Approach/Retraction Program User Guide

1. Purpose

The purpose of the Approach/Retraction program created by Rodolfo is an electronic method that simplifies the process to execute SPM probes to approach the surface and obtain results.

1. The Layout and Opening the Program

On the Administrator account, open a folder and press on the Local Disk (C:) drive and press on the Users folder. Then, find the folder SB130-XPS and press on it. Navigate to the My Documents folder and open the FPGA Approach Retraction folder. Once inside the folder, click on the **Approach-Retraction-Software** and that is a Labview project.

Once the Labview project is open, left click on the + sign next to FPGA Target to view all the programs listed under the FPGA. The program Approach-Retraction-VI-NanoHS50-Host-with-averager-2013-04-23-1a-data-storage-no-real-time-display.vi is the main program where the Approach/Retraction experiments will be controlled from. In order for there to be no functional and operating errors, check to see that the FPGA Target directory say **FPGA Target (RIO0, PCI-7831R)**. If it is not setup to this specification, right click the FPGA Target, hover the mouse over Execute VI on, and press FPGA Target. The last step is to check the FIFO DMA 1 and 2. Right click on the FIFO DMA 1, click on properties, select the data type category, and check the data type is U64. Do this for also FIFO DMA 2 and check for the data type. If the data type is not U64, change it to U64 and press ok. After this step, right click on Build Specifications and right click on Automatic-Approach-Retraction-MCL-2013-04-28-1a-data-storage-1b. Click on Rebuild and continue the compilation process. This process will take up to 10-15 minutes and once it is done, close the window and open the project to check for the changes.

Once the checking is done, double click on Approach-Retraction-VI-NanoHS50-Host-with-averager-2013-04-23-1a-data-storage-no-real-time-display.vi program. If the buttons are not already pressed, press on the manual control switch so that the green lights turn on and none of the other switches are turned on. Then press the run button. The program will start to load and soon the graphs will start to operate and straight lines will be seen all the graphs. To test the Topography graph, press the down arrow on the MCL Counter 2 and watch the graph change. Press the stop button to stop the program.

1. The Functions of the Program

Before approach/retraction curves can be obtained, the electrical connections and the configuration of input and outputs must be set.

Tuning Fork Setup:

On the microscope stage, there are two alligator wire that are going inside a tube or there are two leads poking out of a hole in the microscopic stage. These two leads are connected to the tuning fork and give the driving voltage to operate the tuning fork. If the alligator wires have not been connected to the leads yet, do so. Once done there are two BNC input/output connections on the left side of the microscopic stage. On the left side of the connector, the BNC cable is connected their and on the right side of the connector, there is one unattached lead on each pin that sticks out. Connect the alligator wires to hook onto one of the leads. The order does not matter. Now, take two BNC cables and plug them into their respective holes. Take the remaining end of one BNC cable and hook it up to the Signal In A-1 on the SR850 Lock-In. The other BNC cable should be hooked up to the Sine Out pin.

MCL System Setup:

The MCL Setup is required to work in order to operate the MCL stage on the microscope. There are two boxes, one is a power supply and another box is a filter with the name of Andres. These two boxes are connected by a blue wire. Get a multimeter with a BNC attachment to measure the voltage of the output of the filter. Connect a BNC T-connector to the multimeter attachment. Take one BNC cable and plug it into the OUT of the filter and plug the other side into one side of the T-connector. Take another BNC cable and connect one end to the T-connector and hook the other end to the MCL Nano-Drive 85 Input pin. The setup is complete but before the MCL or the power supply is turned on the floating voltage from the filter must be checked. Take out the BNC cable connected to the MCL and turn only the power supply on and check to see if the voltage is around 0. If it is then the setup is done.

SR850 Digital Lock-In Amplifier Setup:

Turn on the SR850 Lock-In Amplifier. Press the Ref Phase button on the Lock-In and look at the menu. The menu displays Ref. Phase, Ref. Source, etc. Set the Ref. Phase to 0 degrees, Ref. Source to Internal, and change the Sine Output to 0.004 volts. The rest of the functions on the Gain TC, Trace Scan, and Display Scale menu are all previous settings that were used but they are optional, other settings that are preferred can be used.

Tuning Fork Frequency Scan

The resonance frequency of the tuning fork varies quite a bit from different tuning forks. To do a basic sweep, press on the Ref Phase menu and change the Ref. Source to “Internal Sweep”. On the Sweep subcategory, press on menu and set the sweep type to linear. Then change the starting frequency to 30,000 Hz and the end frequency to 40,000 Hz. Press on the Display Scale button to display a graph. On the Format subcategory, switch it to Single. In the Display subcategory, change the type of display to Chart. Underneath, check to see if the trace is set to 1 and the 1 is showing the data type R.

FPGA Pin Setup:

The FPGA installed in this computer setup is a NI-7831R MIO board. The NI-7831R is the board model and the MIO indicates if it’s a strictly digital board or a digital and analog board. MIO is both a digital and analog board. On the back of the desktop, connect the FPGA card to the MIO port. Do not connect into the DIO port. Connect the other end to the break-out box if it has not already been done. Usually these two steps will already be setup.

The seven monitors that are contained on the main Approach/Retraction program and a few other controls on the program are controlled by the FPGA. The controls on the program controlled by the FPGA are already setup and don’t need to be touched. We will worry about the seven monitors because that is what we can manipulate.

Each monitor on the top left side has a number attached to analog pin. For example, the monitor below the topography (the only one that we don’t consider) has a label called AI2. This reference is referred to the pin setup of the FPGA which is located here: <http://www.ni.com/pdf/manuals/323256b.pdf> . Go to page 11 in the FPGA manual and look at the MIO input and output pins. Locate the AI2+ and the AI2 Ground. On top of the break-out box you will see BNC pins labeled tuning fork am and USBS Amp. These are the two you are going to use. For this example, we will use tuning fork am. Behind the connectors, there is a red and white wire projecting out. The red wire is for the positive and the white wire is for the ground. You will also see pins named J with some number attached. Each of these pins correspond to an output or input described in page 11 of the FPGA manual. Take the free end of the BNC wire coming out of the SR850’s CH1 Output and plug it into the tuning fork am connector on the break-out box. Locate the respective pin numbers for the AI2+ and AI2 Ground and then screw the wires into the respective pins. Go to the main program and click run. You should see the signal of the tuning fork on the AI2 screen and to test it, change the tuning fork frequency.

1. How to Run the Program

All the relevant functions needed to know in the program will be described below:

1. Fast Approach Velocity:

The fast approach velocity function is described in nanometers/second and the scale is 0-100 nm/s. This function defines the speed when you are approaching the surface at a fast rate.

2. First Fast Approach Offset:

The approach offset