1.0 PURPOSE/SCOPE

The purpose of this document is to describe the functions of and testing of the Peak Force TUNA (PFT) module

2.0 RESPONSIBILITIES/AUTHORITIES

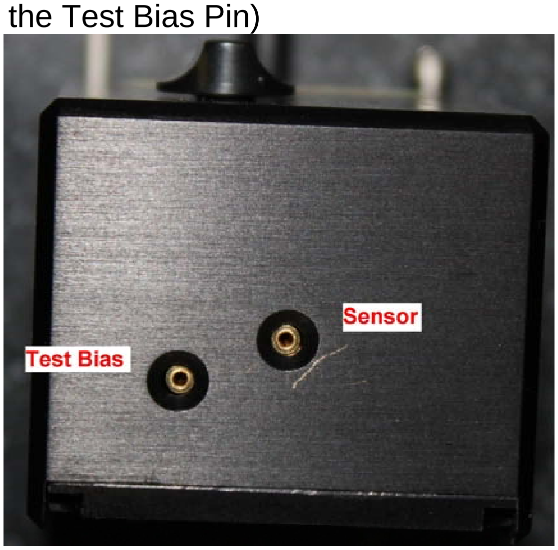
Persons needing a clearer understanding of the workings of and testing of the PFT module are to refer to this document

3.0 RELATED DOCUMENTS

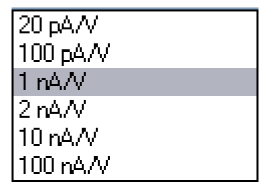
NBSB0097_App Mod Continuity Check

4.0 DEFINITIONS

- PFT module (840-017-322) – Peak Force TUNA module, not repairable
- TUNA – Tunneling AFM (able to measure very small current values in the pA range)
- Test Bias Pin – Pin used in order to test the module
- Sensor Pin – Pin used to measure current flow into the module (pic shown below along with the Test Bias Pin)



- The Multimode version of this module has a new cantilever holder p/n 960-017-300 and longer wires associated with it p/n 820-017-300
    - This cantilever holder and the wires are backwards compatible, the older versions will not be compatible with the new module however
- The Dimension version of this module and holder use the same cantilever holder and wires as that of the TUNA2 module
    - There is a switch to allow proper grounding on a Nanodrive system. Currently this module is not sold on Nanodrive systems so this switch is always set to the correct position for Nanoscope controllers
- Details:
    - The module is specially designed for Peak Force Tapping
    - When using this module Peak Force Tapping will change frequency from 2kHz to 1kHz to accommodate the module collecting current data during the contact portion of this scanning mode
    - This module uses the same test resistor as the previous model
    - Users can access 6 different gain values while in Peak Force Tapping mode (100nA/V minimum to 20pA/V maximum)

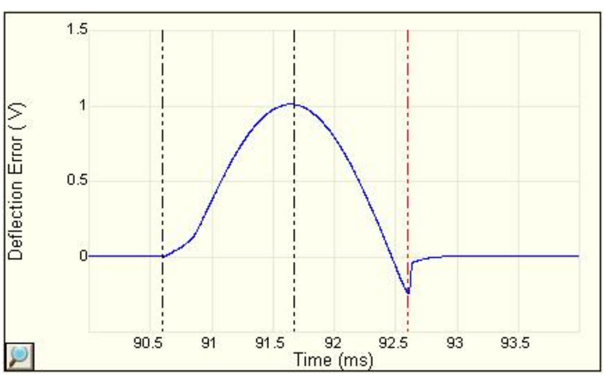


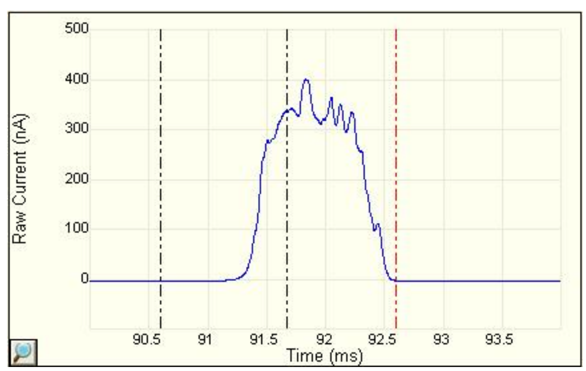
    - In contact mode there are 6 different gain values and 2 extra with limited BW that would be the same as the predecessor Ext TUNA (labeled LBW)
    - There is a switch for Hi and Lo gain
        - Nanoscope Software (SW) doesn't know what position this switch is in
        - The SW will prompt the user to place the switch in the correct position when gain values are changed
        - The position has to be all the way to either side in order for it to make contact, if not fully in Lo or Hi position switch will remain open and the module will not perform correctly

    - There is an offset potentiometer for the module
        - It is not needed, do not change it

- The module's offset will be adjusted by the system when the gain is changed **only while in scan mode** (IE during ramp, a change in the gain value will not prompt the system to adjust for any offset of the sensor)

- The module has 3 main data channels associated with it
  - TUNA Current – the total average current for the cycle (IE: Average current over1 millisecond)
    - In the images below the "TUNA Current" value would be the average of the Raw Current data channel for the entire time shown
  - Contact Current – the average current only while the probe is making contact (IE: the time that there is positive deflection)
    - In the images below the "Contact Current" value would be the average current of the Raw Current data channel for the time between the first marker and the third marker
  - Peak Current – the current value when deflection is at its maximum value in the peak force tapping cycle
    - In the images below the "Peak Current" value would be the current value of the Raw Current data channel at the 2nd marker





5.0 SUPPLIES, TOOLS/TOOLING, AND EQUIPMENT

-Multimeter
-Calibration Resistor p/n 840-009-609

6.0 SAFETY REQUIREMENTS

-Follow all safety requirements of the system this accessory is being used with
-Make sure to be careful when handling the module as well as any scan head or other AFM components that the module attaches to as all are delicate and will be damaged if dropped

7.0 REFERENCE EXPERTS

-John Tedesco
-Chunzeng Li

8.0 PROCEDURE

It is necessary to test all the gain stages individually

The below describes how to test any of the 6 stages, it is suggested to go from lowest to highest gain and carefully read the instructions below in order to test each stage correctly

Test Procedure (for each gain stage):

- Start Nanoscope SW and select the PFT TUNA experiment (if checking the LBW gain values select the 'Tunneling Current AFM (PF-TUNA module)' experiment)
- Place the Calibration Resistor on the PFT module with resistance set to 100MegOhm (if the 10Gig resistor is used there will be a lot of error due to the accuracy of the resistor)
- Align the laser on a cantilever and get a sum signal greater than 500mV
- Set the system to the gain setting to be tested while in the 'Scan Mode'
    - **NOTE:** In order for the offset adjustment to be done correctly the gain value must be changed in the 'Scan Mode' (**not** 'Ramp Mode'). See **appendix A** for an example of improper offset correction
- Make sure the switch is set to the proper location when prompted by the SW
    - NOTE: If 'OK' is clicked before the **switch is in the appropriate position** the offset correction will not be done correctly)
- False Engage the system (Microscope→False Engage)
- Enter 'Ramp Mode'
- Set Parameter values to those shown in the below section and that correspond to the gain value being tested

- **Remember:** To test each stage will require changing the gain in 'Scan Mode', entering 'Ramp Mode', setting parameters correctly and then clicking 'Continuous Ramp'

- **NOTE:** The 1nA setting is cutoff in the test below. This is because the first gain stages are only using +/-6V to run the circuit resolving current, thus limiting the total current range detectable. It is not noticed on the other gain settings because the ramping voltage chosen in the test is not large enough to push the detectable range for that circuit to its limits

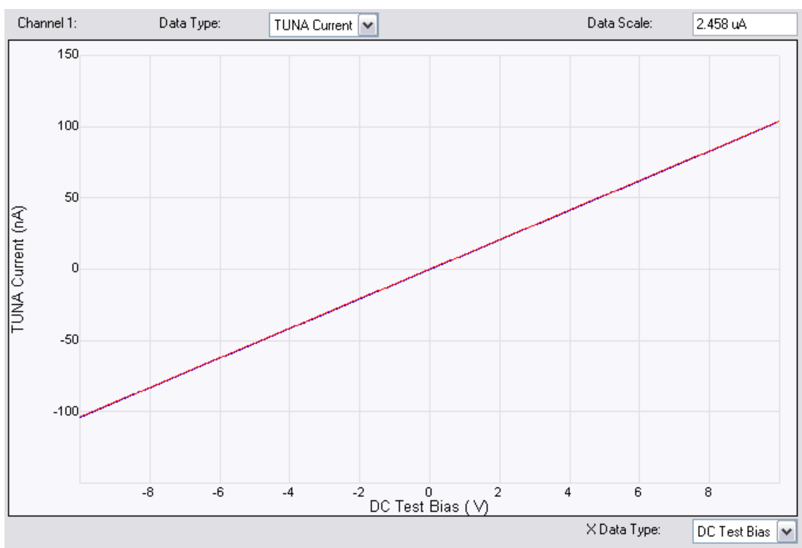
- **NOTE:** This test requires that the DC test bias be generated from NanoscopeV (see appendix B) and that the A/D responsible for reading the current signal from the module also work correctly. Make sure that NanoscopeV works properly before doing the above test

Parameter values will be shown on next six pages

Testing the 100nA/V gain setting:

- Set the parameters as shown below:
  - Ramp Output – DC Test Bias
  - Ramp Begin – (-10.0V)
  - Ramp End – +10.0V
  - Ramp Rate – 1Hz
  - Trigger Mode – Off
  - Channel 1 Data Type – TUNA Current
  - Channel 1 X Data Type – DC Test Bias

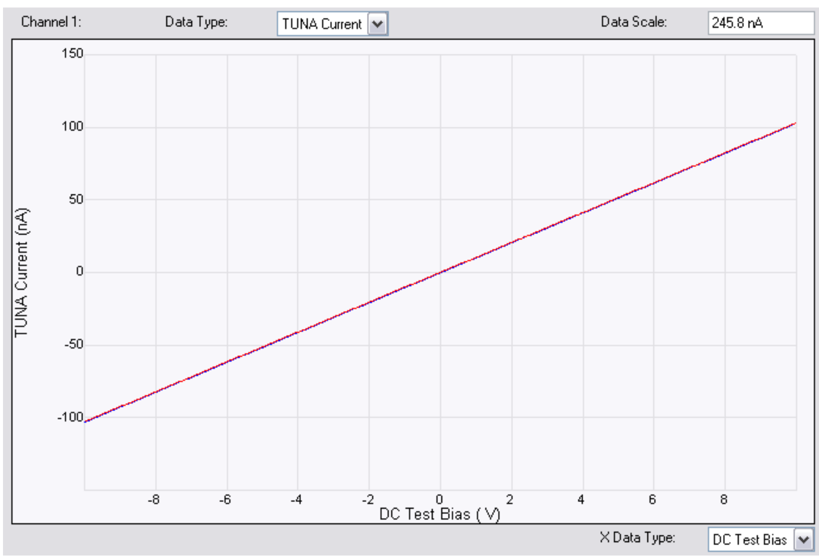
Ch1 Graph:



Testing the 10nA/V gain setting:

- Set the parameters as shown below:
  - Ramp Output – DC Test Bias
  - Ramp Begin – (-10.0V)
  - Ramp End – +10.0V
  - Ramp Rate – 1Hz
  - Trigger Mode – Off
  - Channel 1 Data Type – TUNA Current
  - Channel 1 X Data Type – DC Test Bias

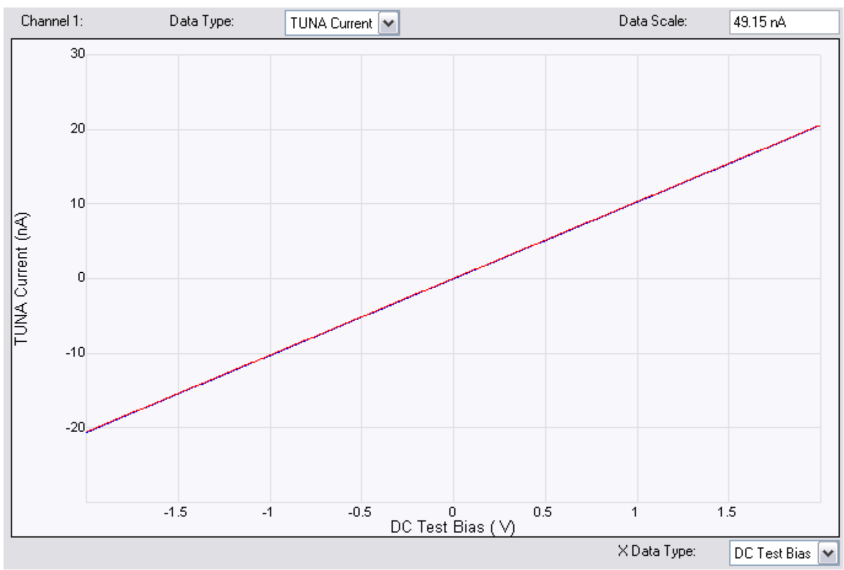
Ch1 Graph:



Testing the 2nA/V gain setting:

- Set the parameters as shown below:
  - Ramp Output – DC Test Bias
  - Ramp Begin – (-2.0V)
  - Ramp End – +2.0V
  - Ramp Rate – 1Hz
  - Trigger Mode – Off
  - Channel 1 Data Type – TUNA Current
  - Channel 1 X Data Type – DC Test Bias

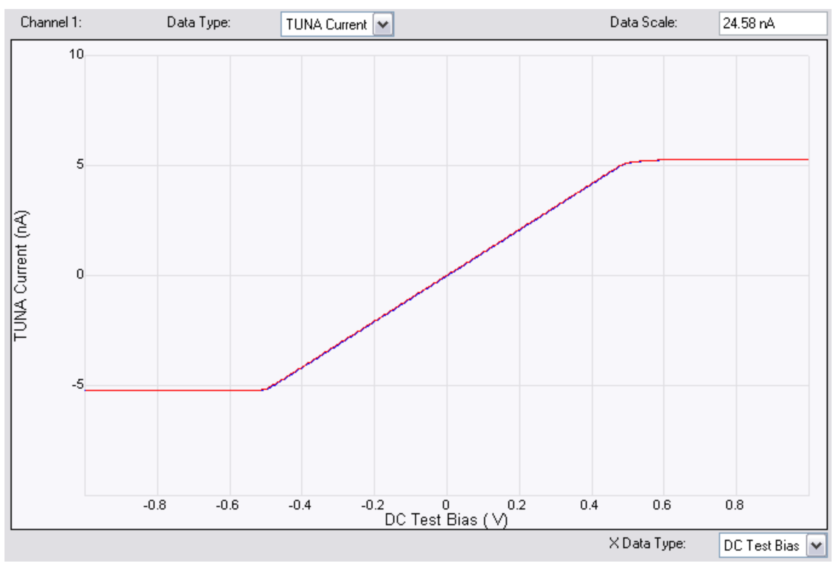
Ch1 Graph:



Testing the 1nA/V gain setting:

- Set the parameters as shown below:
  - Ramp Output – DC Test Bias
  - Ramp Begin – (-1.0V)
  - Ramp End – +1.0V
  - Ramp Rate – 1Hz
  - Trigger Mode – Off
  - Channel 1 Data Type – TUNA Current
  - Channel 1 X Data Type – DC Test Bias

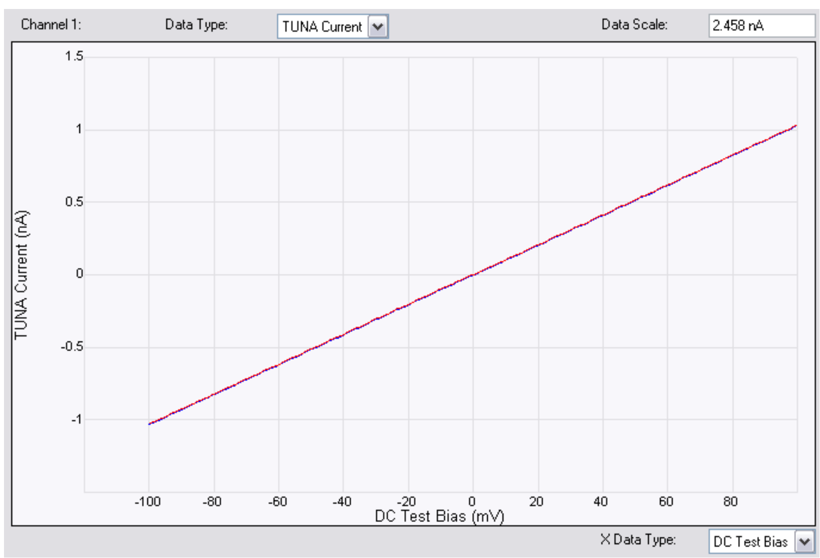
Ch1 Graph:



Testing the 100pA/V gain setting:

- Set the parameters as shown below:
  - Ramp Output – DC Test Bias
  - Ramp Begin – (-100mV)
  - Ramp End – +100mV
  - Ramp Rate – 1Hz
  - Trigger Mode – Off
  - Channel 1 Data Type – TUNA Current
  - Channel 1 X Data Type – DC Test Bias

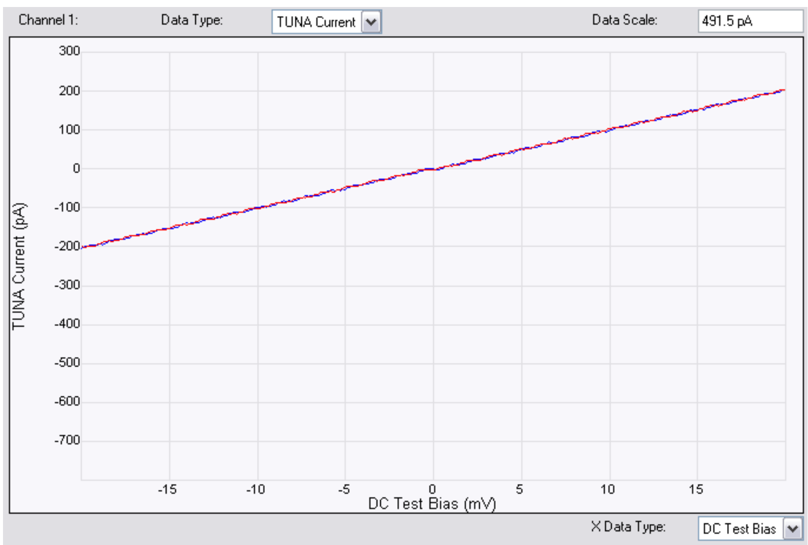
Ch1 Graph:



Testing the 20pA/V gain setting:

- Set the parameters as shown below:
  - Ramp Output – DC Test Bias
  - Ramp Begin – (-20mV)
  - Ramp End – +20mV
  - Ramp Rate – 1Hz
  - Trigger Mode – Off
  - Channel 1 Data Type – TUNA Current
  - Channel 1 X Data Type – DC Test Bias

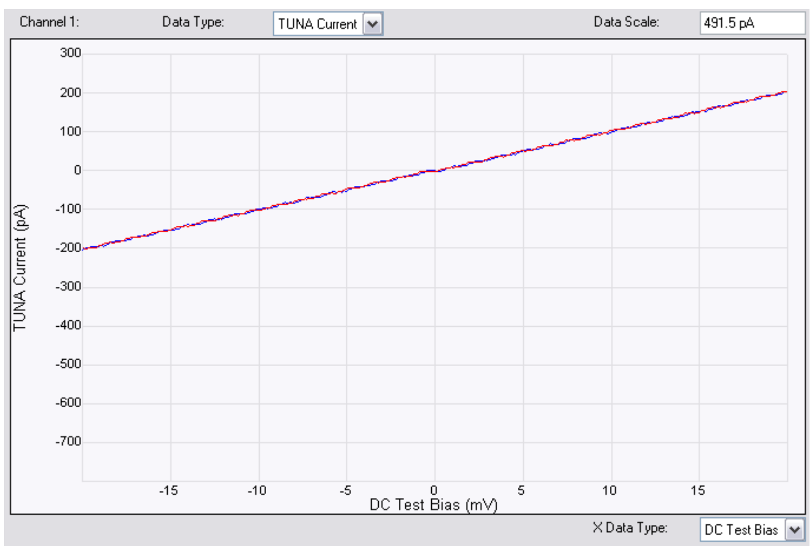
  Ch1 Graph:



Testing the 20pA/V LBW gain setting:

- Set the parameters as shown below:
    - Ramp Output – DC Test Bias
    - Ramp Begin – (-20mV)
    - Ramp End – +20mV
    - Ramp Rate – 0.2Hz
    - Trigger Mode – Off
    - Channel 1 Data Type – TUNA Current
    - Channel 1 X Data Type – DC Test Bias

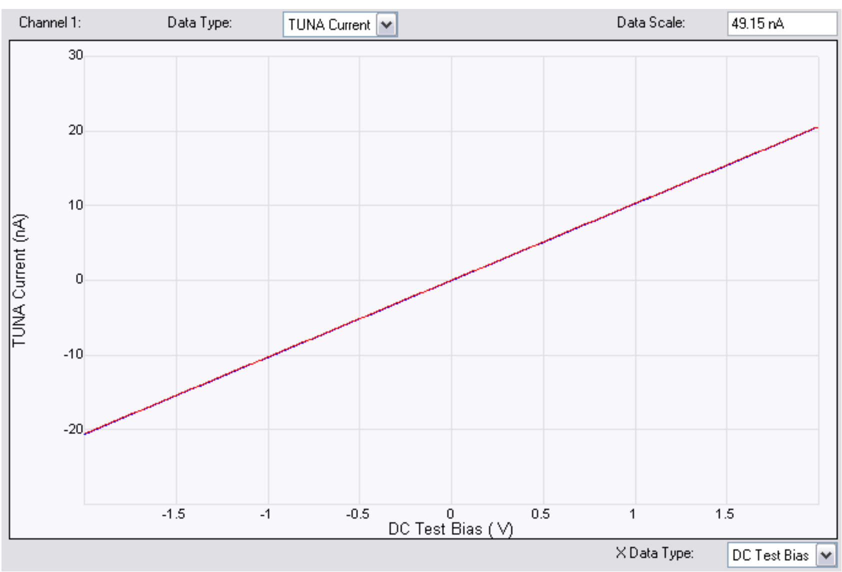
Ch1 Graph:



Testing the 2nA/V LBW gain setting:

- Set the parameters as shown below:
  - Ramp Output – DC Test Bias
  - Ramp Begin – (-2.0V)
  - Ramp End – +2.0V
  - Ramp Rate – 0.2Hz
  - Trigger Mode – Off
  - Channel 1 Data Type – TUNA Current
  - Channel 1 X Data Type – DC Test Bias

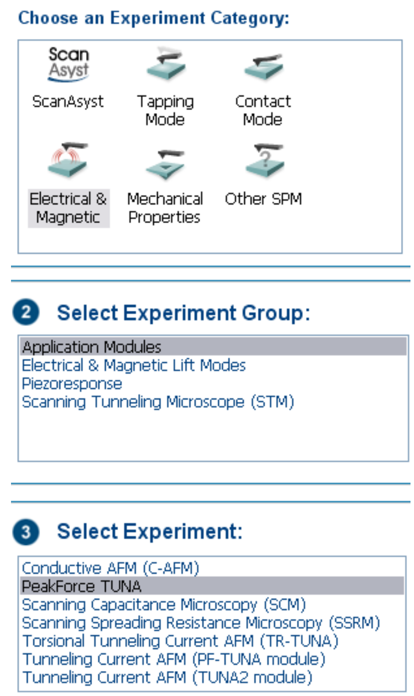
Ch1 Graph:



Noise Test:

PFT TUNA Mode:

- Load a cantilever in the holder and attach to the module with the signal wire
- Open the PeakForce TUNA experiment under electrical measurements
- 1nm scan size
- 2.44 Hz scan rate
- 256 samples per line
- Open TUNA Current data channel
- Planefit set to 'none'
- Set gain to highest possible (2pA/V)
- False Engage
- Capture an image
    - o 1st order flatten
    - o RMS roughness should be <.1pA



Contact Mode:

- Load a cantilever in the holder and attach to the module with the signal wire
- Open the Tunneling Current AFM (PF-TUNA module) mode experiment under electrical measurements

Tunneling Current AFM (PF-TUNA module)

- 1nm scan size
- 0.5Hz scan rate
- 256 samples per line
- Open TUNA Current data channel
- Planefit set to 'none'
- Set gain to highest possible (2pA/V)
- False Engage
- Capture an image
    - o 1st order flatten
    - o RMS roughness should be <.1pA

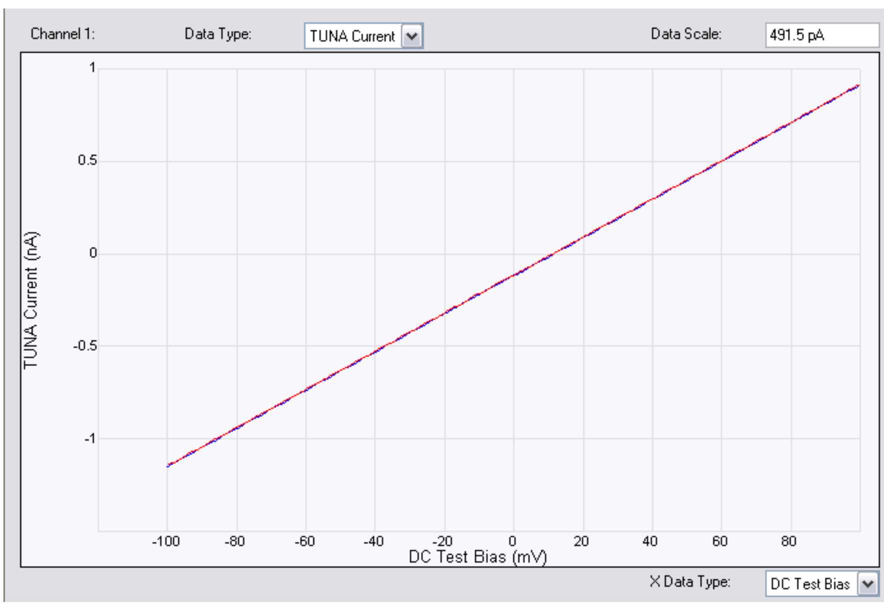
9.0 REVISION HISTORY AND APPROVAL

Rev	Date	Originator	Change Description
1	1/25/2011	John Tedesco	Initial Release

Approvals		
Originator	Director, Service	Director, Quality
John Tedesco	John Trahan	Bob Wilkins

Appendix A

The below will happen only if the SW adjustment is not done or the sequence of events used to switch gains is done improperly (see the 4th bullet point in the test procedure above). Example of improper offset adjustment:

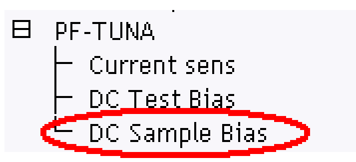


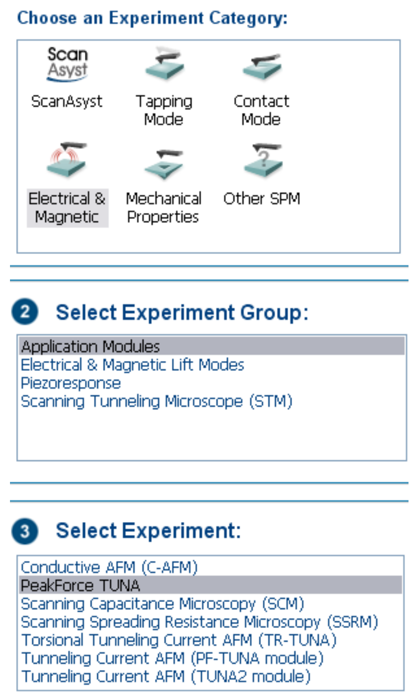
Notice that the overall range is correct, however the values are not centered.

Appendix B

In order for the system to properly work on a real sample (not just the test resistor) the sample bias has to work correctly. Testing Sample Bias:

- Place a 100mV DC Sample Bias value Under the PF-TUNA parameters into the SW while in the PeakForce TUNA experiment





- Use a Voltmeter to measure the value on the sample stage (should match the value placed in the parameter)
- Use the Nanoscope Controller as the reference ground for the Voltmeter
- Try the above at 1V, 5V, -1V, -5V, 10V, and -10V to assure that the entire range of the bias is working

To test for DC Test Bias (used with calibration resistor) do the above test but measuring on the Test Bias pin shown below and adjusting the DC Test Bias parameter