FREEDOM DATA PC PLATFORM

Sonic Echo/Impulse Response Test (SE/IR)

System Reference Manual

Freedom Data PC with WinSEIR Software Version 1.5

Olson Instruments, Inc.

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1.0 INTRODUCTION

The Olson Instruments Sonic Echo/Impulse Response (SE/IR) system is commonly used for quality assurance, condition evaluation, and forensic testing of piles and deep foundations. Common applications of the SE/IR system are determining the length of foundations and/or locating defects within foundations. The basic requirement for any foundation to be testable by this system is that an area of approximately 3 inches (7.6 cm) by 5 inches (12.7 cm) access be available on the foundation top, and that the surface to be tested is relatively smooth and flat. Alternatively, testing can be done by mounting the receiver to a block on the side of the pile, but the data quality will be lower.

The Freedom Data PC (FDPC) system with the SE/IR test consists of several basic components. These components include the FDPC platform for data acquisition, analysis and display, an accelerometer, an instrumented 3 lb hammer, a geophone, grease and cables. Details of the hardware and its usage are included in Section 2.0.

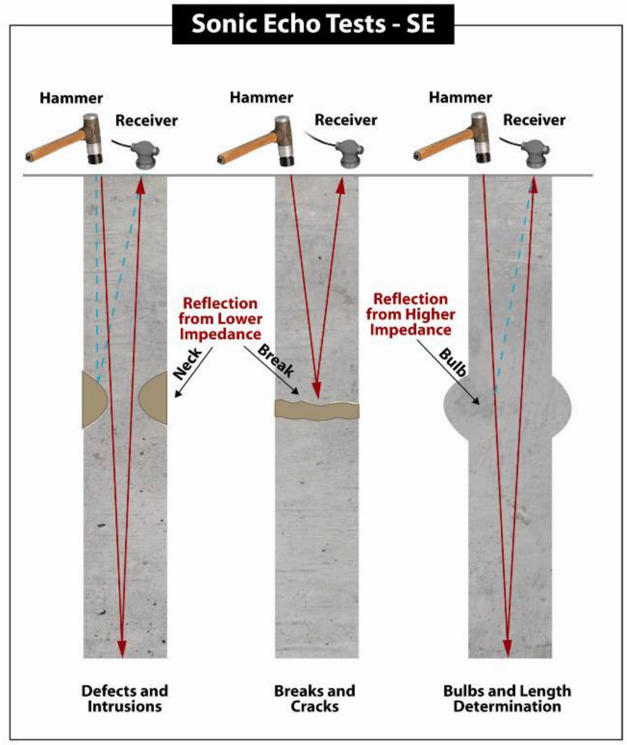
The Windows WinSEIR software is a post data analysis program with a number of specialized SE/IR analysis tools built-in. This manual covers step-by-step hardware assembly, software setup, data acquisition, data analysis, and output generation.

1.1 Organization and Scope of Manual

This operation manual for the SE/IR test with the Freedom Data PC system manufactured by Olson Instruments includes all required instruction for the use of the hardware and software included with the system. If any problems with the system appear that are not covered in this manual, please call Olson Instruments at the number included in the front of this manual. Note that training in the use of the system by Olson Instruments personnel is recommended for the most effective operation of this system.

1.2 Test Methodology

The SE method is a low strain integrity test conducted from the top (or upper side) of the shaft as shown in the figure below. Test equipment includes a 3 pound (1.36 kg) hammer (instrumented or mechanical), receiver (accelerometer and/or geophone) mounted on the top (or upper side) of the shaft, and a data acquisition platform. The test involves hitting the foundation top with the hammer to generate wave energy that travels to the bottom of the foundation. The wave reflects off irregularities (cracks, necks, bulbs, soil intrusions, voids, etc.) and/or the bottom of the foundation and travels back along the foundation to the top. The receiver measures the vibration response of the foundation to each impact. The data collection platform acquires, processes and displays the receiver outputs. Foundation length and integrity of concrete are evaluated by identifying and analyzing the arrival times, direction, and amplitude of reflections measured by the receivers in time. The echo depth (D) is calculated by multiplying the reflection time (t) by the compression wave velocity (V) and dividing this quantity by 2 to account for the fact that the wave has gone down and reflected back, i.e., D = V*t/2 .



Analysis of the length determination and the integrity evaluation of a foundation with the SE method is based on the identification and evaluation of reflections. Test results are analyzed in the time domain for the SE test.

The SE test method is sensitive to changes in the shaft impedance (shaft concrete area * velocity * mass density where mass density equals unit weight divided by gravity), which cause the reflections of the compression wave energy. Compression wave energy (hammer impact energy) reflects differently from increased shaft impedance than from decreased shaft impedance. This phenomenon allows the type of reflector to be identified as follows. Soil intrusions, honeycomb, breaks, cracks, cold joints, poor quality concrete and similar defects are identified as reflections that correspond to a decrease in the shaft impedance. Increases in the shaft cross-section or the competency of surrounding materials such as bedrock and stiffer soil strata are identified as reflections corresponding to increases in the shaft impedance. A decrease in impedance is indicated by a downward initial break of a reflection event in an SE record and frequency peaks positioned in a record such that a peak could be extrapolated to be near 0 Hz in the mobility plot. Conversely, an increase in shaft impedance is identified by an upward initial break for an SE reflector.

When length to diameter ratio exceeds 20:1 to 30:1 for shafts in stiffer soils/bedrock, the attenuation of compression wave energy is high and bottom echoes are weak or unidentifiable in SE test results. If the shaft is embedded in a material which has similar impedance to that of the shaft, it may not be possible to see a reflection from the bottom of the shaft.

Impulse Response (IR) - The IR method is also an echo test and uses the same test equipment as the SE method. The test procedures are similar to the SE test procedures, but the data processing is different. The IR method involves frequency domain data processing, i.e., the vibrations of the foundation measured by the receivers are processed with Fast Fourier Transform (FFT) algorithms to generate transfer functions for analyses. The coherence of the impulse hammer impact and accelerometer receiver response data versus frequency is calculated to indicate the data quality. A coherence near 1.0 indicates good quality data. For shafts in air or in relatively soft soils, the coherence will typically only be near 1.0 at frequencies for which the mobility is non-zero. In the IR records the linear transfer function amplitude is in inches/second/pound force on the vertical axis (mobility) and frequency in Hz on the horizontal axis. Because of the rod-like shape of a deep foundation, reflections are indicated by equally spaced resonant peaks that correspond to modes of vibration associated with the depth of the reflector. The inverse of the SE reflection time, t, is equal to the change in frequency, delta f, between the resonant peaks in the IR mobility plot. The reflector depth is then calculated as:

$D = V/(2*\Delta f)$.

SE/IR Analyses - Analysis of the length determination and the integrity evaluation of a foundation for both the SE and IR methods is based on the identification and evaluation of reflections. However, test results are analyzed in the time domain for the SE and in the frequency domain for the IR method. The reflections are shown as resonant frequency peaks in the frequency domain for IR test data. The two methods complement each other because the identifications of reflections are sometimes clearer in either the time or the frequency domain.

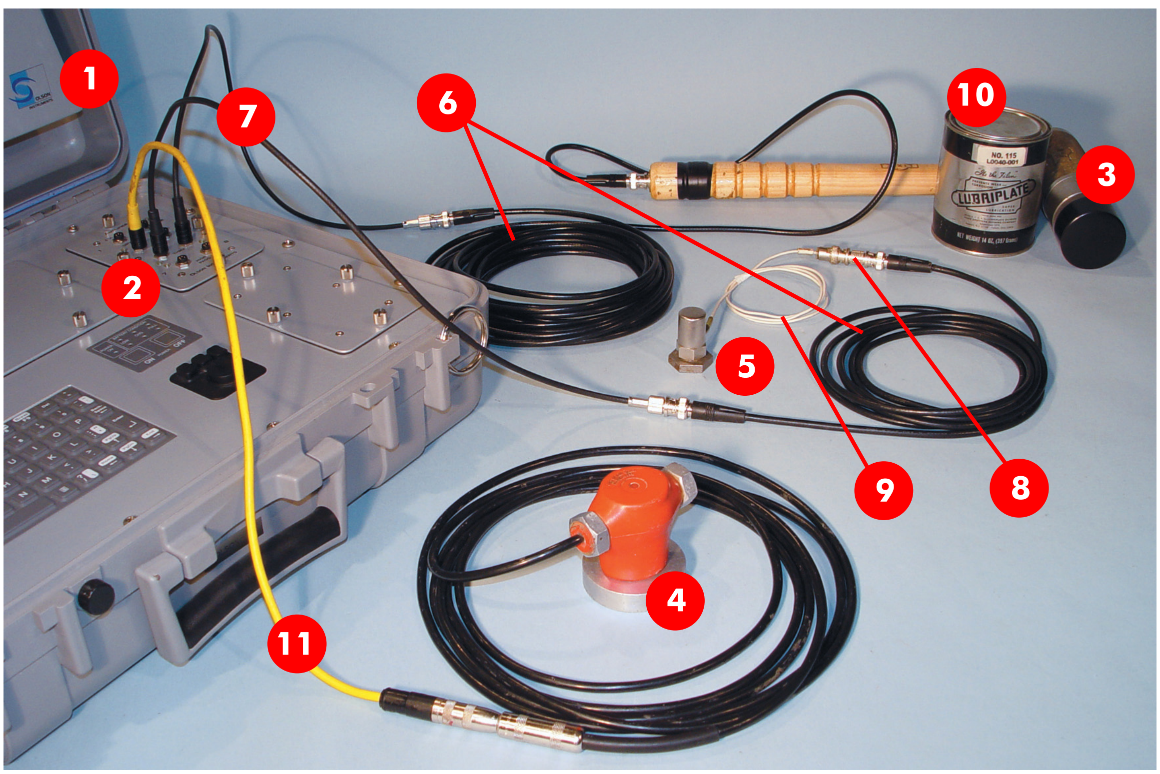
The SE and IR test methods are sensitive to changes in the shaft impedance (shaft concrete area * velocity * mass density where mass density equals unit weight divided by gravity), which cause the reflections of the compression wave energy. Compression wave energy (hammer impact energy) reflects differently from increased shaft impedance than from decreased shaft impedance. This phenomenon allows the type of reflector to be identified as follows. Soil intrusions, honeycomb, breaks, cracks, cold joints, poor quality concrete and similar defects (referred to herein as a neck) are identified as reflections that correspond to a decrease in the shaft impedance. Increases in the shaft cross-section or the competency of surrounding materials such as bedrock and stiffer soil strata (referred to herein as a bulb) are identified as reflections corresponding to increases in the shaft impedance. A decrease in impedance is indicated by a downward initial break of a reflection event in an SE record and frequency peaks positioned in a record such that a peak could be extrapolated to be near 0 Hz in the mobility plot. Conversely, an increase in shaft impedance is identified by an upward initial break for an SE reflector and frequency peaks positioned in an IR record such that a trough could be extrapolated to be near 0 Hz in the mobility plot. When length to diameter ratios exceed 20:1 to 30:1 for shafts in stiffer soils/bedrock, the attenuation of compression wave energy is high and bottom echoes are weak or unidentifiable in SE/IR test results. The term “weak bottom echo” is used to indicate that a bottom echo is seen, but that it is barely visible above the normal background noise. Note that it is possible for a perfectly sound shaft to have a weak bottom echo, as a weak echo can be caused by either a shallow reflector blocking energy from the shaft bottom, or from wave energy coupling into the bedrock at the shaft bottom rather than reflecting back up. Thus, the strength of the bottom echo is used as a secondary, minor consideration as to shaft condition.

2.0 HARDWARE COMPONENTS

2.1 Equipment List for Sonic Echo/Impulse Response (SE/IR)

(1) - 1 Olson Freedom Data PC
(2) - 1 Input Module Containing:
- 1 Wideband Channel for Hammer (Green Light Required)
- 1 Wideband Channel for Accelerometer (Green Light Required)
- 1 Wideband Channel for Input (Geophone)

(3) - 1 Impulse Hammer
(4) - 1 5.5 Hz Geophone
(5) - 1 Accelerometer
(6) - 2 BNC Cable
(7) - 2 BNC to 4 Pin Adapter Cable
(8) - 1 Female-Female BNC Adapter
(9) - 1 Microdot to BNC Cable
(10) - Coupling Grease
(11) - 1 Phone Plug to 4 Pin Adapter Cable



* Equipment/Software included for testing not shown in photo:
- Latest WinSEIR Software
- Field Notebook & Pen

2.2 Freedom Data PC Hardware Setup

A step-by-step procedure for connecting the various system components is illustrated below. Please refer to these figures during connection of the components.

1. Lay the instrument case and Freedom Data PC down on a flat, stable surface. Unlock the case if locked. Next, open the Freedom Data PC case. The location of the Freedom PC should be within 15 m (50 ft) of the subject/material to be tested.

2. Next, if desired, connect the Freedom Data PC to the external power supply with the 120/240 VAC Power Supply/Charger. The external power supply/charger automatically switches between120/240 Volts AC.

The computer is designed to be resistant to light rain or other moisture but should not be exposed to heavy rain.

3. BATTERY INSTALLATION: If it is necessary to replace the batteries, remove the battery cover as shown. Insert both batteries with the (+) polarity to the right (photo below).

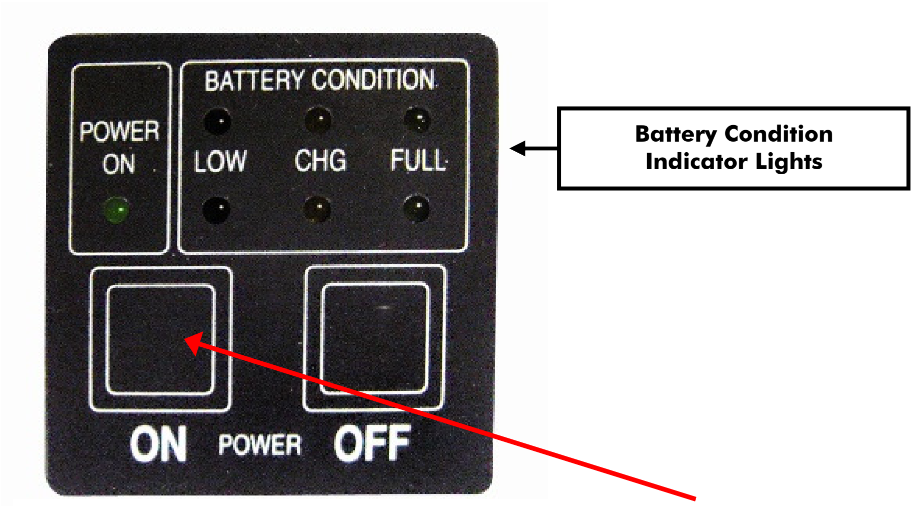
Fully charged batteries should power the IE system for 8 – 10 hours depending on the processor speed of the unit used. The Freedom Data PC can also be powered from a car cigarette lighter socket using a 12 VDC adapter. However, this may drain a weak car battery in a few hours if the engine is not running.

BATTERY CONDITION INDICATOR LIGHTS
Green Light – Batteries are fully charged
Yellow Light – Batteries are charging
Red Light – Low Battery, ~ 15 minutes usage left, apply external power supply at this point

2.3 Freedom Data PC Hardware Operation

After the Freedom Data PC hardware is properly set up, operation is straightforward and primarily involves the use of the Freedom Data PC and the installed modules. The use of the Input Module and Pulser Module is described in this section.

1. Power



Power on Freedom Data PC by pressing the "ON" Button as shown.

If the battery LED is ***red***, do not try to operate the computer, as the batteries are very low. In this case, the system should be run on external power rather than off the batteries. Charging of the batteries will begin once external power is attached. A running automobile outputs approximately 14.2 VDC, which will charge the batteries to around 85% of full charge. To achieve 100% charging power, use the 16 VDC AC powered external power supply that is shipped with your instrument.

When operating the computer on external power with partially or fully discharged batteries, a "Fault" light may appear after a period of time. This yellow flashing light is normal, and is due to the combined current drain of the computer operation and the battery charge current. The batteries will charge normally when the power supply is connected with the computer shut off (such as overnight). Totally drained batteries will require 12 – 13 hours for full charging.

2.3.1 Freedom Data PC Operation Notes

The Freedom Data PC is a self-contained data conditioning, collection, and processing platform usable for a number of types of NDT tasks as well as general data acquisition. The data acquisition tasks for which the Freedom Data PC is capable, depends on the modules installed (up to two at a time). The following section discusses the basics of the hardware operation of the Freedom Data PC, including module replacement, battery charging and replacement, external powering, and general maintenance.

2.3.1.1 General Maintenance and Usage

The Freedom Data PC is a rugged unit designed for field conditions. It is normally water and air tight when closed and latched, which will protect it in most storage and transportation conditions.

While the Freedom Data PC is watertight when closed, it is water resistant (not water tight) when open or operating. Thus, rain or other normal moisture should not bother the unit, but it should **NOT** be submerged or sprayed at high pressure. Also, water should not be allowed to collect on the face of the computer unit.

> ! ***Never expose the external power supply/charger to rain or moisture.***

When used in a field environment, the Freedom Data PC should be expected to get dirty. If this happens, wipe the unit with a damp (not wet), clean towel. Do not allow water to flow into any of the components, and do not wipe the screen with a dry or dirty towel.

> ! ***The screen is subject to damage if impacted or pressed on.***

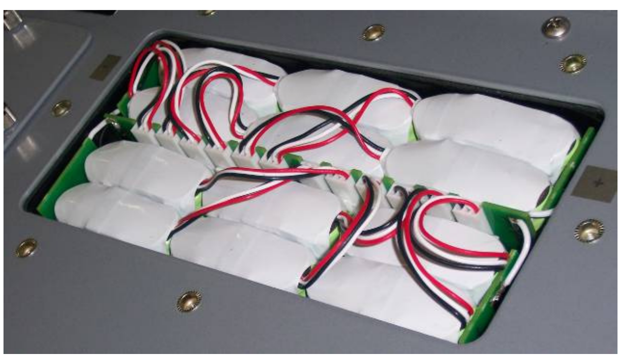
2.3.1.2 Battery Charging and Usage

The batteries inside the Freedom Data PC consist of 2 sealed units, each of which is 12 VDC, 11 Ampere-Hours. Depending on the usage, these batteries should last for 8-12 hours of continuous use. After this, the batteries should be recharged or switched out with a fully charged pair. The batteries used are Lithium Ion batteries with internal protection circuitry. There is no memory effect, so batteries can be used freely with only a partial charge.

External power supply jack

Opening battery cover

Cover removed, exposing 2 Lithium Ion batteries (Domestic Usage)



Cover Removed, exposing array of 12 Lithium Ion mini battery packs (for International Usage)

Charging the Batteries

1. Turn off "POWER" to the Freedom Data PC.
2. Plug the external power supply/charger into the jack in the upper left-hand corner on the front panel of the unit (top left photo). The yellow "CHARGE" lights will come on for each battery for the bulk of the charge cycle. At 85% of capacity, the green "FULL" lights will light, with all lights out when the battery is completely charged. Always charge the batteries in a protected environment, at normal room temperatures. The batteries red "charge" light indicates that the batteries are nearly fully drained and need recharging.

To prolong battery life, always recharge the batteries immediately after use.

Do not disassemble, incinerate, short out, or otherwise abuse the batteries as there is a possible risk of fire or explosion.

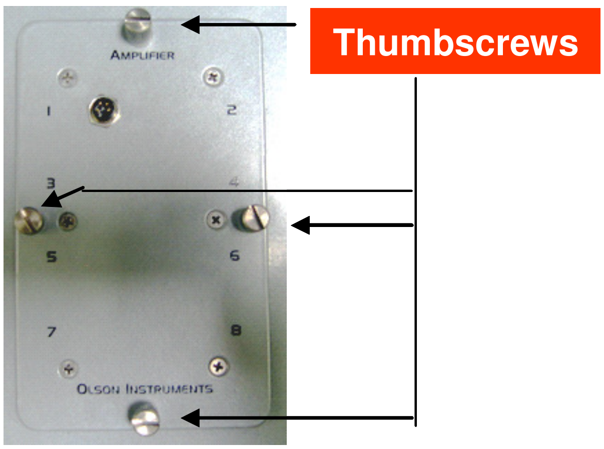
If power is available at the field site (110/220 VAC), the external power supply/charger can be used to power the Freedom Data PC with or without batteries installed. The external power supply/charger will run the unit and start to charge the batteries if installed. Note that the Freedom Data PC should be turned OFF before connecting or disconnecting the external power supply/charger. Disconnecting the power supply/charger during operation may cause the Freedom PC to reboot and lose data in memory, especially if the batteries are very low. If it does reboot, turn off power, then turn on again for normal operation. A 12VDC adaptor can also be used to power the unit off of a car battery.

Notes on maximizing battery life. The following can help maximize the run-time of the batteries:

- Turn off the computer when not in use (when moving or setting up other equipment)
- Use external power when easily available
- Recharge the batteries immediately after each use to preserve capacity

2.3.1.3 Removing/Replacing Batteries and Modules

The batteries and Amplifier/Pulser Modules on the Freedom Data PC are field replaceable. They all use thumbscrew fasteners for securing. To remove the modules, turn off power to the Freedom Data PC, disconnect all cables from the module, and unscrew the thumbscrews counterclockwise. Then pull up firmly and evenly on the screws to remove the module. To replace, simply press the module fully into the slot and tighten the screws.

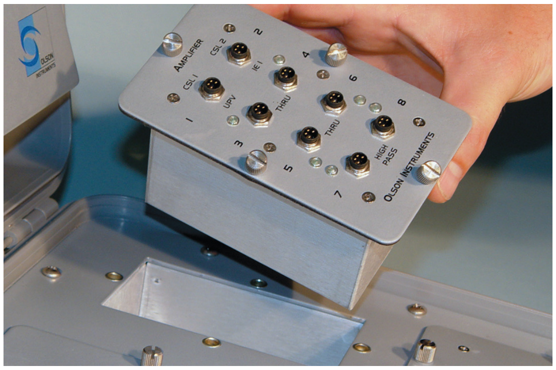


The amplifier module should be in the upper position and the pulser module, if required, in the lower position. No damage will occur by switching the locations, but no signal will be coupled from the amplifier module to the data acquisition card, and thus the modules must be placed in the right position.

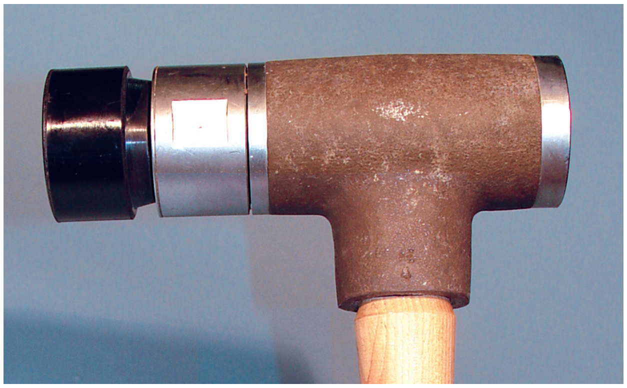
Replacing the batteries in the Freedom Data PC is a similar operation. Unscrew the 8 thumbscrews then lift off the battery cover. The battery cover should lift up freely. Next, lift the batteries out by the lifting cord. Install new batteries by dropping them into the compartment (they are keyed for polarity and cannot be inserted wrong). Replace the cover. Finally, press and tighten each of the thumbscrews.

2.4 Step-by-Step Guide for SE/IR Hardware Setup

1. After opening the Freedom Data PC, insert the input module into the top module pocket if not already present. This pocket is reserved for the input modules. Make sure to align the four thumbscrews on the module with the holes in the Freedom Data PC, and hand-tighten securely into place.

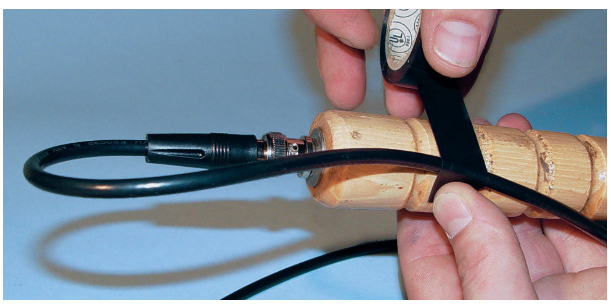


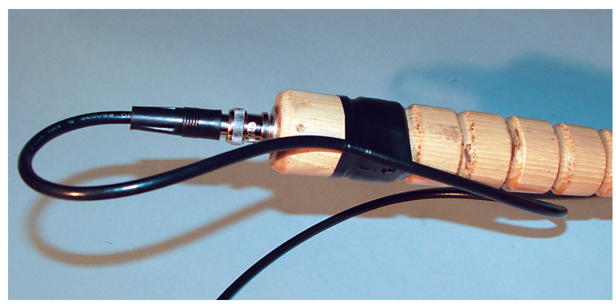
2. Next, the appropriate tip must be connected to the end of the impulse hammer. The tips differ by their hardness. Each color represents a different hardness; refer to the SASW, US/PS, and UPV manuals for specific hardness color combinations. The tip is connected to the impulse hammer by aligning the screw on the tip with the hole in the load cell portion of the hammer. Please note that over-tightening or excessive force used during the removal of the tip will permanently damage the load cell.



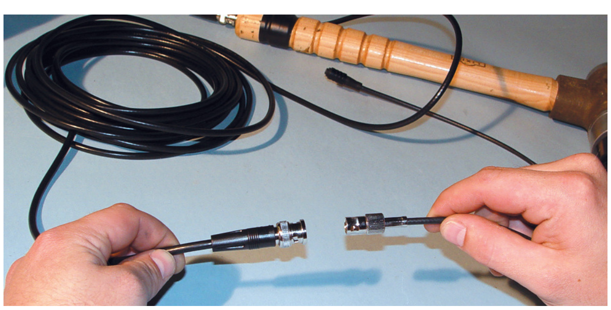
3. Connect a BNC cable to the BNC connection on the bottom of the impulse hammer's handle. Align the BNC cable with the BNC connector and hand-tighten the connection. Note that there is a locking mechanism involved when connecting BNC cables. This will prevent you from over tightening the cable.

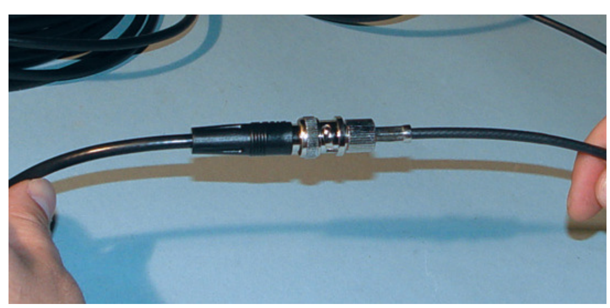
4. The BNC cable must then be taped to the handle of the impulse hammer. This is done to protect the cable and the connection from being damaged during the testing. Note that the cable should not be bent at a ninety degree angle at the base; leave some slack in the cable when taping.





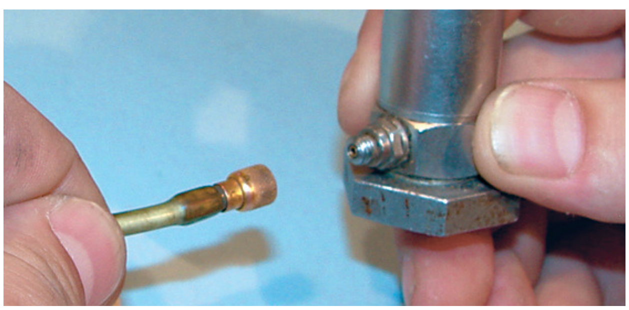
5. Next the BNC cable that is connected to the impulse hammer must be connected to a 4 Pin Adapter Cable. This is done by connecting the other end of the BNC cable to the BNC end of the 4 Pin Adapter Cable. Align the connectors and hand-tighten them. Once again, the BNC connection has a locking mechanism which will prevent you from over tightening the connection.

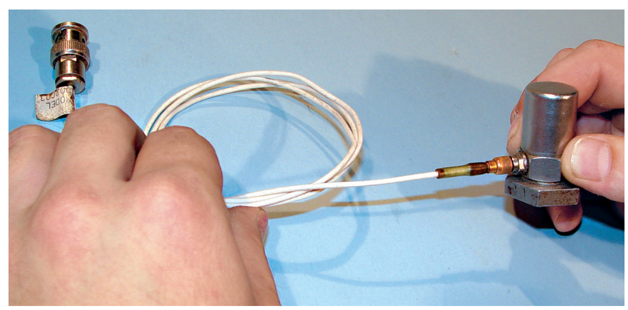




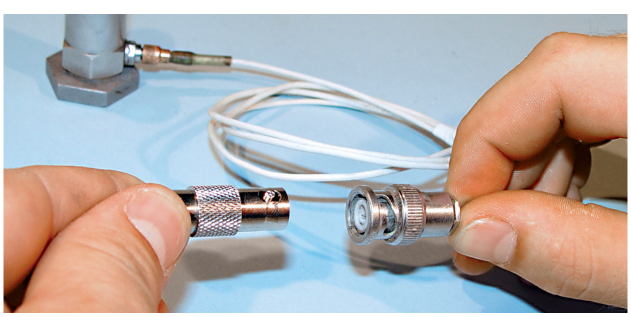
6. The 4 Pin Adapter Cable, which is connected to the BNC cable and impulse hammer, must be inserted into the appropriate slot in the input module. For SE/IR testing it is important to use a channel that is wideband (has no filtering applied). It is also important that this channel has power supplied to it; this is indicated by a green light next to the channel. This can be done by pulling back on the small black sleeve at the end of the cable and carefully lining up the four holes on the cable with the four pins on the input module. The green light will illuminate when the impulse hammer is properly connected.

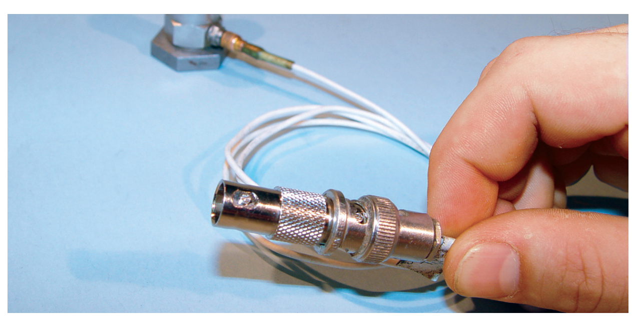
7. Next, connect the microdot cable to the accelerometer by aligning the pin on the microdot cable with the corresponding hole in the accelerometer and then hand-tightening the connection.





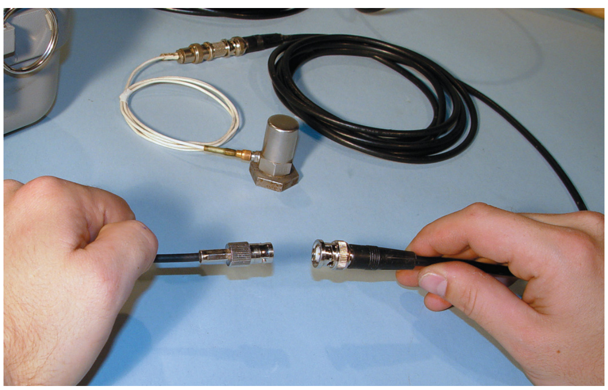
8. If needed, attach the female BNC adapter to the BNC end of the microdot cable by aligning the pin with the hole and gently connecting the two pieces. This connection will have a locking mechanism that will prevent you from over- tightening the connection.



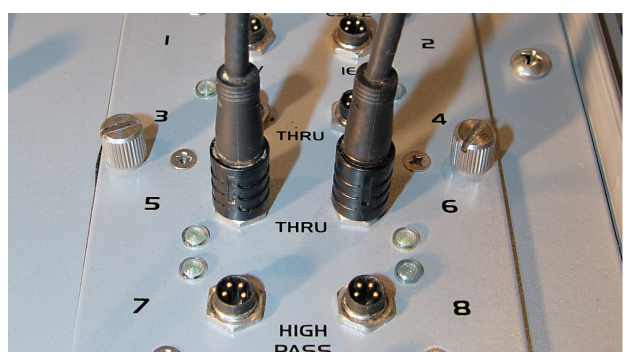


9. Next, attach the other end of the female BNC adapter to a BNC cable. Follow the same procedure as before when connecting these two cables.

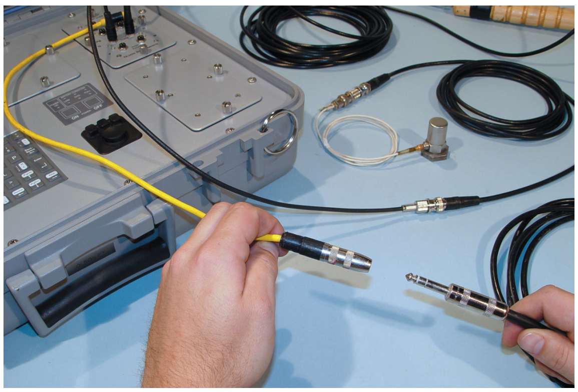
10. Now attach the BNC cable to the 4 pin adapter cable using the same procedure as before when connecting these two cables.

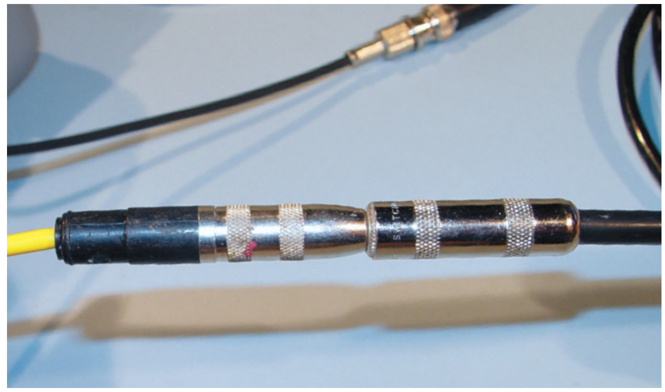


11. Insert the 4 pin adapter cable into a wideband channel in the input module. It is also important to note that this channel has power supplied to it; this is indicated by a green light next to the channel. This can be done by pulling back on the small black sleeve at the end of the cable and carefully lining up the four holes on the cable with the four pins on the input module. Note that the green light will illuminate when the accelerometer is properly connected.

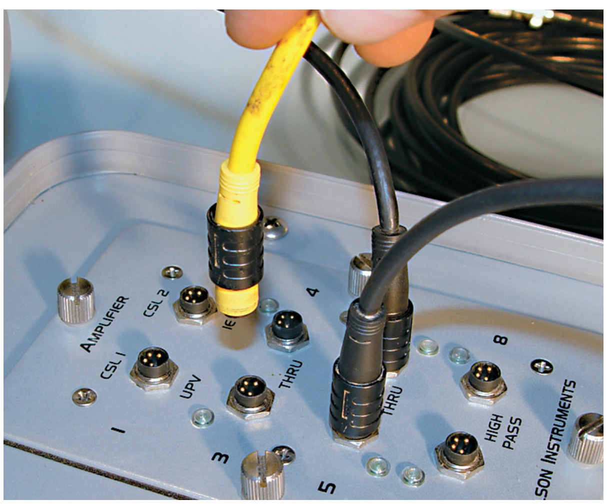


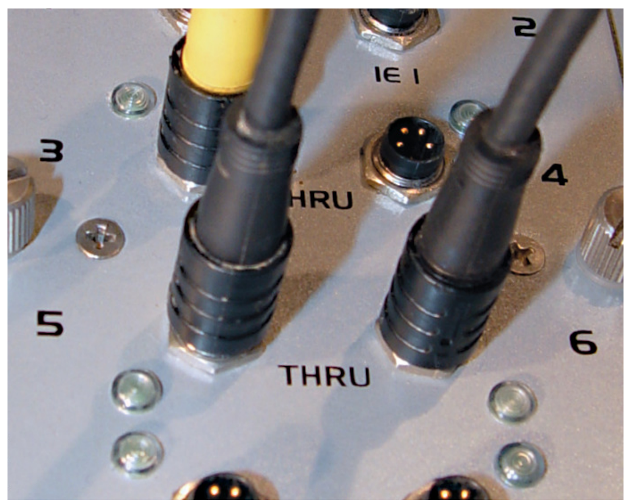
12. Next the geophone must be connected to the Freedom Data PC. First connect the phone jack of the geophone cable to the 4-pin adapter cable.





13. Now insert the 4-pin adapter into a wideband channel in the input module. This channel does not need to have power supplied to it, but can be plugged into a channel with a green light if necessary. See step 6 for further details.





14. The hardware setup for the acquisition system is now complete. Note to make sure all connections are secure and that the green light on the desired channels is on.

Complete SE/IR System with Accelerometer showing all components properly attached

3.0 WinSEIR SOFTWARE SETUP

The software for the SE/IR System is pre-installed and thoroughly tested at the manufacturer. If for any reason you need to reinstall/uninstall the software, or if you are installing software on a desktop/laptop computer, the steps required are included in this section.

3.1 Software Installation

1. National Instruments Data Acquisition (NIDAQ) software is necessary to run the Olson Instruments WinSEIR program. The NIDAQ drivers can be located on the supplied installation jump drive (run the NIDAQ SETUP file on the included jump drive and use the recommended defaults) or downloaded at:

http://joule.ni.com/nidu/cds/view/p/id/2888/lang/en

It is very important to uninstall any previous versions of NIDAQ before installing a new version.

NIDAQ Version 9.5 is required for Windows XP, Vista, Windows 7 – 32 bit and 64 bit.

There are two options for retrieving the driver from the web. The first option and the more stable option is to download the NI Downloader. The second option is to download the zip file. The second option can be a less stable experience for downloading files, especially if the download is unintentionally interrupted due to dropped connectivity. Note that an account (free of charge) may be required to proceed to the download page.

> ***Failure to install the prerequisites will result in an error when running the WinSEIR software.***

2. Uninstall the previous version of WinSEIR
3. Run “Setup.exe” from the Olson Instruments installation jump drive
4. Follow the default setup
5. After finishing the installation, the “WinSEIR.exe” file will be found on: drive C:\Program Files\Olson Instruments\WinSEIR.. The shortcut to “WinSEIR.exe” will be placed on the desktop

> ***Failure to uninstall the previous version of the WinSEIR software will prevent the installation of the new version.***

3.2 WinSEIR Software Uninstallation

For Windows XP Operating System:

1. Click on Start/Settings/Control Panel
2. Select “Add/Remove Programs”
3. Highlight WinSEIR Setup, select “Remove”

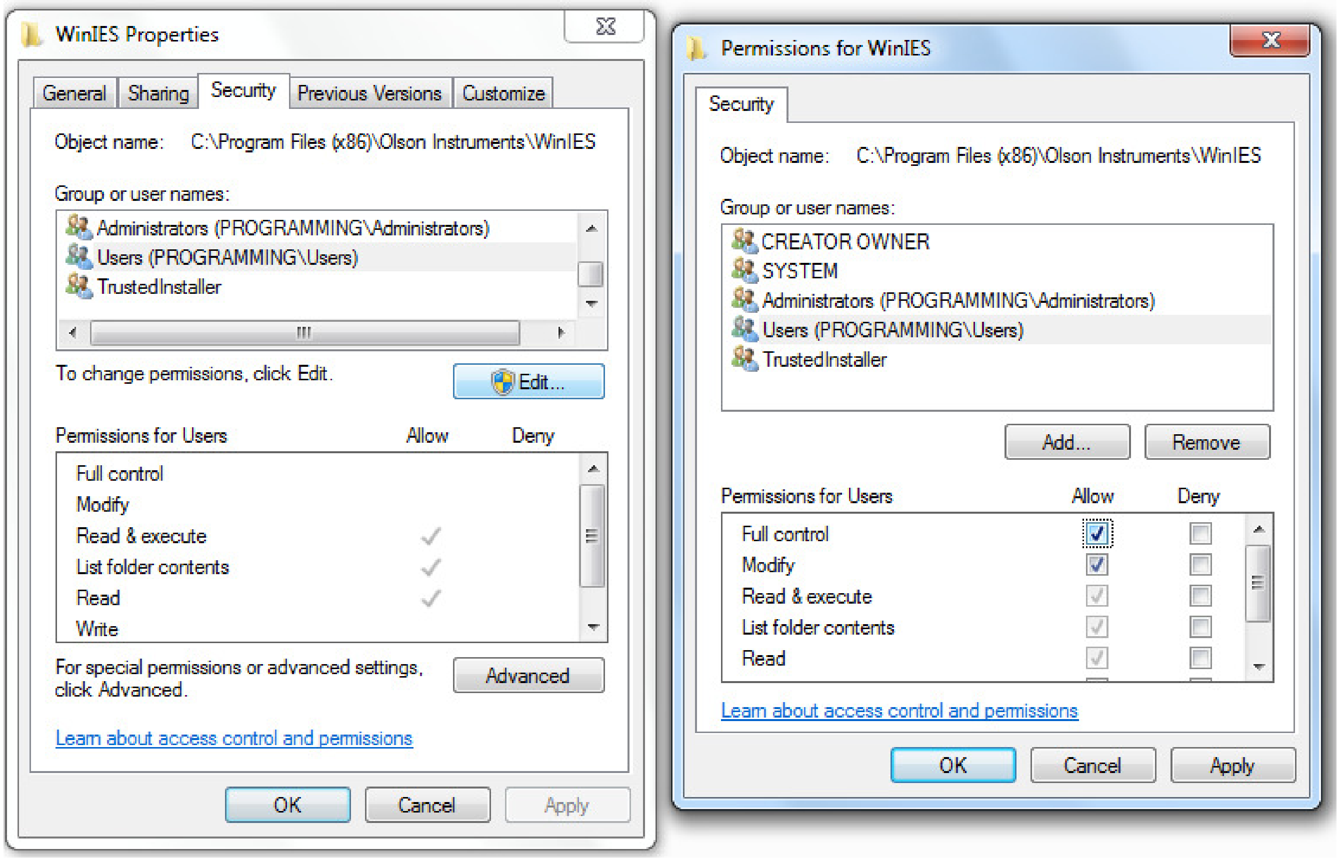
For Windows 7 Operating System:

1. Click on Start/Control Panel
2. Select “Programs and Features”
3. Highlight WinSEIR Setup, select “Uninstall”

The uninstall process will begin automatically, removing all installed components including shortcuts. This uninstall process might take up to five minutes. Do not exit the installation until it is completed.

3.3 Before Running the WinSEIR Software on Windows 7 or Vista

On Windows 7 and Vista operating systems, the files installed from the installer are automatically marked as “read only”. The WinSEIR file uses several parameter files that allow the user to save customized parameters into these files. Therefore, full permission must be allowed for the user profile to ensure that Windows allows access to these files. (See figure below.)



These steps are not necessary for Windows XP.

3.4 First Time Executing the WinSEIR Software

To run the WinSEIR software, execute “WinSEIR.exe” from the icon on the desktop. When the SEIR software is executed for the first time, the program will detect the missing parameter file (default.prm). The program will display a warning that the parameter file is missing and then will automatically generate and save a default file. If the software is unable to save the default file, see Section 3.3 to check the security settings for the user profile.

4.0 DATA ACQUISITION

This section covers step-by-step instructions for data acquisition.

4.1 Start Program

To run the WinSEIR software, simply execute “WinSEIR.exe” from the shortcut on the desktop and the software will launch, displaying a parameter panel on the left side of the screen and a filter panel on the top right portion of the screen above the waveform plot(s). (See Figure 4.1 below.) The status is highlighted in yellow at the upper right portion of the screen and is in “Stand by” mode.

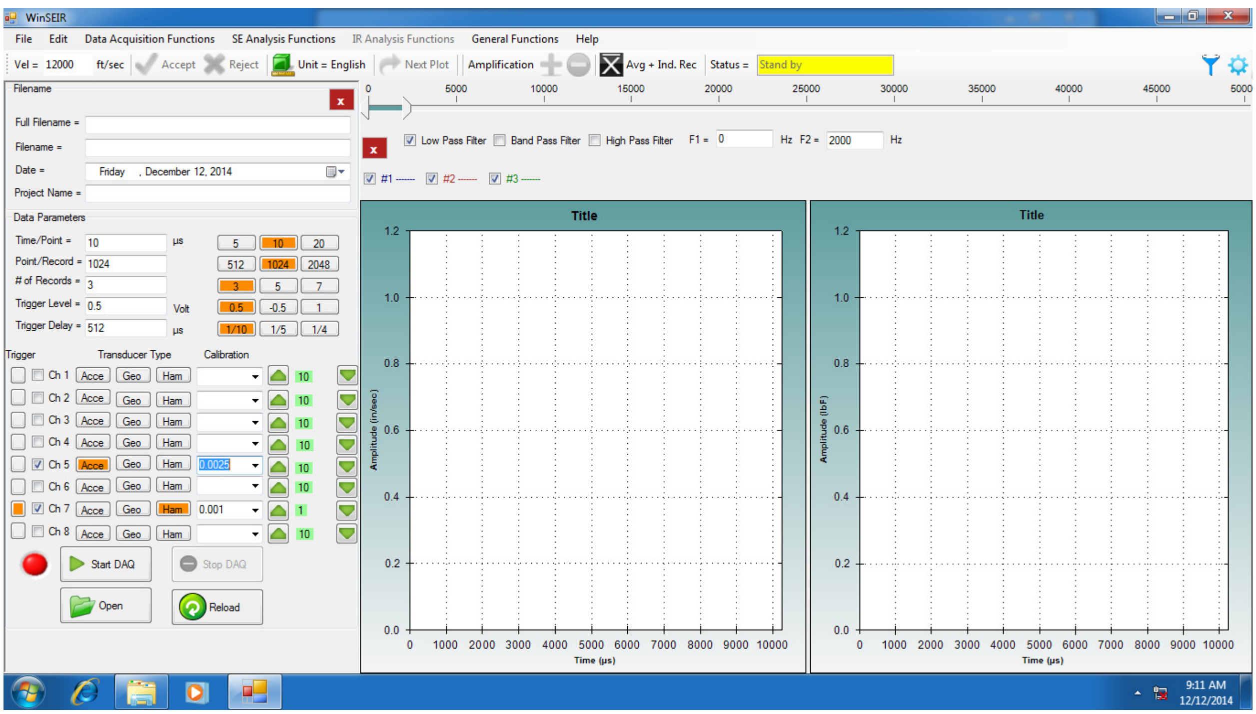
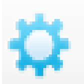


Figure 4.1 – First Screen WinSEIR Software

4.2 Shortcuts to Manage Panels

The WinSEIR software is designed to operate with two panels as well as the waveform plot(s) on the main screen of the WinSEIR program. The icon shortcuts for each of the display panels are located at the upper right corner of the screen. The list below identifies the purpose of each shortcut icon.

- Turns on the parameter panel. This panel opens on the left side of the screen and is used to set up the parameters for data acquisition. In general, this panel can be collapsed once the data acquisition starts.

- Turns on the filter panel.

4.3 Basic Analysis Parameters for Data Acquisition

Data parameters are created by the program when the program detects that the parameter default file is missing. However, these values can be edited in the Parameter Panel (located on the left side of the screen) as shown in Figure 4.1. There are 7 parameters that affect the SE/IR data acquisition:

- Time Per Point or Sampling Rate means how often (in the time domain) the system will acquire data points within a given data trace. The default Sample Rate is set at 20 microseconds. This means the system will acquire data at 20 microsecond intervals.

- Number of Points Per Record or Record Size is the number of sampling points for each waveform. The higher this value, the more data is acquired in each waveform. The total time of a record (period of the waveform) is affected by both the Sample Rate and the Record Size. The default value for Point Per Record is 1024 points.

- # of Records is the total number of SE/IR data records you want to save per test location. The default value for # of Records is 3. For each record, a small check box will appear above the waveform plots indicating the color assigned to each record's waveform.

- Trigger Level is the minimum signal amplitude (in volts) required to trigger data acquisition. The default value for Trigger Level is 0.5 volts.

- Trigger Delay is the time (in microseconds) that data collection starts preceding the trigger event. The default value for Trigger Delay is 2048 microseconds.

- Channel Setup is the place to turn on and define the channels used in data acquisition. In Figure 4.1, the accelerometer is connected to Channel 5 and the hammer is connected to Channel 7. Please refer to the input module to identify the correct channel. Note that each unit may differ as the Freedom Data PC is customized to the needs of each client.

Analysis Parameters include:

- Concrete velocity is used to calculate shaft length. A concrete velocity of sound, normal strength concrete (12,500 ft/sec) is typically used. However, calibration can be performed on a shaft of known length. Velocity can be adjusted in the Toolbar below the Main Menu Bar.

- Filter settings. The Filtering Slider can be found directly above the Waveform Panel. High pass, Low pass or Band pass functions can be locked in by clicking on the appropriate box. It can also be manually entered by typing into the F1 and F2 fields. The default filter setting is 0-2000 Hz.

4.4 Gain Control

The transducer gain values can be increased or decreased manually using the green arrows located in the parameter panel (see Figure 4.1). The gain values should be set such that the %FS (Full Scale) shown above each plot during data acquisition is between 10-90%. Typical gain values are as follows: Instrumented Hammer ~ 1-2, Geophone ~ 5-50, Accelerometer ~ 2-20.

4.5 SE/IR Data Acquisition

When the channels and parameters are set up (and the hardware is connected according to Section 2.4), click on the “Start DAQ” button located in the lower left portion of the screen. Then an applet will appear as shown in Figure 4.2 below, prompting the user to assign a file name.

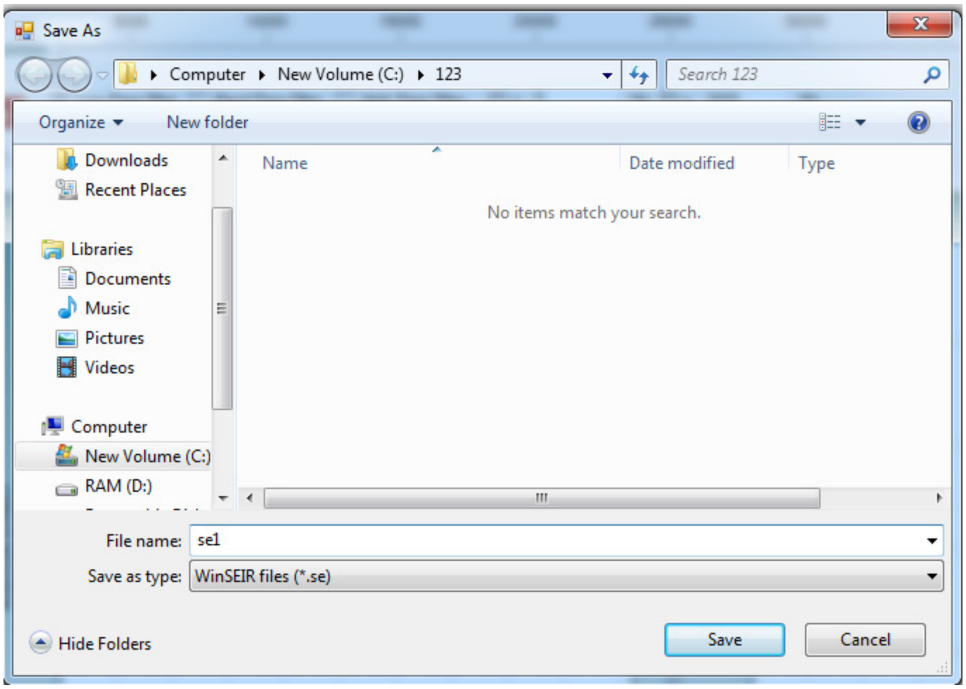


Figure 4.2 – "Save As" Applet

A waveform plot box will then open for each channel being used as shown in Figure 4.3 below. The status is highlighted in yellow and is in “Ready to Take Data” mode.

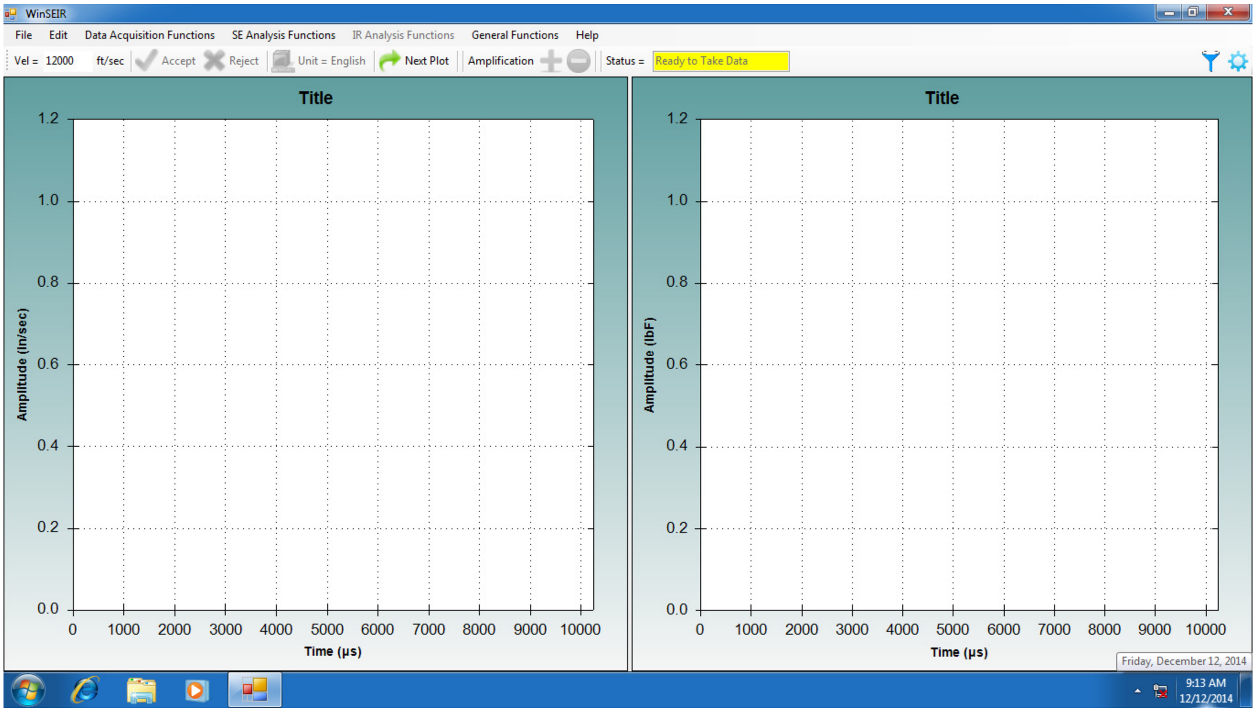


Figure 4.3 – Ready to Take Data

Strike the hammer against the surface of the shaft and a screen similar to Figure 4.4 below will appear as the waveform data is collected by the software and displayed on the waveform plots. In the example figure below, the left plot is displaying data from the accelerometer and the right plot is displaying data from an instrumented hammer. The status is highlighted in yellow and is in “Accept or Reject” mode.

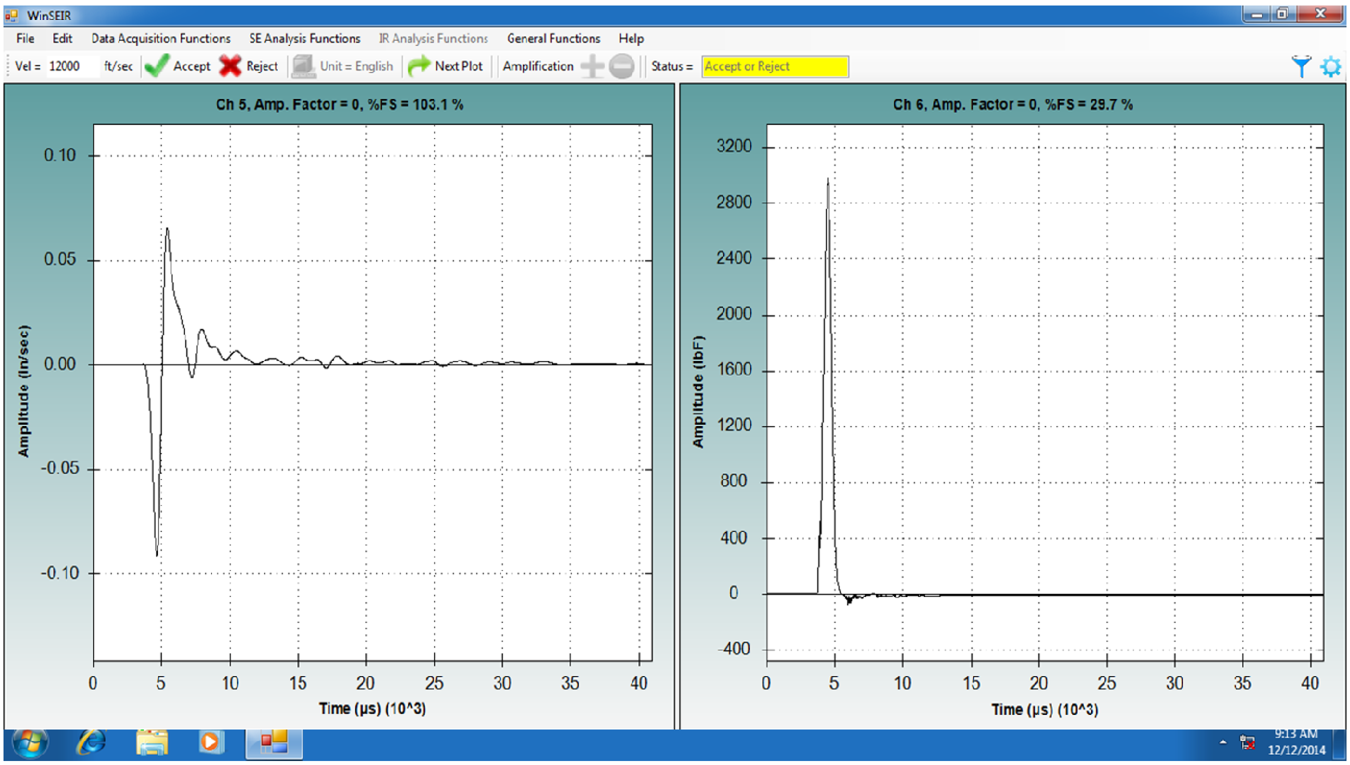


Figure 4.4 – Accept or Reject Data

If the quality of data is acceptable, click on the green "check" on the Toolbar to accept the data. If the quality of data is not acceptable, click on the red "cross" on the Toolbar to reject the data and repeat the test. Continue collecting data until you have completed the number of tests originally specified in the parameter setup under "# of Records". Each time the hammer is impacted against the shaft top, another set of waveforms (in a different color) will be plotted on the waveform plots as shown in Figure 4.5 below. When the specified number of tests has been completed, the status is highlighted in yellow and is in "Testing Complete" mode.

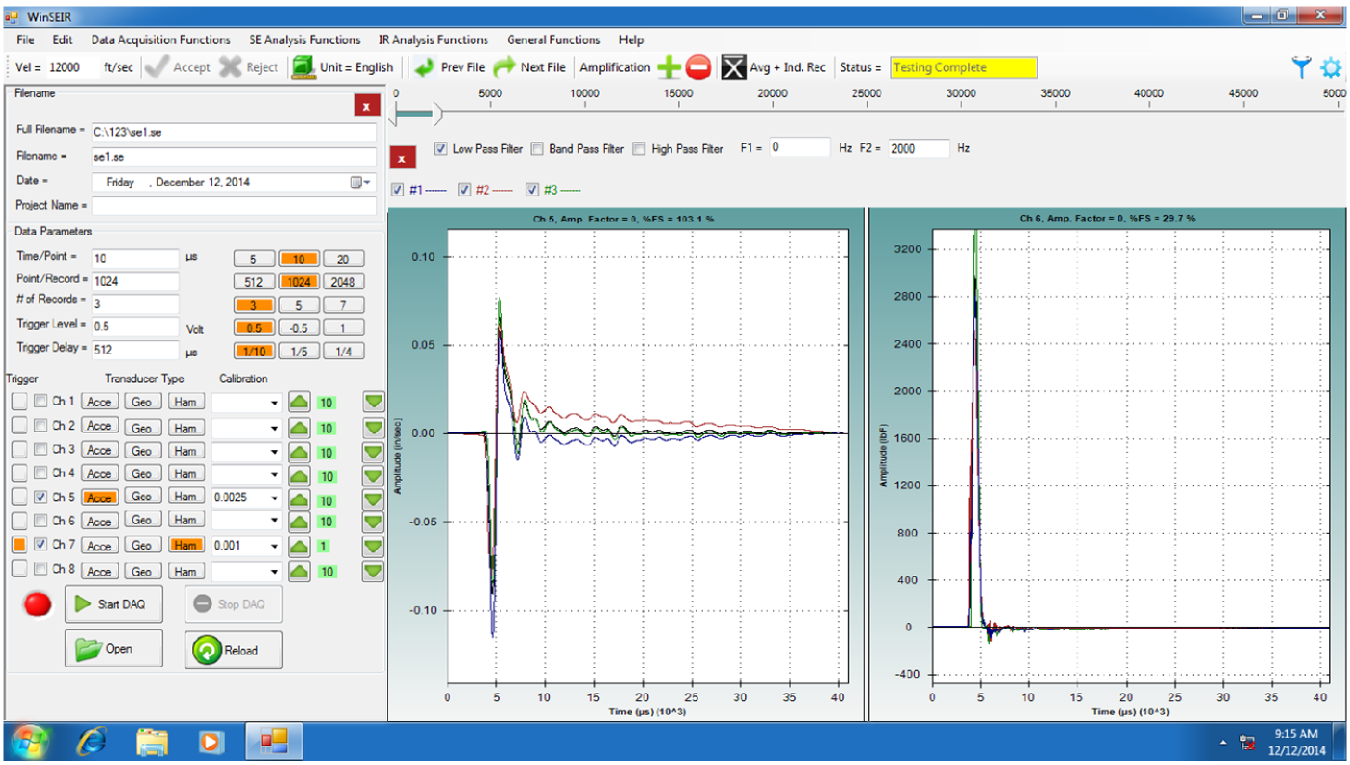


Figure 4.5 – Testing Complete

5.0 WinSEIR DATA ANALYSIS

5.1 Open Data

To open previously collected files, go to “File/Open” (or click on the “Open” button at the bottom left portion of the screen) and select the filename to be opened. If you do not immediately see your data, check the drop down box beside the “File name” field to help locate data with different file extensions.

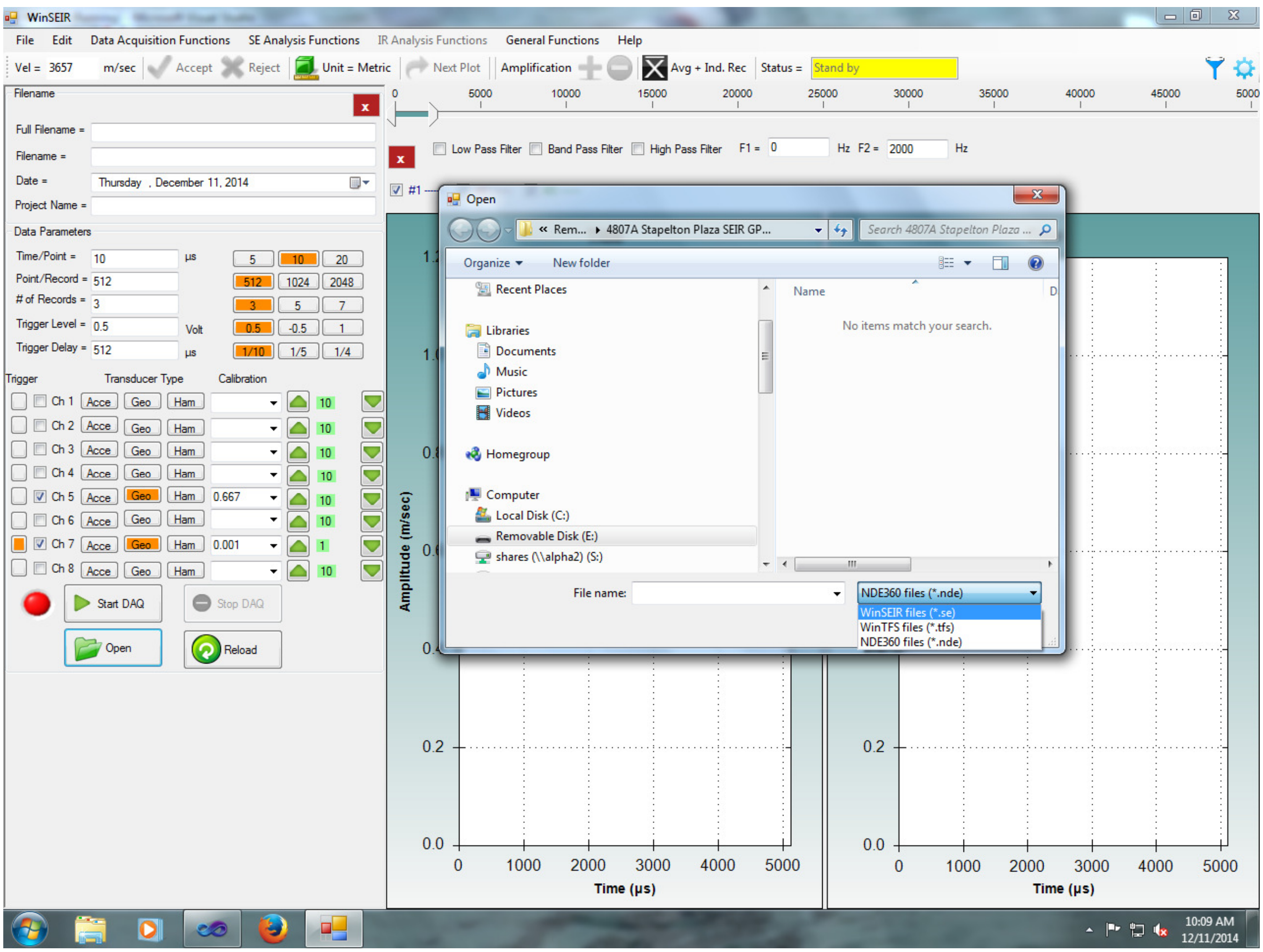


Figure 5.1 – Open File

After you have selected the file you want to open, the waveform data will be displayed on the screen as shown in Figure 5.2 below. The status is highlighted in yellow and is in “Analysis” mode.

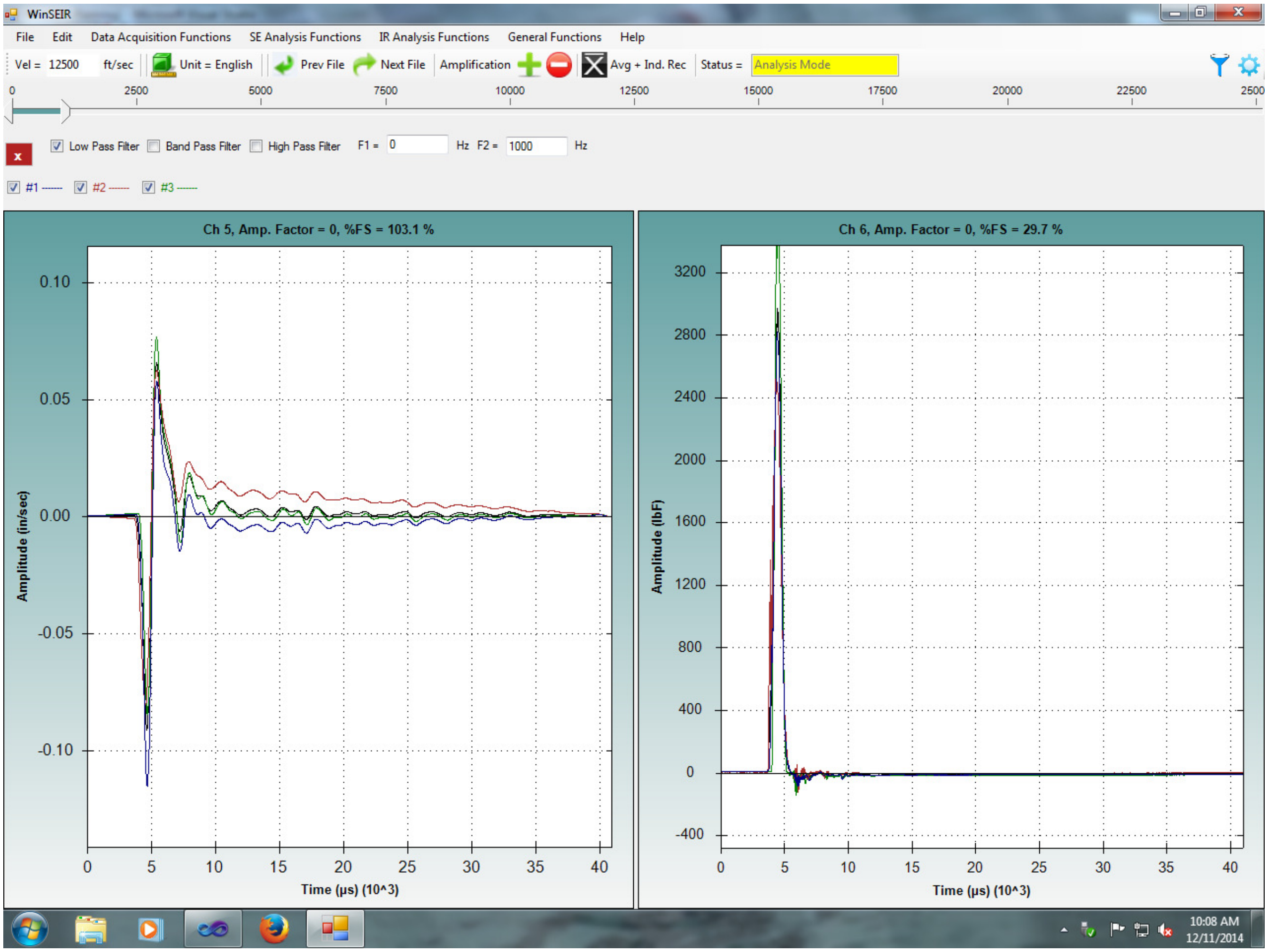


Figure 5.2 – Analysis Mode

The square, black cross button on the Toolbar can be toggled on and off between “Avg” and “Avg +Ind. Rec”. When “Avg” is active, all of the selected records are averaged into one waveform. When “Avg + Ind. Rec” is active, the software displays the average waveform as well as each individual waveform. (See Figure 5.3 and Figure 5.4)

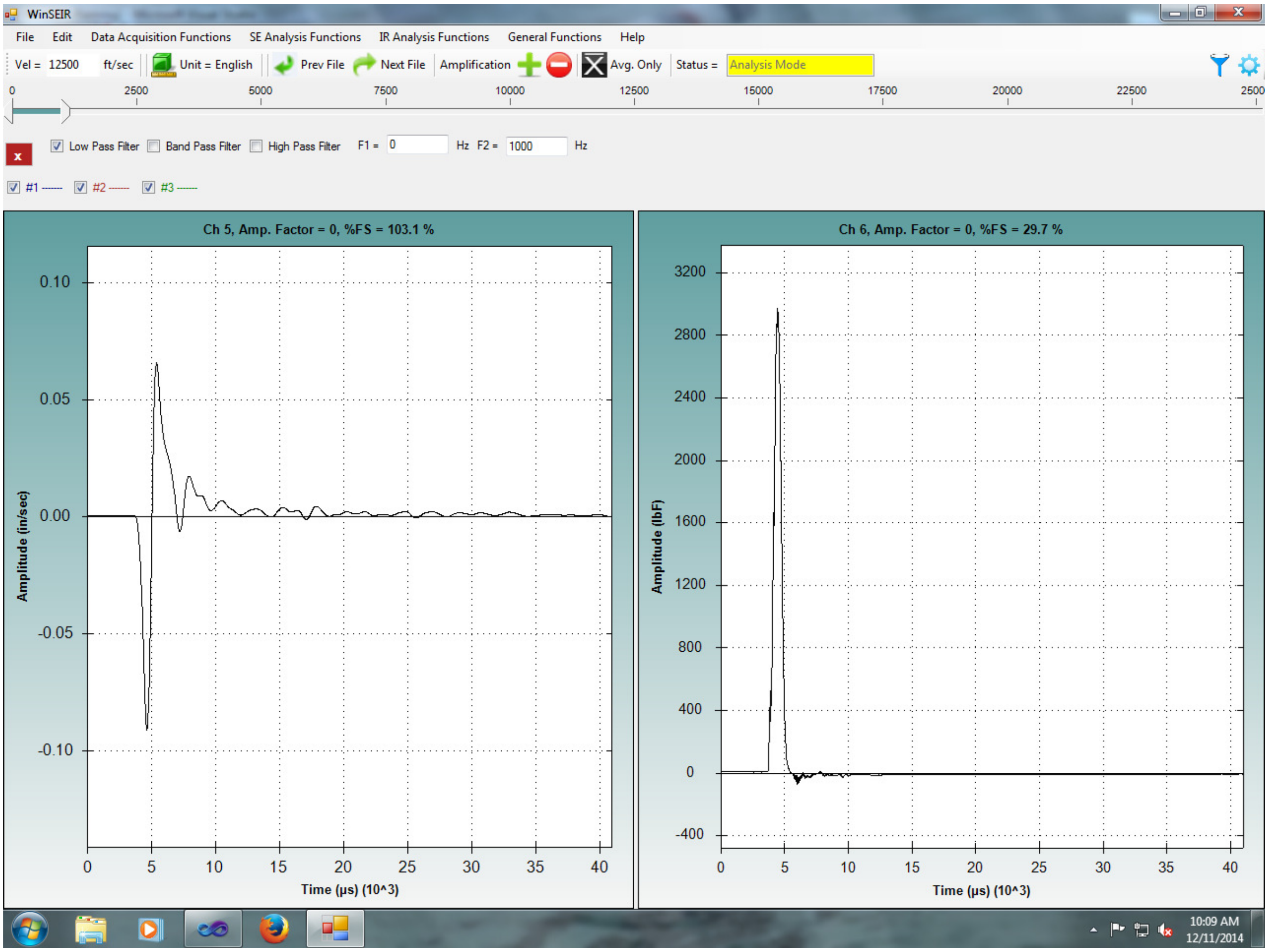


Figure 5.3 – Average Waveform of all Three Records

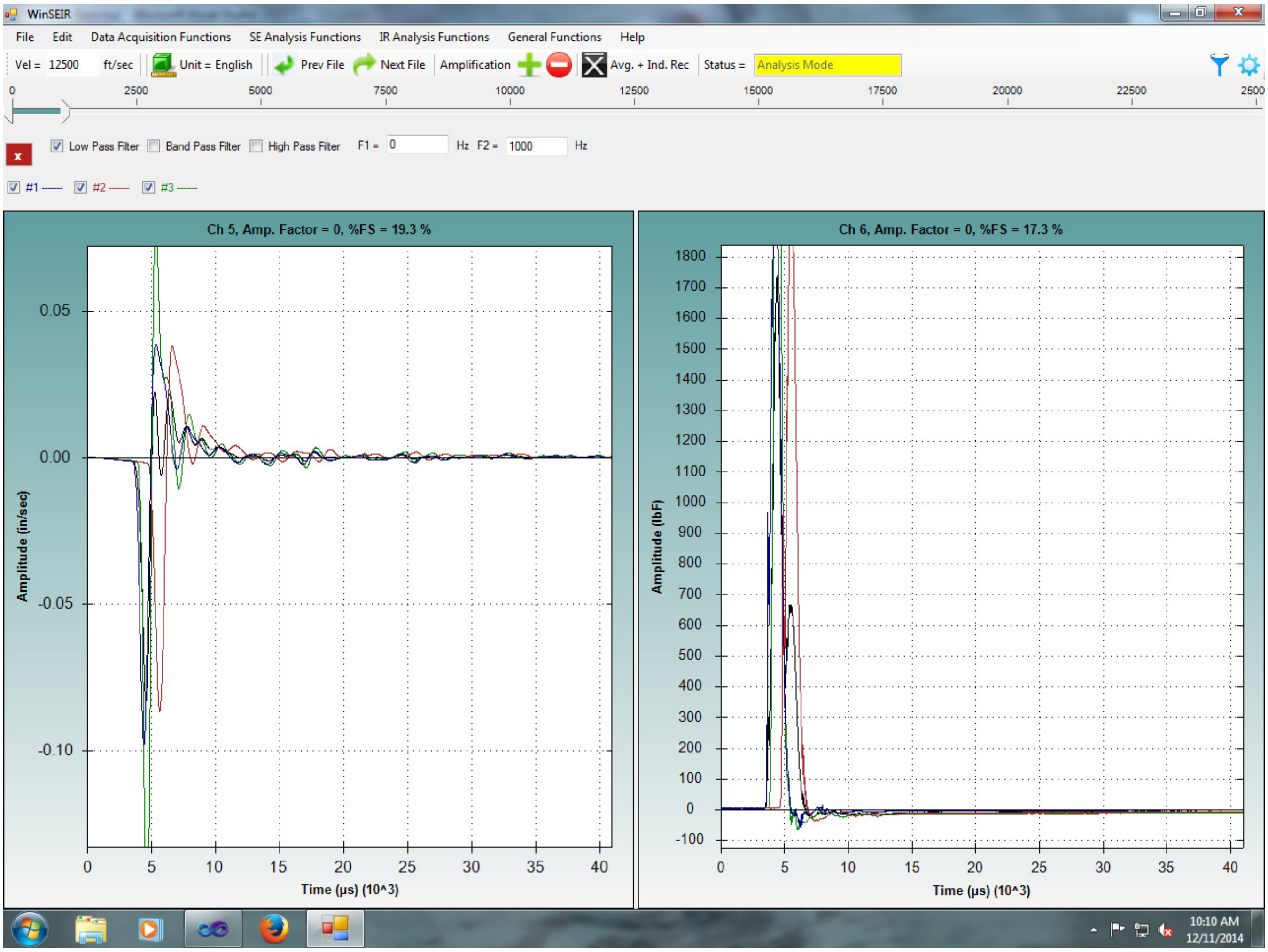


Figure 5.4 – Average and Individual Waveforms

Individual waveforms can removed from the analysis by clicking on the box indicating the number and color of the waveform you want to remove. Per Figure 5.5 below, Record #2 (red) has been removed from the analysis. This is useful when a bad record is accidently collected or if the record appears to be outside the norm for the rest of the data. Once removed, this waveform is not included in the average. (See Figure 5.6.)

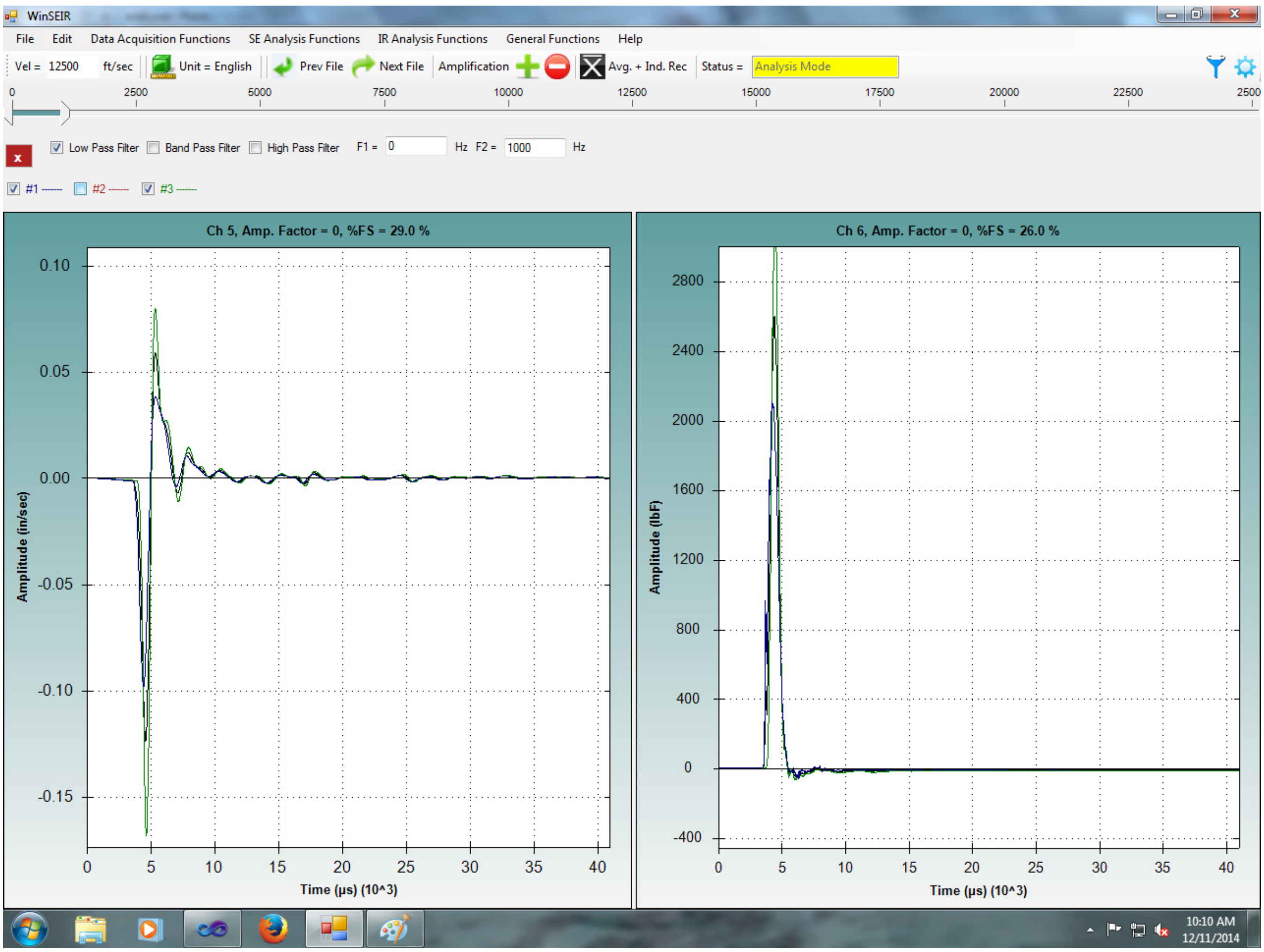


Figure 5.5 – Record #2 Removed from the Analysis

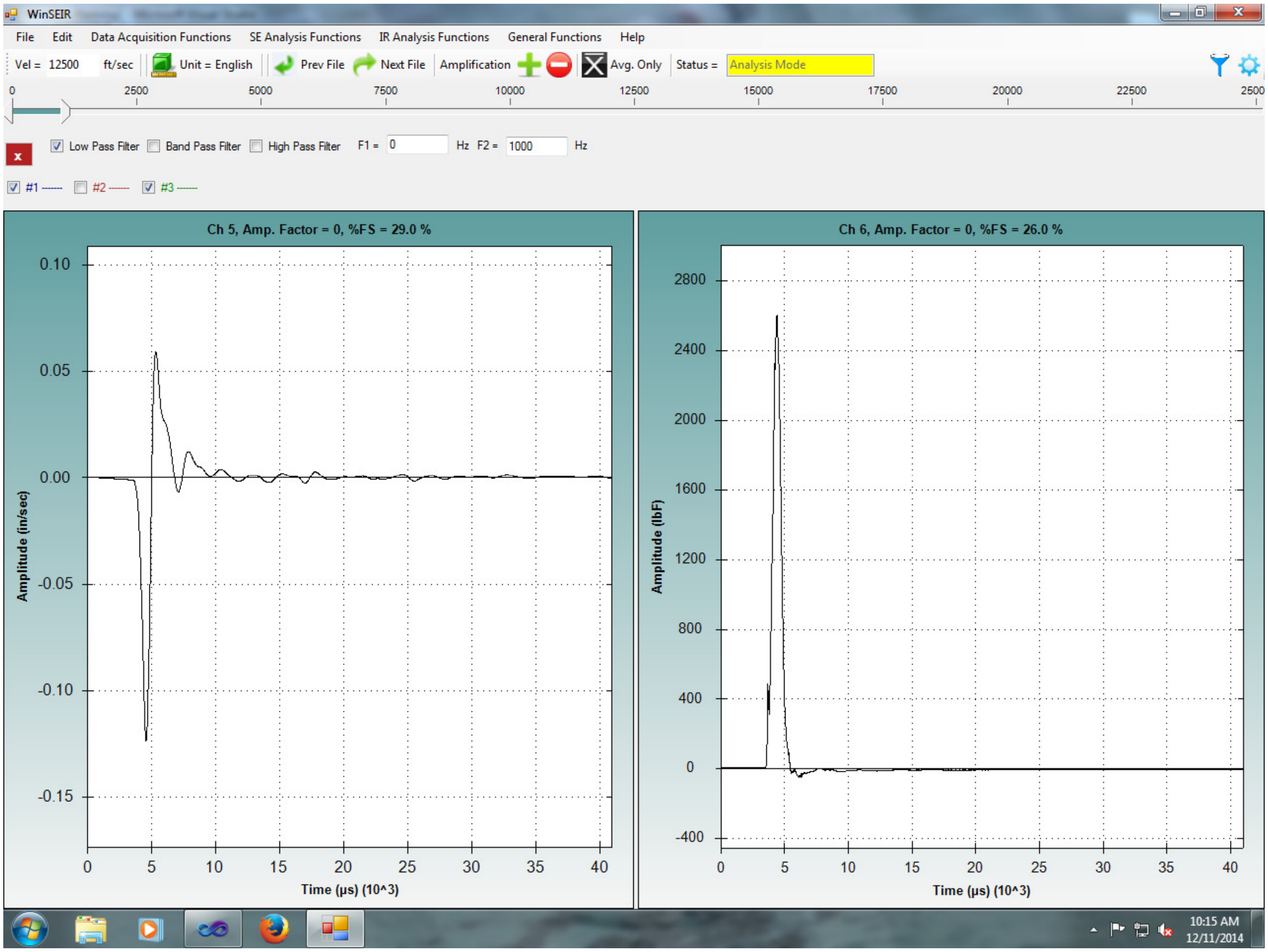


Figure 5.6 – Average Waveform after Removal of Record #2

5.2 Zoom In/Out

An Automatic Zoom In/Out feature is implemented in the software and allows the user to zoom in/out on the X axis. The zoom feature can be used by going to "SE Analysis Functions/Auto Zoom" or "IR Analysis Functions/Auto Zoom". In addition, you can zoom in on both the X and Y axis by creating a box around the area of interest. This is accomplished by holding down the left click button and dragging the mouse to create a box around your area of interest. Release the left click button when the box is the desired size.

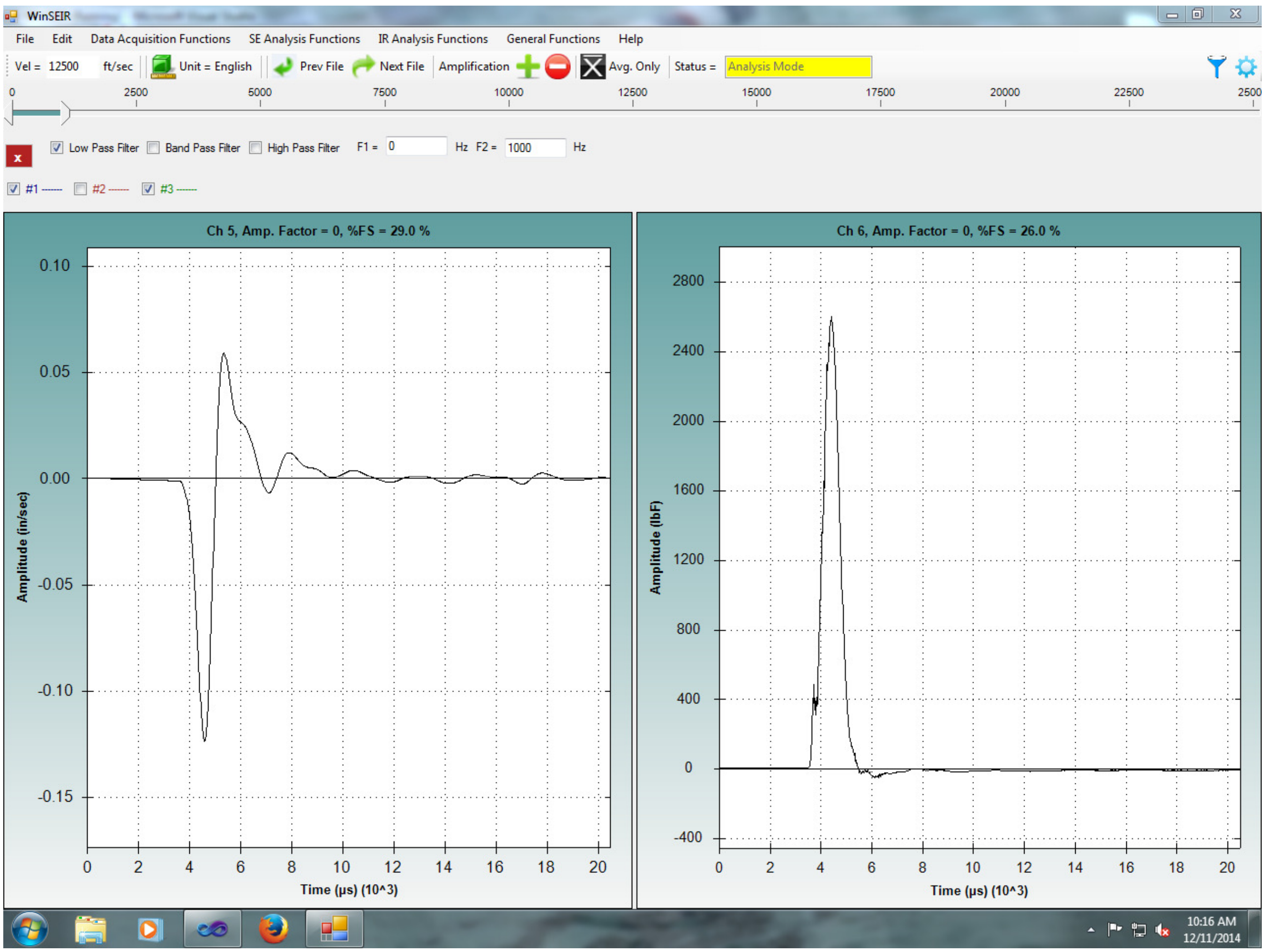


Figure 5.7 – Zoom

5.3 Amplification

The data can be amplified exponentially using the +/- buttons on the toolbar to increase and decrease the amplification factor. This feature can make the bottom echo clearer.

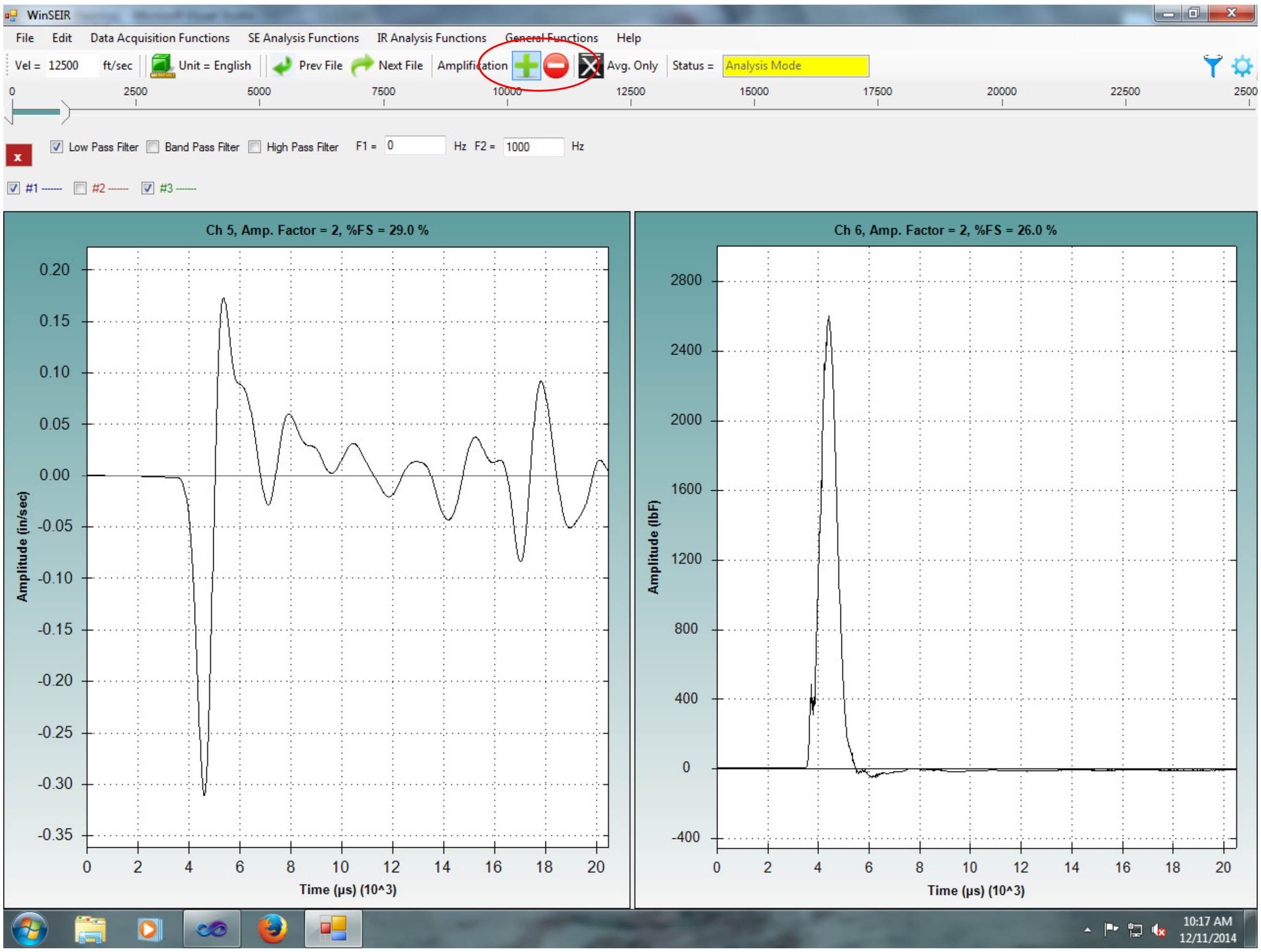


Figure 5.8 – Amplification

5.4 Using SE to Identify Shaft Depth

SE data is analyzed by picking the troughs in the wave form. This is done by placing the mouse cursor on the lowest point of the trough and left clicking the mouse as shown in Figure 5.9 below. The first trough representing the initial impact should be selected, along with the subsequent trough deemed to represent the shaft bottom (or other significant reflection). Based on these picks, the shaft depth will be automatically calculated and displayed at the top of the waveform panel. If an error is made or if you want to adjust your pick selection, you can double click to clear previous selections. If multiple picks are made at locations where multiple echoes appear in the waveform, the depth value will be averaged.

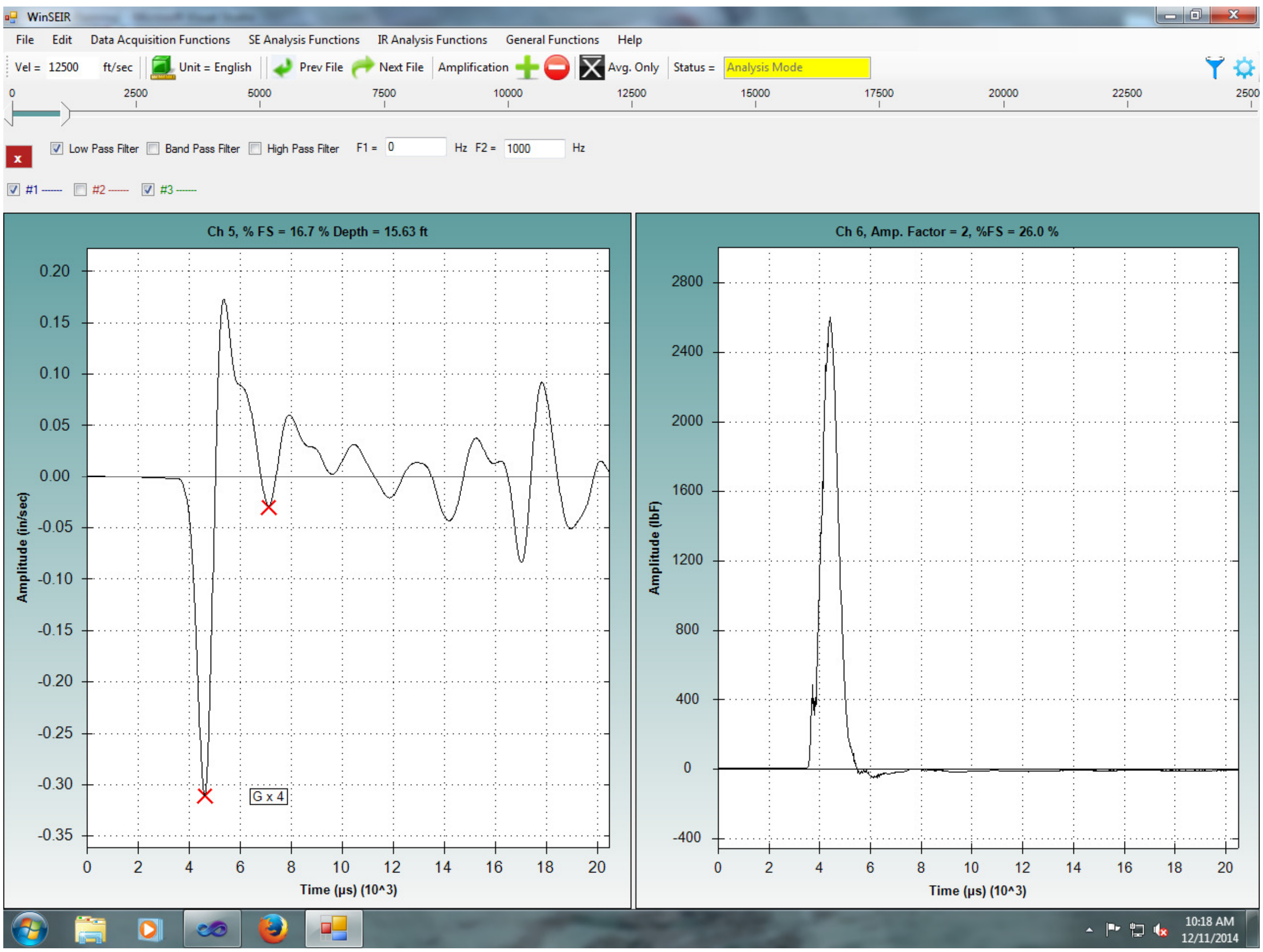


Figure 5.9 – Analysis of SE data

5.5 Using IR to Identify Shaft Depth

If the SE/IR data is collected with an instrumented hammer, impulse analysis can be performed by going to "IR Analysis Functions/Display Impulse Response". Along with the original SE accelerometer or geophone waveform, two additional plots will be displayed: IR Magnitude Response and IR Coherence as shown in Figure 5.10 below.

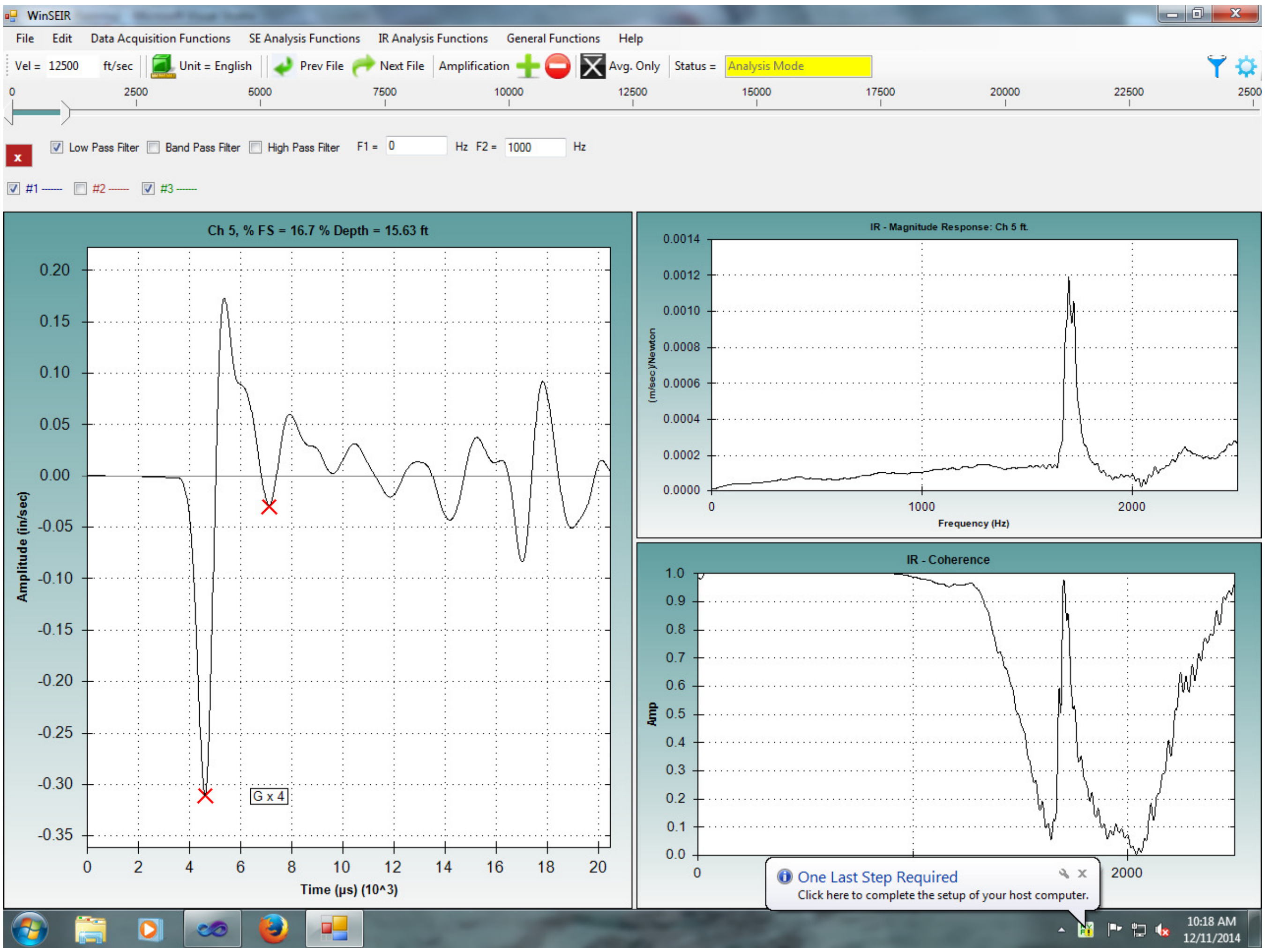


Figure 5.10 – Display of IR Data

IR data quality is high when coherence approaches 1.0. In this example, that occurs between 0 and 1000 Hz. In Figure 5.11 below, zoom has been used to focus on this frequency range.

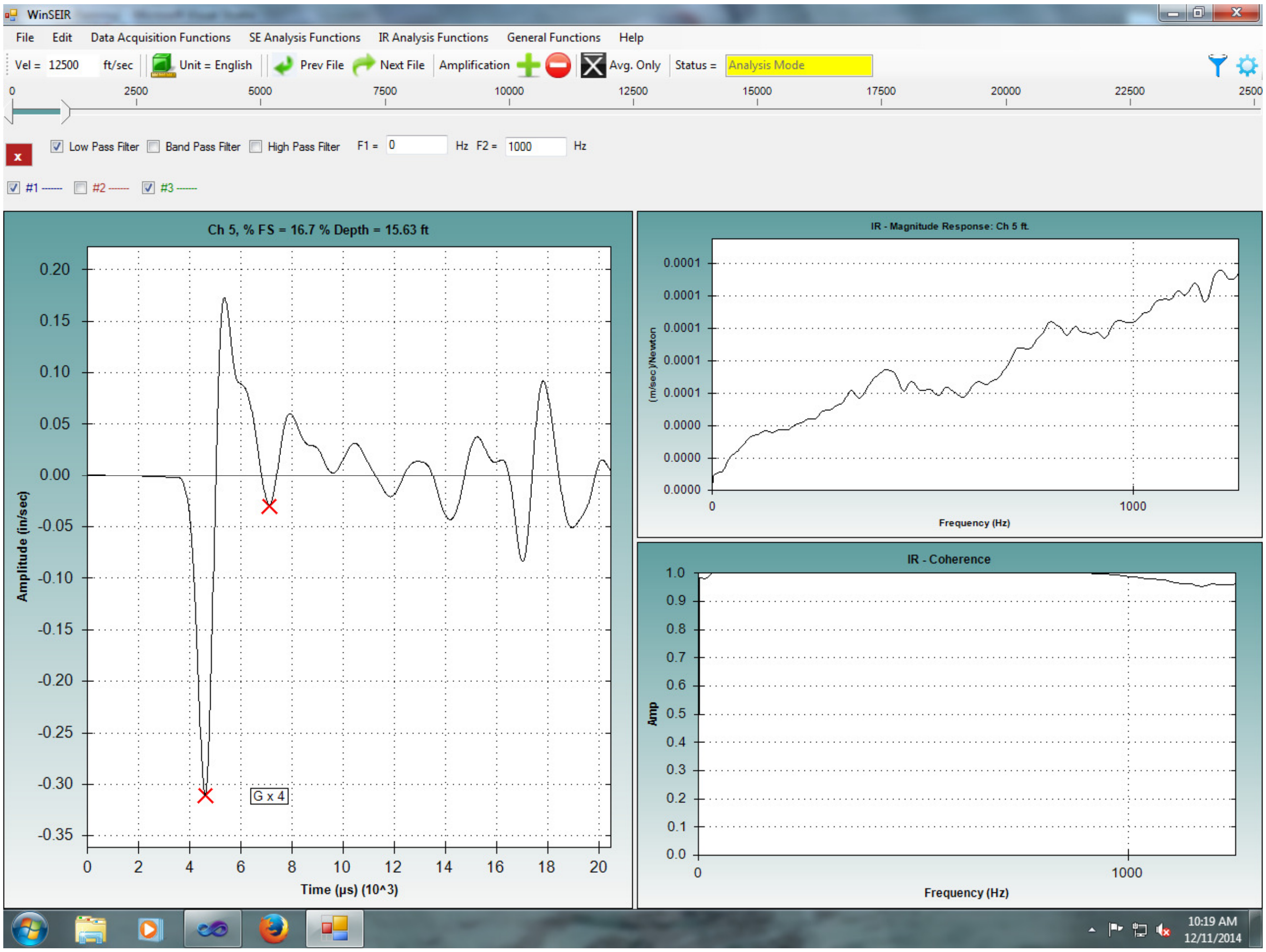


Figure 5.11 – Zoom in on Data with High Coherence

IR data is analyzed by picking the peaks in the Magnitude Response waveform. This is done by placing the mouse cursor on a peak and left clicking the mouse as shown in Figure 5.12 below. This should be repeated on each peak, moving from left to right. Based on these picks, the shaft depth will be automatically calculated and displayed at the top of the waveform panel. If an error is made or if you want to adjust your pick selection, you can double click to clear previous selections. As multiple echo peaks are selected in the waveform, the depth value is averaged.

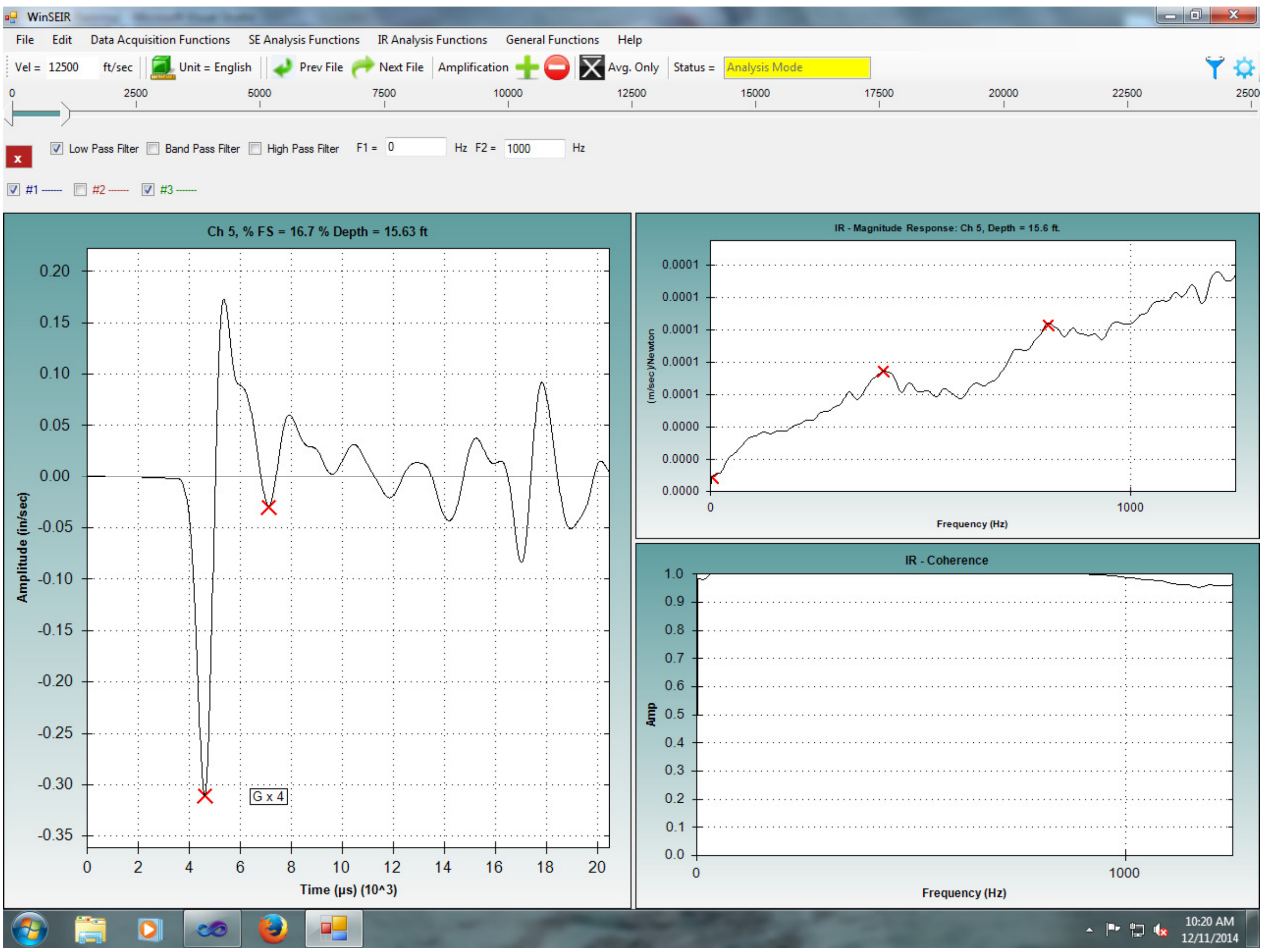


Figure 5.12 – Analysis of IR Data

5.6 Next File/Previous File

If the data filenames have the same alphabetical prefix and are numbered sequentially in the suffix, it is possible to scroll quickly through the data. Click on the “Next File” or “Previous File” button on the Toolbar to move to the next data file.

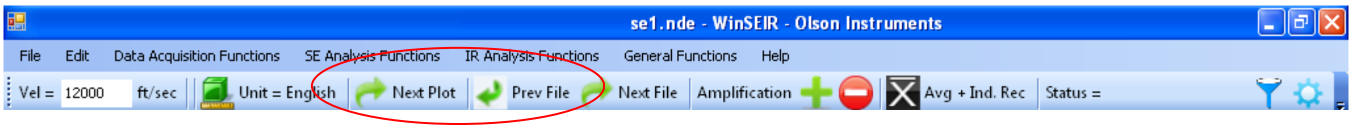


Figure 5.13 – Next File/Previous File

5.7 Unit Conversion

Click on the “Unit” button on the Toolbar to switch to Metric units or English units. This is a toggle button between English and Metric Units.

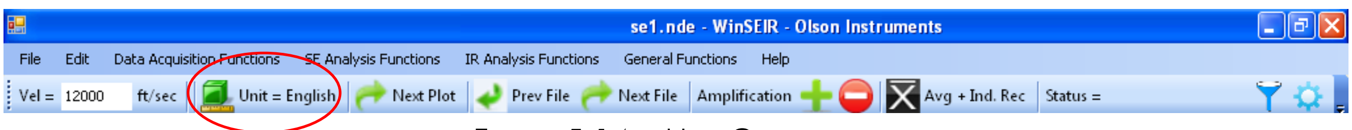


Figure 5.14 – Unit Conversion

5.8 Calibration Database

The software has a built-in database for the calibration values of the transducers/hammer. To edit the database, go to the Main Menu and select “General Functions/Enter Calibrations” and an applet will appear as shown in Figure 5.15 below that allows input of transducer/hammer calibration values into the database.

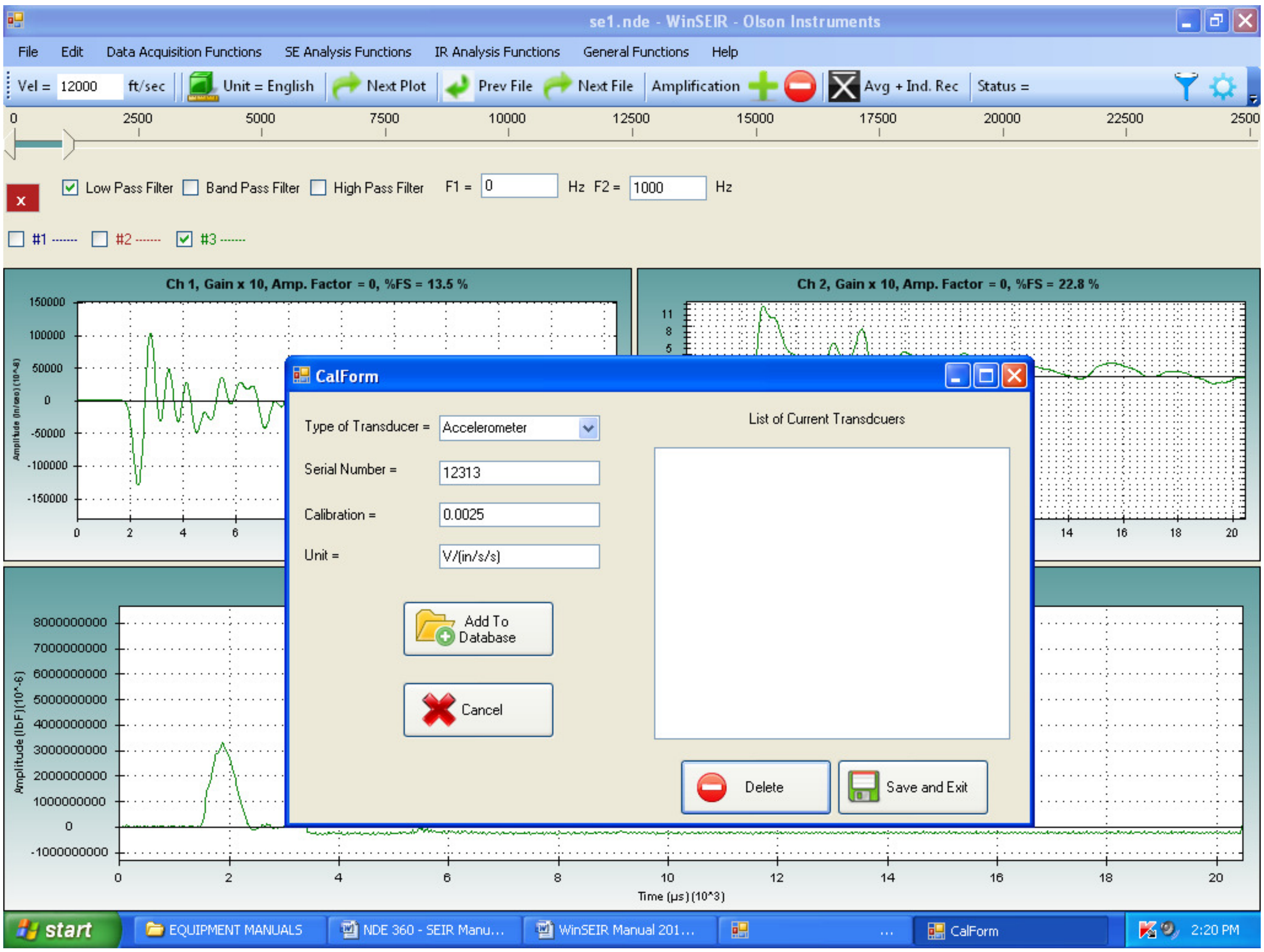


Figure 5.15 – Calibration Database

6.0 WinSEIR SOFTWARE EXPORTING OPTIONS

6.1 Copy Image to the Clipboard

After analysis, displayed plots can be copied to the clipboard for easy pasting into reports or other documents. Go to “Edit/Copy Current SE Plot” or “Edit/Copy IR Plot” to copy the desired plot to the clipboard.

6.2 Save Image to .jpg

After analysis the displayed plots can be saved to .jpg format. Go to “File/Save Current SE Image” or “File/Save IR Plot Image” to save the desired plot in .jpg format.

6.3 Export Waveform to a Comma Separated Format

The raw waveform data can be exported to a text file readable by Excel, MatLab, or similar programs by going to the Main Menu and selecting “File/Export Raw Data to Comma Separated Format”.