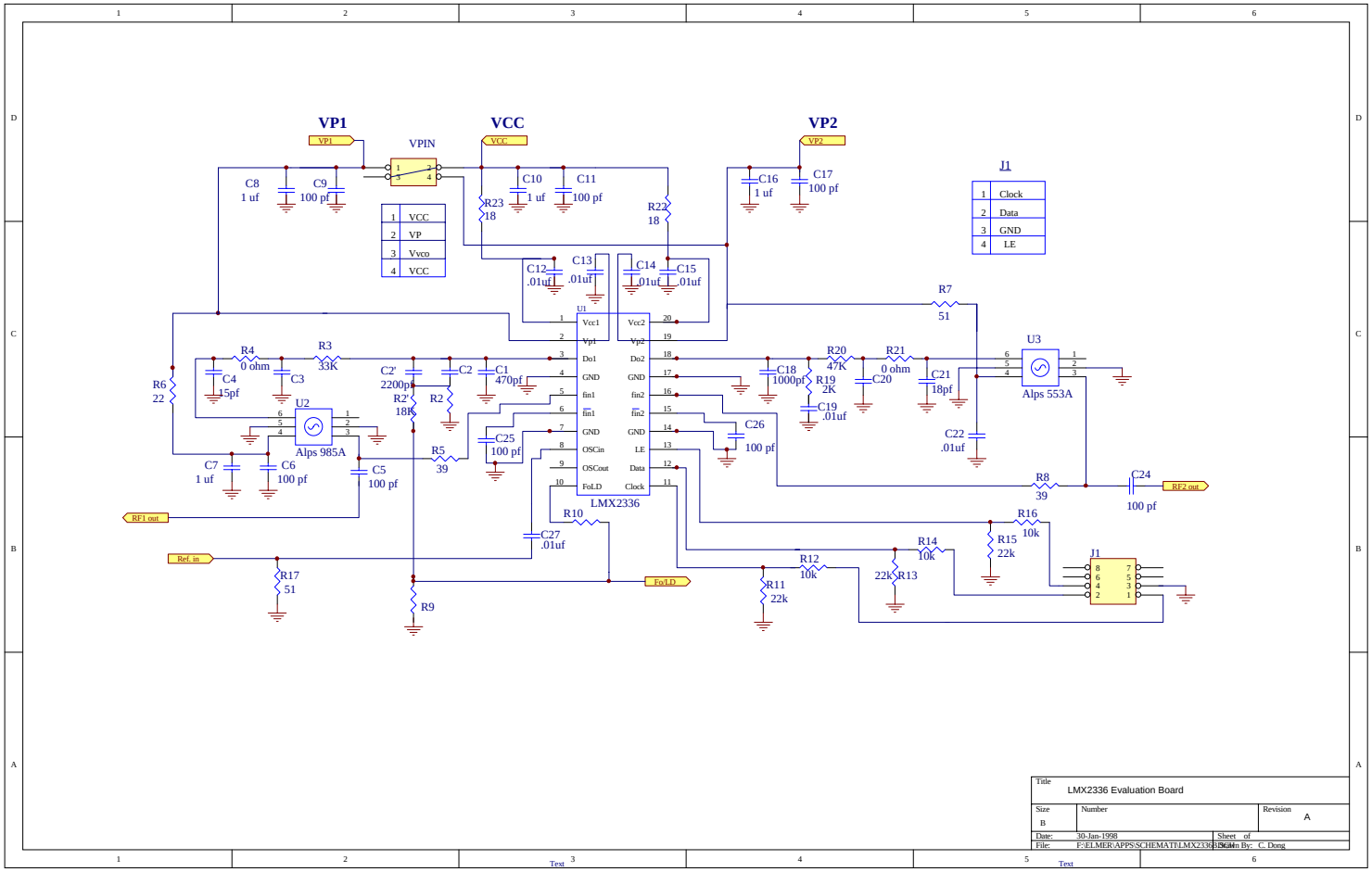
- Verify that the **LMX2336/LMX2336L** is getting the proper programming signals by putting the software in "switch" mode and probing the CLOCK, DATA, and LE pins with an oscilloscope. Also verify that the programming signals are at the appropriate level for your application (i.e. if your application is a 3V one, make sure that the 5 volt signals from the PC are being resistivly divided so that they don't overdrive the PLL inputs.)

- When de-bugging one side (RF1 or RF2) of the dual PLL, power down the other side to facilitate the process.

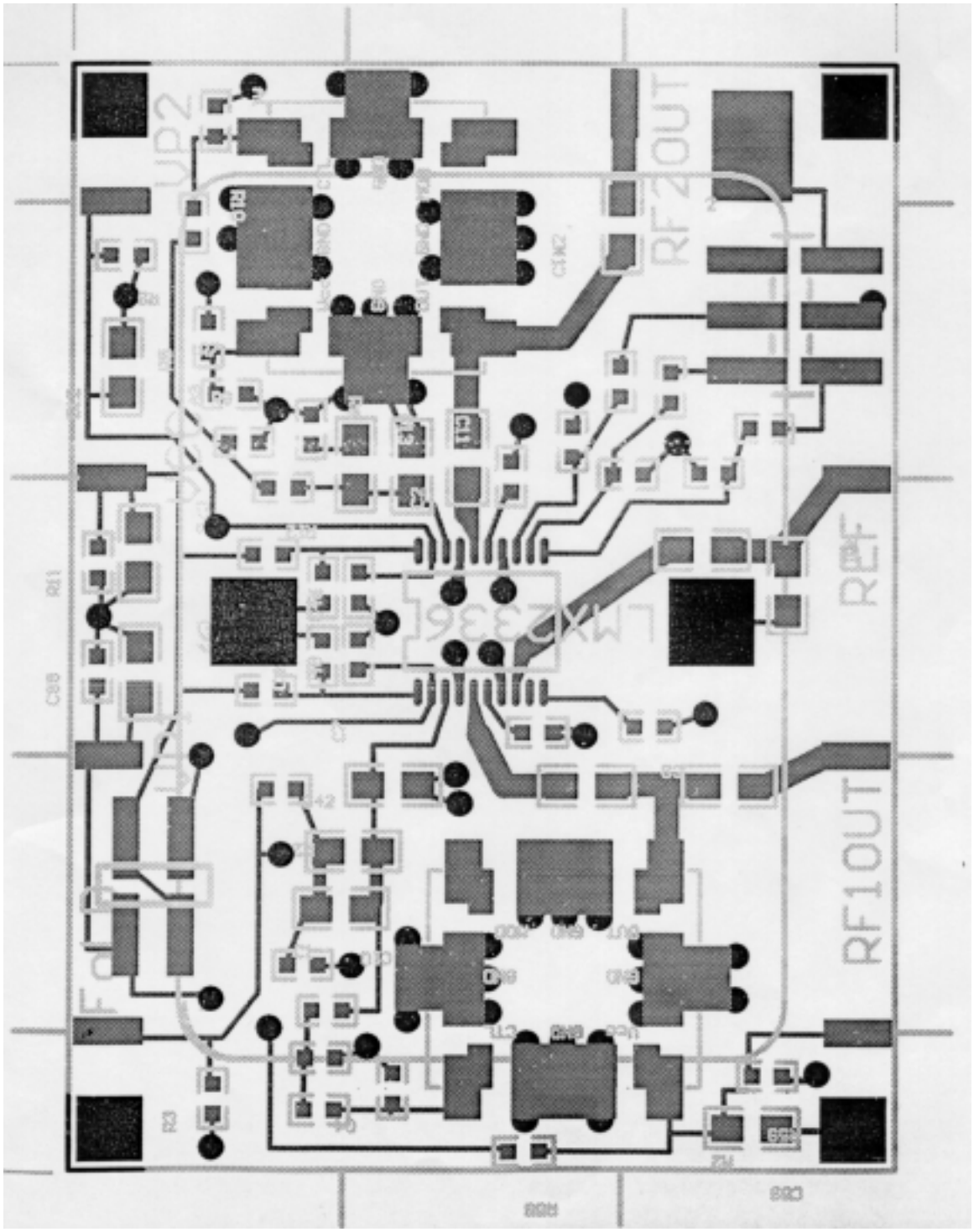
- Verify proper values for VCO frequency, Reference frequency, and crystal frequency in the evaluation software. Also verify that the RF and IF VCOs are powered up and enabled. This is also controlled by the software.

- 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: LMX2336/LMX2336L Evaluation Board Schematic



APPENDIX B: LMX2336/LMX2336L Evaluation Board Layout



APPENDIX C: LMX2336/LMX2336L Evaluation Board - Bill of Materials

For 3 Volt Operation:

QTY	DESCRIPTION	SIZE	LOCATION
8	100 pF	603	C5, C6, C9, C11, C17, C24,C25,C26
6	0.01 uF	603	C12, C13, C14, C15, C22, C27
4	1 uF	603	C7, C8, C10, C16
2	0 Ω	603	R4, R21
2	18 Ω	603	R22, R23
1	22 Ω	603	R6
2	39 Ω	603	R5, R8
2	51 Ω	603	R7, R17
3	10 kΩ	603	R12, R14, R16
3	22 kΩ	603	R11, R13, R15
1	2 k	603	R19
1	18 k	603	R2’
1	33 k	603	R3
1	47 k	603	R20
1	15 pF	603	C4
1	18 pF	603	C21
1	470 pF	603	C1
1	1000 pF	603	C18
1	2200 pF	603	C2’
1	Alps553a	VCO	U3
1	Alps985a	VCO	U2
1	LMX2336/LMX2336L		U1

4	Shunts 0.100” Doublewipe contacts
1	Surface mount Header 0.100” X 0.100” Double Row, 6 position
1	Surface mount Header 0.100” X 0.100” Double Row, 4 position
6	SMA PC Mount End Launch Jack Receptacles for RF1 out, RF2 out, RF in, Vp1, Vp2, VCC

For Fastlock Operation make the following changes:

A. Include resistor R2’ equal to R2.
B. Use 0 Ω resistor for R10.
C. Leave resistor R9 as an open circuit.

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

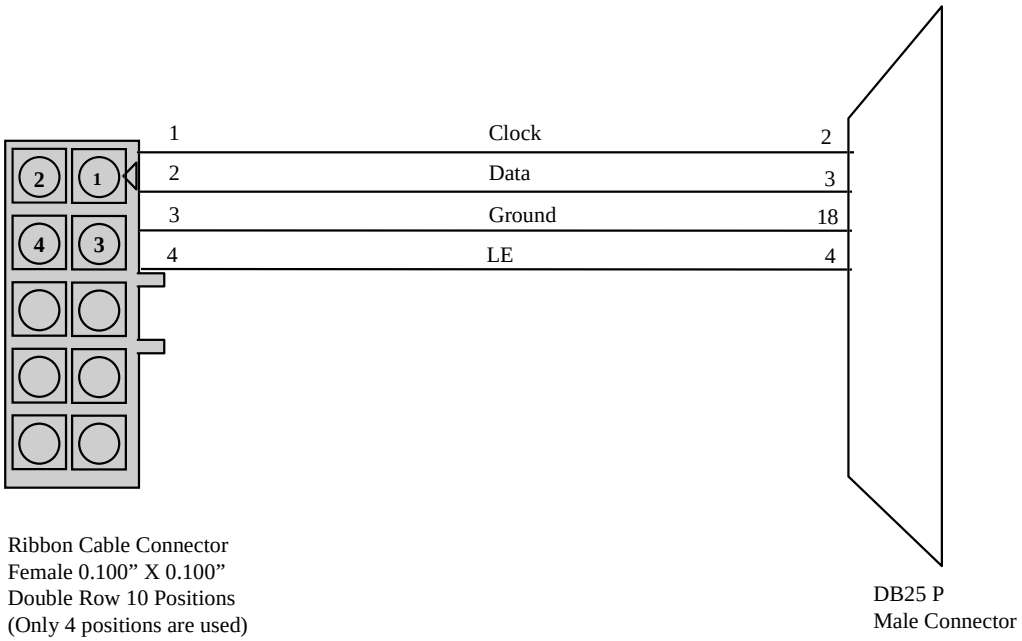
Alps Components
8141 Kaiser Blvd.
Anaheim, Ca. 92808
Phone: (714)279-1554
FAX: (714)279-1570

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: (800) 831-9172
FAX: (404) 436-3030

Valid
1101 East 51st Ave.
Denver, Co. 80239
Phone (303) 371-1560
Fax(303) 371-0845

APPENDIX E: Parallel port to MICROWIRE™ Interface Cable



Ribbon Cable Connector
Female 0.100” X 0.100”
Double Row 10 Positions
(Only 4 positions are used)

DB25 P
Male Connector