

## AD9516-x, AD9517-x, and AD9518-x Evaluation Board

### FEATURES

- Simple power connection using 6 V wall adapter and on-board LDO voltage regulators
- LDOs are easily bypassed for power measurements
- 8 ac-coupled differential LVPECL SMA connectors
- 2 ac-coupled LVPECL differential headers
- 2 dc-coupled differential LVDS SMA connectors that are reconfigurable to four CMOS SMA connectors
- 2 dc-coupled LVDS differential headers that are reconfigurable to four CMOS connectors
- SMA connectors for
  - 2 reference inputs
  - Charge pump output
  - Clock distribution input
- USB connection to PC
- Microsoft Windows-based evaluation software with simple graphical user interface
- On-board PLL loop filter
- Easy access to digital I/O and diagnostic signals via I/O header
- Status LEDs for diagnostic signals

### APPLICATIONS

- Clocking of analog-to-digital and digital-to-analog converters up to 2.9 GHz
- Networking and communications line cards
- Test and measurement equipment
- Wireless base stations, controllers
- Clock cleanup/jitter attenuation
- Clock distribution

### GENERAL DESCRIPTION

The AD9516-x, AD9517-x, and AD9518-x are very low noise PLL clock synthesizers featuring an integrated VCO, clock dividers, and up to 14 outputs. The AD9516 features automatic holdover and a flexible reference input circuit allowing for very smooth reference clock switching. The AD9516 family also features the necessary provisions for an external VCXO.

The AD9516 evaluation board is a compact, easy-to-use platform for evaluating all features of the AD9516. This user guide covers all six versions of the AD9516 family, as well as the AD9517 and AD9518 families (hereafter referred to as AD951x). The AD9516, AD9517, and AD9518 differ only in package size, and the number of outputs. The evaluation software main window for the AD9517 and AD9518 reflects fewer outputs, but the operation is identical for all devices.

Although the Quick Start Guide to the AD9516 PLL section applies specifically to the AD9516-3, increasing the N (feedback) divider and channel divider increases the VCO frequency to the allowable frequency range of other AD9516 versions.

For the AD9516-5, which lacks an internal VCO, certain portions of this document that apply to the internal VCO (such as VCO calibration) can be ignored.

For convenience, detailed information from the AD9516 data sheet has been included here. Use this user guide in conjunction with the AD9516, AD9517, and AD9518 data sheets, as well as additional documentation available at [www.analog.com](http://www.analog.com).

## AD9516 EVALUATION BOARD

Figure 1.



## EVALUATION BOARD HARDWARE

The following instructions are for setting up the physical connections to the AD951x evaluation board.

When connecting the evaluation board to a PC for the first time, the user must install the evaluation software prior to connecting the evaluation board.

### POWER AND PC CONNECTIONS

Use the following steps to connect the AD951x evaluation board to its power supply and lab equipment.

1. Install the AD951x evaluation software. Administrative privileges are required for installation. The 64-bit versions of Windows® are not supported.
2. Connect the wall power supply to the main power connector labeled P2. The following five LEDs should be on: CR1 (USBSTAT), CR7 (VS), CR8 (VS-CP), CR9 (VS\_USB), and CR10 (VS\_LVPECL).
3. Connect the USB cables to the evaluation board and the computer. The red LED labeled CR2 (VBUS) on the AD951x evaluation board should illuminate and the CR1 (USBSTAT) LED should start blinking.
4. If the Found New Hardware Wizard window automatically appears when the evaluation board is connected, select Install the software automatically and click Next.

The Found New Hardware Wizard window may appear twice, and a system restart may be required.

Refer to the Evaluation Board Software section for details on running the AD951x evaluation board software.

If the USBSTAT LED is not blinking, ensure that:

- Jumpers are installed on Position S1 and Position S2.
- The jumper on S4 is across the center pin and the minus symbol.
- The USB port on the PC is operational and that the USB cable is not damaged.

### SIGNAL CONNECTIONS

To connect signals, use the following steps:

1. Connect a signal generator to the J10 SMA connector. By default, the reference inputs on this evaluation board are ac-coupled and terminated 50  $\Omega$  to ground. An amplitude setting of 0 dBm to 6 dBm is fine.
2. If the user wants to connect a signal to REF2, connect that signal to the J13 SMA connector. DC-coupling is recommended in applications requiring automatic hitless reference switching. There is a possibility that the device receive buffer can chatter when an ac-coupled clock stops toggling.
3. Connect an oscilloscope, spectrum analyzer, or other lab equipment to any of the J0 to J9 SMA connectors on the right side of the board.

OUT0 through OUT5 are ac-coupled LVPECLs. OUT8 and OUT9 are dc-coupled and have no output termination. These allow the user to evaluate the AD951x output driver in either LVDS or CMOS mode.

### BYPASSING THE WALL POWER SUPPLY

To bypass the wall power supply, remove the following ferrite beads (on the backside of the board): F7, F4, F2, and F6. Connect a bench power supply to TB1 on the evaluation board. This is useful for making AD951x power consumption measurements.

### BYPASSING THE PLL (CLOCK DISTRIBUTION ONLY)

To bypass the PLL, connect a signal generator to the SMA connector labeled CLK. By default, this connection is ac-coupled to the CLK pin and terminated with a 50  $\Omega$  resistor to ground. Refer to the Evaluation Software Components section for details on running the AD951x evaluation board software.

### USING AN EXTERNAL VCXO

To use an external VCXO, use the following steps.

1. Install a 0  $\Omega$  resistor at R9 and remove R8.
2. Connect a loop filter and external VCO/VCXO input to J12.
3. Connect the external VCO/VCXO output to the J11 SMA connector (CLK input).

## EVALUATION BOARD SOFTWARE

Use the following instructions to set up the AD951x evaluation board software.

### SOFTWARE INSTALLATION

Do not connect the evaluation board until the software installation is complete.

1. The evaluation software and documentation can be downloaded from [www.analog.com](http://www.analog.com).
2. If the software was downloaded, skip to Step 3. If installing from the CD, insert the AD951x evaluation software CD. Double-click My Computer and then double-click the AD9516\_17\_18EV CD icon. A window opens showing the contents of the CD divided into four sections: Datasheet, Layout, Schematic, and Software. The file named readme.txt contains a description of the CD contents as well as any additional instructions or information. Double-click the Software folder.
3. Double-click AD9516\_17\_18Eval\_Setup1.1.0.exe. (Note that the website may have a version newer than Version 1.1.0.) Follow the installation instructions. The default location for installation of the evaluation software is: C:\Program Files\Analog Devices\AD9516 Eval Software\.

### RUNNING THE SOFTWARE

Power up and connect the evaluation board to the PC. See Evaluation Board Hardware section for details on the various connectors on the evaluation board.

1. Double-click AD9516\_17\_18 Eval Software to run the AD951x evaluation software. Depending on whether the evaluation board was found by the software, either light blue text appears in a pop-up window, indicating that the evaluation board was found, or red text appears, indicating that the evaluation board was not found.
2. If the evaluation board is found, click anywhere in the pop-up window with the Evaluation Software Ready message, and the main window for the software appears. Proceed to the Evaluation Software Components section for details about running the software.  
If the evaluation board is not found, a dialog box appears allowing you to select which AD951x evaluation board is connected while the software runs in standalone mode.

See the Evaluation Board Hardware section for information on connecting the evaluation board.

If the evaluation board is connected while the evaluation software is running, the window in Figure 2 appears to prompt

you to load the evaluation board with the evaluation software settings or read the evaluation board settings into the software.

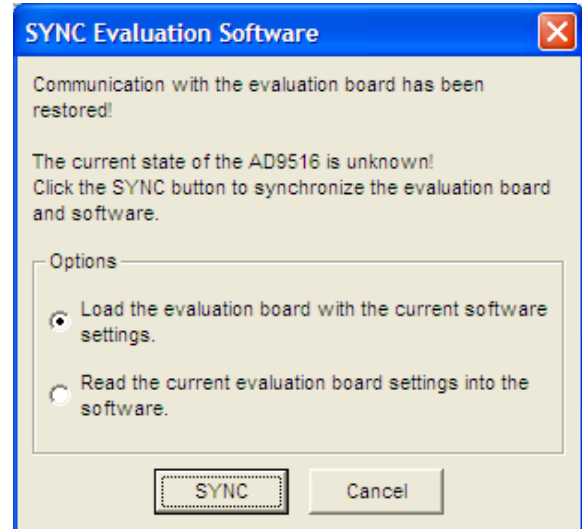


Figure 2. SYNC Evaluation Software Window

If the evaluation board was not automatically detected when it was connected, you can also select the Select Evaluation Board option from the I/O menu (see Figure 24), and select Ezssp-0, Ezssp-1, or Ezssp-2.

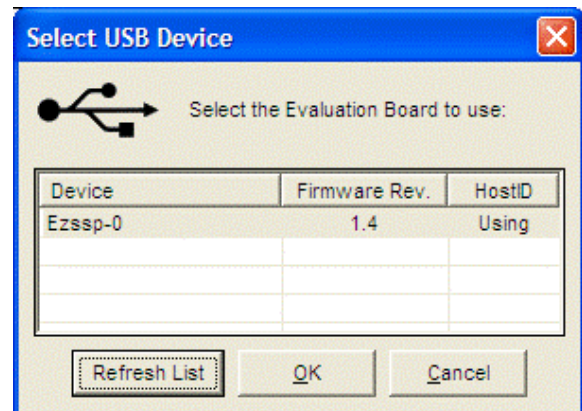


Figure 3. Select USB Device Window

See the Evaluation Software Components section for a description of the evaluation software features, or the Quick Start Guide to the AD9516 PLL section for details on the individual blocks of the AD951x.



6. Program the R (reference) divider by clicking the R DIVIDER box at the top of the main window. Set the desired value and click OK (see Figure 12).
7. Program the N (feedback) divider by clicking the N DIVIDER box at top of the main window. Set the desired value and click OK. For the example,  $N = 200$  can use 8/9 dual modulus mode with  $A = 0$  and  $B = 25$ .
8. Set the charge pump current by clicking the CHARGE PUMP box in the upper right corner of the main window, and then click OK.
9. Note that if the desired configuration has the phase detector frequency above 50 MHz, an antibacklash pulse width of 1.3 ns may work better. This setting is accessed by clicking the PFD button to the left of the CHARGE PUMP box. However, this setting normally does not need to be modified.
10. Set the VCO divider by clicking the green VCO box in the center of the main window, immediately to the left of the Cal VCO button.

11. Power down unused drivers, click the numbered triangular symbol on the right side of the main window (see Figure 7), select 2 - Safe Power Down, and click OK (see Figure 20).

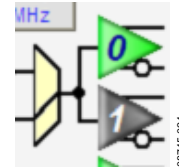


Figure 7. Driver Symbol

12. Set the channel dividers by clicking DIVIDER 0 through DIVIDER 4 and enter the divider ratio.
13. Click the flashing red WRITE button under the REGISTER W/R section. This loads the desired settings to the AD951x evaluation board,
14. Click the blinking yellow Cal VCO button to load the VCO calibration window. The default VCO divide ratio (16) works for all applications. Click the Cal VCO button in the Calibrate VCO window to begin calibration (see Figure 17). The PLL should now be locked and the LD (lock detect) LED on the left side of the board should be on.

# EVALUATION SOFTWARE COMPONENTS

## MAIN WINDOW

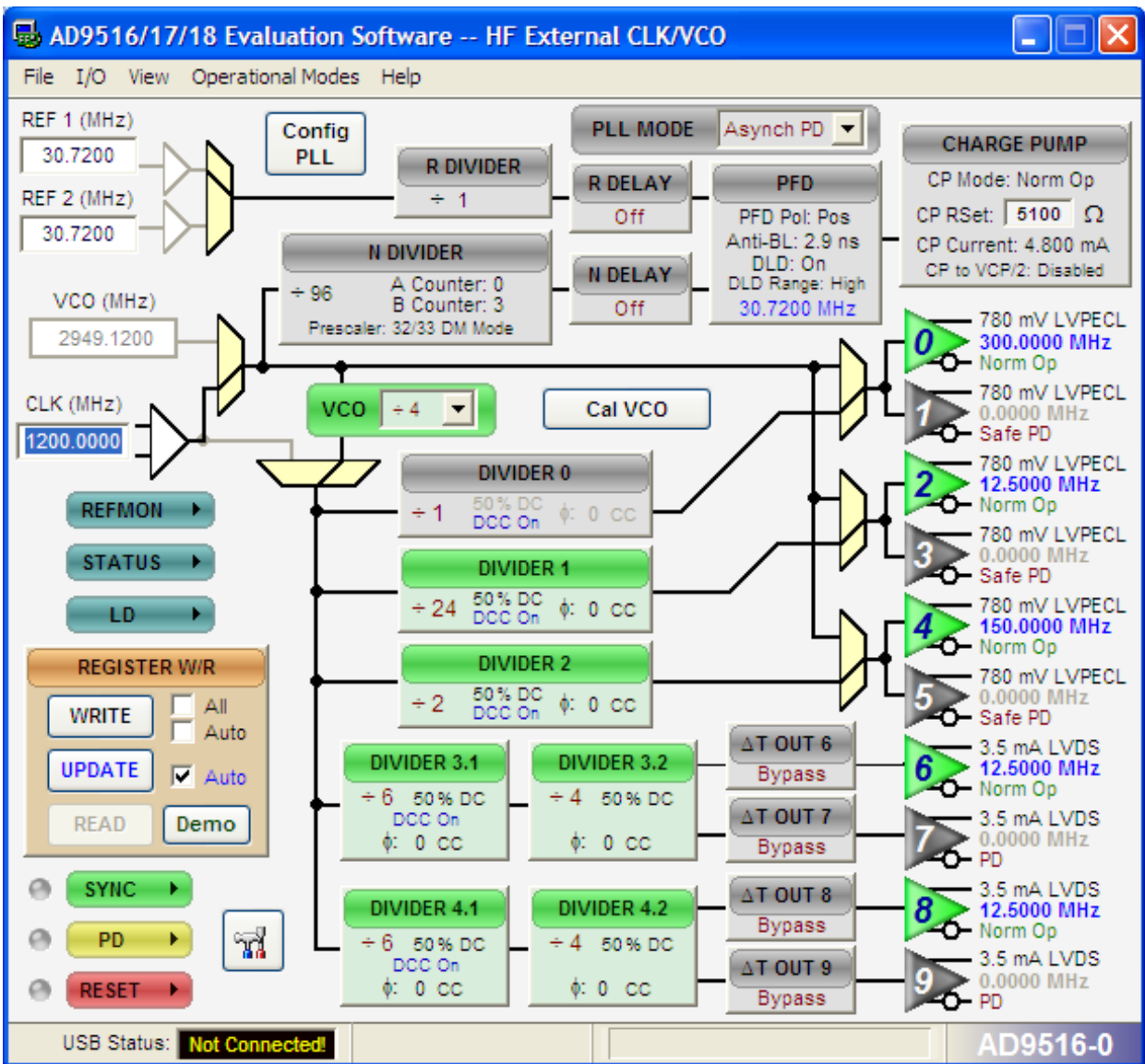


Figure 8. Evaluation Software Main Window

The AD951x evaluation software is composed of subsections that correspond to the major functional blocks of the AD951x. These subsections are listed in the following sections and each of these has its own window. From the main window, each functional block can be accessed by clicking that block in the main window.

When a subwindow closes after clicking OK, the WRITE box on the main window (under the REGISTER W/R section) may blink red. This indicates that there are settings that have not been loaded to the AD951x evaluation board. Clicking the blinking red WRITE button loads these settings to the evaluation board.

## PLL REFERENCE INPUT WINDOW

The Reference Input Control window is shown in Figure 10 and is accessed by clicking either of the triangular buffer symbols immediately to the right of the REF 1 (MHz) and REF 2 (MHz) input reference frequency boxes (see Figure 9).

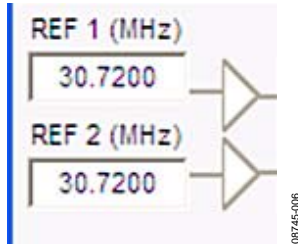


Figure 9. Buffer Symbol

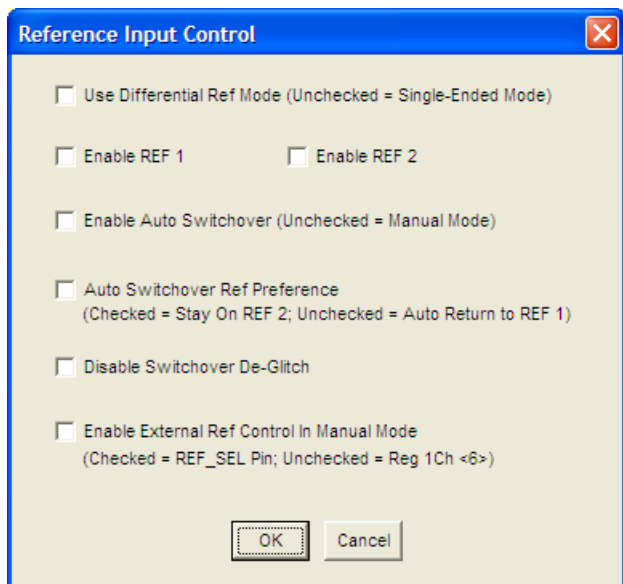


Figure 10. Reference Input Control Window

This window is used to enable the PLL reference inputs, which are powered down by default.

Select Enable REF 1, or Enable REF 2, or both to enable the appropriate reference input, and click OK when finished. If a differential input is used, select the Use Differential Ref Mode (Unchecked = Single-Ended Mode) check box. Note that this mode should not be used simultaneously with Enable REF 1 or Enable REF 2.

The remaining four check boxes control the reference switchover modes. If Disable Switchover De-Glitch is activated, the AD951x maintains the phase relationship between the active input and PLL output during a reference switchover. Otherwise, the AD951x minimizes the phase disturbance at the output during a reference switchover.

## PLL CONFIGURATION WINDOW

The PLL Configuration window shown in Figure 11 is opened by clicking the Config PLL button on the main screen. This window has three sections: SyncB Counter Reset Mode, ReadBack Registers, and Settings.

The SyncB Counter Reset Mode section indicates whether the R, A, and B counters are reset when the  $\overline{\text{SYNC}}$  pin is activated, and controls R0x019[7:6]. See the AD951x data sheet for more details.

The ReadBack Registers section allows you to see the current value of the read-only PLL status register (Address 0x01F). This function is very useful for ensuring that the AD951x VCO has finished VCO calibration, and that the PLL is locked.

The Settings section controls the various PLL settings such as hold-over. The AD951x data sheet describes these functions in detail.

Note that the automatic holdover feature should not be enabled during VCO calibration.

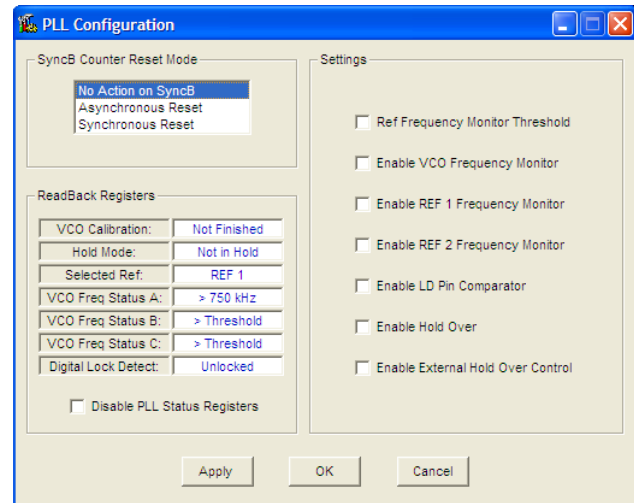


Figure 11. PLL Configuration Window

## REFMON, STATUS, AND LD BUTTONS

These three blue buttons (REFMON, STATUS, and LD) allow you to select which signals appear at the REFMON, STATUS, and LD pins at Connector P1. Connector P1 is located in the center of the evaluation board. The pins in the left column of Connector P1 are ground pins, and the ones in the right column are signal pins.

There are many useful diagnostic signals available at these pins. The R divider output is particularly useful. In the example used in the Quick Start Guide to the AD9516 PLL section, the 80 kHz signal is visible on the STATUS pin to ensure that the reference inputs and R divider are working properly.

Dynamic signals (such as the R divider output) are primarily intended for diagnostics. These diagnostic signals may adversely affect PLL performance in critical applications if left on in normal operation.



**REGISTER W/R BOX**

The REGISTER W/R (write/read) box has four buttons and three check boxes.

The WRITE button transfers the values stored in the evaluation software to the evaluation board. It blinks red when register values have changed.

The READ button transfers the values stored in the evaluation board to the evaluation software.

The UPDATE button issues an I/O update command by writing 0x01 to Register 0x232.

Selecting the All check box transfers all of the registers when the WRITE button is clicked. When this check box is cleared, only the registers whose value has changed are written.

Selecting the Auto check box adjacent to the WRITE box forces the evaluation software to write the register changes to the evaluation board automatically when they occur.

Selecting the Auto check box adjacent to the UPDATE box forces the evaluation software to issue an I/O update command whenever registers are written to the AD951x. It is checked by default.

**SYNC, PD (POWER DOWN), AND RESET BUTTONS**

The SYNC, PD, and RESET buttons allow you to control the SYNC, PD, and RESET pins on the AD951x.

Each button has three options: Strobe, Latch, and Release. Strobe activates the pin, and then releases it. Latch holds the pin active until the Release command is issued.

**REFERENCE (R) DIVIDER WINDOW**

The R Divider window shown in Figure 12 is accessed by clicking the R DIVIDER box on the main window. It allows you to set the reference divider. If this box is colored gray, the PLL is off. To turn the PLL on, click the PLL MODE box at the top of the main window, and select Norm Op.

The R Divider window has a check box for holding the R divider in reset. When the R divider is held in reset, the PLL loop is opened. Therefore, this feature is seldom used.

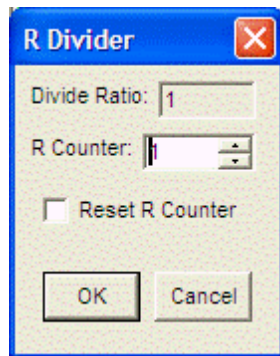


Figure 12. R Divider Window

**R AND N DELAY WINDOW**

The AD951x features two delay circuits (one on the reference divider path, and one on the feedback divider path) that allow the user to control the static phase offset between the reference input and the PLL output. The R Path Delay window shown in Figure 13 is accessed by clicking the R DELAY button on the main screen. The R DELAY box is identical to the N DELAY box. These delay settings allow you to vary the static phase offset of the PLL.

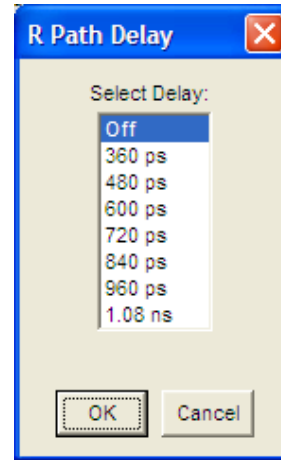


Figure 13. R Path Delay Window

**FEEDBACK (N) DIVIDER WINDOW**

The reference divider window shown in Figure 14 is accessed by clicking the N DIVIDER box on the main screen. If this box is colored gray, the PLL is off. To turn the PLL on, click the PLL MODE box at the top of the main screen, and select Norm Op.

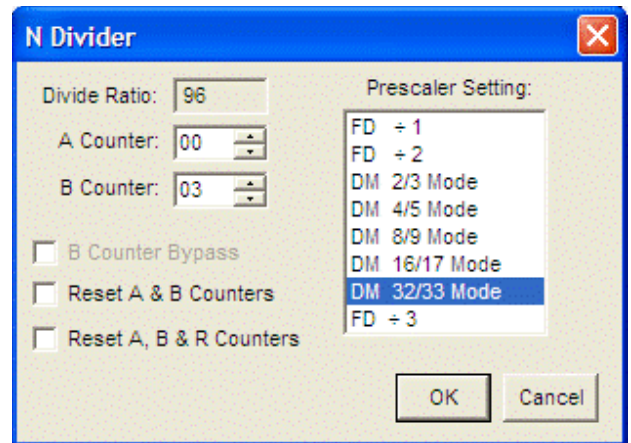


Figure 14. N Divider Window

The various modes of the N divider are described in detail in the AD951x data sheet. For most applications, the 8/9 or 16/17 dual modulus modes are used. For applications requiring a divider value larger than 131,119, the 32/33 mode is provided. Different applications require different settings, and you can experiment with the different settings.

The evaluation software has internal checking to ensure that invalid settings are not programmed. For example, the B counter must always be larger than the A counter. Another restriction is that 8/9 dual modulus mode cannot be used for VCO frequencies greater than 2400 MHz. In cases where a feedback divider restriction cannot be resolved, you may need to adjust the R (reference) divider to allow a different feedback divider value. For example, it is not possible to use the internal VCO, and a feedback divider of 30. However, the R divider can be doubled, which allows a feedback divider of 60.

The feedback divider window has a check box for holding the N divider in reset. When the N divider is held in reset, the PLL loop is open. Therefore, this feature is seldom used.

### PHASE FREQUENCY DETECTOR (PFD) WINDOW

The Phase Frequency Detector (PFD) window shown in Figure 15 is accessed by clicking the PFD box on the main window.

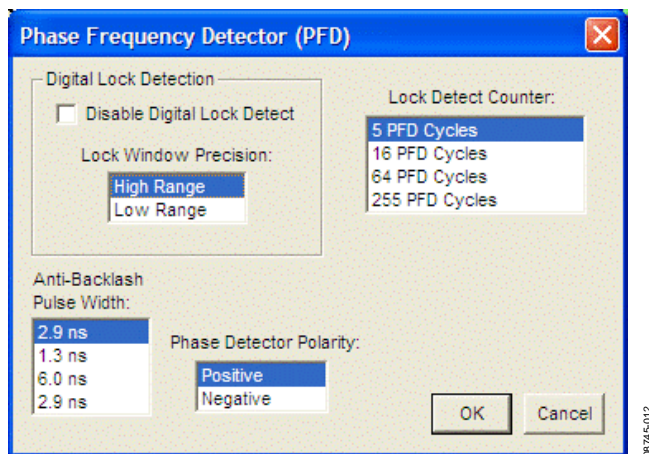


Figure 15. Phase Frequency Detector Window

The features accessible in this window are described in detail in the AD951x data sheet. The most commonly used settings are the Anti-Backlash Pulse Width and the Lock Detect Counter.

For phase detector frequencies greater than 50 MHz, the PLL may work better with the 1.3 ns antibacklash pulse width setting.

Setting the lock detect counter to values greater than 5 PFD cycles can be useful in applications where the loop bandwidth is low and the lock detect counter chatters during acquisition.

### CHARGE PUMP WINDOW

The Charge Pump Setup window shown in Figure 16 is accessed by clicking the CHARGE PUMP box on the main screen.

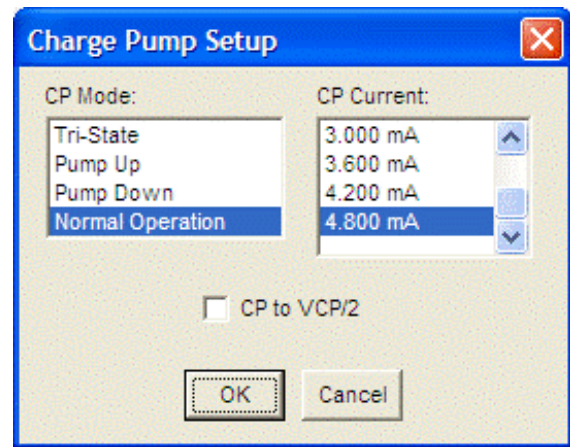


Figure 16. Charge Pump Setup Window

This window is most often used to vary the charge pump current.

The window also has a check box for setting the charge pump voltage to  $V_{CP}/2$ , which is very useful for debugging the PLL and isolating the output driver section of the AD951x from the PLL section.

### VCO CALIBRATION WINDOW

The Calibrate VCO window shown in Figure 17 is accessed by clicking the Cal VCO button on the main window.

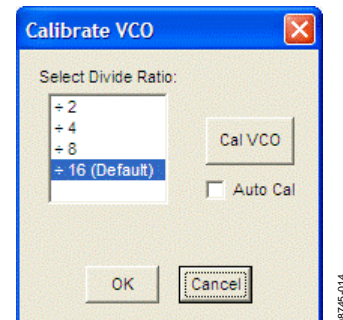


Figure 17. Calibrate VCO Window

A valid reference input signal must be present to complete VCO calibration, and the VCO must be recalibrated any time the VCO frequency changes by more than 40 MHz.

A VCO divider of 16 is suitable for all applications. However, for applications where the phase detector frequency is <12 MHz, using a smaller VCO calibration divider reduces calibration time. Refer to the AD951x data sheet for more details.

Note that the automatic holdover feature must not be enabled during VCO calibration. See the PLL Configuration Window section, and make sure that the Enable Hold Over check box is cleared during VCO calibration.

### CHANNEL DIVIDER WINDOW

The channel divider window shown in Figure 18 is accessed by clicking the appropriate channel divider. It is usually sufficient to change only the divide ratio because the evaluation software and the AD951x duty cycle correction ensure that the output duty cycle remains very close to 50%.

You can also vary the phase offset by changing the Phase Offset Bits setting. However, to have the new phase take effect, the SYNC signal needs to be toggled by using the SYNC button in the lower left corner of the main window.

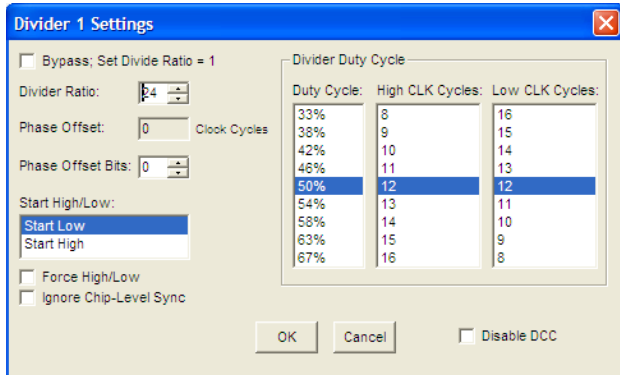


Figure 18. Divider 1 Settings Window

### LVPECL OUTPUT DRIVER WINDOW

The LVPECL Output 0 Settings window shown in Figure 20 is accessed by clicking the OUT0 through OUT5 output driver symbols on the right side of the main window (see Figure 19).



Figure 19. OUT0 Through OUT5 Output Driver Symbols

It is important to power down unused outputs on the evaluation board because they can be a source of unwanted spurs.

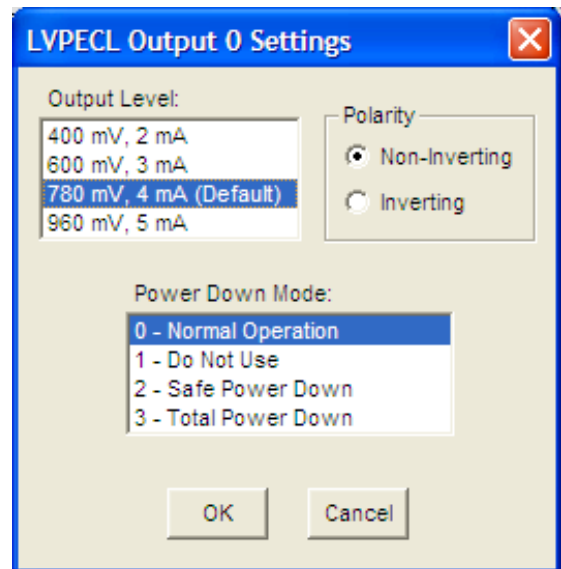


Figure 20. LVPECL Output 0 Driver Window

### LVDS/CMOS OUTPUT DRIVER WINDOW

The LVDS/CMOS Output 6 Settings window shown in Figure 21 is accessed by clicking the OUT6 through OUT9 output driver symbols on the lower right side of the main window.

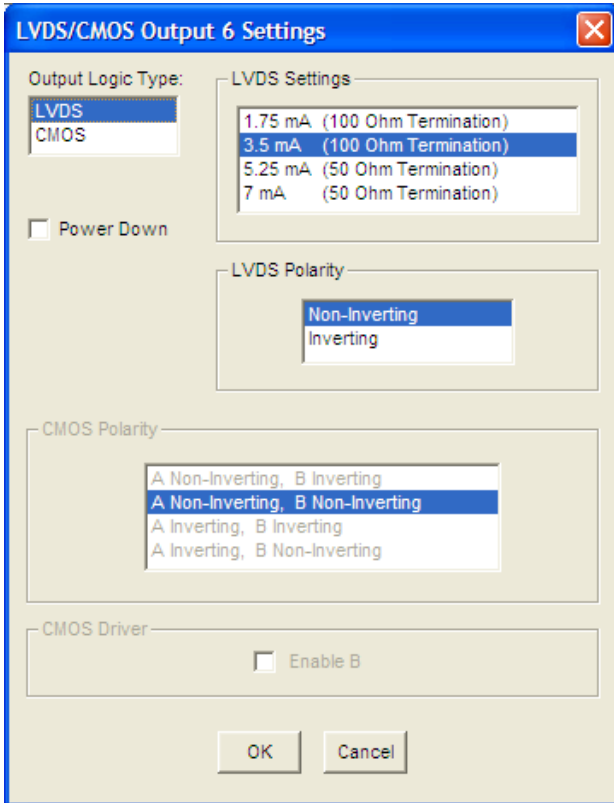


Figure 21. LVDS/CMOS Output 6 Settings Window

If LVDS mode is selected, the bottom (CMOS) portion of the window is grayed out. Likewise, if CMOS mode is selected, the top (LVDS) portion of the window is grayed out.

It is important to power down unused outputs on the evaluation board because they can be a major source of unwanted spurs. This is especially true of the CMOS drivers.

### LVDS/CMOS OUTPUT DELAY WINDOW

The Output 6 Delay window shown in Figure 22 is accessed by clicking the T OUT 6 button on the right of the main screen. To access any other output delay window, click the appropriate T OUT x button.

Selecting the various combinations of ramp current and ramp capacitors changes the amount of delay for that driver, and the estimated amount of delay is shown in the right half of the window. The feature is described in detail in the AD951x data sheet.

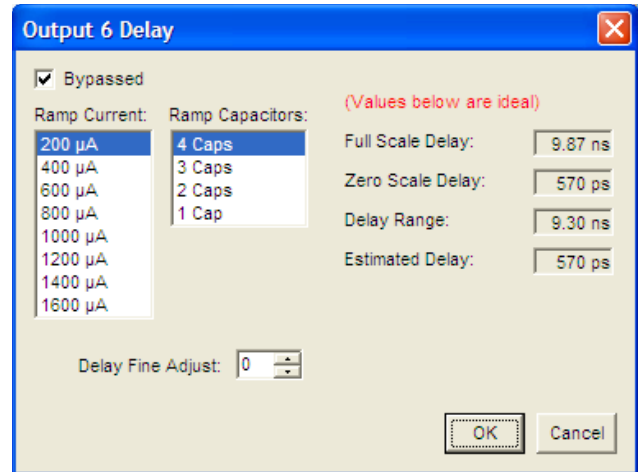


Figure 22. Output 6 Delay Window

### DEBUG WINDOW

The Debug window shown in Figure 23 is accessed by clicking Debug from the View menu from on the main window menu bar (see Figure 24).

The Serial I/O section of this window is a convenient way to read and write registers directly.

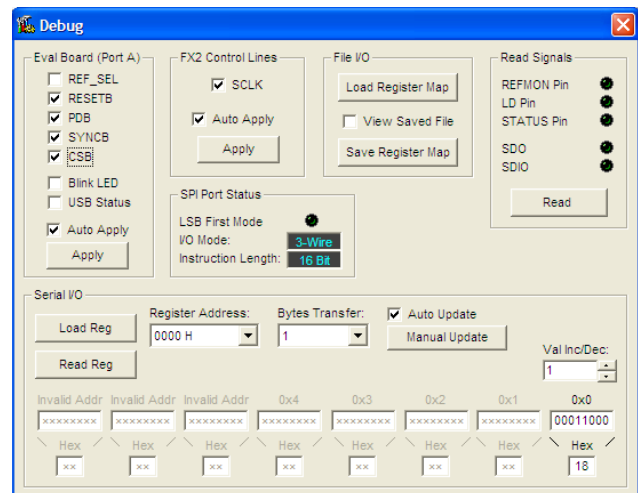


Figure 23. Debug Window



## EVALUATION SOFTWARE MENU ITEMS

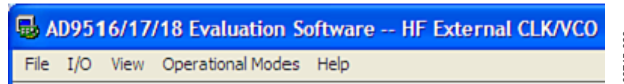


Figure 24. Menu Bar

### MENU BAR

#### File Menu

The File menu has the following options:

##### Load Setup

Selecting Load Setup loads a previously saved AD951x setup file (.stp). A setup file is a text file that contains the AD951x register setup file, plus any evaluation board settings. Note that you must still perform a VCO calibration.

##### Save Setup

Selecting Save Setup saves an AD951x setup file (.stp). A setup file is a text file that contains the AD951x register setup file, plus any evaluation board settings.

##### Exit

Exits the evaluation software. No checking is performed to ensure that the existing setup is saved.

#### I/O Menu

The I/O menu has the following options:

##### Select Evaluation Board

The AD951x evaluation system allows one PC to control multiple evaluation boards. This window allows you to select which evaluation board the software is controlling. Click Refresh List to detect a recently connected evaluation board (see Figure 25).

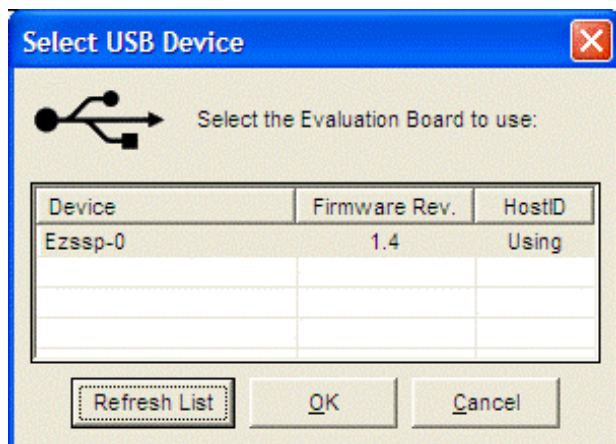


Figure 25. Select USB Device Window

##### Configure Serial Port

The Serial Port Config window allows you to control how the USB controller interacts with the AD951x serial port (see Figure 26).

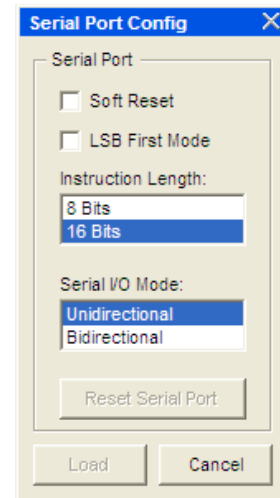


Figure 26. Serial Port Config Window

#### View Menu

The View menu includes the following options:

##### Debug

This window (see Figure 23) allows you to write and read registers directly, as well as force the various configuration pins high and low.

##### Options

This window allows you to select Windows®XP visual styles.

#### Operational Modes Menu

This menu allows you to select any of the three operational modes in the AD951x data sheet: high frequency clock distribution mode, external clock/VCO distribution, and internal VCO and clock distribution.

#### Help Menu

Selecting Help opens the About AD951x dialog box, which contains information such as revision number, region information, contact information.





