ES Control User Manual

593-00870-01
Revision C

CONTACT INFORMATION

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1. Introduction

The ES Control software application provides the graphical user interface capable of controlling the firing of seismic sources and provides tools to set parameters and monitoring operations on the auxiliary devices GSIx and SDRx (see appendixes 1 and 2 for hardware information).

Data from these devices is collected via LAN using ES Control or GSR reader software or connect it directly to the GeoReaper servers through the Ethernet switch. For SDRx data is typically retrieved by removing the flash card and downloading the data using the CardReader Software.

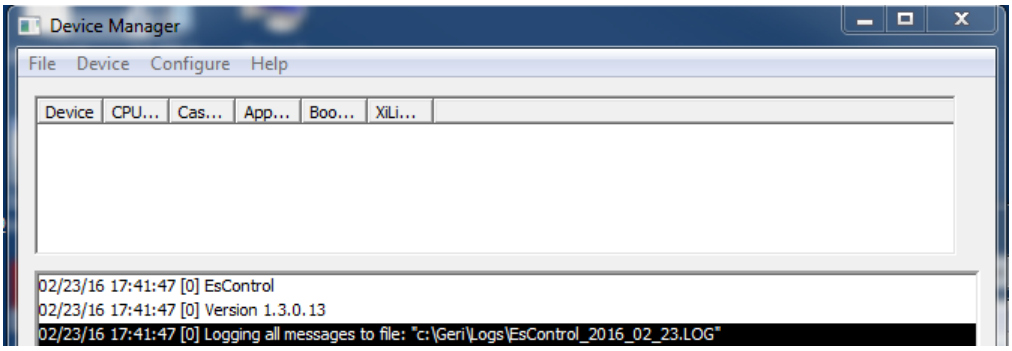
2. Device Manager

It is the software used to interface with auxiliary devices and setup general operational parameters

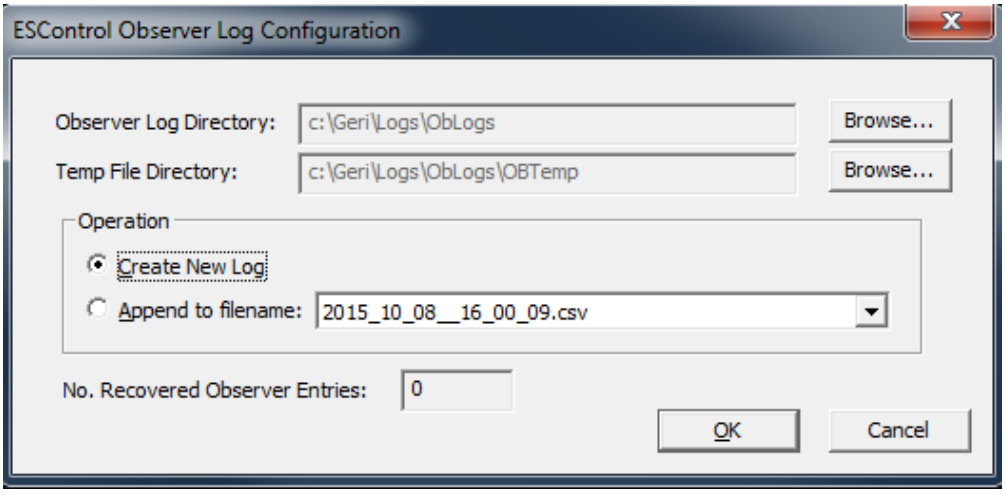
2.1 Configuration

To open ES Control, double-click the **ES Control** icon:

A **Device Manager** window opens:



The **ESControl Observer Log Configuration** window appears:



Browse to select the directories where you want log files to be generated:

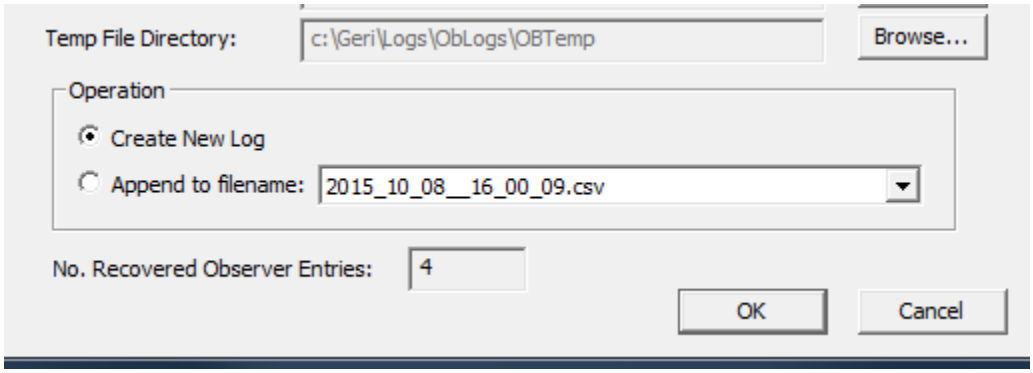
- **Observer Log Directory**: Location where observer's logs will be available at the end of the operation.
- **Temp File Directory**: Temporary location where log files are updated each time a new trigger event is acquired. When the program is closed, the log file will be moved to the Observer Log Directory.

The following options are available in the **Operation** section of this window:

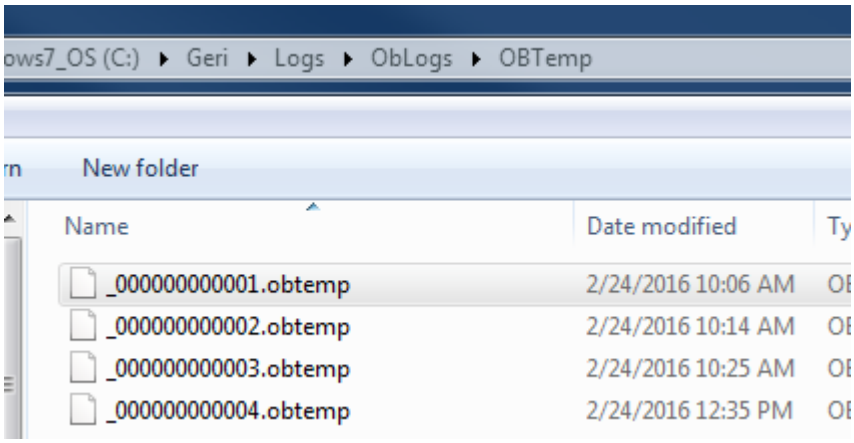
- **Create New Log**: When this option is selected, a new log is created. The first line of the log file will correspond to information associated to the first trigger after ES Control software is ready.
- **Append to Filename**: When this option is selected, information associated to the first acquisition performed after ES Control software is ready will be attached to the previous log file selected from a drop-down list with the last 25 log files.

No. Recovered Observer Entries: If the ES Control program closes without properly generating the Observer log file, the system shows the quantity of Entries to be recovered.

The example below shows the No. Recovered Observer Entries: **4**

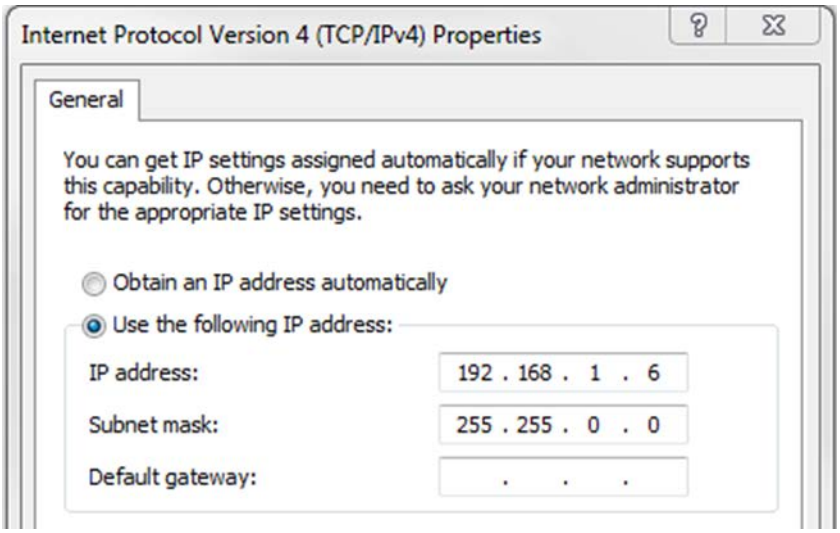


These four entries are located in the designated Temp File Directory (in this case, named "OBTemp":

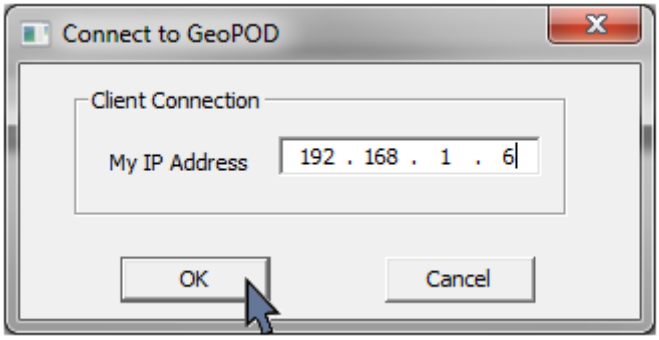


They will be recovered the next time the program closes properly.

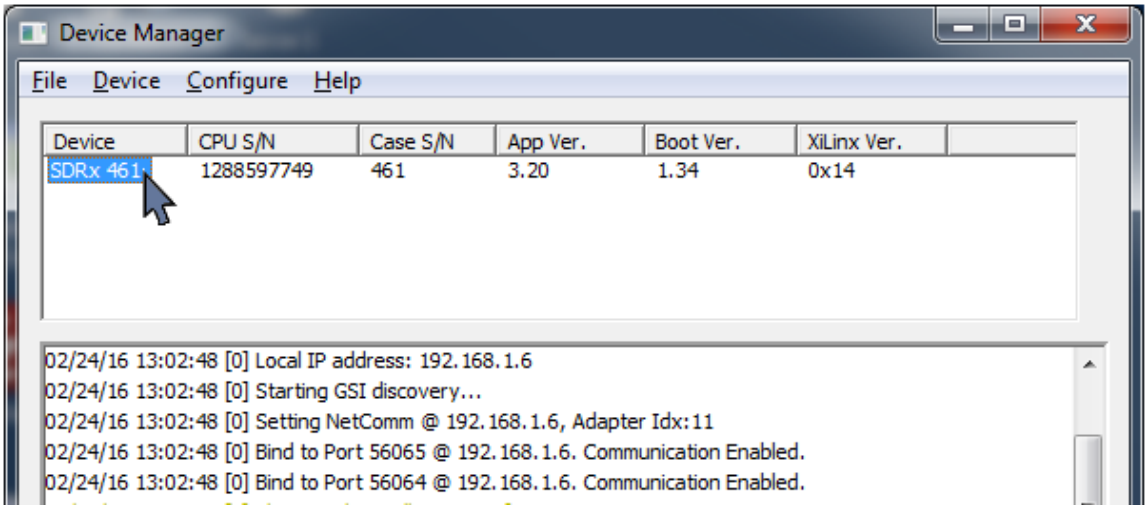
To set-up the proper Ethernet interface between a computer using ES Control software and GSIx SDRx auxiliary devices, set the Local Area Connection Properties for TCP/IPv4 to a fixed IP address type **192.168.xxx.xxx**. See example below with setting of IP address for internet protocol version 4 to **192.168.1.6**:



When ES Control software is opened, use the **Connect to GeoPOD** window to designate the IP address selected in the LAN port where auxiliary devices connect, and click **OK.**



When communication is established with auxiliary devices, the main panel shows:



- **Device type**: all devices connected to the program through the LAN port associating the type and unit serial number, one line per device.
- **CPU S/N:** the internal device's serial number
- **Case S/N**: device's serial number
- **App. Version:** the APP version installed in the device
- **Boot Version**: the Boot version installed in the device.
- **XiLinx Version**: the Xilinx version installed in devices.

Note: Verify if the installed versions are compatible with associated GeoRes XTC software.

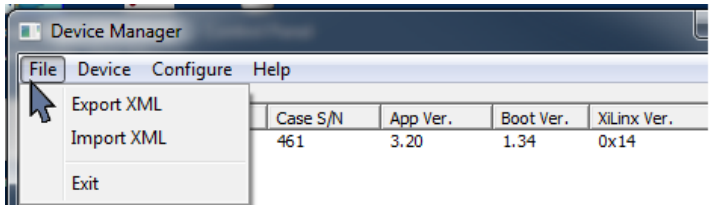
The ES Control window opens automatically when communication is established. In case it is not shown on the screen, double-click on the device's line.

2.2 Toolbar panel

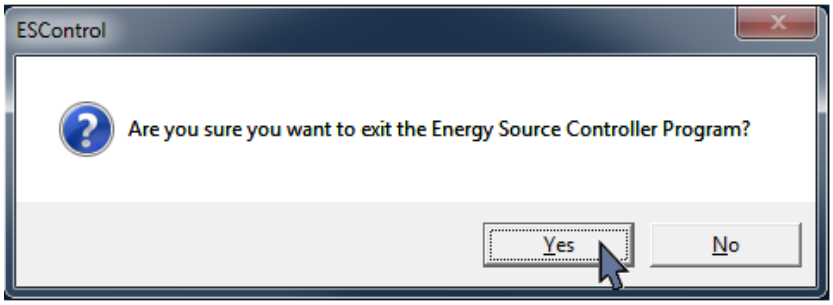
Tools available in the **Device Manager** environment are:

2.2.1 File menu

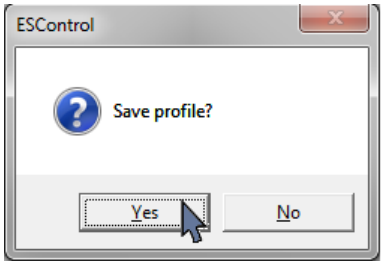
To export or import xml parameters, or exit the software:



- **Export XML:** To export a file that includes all Device Manager operation parameters. If several devices are connected, file includes setting for each one of the units.
- **Import XML:** To import all Device Manager Parameters using a previously exported parameter file.
- **Exit:** To exit the program, click **Yes** to confirm exit.



Select if you want to save a profile:

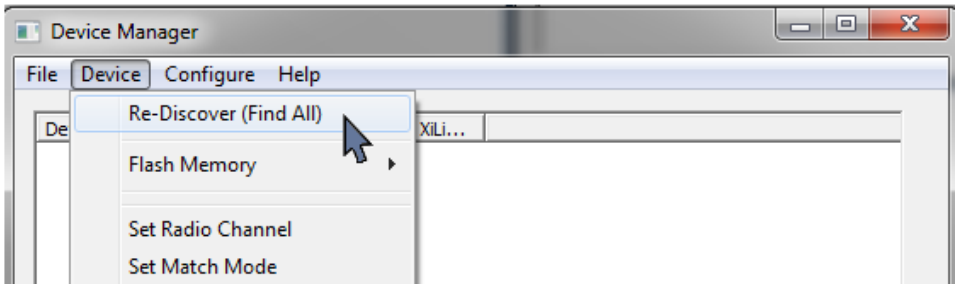


- **Yes**: The current parameters configuration is internally saved and it will be used next time the program is opened.
- **No**: Parameter configuration file is not updated.

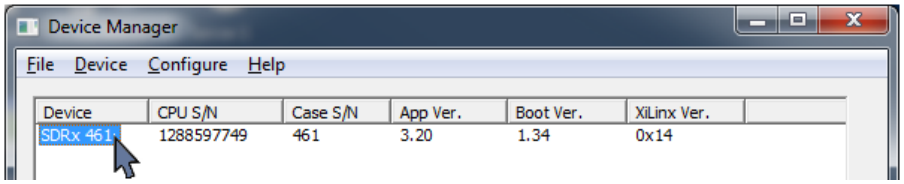
2.2.2 Device menu

To select operation in selected devices:

- **Re-Discover (Find All):** If for any circumstance, devices are not available on the main panel, you can associate them using this function.



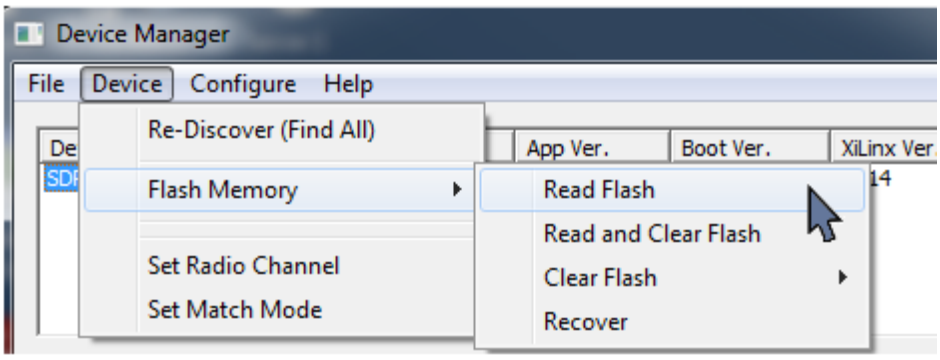
After the device is available, click on its description in the Device Manager window to open its specific **ES Control** window:



- **Flash Memory:** To perform operations related to the memory in auxiliary devices:

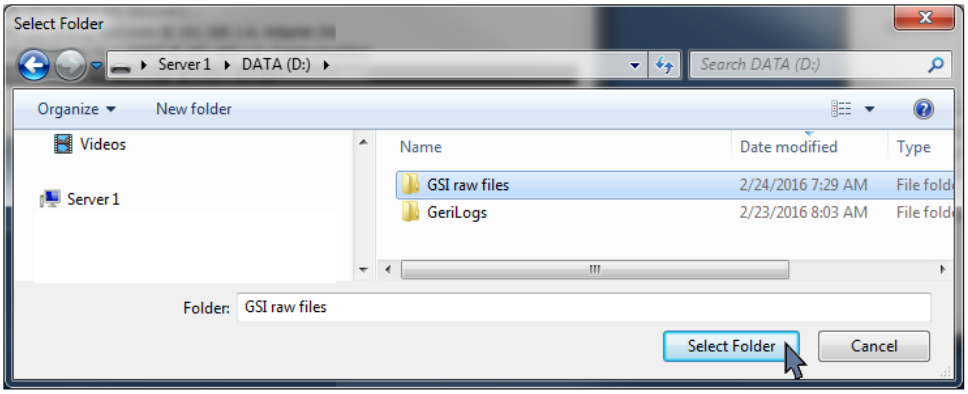
  – **For GSIx:** this function performs operations to the internal memory.

  – **For SDRx:** By default this function operates on the external flash card. To enable operations for internal memory, the external card must to be removed from the slot.

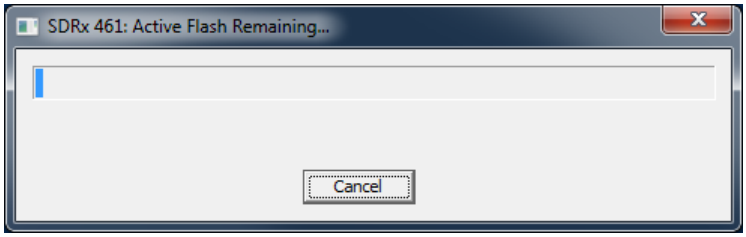


- **Read Flash:** To read data from auxiliary devices:

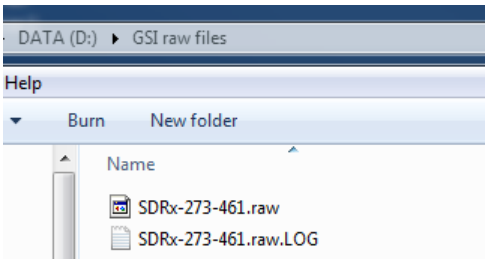
  In the next window, select a folder with available space where raw files will be stored:

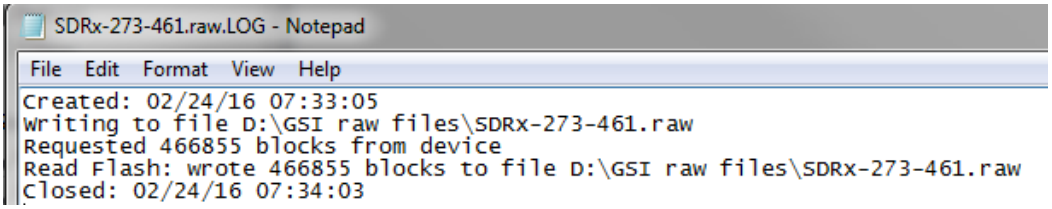


  A window pops up indicating the progress of the operation:

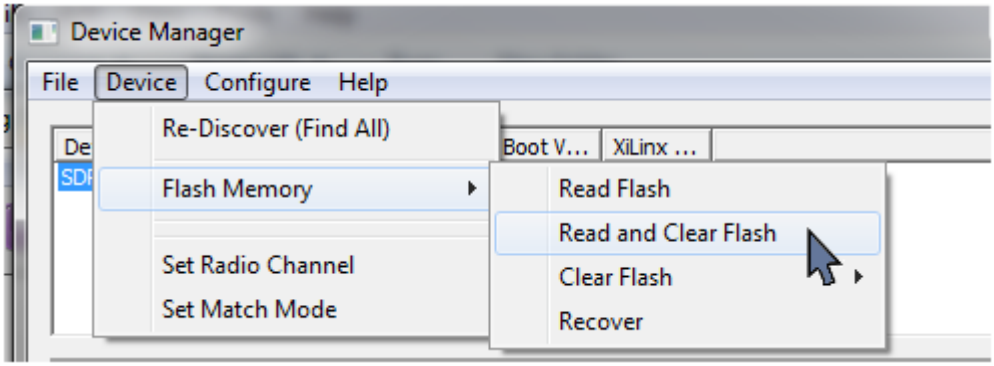


  A log file is created together with the raw file in the selected directory:

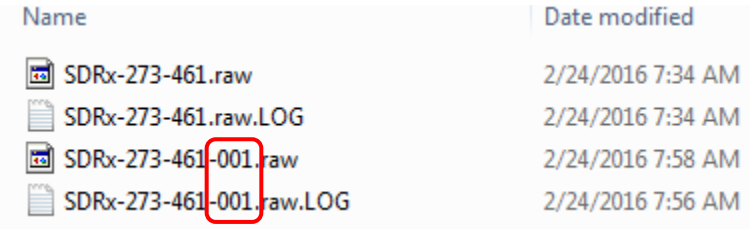




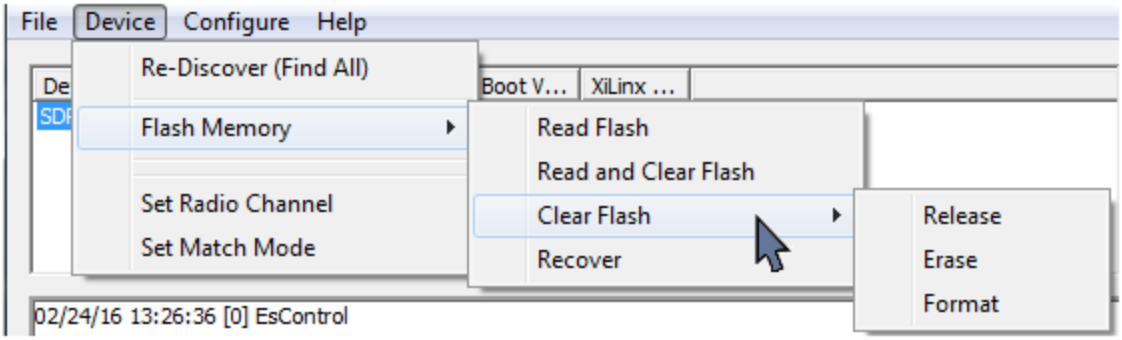
- **Read and Clear Flash:** To read data from auxiliary devices and clear the memory after data is successfully saved in a selected folder.



Raw file and log files are created in selected folder. In case data from same device was read before, the software does not overwrite old files; it creates new files adding to the end of the device name a sequential number. Example below shows files results after reading SDRx 461 twice:



- **Clear Flash:** to clear the flash memory.



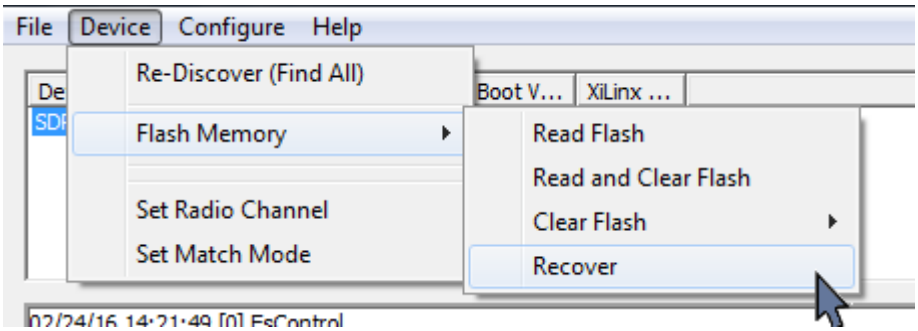
The following options are available:

- **Release:** release the memory, erasing the data.
- **Erase:** clear the memory in GSIx, or delete all data in SDRx.

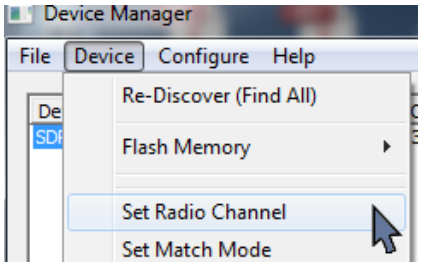
Note: Clearing flash in GSIx generates a timing mark (same as GSXs), allowing future recovery of old data.

- **Format:** to format the auxiliary device's memory; all data will be deleted and device starts recording from beginning of memory.

- **Recover:** unerases the device's internal memory (valid for GSIx only):

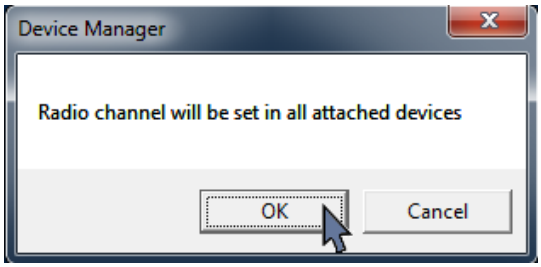


- **Set Radio Channel:** SDRx has a radio to allow communication with LineViewers. Use this tool to set the radio channel in all connected SDRx devices. GSIx does not have an internal radio.

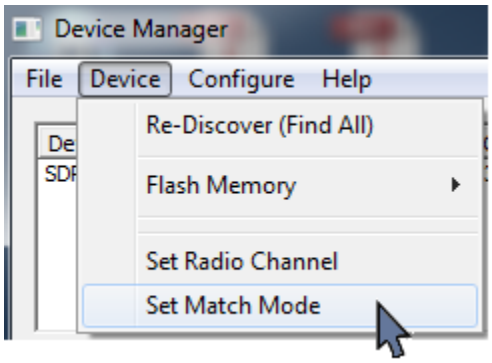


The program uses the channel previously saved in local profile.

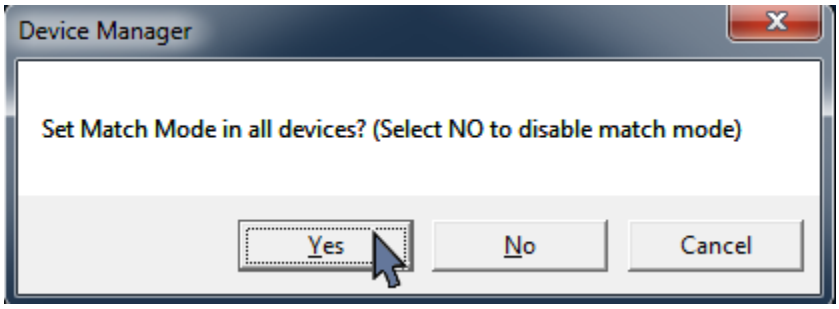
Click **OK** in the dialog box to program the radio channel previously saved in the local profile into all connected devices:



- **Set Match Mode:** This tool is available to make older models of auxiliary devices (SDR and GSI) compatible with newer versions of acquisition devices, they must to be set to match mode to have the same filter response as GSXs.



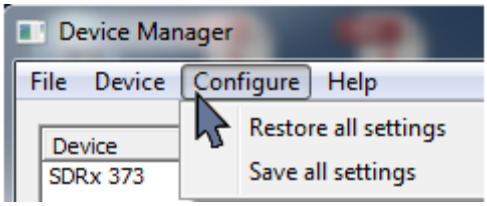
Select the menu item **Set Match Mode**, and then click **Yes** in the resulting dialog box.



Note: This mode does not apply to GSIx or SDRx.

2.2.3 Configure menu

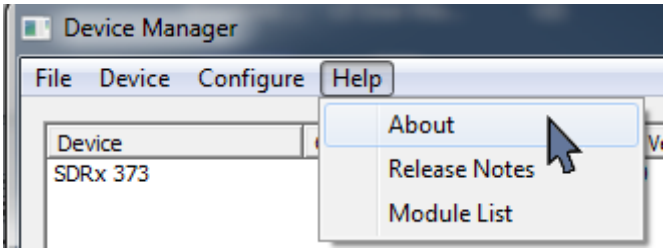
To save or restore operational parameters:



- **Restore all settings:** All settings are restored from internally saved Device Manager parameters.
- **Save all settings:** Saves internally all settings for Device Manager parameters.

2.2.4 Help menu

To see useful information about ES Control software:

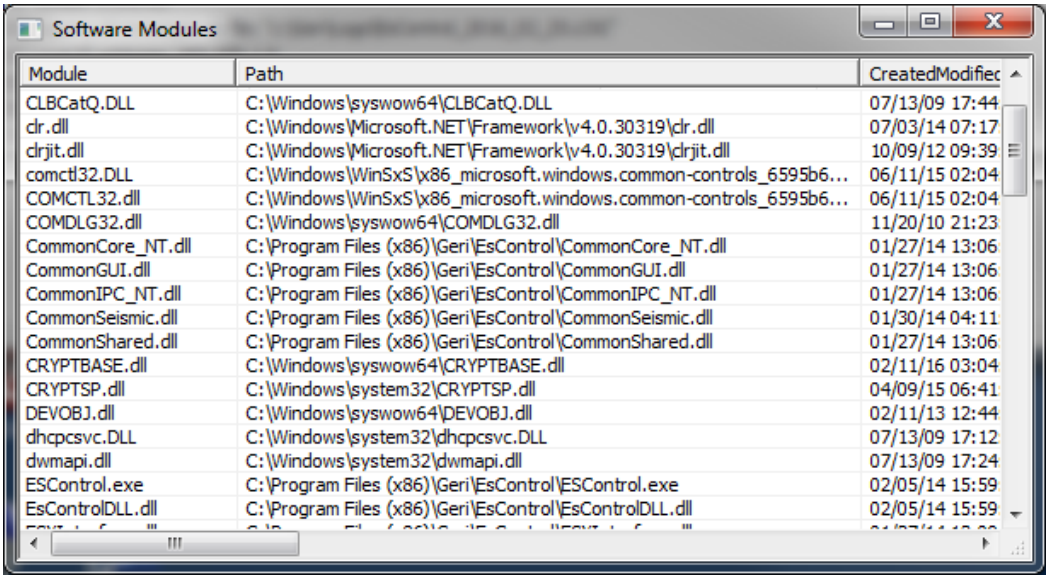


- **About:** shows detailed information about version installed in the computer:

- **Release Notes:** shows information about latest released version:

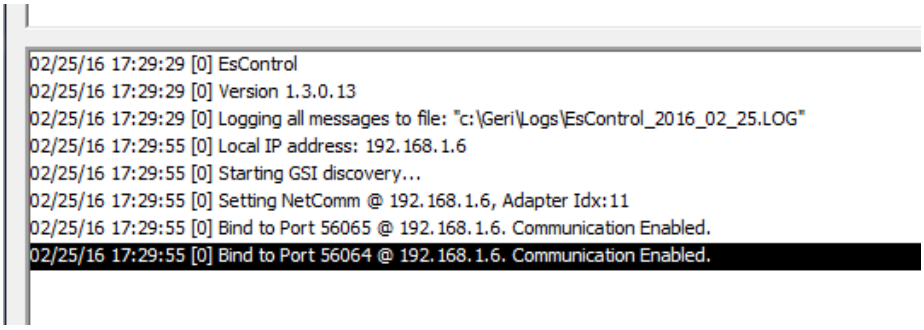
```
Dyo Geospace, Inc.
Energy Source Control
"ESControl" v 1.3
Release History

New in version 1.3
    SDR support is expanded
        Monitor data while SDR is active
        Allow SDR to act like GSI as much as possible
```

- **Module list:** is a tool to provide information for Geospace internal use:



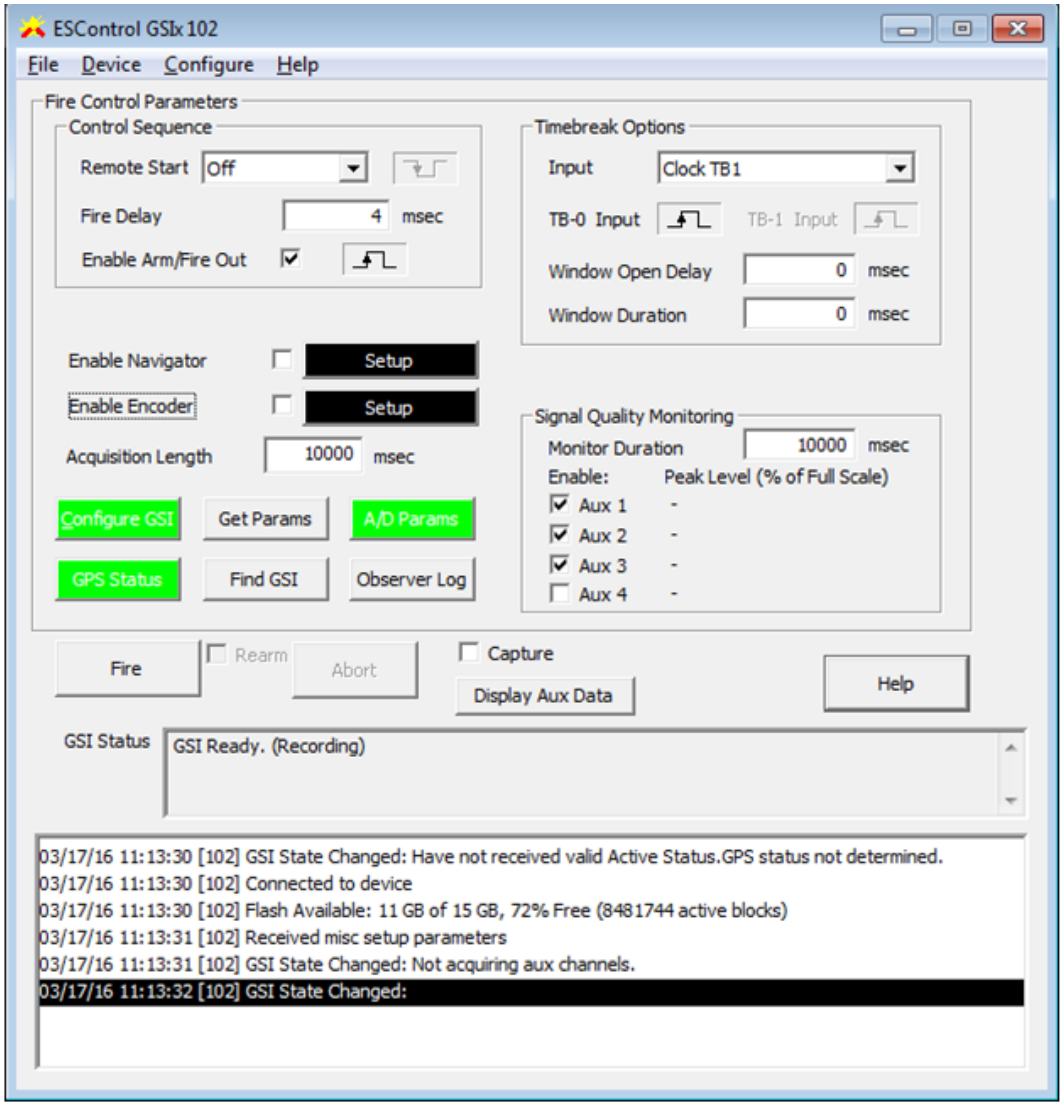
2.3 Information panel

The information panel shows information related to communication with auxiliary devices:



3. ES Control

The ES Control environment window opens automatically for each connected auxiliary device when the software is opened. It allows you to observe the options selected for associated GSIx/SDRx, setting of parameters, and signal quality monitoring, including the information panel to evaluate device performance:

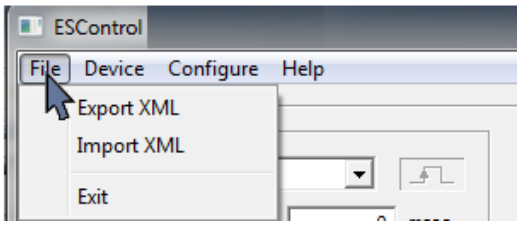


3.1 Menus

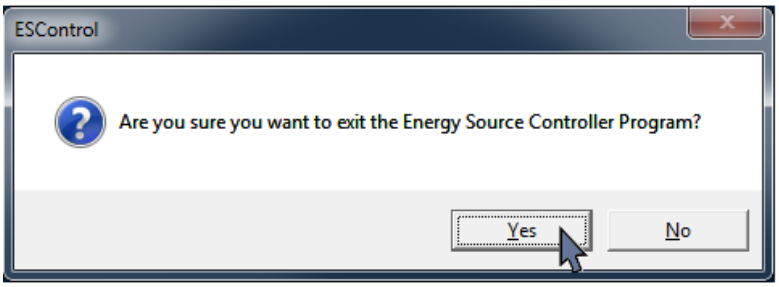
Options available in menu bar are:

3.1.1 File menu

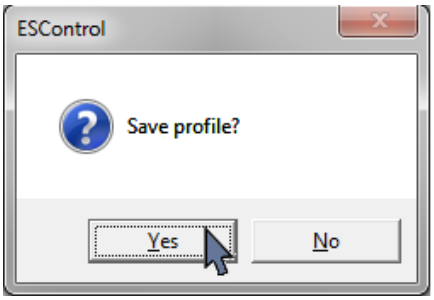
To export/ import parameters and exit the software:



- **Export XML:** generates an XML file including all ES Control operation parameters.
- **Import XML:** imports an XML file with all ES Control related parameters using a previously exported parameter file.
- **Exit:** to exit the program; click **Yes** to confirm exit:



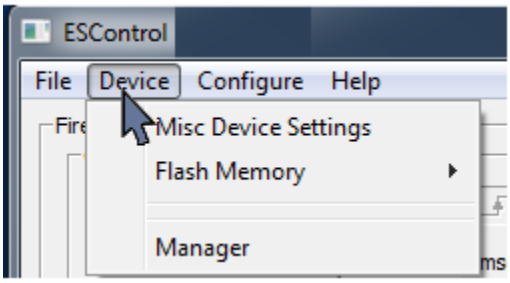
Select whether you want to save a profile:



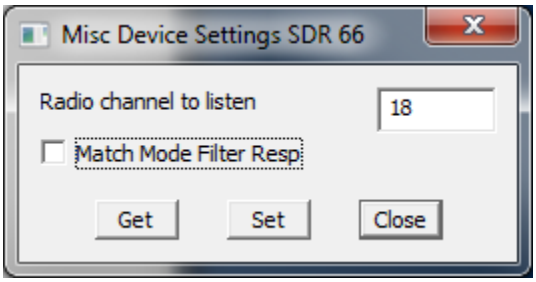
- **Yes**: the current parameters configuration is internally saved and it will be used next time the program is opened.
- **No**: the parameter configuration file is *not* updated.

3.1.2 Device menu

To set operations with memory and miscellaneous settings:



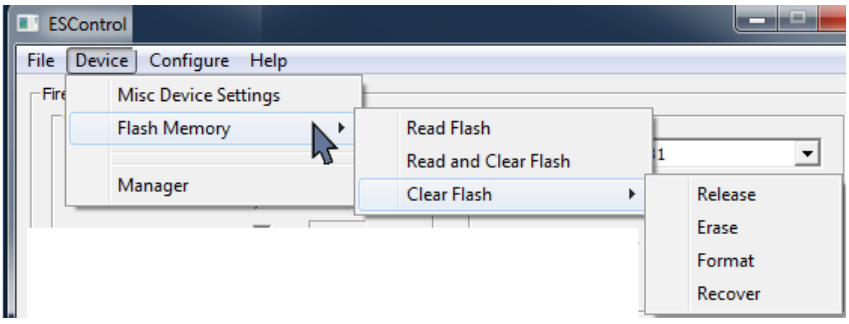
- **Misc Device Settings**: displays the Miscellaneous Device Settings dialog box:



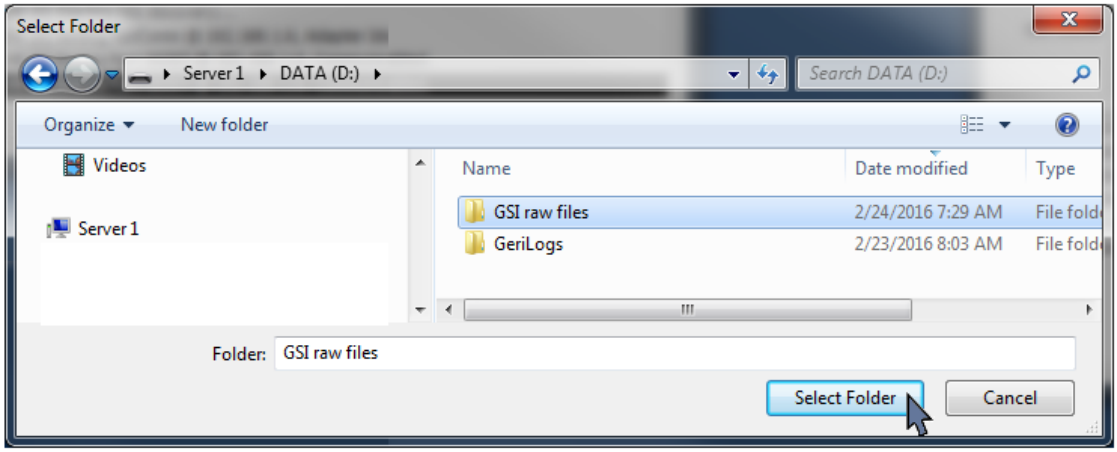
  - **Radio channel to listen:** This field allows you to set the radio channel for communication with LineViewers. This option is valid only for SDRx.

  - **Match Mode Filter Response**: Select this only for older models of auxiliary devices (SDR and GSI) to make them compatible with newer versions of GeoRes XTC software. Do not enable this mode when working with GSIx or SDRx.

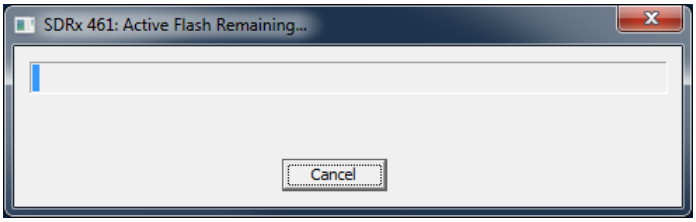
- **Flash Memory**. To perform any operation related to the recording devices' flash memory:



- **Read Flash:** To read data from auxiliary device. Select a folder with available space where raw files will be stored:



The next window indicates the progress of the operation:



A log file is also created in selected directory and opens automatically to show performance of the operation.

- **Read and Clear Flash:** To read device memory and then clear flash for GSIx or delete all data for SDRx. Data and log are located in the folder selected for read data only.

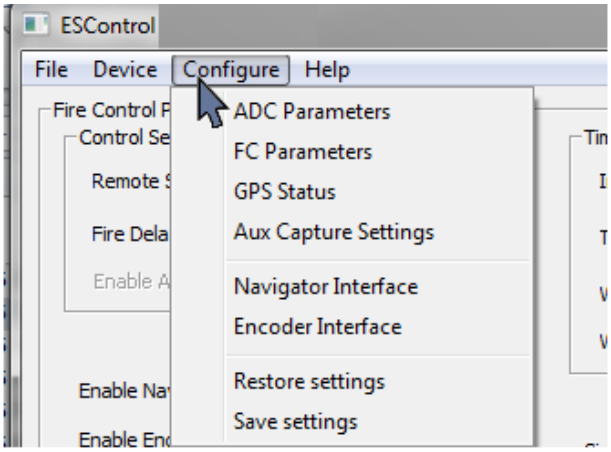
- **Clear Flash:** When clearing flash, the following options are available:
  - **Release:** To release the memory, erasing the data.
  - **Erase:** To clear the memory in GSIx or delete the data in memory when using SDRx
  - **Format:** To format the auxiliary device memory, all data will be erased.

- **Recover:** To unerase the device's internal memory (valid for GSIx only).

- **Manager:** To re-open the **Device Manager** window in case it was closed or minimized.

3.1.3 Configure

To set parameters related to auxiliary device operation, parameters settings are covered in following sections:



- **ADC parameters:** To select Auxiliary device channels' acquisition parameters. (section 3.2.3)
- **FC parameters:** To select Fire Control parameters to interface properly the source controller. (section 3.3)
- **GPS status:** To see the GPS status acquired from Auxiliary device. (section 3.3.4.5)
- **Aux capture settings:** To enable and select timing option for data from auxiliary channels to be displayed. (section 3.4.2)
- **Navigator Interface:** To select type of navigator interface and associated serial port. (section 3.3.3.2)
- **Encoder Interface:** To select type of encoder interface, selected port and associated parameters. (section 3.3.3.1)
- **Restore settings:** To restore last settings internally saved.
- **Save settings:** To save settings internally.

3.1.4 Help

To see useful information about ES Control software. (same as 2.2.4)

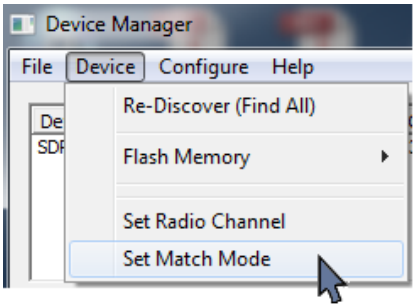
3.2 Program Auxiliary Devices

Prior to use auxiliary devices in the field, the following parameters settings are required:

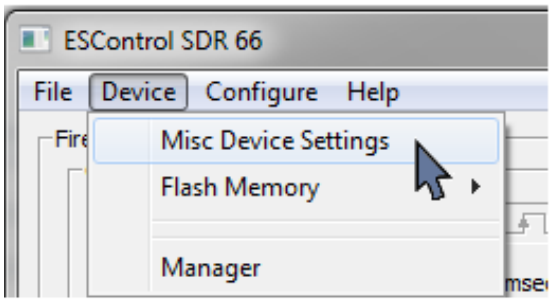
3.2.1 Setting Match Mode for GSI and SDR

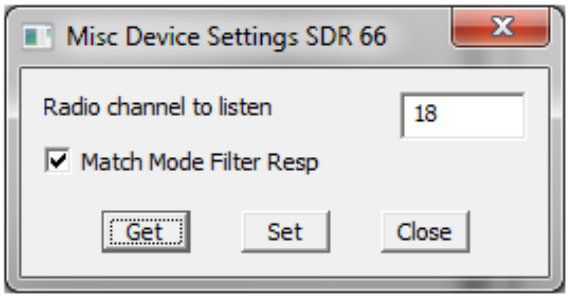
If older models of SDR and GSI are used, they must to be programmed to use **Match Mode** filter response. To program this:

- ***Using Device Manager:*** allows programming one or more devices connected to Device Manger. Select them in the main window and then select on **Device** menu **> Set Match Mode**:



- ***Using ES Control.*** To program devices one at a time, click the **Device** menu **> Misc Device Settings** and then in the window that appears, select the option for **Match Mode Filter Resp** and click the **Get** button.



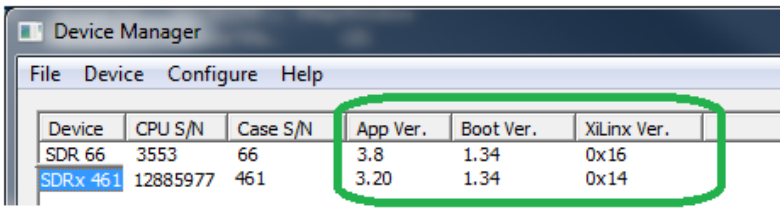


This operation requires user confirmation before you may proceed.

3.2.2 Evaluate firmware installed in devices

Auxiliary devices' firmware versions should be evaluated to determine if they comply with minimum requirements to work with the GeoRes XTC software used in acquisition.

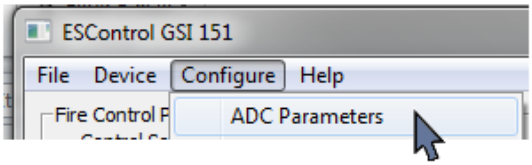
The version numbers of the firmware installed in auxiliary devices are available in the main panel in the **Device Manager** environment:

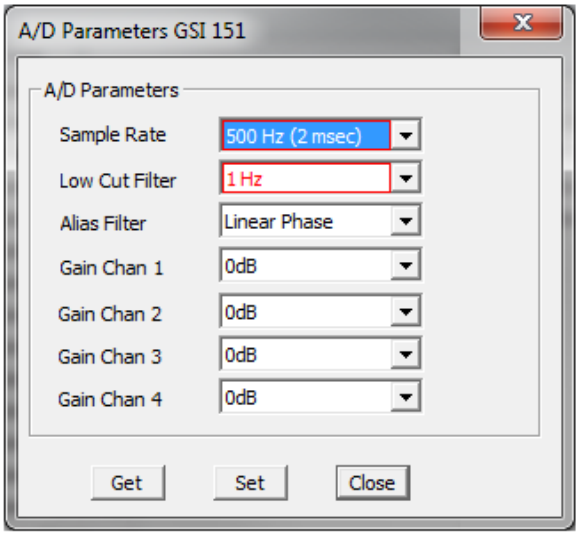


If auxiliary device(s) do not have proper version(s), load new codes using GeoReaper software.

3.2.3 Program Acquisition parameters

Acquisition parameters for auxiliary channel should be programmed with settings similar to those used in the recording devices. To select them, click on **Configure** menu **> ADC parameters.**





Note: Parameters are shown in **red** if values configured in ES Control do not match with the actual parameters programmed in the device.

Tools available at the bottom of this window are:

- **Get:** click this to update/reload ADC parameters from the auxiliary device.
- **Set:** to program ADC parameters into the auxiliary device.
- **Close:** to close the A/D Parameters environment.

The following parameter options are available:

- **Sample Rate:** The parameters selected here represent the sampling frequency followed by the sample rate between parentheses:
  - **4 KHz** (.25 msec)
  - **2 KHz** (0.5 msec)
  - **1 KHz** (1 msec)
  - **500 Hz** (2 msec)
  - **250 Hz** (4 msec)

- **Low cut frequency:** is a filter that removes frequencies lower than specified value; options are:
  - **Disabled**. Is a requested feature to be used in case no low-cut filter is required; it introduces DC offset in the recorded data.
  - **3 Hz:** Not supported in GSIx or SDRx.
  - **1 Hz:** Typical setting.

- **Alias Filter:** is a filter used to restrict the bandwidth of a signal to avoid aliasing of high frequencies. Options are:
  - **Linear Phase:** Alias filter frequency at -3 dB point is 0.82 Nyquist Linear phase filter
  - **Minimum phase:** Alias filter frequency at -3 dB point is 0.82 Nyquist Minimum phase filter

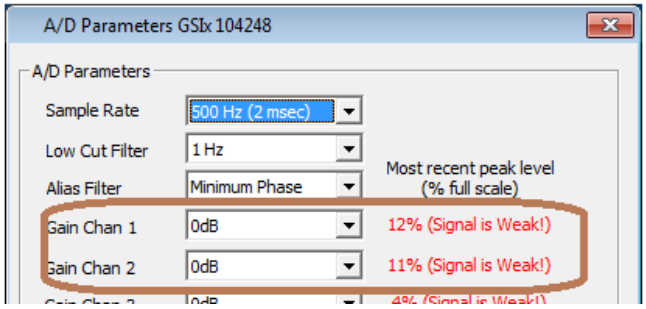
- **Gain Channel #:** selects the fixed gain factor to be applied to the devices' analog input data. Options available are from 0 to 36 dBs in steps of 6dBs.

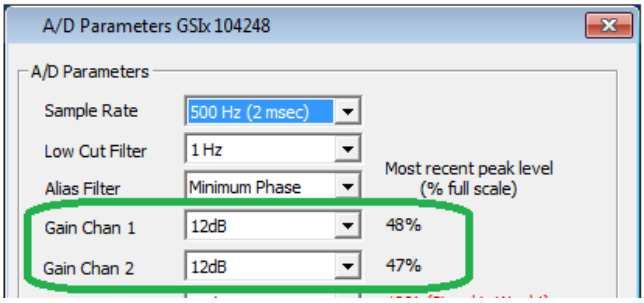
  In addition to selected gain, auxiliary devices includes attenuation for input channels; they are implemented to accommodate the large signals (up to 40 Volts peak) produced by some source equipment.

  Gain applied to each channel must to be selected according the type of operations; typically the higher gain that does not clip the data is recommended to be used.

  At right side of the view you can observe the most recent peak value read from recording device for auxiliary channels, this information is used as reference to adjust properly the Gain settings for each channel. Signal amplitudes reporting less than 30% of their full scale are shown in red font.

Example below shows weak signals in channels 1 and 2 corrected after increasing the gain:





3.3 Parameters for Synchronization with Encoders

To allow coordinated synchronization between the GSIx-ES Control system and source encoders (see attachments for connectors' pinout description), the following signals are typically used:

- **Remote Fire (REM FIRE):** Signal provided from external equipment (typically a source controller) to request the GSIx-ES Control to start the fire sequence. Use of this is optional.

- **Fire (FIREOUT):** Signal sent by the GSIx under ES Control to command the Source controller to start the fire sequence. This signal is synchronized with the GSIx 4 milliseconds clock.

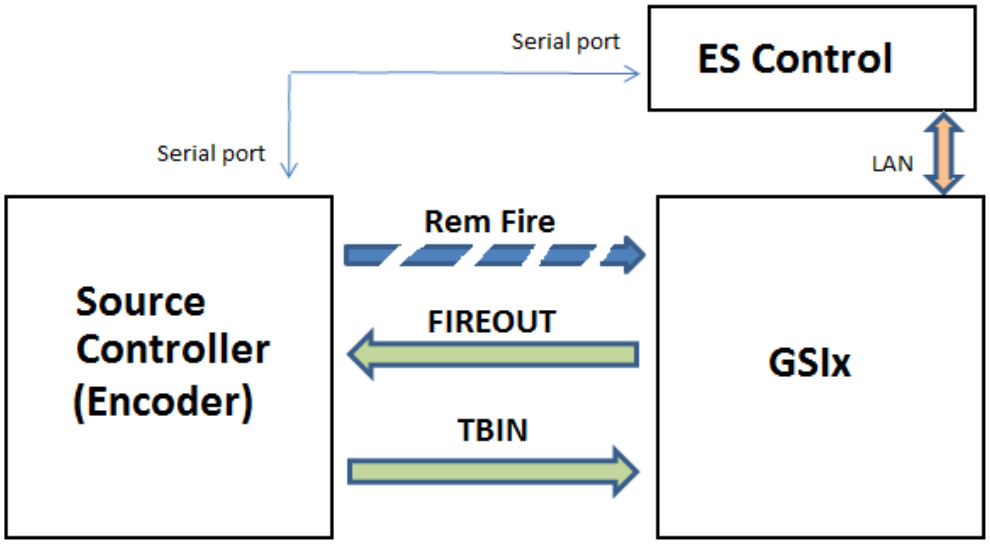
- **Time Break (TBIN)**: Signal received from Source Controller to indicate the instant the source was activated (dynamite blast, sweep starts, etc.). ES Control generates a trigger time synchronized to the GSIx's GPS with accuracy of 1 microsecond to be associated with this event.

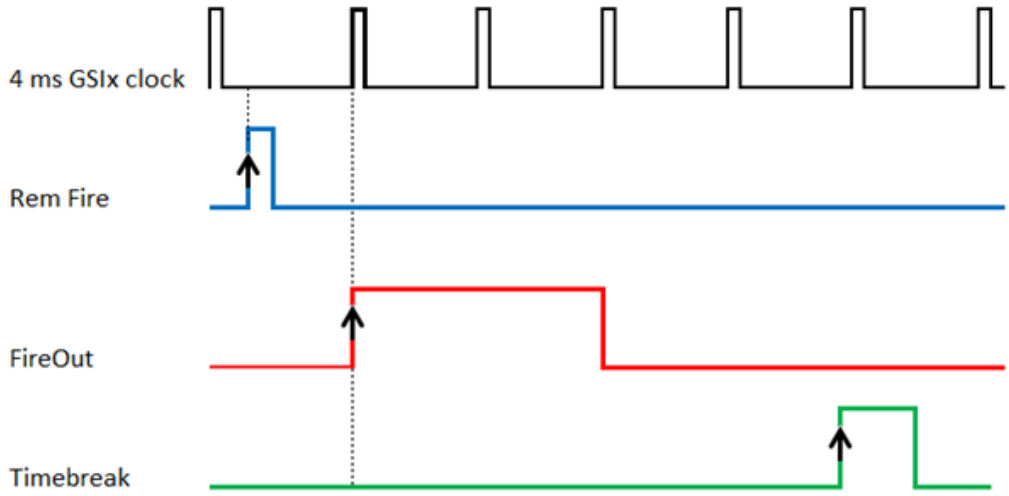
Triggers can be synchronous (if sources are GPS time synchronized at 4 msec clock), or asynchronous (occurs any time).

- **Serial port connection(s):** To allow communications with Encoders and/ or navigator system to coordinate the operation, select the source and receive data related to the source performance after the activation.

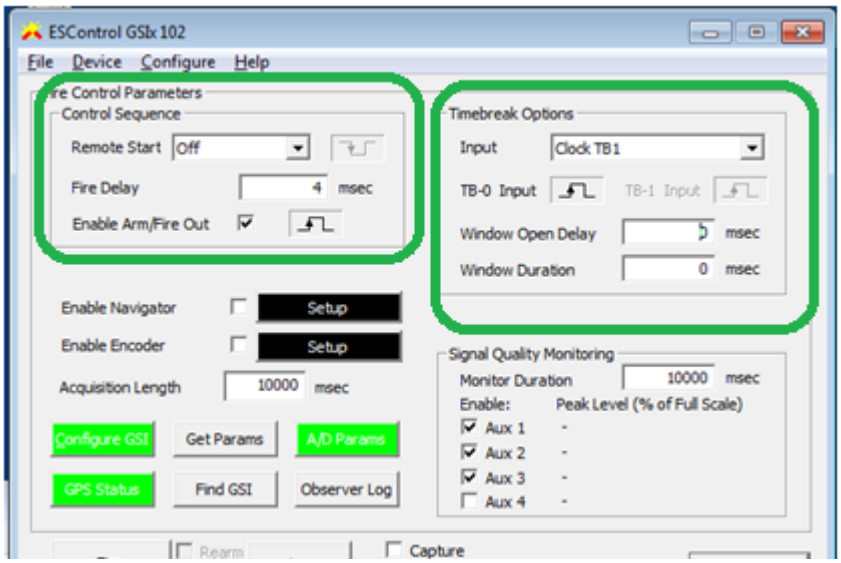
- **LAN connection:** Network communication between computer using ES Control software and the GSIx.

The graphic below shows interconnection of these signals and the ES Control-GSIx Fire Sequencing Diagram:

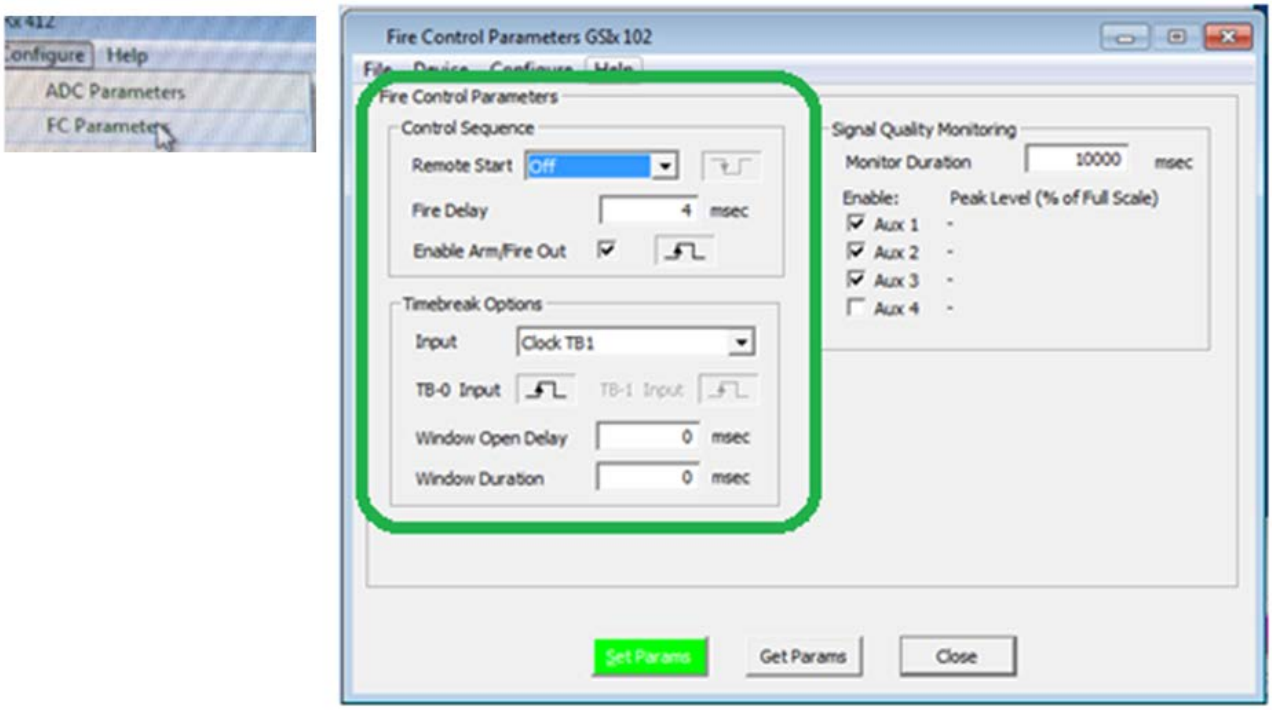




Parameters to synchronize this operation area directly are available in the main **ESControl** window in the **Fire Control Parameters** and **Timebreak Options** sections:



Another way you can select these parameters is to select **Configure** menu **> FC parameters**:

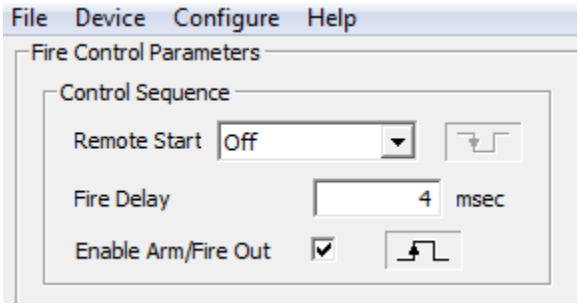


Parameters are grouped into sections:

- Control Sequence: to select options to start operation from external equipment and synchronize the generation of the Fire Order signal.
- Time Break: to select options for the incoming Time Break signal and its operational window.

3.3.1 Control Sequence section

Use these parameters for remote control and fire order settings. They are available in the **Control Sequence** section:

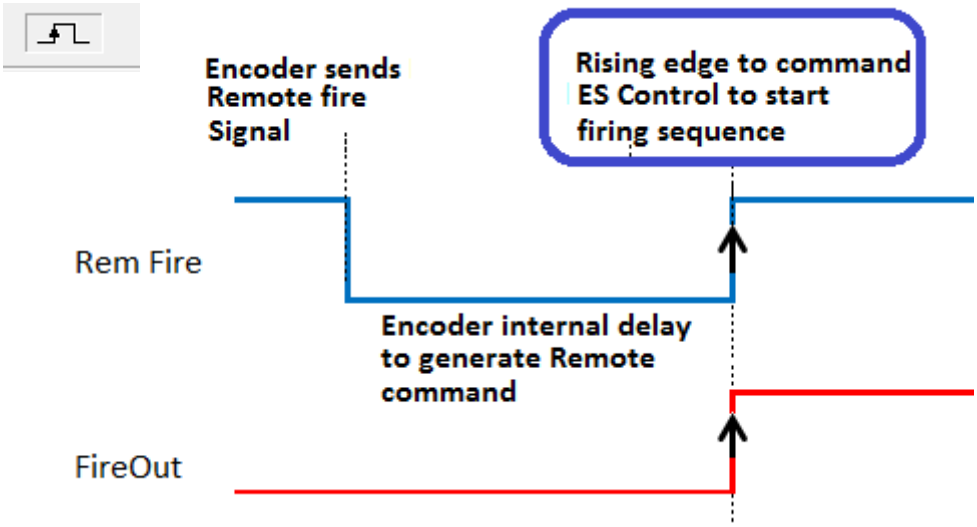


3.3.1.1 Remote Control

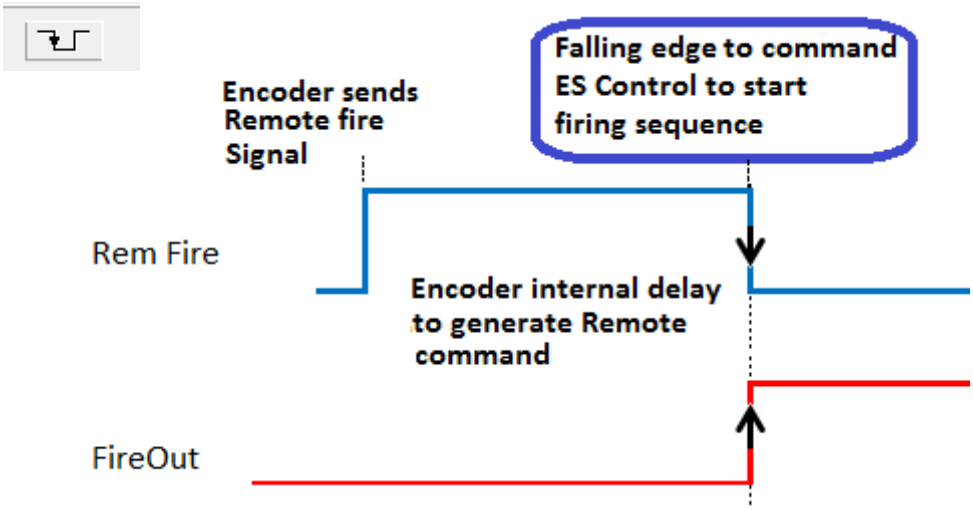
To allow remote control from an external device:

- **Remote Start.** Options are:
  - **Off**: The ES Control does not wait for remote commands to start its operation. The Rem Fire signal is not used.
  - **On**: ES Control waits acknowledgment of the Rem Fire signal to start the firing sequence.
- **Edge selection.** If Remote Start is ON, you must specify which kind of signal edge will activate the control. To change the type of edge, click the icon available at the right side of the Remote Start selection (the icon shows the actual edge selected in ES Control). When the background color of the icon is red, that indicates the edge programmed in the GSI differs from the edge programmed in ES Control; the GSI must be reprogrammed to use the new edge.

- **Rising edge.** The REM Fire signal transition from low to high commands the ES Control to start the firing sequence.



- **Falling edge**: The REM Fire signal transition from high to low commands the ES Control to start the firing sequence.



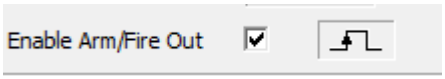
3.3.1.2 Fire Control section

Parameters in this section are:

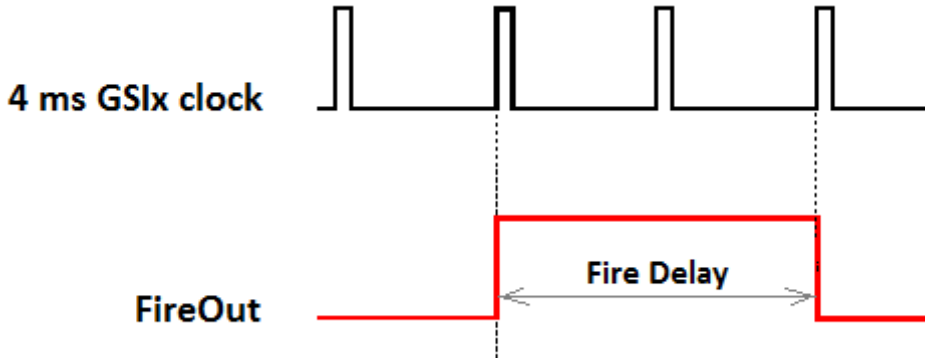
- **Enable Arm/Fire Out.** Options are:
  - **Not checked**: ES Control does not generate the **FireOut** signal; the system works in slave mode and only waits for the **Timebreak** signal from Encoder to generate associated triggers.
  - **Checkmarked:** ES Control commands the GSIx to generate the **FireOut** signal, and then waits for the **Timebreak** signal from the Encoder to generate associated triggers.

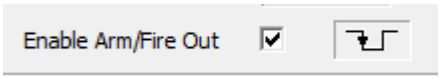
- **Fire Delay**. To set (in milliseconds) the time duration of the **FireOut** signal, it must be selected in multiples of 4 milliseconds because it is synchronized with the 4 msec GSIx clock. The final edge (after Fire Delay) should be used by the Encoder to send start codes to decoders.

- **Edge selection.** If Enable Arm/Fire Out is selected, you must specify the signal shape to be used by Encoder to send start codes.

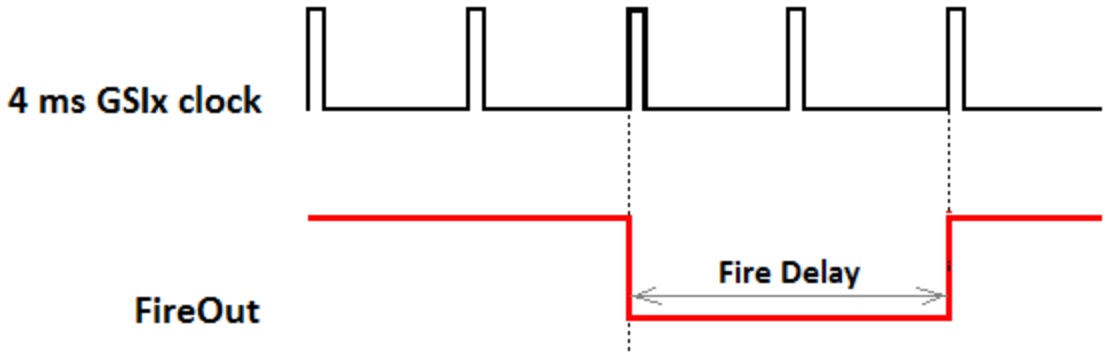
  - **Rising edge**. 

    GSIx is commanded by ES Control to generate the **FireOut** signal with the following shape:



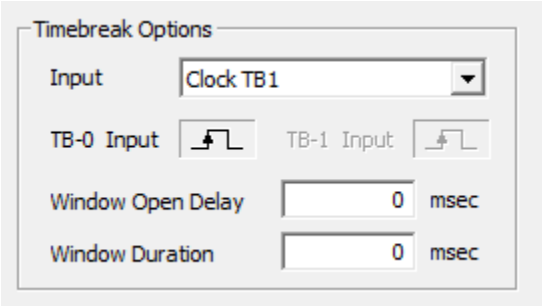
- **Falling edge.** 

  GSIx is commanded by ES Control to generate the **FireOut** signal with the following shape:



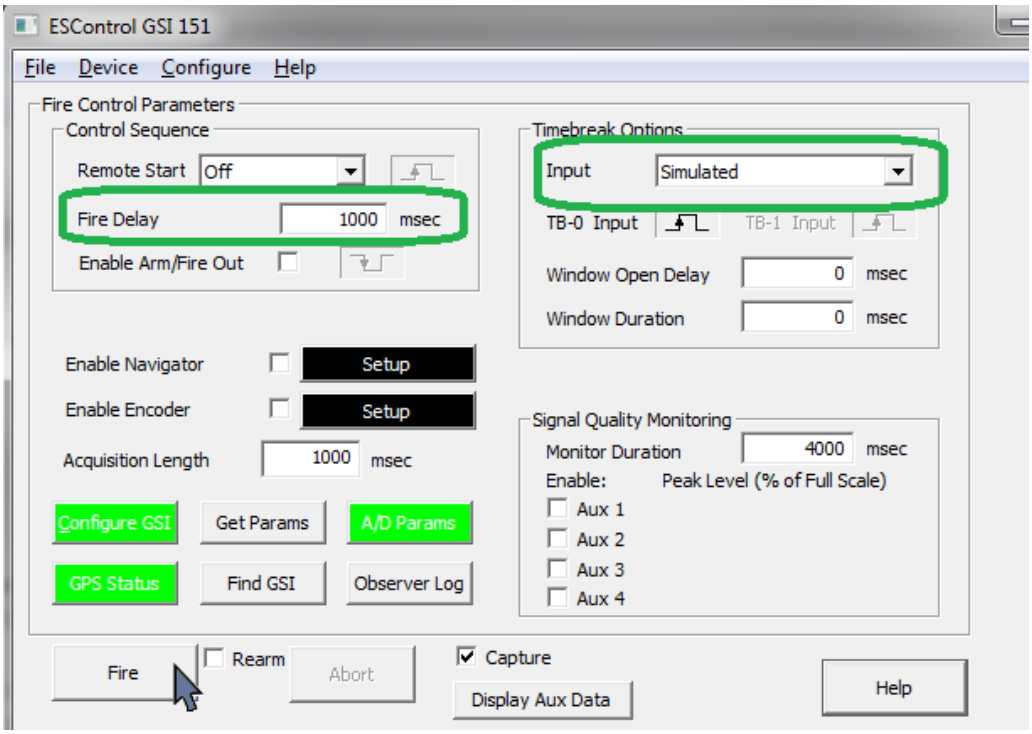
3.3.2 Timebreak options

These parameters allow you to setup ES Control to select the type of Timebreak signal to generate triggers. They are available in the Timebreak Options section:



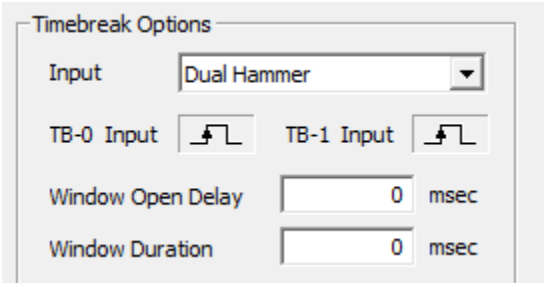
3.3.2.1 Input

The following options are available:



- **Simulated**: an internal Timebreak is generated when clicking on the **Fire** command and after the control sequence **Fire Delay** time.
- **Clock TB1:** a trigger event is generated when a Timebreak signal is received at the GSIx Encoder connector, pins E and reference.
- **Clock TB2:** (available only in earlier version of GSIs) a trigger event is generated when a Timebreak signal is received at the GSI Encoder-2 connector, pins E and reference.
- **Hammer Switch 1:** (available for SDRx) a trigger event is generated when a signal is received at the SDRx Decoder connector, pins C and reference. This option also enables the use of the BNC TB-IN connector in SDRx.
- **Hammer Switch 2:** (available for SDRx) a trigger event is generated when a signal is received at the SDRx Decoder connector, pins D and reference.

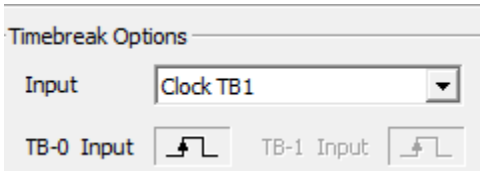
- **Dual Hammer:** (available for SDRx) a trigger event is generated when a signal is received at the SDRx Decoder connector, pins C and reference and/or pins D and reference. This option enables the selection of **TB-1 Input** edge selection.



3.3.2.2 Input edge selection

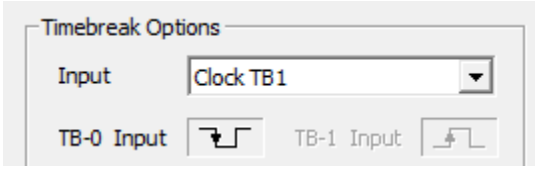
Options available for **TB-0** (GSIx and SDRx) and **TB-1** (for Dual Hammer in SDRx) are:

- **Rising edge**.



The GPS time trigger is generated when the Timebreak signal goes from low to high.

- **Falling edge**.

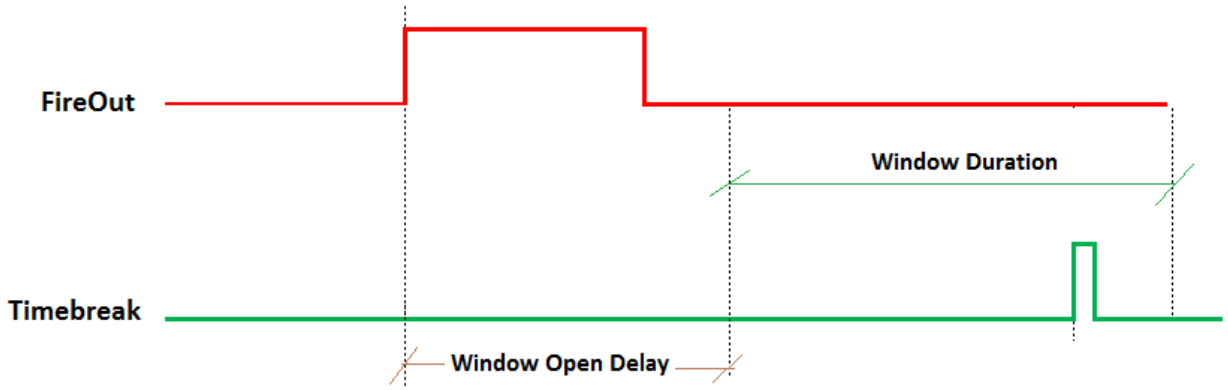


The GPS time trigger is generated when the Timebreak signal goes from high to low.

3.3.2.3 Timebreak window

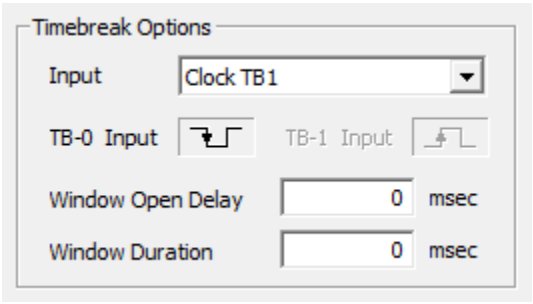
Parameters here allow the selection of a time window were the ES Control waits for the Timebreak signal to arrive.

When Fire commands are generated (independently of polarity and Fire delay), the ES Control waits for the time set in **Window Open Delay** before opening a window to wait for the Timebreak signal to occur. This window is opened for a length of time (in milliseconds) set in **Windows Duration.** If the Timebreak falls inside this window the trigger is generated.



If the Timebreak occurs outside this time window, ES Control does not associate a trigger to this event and shows a **Misfire** status.

Note: To disable the use of a window (ES Control always waits for Timebreak), set **Windows Open Delay** and **Window Duration** to 0 milliseconds.



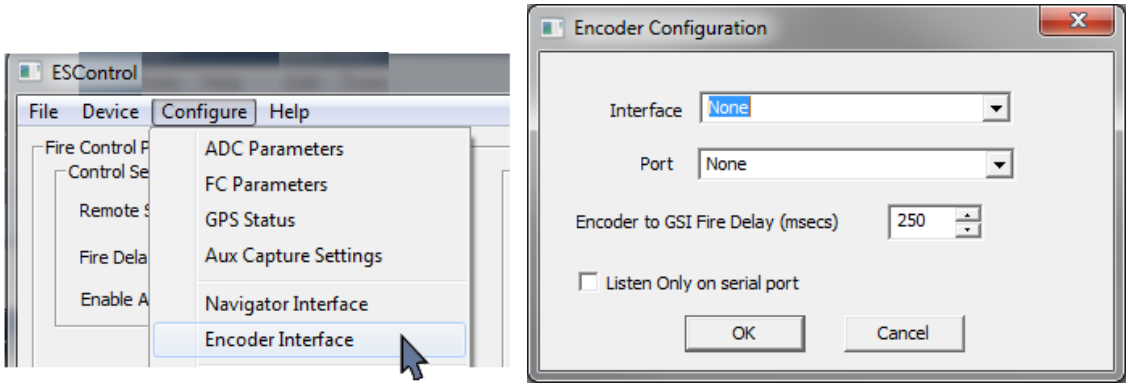
3.3.3 Encoder and Navigation Interface

For optimum coordination with decoders, ES Control software has options to interface encoders and navigation systems through computer serial ports.

3.3.3.1 Encoder Interface

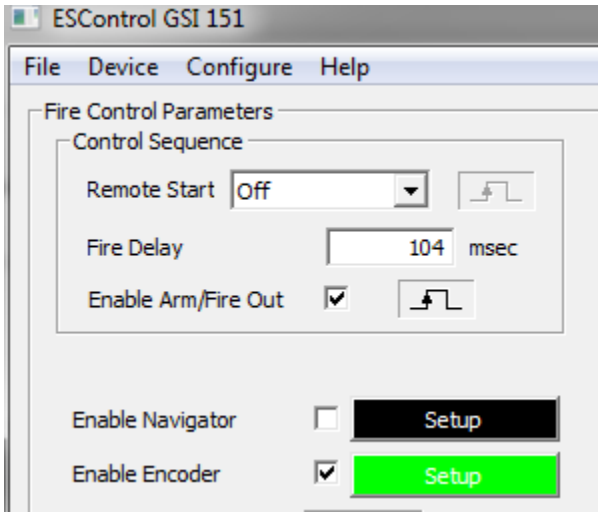
The ES Control can operate with any source control system, but some of them include an advanced digital communication protocol (RTI: Recording Truck Interface). This communication allows selecting shot points and source ID as well as receiving status relative to activated shot or VP (PFS, PSS, etc.).

To select related parameters select **Configure > Encoder Interface:**



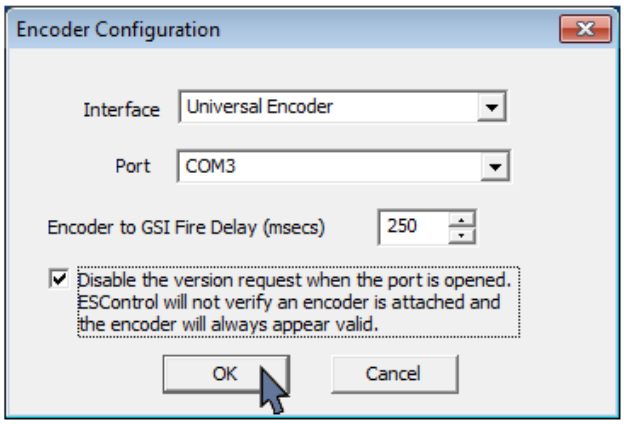
- **Interface**: RTI messages are not the same for all available Encoders; you should select the associated system from a drop-down list with the following options:
  - **None**: no Source Interface is selected
  - **Universal Encoder ™** from Seismic Source.
  - **VibPro ™** from Pelton
  - **TDMA ™** advanced source control system from Seismic Source
  - **OnSeis ™** Onshore Synchronized Electrical Impulsive Source from Geokinetics
- **Port**. to select the serial port to be used for RTI communication. Refer to the third party Encoder manual to select properly the serial port settings in the computer running ES Control to match their port selection.
- **Encoder to GSI Fire Delay**: is available to set an extra delay between acquisitions to allow proper reception of RTI information sent by source controller system (PFS, PSS, SSR, etc.). A minimum value of 100 milliseconds must be selected.
- **Listen Only on serial port**: when this option is selected, ES Control does not send any message to the Encoder, only receives information through serial port. This option is used when working in slave mode.

To enable an interface with the encoder using selected parameters, select the **Enable Encoder** checkbox option:



Some Encoders requires passing a communication test to enable the interface.

The **Setup** button to the right of the Enable Encoder option provides a quick access to the encoder configuration environment. A green button indicates that parameters were set properly; a red button indicates that attempt to connect failed and corrections must to be implemented before enabling the interface.

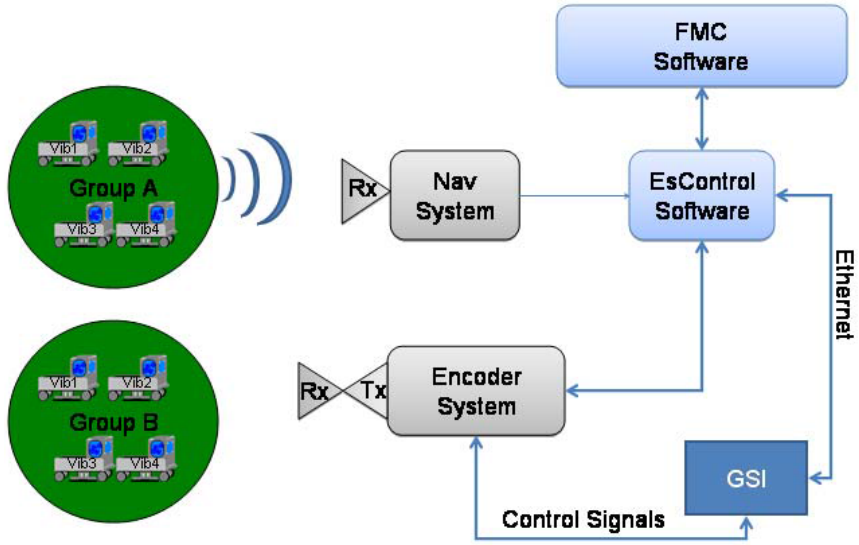


In the Encoder Configuration window, click **OK** to apply the selected parameters.

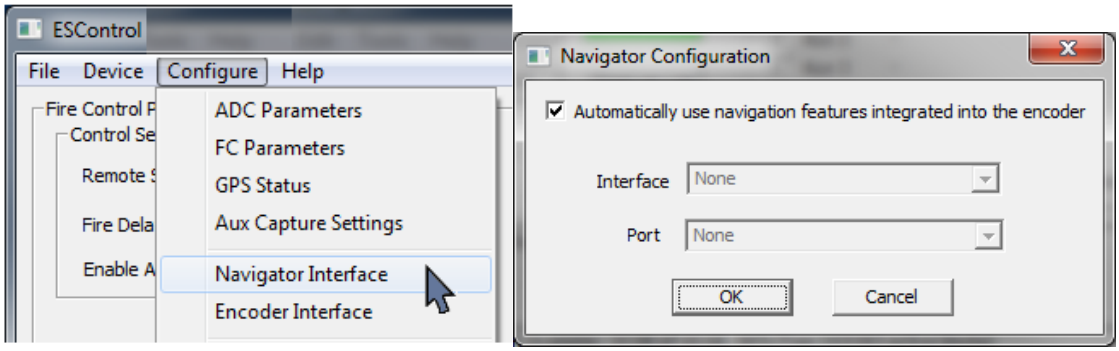
3.3.3.2 Navigator Interface

Navigation systems provide a way to determine the location of a vehicle or vessel in reference to a planned position. Using this interface, the Navigation system

dictates which source is ready in a shot position, and then ES Control under a shot management system commands the GSIx to start firing sequence with the preconfigured fire control parameters.



To select related parameters click on **Configure > Navigator Interface:**

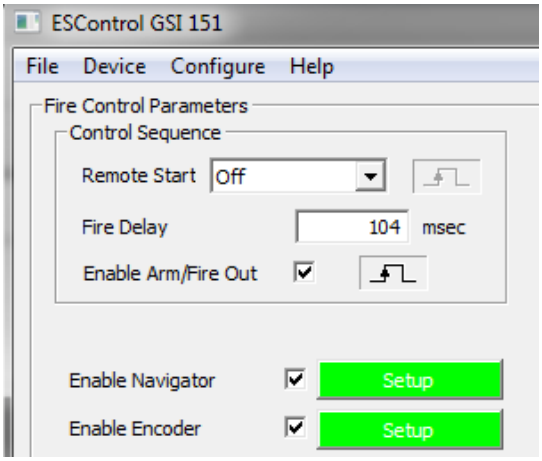


- **Automatically use navigation features integrated into the encoder.** This option uses the navigation information already included in the RTI sent by the Encoder. When this is selected there is no need to select additional parameters.

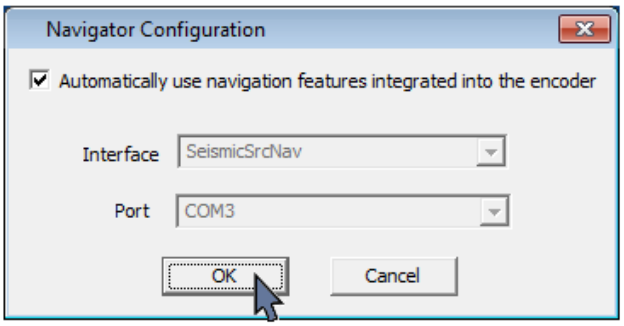
- **Interface.** Messages from Navigations systems are different according to the equipment and format used. ES Control allows following interfaces:
  - **None**
  - **TigerNav ™**
  - **PeltonNav ™**
  - **SeismicScrNav ™**
  - **OnSeisNav ™**

- **Port.** To select the serial port to be used for communication with the Navigation system. Refer to the third party Navigator manual to select the proper serial port settings in the computer running ES Control to match their port selection.

  To enable the interface with Navigator using selected parameters, select the **Enable Navigator** option:



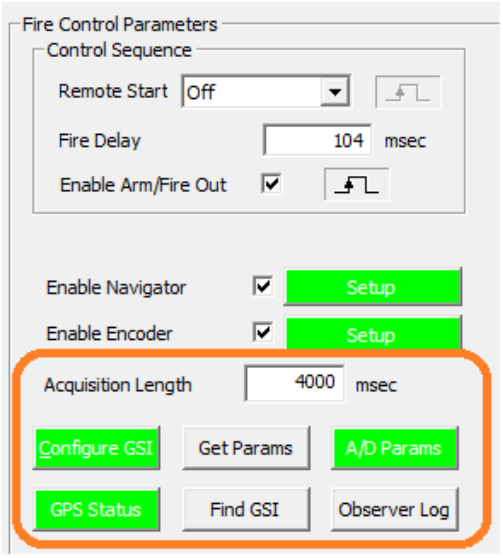
  The **Setup** button to the right of the Enable Navigator option provides quick access to the Navigator configuration environment. A green button indicates that parameters were set correctly; a red button indicates that corrections must to be implemented before enabling the interface.



  In the **Navigator Configuration** window, click **OK** to apply the selected parameters.

3.3.4 Miscellaneous parameters and options

Other settings and tools are included at the bottom part of Fire Control Parameters section:



3.3.4.1 Acquisition Length

ES Control uses the **Acquisition Length** time to allow proper signal acquisition in auxiliary devices after reception of Timebreak. During this time, the generation of new Fire commands is disabled, as well as trigger events if Timebreak signals are received.

The acquisition length should be selected in coordination with the acquisition time (record length and sweep length) to be used in the generation of deliverable files.

Acquisition length must be higher than 100 milliseconds.

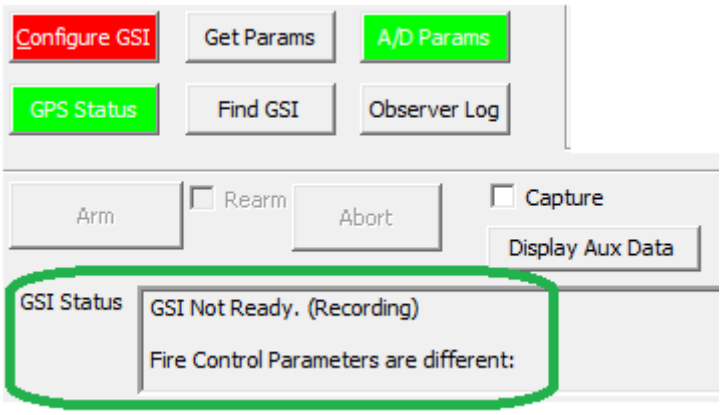
***Note*:** If an FMC system is used in conjunction with ES Control, this time is automatically set by FMC.

3.3.4.2 Configure GSI

This button is used for verification of GSIx settings and as quick access to programming the auxiliary device with parameters selected in ES Control environment.

The color of this button allows you to evaluate if parameters selected in ES Control are the same as the ones already programmed in auxiliary device:

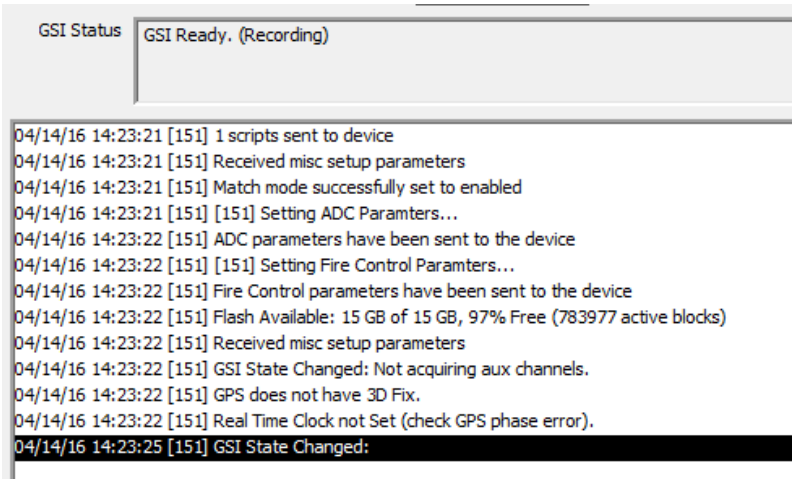
- **Green:** Parameters match, GSIx is ready to operate.
- **Red:** At least one GSIx related parameter does not match with ES Control parameters, and the GSIx is not ready. The **GSIx Status** message field provides additional information about the cause of the issue:



Clicking the **Configure GSI** button generates following sequence:

- Disable GSIx for acquiring data
- Enable Match Mode (if applicable)
- Set GSIx ADC parameters
- Set all Fire Control Parameters (Control Sequence, Timebreak options, Signal Quality Monitoring)
- Confirm GPS status OK
- Go to recording mode

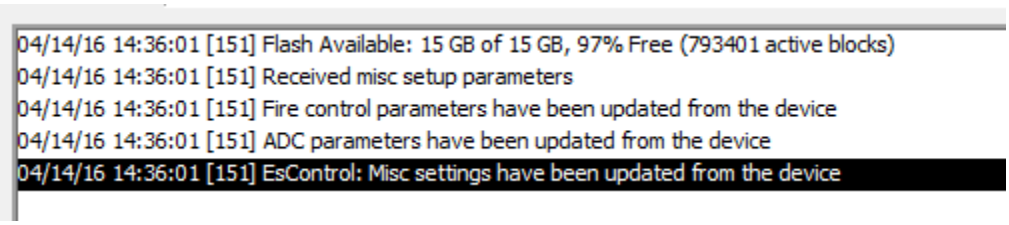
The **Information** panel provides additional information about this sequence:



3.3.4.3 Get Parameters

This tool allows you to retrieve parameters from the auxiliary device and use them to set ES Control parameters. To implement it click on **Get Params** button.

The Information panel provides additional information about this sequence:



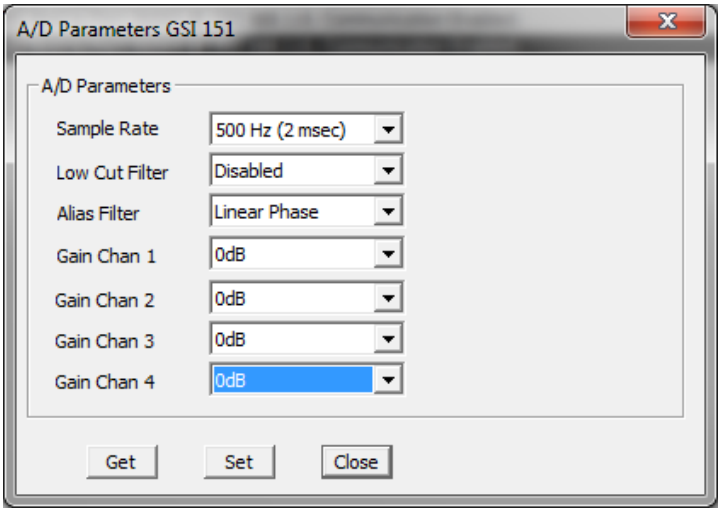
3.3.4.4 A/D Parameters

This button is used for verification of GSIx ADC settings, and quick access to programming the auxiliary device.

The color of this button allows you to evaluate if ADC parameters selected in ES Control are the same as the ones already programmed in auxiliary device:

- **Green**: Parameters match, GSIx is ready to operate
- **Red**: At least one ADC related parameter does not match with ES Control parameter.

Clicking on the **A/D Params** button opens the A/D Parameters window:



If it is required, modify this settings following instruction explained in section 3.2.3.

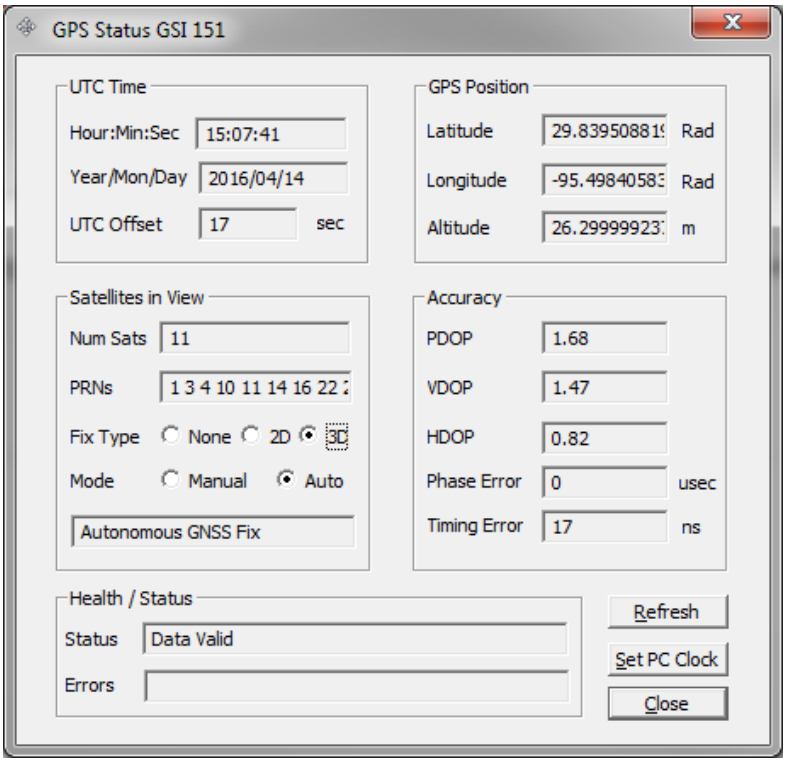
3.3.4.5 GPS Status

Auxiliary devices are configured with GPS mode always on. If GPS signal is not locked (3D fix and PLL locked), the auxiliary device cannot start recording and ES Control is disabled to command shooting operation.

This color coded button allows you to verify a valid GPS clock:

- **Green:** GPS signal is OK; the GSIx is ready to operate.
- **Red:** GPS is not ready.

Clicking the **GPS Status** button opens the GPS Status window:

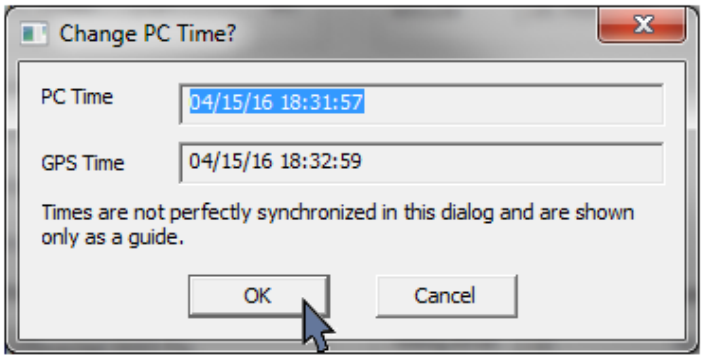


- **UTC Time**: shows Coordinated Universal Time (UTC) extracted from the GPS signal from GSIx. The UTC offset corresponds to the amount of Leap seconds reported by the device.

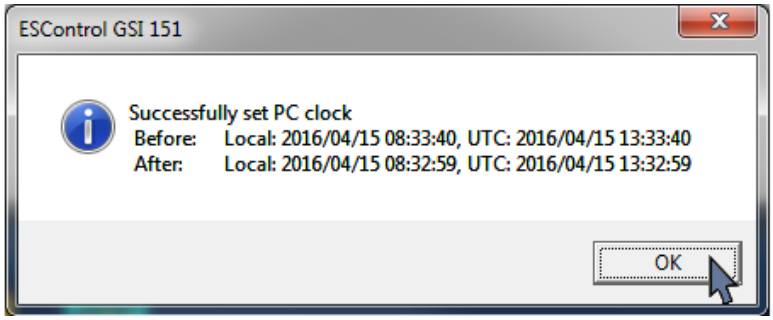
- **PC Time:** includes the date and time, as the time zone set in the computer's operating system. It is used for logs and time for file generation.

You should set the PC Time (time zone included) as close as possible to GPS Time because the ES Control associates logs to this time. The PC clock can be adjusted to GPS time by clicking the **Set PC Clock** button:

In the Change PC Time? window click **OK**:



A message confirms the change, click **OK**:



- **Satellites in View**: includes information from:
  - **Number of Sats**: shows the quantity of valid satellite signals received by the device. A minimum of four (4) are required to get a 3D fix
  - **PRNs**: shows the unique codes from satellites; names are linked to their pseudo-random-noise.

- **Fix type**: options shown here are:
  - **None**: no fix acquired from satellite information.
  - **2D:** shows the GPS locked onto the signals from a minimum of three different satellites (Two-Dimensional)
  - **3D:** shows that GPS locked onto the signals from a minimum of four different satellites (Three-Dimensional).
  - **Mode**: should show Auto. Manual mode is not implemented.
  - **Message**: shows status relative to fix type.

- **GPS Position:** shows latitude, longitude, and altitude, measured by the GPS system in the auxiliary device.

- **Accuracy:** shows values relative to the accuracy of acquired GPS position:
  - **PDOP:** Positional Dilution Of Precision. This value includes Vertical and Horizontal DOPs; a value less than 2 is excellent and up to 10 can be used for positional measurements.
  - **VDOP**: Vertical Dilution Of Precision.
  - **HDOP:** Horizontal Dilution Of Precision.
  - **Phase error:** shows errors in microseconds relative to the GPS carrier signal.
  - **Timing errors:** shows errors in nanoseconds of acquired GPS time.

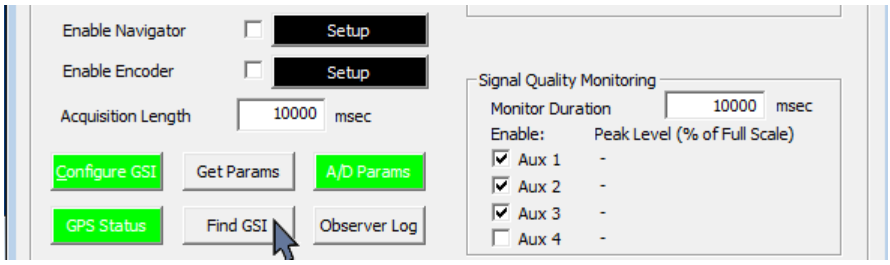
- **Heath / Status**: shows:
  - **Status:** shows status relative to the GSIx data acquisition (as a result of GPS status).
  - **Errors:** typical errors shown here in red font are:
    - No Fix
    - RTK clock not set
    - No Leap Second
    - PLL unlocked.

  It should be empty (free of errors) to enable data acquisition.

- **Refresh** button: statuses are refreshed every five seconds, but if you need to manually update status, click the **Refresh** button.

3.3.4.6 Find GSI

If communication with the device is lost, clicking the **Find GSI** button provides a quick way to reestablish communication with the auxiliary device:

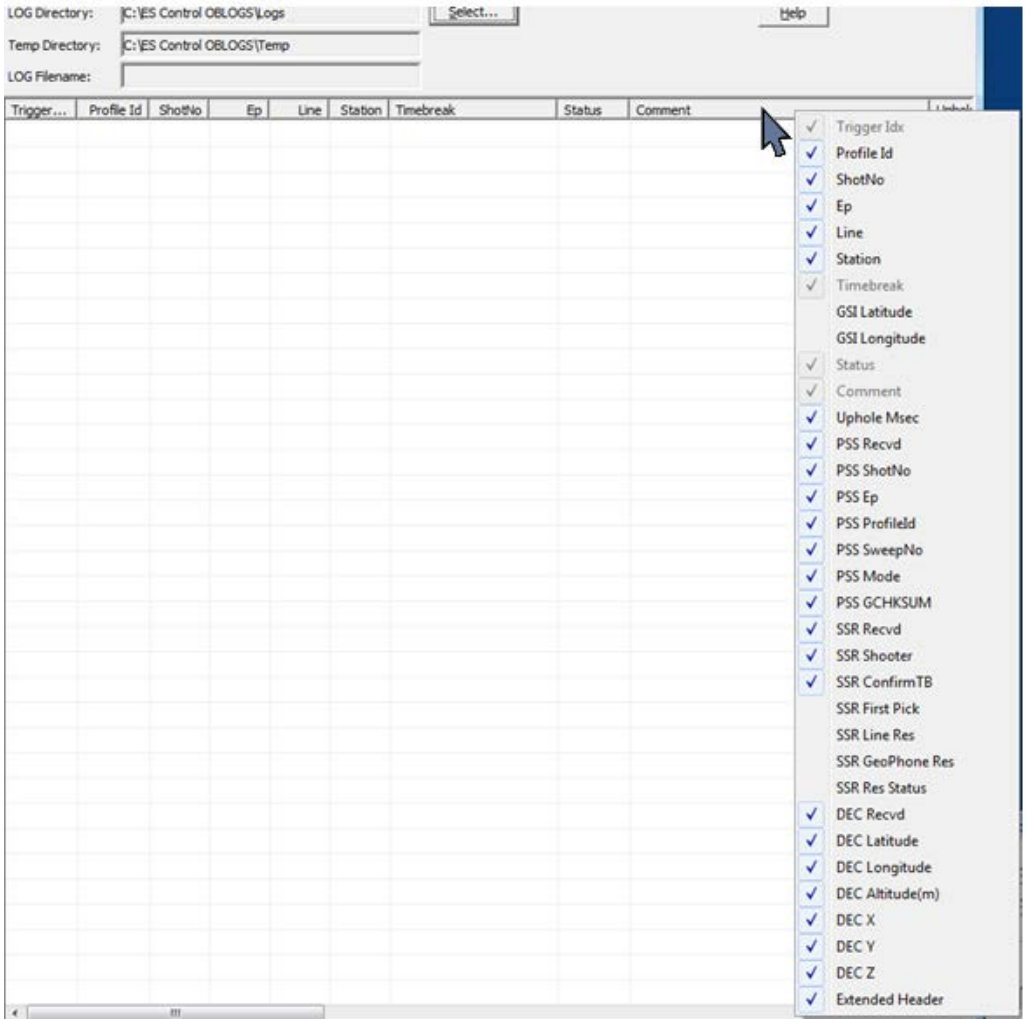


3.3.4.7 Observer Log

Clicking in this button provides access to the internal log that is updated every time a new trigger event occurs. Logs provide association between the GPS trigger time, source selection (from FMC), and SP performance data if Encoder/ Navigation interfaces are enabled.

The log is updated every time a Timebreak is received, even if the Observer Log window is not opened.

The report can be customized by right-clicking in the header and then clicking the columns you want:



Columns available to be included in the report are:

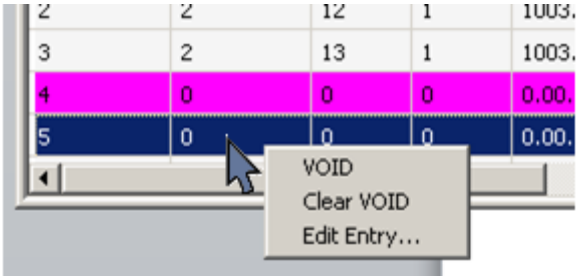
- **Trigger Index:** a sequential number incremented automatically every time a new trigger event is received.
- **Profile Id:** the profile ID imported from FMC.
- **Shot No:** the shot ID imported from FMC.
- **Ep:** the EP number imported from FMC.
- **Line:** the Shot Line imported from FMC that corresponds to the associated trigger time.
- **Station:** the Shot Station imported from FMC that corresponds to the

associated trigger time.

- **Timebreak:** trigger corresponding to the GPS time when the Timebreak edge selected in **Timebreak Options > Input** occurs. Its format is yyyy/MM/dd hh:mm:ss.ffffff
- **GSI Latitude:** the GPS latitude position acquired from GSIx at the trigger time.
- **GSI Longitude:** the GPS longitude position acquired from GSIx at the trigger time.
- **Status:** shows the status related to generated trigger:
  - **Valid:** normal acquisition
  - **VOID:** trigger marked VOID by user
  - **Misfire:** trigger was received outside Timebreak window
  - **Abort:** trigger generated after an abort operation
- **Comment:** a comment provided by ES Control in case of errors, or added/ edited by user in this location.
- **Uphole Msec**: the uphole time received from the Encoder interface, or added manually.
- **PSS Recvd:** **i**ndicates if a valid PSS (Post Sweep Services) signal was received from Encoder.
- **PSS ShotNo:** the shot number received from Encoder via PSS.
- **PSS Ep:** the EP number received from Encoder via PSS.
- **PSS ProfileId:** the Profile ID received from Encoder via PSS.
- **PSS SweepNo:** the Sweep number received from Encoder via PSS.
- **PSS Mode:** the PSS mode received from Encoder via PSS.
- **PSS CHKSUM:** the Sweep checksum received from Encoder via PSS.
- **SSR Recvd**: indicates if a valid SSR (Shallow Seismic Reflection) signal was received from Encoder.
- **SSR Shooter:** the Shooter information received from SSR.
- **SSR ConfirmTB:** the Confirmed Timebreak information received from SSR.
- **SSR First Pick:** the First pick (equivalent to uphole time) information received from SSR.
- **SSR Line Res:** the Fire Line Resistance information received from SSR.

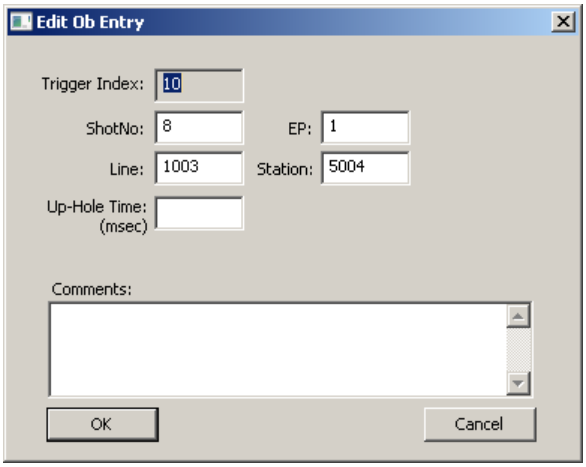
- **SSR GeoPhone Res:** the uphole geophone resistance information received from SSR.
- **SSR Res Status:** the uphole resistance status received from SSR.
- **DEC Recvd**: indicates if a valid GPS position was reported from decoder.
- **DEC Latitude**: shows the latitude position reported by decoder at the time the source is activated. This has valid information only if sources include a GPS system and they report their position through the encoder or navigation system.
- **DEC Longitude:** shows the longitude position reported by the decoder at the time the source is activated. This has valid information only if sources include a GPS system and they report their position through the encoder or navigation system.
- **DEC Altitude(m):** shows the elevation reported by the decoder at the time the source is activated. This has valid information only if sources include a GPS system and they report their position through the encoder or navigation system.

OB entries can be edited in this report by right-clicking on any particular entry. The following options are available:



- **VOID:** to mark the trigger as a void input.
- **Clear VOID:** to clear a previously marked VOID status.

- **Edit Entry…:** allows you to modify the data associated to the trigger:

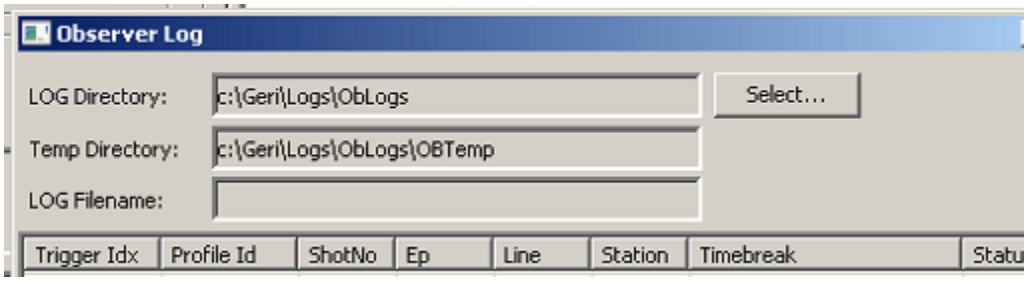


  - **Trigger Index**: shows the selected trigger index; this cannot be edited.
  - **ShotNo:** shows imported Shot Number; you can edit this value.
  - **EP:** shows the imported EP number; you can edit this value.
  - **Line:** shows imported Line Number; you can edit this value.
  - **Station:** shows imported actual Station Number; you can edit this value.
  - **Up-Hole Time (msec):** shows imported uphole time; you can edit this value.
  - **Comments:** you can add or modify a comment associated to the trigger.

OB entries are color coded:

- ***Brown*:** acquiring data after shot.
- ***No Color***: trigger is associated to line and stations, and reports a valid status; this is the normal condition.
- ***Violet***: no line and station number associated to the trigger.
- ***Yellow***: trigger was manually voided by user.
- ***Red*:** there is no trigger time; this is generated after an abort condition.
- ***Dark Blue*:** selected raw.

Log files are created in the selected LOG directory when ES Control program is closed properly. If for any circumstance triggers are not recorded in the report, they are available in the selected temporary directory and will be added to the report next time the program is opened and closed properly.



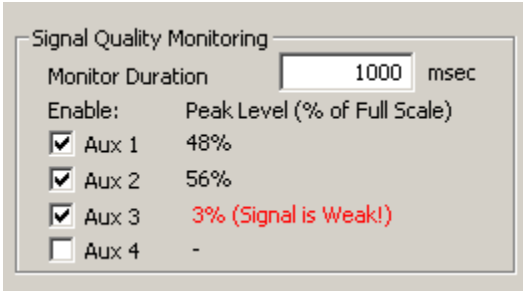
At the top of the Observer Log window, you can see the directories selected when **Device Manager** software was opened (see section 2.1). If there are no triggers available, you can change the LOG Directory by clicking the **Select…** button. If the **Append to filename** option was used, the name of the file is available in the **LOG Filename** field.

3.4 Evaluating auxiliary channels data

ES Control includes windows to evaluate performance of auxiliary channels when trigger events occur.

3.4.1 Signal Quality Monitoring

This option allows a quick evaluation of the maximum amplitude of auxiliary channels' input signal in percentage of full scale.



Parameters to select are:

- **Monitor Duration:** to select the length of time to be used to evaluate the analog input after the time break occurs.

  ***Note*:** If this time is greater than the acquisition length, you are not able to fire until this time expires.

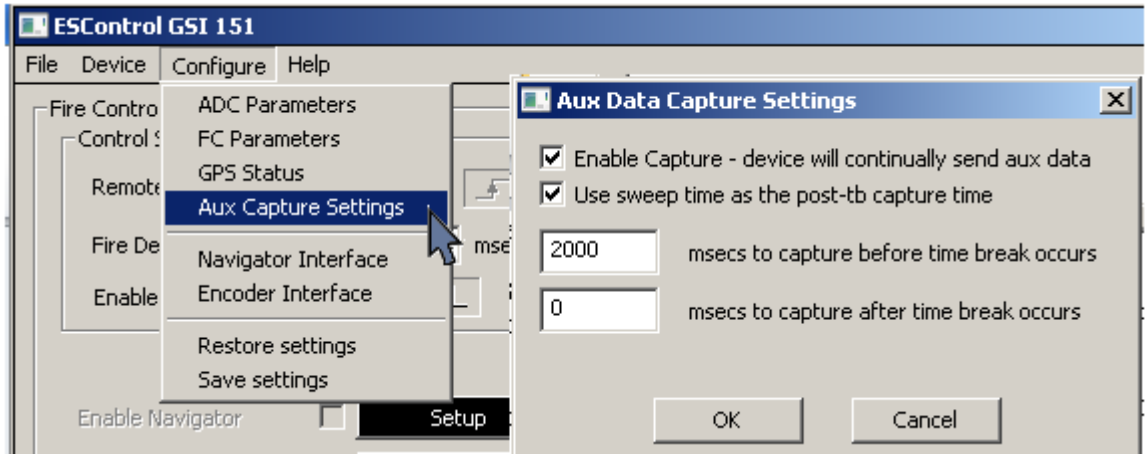
- **Enable:** available for auxiliary channels 1 through 4. Select only the auxiliary channels with valid input signal for the monitoring process.

After every trigger, peak level values of the data received on auxiliary channels in percentage of full scale are shown at the right side of selected channels. Full scale depends on the selected gain for each channel (see section 3.2.3). These values are shown in red font if amplitude is lower than 30% of their respective full scale.

3.4.2 Auxiliary Channels Capturing.

This tool provides a way to display auxiliary channels for reference use only.

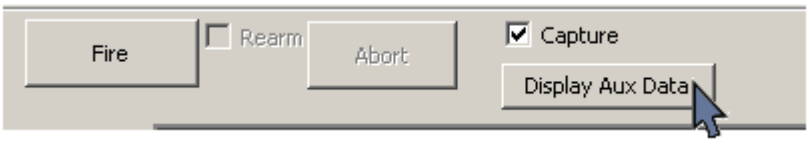
To set associated parameters, click **Configure > Aux Capture Settings**:



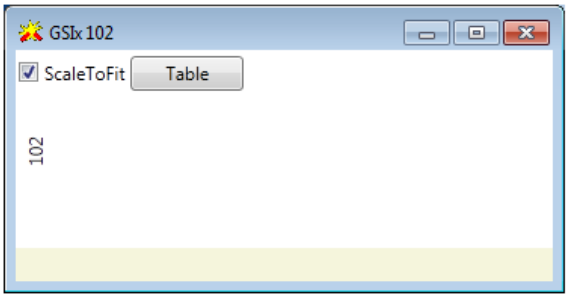
Set the following parameters:

- **Enable Capture:** to enable capturing auxiliary data from next trigger event.
- **Use sweep time as the post-tb capture time**: to show auxiliaries during the time specified in the acquisition length (section 3.3.4.1)
- **msecs to capture before time break occurs:** to select the number of milliseconds to show data before the trigger occurs.
- **msecs to capture after time break occurs**: to select the number of milliseconds to show data after the trigger occurs. This entry is ignored if **Use Sweep time as the post-tb capture time** was selected.

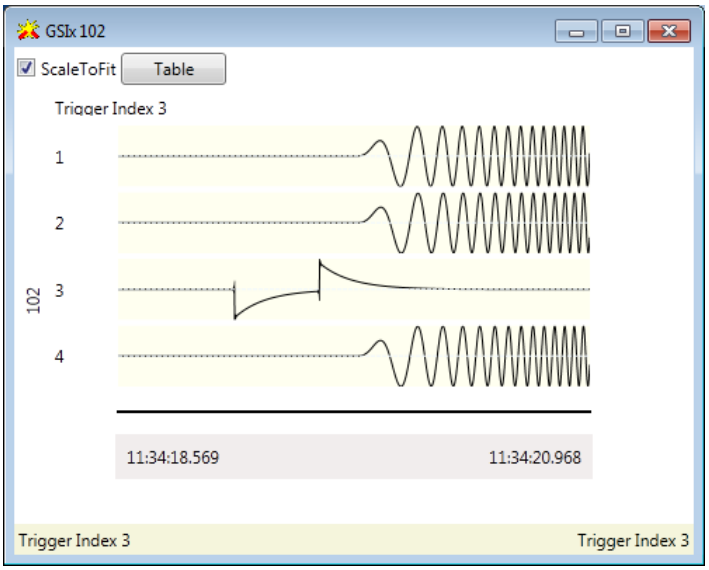
To view the auxiliary channels select the **Capture** option and click the **Display Aux Data** button:



The following window appears:

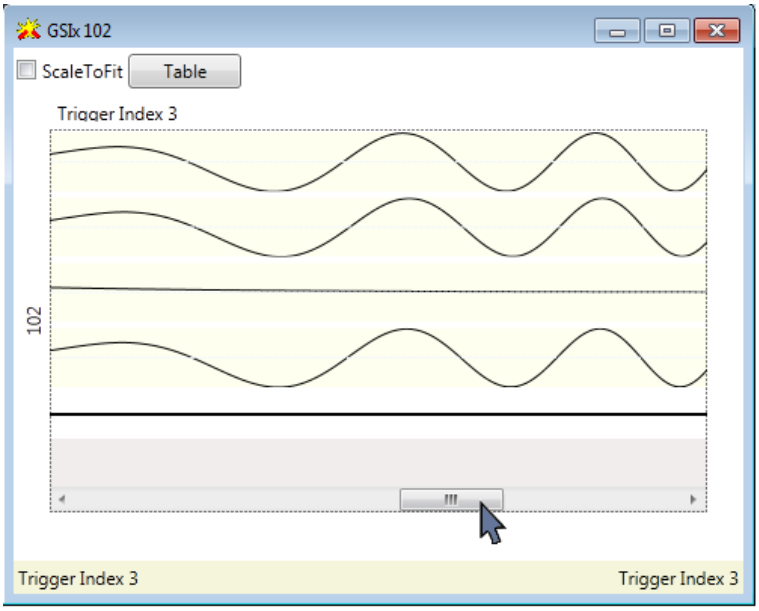


When a trigger is generated, the capture window shows the auxiliary channels during the time selected in **Aux Data Capture Settings** parameters.

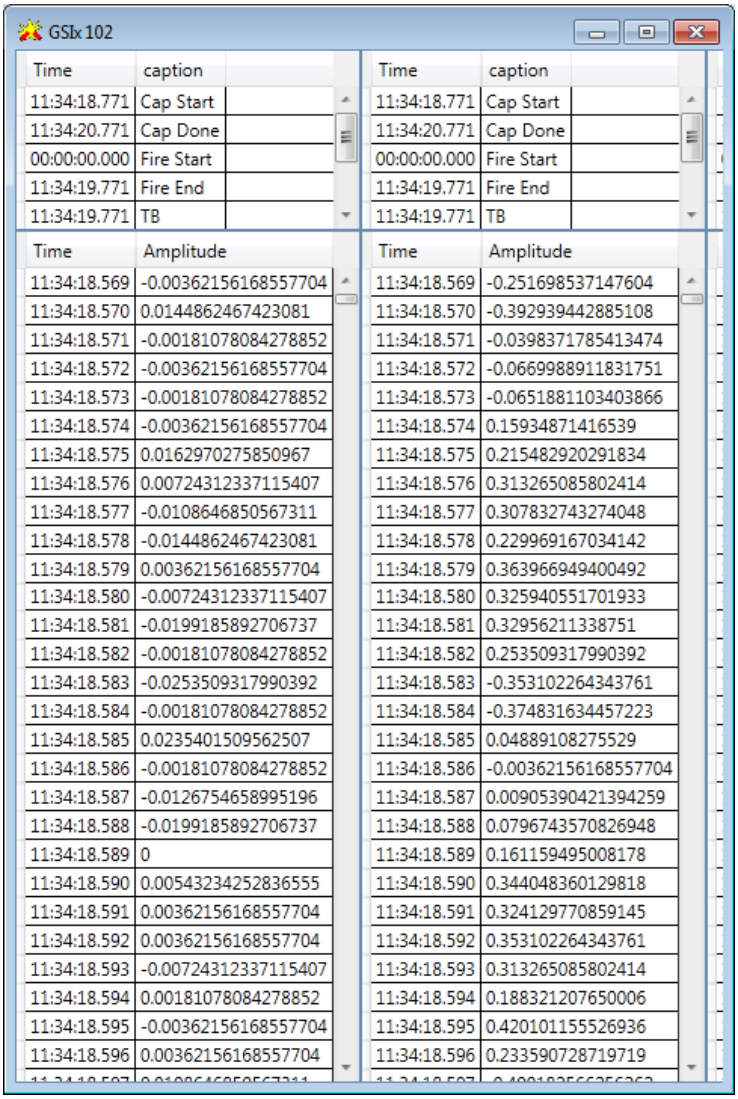


Plotting times are shown at the bottom of the view. They are not GPS synchronized and can vary depending on the acquisition.

The **ScaleToFit** option is selected by default and it compresses all samples to the size of the window. If it is deselected, the view expands and a scroll bar in the bottom allows selecting display time:



To view the numerical values of the samples, click the **Table** button:



Time	caption	Time	caption
11:34:18.771	Cap Start	11:34:18.771	Cap Start
11:34:20.771	Cap Done	11:34:20.771	Cap Done
00:00:00.000	Fire Start	00:00:00.000	Fire Start
11:34:19.771	Fire End	11:34:19.771	Fire End
11:34:19.771	TB	11:34:19.771	TB

Time	Amplitude	Time	Amplitude
11:34:18.569	-0.00362156168557704	11:34:18.569	-0.251698537147604
11:34:18.570	0.0144862467423081	11:34:18.570	-0.392939442885108
11:34:18.571	-0.00181078084278852	11:34:18.571	-0.0398371785413474
11:34:18.572	-0.00362156168557704	11:34:18.572	-0.0669988911831751
11:34:18.573	-0.00181078084278852	11:34:18.573	-0.0651881103403866
11:34:18.574	-0.00362156168557704	11:34:18.574	0.15934871416539
11:34:18.575	0.0162970275850967	11:34:18.575	0.215482920291834
11:34:18.576	0.00724312337115407	11:34:18.576	0.313265085802414
11:34:18.577	-0.0108646850567311	11:34:18.577	0.307832743274048
11:34:18.578	-0.0144862467423081	11:34:18.578	0.229969167034142
11:34:18.579	0.00362156168557704	11:34:18.579	0.363966949400492
11:34:18.580	-0.00724312337115407	11:34:18.580	0.325940551701933
11:34:18.581	-0.0199185892706737	11:34:18.581	0.32956211338751
11:34:18.582	-0.00181078084278852	11:34:18.582	0.253509317990392
11:34:18.583	-0.0253509317990392	11:34:18.583	-0.353102264343761
11:34:18.584	-0.00181078084278852	11:34:18.584	-0.374831634457223
11:34:18.585	0.0235401509562507	11:34:18.585	0.04889108275529
11:34:18.586	-0.00181078084278852	11:34:18.586	-0.00362156168557704
11:34:18.587	-0.0126754658995196	11:34:18.587	0.00905390421394259
11:34:18.588	-0.0199185892706737	11:34:18.588	0.0796743570826948
11:34:18.589	0	11:34:18.589	0.161159495008178
11:34:18.590	0.00543234252836555	11:34:18.590	0.344048360129818
11:34:18.591	0.00362156168557704	11:34:18.591	0.324129770859145
11:34:18.592	0.00362156168557704	11:34:18.592	0.353102264343761
11:34:18.593	-0.00724312337115407	11:34:18.593	0.313265085802414
11:34:18.594	0.00181078084278852	11:34:18.594	0.188321207650006
11:34:18.595	-0.00362156168557704	11:34:18.595	0.420101155526936
11:34:18.596	0.00362156168557704	11:34:18.596	0.233590728719719

When available, information in the upper side includes start and end timing for Cap and fire events.

4. Modes of Operation

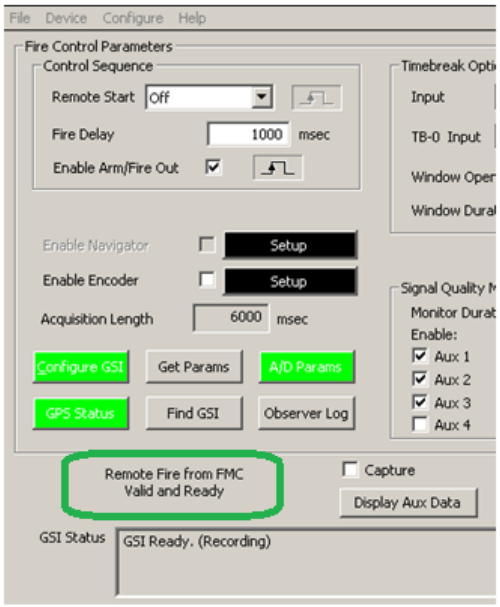
Seismic field operation related to sources can be classified as:

- ***Master*:** When the FMC or similar software associated to the ES Control commands the operation and/or the GSIx generated the Fire Command.
- ***Slave***: When ES Control only waits for the Timebreak signal to generate triggers.

4.1 Master Mode

In this mode, Remote Start is optional, but **Fire Out** and **Timebreak** options must be selected properly to synchronize the operation with the encoder. Geospace provides the FMC software to coordinate the shooting operation selecting the type of source, source driven, arming, and firing specific shot points.

When connection to FMC is established, ES Control no longer runs in standalone mode and the system shows the message: "**Remote Fire from FMC Valid and Ready**":



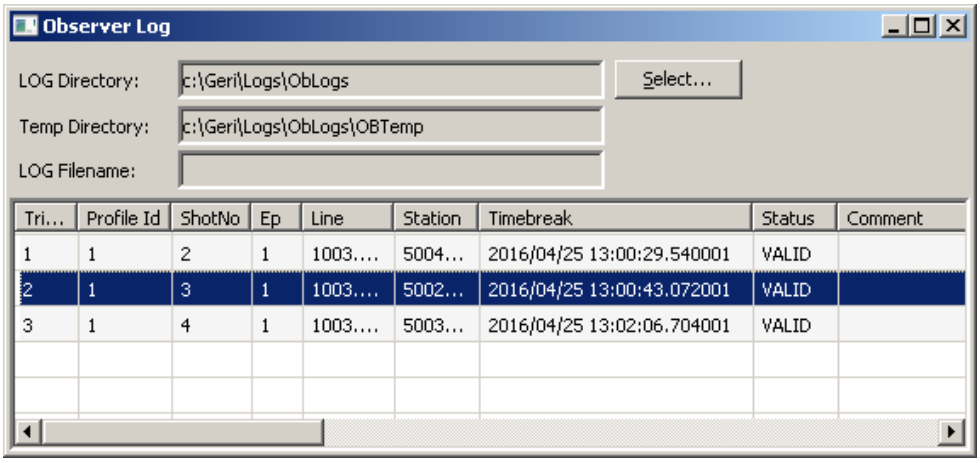
ES control operates upon instruction from FMC to command the GSIx in coordination with the source interface equipment.

The following parameters should be selected:

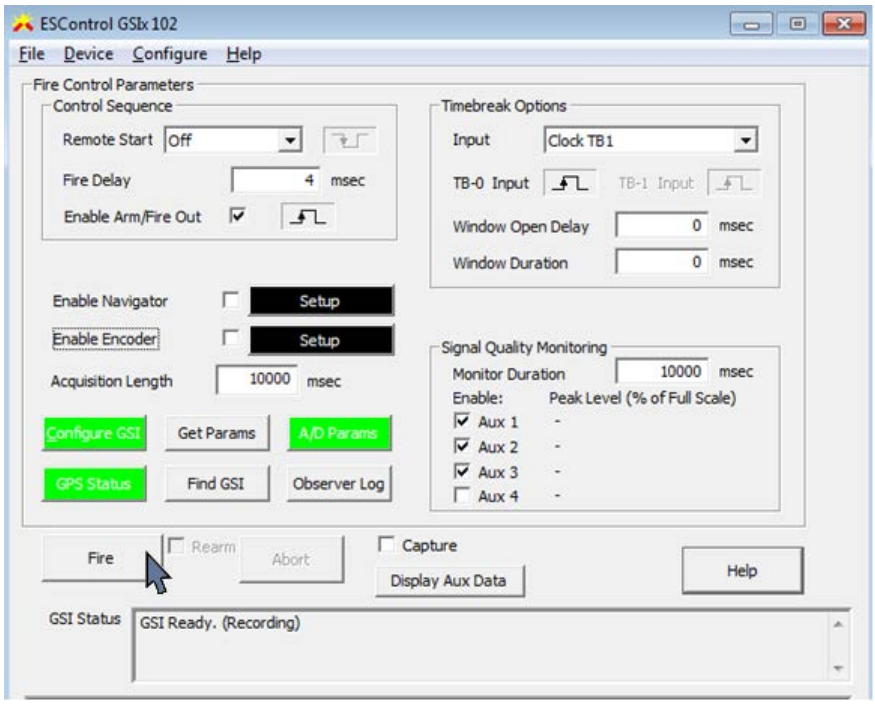
- **Remote control** (section 3.3.1.1): Its use is optional.
- **Fire Control** (section 3.3.1.2): Arm/Fire Out is enabled in master mode.
- **Time Break** (section 3.3.2): To set according to the type of and edge of signal selected as Timebreak.

- **Navigator/Encoder** (section 3.3.3): Enable communication whenever it is possible.

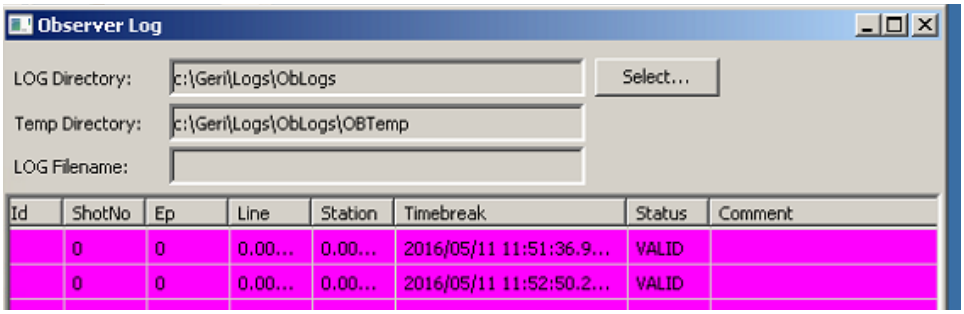
ES control operates upon instruction from FMC to command the GSIx in coordination with the source interface equipment. Once communication is established no further action is required from ES Control. It is good practice to keep open the Observer Logs to see triggers and proper association with their respective line-station point:



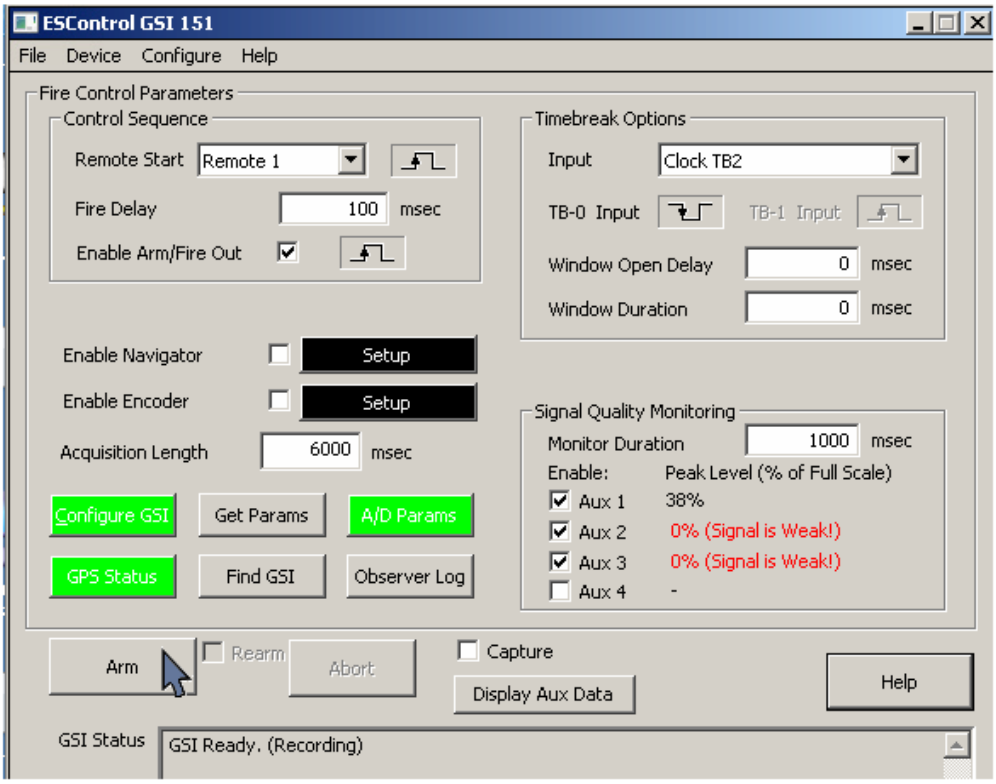
In case the ES Control is operating in standalone mode (mainly for test purposes), you must to click on the **Fire** button to start the shooting sequence:



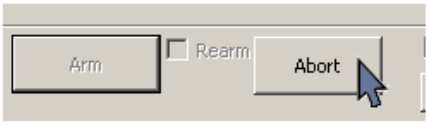
Logs will show error status because line-station points are not included:



If **Remote Start** is enabled, you must click the **Arm** button to enable ES Control to receive the remote command:



Click the **Abort** button if you want to cancel the current operation:



4.2 Slave Mode

In this mode **Remote Start** is optional, **Enable Arm/Fire Out** must be disabled, only proper **Timebreak** options should be selected. FMC software can be used in conjunction with ES Control to provide line-station information.

This mode can use GSIx or SDRx.

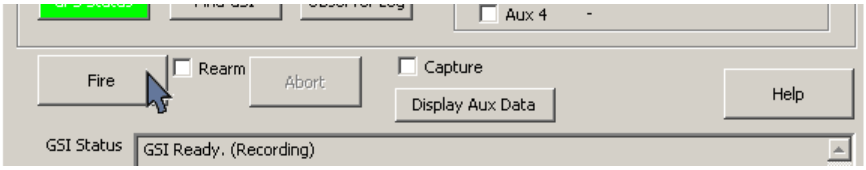
4.2.1 Using GSIx in Slave Mode

The following parameters should be selected:

- **Remote control** (section 3.3.1.1): Its use is optional.
- **Fire Control** (section 3.3.1.2): Arm/Fire Out disabled.
- **Time Break** (section 3.3.2): Select it in coordination with encoder.
- **Navigator/Encoder** (section 3.3.3): Enable communication whenever is possible.

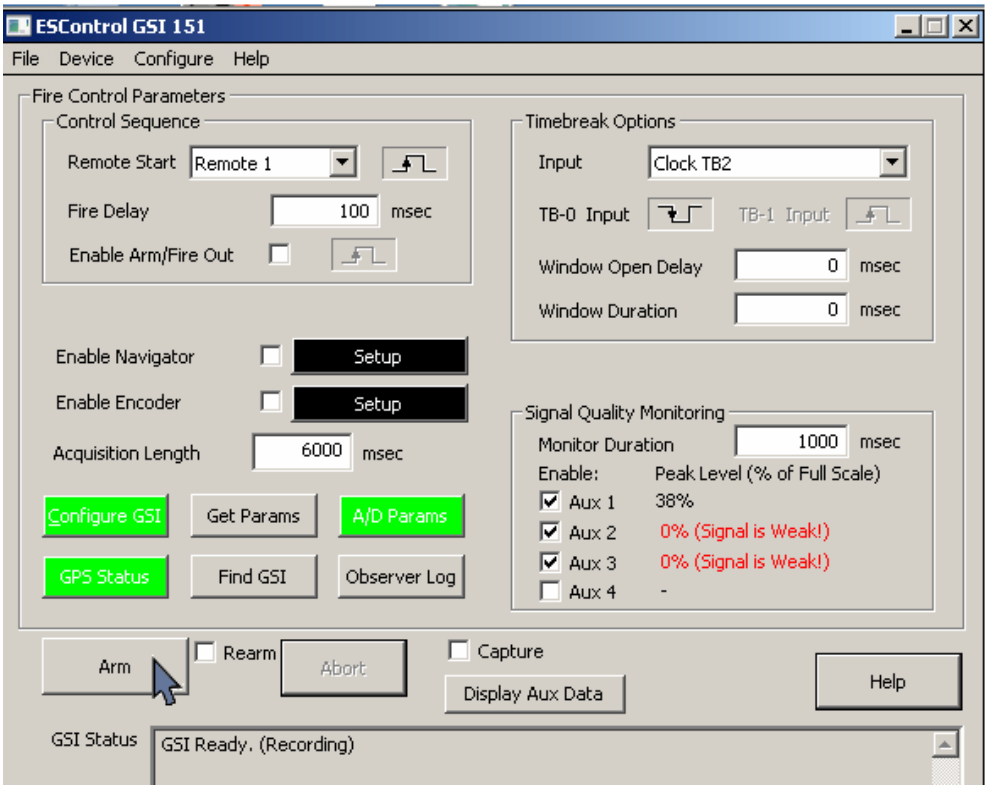
When ES control operates upon instruction from FMC, no further action is required.

If ES Control works in standalone mode, you must wait for the master system to be ready and then click the **Fire** button before the Fire Commands are generated:

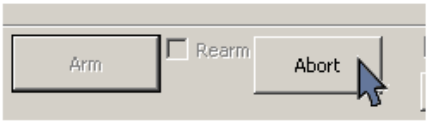


Select **Rearm (**available in slave standalone mode**),** at the right side of the Fire button, to keep the ES Control always armed and waiting for external Timebreak to generate triggers. It should be disabled before the last Timebreak event is generated. ES Control program cannot be closed properly if triggers are pending.

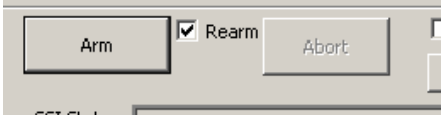
If **Remote Start** is enabled, you must click the **Arm** button to enable ES Control to receive the remote signal:



Click the **Abort** button if you want to cancel the current operation:



Select **Rearm (**available in slave standalone mode**)** at the right side of the Arm button to keep the ES Control always waiting for a remote start signal:



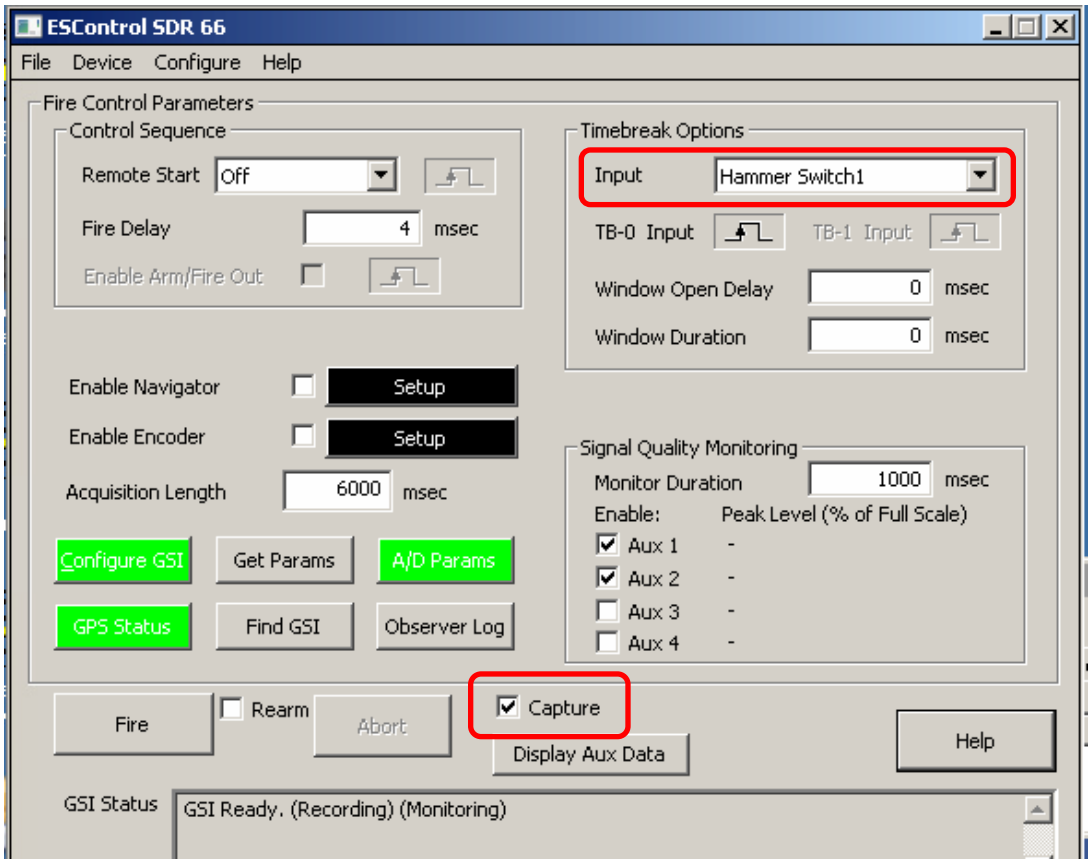
It should be disabled before the last Timebreak event is generated. ES Control program cannot be closed properly if triggers are pending.

4.2.2 Using SDRx

The Geospace Source Decoder Recorders (SDRx) are designed to be used in decoder units to get auxiliary data when a Timebreak is received, but there is a special mode that can be implemented to use them in conjunction with ES Control to generate triggers logs when a Timebreak signal is received in the Hammer switch 1 input.

To use this mode, the following parameters should be selected:

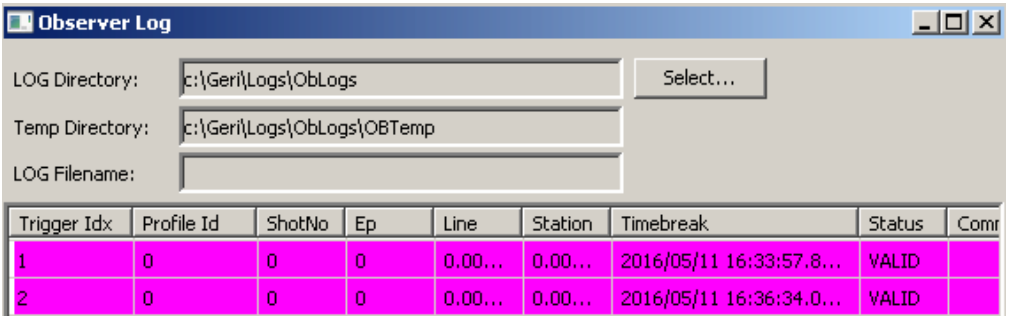
- **Remote Start** (section 3.3.1.1): Off
- **Fire Control** (section 3.3.1.2): Arm/Fire Out (not available)
- **Timebreak Options: Input**: Hammer Switch1 (select edge according the type of signal received from encoder).
- **Capture:** select this option to enable using SDRx in this mode:



If ES Control works in standalone mode, you must to wait for the master system to be ready and then click the **Fire** button before Fire signal is generated.

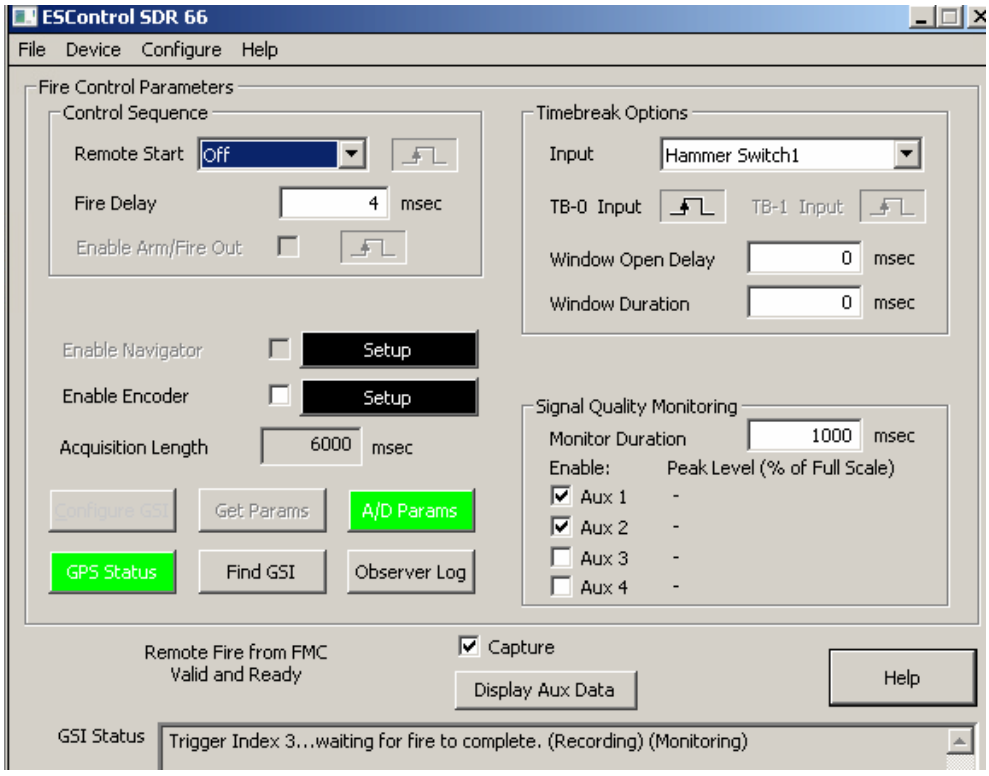
Select the **Rearm** option to the right of the Fire button to keep ES Control always armed and waiting for external Timebreak to generate triggers. This should be disabled before the last Timebreak event is generated.

Logs will show errors status because line-station points are not included, but they can be added manually to the report.



Every time a trigger is generated the SDRx beeps 3 times.

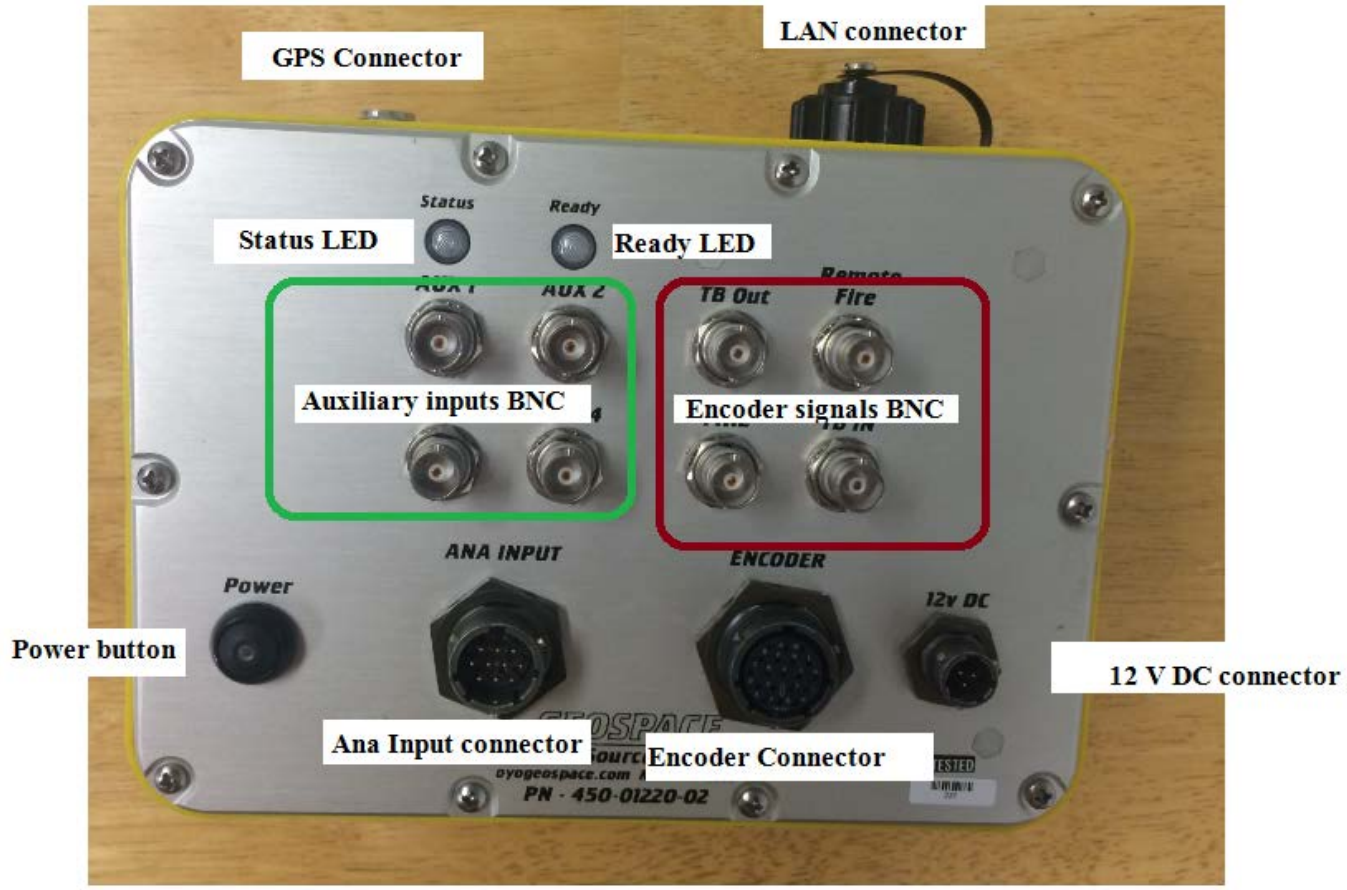
When ES control operates upon instruction from FMC, no further action is required. Logs include the line station associated to the trigger:



5. Appendix 1: GSIx (Geospace Source Interface)

The GSIx is the Geospace unit available to interface Encoders used to control the generation of seismic energy. It has four analog channels of 24-bit digitization, an integrated/high sensitivity GPS receiver, built-in test signal generator, a minimum of 4 GB per channel of internal non-volatile solid-state data storage, and a high speed LAN port.

It contains:



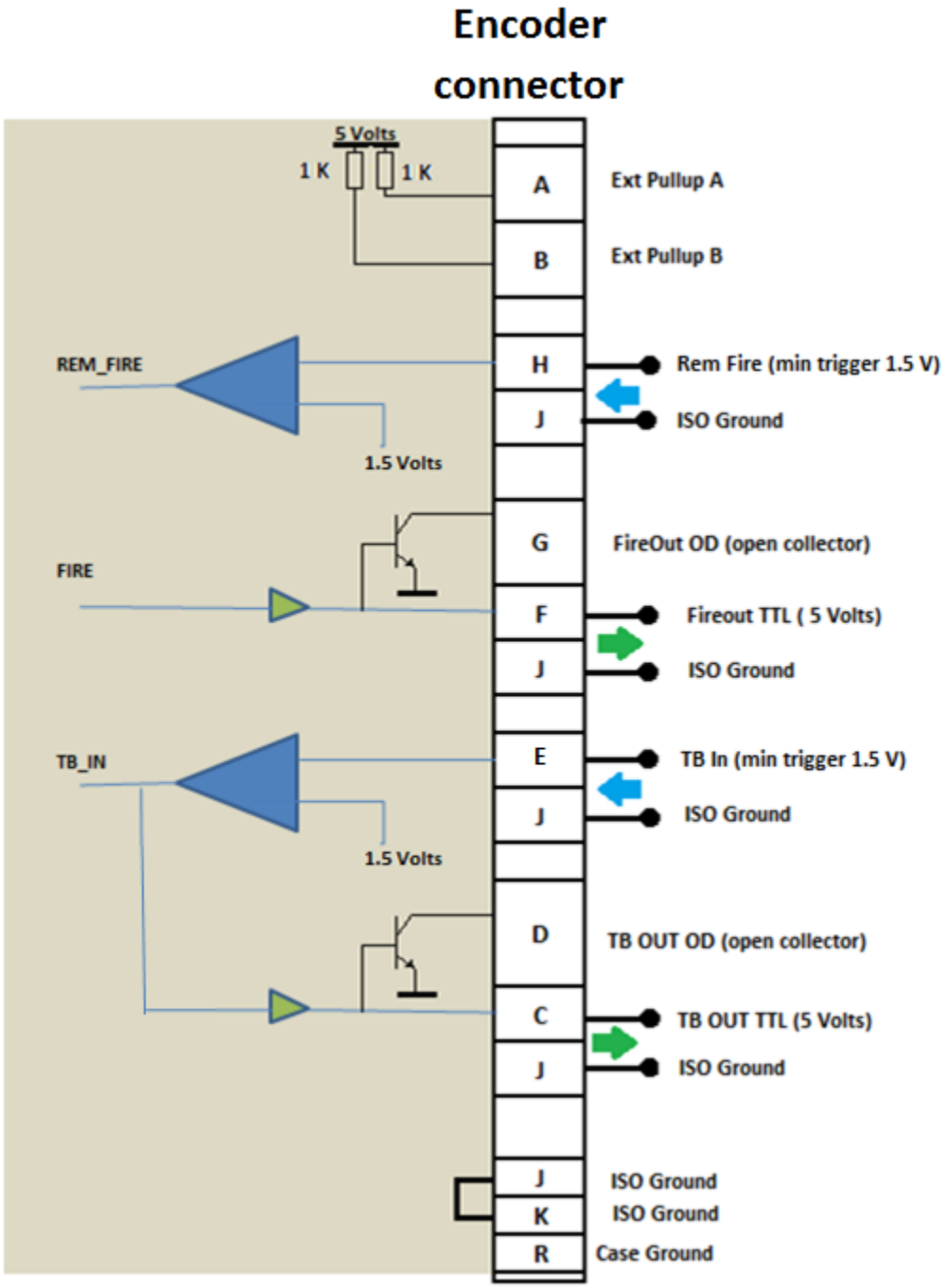
- **GPS Connector**: to connect a GPS antenna.
- **LAN connector:** Ethernet connection to ES Control computer.

- **12 V DC connector**: 12 Volts power:

POWER CONN Amphenol Part Number PT06E-8-3S	
A-	PWR IN+
B-	PWR IN-
C-	SPARE

- **Encoder Connector:** to connect to the Encoder:

Encoder Input DB-25 Female Amphenol Part Number PT06E-14-19S	
A-	EXT PULLUP A
B-	EXT PULLUP B
C-	TBOUT TTL
D-	TBOUT OD
E-	TBIN
F-	FIREOUT TTL
G-	FIREOUT OD
H-	REM FIRE
J-	ISOGRD
K-	ISOGRD
R-	CASE


Encoder
connector
5 Volts
1 K
1 K
A
Ext Pullup A
B
Ext Pullup B
REM_FIRE
H
Rem Fire (min trigger 1.5 V)
J
ISO Ground
1.5 Volts
G
FireOut OD (open collector)
FIRE
F
Fireout TTL (5 Volts)
J
ISO Ground
TB_IN
E
TB In (min trigger 1.5 V)
J
ISO Ground
1.5 Volts
D
TB OUT OD (open collector)
C
TB OUT TTL (5 Volts)
J
ISO Ground
J
ISO Ground
K
ISO Ground
R
Case Ground

- **Remote Fire BNC:** in parallel with REM FIRE Encoder input:

Remote Fire BNC	
Center pin	REM FIRE (H)
Barrel	ISOGRD (J)

- **Fire BNC:** in parallel with FIREOUT TTL Encoder output:

Fire BNC	
Center pin	FIRE OUT TTL (F)
Barrel	ISOGRD (J)

- **TB IN BNC**: In parallel with TBIN Encoder input:

TBIN BNC	
Center pin	TB IN (E)
Barrel	ISOGRD (J)

- **TB Out:** In parallel with TBOUT TTL Encoder output:

TBOUT BNC	
Center pin	TBOUT TTL (C)
Barrel	ISOGRD (J)

- **Ana Input connector**: to connect the Analog signals to the GSIx auxiliary channels:

Analog Input Connector	
A-	SEIS IN 1+
B-	SEIS IN 1-
C-	SEIS IN 2+
D-	SEIS IN 2-
G-	SEIS IN 3+
H-	SEIS IN 3-
J-	SEIS IN 4+
K-	SEIS IN 4-

- **Aux 1 BNC:** in parallel with Analog Input connector channel one (Differential signal):

Aux 1	
Center pin	SEIS IN 1+ (A)
Barrel	SEIS IN 1- (B)

- **Aux 2 BNC:** in parallel with Analog Input connector channel two (Differential signal):

Aux 2	
Center pin	SEIS IN 2+ (C)
Barrel	SEIS IN 2- (D)

- **Aux 3 BNC:** in parallel with Analog Input connector channel three (Differential signal):

Aux 3	
Center pin	SEIS IN 3+ (G)
Barrel	SEIS IN 3- (H)

- **Aux 4 BNC:** in parallel with Analog Input connector channel four (Differential signal):

Aux 4	
Center pin	SEIS IN 4+ (J)
Barrel	SEIS IN 4- (K)

- **Power button:** Press to power on the GSIx. A green LED shows status ON.

- **Status LED**:
  - **Blinks rapidly, 3 times per second:** GSIx is booting up or it did not connect to ES Control after power up.
  - **Blinks slowly, 1 every two seconds:** ES Control is connected to GSIx.
  - **Two quick flashes once per second:** GSIx got GPS lock, but it was disconnected from ES Control.

- **Ready LED**:
  - **On:** turns ON after first time GSIx is ready to operate.
  - **Blinks once:** when trigger is received.

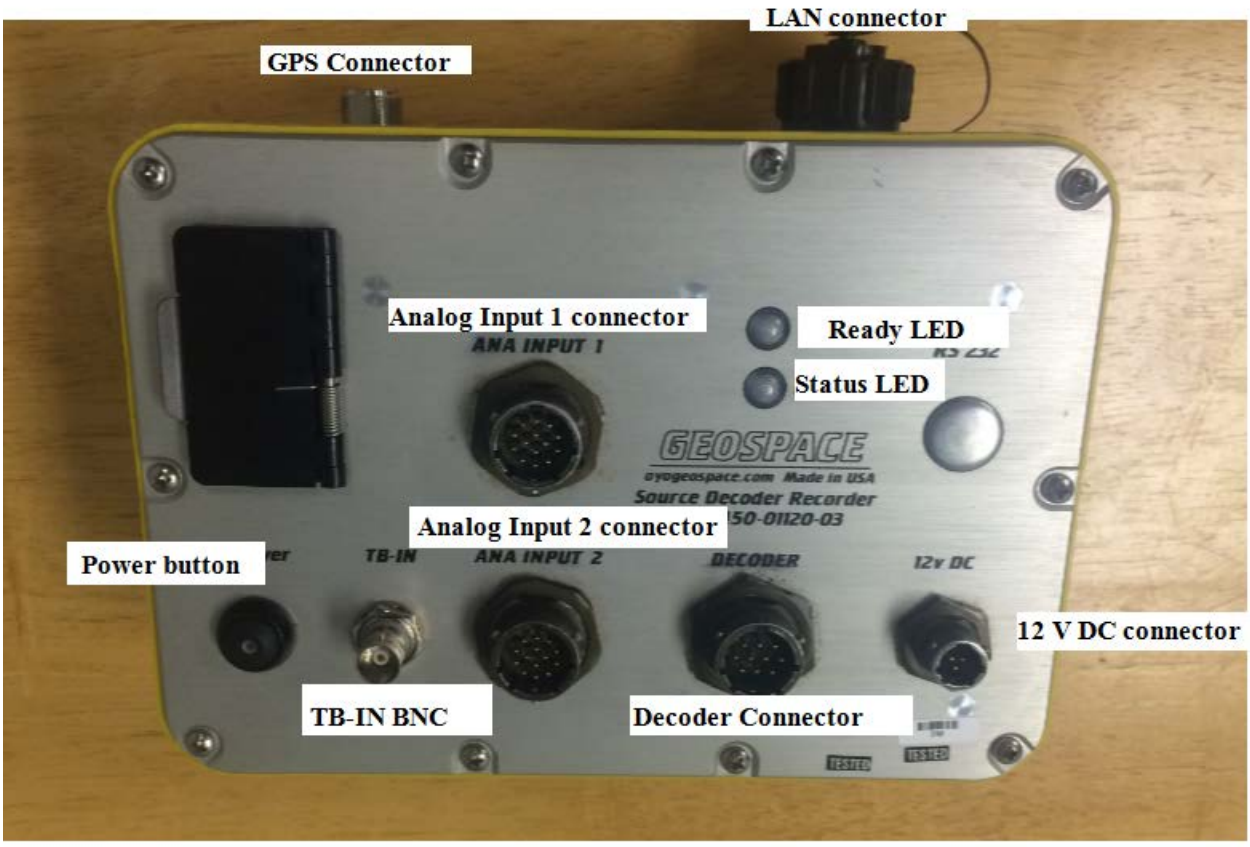
- **Buzzer:** Beeps twice when unit powers up.

6. Appendix 2: SDRx (Source Decoder Recorder)

The SDRx is the Geospace unit available to interface source interface decoders. It has the capability of recording source trigger event times and auxiliary data. It can record up to 15 days continuously. The SDRx delivers high resolution data and contains 4 channels with a 24-bit digitization, an integrated/high sensitivity GPS receiver, built-in test signal generator, a minimum of 4GB per channel (internal and external flash non-volatile solid-state data storage), and a high-speed LAN port. It records TBs, and actual position of each shot.

It uses internal non-volatile solid-state data storage (removable SD flash card in the front panel) and internal storage media.

It contains:



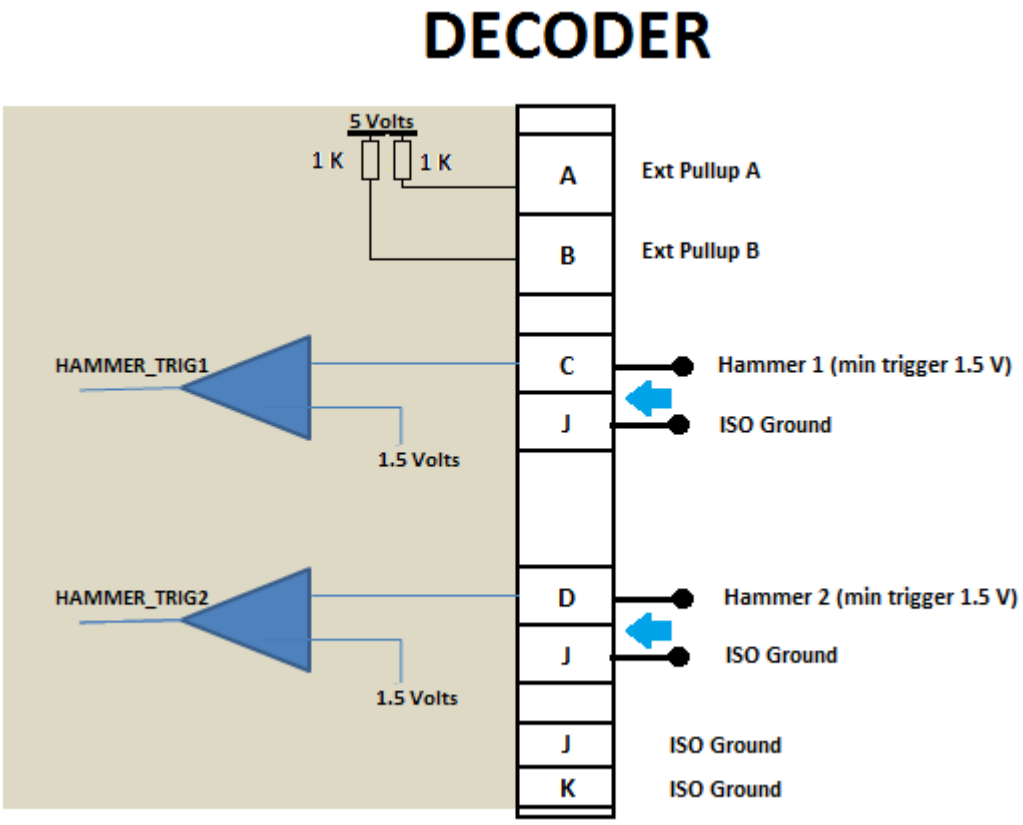
- **GPS Connector**: to connect a GPS antenna.
- **LAN connector:** Ethernet connection to ES Control computer.

- **12 V DC connector**: 12 Volts power:

POWER CONN Amphenol Part Number PT06E-8-3S	
A-	PWR IN+
B-	PWR IN-
C-	SPARE

- **Decoder Connector:** to connect to Decoder:

DECODER	
A	EXT PULLUP A
B	EXT PULLUP B
C	HAMMER1
D	HAMMER2
E	N/C
F	N/C
G	PUSH BUTTON
H	PROXIMITY
J	ISO GROUND
K	ISO GROUND



- **TB-IN BNC:** In parallel with TBIN Decoder input:

TB-IN BNC	
Center pin	HAMMER 1 (C)
Barrel	ISO Ground (J)

- **Analog Input 1 connector:** To connect auxiliary channels:

Analog Input 1	
Pin A:	Analog Input Channel 1+
Pin B:	Analog Input Channel 1–
Pin C:	Analog Input Channel 2+
Pin D:	Analog Input Channel 2–
Pin E:	Analog Input Channel 3+
Pin F:	Analog Input Channel 3–
Pin H:	Analog Input Channel 4+
Pin J:	Analog Input Channel 4–
Pin K:	No connect
Pin L:	No connect
Pin M:	Case Ground
Pin N:	Case Ground
Pin P:	No connect
Pin R:	No connect

- **Analog Input 2 connector:** In parallel with Analog input 1.

- **Power button:** Press to power on the SDRx. A green LED shows status ON.

- **Status LED**:
  - **Blinks rapidly, 3 times per second:** SDRx is booting up.
  - **Blinks slowly, 1 per second:** SDRx is acquiring GPS fix or connected to ES Control.
  - **Two quick flashes once per second:** SDRx got GPS lock and unit is ready to operate.

- **Ready LED**:
  - **Off:** Unit is booting up. If SDRx is connected to ES Control, the LED is off until **Capture** is selected.
  - **Steady ON**: SDRx is ready to operate (GPS signal locked).
  - **Blinks continuously twice per second**: SDRx flash card is not available.
  - **3 short blinks:** Timebreak is detected.

- **Buzzer**:
  - **Beeps one second**: SDRx is ready to operate after power up.
  - **1 short beep**: the flash card is removed or when the inserted card serial number matches the SDRx.
  - **4 long beeps**: Flash card has a different serial number than SDRx.
  - **Continuously:** GPS error, unit is not recording. When unit is using ES Control and any selected monitored signal amplitude is less than 30% full scale.
  - **Beeps 3 times:** Timebreak is detected.